Data for Self-Assessment and External Review

Individual Member

January 10-11, 2013

The University of Tokyo

Department of Earth and Planetary Science

Graduate School of Science

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Contents

Member List

Member List (as of January, 1, 2013)

Name	Rank	Specialty
Atmospheric and Oceanic Science Group		
SATO, Kaoru	P	Atmospheric Dynamics, Middle Atmosphere Sciences
HIBIYA, Toshiyuki	P	Ocean Dynamics
KOIKE, Makoto	AP	Atmospheric Environmental Science
TOZUKA, Tomoki	AP	Physical Oceanography, Climate Dynamics
MIYRA, Hiroaki	AP	Atmospheric Dynamics, Tropical Dynamics, Atmospheric modeling
TANAKA, Yuki	RA	Dynamical Oceanography, Physics in Marginal Seas, Mixing Processes in Straits
NIWA, Yoshihiro	PAP	Physical Oceanography
OETTLI, Pascal	PRA	Climate Dynamics
YAMAGATA, Toshio	EP	Ocean-Atmosphere Coupled Dynamics, Large-scale Ocean Dynamics, Geophysical Fluid Dynamics
Space and Planetary Science Group		
NAOJI, Sugiura	P	Planetary Science, Meteoritics
HOSHINO, Masahiro	P	Space Physics
MIYAMOTO, Masamichi	P	Planetary Material Science
IWAGAMI, Naomoto	AP	Optical Remote Sensing of Planetary atmospheres
HIYAGON, Hajime	AP	Planetary Science, Isotope Cosmochemistry, Meteoritics
MIKOUCHI, Takashi	AP	Planetary Science, Mineralogy, Meteoritics
YOKOYAMA, Takaaki	AP	Solar and Astrophysical Plasma Physics
YOSHIKAWA, Ichiro	AP	Planetary Airglow
AMANO, Takanobu	RA	Space Physics
MIURA, Akira	RA	Space Plasma Physics
YAMAMOTO, Takashi	RA	Solar-Terrestrial Physics

Earth and Planetary System Science Group

KAYANNE, Hajime	P	Earth System Science (coral reef, coast, carbon cycle, global change, paleoenvironment)
KONDO, Yutaka	P	Global Atmospheric Environment
TADA, Ryuji	P	Earth System Dynamics, Paleooceanography, Paleoclimatology, Sedimentology
NAGAHARA, Hiroko	P	Planetary Science
ABE, Yutaka	AP	Planetary System Physics (planetary evolution, planetary atmosphere, planetary climate)
IKOMA, Masahiro	AP	Theoretical Planetology, Exoplanetology
KAWAHARA, Hajime	RA	Exoplanetology
TAKAHASHI, Satoshi	RA	Palaeontology, Geochemistry
GENDA, Hidenori	PRA	Theoretical Planetary Science
MOTEKI, Nobuhiro	PRA	Atmospheric Material Science, Atmospheric Dynamics
MATSUI, Hitoshi	PRA	Atmospheric Chemistry, Atmospheric Environmental Science

Solid Earth Science Group

Kazuhito Ozawa	P	Petrology
KIMURA, Gaku	P	Tectonics and Structural Geology
GELLER, Robert	P	Seismology
IKEDA, Yasutaka	AP	Tectonic Geomorphology, Active tectonics
IDE, Satoshi	AP	Earthquake Source Physics
FUNAMORI, Nobumasa	AP	High-Pressure Mineral Physics
IIZUKA, Tsuyoshi	L	Geochemistry and Cosmochemistry
TANAKA, Hidemi	L	Material Seismology, Structural Geology
SAKURABA, Ataru	RA	Geodynamics, Planetary Dynamos, Geomagnetism
SHIMIZU, Ichiko	RA	Structural Geology, Rock Rheology
NAMIKI, Atsuko	RA	Geodynamics, Physical Volcanology
KAMEDA, Jun	PRA	Mineralogy, Structural Geology

SUZUKI, Takehito	PRA	Earthquake Source Physics

Geosphere and Biosphere Science Group

URABE, Tetsuro	P	Chemical Geology, Economic Geology, Hydrothermal Activity, Deep Biosphere
ENDO, Kazuyoshi	P	Molecular Palaeontology, Skeletogenesis
MURAKAMI, Takashi	P	Environmental Mineralogy
KOGURE, Toshihiro	AP	Mineralogy, Material Science, Electron Microscopy, Crystallography
SUZUKI, Yohey	AP	Geomicrobiology, Geochemistry, Nanomineralogy
TSUIHIJI, Takanobu	L	Vertebrate Paleontology, Vertebrate Comparative Morphology
OGIHARA, Shigenori	RA	Organic Geochemistry
SUNAMURA, Michinari	RA	Geomicrobiology, Microbial Ecology
TANABE, Kazushige	EP	Evolutional Paleontology, Paleoecology

P: Professor, AP: Associate Professor, L: Lecturer, RA: Assistant Professor/ Research Associate, PAP; Project Associate Professor, PRA: Project Assistant Professor/ Project Research Associate, EP: Emeritus Professor retired on Mar. 31, 2012

Atmospheric and Oceanic Science Group

Kaoru Sato

I. C.V.

Name： Kaoru Sato
Present Position: Professor, The University of Tokyo, Graduate School of Science

Education
B.S. (Geophysics), The University of Tokyo, March 1984
M.S. (Geophysics), The University of Tokyo, March 1986
Ph.D. (Geophysics), Kyoto University, March 1991

Professional Experience
April, 1986-June, 1987, Opto-Electronics Research Laboratories, NEC Corporation
April, 1991-March, 1993, JSPS Research Fellow (PD), Graduate School of Science, Kyoto University
July 1993-March, 1995, Research Associate, Center for Climate System Research, The University of Tokyo
April, 1995-November, 1999, Assistant Professor, Graduate School of Science, Kyoto University
December, 1999-September, 2005, Associate Professor, National Institute of Polar Research
October, 2005-, Professor, Graduate School of Science, The University of Tokyo

July, 1995-August, 2001, Visiting Scientist, NorthWest Research Associates, U.S. A.
November, 2002-March, 2004, Wintering Member, The 44th Japanese Antarctic Research Expedition
October, 2005-March, 2006; April, 2010-March, 2013, Visiting Professor, National Institute of Polar Research

II. Scientific Research Activity

2. Major achievements

A. Middle atmosphere dynamics using a high-resolution general circulation model (GCM)

This is a group study by six members including four young scientists who graduated from different universities. We performed simulations using a newly developed gravity-wave resolving high-resolution GCM which covers from the ground to the upper mesosphere. By analyzing the hourly outputs over three model years from the simulation as surrogate of the real atmosphere, various fundamental topics were examined: 1. Contribution of respective waves to the momentum budget in the middle atmosphere in each season. 2. Driving mechanism and longitudinal dependence of the quasi-biennial oscillation (QBO). Contribution of respective equatorial waves and internal gravity waves, and meridional circulation were discussed. 3. Formation and maintenance mechanisms of the stratopause and tropopause. 4. Dynamics of formation and dissipation processes of the stratospheric sudden warming in terms of wave forcing and diabatic heating. 5. Three dimensional propagation of gravity waves and its importance on the momentum budget in the middle atmosphere. Ten papers have been published. The first paper was selected as an editor's highlight; two are given Young-Scientist award by Meteorological Society of Japan (MSJ) in 2011 and 2012. Seven invited talks in the

international conference have been made.

B. Direct and indirect effects of atmospheric gravity waves in the climate system

This is a group study in KS's laboratory including graduate students and two visiting scientists. Gravity waves (GW) play two kinds of roles in the earth climate. One is a direct effect in which GW propagate momentum vertically to maintain and/or drive the zonal jets and meridional circulation in the middle and high latitudes and to drive the QBO. The other is an indirect effect in which GW temperature fluctuations modify the amounts of polar stratospheric and mesospheric clouds (PSC/ PMC) related to ozone chemistry and radiation. These effects were examined by using data from high-resolution GCM simulation, high-resolution satellite observation, and chemistry climate model projection: 1. Leeward propagation in three dimensional (3-d) flow of GW originating from the Southern Andes and Antarctic Peninsula. 2. Quantitative estimation of modification of PSC by respective waves including GW. 3. Contribution of GW to the Brewer-Dobson circulation and its trend. 4. Spectral characteristics of surface meteorological parameters in a wide frequency range from $(2\ h)^{-1}$ to $(20\ y)^{-1}$. Moreover, 5. a unified theory describing of 3-d wave activity flux and residual mean flow that is applicable to both gravity waves and Rossby waves was developed. Seven papers have been published, four papers have been submitted, and three papers are in preparation. A graduate student (T. Kinoshita) gave an invited talk on Topic 5 (PhD thesis) in MSJ 2012 spring meeting. One paper was given JMSJ award. Another graduate student (K. Okamoto) was given Student Outstanding Presentation Award, Japan Geoscience Union (JpGU) Meeting in 2012.

C. Program of the Antarctic Syowa MST/IS radar (PANSY)

This is a big project to perform atmospheric sciences by using the first Antarctic MST/IS radar that is constructed and operated at Syowa Station, in collaboration with 19 universities and institutes in Japan with a core of U Tokyo, National Institute of Polar Research and Kyoto U. KS has been working as the leader. The project started in 2000. By using a JSPS grant, an international workshop was held in 2002 in which Prof. M. Geller and R. A. Vincent, senior scientists of this research field were invited. Scientific topics and technological problems to be overcome were clarified. After that, vigorous efforts on technological development were made including high-efficiency TR modules suitable to the limited power condition in the Antarctic, and light and tough antenna against extremely cold and windy weather condition. Moreover, feasibility study and environmental tests of each piece of the equipment were accumulated. Relevance of Syowa Station as a typical location to observe Antarctic atmosphere was confirmed by analyzing radiosonde data at 12 stations over 10 years. Wintering members were sent to Syowa Station in two years (KS herself wintered in 2003), performed intensive radiosonde observation in 2002 and ozonesonde network observation of the Antarctic ozone hole in collaboration with 9 stations in 2003, and confirmed scientific significance of the PANSY radar. Moreover, discussion from both science and technological viewpoints were continuously made by organizing a small workshop once a year, two symposiums and two special sessions in MSJ, one union session in JpGU, one special session in SGEPSS. Resolution and recommendation from five related international organizations (IUGG, URSI, SCAR, SCOSTEP, and SPARC) were obtained. Through these activities, the PANSY project was accepted as one of main activities in Japanese Antarctic Research Expedition in 2008 and the radar was funded by government in 2009. The radar construction started in 2010 and obtained the 1st data in 2011. Continuous measurements of the troposphere and stratosphere started in May 2012 with the quarter radar system.

3. Five Important Papers in your career

1. Watanabe, S., Y. Kawatani, Y. Tomikawa, K. Miyazaki, M. Takahashi, and K. Sato (2008), General aspects of a T213L256 middle atmosphere general circulation model, J. Geophys. Res., 113, D12110, doi:10.1029/2008JD010026. (Editors' Highlight, Times Cited: 38).
2. Yoshiki, M., and K. Sato, A statistical study of gravity waves in the polar regions based on operational radiosonde data. J. Geophys. Res., 105, 17995-18011, 2000 (Times Cited, 52)
3. Sato, K., T. Kumakura, and M. Takahashi, Gravity waves appearing in a high-resolution GCM simulation. J. Atmos. Sci., 56, No.8, 1005-1018, 1999. (Times Cited, 62)
4. Sato K., A statistical study of the structure, saturation and sources of inertio-gravity waves in the lower stratosphere observed with the MU radar (1994), J. Atmos. Terr. Phys., 56, 755-774. (Times Cited: 100).
5. Sato, K., and T. J. Dunkerton (1997), Estimates of momentum flux associated with equatorial Kelvin and gravity waves, J. Geophys. Res., 102, 26,247-26,261. (Times Cited: 87).

4. Awards and Honors throughout your career

- Yamamoto-Syono Award for Outstanding Papers, The Meteorological Society of Japan, 1991
- The Award of the Meteorological Society of Japan, The Meteorological Society of Japan, 1998
- The JMSJ Award, the Meteorological Society of Japan, 2010

5. Future Research Plan

A. High-resolution atmospheric dynamics

Continuous development of ground-based and space-born observation and super computer techniques, the gravity waves, which were small-scale internal waves of the atmosphere, treated as meteorological noise before early 1980's and as physical parameter in 1990's and 2000's, currently become "resolved" waves. This means that gravity waves are now on an equal footing with Rossby waves in atmospheric dynamics. Recent studies indicate that dynamics of the middle atmosphere (i.e., stratosphere, mesosphere and lower thermosphere) including atmospheric waves affects surface meteorology. For example, high-top models (the top is the upper mesosphere) are needed to simulate realistic response of the sea level pressure in the Arctic to the El Nino event. The features of global warming projection are largely different between low-top (the top is the middle of the stratosphere) and high-top model simulations. One of the most plausible processes to explain this fact is the momentum budget including gravity waves that are usually included by parameterizations.

In our group, the studies on gravity waves and other small-scale phenomena, and their interaction with large-scale fields have been continued. Using gravity wave resolving GCM simulation, stratopause structure and momentum budget of the mesosphere will be examined in terms of seasonal and intraseasonal variations. Further simulations will be made using SST at El Nino and La Nina events as boundary condition for exploring possible year-to-year variation. Moreover, using recently derived formulas describing 3-d quasi-Lagrangian flow and wave activity fluxes, three dimensional structure of global circulation will be examined. The analysis using climate data will be also made to study year-to-year variation and long-term trend.

High-resolution observation data such as from the PANSY radar will be also analyzed for model validation.

B. Program of the Antarctic Syowa MST/IS radar (PANSY)

In next several tens of years, the Earth's climate will certainly change along with ozone layer recovery and increase in greenhouse gas concentration. The polar regions play an important role in the Earth's climate system. They are the exit regions of the material circulation in the stratosphere, and the entry (exit) regions during the summer-time (winter-time) in the mesosphere. This material circulation is essentially wave-driven and maintains a thermal structure of the middle atmosphere far from that expected by radiative balance. The resulting low temperatures in the summer upper mesosphere and winter lower stratosphere lead to conditions under which polar mesospheric clouds (PMC) and polar stratospheric clouds (PSC) can form, respectively. The PSCs serve as an environment for producing the conditions that can lead to catalytic destruction of ozone during Antarctic spring, forming the ozone hole. PMCs are a phenomenon that was first reported late in the 19th century and were considered to have appeared due to the changing climate, after the Industrial Revolution. Moreover, the polar atmosphere is different from lower latitude regions because of possible strong energy inputs from geospace due to the orientation of the Earth's magnetic field lines, which are directly connected to the plasma sheet there. Despite the importance of the southern polar atmosphere, observational studies have thus far been restricted due to the harsh physical conditions on the Antarctic continent.

In order to address this deficiency, to explore the physics of these unique phenomena, and to study the quantitative effects of the polar atmosphere on the Earth's climate, we will complete the setup of the full PANSY radar system and start continuous operation to observe three dimensional winds with fine time and height resolution in the troposphere, stratosphere and mesosphere, and plasma parameters in the ionosphere in 2013. The purpose of this program is to deepen the quantitative understanding of the polar atmosphere as a module of the Earth's climate, and to elucidate the connection of the whole atmosphere and mechanism of global circulation of minor constituents such as ozone. A comprehensive study of the polar atmosphere will be made in combination with various observations including pre-existing instruments at Syowa Station, global MST/IS radar network, and satellites, and various high-resolution numerical models covering the atmospheric regions from the boundary layer to the ionosphere, in addition to the PANSY radar. Graduate students will also join the studies with basic research topics.

6. Funding Received

(1) JSPS Grants

- Grant-in-Aid for Scientific Research (C) Dynamics of the Antarctic ozone hole, FY2006, 1,500,000JPY
- Grant-in-Aid for Scientific Research (A) A study of middle atmosphere dynamics using high-resolution general circulation model, FY2007-2009, 34,300,000JPY
- Grant-in-Aid for Scientific Research (B) A study of direct and indirect effects of atmospheric gravity waves in the climate system, FY2010-2011, 10,100,000JPY

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

· The Meteorological Society of Japan, Grant-in-Aid for Scientific Research,. 1,992,386JPY

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Gavrilov, N. M., S. Fukao, H. Hashiguchi, K. Kita, K. Sato, Y. Tomikawa, and M. Fujiwara (2006), Combined MU radar and ozonesonde measurements of turbulence and ozone fluxes in the tropo-stratosphere over Shigaraki, Japan, Geophys. Res. Let. 33, L09803.
2. Sugita, T., H. Nakajima, T. Yokota, H. Kanzawa, H. Gernandt, A. Herber, P. von der Gathen, G. Konig-Langlo, K. Sato, V. Dorokhov, V. Yushkov, Y. Murayama, M. Yamamori, S. Godin-Beekmann, F. Goutail, H. Roscoe, T. Deshler, M. Yela, P. Taalas, E. Kyro, S. Oltmans, B. Johnson, M. Allaart, Z. Litynska, A. Klekociuk, S. B. Andersen, G. Braathen, H. D. Backer, C. Randall, R. Bevilacqua, G. Taha, L. Thomason, H. Irie, M. Ejiri, N. Saitoh, T. Tanaka, Y. Terao, H. Kobayashi, and Y. Sasano (2006), Ozone profiles in the high-latitude stratosphere and lower mesosphere measured by the Improved Limb Atmospheric Spectrometer (ILAS)-II: Comparison with other satellite sensors and ozonesondes, J. Geophys. Res. 111, D11S02.
3. Yamamori, M. and K. Sato (2006), Characteristics of inertia gravity waves over the South Pacific as revealed by radiosonde observations, J. Geophys. Res. 111, D16110.
4. Watanabe, S., K. Sato, and M. Takahashi (2006), A GCM study of orographic gravity waves over Antarctica excited by katabatic winds, J. Geophys. Res. 111, D18104.
5. Tomikawa, Y., M. Yoshiki, and K. Sato (2006), A neutral wave observed in the Antarctic polar vortex, J. Met. Soc. Japan 84 97-113.
6. Tomikawa, Y., K. Sato, and T. G. Shepherd (2006), A diagnostic study of waves on the tropopause, J. Atmos. Sci. 63 3315-3332.
7. Ogino, S., K. Sato, M. D. Yamanaka, and A. Watanabe (2006), Lower-stratospheric and upper-tropospheric disturbances observed by radiosondes over Thailand during January 2000, J. Atmos. Sci. 63 3437-3447.
8. (in Japanese) M. Yoshiki, N. Kizu, and K. Sato (2006), A Comparison of Vaisala RS80-15GH and Meisei RS2-91 Radiosonde Data Based on Simultaneous Observations at Syowa Station, TENKI, 53 123-133.
9. Sato, K. and N. Hirasawa (2007), Statistics of Antarctic surface meteorology based on hourly data in 1957-2007 at Syowa Station, Polar Sci. 1 1-15.
10. Luce, H., G. Hassenpflug, M. Yamamoto, S. Fukao, and K. Sato (2008), High-Resolution Observations with MU Radar of a KH Instability Triggered by an Inertia-Gravity Wave in the Upper Part of a Jet Stream, J. Atmos. Sci. 65 1711-1718.
11. Sato, K. and M. Yoshiki (2008), Gravity wave generation around the polar vortex in the stratosphere revealed by 3-hourly radiosonde observations at Syowa Station, J. Atmos. Sci. 65 3719-3735.
12. Tateno, S. and K. Sato (2008), A study of inertia-gravity waves in the middle stratosphere based on intensive radiosonde observations, J. Meteorol. Soc. Japan 86(5) 719-732.
13. Watanabe, S., Y. Kawatani, Y. Tomikawa, K. Miyazaki, M. Takahashi, and K. Sato (2008), General Aspects of a T213L256 Middle Atmosphere General Circulation Model, J.

Geophys. Res. 113, D12110. (Editor's highlight)

14. Tomikawa, Y., K. Sato, S. Watanabe, Y. Kawatani, K. Miyazaki, and M. Takahashi (2008), Wintertime temperature maximum at the subtropical stratopause in a T213L256 GCM, J. Geophys. Res. 113, D17117.
15. Kawatani, Y., M. Takahashi, K. Sato, S. P. Alexander, and T. Tsuda (2009), Global distribution of atmospheric waves in the equatorial upper troposphere and lower stratosphere: AGCM simulation of sources and propagation, J. Geophys. Res. 114, D01102.
16. Sato, K., Y. Tomikawa, G. Hashida, T. Yamanouchi, H. Nakajima, and T. Sugita (2009), Longitudinal dependence of ozone recovery in the Antarctic polar vortex revealed by balloon and satellite observations, J. Atmos. Sci. 66(6) 1807-1820.
17. Kurihara, J., T. Abe, I. Murata, K. Sato, and Y. Tomikawa (2009), Development of quartz friction gauge on board balloon and sounding rocket.Trans, JSASS Space Tech. Japan 7 Pm_7-Pm_11.
18. Murata, I., K. Sato, S. Okano, and Y. Tomikawa (2009), Measurements of stratospheric ozone with a balloon-borne optical ozone sensor, Int. J. Remote Sens. 30(15-16) 3961-3966.
19. Watanabe, S., Y. Tomikawa, K. Sato, Y. Kawatani, K. Miyazaki, and M. Takahashi (2009), Simulation of the eastward 4-day wave in the Antarctic winter mesosphere using a gravity wave resolving general circulation model, J. Geophys. Res. 114, D16111.
20. Sato, K., S. Watanabe, Y. Kawatani, Y. Tomikawa, K. Miyazaki, and M. Takahashi (2009), On the origins of mesospheric gravity waves, Geophys. Res. Lett. 36, L19801.
21. Kawatani, Y., K. Sato, T. J. Dunkerton, S. Watanabe, S. Miyahara, and M. Takahashi (2010), The roles of equatorial trapped waves and internal inertia-gravity waves in driving the quasi-biennial oscillation. Part II: Three-dimensional distribution of wave forcing, J., Atmos. Sci, 67, 981-997.
22. Kawatani, Y., K. Sato, T. J. Dunkerton, S. Watanabe, S. Miyahara, and M. Takahashi (2010), The roles of equatorial trapped waves and internal inertia-gravity waves in driving the quasi-biennial oscillation. Part I: zonal mean wave forcing, J. Atmos. Sci, 67, 963-980. (Yamamoto-Syono Award for Outstanding Papers, The Meteorological Society of Japan, 2011)
23. Miyazaki, K., K. Sato, S. Watanabe, Y. Tomikawa, Y. Kawatani, and M. Takahashi (2010), Transport and mixing in the extratropical tropopause region in a high vertical resolution GCM. Part II: Relative importance of large-scale and small-scale dynamics, J. Atmos. Sci, 67, No. 5, 1315–1336.
24. Miyazaki, K., S. Watanabe, Y. Kawatani, Y. Tomikawa, M. Takahashi, and K. Sato (2010), Transport and Mixing in the Extratropical Tropopause Region in a High-Vertical-Resolution GCM. Part I: Potential Vorticity and Heat Budget Analysis, J. Atmos. Sci, 67, 5, 1293–1314. (Yamamoto-Syono Award for Outstanding Papers, The Meteorological Society of Japan, 2012)
25. Tomikawa, Y., and K. Sato (2010), Ozone enhanced layers in the 2003 Antarctic ozone hole, J. Met. Soc. Japan, 88, 1, 1-14, doi: 10.2151/jmsj.2010-101.
26. Kinoshita, T., Y. Tomikawa and K. Sato, On the three-dimensional residual mean circulation and wave activity flux of the primitive equations, J. Met. Soc. Japan, 88, 3, 373-394, doi: 10.2151/jmsj.2010-307. (JMSJ Award)

27. Alexander, M. J., M. Geller, C. McLandress, S. Polavarapu, P. Preusse, F. Sassi, K. Sato, S. Eckermann, M. Ern, A. Hertzog, Y. Kawatani, M. Pulido, T. Shaw, M. Sigmond, R. Vincent, S. Watanabe (2010), Recent developments in gravity wave effects in climate models, and the global distribution of gravity wave momentum flux from observations and models, Q. J. Roy. Meteorol. Soc, 136, 1103-1124.

28. Okamoto, K., K. Sato, and H. Akiyoshi, A study on the formation and trend of the Brewer-Dobson circulation (2011), J. Geophys. Res, 116, D10117, 11 PP, doi: 10.1029/2010JD014953.

29. Tsuchiya, C., K. Sato, T. Nasuno, A. T. Noda, and M. Satoh (2011), Universal Frequency Spectra of Surface Meteorological Fluctuations. J. Climate, 24, 4718–4732.

30. Kohma, M., and K. Sato (2011), The effects of atmospheric waves on the amounts of polar stratospheric clouds. Atmos. Chem. Phys., 11, 11535-11552.

(2) Selected Conference Proceedings

(3) Review Papers

1. Sato, K., and T. Hirooka, The middle atmosphere, TENKI, 54, 399-402.

2. Sato. K., M. Tsutsumi, T. Sato, T. Nakamura , A. Saito, Y. Tomikawa, K. Nishimura, H. Yamagishi and T. Yamaouchi (2011), Program of the Antarctic Syowa MST/IS Radar (PANSY), SPARC Newsletter, 36, 23-26. (Refereed)

3. Sato., K., M. Tsutsumi, T. Sato, T. Nakamura, A. Saito, Y. Tomikawa, K. Nishimura, H. Yamagishi, and T. Yamanouchi (2011), MSTIS radar detected the first echo from the atmosphere in the Antarctic, CAWSES-II TG4 Newsletter, Vol.5, 1-2. (Non-refereed)

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Sato, K., Y. Tomikawa, G. Hashida, A. Kadokura, H. Nakajima, T. Sugita, I. Murata, M. Namiki, Y. Matsuzaka, T. Yamagami, T. Aso, and T. Yamanouchi, Dynamics of Antarctic ozone hole dissipation revealed by balloon and satellite observations, Ozone Workshop in Matushima, February, 2006. (invited)

2. Sato, K., Y. Tomikawa, G. Hashida, A. Kadokura, H. Nakajima, T. Sugita, I. Murata, M. Namiki, Y. Matsuzaka, T. Yamagami, T. Aso, and T. Yamanouchi, Dynamics of Antarctic ozone hole dissipation based on balloon and satellite observations, 36th COSPAR Scientific Assembl, Beijing, China, July 16-23, 2006. (invited)

3. Sato, K., Gravity waves generation around the polar vortex in the stratosphere, 24th IUGG General Assembly, Perugia, July, 2007. (invited)

4. Watanabe, S., Y. Kawatani, Y. Tomikawa, M. Takahashi, and K. Sato, Development of a T213L256 Middle Atmosphere General Circulation Model, International CAWSES Symposium, Kyoto, Japan, October 23-27, 2007. (invited)

5. Tomikawa, Y., S. Watanabe, Y. Kawatani, K. Miyazaki, M. Takahashi, and K. Sato, Wintertime Temperature Maximum at the Subtropical Stratopause in a T213L256 AGCM, International CAWSES Symposium, Kyoto, Japan, October 23-27, 2007. (invited)

6. Sato, K., S. Watanabe, Y. Kawatani, Y. Tomikawa, K. Miyazaki, and M. Takahashi, A study of the middle atmosphere dynamics using a gravity-wave resolving GCM

simulations, AOGS (Asia Oceania Geosciences Society) 2008, Busan, Korea, June 16-20, 2008. (invited)

7. Sato, K., S. Watanabe, Y.Kawatani, Y. Tomikawa, K.Miyazaki, S. Tateno, and M.Takahashi, A study of the middle atmosphere dynamics using a gravity-wave resolving GCM, SPARC 4th General Assembly, Bologna, Italy, August 31 - September 5, 2008. (invited)
8. Sato, K., S. Watanabe, Y. Kawatani, Y. Tomikawa, K. Miyazaki, S. Tateno, and M. Takahashi, Gravity Wave Generation and Propagation in the Middle Atmosphere Revealed by a High-Resolution GCM, MOCA-09, Joint Assembly of IAMAS, IAPSO and IACS, Montreal, Canada, July 19-29, 2009. (invited)
9. Sato, K., S. Watanabe, Y. Kawatani, Y. Tomikawa, K. Miyazaki, S. Tateno, and M. Takahashi, Gravity Wave Generation and Propagation in the Middle Atmosphere Revealed by a High-Resolution GCM, IGAC-SPARC Joint Workshop in Kyoto, The One Atmosphere: Integration, Interface, and Impact, Kyoto (Inamori Hall at Shiran-Kaikan), October 25-26, 2009. (invited)
10. Sato, K., M. Tsutsumi, T. Sato, T. Nakamura, A. Saito, Y. Tomikawa, K. Nishimura, H. Yamagishi, T. Yamanouchi, T. Aso, and M. Ejiri, Program of the Antarctic Syowa MST/IS Radar (PANSY), The 38th Assembly of the Committee on Space Research, Bremen, Germany, July 18-25, 2010. (invited)
11. Sato, K., M. Tsutsumi, T. Sato, T. Nakamura, A. Saito, Y. Tomikawa, K. Nishimura, H. Yamagishi, and T. Yamanouchi, Program of the Antarctic Syowa MST/IS Radar (PANSY), International Symposium on the 25th Anniversary of the MU Radar, Uji, September 2-3, 2010. (invited)
12. Sato, K., M. Tsutsumi, T. Sato, T. Nakamura, A. Saito, Y. Tomikawa, K. Nishimura, H. Yamagishi, and T. Yamanouchi, Program of the Antarctic Syowa MST/IS Radar (PANSY), IUGG 2011 General Assembly, Melbourne, Australia, June 28-July 7, 2011. (invited)

(Total, 48)

(2) Domestic Conferences

105 talks including 6 invited talks

III. Educational Activity (2002-2011)

9. Notable achievements in education

· T. Kinoshita, Outstanding student award, the 124 Assembly of Society of Geomagnetism and Earth, Planetary and Space Sciences, 2008.

· T. Kinoshita, Y. Tomikawa and K Sato, JMSJ Award, 2011.

· T. Kinoshita, JSPS Research Fellowship for Young Scientists DC2 2010.4-2012.3

· M. Kohma, JSPS Research Fellowship for Young Scientists DC1 2011.4-2014.3

· An intensive course, Ibaraki University, 2007.

· Invited Lecture, Yonsei University, 2009

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Journal of the Meteorological Society of Japan, Chief Editor (2008～2009), Co-Chief Editor (2010-2011), Editor (2000-2002, 2004-2007)

(2) Academic Societies

· Director of the Meteorological Society of Japan

· Director and Representative of Japan Geoscience Union

· Scientific Discipline Representative of Scientific Committee on Solar-Terrestrial Physics,

(3) International Conferences

· AGU Chapman Conference on Atmospheric Gravity Waves and Their Effects on General Circulation and Climate, Convener, Honolulu, Hawaii, 28 February- 4 March 2011.

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

2006

· An invited lecture (JpGU)

· One newspaper article (Todai Shinbun)

2007

· One newspaper article (Yomiuri Shinbun)

2008

· An invited lecture (Hokkaido University)

· One journal article (Rigakuru)

· Two newspaper articles (Nihon Keizai Shinbun, Nikkei Ecolomy)

2009

· Two newspaper articles (Asahi Shinbun, Mainichi Shinbun)

· An invited lecture (The University of Tokyo)

2010

· One press release (with National Institute Polar Research)

· More than 20 newspaper articles

· One TV news (NHK)

2011

· One press release (with National Institute of Polar Research)

· Six newspaper articles (Akahata, Yomiuri Shinbun, Nikon news)

· Two articles of Rigakubu Newsletter (The University of Tokyo)

· Two invited lectures (The University of Tokyo, Yomiuri Techno Forum)

· An invited talk at RU11 Symposium “the Great East Japan Earthquake and Tsunami:

· Responsibility and Contribution of Universities”

12. Internal and External Committee Memberships (2006-2011)

· Head of Undergraduate Department of Earth and Planetary Physics, The University of Tokyo (FY2010)

· Adviser to the President, The University of Tokyo (FY2011)
· Adviser to the Dean of Graduate School of Science (FY2012)
· Member of the Science Council of Japan (FY2005-)
· Advisory Committee Member, Council for Science and Technology, MEXT (FY2009)
· Temporary Committee Member, Evaluation Committee for Incorporated Administrative Agency, MEXT (FY2006-2008)
· Advisory Member, Committee for Grants-in-Aid for Scientific Research (FY2005)
· Advisory member, Academic Degree Examination Board, National Institution for Academic Degrees and University Evaluation (FY2010)
· Member, Quality Assessment Committee, Japan Meteorological Agency (FY2006-)
· Member, Board of Councilors, Meteorological Research Institute, Japan Meteorological Agency (FY2007-)
· Member, Large Balloon Committee, ISAS/JAXA (FY2006-2008)
· Commission member, ICMMA, IAMAS, IUGG (2000-2006)
· Member, CAWSES/CAWSESII, SCOSTEP (2004-)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting
Foreign Students: 0
Foreign Researchers:1
Sending
Japanese Students:4
Japanese Researchers:0
Visitors from Abroad:9

Toshiyuki Hibiya

I. C.V.

Name： Toshiyuki Hibiya

Present Position: Professor, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo

Education

B.S. (Geophysics), Department of Geophysics, Faculty of Science, The University of Tokyo, March 1980

M.S. (Physical Oceanography), Department of Geophysics, Graduate School of Science, The University of Tokyo, March 1982

Ph.D. (Physical Oceanography), Department of Geophysics, Graduate School of Science, The University of Tokyo, September 1985

Professional Experience

Research Assistant: Department of Tsunami and Storm Surges, Earthquake Research Institute, The University of Tokyo, October 1985 – March 1987

Research Associate: Department of Tsunami and Storm Surges, Earthquake Research Institute, The University of Tokyo, April 1987 – February 1992

-Postdoctoral Research Associate: Department of Oceanography, University of British Columbia, B.C., Canada, May 1989 – April 1990

-Postdoctoral Research Associate: Geophysics Program, University of Washington, WA, U.S.A., May 1990 – April 1991

Associate Professor: Division of Earth and Planetary Sciences, Graduate School of Science, Hokkaido University, March 1992 – September 1995

Associate Professor: Center for International Cooperation, Ocean Research Institute, The University of Tokyo, October 1995 – October 1998

Associate Professor: Department of Earth and Planetary Physics, Graduate School of Science, The University of Tokyo, November 1998 – March 2000

Professor: Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, April 2000 – Present

II. Scientific Research Activity

2. Major achievements

(1) Parameterization of diapycnal mixing processes in the deep ocean for next-generation global circulation models

The global mapping of diapycnal diffusivity in the deep ocean is essential to improve the ability of global ocean circulation models in predicting future climate changes. First, we have carried out numerical experiments to clarify that the cascade of energy supplied from the semidiurnal internal tide and atmospheric disturbances through the deep ocean internal wave spectrum down to dissipation scales is dominated by the internal wave-wave interaction termed *parametric subharmonic instability* which transfers energy from low-vertical wavenumber internal waves with twice the local near-inertial frequency to high-vertical wavenumber internal waves with the local near-inertial frequency. We have also carried out separate numerical

experiments to find that wind-induced internal wave energy is mostly dissipated within the upper 150 m depth so that the major energy source for diapycnal diffusivity in the deep ocean is the semidiurnal internal tides. This implies that enhanced fine-scale near-inertial current shear causing strong diapycnal diffusivity will not be found at latitudes farther than about 30° from the equator where the diurnal tidal frequency is less than the local inertial frequency so that a resonant triad of internal waves for *parametric subharmonic instability* cannot be formed. This theoretical prediction has been validated through detailed expendable current profiler (XCP) surveys throughout the world's oceans. Furthermore, based on the results of the XCP surveys, an empirical relationship has been found between the diapycnal diffusivity inferred using fine-scale parameterization and the local energy density of the semidiurnal internal tide; by incorporating the numerically predicted energy density of the semidiurnal internal tide at each longitude and latitude into the resulting empirical formula, we have obtained a global map which shows that diapycnal diffusivity is significantly enhanced around prominent topographic features in the latitude range from 20° to 30° (mixing hotspots). Finally, the validity of the resulting global map of diapycnal diffusivity has been confirmed through direct turbulence measurements using microstructure profilers deployed down to depths of ~5000 m at key locations in the North Pacific.

(2) Accurate modeling of the upper ocean response through improved parameterization of mixed layer dynamics

By comparison with the results from large eddy simulation of the resonant inertial response of the upper ocean to strong wind forcing, we have evaluated the performance of each of the two second-order turbulence closure models presented by Mellor and Yamada (1982) (MY) and by Nakanishi and Niino (2009) (NN). The major difference between MY and NN is in the formulation of the stability functions and the turbulent length scale, both strongly linked with turbulent fluxes; in particular, the turbulent length scale in NN, unlike that in MY, is allowed to decrease with increasing density stratification. We have found that MY underestimates and NN overestimates the development of mixed layer, for example, the strong entrainment at the base of the oceanic mixed layer and the accompanying decrease of sea surface temperature. Considering that the stability functions in NN perform better than those in MY in reproducing the vertical structure of turbulent heat flux, we have slightly modified NN to find that the discrepancy between LES and NN can be reduced by more strongly restricting the turbulent length scale with increasing density stratification.

(3) Dynamics of the Kuroshio meander

We have carried out numerical experiments of the transient response of the Kuroshio leading to the large meander formation using a three-dimensional, primitive equation numerical model that takes into account realistic topography. We have found that baroclinic instability enhanced over the local topographic feature, *Koshu-Seamount*, located ~ 200 km to the south of Cape Shiono-misaki, is the dominant mechanism for the rapid amplification of the Kuroshio meander leading to the large meander formation.

3. Five Important Papers in your career

1. Hibiya, T., and M. Nagasawa: Latitudinal dependence of diapycnal diffusivity in the thermocline estimated using a finescale parameterization, *Geophysical Research Letters*, **31**(1), L01301, doi:10.1029/2003GL017998, 2004.

First observational study showing that the intensity of turbulent mixing in the deep ocean is

strongly latitude-dependent. One of the results of the research awarded "The Society Prize of the Oceanographic Society of Japan" in 2008

2. Hibiya, T., M. Nagasawa, and Y. Niwa: Nonlinear energy transfer within the oceanic internal wave spectrum at mid and high latitudes, *Journal of Geophysical Research*, **107**(C11), 3207, doi: 10.1029/2001JC001210, 2002.

First numerical study showing that energy cascade from large scale to dissipation scale in the deep ocean is dominated by *parametric subharmonic instabilities*. One of the results of the research awarded "The Society Prize of the Oceanographic Society of Japan" in 2008

3. Niwa, Y., and T. Hibiya: Numerical study of the spatial distribution of the M_2 internal tide in the Pacific Ocean, *Journal of Geophysical Research*, **106**(C10), 22441-22449, 2001.

First high-resolution numerical experiment clarifying the distribution of M_2 internal tide energy over the whole Pacific Ocean. The number of citation of this paper reaches nearly 80 at the end of October 2012

4. Hibiya, T.: Generation mechanism of internal waves by tidal flow over a sill, *Journal of Geophysical Research*, **91**(C6), 7697-7708, 1986.

First unified theory of internal wave generation by tide-topography interaction with a special attention to crucial roles of tidal advection effects. One of the results of the research awarded "The Okada Memorial Prize of the Oceanographic Society of Japan" in 1989

5. Hibiya, T., and K. Kajiura: Origin of the Abiki phenomenon (a kind of seiche) in Nagasaki Bay, *Journal of the Oceanographical Society of Japan*, **38**(3), 172-182, 1982.

The paper solving long-term mystery involved in the generation of tsunami-like huge ocean waves (*Abiki*) attacking the west coast of Kyushu Island without any precursory phenomena, which has greatly contributed to its future predictability

4. Awards and Honors throughout your career

- Hibiya, T.: *The Society Prize of the Oceanographic Society of Japan* (April 2008) "Theoretical and observational studies of the global distribution of diapycnal diffusivity in the deep ocean"
- Hibiya, T.: *The Okada Memorial Prize of the Oceanographic Society of Japan* (April 1989) "Study of internal wave generation by tide-topography interaction"
- Hibiya, T.: *Distinguished Lecturer for the Ocean Sciences Section for the 8th Annual Meeting of the Asia Oceania Geosciences Society (AOGS)* (August 2011) "Theoretical and observational studies of the global distribution of diapycnal diffusivity in the deep ocean"
- Hibiya, T.: *Research Fellowship in the Natural Sciences of the Mitsubishi Foundation* (October 2005) "Global mapping of diapycnal diffusivity in the deep ocean for next-generation global circulation models"
- Hibiya, T.: *The Japanese-French Oceanographic Society Outstanding-Publication Award* (April 2010) "Transition to the large meander path of the Kuroshio as observed by satellite altimetry", *La mer*, 47, 19-27, 2009 (with D. Ambe, T. Endoh, and S. Imawaki)

5. Future Research Plan

We aim to make a significant breakthrough in modeling the general ocean circulation and/or ocean-atmosphere interactions by introducing updated subgrid-scale information such as turbulent mixing throughout the water column from the surface mixed layer down to the seabed in the deep ocean. The updates will be based on observational data that we have been collecting and analyzing. The research topics we are planning to carry out in the near future follow;

(1) Global mapping of the intensity of near boundary benthic mixing

Although we have succeeded in clarifying the global distribution of diapycnal diffusivities down to a depth of ~ 2000 m as mentioned in section II-2, that of diapycnal diffusivities below ~ 2000 m depth remains unknown. In order to clarify this, we are planning to deploy a free-fall microstructure profiler called VMP-5500 equipped with a Seabird conductivity-temperature-depth (CTD) sensor to measure temperature and salinity with depth as well as a geomagnetic current meter (GEMC) that can measure microscale turbulence as well as the background fine-scale shear and strain from the sea surface down to a depth of ~ 6000 m. Using a combination of the fine-scale (CTD) and microscale (GEMC) data obtained simultaneously, enables us to calculate breaking and dissipation of internal waves which are generated by tidal interaction with abyssal rough bottom and propagate through the background shear and strain fields. This will allow us to develop an empirical formula for diapycnal diffusivities near abyssal rough sea beds expressed in terms of fine-scale parameters such as the dominant horizontal wavenumbers of bottom irregularities, tidal flow amplitude, abyssal stratification, and background fine-scale shear and strain. This empirical formula, incorporated with fine-scale parameters for each domain in the global oceans, would supplement the global distribution of diapycnal diffusivities needed to improve the model's capability and skill to predict future climate changes.

(2) Assessment of fine-scale parameterizations of turbulent dissipation rates near mixing hotspots in the deep ocean

Based on the results from the simultaneous microscale and fine-scale observations mentioned above, we will check the validity of the existing fine-scale parameterization of turbulent dissipation rates in the interior ocean, namely, Gregg's parameterization (shear-based parameterization), Wijesekera et al.'s parameterization (strain-based parameterization), and Gregg-Henyey-Polzin parameterization (shear- and strain-based parameterization).

(3) Direct microstructure observations in the area of Indonesian archipelago

We are planning to carry out microstructure measurements using VMP-5500 in the area of Indonesian archipelago where strong tidal mixing plays an important role in controlling the Indonesian Throughflow and air-sea interaction processes, both of which are strongly linked to the global climate. Quantifying turbulent mixing in the Indonesian waters and then incorporating this information into coupled ocean-atmosphere models, we can evaluate the important role of the Indonesian waters in controlling the global climate.

(4) Assessment of the performance of the modified Mellor-Yamada model in coupled ocean-atmosphere general circulation models

The fact that the Mellor-Yamada (MY) model underestimates the intensity of turbulent mixing in the atmospheric boundary layer lead to the construction of the Nakanishi-Niino (NN) model which modifies MY's formulation of the turbulent length scale. The assessment of NN model, however, has been limited to the atmosphere and not yet fully examined to the ocean. We are planning, therefore, to incorporate NN model into coupled ocean-atmosphere models to

assess its performance; special attention is directed to see if the prediction of the growth and decay of the typhoon can be improved by using NN model.

(5) *In-situ* observations to assess the theoretically-predicted important role of Koshu-Seamount in the dynamics of the Kuroshio meander

We showed numerically and theoretically that Koshu-Seamout located off Kii Peninsula plays an important role in the transition to the large meander path of the Kuroshio. In order to check the validity of this theoretical prediction, we would like to carry out in-situ observations near Koshu-Seamount.

6. Funding Received

(1) JSPS Grants

- Grant-in-Aid for Scientific Research (B): (2005–2006, 15,300,000 JPY) "*Quantification of the intensity of mixing hotspots to clarify the dynamics of the global meridional overturning circulation*"
- Grant-in-Aid for Scientific Research (B): (2007–2008, 18,720,000 JPY) "*Identification of mixing hotspots on the abyssal rough bottom using a microstructure profiler and their incorporation into the global thermohaline circulation model*"
- Grant-in-Aid for Scientific Research (B): (2009–2011, 18,720,000 JPY) "*Quantification of boundary mixing using microstructure profilers for the deep ocean and its incorporation into the global thermohaline circulation model*"
- Grant-in-Aid for Challenging Exploratory Research: (2011–2012, 3,770,000 JPY) "*Improvement of ocean mixed layer model toward the accurate prediction of global warming*"
- Grant-in-Aid for Scientific Research (A): (2008–2011, 11,950,000 JPY) "*Seismic imaging of fluid-containing structure beneath the seafloor and vertical mixing structure of the ocean*"
- Grant-in-Aid for Scientific Research on Priority Areas (2009–2010, 3,300,000 JPY) "*Physical processes in the system consisting of Subtropical Mode Water and a seasonal pycnocline and their roles in biological/chemical processes*"
- Grant-in-Aid for Scientific Research (A): (2011–2011, 1,560,000 JPY Note: this project was suspended at the end of the fiscal year 2011 due to the PI's death) "*Quantification of deep water upwelling in the Northeast Pacific Basin to construct the dynamical model of the Pacific Ocean overturning circulation*"
- Grant-in-Aid for Scientific Research (B) (2010–2012, 3,640,000 JPY) "*Clarification of deep water circulation in the Japan Sea on the basis of the results of direct measurements of abyssal turbulent mixing and chemical tracer experiments*"

(2) Cooperative Research

- Grant-in-Aid for Scientific Research (B) (2010–2012, 4,030,000 JPY) "*Clarification of deep water circulation in the Japan Sea on the basis of the results of direct measurements of abyssal turbulent mixing and chemical tracer experiments*"

(3) Research Contracts

- Project for Sustainable Coexistence of Human, Nature, and the Earth supported by Environment and Energy Division, Research and Development Bureau, Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan
- (2002–2006, 493,900,000 JPY) "*Improvement of parameterizations of various sub-grid scale physical processes in the ocean and atmosphere for the next-generation coupled*

ocean-atmosphere general circulation models”

· Innovative Program of Climate Change Projection for the 21st Century supported by Environment and Energy Division, Research and Development Bureau, Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan (2007–2011, 157,163,000 JPY) “*Subgrid-scale parameterization in the ocean – High-precision parameterization of marine microphysics using large eddy simulation –*”

(4) Grants and Gifts

· Research Fellowship in the Natural Sciences of the Mitsubishi Foundation (2005–2007, 9,500,000 JPY) “*Global mapping of diapycnal diffusivity in the deep ocean for next-generation thermohaline circulation models*”

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Hibiya, T., M. Nagasawa and Y. Niwa: Global mapping of diapycnal diffusivity in the deep ocean based on the results of expendable current profiler (XCP) surveys, *Geophysical Research Letters*, **33**(3), L03611, DOI:10.1029/2005GL025218, 2006.
2. Endoh, T. and T. Hibiya: Numerical study of the meridional overturning circulation with "mixing hotspots" in the Pacific Ocean, *Journal of Oceanography*, **62**(3), 259-266, DOI:10.1007/ s10872-006-0050-x, 2006.
3. Iwamae, N., T. Hibiya and Y. Niwa: Numerical study of enhanced energy dissipation near a seamount, *Journal of Oceanography*, **62**(6), 851-858, DOI:10.1007/ s10872-006-0103-1, 2006.
4. Sasaki,W. and T. Hibiya: Interannual variability and predictability of summertime significant wave heights in the western North Pacific, *Journal of Oceanography*, **63**(2), 203-213, DOI:10.1007/s10872-007-0022-9, 2007.
5. Nagasawa, M., T. Hibiya, K. Yokota, Y. Tanaka, and S. Takagi: Microstructure measurements in the mid-depth waters of the North Pacific, *Geophysical Research Letters*, **34**(5), L05608, DOI:10.1029/2006GL028695, 2007 (AGU Journal Highlight).
6. Endoh, T. and T. Hibiya: Meridional overturning circulation of the deep Pacific estimated assuming the vertical advective-diffusive balance, *Geophysical Research Letters*, **34**(11), L11602, DOI:10.1029/2007GL030027, 2007.
7. Tanaka, Y., T. Hibiya and Y. Niwa: Estimates of tidal energy dissipation and diapycnal diffusivity in the Kuril Straits using TOPEX/POSEIDON altimeter data, *Journal of Geophysical Research*, **112** (10), C10021, DOI:10.1029/2007JC004172, 2007.
8. Hibiya, T., M. Nagasawa and Y. Niwa: Latitudinal dependence of diapycnal diffusivity in the thermocline observed using a microstructure profiler, *Geophysical Research Letters*, **34**(24), L24602, DOI:10.1029/2007GL032323, 2007.
9. Watanabe, M. and T. Hibiya: Energetics of wind-induced turbulent mixing in the ocean, *Journal of Oceanography*, **64**(1), 131-140, DOI:10.1007/s10872-008-0010-8, 2008.
10. Furuichi, N., T. Hibiya and Y. Niwa: Model-predicted distribution of wind-induced internal wave energy in the world’s oceans, *Journal of Geophysical Research*, **113** (C9), C09034, DOI:10.1029/2008JC004768, 2008.
11. Hibiya, T.: Theoretical and observational studies of the global distribution of diapycnal

diffusivity in the deep ocean (in Japanese with English abstract), *Umi no Kenkyu (Oceanography in Japan)*, **18**(2), 115-134, 2009.

12. Sugiyama, Y., Y. Niwa, and T. Hibiya: Numerically reproduced internal wave spectra in the deep ocean, *Geophysical Research Letters*, **36**, L07601, DOI:10.1029/ 2008GL036825, 2009.
13. Iwamae, N., T. Hibiya, and M. Watanabe: Numerical study of the bottom-intensified tidal mixing using an "eikonal approach", *Journal of Geophysical Research*, **114**, C05022, DOI:10.1029/ 2008JC005130, 2009.
14. Ambe, D., T. Endoh, T. Hibiya, and S. Imawaki: Transition to the large meander path of the Kuroshio as observed by satellite altimetry, *La Mer*, **47**(1-2), 19-27, 2009.
15. Zhai, X., R.J. Greatbatch, C. Eden, and T. Hibiya: On the loss of wind-induced near-inertial enegy to turbulent mixing in the upper ocean, *Journal of Physical Oceanography,* **39**(11), 3040-3045, DOI:10.1175/2009JPO4259.1, 2009.
16. Endoh, T., and T. Hibiya: Interaction between the trigger meander of the Kuroshio and the abyssal anticyclone over Koshu Seamount as seen in the reanalysis data, *Geophysical Research Letters*, **36**, L18604, DOI:10.1029/2009GL039389, 2009.
17. Tanaka, Y., T. Hibiya, Y. Niwa, and N. Iwamae: Numerical study of K_1 internal tides in the Kuril Straits, *Journal of Geophysical Research*, **115**, C09016, DOI:10.1029/ 2009JC 005903, 2010.
18. Mohri, K., T. Hibiya, and N. Iwamae: Revisiting internal wave generation by tide-topography interaction, *Journal of Geophysical Research*, **115**, C11001, DOI:10.1029/2009JC005908, 2010.
19. Tanaka, Y., T. Hibiya, and Y. Niwa: Assessment of the effect of tidal mixing in the Kuril Straits on the formation of the North Pacific Intermediate Water, *Journal of Physical Oceanography*, **40**(12), 2569-2574, DOI:10.1175/2010JPO4506.1, 2010.
20. Endoh, T., H. Tsujino, and T. Hibiya: The effect of Koshu Seamount on the formation of the Kuroshio large meander south of Japan, *Journal of Physical Oceanography*, **41**(9), 1624-1629, DOI:10.1175/JPO-D-11-074.1, 2011.
21. Nagai, T., and T. Hibiya: The processes of semi-enclosed basin-ocean water exchange across a tidal mixing zone, *Journal of Oceanography*, **67**(4), 533-539, DOI: 10.1007/s10872-011-0045-0, 2011.
22. Niwa, Y., and T. Hibiya: Estimation of baroclinic tide energy available for deep ocean mixing based on three-dimensional global numerical simulations, *Journal of Oceanography*, **67**(4), 493-502, DOI:10.1007/s10872-011-0052-1, 2011.
23. Iwamae, N., and T. Hibiya: Numerical study of tide-induced mixing over rough bathymetry in the abyssal ocean, *Journal of Oceanography*, **68**(1), 195-203, DOI:10.1007/s10872-011-0088-2, 2012.
24. Furuichi, N., T. Hibiya, and Y. Niwa: Assessment of turbulence closure models for resonant inertial response in the oceanic mixed layer using a large eddy simulation model, *Journal of Oceanography*, **68**(2), 285-294, DOI:10.1007/ s10872-011-0095-3, 2012.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

1. Hibiya, T., Global mapping of diapycnal diffusivity for the accurate modeling of global

overturning circulation (in Japanese), in*, To what extent the global warming has been clarified? – Contribution of Japanese scientists, and future prospect in 2006 –,* pp. 144-145, edited by I. Koike, Maruzen, 277pp., 2006.

2. Hibiya, T., Global circulation in the ocean (in Japanese), in, *Explanation of some keywords in modern science edited by the Graduate School of Science of the University of Tokyo*, pp.79-89, Kagaku-dojin, 235pp., 2009.

3. Hibiya, T., Deep water circulation driven by the moon - Solving the mystery of global overturning circulation (in Japanese), in, *RIGAKURU - Introduction of the ongoing research in the Faculty of Science of the University of Tokyo,* pp. 62-63, Nikkei Business Publications, Inc., 2010.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Hibiya, T.: Mapping of mixing hotspots in the world's oceans, Korea-Japan Physical Oceanography Workshop, Yonsei University, Korea, March 8, 2007 (Invited Talk)

2. Hibiya, T., M. Nagasawa, and Y. Niwa: Theoretical and observational studies of the global distribution of diapycnal diffusivity in the deep ocean, The 15th Pacific Asian Marginal Seas (PAMS) Meeting, Novotel Ambassador Hotel, Busan, Korea, April 24, 2009 (Invited Talk)

3. Hibiya T.: Theoretical and observational studies of the global mapping of diapycnal diffusivity in the world's deep oceans, 2010 Western Pacific Geophysics Meeting, Taipei International Convention Center, Taipei, Taiwan, June 24, 2010 (Invited Talk)

and 38 other general talks

(2) Domestic Conferences

4. Hibiya, T.: Mechanisms of turbulent mixing and its global distribution in the deep ocean – Toward accurate parameterization of deep ocean mixing processes (in Japanese), Symposium "Study of Turbulent Mixing: Current Status and Future Prospects", Yokohama City University, March 26, 2006 (Invited Talk)

5. Hibiya, T.: Ocean Microscale processes controlling the Earth's climate – Toward quantification of turbulent mixing in the deep ocean –, Symposium "Ocean Research in the University of Tokyo – Benefits and Troubles from the Ocean –" (in Japanese), Yayoi Auditorium, Ichijyo-Hall, The University of Tokyo, July 12, 2006 (Invited Talk)

6. Hibiya, T.: Microscale processes in the deep ocean controlling the Earth's climate – Turbulent mixing in the deep ocean which drives abyssal water circulation – (in Japanese), Workshops "Mathematical Aspects and Applications of Wave Phenomena", Research Institute for Mathematical Science, Kyoto University, October 31, 2006 (Invited Talk)

7. Hibiya, T.: "*Abiki* Phenomenon" – Tsunami-like huge ocean waves attacking the west coast of Kyushu Island without any precursory phenomena, Symposium "Ocean Research in the University of Tokyo – The Ocean Today and Tomorrow " (in Japanese), Yayoi Auditorium, Ichijyo-Hall, The University of Tokyo, July 14, 2009 (Invited Talk)

and 66 other general talks

III. Educational Activity (2002-2011)

9. Notable achievements in education

- I have supervised so far 17 M.Sc. students and 8 Ph.D. students; 11 graduates out of them are now engaged in scientific pursuit at universities and government/private research institutions. My first graduate student, Yoshihiro Niwa (now an Associate Professor of the University of Tokyo Ocean Alliance), in particular, was awarded the Okada Prize of the Oceanographic Society of Japan for 2004.
- My undergraduate course lecture "Physical Oceanography" is constantly highly rated by attending students.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

- Editor-in-Chief, *Journal of Oceanography*, 2011–Present

(2) Academic Societies

- Executive Committee Member, the International Association for the Physical Sciences of the Oceans (IAPSO), 2011–Present
- President, Ocean Sciences Section of the Asia Oceania Geosciences Society (AOGS), 2011–Present
- Full Member, IAPSO/SCOR Working Group 121 on "Deep-Ocean Mixing", 2003– 2008
- Councilor, Oceanographic Society of Japan, 1997–Present
- Officer, Oceanographic Society of Japan, 1997–2000, 2003–2006, 2011–Present
- Member, Awards Committee of the Oceanographic Society of Japan, 2005–2006, 2008–2009, 2011–Present
- Member, Coastal Oceanography Research Committee of the Oceanographic Society of Japan, 1991–Present
- Delegate and Science Board Member, Japan Geophysical Union, 2011–Present

(3) International Conferences

- Session Convener, "Ocean Mixing", XXV General Assembly of the International Union of Geodesy and Geophysics (IUGG 2011), Melbourne, Australia, June 28 –June 30, 2011.

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

- "Microscale phenomena in the deep ocean controlling the Earth's climate" (in Japanese), Invited lecture at the JFE Advantech Co., Ltd., Kobe, Japan, July 25, 2008
- "The Abiki (tsunami-like huge ocean waves without any precursory phenomena) which attacked the west coast of Kyushu Island from February 24 through 26" (in Japanese), Commentary on the generation mechanism of the Abiki phenomenon in the TV program "Broadcast Station"（TV Asahi）, February 26, 2009
- "What is the generation mechanism of the Abiki (tsunami-like huge ocean waves without any precursory phenomena) which attacked the west coast of Kyushu Island from February 24 through 26 ? " (in Japanese), Commentary on the generation mechanism of the Abiki phenomenon in the TV program "Sukkiri !!" (Nippon Television), February 27, 2009

· “Theoretical and observational studies of the global distribution of diapycnal diffusivity in the deep ocean” (in Japanese), Invited lecture at the annual meeting of young researchers of the oceanographic society of Japan, July 31, 2009.

· “Microscale processes in the deep ocean controlling the Earth’s climate – Turbulent mixing in the deep ocean which drives abyssal water circulation –” (in Japanese), Invited lecture at the non profit organization “Global Environmental College”, GE College Hall, Tokyo, October 5, 2009

· “Japanese university students today” (in Japanese), interview with Japanese weekly magazine “Shukan Gendai” (Kodansha Ltd.), December 19, 2009

· “Development of human resources and several issues of postdoctoral researchers in the graduate school of oceanography” (in Japanese), Special symposium during the 2011 spring annual meeting of the oceanographic society of Japan, Kashiwa campus of the University of Tokyo, March 22, 2011.

· “Microscale processes in the deep ocean controlling the Earth’s climate – Turbulent mixing in the deep ocean which drives abyssal water circulation –” (in Japanese), Invited lecture at the Oceanographic Command of the Maritime Self-Defense Forces, Yokosuka, Japan, March 5, 2012.

12. Internal and External Committee Memberships (2006-2011)

[External Committee]

· Member, Science Advisory Committee for the International Pacific Research Center (IPRC) of the University of Hawaii, Honolulu, U.S.A., 2007–Present

· Member, National Committee for the International Association for the Physical Sciences of the Oceans (IAPSO), the Science Council of Japan, 2011–Present

· Member, Liaison Committee for Atmospheric and Hydrospheric Sciences, the Science Council of Japan, 2003–2006

· Member, Council for University Chartering and School Juridical Person, 2006– 2007

· Member, Committee on Grant-in-Aid for Scientific Research, Japan Society for the Promotion of Science, 2005–2006, 2008–2009

· Member, Committee of Validation and Examination for Degrees in the National Institution for Academic Degrees and University Evaluation, 2010–Present

· Member, Operation Committee for R/V “Mirai” of the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), 2004–2006

· Visiting Scientist at the National Research Institute for Earth Science and Disaster Prevention, 2006–2010

· Delegate for the Joint Research Program in the Research Institute for Applied Mechanics, Kyushu University, 2010–Present

· Guest Lecturer, Institute of Low Temperature Science, Hokkaido University, June 2008

· Guest Lecturer, Research Institute for Applied Mechanics, Kyushu University, July 2008

· Guest Lecturer, Center for Marine Environmental Studies, Ehime University, February 2011

· Secretary General, 2009 Spring Annual Meeting of the Oceanographic Society of Japan, April 2009

[Internal Committee]

- Advisor to the President of the University of Tokyo, 2010
- Member, Advisory Committee for the Consolidation of the Ocean Research Institute and the Center for Climate System Research, 2008
- Member, Committee for the Admission Office Entrance Examination for the PEAK Programs in English at the University of Tokyo, 2011–Present
- Member, Promotion Committee of the University of Tokyo Ocean Alliance, 2009–Present
- Member, Steering Committee of the University of Tokyo Ocean Alliance, 2011–Present
- Member, Campus Transportation Committee of the University of Tokyo, 2004–2007
- Member, Planning Committee of the Graduate School of Science of the University of Tokyo, 2010
- Director, Overseas Internship Program for Outstanding Young Earth and Planetary Researchers (OIYR Program) of the University of Tokyo, 2009–Present
- Secretary General of the 21st century COE program of the Earth and Planetary Science of the University of Tokyo, 2006–2007
- Member, Steering Committee of the Global COE program of the Earth and Planetary Science of the University of Tokyo, 2009–Present
- Head, Department of Earth and Planetary Physics of the Faculty of Science of the University of Tokyo, 2006–2007
- Member, Steering Committee of the Atmosphere and Ocean Research Institute of the University of Tokyo, 2009–Present
- Member, Steering Committee of the Earthquake Research Institute of the University of Tokyo, 2009–Present

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 1 [M.Sc.: 1 (Indonesia: 1), Ph.D.: 0]

Foreign Researchers: 2 [Canada: 1, Netherland: 1]

Sending

Japanese Students: 0 [M.Sc.: 0, Ph.D.: 0]

Japanese Researchers: 2

Visitors from Abroad: 25 [U.S.A.: 12, Korea: 3, Canada: 2, Germany: 2, Netherland: 1, Australia: 1, France: 1, Israel: 1, Indonesia: 1, Sweden: 1]

Makoto Koike

I. C.V.

Name： Makoto Koike
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Physics, Waswda University, March, 1985
M. Sc., Geophysics, The University of Tokyo, March, 1987
Ph. D., Geophysics, The University of Tokyo, March, 1990

Professional Experience
April, 1990-March, 1998, Research Associate, Atmospheric Environment Division, Solar-Terrestrial Environment Laboratory, Nagoya University
April, 1998-September, 2000, Associate Professor, Atmospheric Environment Division, Solar-Terrestrial Environment Laboratory, Nagoya University
October, 2000-, Associate Professor, Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

Research on Tropospheric Ozone

Tropospheric ozone is important for green-house effect and atmospheric oxidizing capacity. We have carried out a series of aircraft measurements of reactive nitrogen, which regulates the ozone production rate. Through these experiments, we have evaluated the source strengths of individual reactive nitrogen sources. We have found that a lightning production of reactive nitrogen has a significant contribution in the tropical Western Pacific. We have also successfully estimated the global production rate by lightning using ground-based and satellite lightning observations.

Modeling studies on aerosols and their direct and indirect effects

Atmospheric aerosols (suspended particles) affect radiation budget and climate by scattering and absorbing solar radiation (direct effect) and affecting clouds (indirect effect). We have been developing aerosol model, which explicitly describes key processes, which control strength of aerosol direct and indirect effects. Using this model we have evaluated the new particle formation (NPF) processes, which increase aerosol number concentration that is the key of aerosol indirect effect. As a result, we have successfully reproduced a contrast in the occurrence frequency of NPF under different meteorological and atmospheric conditions. The onset of the NPF events was a long-standing question and we successfully show that it is controlled by a balance between the two competing processes taking place in the atmosphere. Regarding to the aerosol direct effect, one of the most important factors is the mixing state of black carbon (BC) particles, because it controls strength of light absorption and removal rate (lifetime) in the atmosphere. By explicitly describe the BC mixing state as well as processes that affect the mixing state, we successfully show an evolution of BC mixing state in the atmosphere. In addition to these studies, we have studied differences of evolution of primary and secondary aerosols over the East Asia, a role of humidity (aerosol water) for aerosol radiative forcing, and

others.

Impact of aerosols on cloud physics

We have carried out a series of aircraft experiments to study aerosol impacts on warm clouds. We have successfully capture clear evidences that anthropogenic aerosols indeed affect cloud microphysical parameters in the East Asia for the first time. We further found that the strength of aerosol indirect effect (Twomey effect) isinfluenced by the warm Kuroshio ocean current because the warm sea surface temperature (SST) destabilized atmosphere and enhance updraft velocity. Cold air outbreak from over the Asian continent in winter and early spring is found to not only bring a large amount of anthropogenic aerosols but also enhance aerosol impacts over the Kuroshio currnet.

3. Five Important Papers in your career

1. Koike, M., N.B. Jones, W.A. Matthews, P.V. Johnston, R.L. McKenzie, D. Kinnison, and J. Rodriguez, Impact of Pinatubo aerosols on the partitioning between NO2 and HNO3, Geophys. Res. Lett., 21, 597-600, 1994.

In this paper, we have shown that heterogeneous reaction on volcanic aerosols efficiently convert NO2 to HNO3, using infrared spectroscopic measurements. This is a clear evidence of the stratospheric ozone destruction mechanism following a large volcanic eruption. This paper has been cited 63 times and I received the Yamamoto-Shono Award from the Japan Meteorological Society in 1995.

2. Koike, M., Y. Kondo, H. Ikeda, G.L. Gregory, B.E. Anderson, G.W. Sachse, D.R. Blake, S.C. Liu, H.B. Singh, A.M. Thompson, K. Kita, Y. Zhao, T. Sugita, R.E. Shetter, and N. Toriyama, Impact of aircraft emissions on reactive nitrogen over the North Atlantic Flight Corridor region, J. Geophys. Res., 105, 3665-3677, 2000.

In this paper we have shown an impact of aircraft exhaust on upper tropospheric reactive nitrogen budget through aircraft measurement. Reactive nitrogen in the upper troposphere is a key parameter for ozone budget, which affect ozone green-house effect. The results presented in this study serve as critical data for model evaluation. For a series of the study on the budget of reactive nitrogen, I received the Horiuchi Award from the Japan Meteorological Society in 2001.

3. Koike, M., Y. Kondo, K. Kita, N. Takegawa, Y. Masui, Y. Miyazaki, M. W. Ko, A. J. Weinheimer, F. Flocke, R. J. Weber, D. C. Thornton, G. W. Sachse, S. A. Vay, D. R. Blake, D. G. Streets, F. L. Eisele, S. T. Sandholm, H. B. Singh, and R. W. Talbot, Export of anthropogenic reactive nitrogen and sulfur compounds from the East Asia region in spring, J. Geophys. Res., 108(D20), 8789, doi:10.1029/2002JD003284, 2003.

In this paper, we have shown a transport efficiency defined in this study for reactive nitrogen and sulfate. The transport efficiencies of these species were found to be lower in the free troposphere as compared in the boundary layer due to wet removal processes during upward transport. A fraction of aerosol sulfate within total amount (gas + aerosol) was found to depend on air history. This paper shows a fate of anthropogenic emissions and transport processes of Asian anthropogenic emissions and has been cited 44 times.

4. Matsui, H., M. Koike, Y. Kondo, N. Takegawa, A. Wiedensohler, J. D. Fast, and R. A. Zaveri Impact of new particle formation on the concentrations of aerosol number and cloud condensation nuclei around Beijing *J. Geophys. Res*., 116, D19208,

doi:10.1029/2011JD016025, 2011.

In this study, we have developed an aerosol model for new particle formation (NPF) processes and successfully reproduced observed features. The fact that the NPF events take place more frequently in clean air condition (such as after a passage of cold front) as compared with polluted conditions (under high pressure systems) was found to be due to smaller loss rate of nucleated particles under the clean conditions so that these particles can survive and grow to size detectable of aerosol measurements.

5. Koike, M., N. Takegawa, N. Moteki, Y. Kondo, H. Nakamura, K. Kita, H. Matsui, N. Oshima, M. Kajino, and T. Y. Nakajima, Measurements of Regional-Scale Aerosol Impacts on Cloud Microphysics over the East China Sea: Possible Influences of Warm Sea Surface Temperature over the Kuroshio Ocean Current *J. Geophys. Res*., doi:10.1029/2011JD017324, 2012.

In this paper, we have provided the first clear evidence of anthropogenic aerosol impacts on warm clouds in the East Asia through a systematic aircraft measurement. We further showed that this aerosol impacts were enhanced over the warm Kuroshio ocean current because of enhanced updraft velocity. Temperature contrast between the atmosphere and ocean was found to affect both the macro (cloud thickness) and micro (aerosol impact) features of clouds. This is the first study, which suggest SST impacts on aerosol indirect effect that is potentially very important for climate study.

4. Awards and Honors throughout your career

· Yamamoto-Syono Award from the Meteorological Society of Japan, 17 October, 1995.

· Horiuchi Award from the Meteorological Society of Japan, 11 October, 2001”

5. Future Research Plan

The atmospheric science is coming to the new stage. The atmospheric science was advanced by introducing climate research to the traditional meteorology. Now, the atmospheric chemistry is the third component of the atmospheric science and becoming a driver to create new areas. The center of this comprehensive study is aerosol-cloud-precipitation system. In the future study, I would like to promote the new atmospheric science by combining atmospheric chemistry with traditional meteorology and climate research.

First, the global warming and environmental changes in the atmosphere clearly show that research on atmospheric compounds, such as green-house gases and aerosols, is critical for the atmospheric science. Second, this situation indicates that clouds and precipitation, the fundamental elements of the meteorology, should be investigated within the new atmospheric science framework, in which roles of aerosols are taken into account. Third atmospheric compounds control air quality on which human beings depend and play a central role as a linkage between human dimension, terrestrial eco-system, ocean, and other terrestrial systems.

To promote this new atmospheric science, I will do both observational and modeling research to study aerosol-cloud-precipitation system. First, for observational studies, I will carry out intensive campaign experiment to identify and quantify new processes, especially using research aircraft, as I and my colleagues have been performing. Over the Western Pacific, the warm Kuroshio ocean current has been found to affect aerosol-cloud interaction (cloud micro features) in addition to the cloud macro-structures. I will further investigate this unique

boundary layer structure affected by sea surface temperature and aerosol-cloud-precipitation system that form within the layer. The other category of observations is the semi-long-term (5-years) ground-based measurements. Black carbon (key of aerosol direct effect) and aerosol size distribution (key of indirect effect) measurements should be conducted. I will keep making effort to improve instrumentation for these observations.

Second, for modeling studies, I will further improve our aerosol model and develop cloud physics model, with which I will promote regional scale aerosol-cloud-precipitation study, especially over the East Asia. In our previous studies, we have introduced the new particle formation processes, secondary aerosol production, and aerosol mixing state expression into our model. Through these studies, we have shown that some essential features of aerosols can be well simulated when key parameters and processes are explicitly described in model calculations. By expanding this strategy to cloud modeling, we have been developing bin-structure cloud model and try to explicitly calculate aerosol impacts on cloud microphysics (precipitation etc.) and macro-structures (liquid water path and cloud fraction). Using this new aerosol-cloud model, I will study, how the anthropogenic emissions affect cloud-precipitation system and how the unique meteorological system in the East Asia (Asian monsoon, high SST, and others) influence aerosol impacts on cloud and precipitation.

For long-term modeling research, I would like to expand my research area to global scale using global models. I would also think that it is important to introduce lectures of this new atmospheric science into under-graduate and graduate course lectures.

6. Funding Received

(1) JSPS Grants

- Scientific Research (B)(2), “Size distribution and mixing state of black carbon aerosols in China”, PI, H18-19 (¥15,500,000)
- Scientific Research (A), “Behaviors of carbonaceous aerosols and their direct radiative effect in East Asia”, PI, H20-22 (¥26,300,000)
- and other five grants (Scientific Research S x2, A x 1, and B x 2)

(2) Cooperative Research

(3) Research Contracts

- Environment Research and Technology Development Fund, “Evaluation study of reduction of black carbon emissions as global warming measure”, co-I, H23-25 (¥148,193,000)

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Matsui, H., Y. Kondo, N. Moteki, N. Takegawa, L. K. Sahu, M. Koike, Y. Zhao, H. E. Fuelberg, W. R. Sessions, G. Diskin, B. E. Anderson, D. R. Blake, A. Wisthaler, M. J. Cubison, and J. L. Jimenez, Accumulation-mode aerosol number concentrations in the Arctic during the ARCTAS aircraft campaign: Long-range transport of polluted and clean air from Asia, *J. Geophys. Res*., 116, D20217, doi:10.1029/2011JD016189, 2011.
2. Matsui, H., M. Koike, Y. Kondo, N. Takegawa, A. Wiedensohler, J. D. Fast, and R. A. Zaveri Impact of new particle formation on the concentrations of aerosol number and

cloud condensation nuclei around Beijing *J. Geophys. Res*., 116, D19208, doi:10.1029/2011JD016025, 2011.

3. Matsui, H., Y. Kondo, N. Moteki, N. Takegawa, L. K. Sahu, Y. Zhao, H. E. Fuelberg, W. R. Sessions, G. Diskin, D. R. Blake, A. Wisthaler, and M. Koike, Seasonal variation of the transport of black carbon aerosol from the Asian continent to the Arctic during the ARCTAS aircraft campaign, *J. Geophys. Res*., 116, D05202, doi:10.1029/2010JD015067, 2011.

4. Kondo, Y., L. Sahu, N. Moteki, F. Khan, N. Takegawa, X. Liu, M. Koike, and T. Miyakawa, Consistency and traceability of black carbon measurements made by laser-induced incandescence, thermal-optical transmittance, and filter-based photo-absorption techniques, *Aerosol Sci. Technol*., 45, 295-312, 2011.

5. Kikuchi, K., T. Nishibori, S. Ochiai, H. Ozeki, Y. Irimajiri, Y. Kasai, M. Koike, T. Manabe, K. Mizukoshi, Y. Murayama, T. Nagahama, T. Sano, R. Sato, M. Seta, C. Takahashi, M. Takayanagi, H. Masuko, J. Inatani, M. Suzuki, and M. Shiotani, Overview and Early Results of the Superconducting Submillimeter-Wave Limb-Emission Sounder (SMILES), *J. Geophys. Res*. 115, doi:10.1029/2010JD014379, 2010.

6. Kondo, Y., N. Takegawa, H. Matsui, T. Miyakawa, M. Koike, Y. Miyazaki, Y. Kanaya, M. Mochida, M. Kuwata, Y. Morino, and M. Shiraiwa, Formation and transport of aerosols in Tokyo in relation to their physical and chemical properties: a review, *J. Meteor. Soc. Japan, 88*, 597 – 624, 2010.

7. Matsui, H., M. Koike, Y. Kondo, N. Takegawa, J. D. Fast, U. Poschl, R. M. Garland, M. O. Andreae, A. Wiedensohler, N. Sugimoto, and T. Zhu, Spatial and Temporal Variations of Aerosols Around Beijing in the Summer 2006: 2. Local and column aerosol optical properties, *J. Geophys. Res*., 115, doi:10.1029/ 2010JD013895, 2010.

8. Parrish, D. D., W. C. Kuster, Min Shao, Y. Yokouchi, Y. Kondo, P. D. Goldan, J. A. de Gouw, M. Koike, and Tomoko Shirai, Comparison of Air Pollutant Emissions among Mega-Cities, *Atmos. Environ*., 43, 6435-6441, 2009.

9. Oshima, N., M. Koike, Y. Zhang, and Y. Kondo, Aging of black carbon in outflow from anthropogenic sources using a mixing state resolved model: 2. Aerosol optical and cloud condensation nuclei properties, *J. Geophys. Res*., 114, doi:10.1029/ 2008JD011681, 2009.

10. Matsui, H., M. Koike, Y. Kondo, N. Takegawa, K. Kita, Y. Miyazaki, M. Hu, S-Y Chang, D. R. Blake, J. D. Fast, R. A. Zaveri, D. G. Streets, Q. Zhang, and T. Zhu, Spatial and Temporal Variations of Aerosols Around Beijing in the Summer 2006: 1. Model Evaluation and Source Apportionment, *J. Geophys. Res*., 114, doi:10.1029/ 2009JD010906, 2009.

11. Oshima, N., M. Koike, Y. Zhang, Y. Kondo, N. Moteki, N. Takegawa, and Y. Miyazaki, Aging of black carbon in outflow from anthropogenic sources using a mixing state resolved model: 1. Model development and evaluation, *J. Geophys. Res*., 114, doi:10.1029/ 2008JD010680, 2009.

12. Matsui, H., M. Koike, N. Takegawa, Y. Kondo, R. J. Griffin, Y. Miyazaki, Y. Yokouchi, and T. Ohara, Secondary Organic Aerosol Formation in Urban Air: Temporal Variations and Possible Contributions from Unidentified Hydrocarbons, *J. Geophys. Res*., 114, doi:10.1029/ 2008JD010164, 2009

13. Sahu, L. K., Y. Kondo, Y. Miyazaki, M. Kuwata, M. Koike, N. Takegawa, H. Tanimoto, H. Matsueda, S. C. Yoon, and Y. J. Kim, Anthropogenic aerosols observed in Asian continental outflow at Jeju Island, Korea, in spring 2005, *J. Geophys. Res*., 114,

doi:10.1029/2008JD010306, 2009.

14. Kondo, Y., Y. Morino, M. Fukuda, Y. Kanaya, Y. Miyazaki, N. Takegawa, H. Tanimoto, R. McKenzie, P. Johnston, D.R. Blake, T. Murayama, and M. Koike, Formation and transport of oxidized reactive nitrogen, ozone, and secondary organic aerosol in Tokyo, *J. Geophys. Res*., 113, doi:10.1029/2008JD010134, 2008.

15. Kondo, Y., R. C. Hudman, K. Nakamura, G. Chen, Y. Miyazaki, N. Takegawa, M. Koike, M. Ko, K. Kita, D. R. Blake, T. Shirai, and S. Kawakami, Mechanisms that influence the formation of high-ozone regions in the boundary layer downwind of the Asian continent in winter and spring, *J. Geophys. Res*., *113*, D15304, doi:10.1029/2007JD008978, 2008.

16. Kanaya, Y., M. Fukuda, H. Akimoto, N. Takegawa, Y. Komazaki, Y. Yokouchi, M. Koike, and Y. Kondo, Urban photochemistry in central Tokyo: 2. Rates and regimes of oxidant (O_3 + NO_2) production, *J. Geophys. Res*., 113, D06301, doi:10.1029/2007JD008671, 2008.

17. Kanaya, Y., R. Cao, H. Akimoto, M. Fukuda, Y. Komazaki, Y. Yokouchi, M. Koike, H. Tanimoto, N. Takegawa, and Y. Kondo, Urban photochemistry in central Tokyo: 1. Observed and modeled OH and HO2 radical concentrations during the winter and summer of 2004, *J. Geophys. Res*., 112, D21312, doi:10.1029/2007JD008670, 2007.

18. Shirai, T., Y. Yokouchi, D. R. Blake, K. Kita, K. Izumi, M. Koike, Y. Komazaki, Y. Miyazaki, M. Fukuda, and Y. Kondo, Seasonal variation of atmospheric C2-C7 nonmethane hydrocarbons in Tokyo, J. Geophys. Res., 112, D24305, doi:10.1029/2006JD008163, 2007.

19. Koike, M., Y. Kondo, K. Kita, N. Takegawa, N. Nishi, B. Liley, T. Kashihara, S. Kudoh, S. Kawakami, D. Blake, T. Shirai, M. Ko, Y. Miyazaki, Z. Kawasaki, and T. Ogawa, Measurements of Reactive Nitrogen Produced by Tropical Thunderstorms during BIBLE-C, *J. Geophys. Res.*, 112, D18304, doi:10.1029/2006JD008193, 2007.

20. Miyazaki, Y., Y. Kondo, S. Han, M. Koike, D. Kodama,Y. Komazaki, H. Tanimoto, and H. Matsueda, Chemical characteristics of water-soluble organic carbon in the Asian outflow, *J. Geophys. Res.*, *112*, D22S30, doi:10.1029/2007JD009116, 2007.

21. Moteki, N., Y. Kondo, Y. Miyazaki, N. Takegawa, T. Miyakawa: Y. Komazaki, G. Kurata, T. Shirai, D. R. Blake, and M. Koike, Evolution of mixing state of black carbon particles: Aircraft measurements over the western Pacific in March 2004, *Geophys. Res. Lett.*, 34, L11803, 10.1029/2006GL028943, 2007.

22. Gamblin, B., O. B. Toon, M. A. Tolbert, Y. Kondo, N. Takegawa, H. Irie, M. Koike, P. K. Hudson, J. O. Ballenthin, D. E. Hunton, T. M. Miller, A. A. Viggiano, B. E. Anderson, M. Avery, G. W. Sachse, K. Guenther, C. Sorenson, and M. J. Mahoney, Nitric acid condensation on ice: 2. Kinetic limitations, a possible ‘‘cloud clock’’ for determining cloud parcel lifetime, *J. Geophys. Res*., 112, D12209, doi:10.1029/2005JD006049, 2007.

23. Koike, M., N. B. Jones, P. I. Palmer, H. Matsui, Y. Zhao, Y. Kondo, Y. Matsumi, and H. Tanimoto, Seasonal Variation of Carbon Monoxide in Northern Japan: FTIR Measurements and Source-labeled Model Calculations, *J. Geophys. Res.*, 111, D15306, doi:10.1029/2005JD006643, 2006.

24. Gamblin, B., O. B. Toon, M. A. Tolbert, Y. Kondo, N. Takegawa, H. Irie, M. Koike, J. O. Ballenthin, D. E. Hunton, T. M. Miller, A. A. Viggiano, B. E. Anderson, M. Avery, G. W. Sachse, J. R. Podolske, K. Guenther, C. Sorenson, and M. J. Mahoney, Nitric acid condensation on ice: 1. Non-HNO3 constituent of NOY condensing cirrus particles on upper tropospheric, J. Geophys. Res., 111, D21203, doi:10.1029/2005JD006048, 2006.

25. Kondo, Y., Y. Komazaki, Y. Miyazaki, N. Moteki, N. Takegawa, M. Nogami, S. Deguchi,

M. Fukuda, T. Miyakawa, Y. Morino, D. Kodama, and M. Koike, Temporal variations of elemental carbon in Tokyo, *J. Geophys. Res.*, 111, D12205, doi:10.1029/2005JD006257, 2006.

26. Takegawa, N., T. Miyakawa, Y. Kondo, D. R. Blake, Y. Kanaya, M. Koike, M. Fukuda, Y. Komazaki, Y. Miyazaki, A. Shimono, and T. Takeuchi, Evolution of submicron organic aerosol in polluted air exported from Tokyo, *Geophys. Res. Lett.*, 33, L15814, doi:10.1029/2006GL025815, 2006.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

1. Global changes in atmosphere and terrestrial eco-systems, Section 3-2 Nitrogen in the atmosphere, Shimizu-Koubun-do-shoten, 2010 (in Japanese)
2. Encyclopedia on modern science, 150-151, Kagakudoujin-sha, 2009 (in Japanese)

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. M. Koike, H. Matsui, Y. Kondo, N. Takegawa, J. D. Fast, and R. A. Zaveri, Synoptic-scale Variations of Aerosols and Their Optical Properties around Beijing in the Summer 2006, IAMA (International Aerosol Modeling Algorithms) conference (Davis, California, December 2009) invited

and others (1 invited presentation and 7 regular presentations)

(2) Domestic Conferences

2. M. Koike et al., Anthropogenic aerosol impacts on warm clouds in the East China Sea, annual conference of Japan Association of Atmospheric Chemistry, November, 2010, Tokyo, Japan

and others (16 regular presentations)

III. Educational Activity (2002-2011)

9. Notable achievements in education

· In last 10 years, two Ph. D and ten master course students have been graduated from our group. One of the Ph. D students moved to the Meteorological Research Institute as a researcher (permanent position). The other Ph. D student is now research associate (non-permanent position).

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Editor of SOLA (Scientific Online Letters on the Atmosphere), Japan Meteorological Society, 2006-present

(2) Academic Societies

· Chair of Committee of IGAC (International Global Atmospheric Science), Science Council of Japan, 2006-2009
· Committee of IGAC, Science Council of Japan, 2010-present
· Committee of SPARC, Science Council of Japan, 2006-2009
· Committee of iLEAPS, Science Council of Japan, 2006-present
· Committee of MAHASRI, Science Council of Japan, 2006-2009

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

[External Committee]

· Committee of GCOM (Global Change Observation Mission), 2006-present

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting
Foreign Students: 0 [M.Sc.: 0, Ph.D.: 0]
Foreign Researchers: 0
Sending
Japanese Students: 3 [M.Sc.: 1, Ph.D.: 2]
Japanese Researchers: 2
Visitors from Abroad: 5

Tomoki Tozuka

I. C.V.

Name： Tomoki Tozuka
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education

B. Sc., Earth and Planetary Physics, The University of Tokyo, March, 1999
M. Sc., Earth and Planetary Science, The University of Tokyo, March, 2001
Ph. D., Earth and Planetary Science, The University of Tokyo, March, 2004

Professional Experience

Apr., 2003-Mar., 2004, JSPS Researcher, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo
Apr., 2004-Mar., 2006, Project Postdoctoral Fellow, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo
Apr., 2006-Mar., 2007, Project Research Assistant, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo
Apr., 2007-Mar., 2008, Project Assistant Professor, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo
Apr., 2008-Nov., 2011, Assistant Professor, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo
Nov., 2011-, Associate Professor, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo

II. Scientific Research Activity

2. Major achievements

By conducting simulations using general circulation models and analyzing various observational data, I have studied ocean-atmosphere interaction especially in the tropics. Three main research achievements are as follows.

(1) Relation between thermocline domes and climate variation phenomena

Because of upwelling of cold and nutrient-rich water from the subsurface, thermocline domes in the tropics have significant impacts on climate and ecosystem. I have studied the relation between these thermocline domes and climate variation phenomena. In particular, I have examined the mechanism of seasonal and interannual variations of the Mindanao Dome located to the east of Philippines, and showed that annual Rossby waves associated with "Annual El Niño/Southern Oscillation (ENSO)" plays an important role in the seasonal decay of the Mindanao Dome. In addition, I have studied the Seychelles Dome in the southwestern tropical Indian Ocean and quantitatively clarified the relation with the Indian Ocean Dipole (IOD).

(2) Role of the South China Sea in climate variations

The South China Sea is located in between the Pacific Ocean where ENSO occurs and the Indian Ocean where the IOD occurs. Because of its location, it is considered to be an important region, but its role in climate variations remained to be understood. By conducting sensitivity experiments with general circulation models, I have shown that the South China Sea

throughflow has dramatic impacts on heat transport by the Indonesian Throughflow, which plays an important role in global climate. Also, it was shown that it influences occurrences of ENSO.

(3) Decadal variation of the Indian Ocean Dipole

Although many studies have been devoted to the IOD after its discovery, its long-term variation was not examined in detail. I have clarified the mechanism of decadal variations in the IOD based on heat budget analyses. Also, I used a new statistical method in climate research community called self-organizing maps and was able to discuss the relationship between climate modes in the Pacific and Indian Oceans from a new viewpoint.

Also, I have played a central role in developing a new coupled general circulation model at the University of Tokyo. This coupled model, called the University of Tokyo Coupled general circulation Model (UTCM), is showing high performances. In particular, this model has succeeded to reproduce the zonal sea surface temperature gradient of the equatorial Atlantic for the first time.

3. Five Important Papers in your career

1. Qu, T., Y. Y. Kim, M. Yaremchuk, T. Tozuka, A. Ishida, and T. Yamagata (2004), Can Luzon Strait transport play a role in conveying the impact of ENSO to the South China Sea? *J. Climate, 17*, 3644-3657.

This paper received attention because it showed that the South China Sea plays an important role in climate variations, and it was cited 81 times.

2. Tozuka, T., and T. Yamagata (2003), Annual ENSO, *J. Phys. Oceanogr., 33*, 1564-1578.

This paper pointed out the existence of "Annual ENSO", and it was introduced in Bulletin of American Meteorological Society.

3. Beal, L., W. P. M. De Ruijter, A. Biastoch, R. Zahn, and SCOR/WCRP/IAPSO Working Group 136 (M. Cronin, J. Hermes, J. Lutjeharms, G. Quartly, T. Tozuka, S. Baker-Yeboah, T. Bornman, P. Cipollini, H. Dijkstra, I. Hall, W. Park, F. Peeters, P. Penven, H. Ridderinkhof, J. Zinke) (2011), On the role of the Agulhas system in ocean circulation and climate, *Nature, 472*, 429-436.

This is a review paper on the Agulhas Current in Nature, and it appeared on media in many different countries. Although only 1.5 years have passed since its publication, it has been cited 20 times.

4. Tozuka, T., T. Doi, T. Miyasaka, N. Keenlyside, and T. Yamagata (2011), Key factors in simulating the equatorial Atlantic zonal sea surface temperature gradient in a coupled general circulation model, *J. Geophys. Res., 116*, C06010, doi:10.1029/2010JC006717.

Although all IPCC models fail to reproduce the correct sea surface temperature gradient along the equatorial Atlantic, we have reported that we have succeeded in this aspect for the first time.

5. Tozuka, T., T. Qu, and T. Yamagata (2007), Dramatic impact of the South China Sea on the Indonesian Throughflow, *Geophys. Res. Lett., 34*, L12612, doi:10.1029/2007GL030420.

This paper presented the first quantitative evidence that the South China Sea throughflow influences the Indonesian Throughflow, which controls the global climate. I gave an invited talk with this study at an international conference.

4. Awards and Honors throughout your career

· Tomoki Tozuka, Geophysical Fluid Dynamics Fellow, Woods Hole Oceanographic Institution, June-August 2002.

· Tomoki Tozuka, Okada Memorial Prize, Oceanographic Society of Japan, April 2006.

5. Future Research Plan

I plan to work on the following three topics for my research.

(1) Climate Variations in the Atlantic Ocean

I have played a central role in developing the University of Tokyo Coupled Model (UTCM). This model has succeeded in simulating the zonal sea surface temperature gradient along the equatorial Atlantic, even though all coupled models that contributed to IPCC AR4 failed in this aspect. Since modeling the mean climate state reasonably is the first step toward simulating as well as predicting climate variations, no one has succeeded in predicting climate modes in the tropical Atlantic such as Atlantic Niño (zonal mode) and Atlantic meridional mode. Thus, I plan to try for the first successful prediction of these climate modes.

(2) Interaction between thermocline domes and climate modes

Since I studied the Mindanao Dome when I was a graduate student, I have been interested in thermocline domes (Angola Dome, Guinea Dome, and Seychelles Dome) over the global ocean. Although the phenomena are considered important for its impacts on local climate and ecosystem, our studies based on ocean general circulation models and observational data have shown that they also interact with large-scale climate modes. Using coupled general circulation models, I plan to study interactions between thermocline domes and climate modes.

(3) Role of the Greater Agulhas System in climate

Although the Agulhas Current is suggested to play an important role in climate variations, it received less attention compared with other western boundary currents. I plan to study the climatic importance of the Greater Agulhas System using general circulation models. This research will be conducted in collaboration with other members of SCOR/WCRP/IAPSO working group #136 on “Climatic Importance of the Greater Agulhas System” and scientists who are involved in a project entitled "Prediction of Climate Variations and its Application in the Southern African Region" under Science and Technology Research Partnership for Sustainable Development (SATREPS).

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for Young Scientist (B), Thermodynamical study on decadal modulations of El Niño/Southern Oscillation, FY 2006-2008, 3570 thousand yen.

· Grant-in-Aid for Young Scientist (B), A study on the South China Sea throughflow using coupled general circulation model, FY 2009-2011, 4160 thousand yen.

(2) Cooperative Research

(3) Research Contracts

· Japan Science and Technology Agency, Science and Technology Research Partnership for Sustainable Development, FY 2010-2011, 27659 thousand yen.

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Morioka, Y., T. Tozuka, and T. Yamagata (2011), On the growth and decay of the subtropical dipole mode in the South Atlantic, *J. Climate, 24*, 5538-5554.
2. Tozuka, T., T. Doi, T. Miyasaka, N. Keenlyside, and T. Yamagata (2011), Key factors in simulating the equatorial Atlantic zonal sea surface temperature gradient in a coupled general circulation model, *J. Geophys. Res., 116*, C06010, doi:10.1029/2010JC006717.
3. Morioka, Y., T. Tozuka, and T. Yamagata (2010), Climate variability in the southern Indian Ocean as revealed by self-organizing maps, *Clim. Dyn., 35*, 1059-1072.
4. Doi, T., T. Tozuka, and T. Yamagata (2010), Equivalent forcing depth in tropical oceans, *Dyn. Atmos. Oceans, 50*, 415-423.
5. Tozuka, T., T. Yokoi, and T. Yamagata (2010), A modeling study of interannual variations of the Seychelles Dome, *J. Geophys. Res., 115*, C04005, doi:10.1029/2009JC005547.
6. Doi, T., T. Tozuka, and T. Yamagata (2010), The Atlantic Meridional Mode and its coupled variability with the Guinea Dome, *J. Climate, 23*, 455-475.
7. Doi, T., T. Tozuka, and T. Yamagata (2009), Interannual variability of the Guinea Dome and its possible link with the Atlantic Meridional Mode, *Clim. Dyn., 33*, 985-998.
8. Yuan, C., T. Tozuka, T. Miyasaka, and T. Yamagata (2009), Respective influences of IOD and ENSO on the Tibetan snow cover in early winter, *Clim. Dyn., 33*, 509-520.
9. Tozuka, T., T. Qu, Y. Masumoto, and T. Yamagata (2009), Impacts of the South China Sea throughflow on seasonal and interannual variations of the Indonesian Throughflow, *Dyn. Atmos. Oceans, 47*, 73-85.
10. Yokoi, T., T. Tozuka, and T. Yamagata (2009), Seasonal variations of the Seychelles Dome simulated in the CMIP3 models, *J. Phys. Oceanogr., 39*, 449-457.
11. Iskandar, I., S. C. Rao, and T. Tozuka (2009), Chlorophyll-a bloom along the southern coasts of Java and Sumatra during 2006, *Int. J. Remote Sensing, 30*, 663-671.
12. Qu, T., J. Gan, A. Ishida, Y. Kashino, and T. Tozuka (2008), Semiannual variation in the western tropical Pacific, *Geophys. Res. Lett., 35*, L16602, doi:10.1029/2008GL035058.
13. Yokoi, T., T. Tozuka, and T. Yamagata (2008), Seasonal variation of the Seychelles Dome, *J. Climate, 21*, 3740-3754.
14. Tozuka, T., J.-J. Luo, S. Masson, and T. Yamagata (2008), Tropical Indian Ocean variability revealed by self-organizing maps, *Clim. Dyn., 31*, 333-343.
15. Iskandar, I., T. Tozuka, Y. Masumoto, and T. Yamagata (2008), Impact of Indian Ocean Dipole on intraseasonal zonal currents at 90°E on the equator as revealed by self-organizing maps, *Geophys. Res. Lett., 35*, L14S03, doi:10.1029/2008GL033468.
16. Doi, T., T. Tozuka, H. Sasaki, Y. Masumoto, and T. Yamagata (2007), Seasonal and interannual variations of oceanic conditions in the Angola Dome, *J. Phys. Oceanogr., 37*, 2698-2713.
17. Tozuka, T., J.-J. Luo, S. Masson, and T. Yamagata (2007), Seasonally stratified analysis of simulated ENSO thermodynamics, *J. Climate, 20*, 4615-4627.

18. Tozuka, T., J.-J. Luo, S. Masson, and T. Yamagata (2007), Decadal modulations of the Indian Ocean Dipole in the SINTEX-F1 coupled GCM, *J. Climate, 20*, 2881-2894.

19. Tozuka, T., T. Qu, and T. Yamagata (2007), Dramatic impact of the South China Sea on the Indonesian Throughflow, *Geophys. Res. Lett., 34*, L12612, doi:10.1029/2007GL030420.

20. Iskandar, I., T. Tozuka, H. Sasaki, Y. Masumoto, and T. Yamagata (2006), Intraseasonal variations of surface and subsurface currents off Java as simulated in a high-resolution OGCM, *J. Geophys. Res., 111*, C12015, doi:10.1029/2006JC003486.

(2) Selected Conference Proceedings

(3) Review Papers

1. Beal, L., W. P. M. De Ruijter, A. Biastoch, R. Zahn, and SCOR/WCRP/IAPSO Working Group 136 (M. Cronin, J. Hermes, J. Lutjeharms, G. Quartly, T. Tozuka, S. Baker-Yeboah, T. Bornman, P. Cipollini, H. Dijkstra, I. Hall, W. Park, F. Peeters, P. Penven, H. Ridderinkhof, J. Zinke) (2011), On the role of the Agulhas system in ocean circulation and climate, *Nature, 472*, 429-436. (reviewed)

2. Tozuka, T., J.-J. Luo, S. Masson, T. Yamagata (2007), Decadal variability in the tropical Indian Ocean, *Gekkan Kaiyou, 39*, 677-682. (not reviewed)

3. Tozuka, T. (2006), Seasonal air-sea interaction in the Tropics, *Oceanography in Japan, 15*, 455-463. (not reviewed)

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Tozuka, T., A. Biastoch, P. Penven, W. Sasaki, J.-J. Luo, and T. Yamagata, An overview of ocean and coupled models, 2nd DBCP Africa/Western Indian Ocean Capacity Building Workshop, May 2011, Mauritius, invited.

3. Tozuka, T., Y. Morioka, and T. Yamagata, Subtropical Dipole Modes and their influence on the Southern African Region, International Symposium on "Roles of the Indo-Pacific Oceans in Climate Change and Variability in Commemoration of the 50th Anniversary of IOC/UNESCO", December 2010, Tokyo, oral.

4. Tozuka, T., T. Qu, and T. Yamagata, Role of the South China Sea throughflow in the global climate system, 2010 Western Pacific Geophysics Meeting, June 2010, Taipei, Taiwan, June 2010, invited.

5. Tozuka, T., T. Yokoi, and T. Yamagata, Simulated interannual variations of the Seychelles Dome, 2010 Ocean Sciences Meeting, February 2010, Portland, USA, oral.

6. Tozuka, T., J.-J. Luo, S. Masson, and T. Yamagata, Tropical Indian Ocean climate variability revealed by self-organizing maps, 2008 Western Pacific Geophysics Meeting, July 2008, Cairns, Australia, oral.

7. Tozuka, T., T. Qu, and T. Yamagata, Influences of the South China Sea throughflow on seasonal and interannual variations of the Indonesian Throughflow, 2008 Western Pacific Geophysics Meeting, July 2008, Cairns, Australia, oral.

8. Tozuka, T., and T. Yamagata, Permanent El Niño and Indian Ocean Dipole in Pliocene, Conference on Milankovitch cycles over the past 5 million years, March 2007, Trieste,

Italy, oral.

9. Tozuka, T., J.-J. Luo, S. Masson, and T. Yamagata, Decadal modulations of the Indian Ocean Dipole in the SINTEX-F1 coupled GCM, 2006 Ocean Sciences Meeting, February 2006, Hawaii, USA, oral.

In addition, 24 other presentations were made.

(2) Domestic Conferences

10. Tozuka, T., T. Qu, and T. Yamagata, A coupled modeling study on roles of South China Sea throughflow in the global climate, 2011 Japan Geoscience Union Meeting, May 2011, Makuhari, oral.

11. Tozuka, T., T. Qu, and T. Yamagata, A coupled general circulation model study on the South China Sea throughflow, 2010 Japanese Oceanographic Society Fall Meeting, September 2010, Abashiri, Hokkaido, oral.

12. Tozuka, T., Y. Morioka, and T. Yamagata, Indian Ocean Subtropical Dipole Mode and its influence on the Southern African Region, 2010 Japan Geoscience Union Meeting, May 2010, Makuhari, oral.

13. Tozuka, T., T. Doi, T. Miyasaka, and T. Yamagata, Simulation of the equatorial Atlantic sea surface temperature in a coupled general circulation models, 2010 Japanese Oceanographic Society Spring Meeting, March 2010, Tokyo, oral.

14. Tozuka, T., T. Yokoi, and T. Yamagata, Interannual variations of the Seychelles Dome, 2009 Japanese Oceanographic Society Spring Meeting, April 2009, Tokyo, oral.

15. Tozuka, T., T. Qu, and T. Yamagata, Impacts of the South China Sea throughflow on interannual variations of the Indonesian Throughflow, 2008 Japanese Oceanographic Society Fall Meeting, September 2008, Kure, Hiroshima, oral.

16. Tozuka, T., T. Qu, and T. Yamagata, Impacts of the South China Sea throughflow on the Indonesian Throughflow, 2007 Japanese Oceanographic Society Fall Meeting, September 2007, Naha, Okinawa, oral.

17. Tozuka, T., Seasonal ocean-atmosphere interactions in the tropics, 2006 Japanese Oceanographic Society Fall Meeting, March 2006, Yokohama, Kanagawa, invited.

In addition, 6 other presentations were made.

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Since I was promoted to an Associate Professor in November 2011, I did not officially supervise any graduate students before March 2012.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Geophysical Research Letters: Associate Editor (2009-2011)

· Journal of Oceanography: Editor (2011)

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Photo exhibition by Japan Science and Technology Agency/The World Bank, October 2011.

· Earth and Planetary Science Symposium on “Climate Variation – Past, Present, and Future”, “Another El Niño: Indian Ocean Dipole”, May 2009.

12. Internal and External Committee Memberships (2006-2011)

[External Committee]

· SCOR/WCRP/IAPSO Working Group 136 on “Climatic Importance of the Greater Agulhas System”, Full member

[Internal Committee]

· Public relations committee, Department of Earth and Planetary Science, Graduate School of Science, the University of Tokyo (2008-2011)

· Open campus committee, School of Science, the University of Tokyo (2009-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0 [M.Sc.: 0, Ph.D.: 0]

Foreign Researchers: 1 [France: 1]

Sending

Japanese Students: 0 [M.Sc.: 0, Ph.D.: 0]

Japanese Researchers: 0

Visitors from Abroad: 8 [South Africa: 7, U.S.A.: 1, France: 1]

Hiroaki Miura

I. C.V.

Name： Hiroaki Miura
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Science, Kyoto University, March, 1999
M. Sc., Science, The University of Tokyo, March, 2001
Ph. D., Science, The University of Tokyo, March, 2004

Professional Experience
April, 2004-Jan., 2008, Postdoctral Researcher, Frontier Research Center for Global Change, Japan Agency for Marine-Earth Science and Technology, Japan
Feb., 2008-Sep. 2009, Visiting Scientist, Department of Atmospheric Science, Colorado State University, USA
Oct. 2009-March 2012, Project Assistant Professor, Center for Climate System Research, University of Tokyo, Japan
April 2012-, Associate Professor, Graduate School of Science, University of Tokyo, Japan

II. Scientific Research Activity

2. Major achievements

I started the research on the next generation global climate model, which is called “the global cloud-resolving model”, since I was a Ph. D. student of University of Tokyo at 2002. After I got Ph. D. on the numerical modeling on the icosahedral geodesic grids at 2004, I became a postdoctoral researcher of Frontier Research Center for Global Change, Japan-Agency for Marine Earth Science and Technology, and joined the development team of a global cloud-resolving model named Non-hydrostatic Icosahedral Atmosphere Model (NICAM). I worked with Dr. Tomita and the other colleagues to realize the world first global cloud-resolving simulation under the “aquaplanet” condition on the Earth Simulator (Tomita et al. 2005, Geophys. Res. Lett.). Then, I investigated the climate sensitivity of NICAM and showed that NICAM was relatively less sensitive to the CO2 doubling than common climate models (Miura et al. 2005, Geophys. Res. Lett.). This work was introduced by the science journal “Science”.

Following these works, I achieved the world first global cloud-resolving simulation for a realistic atmospheric, ocean, and land condition and showed that a typhoon development was realistically simulated by NICAM (Miura et al. 2007a, Geophys. Res. Lett.). Then, I tried a simulation of the Madden-Julian Oscillation (MJO) event, which is a massive weather event in the tropics and is thought to be difficult to simulate with conventional climate models, and showed that NICAM had an ability to reproduce an MJO event quite realistically, including the generation of a tropical storm (Miura et al. 2007b, Science).

In addition to the above researches using NICAM, I conducted more fundamental study to improve numerical schemes for global cloud-resolving models. I proposed a new transport scheme for passive tracers on the spherical icosahedral geodesic grid (Miura 2007c), which simplified the scheme based on the Semi-Lagrangian method under the complex geometric of

the grid. This new scheme has been adopted not only by NICAM but also by several research institutes in USA and France and the meteorological prediction center of Germany. This work and another work to develop higher-order gradient operator on the hexagonal grid structure (Miura et al. 2007d) were recently followed by more accurate transport scheme by Miura and Skamarock (2012).

I visited Colorado State University (CSU) for two years from February 2008 and worked with Prof. David Randall to develop the new dynamical core of the global cloud-resolving model of CSU. We tried a new system of equations that eliminates the sound wave but still retains the compressibility that is not related to the sound wave. We successfully showed that the new equation system was applicable for the atmospheric models. My program code is used as a basis of the CSU model.

3. Five Important Papers in your career

1. Miura, H., M. Satoh, and M. Katsumata (2009), Spontaneous onset of a Madden-Julian oscillation event in a cloud-system-resolving simulation, *Geophys. Res. Lett.*, *36*, L13802, doi:10.1029/2009GL039056.

Cited by 7 papers

2. Miura, H., M. Satoh, T. Nasuno, A. Noda, and K. Oouchi (2007), A Madden-Julian oscillation event realistically simulated by a global cloud-resolving model. *Science*, *318*, 1763-1765, doi: 10.1126/science.1148443.

Cited by 90 papers

3. Miura, H., M. Satoh, H. Tomita, A. Noda, T. Nasuno, and S. Iga (2007), A short-duration global cloud-resolving simulation with a realistic land and sea distribution, *Geophys. Res. Lett.*, *34*, L02804, doi:10.1029/2006GL027448.

Cited by 28 papers

4. Miura, H. (2007), An upwind-biased conservative advection scheme for spherical hexagonal–pentagonal grids, *Mon. Weather Rev.*, *135*, 4038-4044.

Cited by 14 papers

5. Miura, H. Tomita, T. Nasuno, S. Iga, M. Satoh, and T. Matsuno (2005), A climate sensitivity test using a global cloud resolving model under an aqua planet condition. *Geophys. Res. Lett.*, **32**, L19717, doi:10.1029/2005GL023672.

Cited by 44 papers

4. Awards and Honors throughout your career

· 2008 Yamamoto-Syono Award for Outstanding Papers, Meteorological Society of Japan

5. Future Research Plan

I worked on the research topics relating to global cloud-resolving models for the last 6 years. I worked on the super-computer to perform simulations and also developed new numerical schemes. The one side of my research will be also about the global cloud-resolving model in the new 6 years. In addition, as the other side, I am planning to research to deepen the understanding about the organization of convection.

About the global cloud-resolving model, I am working with RIKEN Advanced Institute for Computational Science, where the new super-computer "K" is placed, to realize further high-resolution simulation of the atmosphere. The "high-resolution" simulation on the Earth Simulator could not simulate the entrainment and detrainment process around the boundary between clouds and their environment. It is expected that the next high-resolution run, "global LES", enables simulation of such turbulent processes and improve simulation of clouds.

One way to use "K" is to address higher-resolution, but the other is to increase robustness of the global cloud-resolving model. Until now, the global cloud-resolving simulations were just demonstrations of the ability of the model because the computer resources required for the simulations were very close to the upper limit of the super-computers. By using "K", we can run the model for longer time and for more cases. We have already started a work to run a large number of simulations to check robustness of the representation of the Madden-Julian Oscillation events in a global cloud-resolving model.

Using the fast computers, I want to research about the organization of convection. It is still not understood which and how atmospheric conditions are responsible for the organization of deep cumulus clouds. Simple radiative-convective equilibrium simulations may be the starting point.

6. Funding Received

(1) JSPS Grants

· Young Scientists (B) of MEXT (No. 22740310) (April 2010-March 2013)

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Miura, H., M. Satoh, and M. Katsumata (2009), Spontaneous onset of a Madden-Julian oscillation event in a cloud-system-resolving simulation, *Geophys. Res. Lett.*, *36*, L13802, doi:10.1029/2009GL039056.
2. Miura, H., M. Satoh, T. Nasuno, A. Noda, and K. Oouchi (2007), A Madden-Julian oscillation event realistically simulated by a global cloud-resolving model. *Science*, *318*, 1763-1765, doi:10.1126/science.1148443.
3. Miura, H., M. Satoh, H. Tomita, A. Noda, T. Nasuno, and S. Iga (2007), A short-duration global cloud-resolving simulation with a realistic land and sea distribution, *Geophys. Res. Lett.*, *34*, L02804, doi:10.1029/2006GL027448.
4. Miura, H. (2007), An upwind-biased conservative advection scheme for spherical hexagonal–pentagonal grids, *Mon. Weather Rev.*, *135*, 4038-4044.
5. Miura, H. (2007), A fourth-order centered finite-volume scheme for regular hexagonal grids, *Mon. Weather, Rev.*, *135*, 4030-4037.

and 21 papers as a co-author.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Hiroaki Miura: Cloud-resolving modeling and its potential for climate study, Korea-Japan Joint Workshop on Climate System Modeling, 2010-09-27, Ansan, Korea.（Invited）
2. Hiroaki Miura, T. Inoue, and M. Satoh: A global cloud-system-resolving simulation and its validation by satellite data sets, 2010-06-23, Western Pacific Geophysical Meeting, Taipei, Taiwan.（Invited）
3. Hiroaki Miura and M. Satoh: Global cloud-system-resolving simulations of an eastward propagation and a spontaneous onset of the Madden-Julian oscillation, 2010-06-23, Western Pacific Geophysical Meeting, Taipei, Taiwan.（Invited）
4. Hiroaki Miura: Challenge in modeling tropical convection and clouds in very high-resolution models and implications for climate prediction, 2009 Japan-America Frontiers of Engineering Symposium, 2009-11-9 to 2009-11-11, Irvine, California, USA.（Invited）
5. Hiroaki Miura: A Madden-Julian oscillation simulation using a global cloud-resolving model, The 12th US Japan Workshop on Global Change: Long-term Projection, Near-term Prediction, Extreme Events Projection and Observations, 2008-06-30 to 2008-07-02, Bloomfield, Colorado, USA.（Invited）
6. Hiroaki Miura: High-resolution simulations using a global cloud-resolving model, JSPS-DFG Round Table on 'Climate System Research – Status and Perspective', 2008-01-15 to 2008-01-18, Hamburg, Germany.（Invited）
7. Hiroaki Miura: A global cloud resolving simulation and its validation using satellite observations, 2006 Western Pacific Geophysics Meeting, 2006-07-24, Beijing, China.（Invited）
8. Hiroaki Miura, Masaki Satoh, Hirofumi Tomita, Tomoe Nasuno, and Shin-ichi Iga: A global cloud resolving simulation and sensitivity to horizontal resolution, 2006 Western Pacific Geophysics Meeting, 2006-07-24, Beijing, China.（Invited）

and 12 presentations with no invitation.

(2) Domestic Conferences

9. Hiroaki Miura: Study on the Madden-Julian Oscillation using a global cloud-resolving model, 2008 Fall meeting of Japan Meteorological Society, 2008-11-20, Sendai, Japan. (Invited)

and 4 presentations with no invitation.

III. Educational Activity (2002-2011)

9. Notable achievements in education

· N/A (starting education career from 2012)

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Tokio Marine & Nichido Fire Insurance Co., Ltd. Seminar, 2011-01-14

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

N/A (starting education career from 2012)
Hosting
Foreign Students:
Foreign Researchers:
Sending
Japanese Students:
Japanese Researchers:
Visitors from Abroad:

Yuki Tanaka

I. C.V.

Name： Yuki Tanaka
Present Position: Assistant Professor, Graduate School of Science, The University of Tokyo

Education

B. Sc., Geophysics, The University of Tokyo, March, 2005
M. Sc., Geophysics, The University of Tokyo, March, 2007
Ph. D., Geophysics, The University of Tokyo, March, 2010

Professional Experience

April, 2008–Mar., 2010, Research Fellow of the Japan Society for the Promotion of Science (DC2), Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, Japan.
April, 2010–Mar., 2012, Research Fellow, Atmosphere and Ocean Research Institute, The University of Tokyo, Japan.
April, 2012–, Assistant Professor, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, Japan

II. Scientific Research Activity

2. Major achievements

The Kuril Straits separating the Okhotsk Sea from the North Pacific Ocean are representative regions of tide-induced strong diapycnal mixing in the world's oceans. Tidal mixing in the Kuril Straits is considered as one of the essential factors controlling the formation of the North Pacific Intermediate Water (NPIW) by creating the source water and enhancing its southward transport. Actually, the realistic distribution of the NPIW has been reproduced in an ocean general circulation model (OGCM) only when large diapycnal diffusivity ~200 cm^2 s^{-1} is assumed to exist over the whole Kuril Straits. The spatial distribution of diapycnal diffusivity in the Kuril Straits, however, remains unknown although both the observational and numerical studies have shown that diapycnal diffusivity exceeding 1000 cm^2 s^{-1} exists locally. In the present study, definite quantification of diapycnal diffusivity in the Kuril Straits is carried out in terms of the amount of energy lost from the barotropic tides to internal waves. In addition, incorporating the obtained diapycnal diffusivity into an OGCM, we assess the impact of tidal mixing in the Kuril Straits on the formation of NPIW.

We first carry out numerical simulation of the tidal elevation field in the Okhotsk Sea using a barotropic tide model. It is found that, in order to reproduce the satellite-observed tidal elevation field in the Okhotsk Sea, the energy lost from the incoming barotropic tides to internal waves should be taken into account within the Kuril Straits. The numerical experiments show that the model predicted tidal elevations in the Okhotsk Sea best fit the TOPEX/POSEIDON altimeter data by considering the baroclinic energy conversion in the Kuril Straits ~16 GW for the predominant K1 tidal constituent and ~37 GW for the major four tidal constituents (K1, O1, M2, S2).

We next drive a three-dimensional numerical model to examine propagation and dissipation features of the generated internal tides. It is shown that most of the internal wave

energy subtracted from the predominant K1 barotropic tide is dissipated near the Kuril Straits such that the local dissipation efficiency becomes ~1.0, about three times the value widely used. This is because the K1 tidal frequency is subinertial in this area so that significant amount of K1 tidal energy is fed into coastal trapped waves (CTWs) which stay around each island without propagating away from the straits. CTWs induce strong velocity shear near the ocean bottom causing bottom-confined intense mixing with a vertical decay scale ~200 m, less than half the value widely used. Although this results in large diapycnal diffusivity exceeding 1000 cm^2 s^{-1} near the bottom in the limited areas, the averaged value over the whole Kuril Straits is estimated as ~25 cm^2 s^{-1}, an order of magnitude less than assumed for the Kuril Straits in the existing OGCMs.

Finally, to accurately assess the effects of tidal mixing in the Kuril Straits on the formation of NPIW, we incorporate the above estimated diapycnal diffusivity into an eddy-permitting OGCM. It is shown that the NPIW is well reproduced, although the increase of the thermohaline circulation in the North Pacific and the decrease of salinity of the NPIW are both an order of magnitude less than attributed to the effect of tidal mixing in the Kuril Straits in low-resolution OGCMs. This implies that the effect of tidal mixing in the Kuril Straits on the formation of NPIW is minor and missing processes in low-resolution OGCMs such as isopycnal mixing are more important.

3. Five Important Papers in your career

1. Tanaka, Y., I. Yasuda, H. Hasumi, H. Tatebe, and S. Osafune (2012), Effects of the 18.6-year modulation of tidal mixing on the North Pacific bidecadal climate variability in a coupled climate model, *J. Clim., 25*, 7625–7642.

Reason: This study demonstrates a possibility that we can improve climate predictability by taking into account the modulation of tidal mixing in a coupled climate model.

2. Tanaka, Y., T. Hibiya, and Y. Niwa (2010), Assessment of the effects of tidal mixing in the Kuril Straits on the formation of the North Pacific Intermediate Water, *J. Phys. Oceanogr.*, *40*, 2569–2574.

Reason: This study gives a warning against using diapycnal diffusivity just as a tuning parameter to reproduce desirable results in an ocean general circulation model.

3. Tanaka, Y., T. Hibiya, Y. Niwa, and N. Iwamae (2010), Numerical study of K_1 internal tides in the Kuril straits, *J. Geophys. Res.*, *115*, C09016, doi:10.1029/2009JC005903.

Reason: This study shows that diurnal internal tides, which nave not been studied well, have unique physical characteristics compared to semidiurnal ones.

4. Tanaka, Y., T. Hibiya, and Y. Niwa (2007), Estimates of tidal energy dissipation and diapycnal diffusivity in the Kuril Straits using TOPEX/POSEIDON altimeter data, *J. Geophys. Res.*, *112*, C10021, doi:10.1029/2007JC004172.

Reason: This study demonstrates that combining satellite altimeter data with tide-model allows us to estimate spatial distribution of tide-induced vertical mixing.

4. Awards and Honors throughout your career

5. Future Research Plan

Vertical mixing in the deep ocean is one of the most important processes that control global thermohaline circulation as well as the associated water mass formation and transportation, and hence the global climate. Based on climatological data, it is estimated that ~2.1 TW of power is required for the turbulent mixing processes in the abyssal ocean to sustain the observed volume transport of the global thermohaline circulation against the vertical distribution of temperature and salinity in the global ocean. The main source of this power has been thought to be internal tides that are generated by barotropic tidal flow impinging on rough bottom bathymetry and near-inertial internal waves that are generated by wind stress fluctuations at the sea surface. However, recent high-resolution numerical modeling studies have shown that, although tide-topography interaction can generate internal tide energy as much as ~1.1 TW, only ~0.6 TW of this energy is available for abyssal ocean mixing, and that although wind stress fluctuations can generate near-inertial internal wave energy as much as ~0.7 TW, most of this energy is dissipated within surface mixed layer, remaining only ~0.1 TW to mix the abyssal ocean. As a result, it is now becoming widely recognized that the above two processes cannot supply enough energy to sustain the observed amount of the global thermohaline circulation.

On the other hand, it is also known that wind stress supplies a large amount of energy not only for directly generating near-inertial internal waves but also for forming basin-scale geostrophic circulation. This energy supply is estimated to reach ~1.0 TW, which is believed to be finally lost to dissipation processes through meso-scale eddies with horizontal scales of ~100 km generated by baroclinic instability of the wind-driven geostrophic flow. However, it is not revealed how this energy is transferred from meso-scale eddies to turbulent mixing and where it is lost to dissipation contributing to the vertical mixing processes to sustain the thermohaline circulation.

We are now planning to investigate roles of the meso-scale eddies as potential sources of mechanical energy supply that can make up for the above-described lack of the turbulent energy dissipation in the deep ocean. Special attention will be directed to internal waves generated by eddy flow impinging on rough bottom topography and those generated through geostrophic adjustment processes during life cycles of eddies. First, we perform numerical experiments using a global ocean general circulation model that can simultaneously resolve meso-scale eddies and low vertical mode internal waves, which experiments will be forced by realistic surface wind stress. The global distribution of the eddy-induced internal wave characteristics such as frequency, wavenumber, and energy density is examined. Furthermore, we calculate energy flux of the eddy-induced internal waves propagating down into deep oceans as well as energy flux divergence to reveal where the internal waves are generated and dissipated. Next, we perform numerical experiments using a higher-resolution non-hydrostatic regional ocean model under idealized situations to investigate physical processes responsible for the generation, propagation, and dissipation of the internal waves. In particular, sensitivity of the internal wave energy generation rate to various parameters such as the Rossby number, and effects of eddy-internal wave interaction will be examined.

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for JSPS Fellows, Parameterization of boundary mixing processes toward improvement of ocean general circulation model, 2008–2009, ¥1,200,000

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Tanaka, Y., I. Yasuda, H. Hasumi, H. Tatebe, and S. Osafune (2012), Effects of the 18.6-year modulation of tidal mixing on the North Pacific bidecadal climate variability in a coupled climate model, *J. Clim., 25*, 7625–7642.
2. Tanaka, Y., T. Hibiya, and Y. Niwa (2010), Assessment of the effects of tidal mixing in the Kuril Straits on the formation of the North Pacific Intermediate Water, *J. Phys. Oceanogr.*, *40*, 2569–2574.
3. Tanaka, Y., T. Hibiya, Y. Niwa, and N. Iwamae (2010), Numerical study of K_1 internal tides in the Kuril straits, *J. Geophys. Res.*, *115*, C09016, doi:10.1029/2009JC005903.
4. Tanaka, Y., T. Hibiya, and Y. Niwa (2007), Estimates of tidal energy dissipation and diapycnal diffusivity in the Kuril Straits using TOPEX/POSEIDON altimeter data, *J. Geophys. Res.*, *112*, C10021, doi:10.1029/2007JC004172.
5. Nagasawa, M., T. Hibiya, K. Yokota, Y. Tanaka, and S. Takagi (2007), Microstructure measurements in the mid-depth waters of the North Pacific, *Geophys. Res. Lett.*, *34*, L05608, doi:10.1029/2006GL028695.

(2) Selected Conference Proceedings

(3) Review Papers

(Non-refereed)

1. Tanaka, Y., I. Yasuda, H. Hasumi, H. Tatebe, and S. Osafune (2012), Effects of the 18.6-year modulation of tidal mixing on the North Pacific bidecadal climate variability in a coupled climate model, *Kaiyo Monthly*, *44*(8), 452–459 (in Japanese).
2. Tanaka, Y., T. Hibiya, and Y. Niwa (2011), Numerical study of tidal mixing in the Kuril Straits, *Kaiyo Monthly*, *43*(11), 673–681 (in Japanese).

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Tanaka, Y., I. Yasuda, H. Hasumi, H. Tatebe, and S. Osafune, Effects of the 18.6-year modulation of tidal mixing on bidecadal climate variability in the North Pacific, Ocean Sciences Meeting, Salt lake City, USA, February 2012.
2. Tanaka, Y., T. Hibiya, and Y. Niwa, Assessment of the effects of tidal mixing in the Kuril Straits on the formation of the North Pacific Intermediate Water, International Union of Geodesy and Geophysics, Melbourne, Australia, June 2011.
3. Tanaka, Y., T. Hibiya, Y. Niwa, and N. Iwamae, Numerical study of K_1 internal tides in the Kuril Straits, Ocean Sciences Meeting, Portland, USA, February 2010.
4. Tanaka, Y., T. Hibiya, and Y. Niwa, Estimates of tidal energy dissipation and diapycnal

diffusivity in the Kuril Straits using TOPEX/POSEIDON altimeter data, Japan-Korea Joint Seminar on Physical Process in the Ocean and its Parameterization, Tokyo, Japan, December 2007.

5. Tanaka, Y., T. Hibiya, and Y. Niwa, Estimates of tidal energy dissipation and diapycnal diffusivity in the Kuril Straits using TOPEX/Poseidon altimeter data, International Union of Geodesy and Geophysics, Perugia, Italy, July 2007.

and 38 other talks

(2) Domestic Conferences

6 oral and 1 poster presentations, all in Japanese.

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 1 (Myself, The Overseas Internship Program for Outstanding Young Earth and Planetary Researchers)

Visitors from Abroad: 0

Yoshihiro Niwa

I. C.V.

Name： Yoshihiro Niwa
Present Position: Project Associate Professor, University of Tokyo, Graduate School of Science

Education
B. Sc. in Geophysics, Hokkaido University, March, 1993
M. Sc. in Geophysics, Hokkaido University, March, 1995
Ph. D. in Geophysics, Hokkaido University, March, 1998

Professional Experience
April, 1998-Mar., 1999, Research Fellow of the Japan Society for the Promotion of Science, Ocean Reserch Institute, The University of Tokyo, Japan
April, 1999-Mar., 2002, Research Fellow of the Japan Society for the Promotion of Science, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, Japan
April, 2002-Mar., 2007, Research Associate, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, Japan
April, 2007-Feb., 2011, Assistant Professor, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, Japan
Feb, 2011-, Project Associate Professor, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo, Japan

II. Scientific Research Activity

2. Major achievements

The global mapping of diapycnal diffusivity in the deep ocean is essential to improve the ability of global ocean circulation models in predicting future climate changes. First, we have carried out numerical experiments to clarify that the cascade of energy supplied from the semidiurnal internal tide and atmospheric disturbances through the deep ocean internal wave spectrum down to dissipation scales is dominated by the internal wave-wave interaction termed *parametric subharmonic instability* which transfers energy from low-vertical wavenumber internal waves with twice the local near-inertial frequency to high-vertical wavenumber internal waves with the local near-inertial frequency. We have also carried out separate numerical experiments to find that wind-induced internal wave energy is mostly dissipated within the upper 150 m depth so that the major energy source for diapycnal diffusivity in the deep ocean is the semidiurnal internal tides. This implies that enhanced fine-scale near-inertial current shear causing strong diapycnal diffusivity will not be found at latitudes farther than about 30° from the equator where the diurnal tidal frequency is less than the local inertial frequency so that a resonant triad of internal waves for *parametric subharmonic instability* cannot be formed. This theoretical prediction has been validated through detailed expendable current profiler (XCP) surveys throughout the world's oceans. Furthermore, based on the results of the XCP surveys, an empirical relationship has been found between the diapycnal diffusivity inferred using fine-s Internal waves are ubiquitous phenomena in the global ocean with the scales ranging from mesoscales to microscales. They are generated mainly by tide-topography interactions (internal

tides) and atmospheric disturbances. It is widely recognized that internal waves play crucial roles in the ocean dynamics. Internal wave energy, generated at large scales, is cascaded across the internal wave spectrum down to small dissipation scales through nonlinear wave-wave interactions causing diapycnal mixing in the deep ocean. Thus induced diapycnal mixing has a strong influence on the global-scale thermohaline circulation. Hence, clarifying the global distribution of the diapycnal diffusivity is essential for accurate modeling of the thermohaline circulation and hence climate.

As a basic study for this subject, we have carried out, for the first time, the numerical model simulation of the global internal tide fields [Niwa and Hibiya, 2001], which showed that the global distribution of internal tide energy is highly inhomogeneous reflecting the fact that the generation of energetic internal tides is restricted over a limited number of prominent bottom topographic features. The detailed structure and energy budget of internal tide field around the prominent topographic features have been investigated in the East China Sea [Niwa and Hibiya, 2004] and the Kuril Islands [Tanaka et al., 2007]. Furthermore, based on the results of the global numerical model simulations, we have made a first quantitative estimate of internal tide energy available for the deep ocean mixing that sustains the thermohaline circulation [Niwa and Hibiya, 2011]. We also have carried out a there-dimensional numerical model simulation to investigate the distribution of wind-induced internal waves in the world's ocean, which indicated that the generation of energetic near-inertial internal waves is also limited in the restricted region along the mid-latitude storm tracks [Furuichi et al., 2008].

Additionally, we have investigated the energy cascade processes in the ocean internal wave field. It has been demonstrated that the universal equilibrium internal wave spectrum is created and maintained only when energy is supplied both from the wind-induced near-inertial forcing and the semidiurnal tidal forcing [Sugiyama, et al., 2008]. Furthermore, we have shown that the energy cascade of the low-mode semidiurnal internal tide waves is promoted only in the latitudes below 30° which is consistent with the nonlinear resonant interaction mechanism called "Parametric Subharmonic Instability"(PSI) [Furuichi et al., 2005]. These results suggest that the distribution of the diapycnal diffusivity in the global ocean is strongly anisotropic depending on the latitude, as well as the generation sites of large-scale internal waves.

3. Five Important Papers in your career

1. Niwa Y., and T. Hibiya (1997), Nonlinear processes of energy transfer from traveling hurricanes to the deep ocean internal wave field, *J. Geophys. Res.*, **102**, 12469-12477.

The first paper pointing out the possibility that double-inertial internal waves can be effectively generated by travelling atmospheric disturbances. Times cited: 18

2. Niwa Y., and T. Hibiya (1999), Response of the deep ocean internal wave field to traveling midlatitude storms as observed in long term current measurements *J. Geophys. Res.*, **104**, 10981-10989.

The first paper showing that travelling storms actually generate double-inertial internal waves in the real ocean. Times cited: 17

3. Niwa Y., and T. Hibiya (2001), Numerical study of the spatial distribution of the M_2 internal tide in the Pacific Ocean, *J. Geophys. Res.*, **106**, 22441-22449.

The first numerical model simulation reproducing the internal tide field in the Pacific Ocean. Times cited: 76

4. Niwa Y., and T. Hibiya (2004), Three-dimensional numerical simulation of M2 internal

tides in the East China Sea, *J. Geophys. Res.*, **109**, 22441-22449, DOI: 10.1029/2003JC001923.

The first paper investigating the internal tide field and its energetics around the East China Sea. Times cited: 62

5. Niwa Y., and T. Hibiya (2011), Estimation of baroclinic tide energy available for deep ocean mixing based on three-dimensional global simulations, *J. Oceanogr.*, **67**, 493-502, DOI: 10.1007/s10872-011-0052-1.

The first paper that quantitatively estimates internal tide energy available deep ocean mixing based on global numerical model simulations. Times cited: 3

4. Awards and Honors throughout your career

· Yoshihiro Niwa, Numerical studies about the global distribution of internal wave energy available for deep ocean mixing, The Okada Prize, The oceanographic society of Japan, 28 March 2004.

5. Future Research Plan

Our final goal is to clarify the distribution of small-scale diapycnal diffusivity in the global ocean. For this goal, we will continue to investigate quantitatively more in detail the energy transfer processes of the global internal wave field from large-scale generation down to small-scale dissipation. Specifically, the following topics will be addressed.

(1) Numerical experiments reproducing the global internal wave field

The global internal wave field is maintained by the energy balance between multiple physical processes, e.g. generation of large-scale internal waves by tidal and wind stress forcing, their long-range propagation, nonlinear energy cascade from large to small scales within the background internal wave spectrum, and dissipation of small-scale internal waves. For full understanding of the global internal wave field, we will try to numerically reproduce these multiple physical processes in a vertically two-dimensional high-resolution numerical model covering a wide latitudinal range from the equator to high latitudes, and investigate the interplay between each physical process to maintain the equilibrium state of the global internal wave spectrum. Especially, we try to identify the factors controlling the energy level of the internal wave spectrum, because it is strongly correlated with the strength of small-scale diapycnal diffusivity.

(2) Quantitative evaluation of the energy cascade processes across internal wave spectrum

We will try to numerically reproduce the Garrett-Munk-like equilibrium internal wave spectrum in a three-dimensional very high-resolution numerical model, and then quantitatively evaluate how much of internal wave energy is cascaded down to small dissipation scales by nonlinear interactions within the internal wave spectrum. Especially, by conducting the numerical experiments with changing the factors identified in the experiment ① as influencing the energy level of the internal wave spectrum, We will try to propose the parameterization that relates the value of each factor with the small-scale diapycnal diffusivity.

(3) Investigating the turbulent mixing processes near the generation sites of internal waves

It is well known that significant generation sites of intense internal waves, such as prominent topographic features and near-surface mixed layer under storm tracks, become mixing hot spots. We will investigate the physical processes causing the mixing hot spots using a newly developed VLES (very large eddy simulation) model, and try to develop a new

parameterization schemes for diapycnal diffusivity applicable in the mixing hot spots.

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for Young Scientists (B), Investigating the formation processes of ocean internal wave spectrum toward the parameterization of deep ocean mixing, F.Y. 2007-2010, JPY3700K.

· Scientific Research (C), Investigating the turbulent mixing processes near the generation sites of ocean internal waves by using a VLES (very large eddy simulation) model, F.Y. 2010-2012, JPY 4030K.

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Iwamae N., T. Hibiya, and Y. Niwa (2006), Numerical study of enhanced energy dissipation near a seamount, *J. Oceanogr.*, **62**, 851-858.
2. Hibiya T., M. Nagasawa, and Y. Niwa(2006), Global mapping of diapycnal diffusivity in the deep ocean based on the results of expendable current profiler (XCP) surveys, *Geophys. Res. Lett.*, **33**, doi:10.1029/2005GL025218.
3. Tanaka Y., T. Hibiya, and Y. Niwa (2007), Estimates of tidal energy dissipation and diapycnal diffusivity in the Kuril Straits using TOPEX/POSEIDON altimeter data, *J. Geophys. Res.*, **112**, doi: 10.1029/2007JC004172.
4. Hibiya T., M. Nagasawa, and Y. Niwa (2007), Latitudinal dependence of diapycnal diffusivity in the thermocline observed using a microstructure profiler, *Geophys. Res. Lett.*, **34**, doi: 10.1029/2007GL032323.
5. Furuichi N., T. Hibiya, and Y. Niwa (2008), Model-predicted distribution of wind-induced internal wave energy in the world's oceans, *J. Geophys. Res.*, **113**, doi:10.1029/2008JC004768.
6. Sugiyama Y., Y. Niwa, and T. Hibiya (2009), Numerically reproduced internal wave spectra in the deep ocean, *Geophys. Res. Lett.*, **36**, doi: 10.1029/2008GL036825.
7. Tanaka Y., T. Hibiya, Y. Niwa, and N. Iwamae (2010), Numerical study of K_1 internal tides in the Kuril Straits, *J. Geophys. Res.*, **115**, doi:10.1029/2009JC005903.
8. Tanaka Y., T. Hibiya, and Y. Niwa (2010), Assessment of the effect of tidal mixing in the Kuril Straits on the formation of the North Pacific Intermediate Water, *J. Phys. Oceanogr.*, **40**, 2569–2574.
9. Niwa Y., and T. Hibiya (2011), Estimation of baroclinic tide energy available for deep ocean mixing based on three-dimensional global simulations, *J. Oceanogr.*, **67**, 493-502, doi: 10.1007/s10872-011-0052-1.

(2) Selected Conference Proceedings

1. Niwa Y., T. Hibiya (2009), Numerically predicted distribution of the global internal tide

energy, *Proceeding of 23rd CFD symposium*, D-53 (in Japanese)

(3) Review Papers

1. Niwa Y. (2006), Numerical studies about the global distribution of internal wave energy available for deep ocean mixing, *Umi no Kenkyu*, **15**, 395-417 (in Japanese) (Non-refereed)

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Niwa Y. and T. Hibiya, Numerically predicted distribution of internal tide energy in the global ocean, 2010 Fall Meeting・American Geophysical Union, 13-17 Dec. 2010, San Francisco [general]
2. Niwa Y. and T. Hibiya, Estimation of internal tide energy available for deep ocean mixing based on three-dimensional global numerical simulations, The 16th Pacific-Asian Marginal Seas Meeting, 21-23 Apr. 2011, Taipei [invited]
3. Niwa Y. and T. Hibiya, Estimation of baroclinic tide energy available for deep ocean mixing based on three-dimensional global numerical simulations, 2012 Ocean Sciences Meeting・American Geophysical Union, 20-24 Feb. 2012, Salt Lake City [general]

(2) Domestic Conferences

4. Niwa Y. and T. Hibiya, Numerical simulation of the global internal tide field, JOS Fall Meeting・The Oceanographic Society of Japan, 24-28 Sept. 2008, Kure campus of Hiroshima International University [general]
5. Niwa Y. and T. Hibiya, Estimation of internal tide energy based on the global numerical simulation and its sensitivity to the horizontal grid resolution, JOS Fall Meeting・The Oceanographic Society of Japan, 26-30 Sept. 2011, Chikushi campus of Kyushu University [general]

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

- Niwa, Y., Marine education based on Tsunami simulation, Public Symposium: Marine education for disaster prevention・The University of Tokyo Ocean Alliance, 27 Aug. 2011, The University of Tokyo Yayoi auditorium.

· Niwa, Y., Visiting lecture at Oita Tomei High School, 7 Dec. 2011, Oita

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers:0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 0

Pascal Oettli

I. C.V.

Name : Pascal Oettli
Present Position: Project Assistant Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Geography, L'université Paris Diderot, March, 2001
M. Sc., Geography, Université de Bourgogne, March, 2002
Ph. D., Geography, Université de Bourgogne, July, 2008

Professional Experience
Jan., 2009-Sept., 2010, Post-Doctoral position at the "Laboratoire d'Oceanographie et du Climat : Experimentations et Approches Numeriques" (LOCEAN), Paris
Oct., 2010, Project Assistant Professor, University of Tokyo, Graduate School of Science

II. Scientific Research Activity

2. Major achievements

1. A better understanding of the influence of topography on rainfall spatial distribution, for an optimal interpolation

That work had two aims: a better understanding of the influence of topography on the spatial distribution of rainfall and an optimal interpolation of station rainfall data, taking into account topography.

First, a statistical model was defined, with the help of a multi-scalar decomposition of topographical information into descriptors. This model was used to better understand the relationship between rainfall and topography.

Second, the errors of the statistical modeling were interpolated with the help of geostatistical modeling. The result is a multiplicative model, used to reconstitute monthly mean rainfall fields, for each region. The corresponding maps demonstrate the capacity of the model to reproduce spatial variability of mean monthly rainfall, especially in Eastern Africa.

2. Reducing bias in regional climate modeling, a compulsory step for crop modeling

First, the analyze of crop yields simulations in future climate (SRES A1B) have shown that for the present-day analysis, some climatic parameters, as precipitation or downward radiation, have important biases. For the future period climate, first results have shown a decrease in crop yields, at country scale (about 16%), with a south/north gradient. Yields are estimated to be between 5 and 25% below the 1990-2010 mean.

Second, promising results are obtained by applying a bias correction technique (CDFt) to biased outputs. Simulated yields with bias corrected climate variables show much more realistic means and standard deviations.

3. The Madden-Julian Oscillation in central tropical Indian Ocean, a key factor for the rainfall intraseasonal variability in Southern Africa

The Madden-Julian oscillation (MJO) is the dominant mode of the intraseasonal variability in the tropical atmosphere. By introducing a non-linear classification, the self-organizing map (SOM), the description of the MJO activity and seasonality is enhanced, providing more temporal and spatial information, complimentary to the usual Real-time Multivariate MJO index

(RMM).

Based on the previous classification, main results show the existence of a relation between the MJO and the rainfall over the SAR at the MJO time scale (around 52 days). They also show the delayed effect of the MJO on subtropical atmosphere dynamic (around 10 days after), when the MJO is located between 65° and 85°E, in the tropical band. This emphasizes the need for a better understanding of the interactions between tropics and subtropics to enhance numerical modeling and forecasting.

3. Five Important Papers in your career

1. Oettli, P., and P. Camberlin (2005), Influence of topography on monthly rainfall distribution over East Africa, *Clim. Res.*, *28*(2), 199-212, doi:10.3354/cr028199.

A simple but efficient modeling of the rainfall taking into account the topography at monthly time scale

2. Castel, T., and P. Oettli (2008), Sensitivity of the C-band SRTM DEM Vertical Accuracy to Terrain Characteristics and Spatial Resolution, in *Headway in spatial data handling*, edited by A. Ruas and C. Gold, pp. 163-176, Springer, Berlin.

An improvement of the digital topography from satellite observation

3. Camberlin, P., B. Fontaine, S. Louvet, P. Oettli, and P. Valimba (2010), Climate adjustments over Africa accompanying the Indian monsoon onset, *J. Climate*, *23*(8), 2047–2064, doi:10.1175/2009JCLI3302.1.

A better knowledge of the relationships between Africa and Indian Monsoon with the help of the topography

4. Oettli, P., B. Sultan, C. Baron, and M. Vrac (2011), Are regional climate model relevant for crop yield prediction in West Africa?, *Environ. Res. Lett.*, *6*(1), doi:10.1088/1748-9326/6/1/014008.

A compulsory step for a better use of regional climate model for applications

4. Awards and Honors throughout your career

· Best young scientist's poster ("*Assessment of RCM output from the ENSEMBLE RT3 project in AMMA-region: focus on Senegal actual reproduction and effects on simulated crop yields."*), International conference "Water 2010", 2010, Quebec, Canada.

5. Future Research Plan

1. Improving the early warning system for maize culture in South Africa by using a crop model driven by seasonal climate predictions

The rainfed agriculture is the world's predominant agriculture system. But this system is highly sensitive to the climate variability. In terms of food security, it is important to implement a reliable early warning system for farmers.

First, a test phase of the French crop model SARRAH will be performed in the Limpopo province. This phase will include the calibration of the model and a hindcasts of yields, in order to test the ability of the model to reproduce the observed maize yields for past years.

Second, if the first phase is successfully achieved, a prediction phase will be made. Using the seasonal climate predictions from the SINTEX-F coupled model, and their downscaled

versions from the regional climate model WRF, yields predictions of maize will be issued. They will be associated to predictions made by a purely statistical model.

2. Investigating the relationships between the Madden-Julian Oscillation and the Tropical-Temperate Troughs.

On the one hand, the Madden-Julian Oscillation (MJO) is the main mode of the intraseasonal variability of the convection in the Tropics. At this time scale, the MJO has an influence on the variability of the convection and the rainfall in the southern African region, with a lag of around 10 days. On the other hand, the Tropical-Temperate Troughs (TTTs) is the dominant rainfall-producing weather system over southern Africa during the austral summer, at the synoptic time scale.

Using a TTTs index recently developed at JAMSTEC, and in cooperation with the creator of this index, it appears to be interesting to investigate the possible link between the MJO and the TTTs, mainly for predictive purpose.

3. Clarifying the role of the Madden-Julian Oscillation on the rainfall in the southern African region by using a coupled General Circulation Model and exploring the potential predictability.

The MJO influences the variability of the convection over the southern African region, at the intraseasonal time scale. But the mechanisms of this influence still remain unclear. A region in the central tropical Indian Ocean (65°E-85°E / 10°S-10°N) appears to be the key to understand these mechanisms.

Using a coupled model and introducing variability in the traveling heating/cooling in the previously cited region, we might be able to explore the modification of the subtropical atmosphere, in response to the heating/cooling. This could be achieved in cooperation with the Council for Scientific and Industrial Research (CSIR) in the Republic of South Africa, using the coupled model CCAM.

6. Funding Received

(1) JSPS Grants

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Castel, T., P. Oettli (2008), Sensitivity of the C-band SRTM DEM Vertical Accuracy to Terrain Characteristics and Spatial Resolution, in *Headway in spatial data handling*, edited by A. Ruas and C. Gold, 163-176, Springer, Berlin.
2. Camberlin, P., B. Fontaine, S. Louvet, P. Oettli, and P. Valimba (2010), Climate adjustments over Africa accompanying the Indian monsoon onset, *J. Climate*, *23*(8), 2047–2064, doi:10.1175/2009JCLI3302.1.
3. Oettli, P., B. Sultan, C. Baron, and M. Vrac (2011), Are regional climate model relevant for crop yield prediction in West Africa?, *Environ. Res. Lett.*, *6*(1), doi:10.1088/1748-9326/6/1/014008.
4. Traoré, S.B., A. Alhassane, B. Muller, M. Kouressy, L. Somé, B. Sultan, P. Oettli, A. Berg,

A.C. Siéné Laopé, E. Vintrou, S. Sangaré, M. Vaksmann, M. Diop, A. Bégué, M. Dingkhun, C. Baron (2011), Characterizing and Modelling the Diversity of Cropping Situations under Climatic Constraints in West Africa, *Atmosph. Sci. Lett.*, *12*(1), 89-95, doi: 10.1002/asl.295.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Oettli P., Role of topography on rainfall distribution in tropical Africa: the case of East Africa, *INYS seminar "Climate-Society interactions: case studies from Africa",* January 9-12, 2006, Paris, France. Contributed
2. Castel T, Oettli P., Sensitivity of the C-band SRTM DEM vertical accuracy to terrain characteristics and spatial resolution, *SDH 2008 - The 13th International Symposium on Spatial Data Handling*, June 23-25, 2008, Montpellier, France. Contributed
3. Oettli P., 2010, Vaal-Orange Region: Relationships between monthly rainfall, sea-surface temperatures and atmospheric circulation for the period 1970-1999, *Mini-Workshop on Seasonal to Interannual Climate Variations*, November 30, 2010, Tokyo, Japan. Contributed
4. Oettli P., Sultan B., Baron C, Vrac M., Role of Climate Simulation in Crop Modeling of West Africa, *SATREPS Symposium on Climate Prediction and Iinformation for the Society*, December 17, 2010, Aizu, Japan. Contributed
5. Oettli P., Tozuka T., Izumo T., Yamagata T., Spatio-temporal structures of monthly OLR over the tropical region as revealed by a self-organizing map, *Mini-workshop on Simulation and Prediction of Climate Modes Influencing the Southern African Region*, March 15, 2011, Tokyo, Japan. Contributed
6. Oettli P., Tozuka T., Izumo T., Yamagata T., Spatial patterns of OLR anomalies over the tropical region at the intra-seasonal time scale, as revealed by a self-organizing map, *SATREPS Symposium on Prediction of Climate Variations and its Application in the Southern African Region*, August 22, 2011, Pretoria, South Africa. Contributed
7. Oettli P., Sultan B., Baron C, Vrac M., Reducing bias in regional climate modeling, a compulsory step for crop modeling, *SATREPS Symposium on Prediction of Climate Variations and its Application in the Southern African Region*, October 21, 2011, Tokyo, Japan. Contributed
8. Oettli P., Sultan B., Baron C, Vrac M, Reducing Bias in Regional Climate Modelling, a Compulsory Step for Crop Modelling, *SATREPS Workshop*, February 23, 2012, Tokyo, Japan. Contributed
9. Oettli P., Tozuka T., Izumo T., Yamagata T., Spatial patterns of intraseasonal OLR anomalies, as revealed by a self-organizing map. Influence on southern Africa rainfall, *10th International Conference on Southern Hemisphere Meteorology and Oceanography*, April 23, 2012, Noumea, New Caledonia. Contributed
10. Oettli P., Tozuka T., Izumo T., Yamagata T., Spatial patterns of tropical OLR intraseasonal anomalies, as revealed by a self-organizing map, *Japan Geoscience Union*

Meeting 2012, May 25, 2012, Chiba, Japan. Contributed

(2) Domestic Conferences

11. Oettli P., Camberlin P, Evolution saisonniere des relations precipitations/relief en Afrique orientale (in French), *XVII^e Colloque International de Climatologie*, September 8-10, 2004, Caen, France. Contributed
12. Oettli P., Camberlin P., Variabilite temporelle de l'influence du relief sur la distribution spatiale des precipitations mensuelles en Afrique de l'Est (in French), *Les Journees de la climatologie de la Commission "Climat et Societe"*, March 12, 2009, Besancon, France. Contributed

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students:

Foreign Researchers:

Sending

Japanese Students:

Japanese Researchers:

Visitors from Abroad:

Toshio Yamagata

I. C.V.

Name : Toshio Yamagata

Position : (retired on Mar. 31, 2012; now Emeritus Professor): Professor, Graduate School of Science

Education

B. Sc., Geophysics, The University of Tokyo, June, 1971

M. Sc., Geophysics, The University of Tokyo, March, 1973

Ph.D., Geophysics, The University of Tokyo, October, 1977

Professional Experience

April, 1975-Mar., 1979, Research Associate, Research Institute for Applied Mechanics, Kyushu University

April, 1979-Mar., 1991, Associate Professor, Research Institute for Applied Mechanics, Kyushu University

Sept., 1981-Aug., 1983, Visiting Research Scholar, Geophysical Fluid Dynamics Program, Princeton University, USA

Sept., 1991-Mar., 1994, Associate Professor, Graduate School of Science, The University of Tokyo

April, 1994-Mar., 2012, Professor, Graduate School of Science, The University of Tokyo

April, 2007-Mar., 2009, Vice Dean of School of Science, The University of Tokyo

April, 2009-Mar., 2012, Dean of School of Science, The University of Tokyo

Oct., 1997-June, 2003, Program Director, International Pacific Research Center, SOEST, University of Hawaii/JAMSTEC (Honolulu)

Oct., 1997-Mar., 2009, Program Director, Frontier Research Center for Global Change, Japan Agency for Marine-Earth Science and Technology

April, 2009-Mar., 2012, Lab Head, Application Laboratory, Yokohama Institute for Earth Sciences, Japan Agency for Marine-Earth Science and Technology

II. Scientific Research Activity

2. Major achievements

(1) Together with research colleagues, we clarified the mechanism of the phenomenon which brings floods over the wide area of Saudi Arabia from late fall through early winter. The moisture advection associated with the Indian Ocean Dipole and the intrusion of cyclones from the Atlantic Ocean to the Arabian Peninsula via the Mediterranean Sea are identified as two important components of this extreme phenomenon named “the Arabian cyclone” by us.

(2) In collaboration with research colleagues, we were successful for the first time in predicting the Indian Ocean Dipole by use of an ocean-atmosphere coupled GCM.

(3) A new concept of “El Niño Modoki” was introduced to explain the recent change in the coupled ocean-atmosphere phenomenon in the tropical Pacific. This generated a new research trend in the world climate research community.

(4) Together with a graduate student and a research colleague, we studied the large upwelling phenomenon in the western tropical Indian Ocean. Its generation mechanism was

found to be related to the large-scale wind field. The phenomenon was named “the Seychelles Dome” by us.

(5) Together with a graduate student and a research colleague, the interannual variability of the early winter snowfall over the Tibetan Plateau was clarified to be closely related to the Indian Ocean Dipole. This denied the conventional idea that strengthens the link with El Niño. The mechanism was also confirmed by use of the atmospheric GCM.

(6) Together with a fellow researcher from Iran and a research colleague, we revealed for the first time the link between the Indian Ocean Dipole and the phenomenon bringing abnormal precipitation over the southern part of Iran.

(7) Together with a graduate student and research colleagues, we have clarified the mechanism of the Subtropical Dipole Modes that brings abnormal precipitation over the southern part of Africa. With the support of the SATREPS project of JICA and JST, we worked to improve the seasonal prediction system in the Republic of South Africa by including the advanced coupled model prediction information

3. Five Important Papers in your career

1. Saji, N. H., B. N. Goswami, P. N. Vinayachandran, and T. Yamagata, 1999 : A Dipole Mode in the Tropical Indian Ocean. Nature, 401, 360-363. 【cited times 1,018】
2. Neelin, J. D., D. S. Battisti, A. C. Hirst, F. F. Jin, Y. Wakata, T. Yamagata, S. Zebiak, 1998 : ENSO Theory. J. Geophys. Res., 103 (C7), 14261-14290. 【cited times 296】
3. Ashok, K., S. K. Behera, S. A. Rao, H. Weng, and T. Yamagata, 2007 : El Niño Modoki and its possible teleconnection. J. Geophys. Res., 112, C11007, doi:10.1029/2006JC003798. 【cited times 225】
4. Nakamura, H., G. Lin, and T. Yamagata, 1997 : Decadal Climate Variability in the North Pacific during the Recent Decades. Bulletin of the American Meteorological Society, 78 (10), 2215-2225. 【cited times 205】
5. Philander, S. G. H., T. Yamagata, and R. C. Pacanowski, 1984 : Unstable Air-Sea Interactions in the Tropics. J. Atmos. Sci., 41 (4), 604-613. 【cited times 204】

4. Awards and Honors throughout your career

- June 1976: GFD Fellow of WHOI, U.S.A.
- April 1981: Okada Memorial Prize of the Oceanographic Society of Japan
- May 1987: Society Prize of the Meteorological Society of Japan
- June 1989: Burr Steinbach Scholar of MIT/WHOI, U.S.A.
- April 1997: Society Prize of the Oceanographic Society of Japan
- January 2004: The Sverdrup Gold Medal Prize of American Meteorological Society
- January 2004: Fellow, American Meteorological Society
- 2004: Thomson Scientific Research Front Award 2004 (Leading 16 Japanese Scientists in Emerging Research Fronts)
- April 2005: Medal with Purple Ribbon from the Emperor of Japan

· January 2007: Fellow, American Geophysical Union

· April 2008: Techno-Ocean Award

· November 2011: Fellow, The Japan Society of Fluid Mechanics

5. Future Research Plan

6. Funding Received

(1) JSPS Grants

· Scientific Research(A), Decadal Variation of the Indian Ocean Dipole, 2005-2007, 41,860,000 (total)

· Scientific Research (B), Long-term modulations of tropical climate modes and ocean warming, 2008-2010, 17,810,000 (total)

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

· Grant for Environmental Research Projects of the Sumitomo Foundation, Variations in the Tibetan Plateau snow and its relation with climate modes, 2008-2010, 2,100,000

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Chakraborty, A., S. Behera, M. Mujumdar, R. Ohba, and T. Yamagata, 2006 : Diagnosis of Tropospheric Moisture over Saudi Arabia and Influences of IOD and ENSO. Monthly Weather Review. 134 (2), 598-617.
2. Behera, S. K., J.-J. Luo, S. Masson, S. A. Rao, H. Sakuma, and T. Yamagata, 2006 : A CGCM Study on the Interaction between IOD and ENSO. J. Climate. 19(9), 1688-1705.
3. Chakraborty, A., M. Mujumdar, S. K. Behera, R. Ohba, and T. Yamagata, 2006 : A Cyclone over Saudi Arabia on 5 January 2002 : A Case Study . Meteorol. Atmos. Phys., 93, 115-122.
4. Aiki, H., K. Takahashi, and T. Yamagata, 2006 : The Red Sea Outflow Regulated by the Indian Monsoon. Continental Shelf Research, 26, 1448-1468.
5. Chang, P., T. Yamagata, P. Schopf, S. K. Behera, J. Carton, W. S. Kessler, G. Meyers, T. Qu, F. Schott, S. Shetye, and S.-P. Xie, 2006 : Climate Fluctuations of Tropical Coupled Systems - The Role of Ocean Dynamics. J. Climate. 19(20), 5122-5174.
6. Kayanne, H., H. Iijima, N. Nakamura, T. R. McClanahan, S. Behera, and T. Yamagata, 2006 : Indian Ocean Dipole Index Recorded in Kenyan Coral Annual Density Bands. Geophys. Res. Lett., 33, L19709, doi : 10.1029/2006GL027168.
7. Guo, X., Y. Miyazawa, and T. Yamagata, 2006 : The Kuroshio Onshore Intrusion along the Shelf Break of the East China Sea : the Origin of the Tsushima Warm Current. J. Phys. Oceanogr., 36(12), 2205-2231.
8. Kug, J.-S., T. Li, S.-I. An, I.-S. Kang, J.-J. Luo, S. Masson, and T. Yamagata, 2006 : Role of the ENSO-Indian Ocean Coupling on ENSO Variability in a Coupled GCM. Geophys.

Res. Lett., 33 (9), L09710, doi : 10.1029/2005GL024916.

9. Saji, N. H., S.-P. Xie, and T. Yamagata, 2006 : Tropical Indian Ocean Variability in the IPCC Twentieth-Century Climate Simulations. J. Climate, 19(17), 4397-4417.

10. Aiki, H., and T. Yamagata, 2006 : Energetics of the Layer-thickness Form Drag Based on an Integral Identity. Ocean Sci., 2, 161-171 .

11. Iskandar, I., T. Tozuka, H. Sasaki, Y. Masumoto, and T. Yamagata, 2006 : Intraseasonal Variations of Surface and Subsurface Currents off Java as Simulated in a High-Resolution Ocean General Circulation Model. J. Geophys. Res., 111, C12015, doi:10.1029/2006JC003486.

12. Marchant, R., C. Mumbi, S. Behera, and T. Yamagata, 2006 : The Indian Ocean Dipole - the Unsung Driver of Climatic Variability in East Africa. Afr. J. Ecol., 45, 4-16.

13. Weng, H., K. Ashok, S. K. Behera, S. A. Rao, and T. Yamagata, 2007 : Impacts of Recent El Niño Modoki on Dry/Wet Conditions in the Pacific Rim during Boreal Summer. Climate Dynamics, 29, 113-129.

14. Luo, J.-J., S. Masson, S. Behera, and T. Yamagata, 2007 : Experimental Forecasts of Indian Ocean Dipole Using a Coupled OAGCM. J. Climate. 20 (10), 2178-2190.

15. Bengtsson, L., K. Hodges, M. Esch, N. Keenlyside, L. Kornblueh, J.-J. Luo, and T. Yamagata, 2007 : How may Tropical Cyclones Change in a Warmer Climate? Tellus, 59A, 539-561.

16. Tozuka, T., J.-J. Luo, S. Masson, and T. Yamagata, 2007 : Decadal Modulations of the Indian Ocean Dipole in the SINTEX-F1 coupled GCM. J. Climate. 20 (13), 2881-2894.

17. Tozuka, T., T. Qu, and T. Yamagata, 2007 : Dramatic Impact of the South China Sea on the Indonesian Throughflow. Geophys. Res. Lett., 34, L12612, doi: 10.1029/2007GL030420.

18. Rao, S. A., S. Masson, J.-J. Luo, S. K. Behera, and T. Yamagata, 2007 : Termination of Indian Ocean Dipole Events in a Coupled General Circulation Model. J. Climate, 20 (13), 3018-3035.

19. Cherchi, A., S. Gualdi, S. Behera, J.-J., Luo, S. Masson, T. Yamagata, and A. Navarra, 2007 : The Influence of Tropical Indian Ocean SST on the Indian Summer Monsoon. J. Climate. 20 (13), 3083-3105.

20. Ashok, K., H. Nakamura, and T. Yamagata, 2007 : Impacts of ENSO and Indian Ocean Dipole Events on the Southern Hemisphere Storm-Track Activity during Austral Winter. J. Climate, 20 (13), 3147-3163.

21. Ashok, K., S. K. Behera, S. A. Rao, H. Weng, and T. Yamagata, 2007 : El Niño Modoki and its Possible Teleconnection. J. Geophys. Res., 112, C11007, doi:10.1029/2006JC003798.

22. Doi, T., T. Tozuka, H. Sasaki, Y. Masumoto, and T. Yamagata, 2007 : Seasonal and Interannual Variations of Oceanic Conditions in the Angola Dome. J. Phys. Oceanogr., 37 (11), 2698-2713.

23. Tozuka, T., J.-J. Luo, S. Masson, and T. Yamagata, 2007 : Seasonally Stratified Analysis of Simulated ENSO Thermodynamics. J. Climate, 20 (18), 4615-4627.

24. Qu, T., Y. Du, J. McCreary, G. Meyers, and T. Yamagata, 2008 : Buffering Effect and its Related Ocean Dynamics in the Indonesian Throughflow Region. J. Phys. Oceanogr., 38 (2), 503-516.

25. Navarra, A., S. Gualdi, S. Masina, S. Behera, J. - J. Luo, S. Masson, E. Guilyardi, P. Delecluse, and T. Yamgata, 2008 : Atmospheric Horizontal Resolution Affects Tropical Climate Variability in Coupled Models. J. Climate, 21 (4), 730-750.

26. Luo, J.-J., S. Masson, S. Behera, and T. Yamagata, 2008 : Extended ENSO Predictions Using a Fully Coupled Ocean-Atmosphere Model. J. Climate, 21 (1), 84-93.

27. Yokoi, T., T. Tozuka, and T. Yamagata, 2008 : Seasonal Variation of the Seychelles Dome. J. Climate. 21(15), 3740-3754.

28. Tozuka, T. J. J. Luo, S. Masson, and T. Yamagata, 2008 : Tropical Indian Ocean Variability Revealed by Self-organizing Maps. Climate Dynamics, 31, 333-343.

29. Iskandar, I., T. Tozuka, Y. Masumoto, and T. Yamagata, 2008 : Impact of Indian Ocean Dipole on Intraseasonal Zonal Currents at 90° E on the Equator as Revealed by Self-organizing Map. Geophys. Res. Lett., 35, L14S03, doi:10.1029/2008GL033468.

30. Behera, S., J.-J. Luo, and T. Yamagata, 2008 : Unusual IOD Event of 2007. Geophys. Res. Lett., 35, L14S11, doi:10.1029/2008GL034122.

31. Jin, E. K., L. Kinter III, B. Wang, I.- S. Kang, J. Shukla, B. P. Kirtman, J.- S. Kug, T. Yamagata, J.- J. Luo, J. Schemm, and A. Kumar, 2008 : Current Status of ENSO Prediction Skill in Coupled Ocean-Atmosphere Models. Climate Dynamics, 31, 647-664.

32. Luo, J.-J., S. Behera, Y. Masumoto, H. Sakuma, and T. Yamagata, 2008 : Successful Prediction of the Consecutive IOD in 2006 and 2007. Geophys. Res. Lett., 35, L14S02, doi:10.1029/2007GL032793.

33. Wang, B., J.-Y. Lee, I.-S. Kang, J. Shukla, J.-S. Kug, A. Kumar, J. Schemm, J-J. Luo, T. Yamagata, and C.-K. Park, 2008: How Accurately Do Coupled Climate Models Predict the Asian-Australia Monsoon Interannual Variability? Climate Dynamics, 30, 605-619.

34. Izumo, T., C. Montegut, J.-J. Luo, S. Behera, S. Masson, and T. Yamagata, 2008 : The Role of the Western Arabian Sea Upwelling in Indian Monsoon Rainfall Variability. J. Climate, 21, 5603-5623.

35. Chan, S. C., S. K. Behera, and T. Yamagata, 2008 : Indian Ocean Dipole Influence on South American Rainfall. Geophys. Res. Lett., 35, L14S12.

36. Ajayamohan R. S., S. A. Rao, and T. Yamagata, 2008 : Influence of Indian Ocean Dipole on Poleward Propagation of Boreal Summer Intraseasonal Oscillations. J. Climate, 21, 5437-5454.

37. Yokoi, T., T. Tozuka, and T. Yamagata, 2009 : Seasonal Variations of the Seychelles Dome Simulated in the CMIP3 Models. J. Phys. Oceanogr., 39. (2), 449-457.

38. Weng, H., S. K. Behera, and T. Yamagata, 2009 : Anomalous Winter Climate Conditions in the Pacific Rim during Recent El Niño Modoki and El Niño Events. Climate Dynamics, 32, 663-674, DOI 10.1007/s00382-008-0394-6.

39. Qu, T., and T. Yamagata, 2009 : The South China Sea and its Impact on Climate. Dynamics of Atmospheres and Oceans, 47, 1-2.

40. Qu, T., Y. T. Song, and T. Yamagata, 2009 : An Introduction to the South China Sea Throughflow : Its Dynamics, Variability, and Application for Climate. Dynamics of Atmosphere and Oceans, 47, 3-14.

41. Tozuka, T., T. Tangdong,, Y. Masumoto, and T. Yamagata, 2009 : Impacts of the South China Sea Throughflow on Seasonal and Interannual Variations of Indonesian Throughflow. Dynamics of Atmosphere and Oceans, 47, 73-85.

42. Wang, B., June-Yi Lee, In-Sik Kang, J. Shukla, C.-K. Park, A. Kumar, J. Schemm, S. Cocke, J.-S. Kug, J.-J. Luo, T. Zhou, B. Wang, X. Fu, W.-T. Yun, O. Alves, E. K. Jin, J. Kinter, B. Kirtman, T. Krishnamurti, N. C. Lau, W. Lau, P. Liu, P. Pegion, T. Rosati, S. Schubert, W. Stern, M. Suarez and T. Yamagata, 2008 : Advance and Prospectus of Seasonal Prediction: Assessment of the APCC/CliPAS 14-model Ensemble Retrospective Seasonal Prediction (1980- 2004). Climate Dynamics, 33, 93-117, DOI 10.1007/s00382-008-0460-0.10.

43. Yuan, C., T. Tozuka, T.Miyasaka, and T. Yamagata, 2009 : Respective Influences of IOD and ENSO on the Tibetan Snow Cover in Early Winter. Climate Dynamics, 33, 509-520, DOI 10.1007/s00382-008-0495-2.

44. Doi, T., T. Tozuka, and T. Yamagata, 2009 : Interannual Variability of the Guinea Dome and its Possible Link with the Atlantic Meridional Mode. Climate Dynamics. 33, 985-998, DOI 10.1007/s00382-009-0574-z.

45. Ajayamohan, R. S., S. A. Rao, J.-J.- Luo, and T. Yamagata, 2009: Influence of Indian Ocean Dipole on Boreal Summer Intraseasonal Oscillations in a Coupled General Circulation Model. Journal of Geophysical Research, 114, D06119, doi: 10.1029/2008JD011096.

46. Ashok, K., and T. Yamagata, 2009 : CLIMATE CHANGE The El Niño with a Difference. Nature. 461, 481-484.

47. Rao, S. A., J.-J. Luo, S. K. Behera, and T. Yamagata, 2009 : Generation and Termination of Indian Ocean Dipole Events in 2003, 2006 and 2007. Climate Dynamics, 33, 751-767, DOI10.1007/s00382-008-0498-z.

48. Nakamura, N., H. Kayanne, H. Iijima, T. R. McClanahan, S. K. Behera, and T. Yamagata, 2009 : Mode shift in the Indian Ocean Climate under Global Warming Stress. Geophys. Res. Lett., 36, L23708, doi:10.1029/2009GL040590.

49. Takeshi Izumo, Jerome Vialard, Matthieu Lengaigne, Clement de Boyer Montegut, Swadhin K. Behera, Jing-Jia Luo, Sophie Cravatte, Sebastien Masson and Toshio Yamagata, 2010 : Influence of the State of the Indian Ocean Dipole on Following Year's El Niño. Nature Geoscience 3, 168-172 doi:10.1038/ngeo760.

50. Doi, T., T. Tozuka, and T. Yamagata, 2010 : The Atlantic Meridional Mode and its Coupled Variability with the Guinia Dome. J. Climate. 23, 455-475. DOI: 101175/2009JCL13198.1.

51. Luo, J.-J., R. Zhang, S. K. Behera, Y. Masumoto, F.-F. Jin, R. Lukas, and T. Yamagata, 2010 : Interaction between El Niño and Extreme Indian Ocean Dipole. J. Climate. 23, 726-742. DOI: 10.1175/2009JCL13104.1.

52. Maiwa, K., Y. Masumoto, and T. Yamagata, 2010 : Characteristics of Coastal Trapped Waves along the Southern and Eastern Coasts of Australia. J. Oceanogr. 2, 243-258.

53. Ratnam, J. V., S. K. Behera, Y. Masumoto, and T. Yamagata, 2010 : Pacific Ocean Origin for the 2009 Indian Summer Monsoon Failure. Geophys. Res. Lett. 37, L07807, doi: 10.1029/2010GL042798.

54. Tozuka, T., T. Yokoi, and T. Yamagata, 2010 : A Modeling Study of Interannual Variations of the Seychelles Dome. J. Geophys. Res. 115, C04005, doi: 10.1029/2009JC005547.

55. Lee, J.-Y., B. Wang, I.-S., Kang, J. Shukula, A. Kumar, J.-S. Kug, JKE. Shemm, J.-J. Luo, T. Yamagata, X. Fu, O. Alves, B. Stern, T. Rosati, C. K. Park, 2010 : How Are Seasonal

Prediction Skills Related to Models' Performance on Mean State and Annual Cycle? Climate dynamics. 35, 267-283.

56. Izumo, T., S. Masson, J. Vialard, C. de Boyer Montegut, S. K. Behera, G. Madec, K. Takahashi, and T. Yamagata, 2010 : Low and High Frequency Madden-Julian Oscillations in Austral Summer: interannual variations. Climate Dynamics, 35 (4), 669-683,, DOI 10.1007/s00382-009-0655-z.

57. Morioka, Y., T. Tozuka, and T. Yamagata, 2010 : Climate Variability in the Southern Indian Ocean as Revealed by Self-Organizing Maps. Climate Dynamics, 35, 1075-1088, DOI 10.1007/s00382-010-0843-x.

58. Richter, I., S. K. Behera, Y. Masumoto, B. Taguchi, N. Komori, and T. Yamagata, 2010 : On the Triggering of Benguela Niños : Remote Equatorial Versus Local Influences. Geophys. Res. Lett., 37, L20604, DOI: 101029/2010GL044461.

59. Doi, T., T. Tozuka, and T. Yamagata, 2010 : Equivalent Forcing Depth in Tropical Oceans. Dynamics of Atmospheres and Oceans, 50, 415-423.

60. Behera, S. K., and T. Yamagata, 2010 : Imprint of the El Niño Modoki on Decadal Sea Level Changes. Geophys. Res. Lett. 37, L23702, doi:10.1029/2010GL045936.

61. Weng, H., G. Wu, Y. Liu, S. K. Behera, and T. Yamagata, 2011: Anomalous Summer Climate in China Influenced by the Tropical Indo-Pacific Oceans. Clim. Dyn., 36, 769-782, DOI 10.1007/s00382-009-0658-9.

62. Luo, J.-J., S. K. Behea, Y. Masumoto, and T. Yamagata, 2011: Impact of Global Ocean Surface Warming on Seasonal - to - Interannual Climate Prediction. J. Climate. 24 (6), 1626-1646.

63. Chowdary, J. S., S.-P. Xie, J.-J. Luo, J. Hafner, S. Behera, Y. Masumoto, and T. Yamagata, 2011: Predictability of Northwest Pacific Climate during Summer and the Role of the Tropical Indian Ocean. Clim. Dyn., 36, 607-621, DOI: 10.1007/s00382-009-0686-5.

64. Tozuka, T., T. Doi, T. Miyasaka, N. Keenlyside, and T. Yamagata, 2011: Key factors in Simulating the Equatorial Atlantic Zonal Sea Surface Temperature Gradient in a Coupled General Circulation Model. J. Geophys. Res. 116, C06010, doi: 10.1029/2010JC006717.

65. Ajayamohan, R. S., H. Annamalai, J.-J. Luo, J. Hafner, and T. Yamagata, 2011: Poleward Propagation of Boreal Summer Intraseasonal Oscillations in a Coupled Model : Role of Internal Processes. Clim. Dyn., 37, 851-867, DOI: 10.1007/s00382-010-0839-6.

66. Morioka, Y., T. Tozuka, and T. Yamagata, 2011 : On the Growth and Decay of the Subtropical Dipole Mode in the South Atlantic. J. Climate, 24, 5538-5554, DOI: 10.1175/2011JCL14010.1.

67. Nakamura, N., H. Kayanne, H. Iijima, T. R. McClanahan, S. K. Behera, and T. Yamagata, 2011 : Footprints of IOD and ENSO in the Kenyan Coral Record. Geophys. Res. Lett., 38, L24708, doi: 10.1029/2011GL049877.

(2) Selected Conference Proceedings

1. Yamagata, T. 2009 : Scientific Aspects of Sea Level Rise in the Central Tropical Pacific . Proceedings of International Symposium on Islands and Oceans. 48-54, Ocean Policy Research Foundation.

(3) Review Papers

1. Tozuka, T., T. Miyasaka, A. Chakraborty, M. Mujumdar, S. Behera, Y. Masumoto, H. Nakamura, and T. Yamagata, 2006 : University of Tokyo Coupled General Circulation

Model (UTCM1.0). Ocean-Atmosphere Research Report, 7, 1-44.

2. Luo, J.-J., S. Masson, S. Behera, H. Sakuma, and T. Yamagata, 2007 : ENSO and IOD Predictions Using a Fully Coupled Ocean-Atmosphere Model. KAIYO MONTHLY, 39(10), 658-668.

3. Yamagata, T. and S. Behera, 2009 : International Symposium on the Application of Climate Information. Eos, Transactions, American Geophysical Union, Vol. 90, No.17, 28 April 2009, Page 148.

Refreed 6 (in Japanese), Non-refreed 19 (3 in English and 16 in Japanese)

(4) Books

1. Behera, S. K., and T. Yamagata, 2011: Dynamics of the Indian and Pacific Oceans, Chapter 4, pp.99-131, "Environmental Hazards The Fluid Dynamics and Geophysics of Extreme Events" Eds. by H. K. Moffatt, and Emily Shuckburgh, Lecture Notes Series, Institute for Mathematical Sciences, National University of Singapore Vol. 21, World Scientific.

One book in Japanese

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

Invited (including keynote)

1. Yamagata, T., Forecasting System for Kuroshio variability, Ocean Observations Panel for Climate (GCOS/GOOS/WCRP; IOC, WMO,ICSU, UNEP) (Tokyo, Japan, 2006.5).

2. Yamagagta, T., Indian Ocean Dipole: A Coupled Ocean-Atmosphere Phenomenon, 9th Tamura Symposium Frontiers in Dynamics : Physical and Biological Systems (Tokyo, Japan, 2006.5).

3. Yamagata, T., Ocean-atmosphere coupled dynamics in the Indo-Pacific sector, David Anderson's retirement seminar (ECMWF, UK, 2006.6).

4. Yamagata, T., Coupled ocean-atmosphere variability in the tropical Indian Ocean and its predictability, ESF-JSPS Frontier Science Conference for Young Researchers -Climate Change- (Nynäshamn, Sweden, 2006.6)

5. Yamagata, T., El Niño Modoki (Pseudo-El Niño) and its impact on the World Climate, APCC Climate Center Symposium (Busan, Korea, 2006.9).

6. Yamagata, T., The ENSO Modoki: Another Coupled Mode in the Tropical Pacific?, EU-Japan Meeting on the Development of Next Generation Climate Models (Venice, Italy, 2006.12).

7. Yamagata, T., An oceanographic history leading to the Japan Coastal Ocean Prediction Experiment (JCOPE), Italy-Japan Meeting for the Ocean Weather Forecast and Modeling (Bologna, Italy, 2006.12) .

8. Yamagata, T., Earth Observation and Prediction of Climate Variations under the Global Warming Stress, The 7th Meeting of France-Japan Joint Advisory Council On Cooperation in Science and Technology (Paris, France, 2007.2).

9. Yamagata, T., C. K. Park (APCC) : Convener, Symposium on Predictability of Climate Variations in the Indo-Pacific Sector (Shinagawa Prince Hotel, 2007.3).
10. Yamagata, T. : Convener, Workshop on the Predictability of the Climate Variations in the Indo-Pacific Sectors (Hakone, 2007.3).
11. Yamagata, T., K. Ashok, S. Behera, S. Rao and H. Weng, El Ni?o Modoki (Pseudo-El Ni?o) and its Impact on the World Climate, The 14th PAMS/JECSS Workshop (Hiroshima, 2007.5)
12. Yamagata, T., K. Ashok, S. Behera, S. Rao and H. Weng, El Nino Modoki (Pseudo-El Niño) and its Impact on the World Climate, AOGS2007 4th Annual Meeting (Bangkok, Thailand, 2007.8).
13. Yamagata, T., Indian Ocean Observations for Predicting Climate Variations under the Global Warming Stress, AOGS2007 4th Annual Meeting (Bangkok, Thailand, 2007.8)
14. Yamagata, T., Ocean and Climate Change, Hiroshima Office of UNITAR (United Nations) for Asian and the Pacific (HOAP) Series on Sea and Human Security "Toward a comprehensive security for seas and oceans (Hiroshima, 2007.10).
15. Yamagata, T., S. K. Behera, J.-J. Luo, and T. Tozuka, Indian-Pacific connection: a perspective from climate dynamics, WCRP/CLIVAR Workshop on Western Tropical Pacific:Hatchery for ENSO and Global Teleconnections (Guangzhou, China, 2007.11).
16. Yamagata, T., Indian Ocean Dipole and Climate Variations, 13th Japanese-German Symposium
17. Marine Research The Importance of Oceans for mankind (Rostock, Germany, 2008.5)
18. Yamagata, T., Indian Ocean Dipole and its possible link with climate modes in the Pacific, 22nd International Congress of Theoretical and Applied Mechanics (Adelaide, Australia, 2008.8)
19. Yamagata, T., Toward predicting climate variations for disaster prevention under the global warming stress, Series on Sea and Human Security Towards a comprehensive security for seas and oceans: the Hiroshima Initiative (Unitar, Hiroshima, 2008.9)
20. Yamagata, T., Scientific Aspects of Sea Level Rise in the Central Tropical Pacific, International Symposium on Islands and Oceans (Ocean Policy Research Foundation, Tokyo, 2009.1)
21. Yamagata, T., Importance of Ocean Research for Sustainability under the Global Warming Stress - A Dynamicist's View, First JSPS Ocean Research Workshop in 2009 - Future Collaboration Beyond the JSPS "Coastal Marine Science" program (Ocean Research Institute, The University of Tokyo, 2009.2)
22. Yamagata, T., IOD, ENSO and Their Interactions, Workshop on Modeling: the Ocean dynamics, Syntheses and Prediction (Taipei, Taiwan, 2009.2)
23. Yamagata, T., Past, Present and Bright Future of Operational Oceanography, MOCA-09 IAMAS-IAPSO-IACS 2009 Joint Assembly (Montreal, Canada, 2009.7).
24. Yamagata, T., Adverse effects of climate change and variability and their effects on islands and their surrounding waters, International Seminar on Islands and Oceans 2010
25. Yamagata, T., Climate Change, variation and Sustainable Green Energy, Renewable Energy 2010 (Pacifico Yokohama, 2010.6)
26. Yamagata, T., Climae Prediction and its Rich Application, South Africa-Japan SATREPS

Kick-off Meeting (South Africa, Pretoria, 2010.8)

27. Yamagata, T., Prediction of Climate Variations and Its Application in the Southern African Region, Applied Center for Climate and Earth Systems Science(ACCESS) Earth System Symposia (South Africa, Cape Town, 2010.8)
28. Yamagata, T., Integration of Observation and Modeling for Ocean Forecast and its Application -Evolution of Operational Oceanography-（Yokohama、2010.9）
29. Yamagata, T., Thoughts on Climate Problems for More Appropriate Adaptation Measures, STS forum 7th Annual Meeting (Kyoto, 2010.10)
30. Yamagata, T., Climate Variations and their impact on society, India-Japan Symposium on Emerging Technologies (Indian Embassy Auditorium, 2010.10)
31. Yamagata, T., Contributions of Japan to the activity of IOC/WESTPAC for 50 years, (Horiba International Conference) "New Direction of Ocean Research in the Western Pacific" -Past, Present and Future of UNESCO/IOC/WESTPAC Activity for 50years and the JSPS Project "Costal Marine Science" (The University of Tokyo AORI, 2010.10)
32. Yamagata, T., Ocean-related Climate Variability and Extreme Weather Events, International Symposium "Roles of the Indo-Pacific Oceans in Climate Change and Variability in Commemoration of the 50th Anniversary of IOC/UNESCO" (United Nations University, 2010.12)
33. Yamagata, T., Climate and Society, SATREPS SYMPOSIUM ON CLIMATE PREDICTION AND INFORMATION FOR THE SOCIETY (The University of Aizu, 2010.12)
34. Yamagata, T., Tsunami Catastrophe, 26th Session of the IOC Assembly Opening (UNESCO, Paris, 2011. 6)
35. Yamagata, T., S. Behera, and T. Tozuka, El Niño Modoki and Indian Ocean Dipole, IUGG2011 (Melbourne Convention and Exhibition Center, 2011.7)
36. Yamagata,T., Tsunami Catastrophe, CSIRO (Commonwealth Scientific and Industrial Research Organization, Perth, 2011.7)
37. Yamagata, T., Prediction of climate modes and the value of scientific research, Public Lecture on Seasonal Climate: What Can We Predict? , SATREPS Symposium: Prediction of Climate Variations & its Application in the Southern African Region (Department of Science and Technology, Pretoria, 2011.8)
38. Yamagata, T., Tsunami Catastrophe : Lessons Learned from the 3.11 Calamity Caused by the Earthquake off Tohoku, Japan (University of Pretoria, South Africa, 2011.8)

23 Another presentations

(2) Domestic Conferences

33 presentations at domestic conferences

III. Educational Activity (2002-2011)

9. Notable achievements in education

- JSPS Research fellowship for young scientists (4)
- JSPS Postdoctoral Fellowships for Foreign Researchers (1)
- Sasakawa Scientific Research Grant of The Japan Science Society (4)

· Okada Memorial Prize of the Oceanographic Society of Japan (2)
· Award for Distinguished Young Researcher in Fluid Mechanics (1)
· Shanti Swarup Bhatnagar Prize for Science and Technology (1)
· Supervisor of an Iranian PhD student (1)

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Associate Editor, Geophysical and Astrophysical Fluid Dynamics (Taylor & Francis)
· Editorial Board Member, Dynamics of Atmospheres and Oceans (Elsevier) Editorial Board Member, World Scientific Series on Meteorology of East Asia
· Member of Editorial Board, Climate Science and Policy (Euro-Mediterranean Center on Climate Change)
· Chief Editor, Ship & Ocean Newsletter, Ocean Policy Research Foudation
· Chief Editor, Journal of Japan Society of Ocean Policy

(2) Academic Societies

· Council member of the Oceanographic Society of Japan
· Executive member of Japan Society of Ocean Policy
· Executive member of Japan Marine Science Foundation

(3) International Conferences

· Symposium on the Predictability on Climate Variations in the Indo-Pacific Sector (Convener)
· AOGS2007 (Session chair)
· WCRP/CLIVAR Workshop on Western Tropical Pacific:Hatchery for ENSO and Global Teleconnections (Chairperson)
· International Symposium “Role of the Indo-Pacific Oceans in Climate Change and Variability in Commemoration on the 50th Anniversary of IOC/UNESCO”(Organizer)
· SATREPS Symposium on Climate Prediction and Its Application in the Southern African Region (Organizer)

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

[External Committee]

· Member of the Oceanographic Society of Japan
· Member of the Meteorological Society of Japan
· Member of the Japan Society of Fluid Mechanics
· Council Member of the Oceanographic Society of Japan
· Okada Memorial Prize, Society Prize, Uda Memorial Prize Selection Committee Member (Oceanographic Society of Japan)

· Society Prize Selection Committee Member (Meteorological Society of Japan)
· Kyoto Prize Jury and Nomination Member
· Blue Planet Prize Nomination Member
· Expert Committee Member of National Committee for UNESCO under Ministry of Education, Science, Sports and Culture
· Delegation Head of National Committee for Intergovernmental Oceanographic Commission (IOC) of UNESCO
· Executive Member, Japan Marine Science Foundation
· Liaison Member, Science Council of Japan
· Founder of Forecast Ocean Partnership, LLP
· Senior advisor, Forecast Ocean Plus, Inc.
· Fellow Member of American Meteorological Society (U.S.A.)
· Charter Life Member of the Oceanographic Society (U.S.A.)
· Fellow Member of American Geophysical Union (U.S.A.)
· Visiting Professor, Udayana University (Bali, Indonesia)
· Affiliate Scientist and Science Advisory Board Member, APEC Climate Center (Busan, Korea)
· International Council for Science (ICSU), Regional Committee for Asia and the Pacific (RCAP) Member

[Internal Committee]

· Vice Dean of School of Science, The University of Tokyo
· Dean of School of Science, The University of Tokyo

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting
Foreign Students: 6 [M.Sc.: 2, Ph.D.: 4]
Foreign Researchers: 6
Sending
Japanese Students: 3
Japanese Researchers: 2
Visitors from Abroad: many

Space and Planetary Science Group

Naoji Sugiura

I. C.V.

Name： Naoji Sugiura
Present Position: Professor, University of Tokyo, Graduate School of Science

Education
University of Tokyo, B. Sc., Geophysics, March, 1972
University of Tokyo, M. Sc., Geophysics, March, 1974
University of Tokyo, Ph. D., Geophysics, March, 1977

Professional Experience
April, 1977-Aug., 1986, Research associate, Department of Geology, University of Toronto, Canada
Sep., 1986-Mar., 1987, Research associate, Department of Geology, University of British Columbia, Canada
Mar., 1987- Mar., 1998, Associate Professor, Department of Geophysics, Tokyo University
Mar., 1998-, Professor, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

Aiming at understanding early history of the solar nebula, ages of meteorites, condensation and accretion processes of solid particles in meteorites and stable isotope anomalies of various elements in meteorites were studied.

I made Mn-Cr age determinations of carbonates in carbonaceous chondrites. Previously, there were such studies using ion probes, which reported old ages as old as CAIs (Ca-Al rich Inclusions) which are the oldest solid materials in the solar system. These studies were made, however, without proper calibration of Mn/Cr relative sensitivities and therefore could be grossly inaccurate. Therefore, I made a standard carbonate sample which contains appropriate amounts of Mn and Cr. Using this standard sample I was able to obtain accurate formation age of carbonates. In the case of CM chondrites, the carbonate ages are 5 million years after CAIs and the age of parent body accretion is 3.5 million years after CAIs. This is the youngest accretion age among meteorites and suggests that early-formed planetesimals were heated to higher temperatures. In other words, accretion occurred in the order of achondrites+ irons to ordinary chondrites to carbonaceous chondrites. By extrapolating the distribution of carbonaceous and ordinary chondrites in the asteroidal belt, I suggest that accretion of achondrites and irons occurred near the inner edge of the solar nebula. The accretion ages of meteorites are well correlated with ^{54}Cr anomalies. ^{54}Cr is known to be produced in supernovae and the carrier of the isotope anomaly is Cr oxide. These facts suggest that the ^{54}Cr carriers were injected into the far end of the forming solar nebula and gradually moved into the inner solar system by diffusive advection. With the aid of computer simulation of this process, I was able to estimate the diffusion parameter in the solar nebula. These results constitute significant advances in our understanding of the solar nebula.

Corundum is the first major condensate from high temperature solar nebula and therefore important for understanding how solid grains condensed and accreted. But there was no study

that aimed at such understanding. I found many corundum grains in a primitive chondrite. Many of them are aggregates, suggesting a high number density in the nebula. There are some corundum grains that are overgrown by hibonite, suggesting slow cooling in the nebula.

Olivine is the most abundant condensate from the nebula. Based on the chemical compositions of olivine aggregates, I found that fine-grained olivine aggregates did not form by equilibrium condensation. Coarse-grained olivine aggregates are more equilibrated suggesting that they formed either during very slow cooling or they formed by reheating of fine-grained olivine aggregates. These are important findings on the condensation and accretion in the solar nebula.

3. Five Important Papers in your career

1. McClelland E. and N. Sugiura (1987), A kinematic model of TRM acquisition in multidomain magnetite. Phys. Earth Planet. Interi., 46, 9-23.

Fundamental contribution to rock-magnetism

2. Heider F., D.J. Dunlop, and N. Sugiura (1987), Magnetic properties of hydrothermally recrystallized magnetite crystals. Sci., 236, 1287-1290.

Cited many times

3. Sugiura N., Y. Shuzou and A. Ulyanov. (2001), Be-B and Al-Mg systematics of CAIs in CV chondrites. Meteoritics and Planet. Sci., 36, 1397-1408.

Established importance of the Be-B system

4. Nakamura T.M., N. Sugiura, M. Kimura, A. Miyazaki and A.N. Krot (2007), Condensation and aggregation of solar corundum and corundum-hibonite grains. Meteoritics & Planet. Sci., 42, 1267-1279.

Condensation and accretion of solid grains in the solar nebula were investigated.

5. Fujiya, W., N. Sugiura, H. Hotta, K. Ichimura, and Y. Sano (2012), Evidence for the late formation of hydrous asteroids from young meteoritic carbonates, Nature Communications, 3, 627.

An accretion age of a primitive chondrite parent body was determined.

4. Awards and Honors throughout your career

- N. Sugiura, A study on meteorite magnetism, Tanakadate Prize, Society of Geomagnetism and Earth, Planetary and Space Sciences, April 17th, 1988.
- N. Sugiura, A study on chronology and material evolution in the early solar system, The Japan Geochemical Society Award. The Geochemical Society of Japan, September 12th, 2012.

5. Future Research Plan

My study on the accretion of planetesimals in the early solar system needs to be continued. As described in the "scientific research activity", there is a good correlation between the accretion ages and the ^{54}Cr isotope anomalies. However, the correlation is not perfect and there are exceptions. At present, we do not know the meaning of the exceptions. Therefore, we need to study more parent bodies with respect to the accretion ages and ^{54}Cr anomalies. Almost all

the main groups of meteorites have already been studied in these respects. However, there are newly-found minor achondrite groups. They consist of only a few members. They are probably derived from small fragments of asteroids that accreted early in the earth-forming region. If they show old ages and negative ^{54}Cr anomalies, as expected from the correlation among the existing meteorite groups, then it could strengthen the model of the early solar system formation that I am proposing. To this end, I have been trying to measure formation ages of such newly-found achondrites. The appropriate dating method is the Mn-Cr system which has a half-life of 3.7 Ma. For accurate age determination, making a good standard sample is essential and I am making a standard sample for this dating. Also, I am preparing achondrite samples for the age determination. Using SEM-EDS, appropriate minerals for dating are being searched for. As to the measurements of ^{54}Cr anomalies, I collaborate internationally with various scientists who are good at measuring this isotope.

Another study I am interested in is the formation of mesosiderites. Mesosiderites are a group of stony-iron meteorites. There are many unsolved issues concerning its origin. First, the origin of the metal is controversial. Usually, it is considered to have been derived from a core of an asteroid. But the metal composition is rather chondritic and the metal could be a product of a nebula process. Second, the heat source of reheating the mesosiderites is unknown. Mesosiderites were reheated after mixing of silicates and metal and then cooled quickly. The heat source for this reheating is usually attributed to hot metal or silicates. But the metal was solid at the time of mixing. The silicates were also mostly solid as suggested by the brecciated texture. Therefore, in my opinion, we need a yet unidentified heat source. The rapid cooling after the reheating suggests that the mesosiderites were located close to the surface of the parent body. In order to solve these issues, observations of several mesosiderites are being made. Preliminary observations suggest that the mesosiderite metal was fine-grained and well size-sorted at the time of metal-silicate mixing, suggesting nebula origin of the metal. Trace elements in the metal are to be measured for clarification of the metal formation condition. For understanding the heat source of reheating, we are investigating the peak reheating temperature, the duration of reheating and the subsequent cooling rate. Since mesosiderites were located close to the surface, we need to clarify whether the heat source was within the parent body or outside the parent body. I may be worth commenting that at about this time, chondrules were formed in the asteroidal belt and therefore having a nebula heat source is not totally impossible. More generally speaking, mesosiderites may have formed early enough that they may remember the solar nebula environment within 3~4 Ma from the birth of the solar system. Deciphering that environment is the ultimate purpose of my study.

6. Funding Received

(1) JSPS Grants

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Sugiura N. and A. Miyazaki (2006), Mn-Cr ages of Fe-rich olivine in two Rumuruti

chondrites. Earth Planets and Space, 58, 689-694.

2. Sugiura N., A. Miyazaki and Q.-Z. Yin (2006), Heterogeneous distribution of ^{60}Fe in the early solar nebula: Achondritic evidence. Earth Planets and Space, 58, 1079-1086.
3. Ushikubo T., H. Hiyagon and N. Sugiura (2007), A FUN like hibonite inclusion with a large ^{26}Mg-excess. Earth Planet. Sci. Lett., 254, 115-126.
4. Nakamura T. M., N. Sugiura, M. Kimura, A. Miyazaki, A.N. Krot (2007), Condensation and aggregation of solar corundum and corundum-hibonite grains. Meteoritics & Planet. Sci., 42, 1267-1279.
5. Sugiura N. and A.N. Krot (2007), ^{26}Al-^{26}Mg systematics of Ca-Al-rich inclusions, amoeboid olivine aggregates and chondrules from the ungrouped carbonaceous chondrite Acfer 094. Meteoritics & Planet. Sci., 42, 1183-1195.
6. Ushikubo T., Y. Guan, H. Hiyagon, N. Sugiura, and L.A. Leshin (2007), ^{36}Cl, ^{26}Al, and O isotopes in an Allende type B2 CAI: Implications for multiple secondary alteration events in the early solar system. Meteoritics & Planet. Sci., 42, 1267-1279.
7. Sugiura N., M.I. Petaev, M. Kimura, A. Miyazaki and H. Hiyagon (2009), Nebular history of amoeboid olivine aggregates, Meteoritics & Planet. Sci., 44, 559-572.
8. Sugiura N., K. Ichimura, W. Fujiya W. and N. Takahata (2010), Mn/Cr relative sensitivity factors for synthetic calcium carbonate measured with a NanoSIMS ion microprobe. Geochemical Journal, 44, e11 - e16.
9. Fujiya W., N. Sugiura, N. Takahata and H. Hiyagon (2011), In-situ chromium isotope measurement of chromium-rich fine grains in the Murchison CM2 chondrite. Geochem. J., 45, 275-281.

(2) Selected Conference Proceedings

1. Sugiura N and W. Fujiya (2011), Correlation between ^{54}Cr anomalies and accretion ages of meteorite parent bodies: Implications for the evolution of the solar nebula. Meteoritics and Planet. Sci., 5105.pdf.

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. N. Sugiura, K. Ichimura, W. Fujiya, K. Takahata and Y. Sano, A preliminary study on ^{55}Mn/^{52}Cr relative sensitivity for a synthetic calcite: Implications. 72nd Meteoritical Society Meeting, July13-18, 2009, Nancy, France.

Total presentation : 26

(2) Domestic Conferences

2. N. Sugiura, The metal grain size distribution in the NWA1878 mesosiderite. PPS004-01, Japan Geoscience Union Meeting, May 2011, Chiba, Japan.

Total presentation: 13

III. Educational Activity (2002-2011)

9. Notable achievements in education

· A.Yamada, Research incentive award for the Master Course Students of the Department of Science, March, 2010

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 1 [M.Sc.: 0, Ph.D.: 1]

Japanese Researchers: 0

Visitors from Abroad: 2 [U.S.A.: 1, Canada: 1]

Masahiro Hoshino

I. C.V.

Name： Masahiro Hoshino
Present Position: Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Faculty of Science, University of Tokyo, March, 1981
M. Sc., Faculty of Science, University of Tokyo, March, 1983
Ph. D., Faculty of Science, University of Tokyo, July, 1986

Professional Experience
July, 1986 - September, 1988, Resident Research Associate, National Academy of Science and National Research Council, NASA-GSFC, USA
October, 1988 - May, 1991, Post-Doctoral Research Associate, Lawrence Livermore National Laboratory/IGPP, USA
April, 1991 - October, 1993, Special Researcher, Basic Science Program, Institute of Physical and Chemical Research (RIKEN)
October, 1993- December, 1998, Associate Professor, Institute of Space and Astronautical Science (ISAS)
January, 1998 - present, Professor, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

My main research interest is to clarify fundamental plasma processes related to particle acceleration in magnetic reconnection and collisionless shock. Thank to modern satellite observations, a great deal of attention is now being paid to the physics of particle acceleration from the near-hand space to the deep universe, and the research area of particle acceleration is regarded as the interdisciplinary field of the frontier science. I will mention some highlights of my accomplishments in both sides of theory and observation below.

I would like to mention first about our study of magnetic reconnection in relativistic regime expected in pulsar and magnetar magnetosphere (Hoshino and Lyubarsky, SSR, 2012). We studied the nonlinear evolution of multi-dimensional magnetic reconnection by using PIC simulations, and found that the efficiency of plasma heating and particle acceleration in association with the topological change of magnetic fields are strongly controlled by a guide magnetic field (Zenitani & Hoshino, ApJ, 2007; Zenitani & Hoshino, ApJ, 2008). We also found that the radiation loss effect is important for dynamical evolution of reconnection (Jaroscheck and Hoshino, PRL, 2009). Not only the relativistic reconnection, but the non-relativistic reconnection, which is a central problem in space plasma physics, has been also investigated in my group. I have come up with straightforward and innovative approach to understand particle acceleration by combining two different approaches of observation and computer simulation. Based on our previous computational and theoretical studies (Hoshino et al. JGR, 2001, Hoshino, JGR, 2005), we confirmed that the interaction of the fast Alfvenic flow and the magnetic field pile-up region is responsible to the energetic particle acceleration during reconnection by using the Geotail and Cluster satellite data (Imada et al. JGR, 2007; Imada and

Hoshino, JGR, 2008; Imada et al., JGR, 2011). We also studied the structure of slow mode shock (Higashimori and Hoshino, JGR, 2011), turbulence reconnection (Yokoi and Hoshino, PoP, 2011), and stochastic particle acceleration in multiple magnetic islands (Hoshino, PRL, 2012).

Secondly, my group challenged to non-thermal electron acceleration problem in high Mach number shocks by using super-computers. We had already succeeded in demonstrating the formation of electrostatic solitary waves and the resultant surfing acceleration in the shock transition layer in the one-dimensional system (Hoshino and Shimada, ApJ, 2002). We extended this study to a multi-dimensional system, and then we found the strong acceleration by the interaction of electrons with turbulent-like electrostatic waves. We also estimated the acceleration efficiency, and applied to the injection rate of the interplanetary shock and of the supernova shock (Amano and Hoshino, ApJ 2007; Amano and Hoshino, ApJ, 2009; Matsumoto et al., ApJ, 2012). We pointed out importance of such small scale electric fields on electron acceleration and heating, and suggested that this kind of processes can be recognized to give an answer to resolve at least the so-called electron injection problem in the diffusive shock acceleration (Amano and Hoshino, PRL, 2010) .

Thirdly, I have worked in the area of the interaction of "photon" and "plasma" focusing on ultra-high energy particle acceleration. The interaction of photon and plasma is ubiquitous and important phenomena not only in laser plasma but in plasma universe. I found in a relativistic shock wave that the interaction of large amplitude, electromagnetic precursor wave (i.e., photon) and the upstream cold plasma can generate ultra-high energy particles (Hoshino, ApJ, 2008), and co-worked with laser plasma experiment group focusing on the incoherent wakefield acceleration (Kuramitsu et al., ApJ Letter, 2008; Kuramitsu et al. PoP, 2011; Kuramitsu et al. Phys. Rev. E, 2011).

3. Five Important Papers in your career

1. M. Hoshino, J. Arons, Y. Gallant, and A. B. Langdon, Relativistic Magnetosonic Shock Waves in Synchrotron Sources: Shock Structure and Nonthermal Acceleration of Positrons, Astrophys. J., 390, 2, 454-479 (1992)

The origin of relativistic particles emitting X-ray and gamma ray in Crab synchrotron nebula was investigated in the framework of a relativistic magnetosonic shock wave, and we proposed a new particle acceleration mechanism under the synchrotron resonance between charged particles and the magnetosonic wave. (citation 231)

2. M. Hoshino, T. Mukai, T. Terasawa, and I. Shinohara, Suprathermal electron acceleration in magnetic reconnection, J. Geophys. Res., 106, 25,979-25,998 (2001)

The mechanism of non-thermal electron during magnetic reconnection observed in the earth's magnetosphere and in the solar corona was studied by using a Particle-in-cell (PIC) simulation. We revealed that the efficient acceleration occurs not only in the X-type region where the magnetic field weak but also around the O-type region with strong pile-up magnetic field. (citation 96)

3. M. Hoshino, A. Nishida, T. Yamamoto, and S. Kokubun, Turbulent Magnetic Field in the Distant Magnetotail: Bottom-Up Process of Plasmoid Formation?, Geophys. Res. Lett., 21, 2,935-2,938 (1994)

From the data analysis of the magnetic field observed in the earth's magnetotail, we discussed that the plasma sheet has two different states: a quiet state and an active state where the

magnetic fluctuation can be described by MHD turbulence. We found that the turbulent spectrum in the active state has a typical scales which is related to the size of magnetic island initiated by magnetic reconnection. (citation 93)

4. M. Hoshino and N. Shimada, Nonthermal Electrons at High Mach Number Shocks: Electron Shock Surfing Acceleration, Astrophys. J., 572, 880-887 (2002)

Although non-thermal electrons are observed in high Mach number shocks such as supernova shocks and interplanetary shocks, injection process of the seed electrons, which is necessary as the pre-acceleration for Fermi shock acceleration, remains an unresolved issue. We found that the relativistic electrons can be generated by the surfatron/surfing mechanism of a small scale electrostatic wave. (citation 81)

5. M. Hoshino, A. Nishida, T. Mukai, Y. Saito, T. Yamamoto, and S. Kokubun, Structure of Plasma Sheet Current in Magnetotail: Double-Peaked Electric Current Sheet, J. Geophys. Res., 101, 24,775-24,786 (1996)

The plasma sheet structure in the earth's magnetotail is known to be well approximated by a Harris solution of the Vlasov equilibrium. We analyzed the magnetic and plasma data observed by the Geotail satellite, and found that the bifurcated current sheet, which has quite different behavior from the conventional Harris solution, is often observed. This finding stimulated further theoretical and observational studies of current sheet structure. (citation 72)

4. Awards and Honors throughout your career

- Physics Distinguished Achievement (1990), Lawrence Livermore National Laboratory, USA, Study on particle acceleration in relativistic shock waves
- Tanaka-date Award (1998), Society of Geomagnetism and Earth, Planetary and Space Science of Japan, Study on particle acceleration and plasma heating in magnetic reconnection
- Group Achievement Award (1998), NASA/USA, Study on Magnetosphre by Geotail Satellite

5. Future Research Plan

My major research topic is to clarify particle acceleration in space and astrophysical plasmas. Non-thermal particles whose energies are much larger than their thermal energies are common in our universe, from the earth's magnetosphere to astrophysical settings such as supernova, pulsar magnetosphere, AGN jets and so on. The number density of the non-thermal particles is in general much smaller than the thermal population, but the non-thermal energy density is not necessarily negligible and sometimes exceeds the thermal energy density. My main objective of the study of particle acceleration is to understand how and where those non-thermal particles are generated in the course of the dynamical evolution of space and astrophysical phenomena.

(Physics of Collisionless Shock Waves) In the interplanetary shock initiated by the solar flare, the non-thermal ions are often observed, while the observation of non-thermal electron is very rare. On the other hand, the relativistic electrons and their synchrotron radiation can be observed from the supernova shocks. To understand why the electron acceleration is different between the interplanetary shock and the supernova shock, we investigated the shock structure in details focusing on the micro- and micro-scale couplings as the function of Mach number. So far we have revealed that the electrostatic waves generated in the foreshock region is

responsible for the electron pre-acceleration, which is so called the "shock injection problem", by using the plasma particle-in-cell (PIC) simulation (e.g., Hoshino and Shimada, ApJ, 2002; Amano and Hoshino, PRL, 2010). However, due to the limited computational power, our study has been carried out under either a non-very-high Mach number shock or a small mass ratio between ions and electrons (e.g., Matsumoto, Amano and Hoshino, ApJ, 2011). We will extend the above our simulation study to much higher Mach number shocks with a realistic plasma parameter using the super-computers of FX10/K-Computer

(Study of Kinetic Magneto-Rotational Instability in Accretion Disk) Second future plan is the study of collisionless (kinetic) accretion disk around a massive central object. Recently the magneto-rotational instability (MRI) is extensively investigated as an important mechanism of angular momentum transport to maintain the accretion disk under collisional MHD system. However, the study of collisionless accretion disk is required, because non-thermal particles and the non-equilibrium temperature between ions and electrons are observed from the central region of our galaxy where the massive black hole exists. By making use of our understandings of kinetic plasma processes studied in our Heliosphere, we will investigate the angular momentum transport process and the production of nonthermal particles under the action of gravity. We have already started this project a couple of years ago, and we obtained a preliminary result of non-thermal acceleration with a harder spectrum during the time evolution of MRI by using PIC simulations. We will unify our understandings of MRI appeared in collisional and collisionless systems in accretion disk.

(Study of Magnetic Reconnection under Turbulence) Magnetic reconnection is a long standing problem in a magneto-active plasma system such as the earth's magnetotail, the solar corona and so on. So far our grope has extensively studied the magnetic energy dissipation process and the physics of particle acceleration in both non-relativistic and relativistic regimes of plasma temperature for the case of a single X-type reconnection (e.g., Zenitani and Hoshino, PRL, 2005: Jaroschek and Hoshino, PRL, 2009). The next important step is to study the interaction of multiple reconnection region and highly turbulence reconnection regime (Hoshino, PRL, 2012). We will develop a sophisticated turbulent reconnection model including the cross-helicity evolution which may break the symmetry of reconnection topology (e.g., Yokoi and Hoshino, PoP, 2011), and will study how the reconnection rate is modified under the action of self-generated turbulence. I will also collaborate with theoretical and data analysis of Magnetospheric MultiSacle (MMS/NASA) mission after the satellite launch in 2014, as a member of the Co-I of MMS-SMART team.

6. Funding Received

(1) JSPS Grants

(PI)

- Scientific Research (B): Plasma dynamics and particle acceleration in relativistic plasma sheet with radiation loss effect (2010-2013, 15,600K yen)
- Challenging Exploratory Research: Generation of magnetic field under the interaction between radiation and plasma (2010-2011, 2,960K yen)
- Scientific Research (B): Wakefield acceleration in relativistic shocks (2007-2009, 15,860K yen)
- Scientific Research (C): Relativistic plasma trinity (2006, 3,100K yen)

(Co-I)

· Scientific Research (C): Study on cosmic ray abundance of electron and proton suggested from the standard shock acceleration theory

· Scientific Research (A): Towards understanding of dynamical shock structure and particle acceleration in ultra-intense laser experiment

· Creative Scientific Research: Basic Research on Space Weather (2005-2009, 20,000K yen in total of 580M yen)

(2) Cooperative Research

· Magnetospheric MultiScale Mission/MMS -Smart, NASA

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Y. Matsumoto and M. Hoshino, Turbulent mixing and transport of colllisionless plasmas across a stratified velocity shear layer, J. Geophys. Res., Vol.111, doi:10.1029/2004JA010988 (2006)
2. W. Baumjohann, A. Matsuoka, K.H. Glassmeier, C.T. Russell, T. Nagai, M. Hoshino, T. Nakagawa, A. Balogh, J.A. Slavin, R. Nakamura, and A. Magnes, The magnetosphere of Mercury and its solar wind environment: Open issues and scientific questions, Adv. Space Res., Vol.38, Issue 4, 604-609 (2006)
3. S. Imada, R. Nakamura, P.W. Daly, M. Hoshino, W. Baumjohann, S. Muhlbachler, A. Balogh, and H. Reme, Energetic electron acceleration in the downstream reconnection outflow region, J. Geophys. Res., Vol.112, 10.1029/2006JA011847, CiteID A03202 (2007)
4. T. Amano and M. Hoshino, Electron Injection at High Mach Number Quasi-Perpendicular Shocks: Surfing and Drift Acceleration, Astrophys. J., 661, 190 (2007/05)
5. W. Baumjohann, A. Roux, O. Le Contel, R. Nakamura, J. Birn, M. Hoshino, A. T. Y. Lui, C. J. Owen, J.-A. Sauvaud, A. Vaivads, D. Fontaine, and A. Rounov, Dynamics of Thin Current Sheets: Cluster Observations, Annales Geophysicae, 21, 1-25 (2007/06)
6. S. Zeniani and M. Hoshino, Particle Acceleration and Magnetic Dissipation in Relativistic Current Sheet of Pair Plasmas, Astrophys. J., 670, 702-726 (2007/11)
7. Y. Saito, S. Yokota, K. Asamura, T. Tanaka, R. Akiba, M. Fujimoto, H. Hasegawa, H. Hayakawa, M. Hirahara, M. Hoshino, S. Machida, T. Mukai, T. Nagai, T. Nagatsuma, M. Nakamura, K. Oyama, E. Sagawa, S. Sasaki, K. Seki, and T. Terasawa, Low energy charged particle measurement by MAP-PACE onboard SELENE, Earth, Planet and Space, 60, 375-385 (2008)
8. M. Hoshino, Wakefield Acceleration by Radiation Pressure in Relativistic Shock Waves, Astrophys. J., 672, 940-956 (2008/01)
9. C. Jaroschek and M. Hoshino, Stochastic Particle Acceleration by the Forced Interaction of Relativistic Current Sheets, Adv. Space. Res., 41, 481-490 (2008/02)
10. S. Zenitani and M. Hoshino, The Role of Guide Field in Relativistic Pair Plasma

Reconnection, Astrophy. J., 677, 530-544 (2008/04)

11. A.S. Sharma, R. Nakamura, A. Runov, E.E. Grigorenko, H. Hasegawa, M. Hoshino, P.Louarn, C.J. Owen, A. Petrukovich, J.-A. Sauvaud, V.S. Semenov, V.A. Sergeev, J.A. Slavin, B.U.O. Sonnerup, L.M. Zelenyi, G. Fruit, S. Haaland, H. Malova, and K. Snekvik, Transient and localized processes in the magnetotail: A revew, Annales Geophysicae, 26 (4), 955-1006 (2008/05)

12. K. Nagata, M. Hoshino, C. Jaroschek, and H. Takabe, Interaction between Alternating Magnetic Fields and a Relativistic Collisionless Shock, Astrophy. J., 680. 627-638 (2008/06)

13. Y. Kuramitsu, Y. Sakawa, T. Kato, H. Takabe, and M. Hoshino, Nonthermal Acceleration of Charged Particles due to an Incoherent Wakefield Induced by a Large-Amplitude Light Pulse, Astrophys. J. Lett., 682, L113-L116 (2008/08)

14. S. Imada, M. Hoshino, and T. Mukai, The Dawn-Dusk Asymmetry of Energetic Electron in the Earth's Magnetotail: Observation and Transport Models, J. Geophys. Res., 113(A11), 10.1029/2008JA013610 (2008/12)

15. T. Amano and M. Hoshino, Electron Shock Surfing Acceleration in Multidimensions: Two-Dimensional Particle-In-Cell Simulation of Collisionless Perpendicular Shock, Astrophy. J., 690, 244-251 (2009/01)

16. E.E. Grigorenko, M. Hoshino, M. Hirai, T. Mukai and L.M. Zelenyi, "Geography" of ion acceleration in the magnetotail: X-line versus Current sheet effects, J. Geophys. Res., 10.1029/2008JA013610 (2009/03)

17. C. H. Jaroschek and M. Hoshino, Radiation Dominated Relativistic Current Sheets, Phys. Rev. Letters, 103 (7) DOI:10.1103/PhyRevLett.103.075002 (2009/08)

18. T. Amano and M. Hoshino, Nonlinear Evolution of Buneman Instability and Its Implication for Electron Acceleration in High Mach Number Collisionless Perpendicular Shocks, Physics of Plasmas, 16, DOI:10.10631.1,3240336 (2009/10)

19. W. Baumjohann, A. Matsuoka, W. Magnes, K.-H. Glassmeier[c], R. Nakamura, H. Biernat, M. Delva, K. Schwingenschuh, T. Zhang, H.-U. Auster, K.-H. Fornacon, U. Motschmann, I. Richter, A. Balogh, C. Carr, M. Dougherty, P. J. Cargill, T. S. Horbury, E. A. Lucek, F. Tohyama, T. Takahashi, M. Tanaka, T. Nagai, H. Tsunakawa, M. Matsushima, M. Shinohara, H. Kawano, A. Yoshikawa, H. Shibuya, T. Nakagawa, M. Hoshino, Y. Tanaka, R. Kataoka, B. J. Anderson, C. T. Russell, Magnetic Field Investigation of Mercury's Magnetosphere and the Inner Heliosphere by MMO/MGF, Planetary Space Science, 58, 279-286 (2010/01)

20. N. Shimada, M. Hoshino, and T. Amano, Structure of a Strong Supernova Shock Wave and Rapid Electron Acceleration Confined in its Transition Region, Physics of Plasmas, 17, 032902 (2010/03)

21. T. Amano and M. Hoshino, Critical Mach number for electron injection in collisionless shock, Physical Review Letters, 104(18), DOI: 10.1103/PhysRevLett.104.181102 (2010/05)

22. Y. Saito, S. Yokota, K. Asamura, T. Tanaka, M.N. Nishino, T. Yamamoto, Y. Terakawa, M. Fujimoto, H. Hasegawa, H. Hayakawa, M. Hirahara, M. Hoshino, S. Machida, T. Mukai, T. Nagai, T. Nagatsumo, T. Nakagawa, M. Nakamura, K. Oyama, E. Sagawa, S. Sasaki, K. Seki, I. Shinohara, T. Terasawa, H. Tsunakawa, H. Shibata, M. Matsumoto, H. Shimizu, F. Takahashi, In-Flight Performance and Initial Results of Plasma Energy Angle and Composition Experiment (PACE) on SELENE (Kaguya), Space Science Reviews,

154, 265-303 (2010/7)

23. Y. Kuramitsu, N. Nakanii, K. Kondo, Y. Sakawa, Y. Mori, E. Miura, K. Tsuji, K. Kimura, S. Fukumochi, M. Kashihara, T. Tanimoto, H. Nakamura, T. Ishikura, K. Takeda, M. Tampo, R. Kodama, Y. Kitagawa, K. Mima, K. A. Tanaka, M. Hoshino, and H. Takabe, Model Experiment of Cosmic Ray Acceleration due to an Incoherent Wakefield Induced by an Intense Laser Pulse, Phys. of Plasmas, 18 (1) DOI: 10.1063/1.3528434 (2011/01)

24. Y. Kuramitsu, N. Nakanii, K. Kondo, Y. Sakawa, Y. Mori, E. Miura, K. Tsuji, K. Kimura, S. Fukumochi, M. Kashihara, T. Tanimoto, H. Nakamura, T. Ishikura, K. Takeda, M. Tampo, R. Kodama, Y. Kitagawa, K. Mima, K. A. Tanaka, H. Takabe, and M. Hoshino, Experimental Evidence of Nonthermal Acceleration of Relativistic Electrons by an Intensive Laser Pulse, Phys. Rev. E, 83 (2) DOI:10.1103/PhysRevE.83.026401 (2011/02)

25. S. Imada, M. Hirai, M. Hoshino and T. Mukai, Favorable conditions for energetic electron acceleration during magnetic reconnection in the Earth's magnetotail, J. Geophys. Res., 116 (A8), CiteIDA08217, DOI:10.1029/2011JA016576 (2011/08)

26. C.-C. Hung, L.-N. Hau, and M. Hoshino, Magnetic reconnection in an anisotropic plasma: Observation and theory, Geophys. Res. Letters. 38, Issue 18, CiteID L18106 (2011/08)

27. N. Yokoi and M. Hoshino, Flow-turbulence interaction in magnetic reconnection, Physics Plasmas, 18(11), DOI:10.1063/1.3641968 (2011/11)

28. E. Grigorenko, L.M. Zelenyi, M.S.Dollgonosov, A.V. Artemiev, C.J. Owen, J.-A. Sauvard, M. Hoshino and M. Hirai, Non-adiabatic Ion Acceleration in the Earth Magnetotail and Its Various Manifestations in the Plasma Sheet Boundary Layer, Space Science Review, 164, 133-181, DOI 10.1007/s11214-011-9858-9 (2011/12)

(2) Selected Conference Proceedings

1. C.H. Jaroschek, Lesch, H., Hoshino, M., Jessner, A., and Treumann, R.A., Radiative Outbursts in Pulsar Emission and Collective Plasma Instabilities: The Potential of Kinetic Plasma Simulations, Springer Lecture Notes of the 363rd Heraeus Seminar, Bad Honnef, (2006)

2. M. Hoshino, S. Zenitani, K. Nagata, and Y. Takagi, Particle Acceleration in Kinetic Plasma Processes, in Energy Budget in the High Energy Universe, (eds. K. Sato and J. Hisano), Proceedings of the International Workshop, World Scientific, 108-118 (2007)

3. Masahiro Hoshino, Particle Acceleration due to Radiation Pressure in Relativistic Shock Waves, 30th International Cosmic Ray Conference, OG1.4+2.2, 432 (2007)

4. Takanobu Amano and Masahior Hoshino, Electron Injection at Quasi-Perpendicular Supernova Remnant Shocks, 30th International Cosmic Ray Conference, OG1.4+2.2, 244 (2007)

5. N. Shimada and M. Hoshino, Role of microscopic plasma instabilities on shock dissipation process, AIP Conference Proceedings on Future Perspectives of Space Plasma and Particle Instrumentation and International Collaborations, 1144, 25-28 (2009/12)

6. T. Amano and M. Hoshino, Quasi-Perpendicular Shocks, AIP Conference Proceedings on Future Perspectives of Space Plasma and Particle Instrumentation and International Collaborations, 1144, 36-39 (2009/12)

7. M. Hirai, T. Kuroda, S. Ida and M. Hoshino, “Heart-Shaped” Plasmoid Observed in the Distant Magnetotail, AIP Conference Proceedings on Future Perspectives of Space Plasma and Particle Instrumentation and International Collaborations, 1144, 44-47 (2009/12)

(3) Review Papers

1. M. Hoshino and T. Amano, Particle acceleration mechanisms in universe, Butsuri (Physical Society of Japan), Vol.64, No.6, 421-429 (2009/06). (in Japanese)「refereed」

(4) Books

1. M. Hoshino, Nonthermal particle acceleration, in connection of Magnetic Reconnection, (eds. J. Birn and E. Priest), Cambridge Univ. Press, 154-166 (2007)
2. M. Hoshino, Computational Astrophysics, Chapter 6.1, Plasma particle-in-cell simulation, Modern Astronomy Series, Nippon Hyoron Sha Co. (2007) (in Japanese)
3. M. Hoshino, Basic Astrophysics II, Chapter 2, Plasma and Magnetohydrodynamics, Modern Astronomy Series, Nippon Hyoron Sha Co. (2008) (in Japanese)
4. M. Hoshino, Particle-in-cell simulation in plasma universe, Chapter 5.2, Handbook of computational dynamic, Maruzen Co.（2009/12）(in Japanese)
5. M. Hoshino, Magnetic Reconnection, Chapter 17, Basic physical mechanisms in Space weather、 Kyoto University Press (2011/5) (in Japanese)

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. M. Hoshino, Magnetic reconnection in magnetotail and beyond, Workshop on magnetotail current sheets, IKI, Moscow, Russia (September 26-30. 2011) (invited)
2. M. Hoshino, Stochastic Particle Acceleration in Magnetic Reconnection, 2nd International Space Plasma Symposium 2011, Taina, Taiwan (August 15-19, 2011) (invited)
3. M. Hoshino, Particle Acceleration in Turbulent Magnetic Reconnection and in Accretion Disks, 11th International Workshop on the Interrelationship between Plasma Experiments in the Laboratory and in Space (IPELS), Whistler, Canada (July 10-15,2011) (invited)
4. M. Hoshino, Stochastic Particle Acceleration in Multiple Magnetic Reconnection Sites, International Astrophysics Forum Alpbach (IAFA) 2011, Alpbach, Austria (June 20-24, 2011) (invited)
5. M. Hoshino, Lecture on Kinetic Reconnection, Summer School of MHD and Kinetic Processes in Laboratory, Space and Astrophysical Plasmas, KIAA, Peking University, China (May 30-June 3, 2011) (keynote)
6. M. Hoshino, Particle Acceleration in Relativistic Reconnection, Understanding Relativistic Jets, Krakow, Poland, (May 23-26, 2011) (keynote)
7. M. Hoshino, Electron Acceleration in Reconnection, ISSI Workshop on particle acceleration in cosmic plasmas, Bern, Swiss (May 16-20, 2011) (invited)
8. M. Hoshino, Fermi Acceleration in Turbulent Magnetic Reconnection, 10th Annual International Astrophysics Conference, Maui, Hawaii, USA (March 13-18,2011) (invited)
9. M. Hoshino, Particle Acceleration in Turbulent Magnetic Reconnection, Earth-Sun System Exploration: Variability in Space Plasma Phenomena, Kona, Hawaii, USA (January 16-21, 2011) (invited)
10. M. Hoshino, Magnetic Reconnection in Relativistic Astrophysics, 4th East Asia Numerical Astrophysics Meeting, EANAM 2010, Taipei, Taiwan (November 2-5, 2010) (invited)

11. M. Hoshino, Reconnection Modeling: Particle Acceleration in Turbulent Reconnection, MMS Science Working Team Meeting, St Michael, Maryland, USA (October 19-21, 2010) (invited)

12. M. Hoshino, Magnetic Reconnection as Studied in Space and Astrophysical Plasmas by using PIC Simulation, 39th COSPAR Scientific Assembly, Bremen, Germany (July 18-25, 2010) (invited)

13. M. Hoshino, Plasma Heating and Acceleration in a High Mach Number Shock, Western Pacific Geophysics Meeting 2010, Taipei, Taiwan (June 22-25, 2010) (invited)

14. M. Hoshino, Physics of Nonthermal Particle Acceleration in Collisionless Shocks, International Space Plasma Symposium 2010, Taina, Taiwan (June 27-30, 2010) (invited)

15. M. Hoshino, Magnetic Reconnection in Space and Astrophysical Plasmas, West Lake International Symposium on Space Plasma Physics, Hangzhou, China (April 19-21, 2010) (invited)

16. M. Hoshino, Reconnection in Relativistic and Strongly Magnetized Plasmas and Their Radiation, Workshop on Opportunities in Plasma Astrophysics, Princeton Plasma Physics Laboratory, New Jersey (January 18-21, 2010) (invited)

17. M. Hoshino, Collisiionless Shocks as Particle Accelator in the Universe, Workshop on indirect dark matter search, IMPU/University of Tokyo, Kashiwa (December 7-11, 2009) (invited)

18. M. Hoshino, Particle Acceleration and Magnetic Field Generation in Relativistic Shocks, 5th Korean Astrophysics Workshop on Shock Wave, Turbulence, and Particle Acceleration, APCTP, Pohang, Korea (November 18-21, 2009) (invited)

19. M. Hoshino, Lecture on Particle Acceleration in Shock Waves, International School-Particle Acceleration in the Universe, GCOE Program/Nagoya University (November 12-14, 2009) (keynote)

20. M. Hoshino, Particle Acceleration and Injection in Non-Relativistic Magnetosonic Shocks, Nonlinear Processes in Astrophysical Plasmas: Particle Acceleration, Magnetic Field Amplification, and Radiation Signatures, Kavli Institute for Theoretical Physics, San Diego, USA (September 2009) (invited)

21. M. Hoshino, Toward Understanding of Electron Fermi Acceleration in Magnetosonic Shocks: Plasma Physics View, TeV Particle Astrophysics 2009, SLAC National Accelerator Laboratory, USA (July, 2009) (invited)

22. M. Hoshino, Particle Acceleration and Injection Problem in Collisionless Shocks, The high-energy astrophysics of outflow from compact objects, Ringberg Castle, Tegernsee, Germany (December 2008) (invited)

23. M. Hoshino, Particle Energization of Magnetic Reconnection in Space and Astrophysical Plasmas, 2008 Huntsville Workshop: The physical processes for energy and plasma transport across magnetic boundaries, Huntsville, Alabama, USA (October 2008) (invited)

24. M. Hoshino, Particle Acceleration and Injection Problem in Relativistic and Nonrelativistic Shocks, Kinetic Modeling of Astrophysical Plasmas, Krakow, Poland (October 2008) (invited)

25. M. Hoshino, Particle Acceleration in Relativistic Astrophysical Shocks, International Congress on Plasma Physics (ICPP 2008), Fukuoka, Japan (September 2008) (invited)

26. M. Hoshino, Shock Injection Problem and Beyond in Hybrid/Particle-in-Cell Simulations, COSPAR, Montreal, Canada (July 2008) (invited)
27. M. Hoshino, Relativistic Shock Acceleration with Intense Electromagnetic Fields, 7th International Workshop on Nonlinear Waves and Turbulence in Space Plasmas, Beaulieu, France (April 2008) (invited)
28. M. Hoshino, Relativistic Shock and Particle Acceleration with Intense Electromagnetic Fields, International Workshop on Plasma Shock and Particle Acceleration, Senri-Chikusa, Osaka (January 2008) (keynote)
29. M. Hoshino, Cosmic Ray Acceleration by Wakefield, 2nd International JEM-EUSO meeting, RIKEN, Saitama (November 2007) (invited)
30. M. Hoshino, Particle Acceleration by Radiation Pressure in Relativistic Shock Waves, ASTRONUM 2007 International Conference, Paris, France (June 2007) (invited)
31. M. Hoshino, Energetic Electrons during Magnetic Reconnection: Theory and Observations, 4th Annual Meeting AOGS, Bangkok, Thailand (July 2007) (invited)
32. M. Hoshino, Nonlinear Electromagnetic Waves and Nonthermal Particle Acceleration in Relativistic Shock Waves, Japan-Korea Mini-Workshop on Laboratory, Space and Astrophysical Plasmas, Daejeon, Korea (April 2007) (invited)
33. M. Hoshino, Fireball Generated by Relativistic Reconnection Jets: Wakefield Acceleration by Relativistic Shock, US-Japan Conference on Magnetic Reconnection, St. Michaels, Maryland, USA (March 2007) (invited)
34. M. Hoshino, Wakefield Acceleration in Relativistic Shock Waves, IRCS International Workshop on Shock Formation under Extreme Environments in the Universe, TokyoTech, Tokyo (February 2007) (invited)
35. M. Hoshino, Particle Acceleration in Relativistic Shock Waves, 2nd East-Asia Numerical Astrophysics Meeting, Daejeon, Korea (November 2006) (invited)
36. M. Hoshino, A New Wakefield Acceleration in Relativistic Shock Waves, 6th International Workshop on Nonlinear Waves and Turbulence in Space Plasmas, Fukuoka, Japan (October 2006) (invited)
37. M. Hoshino, Energetic Electron Acceleration in Magnetic Reconnection, 36th COSPAR Science Assembly, Beijin, China (July 2006) (invited)
38. M. Hoshino, Surfing Acceleration of Energetic Electrons during Magnetic Reconnection, General Assembly of European Geosciences Union, Vienna, Austria (April 2006) (invited)
39. M. Hoshino, Future Theoretical Challenges in Magnetic Reconnection, Harry Petschek Symposium on Magnetic Reconnection, College Park, Maryland, USA (March 2006) (invited)
40. M. Hoshino, Particle Acceleration in Kinetic Plasma Processes, International workshop on Energy Budget in the High Energy Universe, Kashiwa, Chiba (February, 2006) (invited)

Total number of presentations (including co-author) 40 + 40 (invited/keynote)

(2) Domestic Conferences

Total number of presentations (including co-author) 71 + 11 (invited/keynote)

III. Educational Activity (2002-2011)

9. Notable achievements in education

Honors and Awards to Advisees

· Seiji Zenitani, Obayashi Awards, Society of Geomagnetism and Earth, Planetary and Space Science of Japan (2011)

· Keisuke Shirakawa, Aurora Medal, Society of Geomagnetism and Earth, Planetary and Space Science of Japan (2011)

· Mariko Hirai, Aurora Medal, Society of Geomagnetism and Earth, Planetary and Space Science of Japan (2010)

· ShinsukeImada, Aurora Medal, Society of Geomagnetism and Earth, Planetary and Space Science of Japan (2005)

Careers of Advisees

· Takanobu Amano, (Ph.D 2008) Assistant Professor, Faculty of Science, University of Tokyo

· Shinsuke Imada (Ph.D 2006) Assistant Professor, Solar-Terrestrial Environment Laboratory, University of Nagoya

· Seiji Zenitani (Ph.D 2006) Project Assistant Professor/NAO Fellow, National Astronomical Observatory, Division of Theoretical Astronomy

· Yosuke Matsumoto (Ph.D 2004) Project Assistant Professor/HPCI Super-Computer Project, Faculty of Science, Chiba University.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Journal of Geophysical Research, Associate Editor (2002-2006)

(2) Academic Societies

(3) International Conferences

· Convener, 2nd International Space Plasma Symposium, Taiwan, 2011

· Convener, International Workshop on Kinetic Modeling of Astrophysical Plasmas, Krakow, Poland, 2008

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

· Program Officer, Japan Society for the Promotion of Science/JSPS (2006-2009)

· Councilor Committee, Nagoya University/Solar Terrestrial Environment Laboratory (2008-present)

· Steering Committee, Osaka University, Institute of Laser Engineering (2008-present)

· Student Award Committee, University of Tokyo (2006-2009)

· Steering Committee, Information Technology Center (2009-present)

· Science Committee, International Space Science Institute/Switzerland (2010-present)

· Head of Undergraduate Department, Department of Earth and Planetary Physics (2011)

· Head of Department, Faculty of Science, Earth and Planetary Science (2010)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0 [M.Sc.: 0, Ph.D.: 0]

Foreign Researchers: 2

(Claus Jaroschek, JSPS, Postdoctoral Fellowships, 2006-2008)

(Elena Grigorenko, JSPS, Invitation Fellow Program, 2006)

Sending

Japanese Students: 1 [M.Sc.: 0, Ph.D.: 1]

Japanese Researchers: 0

Visitors from Abroad: 8 [U.S.A.: 2, Canada: 1, Germany: 2, others: 3]

Danny Summers (Memorial University of Newfoundland) January 2011

Melvyn Goldstein (NASA/Goddard Flight Center) December 2010

Martin Lee (University of New Hampshire) November 2010

Manfred Scholer (Max-Planck-Institut fur Extraterrestrische Physik) November 2010

Manfred Scholer (Max-Planck-Institut fur Extraterrestrische Physik) June 2010

and others, 2-3 visitors per year

Masamichi Miyamoto

I. C.V.

Name : Masamichi Miyamoto
Present Position: Professor, University of Tokyo, Graduate School of Science

Education

B. A., Pure and Applied Sciences, College of Arts and Science, University of Tokyo, March, 1972
M. Sc., Mineralogy, Graduate School of Science, University of Tokyo, March, 1974
D. Sc., Mineralogy, University of Tokyo, February, 1978

Professional Experience

April, 1976-Oct., 1979, Assistant Professor, Department of Science, Kobe University, Japan
November, 1979-Mar., 1988, Assistant Professor, College of Arts and Science, University of Tokyo
Sept., 1983-Oct., 1984 National Research Council, USA, NASA/JSC
April, 1988-Jul., 1990, Lecturer, College of Arts and Science, University of Tokyo
August, 1990-Sep., 1992, Associate Professor, College of Arts and Science, University of Tokyo
October, 1992-Mar., 1993, Professor, Faculty of Science, University of Tokyo
April, 1993-, Professor, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

My major achievements from 2006 to 2011 are: (1) studies of the cooling rate and thermal metamorphism of meteorites by using chemical zoning of minerals and (2) development of the method to analyze the diffuse reflectance spectra of asteroids. In this section, I will describe the former result.

Minerals usually show chemical zoning that contains information on crystal growth, cooling history (cooling rate, reheating, or thermal metamorphism etc.). I developed the method to calculate the cooling rate and burial depth by analyzing the chemical zoning of olivine and taking into consideration of crystal growth. This model is basically base on the atomic diffusion, atomic partition, fractional crystallization, and crystal growth and I estimated the cooling rates by solving the formulae concerning the above several phenomena simultaneously. The temperatures where olivine starts to crystallize and ends to crystallize are estimated by using MELTS program. This also enabled us to correct the cutting effect of thin section. I performed the verification of this model by using the zoning profiles experimentally made. This method includes the calculation of the cooling rate, burial depth in a seat, and burial depth in ^{26}Al heated parent body.

I applied this method to calculating the cooling rates of olivines in porphyritic olivine chondrules in the Semarkona (LL3.00) ordinary chondrite that is considered to be the least methamorphosed chondrite in the parent body. This meteorite, therefore, contains information on the primitive solar nebula and gives many constraints of the formation of chondrites. The results of cooling rates are from 0.7 ^{o}C/h to 2400 ^{o}C/h and this range is broadly consistent with

those obtained by dynamic crystallization experiments. Variations in cooling rates among chondrules in the same chondrite suggest that each chondrule formed in different conditions, for example, in regions with varying gas density, and assembled in the Semarkona parent body after chondrule formation.

Although many dynamic crystallization experiments have been performed to obtain the cooling rate of chondrules, these experiments only provide a possible range of cooling rates, rather than providing actual measured values from natural chondrules. My results made a definitive conclusion about the cooling rate of ordinary chondrite that is a one of the most important problems in planetary science and give different scientific significance from that by dynamic crystallization experiments.

3. Five Important Papers in your career

1. Miyamoto, M., N. Fujii, and H. Takeda (1981), Ordinary chondrite parent body: An internal heating model, *Proc. Lunar Planet. Sci. Conf. 12B, Suppl. 16, Geochim. Cosmochim. Acta,* 1145-1152.

We first proposed the parent body model of ordinary chondrites by ^{26}Al heat source and predicted the $^{26}Al/^{27}Al$ ratio when the parent body formed. This value was, later, confirmed by measurements of ordinary chondrites. This model is cited as an example of onion-shell model. SCI=93

2. Miyamoto, M. and H. Takeda (1983), Atomic diffusion coefficients calculated for transition metals in olivine, *Nature, 303*, 602-603. 19

We determined the parameters concerning each atom by the lattice-energy minimization method and successfully estimated the diffusion coefficients of atoms in olivine. Later, we calculated the diffusion paths of cations in olivine and $MgSiO_3$-perovskite. SCI=19

3. Miyamoto, M., D. S. McKay, G. A. McKay, and M. B. Duke (1986), Chemical zoning and homogenization of olivines in ordinary chondrites and implications for thermal histories of chondrules, J*ournal of Geophysical Research, 91*, 12804-12816.

We calculated the cooling rate by analyzing chemical zoning of olivine. This is my first paper concerning diffusional modification calculation to study thermal history of meteorites such as cooling rate, burial deoth,or thermal metamorphism. SCI=36

4. Miyamoto, M., and H. Takeda (1994), Evidence for excavation of deep crustal material of a Vest-like body from Ca compositional gradients in pyroxene, *Earth Planet. Sci. Lett., 122*, 343-350.

We estimated the depth of the primitive crust of asteroid 4Vesta (probably, the parent body of HED achondrites) by analyzing the growth and width of Ca lamella in pyroxene, and determined the time and temperature of excavation of the HED meteorites from Vesta. SCI=31

5. Miyamoto M., T. Mikouchi, and R. H. Jones (2009), A wide range of the cooling rate of type II porphyritic olivine chondrules in Semarkona (LL3.00) by diffusion calculation from olivine Mg-Fe zoning, *Meteoritics and Planet. Sci., 44*, 521-530.

I have already described in section II-2 about this paper. SCI=7

4. Awards and Honors throughout your career

· M. Miyamoto: Encouraging award, Japan Association of Mineralogical Sciences, May 28, 1984

5. Future Research Plan

My method to calculate the cooling rate (or burial depth) can be widely applied to many questions in earth and planetary sciences. I, first, apply this method to estimate the metamorphic temperatures of type 3 chondrites in their parent bodies, because the metamorphic temperature is relatively low and is difficult to estimate by using the traditional method (e.g., geothermometer on the basis of partition coefficients of elements).

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for Scientific Research (C), Experimental resolution of primitive materials evolution in solar nebula: From chondrite to achondrite 2006-2008、4.07 million yen

· Grant-in-Aid for Scientific Research (C): Variations of the cooling rate of chondrules, 2010-2012、2.58 million yen

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Monkawa A., T. Mikouchi, E. Koizumi, K. Sugiyama, and M. Miyamoto (2006) , Determination of the Fe oxidation state of the Chassigny kaersutite: A micro XANES spectroscopic study, *Meteoritics and Planet. Sci.*, *41*, 1321-1329.
2. Arai T., M. H. Takeda, and M. Miyamoto (2006), Experimental petrology of ancient lunar mare basalt Asuka-881757: Spinel crystallization as a petrologic indicator. *Antarctic Meteorite Res., 19*, 1-19.
3. Miyamoto M., T. Mikouchi, and Jones R. H. (2009), A wide range of the cooling rate of type II porphyritic olivine chondrules in Semarkona (LL3.00) by diffusion calculation from olivine Mg-Fe zoning, *Meteoritics and Planet. Sci., 44*, 521-530.
4. Komatsu M., T. Mikouchi, and Miyamoto M. (2009), High temperature annealing of amoeboid olivine aggregates: Heating experiments of olivine and anorthite mixtures, *Polar Science, 3*, 31-55.
5. Miyamoto M., T. Arai, M. Komatsu, A. Yamamoto, and T. Mikouchi (2009), Evaluation of a curve-fitting method for diffuse reflectance spectra in the UV-Visible-NIR wavelength region, *Polar Science, 3*, 110-116.
6. Arai T., B. R. Hawke, T. A. Giguere, K. Misawa, M. Miyamoto, and H. Kojima (2010), Antarctic lunar meteorites Yamato-793169, Asuka-881757, MIL 05035, and MET 01210 (YAMM): Launch pairing and possible cryptomare origin, *Geochimica. Cosmochimica. Acta, 74*, 2231-2248.
7. Goodrich C. A., N. T. Kita, M. K. Spicuzza, J. W. Valley, J. Zipfel, T. Mikouchi, and M.

Miyamoto (2010), The Northwest Africa 1500 meteorite: Not a ureilite, maybe a brachinite, *Meteoritics and Planet. Sci., 45*, 1906-1928.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

24 presentations

(2) Domestic Conferences

10 presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

· Governing board of The University Museum, The University of Tokyo

· Governing board of Antarctic meteorite research committee of National Institute of Polar Research

· Expert investigators of National Institute of Science and Technology Policy

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 1

Naomoto Iwagami

I. C.V.

Name： Naomoto Iwagami
Present Position: Associate Professor, Graduate School of Science, University of Tokyo

Education
B. Sc., Astrophysics, Tohoku University, March 1973
M. Sc., Geophysics, University of Tokyo, March 1975
Ph. D., Geophysics, University of Tokyo, March 1980
of Geophysics, Graduate School of Science, The University of Tokyo, September 1985

Professional Experience
Oct. 1976-Mar. 1978, Researcher, National Institute of Polar Research
Oct. 1981, Research Associate, Geophysics Research laboratory, University of Tokyo
Feb. 1991, Associate Professor, Geophysics Research laboratory, University of Tokyo
April, 2000, Associate Professor, Dep. of Earth and Planetary Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

Japanese Venus Mission Project “AKATSUKI” started at a meeting held on August 1999 discussing the scientific objectives. After that and until the launch in June 2010, I have heavily concerned to the project as the principal investigator (PI) of the 1 mm camera (IR1) which is one of the main instruments. I have worked on various procedures such as selection of scientific object, specification for the camera, designing and manufacturing by collaboration with optics and electronics companies, various functional and environmental tests and so on. AKATSUKI was successfully launched in June 2010, however, it failed to be inserted into the Venus orbit in Dec. 2010, and we have not obtained expected data set yet. AKATSUKI is now going on an orbit with a period of 199 days; this is a little shorter than that of Venus. In spite of unexpected heat input due to the small orbit and hazardous corpuscular radiations, all the instruments are ready to work still now. It is scheduled to retry the insertion again at the end of 2015. If it goes successfully, we may have a chance to get the data sets nearly as initially expected.

In preparation for data shortage during development of IR1, we started ground-based IR spectroscopic observation of the Venus atmosphere aiming at O_2 1.27 mm airglow and important minor constituents such as HCl. At first we tried in Japan such as at Okayama Astrophysical Observatory, but we could get just a little data due to unhappy weather. Then we changed the telescope to NASA/IRTF, and could start to get good data set; recently, we visit IRTF once a year for 4-8 days on average producing scientific information continuously. Up to now, we have published about the hemispherical distributions of O_2 1.27 mm airglow intensity and the rotational temperature, and those of minor constituents such as HCl (Iwagami et al.2008)、CO (Iwagami et al. 2010) and HDO (Matsui et al. 2012). Also, we succeeded to derive signatures of atmospheric waves from the cloud height distribution (Hosouchi et al. 2012); this is a new way to investigate atmospheric waves.

Since the expected data do not come from AKATSUKI for several years, from around 2010, we started to collaborate with the SOIR (Solar Occultation in InfraRed)/VEX (Venus

Express) team analyzing the occultation data. From a statistical processing of the data of the upper haze, we got an unexpected results showing an enhancement in mixing ratio at 100 km (Takagi et al. paper in preparation). Similar unexpected enhancements are also found in the SO and SO_2 distributions at 100 km, and several production mechanisms such as through transportation of cloud sols have been proposed.

3. Five Important Papers in your career

1. Iwagami, N. and T. Ogawa (1980), An Antarctic NO density profile deduced from the gamma band airglow, Planet. Space Sci. 28, 867-873.

Recognition of auroral modulation of the atmosphere

2. Iwagami, N., S. Inomata, I. Murata and T. Ogawa (1995), Doppler detection of hydroxyl column abundance in the middle atmosphere, J. Atm. Chem. 20, 1-15.

Unique use of solar rotation

3. Iwagami, N., H. Yamamoto, K. Yajima, H. Sekiguchi, T. Watanabe, K. Suzuki, K. Shibasaki, H. Amemiya, M. Yamamoto and T. Ono (1998), Polar thermosphere-stratosphere photochemical coupling experiment: Two rocket measurements in polar winter at 69N, Earth, Planets and Space, 50, 745-753.

Quest of the missing link between sun and weather

4. Iwagami, N., T. Shibaki, T. Suzuki, H. Sekiguchi, N. Takegawa and W.H. Morrow (2003), Rocket observation of atomic oxygen density and airglow emission rate in the WAVE2000 campaign, J. Atm. Solar-Terr. Phys. 65, 1349-1360.

Sophisticated interpretation of the airglow

5. Iwagami, N., S. Ohtsuki, K. Tokuda, N. Ohira, Y. Kasaba, T. Imamura, H. Sagawa, G.L. Hashimoto, S. Takeuchi, M. Ueno and S. Okumura (2008), Hemispheric distributions of HCl above and below the Venus' clouds by ground-based 1.7 mm spectroscopy, Planet. Space Sci. 56, 1424-1434.

HCl above and below the clouds.

4. Awards and Honors throughout your career

· Tanakadate Award no.120, Society of Geomagnetism and Earth and Planetary and Space Sciences, Oct. 1988

5. Future Research Plan

AKATSUKI will retry the Venus orbit insertion at the end of 2015, and if everything goes well, we can start to get new data sets. Although I am to retire in March 2015, I want to concern with the AKATSUKI data.

I want to continue ground-based measurement too. The inferior conjunctions are coming in Jan. 2014 and Aug. 2015, and the observational chances are within two months before and after them. I want to plan spectroscopic observations of airglow, minor constituents and isotopes by using a ground-based telescope such as NASA/IRTF.

Also I want to concern with the SOIR occultation data analyzing the upper haze layer and distributions of minor constituents.

6. Funding Received

(1) JSPS Grants

· Basic Research (C) “Study of chemical and Dynamical processes of the Venus atmosphere based on ground-based spectroscopy” Heisei 21-25 fiscal year, 4.42 million yen

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Kurihara, J., K-I. Oyama, N. Iwagami and T. Takahashi (2006), Numerical simulation of 3D flow around sounding rocket in the lower thermosphere, Ann. Geophys. 24, 89-95.
2. Iwagami, N., S. Komada and T. Takahashi (2006), Preliminary results of rocket attitude and auroral green line emission rate in the DELTA campaign, Earth, Planets and Space, 58, 1107-1111.
3. Kurihara, J., T. Abe, K-I. Oyama, E. Griffin, M.Kosch, A. Aruliah, K. Kauristie, Y. Ogawa S. Komada and N. Iwagami (2006), Observation of the lower thermospheric neutral temperature and density in the DELTA campaign, Earth, Planets and Space, 58, 1123-1130.
4. Abe, T., J. Kurihara, N. Iwagami, S. Nozawa, Y. Ogawa, R. Fujii, H. Hayakawa and K-I. Oyama (2006), Dynamics and energetics of the lower thermosphere in aurora (DELTA)-Japanese sounding rocket campaign-, Earth, Planets and Space, 58, 1165-1171.
5. Kubota, M., S. Kawamura, M. Abo, Y. Koizumi, Y. Murayama, M. Yamamori, K. Shiokawa, Y. Otsuka, M. Uchiumi, K. Igarashi, T. Abe, K-I. Oyama and N. Iwagami (2006), A fast-propagating large-scale atmospheric gravity wave observed in the WAVE2004 campaign, J. Geophys. Res. 111, D21110.
6. Nakamura, M., T. Imamura, M. Ueno, N. Iwagami, T. Satoh, S. Watanabe, M. Taguchi, Y. Takahashi, M. Suzuki, T. Abe, G.L. Hashimoto, T. Sakanoi, S. Okano, Y. Kasaba, J. Yoshida, M. Yamada, N. Ishii, T. Yamada, K. Uemizu, T. Fukuhara and K-I. Oyama (2007), Planet-C: Venus Climate Orbiter mission of Japan, Planet. Space Sci. 55, 1831-1842.
7. Taguchi, M., T. Fukuhara, T. Imamura, M. Nakamura, N. Iwagami, M. Ueno, M. Suzuki, G.L. Hashimoto and K. Mitsuyama (2007), Longwave Infrared Imager onboard the Venus Climate Orbiter, Adv. Space Res. 40, 861-868.
8. Ohtsuki, S., N. Iwagami, H. Sagawa, M. Ueno, Y. Kasaba, T. Imamura and E.Nishihara (2008), Imaging spectroscopy of the Venus 1.27-mm O2 airglow with ground-based telescopes, Adv. Space Res. 41(9), 1375-1380.
9. Iwagami, N., S. Ohtsuki, K. Tokuda, N. Ohira, Y. Kasaba, T. Imamura, H. Sagawa, G.L. Hashimoto, S. Takeuchi, M. Ueno and S. Okumura (2008), Hemispheric distributions of HCl above and below the Venus' clouds by ground-based 1.7 mm spectroscopy, Planet. Space Sci. 56, 1424-1434.
10. Ohtsuki, S., N. Iwagami, H. Sagawa, M. Ueno, Y. Kasaba, T. Imamura, K. Yanagisawa

and E. Nishihara (2008), Distributions of the Venus 1.27-mm O2 airglow and rotational temperature, Planet. Space Sci. 56, 1391-1398.

11. Satoh, T., Imamura, T., Hashimoto, G.L., Iwagami, N., Mitsuyama, K., Sorahana, S., Dorossart, P. and Piccioni, G. (2009), Cloud structure in Venus middle-to-lower atmosphere as inferred from VEX/VIRTIS 1.74-mm data, J. Geophys. Res. 114, E00B37.
12. Koizumi, Y., M. Kubota, Y. Murayama, M. Abo, M. Uchiumi, K. Igarashi, N. Iwagami, T. Abe and K-I Oyama (2009), In situ observations of instabilities in the mesopause region using foil chaff technique during the WAVE campaigns, J. Geophys. Res. 114, D20114.
13. Kurihara, J., Oyama, S., Nozawa, S., Tsuda, T.T., Fujii, R., Ogawa, Y., Miyaoka, H., Iwagami, N., Abe, T., Oyama, K. -I., Kosch, M.J., Aruliah, A., Griffin, E., Kauristie, K. (2009), Temperature enhancements and vertical winds in the lower thermosphere associated with auroral heating during the Dynamics and Energetics of the Lower Thermosphere in Aurora (DELTA) campaign, J. Geophys. Res. 114, A12306.
14. Iwagami, N., T. Yamaji, S. Ohtsuki, and G.L. Hashimoto (2010), Hemispherical distribution of CO above the Venus' clouds by ground-based 2.3 mm spectroscopy, ICARUS 207, 558-563.
15. Kurihara, J., Y. Koizumi-Kurihara, N. Iwagami, T. Suzuki, A. Kumamoto, T. Ono, M. Nakamura, M. Ishii, A. Matsuoka, K. Ishisaka, T. Abe, and S. Nozawa (2010), Horizontal structure of sporadic E layer observed with a rocket-borne magnesium ion imager, J. Geophys. Res. 115, A12318.
16. Takagi, S. and N. Iwagami (2011), Contrast sources for the infrared images taken by the Venus mission AKATSUKI, Earth Planets Space 63, 435-442.
17. Nakamura, M., T. Imamura, N. Ishii, T. Abe, T. Satoh, M. Suzuki, M. Ueno, A. Yamazaki, N. Iwagami, S. Watanabe, M. Taguchi, T. Fukuhara, Y. Takahashi, M. Yamada, N. Hoshino, S. Ohtsuki, K. Uemizu, G. L. Hashimoto, M. Takagi, Y. Matsuda, K. Ogohara, N. Sato, Y. Kasaba, T. Kouyama, N. Hirata, R. Nakamura, Y. Yamamoto, N. Okada, T. Horinouchi, M. Yamamoto, and Y. Hayashi (2011), Overview of Venus orbiter, Akatsuki, Earth Planets Space 63, 443-457.
18. Iwagami, N., S. Takagi, S. Ohtsuki, M. Ueno, K. Uemizu, T. Sato, T. Sakanoi and G.L. Hashimoto (2011), Science requirements and description of the 1 mm camera onboard the Akatsuki Venus Orbiter, Earth Planets Space 63, 487-492.
19. Fukuhara, T., M. Taguchi, T. Imamura, M. Nakamura, M. Ueno, M. Suzuki, N. Iwagami, M. Sato, K. Mitsuyama, G. Hashimoto, R. Ohshima, T. Kouyama, H. Ando and M. Futaguchi (2011), LIR: Longwave Infrared Camera onboard the Venus orbiter Akatsuki, Earth Planets Space 63, 1009-1018.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Iwagami, N., Atomic oxygen measurement by resonance lamp, 2010 Taiwan-Japan Space Instrument Workshop, 8-10 Sep. 2010, National Cheng Kung University, Tainan, Taiwan (invited)

15 times more presentations at European Geoscience Union, Asia Oceania Geosciences Society and so on.

(2) Domestic Conferences

2. Iwagami, N. and S. Ohtsuki, 1 mm camera IR1 on board AKATSUKI: current status and future view, Japan Geoscience Union Meeting International Session, Makuhari Messe, May 2011 (invited)
3. Iwagami N, S. ohtsuki and S. Takagi, 1 mm camera on board AKATSUKI (in Japanese), Japan Geoscience Union Meeting, Makuhari Messe, May 2010 (invited)
4. Iwagami N, Gas measurement on board the reusable rocket (in Japanese), Japan Geoscience Union Meeting, Makuhari Messe, May 2007 (invited)

83 times more presentations at Japan Geoscience Union Meeting and so on.

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Ohtsuki, S, now a lecturer at Senshu University: 2002-2007 advisor for master and doctor courses.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

· Head of Japan Geoscience Union meeting organizing team (2003 to present)

· Vice chair of the Japan Geoscience Union meeting organizing committee (2010 to present)

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Iwagami N, “An infrared camera on board AKATSUKI” (in Japanese), Aogaku business forum, Aoyama gakuin, Feb. 2011

· Iwagami N, “Chemistry of Venus atmosphere” Planetarium workshop, Institute of Space and Astronautical Science, Sep. 2009

· Iwagami N, Astro-talk “Sending a camera to Venus!” Chiba science museum, Jan. 2012

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 2 [M.Sc.: 1 (Belgium), Ph.D.: 1 (Belgium)]

One doctoral course student (Takagi S: Belgian Institute of Space Aeronomy from Dec. 2011 to March 2012)

One master course student (Matsui H: Belgian Institute of Space Aeronomy from Dec.

Visitors from Abroad: 0

Hajime Hiyagon

I. C.V.

Name： Hajime Hiyagon
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education

B. Sc., Geophysics, The University of Tokyo, March, 1979
M. Sc., Geophysics, The University of Tokyo, March, 1981
Ph. D., Geophysics, The University of Tokyo, November, 1984

Professional Experience

Oct., 1984-Mar., 1985, Research Fellow, JSPS, Faculty of Science, The University of Tokyo
Apr., 1985-Sep., 1986, Research Fellow, Department of Physics, University of California, Berkeley, U.S.A.
Oct., 1986-Mar. 1993, Assistant Professor, Geophysical Institute, Faculty of Science, The University of Tokyo
Apr., 1993-Jan., 1999, Assistant Professor, Geophysical Institute, Graduate School of Science, The University of Tokyo
Jan. 1999-Mar. 2000, Associate Professor, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo
Apr., 2000-present, Associate Professor, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo

Apr., 1995-Mar., 1997, Part-time Lecturer, Tokyo University of Agriculture and Technology, Faculty of Engineering

II. Scientific Research Activity

2. Major achievements

I have been studying evolution of the early solar system materials based on isotopic and trace element analyses using ion microprobes, such as, O, Ca, and Ti isotopes, rare earth elements (REEs), chronological systems of various short-lived nuclides (e.g., ^{26}Al-^{26}Mg, ^{41}Ca-^{41}K, ^{53}Mn-^{53}Cr, etc.), and trace siderophile elements (on going project).

I have established an ion microprobe technique of precise REE analyses in 2003-2005. Using this technique, I conducted REE analyses on different types of CAIs, such as, ultra-refractory CAIs and fine-grained CAIs. The latter have not been analyzed intensively probably due to their small grain sizes and their analytical difficulties. I have found in fine-grained CAIs new types of REE patterns (with excesses in Ce, Eu and Yb), which have not been attracted much attention before, and discussed their formation conditions. The results suggest that fine-grained CAIs experienced migration from one region to another probably near the proto-sun (Hiyagon et al., 2011).

Among the chronological studies, a significant achievement has been done by Wataru Fujiya (my PhD-student, now staying in Max Plank Institute, Germany), who succeeded to determine precise and accurate ^{53}Mn-^{53}Cr ages of carbonates in CM and CI chondrites and formation times of their parent bodies (Fujiya et al., 2011, 2012; Professor Naoji Sugiura as a

coworker). Also I have been conducting intensively isotopic and chronological studies on hibonite ($CaAl_{12}O_{19}$)-bearing inclusions from CM chondrites. Hibonite is one of the first condensates from the hot solar nebula next to corundum (Al_2O_3) and may have important information about the earliest evolution of the solar system materials. Our earlier studies were published as Ushikubo et al. (2007), in which O-isotopes and chronological studies of ^{26}Al-^{26}Mg and ^{41}Ca-^{41}K systems were conducted. (The ^{41}Ca-^{41}K study was the second successful one in the world and first one in Japan.) Recently I found two hibonite-bearing inclusions showing surprisingly large mass-dependent isotopic fractionation of Mg (up to ~50 permil/amu), suggesting more than 95% of Mg had been evaporated from the molten precursors. This is an on-going project and further analyses are scheduled for Si, Ca, Ti and O isotopes, rare earth elements, and siderophile elements on hibonite-bearing inclusions to better understand the earliest evolution of the solar system materials. (Coworkers: Dr. N. Takahata, Y. Sano at AORI, Univ. Tokyo, Kashiwa, Japan, and Dr. Y. Morishita at AIST, Tsukuba, Japan.)

Now I am developing ion microprobe techniques of analyzing trace amounts of siderophile elements (including Pt-group elements) in Fe-Ni metal in meteorites, for understanding the fractionation mechanisms of siderophile elements in the solar nebula. I have so far succeeded Pd analysis at the ppm level. I am preparing many metal standards containing various siderophile elements for determination of relative sensitivity factors for the SIMS analysis (i.e., matrix effects).

I am also studying igneous clasts in a CR chondrite. We found clasts containing high-pressure mineral assemblages (eclogite) and now we are conducting ion microprobe studies of O and N isotopes, and rare earth elements to understand the origin of such unusual clasts. (Coworkers: Drs. N. Sugiura, M. Kimura, T. Mikouchi, and N. Kita.)

3. Five Important Papers in your career

1. Hiyagon, H. and M. Ozima, Partition of noble gases between olivine and basalt melt, *Geochim. Cosmochim. Acta* **50**, 2045-2057, 1986.

First successful determination of distribution coefficients of noble gases between olivine and basaltic melt. Important constraints on the degassing and formation history of the Earth based on noble gas geochemistry. Citation: 100

2. Hiyagon, H., M. Ozima, B. Marty, S. Zashu and H. Sakai, Noble gases in submarine glasses from Mid Oceanic Ridges and Loihi Seamount: Constraints on early history of the Earth, *Geochim. Cosmochim. Acta* **56**, 1301-1316, 1992.

Precise analyses of isotopic and elemental abundances of all five noble gases extracted from Mid Oceanic Ridges and the Loihi Sea Mount. Isotopic evolution of noble gases in the mantle (upper and lower) and in the atmosphere were discussed in detail. Citation: 136

3. Hiyagon, H., Retention of solar helium and neon in IDPs in deep sea sediment, *Science* **263**, 1257-1259, 1994.

Interplanetary Dust Particles, or IDPs, in deep-sea sediments contain high concentrations of He and Ne of solar wind origin. Based on diffusion experiments, it was shown that solar He and Ne might not be brought into the mantle due to weak retentivity of these gases in IDPs. Citation: 54

4. Hiyagon, H. and A. Hashimoto, ^{16}O excesses in olivine inclusions in Yamato-86009 and Murchison chondrites and their relation to CAIs. *Science* **283**, 828-831, 1999.

Ion microprobe analyses of oxygen isotopes were conducted for amoeboid olivine aggregates

(AOAs) for the first time, showing highly ^{16}O-rich signature of olivine grains in AOAs in spite of their non-refractory nature. Citation: 49

5. Hiyagon H., A. Yamakawa, T. Ushikubo, Y. Lin, and M. Kimura, Fractionation of eare earth elements in refractory inclusions from the Ningqiang meteorite: Origin of positive anomalies in Ce, Eu and Yb, *Geochim. Cosmochim. Acta*, **75**, 3358-3384, 2011.
6. Ion microprobe analyses of rare earth elements have been conducted for many CAIs from the Ningqiang meteorite, and new types of REE patterns were recognized. The results suggest that many fine-grained CAIs migrated frequently from one region to another probably near the early sun. I obtained a very positive comment from a significant researcher in this field that the newly obtained REE data are very good and valuable, and the discussions of REEs are very interesting.

4. Awards and Honors throughout your career

· Award for Young Scientist, Mass Spectrometry Society of Japan, May, 1995.*ciety of Japan* (April 1989) “Study of internal wave generation by tide-topography interaction

5. Future Research Plan

My first project is an ion microprobe study on hibonite ($CaAl_{12}O_{19}$)-bearing inclusions separated from CM chondrites. The purpose of the project is to understand evolution of the earliest solar system materials, because hibonite is one of the first condensates next to corundum (Al_2O_3) and may have important information in the earliest history of the solar system. I am planning to conduct various ion microprobe analyses such as O isotopes, Ca and Ti isotopes, chronological systems (^{26}Al-^{26}Mg, ^{41}Ca-^{41}K, ^{10}Be-^{10}B, etc.), and rare earth elements (REEs) on these inclusions. The major questions about hibonite-bearing inclusions are: (1) their formation time, (2) heterogeneous or homogeneous distribution of ^{26}Al and other isotopes, and (3) formation conditions and possible formation regions of these inclusions. It has been pointed out that some types of hibonite-bearing inclusions show almost no excess ^{26}Mg from ^{26}Al decay, but large anomalies in Ca and Ti isotopes. These signatures may be interpreted either (1) they formed *after* ^{26}Al completely decayed, or (2) they formed *before* ^{26}Al was introduced into the solar system from, e.g., nearby supernova. Simultaneous analyses of various isotopes and trace elements would be essential to answer these questions. I will also study further the two hibonite inclusions with large Mg isotopic fractionations, because very strong evaporation event is necessary to explain such signatures.

Another project is an ion microprobe study of trace siderophile elements in metallic grains in meteorites. The purpose of the project is to understand fractionation processes of siderophile elements in the solar nebula. There are relatively few data about trace siderophile elements in individual Fe-Ni metallic grains in meteorites. Usually it is interpreted that gradual decrease in elemental abundance in bulk chondrites with increasing volatility may reflect evaporation /condensation of these elements and solid-gas separation in the solar nebula, but there are still many unknowns about these mechanisms and structure and evolution of the solar nebula. At present, I am developing techniques of ion microprobe analyses of various trace siderophile elements in Fe-Ni metals. So far, I have succeeded Pd analysis at ppm level. I am preparing many metal standards containing various amounts of siderophile elements. Using these standards, I will determine relative sensitivity factors, efficiencies of secondary ion productions, during the SIMS analysis. Then I will apply the technique to individual metallic

grains in chondrites to understand the nature and fractionation mechanisms of siderophile elements in the solar nebula.

These projects will be performed using two different ion microprobes with different analytical capabilities: *NanoSIMS* at Atmosphere and Ocean Research Institute (AORI), The University of Tokyo, Kashiwa, Japan (coworkers: Drs. N. Takahata and Y. Sano), and *ims-1270* at National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan (coworker: Dr. Y. Morishita).

6. Funding Received

(1) JSPS Grants

- Grant-in-Aid for Scientific Research (C), 2011-2013, SIMS study of siderophile element fractionation processes in the early solar system, (Project Leader), ¥3,380,000 (project total: ¥4,940,000), Members: Hajime Hiyagon (Univ. Tokyo) and Yuichi Morishita (AIST).
- Grant-in-Aid for Scientific Research (C), 2011-2013, Understanding the formation processes of rare metal deposit using SIMS analyses, (Project Member), ¥600,000 (project total: ¥4,810,000), Members: Yuichi Morishita (Project Leader), Hajime Hiyagon (Univ. Tokyo) and Koichi Goto (AIST).

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Hiyagon, H., A. Yamakawa, T. Ushikubo, Y. Lin and M. Kimura (2011), Fractionation of rare earth elements in refractory inclusions from the Ningqiang meteorite: Origin of positive anomalies in Ce, Eu and Yb, *Geochim. Cosmochim. Acta*, 75, 3358-3384, 2011.
2. Fujiya, W., N. Sugiura, N. Takahata and H. Hiyagon, *In-situ* chromium measurement of chromium-rich fine grains in the Murchison CM2 chondrite, *Geochem. J.*, 45, 275-281, 2011.
3. Sugiura N., M. I. Petaev, M. Kimura, A. Miyazaki and H. Hiyagon, Nebular history of amoeboid olivine aggregates, *Meteoritics Planet. Sci.* **44**, 559-572, 2009.
4. Ruzicka, A., H. Hiyagon, M.Huston and C. Floss, Relict olivine, chondrule recycling, and the evolution of nebular oxygen reservoirs, *Earth Planet. Sci. Lett.* **257**, 274-289.
5. Ushikubo T., Y. Guan, H. Hiyagon, N. Sugiura and L. A. Leshin, ^{36}Cl, ^{26}Al, and O isotopes in an Allende type B2 CAI: Implications for multiple secondary alteration events in the early solar system, *Meteoritics Planet. Sci.* **42**, 2007.
6. Ushikubo T., H. Hiyagon and N. Sugiura, A FUN-like hibonite inclusion with a large ^{26}Mg-excess, *Earth Planet. Sci. Lett.* **254**, 115-126, 2007.
7. Kimura M., H. Nakajima, H. Hiyagon and M. K. Weisberg, Spinel group minerals in LL3.00-6 chondrites: Indicators of nebular and parent body processes, *Geochim. Cosmochim. Acta* **70**, 5634-5650, 2006.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Hiyagon, H., A. Yamakawa, M. Sasaki, K. Uchiyama, T. Ushikubo, Lin Y. and M. Kimura, Rare earth element fractionation in fine-grained inclusions from the Ningqiang and other carbonaceous chondrites: Origin of Ce-Eu-Yb anomalies, *40th Lunar and Planetary Science Conference*, March, 2009, League City, Texas, U.S.A.

and other 6 presentations

(2) Domestic Conferences

2. Hiyagon H., Fromation conditions of fine-grained inclusions inferred from rare earth element abundance patterns, Japan Geoscience Union, May, 2009, Makuhari, Japan.

and other 13 presentations.

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Under my supervision, the following two graduate students took the doctoral degree in science at the University of Tokyo. Both of them continue their research work actively in U.S.A. or in Germany.

· Takayuki Ushikubo: Dr. Degree, May, 2005; Postdoctoral Fellow at Arizona State University, U.S.A. (2005-2007), Postdoctoral Fellow at University of Wisconsin, Madison, U.S.A. (2007 to present). Now working actively with Drs. N. Kita and J. Valley in various fields of geochemistry and cosmochemistry using an ion microprobe.

· Wataru Fujiya: Dr. Degree, Mar., 2012; Staying as a visiting researcher (Research Fellow of JSPS) at Max Plank Institute for Chemistry, Mainz, Germany, and working with Dr. Hoppe using a NanoSIMS in the field of cosmochemistry. Best Oral Presentation Award, Mass Spectrometry Society of Japan, Oct., 2009; Best Presentation Award, Japanese Society for Planetary Science, Oct., 2011; Award for Young Scientists (Dr. course), The University of Tokyo, Mar., 2012. His doctoral work was published in Nature Communications as a highlighted paper, which was also press released and was taken up in major newspapers. (Coworker: Prof. Naoji Sugiura)

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 1 [M.Sc.: 0, Ph.D.: 1 (Germany: 1)]

(W. Fujiya, to Max Plank Institute, Mainz, Germany, April-June, 2011)

Japanese Researchers: 0

Visitors from Abroad: 0

Takashi Mikouchi

I. C.V.

Name： Takashi Mikouchi

Present Position: Associate Professor, Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo

Education

B. Sc., Geoscience (Geology and Mineralogy), The University of Tokyo, March, 1993

M. Sc., Mineralogy, The University of Tokyo, March, 1995

D. Sc., Mineralogy, The University of Tokyo, April, 1998

Professional Experience

April, 1995, Research Fellow, Japan Society for Promotion of Science (at Mineralogical Institute, University of Tokyo)

May, 1995-Mar., 2000, Assistant Professor, Mineralogical Institute, University of Tokyo

April, 1999-Mar., 2000, Postdoctoral Fellow, National Research Council, USA (at NASA Johnson Space Center)

April, 2000-May, 2011, Assistant Professor, Department of Earth and Planetary Science, University of Tokyo

May, 2011-, Associate Professor, Department of Earth and Planetary Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

I have worked on mineralogical analyses of various solid planetary materials to understand general processes of material evolution in the solar system. Especially, I have focused on meteorites, which record such evolution processes from micrometer-sized dusts at the birth of the solar system to planet-sized bodies at present. My major techniques involve scanning and transmission electron microscopy, electron microprobe analysis and X-ray diffraction on these planetary materials by combining experimental works at laboratories. I have been involved in the initial analysis of comet Wild 2 dust particles as returned by NASA Stardust spacecraft in 2006. My other special interests are on Martian and lunar samples, which broadens the variation of materials studied, and they are important to understand the general material evolution in the solar system. The most characteristic aspect of my study is employing various micro-area analytical techniques to obtain maximum information from minute samples. Another characteristic aspect is international collaboration, which has started with NASA when I was a master-course student. Since then, my international collaboration has been expanded and now several projects are ongoing worldwide. By these works, many achievements have been done, which is proved by annual Lunar and Planetary Science Conference in Houston, where my works have been accepted as oral presentations every year since I was a master-course student. Followings are selected achievements in recent years.

(1) I showed that major constituent phases in the Wild 2 particles are olivine and pyroxene with variable chemical compositions, and are most similar to anhydrous interplanetary dust particles. This study proved the presence of large-scale transportation of solid materials by e.g.,

X-wind at the birth of the solar system.

(2) I found an unknown phase in carbonaceous chondrite and gave a constraint on its formation environment in the solar nebula by identifying it as a new mineral. This is one of the earliest works using SEM-EBSD (electron back-scatter diffraction) in the field of planetary material science to characterize crystallography of sub-micrometer areas. I also developed energy-scanning X-ray diffraction technique using synchrotron radiation, which also allowed obtaining diffraction patterns from 1 mm area of thin sections.

(3) I studied polymict ureilite (Almahata Sitta), which is the first (and still only) example of the recovered asteroid fragments (its parent asteroid was observed before the fall). This study showed that the samples experienced quenching at high temperature and they originated from a small rubble-pile body by re-accumulation.

(4) I studied angrites, which is the oldest basalt in the solar system, and showed that they formed near the surface of the parent asteroid. I also pointed out that their parent magma composition is close to the partial melt of CV chondrites at high oxygen fugacity. This is the first example relating parent magma of achondritic meteorites to partial melting of chondrites.

(5) Although most Martian meteorites are basaltic cumulates, I found that some Martian meteorites represent melts from parent magmas by crystallization experiments, and discussed relationship to Martian mantle. I pointed out that known nakhlites are samples from different depths in cooling cumulus piles by carefully studying chemical zoning and microstructures of silicate minerals and proposed a model of the nakhlite igneous body. This model is now widely accepted as a standard model of nakhlites.

(6) Detailed TEM works of dark olivine grains in Martian meteorites showed the presence of 10-20nm nano-particles of Fe metal and magnetite, which is responsible for the dark color. They were reproduced by shock experiments at >40 GPa which is consistent with the estimated shock pressure for Martian meteorites. I also pointed out that the presence of nano-particles drastically changes magnetic and spectral characteristics.

3. Five Important Papers in your career

1. Mikouchi, T., H. Takeda, M. Miyamoto, K. Ohsumi, and G. McKay (1995), Exsolution lamellae of kirschsteinite in magnesium-iron olivine from an angrite meteorite, American Mineral., 80, 585-592.

This paper gives detailed description of Ca-rich exsolution lamellae in Fe-Mg olivine from angrite meteorite. This paper has been referred in many papers as an excellent example of Ca-rich exsolution in olivine (referred by 18 papers: Web of Science on Oct. 26, 2012).

2. Mikouchi, T., I. Yamada, and M. Miyamoto (2000) Symplectic exsolution in olivine from the Nakhla martian meteorite, Meteoritics and Planet. Sci., 35, 937-942. We found symplectic exsolution of magnetite and augite in olivine from nakhlite Martian meteorite, and provided its detailed TEM work.

Many papers have referred it as evidence of oxidizing Martian environment recorded in Martian meteorites (referred by 23 papers: Web of Science on Oct. 26, 2012).

3. Mikouchi, T., M. Miyamoto, and G. McKay (2001), Mineralogy and petrology of the Dar al Gani 476 martian meteorite: Implications for its cooling history and relationship to other shergottites, Meteoritics and Planet. Sci., 36, 531-548.

This paper describes mineralogy and petrology of Dar al Gani 476 Martian meteorite, and discusses petrogenetic relationship to other Martian meteorites. Most papers dealing with this

sample referred this work (referred by 27 papers: Web of Science on Oct. 26, 2012).

4. Zolensky, M. E., T. J. Zega, H. Yano, S. Wirick, A. Westphal, M. Weisberg, I. Weber, J. L. Warren, M. A. Velbel, A. Tsuchiyama, P. Tsou, A. Toppani, N. Tomioka, K. Tomeoka, N. Teslich, M. Taheri, J. Susini, R. Stroud, T. Stephan, F. J. Stadermann, C. J. Snead, S. B. Simon, A. Simionovici, T. H. See, F. Robert, F. J. M. Rietmeijer, W. Rao, M. C. Perronnet, D. A. Papanastassiou, K. Okudaira, K. Ohsumi, I. Ohnishi, K. Nakamura-Messenger, T. Nakamura, S. Mostefaoui, T. Mikouchi, A. Meibom, G. Matrajt, M. A. Marcus, H. Leroux, L. Lemelle, L. Le, A. Lanzirotti, F. Langenhorst, A. N. Krot, L. P. Keller, A. T. Kearsley, D. Joswiak, D. Jacob, H. Ishii, R. Harvey, K. Hagiya, L. Grossman, J. N. Grossman, G. A. Graham, M. Gounelle, P. Gillet, M. J. Genge, G. Flynn, T. Ferroir, S. Fallon, D. S. Ebel, Z. R. Dai, P. Cordier, M. Chi, A. L. Butterworth, D. E. Brownlee, J. C. Bridges, S. Brennan, A. Brearley, J. P. Bradley, P. Bleuet, P. A. Bland, and R. Bastien (2006), Mineralogy and petrology of Comet 81P/Wild 2 nucleus samples, Science, 314, 1735-1739.

This is an initial result report of mineralogy and petrology of Wild 2 cometary dust particles and suggested dynamic transportation of solid materials in the early solar system. The number of referred papers shows the importance of this work (referred by 304 papers: Web of Science on Oct. 26, 2012).

5. Mikouchi, T., M. E. Zolensky, M. Ivanova, O. Tachikawa, M. Komatsu, L. Le, and M. Gounelle (2009), Dmitryivanovite: A new calcium aluminum oxide from the Northwest Africa 470 CH3 chondrite characterized using electron back-scatter diffraction analysis, American Mineral., 94, 746-750.

This paper reports identification of a new mineral “dmitryivanovite” by SEM-EBSD. This is almost the first work using SEM-EBSD in the field of meteorite science to identify new minerals, and this technique has become very popular after this work (referred by 6 papers: Web of Science on Oct. 26, 2012).

4. Awards and Honors throughout your career

· Takashi Mikouchi, Student Travel Award, The Meteoritical Society, Sep. 1995

5. Future Research Plan

In the 21st century planetary material science will make a great progress thanks to tons of data obtained by spacecraft missions and recovery of thousands of meteorites from deserts and Antarctica. I plan to make the most of this merit to study more planetary materials and try to better understand the material evolution in the solar system. Especially, Mars, moon, asteroids, and comets represent important stages in material evolution, respectively, and samples from these bodies have been already in our hands as meteorites or by sample return missions. Therefore, I will work more on these samples by paying attention to their nature as comparative planetological samples and plan to start their trace element analyses.

I am also planning to be more deeply involved in spacecraft missions such as “MELOS” and “Hayabusa 2” since I have been a member of these projects and I believe that my knowledge on these bodies through meteorite analyses can be well feed-backed to the mission science. In near future, we will have more returned samples (albeit very small) from various bodies, and therefore, non-destructive analytical techniques from 1 mm area will be significantly important. Recent advancement of chemical and isotopic analyses has allowed

obtaining data from submicron areas, but we are not able to properly obtain crystallographic data from similar small areas although crystallographic data represent one of the most fundamental parameters of the materials. Therefore, I am developing a synchrotron radiation X-ray diffractometer from 1 mm area at SPring-8 by energy scanning, and plan to develop a similar system at a university laboratory. In order to realize it, I am collaborating with researchers in the field of material science where development of analytical instruments is more advanced compared to our field.

Also, experimental approach is another important aspect of my study, and I plan to be more engaged in simulation experiments to reproduce planetary materials. I have worked on experimental study of shock metamorphism of Martian meteorites, and now plan to apply it to deep earth materials as well as understanding shock metamorphism in the solar system in general because shock is one of the most important processes in the evolution of planetary materials. I will also keep working on nano-second time-resolved X-ray diffraction study of planetary materials by synchronization of intense laser and synchrotron radiation pulse, which is a unique experiment to better understand shock physics of planetary materials.

Planetary material science is an international research field, and in fact I have been involved in many international projects. On these (and future) projects I would like to emphasize the Japanese merit because Japan possesses advanced technique of small body exploration as well as thousands of Antarctic meteorites curated at National Inst. of Polar Research.

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for Scientific Research (B), Collaborative Investigator, Phosphate capacity of di-calcium silicates on the atomic level and their application to new materials, 3 years (2011-2013), 3,660,000 JPY.

· Grant-in-Aid for Young Scientists (B), Principal investigator, Origin of brown olivine in Martian and lunar meteorites, and their application to interpret remote sensing data, 3 years (2008-2010), 3,300,000 JPY.

· Grant-in-Aid for Young Scientists (B), Principal investigator, Search for the original bodies of nakhlite and chassignite Martian meteorites on Mars by infrared spectroscopy, 2 years (2006-2007), 3,300,000 JPY.

(2) Cooperative Research

· Institute of Materials Research, Tohoku University, Structures of Ca_2SiO_4–$Ca_3(PO_4)_2$ solid solution in meteorites, 2 years (2009-2010), 523,080 JPY.

· Institute of Materials Research, Tohoku University, Structure of iron-iron compounds in meteorites and their formation processes, 2 years (2011-2012), 562,000 JPY.

(3) Research Contracts

(4) Grants and Gifts

· Fuji Film Co., Orientation analysis of organic-inorganic hybrid films by X-ray diffraction, 1,000,000JPY.

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Monkawa, A., T. Mikouchi, E. Koizumi, K. Sugiyama, and M. Miyamoto (2006), Determination of the Fe oxidation state of the Chassigny kaersutite: A micro XANES spectroscopic study, Meteoritics and Planet. Sci., 41, 1321-1329.

2. Brownlee, D., P. Tsou, J. Aleon, C. M. D. Alexander, T. Araki, S. Bajt, G. A. Baratta, R. Bastien, P. Bland, P. Bleuet, J. Borg, J. P. Bradley, A. Brearley, F. Brenker, A. Brennan, J. C. Bridges, N. D. Browning, J. R. Brucato, E. Bullock, M. J. Burchell, H. Busemann, A. Butterworth, M. Chaussidon, A. Cheuvront, M. Chi, M. J. Cintala, B. C. Clark, S. J. Clemett, G. Cody, L. Colangeli, G. Cooper, P. Cordier, C. Daghlian, Z. Dai, L. D. Hendecourt, Z. Djouadi, G. Dominguez, T. Duxbury, J. P. Dworkin, D. S. Ebel, T. E. Economou, S. Fakra, S. A. J. Fairey, S. Fallon, G. Ferrini, T. Ferroir, H. Fleckenstein, C. Floss, G. Flynn, I. A. Franchi, M. Fries, Z. Gainsforth, J. -P. Gallien, M. Genge, M. K. Gilles, P. Gillet, J. Gilmour, D. P. Glavin, M. Gounelle, M. M. Grady, G. A. Graham, P. G. Grant, S. F. Green, F. Grossemy, L. Grossman, J. N. Grossman, Y. Guan, K. Hagiya, R. Harvey, P. Heck, G. F. Herzog, P. Hoppe, F. Horz, J. Huth, I. D. Hutcheon, K. Ignatyev, H. Ishii, M. Ito, D. Jacob, C. Jacobsen, S. Jacobsen, S. Jones, D. Joswiak, A. Jurewicz, A. T. Kearsley, L. P. Keller, H. Khodja, A. L. D. Kilcoyne, J. Kissel, A. Krot, F. Langenhorst, A. Lanzirotti, L. Le, L. A. Leshin, J. Leitner, L. Lemelle, H. Leroux, M. -C. Liu, K. Luening, I. Lyon, G. MacPherson, M. A. Marcus, K. Marhas, B. Marty, G. Matrajt, K. McKeegan, A. Meibom, A. Mennella, K. Messenger, S. Messenger, T. Mikouchi, S. Mostefaoui, T. Nakamura, T. Nakano, M. Newville, L. R. Nittler, I. Ohnishi, K. Ohsumi, K. Okudaira, D. A. Papanastassiou, R. Palma, M. E. Palumbo, R. O. Pepin, D. Perkins, M. Perronnet, P. Pianetta, W. Rao, F. J. M. Rietmeijer, F. Robert, D. Rost, A. Rotundi, R. Ryan, S. A. Sandford, C. S. Schwandt, T. H. See, D. Schlutter, J. Sheffield-Parker, A. Simionovici, S. Simon, I. Sitnitsky, C. J. Snead, M. K. Spencer, F. J. Stadermann, A. Steele, T. Stephan, R. Stroud, J. Susini, S. R. Sutton, Y. Suzuki, M. Taheri, S. Taylor, N. Teslich, K. Tomeoka, N. Tomioka, A. Toppani, J. M. Trigo-Rodriguez, D. Troadec, A. Tsuchiyama, A. J. Tuzzolino, T. Tyliszczak, K. Uesugi, M. Velbel, J. Vellenga, E. Vicenzi, L. Vincze, J. Warren, I. Weber., M. Weisberg, A. J. Westphal, S. Wirick, D. Wooden, B. Wopenka, P. Wozniakiewicz, I. Wright, H. Yabuta, H. Yano, E. D. Young, R. N. Zare, T. Zega, R. Ziegler, L. Zimmerman, E. Zinner, and M. Zolensky (2006), Comet 81P/Wild 2 under a microscope, Science, 314, 1711-1716.

3. Zolensky, M. E., T. J. Zega, H. Yano, S. Wirick, A. Westphal, M. Weisberg, I. Weber, J. L. Warren, M. A. Velbel, A. Tsuchiyama, P. Tsou, A. Toppani, N. Tomioka, K. Tomeoka, N. Teslich, M. Taheri, J. Susini, R. Stroud, T. Stephan, F. J. Stadermann, C. J. Snead, S. B. Simon, A. Simionovici, T. H. See, F. Robert, F. J. M. Rietmeijer, W. Rao, M. C. Perronnet, D. A. Papanastassiou, K. Okudaira, K. Ohsumi, I. Ohnishi, K. Nakamura-Messenger, T. Nakamura, S. Mostefaoui, T. Mikouchi, A. Meibom, G. Matrajt, M. A. Marcus, H. Leroux, L. Lemelle, L. Le, A. Lanzirotti, F. Langenhorst, A. N. Krot, L. P. Keller, A. T. Kearsley, D. Joswiak, D. Jacob, H. Ishii, R. Harvey, K. Hagiya, L. Grossman, J. N. Grossman, G. A. Graham, M. Gounelle, P. Gillet, M. J. Genge, G. Flynn, T. Ferroir, S. Fallon, D. S. Ebel, Z. R. Dai, P. Cordier, M. Chi, A. L. Butterworth, D. E. Brownlee, J. C. Bridges, S. Brennan, A. Brearley, J. P. Bradley, P. Bleuet, P. A. Bland, and R. Bastien (2006), Mineralogy and petrology of Comet 81P/Wild 2 nucleus samples, Science, 314, 1735-1739.

4. Nakamura, T., T. Mikouchi, and A. Tsuchiyama (2007), Non-destructive analysis on Stardust particles by synchrotron radiation (in Japanese), Yu-sei-jin (Journal of The Japan Society of Planetary Science), 16, 285-289.

5. Zolensky, M., K. Nakamura-Messenger, F. Rietmeijer, H. Leroux, T. Mikouchi, K. Ohsumi, S. Simon, L. Grossman, T. Stepehn, M. Weisberg, M. Velbel, T. Zega, R. Stroud,

K. Tomeoka, I. Ohnishi, N. Tomioka, T. Nakamura, G. Matrajt, D. Joswiak, D. Brownlee, F. Langenhorst, A. Krot, A. Kearsley, H. Ishii, G. Graham, Z. R. Dai, M. Chi, J. Bradley., K. Hagiya, M. Gounelle, and J. Bridges (2008), Comparing Wild 2 particles to chondrites and IDPs, Meteoritics and Planet. Sci., 43, 261-272.

6. Park, J., D. Bogard, T. Mikouchi, and G. McKay (2008), The Dhofar-378 Martian shergottite: Evidence of early shock melting, Jour. Geophys. Res., 113, E08007, doi:10.1029/2007JE003035.

7. Mikouchi, T., and T. Kurihara (2008), Mineralogy and petrology of paired lherzolitic shergottites Yamato 000027, Yamato 000047 and Yamato 000097: Another fragments from a Martian "lherzolitic" block, Polar Science, 2, 175-194.

8. Zolensky, M. E., M. Gounelle, T. Mikouchi, K. Ohsumi, K. Hagiya, and O. Tachikawa (2008), Andreyivanovite: A second new phosphide from the Kaidun meteorite, American Mineral., 93, 1295-1299.

9. Mikouchi, T., M. E. Zolensky, M. Ivanova, O. Tachikawa, M. Komatsu, L. Le, and M. Gounelle (2009), Dmitryivanovite: A new calcium aluminum oxide from the Northwest Africa 470 CH3 chondrite characterized using electron back-scatter diffraction analysis, American Mineral., 94, 746-750.

10. Miyamoto, M., T. Mikouchi, and R. H. Jones (2009), A wide range of the cooling rate of type II porphyritic olivine chondrules in Semarkona (LL3.00) by diffusion calculation from olivine Mg-Fe zoning, Meteoritics and Planet. Sci., 44, 521-530.

11. Ota, K., T. Mikouchi, and K. Sugiyama (2009), Crystallography of hornblende amphibole in the LAP04840 R chondrite and implication for its metamorphic history, Jour. of Mineral. And Petrol. Sci., 104, 215-225.

12. Sugita, S., H. Miyamoto, S. Tachibana, T. Okada, H. Demura, S. Omori, N. Namiki, Y. Takahashi, Y. Miura, K. Nagao, T. Mikouchi, and T. Sato (2009), Martian surface science mission by MELOS (in Japanese), Yu-sei-jin (Journal of The Japan Society of Planetary Science), 18, 79-83.

13. Komatsu, M., T. Mikouchi, and M. Miyamoto (2009), High temperature annealing of amoeboid olivine aggregates: Heating experiments of olivine and anorthite mixtures, Polar Science, 3, 31-55.

14. Miyamoto, M., T. Arai, M. Komatsu, A. Yamamoto, and T. Mikouchi (2009), Evaluation of a curve-fitting method for diffuse reflectance spectra in the UV–Visible–NIR wavelength region, Polar Science, 3, 110-116.

15. Kimura, M., T. Mikouchi, A. Suzuki, M. Miyahara, E. Ohtani, and A. El Goresy (2009), Kushiroite, $CaAlAlSiO_6$: A new mineral of the pyroxene group from the ALH 85085 CH chondrite, and its genetic significance in refractory inclusions, American Mineral., 93, 1479-1482.

16. Misawa, K., M. Kohno, T. Tomiyama, T. Noguchi, T. Nakamura, K. Nagao, T. Mikouchi, and K. Nishiizumi (2010), Two extraterrestrial dust horizons found in the Dome Fuji ice core, East Antarctica, Earth and Planet. Sci. Lett., 289, 287-297.

17. Kameda, J., A. Okamoto, T. Mikouchi, R. Kitagawa, and T. Kogure (2010), The occurrence and structure of vermiform chlorite, Clay Science, 14, 155-161.

18. Mikouchi, T., M. Zolensky, I. Ohnishi, T. Suzuki, H. Takeda, P. Jenniskens, and M. H. Shaddad (2010), Electron microscopy of pyroxenes in the Almahata Sitta ureilite, Meteoritics and Planet. Sci., 45, 1812-1820.

19. Zolensky, M. E., J. Herrin, T. Mikouchi, K. Ohsumi, J. M. Friedrich, A. Steele, M. Fries, S. A. Sandford, S. Milam, K. Hagiya, H. Takeda, W. Satake, T. Kurihara, M. Colbert, R. Hanna, J. Maisano, R. Ketcham, L. Le, G. A. Robinson, J. E. Martinez, P. Jenniskens, and M. H. Shaddad (2010), Mineralogy and petrography of the Almahata Sitta ureilite, Meteoritics and Planet. Sci., 45, 1618-1637.

20. Goodrich, C. A., N. T. Kita, M. K. Spicuzza, J. W. Valley, J. Zipfel, T. Mikouchi, and M. Miyamoto (2010), The Northwest Africa 1500 meteorite: Not a ureilite, maybe a brachinite, Meteoritics and Planet. Sci., 45, 1906-1928.

21. Ohtani, E., S. Ozawa, M. Miyahara, Y. Ito, T. Mikouchi, M. Kimura, T. Arai, K. Sato, and K. Hiraga (2011), Coesite and stishovite in a shocked lunar meteorite, Asuka-881757, and impact events in lunar surface, Proc. of Natl. Academy Sci., 108, 463-466.

22. Mikouchi, T., A. Monkawa, and K. Sugiyama (2011), Crystal chemistry of amphiboles in extraterrestrial materials and their formation processes (in Japanese), Journal of the Crystallographic Society of Japan, 53, 64-69.

23. Mikouchi, T., T. Kurihara, and T. Kasama (2011), Dark olivines in Martian meteorites: Formation of Fe-rich nano-particles by shock metamorphism (in Japanese), Yu-sei-jin (Journal of The Japan Society of Planetary Science), 20, 161-168.

24. Hoffmann, V. H., R. Hochleitner, M. Torii, M. Funaki, T. Mikouchi, and Almahata Sitta Consortium (2011), Magnetism and mineralogy of Almahata Sitta polymict ureilite, Meteoritics and Planet. Sci., 46, 1551-1564.

(2) Selected Conference Proceedings

1. Mikouchi, T., M. Zolensky, O. Tachikawa, M. Komatsu, M. A. Ivanova, L. Le, and M. Gounelle (2006), Electron back-scatter diffraction (EBSD) analysis of two unusual minerals in carbonaceous chondrites, Lunar and Planet. Sci., XXXVII, Abstract #1855, Lunar Planet. Inst., Houston (CD-ROM).

2. Mikouchi, T., M. Miyamoto, E. Koizumi, J. Makishima, and G. McKay (2006), Relative burial depths of nakhlites: An update, Lunar and Planet. Sci., XXXVII, Abstract #1865, Lunar Planet. Inst., Houston (CD-ROM).

3. Mikouchi, T., K. Ota, J. Makishima, A. Monkawa, and K. Sugiyama (2007), Mineralogy and crystallography of LAP 04840: Implications for metamorphism at depth in the R chondrite parent body, Lunar and Planet. Sci., XXXVIII, Abstract #1928, Lunar Planet. Inst., Houston (CD-ROM).

4. Mikouchi, T., O. Tachikawa, K. Hagiya, K. Ohsumi, Y. Suzuki, K. Uesugi, A. Takeuchi, and M. Zolensky (2007), Mineralogy and crystallography of Comet 81P/Wild 2 particles, Lunar and Planet. Sci., XXXVIII, Abstract #1946, Lunar Planet. Inst., Houston (CD-ROM).

5. Mikouchi, T., and E. Koizumi (2007), Theoretical crystallization of a reduced shergottite: Applying MELTS to Y980459, Meteoritics and Planet. Sci., 42, Supple. A107.

6. Mikouchi, T., T. Kurihara, and M. Miyamoto (2008), Petrology and mineralogy of RBT 04262: Implications for stratigraphy of the lherzolitic shergottite igneous body, Lunar and Planet. Sci., XXXIX, Abstract #2403, Lunar Planet. Inst., Houston (CD-ROM).

7. Mikouchi, T., G. McKay, and J. Jones (2008), Petrogenesis and crystallization history of quenched angrites, Meteoritics and Planet. Sci., 43, Supple. A98

8. Mikouchi, T. (2008), Petrographic and chemical variation of lherzolitic shergottites and implications for the classification of shergottites, Meteoritics & Planet. Sci., 43, Supple.

A186.

9. Mikouchi, T., K. Ohsumi, K. Ichiyanagi, S. Adachi, S. Nozawa, S. Koshihara, and M. E. Zolensky (2009), Nano-second time-resolved synchrotron X-ray diffraction study of olivine under laser-induced shock compression, Lunar and Planet. Sci., XL, Abstract #2250, Lunar Planet. Inst., Houston (CD-ROM).

10. Mikouchi, T. (2009), Petrological and mineralogical diversities within the lherzolitic shergottites require a new group name?, Lunar and Planet. Sci., XL, Abstract #2272, Lunar Planet. Inst., Houston (CD-ROM).

11. Mikouchi, T. and J. A. Barrat (2009), NWA 5029 basaltic shergottite: A clone of NWA 480/1460?, Meteoritics and Planet. Sci., 44, Supple. A143.

12. Mikouchi, T., M. Zolensky, H. Takeda, K. Hagiya, K. Ohsumi, W. Satake, T. Kurihara, P. Jenniskens, and M. H. Shaddad, (2010) Mineralogy of pyroxene and olivine in the Almahata Sitta ureilite, Lunar and Planet. Sci., XLI, Abstract #2344, Lunar Planet. Inst., Houston (CD-ROM).

13. Mikouchi, T., M. E. Zolensky, I. Ohnishi, T. Suzuki, H. Takeda, P. Jenniskens, and M. H. Shaddad (2010), Transmission electron microscopy of pyroxenes in the Almahata Sitta ureilite, Meteoritics and Planet. Sci., 45, Supple. A138.

14. Mikouchi, T., T. Kasama, and T. Kurihara (2011), More on nano-particles in olivine from the Northwest Africa 1950 shergottite, Lunar and Planet. Sci., XLII, Abstract #1689, Lunar Planet. Inst., Houston (CD-ROM).

15. Mikouchi, T., M. Miyamoto, and G. McKay (2011), Kirschsteinite exsolution lamellae in olivine from young angrites: Implications for their thermal history, Mineral. Mag., 75, 1469.

(3) Review Papers

1. Mikouchi, T. (2007), Early solar system as revealed by the Stardust mission (in Japanese), Yu-sei-jin (Journal of The Japan Society of Planetary Science), 16, 270-273, refereed.

(4) Books

1. Mikouchi, T. (2007), Martian environment as inferred from Martian meteorites (in Japanese), “Exploring other bodies, from Apollo to Hayabusa”, eds., H. Miyamoto, S. Tachibana, N. Hirata, and S. Sugita, University Museum, The University of Tokyo, 147-153.

2. Mikouchi, T. (2007), Poplardia Johokan, Universe (in Japanese), 55-61 pp, eds., J. Watanabe, Poplar Publishing Co., ISBN 978-4-591-09597-3.

3. Mikouchi, T. (2007), Exploring moon by Japanese lunar orbiting spacecraft, Kaguya (in Japanese), Monthly Magazine “Hoshi Navi”, Oct, 2007, Ascii.

4. Mikouchi, T. (2008), Martian environment as inferred from Martian meteorites (in Japanese), “Planetary Geology”, eds., H. Miyamoto, S. Tachibana, N. Hirata, and S. Sugita, The University of Tokyo Press, 147-153.

5. Mikouchi, T. (2008), Ice on Mars, direct evidence from the Phoenix spacecraft (in Japanese), Monthly Magazine “Hoshi Navi”, Sep, 2008, Ascii.

6. Mikouchi, T. (2009), Keywords to understand astronomy and universe (in Japanese), Monthly Magazine “Hoshi Navi”, Mar, 2009, Ascii.

7. Yazawa, Y., T. Mikouchi, and H. Takeda (2010), Chapter 19, Available resources and energy sources from Mars rock and soil and their applications for human exploration on

the surface of Mars, In "Mars: Prospective Energy and Material Resources", Badescu, Viorel (Editor), Springer, ISBN 978-3642036286 (3642036287), p. 483-516, (700 pp).

8. Mikouchi, T. (2010), Mars science through Martian meteorites, "Mars Why is Mars red?" (in Japanese), eds., H. Miyamoto, N. Hirata, and S. Tachibana, University Museum, the University of Tokyo, 51-59.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Mikouchi, T., M. Zolensky, O. Tachikawa, M. Komatsu, M. A. Ivanova, L. Le, and M. Gounelle, Electron back-scatter diffraction (EBSD) analysis of two unusual minerals in carbonaceous chondrites, 37th Lunar and Planet. Sci. Conf., Mar. 13-17, 2006, Houston, USA, General.
2. Mikouchi, T., O. Tachikawa, K. Hagiya, K. Ohsumi, Y. Suzuki, K. Uesugi, A. Takeuchi, and M. Zolensky, Mineralogy and crystallography of Comet 81P/Wild 2 particles, 38th Lunar and Planet. Sci. Conf., Mar. 12-16, 2007, Houston, USA, General.
3. Mikouchi, T., T. Kurihara, and M. Miyamoto, Petrology and mineralogy of RBT 04262: Implications for stratigraphy of the lherzolitic shergottite igneous body, 39th Lunar and Planet. Sci. Conf., Mar. 10-14, 2008, Houston, USA, General.
4. Mikouchi, T., G. McKay, and J. Jones, Petrogenesis and crystallization history of quenched angrites, 71st Annual Meeting of The Meteoritical Society, Jul. 28-Aug. 1, 2008, Matsue, Japan, Invited.
5. Mikouchi, T., K. Ohsumi, K. Ichiyanagi, S. Adachi, S. Nozawa, S. Koshihara, and M. Zolensky, Nano-second time-resolved synchrotron X-ray diffraction study of olivine under laser-induced shock compression, 40th Lunar and Planet. Sci. Conf., Mar. 23-27, 2009, The Woodlands, USA, General.
6. Mikouchi, T., M. Zolensky, H. Takeda, K. Hagiya, K. Ohsumi, W. Satake, T. Kurihara, P. Jenniskens, and M. H. Shaddad, Mineralogy of pyroxene and olivine in the Almahata Sitta ureilite, 41st Lunar and Planet. Sci. Conf., Mar. 1-5, 2010, The Woodlands, USA, General.
7. Mikouchi, T., T. Kasama, and T. Kurihara, More on nano-particles in olivine from the Northwest Africa 1950 shergottite, 42nd Lunar and Planet. Sci. Conf., Mar 7-11, 2011, The Woodlands, USA, General.
8. Mikouchi, T., M. Miyamoto, and G. McKay, Kirschsteinite exsolution lamellae in olivine from young angrites: Implications for their thermal history, 21st Annual Goldschmidt Conference, Aug. 14-19, 2011, Prague, Czech, Invited.

16 other oral presentations.

(2) Domestic Conferences

9. Mikouchi, T., and T. Kurihara, Darkening of olivine in Martian meteorites: Formation of Fe-rich nano-particles by shock metamorphism and their implications (in Japanese), 6th Research Meeting on Shock, The Institute of Low Temperature Science, Hokkaido University, "Clarifying shock physics of planetary bodies (VI) –shock and material science, Nov. 5-6, 2011, Invited.

16 other oral presentations.

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Akira Monkawa (advisee during doctoral course), 2010 Applied Mineralogy Award, Japan Association of Mineralogical Sciences.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· 2007-present, “Earth, Planets, and Space”, Steering Committee, Member

· 2011-present, Journal of Mineralogical and Petrological Sciences, Associate Editor

(2) Academic Societies

· 2003～2008, Japan Association of Mineralogical Sciences, Japan Geoscience Union Meeting Program Committee, Member

· 2007-present, The Japan Society of Planetary Science, Western-Language Journal Committee, Member

· 2008-present, Japan Geoscience Union, Information System Committee, Member

· 2009-present, The Japan Society of Planetary Science, Western-Language Journal Committee, Chair

· 2009-present, The Japan Society of Planetary Science, Steering Committee, Member

· 2010-present, The Meteoritical Society, Nomenclature Committee, Member

· 2011-present, The Meteoritical Society, Publications Committee, Member

(3) International Conferences

· 71st Annual Meeting of The Meteoritical Society, Local Organizing Committee, Member, Jul. 2008.

· 71st Annual Meeting of The Meteoritical Society, Program Committee, Member, Jul. 2008.

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· “Big science news in 2006”, Stardust mission, NHK Educational TV, Science ZERO, Dec. 2006.

· “What is comet? –Dusts returned by the Stardust spacecraft”, Science Live Show “Universe”, Science Museum, May, 2007.

· “Exploring rabbits on the moon”, NHK Educational TV, Kagaku Daisuki Doyo Juku, Nov. 2007.

· “Mars through Martian meteorites”, Space Agriculture Salon Meeting, Tokyo Yayesu Hall, Sep. 2011.

· “Exploring Mars –From Martian meteorites to Martian life”, Lecture on the occasion of the 51st Special Exhibition, Ibaraki Nature Museum, Jun. 2011.

· “Exploring planetary formation in the solar system, What meteorites tell us”, Wanna know more!, Door to astronomy and universe on the 2nd Sunday, Time Dome Akashi, Chuo-ku, Tokyo, Oct., 2011.

· “Meteorite research and Hayabusa mission”, Dreaming Lecture at Nakagawa Elementary School, Kashiwa-city, Nov. 2011.

· “Now at Faculty of Science!, Approaching mystery of Itokawa”, Science Museum, Mar. 2012.

12. Internal and External Committee Memberships (2006-2011)

· 2011-present, NASA, Meteorite Working Group, Member

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0 [M.Sc.: 0, Ph.D.: 0]

Foreign Researchers: 0

Sending

Japanese Students: 4 [M.Sc.: 3, Ph.D.: 1]

Japanese Researchers: 0

Visitors from Abroad: 25 [U.S.A.: 19, Germany: 5, Denmark: 1]

Takaaki Yokoyama

I. C.V.

Name：Takaaki Yokoyama
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education

B. Eng., Department of Aeronautical Engineering, School of Engineering, Kyoto University, March, 1990
M. Eng., Department of Aeronautical Engineering, School of Engineering, Kyoto University, March, 1992
D. Sc., Department of Astronomy, School of Mathematics and Physics, The Graduate University for Advanced Studies

Professional Experience

April, 1995, Postdoctoral Fellow, National Astronomical Observatory of Japan
January, 1996, Research Fellow, JSPS
April, 1998, Assistant Professor, National Astronomical Observatory of Japan
April, 2003, Associate Professor, The University of Tokyo

II. Scientific Research Activity

2. Major achievements

We have been studying the solar and astronomical plasma physics by numerical simulations and observational data analysis. (In this section, "TY" in the reference denotes "T. Yokoyama".)

Study of solar coronal activities and magnetic reconnection:

Coronal jet, one of the prominent solar activities, is an elongation phenomena of hot plasma (a few million K) by the sound speed (~150km/s). We performed numerical simulations based on the proposed magnetic reconnection model and newly found a correspondance of a cool jet (a few 10^5 K) with a hot one. This work was published in *Nature* (TY & Shibata 1995) and is obtaining citations even now. It was evolved to more detailed models by an extension into three-dimensional one with twist and filamentary structures (Isobe, TY, et al. 2005, *Nature*), and by an inclusion of the thermally driven processes (Matsui & TY 2012). Observational studies by using the Hinode (the solar observation spacecraft by JAXA/ISAS) data on related processes are also carried out in our group (Kitagawa, TY et al., 2013).

Modeling of the flare onset, one of the most important subjects in solar and heliospheric physics, is also studied based on the hypothesis of emerged magnetic flux de-stabilization (Notoya & TY 2007, Kaneko & TY in preparation). The approach to the magnetic reconnection physics is also performed. We, for the first time according to our best knowledge, performed MHD simulations of reconnection in a relativistically strong magnetic field (Watanabe & TY 2006). We are also interested in the effect of turbulent structure on reconnection energy release and found a new process that enhances it (TY & Isobe 2013 in preparation). The acceleration of non-thermal particles in flares is studied by using the microwave and hard X-ray data in support with numerical modeling of Fokker-Planck simulations (Minoshima & TY 2008).

Dynamo, magnetic flux emergence, and surface magneto-convection:

The magnetic fluxs as source of solar activities emerge from the interior where they are generated by the dynamo processes. The solar magnetic cycle is one of the consequences of the dynamo. We have been worked on it based on the kinematic framework and proposed an explanations on the parity rule of the Sun (why it is a dipole, not a quadrapole) and on the polar field weakness (Hotta & TY 2010, 2011). Now we are developping a new numerical codes for the non-kinematic (i.e. self-consistent) magnetohydrodynamic simulations of dynamo process (Hotta et al. 2012). We are also studying the formation of active regions by the emergence of magnetic flux tubes (Toriumi & TY 2010, 2011), the surface magneto-convection by newly developed radiative MHD code (Iijima & TY in preparation), and observational study on surface magnetisms (Iida, TY et al. 2012).

3. Five Important Papers in your career

1. Yokoyama, T. and Shibata, K. 1995, ‘Magnetic reconnection as the origin of X-ray jets and H-alpha surges on the Sun’ Nature, 375, 42.

The first numeical simulations of X-ray jets, one of the typical dynamic phenomena in the solar corona. It is predicted that, along with the hot jet, a cool H-alpha jet is ejected, which is later observationally found. (Citation 200, A related paper Yokoyama & Shibata 1996 with 184 citations)

2. Yokoyama, T. and Shibata, K. 2001, ‘Magnetohydrodynamic Simulation of a Solar Flare with Chromospheric Evaporation Effect Based on Magnetic Reconnection Model’ The Astrophys. J., 549, 1160-1174.

The first self-consistent simulations of a solar flare including the energy release by magnetic reconnection to the dense gas supply by the "chorompsheric evaporation". The scaling law on the flare temperature is proposed and becomes the base of the unified picture of the YSO-stellar-solar flares. (Citation 109, A related paper Yokoyama & Shibata 1998 with 84 citations)

3. Yokoyama, T. K. Akita, T. Morimoto, K. Inoue, J. Newmark, 2001, ‘Clear Evidence of Reconnection Inflow of a Solar Flare’ The Astrophys. J., 546, L69-L72.

An observation of a flare in which, for the first time, the magnetic reconnection inflow was found. (Citation 157)

4. Watanabe, N. and Yokoyama, T. 2006, ‘Two-dimensional Magnetohydrodynamic Simulations of Relativistic Magnetic Reconnection’ The Astrophys. J., 647, L123-L126.

The first numerical simulations of the relativistic magnetic reconnection. It is found that the reconnection energy release becomes more efficient than that of the non-relativistic regime. (Citation 30)

5. Minoshima, T., Yokoyama, T., Mitani, N. 2008, ‘Comparative analysis of nonthermal emissions and electron transport in a solar flare’ The Astrophys. J., 673, 598-610.

Observation of a flare forcused on the non-thermal high-energy electrons by using the microwave and hard X-ray data sets. The pitch angle distribution of accelerated electrons is discussed at their injection. (Citation 16)

4. Awards and Honors throughout your career

· 1999 March, ASJ Young Astronomer Award, "Research on Solar X-ray Jets and Flares by

Magnetohydrodynamic Simulations", The Astronomical Society of Japan

5. Future Research Plan

The solar and astronomical plasma physics has been and will be the major part of my research subjects. Numerical simulations as well as observational analysis will be the basis of our research promotion. In addition, the planetary physics is one of the next challenge for us.

In the solar/stellar physics, our most effort will be given to the dynamo and the related physics. The final goal is the accomplishment of the dynamo model, i.e. the full understanding of the generation of the magnetism in the Sun and stars. In this five years, we (re-)organized a research group in Japan for this field, that is now rapidly growing simultaneously in US, Europe, and India in this decade. The self-consistent modeling of the differential rotation, the quantitative evaluation of the thermal convection turbulence, and the dynamics of the magnetic flux tubes in the interior are our most confronting subjects. By developing a new computational method, we will perform large-scale simulations with a unprecedented scale, resolutions, and efficiency by, e.g. using the RIKEN "K" system. One of our other subjects is the dynamics of the surface convection along with the magnetic field and the radiation field, which consequently becomes the source of the heating and various activities in the upper atmosphere. These are the main mission targets of the proposed Solar-C mission in ISAS/JAXA , for which we would like to contribute from the theoretical side.

In the planetary or heliospheric physics, one of the the key processes is the magnetic reconnection. It is considered to play a role for the transport of plasmas and energies from the solar wind to the terrestrial and planetary magnetosphere. Not only in the solar but also various astronomical objects, the importance of the reconnection is becoming more and more evident. On the other hand, there still remain many unsolved issues on its fundamental process. For example, the influence of the turbulence on reconnection energy release is a recent widely-studied subject. The scale-coupling of the macro- and micro-physics (i.e., the fluid and particle physics) is another very important and interesting subject.

The planetary dynamo is our another target. Based on the experience of the solar dynamo, we would like to challenge it by collaborating with the other members in our department. We also will work on the astronomical magnetohydrodynamics based on our knowledge on the solar plasmas. This may be achieved by collaborations with members in other departments, e.g. dept. of physics, dep't. of astronomy, and so on.

6. Funding Received

(1) JSPS Grants

- Kiban (B), 2011fy-2015fy, Study on Generation and Dynamics of Solar Magnetic Field, Research Leader, 4.6 Myen
- Kiban (C), 2006fy-2009fy, Study on Explosive Activities of Sun and Astronomical Objects, Research Leader, 3.4 Myen
- Kiban (B), 2008fy-2010fy, Study of Emission Variability and Jet Formation in Accretion Disks by MHD simulator, Participant Researcher, 2.4 Myen (Lead by Prof. R. Matsumoto, Chiba Univ.)

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. H. Hotta, M. Rempel, T. Yokoyama, Generation of twist on magnetic flux tubes at the base of the solar convection zone, Astronomy and Astrophysics, in press,
2. H. Hotta, M. Rempel, T. Yokoyama, (2012), Magnetic field intensification by three-dimensional``explosion', The Astrophysical Journal, 759, L24
3. Matsui, Y.; Yokoyama, T.; Kitagawa, N.; Imada, S., (2012), Multi-wavelength Spectroscopic Observation of Extreme-ultraviolet Jet in AR 10960, The Astrophysical Journal, 759, 15
4. Iida, Y.; Hagenaar, H. J.; Yokoyama, T., (2012), Detection of Flux Emergence, Splitting, Merging, and Cancellation of Network Field. I. Splitting and Merging, The Astrophysical Journal, 752, 149
5. Toriumi, S.; Hayashi, K.; Yokoyama, T., (2012), Detection of the Horizontal Divergent Flow Prior to the Solar Flux Emergence, The Astrophysical Journal, 751, 154
6. Hotta, H.; Iida, Y.; Yokoyama, T., (2012), Estimation of Turbulent Diffusivity with Direct Numerical Simulation of Stellar Convection, The Astrophysical Journal, 751, 9
7. H. Hotta, M. Rempel, T. Yokoyama, Y. Iida, Y. Fan, (2012), Numerical calculation of convection with reduced speed of sound technique, Astronomy and Astrophysics, 539, A30
8. S. Toriumi and T. Yokoyama, (2012), Large-scale 3D MHD simulation on the solar flux emergence and the small-scale dynamic features in an active region, Astronomy and Astrophysics, 539, A22
9. H. Hotta, T. Yokoyama, (2011), Modeling of differential rotation in rapidly rotating solar-type stars, The Astrophysical Journal, 740, 12
10. S. Toriumi and T. Yokoyama, (2011), Numerical Experiments on the Two-step Emergence of Twisted Magnetic Flux Tubes in the Sun, The Astrophysical Journal, 735, 126
11. S. Toriumi, T. Miyagoshi, T. Yokoyama, H. Isobe, and K. Shibata, (2011), Dependence of the Magnetic Energy of Solar Active Regions on the Twist Intensity of the Initial Flux Tubes, Publications of the Astronomical Society of Japan, 63, 407-415
12. Kitagawa, N., Yokoyama, T., Shinsuke, I., and Hara, H., (2010), Mode Identification of MHD Waves in an Active Region Observed with Hinode/EIS, The Astrophysical Journal, 721, 744-749
13. Hotta, H..; Yokoyama, T., (2010), Solar Parity Issue with Flux-transport Dynamo, The Astrophysical Journal, 714, L308-L312
14. Toriumi, S.; Yokoyama, T., (2010), Two-step emergence of the magnetic flux sheet from the solar convection zone, The Astrophysical Journal, 714, 505-516
15. Iida, Y.; Yokoyama, T.; Ichimoto, K., (2010), Vector Magnetic Fields and Doppler Velocity Structures Around a Cancellation Site in the Quiet Sun, The Astrophysical Journal, 713, 325-329
16. Hotta, H.; Yokoyama, T., (2010), Importance of Surface Turbulent Diffusivity in the Solar

Flux-Transport Dynamo, The Astrophysical Journal, 709, 1009-1017

17. Minoshima, T.; Imada, S.; Morimoto, T.; Kawate, T.; Koshiishi, H.; Kubo, M.; Inoue, S.; Isobe, H.; Masuda, S.; Krucker, S.; Yokoyama, T., (2009), Multiwavelength Observation of Electron Acceleration in the (2006) December 13 Flare, The Astrophysical Journal, 697, 843-849

18. Okamoto, Takenori J.; Tsuneta, Saku; Lites, Bruce W.; Kubo, Masahito; Yokoyama, Takaaki; Berger, Thomas E.; Ichimoto, Kiyoshi; Katsukawa, Yukio; Nagata, Shin'ichi; Shibata, Kazunari; Shimizu, Toshifumi; Shine, Richard A.; Suematsu, Yoshinori; Tarbell, Theodore D.; Title, Alan M., (2009), Prominence Formation Associated with an Emerging Helical Flux Rope, The Astrophysical Journal, 697, 913-922

19. Asai, A. et al., (2009), Imaging Spectroscopy on Preflare Coronal Nonthermal Sources Associated with the 2002 July 23 Flare, The Astrophysical Journal, 695, 1623-1630

20. Chifor, C.; Isobe, H.; Mason, H. E.; Hannah, I. G.; Young, P. R.; Del Zanna, G.; Krucker, S.; Ichimoto, K.; Katsukawa, Y.; Yokoyama, T., (2008), Magnetic flux cancellation associated with a recurring solar jet observed with Hinode, RHESSI, and STEREO/EUVI,Astronomy and Astrophysics, 491, 279-288

21. Minoshima, T.; Yokoyama, T., (2008), Numerical Study of a Propagating Nonthermal Microwave Feature in a Solar Flare Loop, The Astrophysical Journal, 686, 701-708

22. Chifor, C.; Hannah, I. G.; Mason, H. E.; Isobe, H.; Yokoyama, T.; Young, P. R.; Tripathi, D., (2008), Active Region Microflares From Hinode and RHESSI, First Results From Hinode ASP Conference Series, Vol. 397, 397, 164

23. Inoue, S.; Kusano, K.; Masuda, S.; Miyoshi, T.; Yamamoto, T.; Magara, T.; Tsuneta, T.; Sakurai, T.; Yokoyama, T., (2008), Three-Dimensional Structure Analysis of Coronal Magnetic Field in AR NOAA 10930 Based on Vector Magnetogram Observations with Hinode/SOT, First Results From Hinode ASP Conference Series, Vol. 397, 397, 110

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Emissions and Electron Transport in a Solar Flare, The Astrophysical Journal, 673, 598-610

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33. Kubo, M.; Yokoyama, T.; Katsukawa, Y.; Lites, B.; Tsuneta, S.; Suematsu, Y.; Ichimoto, K.; Shimizu, T.; Nagata, S.; Tarbell, T. D.; Shine, R. A.; Title, A. M.; Elmore, D., (2007), Hinode Observations of a Vector Magnetic Field Change Associated with a Flare on (2006) December 13, Publications of the Astronomical Society of Japan, 59, S779-S784

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39. Asai, A., T. Yokoyama, M. Shimojo, S. Masuda, K. Shibata, (2006), Flare Ribbon Expansion and Energy Release, Journal of Astrophysics and Astronomy, 27, 167-173

40. Nagashima, K., T. Yokoyama, (2006), Statistical Study of the Reconnection Rate in Solar Flares Observed with Yohkoh SXT, The Astrophysical Journal, 647, 654-661

41. Watanabe, N., T. Yokoyama, (2006), Two-dimensional Magnetohydrodynamic Simulations of Relativistic Magnetic Reconnection, The Astrophysical Journal, 647, L123-L126

42. Isobe, H., T. Miyagoshi, K. Shibata, and T. Yokoyama, (2006), Three-Dimensional Simulation of Solar Emerging Flux Using the Earth Simulator I. Magnetic Rayleigh-Taylor Instability a the Top of the Emerging Flux as the Origin of Filamentary Structure, Publications of the Astronomical Society of Japan, 58, 423-438

43. Shimojo, M., T. Yokoyama, A. Asai, H. Nakajima, and K. Shibasaki, (2006), One Solar-Cycle Observations of Prominence Activities Using the Nobeyama Radioheliograph 1992-2004, Publications of the Astronomical Society of Japan, 58, 85-92

(2) Selected Conference Proceedings

Omitted

(3) Review Papers

(4) Books

1. Gendai no Tenmongaku 10 "Taiyo (The Sun)", Chap. 6 Solar Cycle and Dynamo

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Yokoyama, T.,MHD Simulations of Reconnection in a Current Sheet with Initial Finite Perturbations with a review on MHD Turbulent Reconnection,3rd Solaire Network Meeting and 2009 Flux Emergence Workshop ,2009/11/4, Tenerife, Spain, invited

2. Yokoyama, T., Isobe, H.,Magnetic reconnection with finite fluctuations,COSPAR Sci. Assembly,2010/7/22, Bremen, Germany, invited

3. Yokoyama, T.,Simulations of a Current Sheet with Initial Finite Perturbations, US-Japan Workshop on Magnetic Reconnection MR2010,2010/12/6, Nara, invited

4. Yokoyama, T.,Magnetic Reconnection in the Solar Atmosphere,NE Asian Symp. on Plasma Fusion, 2011/9/27, Daejeon, invited

plus 71 papers (including papers as a co-author)

(2) Domestic Conferences

141 papers (including papers as a co-author)

III. Educational Activity (2002-2011)

9. Notable achievements in education

· H. Hotta, 2010fy, Graduate-School-of-Science Award for outstanding students

· S. Toriumi, 201fy, Graduate-School-of-Science Award for outstanding students

· Reseach supervision: PhD students: 3 (including prospect 1), Master students: 12 (including prospect 1)

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· 2005 Jan. to 2009 Dec. associate editor of the Publication of Astronomical Society of Japan

(2) Academic Societies

(3) International Conferences

· 2006 July, AOGS Session Convener, Singapore

· 2006 Nov. Conferences of Space Weather Modelings, LOC, Yokohama

· 2008, Sep. Flux Emergence Workshop, LOC, Kyoto

· 2011 Nov., Plasma Conference 2011, LOC, Kanazawa

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· 2009 Aug, UT Open Campus, Dept. EPS public seminars

· 2009 July, Tanabata public seminar, Tsukuba Univ.

· 2008 Aug., NAOJ/NRO open campus, public seminar

12. Internal and External Committee Memberships (2006-2011)

· Public Relations Comittee, School of Science, UT

· Gender Equality Workinggroup, School of Science, UT

· Public Relation Comittee, School of Science, UT

· Newsletters sub-Comittee (chair), PR Comittee, School of Science, UT

· Public Relations Comittee (chair), Dept. EPS, UT

· Network Comittee (chair), Dept EPS, UT

· Entrance Exam. Comittee (vice-chair)

· Solar and Astronomical Plasmas Comittee, National Astronomical Observatory of Japan (NAOJ)

· Radioheliogprah Operation sub-Comittee, NAOJ

· Theory and Computation Comittee, NAOJ

· C-SODA Operation Comittee, JAXA/ISAS

· Integrated Studies Comittee, STE lab., Nagoya Univ.

· Collaboative Research Comittee, STE lab., Nagoya Univ.

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 2 [M.Sc.: 1 (China: 1), Ph.D.: 1 (UK: 1)]

Foreign Researchers:0

Sending

Japanese Students: 9 [M.Sc.: 2 (US: 2), Ph.D.: 7 (US: 6, Germany: 1)]

Japanese Researchers: 1 [U.S.A.]

Visitors from Abroad: ~10

Ichiro Yoshikawa

I. C.V.

Name： Ichiro Yoshikawa
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Geophysics, The University of Tokyo, March, 1994
M. Sc., Geophysics, The University of Tokyo, March, 1996
Ph. D., Geophysics, The University of Tokyo, March, 2000

Professional Experience
April, 1998-Mar., 2005, Assistant professor, Institute of Space and Astronautical Science (ISAS)
April, 2005-, Associate Professor, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

(1) Imaging of the terrestrial plasmasphere

In the 1960s, Professor Nishida (The University of Tokyo) proposed his theory regarding the evolution of the Earth's plasmasphere, and in the 1970s Professor Ogawa (The University of Tokyo) established the basic technology of measurement of terrestrial airglow in the spectral range of extreme ultraviolet (EUV) using sounding rockets. I have begun the research which visualizes the plasmasphere in the EUV since the late1990s. In 2000, I have succeeded in imaging the plasmasphere for the first time.

After 2000, my leading team developed two telescopes boarded on the Japanese lunar orbiter "KAGUYA". One telescope measured the terrestrial radiations in EUV (He II 30.4nm and O II 83.4nm) and the other is in visible spectral range from the lunar orbit.

This project produced three excellent remarks,

1. Imaging of the plasmasphere from the equator
2. Production process of the lunar sodium atmosphere
3. Finding of many EUV stars

The graduate student (Dr. Go Murakami) who took part in this project from 2005 acquired the PhD in 2011, and was chosen as the President Prize of the University of Tokyo.

(2) Participation in the space projects

In the international Mercury exploration mission led by JAXA and ESA (European Space Agency), I am a principal investigator of Ultraviolet spectrometer and Sodium imaging camera. Both instruments are now at the final stage of the development, the science data will be available from 2020. There is still debate regarding the alkali-metallic atmosphere of Mercury based on similarity of the lunar exosphere. The instruments will put a definite conclusion regarding this issue. This issue is also important to study the small planets' atmosphere and heavy-core planets (like Merrucy).

The long cherished dream will come true. The Earth-orbiting EUV spectrometer for the study of planetary atmosphere will be launched in 2013 (EXCEED mission). The space mission

will observe the planetary atmosphere/magnetosphere outside the Earth atmosphere to avoid its absorption. The main science targets are to investigate the atmospheric loss occurring at Mars and Venus, and to investigate the atmospheres of small-body planets, and Jovian magnetosphere. The graduate student (Dr. Kazuo Yoshioka) who took part in this project from 2005 acquired the PhD in 2010, and was chosen as the School of Science encouragement award of the University of Tokyo.

(3) Observation of the planetary atmosphere by ground-based telescope

I am leading of the international network regarding the worldwide observation for Merucry among Boston University, University of Maryland, LAMOS institute (France), and the University of Tokyo. The graduate student (Dr. Shingo Kameda) who took part in this project from 2005 acquired the PhD in 2008, and was chosen as the School of Science encouragement award of the University of Tokyo.

3. Five Important Papers in your career

1. Yoshikawa et al., 1997, JGR, Observation of He II emission from the plasmasphere by a newly developed EUV telescope on board sounding rocket S-520-19.
2. Nakamura et al., 2000, GRL, Terrestrial plasmaspheric imaging by an extreme ultraviolet scanner on Planet-B.

The cover page of GRL, the first success of imaging of the plasmasphere.

3. Terasawa et al., 2006. Nature, Repeated injections of energy in the first 600ms of the giant flare of SGR1806 – 20.

Citation index is over 90.

4. Yoshikawa et al., 2010, JRL, Plasmaspheric EUV image seen from the lunar orbit: Initial Result of Extreme Ultraviolet Telescope onboard KAGUYA spacecraft.
5. Yoshikawa et al., 2010, Advances in Geosciences, Extreme Ultraviolet Spectrometer for Exospheric Dynamics Explore (EXCEED).

Papers (1), (4), and (5) prove and demonstrate EUV imaging of space plasmas. I received Oobayashi Award in SGEPSS.

4. Awards and Honors throughout your career

· November, 2003, Ichio Yoshikawa, Imaging of the plasmasphere in EUV, Oobayashi award, Society of Geomagnetism and Earth, Planetary and Space Sciences (SGEPSS)

5. Future Research Plan

I will extend my present researches

(1) Establish of database for the plasmaspheric images : NASA's IMAGE mission was building up the database consisting of much volume of plasmaspheric images. However, the IMAGE mission was ended in 2009, the plasmaspheric geophysics will be in stagnation for a while. I will plan the ISAS-leading small satellite (4^{th} scientific satellite) as the post-IMAGE satellite and build the new database for inner magnetosphere.

(2) EUV astronomy by spacecraft with the help of Russian space institute: The EUV

spectral range is unexplored as well as the hard X-ray in the astronomy. Only if the instrumental efficiency was higher, we have identified many discoveries. The observation of new category star, radiation field、AGN, and galaxy will be feasible in the EUV. If diffraction-limited normal-incidence optics is available, we can measure the size of star. If a neutron star radiates at 10^5K and is located at 100 parsec or closer, we can measure the size.

(3) International Mercury Exploration mission : The international Mercury exploration satellites mission is now at the final stage of development. My responsible instrument will provide Mercury airglow spectrums in the UV and visible spectral ranges. It will be also important database to study small-body planets。

(4) Earth-orbiting spectrometer mission (EXCEED): the EUV spectrometer developed by my team will be launched in 2013. It will provide us the science ate regarding Jovian magnetosphere. I will study issues about (1) plasma transport and diffusion in the radial direction in Jupiter (2) atmospheric loss to the space in the terrestrial planets.

(5) Observation from KIBO(international space station) : I have started the observation in EUV for the Earth's ionosphere and plasmasphere from the international space station (KIBO). I will study (1) the coupling between the ionosphere and plasmasphere, (2) plasmaspheric refilling to the magnetic flux tube from the ionosphere by using KIBO data.

6. Funding Received

(1) JSPS Grants

· Wakate-A, 2006-2007, Development of highly stable Fabry-Perot Interferometer boarded on microsatellites, 13,000 k Yen

· Kiban-C、2010-2012, Development of the optics for future survey of EUV stars., 4,550 k Yen.

(2) Cooperative Research

(3) Research Contracts

· JAXA, Development fund for space-borne instruments, 2006-2007, Development of EUV detectors using CsＴｅ as a photocathode, 5000k Yen

· JAXA, Development fund for space-borne instruments, 2009, Development of multilayer coated mirror higher than Mo/Si, 3500k Yen

· JAXA, Development fund for space-borne instruments, 2010-2011, Development of curved-shape MCP to reduce the curvature field, 6728k Yen

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Kanao, M., N. Terada, A. Yamazaki, I. Yoshikawa, T. Abe, and M. Nakamura, Effect of the motional electric field on the Venus nightside ionopause, *Journal of Geophysical Research*, Vol. 111, CiteID A03306, 2006.

2. Yamazaki, A., I. Yoshikawa, K. Shiomi, Y. Takizawa, W. Miyake, and M. Nakamura, Latitudinal variation of the solar He I 58.4 nm irradiance from the optical observation of the interplanetary He I emission, *Journal of Geophysical Research*, Vol. 111, CiteID A06106, 2006.

3. Yoshikawa, I., H. Nozawa, S. Kameda, S. Okano, and H. Misawa, Observation of the Sodium Exosphere from Mercury Magnetospheric Orbiter, *Advance in Space Research*, Vol. 38, 659-663, 2006.

4. Sako, T., K. Watanabe, Y. Muraki, Y. Matsubara, H. Tsujihara, M. Yamashita, T. Sakai, S. Shibata, J. F. Valdes-Galicia, L. X. Gonzalez, A. Hurtado, O. Musalem, P. Miranda, N. Martinic, R. Ticona, A. Velarde, F. Kakimoto, S. Ogio, Y. Tsunesada, H. Tokuno, Y. T. Tanaka, I. Yoshikawa, T. Terasawa, Y. Saito, and T. Mukai, Long-lived Solar Neutron Emission in Comparison with Electron-produced Radiations, *Astrophysical Journal*, Vol. 651, L69-L72, 2006.

5. Terasawa, T., Y. Tanaka, I. Yoshikawa, N. Kawai, Geotail observation of soft gamma repeater giant flares, *Journal of Physics: Conference Series*, Vol. 31, 76-79, 2006.

6. Tanaka, Y. T., I. Yoshikawa, K. Yoshioka, T. Terawasa, Y. Saito, and T. Mukai, Gamma-ray detection efficiency of the microchannel plate installed as an ion detector in the low energy particle instrument onboard the GEOTAIL satellite, *Review of Scientific Instruments*, Vol. 78, 034501-1-034501-4, 2007.

7. Watanabe, K. T. Sako, Y. Muraki, Y. Y. Matsubara, T. Sakai, S. Shibata, J. F. s-Galicia Vald, L. X. Gonz lez, A. Hurtado, O. Musalem, P. Miranda, N. Martinic, R. Ticona, A. Velarde, F. Kakimoto, S. Ogio, Y. Tsunesada, H. Tokuno, Y. Tanaka, I. Yoshikawa, T. Terasawa, Y. Saito, T. Mukai, and M. Gros, Highly significant detection of solar neutrons on 2005 September 7, *Advances in Space Research*, Vol. 39, 1462-1466, 2007.

8. Murakami, G., M. Hirai, and I. Yoshikawa, The plasmapause response to the southward turning of the IMF derived from sequential EUV images, *Journal of Geophysical Research*, Vol. 112, A06217, doi:10.1029/2006JA012174, 2007.

9. Tanaka, Y. T., T. Terasawa, N. Kawai, A. Yoshida, I. Yoshikawa, Y. Saito, T. Takashima, and T. Mukai, Comparative Study of the Initial Spikes of SGR Giant Flares in 1998 and 2004 Observed with GEOTAIL: Do Magnetospheric Instabilities Trigger Large-Scale Fracturing of a Magnetar's Crust?, *The Astrophysical Journal*, Vol. 665, L55-L58, 2007.

10. Yoshikawa, I., S. Kameda, K. Matsuura, K. Hikosaka, G. Murakami, K. Yoshioka, H. Nozawa, D. Rees, S. Okano, H. Misawa, A. Yamazaki, and O. Korablev, Observation of Mercury's sodium exosphere by MSASI in the BepiColombo mission, *Planetary and Space Science*, Vol. 55 1622-1633, 2007.

11. Kameda, S., I. Yoshikawa, J. Ono, and H. Nozawa, Time variation in exospheric sodium density on Mercury, *Planetary and Space Science*, Vol. 55, 1509-1517, 2007.

12. Yoshioka, K., K. Hikosaka, S. Kameda, H. Nozawa, A. Yamazaki, and I. Yoshikawa, Mercury's sodium exosphere explored by the BepiColombo mission, *Advances in Space Research*, Vol. 41, 1386-1391, 2008.

13. Kameda, S., M. Kagitani, S. Okano, I. Yoshikawa, and J. Ono, Observation of Mercury's sodium tail using Fabry-Perot Interferometer, *Advances in Space Research*, Vol. 41, 1381-1385, 2008.

14. K. Yoshioka, K. Hikosaka, G. Murakami, I. Yoshikawa, A. Yamazaki, and H. Nozawa, Development of the EUV detector for the BepiColombo mission, *Advances in Space Research*, Vol. 41, 1392-1396, 2008.

15. Yoshikawa, I., A. Yamazaki, G. Murakami, K. Yoshioka, S. Kameda, F. Ezawa, T. Toyota, W. Miyake, M. Taguchi, M. Kikuchi, and M. Nakamura, Telescope of extreme ultraviolet (TEX) onboard SELENE: science from the Moon, *Earth, Planets and Space*, Vol. 60, 407-416, 2008.

16. Yoshikawa, I., S. Kameda, K. Hikosaka, G. Murakami, D. Rees, H. Nozawa, S. Okano, O. Korablev, Attempt to identify a source mechanism of Mercury's sodium exosphere by a spectrometer using Fabry-Perot etalon, *Advances in Space Research*, Vol. 42, 1172-1179, 2008.

17. Yoshikawa, I., J. Ono, K. Yoshioka, G. Murakami, F. Ezawa, T. Toyota, S. Kameda, and S. Ueno, Observation of Mercury's sodium exosphere during the transit on November 9, 2006, *Planetary and Space Science*, Vol. 56, 1676-1680, 2008.

18. Nakagawa, H., M. Bzowski, A. Yamazaki, H. Fukunishi, S. Watanabe, Y. Takahashi, M. Taguchi, I. Yoshikawa, K. Shiomi, and M. Nakamura, UV optical measurements of the Nozomi spacecraft interpreted with a two-component LIC-flow model, *Astronomy & Astrophysics*, aa9241-07, 2008.

19. Kameda, S., I. Yoshikawa, M. Kagitani, and S. Okano, Interplanetary dust distribution and temporal variability of Mercury's atmospheric Na, *Geophysical Research Letters*, Vol. 36, doi:10.1029/2009GL039036, 2009.

20. Kagitani, M., M. Taguchi, A. Yamazaki, I. Yoshikawa, G. Murakami, K. Yoshioka, S. Kameda, F. Ezawa, T. Toyota, and S. Okano, First optical observation of the Moon's sodium exosphere from the lunar orbiter SELENE (Kaguya), *Earth, Planets and Space*, Vol. 61, 1025-1029, 2009.

21. M. Taguchi, T. Sakanoi, S. Okano, M. Kagitani, M. Kikuchi, M. Ejiri, I. Yoshikawa, A. Yamazaki, G. Murakami, K. Yoshioka, S. Kameda, W. Miyake, M. Nakamura, and K. Shiokawa, The Upper Atmosphere and Plasma Imager / the Telescope of Visible Light (UPI/TVIS) onboard the Kaguya Spacecraft, *Earth, Planets and Space*, Vol. 61, 17-23, 2009.

22. Yoshikawa, I., O. Korablev, S. Kameda, D. Rees, H. Nozawa, S. Okano, V. Gnedykh, V. Kottsov, K. Yoshioka, G. Murakami, F. Ezawa, and G. Cremonese, The Mercury Sodium Atmospheric Spectral Imager for the MMO Spacecraft of Bepi-Colombo, *Planetary and Space Science*, Vol. 58, 224-237, 2010.

23. Chassefiere, E., J.-L. Maria, J.-P. Goutail, E. Quemerais, F. Leblanc, S. Okano, I. Yoshikawa, O. Korablev, V. Gnedykh, G. Naletto, P. Nicolosi, M.-G. Pelizzo, J.-J. Correia, S. Gallet, C. Hourtoule, P.-O. Mine, C. Montaron, N. Rouanet, J.-B. Rigal, G. Muramaki, K. Yoshioka, O. Kozlov, V. Kottsov, P. Moisseev, N. Semena, J.-L. Bertaux, M.-Th. Capria, J.Clarke, G. Cremonese, D. Delcourt, A. Doressoundiram, S. Erard, R. Gladstone, M. Grande, D. Hunten, W. Ip, V. Izmodenov, A. Jambon, R. Johnson, E. Kallio, R. Killen, R. Lallement, J. Luhmann, M. Mendillo, A. Milillo, H. Palme, A. Potter, S. Sasaki, D. Slater, A. Sprague, A. Stern, and N. Yan, PHEBUS: A double ultraviolet spectrometer to observe Mercury's exosphere, *Planetary and Space Science*, Vol. 58, 201-223, 2010.

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30. Murakami, G., I. Yoshikawa, Y. Obana, K. Yoshioka, G. Ogawa, A. Yamazaki, M. Kagitani, M. Taguchi, M. Kikuchi, S. Kameda, and M. Nakamura, First sequential images of the plasmasphere from the meridian perspective observed by KAGUYA, *Earth, Planets and Space*, Vol. 62, e9–e12, 2010.

31. Yoshikawa, I., G. Murakami, G. Ogawa, K. Yoshioka, Y. Obana, M. Taguchi, A. Yamazaki, S. Kameda, M. Nakamura, M. Kikuchi, M. Kagitani, S. Okano, W. Miyake, Plasmaspheric EUV image seen from the lunar orbit: Initial Result of Extreme Ultraviolet Telescope onboard KAGUYA spacecraft, *Journal of Geophysical Research*, 115, CiteID A04217, 2010.

32. Murakami, G., K. Yoshioka, I. Yoshikawa, High-resolution imaging detector using five microchannel plates and a resistive anode encoder, *Applied Optics*, Vol. 49, 2985-2993, 2010.

33. Tsuchiya, F., M. Kagitani, N. Terada, Y. Kasaba, I. Yoshikawa, G. Murakami, K. Sakai, T. Homma, K. Yoshioka, A Yamazaki, K. Uemizu, T. Kimura, and M. Ueno, Plan for observing magnetospheres of outer planets by using the EUV spectrograph onboard the SPRINT-A/EXCEED mission, *Advances in Geosciences*, Vol. 25, 57-72, 2010.

34. Murakami, G., K. Sakai, T. Homma, K. Yoshioka, I. Yoshikawa, S. Ichimaru, and H. Takenaka, Performance of Y2O3/Al multilayer coatings for the He-II radiation at 30.4 nm, *Review of Scientific Instruments*, Vol. 82, 033106-1-4, 2011.

35. Yoshioka, K., I. Yoshikawa, F. Tsuchiya, M. Kagitani, and G. Murakami, Hot electron component in the Io plasma torus confirmed through EUV spectral analysis, *Journal of Geophysical Research*, Vol. 116, A09204, doi:10.1029/2011JA016583, 2011.

36. Yoshioka, K., I. Yoshikawa, F. Tsuchiya, M. Kagitani, G. Murakami, K. Sakai, and T. Homma, Feasibility study of EUV spectroscopic observation of the Io plasma torus from the Earth-orbiting satellite EXCEED, *Planetary and Space Science,* 62, 104-110, 2012.

37. Yoshioka, K. T. Homma, G. Murakami, and I. Yoshikawa, High sensitivity microchannel plate detectors for space extreme ultraviolet missions, Review of Scientific Instruments, Volume 83, Issue 8, 083117-083117-6, 2012.

(2) Selected Conference Proceedings

1. Murakami, G., F. Ezawa, K. Yoshioka, and I. Yoshikawa, Development of the High-resolution FUV detector for the BepiColombo Mission, Preprints of 26th International Symposium on Space Technology and Science (ISTS), 2008-k-69p, 2008.

2. Yoshioka, K., G. Murakami, and I. Yoshikawa, Optimization of the MCP Detector for the BepiColombo Mission, 26th International Symposium on Space Technology and Science (ISTS), Hamamatsu, Japan, 2008-k-68p, 2008

3. Yoshikawa, I., A. Yamazaki, G. Murakami, F. Ezawa, K. Yoshioka, S. Kameda, W.

Miyake, M. Taguchi, M. Kikuchi, M. Nakamura, T. Sakanoi and S. Okano, Observation of the Near-Earth Plasmas by Telescope of Extreme Ultraviolet (TEX) Onboard SELENE: Science from the Moon, 26th International Symposium on Space Technology and Science (ISTS), Hamamatsu, Japan, 2008-k-50, 2008

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Yoshikawa, I., K. Hikosaka, S. Kameda, S. Okano, H. Nozawa, A. Yamazaki, O. Korablev, and D. Rees, Attempt to identify a source mechanism of Mercury's sodium exosphere by remote-sensing technique, 36th COSPAR Scientific Assembly, Beijin, China, 2006. [invited]
2. Yoshikawa, I., S. Kameda, O. Korablev, and D. Rees, Mercury Sodium Atmosphere Spectral Imager (MSASI) - taking High Resolution Interferometry to the Planets, 37th COSPAR Scientific Assembly, Montreal, Canada, 16 July 2008. [invited]
3. Yoshikawa, I., G. Murakami, K. Yoshioka, K. Sakai, T. Homma, The Plasmasphere seen from the moon and the ionosphere, IUGG, Melbourne, Australia, 6 July 2011. [invited]
4. Yoshikawa, I., Plasmasphere from the Moon, International Symposium on Recent Observations and Simulations of the Sun–Earth System II, Borovets, Bulgaria, 11–16 September, 2011. [invited]

and 20 other talks

(2) Domestic Conferences

5. Ichiro Yoshikawa, Atsushi Yamazaki, Naoki Terada, Remote sensing for planetary plasma, Japan Geoscience Union Meeting, Chiba Makuhari Messe, 2006. [invited]
6. Ichiro Yoshikawa and SELENE UPI team, Observation of Upper atmosphere and plasma imager, 122th Society of Geomagnetism and Earth, Planetary and space sciences meeting, Nagoya, September 2007. [invited]
7. Ichiro Yoshikawa, Muneaka Ueno, Yasumasa Kasaba, Atsushi Yamazaki, Naoki Terada, Fuminori Tsuchiya, Masao Kagitani, Hiroaki Misawa, Kazuo Yoshioka, Go murakami, The current status of EUV spectrometer on the 1st scientific small satellite, 124th Society of Geomagnetism and Earth, Planetary and space sciences meeting, Sendai, October 2008. [invited]
8. Ichiro Yoshikawa, EUV imaging observation by the normal-incidence multi-layer coated mirror on the lunar orbiter (KAGUYA), 10^{h} X-ray imaging optics symposium, Tsukuba international conference building, November, 2009. [invited]

and 20 other talks

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Go Murakami: JAXA project researcher

March, 2011 President Prize of the University of Tokyo
March, 2011 the School of Science encouragement award of the University of Tokyo (Doctor Corse)
March, 2008 the School of Science encouragement award of the University of Tokyo (Master Corse)
September, 2007 122th SGEPSS annual meeting Auroral Medal

· Kazuo Yoshioka: JAXA project researcher

September 2009, 126th SGEPSS annual meeting Auroral medal
March, 2010 the School of Science encouragement award of the University of Tokyo (Doctor Corse)
2010 COSPAR outstanding paper award for young scientists

· Shingo Kameda: Rikkyo University, Associate Professor

March 2008, the School of Science encouragement award of the University of Tokyo (Doctor Corse)

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

· 2011-2012 SGEPSS 26h steering committee
· 2009-2010 SGEPSS 25th steering committee
· 2007-2008 SGEPSS 24th steering committee

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting
Foreign Students: 2
Foreign Researchers: 0
Sending
Japanese Students: 5
Japanese Researchers: 0
Visitors from Abroad: 5

Takanobu Amano

I. C.V.

Name : Takanobu Amano

Present Position: Assistant Professor, Department of Earth and Planetary Science, University of Tokyo

Education

B. Sc., Geophysics, March, 2003, Department of Earth and Planetary Physics, University of Tokyo

M. Sc., Geophysics, March, 2005, Department of Earth and Planetary Science, University of Tokyo

Ph. D., Geophysics, March, 2008, Department of Earth and Planetary Science, University of Tokyo

Professional Experience

April, 2005-Mar., 2008, JSPS Fellowship for Young Scientists (DC1), Department of Earth and Planetary Science, University of Tokyo

April, 2008-Mar. 2009, Postdoctoral Researcher, Solar-Terrestrial Environment Laboratory, Nagoya University

April, 2009-Mar. 2012, Designated Assistant Professor, Graduate School of Science, Nagoya University

Mar., 2012-, Assistant Professor, Department of Earth and Planetary Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

Electron Injection Problem in Collisionless Shocks

Galactic cosmic rays showering the earth's atmosphere from space are believed to be accelerated by shock waves produced by supernova explosions. The standard model for particle acceleration at shocks, called 1st order Fermi acceleration, has the so-called injection problem. Namely, since the Fermi acceleration is far less efficient for low energy particles, one must invoke some other mechanisms that can pre-accelerate thermal particles above the injection threshold. The injection of electrons in particular has been considered to be much more difficult compared to protons and heavy ions. By performing one-dimensional particle-in-cell (PIC) simulations, we found that a small fraction of upstream electrons are accelerated through intense electrostatic waves generated by a beam-plasma instability, as well as magnetic mirror reflection. We showed that in a very high Mach number shock, the accelerated electrons have energy sufficient for the injection. Two-dimensional PIC simulations were also performed, from which we found that the electron acceleration by electrostatic waves is effective also in multi-dimensions.

Later, theoretical analysis based on the idea of self-generation of high frequency whistler waves showed that the required Mach number for the injection is lower by roughly a factor of 40 than previously thought. This theory was shown to be able to explain a statistical analysis of Earth's bow shock observations. This gives for the first time a reasonable explanation for an

observational discrepancy in electron acceleration efficiency between heliospheric and astrophysical shocks.

Development of Numerical Simulation Model for Inner Magnetosphere

Energetic (1-300 keV) ring current particles in the inner magnetosphere is the dominant component providing the plasma pressure in this region. Because of their high energies, conventional magnetohydrodynamic (MHD) approximation does not necessarily gives an accurate description of inner magnetospheric phenomena. We have been developing a new kinetic simulation model for ring current particles that incorporates self-consistent coupling between particles and electromagnetic fields. So far, our model is shown to be able to successfully describe MHD waves as well as kinetic drift effects, which has been a missing feature in conventional models for a long time.

3. Five Important Papers in your career

1. Amano, T., K. Seki, Y. Miyoshi, T. Umeda, Y. Matsumoto, Y. Ebihara, and S. Saito (2011), Self-consistent Kinetic Numerical Simulation Model for Ring Current Particles in the Earth's Inner Magnetosphere, J. Geophys. Res., 116, A02216
2. Amano, T., and M. Hoshino (2010), A Critical Mach Number for Electron Injection in Collisionless Shocks, Phys. Rev. Lett., 104, 181102
3. Amano, T., and M. Hoshino (2009), Nonlinear Evolution of Buneman Instability and Its Implication for Electron Acceleration in High Mach Number Collisionless Perpendicular Shocks, Phys. Plasmas, 16, 102901
4. Amano, T., and M. Hoshino (2009), Electron Shock Surfing Acceleration in Multidimensions: Two-Dimensional Particle-In-Cell Simulation of Collisionless Perpendicular Shock, Astrophys. J., 690, 244-251
5. Amano, T., and M. Hoshino (2007), Electron Injection at High Mach Number Quasi-Perpendicular Shocks : Surfing and Drift Acceleration, Astrophys. J., 661, 190-202

A new simulation model developed in the paper [1] includes a new feature that has been missing in conventional models for a long time. This may become a breakthrough in inner magnetospheric physics.

Papers [2-5] dealt with the injection problem in particle acceleration theory in collisionless shocks. In particular, the paper [2] proposed a new injection model that can, for the first time, very well explain observations of particle acceleration at shocks in space.

4. Awards and Honors throughout your career

5. Future Research Plan

Particle Acceleration in Collisionless Shocks

We have so far found that there exists a critical Mach number above which electrons are efficiently injected into the subsequent Fermi acceleration process. At this moment, however, this theory cannot predict anything about the amount of injected particles, or the injection rate. For a quantitative estimate of the injection rate, we are planning to investigate the injection

process with various approaches including large scale numerical simulations, in-situ observation data analysis, and theoretical study. Numerical simulation must always use artificial parameters to reduce computational resources. On the other hand, it is impossible to obtain all the parameters possibly affecting acceleration processes, and also distinction between temporal and spatial variations from single spacecraft observations is rather difficult. Theoretical study is therefore needed to bridge the gap between the two approaches. By combining all the possible approaches, we try to estimate quantitatively the injection rate of electrons in collisionless shocks.

When the injection is very efficient so that the energy density of energetic particles becomes no longer negligible as compared with the thermal plasma, the shock is known to be modified by feedback from energetic particles. We will investigate this nonlinear feedback using numerical simulations. In particular, the effects of shock modification on the injection rate, as well as Fermi acceleration efficiency will be investigated in detail.

Development of Numerical Simulation Model for Inner Magnetosphere

There has been a need for development of a new model that is capable of describing kinetic effects of ring-current particles as well as fully self-consistent development of electromagnetic fields in the inner magnetosphere. Our prototype model has been proven to be very promising to meet the above requirement. There are, however, numerical issues that prevent simulations being performed for a long time with reasonable accuracy. We are planning to implement some missing physics modules, optimize grid structure, numerical scheme, and parallelization efficiency. By doing this, our simulation model will become a practical tool that is able to simulate inner magnetospheric phenomena including geomagnetic storms.

Since this model will describe field variations in the inner magnetosphere, it may be a central tool to understand the variation of radiation belt electrons as they strongly influenced by field variations. Therefore, this model development is very important to understand observational data from upcoming inner magnetospheric missions including RBSP (USA) and ERG (Japan) satellites.

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for JSPS Fellows, 2005-2007, 2.70 million yen

· Grant-in-Aid for Young Scientists (B), 2009-2011, 4.03 million yen

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Amano, T., K. Torii, T. Hayakawa, and Y. Fukui (2011), Stochastic Acceleration of Cosmic Rays in the Central Molecular Zone of the Galaxy, Publ. Astron. Soc. Jpn., 63, L63-L66

2. Minoshima, T., Y. Matsumoto, and T. Amano (2011), Multi-Moment Advection Scheme for Vlasov Simulations, J. Comput. Phys., 230, 17, 6800-6823

3. Amano, T., K. Seki, Y. Miyoshi, T. Umeda, Y. Matsumoto, Y. Ebihara, and S. Saito (2011), Self-consistent Kinetic Numerical Simulation Model for Ring Current Particles in the Earth's Inner Magnetosphere, J. Geophys. Res., 116, A02216
4. Amano, T., and M. Hoshino (2010), A Critical Mach Number for Electron Injection in Collisionless Shocks, Phys. Rev. Lett., 104, 181102
5. Shimada, N., M. Hoshino, and T. Amano (2010), Structure of a Strong Supernova Shock Wave and Rapid Electron Acceleration Conned in Its Transition Region, Phys. Plasmas, 17, 032902
6. Amano, T., and M. Hoshino (2009), Nonlinear Evolution of Buneman Instability and Its Implication for Electron Acceleration in High Mach Number Collisionless Perpendicular Shocks, Phys. Plasmas, 16, 102901
7. Amano, T., and M. Hoshino (2009), Electron Shock Surfing Acceleration in Multidimensions: Two-Dimensional Particle-In-Cell Simulation of Collisionless Perpendicular Shock, Astrophys. J.,690, 244-251
8. Amano, T., and M. Hoshino (2007), Electron Injection at High Mach Number Quasi-Perpendicular Shocks : Surfing and Drift Acceleration, Astrophys. J., 661, 190-202

(2) Selected Conference Proceedings

1. Amano, T., and M. Hoshino (2009), Effect of Shock Angle on Fast and Direct Acceleration of Electrons in High Mach Number Quasi-Perpendicular Shocks, Future Perspectives of Space Plasma and Particle Instrumentation and International Collaborations, AIP Conf. Proc., 1144, 36

(3) Review Papers

(4) Books

(5) Patents

1. Minoshima, T., Y. Matsumoto, T. Amano, and S. Masuda, method for numerically solving advection equation, method for numerically solving vlasov equation and maxwell equation, and program (Pub. No.:2011-159032)

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Amano, T., and M. Hoshino, Nonthermal Electron Acceleration and Injection in Collisionless Shocks, International Astrophysics Forum Alpbach (IAFA) 2011, Alpbach, Austria, Jun. 24, 2011, invited
2. Amano, T., K. Seki, Y. Miyoshi, T. Umeda, Y. Matsumoto, Y. Ebihara, and S. Saito, Kinetic and Self-consistent Numerical Modeling of the Terrestrial Inner Magnetosphere, 6th International Conference on Numerical Modeling of Space Plasma Flows (ASTRONUM 2011), Valencia, Spain, Jun. 17, 2011, invited
3. Amano, T., and M. Hoshino, Electron Acceleration and Injection by Whistler Waves in Collisionless Shocks, 2010 International Space Plasma Symposium, Tainan, Taiwan, Jun. 28, 2010, invited
4. Amano, T., and M. Hoshino, Surfing and Drift Acceleration of Electrons at High Mach Number Quasi-perpendicular Shocks, Kinetic Modeling of Astrophysical Plasmas, Crakow, Poland, Oct. 6, 2008, invited
5. Amano, T. and M. Hoshino, Nonthermal Electron Acceleration in High Mach Number

Collisionless Shocks, The 9th International Workshop on the Interrelationship between Plasma Experiments in Laboratory and Space (IPELS), Palm Cove, Australia, Aug. 10, 2007, invited

13 others

(2) Domestic Conferences

17 (2 of them are invited talk)

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

N/A (starting education career from 2012)
Hosting
Foreign Students:
Foreign Researchers:
Sending
Japanese Students:
Japanese Researchers:
Visitors from Abroad:

Akira Miura

I. C.V.

Name： Akira Miura
Present Position: Assistant Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Electronics, The University of Electro-Communications, March, 1974
M. Sc., Geophysics, The University of Tokyo, March, 1976
Withdrawal from Dr. course
Ph. D., Geophysics, The University of Tokyo, June, 1980

Professional Experience
Nov., 1978-Sept., 1980, Research Associate, Geophysics Research Laboratory, University of Tokyo
Oct., 1980-Sept., 1982, Visiting Scientist, Institute of Geophysics and Planetary Physics, University of California, USA
Oct., 1982-Mar., 1991, Research Associate, Geophysics Research Laboratory, University of Tokyo
Apr., 1991-Mar., 2000, Research Associate, Department of Earth and Planetary Physics, University of Tokyo
Apr., 2000-, Assistant Professor, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

Major achievements in this researcher's study of pressure-driven, ionosphere-driven and velocity shear-driven MHD instabilities, which are important in understanding the magnetospheric stability during the quiet time and during the periods of substorms and magnetic storms, are as follows.

The magnetospheric stability depends on the sign of the magnetospheric potential energy variation δW, since $\delta W < 0$ means that the potential energy is converted to kinetic energy within the magnetosphere to make the magnetospheric plasma unstable.

The calculation of δW from compressible ballooning eigenmode equations by using an ionospheric boundary condition (the displacement vector $\xi_\perp = 0$) showed that in a highly stretched tail configuration appearing prior to the substorm onset, the compressible term in δW can be neglected and ballooning mode occurs without strong stabilizing influence by the compressibility. This study also showed that pressure-driven interchange mode, which has a nonzero $\xi_\perp$ at the ionosphere, is stabilized ($\delta W > 0$) when the equatorial plasma beta exceeds the order of one.

The need for a more consistent global treatment, which should clarify valid ionospheric boundary conditions, led to the formulation of a magnetospheric energy principle. According to this principle there are four possible ionospheric boundary conditions, which can clearly separate ballooning mode from interchange mode. This principle also showed that δW contains a negative ionospheric contribution δW_I to δW and thus showed the possibility of an ionosphere-driven ideal MHD instability.

The minimization of δW obtained in the energy principle by using the eikonal assumption for an arbitrary axisymmetric magnetosphere gave a general instability criterion for interchange modes. In the case of pressure-driven interchange mode for the dipole mangnetic field, this instability criterion agreed with that of Gold (1959), which was obtained from thermodynamic consideration for a magnetospheric flux tube. This general criterion also showed that the ionosphere-driven interchange mode indeed occurs in the low-beta radiation belts for an azimuthal mode number m <2.

An extended magnetospheric energy principle to include the neutral atmosphere and the conducting ground surface showed that the atmospheric magnetic energy variation does not contribute to δW and to the stabilization of the ionosphere-driven interchange mode.

In the subsolar magnetopause and the near-earth magnetosphere, where the ideal MHD fluid velocity and its gradient are very small, there is no fluid-type velocity shear instability. However, a general 2-component MHD fourth order differential eigenmode equation showed that a nonideal MHD instability driven by the shear in the ion diamagnetic drift velocity occurs in those regions when the whistler mode component is neglected and when there is no magnetic shear ($\mathbf{k} \cdot \mathbf{B}_0 = 0$).

3. Five Important Papers in your career

1. Miura, A., Nonlinear evolution of the magnetohydrodynamic Kelvin-Helmholtz instability, Phys. Rev. Lett., 49, 779-782, 1982.

This paper is important, because it is an early simulation, which showed the nonlinear evolution of MHD K-H instability for flows parallel and perpendicular to the magnetic field.

2. Miura, A., Nonideal magnetohydrodynamic Kelvin-Helmholtz instability driven by the shear in the ion diamagnetic drift velocity in a high-b plasma, Phys. Plasmas, 8, 5291-5295, 2001.

This paper is important, because it showed the existence of a nonideal MHD instability owing to the shear in the ion diamagnetic drift velocity, which does not exist in the ideal MHD macroscopic drift velocity.

3. Miura, A., Conditions for the validity of the incompressible assumption for the ballooning instability in the long-thin magnetospheric equilibrium, J. Geophys. Res., 105, 18793-18806, 2000.

This paper is important, because it validates on the quantitative basis the incompressible assumption made in an early ballooning eigenmode analysis when the field lines are highly stretched in the tail.

4. Miura, A., A magnetospheric energy principle for hydromagnetic stability problems, J. Geophys. Res., 112, A06234, doi:10.1029/2006JA011992, 2007.

This paper is important, because it formulated an ideal MHD magnetospheric energy principle. This energy principle is peculiar to magnetospheric plasmas having ionospheric boundaries, on which field lines are incident vertically and threading the boundaries. It also showed the existence of a negative destabilizing ionospheric contribution to the magnetospheric potential energy variation δW .

5. Miura, A., Pressure-driven and ionosphere-driven modes of magnetospheric interchange instability, J. Geophys. Res., 114, A02224, doi:10.1029/2008JA013668, 2009.

This paper is important, because it showed that the negative destabilizing ionospheric

contribution to δW indeed causes a new ionosphere-driven interchange instability for realistic parameters in the magnetosphere.

4. Awards and Honors throughout your career

5. Future Research Plan

The magnetospheric energy principle and the eikonal assumption showed that a negative ionospheric destabilizing contribution δW_I to the magnetospheric potential energy variation δW leads to an ionosphere-driven interchange instability, which is different from pressure-driven interchange instability (Gold, 1959). The assumption of axisymmetric dipole field further showed that this instability occurs in magnetospheric low beta plasma regions such as radiation belts for the azimuthal mode number m <2. This instability occurs due to the field line motion over the spherical ionospheric surface. However, the ultimate energy source for this instability is still not clear. The future research is mainly focused on this instability, its enegy source and its magnetospheric consequences.

In order to verify the existence of δW_I in the magnetospheric energy principle and the existence of the ionosphere-driven interchange instability, I plan to derive the potential energy variation δW from the compressible ballooning eigenmode equations by imposing the ionospheric boundary condition for the interchange mode ($\xi_\perp \neq 0$), which was obtained by the magnetospheric energy principle. Such a calculation will independently validate the existence of the ionosphere-driven interchange instability.

In the ideal MHD energy principle only magnetic and internal energies can be potential energies for MHD instabilities. Since δW_I doesn't include the pressure gradient, the energy source for this instability cannot obviously be the internal energy in the magnetosphere. The magnetic energy variation in the neutral atmosphere doesn't contribute to δW and it cannot be the energy source for this instability. Since the magnetospheric energy principle is based on the total energy conservation within the magnetosphere including energy input through the ionospheric boundary, the ultimate energy source for the instability must exist in the finite volume ionosphere. In order to identify the energy source, I plan to calculate the Joule dissipation, the negative Joule dissipation due to ionospheric conductivity change, and the magnetic potential energy variation in the finite volume spherical ionospheric layer to determine which term is responsible for the instability.

The ionosphere-driven and pressure-driven interchange instabilities cause the compression and expansion of magnetic flux tubes in the magnetosphere. They are very likely to be responsible for the adiabatic acceleration of radiation belt particles through the change of magnetic field strength. For the dipole field and an azimuthally asymmetric perturbation, I plan to investigate the possibility of the net adiabatic acceleration of radiation belt particles by calculating the energy increase of 90 degree pitch angle particles under the assumption of the first invariant conservation. This investigation will clarify which interchange instability between ionosphere-driven and pressure-driven ones is more important for the adiabatic acceleration in radiation belts.

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for Scientific Research (C), A theoretical study of magnetohydrodynamic

instabilities in non-rotating and rotating magnetospheres、2008-2012、2600000 yen.

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Miura, A., A magnetospheric energy principle extended to include neutral atmosphere, Physics of Plasmas, 18 (3), 032904, 2011.
2. Miura, A., Pressure-driven and ionosphere-driven modes of magnetospheric interchange instability, J. Geophys. Res., 114, A02224, doi: 10.1029/2008JA013668, 2009.
3. Miura, A., Single-fluid stability of stationary plasma equilibria with velocity shear and magnetic shear, Physics of Plasmas, 16, 102107, 2009.
4. Miura, A., A magnetospheric energy principle for hydromagnetic stability problems, J. Geophys. Res., 112, A06234, doi: 10.1029/2006JA011992, 2007.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

(2) Domestic Conferences

1. Miura, A., A magnetospheric energy principle for hydromagnetic stability problems, JpGU Meeting, JpGU, May14-18, 2006, Makuhari-Messe, Contributed.
2. Miura, A., Pressure-driven and ionosphere-driven interchange instabilities in an asymmetric magnetospheric model, SGEPSS Meeting, SGEPSS, October 9-12, 2008, Sendai, Contributed.

The total number of other presentations: 7

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 0

Takashi Yamamoto

I. C.V.

Name： Takashi Yamamoto
Present Position: Assistant Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Geophysics, The University of Tokyo, March, 1972
M. Sc., Geophysics, The University of Tokyo, March, 1974
Ph. D., Geophysics, The University of Tokyo, March, 1977

Professional Experience
April, 1977-Mar., 1978, Research Fellow, Department of Geophysics, Tokyo University
Jun, 1983-Jun, 1985, Postdoctoral Fellow, Geophysical Institute, University of Alaska, USA
Oct., 1981-Mar., 2012, Assistant Professor, Department of Earth and Planetary Science, Tokyo University

II. Scientific Research Activity

2. Major achievements

My research interest is in understanding how the field-aligned currents are produced in the magnetosphere-ionosphere coupling system and how they are related to the formation of auroras. Recent progresses in my research work are summarized as follows.

The global field-aligned currents (FACs) connecting the auroral oval to the magnetospheric plasmas are quite important in maintaining the convection flow in the magnetosphere besides causing the discrete auroras. We have proposed a new paradigm that the global FACs can be produced in the situation that the flux-tube-integrated energy density is not aligned with the direction of average magnetic drift of auroral particles. That nonalignment is ultimately caused by the interaction between the solar wind and the magnetosphere. Specifically, the generation of dayside region 1 FACs in the low-latitude boundary layer is explained as follows: a plasma injected from the magnetosheath is polarized because the magnetopause boundary is distorted by the solar wind pressure so that the magnetosheath inner boundary is not aligned with the average magnetic drift direction. Similar distortion occurs on the nightside plasma sheet: the interface between the nonadiabatic and adiabatic plasmas is observationally inferred to be not aligned with the average magnetic drift direction, leading to the generation of region 1 FACs around that interface, a result of magnetic-drift-induced polarization of nonadiabatically accelerated particles. Actually, our numerical simulation has reproduced a total system of combined region 0, region1 and region 2 FACs, in a frame work of the above mentioned distortion model and the newly introduced concept of polarization by anomalous cross-filed particle diffusion. Traditionally, the formation of auroral omega bands and periodic distortions in the plasma sheet had been interpreted as a result of the electrostatic Kelvin-Helmholtz (KH) instability. On the basis of evaluation of the inertial capacitance of a magnetospheric plasma using the Tsyganenko's model, it has been shown that the KH instability is suppressed by the effect of Pedersen coupling between the magnetosphere and the ionosphere and that instead the hybrid KH/RT (Rayleigh-Taylor) instability is more likely to produce the omega bands and periodic distortions. In fact, our

numerical simulation has reproduced these aural forms; their characteristics are found to be quite consistent with the observations.

3. Five Important Papers in your career

1. Yamamoto, T., and S. Inoue (2004), Numerical simulation of the combined system of nighttime region 0, region 1, and region 2 field-aligned currents, J. Geophys. Res., 109, A12223, doi:10.1029/2003JA010272.

A total system of the region 0, region 1 and region 2 has been reproduced by the numerical simulation for the first time

2. Yamamoto, T., and M. Ozaki (2005), A numerical model of the dayside aurora, J. Geophys. Res., 110, A05215, doi:10.1029/2004JA010786.

The characteristic pattern of dayside auroras has been numerically reproduced for the first time.

3. Yamamoto T. (2006), A theoretical model for the distribution of latitudinal extents of field-aligned electron acceleration, J. Geophys. Res., 111, A11217, doi:10.1029/2006JA011693.

The observed distribution of latitudinal extents of field-aligned electron acceleration has been theoretically understood for the first time.

4. Yamamoto T. (2009), Hybrid Kelvin-Helmholtz/Rayleigh-Taylor instability in the plasma sheet, J. Geophys. Res., 114, A06207, doi:10.1029/2008JA013760.

It has been found for the first time that auroral deformations of long wavelength are caused by not the KH instability, but the hybrid KH/RT instability.

5. Yamamoto, T. (2011), A numerical simulation for the omega band formation, J. Geophys. Res., 116, A02207, doi:10.1029/2010JA015935.

A metastable state of the region 1 field-aligned current in the plasma sheet has been reproduced by the numerical simulation for the first time. The formations of auroral omega bends and periodic distortions have been numerically reproduced as a result of the hybrid KH/RT instability for the first time.

4. Awards and Honors throughout your career

5. Future Research Plan

In the near future, the numerical simulation of the electrostatic coupling between the magnetosphere and the ionosphere will be intended for the formation of stable discrete auroras, specifically an auroral circle and a long-lived (longer than 30 min) growth-phase arc. An expected scenario of these auroral formations may be outlined as follows.

The both types of aurora are assumed to result from charge separation by anomalous cross-field diffusion of ions in regions where the energy density of auroral particles has a steep latitudinal gradient. As inferred from the satellite observations of precipitating particles across the open-closed boundary, such energy density gradient may occur along the boundary, leading to the formation of an auroral circle encircling the polar cap. Another site of steep energy density gradient is the interface between stretched field lines and dipolar ones, where the flux tube volume changes considerably. The associated adiabatic energization of particles can be responsible for the generation of a long-lived growth-phase arc through diffusion-induced

polarization. It will be further shown that short-lived (shorter than 15 min) arcs are formed as a result of random fluctuation of the energy density of injected particles which could be caused by irregular variations of magnetic fields in the solar wind. Such a random generation mechanism for discrete auroras is in conformity with the "quasi-exponential" distribution of latitudinal scale sizes for electron acceleration events, an observational finding by Newell et al. (1996).

6. Funding Received

(1) JSPS Grants

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Yamamoto T. (2006), A theoretical model for the distribution of latitudinal extents of field-aligned electron acceleration, J. Geophys. Res., 111, A11217, doi:10.1029/2006JA011693.
2. Yamamoto T. (2008), A linear analysis of the hybrid Kelvin-Helmholtz/Rayleigh-Taylor instability in an electrostatic magnetosphere-ionosphere coupling system, J. Geophys. Res., 113, A06206, doi:10.1029/2007JA012850.
3. Yamamoto T. (2009), Hybrid Kelvin-Helmholtz/Rayleigh-Taylor instability in the plasma sheet, J. Geophys. Res., 114, A06207, doi:10.1029/2008JA013760.
4. Yamamoto, T. (2011), A numerical simulation for the omega band formation, J. Geophys. Res., 116, A02207, doi:10.1029/2010JA015935.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

(2) Domestic Conferences

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 0

Earth and Planetary System Science Group

Hajime Kayanne

I. C.V.

Name： Hajime Kayanne
Present Position: Professor, School of Science, the University of Tokyo

Education

B. Sc., Geography, The University of Tokyo, March, 1982
M. Sc., Geography, The University of Tokyo, March, 1984
Ph. D., Geography, The University of Tokyo, March, 1989

Professional Experience

April, 1987-Mar., 1988, JSPS Research Fellow, Department of Geography, University of Tokyo
April, 1988-Oct., 1992, Scientist, Marine Geology Department, Geological Survey of Japan
Oct, 1992-Mar., 1995, Chief Scientist, Marine Geology Department, Geological Survey of Japan
April, 1995-Mar., 2000, Associate Professor, Department of Geography, University of Tokyo
April, 2000-Nov., 2007, Associate Professor, Department of Earth and Planetary Science, University of Tokyo
Nov., 2007-present, Professor, Department of Earth and Planetary Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

Coral reefs are formed by calcifying organisms and are related to the global carbon cycle through high community metabolism; thus, interactions involving the atmosphere, ocean, land, and biosphere occur. Through these interactions, coral reefs are very sensitive to global warming and so are regarded as a signature ecosystem in studies of the effects of global warming on ecosystems. We studied coral reef responses to global warming by examining community metabolism, CO_2 responses to global warming and sea level rise, and the reconstruction of the paleoenvironment.

We successfully measured changes in reef water CO_2 and community metabolism at Shiraho Reef, Ryukyu Islands, for a full year and showed that reefs act as sinks of CO_2 because of high photosynthesis; however, reefs become a source of CO_2 during bleaching events because respiration increases relative to photosynthesis (Kayanne et al., 2005). The monitoring results also showed that dissolution of high magnesium calcite sediments occurred at night. Coral cover on the Shiraho Reef has decreased to one-tenth of its amount in 1998. The decline resulted from repeated bleaching events and possibly from increasing levels of local stresses (nutrient enrichment and silt effluent). Damage and recovery processes differed for the various stresses and coral species.

Atoll islands consist of low flattened land having an altitude of only 1 to 2 m, and they are threatened by rising sea level. The formation processes of an atoll island were reconstructed for Majuro Atoll. The reconstruction showed that deposition of coral debris and foraminifera sand over a rigid coral reef flat, triggered by a fall in sea level, has been occurring since 2000 years BP (Kayanne et al., 2011). At Majuro and Tuvalu, sand production, transportation, and sedimentation processes showed that current problems were due mainly to local human impacts,

such as expansion of residences into more vulnerable areas, artificial construction along the coast, and the loss of foraminifera sand by ecosystem degradation. This viewpoint is in opposition to the general idea that Tuvalu had already started to submerge as a result of rising sea level. However, these local problems increase the vulnerability of the islands to projected future global environmental changes.

Corals and coral reefs record environmental changes at a high time resolution. Coral annual band analysis has been used to reconstruct mode shifts of ENSO, the IOD (Indian Ocean Dipole), and the Asian monsoon at monthly resolution. Annual band analysis of corals from Kenya was used to reconstruct a 115-year history of the IOD, which showed an increase in frequency and magnitude of Indian Ocean warming through the 20th century (Nakamura et al., 2007). Paleo-sea level has been estimated from fossil corals and reef cores to within 0.1-m accuracy, and a history of Holocene sea level change and tectonics has been reconstructed (Kayanne et al., 2007).

3. Five Important Papers in your career

1. Nakamura, R., W. Ando, H. Yamamoto, M. Kitano, A. Sato, M. Nakamura, H. Kayanne, and M. Omori (2011), Corals mass-cultured from eggs and transplanted as juveniles to their native, remote coral reef, *Marine Ecol. Progr. Ser., 436*, 161-168.

We succeeded in replanting 63,000 juvenile corals, two order magnitude large amount than the previous trials, hatched from eggs to Okinotorishima Island. The success opens a way to rehabilitate degraded coral reefs in the world.

2. Kayanne, H., T. Yasukochi, T. Yamaguchi, H. Yamano, and M. Yoneda (2011), Rapid settlement of Majuro Atoll, central Pacific, following its emergence at 2000 years CalBP, *Geophys. Res. Lett*., *38,* L20405, doi:10.1029/2011GL049163.

Geomorphological and archaeological survey reveals that emergence of an island at Majuro Atoll, central Pacific, was triggered by sea level fall at 2000 years BP and was quickly followed by human settlement within 100 years. It provides ground-truth data for human dispersal in the Pacific through integration of humanities and natural science.

3. Nakamura, N., H. Kayanne, H. Iijima, T. R. McClanahan, S. K. Behera, and T. Yamagata (2009), Mode shift in the Indian Ocean climate under global warming stress, *Geophys. Res. Lett., 36*, L23708, doi: 10.1029/2009GL040590.

A 115-year history of IOD (Indian Ocean Dipole) was reconstructed, which shows a mode shift from decadal to 2-year frequencies with increasing magnitude in the course of a warming of the Indian Ocean. The paper was selected as AGU journal highlight, and covered by major national newspapers and overseas media.

4. Kayanne, H., Y. Ikeda, T. Echigo, M. Shishikura, T. Kamataki, K. Satake, J. N. Malik, S. R. Basir, G. K. Chakrabortty, and A. K. Ghosh Roy (2007), Coseismic and postseismic creep in the Andaman Islands associated with the 2004 Sumatra-Andaman earthquake, *Geophys. Res. Lett., 34*, L01310, doi: 10.1029/2006GL028200.

Field campaigns confirm large coseismic uplift up to 1.3m occurred on the Andaman Islands with the 2004 Sumatra-Andaman earthquake followed by a slow submergence. This process is explained by a rupture model. The paper was selected as AGU journal highlight, and covered by major national newspapers and overseas media.

5. Kayanne, H., H. Hata, S. Kudo, H. Yamano, A. Watanabe, Y. Ikeda, K. Nozaki, K. Kato,

A. Negishi and H. Saito (2005), Seasonal and bleaching-induced changes in coral reef metabolism and CO_2 flux, *Global Biogeochemical Cycles, 19 (3)* GB3015, doi:10.1029/2004GB002400 (2005).

A full-year monitoring of seawater CO_2 and community metabolism on Shiraho Reef revealed that the reef acts as a sink of CO_2 by high photosynthesis, but it turns to a source by respiration during a bleaching event. The paper provides a basis to investigate relation between community metabolism and its role to CO_2.

4. Awards and Honors throughout your career

5. Future Research Plan

Studies to date have shown that coral reefs are strongly affected by each change caused by global warming: ocean acidification caused by increasing CO_2, bleaching caused by warming temperatures, and submergence resulting from sea level rise. Local stresses such as nutrient enrichment and siltation are superimposed on the global stresses, and the compounded stresses lead to degradation of coral reefs and a shift from a coral to a macro-algal community. This shift is regarded as a phase shift from one steady state to another that appears as a non-linear response of the system. Increasing stress decreases the resilience of a system, and at a threshold level, the system finally shifts to another state. In some cases, a system adapts to the stress.

Our future research plan is to analyze shifts of coral reefs to other states from an earth-system science perspective; to examine reef steady states, resilience against multiple stresses, and adaptations to increasing stress; and to construct a general model through field observations and laboratory experiments. Steady states other than coral and macro-algae states should be investigated. Under high CO_2 conditions, soft corals having low calcification rates may become dominant. Conditions regulating such shifts will be examined.

Resilience is a key concept for understanding shifts within a framework of system science and for managing ecosystems. High community metabolisms (photosynthesis/respiration and calcification/dissolution) interact internally through the seawater carbonate system and through positive or negative feedbacks. We will examine whether negative feedbacks by photosynthesis and calcification support resilience and whether dissolution acts as a buffer against increasing CO_2.

At an ecosystem scale, landscape heterogeneity and interactions with other communities (mangrove, seagrass, and algae) might provide resilience. Landforms of coral reefs and atoll islands might represent resilience that has not been lost due to human stresses. These hypotheses will be examined, and the concept of resilience will be extended and applied to the management of ecosystems and landforms.

Based on the phase-shift model and the resilience of coral reefs, countermeasure plans to maintain and restore coral reefs by strengthening resilience and enhancing adaptation processes will be proposed. The 1998 bleaching event is cited as the first case for emergence of the effect of global warming at an ecosystem scale. Coral reefs are regarded as a signature ecosystem for monitoring the effects of global warming on ecosystems. Results obtained from coral reefs will be applied to other ecosystems with the aim of providing a basis for a sustainable relationship between humans and ecosystems.

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for Scientific Research on Innovative Areas, Coral Reef Science –Strategy for Ecosystem Symbiosis and Coexistence with Human-beings under Multiple Stresses, FY2008-FY2012, 686,844,000 yen (131,700,000 yen for Univ. Tokyo) (P.I.)

· Grant-in-Aid for Scientific Research (A), Reconstruction of Past 450-year Sea Surface Temperature and Salinity by Annual Band Analysis of a Large Coral Head in Palau, FY2006-FY2009, 26,420,000 yen (P.I.)

· Grant-in-Aid for Scientific Research (A), Experiment of Limestone Dissolution under High CO_2 Concentration and High Pressure, FY2004-FY2008, 22,100,000 yen (P.I.)

(2) Cooperative Research

(3) Research Contracts

· Construction Research and Technology Development Fund of Ministry of Land, Infrastructure, Transport and Tourism, Modeling Reef Island Formation Process, FY2011-FY2013, 26,700,000 yen (P.I.)

· Science and Technology Research Partnership for Sustainable Development (JST-JICA), Eco-technological Management of Tuvalu against Sea Level Rise, FY2009-FY2013, 366,866,000 yen (119,950,000 yen for Univ. Tokyo) (P.I.)

· Environmental Research and Technology Development Fund of the Ministry of the Environment, Japan, Adaptive measures to changes in geomorphology and water resources on atoll island countries, FY2008-FY2010, 19,401,000 yen (C.I.)

· Environmental Research and Technology Development Fund of the Ministry of the Environment, Japan, Research on Sustainable Land Management in Atoll Island Countries, FY2003-FY2007, 137,206,000 yen (57,190,000 yen for Univ. Tokyo) (P.I.)

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Kayanne, H., H. Iijima, N. Nakamura, T. R. McClanahan, S. Behera, and T. Yamagata (2006), Indian Ocean Dipole index recorded in Kenyan coral annual density bands, *Geophys. Res. Lett.*, *33*, L19709, doi:10.1029/2006GL027168.

2. Yamano, H., H. Shimazaki, T. Matsunaga, A. Ishoda, C. McClennen, H. Yokoki, K. Fujita, Y. Osawa, and H. Kayanne (2006), Evaluation of various satellite sensors for waterline extraction in a coral reef environment: Majuro Atoll, Marshall Islands, *Geomorphology, 82*, 398-411.

3. Watanabe, A., H. Kayanne, H. Hata, S. Kudo, K. Nozaki, K. Kato, A. Negishi, Y. Ikeda, and H. Yamano (2006), Analysis of the seawater-CO_2 system in the barrier reef-lagoon system of Palau using total alkalinity-dissolved inorganic carbon diagrams, *Limnol. Oceanogr.*, *51*, 1614-1628.

4. Oda, S., H. Kayanne, K. Shirai, N. Takahata and Y. Sano (2006), Sr/Ca and Mg/Ca ratio measurements of coral skeletons: Evaluation of analytical methods, *J. Geochem., 40,* 231-238. (In Japanese with English abstract).

5. Miyajima, T., H. Hata, Y. Umezawa, H. Kayanne, and I. Koike (2007), Distribution and partitioning of nitrogen and phosphorus in a fringing reef lagoon of Ishigaki Island,

Northwest Pacific, *Mar. Ecol. Progr. Ser., 341,* 45-57.

6. Miyajima, T., Y. Tanaka, I. Koike, H. Yamano, and H. Kayanne (2007), Evaluation of spatial correlation between nutrient exchange rates and benthic biota in a reef-flat ecosystem by GIS-assisted flow tracking method, *J. Oceanogr. 63*, 643-659.
7. Yamano, H., H. Kayanne, T. Yamaguchi, Y. Kuwahara, H. Yokoki, H. Shimazaki, and M. Chikamori (2007), Atoll island vulnerability to flooding and inundation revealed by historical reconstruction: Fongafale Islet, Funafuti Atoll, Tuvalu, *Global Planet. Change, 57*, 407-416.
8. Morimoto, M., H. Kayanne, O. Abe, and M. T. McCulloch (2007), Intensified mid-Holocene Asian monsoon recorded in corals from Kikai Island, subtropical northwestern Pacific, *Quaternary Res., 67*, 204-214.
9. Kayanne, H., Y. Ikeda, T. Echigo, M. Shishikura, T. Kamataki, K. Satake, J. N. Malik, S. R. Basir, G. K. Chakrabortty, and A. K. Ghosh Roy (2007), Coseismic and postseismic creep in the Andaman Islands associated with the 2004 Sumatra-Andaman earthquake, *Geophys. Res. Lett., 34*, L01310, doi: 10.1029/2006GL028200.
10. Tanaka, Y., and H. Kayanne (2007), Relationship of species composition of tropical seagrass meadows to multiple physical environmental factors, *Ecol. Res., 22*, 87-96.
11. Tokoro, T., A. Watanabe, H. Kayanne, K. Nadaoka, H. Tamura, K. Nozaki, K. Kato, and A. Negishi (2007), Measurement of air-water CO_2 transfer at four coastal sites using a chamber method, *J. Mar. Systems*, *66,* 140-149.
12. Nakayama, H., H. Iijima, N. Nakamura and H. Kayanne (2008) Carbon and oxygen stable isotope ratios of GSJ carbonate reference materials (JCp-1 and JCt-1), *Bull. Geol. Surv. Japan, 59,* 461-466. (In Japanese with English abstract).
13. Tokoro, T., H. Kayanne, A. Watanabe, K. Nadaoka, H. Tamura, K. Nozaki, K. Kato, and A. Negishi (2008), High gas-transfer velocity in coastal regions with high energy-dissipation rates, *J. Gophys. Res.*, *113*, C11006, doi:10.1029/2007JC004528.
14. Kuwahara, Y., H. Yokoki, D. Sato, H. Yamano and H. Kayanne (2008), Analysis of land use change in the coastal zone on Funafuti atoll, Tuvalu, *J. Coastal Zone Studies, 21*, 21-32. (In Japanese with English abstract).
15. Murase, T., M. Tanaka, T. Tani, Y. Miyashita, N. Ohkawa, S. Ishiguro, Y. Suzuki, H. Kayanne, and H. Yamano (2008), A photogrammetric correction procedure for light refraction effects at a two-mediumboundary, *Photogrammetric Engineering and Remote Sensing*, *74*, 1129-1136.
16. Uchida, A., M. Nishizawa, K. Shirai, H. Iijima, H. Kayanne, N. Takahata, and Y. Sano (2008), High sensitivity measurements of nitrogen isotopic ratios in coral skeletons from Palau, western Pacific: Temporal resolution and seasonal variation of nitrogen sources, *Geochem. J., 42*, 255-262.
17. Nakamura, N., H. Kayanne, H. Iijima, T. R. McClanahan, S. K. Behera, and T. Yamagata (2009), Mode shift in the Indian Ocean climate under global warming stress, *Geophys. Res. Lett., 36*, L23708, doi: 10.1029/2009GL040590.
18. Yamaguchi, T., H. Kayanne, and H. Yamano (2009), Archaeological investigation of the landscape history of an oceanic atoll: Majuro, Marshall Islands, *Pacific Sci., 63*, 537-565.
19. Hongo, C., and H. Kayanne (2009), Holocene coral reef development under windward and leeward locations at Ishigaki Islands, Japan, *Sediment. Geol., 214*, 62-73.

20. Fujita, K., Y. Osawa, H. Kayanne, Y. Ide, and H. Yamano (2009), Distribution and sediment production of large benthic foraminifers on reef flats of the Majuro Atoll, Marshall Islands, *Coral Reefs, 28,* 29-45.

21. Baioumy, H. M., H. Kayanne, and R. Tada (2010), Reconstruction of lake-level and climate changes in Lake Qarun, Egypt, during the last 7000 years. *J. Great Lake Res., 36*, 318-327.

22. Hongo, C., and H. Kayanne, (2010), Holocene sea-level record from corals: Reliability of paleodepth indicators at Ishigaki Island, Ryukyu Islands, Japan, *Palaeogeogr. Palaeoclimat. Palaeoecol,, 287*, 143-151.

23. Hongo, C., and H. Kayanne (2010), Relationship between species diversity and reef growth in the Holocene at Ishigaki Island, Pacific Ocean, *Sediment. Geol*,, 223, 86-99.

24. Osawa, Y., K. Fujita, Y. Umezawa, H. Kayanne, Y. Ide, T. Nagaoka, T. Miyajima, and H. Yamano (2010), Human impacts on large benthic foraminifers near a densely populated area of Majuro Atoll, Marshall Islands, *Mar. Pollution Bull., 60,* 1279-1287.

25. Nakamura, N., H. Kayanne, H. Iijima, T. R. McClanahan, S. K. Behera, and T. Yamagata (2011), Footprints of IOD and ENSO in the Kenyan coral record, *Geophys. Res. Lett., 38*, L24708, doi:10.1029/2011GL049877.

26. Baioumy, H. M., H. Kayanne, and R. Tada (2011), Record of Holocene aridification (6000-7000 BP) in Egypt (NE Africa): Authigenic carbonate minerals from lake Qarun. *Quaternary International, 245*, 170-177.

27. Kayanne, H., T. Yasukochi, T. Yamaguchi, H. Yamano, and M. Yoneda (2011), Rapid settlement of Majuro Atoll, central Pacific, following its emergence at 2000 years CalBP, *Geophys. Res. Lett*., *38,* L20405, doi:10.1029/2011GL049163.

28. Inoue, S., H. Kayanne, N. Matta, W. S. Chen, and Y. Ikeda (2011), Holocene uplifted coral reefs in Lanyu and Lutao Islands to the southeast of Taiwan, *Coral Reefs, 30*, 581-592.

29. Nakamura, R., W. Ando, H. Yamamoto, M. Kitano, A. Sato, M. Nakamura, H. Kayanne, and M. Omori (2011), Corals mass-cultured from eggs and transplanted as juveniles to their native, remote coral reef, *Marine Ecol. Progr. Ser., 436*, 161-168.

30. Malik, J. N., M. Shishikura, T. Echigo, Y. Ikeda, K. Satake, H. Kayanne, Y. Sawai, C. V. R. Murty,and O. Dikshit (2011), Geologic evidence for two pre-2004 earthquakes during recent centuries near Port Blair, South Andaman Island, India, *Geology, 39*, 559-562.

31. Hongo, C., and H. Kayanne, (2011), Key species of hermatypic coral for reef formation in the northwest Pacific during Holocene sea-level change, *Marine Geology, 279*, 162-177.

(2) Selected Conference Proceedings

1. Ikeda, Y., H. Hata, K. Nozaki, M. Tsuda, and H. Kayanne (2006), Construction of coral reef ecosystem in the balanced aquarium, Monaco Aquarium, *Proc. 10th Int. Coral Reef Symp.*, 1680-1683.

(3) Review Papers

1. Kayanne, H. (2007), Past climate change recorded in corals, *Tenki, 54*, 429-435. (in Japanese) (Non-refereed)

2. Kayanne, H. (2008), Present state and problems of atoll islands in island countries, *Kaigan, 48(1)*, 27-32. (in Japanese) (Non-refereed)

3. Kayanne, H. (2010), Ecological process controlling atoll island landform formation, *J.*

Japan Soc. Water Environment, 33, 245-248. (in Japanese) (Refereed)

4. Kayanne, H. (2011), Eco-engineering conservation and construction of coral reefs and reef islands, *Civil Engineering, 66(11),* 53-58. (in Japanese) (Non-refereed)

(4) Books

1. Kleypas, J. A. et al. eds. (2006), "Impacts of Ocean Acidification on Coral Reefs and Other Marine Calcifiers: A Guide for Future Research", NSF, NOAA and USGS, 88p.
2. Yamano, H., H. Shimazaki, T. Murase, K. Itou, S. Sano, Y. Suzuki, N. Leenders, W. Forstreuter, and H. Kayanne (2007), Construction of digital elevation models for atoll islands using digital photogrammetry. In: Woodroffe, C.D., E. Bruce, M. Puotinen, and R. A. Furness eds. "GIS for the Coastal Zone: A Selection of Papers from CoastGIS 2006 (Wollongong Papers on Maritime Policy, No. 16)". Australian National Centre for Ocean Resources & Security, University of Wollongong, Wollongong, Australia, pp. 165-175. (Refereed)
3. Kayanne, H., M. Omori, F. Katharina, E. Veheji, P. Colin, Y. Golbuu, and H. Yukihira eds. (2007), "Coral Reefs of Palau" Palau International Coral Reef Center, 231p. (Refereed)
4. Kayanne, H., and C. Hongo (2011), Sea level change and its effect on reef growth. In.Hopley, D. ed. "Encyclopedia of Modern Coral Reefs. Structure, Form and Process" pp966-973, Springer. (Refereed)
5. Kayanne, H. (2011), Coral reefs and global warming, In Japanese Coral Reef Society ed "Science of Coral Reefs" Tokai University Press, 239-258. (in Japanese) (Refereed)

(5) Patents

1. Application of Patent 2008-135204 (May 2008) Tokoro, T., T. Kato, K. Nozaki, K. Kato, A. Negishi and H. Kayanne, Neutralization of CO_2, AIST and Univ. Tokyo. (Domestic)
2. Application of Patent 2009-178987 (July 2009) Tokoro, T., Y. Tanaka, T. Kato, K. Nozaki, K. Kato, A. Negishi and H. Kayanne, CO_2 Storage in Shallow Water Reservoir, AIST and Univ. Tokyo. (Domestic)
3. Patent 4481938 (March 2010), Ide, Y. and H. Kayanne, Foraminifera Aquaculture System, Oceanic Planning Corp. and Univ. Tokyo. (Domestic)

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Kayanne, H., T. Yasukouchi, T. Yamaguchi, H. Yamano and M. Yoneda, Island formation and early settlement in Majuro Atoll, Marshall Islands, 21st Pacific Science Congress (Okinawa, 2007.6). (Invited)
2. Kayanne, H., T. Yasukouchi, H. Yamano and M. Yoneda, Island formation and early settlement induced by sea level fall in Majuro Atoll, the Marshall Islands, International Symposium on Quaternary Environmental Changes and Humans in Asia and the Western Pacific. (Tsukuba, 2007.11). (Invited)
3. Kayanne, H., Coral Reef Science, 2nd Asia Pacific Coral Reef Symposium. (Invited)

and 10 other presentations.

(2) Domestic Conferences

16 presentations in total

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Seven advisees obtained phD for the last 10 years (2002-2012). They are now working as Assistant Professor at Tokyo Institute of Technology, Post-docs at Nagoya University, University of the Ryukyus, University of Tokyo and Port and Airport Research Institute, and a technical staff at RIKEN and JX Nippon Oil & Energy).

· Supervising Marine Expedition Club of the University of Tokyo since 1995, which received the President's Award of the University of Tokyo in 2009 for their success in expedition at Iwotorishima Island (a remote uninhabited volcanic island) lead by one of my advisee, who also received Sasakawa Scientific Research Grant Award in 2009.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

· Secretary General, Japanese Coral Reef Society

(3) International Conferences

· Session Organizer, 2nd Asia Pacific Coral Reef Symposium (June 2010, Phuket, Thai)

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· I have organized "Okinotorishima Workshop" since 2007 and studied eco-technological management of remote coral reef islands and proposed countermeasure plans for their sustainable management to the government and public. The workshop has also acted as a platform for exchanging information among different sectors: academism, goveenment and private companies.

· Based on an international cooperation with Tuvalu, I have proposed eco-technological management plans against sea level rise through seminars, lectures and social media.

12. Internal and External Committee Memberships (2006-2011)

· Chair, Student Academic Affairs Committee and Assistant Dean, Graduate School of Science, University of Tokyo (2008-2009).

· Chair, Student Academic Affairs Committee, Department of Earth and Planetary Science, University of Tokyo (2010-2012).

· Head of Geography Department, University Museum (1995-)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 1 [M.Sc.: 1 (Palau: 1), Ph.D.: 0]

Foreign Researchers: 2 [Egypt: 2]

Sending

Japanese Students: 1 [M.Sc.: 0, Ph.D.: 1 (Australia: 1)]

Japanese Researchers: 2 [Australia: 1, France: 1]

Visitors from Abroad: 6 [India: 4, Tuvalu: 2]

Yutaka Kondo

I. C.V.

Name： Yutaka Kondo
Present Position: Professor, University of Tokyo, Graduate School of Science

Education

B.Sc., Geophysics, The University of Tokyo, 1972
M.Sc., Geophysics, The University of Tokyo, 1974
Ph.D., Geophysics, The University of Tokyo, 1977

Professional Experience

Oct., 1976 – Mar.,1989, Research Associate, Research Institute of Atmospherics, Nagoya University
Apr., 1989 – Mar., 1992, Associate Professor, Research Institute of Atmospherics, Nagoya University
Apr., 1992 – Mar., 2000, Professor, Solar-Terrestrial Environment Laboratory (STEL), Nagoya University
Apr., 1995 – Mar., 2000, Director of Moshiri observatory of Solar-Terrestrial Environment Laboratory
Apr., 1999 – Mar., 2000, Chief of the Atmospheric Environment Division of STEL
Apr., 2000 – Mar., 2011, Professor, Research Center for Advanced Science and Technology, The University of Tokyo
Apr., 2011– Professor, Department of Earth and Planetary Science, Graduate School of Science, The University of Tokyo

II. Scientific Research Activity

2. Major achievements

The importance of aerosols in the atmosphere has been widely recognized. Urban areas are large sources of anthropogenic aerosols. High concentrations of aerosols in urban air have adverse effect on human health. In addition to this local influence, export of anthropogenic aerosols from urban areas to surrounding regions can significantly affect the air quality and radiative balance in those regions as well. They can also influence climate on continental and global scales through direct (aerosol scattering and absorption) and indirect (aerosol-cloud interaction) effects. Understanding of these effects requires temporal and spatial variations of aerosols and their physical and chemical characteristics (size distribution, chemical composition, optical properties, and cloud condensation (CCN) activity).

First, I started systematic studies of aerosol chemistry in Tokyo by conducting intensive ground-based measurements (IMPACT). I characterized the physical and chemical properties of aerosols in Tokyo using a suit of the state of the art instruments for the first time. This also led to greatly improved understanding on the temporal and spatial changes of aerosols and their precursors near the urban center. In Tokyo, organic compounds were found to be the dominant component (40-60% of total volatile aerosol mass). Secondary organic aerosol (SOA) was found to reach a peak value in the early afternoon, especially in summer, in correlation with O_3. A second peak in OA was found around 2100 LT, especially in winter, suggesting SOA

formation via reactions of VOCs with O_3 and NO_3 after sunset and/or condensation of OVOVs. Black carbon (BC) is one of the most important primary anthropogenic aerosols. I identified diesel emissions as the major source of BC in Tokyo from temporal variations of BC and BC-CO correlations for the first time. The mass size distribution of BC was observed to peak around 130 nm, irrespective of local time, reflecting its single major source. I also found that BC particles can act as CCN with a small amount of coating by water soluble compounds. This will limit transport of BC from the boundary layer to the free troposphere even near source regions. For this study, a novel observation system has been developed to measure CCN activity simultaneously with volatility of aerosol particles at 400°C. The major results of IMPACT were published as 21 papers in JGR and other journals. These technologies and methodologies established by IMPACT are making important contributions to studies of other mega-cities in Asia, namely Peal River Delta and Beijing areas in China.

Along with the field measurements, I conducted development of instruments to measure key aerosol parameters. Most notable success is the development of BC instrument using Laser Induced Incandescence (LII). New method to calibrate LII using Aerosol Particle Mass Analyzer (APM) was established. The calibrated LII signals have been shown to be independent of mixing state of BC (coating thickness of BC) based on laboratory experiments. In addition, new algorithm to estimate coating thickness of BC has been theoretically devised and validated by laboratory experiments. These results have provided very useful information to the wider aerosol community. Based on existing LII instrument, I maximized its capability so that it can measure essentially all the aerosol optical properties (scattering and absorption coefficient and single scattering albedo) necessary to evaluate aerosol direct effect. The updated LII instrument, covering the BC size rage of 1000 nm, has also played a critical role in the recent NASA ARCTAS campaigns, aimed to study the impact of aerosol on the climate in the Arctic.

Understanding of the formation and transformation of aerosols are important in evaluating their impacts on regional and global scales. SOA has been found to be formed within a time scale of about 10 hours in urban plumes transported from Tokyo and Nagoya by ground based (IMPACT) and aircraft (PEACE-C) observations. Consistently, coating of BC by SOA and inorganic compounds proceeded with a similar time constant. I also conducted aerosol measurements at Gosan, Korea and at Fukue-Jima Island, Japan, which often received plumes from the Asian continent in spring, as a part of the ABC program. It has been found BC was thickly coated during transport from China to western part of Japan over ~ 1000 km within a few days, enhancing absorption of solar radiation by BC. This information is useful for future assessment of radiative effects of aerosol in East Asia by 3-D models.

3. Five Important Papers in your career

1. Kondo, Y., Y. Komazaki, Y. Miyazaki, N. Moteki, N. Takegawa, D. Kodama, S. Deguchi, M. Nogami, M. Fukuda, T. Miyakawa, Y. Morino, M. Koike, H. Sakurai, and K. Ehara (2006), Temporal variations of elemental carbon in Tokyo, J. Geophys. Res., 111, D12205, doi:10.1029/2005JD006257.

The temporal variations of black carbon (BC) in Tokyo were shown in detail for the first time. The data shown is important for studying long term trend of BC assessing the effects of regulations of particulate emissions. The paper is frequently cited.

2. Kondo, Y., Y. Miyazaki, N. Takegawa, T. Miyakawa, R. J. Weber, J. L. Jimenez, Q. Zhang, and D. R. Worsnop (2007) Oxygenated and water-soluble organic aerosols in

Tokyo, J. Geophys. Res., 112, D01203, DOI:10.1029/2006JD007056.

Organic aerosols (OA) constitute a major fraction of total aerosol mass concentration in many continental regions. Therefore it is important to understand its chemical charactristics in assessing its impact of OA on climate. This paper quantitatively shows for the first time that oxygenated orgaic aerosols and water–soluble organic carbon were very similar in their chemical characteristics.

3. Kondo, Y., L. Sahu, N. Moteki, F. Khan, N. Takegawa, X. Liu, M. Koike, T. Miyakawa (2011), Consistency and traceability of black carbon measurements made by laser-induced incandescence, thermal-optical transmittance, and filter-based photo-absorption techniques, Aerosol Sci. Tech., 45, 295-312, DOI: 10.1080/02786826.2010.533215.

This paper established absolute standard for laser induced incandescence method as an accurate measurement technology of BC. It is used in important parts of the international review paper of BC and the fifth assessment report of IPCC.

4. Kondo, Y., H. Matsui, N. Moteki, L. Sahu, N. Takegawa, M. Kajino, Y. Zhao, M. J. Cubison, J. L.Jimenez, S. Vay, G. S. Diskin, B. Anderson, A. Wisthaler, T. Mikoviny, H. E. Fuelberg, D. R. Blake, G.Huey, A. J. Weinheimer, D. J. Knapp, and H. Brune (2011), Emissions of black carbon, organic, and inorganic aerosols from biomass burning in North America and Asia in 2008, J. Geophys. Res., 116, D08204, doi: 10.1029/2010JD015152.

Physical and chemical characteristics of aerosols emitted from biomass burning in the Arctic have been shown by aircraft observations. It is highly evaluated as one of important results of the NASA ARCTAS (Arctic Research of the Composition of the Troposphere from Aircraft and Satellite) mission.

5. Kondo, Y., N. Oshima, M. Kajino, R. Mikami, N. Moteki, N. Takegawa, R. L. Verma, Y. Kajii, S. Kato,and A. Takami (2011), Emissions of black carbon in East Asia estimated from the observations at a remote site in the East China Sea, J. Geophys. Res., 116, D16291, doi: 10.1029/2011JD015637.

Emission rate of BC in East Asia was estimated accurately for the first time by ground based observations combined with model calculations. This work has been highly evaluated by AGU and other international meetings. In addition, the data used here have been requested by foreign and Japanese scientists.

4. Awards and Honors throughout your career

· 1986 Tanakadate Award from the Society of Geomagnetism and Earth, Planetary and Space Sciences

· 1990 Horiuchi Award from the Meteorological Society of Japan

· 2001 Meteorological Society of Japan Award

· 2009 Fellow of the American Geophysical Union (AGU)

· 2012 The Medal with Purple Ribbon from the MEXT of Japan

· 2012 Miyake Award from the Geochemical Society of Japan

5. Future Research Plan

Quantitative estimates of the effects of aerosols on climate, especially indirect effect, are

still very uncertain. There are strong needs to improve predictions of climate change by greatly reducing the uncertainties of the effects of aerosols. We make studies to greatly improve our understanding of the aerosol and cloud interaction by the new measurements and modeling of key parameters and processes of aerosols and clouds. The present plan consists of 2 major studies. 1) aerosol indirect effect and 2) aerosol semi-direct effect

Aerosol indirect effect

Low level stratocumulus clouds have important roles in the earth's radiation budget due to their high reflectance and large areal coverage. We will make studies to quantify factors controlling aerosol number concentrations and size distributions and aerosol-cloud interaction, mainly for stratocumulus clouds in Asia. Surface and aircraft measurements will be conducted in East Asia and Southeast Asia to study the impacts of aerosol emitted from anthropogenic activities and biomass burning, respectively. These studies will include generation of aerosols (primary and secondary aerosols), aerosol-cloud interaction, and impacts of aerosol on precipitation and cloud cover.

Aerosol semi-direct effect

For improved estimate of the BC heating, we will make aircraft observations of BC by using an LII instrument at 20-45ºN in different seasons. We expect to cover the whole latitude range of China, which is the largest source of BC in Asia. Simultaneously with the aircraft observations, we will conduct Lagrangian type observations of microphysical properties of BC at 3 surface sites over the East China Sea to investigate evolution of microphysical properties of aerosols during long range transport from China.

We plan to develop a new radiative transfer model to efficiently calculate aerosol radiative effects with improved accuracy. Using spatial distributions of aerosol and clouds, we will calculate atmospheric heating and surface cooling rates. The calculations will be validated by comparison with the surface measurements of radiation. The validated radiative transfer model is integrated into regional scale and GCM models to calculate impacts of BC on regional scale circulation.

Integrated studies by 3-D numerical models

We plan to validate regional scale models by comparison with the observations for each step of aerosol-cloud process. Using the validated models, we will

- evaluate indirect and semi-direct effects and the uncertainty of the estimates
- use emission data for anthropogenic and biomass burning for different time periods
- include newly developed aerosol schemes into a GCM model to improve the representations of aerosol-cloud processes

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for Scientific Research (A) H18 (2006) 17,810,000 JPY

· Grant-in-Aid for Scientific Research (S) H19（2007）-H22（2010）110,630,000 JPY

· Grant-in-Aid for Scientific Research (S) H23 (2011) 86,190,000 JPY"

(2) Cooperative Research

(3) Research Contracts

· The Global Environment Research Fund of the Japanese Ministry of the Environment, A-0803, H20 (2008) -H22 (2010), 300,686,000 JPY

· The Global Environment Research Fund of the Japanese Ministry of the Environment,

A-1101, H23 (2011), 58,660,000 JPY

- The Strategic International Cooperative Program of the Japan Science and Technology Agency (JST), H22 (2010), 6,700,000 JPY
- The Strategic International Cooperative Program of the Japan Science and Technology Agency (JST), H23 (2011), 7,500,000 JPY
- The Strategic International Cooperative Program of the Japan Science and Technology Agency (JST), H24 (2012), 5,000,000 JPY

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Irie, H., T. Sugita, H. Nakajima, T. Yokota, H. Oelhaf, G. Wetzel, G. C. Toon, B. Sen, M. L. Santee, Y. Terao, N. Saitoh, M. K. Ejiri, T. Tanaka, Y. Kondo, H. Kanzawa, H. Kobayashi, and Y. Sasano (2006), Validation of stratospheric nitric acid profiles observed by Improved Limb Atmospheric Spectrometer (ILAS)-II, *J. Geophys. Res.*, *110*, D11S03, doi:10.1029/2005JD006115.
2. Kondo, Y., Y. Komazaki, Y. Miyazaki, N. Moteki, N. Takegawa, D. Kodama, S. Deguchi, M. Nogami, M. Fukuda, T. Miyakawa, Y. Morino, M. Koike, H. Sakurai, and K. Ehara (2006), Temporal variations of elemental carbon in Tokyo, *J. Geophys. Res.*, *111*, D12205, doi:10.1029/2005JD006257.
3. Takegawa, N., T. Miyakawa, Y. Kondo, J. L. Jimenez, D. R. Worsnop, and M. Fukuda (2006), Seasonal and diurnal variations of submicron organic aerosol in Tokyo observed using the Aerodyne Aerosol Mass Spectrometer, *J. Geophys. Res.*, *111*, D11206, doi:10.1029/2005JD006515.
4. Kita, K., Y. Morino, Y. Kondo, Y. Komazaki, N. Takegawa, Y. Miyazaki, J. Hirokawa, S. Tanaka, T. L. Thompson, R.-S. Gao, and D. W. Fahey (2006), A chemical ionization mass spectrometer for ground-based measurement of nitric acid, *J. Atmos. Ocean. Tech*., *23*, 1104-1113.
5. Takegawa, N., T. Miyakawa, Y. Kondo, D. R. Blake, Y. Kanaya, M. Koike, M. Fukuda, Y. Komazaki, Y. Miyazaki, A. Shimono, and T. Takeuchi (2006), Evolution of submicron organic aerosol in polluted air exported from Tokyo, *Geophys. Res.*, *Lett.*, *33*, L15814, doi:10.1029/2006GL025815.
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F. Thornton, T. M. Gerlach, A. A. Viggiano, and Y. Kondo (2006), The atmospheric chemistry of a 33-34 hour old volcanic cloud from Hekla Volcano (Iceland): insights from direct sampling and the application of chemical box modeling, *J. Geophys. Res.*, *111*, D20206, doi:10.1029/2005JD006872.

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11. Mochida M., M. Kuwata, T. Miyakawa, N. Takegawa, K. Kawamura, and Y. Kondo (2006), Relationship between hygroscopicity and cloud condensation nuclei activity for urban aerosols in Tokyo, *J. Geophys. Res.*, *111*, D23204, doi:10.1029/2005JD006980.

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15. Moteki, N. and Y. Kondo (2007), Effects of mixing state on black carbon measurements by laser-induced incandescence, *Aerosol Sci. Technol*., *41*, 398-417.

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accumulated refractory particles and the peak inert mode temperature on semi-continuous organic carbon and elemental carbon measurements during the CAREBeijing 2006 campaign, Atmos. Environ., 45, 7192-7200.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

1. Lectures in experimental chemistry (Environmental chemistry, oxides of nitrogen), Maruzen, 2007.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. IGBP Congress 2008/5/6-9 Cape Town, Invited Formation, transport, and deposition of oxidized species over the Tokyo Metropolitan Area.
2. NASA ARCTAS workshop NASA ARCTAS 2009-1/26-28 USA Invited Evolution of physical and chemical properties of black carbon emitted from biomass burning and fossil fuel combustion
3. AGU 2009 Fall meeting 2009/12/14-18 San Francisco, USA, Invited（Y. Kondo, N. Moteki, N. Takegawa, N. Oshima, and L. Sahu）The mixing state of black carbon in Asian outflow

The total number of presentations: 12

(2) Domestic Conferences

4. Kondo, Y., L. Sahu, N. Moteki, and N. Takegawa, Physicak and chemical characteristics of aerosols emitted by biomass burning their impacts on climate, jPGU meeting 2009 (Makuhari, Chiba, 2009.5) (invited)

The total number of presentations: 23

III. Educational Activity (2002-2011)

9. Notable achievements in education

· I gave lectures to undergraduate and graduate students in the field of atmospheric chemistry at the Department of Advanced Interdisciplinary Studies (AIS), Graduate School of Engineering, and Department of Earth and Planetary Science, Graduate School of Science, at the University of Tokyo. I supervised graduate students, who were working for master and doctor courses. These efforts consisted of instructions of laboratory experiments and field studies, analysis and interpretation of data, and preparation of papers for publication in scientific journals. These processes have been made through intensive discussions. I have also supervised foreign graduate students for PhD thesis and post doctoral research scientists by conducting cooperative research studies. Many of them are now working in the forefront of research at National Institutions and Universities in Japan and abroad.

· Manabu Shiraiwa, Otto-Hahn medal, Max Planck Society, June 15, 2012.

· Naga Oshima, Researcher, Meteorological Institute, JMA

· Yu Morino, Researcher, National Institute for Environmental Studies

· Yuzo Miyazaki, Assistant Professor, Hokkaido University
· Nobuhiro Moteki, Assistant Professor, University of Tokyo
· Takuma Miyakawa, Assistant Professor, University of Tokyo
· Kenji Nakamura, Assistant Professor, Waseda University
· Manabu Shiraiwa, Post doctoral scientist, California Institute of Technology
· Mikinori Kuwata, Post doctoral scientist, Harvard University

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· 2006–2012, Steering committee member of SOLA (scientific journal) of Meteorological Society of Japan
· 2007–2009, Editor of Journal of Atmospheric Chemistry
· 2005–2007, Advisory board member of Journal of Earth Science of Taiwan

(2) Academic Societies

· 2011–present, Collaborators in the NCAR program funded by NSF: Chemistry and climate over Asia
· 2010–, Member of Atmospheric Brown Cloud (ABC)-Asia Science Team (UNEP)
· 2007–2010, Member of science committee of GAW/WMO
· 2007–2011, Member of the SSC of the IGAC/IGBP
· 2005–2007, Advisory board member of Journal of Earth Science of Taiwan
· 2005–2006, Selection committee member of the Japan Prize
· 2004–present, Member of the Committee of the Advanced Analytical Measurement Technologies and Instrument Development of Japanese Ministry of Education, Culture, Sports, Science and Technology (MEXT)
· 2004–present, Member of GOSAT (Greenhouse gases observation satellite) science team

(3) International Conferences

· President of the Organizing committee of the Fourth China-Korea-Japan Joint Conference on Meteorology, 2009/11/7-9

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Seminar at University of California, December 15, 2006.
· Seminar at Harvard University, August 1, 2007
· Lecture at Shikoku Electric Power Company, July 17,2008.
· Lecture at AGS, May 22, 2009.
· Lecture at Summer School of Meteorology, 2009.
· Seminar at Laser Sensing Symposium, September 3, 2009.
· Lecture at Association of Corporate Executives, June 28, 2010.

12. Internal and External Committee Memberships (2006-2011)

· Member of the Council for Science and Technology of MEXT, February 1, 2009–January 31, 2011.

· Member of the Council for Grant-in-Aid for Scientific Research of MEXT, February 8, 2011–Present.

· Member of the Council for Science and Technology of MEXT, February 8, 2011–Present.

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 2 [M.Sc.: 0, Ph.D.: 2 (India: 1, Korea: 1)]

Foreign Researchers: 5 [Korea: 1, India: 2, China: 1, GB: 1]

Sending

Japanese Students: 2 [M.Sc.: 0, Ph.D.: 2 (Germany: 1, USA: 1)]

Japanese Researchers: 1 [USA: 1]

Visitors from Abroad: 25 [China: 5, Switzerland: 1, USA: 11, Germany: 4, France: 3, Norway: 1]

Ryuji Tada

I. C.V.

Name： Ryuji Tada
Present Position: Professor, University of Tokyo, Graduate School of Science

Education
B.S. (Geology), The University of Tokyo, 1976
M.S. (Geology), The University of Tokyo, 1978
Ph.D. (Geology), The University of Tokyo, 1981

Professional Experience
Research Fellow of JSPS, The University of Tokyo, April to August 1981
Research Associate of Geology, The University of Tokyo, September 1981-March 1991
Research Fellow of JSPS, Harvard University, March 1983-February 1995
Lecturer of Geology, The University of Tokyo, April 1991-October 1992
Associate Professor of Geology, The University of Tokyo, November 1992 –April 2000
Associate Professor of Earth and Planetary Science, The University of Tokyo, April 2000-June 2000
Professor of Earth and Planetary Science, The University of Tokyo, June 2000-present

II. Scientific Research Activity

2. Major achievements

I participated in ODP (Ocean Drilling Program) Leg 127 to the Japan Sea during the summer of 1989, and fascinated by beautiful and rhythmical alternations of dark and light silty clay layers that characterized the Quaternary sediments of the Japan Sea. Origin and formation mechanism of such alternations were unknown at that time, but when the analytical result of Greenland ice core were published in 1993, and presence of the large and abrupt climatic changes, best known as the Dansgaard-Oeschger Cycles (DOC), became widely recognized, we noticed that alternations of the dark and light layers are associated with the DOC (Tada and Irino, 1995). Since then, we have been exploring the mechanism connecting abrupt climatic changes in the North Atlantic/Greenland and alternations of the dark and light layers in the Japan Sea as well as the recording mechanism of the latter. Based on the several lines of evidences, we hypothesized that East Asian Summer Monsoon (EASM) precipitation over South China controlled the fresh water discharge of the Yangtze River, which in turn controlled the salinity and nutrients input to the Japan Sea and resulted in the alternations of the dark and light layers (Tada et al., 1999). We further hypothesized that westerly jet path changes could be the tele-connecting mechanism of the DOC between North Atlantic and North Pacific/East Asia (Tada, 2005).

In our project from 2006 to 2010, which was funded by Grant-in-Aid for Scientific Research (S), we aimed to test these hypotheses. Furthermore, we expanded our research area to the entire northwestern Pacific including Okhotsk and Bering Seas and explored how the paleoclimatic and paleoceanographic changes associated with the DOC amplified and propagated throughout the area. Following 4 findings were achieved through the project. Firstly, the Yangtze River discharge during summer during the last glacial period changed in

association with the DOC (Kubota et al., 2011MS). Secondly, westerly jet axis over the Japan Sea oscillated in association with the DOC during the last glacial period (Nagashima et al., 2011). Thirdly, surface productivity and deep water circulation of the Japan Sea during the last glacial period changed drastically in association with the DOC (Kido et al., 2007; Watanabe et al., 2007; Fujine et al., 2009). Fourthly, North Pacific Intermediate Water was periodically produced in the northern Bering Sea during the stadials of the DOC in the last glacial period (Rella et al., 2012). In addition, we explored the possibility whether similar millennial-scale abrupt climatic changes occurred during past interglacials, and found that changes in the Yangtze River discharge during summer changed in harmony with climatic changes in the North Atlantic region (Kubota et al., 2010) and that westerly jet axis oscillated in harmony with these changes but with the opposite phase relationship as compared with the last glacial period (Nagashima et al., submitted). In our new project started from 2011, which is also funded by Grant-in-Aid for Scientific Research (S), we focuses on the late Holocene and aim to reconstruct changes in the Yangtze River discharge, westerly jet axis position, and the intensity of Kuroshio with higher time resolution of <10 years and examine their interrelationships on multi-decadal to millennial time-scales.

I also led IGCP (International Geoscience Programme)-476 "Monsoon evolution and tectonics-climate linkage in Asia" (2003-2007) as a leader. As a part of this project, I started cooperative study on "Desertification in inland Asia and its linkage with the uplift of Himalaya and Tibetan Plateau during the Neogene", and clarified the timings of formation of the Taklimakan Desert (Tada et al., 2010; Zheng et al., 2010) and Gobi Desert (Sun et al., 2006, 2007, 2008), and their linkages with tectonics of the Northern Tibet. I also became a co-leader of IGCP-581 "Evolution of Asian River Systems" (2009-2013) with Prof. Zheng (a leader) and started organizing a joint project on the discharge history of the Yangtze River.

Finally, we started a field research on Mesozoic bedded chert in Inuyama area, Central Japan to reconstruct completely continuous sedimentary sequence covering Triassic and Jurassic (Ikeda et al., 2010; Sakuma et al., 2012), and demonstrated that sedimentary rhythms of the bedded chert was paced by astronomical cycles (so-called Milankovitch cycle) (Ikeda et al., 2010). We further demonstrated that the recording mechanism of the bedded chert rhythms seemed to be related to the changes in monsoon intensity paced by astronomical cycles (Ikeda et al., 2012accepted).

3. Five Important Papers in your career

1. Tada, R., Irino, T., and Koizumi, I., Land-ocean linkage in orbital and millennial timescales recorded in Late Quaternary sediments of the Japan Sea, *Paleoceanography, 14,* 236-247, 1999.

This paper extended the scientific results of ODP Legs 127/128 by high-resolution multi-proxy analysis which was rare at that time, and explored the linkage between precipitation in South China, surface productivity in the Japan Sea, and deep water convection in the Japan Sea. This paper gave very large impact on the paleoceanographic studies of the Japan Sea during late Quaternary, and for that reason it was cited 144 times.

2. Tada, R., Paleoceanographic evolution of the Japan Sea, *Palaeogeography, Palaeoclimatology, and Palaeoecology, 108,* 487-508, 1994.

This paper also extended the scientific results of Legs 127/128, but dealing with the entire paleoceanographic history of the Japan Sea since its formation. Because this is still the only comprehensive paper dealing with the entire paleoceanographic history of the Japan Sea, this is continued to be cited to 76 times.

3. Tada, R., and R. Siever, Pressure solution during diagenesis, *Ann. Rev. Earth Planet. Sci., 17,* 89-118, 1989.

This paper is a synthesis on geological evidences on the mechanism of pressure solution in sedimentary rocks. I wrote this paper while I was a post-doc in Harvard University. Actually, I wrote three papers. One is about geological evidences, another is about experiments, and the other is about theoretical discussion on the mechanism. All three are well cited, 109, 65, and 80 times, respectively.

4. Tada, R., Origin of rhythmical bedding in middle Miocene siliceous rocks of the Onnagawa Formation, northern Japan, *Jour. Sedim. Petrol., 61,* 1123-1145, 1991.

This paper deals with the recording mechanism of Middle Miocene siliceous rocks in northern Japan based on quantitative analytical evidence of changes in burial fluxes of biogenic and terrigenous components. Although citation of this paper is only 23, which is not high, but I believe this paper is 20 years ahead of the science in this field because it deals with millennial-scale paleoceanograhic changes in Middle Miocene on which very few people noticed their presence and quantitative evaluation on burial fluxes with this high time resolution has rarely done even at present.

5. Nagashima, K., Tada, R., Matsui, H., Irino, T., Tani, A., and Toyoda, S., Millennial-scale variations in Asian winter monsoon and westerly during the last 150 kys deduced from eolian grain size, *Palaeogeography, Palaeoclimatology, and Palaeoecology, 247*, 144-161, 2007.

This paper show the evidence of millennial-scale oscillations of the westerly jet axis over East Asia during the last glacial period. This paper is also the first paper which applied ESR intensity and crystallinity of quartz to examine provenance of eolian dust in the marine sediments. Nagashima was my student at the time of publication. This paper is cited 27 times.

4. Awards and Honors throughout your career

- Japan Association for Quaternary Research, The Japan Sea sediments and variability of East Asian Monsoon: Toward the IODPdrilling of the Japan Sea and East China Sea.
- Japanese association for petroleum technology, Re-evaluation of depositional environment of the source rock in Japan, 1995

5. Future Research Plan

As parts of the project "Holocene hydrological cycle in East Asia and its relation with Global Monsoon" funded by Grant-in-Aid for Scientific Research (S) (2011-2015), I am planning to conduct following three subprojects.

1) Identify the area(s) of heavy summer monsoon precipitation within the Yangtze River drainage and reconstruct their temporal changes during the Holocene with high time resolution based on the estimation of the provenance of fine-grained detrital quartz delivered to the Yangtze Delta. In order to construct the data base for provenance of quartz within all major branches of the Yangtze River, we conducted sampling of river sediments and suspended particles throughout the entire Yangtze River drainage in 2011 and 2012. We also plan to conduct drilling of the Yangtze River Delta as a joint project with Prof. Zheng of Nanjing Normal University in the spring of 2013. By analyzing this core, we hope to reconstruct changes in area(s) of heavy summer monsoon precipitation within the Yangtze River drainage during the late Holocene with high temporal resolution of ca. 10 years.

2) Based on the analysis of meteorological data, it became evident that position of the

westerly jet axis over east Asia controls the northern limit of East Asian summer monsoon. If true, it is interesting to reconstruct temporal changes in the position of the westerly jet axis during the Holocene and compare the result with the result of subproject 1. With this motivation, we conducted drilling of Lake Suigetsu during July to early August of 2012 and recovered a perfectly continuous sequence of the sediments covering the last 40 ka. We are planning to examine changes in provenance, flux, and grain size of eolian dust within the sediments, with which we hope to reconstruct temporal changes in the position of the westerly jet axis over Japan during the Holocene. We also hope to estimate flux of terrigenous sediments supplied from the drainage area which we expect to have been proportional to the runoff. By comparing this result with the result of subproject 1, I hope to explore the linkage between the westerly jet axis position and the summer monsoon front position over multi-decadal to millennial time-scales. Additionally, I hope to examine the relationship between the precipitation in the Japan Sea side of Honshu and summer monsoon front position estimated from the Yangtze River sediments.

3) It is generally considered that the intensity (flow velocity) of Kuroshio is related to such factors as the position and intensity of the Pacific High as well as those for the westerly jet, through which Kuroshio may also be linked with East Asian summer monsoon and ENSO. For this reason, it is important to examine the relationship between Kuroshio and East Asian monsoon in various time-scales during the Holocene so as to explore the mechanism(s) that connect ENSO-Kuroshio-East Asian summer monsoon-westerly jet. However, there are no good proxy to reconstruct the intensity of Kuroshio and its temporal changes. We (my student Kubota and I) focused the relationship between the degree of tilting of the thermocline on the cross section perpendicular to the Kuroshio axis and the Kuroshio intensity, and planned to reconstruct the degree of tilting of the thermocline and its temporal changes during the Holocene in the central Okinawa trough. By obtaining a successful result, we hope to clarify the linkage between East Asian summer monsoon and ENSO via Kuroshio on multi-decadal to millennial time scales and explore the linking mechanism(s).

In addition to these three subprojects, IODP (Integrated Ocean Drilling Program) Expedition 346 to the Japan Sea and northern East China Sea was scheduled as August to September, 2013. The proposal for this expedition was submitted by me as a lead proponent in 2003, approved in 2005, but stayed in the waiting list for more than 6 years. Early this year, I was selected as a co-chief scientist and with Prof, Murray of Boston University, now organizing the cruise to which approximately 30 scientists from 7 countries will be on-board. Through this project, I hope to clarify the evolution processes of East Asian monsoon and westerly jet circulation during the last 10 m.y. especially with special emphasis on the onset and evolution of the millennial-scale changes in the westerly jet and East Asian summer monsoon as well as the mechanism(s) that controlled the response of the Japan Sea paleoceanography to the changes in east Asian monsoon intensity and the glacioeustatic sea level changes.

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for Scientific Research (S) (as a principal investigator) Paleoceanography for future prediction: a possibility of climate mode jump with global warming, 2006~2010

	Direct	Indirect
2006	¥29,400,000	¥8,820,000
2007	¥28,600,000	¥8,580,000

2008	¥9,200,000	¥2,760,000
2009	¥9,200,000	¥2,760,000
2010	¥7,600,000	¥2,280,000

· Grant-in-Aid for Scientific Research (S) (as a principal investigator) Variability of hydrological cycle in East Asia during the Holocene and its linkage with the Global Monsoon, 2011~2015, Direct in 2011: ¥68,200,000; Indirect in 2011: ¥20,460,000

· Grant-in-Aid for Scientific Research (C) (as an associate investigator) Establishment of physical basis for ESR intensity and crystallinity of quartz as proxies for provenance studies, 2011~2013, Direct: ¥315,000

(2) Cooperative Research

· NFSC Japan-China joint research project, Pattern and variability of hydrological cycle associated with changes in East Asian Summer Monsoon, 2011.4.1～2013.12.31, 2011.4.1～2012.4.1: ¥1,500,000

(3) Research Contracts

(4) Grants and Gifts

· The Mitsubishi Foundation, Grant Amount: ¥4,000,000

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Koizumi, I., Tada, R., Narita, H., Irino, T., Aramaki, T., Oba, T. and Yamamoto, H., (2006), Paleoceanographic history around the Tsugaru Strait between the Japan Sea and the Northwest Pacific Ocean since 30 cal kyr BP, *Palaeogeography Palaeoclimatology Palaeoecology*, *232*, 36-52.
2. Kido, Y., Koshikawa, T., Tada, R., (2006), Rapid and quantitative major element analysis method of wet sediment samples using a XRF microscanner,(2006) *Marine Geology, 229*, 209-225.
3. Yokoyama, Y., Naruse, T., Ogawa N. O., Tada, R., Kitazato, H., and Ohkouchi, N., (2006), Dust influx reconstruction during the last 26,000 years inferred from a sedimentary leaf wax record from the Japan Sea, *Global and Planetary Change, 54*, 239-250.
4. Fujine, K., Yamamoto, M., Tada, R., and Kido, Y., (2006), A salinity-related occurrence of a novel alkenone and alkenoate in Late Pleistocene sediments from the Japan Sea, *Organic Geochemistry, 37*, 1074-1084,
5. Sun, Y., Chen, J., Clemens, S. C., Liu, Q., Ji, J., and Tada, R., (2006), East Asian monsoon variability over the last seven glacial 2 cycles recorded by a loess sequence from the northwestern 3 Chinese Loess Plateau, Geochemistry, *Geophysics, Geosystems,* Q12Q02, doi:10.1029/2006GC001287.
6. Clift, P. D, Tada, R., Zheng, H. B., (2006), Preface to the IGCP 476 "Monsoons and Tectonics" Special edition of palaeogeography, palaeoclimatology, palaeoecology, *Palaeogeography, Palaeoclimatology, and Palaeoecology, 241*, 1-3.
7. Nagashima, K., Tada, R., Tani, A., Toyoda, S., Sun, Y., and Isozaki, Y., (2007), Contribution of aeolian dust in Japan Sea sediments estimated from ESR signal intensity and crystallinity of quartz, *Geochemistry, Geophysics, Geosystems*, *Q02Q04*, doi:10.1029/2006GC001364.

8. Tada, R., Oba, T., Jordan, R., (2007), A tribute to Hiroshi Ujiie: a pioneer of paleoceanographic research of the Japan Sea, *Palaeogeography, Palaeoclimatology, and Palaeoecology, 247*, VII-IX.

9. Tada, R., Oba, T., Jordan, R. W., (2007), Preface for Special Volume: "Quaternary Paleoceanography of the Japan Sea and its linkage with Asian Monsoon", *Palaeogeography, Palaeoclimatology, and Palaeoecology, 247*, 1-4.

10. Nagashima, K., Tada, R., Matsui, H., Irino, T., Tani, A., and Toyoda, S., (2007), Millennial-scale variatios in Asian winter monsoon and westerly during the last 150 kys deduced from eolian grain size, Palaeogeography, Palaeoclimatology, and *Palaeoecology, 247*, 144-161.

11. Watanabe, S., Tada, R., Ikehara, K., Fujine, K., and Kido, Y., (2007), Changes in the bottom water oxygenation condition and possible causes of dark layers deposition I n the Japan Sea during the last 160 kys, *Palaeogeography, Palaeoclimatology, and Palaeoecology, 247*, 50-64.

12. Kido, Y., Minami, I., Tada, R., Fujine, K., Irino, T., Ikehara, K., Chun, J.H., (2007), Orbital-scale stratigraphy and high-resolution analysis of biogenic components and deep water oxygenation conditions in the Japan Sea during the last 640 kys using XRF microscanner, *Palaeogeography, Palaeoclimatology, and Palaeoecology, 247*, 32-49.

13. Yokoyama, Y., Kido, Y., Tada, R., Minami, I., Finkel, R. C., and Matsuzaki, H., (2007), Japan Sea oxygen isotope stratigraphy and global sea-level changes for the last 50,000 years recorded in sediment cores from the Oki Ridge, *Palaeogeography, Palaeoclimatology, and Palaeoecology, 247*, 5-17.

14. Ohkushi, K., Uchida, M., Aoki, K., Yoneda, M., Ikehara, K., Minoshima, K., Kawahata, H., Tada, R., Murayama, M., Shibata, Y., (2007), Radiocarbon marine reservoir in the subarctic region off north Japan during the last deglacial period, *Radiocarbon, 49*, 963-968.

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17. Sun, Y., Tada, R. Chen, J., Chen, H., Toyoda, S., Tani, A., Isozaki, Y., Nagashima, K, J., (2007), Distinguishing the sources of Asian dust based on electron spin resonance signal intensity and crystallinity of quartz, *Atmospheric Environment, 41*, 8537-8548.

18. Goto, K., Tada, R., Tajika, E., Iturralde-Vinent, M. A., Matsui, T., Yamamoto, S., Nakano, Y., Oji, T., Kiyokawa, S., Delgado, D. E. G., Otero, C. D., and Consuegra, R. R., (2008), Lateral lithological and compositional variations of the Cretaceous/Tertiary deep-sea tsunami deposits in northwestern Cuba, *Cretaceous Research, 29*, 217-236.

19. Kashiyama, Y., Ogawa, N.O., Kuroda, J., Shiro, M., Nomoto, S., Tada, R., Kitazato, H., and Ohkouchi, N., (2008), Diazotrophic cyanobacteria as the major photoautotrophs during mid-Cretaceous oceanic anoxic events: Nitrogen and carbon isotopic evidence from sedimentary porphyrin, *Organic Geochemisty, 39*, 532-549.

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sediments, *Biogeosciences, 5*, 797-816.

21. Sun, Y., Tada, R., Chen, J., Liu, Q., Toyoda, S., Tani, A., Ji, J., Isozaki, Y.,(2008), New constraints on the provenance of fine-grained dust deposited on the central Chinese Loess Plateau, *Geophys, Res. Lett., 35, L01804*, doi:10.1029/2007GL031672.

22. Nakano, Y., Goto, K., Matsui, T., Tada, R., and Tajika, E., (2008), PDF orientations in shocked quartz grains around the Chicxulub crater, *Meteoritics and Planetary Science, 43*, 745-760.

23. Hasegawa, H., Tada, R., Ichinnorov, N., and Minjin, C., (2009), Lithostratigraphy and depositional environments of the Upper Cretaceous Djadokhta Formation, Ulan Nuur basin, southern Mongolia, and its paleoclimatic implication, *Journal of Asian Earth Science, 35*, 13-26.

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27. Baioumy, H.M., Kayanne, H., and Tada, R., (2010), Reconstruction of lake-level and climate changes in Lake Qarun, Egypt, during the last 7000 years, *Jour. Great Lakes Res.***,** *36***,** 318-327.

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30. Zheng, H., Tada, R., Jia, J., Lawrence, C., and Wang, K., (2010), Cenozoic sediments in the southern Tarim Basin: implications for the uplift of northern Tibet and evolution of the Taklimakan Desert, in Clift, P., Tada, R., and Zheng, H. (eds.) "Monsoon evolution and tectonic-climate linkage in Asia", *Special Publication of Geological Society of London, 342*, 67-78.

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35. Nagashima, K., Tada, R., Tani, A., Sun, Y., Isozaki, Y., Toyoda, S., Hasegawa, H. , (2011), Millennial-scale oscillations of the westerly jet path during the last glacial period, *Journal of Asian Earth Sciences*, 40, 1214-1220.

36. Tsukamoto, S., Nagashima, K., Murray, A. S., Tada, R., (2011), Variations in OSL components from quartz from Japan sea sediments and the possibility of reconstructing provenance, *Quaternary International*, 234, 182-189.

37. Sekine, Y., Tajika, E., Tada, R., Hirai, T., Goto, K. T., Kuwatani, T., Goto, K., Yamamoto, S., Tachibana, S., Isozaki, Y., Kirschvink, J.L., (2011), Manganese enrichment in the Gowganda Formation of the Huronian Supergroup: A highly oxidizing shallow-marine environment after the last Huronian glaciations, *Earth Planet Sci. Lett.*, 307, 201-210.

38. Sekine, Y., Suzuki, K., Senda, R., Goto, K.T., Tajika, E., Tada, R., Goto, K., Yamamoto, S., Ohkouchi, N., Ogawa, N.O., and Maruoka, T., (2011), Osmium evidence for synchronicity between a rise in atmospheric oxygen and Palaeoproterozoic deglaciation, *Nature Communications*, 2:502 | DOI: 10.1038/ncomms1507.

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42. Baioumy, H., Kayanne, H., Tada, R., (2011), Record of Holocene aridification (6000-7000 BP) in Egypt (NE Africa): Authigenic carbonate minerals from laminated sediments in Lake Qarun, Quaternary International, 245, 170-, DOI: 10.1016/j.quaint.2010.05.021**.**

(2) Selected Conference Proceedings

1. Toyoda, S., Hosogi, K., Nagashima, K., Isozaki, Y., Sun, Y., Tada, R., (2008), Paramagnetic defects in quartz as the proxies for provenance of aeolian and fluvial sediments, Proceedings for Third International Conference on Luminscence and Its Applications.

(3) Review Papers

1. Nagashima, K., Tada, R., Tani, A., Sun, Y., Isozaki, Y., Toyoda, S., (2009), Provenance study of eolian dust using electron spin resonance signal intensity of quartz, *SOLAS NEWS*. (Refereed)

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Tada, R., T. Itaki, Y. Sun, K. Ikehara, T. Nakajima, J. J. Bahk, S. H. Lee, H. Zheng, and S. Gorbarenko, "Outline of #605 Full2: Onset and evolution of millennial-scale variability of Asian monsoon and its possible relation with Himalaya and Tibetan uplift", Workshop on Climate-Tectonic Drilling in Southeast Asia, Sponsored by InterMARGINs, June 5-7th 2006, Kochi, Japan. (Invited)
2. Tada, R., "Onset and propagation of millennial-scale abrupt climatic changes", ESF-JSPS Frontier Science Conference for Young Researchers -Climate Change- r, ESF&JSPS, July 24-29, 2006, Nynashamn, Sweden. (Invited)
3. Tada, R., Y. Sun, K. Nagashima, Y. Isozaki, S. Toyoda, A. Tani, and H. Hasegawa, "Provenance Changes of Eolian Dusts in East Asia on various Time Scales", Session "Aeolian dust as a player and recorder of environmental change", EGU General Assembly, April 19, 2007, Vienna, Austria. (Invited)
4. Tada, R., Zheng, H., Sun, Y., Isozaki, Y., Sugiura, N., Toyoda, S., and Nagashima, K., "Formation and expansion of Taklimakan Desert and its relation to Tibet and Tian Shan uplift during Plio-Pleistocene", 3rd Alexander von Humboldt International Conference on the East Asian Monsoon, Past, Present and Future, IGGCAS & EGU, 27-30 August, 2007. Beijing, China. (Invited)
5. Tada, R., "Orbital- and suborbital-scale changes of Asian monsoon and their impact on paleoceanography of East Asian marginal seas", 100 year Anniversary Symposium of Geological Society of Korea, April, 2007, Seoul, Korea. (Invited)
6. Tada, R., Isozaki, Y., Nagashima, K., Kubota, Y., Sun, Y., Zheng, H., Toyoda, S., Provenance of eolian dust and reconstruction of millennial-scale atmospheric circulation changes in East Asia during the last glacial to the Holocene, 1st PAGES ADOM Workshop on "High-mid latitude northern hemisphere atmospheric circulation", November 1 to 4, 2009, Hyeres, France. (Invited)
7. Tada R., Yoshida, T., Toyoda, S., Zheng, H., "Provenance of quartz in sand fraction of river sediments along the Yangtze River drainage: A preliminary result", The 1st Symposium of IGCP Project-581, May 8, 2010, Nanjing University, Nanjing, China (Invited)
8. Tada, R., Millennial-scale Asian monsoon dynamics, its tele-connection, and possible linkage with solar activity, PAGES Regional Workshop, June 5, 2010, Nagoya University, Nagoya, Japan. (Invited)
9. Tada, R., Nagashima, K., Kubota, Y., "Millennial-scale tele-connection of monsoon in northern hemisphere through westerly jet/ITCZ and its relation with solar activity", PAGES 2nd Global Monsoon Symposium, September 14, 2010, Tongji University, Shanghai, China. (Invited)

10. Tada, R., Nagashima, K., Kubota, Y., "Change in millennial-scale tele-connection of E. Asian Monsoon and N. Atlantic climate between glacial and interglacial boundary conditions", Kochi International symposium on Paleoceanography and Paleoenvironment in East Asia, March 2, 2011, Kochi, Japan.

Total Number of Presentation (as a first author): 21 (including 10 invited presentations)

(2) Domestic Conferences

11. Tada, R., "Onset of rapid variability of Asian Monsoon, its possible linkage with Northern Tibet uplift, and its impact on oceanographic condition", 2006 Annual Meeting of the Japan Association for Quaternary Research, August 5, 2006, Tokyo Metropolitan University, Tokyo. (in Japanese) (Invited)
12. Tada, R. and H. Hasegawa, "Paleoenvironmental researches for future prediction", Domestic Workshop of IGBP PAGES, July 28, 2008, Hokkaido University, Sapporo, Hokkaido, Japan. (in Japanese) (Invited)
13. Tada, R., "Researches on East Asian Monsoon during the Quaternary based on the hemipelagic sediments from the Japan Sea," 2010 Annual Meeting of the Japan Association for Quaternary Research, August 21, 2010, Tokyo Gakugei University, Tokyo. (in Japanese) (Invited)

Total Number of Presentation (as a first author): 14 (including 3 invited presentations)

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Student Poster Award: Kubota, Y., Kimoto, K., Tada, R., Oda, H., Yokoyama, Y., Matsuzaki, H., "Millennial-scale variations in East Asian summer monsoon during the last deglaciation in the northern East China Sea", XVIII INQUA Congress, 20-27 July 2011, Bern, Switzerland.

· The Best Student Poster Award : Ikeda, M., Sakuma, H., and Tada R., "Milankovitch cycles detected from the sedimentary rhythms of bedded chert and its relation to diversity dynamics of radi-olarian fossils," The 12th Meeting of the International Association of Radiolarian Paleontologists the Micropalaeontological Society, September 17 2009, Nanjing University, China.

· American Geophysical Union (AGU) 2008 Fall Meeting, Outstanding Student Paper Award: Hasegawa H., Tada R., Jiang X., Suganuma Y., Imsamut S., Charusiri P., Ichinnorov N., & Khand Y., "Drastic shrinking of the Hadley circulation during the mid-Cretaceous supergreenhouse", American Geophysical Union (AGU) Fall Meeting, December 2008, San Francisco, USA.

· Best Student Poster Prize: Nagashima, K., Tada, R., "East Asian Monsoon/westerly intensity variations during the last 150 kyr based on eolian dust grain size and its N-S contrast in the Japan Sea", XVI INQUA Congress, July, 2003, Reno, USA.

In addition, 6 domestic awards to advisees.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Guest Editor of Palaeogeography, Palaeoclimatology, Palaeoecology Special Issue "Monsoon and Tectonics of Asia" edited by Clift, Tada and Zheng (2006)

· Guest Editor of Palaeogeography, Palaeoclimatology, Palaeoecology Special Issue "Quaternary Paleoceanography of the Japan Sea and its Linkage with Asian Monsoon" edited by Tada, Oba and Jordan (2007)

· Guest Editor of Special Publication 342 of Geological Society "Monsoon Evolution and tectonic-Climate Linkage in Asia" edited by Clift, Tada and Zheng (2010)

· Associate Editor of Paleoceanography (2008-present)

(2) Academic Societies

· A member of Science Steering Committee of Past Global Changes [PAGES] project of International Geosphere Biosphere Program [IGBP] (2001-2006)

· A project leader of International Geoscience Programme [IGCP] no. 476 "Monsoon evolution and tectonics-climate linkage in Asia" (2003-2007)

· Co-chair of Science Steering and Evaluation Panel [SSEP] of Integrated Ocean Drilling Program [IODP] (2006-2008)

· A member of Steering Committee of INVEST, IODP (2008-2010)

· A project co-leader of International Geoscience Programme [IGCP] no. 581 "Evolution of Asian River Systems Linking to Cenozoic Tectonics, Climate and Global Geochemical Cycles" (2009-2013)

· Representative of JpGU（2009－2011）

· A Member of Committee for International Affairs of JpGU（2011－present）

(3) International Conferences

· Organizing Committee Member of 4th Annual Symposium of IGCP-476 "Monsoon, Tectonics, and Paleoclimate/Paleoceanography in East Asia and its Marginal Seas", September 3-6, 2006, Busan, Korea.

· Organizing Committee Chair of 5th Annual Symposium of IGCP-476 ""Monsoon evolution and tectonics-climate linkage in Asia", December 6-8, 2007, Koshiba Hall, University of Tokyo 7-3-1 Hongo, Tokyo, Japan.

· Scientific Committee Member of PAGES 2nd Global Monsoon Symposium "Global Monsoon and Low-Latitude Processes: Evolution and Variability", September 13-15, 2010, Tongji University, Shanghai, China.

· Organizing Committee Member of 2nd Annual Symposium of IGCP-581 "Evolution of Asian River Systems: Tectonics and Climates", June 11-14, 2011, Hokkaido University, Japan.

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Public Lecture: Tada, R., "Catastrophic change of global environment and mass extinction caused by a bolide impact", organized by Faculty of Science, the University of Tokyo, April 21, 2006, Komaba Campus, Tokyo.

· Public Lecture: Tada, R., "Catastrophic change of global environment and mass extinction caused by a bolide impact", National Museum of Emerging Science and Innovation, October 6, 2007, Tokyo.

· Public Lecture: Tada, R., " Global environmental changes caused by a bolide impact", Space-guard Symposium, December 6, 2008, Public Hall, Ebina, Kanagawa Prefecture.

· In-house Lecture No. 256: Tada, R., “When and how the Taklimakan Desert formed?”, Tokyo Geographical Society, February 19, 2010, Tokyo.

· In-house Lecture: Tada, R., “Climatic Change and solar activity”, Shinra-banshoh School on “Solar variability and the earth and planets”, February 22 to 24, 2010, Chitose, Hokkaido.

· Science Café: Tada, R., “ How has the climate of the earth been controlled throughout its history?”, Series “Science for the Climate Change” No. 1, The Hitachi Environment Foundation, February 23, 2011, Saloon de Toyama-bo, Folio, Tokyo.

· Science Café: Tada, R., “ Climate changes as the earth spins”, Series “Science for the Climate Change” No. 2, The Hitachi Environment Foundation, April 27, 2011, Saloon de Toyama-bo, Folio, Tokyo.

· Science Café: Tada, R., “How has atmospheric CO_2 been controlled through time?: Deep water circulation and Biological Pump ” Series “Science for the Climate Change” No. 3, The Hitachi Environment Foundation, June 22, 2011, Saloon de Toyama-bo, Folio, Tokyo.

· Science Café: Tada, R., “The world of Day After Tomorrow: Abrupt climatic changes and their mechanism(s) ” Series “Science for the Climate Change” No. 4, The Hitachi Environment Foundation, August 31, 2011, Saloon de Toyama-bo, Folio, Tokyo.

· Science Café: Tada, R., “Solar Activity and climatic change: The day when sunspot disappeared” Series “Science for the Climate Change” No. 5, The Hitachi Environment Foundation, October 26, 2011, Saloon de Toyama-bo, Folio, Tokyo.

12. Internal and External Committee Memberships (2006-2011)

· A member of a Steering Committee for Radiocarbon Measurement Laboratory（2008-2010）

· A member of a Steering Committee of Asian Studies Network (ASNET)（2008-present）

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 5 [Undergrads: 1 (U.S.A.: 1), M.Sc.: 2 (China: 1, France: 1), Ph.D.: 2 (China: 1, Austria: 1)]

Foreign Researchers: 3 [China: 2, Egypt: 1]

Sending

Japanese Students: 21 [M.Sc.: 11 (China: 6, U.S.A.: 3, Canada: 2), Ph.D.: 10 (China: 4, U.S.A.: 2, Cuba: 2, Korea: 1, Mexico: 1)]

Japanese Researchers: 7 [China: 2, U.S.A.: 2, Korea: 1, Cuba: 1, Mexico: 1]

Visitors from Abroad: 37 [China: 12, Korea: 8, U.S.A.: 5, U.K.: 3, India: 3, Taiwan: 2, Russia: 1, Sri Lanka: 1, Thailand: 1, Canada: 1]

Hiroko Nagahara

I. C.V.

Name： Hiroko Nagahara
Present Position: Professor, University of Tokyo, Graduate School of Science

Education
B. Tech., Resources, Waseda University, March, 1974
M. Tech., Resources, Waseda University, March, 1976
M. Sc., Geology, The University of Tokyo, March, 1980
Ph. D., Geology, The University of Tokyo, March, 1983

Professional Experience
April, 1983 - April, 1984, Research fellow, JSPS at the Univ. Tokyo
May, 1984 - Dec., 1992, Assistant professor, Department of Gelogy, The University of Tokyo
March 1991 – Feb 1992, Research scientist, Geophysical Laboratory, Carnegie Institution of Washington
Dec, 1992-Jul., 2001, Associate Professor, Department of Geology, The University of Tokyo
July, 2001- present, Professor, Graduate School of Science, The University of Tokyo

II. Scientific Research Activity

2. Major achievements

(1) Experimental and theoretical study on chemical fractionation of protoplanetary disks

Finding of exoplanets has pushed the study of planet-formation, specifically that of terrestrial-type planets and habitable planets, to be one of top-sciences, which requires us to couple physics and chemistry in the evolution of protoplanetary systems. We have carried out condensation and evaporation experiments of major rock-forming minerals in order to combine chemical evolution to physical evolution of protoplanetary systems for these years. We have succeeded in obtaining kinetic parameters for condensation/evaporation of forsterite, enstatite and metallic iron and reaction coefficients of forsterite and SiO gas. By using those parameters, we have developed a model for chemical evolution of a system with the solar abundance of elements, and found that the behavior of the system is dependent on the cooling time scale, total pressure, and dust/gas separation rate. The model incudes change of grain species and size, which enables us to calculate temperature of protoplanetary system in the radiation field.

(2) Evolution of solid materials around evolved stars

Dust formation around evolved stars has been investigated with special interests to condensation of alumina, which is the phase that appears at first in a cooling gas with the solar abundance of elements or possible gas compositions around evolved stars. On the basis of our experiments, we have shown that the shape (anisotropy) of condensing alumina grains is dependent on cooling rate and total pressure of the gas, which further suggests that the IR spectra for gas at different locations from the central star can be variable. Observed spectrum variations can be applied to estimation of physical condition of expanding gas of a evolved star. This study develops a new field of astromineraloy, which was primary developed by astronomical study, that mineralogical information will be able to give crucial information for

astronomy.

(3) Physico-chemical study of early evolution of planet formation

We have developed a physic-chemical model for lunar magma ocean, where bulk composition is a free parameter with boundary conditions for the observed anorthosite crust. We are reaching a conclusion that the Moon was richer in FeO than the Earth by about 1.3 times, which is consistent with previous geophysical evaluation.

(4) Origin of chondrules

Chondrules are major components of chondrites, which are thought to be a part of protoplanets. Origin of chondrules is one of most extensively debated issues in planetary science, but is still under debate. We have shown that condensation played a role during crystallization and that mass-dependent oxygen isotopic fractionation in combination with isotopic anomaly was printed in chondrules in primitive chondrites.

3. Five Important Papers in your career

1. Young, E. D., Galy, A., and Nagahara, H. (2002): Kinetic and equilibrium mass-dependent isotope fractionation laws in nature and their geochemical and cosmochemical significance. Geochim. Cosmochim. Acta 66, 1095-1114.

Physical consideration of mass-dependent isotopic fractionation in nature. Citation 229（as of 11/7/2012）

2. Kita, N. T., Nagahara, H., Togashi, S. and Morishita, Y (2000): A short duration of chondrule formation in the solar nebula: evidence from ^{26}Al in Semarkona ferromagnesian chondrules. Geochim. Cosmochim. Acta, 64, 3913-3922.

First showingof the interval of chondrule formation for 2 m.y. at the early stage of the protosoalr disk. Citation124（as of 11/7/2012）

3. H. Nagahara and K. Ozawa (1996): Evaporation of forsterite in H_2 gas. Geochim. Cosmochim. Acta, 60, 1445-1459.

Experimental demonstration of role of hydrogen on evaporatin of forsteriteCitation55（as of 11/7/2012））

4. H. Nagahara (1984): Matrices of type 3 ordinary chondrites -- primitive nebular records. Geochim. Cosmochim. Acta, 48, 2581-2595.

Description of disequilibrium mineral assemblages in the matrix of primitive chondrites. Citation 74（as of 11/7/2012）

5. H. Nagahara (1981): Evidence for the secondary origin of chondrules. Nature, 292, 135-136.

First presentation of the evidence for secondary origin of chondrules. Citation104（as of 11/7/2012）

4. Awards and Honors throughout your career

· Yamazaki Prize, 1986

· Saruhashi Prize, 2001

5. Future Research Plan

(1) Development of an evolution model of a protoplanetary disk that combines physics and chemistry

Recent progress of exoplanet study requires us to describe distribution of terrestrial planets, water, and organic materials in protoplanetary systems. The most important step is the distribution of silicates and metallic iron as a function of radial distance from a protostar. Although we have studied this theme for years theoretically and experimentally (condensation/evaporation experiments), we need to expand our model to internally consistent model that solves physics and chemistry simultaneously. The essential point is the temperature structure of a disk, which is carried out by solid dusts and which affects the species and size distribution of solid dusts. Because dusts in a protoplanetary disk move vertically and radially, the temperature structure evolves with time and space. We have already started collaboration with a planetary physicist and have started co-education of a graduate student on this topic.

(2) Evolution of inorganic materials-organic materials-water in ptoroplanetary disks

Because interaction among rock-forming minerals, organics, and water is thought to proceed from the collapse of a molecular cloud to later stages on parent bodies, through understanding of interaction among the three components is very important when we consider origin of life in planetary systems. We have already started collaboration among many fields including mineralogy, inorganic chemistry, organic chemistry, isotope study, chronolory, and experimental study on this theme, and have studied cometary dusts collected from fresh snow from Antarctica. Most collaborators are analyzing the cometary dusts, and we are planning to carry out experimental and theoretical study. The main purpose of experiments is to know the species and reaction rate of interaction among mineral-orgaics-water at low-pressure and low-temperature conditions of protoplanetary disks. This study will contribute to the coming Hayabusa 2 mission that will collect surface materials of a primitive body and that is expected to retain record of evolution of organic materials in the early solar system.

(3) Physico-chemistry of early evolution of planets

Most important process of planet evolution is its formation that controls later stages. We have studied the evolution of the lunar magma ocean by putting the bulk composition a free parameter and by optimizing the various observations such as the thickness and mineralogy of the anorthosite highland, bulk density, and physical conditions to form the crust. We have been specifically interested in interaction between physics an chemistry in evolution of planets. We are going to apply this model to other small bodies in the early solar system that have various sizes, that is various gravity. The difference in the gravity affects the efficiency of melt separation, that is the efficiency of formation of core/mantle/crust formation.

6. Funding Received

(1) JSPS Grants

- Grant-in-Aid for Scientific Research (S), Experimental study of the relationship between evolution of stars and silicate dust, 2004-2008, 81,300,000 Yen
- Grant-in-Aid for Exploratory Research, Dust formation around stars: estimation of nucleation rates, 2005-2006, 1,400,000 Yen
- Grant-in-Aid for Scientific Research on Priority Areas, Chemical evolution of silicate dusts around young stars: experimental approach, 2005-2006, 2,600,000 Yen
- Grant-in-Aid for Scientific Research (S), Interaction among minerals-water-organic materials: evolution of precursor materials of life, 2010-2015, 166,800,000 Yen

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

· JSPS Fund for investigation of scientific research on trend. 2009-2011, 5,880,000 Yen.

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Lauretta, D. S., H. Nagahara, and C. M. O'D. Alexander (2006), Petrology of ferromagnesian silicate chondrules, in Meteorites and the Early Solar System II, ed. D. S. Lauretta, and H. Y. McSween, Univ. Arizona Press, 431-459.
2. Yamada, M., S. Tachibana, H. Nagahara, and K. Ozawa (2006), Anisotropy of Mg isotopic fractionation during evaporation and Mg self-diffusion of forsterite in vacuum. Planetary and Space Science, 54, 1096-1106.
3. Takigawa, A., Yokoyama, S., Tachibana, S., Nagahara, H., and Ozawa, K. (2007), Infrared spectra of evaporated forsterite in protoplanetary disk. Journal of Planetary Society, 16, 128-134 (in Japanese).
4. Kurahashi, E., N. T. Kita, H. Nagahara, and Y. Morishita (2008), 26Al-26Mg systematics of chondrules in a primitive CO chondrite. Geochim. Cosmochim. Acta 72, 3865-3882.
5. Nagahara, H., N. T. Kita, K. Ozawa, and Y. Morishita (2008), Condensation of major element during chondrule formation. Geochim. Cosmochim. Acta 72, 1442-1465.
6. Odashima, N., T. Morishita, K. Ozawa, H. Nagahara, A. Tsuchiyama, and R. Nagashima (2008), Formation and deformation mechanisms of pyroxene-spinel symplectite in an ascending mantle, the Horoman peridotite complex, Japan: A EBSD (electron backscatter diffraction) study, J. Mineral. Petrol. Sci., 103, 1-15.
7. Nagahara, H., K. Ozawa, R. Ogawa, S. Tachibana, and H. Chiba (2009), Laboratory condensation and reaction of silicate dust. ASP Conf. Ser., 414, 403-410.
8. Takigawa, A., S. Tachibana, H. Nagahara, K. Ozawa, and M. Yokoyama (2009), Anisotropic evaporation of forsterite and its implication for dust formation conditions in circumstellar environments. Astrophys. J. 707, L97-101.
9. Kita, N. T., H. Nagahara, S. Tachibana, S. Tomomura, M. Spicuzza, J. H. Fournelle, and J. W. Valley (2010), High precision SIMS oxygen three isotope study of chondrules in LL3 chondrites: Role of ambient gas during chondrule formation. Geochim. Cosmochim. Acta 74, 6610-6635.
10. Sakai, R., Kushiro, I., Nagahara, H., Ozawa, K., and Tachibana, S. (2010), Constraints on the lunar magma ocean inferred from the crust formation. Journal of the Planetary society 19, 82-88. (in Japanese)
11. Takigawa, A., Tachibana, S., Nagahara, H., Ozawa, K., and Miyata, T. (2010) Estimation of circumstellar dust formation from the anisotropy of corundum. Journal of the Plaentary Society 19, 148-156. (in Japanese)
12. Tachibana, S., H. Nagahara, K. Ozawa, Y. Ikeda, R. Nomura, K. Tatsumi, and Y. Joh (2011), Kinetic condensation and evaporation of metallic iron and implications to metallic iron dust formation, Astrophy. Jour. L736, doi: 10.1088/0004-637X/736/1/16.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Nagahara, H., Evaporation and condensation kinetics for minerals and silicate melt, 19th General. Meeting. Intnatl. Mineral. Assoc. (Kobe, 2006.7) Invited talk
2. Nagahara, H., Laboratory condensation and reaction of silicate dusts, Workshop "Cosmic dust: Near and Far" (Heidelberg, 2008.9) Invited talk
3. Nagahara, H., Link between experiments and modeling in condensation and fractionation in the protoplanetary disc, Workshop "Experimentation and modeling in cosmochemistry" (Nancy, France, 2009.7) Invited talk
4. Nagahara, H., What does bulk composition of chondrules tell us?, Symposium “Chondrules” (New York, 2010.7) Invited talk
5. Nagahara, H., S. Tachibana, and K. Ozawa, Kinetic Condensation of Minerals in Protoplanetary Discs, Workshop on Gas-Grain Interactions in Interstellar Clouds (Tokyo, 2011.10) Invited talk

and 65 other talks

(2) Domestic Conferences

85 talks including 5 invited talks

III. Educational Activity (2002-2011)

9. Notable achievements in education

- 2009 -present, Group leader of Univ. Tokyo, GCOE program “From the Earth to earths”.
- 2012/3, Takigawa, A. Ikushi Prize, JSPS
- 2012/3, Takigawa, A. Prize by the Dean of Science Faculty, Univ. Tokyo
- 2012/4, Takigawa, A., Special Post-Doc fellow (SPD), JSPS
- 2011/4, Sakai, R., DC1, JSPS
- 2010/10, Takigawa, A., Student award by the Planetary Science Society
- 2009/4, Takigawa, A., DC1, JSPS
- 2008/ 4, Kurahashi, E, PD, JSPS
- 2005/11, Kurahashi, E., Student award by the Planetary Science Society
- 2004/4, Kurahashi, E., DC1, JSPS

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· 1998-2007, Associate Editor, Meteocitics and Planetary Science
· 2006-present, Associate editor, Geocimica et Cosmochimica Acta
· 2011-present, Advisory board, Earth and Planetary Science Letters

(2) Academic Societies

· 2000-2005, Meteoritical Society, Leonard Medal Committee
· 2003-2004, Meteoritical Society, Nominating Committee
· 2006, Meteoritical Society, Nomenclature Committee member
· 2006-2007, Meteoritical Society, Vice President
· 2006-2008, Vice President, Japan Planetary Science Society
· 2008-2009, The Meteoritical Society, President
· 2008-2012, Section President of JapanPlanetry and Geoscience Union
· 2010-2011, The Meteoritical Society, Past President
· 2010-present, Committee member, Japan Planetary Science Society

(3) International Conferences

· 2003 Convener, Goldschmidt Conference
· 2008 Organizer, Workshop "Silicate Dust in Protostars : astrophysical, experimental, and meteoritic Link"
· 2010 Convener, Symposium "Chondrules"
· 2011 Organizer, Workshop "Mineral-water-organics in the early solar system"
· 2012 Organizer, Workshop "Mineral-water-organics in the early solar system 2"

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· 2006, Univ. Tokyo Video
· 2006, Nikkei BP, Mukku (Introduction of Faculty of Science, University of Tokyo)
· 2007/9, Lecture on "Astromineralogy" at the Vacuum Exhibition
· 2010/6, Talk on "The precursor materials of planets and life" at the Association of astro-boys"
· 2011/6, Lecture on "Mineral-water-organics in the early solar system" at the 11th Symposium of the National Institute of Natural Sciences
· 2011/12, Lecture on "Astromineralogy" at the Osaka Furitsu Univ.

12. Internal and External Committee Memberships (2006-2011)

· 2006-present, Council member of the Science Council of Japan
· 2008-2012, Officer, Research Center for Science Systems, JSPS
· 2009-Present, Steering Committee member, National Astronomical Observaotry, Japan
· 2008-present, Executive Council member, Institute of Space and Astronomical Science
· 2007- present Executive Council member, Institute of Low Temperature Science, Hokkaido Univeristy
· 2007-2011, Committee member, R & D in Aerospace Field, Ministry of education, culture,

sports, science, and technology

- 2008-prsent, Committee member, R & D in, Ministry of education, culture, sports, science, and technology
- 2007-2008, Committee member, Science Council, Ministry of education, culture, sports, science, and technology
- 2006, Committee member, National Institute for Academic degrees and university evaluation
- 2007, Reviewer for World Tope Level Institute Programm, JSPS
- 2006-2010, Committee member for ground-based aero-space research, Japan Space Forum

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 1 [M.Sc.: 0, Ph.D.: 1 (Germany:1)]

Japanese Researchers: 0

Visitors from Abroad: 10 from 4 foreign countries

Yutaka Abe

I. C.V.

Name： Yutaka Abe
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Geophysics, University of Tokyo, March, 1982
M. Sc., Geophysics, University of Tokyo, March, 1984
Ph. D., Geophysics, University of Tokyo, January, 1987

Professional Experience
April, 1987-March, 1989, Research Fellow, Japanese Society of Promotion of Science
November, 1987-May, 1988, Research Fellow, Division for Earth and Planetary Science, California Institute of Technology,USA
April, 1989-April, 1992, Assistant Professor, Water Research Institute, Nagoya University
May, 1992- Associate Professor, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

My principal research target is to clarify the mechanisms which yield the characteristics of each terrestrial planet. For this purpose, my research activity is focused on theoretical studies in the fields of early evolution and climate of planets.

Early evolution determines the basic structure of planets. Protoatmosphere and oceans give the initial condition of the planetary environment. The magma ocean controls not only the internal structure, but also the startling point of the tectonics. Following earlier studies on the atmosphere and hydrosphere formation (e.g., Abe and Matsui, 1985, 1986, 1988; Matsui and Abe, 1986a, b), and the evolution of the magma ocean (e.g., Abe, 1993, 1997), I investigated more detailed processes with special attention to the recent development of planetary formation theory.

The protoplanetary disks are opaque and likely colder than previous estimate so that water vapor may condense into ice even at the Earth's orbit. Machida and Abe (2010) investigated the competition between the accretion and sublimation of icy planetesimals,and showed that the water content of resulting protoplanets is highly variable (from dry to more than a few tens of %). This may suggest potential variety of water content in extra-solar terrestrial planets.

Giant impacts were thought to be the reseting events of everything. Genda and Abe (2003, 2005) showed that not only a substantial fraction of the atmosphere survives, but also the surface environment at the time of impacts has serious effects on the resulting atmosphere. Sasaki and Abe (2007) showed the mechanism through which core and mantle state of the protoplanets affects that of the final planet.

Hashimoto et al. (2007) showed the possibility that reducing species degass at the impacts of CI-like material. This implies that the impact-generated atmosphere is more reducing than previous estimate.

Hamano and Abe (2010) investigated the modification of the atmosphere through competition between the impact erosion and addition of volatile materials during early heavy

impacts.

Other studies include the estimation of the temperature of dissipating thin disk gas and its effects on the atmosphere capture (Sakamoto and Abe, 2006), and calculations of hydrodynamic escape of a multicomponent planetary atmosphere（Sasaki and Abe, 2007). Early evolution and protoatmosphere are summarized in Abe (2011).

The planetary climate study aims to clarify the stabilizing and destabilizing processes of planetary environment. Since liquid water is thought to be necessary for life, I am working on the climate of "water planets", on which liquid water exists, with special attention to the abundance of water, as large variety may be expected for exoplanets. Abe et al. (2005) introduced the concept of "land planet", less water planets on which the distribution of water is controlled by the atmospheric circulation. Abe et al. (2011) showed that the orbital range where liquid water exists on the surface of planet (the habitable zone) is much wider for land planets than for planets with abundant water like the Earth (aqua planets). Abuku and Abe (2008) estimated the conditions that divide between land and aqua planets. Tsuihiji and Abe (2006,2007) investigated the effects of orbital eccentricity and obliquity using a general circulation model for land and aqua planets.

3. Five Important Papers in your career

1. Genda, H. and Y. Abe: Enhanced atmospheric loss on protoplanets at the giant impact phase in the presence of oceans. Nature, **433** (7028), 842-844, 2005

This paper showed that the surface environment at the time of giant impacts had serious efforts on the resulting planetary atmosphere, unlike the previous belief that the impacts reset everything. Total citation 40｛39 in 2006-2012｝

2. Abe, Y.: Thermal and chemical evolution of the terrestrial magma ocean. Phys., Earth Planet. Int., 100, 27-39, 1997.

This paper is a theoretical study on the cooling and differentiation process of a deep magma ocean. As a one of standard papers on the magma ocean, it is often cited in recent years. Total citation 84｛66 in 2006-2012｝

3. Abe, Y.: Physical state of very early Earth, Lithos, 30, 223-235, 1993.

This paper describes the near-surface environment of the Earth following accretion based on a theory of planetary formation. It contains a diagram for the condition of an ocean formation from an H2O-CO2 atmosphere. Total citation. 46｛17 in 2006-2012｝

4. Nakajima, S., Y.-Y. Hayashi and Y. Abe: A study on the 'runaway greenhouse effect' with a one dimensional radiative convective equilibrium model, J. Atmos. Sci., 49, 2256-2266, 1992.

This paper investigates the mechanism of the runaway greenhouse effect with introducing the concept of various radiation limits. It is one of standard papers on the runaway greenhouse effect. Total citation 40｛12 in 2006-2012｝

5. Matsui, T. and Y. Abe: Evolution of an impact-induced atmosphere and magma ocean on the accreting Earth, Nature, 319, 303-305, 1986.

This paper introduced a new model of an atmosphere-ocean formation, which included the interaction between an impact –generated steam atmosphere and a magma ocean. Total citation 102｛30 in 2006-2012｝

4. Awards and Honors throughout your career

· Able, Y. and T. Matsui, Horiuchi Fund Prize, Japan Meteorological Society, October, 1988 for a new theory of planetary atmosphere formation.

5. Future Research Plan

Thousands of exoplanets have already been found. Although observable properties of exoplanets are severely limited, it is an important phase for developing science of an entire planet as a system, because many examples enable us generalized discussion. My principal research target in near future is to understand the mechanisms which yield the variety of terrestrial planets and the controlling factors of habitable environment on exoplanets.

I think the near surface properties of a planet are results of its evolution through interaction between its interior and atmosphere starting at its accretion phase. Habitability of a planet is directly controlled by the surface environment. The surface environment is affected by the behavior of planetary interior and the origin of the atmosphere through its evolution. For example, the conditions that divide between land and aqua planets, which have very different climate (Abe et al., 2005, 2011), are controlled by water abundance and surface topography (Abuku and Abe, 2008).

Therefore, I am planning to continue theoretical studies on the early evolution and climate of planets with special attention to the behavior of volatile materials including water. Volatile materials constitute the atmosphere and oceans, and control the surface environment of planets. On the other hand, they have large influence on the dynamics of planetary interior. Terrestrial planets may be viewed as a unified system by looking through volatile materials. In addition, since the atmosphere is the first observable property of exoplanets, it will provide a link between the theory and observation.

On the early evolution, I am planning to focus on the topics related to the atmosphere formation. The topics include the supply of volatile materials, the capture of protoplanetary disk gas, the effects of impacts, the escape of the atmosphere, and the properties of mixture atmosphere formed from degassed and captured components.

On the planetary climate, I am planning to focus on the study of variety of climate in relation to their observable features. In particular, since differences between land and aqua planets are potentially observable on exoplanets, it is interesting to clarify their observable characteristics.

6. Funding Received

(1) JSPS Grants

· Principal Investigator, Grant-in-Aid for Scientific Research (C), A study of the climate and habitability of planets with large eccentricity. (18540430), 2006-2007, 3,400,000 Yen

· Co-Investigator, Grant-in-Aid for Scientific Research (B), Estimation of the molecular composition and hydrogen loss-rate of an impact-generated steam atmosphere. (23340168), 2011, 800,000 Yen

· Co-Investigator, Grant-in-Aid for Scientific Research on Innovative Areas. Numerical modeling and formation-evolution theory of exoplanetary atmosphere. (23103003), 2011, 4,615,000Yen”

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Abe, Y., A. Abe-Ouchi, N. H. Sleep, and K. J. Zahnle: Habitable zone limits for dry planets, Astrobiology, **11**, 443-460, doi: 10.1089/ast.2010.0545, 2011.
2. Abe, Y.: Protoatmospheres and Surface Environment of Protoplanets, Earth, Moon, and Planets, **108**, 9-14, doi: 10.1007/s11038-010-9368-x, 2011.
3. Hamano, K., and Y. Abe: Atmospheric loss and supply by an impact-induced vapor cloud: Its dependence on atmospheric pressure on a planet. Earth Planets Space, **62** (7), 599-610, doi:10.5047/eps.2010.06.002, 2010.
4. Machida, R., and Y. Abe: Terrestrial Planet Formation through Accretion of Sublimating Icy Planetesimals in a Cold Nebula. Astrophysical Journal, **716**, 1252-1262, 2010.
5. Sasaki, T. and Y. Abe: Rayleigh-Taylor Instability after Giant Impacts: Imperfect equilibration of Hf-W system and its effect on the core formation age. Earth Planets Space, **59**, 1035-1045, 2007
6. Hashimoto, G. L., Y. Abe and S. Sugita: The chemical composition of the early terrestrial atmosphere: Formation of a reducing atmosphere from CI-like material. Journal of Geophysical Research, **112**, E05010, doi:10.1029/2006JE002844; 2007

(2) Selected Conference Proceedings

1. Kamata, S., S. Sugita, and Y. Abe; A new scheme for the calculation of viscoelastic deformation in a planet with time-dependent viscosity structure. Proceedings of the 42nd ISAS Lunar and Planetary Symposium, Japan Aerospace Exploration Agency, Sagamihara, 2009.
2. Abuku, K., and Y. Abe, The Condition Dividing "Aqua Planets" and "Land Planets", Proceedings of the 41st ISAS Lunar and Planetary Symposium, 43-47, Japan Aerospace Exploration Agency, Sagamihara, 2008.
3. Tsuihiji, D. and Y. Abe, Toward the understanding of the orbital effects on planetary climate, Proceedings of the 40th ISAS Lunar and Planetary Symposium, 158-162, Japan Aerospace Exploration Agency, Sagamihara, 2007.
4. Sasaki, T. and Y. Abe, Hydrodynamic Escape of Planetary Atmospheres, Proceedings of the 40th ISAS Lunar and Planetary Symposium, 170-173, Japan Aerospace Exploration Agency, Sagamihara, 2007.
5. Sakamoto, A. and Y. Abe, 1.The gas temperature in the dissipating solar nebula around protoplanets: effects on the formation of solar-type atmospheres, Proceedings of the 39th ISAS Lunar and Planetary Symposium, Kato, M. and S. Tanaka, 150-153, Japan Aerospace Exploration Agency, Sagamihara, 2006
6. Tsuihiji, D. and Y. Abe, 6.Effects of Obliquity on the Climate of Planets with High Eccentricities, Proceedings of the 39th ISAS Lunar and Planetary Symposium, Kato, M. and S. Tanaka, 170-173, Japan Aerospace Exploration Agency, Sagamihara, 2006

(3) Review Papers

1. Abe, Y., Formation and evolution of habitable planets 3. Yuseijin, **19**, 190-210, 2010. (in Japanese, refereed)
2. Abe, Y., Formation and evolution of habitable planets 2. Yuseijin, **19**, 112-135, 2010. (in Japanese, refereed)
3. Abe, Y., Formation and evolution of habitable planets 1. Yuseijin, **18**, 194-215, 2009. (in Japanese, refereed)
4. Kuramoto, K., Y. Abe, G. L. Hashimoto, Y. –Y. Hayashi, Y. Sekine and M. Sato, Origin, evolution and variety of habitable planets. Tenmon-Geppou,102, 184-189, 2009. (in Japanese, Non-refereed)
5. Abe, Y., Transition of the Earth's environment: from the viewpoint of comparative planetology. Tenki, 54(5), 409-414, 2007. (in Japanese, Non-refereed)
6. Abe. Y., Universality of the Earth's property as a habitable planet. Kagaku, 77(2), 148-149, 2007. (in Japanese, Non-refereed)
7. Abe, Y.. and E. Tajika, Evolution of the atmosphere. Tenki, 54(1), 5-8, 2007. (in Japanese, Non-refereed)

(4) Books

1. Abe, Y., 8.2 Early planetary environment. in "The solar system and planet" Modern Astronomy Vol. 9, ed. J. Watanabe, S. Ida and S. Sasaki, Nippon Hyouron Sya, 261-268, 2008.
2. Abe, Y., 5.1 Formation and evolution of water planets. in "The universe with human" Modern Astronomy Vol. ed. S. Okamura, S. Ikeuchi, N. Kaifu, K. Sato and H. Nagahara, Nippon Hyouron Sya,, 212-235, 2007.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Abe, Y., A. Abe-Ouchi, K. J. Zahnle, N. H. Sleep: Habitable zone limits for dry planets, 25th General Assembly of the International Union of Geodesy and Geophysics, JM07 Atmospheres and ices on terrestrial planets, Melborne, Australia, July 1. 2011. (invited)
2. Abe, Y., How to Make a Habitable Planet, CPS 6th International School of Planetary Sciences, Planetary Atmospheres, Kobe, Japan, January 8, 2010. （invited）
3. Abe, Y., Behavior of Volatile Material During Accretion of Terrestrial Planets, American Geophysical Union, 2009 Fall Meeting, V24: Volatiles in the Earth - From Past to Present, San Francisco, California, U.S.A., December 14, 2009. (invited)
4. Abe, Y., Thermal state and surface environment of protoplanets, Origin and Evolution of Planets 2008, Ascona, Switzerland, July 2, 2008 (invited)
5. Abe, Y., Behavior of Water during Terrestrial Planet Formation, 17th Goldschmidt Conference - "atoms to planets", S-63: Keynote "Water in the Early Earth", Cologne, Germany, August 21, 2007 (invited)

Total 14

(2) Domestic Conferences

6. Abe, Y., Variety of water planets, Japan Geoscience Union Meeting 2010, Chiba,

2010.5.28. (contributed)

Total 41

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Hidenori Genda received the first Best Presentation Award of the Japanese Society of Planetary Sciences in his final year of doctor course student, 2003.

· T. Sasaki, PD, JSPS, 2008.

· T. Sasaki, DC1, JSPS, 2005.

· K. Hamano, DC1, JSPS, 2004

· H. Genda, PD, JSPS, 2004.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

· Member of the International Commission on Planetary Atmospheres and their Evolution of the International Association of Meteorology and Atmospheric Science, 2003-2009

· Member, Steering Committee, Japanese Society of Planetary Sciences, 2005-2006

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

· Committee member of the Disability Service Office, University of Tokyo, 2008-2012

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 1 [M.Sc.: 0, Ph.D.: 1 (Austria: 1)]

Foreign Researchers: 0

Sending

Japanese Students: 1 [M.Sc.: 0, Ph.D.: 1 (Australia: 1)]

Japanese Researchers: 0

Visitors from Abroad: 1

Masahiro Ikoma

I. C.V.

Name： Masahiro Ikoma
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education

B. Sc., Earth and Planetary Sciences, Tokyo Institute of Technology, March, 1996
M. Sc., Earth and Planetary Sciences, Tokyo Institute of Technology, March, 1998
Ph. D., Earth and Planetary Sciences, Tokyo Institute of Technology, March, 2001

Professional Experience

April, 2001-Mar., 2002, JSPS fellow, Department of Earth and Planetary Sciences, Tokyo Institute of Technology
April, 2002-Oct., 2004, JSPS fellow, Interactive Research Center of Science, Tokyo Institute of Technology
Nov., 2004-Feb., 2007, Project Research Associate, Department of Earth and Planetary Sciences, Tokyo Institute of Technology
Mar., 2007-Jan., 2012, Assistant Professor, Department of Earth and Planetary Sciences, Tokyo Institute of Technology
Feb., 2012-, Associate Professor, Department of Earth and Planetary Science, University of Tokyo.

II. Scientific Research Activity

2. Major achievements

I have researched the origin and internal structure of giant planets in the solar system and beyond, including Jupiter, Saturn, Uranus, Neptune, extrasolar gas giants, and super-Earths, and also the formation processes of atmospheres and oceans of terrestrial planets.

Origin and diversity of gas giant planets

Gas giant planets have high-density, icy/rocky cores that are surrounded by massive envelopes composed of hydrogen and helium. In the most widely accepted formation scenario called the core accretion model, when a core reaches a critical mass by growing through planetesimal accretion, it begins to capture the surrounding gas from a protoplanetary disk in a runaway fashion to form a massive envelope. I have done extensive parameter studies of the critical core mass and the final mass of gas giant planets. Through the studies, we found solutions that relax the problem that it takes too long time for Jupiter and Saturn to be formed. Also, we proposed a basic idea that accounts for the observed diversity of gas giant exoplanets.

Internal structure of giant planets

By modeling theoretically their structure that matches with the observed properties (e.g., planetary radii, planetary emission, gravitational moments, etc.), we infer the internal structure and compositions of the icy giants in the solar system, Uranus and Neptune, the hot-Jupiter HD149026b which is the first exoplanets detected by a Japanese group, and the first super-Earth CoRoT-7b. Furthermore, we constrained their origins, by comparing with our theoretical predictions as to the internal structure and compositions.

I have also investigated the equation of state of hydrogen under extremely high pressures

relevant to the deep interior of Jupiter. To do so, as the P.I., I have leaded a team of laser-induced shock high-pressure experiments in Institute of Laser Engineering, Osaka University. We obtained a new pressure-density relationship at pressures higher than previously reached.

Formation of atmospheres and oceans of terrestrial planets

We have researched the formation of atmospheres and oceans of terrestrial planets more broadly than previously. We investigated systematically the formation of hydrogen/helium atmospheres of nebular origin and possibilities of water production from the atmospheres. Then, we revisited the origin of water of the Earth within the modern context of planet formation. Also, we investigated the long-term evolution of the deuterium-hydrogen (D/H) ratio in the seawater, and we pointed out a problem with the chondritic origin hypothesis and claimed the necessity of revisiting the nebular origin.

Origin and orbital evolution of planets orbiting intermediate-mass red giants

Collaborating with observers who have been searching exoplanets around intermediate-mass (about 1.5 to 3 solar masses) red giants that have evolved off the main sequence, we have researched the dependence of outcome of planet formation processes on the mass of host stars. Recently, we simulated the orbital, tidal evolution of planets around evolving stars, and demonstrated that the observed properties of planetary orbits are not formed during evolution of the host stars, but remain as a result of planet formation processes.

3. Five Important Papers in your career

1. Ikoma, M., Nakazawa, K., and Emori, H. (2000), Formation of giant planets: dependences on core accretion rate and grain opacity. Astrophys. J., 537, 1013-1025.

A systematic study of the critical core mass and of gas giant formation. The number of citations is over 100 (Web of Science).

2. Inaba, S. and Ikoma, M. (2003), Enhanced collisional growth of a protoplanet that has an atmosphere, Astron. Astrophys., 410, 711-723.

The first paper that formulates the collisional cross-section for planetesimal capture by planetary atmosphere, which enabled to incorporate the effects of atmospheres on N-body simulations of planetary accretion.

3. Ikoma, M., Guillot, T., Genda, H., Tanigawa, T., and Ida, S. (2006), On the Origin of HD 149026b, Astrophys. J., 650, 1150-1159.

Inferred theoretically the internal structure of the gas giant exoplanets, HD 149026b, which was the first exoplanet discovered by a Japanese group, and proposed its formation scenarios.

4. Valencia, D., Ikoma, M., Guillot, T., and Nettelmann, N. (2010), Composition and fate of short-period super-Earths: The case of CoRoT-7b, Astron. Astrophys., 516, A20.

Modeled the internal structure of the first super-Earth, CoRoT-7b, and constrained its composition.

5. Sano, T., and 21 colleagues (2011), Laser-shock compression and Hugoniot measurements of liquid hydrogen to 55 GPa, Physical Review B 83, 054117.

Performed high-pressure experiments of hydrogen with laser-induced shockwave, as the P. I., and found a pressure-density relationship at pressures higher than previously reached.

4. Awards and Honors throughout your career

- The Japanese Society for Planetary Sciences, Award for Best Scientist (Nov. 2008)
- The Commendation for Science and Technology by the Minister of Education, Culture, Sports, Science and Technology, The Young Scientists' Prize (April, 2012)

5. Future Research Plan

My research goal is to clarify the diversity and origins of planets and planetary systems and understand how typical or atypical the life-harboring planet, the Earth, is in the universe. Then, I would like to contribute to future missions of search for life-bearing planets beyond the solar system, namely, exoplanets. To this end, in addition to continuing to develop theories of planet formation, I will devote much effort to characterization of exoplanets. Also, I will work on issues with the origin of our habitable planet, the Earth, and the evolution of the surface environments, and apply the knowledge from the Earth to exoplanets.

Until recently, the main target in exoplanet science has been gas giant planets that orbit close to their host stars. Also, dynamical aspects have been mainly discussed based on observed masses and orbital periods (i.e., distance to host stars). Recent progresses in observation techniques have enable us to detect distant gas giants like Jupiter and Saturn. Furthermore, as far as planets close to their host stars are concerned, their sizes, surface temperatures, thermal emissions, atmospheric compositions, and so on are measured. Several big projects (e.g., SEEDS, IRD) have started or are about to start also in Japan, so that we will likely have several observational results in several years. However, there are no researcher who analyze the data. I will do so with graduate students who will lead the exoplanets science in the future in Japan.

Specifically, for the next several years, I will focus partly on the transit observation that detects the drops in apparent stellar brightness that are caused by planets passing in front of their host stars. A merit in the transit observation is that the planet's size is determined, which enables us to infer the planet's composition by theoretical modeling of the planet's structure. I am planning to do theoretical population synthesis on the mass-size-period space by integrating planet formation processes. Comparing the theoretical predictions and observational results, I will clarify the origin of short-period planets. Furthermore, transit measurements with multiple different wavelengths reveal atmospheric compositions. This provides important constraints to planetary origin. Thus, collaborating with observers, we are developing a system for such simultaneous multi-wavelength observations.

I will also characterize distant gas giants by using the IR emission to explore the late stages of gas giant formation, because gas giants are shining by losing the accretion energy obtained in their late stages of formation. Such a study has a special importance for understanding the origin of the Earth. Our solar system is a system that has distant gas giants, namely, Jupiter and Saturn. Furthermore, such distant gas giants are likely to have played key roles in making the Earth habitable (e.g., delivery of volatile-bearing meteorites).

Finally, reflected light from Earth-like planets will probably be observed in a decade. It will be thereby possible to identify molecules in atmospheres and the presence of oceans, continents, and plants. I will research the origin and evolution of Earth-like planets more broadly and clarify the diversity of surface environments which may be relevant to the mergence and evolution of life. Also I will develop observational methods to verify theories that I will develop.

6. Funding Received

(1) JSPS Grants

· Scientific Research on Innovative Areas (Research in a Proposed Research Area) “New Frontiers of Extrasolar Planets: Exploring Terrestrial Planets”, 2011, 1 million yen.

· Grant-in-Aid for Scientific Research on Priority Areas “Development of Ex- extrasolar Planetary Science”, Public Research, “Variety of Planetary Atmosphere beyond the Solar System”, 2006, 1 million yen.

(2) Cooperative Research

· Institute of Laser Engineering, Osaka University. “Ultra-high-pressure experiments of hydrogen with hyper-laser and application to planetary interior.” 2006-2011, 3.33 million yen.

(3) Research Contracts

(4) Grants and Gifts

(5) Other

· Tokyo Tech Challenging Award, “Theoretical modeling of the atmospheric and interior structures of exoplanets orbiting M stars.” 2011, 100 million yen.

· The Program for Promoting Internationalization of University Education from the Ministry of Education, Culture, Sports, Science and Technology, Japan, 2008, 3 million yen.

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Hori, Y. and Ikoma, M. (2011), Gas giant formation with small cores triggered by envelope pollution by icy planetesimals. *Mon. Not. Royal Astron. Soc.*, 416, 1419-1429.
2. Kunitomo, M., Ikoma, M., Sato, B., Katsuta, Y., and Ida, S. (2011), Planet engulfment by ~1.5-3 Msun red giants. *Astrophys. J.*, 737, 66.
3. Fortney, J. J., Ikoma, M., Nettelmann, N., Guillot, T., and Marley, M. S. (2011), Self-consistent model atmospheres and the cooling of the solar system's giant planets. *Astrophys. J.*, 729, 32.
4. Sano, T., and 21 colleagues (2011), Laser-shock compression and Hugoniot measurements of liquid hydrogen to 55 GPa. *Physical Review B* 83, 054117.
5. Valencia, D., Ikoma, M., Guillot, T., and Nettelmann, N. (2010), Composition and fate of short-period super-Earths: The case of CoRoT-7b. *Astron. Astrophys.* 516, A20.
6. Hori, Y. and Ikoma, M. (2010), Critical core masses for gas giant formation with grain-free envelopes. *Astrophys. J.*, 714, 1343-1346.
7. Ozaki, N., and 24 colleagues (2009), Shock Hugoniot and temperature data for polystyrene obtained with quartz standard. *Physics of Plasmas*, 16, 062702.
8. Sato, B., and 13 colleagues (2008), Planetary companions around three intermediate-mass G and K giants: 18 Delphini, *x* Aquilae, and HD 81688. *Pub. Astron. Soc. J.* 60, 539.
9. Genda, H. and Ikoma, M. (2008), Origin of the ocean on the Earth: Early evolution of water D/H in a hydrogen-rich atmosphere. *Icarus* 194, 42-52.
10. Tanigawa, T. and Ikoma, M. (2007), A systematic study of the final masses of gas giant planets. *Astrophys. J.*, 667, 557-570.

11. Sato, B., and 13 colleagues (2007), A planetary companion to the Hyades giant *e* Tauri. *Astrophys. J.*, 661, 527-531.
12. Ikoma, M., Guillot, T., Genda, H., Tanigawa, T., and Ida, S. (2006), On the origin of HD 149026b. *Astrophys. J.*, 650, 1150-1159.
13. Ikoma, M. and Genda, H. (2006), Constraints on the mass of a habitable planet with water of nebular origin. *Astrophys. J.*, 648, 696-706.

(2) Selected Conference Proceedings

1. Ikoma, M. (2011), On the protoplanetary-disk origin of the atmospheres of hot super-Earths. Proceedings of Molecules in the Atmospheres of Extrasolar Planets, ASP Conference Series (J.P. Beaulieu, S. Dieteres, and G. Tinetti, eds., San Francisco: Astronomical Society of the Pacific), Vol. 450, p.105.

(3) Review Papers

1. Ikoma, M. (2012), Interior and Bulk Compositions of Transiting Exoplanets., The Astronomical Herald 105, 16-21. (Non-refereed)
2. Ikoma, M. and Ida, S. (2010) Recent Progresses in Exoplanet Exploration. Butsuri 65, 232-238. (Refereed)
3. Ikoma, M., Sano, T., Sakaiya, T., and Shigemori, K. (2008) Unveiling the Interior of Jupiter with High-Power Lasers: Equation of State of Hydrogen at Several 100 GPa. J. Plasma Fusion Res. Vol.84, 93‐99. (Non-refereed)
4. Ikoma, M. and Genda, H. (2007) Origins of Sea Water on the Earth. Journal of Geography 116, 196–210. (Refereed)
5. Ikoma, M. (2007) Origin of Jupiter, Kagaku 77, 186-187. (Non-refereed)

(4) Books

1. Ikoma, M. (2008) Formation of giant planets. In Modern Astronomy 9: Solar System and Planets (J. Watanabe, S. Ida, S, Sasaki eds., Nippon Hyoron Sha), pp. 210-216.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Ikoma, M. and Hori, Y., Accumulation of hydrogen-rich atmospheres of nebular origin on short-period super-Earths: Implications for Kepler-11 Planets, 1st Kepler Science Conference (NASA Ames Research Center, Moffett Field, CA. 2011.12.5-9) (Contributed)
2. Ikoma, M. Accumulation of Hydrogen-rich atmospheres onto the Earth and exo-Earths, ExoClimes 2010: Exploring the Diversity of Planetary Atmospheres (University of Exter, Exter, UK, 2010.9.10) (Contributed)
3. Ikoma, M., Orbital Evolution of Planets around Evolving Low- and Intermediate-Mass Stars, The 4th Workshop on Extrasolar Planet Search with Accurate Radial Velocity Measurements（Hokkaido, 2009.10.7） (Invited)
4. Ikoma, M., Accretion of exoplanets atmospheres, International Workshop on “Thermal Models for Planetary Science” (Beaulieu, France, 2008.9.15) (Invited)
5. Ikoma, M. and Genda, H., On the nebular origin of water on the Earth, Goldschmidt

conference 2007 (Cologne, Germany. 2007.8.19-24) (Invited)

and 9 more presentations.

(2) Domestic Conferences

6. Ikoma, M. Recent Development in Exoplanet Science: Super-Earths, Society of Evolutionary Studies Japan 2010 Tokyo Meeting (Tokyo Tech, 2010.8.5) (Invited)
7. Ikoma, M. Composition, Interior Structure, and Evolution of Short-Period Super-Earths and Hot-Neptunes: The Mass-Radius Relationships for Transiting Low-Mass Exoplanets, 7th Workshop on Exoplanets (NAOJ, 2011.3.9) (Invited)
8. Ikoma, M. Origin and Internal Structure of Giant Planets. JSPS 2009 fall meeting. (Univ. Tokyo, 2009.9.29) (Invited)
9. Ikoma, M., Valencia, D., and Guillot, T., Anatomizing Short-Period Super-Earths: Mass and composition of CoRoT-7b. ASJ 2009 fall meeting (Univ. Yamaguchi, 2009.9.16) (Contributed)
10. Ikoma, M. Importance of Equation of State of H-He Mixture at High Pressures on Planet Formation Theory. JpGU 2006 Meeting (Makuhari, Chiba, 2006.5.17) (Invited)

and 7 more presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Japanese Society for Planetary Sciences (JSPS), a member of editorial board

(2) Academic Societies

· JSPS, a member of the award selection committee

· JSPS, a member of the committee of general purpose

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Public Lecture “What are super-Earths? Answering the mystery of giant Earth-type planets” (Sumida-ku Planetarium, 2010.6.12)

· Science Café (WaMuse, Kichijoji, 2010.9.26)

· Lecture at Culture Center “Super-Earths” (Asahi Culture School, Shinjuku, 2010.1.30)

· Public Lecture “Various Planetary Systems in the Universe” (Univ. Tsukuba, 2009.7.4)

· Lecture at Elementary School “Planet Where You Live” (The Japanese Weekend School of Cote d’Azur, France, 2009.1.31)

· Lecture at Culture Center “Frontier of Astronomy: Emerging Exoplanets”（Asahi Culture School, Yokohama, 2007.2.17）

· Public Lecture “Our Solar System and Other Planetary Systems” (Suginami-ku Science Museum, 2006.11.4)

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 0

Satoshi Takahashi

I. C.V.

Name： Satoshi Takahashi
Present Position: Assistant Professor, University of Tokyo, Graduate School of Science

Education

B. Sc., Geology and Paleontology, Science, Tohoku University, March, 2006
M. Sc., Geology and Paleontology, Science, Tohoku University, March, 2008
Ph. D., Geology and Paleontology, Science, Tohoku University, March, 2011

Professional Experience

April, 2009-Mar., 2011, Research Fellow of Japan Society for the Promotion of Science (DC1), Tohoku University Japan.
April, 2011-present, Assistant Professor of Department of Earth and Planetary Science, University of Tokyo, Japan.

II. Scientific Research Activity

2. Major achievements

1. Geology of North Kitakami Belt, Iwate, Japan(2006-)

Our geologic fieldwork around the range area of Iwaizumi tectonic line in the North Kitakami Belt (Jurassic Accretionary complex) provided geologic map, conodont fossil age, and mineral compositions of sandstone and its distribution. (Takahashi et al., 2006; Ehiro et al., 2008；Takahashi et al., in prepare)

2. Study on the Japanese pelagic deep-sea sedimentary rocks of Permian to Triassic (2008-)

We described oceanic environmental changes that took place in the paleo-super-ocean “Panthalassa”during the end-Permian mass extinction and its aftermath, based on data from pelagic deep-sea sedimentary rocks of latest Permian-earliest Triassic to Early Triassic, exposed in the north Kitakami area of northern Japan (Akkamori section-2: Am-2 section; Takahashi et al., 2009) and the Central Japan (Momotaro-jinja section).

In the former section, radiolarian abundances decrease and total organic carbon (TOC) increases at the boundary between a siliceous claystone and overlying black claystone near the top of the Permian stratigraphic interval, suggesting that oceanic anoxia caused radiolarian demise at the end of the Permian. At the end-Permian level, carbon isotope ratio of organic matter ($\delta^{13}C_{org}$) exhibit a negative shift of 2.0‰, with no temporary $\delta\ ^{13}C_{org}$ increases (Takahashi et al., 2010). This smooth negative shift in δ13Corg in end-Permian strata in pelagic Panthalassa may indicate comparatively minimal algal and bacterial increases in pelagic Panthalassa, relative to theshallow-water Paleotethys where temporary increases in green sulfur bacteria productivity took place. The sulfur isotope ratio of sulfide (δ^{34}Ssulfide) demonstrates a 10‰ rise in the Late Permian followed by a sharp drop (return to pre-rise values) in the latest Permian. These large sulfur isotopic increases and ensuing decreases have also been reported in carbonate-associated sulfates from the end-Permian mass extinction horizon in the shallow-water Paleo-tethys. Such strong variation in sulfur isotopic values suggests the accumulation of H_2S followed by a massive release of ^{32}S-enriched sulfur to the shallow ocean environment at the end of the Permian.

In the latter section, we detected high concentrations of sulphur-included organic molecule in at the end of the upper Early Triassic, suggesting that anoxic deep water pools developed during these times. Anoxia may have been associated with the delay in the recovery of life after the end-Permian mass extinction.

3. Study on the pelagic deep-sea sedimentary rocks in New Zealand (2006-)

We conducted stable carbon and sulphur isotope analysis of the Permian-Triassic deep-sea sedimentary sequence in the Northland, New Zealand (Hori et al., 2011; Takahashi et al., in review)

3. Five Important Papers in your career

1. Satoshi Takahashi, Satoshi Yamakita, Noritoshi Suzuki, Kunio Kaiho, Masayuki Ehiro, High organic carbon content and a decrease in radiolarians at the end of the Permian in a newly discovered continuous pelagic section: a coincidence?, Palaeogeography, Palaeoclimatology, Palaeoecology, Elsevier, 271, 1-12, 2009.

Citation number is 14 (web of science). This paper shows the most continuous pelagic deep-sea stratigraphic record of Permian-Triassic with coincidence of microfossil decrease and anoxic water mass development.

2. Satoshi Takahashi, Masahiro Oba, Kunio Kaiho, Satoshi Yamakita, Susumu Sakata, Panthalassic oceanic anoxia at the end of the Early Triassic: a cause of delay in the recovery of life after the end-Permian mass extinction, Palaeogeography, Palaeoclimatology, Palaeoecology, Elsevier, 274, 185-195, 2009.

Citation number is 6 (web of science). This literature is preceded paper suggesting pelagic anoxic deep-water development at the end of the Early Triassic.

3. Satoshi Takahashi, Kunio Kaiho, Masahiro Oba, Takeshi Kakegawa, A smooth negative shift of organic-carbon isotope ratios at an end-Permian mass extinction horizon in central pelagic Panthalassa, Palaeogeography, Palaeoclimatology, Palaeoecology, Elsevier, 292, 532-539, 2010.

Citation number is 1. This paper showed continuous stable carbon isotope record from Permian/Triassic boundary of pelagic deep sea, for the first time in Japan.

4. Yuichiro Nishikane, Kunio Kaiho, Satoshi Takahashi, Charles M. Henderson, Noritoshi Suzuki, Mizuho Kanno, The Guadalupian–Lopingian boundary (Permian) in a pelagic sequence from Panthalassa recognized by integrated conodont and radiolarian biostratigraphy, Marine Micropaleontology 78, 84-95, 2011.

Citation number is 1 (web of science). This study reported the first identification of the continuous Guadalupian–Lopingian boundary section in pelagic deep-sea using conodont fossil. This achievement provide source material of geologic time-scale in the pelagic deep-sea.

4. Awards and Honors throughout your career

- Satoshi Takahashi, Best poster award, Paleontological Society of Japan, 4 July 2008.
- Satoshi Takahashi, Aoba Society for the Promotion Science Encouragement Award, Aoba Society for the Promotion Science of Tohoku University, 19 March 2010.
- Satoshi Takahashi, Research encouragement award（Taguchi Award）, The Japanese Association of Organic Geochemists, 22 August 2012.

5. Future Research Plan

Long-term objective: Reconstruct environmental history in the past recorded in the sedimentary rocks. Especially, I focus on the significant environmental changes in the Earth history, its spatio-temporal extensity, contemporaneous responses of life, using paleontological and geochemical methods.

Short term objective : My study focus on environmental history of Late Permian to Early Triassic those are characterized by the most severe mass extinction and its aftermath. The main study material is from the pelagic sequence of the Panthalassic super ocean (paleo-Pacific) which is preserved in the accretion complex such as that located in Japan (low-latitude) and New Zealand (middle to high latitude). Recent studies have shown that such oceanic area have different history from that of the low latitude oceanic area. For example, silicic zoo-planktonic recovery (radiolarians) after the mass extinction in the middle latitude-ocean precedes by ca. 5 million years than that of low latitude area. My study project aims to reconstruct the Late Permian to Middle Triassic pelagic deep-sea sequence from several possible localities from Japan and New Zealand. And then combination of study results between these areas would provide cause of different biotic history at each latitude oceanic area.

Research Plan for short-term objective:

(1) Field work and sampling

Distribution area of Japan (North Kitakami mountains, Central Japan, etc.) and New Zealand (North Island, South Island).

(2) Conodont (most useful index fossil for Permian-Triassic) biostratigraphy

(3) Stable carbon isotope analysis for chemo stratigraphy

(4) Organic geochemical analysis for identification of primal products

Tool: GC-MS, GC-IRMS

(5) Inorganic (trace elements) geochemical analysis for redox variation at the sea floor

Tools: XRF, ICP-MS

(6) Stable isotope analysis of Molybdenum and Uranium for estimation of global extent of oxygen-poor seafloor

Tool: MC-ICP-MS

(7) Reconstruction of oceanic environmental history at low-latitude and middle latitude pelagic ocean and their comparison for clarification of cause of mass extinction and its prolonged aftermath

6. Funding Received

(1) JSPS Grants

- JSPS Grants-in-Aid（DC1）、April 2009 - March 2011, 1.2 million yen
- JSPS Grants-in-Aid (Research activity start-up), Oct 2011 – March 2012, 2.5 million yen
- JSPS Grants-in-Aid (Grant-Aid for young Scientists B), April 2012-, 2.21 million yen

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

- Satoshi Takahashi, Financial support for Ph.D. student award, IGCP 572, 4 June 2011, 700 Australia dollars

· Satoshi Takahashi, Fujiwara natural history promotion foundation, March 2012- March 2013, 0.75 million yen

(5) Other

· Satoshi Takahashi、Overseas Internship Program for Outstanding Young Earth and Planetary Researchers, Department of Earth and Planetary Science, University of Tokyo, Visiting research in GNS science New Zealand, February 2012- May 2012

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Noritoshi Suzuki, Satoshi Yamakita, Satoshi Takahashi, Masayuki Ehiro, Middle Jurassic radiolarians from carbonate manganese nodules in the Otori Formation in the eastern part of the Kuzumaki-Kamaishi Subbelt, the North Kitakami Belt, Northeast Japan, Journal of Geological Society of Japan 113, 247-277, 2007. (In Japanese with English abstract)
2. Masayuki Ehiro, Satoshi Yamakita, Satoshi Takahashi, Noritoshi Suzuki, Jurassic accretionary complexes of the North Kitakami Belt in the Akka-kuji area, North Japan, Journal of Geological Society Japan 114, 121-139, 2008. (In Japanese with English abstract)
3. Satoshi Takahashi, Satoshi Yamakita, Noritoshi Suzuki, Kunio Kaiho, Masayuki Ehiro, High organic carbon content and a decrease in radiolarians at the end of the Permian in a newly discovered continuous pelagic section: a coincidence?, Palaeogeography, Palaeoclimatology, Palaeoecology, Elsevier, 271, 1-12, 2009.
4. Satoshi Takahashi, Masahiro Oba, Kunio Kaiho, Satoshi Yamakita, Susumu Sakata, Panthalassic oceanic anoxia at the end of the Early Triassic: a cause of delay in the recovery of life after the end-Permian mass extinction, Palaeogeography, Palaeoclimatology, Palaeoecology, Elsevier, 274, 185-195, 2009.
5. Masahiro Oba, Masahiro Nakamura, Yoshihiko Fukuda, Masatoshi Katabuchi, Satoshi Takahashi, Masataka Haikawa, Kunio Kaiho, Benzohopanes and diaromatic 8(14)-secohopanoids in some Late Permian carbonates. Geochemical Journal, The Geochemical Society of Japan, 43, 29-35, 2009.
6. Satoshi Takahashi, Kunio Kaiho, Masahiro Oba, Takeshi Kakegawa, A smooth negative shift of organic-carbon isotope ratios at an end-Permian mass extinction horizon in central pelagic Panthalassa, Palaeogeography, Palaeoclimatology, Palaeoecology, Elsevier, 292, 532-539, 2010.
7. Kunio Kaiho, Masahiro Oba, Satoshi Takahashi, Yoshihiko Fukuda, Seiji Koga, Zhong-Qiang, Chen, Satoshi Yamakita, An abrupt decrease in atmospheric oxygen by massive release of hydrogen sulfide during the end-Permian mass extinction. Journal of Earth Science 21, Special Issue, 141-142, 2010.
8. Yuichiro Nishikane, Kunio Kaiho, Satoshi Takahashi, Charles M. Henderson, Noritoshi Suzuki, Mizuho Kanno The Guadalupian–Lopingian boundary (Permian) in a pelagic sequence from Panthalassa recognized by integrated conodont and radiolarian biostratigraphy, Marine Micropaleontology 78, 84-95, 2011.
9. Rie S. Hori, Satoshi Yamakita, Minoru Ikehara, Kazuo Kodama, Yoshiaki Aita, Toyosaburo Sakai, Atsushi Takemura, Yoshihito Kamata, Noritoshi Suzuki, Satoshi Takahashi, K. Bernhard Spörli, Jack A. Grant-Mackie, Early Triassic (Induan) Radiolaria and carbon-isotope ratios of a deep-sea sequence from Waiheke Island, North Island, New Zealand, Palaeoworld 20, 2011, 168-178.

10. Kunio Kaiho, Masahiro Oba, Yoshihiko Fukuda, Kosuke Ito, Shun Ariyoshi, Paul Gorjan, Yuqing Riu, Satoshi Takahashi, Zhong-Qiang Chen, Jinnan Tong, Satoshi Yamakita, 2012 in press, Changes in depth-transect redox conditions spanning the end-Permian mass extinction and their impact on the marine extinction: Evidence from biomarkers and sulfur isotopes. Global and Planetary Change, in press.
11. Ryosuke Saito, Kunio Kaiho, Masahiro Oba, Satoshi Takahashi, Zhong-Qiang Chen, Jinnan Tong, A terrestrial vegetation turnover in the middle of the Early Triassic, Global and Planetary Change, in press.

(2) Selected Conference Proceedings

1. Satoshi Takahashi, Kunio Kaiho, Masahiro Oba, Takeshi Kakegawa, A smooth negative shift of organic-carbon isotope ratios at an end-Permian mass extinction horizon in central pelagic Panthalassa, Journal of Earth Science 21, Special Issue, 165-166, 2010.

(3) Review Papers

1. Satoshi Takahashi, Masayuki Ehiro, Noritoshi Suzuki, Geology of North Kitakami Belt: Jurassic accretionary complex in western Akka district, Iwaizumi town (summary report), Geology of Iwate vol. 35-36, Associate of Geologic education Iwate, 65-70, 2006. (in Japanese Non-refereed)
2. Satoshi Takahashi, Satoshi Yamakita, Noritoshi Suzuki, Kunio Kaiho, Masayuki Ehiro, The end-Permian Mass extinction: the newly discovered Permian-Triassic boundary, Geology of Iwate 39, Associate of Geologic education Iwate, 1-11, 2009. (in Japanese, Non-refereed)

(4) Books

1. Satoshi Takahashi, Noritoshi Suzuki, 5.4 Conodont : searching deep-sea fossil age, In: Yoshihiro Tanimura, Akihiro Tsuji (Eds.), Microfossil, National museum of nature and science museum library13, Tohkai University Press, pp. 273-275. (in Japanese)
2. Satoshi Takahashi, Noritoshi Suzuki, Yuichiro Nishikane, 4.1.6 Conodont, In: Yoshihiro Tanimura, Akihiro Tsuji (Eds.), Microfossil, National museum of nature and science museum library13, Tohkai University Press, pp.125-133. (in Japanese)

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Satoshi Takahashi, Kunio Kaiho, Masahiro Oba, Takeshi Kakegawa, A smooth negative shift of organic-carbon isotope ratios at an end-Permian mass extinction horizon in central pelagic Panthalassa, International Geobiology Conference, Wuhan, China, June, 2010. (oral presentation, reviewed)
2. Satoshi Takahashi, Kunio Kaiho, Masahiro Oba, Satoshi Yamakita, Noritoshi Suzuki, Masayuki Ehiro, Takeshi Kakegawa, Shin-ichi Yamasaki, Yasumasa Ogawa, Kazuhiko Kimura, Takahiro Watanabe, Takeyoshi Yoshida, Noriyoshi Tsuchiya , Paleontological and Geochemical Studies of the Latest Permian-Early Triassic Deep-Sea Sedimentary Rocks, B3-06, G-COE symposium 2012 Achievements of GCOE Program for Earth and Planetary Dynamics and the Future Perspective, Sendai, Japan, 27 September, 2012 (oral presentation, invited)

Total number of presentations is 15.

(2) Domestic Conferences

3. Satoshi Takahashi, Kunio Kaiho, Satoshi Yamakita, Masahiro Oba, Takeshi Kakegawa, Takahiro Watanabe, Shin-ichi Yamasaki, Yasumasa Ogawa, Kazuhiko Kimura, Noriyoshi Tsuchiya Takeyoshi Yoshida, Susumu Sakata, Noritoshi Suzuki, Masayuki Ehiro, Paleontological and Geochemical Studies of the Latest Permian-Early Triassic Deep-Sea Sedimentary Rocks, Reconstruction of palaeo-environmental variations during the end-Permian mass extinction and its aftermath at the pelagic super-ocean, ID13(Invited), Geochemical Society Japan, Hokkaido University, Sapporo, September 2011, (in Japanese, Oral, Invited).

4. Satoshi Takahashi, Research achievement on Permian-Triassic boundary section in the North Kitakami Mountains, 65th symposium the association for the geological collaboration Japan, Hirosaki University, Hirosaki, August 2011, (in Japanese, Oral, Invited).

Total number of presentations is 60.

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

· The election management committee of Geological society Japan, April 2011-March 2012

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

(1) Contribution for Society

· Donation of polished rock specimen of Permian-Triassic boundary for Iwate prefectural museum, June 2009.

· Lecturer of 59th field trip of Iwate prefectural museum, 4 July 2010.

· Lecturer of "Kojunsya" environmental research association, 2 June 2011.

· Carrier-up class for "Ohkashiwa" primary school, Tokyo, 9 February, 2011

· Carrier-up class for "Suwadai" Junior school, Tokyo, 30 June, 2012.

· Lecturer in "Rainbow concert", Nara, 13 October, 2012.

(2) Media articles (all article are written in Japanese)

· Mass extinction boundary section from Iwaizumi town, discovered by Tohoku University research group, Daily Iwate (Iwate Nippou), 7 February 2009, top article.

· Achievement of geological study by Takahashi from Kitakami city, Daily Iwate (Iwate Nippou), 8 February 2009, page 20.

· The key to mystery of mass extinction, Daily Iwate evening edition (Iwate Nippou), 16

February 2009, page 4.

- Geologic strata of mass extinction, Asahi shimbun Miyagi edition, 14 March 2009, page 12.
- Sea-reptile in ancient ocean of Tohoku, Asahi shimbun, 19 September 2011

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 0

Hidenori Genda

I. C.V.

Hidenori Genda
Present Position: Global COE Assistant Professor, University of Tokyo, Graduate School of Science

Education

B. Sc., Physics, Keio University, March, 1999
M. Sc., Geophysics, The University of Tokyo, March, 2001
Ph. D., Geophysics, The University of Tokyo, March, 2004

Professional Experience

April, 2004-Mar., 2007, JSPS Fellow, Department of Earth and Planetary Sciences, Tokyo Institute of Technology, Japan
April, 2007-Mar., 2008, COE program post-doctoral Fellow, Department of Earth and Planetary Sciences, Tokyo Institute of Technology, Japan
April, 2008-Sept., 2009, COE program Assistant Professor, Department of Earth and Planetary Sciences, Tokyo Institute of Technology, Japan
Oct, 2009-, Global COE program Associate Professor, Department of Earth and Planetary Science, The University of Tokyo, Japan

II. Scientific Research Activity

2. Major achievements

In order to know how the characteristics and diversities of the planets including exoplanets have been formed, I have investigated the following topics so far: the origin of the atmospheres and ocean (2006-2007), planetary formation considering detail impact process (2008-), and habitability of the planet (2009-).

Research on the origin of the atmospheres and ocean

I investigated the atmosphere formation of the terrestrial planets during planet formation. Especially, I focused on the giant impacts occurred during the last stage of terrestrial planet formation. I firstly showed that the differences between the Earth's and Venus' atmospheres were made during the giant impact stage. This research was published in Nature.

The planets form in gaseous protoplanetary disk, and gravitationally attract the surrounding nebular gas. I proposed new process that the water comes from such a nebular atmosphere. I also showed that the D/H of the Earth's ocean easily increases during 4.6 Gyr through the isotopic exchange and hydrogen escape. This is important for the origin of the ocean on the Earth.

Research on planetary formation

The impact process is the most essential one during planetary formation. Owing to its energetic phenomena, the impacts determine the characteristics and diversities of the planets. I finished making the code for the impact calculation. Using this impact code, I investigated many problems in the field of planetary science. For example, I collaborated with the group of impact experiment, and published the paper about the origin of Titan's atmosphere in Nature

Geoscience.

Research on the habitability of the planet

A lot of extrasolar planets have been discovered so far. In the future, the extra solar planets with ocean and even life like the Earth will be discovered. However, it is not always true that such extrasolar planets have the same amount of ocean and surface environment with the Earth. Therefore, I have just investigated the habitability of the planet that is slightly different from the Earth, using GCM (general circulation model) and EBM (energy balance model).

3. Five Important Papers in your career

1. Genda, H., and Y. Abe (2003) Survival of a proto-atmosphere through the stage of giant impacts: the mechanical aspects, Icarus, 164, 149−162.

Citation 37, featured in News and Views – Nature

2. Genda, H., and Y. Abe (2005) Enhanced atmospheric loss on protoplanets at the giant impact phase in the presence of oceans, Nature, 433, 842−844.

Published in Nature

3. Genda, H., and M. Ikoma (2008) Origin of the ocean on the Earth: Early evolution of water D/H in a hydrogen-rich atmosphere, Icarus, 194, 42−52.

Innovative research of the origin of the ocean

4. Sekine, Y., H. Genda, S. Sugita, T. Kadono, and T. Matsui (2011) Replacement and late formation of atmospheric N2 on undifferentiated Titan by impacts, Nature Geoscience, 4, 359-362.

Published in Nature Geoscience

5. Genda, H., E. Kokubo, and S. Ida, Merging Criteria for Giant Impacts of Protoplanets. Astrophysical Journal 744, 137(8pp) (2012).

Innovative research of the giant impacts

4. Awards and Honors throughout your career

· Best Presentation Award at Fall Meeting of Japan Society of Planetary Science (October 2003)

5. Future Research Plan

In the field of planetary science, comparison among the planets in the solar system is the important method to understand the objective planet in detail. This method is called ‘comparative planetary science’. I am planning to expand such a method to extrasolar planets, that is, ‘comparative exoplanetary science’. Based on this concept, I consider the particularity and generality of the Earth, and finally find the answer toward the ultimate question why the life appeared and evolved on the Earth. This topic is interdisciplinary, related to many fields such as planetary science, geology, biology, and astronomy.

A lot of extrasolar planets have been discovered so far. The information about extrasolar planets is increasing more and more. I am planning to investigate planet formation considering the detail impact process. The impact process has an influence on the various characteristics of

the extrasolar planets such as the size, spin state, and the existence of the satellite. Finally, I want to comprehend the diversity of extrasolar planets from many directions.

I will investigate the criterion for making the planet habitable. First of all, I make detailed investigation of the Earth, and dig into the Earth, and extract the essential prerequisite for making the planet habitable. I investigate the conditions that meet in the extrasolar system.

Recently, I showed that the giant impacts produce a large amount of debris around the central stars. I proposed that the giant impact fragments have influences on the orbital elements of the terrestrial planets, geochemistry of the Earth, and early reducing surface environment on the Earth. This research was one of missing link between planet formation history and Earth's geological history. This is made through the discussion with many researchers who are professional in astronomy, planetology, geology, and geochemistry. I want to investigate such a cross-sectional topic.

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for JSPS Fellows, Mixing effect of degassed and captured atmosphere on atmosphere formation of terrestrial planet, 2004-2006, ¥3,400,000.

· Grant-in-Aid for Young Scientists (B), Impact process and planetary formation, 2008-2009, ¥2,700,000.

· Grant-in-Aid for Young Scientists (B), GPU computing of impact process, 2010-202, ¥2,000,000.

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Genda, H., and M. Ikoma (2008) Origin of the ocean on the Earth: Early evolution of water D/H in a hydrogen-rich atmosphere, Icarus, 194, 42−52.
2. Ikoma, M., T. Guillot, H. Genda, T. Tanigawa, and S. Ida (2006) On the origin of HD149026b, The Astrophysical Journal, 650, 1150−1159.
3. Genda, H., and M. Ikoma (2008) Origin of the ocean on the Earth: Early evolution of water D/H in a hydrogen-rich atmosphere, Icarus, 194, 42−52.
4. Genda, H., M. Ikoma, T. Guillot, and S. Ida (2008) Formation of heavy element rich giant planets by giant impacts, In: Sun, Y.-S., Ferraz-Mello, S. and Zhou, J.-L. (Eds), Exoplanets: Detection, Formation and Dynamics, IAU Symposium No. 249, 267-270.
5. Fukuzaki, S., Y. Sekine, H. Genda, S. Sugita, T. Kadono, and T. Matsui (2010) Impact-induced N_2 production from ammonium sulfate: Implications for the origin and evolution of N_2 in Titan's atmosphere, Icarus, 209, 715-722.
6. Kokubo, E., and H. Genda (2010) Formation of terrestrial planets from protoplanets under a realistic accretion condition, The Astrophysical Journal Letter, 714, L21-L25.
7. Sekine, Y., H. Genda, S. Sugita, T. Kadono, and T. Matsui (2011) Replacement and late

formation of atmospheric N_2 on undifferentiated Titan by impacts, Nature Geoscience, 4, 359-362.

8. Hong, P. K., S. Sugita, N. Okamura, Y. Sekine, H. Terada, N. Takatoh, Y. Hayano, T. Fuse, T. Pyo, H. Kawakita, D. H. Wooden, E. F. Young, P. G. Lucey, K. Kurosawa, H. Genda, J. Haruyama, R. Furusho, T. Kadono, R. Nakamura, S. Kamata, T. Hamura, T. Sekiguchi, M. Soma, H. Noda, and J. Watanabe (2011) A ground-based observation of the LCROSS impact events using the Subaru Telescope, Icarus, 214, 21-29.
9. Sekine, Y., and H. Genda (2012) Giant impacts in the Saturnian System: A possible origin of diversity in the inner mid-sized satellites, Planetary and Space Science, 63-64, 133-138.
10. Genda, H., E. Kokubo, and S. Ida, Merging Criteria for Giant Impacts of Protoplanets. Astrophysical Journal 744, 137(8pp) (2012).

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Genda, H., Giant impacts and terrestrial planet formation, Asia Oceania Geosciences Society 6th Annual Meeting, Suntec, Singapore, 2009. <invited talk>
2. Genda, H., and M. Ikoma, Nebular origin of water on Earth - Impact origin of water, Origins of Water Workshop, Hawaii, February, 2008. <invited talk>

plus 24 presentations

(2) Domestic Conferences

40 presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Genda, H., Planetary Formation, a public talk in Toda-shi public university, 2009.12.

· Genda, H., Cosmic Front in TV (NHK BS), provision of scientific information, 2011.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 0

Nobuhiro Moteki

I. C.V.

Name： Nobuhiro Moteki

Present Position: Project Assistant Professor, University of Tokyo, Graduate School of Science, Department of Earth and Planetary Science.

Education

B. Sc., Chemistry, Tokyo Institute of Technology, March, 2003

M. Sc., Earth and Planetary Science, The University of Tokyo, March, 2005

Ph. D., Earth and Planetary Science, The University of Tokyo, March, 2008

Professional Experience

April, 2005-Mar., 2008, JSPS Research Fellow (DC1)

April, 2008-Mar., 2011, Assistant Professor, University of Tokyo, Research Center for Advanced Science and Technology

April, 2011-Present, Project Assistant Professor, University of Tokyo, Graduate School of Science, Department of Earth and Planetary Science.

II. Scientific Research Activity

2. Major achievements

1. Aerosol Measurements and Atmospheric Environmental Science (Papers 2,7,8,9~23)

I have investigated climatology and changing process of microphysical properties of atmospheric aerosols, including size-resolved number concentration, chemical composition, and mixing states, based on ground and aircraft observations (Papers 7, 9~23). Any techniques of measuring atmospheric aerosols suffer from systematic error depending on the principle of the technique, because of the physical and chemical complexities of atmospheric aerosols. I have investigated the methods to interpret and reduce the systematic error of aerosol measurements from theoretical and experimental points of view (Papers 2,8). Black carbon aerosols, one of the carbonaceous aerosol emitted from incomplete combustion of fossil fuel and biomass, has been recognized to be the second most important contributor of human induced global warming. In this 10 years, climate scientists have been recognized the importance of understanding climatology and changing process of concentration and microphysical properties of black carbon aerosols in the atmosphere in global scale. In this 6 years, I have contributed to develop and improve a new technique of black carbon measurement in the atmosphere: the laser-induced incandescence (LII) technique (Papers 2,8). By using the LII technique deployed on aircrafts and ground observation sites, I have elucidated the size-resolved number concentration and mixing states of black carbon aerosols in troposphere over East Asia, North America, and Arctic (Papers 9,10). In addition, I have validate the regional model with new aerosol microphysical scheme considering mixing state of black carbon aerosols by using the observation data obtained by the LII technique (Paper 16).

2. Optics of small particles (Papers 1,3,5,6)

I have investigated optics of small particles by theoretical and experimental viewpoints for the purposes of possible applications to the new methods of aerosol measurements. The major contributions are the first robust algorithm to quantify optical properties of aerosols

evaporating in a laser beam (Paper 6), new method to estimate refractive index of small nonspherical particles (Paper 3), and first experimental verification of anisotoropy and polarization of thermal emission from nonspherical particles smaller than the wavelength (Paper 1,5). The last contribution is the first experimental proof of the generalized Kirchhoff's law first deduced by Rytov (1953), which predicts polarization and directionality of thermal emission from particles of arbitrary shape and size (Paper 1). This work is the most innovative contribution to the science in my previous studies.

3. Five Important Papers in your career

Cited number is according to Google Scholar (October 15, 2012)

1. Moteki, N., N. Takegawa, K. Koizumi, T. Nakamura, and Y. Kondo, Multi-angle polarimetry of thermal emission and light scattering by individual particles in airflow, *Aerosol Science and Technology*, 45, 1184-1198, 2011. Cited number 0.

This paper report the first experimental evidence of polarized and anisotropic thermal emission from nonspherical particles smaller than the wavelength, associated with comparison with general theory of thermal emission. This optical phenomenon is fundamental and important fining for applications to the aerosol measurements and radiative transfer.

2. Moteki, N., and Y. Kondo, Dependence of laser-induced incandescence on physical properties of black carbon aerosols: Measurements and theoretical interpretation, *Aerosol Science and Technology*, 44, 663-675, 2010. Cited number 26.

This paper describe the fundamental theory of the laser-induced incandescence (LII) method for black carbon measurements and experimental validations of the theory. This paper first shows how to interpret and reduce systematic error in LII method for measuring black carbon in atmosphere.

3. Moteki, N., and Y. Kondo, Method to measure time-dependent scattering cross section of particles evaporating in a laser beam, *Journal of Aerosol Science*, 39, 348-364, 2008. Cited number 17.

This paper introduce an mathematical algorithm to quantify laser-induced particle evaporation in a laser beam in light scattering techniques of aerosol measurements. This algorithm provide a theoretical basis of measurements of thickness of non-refractory coatings on black carbon core, which is important for quantify the radiative forcing of black carbon aerosols.

4. Moteki, N., Y. Kondo, Y. Miyazaki, N. Takegawa, Y. Komazaki, G. Kurata, T. Shirai, D. R. Blake, T. Miyakawa, and M. Koike, Evolution of mixing state of black carbon particles: Aircraft measurement over the western Pacific in March 2004, *Geophysical Research Letters*, 34, L11803, doi:10.1029/2006GL028943, 2007. Cited number 51.

This paper report for the first time the growth rate of coating thickness of black carbon aerosols in the atmosphere. This result has been considered in aerosol wet removal schemes of recent regional air quality models and global climate models.

5. Moteki, N., and Y. Kondo, Effects of mixing state on black carbon measurements by laser-induced incandescence, *Aerosol Science and Technology*, 41, 398-417, 2007. Cited number 61.

This paper report for the first time the experimental and modeling results of internally-mixed black carbon aerosols by laser-induced incandescence (LII) method. This paper is continues to

be referred by many current studies on black carbon measurements by LII technique.

4. Awards and Honors throughout your career

5. Future Research Plan

In the near future, I will concentrate on the theoretical and experimental researches on optics of small particles. Optics of small particles is one of the fundamental topics in radiative transfer and particle characterization technique, which have many applications in astronomy, atmospheric science, biology, and other technical fields. Especially in the atmospheric science, accurate estimates of aerosol radiative forcings and remote sensing of aerosols and clouds require validated theoretical and numerical methods to compute scattering and absorption by small particles. In my research career, I have clarified two outstanding problems in optics of small particles. The first problem is the lack of the verified numerical methods to compute scattering and absorption by highly-nonspherical and strongly-absorbing particles. In volume integral equation methods (VIEM), the most general method suitable for computations of internally-mixed nonspherical particles, we need to solve integral equation of internal electric field of particles by numerically discretizing volume of a particle. The first problem in current VIEM is the large overestimation of absorption in long wavelength limit. The second problem is the erroneous optical response of volume elements near the particle surface that can lead significant overall error as the surface to volume ratio of the particle increases. I will challenge this problem from rigorous electromagnetics and statistical physics of dielectric and metallic solids. In this challenge, I utilize the recently accumulating knowledge of verified numerical computation, including sophisticated schemes to solve integral equation and stable methods for ill-conditioned matrix computations.

The second problem is the lack of verified method to measure optical constants (refractive index for dielectric constatnt) of nonspherical absorbing particles. In atmospheric aerosols, mineral dust and black carbon are absorbing particles contributing heating of the atmosphere. Current estimate of radiative effects of dusts and black carbon rely on obsolete and unverified database of optical constants. I will challenge to develop a new verified and standard experimental method to determine optical constants of nonspherical absorbing particles including mineral dust and black carbon, based on the measurements of scattering and absorption coefficients of sample particles mono-dispersed in mass. The verified computations of scattering and absorption by nonspherical absorbing particles are necessary for error analysis of this new experimental method. Therefore, I will solve the problem on computational method of VIEM first, then I will start to work on the new experimental methods for measuring optical constants.

6. Funding Received

(1) JSPS Grants

- Grants-in-Aid for Young Scientists (Startup), Development of a method to measure shape of soot particles by using polarized thermal emissions, FY2008~FY2009, Total ¥3081000.
- Grants-in-Aid for Young Scientists (B), Methods to infer shape of black carbon particles based on polarization and directionality of thermal emission, FY2010-FY2011, Total ¥4420000.

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

（First Author）

1. Moteki, N., N. Takegawa, K. Koizumi, T. Nakamura, and Y. Kondo, Multi-angle polarimetry of thermal emission and light scattering by individual particles in airflow, *Aerosol Science and Technology*, 45, 1184-1198, 2011.
2. Moteki, N., and Y. Kondo, Dependence of laser-induced incandescence on physical properties of black carbon aerosols: Measurements and theoretical interpretation, *Aerosol Science and Technology*, 44, 663-675, 2010.
3. Moteki, N., Y. Kondo, and S. Nakamura, Method to measure refractive indices of small nonspherical particles: Application to black carbon particles, *Journal of Aerosol Science*, 41, 513-521, 2010.
4. Moteki, N., Y. Kondo, T. Nakayama, K. Kita, L. K. Sahu, T. Ishigai, T. Kinase, Y. Matsumi, Radiative transfer modeling of filter-based measurements of light absorption by particles: Importance of particle size dependent penetration depth, *Journal of Aerosol Science*, 41, 401-412, 2010.
5. Moteki, N., Y. Kondo, N. Takegawa, and S. Nakamura, Directional dependence of thermal emission from nonspherical carbon particles, *Journal of Aerosol Science*, 40, 790-801, 2009.
6. Moteki, N., and Y. Kondo, Method to measure time-dependent scattering cross section of particles evaporating in a laser beam, *Journal of Aerosol Science*, 39, 348-364, 2008.
7. Moteki, N., Y. Kondo, Y. Miyazaki, N. Takegawa, Y. Komazaki, G. Kurata, T. Shirai, D. R. Blake, T. Miyakawa, and M. Koike, Evolution of mixing state of black carbon particles: Aircraft measurement over the western Pacific in March 2004, *Geophysical Research Letters*, 34, L11803, doi:10.1029/2006GL028943, 2007.
8. Moteki, N., and Y. Kondo, Effects of mixing state on black carbon measurements by laser-induced incandescence, *Aerosol Science and Technology*, 41, 398-417, 2007.

（Co-Author）

9. Ohata, S., N. Moteki, Y. Kondo, Evaluation of a method for measurement of the concentration and size distribution of black carbon particles suspended in rainwater, *Aerosol Science and Technology*, 45, 1326-1336, 2011.
10. McNaughton, C. S., A. D. Clarke, S. Freitag, V. N. Kapustin, Y. Kondo, N. Moteki, ... and C. A. Brock, Absorbing aerosol in the troposphere of the Western Arctic during the 2008 ARCTAS/ARCPAC airborne field campaigns. *Atmospheric Chemistry and Physics*, *11*, 7561-7582, 2011.
11. Kondo, Y., H. Matsui, N. Moteki, L. Sahu, N. Takegawa, Y. Zhao, M. J. Cubison, J. L. Jimenez, S. Vay, G. S. Diskin, B. Anderson, A. Wisthaler, T. Mikoviny, H. E. Fuelberg, D. R. Blake, G. Huey, A. J. Weinheimer, D. Knapp, and H. Brune, Emissions of black carbon, organic, and inorganic aerosols from biomass burning in North America and Asia 2008, *Journal of Geophysical Research*, 116, D08204, doi:10.1029/2010JD015152, 2011.

12. Matsui, H., Y. Kondo, N. Moteki, N. Takegawa, L. K. Sahu, Y. Zhao, H. E. Fuelberg, W. R. Sessions, G. Diskin, D. R. Blake, A. Wisthaler, and M. Koike, Seasonal variation of the transport of black carbon aerosol from the Asian continent to the Arctic during the ARCTAS aircraft campaign, *Journal of Geophysical Research*, 116, D05202, doi:10.1029/2010JD015067, 2011.

13. Kondo, Y., L. Sahu, N. Moteki, F. Khan, N. Takegawa, X. Liu, M. Koike, and T. Miyakawa, Consistency and traceability of black carbon measurements made by laser-induced incandescence, thermal-optical transmittance, and filter-based photo-absorption techniques, *Aerosol Science and Technology*, 45, 295-312, 2011.

14. Nakayama, T., R. Hagino, Y. Matsumi, Y. Sakamoto, M. Kawasaki, A. Yamazaki, A. Uchiyama, R. Kudo, N. Moteki, Y. Kondo and K. Tonokura, Measurements of aerosol optical properties in the central Tokyo during summertime using cavity ring-down spectroscopy: Comparison with conventional techniques, *Atmos. Environ.,44,* 3034-3042, 2010.

15. Nakayama, T., Y. Kondo, N. Moteki, L. K. Sahu, T. Kinase, K. Kita, Y. Matsumi, Size-dependent correction factors for absorption measurements using filter-based photometers: PSAP and COSMOS, *Journal of Aerosol Science*, 41, 333-343, 2010.

16. Kondo, Y. L. Sahu, M. Kuwata, Y. Miyazaki, N. Takegawa, N. Moteki, J. Imaru, S. Han, T. Nakayama, N. T. Kim Oanh, M. Hu, Y. J. Kim, K. Kita, Stabilization of the mass absorption cross section of black carbon for filter-based absorption photometry by the use of a heated inlet, *Aerosol Science and Technology*, 43, 741-756, 2009.

17. Koch, D. Schulz, M. Kinne, S., McNaughton, C., Spackman, J. R., Balkanski, Y., Bauer, S., Berntsen, T., Bond, T. C., Boucher, O., Chin, M., Clarke, A., de Luca, N., Dentener, F., Diehl, T., Dubovik, O., Easter, R., Fahey, D. W., Feichter, J., Fillmore, D., Freitag, S., Ghan, S., Ginoux, P., Gong, S., Horowitz, L., Iversen, T., Kirkevåg, A., Klimont, Z., Kondo, Y., Krol, M., Liu, X., Miller, R., Montanaro, V., Moteki, N., Myhre, G., Penner, J. E., Perlwitz, J., Pitari, G., Reddy, S., Sahu, L., Sakamoto, H., Schuster, G., Schwarz, J. P., Seland, Ø., Stier, P., Takegawa, N., Takemura, T., Textor, C., van Aardenne, J. A., Zhao, Y., Evaluation of black carbon estimations in global models, *Atmospheric Chemistry and Physics*, 9, 2009, 9001-9026, 2009.

18. Oshima, N., M. Koike, Y. Zhang, Y. Kondo, N. Moteki, N. Takegawa, and Y. Miyazaki, Aging of black carbon in outflow from anthropogenic sources using a mixing state resolved model: Model development and evaluation, *Journal of Geophysical Research*, 114, D06210, doi:10.1029/ 2008JD010680, 2009.

19. Shiraiwa, M., Y. Kondo, N. Moteki, N. Takegawa, L. K. Sahu, A. Takami, S. Hatakeyama, S. Yonemura, and D. R. Blake, Radiative impact of mixing state of black carbon aerosol in Asian outflow, *Journal of Geophysical Research*, 113, D24210, doi:10.1029/2008JD010546, 2008.

20. Shiraiwa, M., Y. Kondo, N. Moteki, N. Takegawa, Y. Miyazaki, and D. R. Blake, Evolution of mixing state of black carbon in polluted air from Tokyo, *Geophysical Research Letters*, 34, L16803, doi:10.1029/2007GL029819, 2007.

21. Morino,Y., Y. Kondo, N. Takegawa, Y. Miyazaki, K. Kita, Y. Komazaki, M. Fukuda, T. Miyakawa, N. Moteki, and D. R. Worsnop, Partitioning of HNO3 and particulate nitrate over Tokyo: Effect of vertical mixing, *Journal of Geophysical Research*, 111, D15215, doi:10.1029/2005JD006887, 2006.

22. Kondo, Y., Y. Komazaki, Y. Miyazaki, N. Moteki, N. Takegawa, D. Kodama,S. Deguchi, M. Nogami, M. Fukuda, T. Miyakawa, Y. Morino, M. Koike, H. Sakurai, and K. Ehara,

Temporal variation of elemental carbon in Tokyo, *Journal of Geophysical Research*, 111, D12205, doi:10.1029/2005JD006257, 2006.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Moteki, N., Optical properties, including refractive index of BC, International Workshop "Frontiers of Black Carbon Studies", RCAST, Univ. Tokyo, Tokyo, Japan on January 25, 2010. (Invited)

(2) Domestic Conferences

2. Moteki, N., N. Takegawa, K. Koizumi, T. Nakamur, Y. Kondo, Polarized thermal emission from nonspherical particles, Spring conference of JMS, May 2011, Shibuya.

other 8 regular presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Basic experimental lessons for undergraduate students, instructions of advanced experimental and theoretical skills to graduate students and postdoctoral researchers. Essential corrections of manuscripts written by graduate students.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Science Partnership Project 2011: Investigation of macroscopic optical phenomena ~the *corona* in meteorological optics~, Maebashi high school, Gumma.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0
Sending
Japanese Students: 0
Japanese Researchers: 0
Visitors from Abroad: 0

Hitoshi Matsui

I. C.V.

Name： Hitoshi Matsui
Present Position: Project Assistant Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Geophysics, The Univerisity of Tokyo, March, 2004
M. Sc., Geophysics, The Univerisity of Tokyo, March, 2006
Ph. D., Geophysics, The Univerisity of Tokyo, March, 2009

Professional Experience
April, 2009-June, 2011, Research Associate, Research Center for Advanced Science and Technology, University of Tokyo, Japan
July, 2011-, Project Assistant Professor, Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo, Japan

II. Scientific Research Activity

2. Major achievements

1) Development and validation of aerosol microphysical schemes

The impact of atmospheric aerosols on radiation (direct effect) and cloud and precipitation (indirect effects) is one of the most uncertain processes in predicting climate change in the future. Aerosol number concentration, size distribution, and mixing state (chemical composition of each particle) are quite important parameters to evaluate direct and indirect effects accurately. However, these parameters are not considered adequately in the most of current global and climate aerosol models. To simulate these parameters accurately, I developed a regional three-dimensional aerosol model resolving new particle formation (formation of ultra-fine particles from trace gases) and black carbon mixing state explicitly. Model simulations were validated by various field measurements in detail.

2) Transport pathways and mechanisms of black carbon aerosol to the Arctic

Black carbon aerosols (BC) are considered to significantly contribute to Arctic warming through heating of the atmosphere and melting of snow/ice sheets. In this study, I identified the pathways and mechanisms of transport of BC to the Arctic from the Asian continent using the data during the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS) aircraft campaign conducted in spring and summer 2008. The concentration, transport efficiency, and measured altitude of BC were highly dependent on season and origin of air parcels. For example, BC from biomass burning sources in Russia and Kazakhstan was found to transport to the Arctic quite efficiently during spring, while that from anthropogenic sources in East Asia was almost removed during the transport by wet removal processes.

In addition, I have conducted the following studies: 1) a modeling study focused on spatial and temporal variations of aerosol mass concentrations and optical properties in urban air, 2) development of a new source and process apportionment algorithm for aerosols and their precursor gaseous species, 3) and a modeling study of secondary organic aerosol formation.

These studies were summarized and published by international journals such as JGR.

3. Five Important Papers in your career

1. Matsui, H., M. Koike, Y. Kondo, N. Takegawa, A. Wiedensohler, J. D. Fast, and R. A. Zaveri (2011), Impact of new particle formation on the concentrations of aerosols and cloud condensation nuclei around Beijing, J. Geophys. Res., 116, D19208, doi:10.1029/2011JD016025.

In this paper, I developed a new aerosol scheme, which explicitly represents new particle formation processes in the atmosphere. Model simulations using this scheme were validated by measurements in detail. A sensitivity simulation suggests that a reduction of aerosol emissions does not necessarily decrease aerosol and cloud number concentrations in the atmosphere.

2. Matsui, H., Y. Kondo, N. Moteki, N. Takegawa, L. K. Sahu, Y. Zhao, H. E. Fuelberg, W. R. Sessions, G. Diskin, D. R. Blake, A. Wisthaler, and M. Koike (2011), Seasonal variation of the transport of black carbon aerosol from the Asian continent to the Arctic during the ARCTAS aircraft campaign, J. Geophys. Res., 116, D05202, doi:10.1029/2010JD015067.

This paper identified the pathways and mechanisms of transport of black carbon aerosol (BC) from the Asian continent to the Arctic using the data during the Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS) aircraft campaign.

3. Matsui, H., and M. Koike, New source and process apportionment method using a three-dimensional chemical transport model: Process, age, and source region chasing algorithm (PASCAL) (2012) , Atmos. Environ., 55, 399 – 409.

In this paper, I developed a new source and process apportionment method tracing the source regions, the age (elapsed time from emissions), and the contribution of production and loss processes of primary and secondary aerosols and their precursor gaseous species.

4. Matsui, H., M. Koike, Y. Kondo, N. Takegawa, K. Kita, Y. Miyazaki, M. Hu, S-Y. Chang, D. R. Blake, J. D. Fast, R. A. Zaveri, D. G. Streets, Q. Zhang, and T. Zhu (2009), Spatial and temporal variations of aerosols around Beijing in summer 2006: Model evaluation and source apportionment, J. Geophys. Res., 114, D00G13, doi:10.1029/2008JD010906.

This paper clarified spatial and temporal variations of aerosol mass concentrations around Beijing, one of the largest mega-city in the world. Sensitivity simulations revealed the source regions and ages of aerosols around Beijing region.

5. Matsui, H., M. Koike, N. Takegawa, Y. Kondo, R. J. Griffin, Y. Miyazaki, Y. Yokouchi, and T. Ohara (2009), Secondary organic aerosol formation in urban air: Temporal variations and possible contributions from unidentified hydrocarbons, J. Geophys. Res., 114, D04201, doi:10.1029/2008JD010164.

This paper shows the potential importance of high-molecular-weight hydrocarbons for secondary organic aerosol formation..

4. Awards and Honors throughout your career

5. Future Research Plan

1) Development of a detailed aerosol microphysical and chemical model

In addition to new particle formation and BC mixing state (shown in "Major achievements"), secondary organic aerosol (SOA) formation is also highly uncertain process of aerosols in the atmosphere. In this study, I develop a new SOA scheme based on recent findings of laboratory and field measurements. Then, I develop a detailed aerosol microphysical and chemical model by combing the schemes of SOA, new particle formation, and BC mixing state (shown in "Major achievements") with some existing aerosol schemes (e.g., aqueous phase chemistry, dry and wet deposition). The model will become one of the most detailed aerosol models in the world, and will contribute to simulate mass and number concentrations, size distribution, and mixing state of aerosols more accurately.

2) Application of the detailed aerosol model to Asia

The detailed aerosol model is applied to Asian region. The simulations are validated by various field measurements in detail.

The validated model simulations are used to understand spatial and temporal variations of aerosols and their source contributions. In Asia, aerosols and their precursor gases are emitted from various sources such as anthropogenic, biomass burning, biogenic, marine, and soil sources. The contributions from individual sources and their interactions are clarified through sensitivity simulations. I also examine the spatial distributions of aerosols and their seasonal and year-to-year variations, and evaluate the impact of aerosols on radiation and cloud and precipitation processes.

3) Application of the detailed model to the Arctic

The spatial and temporal variations of aerosols over the Arctic are one of the most uncertain problems of aerosol studies. Validation studies using measurements are also very limited. In this study, the detailed model is applied to the Arctic and validated by surface and aircraft measurements (e.g., the ARCTAS campaign shown in "Major achievements"). The validated model is used to understand spatial and temporal variations of aerosols in the Arctic with their meteorological and chemical mechanisms. In addition, the impact of aerosols on radiation and cloud processes will be evaluated quantitatively.

6. Funding Received

(1) JSPS Grants

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Koike, M., N. B. Jones, P. I. Palmer, H. Matsui, Y. Zhao, Y. Kondo, Y. Matsumi, and H. Tanimoto (2006), Seasonal variation of carbon monoxide in northern Japan: Fourier transform IR measurements and source-labeled model calculations, J. Geophys. Res., 111, D15306, doi:10.1029/2005JD006643.
2. Matsui, H., M. Koike, N. Takegawa, Y. Kondo, R. J. Griffin, Y. Miyazaki, Y. Yokouchi, and T. Ohara (2009), Secondary organic aerosol formation in urban air: Temporal variations and possible contributions from unidentified hydrocarbons, J. Geophys. Res.,

114, D04201, doi:10.1029/2008JD010164.

3. Matsui, H., M. Koike, Y. Kondo, N. Takegawa, K. Kita, Y. Miyazaki, M. Hu, S-Y. Chang, D. R. Blake, J. D. Fast, R. A. Zaveri, D. G. Streets, Q. Zhang, and T. Zhu (2009), Spatial and temporal variations of aerosols around Beijing in summer 2006: Model evaluation and source apportionment, J. Geophys. Res., 114, D00G13, doi:10.1029/2008JD010906.
4. Kondo, Y., N. Takegawa, H. Matsui, T. Miyakawa, M. Koike, Y. Miyazaki, Y. Kanaya, M. Mochida, M. Kuwata, Y. Morino, M. Shiraiwa, Formation and transport of aerosols in Tokyo in relation to their physical and chemical properties – A review –, Journal of the Meteorological Society of Japan, #09048, 2010.
5. Matsui, H., M. Koike, Y. Kondo, N. Takegawa, J. D. Fast, U. Pöschl, R. M. Garland, M. O. Andreae, A. Wiedensohler, N. Sugimoto, and T. Zhu (2010), Spatial and temporal variations of aerosols around Beijing in summer 2006: 2. Local and column aerosol optical properties, J. Geophys. Res., 115, D22207, doi:10.1029/2010JD013895.
6. Matsui, H., Y. Kondo, N. Moteki, N. Takegawa, L. K. Sahu, Y. Zhao, H. E. Fuelberg, W. R. Sessions, G. Diskin, D. R. Blake, A. Wisthaler, and M. Koike (2011), Seasonal variation of the transport of black carbon aerosol from the Asian continent to the Arctic during the ARCTAS aircraft campaign, J. Geophys. Res., 116, D05202, doi:10.1029/2010JD015067.
7. Matsui, H., Y. Kondo, N. Moteki, N. Takegawa, L. K. Sahu, M. Koike, Y. Zhao, H. F. Fuelberg, W. R. Sessions, G. Diskin, B. E. Anderson, D. R. Blake, A. Wisthaler, M. J. Cubison, and J. L. Jimenez (2011), Accumulation‐mode aerosol number concentrations in the Arctic during the ARCTAS aircraft campaign: Long‐range transport of polluted and clean air from the Asian continent, J. Geophys. Res., 116, D20217, doi:10.1029/2011JD016189.
8. Matsui, H., M. Koike, Y. Kondo, N. Takegawa, A. Wiedensohler, J. D. Fast, and R. A. Zaveri (2011), Impact of new particle formation on the concentrations of aerosols and cloud condensation nuclei around Beijing, J. Geophys. Res., 116, D19208, doi:10.1029/2011JD016025.
9. Kondo, Y., H. Matsui, N. Moteki, L. Sahu, N. Takegawa, M. Kajino, Y. Zhao, M. J. Cubison, J. L. Jimenez, S. Vay, G. S. Diskin, B. Anderson, A. Wisthaler, T. Mikoviny, H. E. Fuelberg, D. R. Blake, G. Huey, A. J. Weinheimer, D. J. Knapp, and W. H. Brune (2011), Emissions of black carbon, organic, and inorganic aerosols from biomass burning in North America and Asia in 2008, J. Geophys. Res., 116, D08204, doi:10.1029/2010JD015152.
10. Verma, R. L., Y. Kondo, N. Oshima, H. Matsui, K. Kita, L. K. Sahu, S. Kato, Y. Kajii, A. Takami, and T. Miyakawa (2011), Seasonal variations of the transport of black carbon and carbon monoxide from the Asian continent to the western Pacific in the boundary layer, J. Geophys. Res., 116, D21307, doi:10.1029/2011JD015830.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Matsui, H., M. Koike, Y. Kondo, N. Takegawa, A. Wiedensohler, J. D. Fast, and R. A. Zaveri, Impact of new particle formation on the concentrations of aerosols and cloud condensation nuclei around Beijing, 10th AeroCom Workshop, October 2011, Fukuoka, Japan.
2. Matsui, H., M. Koike, Y. Kondo, N. Takegawa, Y. Miyazaki, Modeling study on aerosols and their optical properties around Beijing in summer 2006, International Workshop "Frontiers of Black Carbon Studies", January 2010, Tokyo, Japan.
3. Matsui H., M. Koike, Y. Kondo, N. Takegawa, K. Kita, Y. Miyazaki, M. Hu, S.-Y. Chang, D. R. Blake, J. D. Fast, R. A. Zaveri, D. G. Streets, Q. Zhang, and T. Zhu, Spatial and temporal variations of aerosols around Beijing in summer 2006: Model evaluation and source apportionment, AGU Fall Meeting 2009, December 2009, San Francisco, CA, USA.
4. Matsui H., M. Koike, N. Takegawa, Y. Kondo, R. J. Griffin, Y. Miyazaki, Y. Yokouchi and T. Ohara, Secondary organic aerosol formation in urban air: Temporal variations and possible contributions from unidentified hydrocarbons, IGAC 10th International Conference, September 2008, Annecy, France.

5 other presentations

(2) Domestic Conferences

5. Matsui H., M. Koike, Y. Kondo, and N. Takegawa, Impact of new particle formation on the concentrations of aerosol number and cloud condensation nuclei around Beijing, JPGU meeting 2011, May 2011, Makuhari, Chiba.
6. Matsu H., Y. Kondo, H. Sakamoto, N. Moteki, L. K. Sahu, and N. Takegawa, Source, variation, and removal of black carbon in the Arctic during the ARCTAS aircraft campaign, JPGU meeting 2010, May 2010, Makuhari, Chiba.

13 other presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and

Researchers Abroad

N/A (starting education career from 2012)
Hosting
    Foreign Students:
    Foreign Researchers:
Sending
    Japanese Students:
    Japanese Researchers:
Visitors from Abroad:

Solid Earth Science Group

Kazuhito Ozawa

I. C.V.

Name： Kazuhito Ozawa
Present Position: Professor, University of Tokyo, Graduate School of Science

Education

B. Sc., Geology, The Uniersity of Tokyo, March, 1978
M. Sc., Petrology, The Uniersity of Tokyo, March, 1980
Ph. D., Petrology, The Uniersity of Tokyo, March, 1983

Professional Experience

May, 1983-May, 1993, Assistant Professor, Geological Institute, Faulty of Science, University of Tokyo, Japan
May, 1991-December, 1991, Guest Scientist, Woods Hole Oceanographic Institute, USA
December, 1991-May, 1993, Visiting Scientist, Department of Geology and Geophysics, Yale University, USA
May, 1993-May, 1997, Associate Professor, Geological Institute, Faculty of Science, University of Tokyo, Japan
May, 1997-April, 2000, Professor, Institute for Study of the Earth's Interior, Okayama University, Japan
April, 2000-, Professor, Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo, Japan

II. Scientific Research Activity

2. Major achievements

My research achievement is divided into two; one is concerned about the early solar system before the formation of the earth, and the other is concerned about the evolution of the earth after its formation. The following results relevant to the evolution of the earth were obtained in studies of magma formation and segregation in the mantle, mantle deformation, and magmatic differentiation in the curst,

(1) In order to extract information on magmatic processes involved in the formation of volcanic rocks and mantle peridotites, a very general master equation was derived, which can treat completely open reactions between solid and melt (Ozawa and Shimizu, 1995; Ozawa, 2001). Spreadsheet and web-based calculators were developed, which have been used by many researchers. Application of the equation to melting beneath mid-ocean ridges (Ozawa, 2001), melting in mantle upwelling in a back-arc region (Sakuyama et al., 2009), and melting beneath island arc (Ozawa, 2001; Yoshikawa and Ozawa, 2006) demonstrated prevalence of open-system melting. Procedures to estimate melting conditions in the mantle by using major element concentrations in volcanic rocks are also developed (Ogitsu and Ozawa, 2007; Sakuyama et al., 2009).

(2) During the exhumation of intrusive peridotite bodies, they underwent cooling and deformation, which more or less erased information recorded during their residence in the upper mantle. Such overprinting of exhumation must be scraped off to extract the intact information of the mantle. On the basis of this concept, steady state lithospheric geothermal gradient was

successfully estimated for a ultramafic body after disclosing its pressure (P) – temperature (T) – deformation (d) path (Ozawa and Takahashi, 1995; Ozawa, 1997; Ozawa, 2006; Ueda et al., 2008). New tools for decoding P-T-d history were also developed (Odashima et al., 2008; Suzuki, et al., 2008; Kamijo et al., 2008; Obata and Ozawa, 2011).

(3) Crustal magma chambers are the site where mantle derived magmas underwent differentiation causing chemical diversity of the crust. Actual operation of boundary layer fractionation, one of the important mechanisms of magmatic differentiation driven by exchange of light fractionated melt formed in the boundary layer and the main magma body, was demonstrated in a sheet-like magma body. The important role of quickly formed basal crystal mush was also shown (Simura and Ozawa, 2006; 2011; Takada and Ozawa, 2011).

Processes in the early solar system are addressed by experiments, theory, and meteorite studies and the following achievements were made.

(1) Evaporation and condensation rates and their mechanisms of forsterite and Fe-metal, which are two of the most important mineral phases in the early solar system, were revealed (Nagahara and Ozawa, 1996; Ozawa and Nagahara, 2000; Yamada et al., 2006; Takigawa et al., 2009; Nagahara et al., 2009; Tachibana et al., 2011; Ozawa et al., 2012)

(2) The role of direct condensation of major elements in formation mechanisms of chondrules in ordinary chondrites was demonstrated (Nagahara et al., 2005; Nagahara et al., 2008).

3. Five Important Papers in your career

1. Ozawa, K. (1983), Evaluation of olivine-spinel geothermometry as an indicator of thermal history for peridotites, *Contrib. Mineral. Petrol.*, *82*, 52-65.

This paper analyzes kinetics of strongly temperature-dependent Mg-Fe partitioning between olivine and spinel, which had been often used as a geothermometer, and evaluate its potential as a geospeedometer. The total citation is 80.

2. Ozawa, K. (1984), Olivine-spinel geospeedometry: analysis of diffusion-controlled Mg-Fe exchange, *Geochim. Cosmochim. Acta*, *48*, 2597-2611.

Extending the study of the above 1984 paper, this paper develops olivine-spinel geospeedometry applicable to peridotites, gabbros, and picritic basalts. This and the above 1983 papers are cited in a textbook “Timescales of Magmatic Processes” edited by Dosseto, A. etc. The total citation is 48.

3. Ozawa, K., and N. Shimizu (1995), Open-system melting model in the upper mantle: constraints from the Hayachine-Miyamori ophiolite, northeastern Japan, *Jour. Geophys. Res.*, *100*, 22315-22335.

There had been mass balance equation for melting in closed systems or systems open only for melt separation at that time, this paper proposes a model for melting systems open not only to melt output but also to melt input and presents the mass balance equation. This paper examined open-system melting process in the mantle first in the world. The total citation is 51.

4. Ozawa, K. (1989), Stress-induced Al-Cr zoning of spinel in deformed peridotites. *Nature*, *338*, 141-144. 26

This paper demonstrates diffusion creep actually takes place in natural and synthetic deforming materials for the first time in the world by showing the presence of multi-polar Al-Cr zoning in chromite spinel deformed in the mantle. The paper was picked up in *News and Views* section of

the *Nature* issue. This paper was referred in textbooks on rheology of earth and planetary materials, such as ”Deformation of Earth Materials: An Introduction to the Rheology of Solid Earth” by S. Karato and ”Microtectonics” by C. W. Passchier and R. A. J. Trouw. The total citation is 26.

5. Ozawa, K. (2001), Mass balance equations for open magmatic systems: Trace element behavior and its application to open system melting in the upper mantle. *Jour. Geophys. Res.*, *106*, 13407-13434.

This paper developed the master mass balance equation for general open magmatic reaction systems, from which almost all the mass balance equations formulated so far can be derived as a special case of the general equation. A spreadsheet calculator and a Java application for web calculation are made available, and are used by many researchers. I have been receiving inquires about the applications, and I also held a seminar for how to use the spreadsheet.

4. Awards and Honors throughout your career

· Fellow of the Mineralogical Society of America, November, 15, 2003

· Award for the best paper in 2008, Japanese Association of Mineralogical Sciences, September, 9, 2009. The paper is “Formation and deformation mechanisms of pyroxene-spinel symplectite in an ascending mantle, the Horoman peridotite complex, Japan: An EBSD (electron backscatter diffraction) study.” by Odashima, N., T. Morishita, K. Ozawa, H. Nagahara, A. Tsuchiyama, and R. Nagashima, Journal of Mineralogy and Petrological Sciences, 103, 1-15

5. Future Research Plan

Extending the above-mentioned achievement on processes in the solar system evolution before the earth formation and processes involved in the evolution of the earth, I will focus my future research on examination of thermal histories of the earth and planets based on material information. The following approaches will be taken to tackle the problem.

(1) Secular change of mantle potential temperature are estimated at high precision by combined analysis of thickness of oceanic crust, thickness of depletion zone in the mantle, and chemical composition of extrusive rocks from well-preserved ophiolite after evaluation of the role of water. Because high precision estimation is aimed at, oceanic crust-mantle sections formed under the same tectonics as or similar tectonics to the plate tectonics operating today, Proterozoic ophiolites are chosen as targets. Driving force of melting is carefully investigated to distinguish between passive and active upwelling, and geochemical information is used to specify the original depth of the upwelling for active upwelling. The secular change of chemical stratification of the mantle is relevant and is deal with a parameter that must be constrained with the thermal history of the earth.

(2) On the basis of analysis of pressure-temperature-deformation (P-T-d) history of mantle xenolith and intrusive peridotite complexes, perturbation of lithospheric geotherm is examined to reveal the secular change in thermal gradient of the lithosphere back to the past as long as possible. Mantle xenoliths occurring over a cratonic region with the host kimberlite active in 1.2-1.4Ga, 600Ma, and 100Ma are selected, and spatiotemporal variation of P-T-d history are revealed to infer the secular change of thermal state of the cratonic lithosphere. Exhumation P-T-d histories of intrusive peridotite complexes are estimated to extract the initial condition representing a steady thermal state of the lithosphere. This approach requires a high-resolution

analysis of P-T-d history, which is developed from the method established for the Horoman complex by examining P-T-d history of the Ronda, Lanzo, and Pyrénées peridotites representing diverse tectonic environments. The developed approach is applied to Proterozoic mantle peridotites with specification of their tectonic environment to estimate the secular change of lithospheric geotherm.

(3) Thermochemical state of source planetesimals accreting to form the proto earth is estimated on the basis of information of the chondrite parental bodies existed in the early stage of the solar system evolution. This problem is better to be addressed by examining differentiated meteorites, such as achondrites, iron meteorites, and pallasites, to estimate thermochemical state of their parental bodies. This is because ordinary and carbonaceous chondrites were derived from the near surface environment of a parental body representing transportation path of heat and water escaping to the space. Thus they tell us the average chemical composition, but they do not carry reliable information on pressure, temperature, and water content of the interior of the parental bodies. Differentiated chondrites represent magmas, melting residue, or Fe core formed in the interior and give us information on the source chemical composition, melting temperature, cooling rate, and gravity, from which we can estimate the size of planetesimal as well as the thermal state. Material information that can constrain the heliocentric distance of parental bodies and their relevance to the proto earth will be searched.

6. Funding Received

(1) JSPS Grants

- Grant-in-Aid for Scientific Research (B) (General) Chemical evolution of the upper mantle constrained by temperature and pressure history of the major peridotite complexes in Europe, FY2009-2011, 18,440,000JPY
- Grant-in-Aid for Scientific Research (B) (Oversea Investigation) Maturation processes in the deep island arc: temporal and spatial variation of the crust-mantle boundary in Albanian ophiolites, FY2009-2011, 600,000JPY

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Simura, R., and K. Ozawa (2006), Mechanism of crystal redistribution in a sheet-like magma body: constraints from the Nosappumisaki and other shoshonite intrusions in the Nemuro Peninsula, Northern Japan, *Jour. Petrol.*, *47*, 1809-1851.
2. Yoshikawa, M., and K. Ozawa (2006), Rb-Sr and Sm-Nd isotopic systematics of the Hayachine-Miyamori ophiolitic complex: melt generation process in the mantle wedge beneath an Ordovician island arc, *Gondwana Res.*, *11*, 234-246.
3. Yamada, M., S. Tachibana, H. Nagahara, and K. Ozawa (2006), Anisotropy of Mg isotopic fractionation during evaporation and Mg self-diffusion of forsterite in vacuum, *Planet. Space. Sci.*, *54*, 1096-1106.

4. Odashima, N.,. T. Morishita, K. Ozawa, H. Nagahara, A. Tsuchiyama, and R. Nagashima (2008), Formation and deformation of pyroxene-spinel symplectite in ascending mantle: An EBSD (electron backscatter diffraction) study in the Horoman peridotite complex, Japan, *Jour. Mineral. Petrol. Sci*., 103, 1-15.

5. Nagahara, H., N. Kita, K. Ozawa, and Y. Morishita (2008), Condensation of major elements during chondrule formation and its implication to the origin of chondrules, *Geochim. Cosmochim. Acta*, *72*, 1442-1465.

6. Suzuki A., Y. Yasuda, and K. Ozawa (2008), Cr and Al diffusion in chromite spinel: experimental determination and its implication for diffusion creep, *Phys. Chem. Minerals*, *35*, 433-445.

7. Ueda, T., M. Obata, G. Di Toro, K. Kanagawa, and K. Ozawa (2008), Mantle earthquakes frozen in mylonitized ultramafic pseudotachylytes of spinel-lherzolite facies, *Geology*, *36*, 607-610.

8. Sakuyama, T., K. Ozawa, H. Sumino, and K. Nagao (2009), Progressive melt extraction from upwelling mantle constrained by the Kita-Matsuura basalts in NW Kyushu, SW Japan, *Jour. Petrol.*, *50*, 725-779.

9. Takigawa, A., S. Tachibana, H. Nagahara, K. Ozawa, and M. Yokoyama (2009), Anisotropic evaporation of forsterite and its implication for dust formation conditions in circumsteller environments, *The Astrophysical Journal*, *707*, L97-L101.

10. Nagahara, H., K. Ozawa, R. Ogawa, S. Tachibana, and H. Chiba (2009), Laboratory condensation and reaction of silicate dust, *ASP Conf. Ser.*, *414*, 403-410.

11. Obata, M., and K. Ozawa (2011), Topotaxic relationships between spinel and pyroxene in kelyphite after garnet in mantle-derived peridotites and their implications to reaction mechanism and kinetics, *Mineralogy and Petrology*, *101*, 217-224, doi:10.1007/s00710-011-0145-y.

12. Simura, R., and K. Ozawa (2011), Magmatic fractionation by compositional convection in a sheet-like magma body: constraints from the Nosappumisaki Intrusion, northern Japan, *Jour. of Petrol.*, *52*, 1887-1925, doi:10.1093/petrology/egr034.

13. Tachibana, S., H. Nagahara, K. Ozawa, Y. Ikeda, R. Nomura, K.,Tatsumi, and Y. Joh (2011), Kinetic condensation and evaporation of metallic iron and implications for metallic iron dust formation, *Astrophysical Journal*, *736*, 16, doi: 10.1088/0004-637X/736/1/16.

14. Takada, Y., and K. Ozawa (2011), Cooperation of upper and lower boundary layer fractionations in a sheet-like intrusion: Composition and microstructure of the Aosawa dolerite sill in Yamagata prefecture, northeastern Japan, *Jour. Mineral. Petrol. Sci*., *106*, 277-298, doi:10.2465/jmps.100306.

(2) Selected Conference Proceedings

1. Ogitsu, I., and K. Ozawa (2007), Generation condition of magmas in the arc upper mantle based on major element concentrations of arc volcanic rocks: water content, temperature, and pressure, Chikyu Monthly, 29, 33-40.

2. Sakyuyama, T., S. Nakai, and K. Ozawa (2007), Melting history of a diapiric mantle upwelling: Constraints from spatiotemporal change of Kita-Matsuura basalt in northwestern Kyushu, Chikyu Monthly, 29, 588-596.

3. Kamijo, H., K. Ozawa, and K. Kanagawa (2008), Deformation history of mantle peridotites read from clinopyroxene, Chikyu Monthly, 30, 78-85.

4. Suzuki, A., A. Yasuda, and K. Ozawa (2008), Spinel: A deformation indicator of the upper mantle peridotites, Chikyu Monthly, 30, 55-60.

(3) Review Papers

1. Ozawa, K. (2008), Generation of magmas in the upper mantle: Recent developments in studies on mantle materials. Journal of Geography, 114, 385-409. (Refereed)
2. Morishita, T., K. Ozawa, and M. Obata (2010), A recent trend in sciences on mantle-derived materials, with special emphases on refertilization, rheology, and ophiolite problems: a report of the Fifth International Conference on Orogenic Lherzolite, Japanese Magazine of Mineralogical and Petrological Sciences, 39, 85-103. (Refereed)

(4) Books

1. Ozawa (2011), Chronological Scientific Tables 2012, Geology and Minerals, edited by National Astonomical Observatory of Japan, Maruzen Publishing Co., Ltd., Tokyo, pp. 644-676.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Ozawa, K., Ueda, T., Obata, M., Di Toro G., and Kanagawa, K., Frictional Melting and Deformation in the Upper Mantle: Constraints from Cr-Al Spinel in Ultramafic Psuedotachylyte from Balmuccia, 33rd, International Geological Congress, (Oslo., Norway, 2008.8) (regular)
2. Ozawa, K., Origin of refractory dunite bodies in harzburgite, AGU Chapman Conference on Shallow Mantle Composition & Dynamics, 5th International Orogenic Lherzolite Conference, (Mount Shasta, California, USA, 2008.9) (regular)
3. Ozawa, K., Two-dimensional distribution of trace elements in a reaction texture in plagioclase lherzolite from the Horoman complex, northern Japan, and its implication in ascent processes of the upper mantle, American Geophysical Union, 2009 Fall Meeting, (San Francisco, 2009, 12) (regular)
4. Ozawa, K., Nagahara, H., Morioka, M. and Matsumoto, N. Kinetics of anisotropic evaporation of forsterite, International Mineralogical Association General Meeting in Budapest, (Hungary, 2010, 8) (regular)
5. Ozawa, K., J-L. Bodinier, C. J. Garrido, H. Nagahara New approach for decoding P-T-d history based on Al distribution in orthopyroxene: garnet pyroxenite/peridotite from the Bestiac mass, French Pyrenees, American Geophysical Union, 2010 Fall Meeting, (San Francisco, 2010, 12) (regular)

The total number of presentations: 20

(2) Domestic Conferences

6. Ozawa, K. The origin of dunite: constraints from major exchange component, and incompatible and compatible trace elements, JpGU Meeting 2006 (Makuhari, Chiba, 2006.5) (regular)
7. Ozawa, K. Towards petrogenesis based on multi-scale structures: Analysis of microstructures by using EBSE/FE-SEM, Special Symposium in Annual Meeting of Japanese Association of Mineralogical Sciences 2007 (Univ. Tokyo, 2007.9)（invited）

8. Ozawa, K., Ueda, T., Obata, M., Di Toro, G., Kanagawa, K., Nagahara, H., Frictional Melting and Deformation in the Upper Mantle: Constraints from Cr-Al Spinel in Ultramafic Psuedotachylyte from Balmuccia, JpGU Meeting 2008 (Makuhari, Chiba, 2008.5) (regular)
9. Ozawa, K. Two-dimensional distribution of Sr in plagioclase-olivine aggregates in a plagioclase lherzolite from the Horoman complex: Evaluation as a strain rate meter, JpGU Meeting 2010 (Makuhari, Chiba, 2010.5) (regular)
10. Ozawa, K., J-L. Bodinier, C. J. Garrido, H. Nagahara, Deformation history of mantle peridotites read from internal chemical/textural patterns in pyroxene, JpGU Meeting 2011 (Makuhari, Chiba, 2011.5) (regular)
11. Ozawa, K., Heat transport that drives fractionation of the earth and planets: decoding thermal history from mantle peridotites, Workshop on mantle processes, (Univ. Tokyo, 2012.3) (invited)

The total number of presentations: 40

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Takeshi Kuritani, Associate Professor at Graduate School of Science, Osaka City University
· Rayko Simura, Associate Professor at Institute for Material Research, Tohoku University
· Norihiro Odashima, Award for the best paper in 2008, Japanese Association of Mineralogical Sciences, September 9, 2009.
· Tetsuya Sakuyama, IFREE, JAMSTEC, Researcher

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Geochemistry, Geophysics, Geosystems, Associate editor, 2006-2009

(2) Academic Societies

· Council member, the Japan Association of Mineralogical Sciences 2006-2011
· Chair of the selection committee for Young Research Award of Japanese Association of Mineralogical Sciences, 2009

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Investigation of formation mechanisms of microstructures of the solid earth with EBSD: Towards the understanding the evolution of the earth. 6th EBSD seminar, Oxford Instruments, June, 2010.
· Where is the border between rock and stone, Fuji TV, May, 2011
· My way towards the science: acceptance of the destiny and challenge, seminar at Komaba campus, Univ. Tokyo, April, 2011.

· Charm of earth science, seminar for high school students at Hongo campus, Univ. Tokyo, November, 2012.

12. Internal and External Committee Memberships (2006-2011)

· Member of the Committee for undergraduate education of the University of Tokyo, 2010-2011.

· Member of the Committee for qualification of teachers and curators of the University of Tokyo, 2010-2011

· Member of the Working Group for the evaluation system for teachers

· Chair, Student Academic Affairs Committee, Department of Earth and Planetary Science, University of Tokyo, 2005-2006

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 2 [M.Sc.: 0, Ph.D.: 2 (Spain: 2)]

Foreign Researchers: 1 [Finland: 1]

Sending

Japanese Students: 1 [M.Sc.: 0, Ph.D.: 1 (Korea: 1)]

Japanese Researchers: 4 [France: 2, Spain: 1, Italy: 1]

Visitors from Abroad: 6 [U.S.A.: 4, Australia: 1, France: 1]

Gaku Kimura

I. C.V.

Name： Gaku Kimura
Present Position: Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Geology and Mineralogy, Hokkaido University, March, 1974
M. Sc., Geology and Mineralogy, Hokkaido University, March, 1976
Ph. D., Geology and Mineralogy, Hokkaido University, March, 1981

Professional Experience
April, 1981-April, 1982, Research Fellow, Department of Science, University of Hokkaido
May, 1982-Sep., 1984, Lecturer, Department of Earth Science, Kagawa University
Oct., 1984-Mar., 1994, Associate Professor, Department of Earth Science, Kagawa University
April, 1994-July, 1997, Professor, Department of Earth Science, Osaka Prefecture University
Aug., 1997-, Professor, Graduate School of Science, The University of Tokyo

II. Scientific Research Activity

2. Major achievements

My research focus during this period was the plate boundary process and seismogenesis in subduction zone. The researches were conducted in term of geological analysis of fossilized plate boundary fault rock in ancient accretionary prisms and direct drilling into the the plate boundary in the Nankai Trough.

The specific target for the ancient accretionary prism was the tectonic melange of the Cretaceous-Tertiary Shimanto Belt in Shikoku island, SW Japan, Jurassic complex in central Japan, and the Nobeoka thrust in Kyushu. It is revealed that P-T conditions of the deepest burials of these rocks ranges from 150~320 degree C and are consistent with seismogenic plate boundary in the subduction zone. Pseodotachylyte, heated fault rocks, and dynamically interacted record due to fluid-rock interaction have been well documented from these studies. It was suggested that the effect of dynamic change in fluid pressure might directly control the fault strength and friction property of the plate boundary fault.

Drilling in the Nankai Trough has been conducted as NantroSEIZE project under the Integrated Ocean Drilling Program (IODP) since 2007. I am working for this project as a co-principal proponent, speciality coordinator of structural geology in the project management team, and a co-chief scientist of Expedition IODP 316. Our 316 expedition (2007-2008) clarified that the shallow portion of the splay fault and plate boundary decollement near trench were heated up due to high velocity slip which might have generated tsunamis.

The 2011, 3.11 Tohoku- earthquake and tsunami took place due to abnormal rupture propagation to the trench. The reason why the slip reached to the trench is still unclear and researches keep going. We proposed a hypothesis that suggest an onset of abnormal high fluid pressure along the plate boundary due to dehydration from underthrust sediments and oceanic basement on the basis of on-land geology and kinetic estimation of the dehydration.

The result of IODP drilling showing high velocity slip near the trench in the Nankai Trough and 3.11 Tohoku earthquake and tsunami have forced to modify the maximum risk of

tsunami disaster in SW Japan.

3. Five Important Papers in your career

1. Kimura, G. (1986), Oblique Subduction and Collision: Forearc Tectonics of the Kuril Arc, Geology, 14, 404-407.

Reason: Synthesis of tectonics of the Kuril Arc and Hokkaido. This paper is now evaluated as a classic paper for oblique subduction in the Kurile subduction zone.

2. Kimura, G., and A. Mukai (1991), Underplated units in an accretionary complex: melange of the Shimanto Belt of eastern Shikoku, southwest Japan, Tectonics, 10, 31-50.

Reason: A paper documenting that "melange " in the Shimanto accretionary complex is tectonic in origin on the basis of detailed structural analysis and made a break through common idea of sedimentary origin. Since then, most of the melange in the Shimanto Belt start to be thought as plate boundary related fault rock in subduction zone.

3. Kimura, G., Y. Kitamura, Y. Hashimoto, A. Yamaguchi, T. Shibata, K. Ujiie, and S. Okamoto (2007), Transition of accretionary wedge structures around the up-dip limit of the seismogenic subduction zone, Earth and Planetary Science Letters, 255, 471-484.

Reason: A synthesis paper of the modern Nankai forearc geometry, structure and plate boundary processes.The critical taper theory was applied to the prism and it was discussed that a static friction varies from place to place and controlled mainly by lithology of underthrust sediments and fluid pressure ratio.

4. Kimura, G., G. F. Moore, M. Strasser, E. Screaton D. Curewitz, C. Streiff, and H. Tobin (2011), Spatial and Temporal evolution of the megasplay fault in the Nankai Trough, Geochem. Geophys. Geosyst., 12, Q0A008, doi:10.1029/2010GC003335.

Reason: IODP expedition 316 présents stratigraphies of sediments surrounding the shallow tip of the splay fault. Reconstructed activity of the splay fault is that initiation of the fault was ca. 1.95 Ma and slowed down around 1.0Ma but still keep moving as an active fault although southwestern portion of the fault was already stopped.

5. Kimura, G., A. Yamaguchi, M. Hojo, Y. Kitamura, J. Kameda, K. Ujiie, Y. Hamada, M. Hamahashi, and S. Hina (2012), Tectonic mélange as fault rock of subduction plate boundary, Tectonophysics, 568-569, 25-38, doi:10.1016/j.tecto.2011.08.025.

Reason: A synthesis paper for the tectonic melange from the Shimanto Belt, the Mugi melange in the Tokushima prefecture. Investigation of P-T condition, deformation mechanism, quantitative estimation of the strain, fluid-rock interaction and chemistry, and fault mechanism suggest a seismogenic plate boundary process in the subduction zone.

4. Awards and Honors throughout your career

- Gaku Kimura, Incentive Award, The Geological Society of Japan, 1981.9
- Gaku Kimura, The Geological Society of Japan Award, The Geological Society of
- Japan, 2012.9.15

5. Future Research Plan

My retirement will be the end of fiscal year of 2015 (March 2016). So I describe here my

research plan until the retirement. I continueously focus on the plate boundary process and seismogenesis in subduction zone. The researches were conducted in term of geological analysis of fossilized plate boundary fault rock in ancient accretionary prisms and direct drilling into the plate boundary in the Nankai Trough.

The specific target for the ancient accretionary prism is the Nobeoka thrust in the Shimanto belt in Kyushu. Seismic survey, drilling, logging and coring were already completed and is now conducting detailed analysis of acquired data set. Pseodotachylyte, heated fault rocks, and dynamically interacted record due to fluid-rock interaction have been well recovered from the core.

Drilling in the Nankai Trough as NantroSEIZE project under the Integrated Ocean Drilling Program (IODP) will be completed in 2014. The final target is the plate boundary thurst, which is also the root of the splay fault. As a co-principal proponent, speciality coordinator of structural geology in the project management team, I like to contribute the successful completion of the NantroSEIZE project. The NantroSEIZE project is no doubt a revolutional project by using drilling vessel "Chikyu" spending more than ten years and is expected to clarify the seismo-tsunamigenic fault mechanism in subduction zone. I am happy to work in this project for a long period and to spend in my last phase of academy life.

6. Funding Received

(1) JSPS Grants

- Grant-in-Aid for Scientific Research (B), Dynamics of accretionary prism and seismogenic fault in subduction zone, 2006-2008, 19,630,000yen
- Grant-in-Aid for Scientific Research (C), Global material and energy circulation and accretionary orogen evolution, 2006, 4,420,000yen
- Grant-in-Aid for Scientific Research on Innovative Areas, New perspective of great subduction-zone earthquakes from the super deep drilling, 2009-2013, 47,580,000yen
- Grant-in-Aid for Scientific Research on Innovative Areas, Slip mechanism of seismogenic fault from the material scientific viewpoint, 2009-2013, 126,360,000yen
- Grant-in-Aid for Scientific Research (A), Fault mechanism of seismogenic splay fault in subduction zone, 2011-2014, 40,820,000yen

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Ujiie, K., A. Yamaguchi, G. Kimura, T. Hisamitsu, and A. Taira (2006), Fluid Behavior during Evolution of Plate Boundary Fault from Trench to Seismogenic Depths, *J. Geography*, *115*, 353-366.
2. Hashimoto, Y., T. Nakaya, M. Ito, and G. Kimura (2006), Tectonolithification of sandstone prior to the onset of seismogenic subduction zone: Evidence from tectonic mélange of the Shimanto Belt, Japan, *Geochem. Geophys. Geosyst.*, *7*, Q06013, doi:10.1029/2005GC001062.

3. Tsuji, T., G. Kimura, S. Okamoto, F. Kono, H. Mochinaga, T. Saeki, and H. Tokuyama (2006), Modern and ancient seismogenic out-of-sequence thrusts in the Nankai accretionary prism: Comparison of laboratory-derived physical properties and seismic reflection data, *Geophys. Res. Lett.*, *33*, L18309, doi: 10.1029/2006GL027025.

4. Okamoto, S., G. Kimura, S. Takizawa, and H. Yamaguchi (2006), Earthquake fault rock indicating a coupled lubrication mechanism, *eEarth*, *1*, 23-28.

5. Kimura, G., Y. Kitamura, Y. Hashimoto, A. Yamaguchi, T. Shibata, K. Ujiie, and S. Okamoto (2007), Transition of accretionary wedge structures around the up-dip limit of the seismogenic subduction zone, *Earth Planet. Sci. Lett.*, *255*, 471-484.

6. Takada, Y., Y. Fukahata, A. Hashima, T. Terakawa, K. Fukui, T. Yanagisawa, Y., Ikeda, G. Kimura, and M. Matsu'ura (2007), Development of three-dimensional basement structure in Taiwan deduced from past plate motion: Consistency with the present seismicity, *Tectonics*, *26*, TC3004, doi: 10.1029/2006TC001957.

7. Kawabata, K., H. Tanaka, and G. Kimura (2007), Mass transfer and pressure solution in deformed shale of accretionary complex: Examples from the Shimanto Belt, southwestern Japan, *J. Struct. Geol.*, *29*, 697-711.

8. Harold, T., H. Ito, J. Behrmann, S. Hickman, and G. Kimura (2007), Joint IODP-ICDP Workshop Examines Challenges of Fault Zone Drilling, *Scientific Drilling Special Issue*, *1*, 5-16.

9. Okamoto, S., G. Kimura, A., Yamaguchi, H. Yamaguchi, and Y. Kusaba (2007), Generation Depth of the Pseudotachylyte from an Out-of-Sequence Thrust in Accretionary Prism – Geothermobarometric Evidence, *Scientific Drilling Special Issue*, *1*, 47-50.

10. Ujiie, K., A. Yamaguchi, G. Kimura, and S. Toh (2007), Fluidization of granular material in a subduction thrust at seismogenic depths, *Earth Planet. Sci. Lett.*, *259*, 307-318, doi: 10.1016/l.epsl.2007.04.049.

11. Hugues, R., T. Toyoshima, Y. Harima, and G. Kimura (2007), Grain-size reduction mechanisms and rheological consequences in high-temperature gabbro mylonites of Hidaka, Japan, *Earth Planet. Sci. Lett.*, *267*, 637-653, doi: 10.1016/j.epsl.2007.12.012.

12. Kimura, G., E. J. Screaton, and D. Curewitz (2007), NanTroSEIZE Stage 1: NanTroSEIZE shallow megasplay and frontal thrusts, *IODP Scientific Prospectus*, *316*, doi:10.2204/iodp.sp.316.2007.

13. Kimura, G., E. J. Screaton, and D. Curewitz (2007), NanTroSEIZE Stage 1: NanTro SEIZE shallow megasplay and frontal thrusts addendum, *IODP Scientific Prospectus, 316 addendum*, doi:10.2204/iodp.sp.316add.2007.

14. Kimura, G., Y. Kitamura, A. Yamaguchi, and H. Raimbourg (2008), Links among mountain building, surface erosion, and growth of an accretionary prism in a subduction zone- An example from southwest Japan, *GSA Special Paper*, *436*, 391-403.

15. Shibata, T., Y. Orihashi, G. Kimura, and Y. Hashimoto (2008), Underplating of mélange evidenced by the depositional ages: U-Pb dating of zircons from the Shimanto accretionary complex, southwest Japan, *Island Arc*, *17*, 376-393.

16. Hashimoto, Y., A. Nikaizo, and G. Kimura (2009), A geochemical estimation of fluid flux and permeability for a fault zone in Mugi mélange, the Cretaceous Shimanto Belt, SW Japan, *J. Struct. Geol.*, *31*, 208-214.

17. Hugues, R., T. Shibata, A. Yamaguchi, H. Yamaguchi, and G. Kimura (2009), Horizontal shortening versus vertical loading in accretionary prisms, *Geochem., Geophy., Geosyst.*,

10, Q04007, doi:10.1029/2008GC002279.

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21. Kameda, J., Y. Yamamoto, and G. Kimura (2010), Smectite swelling in the Miura-Boso accretionary prism: Possibly cause for incipient decollement zone formation, *Tectonophysics*, *494*, 75-84.

22. Ide, S., K. Shiomi, K. Mochizuki, T. Tonegawa, and G. Kimura (2010), Split Philippine Sea plate beneath Japan, *Geophys. Res. Lett.*, *37,* L21304, doi:10.1029/2010GL044585.

23. Yamaguchi, A., S. F. Cox, G. Kimura, and S. Okamoto (2011), Dynamic changes in fluid redox state associated with episodic fault rupture along a megasplay fault in a subduction zone, *Earth Planet. Sci. Lett.*, *302*, 369-377.

24. Kimura, G., G. F. Moore, M. Strasser, E. Screaton, D. Curewitz, C. Streiff, and H. Tobin (2011), Spatial and Temporal evolution of the megasplay fault in the Nankai Trough, *Geochem. Geophys. Geosyst.*, *12*, Q0A008, doi:10.1029/2010GC003335.

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26. Kameda, J., H. Raimbourg, T. Kogure, and G. Kimura (2011), Low-grade metamorphism around the down-dip limit of seismogenic subduction zones: Example from an ancient accretionary complex in the Shimanto Belt, Japan, *Tectonophysics*, *502*, 383-392, doi:10.1016/j.tecto.2011.02.010.

27. Kameda, J., K. Ujiie, A. Yamaguchi, and G. Kimura (2011), Smectite to chlorite conversion by frictional heating along a subduction thrust, *Earth Planet. Sci. Lett.*, *305*, 161-170, doi:10.1016/j.epsl.2011.02.051.

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29. Sakaguchi, A., G. Kimura, M. Strasser, E. J. Screaton, D. Curewitz, and M. Murayama, Episodic seafloor mud brecciation due to great subduction zone earthquakes, *Geology*, *39*, 919-922, doi:10.1130/G32043.1.

30. Yamaguchi, A., A. Sakaguchi, T. Sakamoto, K. Iijima, J. Kameda, G. Kimura, K. Ujiie, F. M. Chester, O. Fabbri, D. Goldsby, A. Tsutsumi, C.-F. Li, and D. Curewitz (2011), Progressive illitization in fault gouge caused by seismic slip propagation along a megasplay fault in the Nankai Trough, *Geology*, *39*, 995-998, doi:10.1130/G32038.1.

31. Kameda, J., A. Yamaguchi, S. Saito, H. Sakuma, K. Kawamura, and G. Kimura (2011), A new source of water in seismogenic subduction zones, *Geophys. Res. Lett.*, *38*, L22306, doi:10.1029/2011GL048883.

(2) Selected Conference Proceedings

1. Kimura, G., J. S. Elizabeth, C. Daniel, and the Expedition 316 Scientists (2008), NanTroSEIZE Stage 1A: NanTroSEIZE Shallow Megasplay and Frontal Thrusts, IODP 316 Preliminary Report, doi:10.2204/iodp.pr.316.

(3) Review Papers

2. Kinoshita, M., J. Ashi, G. Kimura, T. Kanamatsu, and S. Kuramoto (2009), Fault breccia sampled from shallow part of a mega-splay thrust in the Nankai Trough off Kii Peninsula, *J. Geography*, *115*, XV-XVI, Non-refereed.

(4) Books

1. Kimura, G., and M. Kinoshita (2009), Accretionary prism and great subduction zone earthquake- for the Nankai earthquake, University of Tokyo Press, pp.1-296.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Kimura, G., Mountain building processes of Japan- present and past, European Geosciences Union, 2006.4.2-7, Vienna, Austria, invited.

2. Kimura, G., Mélange as a plate boundary fault rock- earthquake and slow slip, GSA Meeting, Tectonic Crossroads: Evolving Orogens of Eurashia-Africa-Arabia, 2010.10.4-8, Ankara, Turkey, invited.

3. Kimura, G., S. Hina, Y. Hamada, J. Kameda, T. Tsuji, M. Kinoshita, and A. Yamaguchi, A runaway slip to the trench due to breaking through abnormally pressurized megathrust under the middle trench slope- The tsunami genesis of the 2011 Tohoku earthquake-, AGU Fall Meeting, 2011-12.5-9, San Francisco, USA, general.

Total: 12

(2) Domestic Conferences

4. Kimura, G., J.-O., Park, J. Ashi, K. Kanagawa, M. Kinoshita, and S. Ide, A innovative new project “KANAME”: New perspective of great subduction-zone earthquakes from the super deep drilling, Japan Geoscience Union Meeting 2011, 2011.5.22-27, Makuhari, Chiba, invited.

Total: 29

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Award: Hamada, Y., Student Outstanding Presentation Award, Japan Geoscience Union

Meeting 2011, Solid Earth Sciences Section

· Careers advisees: The Asahi Shimbun Company, Intelligence Ltd., Recruit Co., Ltd., etc.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

Island Arc, Editorial Advisory Board member

(2) Academic Societies

· 2006.5-2008.5, President, Japan Geological Society of Japan

· 2008.12-2012.5, President, Japan Geoscience Union

(3) International Conferences

· Session Convener, "Ocean Mixing", XXV General Assembly of the International Union of Geodesy and Geophysics (IUGG 2011), Melbourne, Australia, June 28 –June 30, 2011.

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· 2011.11.23, Lecturer, Science Café, Hitachi Environment Foundation

12. Internal and External Committee Memberships (2006-2011)

· 2005.3-2014.9 Member of Science Council of Japan

· 2006.6-2009.3 Member of SAS Executive Committee

· 2008.2-2012.3 Advise committee for "Chikyu" management contract

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 1

Foreign Researchers: 2

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 3

Robert Geller

I. C.V.

Name： Robert Geller
Present Position: Professor, University of Tokyo, Graduate School of Science

Education
B. S., Geophysics, California Institute of Technology, June 1973
M. S., Geophysics, California Institute of Technology, June, 1975
Ph. D., Geophysics, California Institute of Technology, June, 1977

Professional Experience
June, 1977-June, 1978, Research Fellow in Geophysics, California Institute of Technology
July, 1978-July, 1985, Assistant Professor of Geophysics, Stanford University
August, 1984-June, 1999- Associate Professor, Faculty of Science/Graduate School of Science, University of Tokyo
July, 1999- Professor, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

My main research interest has been directly inverting seismic waveform data for earth structure. During the period before 2006 we developed important theoretical results, notably the general formulation of the inverse problem (Geller and Hara, GJI, 1993), and accurate and efficient methods for computing the synthetic seismograms (a series of papers, with the key results presented by Geller and Takeuchi, 1995, GJI).

In the period from 2006-2011 we made major progress in our work on waveform inversion. We developed a new version of our algorithm for computing synthetic seismograms (Kawai et al., GJI, 2006), and made free downloadable software available on the web. We then applied our methods to inversion of actual data to determine the 1-D profile of S-wave velocity variation with depth in D", the lowermost layer of the mantle. Our methods allowed us to determine profiles with much finer resolution than pervious studies. We published results for several regions (beneath Central America, the Arctic, the western Pacific, etc.: Kawai et al., GRL, 2007ab; Konishi et al., EPSL, 2009, etc.). These results were used by Kawai and Tsuchiya (PNAS, 2009) to show that the seismic velocities in D" could be explained as a thermal boundary layer without the need to invoke a double crossing phase boundary.

In addition to direct waveform inversion for isotropic seismic velocities we have also carried out waveform inversion for anisotropy and anelasticity. We detected anisotropy in the lowermost mantle under Hawaii showing the existence of upwelling mantle flow from the CMB (Kawai and Geller, EPSL, 2010), and we showed the existence of low Q (strong anelasticity) to depths of 700 km under the western Pacific, consistent with the existence of water to these depths (Fuji et al., PEPI, 2010).

Our methods for computing synthetic seismograms for studies of global earth structure are implemented in the frequency domain, but we have applied these techniques to develop methods for computing synthetic seismograms in the time domain. We developed new algorithms for computing stable and accurate time-domain synthetic seismograms, and have

applied for a patent for a simulation apparatus to implement these algorithms. The patent application is pending in Japan, USA, UK, Canada, and Norway.

After the March 11, 2011 Tohoku earthquake many problems in Japan's efforts to make short-term earthquake predictions and long term hazard forecasts came to light, and deficiencies in provisions for seismic/tsunami countermeasures at nuclear power plants became painfully apparent. I published several papers pointing out the problems and suggesting necessary improvements (Geller, Nature, 2011; Nöggerath et al., Bull. Atom. Sci., 2011; Stein et al., Seismol. Res. Lett., 2011). I think it is important for scientists to contribute to the public discourse on resolving these issues.

3. Five Important Papers in your career

The following five papers provide a good sample of what I have worked on over the years. Each has been and continues to be widely cited, so this work has had an impact in the seismological community. I discuss each paper briefly below.

1. Geller, R. J. (1976), Scaling relations for earthquake source parameters and magnitudes, *Bull. Seism. Soc. Am*., *66*, 1501-1523. Times Cited: 314

This paper presents a simple model that explains why the classical surface-wave magnitude scale saturated at about Ms=8.5 regardless of how large the seismic moment becomes.

2. Geller, R. J., D. D. Jackson, Y. Y. Kagan, and F. Mulargia (1997), Earthquakes cannot be predicted, *Science*, *275*, 1616-1617. Times Cited: 237

This paper highlighted the impossibility of deterministic short-term earthquake prediction at the present time and in the imminent future. It has had an important impact on discourse regarding the prediction problem.

3. Geller, R. J. and C. S. Mueller (1980), Four similar earthquakes in central California (1980), *Geophys. Res. Lett*., *7*, 821-824. Times Cited: 131

This paper reported a previously unreported phenomenon: similar earthquakes (sometimes called repeating earthquakes), i.e., earthquakes with almost identical waveforms, showing that they involved slip on the fault at almost exactly the same site.

4. Geller, R. J. (1997) Earthquake prediction: a critical review, *Geophys. J. Int*., *131*, 425-450. Times Cited: 110

This paper provides an extremely thorough review of earthquake prediction research from 1880 to the time of writing, showing the vast extent of unsuccessful work in this area.

5. Geller, R. J., and T. Ohminato (1994), Computation of synthetic seismograms and their partial derivatives for heterogeneous media with arbitrary natural boundary conditions using the Direct Solution Method, *Geophys. J. Int*., *116*, 421-446. Times Cited: 75

This paper presented the fundamentals of the weak form of the elastic equation of motion for a fluid-solid medium. It is the basis of our group's method for computing synthetic seismograms, the Direct Solution Method. It served to call attention to weak-form methods in the seismological community.

4. Awards and Honors throughout your career

· ARCO Outstanding Young Faculty Award, 1978

· Guggenheim Fellowship, 1984-85

· Also, although not an "award or honor" in the usual sense, after a law was enacted in 1982 to make it possible for non-Japanese citizens to become faculty members of Japanese national universities I was the first non-Japanese citizen to be appointed a permanent (tenured) faculty member at the University of Tokyo.

5. Future Research Plan

As outlined above, in the years leading up to 2006 we developed methods for waveform inversion for Earth structure, and we applied these methods to analyze observed waveform data to determine the depth-dependence of seismic velocity structure in the lowermost mantle for many regions. We also inverted waveform data for the depth dependence of anisotropy and anelasticity.

We are now working on applying these methods to waveform inversion for localized 3-D structure of the lowermost mantle. Promising results have been obtained and will serve as the basis for K. Konishi's Ph.D. thesis (now undergoing final evaluation). We have submitted papers on our results for publication, and are giving several talks (one invited) and posters at the Fall 2012 AGU meeting. We plan to follow up aggressively and conduct large scale work on waveform inversion for 3-D earth structure. We hope to use these results to obtain important new information for understanding geodynamic processes.

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We are continuing our work on applying optimally accurate numerical operators to wave propagation in exploration geophysics. We plan to develop "industrial strength" software and apply it to problems in spherical coordinates. In the near future we plan to begin work on waveform inversion in exploration geophysics.

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After the March 11, 2011 Tohoku earthquake, Japan faces many challenges in reforming the national efforts in seismology, which are now heavily slanted towards work on earthquake prediction. There are also important issues involving seismic and tsunami safety of nuclear power plants. I was the chair of the organizing committee for the "special symposium" organized by the Seismological Society of Japan in Hakodate in October 2012 on the occasion of the 50th anniversary of the start of Japan's earthquake prediction program, and also presented a talk at the symposium.

I also published papers on problems of seismic hazard maps (Stein et al., Tectonophysics, 2012), the flaws in the "characteristic earthquake model" (Kagan et al., Seismol. Res. Lett., 2012), and on problems of communicating uncertainty of natural hazard forecasts to the public (Stein and Geller, Eos, 2012).

I plan to continue to make contributions regarding the above issues, which lie at the interface between pure earth science and policy studies.

6. Funding Received

(1) JSPS Grants

· "Kiban C" grant: Inversion of body-wave data for localized 3-D elastic and anelastic structure, 4,290,000 Yen, 2010-2012

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(2) Cooperative Research

· With Schlumberger, K.K., 450,000 Yen, 2008

(3) Research Contracts

· Project for Sustainable Coexistence of Human, Nature, and the Earth supported by Environment and Energy Division, Research and Development Bureau, Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan

(4) Grants and Gifts

· From Schlumberger, K.K., 4,950,000 Yen, 2006-2010

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Kawai, K., N. Takeuchi, and R. J. Geller (2006), Complete synthetic seismograms up to 2 Hz for transversely isotropic spherically symmetric media, *Geophys. J. Int*., *164*, 411-424.
2. 2. Kawai, K., N. Takeuchi, R. J. Geller, and N. Fuji (2007), Possible evidence for a double crossing phase transition in D" beneath Central America from inversion of seismic waveforms, *Geophys. Res. Lett*., *34*, L09314, doi:10.1029/2007GL029642.
3. 3. Kawai, K., R. J. Geller, and N. Fuji (2007), D" beneath the Arctic from inversion of shear waveforms, Geophys. Res. Lett., 34, L21305, doi:10.1029/2007GL031517.
4. 4. Konishi, K., K. Kawai, R. J. Geller, and N. Fuji (2009). MORB in the lowermost mantle beneath the western Pacific: Evidence from waveform inversion, *Earth Planet. Sci. Lett*., *278*, 219-225.
5. 5. Kawai, K., S. Sekine, N. Fuji, and R. J. Geller (2009), Waveform inversion for D" structure beneath northern Asia using Hi-net tiltmeter data, *Geophys. Res. Lett*., *36*, L20314, doi:10.1029/2009GL039651.
6. 6. Fuji, N., K. Kawai, and R. J. Geller (2010), A methodology for inversion of broadband seismic waveforms for elastic and anelastic structure and its application to the mantle transition zone beneath the Northwestern Pacific, *Phys. Earth Planet. Int*., *180*, 118-137.
7. 7. Kawai, K., and R. J. Geller (2010), Waveform inversion for localized seismic structure and an application to D" structure beneath the Pacific, *J. Geophys. Res*., *115*, B01305, doi:10.1029/2009JB006503.
8. 8. Kawai, K., and R. J. Geller (2010), The vertical flow in the lowermost mantle beneath the Pacific from inversion of seismic waveforms for anisotropic structure, *Earth Planet. Sci. Lett*., *297*, 190-198.
9. 9. Kawai, K., R. J. Geller, and N. Fuji (2010), Waveform inversion for S-wave structure in the lowermost mantle beneath the Arctic: Implications for mineralogy and chemical composition, *Geophys. Res. Lett*., *37*, L16301, doi:10.1029/2010GL043654.
10. 10. Kawai, K., and R. J. Geller (2010), Inversion of seismic waveforms for shear wave velocity, structure in the lowermost mantle beneath the Hawaiian hotspot, *Phys. Earth Planet. Int*., *183*, 136-142.
11. 11. Geller, R. J. (2011), Shake-up time for Japanese seismology, *Nature*, *472*, 407--409. (Commentary article).
12. 12. Stein, S., R. J. Geller, and M. Liu (2011), Bad assumptions or bad luck: Why earthquake hazard maps need objective testing, *Seismological Research Letters*, *82*,

623-626. (Opinion article)

13. 13. Nöggerath, J., R. J. Geller, and V. K. Gusiakov (2011), Fukushima: The myth of safety, the reality of geoscience, *Bulletin of the Atomic Scientists*, *67*(5), 37-46.

(2) Selected Conference Proceedings

1. R.J. Geller, "Reset" for Seismology and Disaster Mitigation Policy (in Japanese) (paper based on invited keynote lecture at Seismological Society of Japan special symposium, Shizuoka, Oct. 2011), http://zisin.jah.jp/pdf/SSJ_final_report.pdf#page=9

(3) Review Papers

(4) Books

1. R. J. Geller, (2011), What Japanese people don't know about "earthquake prediction," Futabasha (in Japanese), ISBN-13: 978-4575303438.

(5) Patents

1. Geller, R. J., H. Mizutani, N. Hirabayashi, and N. Takeuchi, Numerical operators synthesizing method, involves generating stiffness matrix using spatial first-order difference operators, where difference approximation of first-order differentiation is obtained by smearing out operators in directions," Patent Number(s): WO2010058865-A2; JP2010123056-A, Patent Assignee: UNIV TOKYO, Patent applications pending in Japan, U.S.A., U.K., Canada, and Norway.

(5) Software

1. Public Free Software for computing synthetic seismograms in spherically symmetric transversely isotropic (TI) media using the Direct Solution Method (DSM), written principally by K. Kawai, with assistance from other members of my laboratory. Available for download from "http://www-solid.eps.s.u-tokyo.ac.jp/~dsm."

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

22 presentations

(2) Domestic Conferences

19 presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

- One of my Ph.D. advisees at Stanford (Hitoshi Kawakatsu) is a Professor at the Earthquake Research Institute (ERI) of the University of Tokyo. Takao Ohminato, who was my M.Sc. advisee at the University of Tokyo, is now an Associate Professor at ERI, as is Nozomu Takeuchi (who was my advisee in both the M. Sc and Ph. D. courses at Todai).
- Of my more recent Ph.D. advisees at Todai Kenji Kawai (Ph. D., 2006) is Assistant Professor (term-limited) at the Tokyo Institute of Technology, and Nobuaki Fuji (Ph.D., 2010) was appointed to a permanent faculty position (roughly equivalent to Assistant Professor) at the University of Paris in September 2012.
- Takeuchi and Kawai (the latter in the fall of 2012) have both received the award for outstanding young researchers from the Seismological Society of Japan.

· Starting in 2004 I was asked by our department to establish and supervise a course in "scientific English" for graduate students in our department. The actual teaching is done by instructors hired for that purpose, but I continue in charge of that course. We have developed some useful and practical methods of instruction. Details may be found in the home page for our course: http://w3-englishlab.eps.s.u-tokyo.ac.jp/english/en/index.shtml

· I am now working with Professor Y. Nishimura (linguistics) from the Faculty of Letters of the University of Tokyo on a project to apply the lessons learned from our course on difficulties faced by Japanese learners of English more generally to improve English language education in Japan.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

· Member of the Board of Governors of the Seismological Society of Japan.

(3) International Conferences

· Convenor of Session at WPGM meeting in 2011.

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· After the March 11, 2011 Tohoku earthquake I was interviewed many times by the major newspapers, wire services and magazines in Japan and some from overseas. I wrote articles in Japanese for the two major policy-oriented magazines in Japan (Sekai and Chuo Koron). And I was interviewed one or more times by several major TV stations (Fuji TV, Nihon TV, Yomiuri TV) and by international news channels (CNN, Bloomberg, Al Jazeera-English). I also wrote a popular book on the problems of earthquake prediction in Japan. Through these activities I am making a contribution to resolving important policy-related issues due to earthquake prediction, long-term seismic hazard forecasts, and safety of nuclear power plants.

12. Internal and External Committee Memberships (2006-2011)

· Chair of the Academic Affairs Committee of the undergraduate department in Earth and Planetary Physics (and hence member of the Academic Affairs Committee of the School of Science), 2009-10, 2010-11 academic years.

· Chair of faculty search committees for professor (2009) and associate professor (2008) in solid earth science group.

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 2 [M.S. student from Uzbekistan, UTRIP program, India]

Foreign Researchers: 0

Sending

Japanese Students: 2 [M.Sc.: 0, Ph.D.: (U.S.A.: 1, France: 1)]
Japanese Researchers: 0
Visitors from Abroad: 7 [France 1, England 1, Germany 1, USA 4]

Yasutaka Ikeda

I. C.V.

Name： Yasutaka Ikeda
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Geography, University of Tokyo, March 1975
M. Sc., Geography, University of Tokyo, March 1977
D. Sc., Geography, University of Tokyo, March 1989

Professional Experience
August 1980 – February 1991, Research Associate, Faculty of Science, University of Tokyo
March 1991 – April 1992, Lecturer, Faculty of Science, University of Tokyo
May 1991 – March 1993, Associate Professor, Faculty of Science, University of Tokyo
May 1995 – March 2004, Research Scientist, Geological Survey of Japan
April 1993 – Associate Professor, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

My research group has been studying the behavior of, and crustal deformation associated with, active faults including mega-thrusts at subduction zones. Major achievements of our group in the period of 2006-2011 are as follows.

Subsurface structure of the Itoigawa-Shizuoka Tectonic Line (ISTL) in central Japan. The ISTL is one of the most active faults in the Japan arc. We made seismic and gravity profiling along several transects across the ISTL as part of the Integrate Research Project for the Itoigawa-Shizuoka Tectonic Line (sponsored by MEXT), and found that the middle portion of the ISTL dip at a fairly low angle in spite of dominantly strike-slip motion on it. This indicates that the geometry of the ISTL is not adapted to the present-day stress field and that its frictional strength is very low, likely because this portion of ISTL had evolved and matured as a normal fault in Miocene time.

Active nappes in central Japan and their implications for the evolution of the Lesser Himalayan nappes. Our previous studies revealed that the Ina Valley Fault Zone and the southern portion of the ISTL in central Japan have high rates of thrust slip in Late Quaternary time. We conducted seismic and gravity profiling across these faults, and found that their hanging walls have been thrust on top of foreland sediments for a few kilometers, forming nappe structures. We interpreted that, under strong erosional force due to summer monsoon precipitation in central Japan, a thrust fault can form a nappe only if its slip rate exceeds ~10 mm/yr. We further interpreted the evolution of lesser Himalayan nappes, which had grown up (~100 km wide) until, and have retreated by erosion since, late Miocene time under similar climate.

Quantifying horizontal extension and shortening in the Northeast Japan's backarc. We reprocessed existing marine seismic reflection data and compiled seismic, gravity, and surface geologic data in the backarc region of Honshu, and found that the Miocene extension (~E-W) is as much as 31-56 km while the Pliocene-Quaternary shortening is only 10-15 km. This study

provides an important example of positive tectonic inversion in subduction-related orogens. Furthermore, our study has implications for the process of strain buildup and release in subduction zones: Recent GPS observations have revealed crustal strain precisely and extensively, but cannot discriminate elastic and inelastic (= permanent) strain buildups. We have proposed that geological methods and data should be used to evaluate inelastic strain buildup quantitatively, thereby to evaluate present-day elastic strain buildup, which may eventually result in gigantic earthquakes. Our results indicate that most of the strain accumulated in the last 100 years at abnormally high rates in NEJ arc is elastic, and is to be released by slip on the coupled plate interface. Only a fraction (~10%) of geodetically-observed crustal shortening is accommodated within the NEJ arc as long-term (inelastic) deformation.

3. Five Important Papers in your career

1. Ikeda, Y., Thrust-front migration and its mechanism (1983), Evolution of intraplate thrust fault systems, *Bull. Dept. Geogr., Univ. Tokyo*, *15*, 125-159.

This paper systemizes the phenomenology, and discusses the mechanism, of thrust-front migration and accompanying deformation.

2. Ikeda, Y., Y. Suzuki, E. Herece, F. Saroglu, A. M. Isikara, and Y. Honkura (1991), Geological evidence for the last two faulting events on the North Anatolian fault zone in the Mudurnu Valley, western Turkey, *Tectonophysics*, *193*, 335-345.

First report on paleoseismology of the North Anatolian Fault

3. Kayanne, H., Y. Ikeda, T. Echigo, M. Shishikura, T. Kamataki, K. Satake, J. N. Malik, S. R. Basir, G. K. Chakrabortty, and A. K. Ghosh Roy (2007), Coseismic and postseismic creep in the Andaman Islands associated with the 2004 Sumatra-Andaman earthquake, *Geophys. Res. Lett., 34*, L01310, doi:10.1029/2006GL028200.

In this paper we reports evidence for slow, aseismic up-dip propagation of rupture front following the 2004 Sumatra-Andaman earthquake.

4. Ikeda Y., T. Iwasaki, K. Kano T. Ito, H. Sato, M. Tajikara, S. Kikuchi, M. Higashinaka, T. Kozawa, and T. Kawanaka (2009), Active nappe with a high slip rate: Seismic and gravity profiling across the southern part of the Itoigawa-Shizuoka Tectonic Line, central Japan, *Tectonophysics, 472*, 72-85, doi:10.1016/j.tecto.2008.04.008.

Active nappe along the Itoigawa-Shizuoka Tectonic Line was imaged by using reflection seismic and gravity profiling; we also discuss the relationship between erosion retreat and tectonic advance of nappe fronts, and we speculate the evolution of Himalayan nappes and klippen quantitatively.

5. Okada, S., and Ikeda, Y. (2012), Quantifying crustal extension and shortening in the back-arc region of Northeast Japan, *J. Geophys. Res., 117*, B01404, doi: 10.1029/2011JB008355.

We quantitatively determined Miocene crustal extension and Pliocene-Quaternary crustal shortening across the northeast Japan arc by using reflection seismic data, and found that the NE Japan arc is still in a incipient stage of an Andean-type orogen, providing an example of positive tectonic inversion.

4. Awards and Honors throughout your career

· Active Fault Research Group)Ikeda, Y., Ishiyama, T., Imaizumi, T., et al.: Special Award of the Association of Japanese Geographers, March 2003.

· Tajikara, M., and Ikeda, Y.: Award for Academic Papers, Japan Association for Quaternary Research, August 2008

5. Future Research Plan

My main research theme in the coming several years will be a Himalaya-Tibetan study, which I have been nursing since the very beginning of my research career in tectonic geomorphology.

There has been much debate about the evolution mechanism of the Himalaya-Tibetan orogen. Available data indicate that the height of the orogen had increased for ~30 Myr since the onset of the collision, being saturated at ~20 Ma likely because gravity-induced stress reached the strength of lithosphere. Since ~20 Ma, the orogen has been expanding its volume by increasing its width instead of its height (or crustal thickness). The lateral growth has occurred by successively invading foreland lithosphere that has been stable since the Precambrian or early Paleozoic time.

The style of the lateral growth is different from place to place. The lateral growth at the southern margin of the orogen is discrete and episodic; the collision front was first at the Indus-Tsampo Suture Zone, then jumped southward for ~200 km to the MCT at ~20 Ma, and again for ~100 km from the MCT to the MBF in late Miocene time. In contrast, the lateral growth in Yunnan and south Sichuan seems continuous both in space and time, and therefore is well understood in terms of the lower crustal channel- flow model of Royden and others. However, the lateral growth at the northeast margin is complex and problematic.

My main target is the northeast margin of the Tibetan Plateau, where late Quaternary deformation is taking place at considerably high rates. I have organized a research team, which includes Chinese research counterparts from the China Earthquake Administration and the Chinese Academy of Science, to reveal the mechanism of the Tibetan Plateau's lateral growth by geological and geomorphological methods and the surface-exposure-dating method using *in situ* cosmogenic nuclides.

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for Scientific Research (C), "A study on the evolutionary process of a large-scale strike-slip fault," 2006-2007, 4,050,000 yen (Principal investigator)

· Grant-in-Aid for Special Purposes, "Comprehensive Research on the 2008 Great Earthquake in Sichuan Province and Damages Caused by the Earthquake," 2008, 2,400,000 yen (Co-investigator)

· Grant-in-Aid for Scientific Research on Innovative Areas, "High precision topographical/geological surveys for elucidating the activity history of seismogenic faults," 2009-2011 (to be continued to 2014), 2,700,000 yen (Co-investigator)

· Grant-in-Aid for Scientific Research (B), "A study on the lateral growth of the Tibetan Plateau," 2010-2011 (to be continued to 2013), 10,530,000 yen (Principal investigator)

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

· Observation and Research Program for Prediction of Earthquakes and Volcanic Eruptions, "Dynamics of magma generation and crustal deformation in subduction zones," 2009-2011 (to be continued to 2018), 1,100,000 yen (Co-investigator)

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Malik, J.N., Shishikura, M., Echigo, T., Ikeda, Y., Satake, K., Kayanne, H., Sawai, Y., Murty, C.V.R., and Dikshit, O. (2011), Geologic evidence for two pre-2004 earthquakes during recent centuries near Port Blair, South Andaman Island, India, *Geology, 39*, 559–562; doi:10.1130/G31707.1.
2. Inoue, S., Kayanne, H., Matta, N., Chen, W.S., and Ikeda, Y. (2011), Holocene uplifted coral reefs in Lanyu and Lutao Islands to the southeast of Taiwan, *Coral Reefs, 30*, 581-592; doi:10.1007/s00338-011-0783-x.
3. Ikeda Y., T. Iwasaki, K. Kano T. Ito, H. Sato, M. Tajikara, S. Kikuchi, M. Higashinaka, T. Kozawa, and T. Kawanaka (2009), Active nappe with a high slip rate: Seismic and gravity profiling across the southern part of the Itoigawa-Shizuoka Tectonic Line, central Japan, *Tectonophysics, 472*, 72-85, doi:10.1016/j.tecto.2008.04.008.
4. Tajikara, M., Ikeda, Y., and Nohara, S. (2009), Seismogenic fault of the 2008 Iwate-Miyagi Nairiku Earthquake estimated by distribution of uplift rates during the past ca. 150 kyr., *J. Seismol. Soc. Japan, 62*, 1-11. (In Japanese)
5. Shimoyama, S., Iso, N., Chida, N., Okamura, M., Matsuoka, H., Ikeda, Y., Matsuda, M., Takenaka, H., Ishimura, D., Matsusue, M., Matsuyama, H., and Yamamori, K. (2008), A study of characters of the Umi fault along the eastern margin of the Fukuoka Plain, southwest Japan, *Active Fault Research, 29*, 59-70. (In Japanese)
6. He, H., and Y. Ikeda (2007), Faulting on the Anninghe fault zone, Southwest China in Late Quaternary and its movement model, *Acta Seismologica Sinica, 20*, 571-583.
7. Koshiya, S., Morishita, Y., Noda, K., Sato, H., Kurashimo, E., Ogino, S., Takeda, T., Kato, N., Hirano, S., Kato, H., Ikeda, Y., Ikawa, T., Murakami, H. (2007), High-resolution seismic reflection profiling across the western marginal faults of the Kitakami Lowland in Hanamaki area, eastern margin of Ou Backbone Range, Northeast Honshu, Japan, *Bull. Earthq. Res. Inst., 82*, 3-11. (In Japanese)
8. Okada, S., Ikeda, Y., Oda, S., Echigo, T., Toda, S., Suzuki, N., Kawai, Y., Kato, H., Sato, H., Kimura, H., Tajikara, M., Ishiyama, T., Imaizumi, T., Kagohara, K., Matsuta, N., Uchida, T., Uno, T., and Kawai, T. (2007), High-resolution seismic reflection survey "Oguro River Seismic Line" in the Ina Valley Fault Zone, central Japan: data acquisition and processing, *Bull. Earthq. Res. Inst., 82*, 13-23. (In Japanese)
9. Matsuta, N., Ikeda, Y., et al. (2007), P- and S-wave seismic reflection profiling across the Kamishiro Fault, Itoigawa-Shizuoka Tectonic Line active fault system, central Japan, *Bull. Earthq. Res. Inst., 82*, 25-35. (In Japanese)
10. Matsuta, N., Ikeda, Y., et al. (2007), Seismic reflection profiling across the North of Itoigawa-Shizuoka Tectonic Line in Omachi, central Japan, *Bull. Earthq. Res. Inst., 82*, 37-44. (In Japanese)
11. Matsuta, N., Ikeda, Y., et al. (2007), Seismic reflection profiling across the northern part of the Itoigawa-Shizuoka Tectonic Line active fault system, Matsumoto, central Japan,

Bull. Earthq. Res. Inst., 82, 45-55. (In Japanese)

12. Matsuta, N., Ikeda, Y., et al. (2007), Seismic reflection profiling across the central part of the Itoigawa-Shizuoka Tectonic Line in Fujimi, central Japan, *Bull. Earthq. Res. Inst., 82*, 57-63. (In Japanese)
13. Kayanne, H., Y. Ikeda, T. Echigo, M. Shishikura, T. Kamataki, K. Satake, J. N. Malik, S. R. Basir, G. K. Chakrabortty, and A. K. Ghosh Roy (2007), Coseismic and postseismic creep in the Andaman Islands associated with the 2004 Sumatra-Andaman earthquake, *Geophys. Res. Lett., 34*, L01310, doi:10.1029/2006GL028200.
14. Takada, Y., Y. Fukahata, A. Hashima, T. Terakawa, K. Fukui, T. Yanagisawa, Y. Ikeda, G. Kimura, and M. Matsu'ura (2007), Development of three-dimensional basement structure in Taiwan deduced from past plate motion: Consistency with the present seismicity, *Tectonics, 26,* TC3004, doi:10.1029/2006TC001957.
15. He, H., Ran, H., and Ikeda, Y. (2006), Uniform strike-slip rate along the Xianshuihe-Xiaojiang Fault System and its Implications for active tectonics in Southeastern Tibet, *Acta Geologica Sinica, 80*, 376-386.
16. Sato, H., Ikeda, Y., Imaizumi, T., Mikada, H., et al. (2006), High-resolution seismic reflection profiling across the Senya Fault at Hanaoka, northern Honshu, Japan: data acquisition and processing, *Bull. Earthq. Res. Inst., 81*, 97-106. (In Japanese)
17. Kagohara, K., Imaizumi, T., Sato, H., et al. (2006), High-resolution seismic reflection profiling across the Senya Fault at Unjono in the Yokote Basin, northeast Japan: data acquisition and processing, *Bull. Earthq. Res. Inst., 81*, 119-128. (In Japanese)
18. Kurashimo, E., Sato, H., et al. (2006), Shallow seismic reflection profiling across the western margin faults of the Kitakami Lowland, northern Honshu Island, Japan, *Bull. Earthq. Res. Inst., 81*, 139-147. (In Japanese)
19. Sato, H., Yagi, K., Ikeda, Y., et al. (2006), Seismic reflection profiling across active folds in the eastern Shinjo Basin, NE Japan, *Bull. Earthq. Res. Inst., 81*, 157-169. (In Japanese)
20. Okada, S., Ikeda, Y., Echigo, T., et al. (2006), High-resolution seismic reflection survey across the western boundary fault zone of the Nagano Basin, central Japan, *Bull. Earthq. Res. Inst., 81*, 171-180. (In Japanese)

(2) Selected Conference Proceedings

1. Ikeda, Y., T. Iwasaki, K. Kano, T., Ito, S. Abe, and S. Kikuchi (2010), Structure and behavior of the Itoigawa-Shizuoka Tectonic Line, central Japan, as revealed by tectonic geomorphology, seismic reflection surveys, and gravity analyses, *Hokudan International Symposium on Active Faulting*, pp. 30-31.
2. Okada, S., Tajikara, M., Ikeda, Y. and Y. Shirahama (2010), Mid-crustal detachment controls the tectonic evolution in the back-arc region of Northeast Japan, *Hokudan International Symposium on Active Faulting*, pp. 69-70.

(3) Review Papers

1. Ikeda, Y., and Okada, S. (2011), Long-term strain buildup in the Northeast Japan arc-trench system and their implications for the 2011 off the Pacific coast of Tohoku earthquake, *Kagaku, 81*, 1071-1076. (In Japanese)
2. Ikeda, Y. (2011), The process of strain buildup and release in the Northeast Japan arc-trench systems and its implications for gigantic decoupling events, *Report of Coordinating Committee for Earthquake Prediction, 86,* 687-698. (In Japanese)

3. Ikeda, Y. (2011), Long-term strain buildup and release in the Northeast Japan arc-trench systems and its implications for the 2011 earthquake off the Pacific coast of Tohoku, *Report of Coordinating Committee for Earthquake Prediction, 86,* 103-111. (In Japanese)
4. Ikeda, Y., H. He, K. Kano, W. Lin, T. Ishiyama, H. Zhang, Z. Wei, and F. Shi (2009), Geological reconnaissance of the source area of the Wenchuan, Sichuan Province, earthquake of May 12, 2008. In: Konagai, K. (ed.), *Investigation Report of the May 12th 2008, Wenchuan Earthquake, China*, pp. 243-274, http://shake.iis.u-tokyo.ac.jp/wenchuan/
5. Shishikura, M., Ikeda, Y., Echigo, T., Kayanne, H., Satake, K., Malik, J.N., Basir, S.R., Chakrabortty, G.K. (2009), Exploratory trenching of Holocene sediments in coseismically subsided areas in South Andaman Island, seeking evidence for past gigantic subduction earthquakes, *Chikyu, 31*, 158-164. (in Japanese)
6. Ikeda, Y. (2008), The Sichuan, China, earthquake of May 12, 2008, *Geological Society of Japan News, 11* (6), 6-7. (in Japanese)
7. Ikeda, Y. (2008), The Sichuan, China, earthquake of May 12, 2008, *Geological Society of Japan News, 11* (6), 6-7. (in Japanese)
8. Ikeda, Y. (2006), Paradox of seismicity in thin-skinned, fold-and-thrust belts, *Chikyu, Spec. Issue 54*, 26-35. (in Japanese)
9. Ikeda, Y. (2006), Active faults and folds in and around the source region of the Chuetsu earthquakes of 2004, *Chikyu, Spec. Issue 53*, 208-216. (in Japanese)

(4) Books

1. Minoura, K., and Ikeda, Y. (2011), *Tectonics of the Earth 1: Sedimentology and Tectonic Geomorphology*, Modern Geological Science Series 9, Kyoritsu Publ. Co., 202 pp. (in Japanese)
2. Tajikara, M., and Ikeda, Y. (2009), Topography and deformation of an island arc: mountains, ranges and basins in the Northeast Japan Island Arc, In: *Digital book: Progress in Quaternary Research in Japan*, Japan Association for Quaternary Research. (in Japanese)
3. Notsu, K., and Ikeda, Y. (2009), The past 10-year activity of the member institutes: Faculty of Science, University of Tokyo, In: *The Forty-Year History of the Coordinating Committee for Earthquake Prediction*, pp. 40-42, Geographical Survey Institute of japan. (in Japanese)
4. Okada, A., Nakata, T., and Ikeda, Y. (2007), *The Sakaitoge Fault and its Vicinity, 1:25000 Active Fault Map of Urban Area*, Geographical Survey Institute of Japan.
5. Matsuda, T., and Ikeda, Y. (2006), The Kiso Range, In: *Chubu District, Geomorphology of Japan 5,* pp. 164-168, University of Tokyo Press. (in Japanese)

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Ikeda, Y. (2011), Long-term and short-term rates of crustal deformation and their implications for the Tohoku, Northeast Japan, earthquake (Mw 9.0) of March 11, 2011, *Asia Oceania Geoscience Society 2011 Annual Meeting*, Taipei, August 8-12, 2011. (Invited)
2. Goldfinger, C., Ikeda, Y., and Yeats, R.S. (2011), Superquakes and supercycles:

Implications for the GEM seismic hazard model, *The Global Earthquake Model (GEM) Outreach Meeting 2011*, Beijing, June 6-9, 2011. (Invited)

3. Ikeda, Y. (2011), Long-term strain budget in the Northeast Japan arc, and its implications for the gigantic decoupling event in (and after) 2011, *Special Lecture at the Institute of Geology*, *China Earthquake Administration*, Beijing, China, June 8, 2011. (Invited)
4. Ikeda, Y., T. Iwasaki, K. Kano, T., Ito, S. Abe, and S. Kikuch (2010), Structure and behavior of the Itoigawa-ShizuokaTectonic Line, central Japan, as revealed by tectonic geomorphology, seismic reflection surveys, and gravity analyses, *Hokudan International Symposium on Active Faulting*, Awaji City, January 2010. (Invited)
5. Ikeda, Y., K. Kano, T. Iwasaki, and T. Ito (2009), Seismic Hazards from a large fault zone with complex history: An example from the Itoigawa-Shizuoka Tectonic Line, central Japan, *The Second China-Japan Science Forum "The 2008 Wenchuan Earthquake and Natural Disaster Mitigation"*, Beijing, March 2009. (Invited)
6. Ikeda, Y. (2006), Long-term and short-term rates of crustal deformation over the northeast Japan arc, and their implications for gigantic earthquakes at the Japan Trench, *International Workshop on Tectonics of Plate Convergence Zones*, University of Tokyo, September 2006. (Invited)

Total: 28 presentations

(2) Domestic Conferences

7. Ikeda, Y. (2011), Long-term strain buildup in arc-trench systems and its implications for the 2011 gigantic earthquake off the Pacific coast of Tohoku, *Symposium on Observation and Research Program for Prediction of Earthquakes and Volcanic Eruptions: the 2011 Earthquake off the Pacific Coast of Tohoku*, August 20, 2011, Sendai, Japan. (Invited)
8. Ikeda, Y., Kano, K., Iwasaki, T., and Ito, T. (2009), Subsurface structure of the Itoigawa-Shizuoka Tectonic Line as revealed by seismic and gravity profiling, *Symposium on New Findings on Crustal Activity in Fassa Magna Region and Central Japan*, June 2009, Kofu, Geological Society of Japan, Chubu Branch. (Invited)
9. Ikeda, Y. (2007), Process of strain buildup and release in subduction orogens, Japan Geoscience Meeting, May 2007, Chiba. (Invited)
10. Ikeda, Y., Kayanne, H., Echigo, T., Shishikura, M., and Kamataki, T. (2006), Crustal deformation associated with the Sumatra-Andaman earthquake of 2004, *Hokudan Symposium on Active Faults*, Hokudan City, January 2006.

Total: 58 presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Masayoshi Tajikara (Ms and PhD student, 1998-2004): Award for Academic Papers, Japan Association for Quaternary Research, August 2008

· Yoshiki Shirahama (Ms and PhD student, 2009 to date): Award for Excellent Presentations, Seismological Society of Japan, October 2010

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Editor of *Active Fault Research,* published by the Japanese Society for Active Fault Studies and the Active Fault Research Group of Japan, 2006-2011

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Ikeda, Y. (2011), The 2011 gigantic earthquake off Tohoku as part of the process of strain buildup and release in a subduction zone, The 6th Public Symposium of University of Tokyo Ocean Alliance "Science of Earthquake Hazards", July 14, 2011, University of Tokyo.

· Ikeda, Y. (2012), An active fault at the continental-shelf margin off the Shimokita Peninsula: How did the Nuclear Safety Commission evaluate seismic hazards from the large-scale fault extending down-dip beneath nuclear facilities? *Actio 1323* (March 2012), pp. 8-11.

12. Internal and External Committee Memberships (2006-2011)

· Chair of the Education Affairs Committee, Department of Earth and Planetary Environmental Science, Faculty of Science, University of Tokyo, 2008

· Member of the Promotion Committee for Intensive Investigation and Observation of the Itoigawa-Shizuoka Tectonic Line, Headquarters for Earthquake Research Promotion, MEXT, 2006-2009

· Member of the Advisory Committee for Promoting and Circulating Geophysical Data, Headquarters for Earthquake Research Promotion, MEXT, 2006-2007

· Member of the Coordinating Committee for Earthquake Prediction, Geographical Survey Institute, Ministry of Land, Infrastructure, Transport and Tourism, 2006 to date

· Member of the Committee for Mapping Major Active Faults, Geographical Survey Institute, Ministry of Land, Infrastructure, Transport and Tourism, 2006 to date

· Member of the Screening Board for Nuclear Facility Safety, Nuclear Safety Commission, Cabinet Office, Government of Japan, 2006-2012

· Member of the Screening Board for Nuclear Fuel Safety, Nuclear Safety Commission, Cabinet Office, Government of Japan, 2006-2012

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 1 [M.Sc.: 0, Ph.D.: 1 (China: 1)]

Foreign Researchers: 0

Sending

Japanese Students: 5 [M.Sc.: 2 (China:2), Ph.D.: 3 (China: 3)]

Japanese Researchers: 13 [India: 3, China: 10]

Visitors from Abroad: 33 [China: 13, Taiwan: 8, India: 6, UK: 3, U.S.A.: 2, Canada: 2]

Satoshi Ide

I. C.V.

Name： Satoshi Ide
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Geophysics, University of Tokyo, March, 1992
M. Sc., Geophysics, University of Tokyo, March, 1994
Ph. D., Geophysics, University of Tokyo, March, 1007

Professional Experience
April, 1994-March, 1997, JSPS Research Fellow
April, 1997-April, 2002, Assistant Professor, Earthquake Research Institute, University of Tokyo
December, 2000-November, 2001, Visiting Scholar, Department of Geophysics, Stanford University
April, 2002-December, 2008, Lecturer, Graduate School of Science, University of Tokyo
December, 2008-, Associate Professor, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

Our purpose of study is comprehensive understandings of earthquakes and related phenomena. In 2006-2011, we focused on two topics, slow earthquakes and the 2011 Tohoku-Oki earthquake.

Since 2000, strange phenomena, called deep tremor, low-frequency earthquakes (LFE), and slow slip events, have been discovered worldwide. By mainly seismic data analysis we found the following facts.

(1) LFE occurs on the plate interface (published in Nature)
(2) LFE has low-angle thrust-type focal mechanism (highlighted in GRL)
(3) Tremors are swarm activity of many LFEs (published in Nature)
(4) There is a scaling relation for slow earthquakes (published in Nature)
(5) Tremor can be represented by a stochastic process (highlighted in GRL)
(6) Linear structures of tremor correspond to past plate motion (published in Nature)

Based on these facts, we consider that various phenomena are different aspects of a complicated phenomenon, slow earthquake. We also developed an accurate hypocenter determination method for LFE, carried out temporary observation to discover very long-period slow earthquakes, analyzed waveforms of volcanic and semi-volcanic LFEs. We published a short review of slow earthquakes in Science and a long review in Annual Review. Quite recently, we are studying slow earthquakes worldwide.

The 2011 Tohoku-Oki earthquake has been studied intensely. The first peer-reviewed paper of this earthquake was published by our group in Science. The paper suggested that very large slip occurred near the trench and that rupture behavior is quite different in shallow and deep regions. These two conclusions have been confirmed by following studies by many research groups worldwide. We also demonstrated that the complex rupture propagation of the

Tohoku-Oki earthquake can be modeled by a hierarchical heterogeneity fault model.

In addition, we re-examined the scaling relation of seismic energy, developed a multi-scale slip inversion method and applied it to several earthquakes. These studies concluded that both small and large earthquakes are generally well approximated by cascading rupture of hierarchical heterogeneous structures. We developed numerical simulation codes to realize rupture process and earthquake cycles with such hierarchical heterogeneous structures. As a unique result, we published a paper to show that the subducting Philippine Sea plate has a large split, which was widely covered by news media.

3. Five Important Papers in your career

1. Ide, S., and M. Takeo (1997), Determination of constitutive relations of fault slip based on seismic wave analysis, Journal of Geophysical Research, 102, 27379-27391.

Citation 184, as of Oct. 26, 2012. This paper demonstrated that friction laws on earthquake fault plane can be deduced by seismic waveform analysis, and followed by many researches interested in friction properties of rocks. Related invited talk in AGU.

2. Ide, S., and G. C. Beroza (2001), Does apparent stress vary with earthquake size? Geophysical Research Letters, 28, 3349-3352.

Citation 158, as of Oct. 26, 2012. This paper suggests that a scaling law for seismic energy holds for a very wide scale range of about 20 orders. It brought about argument on seismic energy and motivated the 2005 AGU Chapman Conference.

3. Ide, S., G. C. Beroza, D. R. Shelly and T. Uchide (2007), A scaling law for slow earthquakes, Nature, 447, 76-79, doi:10.1038/nature05780.

Citation 120, as of Oct. 26, 2012. This paper showed that slow earthquakes, discovered worldwide in this decade, share a common scaling law completely different from the one for ordinary earthquakes. Widely covered in news media. Invited talk in AGU Union session.

4. Ide, S. (2010), Striations, duration, migration and tidal response in deep tremor, Nature, 466, 356-359, doi:10.1038/nature09251.

Citation 24, as of Oct. 26, 2012. This paper discovered lineation structures in deep tremor zone, which are probably records of historical plate motion. Widely covered in news media. Invited talk in AGU.

5. Ide, S., A. Baltay, and G. C. Beroza (2011), Shallow dynamic overshoot and energetic deep rupture in the 2011 Mw 9.0 Tohoku-Oki earthquake, Science, 332, 1426-1429, doi:10.1126/science.1207020.

Citation 72, as of Oct. 26, 2012. The first peer-reviewd paper for the Tohoku-Oki earthquake, showing that very large slip occurred near the trench and that rupture behavior is quite different in shallow and deep regions. Widely covered in news media.

4. Awards and Honors throughout your career

· Young Scientist Award, the Seismological Society of Japan, May 23, 2005.

· MEXT Young Scientists' Prize, MEXT, Japan, April, 18, 2006.

5. Future Research Plan

Our medium-term (5-10 years) goals would be “understanding the relation between slow earthquakes and megathrust earthquakes” and “characterizing world tremor zones”. We would like to understand the physical process of megathrust earthquakes in subduction zones, based on our leading studies on slow earthquakes. We are doing a research project supported by MEXT KAKENHI, “Study on relationships between tremor, slow earthquakes, and megathrust earthquakes based on systematic data analysis. As rather short-term objectives, we are studying:

· Detection and characterization of deep tremor in subduction zones worldwide.
· Characterization of repeating earthquakes in subduction zones worldwide.
· Detailed investigation of spatio-temporal pattern of deep tremor
· Spatial distribution of deep tremor, slow slip, and megathrust earthquakes
· Characteristics of volcanic and semi-volcanic low frequency earthquakes.
· Effects of fault geometry in dynamic rupture process of megathrust earthquakes.
· Effects of inelastic deformation in rupture process of megathrust earthquakes.
· Characteristics of seismicity in subduction zones worldwide.
· Relation between seismicity and hierarchical heterogeneity of earthquake faults.

The methods of study are mainly data analysis and numerical simulation. There is a large amount of seismic data available in world data servers. We develop efficient methods to collect, maintain, and analyze these data and reveals characteristics of earthquake-like phenomena from various viewpoints. In numerical simulation, we focus on how to represent hierarchical structure of faults, which must be very important to understand earthquake genesis. Generalizing these studies will lead us to the comprehensive understanding of earthquakes.

In future studies, we will introduce knowledge obtained in Geology and Geochemistry. In the research project KANAME led by Prof. G. Kimura, we frequently discuss with researchers in these fields. Though, KANAME project will finish in the next year, we keep the relationship and will plan some extended collaboration. Our department is a good place to make collaboration in various fields, and we also extend the collaboration network to other institutes in Japan and world.

An important aspect for earthquake researches is communication with the society. Unfortunately, accurate earthquake prediction is far from reality, but I believe the increasing knowledge will increase the predictability of earthquakes, in probabilistic ways. It is quite important to inform the society, both our ability and inability for future prediction, carefully and patiently.

6. Funding Received

(1) JSPS Grants

· 2005-2007, Grant-in-Aid for Young Scientists (B), 3,500,000 yen
· 2008-2010, Grant-in-Aid for Scientific Research (B), 14,500,000 yen
· 2009-2013, Grant-in-Aid for Scientific Research on Innovative Areas (Deep Drilling), 36,890,000 yen
· 2011-2015, Grant-in-Aid for Scientific Research (A), 36,900,000 yen

(2) Cooperative Research

· 2008-2009 JSPS Joint Research US-Japan (Stanford Univ., USGS), 4,900,000 yen
· 2011-2012 JST J-RAPID Program (ENS Paris & BRGM, France), 5,000,000 yen

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Shelly, D. R., G. C. Beroza, S. Ide, and S. Nakamula (2006), Low-frequency earthquakes in Shikoku, Japan and their relationship to episodic tremor and slip, *Nature, 442*, 188-191.
2. Shelly, D. R., G. C. Beroza, H. Zhang, C. H. Thurber, and S. Ide (2006), High-Resolution Subduction Zone Seismicity and Velocity Structure in Ibaraki, Japan, *Journal of Geophysical Research, 111*, B06311, doi:10.1029/2005JB004081.
3. Venkataraman A., G. C. Beroza, S. Ide, K. Imanishi, H. Ito, and Y. Iio (2006), Measurements of spectral similarity for microearthquakes in western Nagano, Japan, *Journal of Geophysical Research, 111*, B03303, doi:10.1029/2004JB003834.
4. Shelly, D. R., G. C. Beroza, and S. Ide (2007), Non-volcanic tremor and low-frequency earthquake swarms, *Nature, 446*, 305-307.
5. Ide, S., D. R. Shelly, and G. C. Beroza (2007), The mechanism of deep low frequency earthquakes: Further evidence that deep non-volcanic tremor is generated by shear slip on the plate interface, *Geophysical Research Letters, 34*, L03308, doi:10.1029/2006GL028890.
6. Yamada, T., J. J. Mori, S. Ide, R. E. Abercrombie, H. Kawakata, M. Nakatani, Y. Iio, and H. Ogasawara (2007), Stress drops and radiated seismic energies of microearthquakes in a South African gold mine, *Journal of Geophysical Research, 112*, B3305, doi:10.1029/2006JB004553.
7. Ide, S. (2007), Dynamic rupture propagation on a 2D fault with fractal frictional properties, Earth Planets Space, 59(10), 1099-1109, 2007.
8. Shelly, D. R., G. C. Beroza, and S. Ide (2007), Complex evolution of transient slip derived from precise tremor locations in western Shikoku, Japan, Geochem. Geophys. Geosyst., 8, Q10014, doi:10.1029/2007GC001640.
9. Uchide, T., and S. Ide (2007), Development of multiscale slip inversion method and its application to the 2004 mid-Niigata Prefecture earthquake, Journal of Geophysical Research, 112, B06313, doi:10.1029/2006JB004528.
10. Ide, S., G. C. Beroza, D. R. Shelly and T. Uchide (2007), A scaling law for slow earthquakes, Nature, 447, 76-79, doi:10.1038/nature05780.
11. Yamada, T., and S. Ide (2008), Limitation of the Predominant-Period Estimator for Earthquake Early Warning and the Initial Rupture of Earthquakes, Bulletin of Seismological Society of America, 98, 2739-2745.
12. Ide, S. (2008), A Brownian walk model for slow earthquakes, Geophysical Research Letters, 35, L17301, doi:10.1029/2008GL034821.
13. Ohta, K., and S. Ide (2008), A precise hypocenter determination method using network correlation coefficients and its application to deep low-frequency earthquakes, Earth Planets Space, 60, 877-882.
14. Ide, S., K. Imanishi, Y. Yoshida, G. C. Beroza, and D. R. Shelly (2008), Bridging the gap between seismically and geodetically detected slow earthquakes, Geophysical Research Letters, 35, L10305, doi:10.1029/2008GL034014.

15. Aochi, H., and S. Ide (2009), Complexity in earthquake sequences controlled by multiscale heterogeneity in fault fracture energy, Journal of Geophysical Research, 114, B03305, doi:10.1029/2008JB006034.

16. Uchide, T., S. Ide, and G. C. Beroza (2009), Dynamic high-speed rupture from the onset of the 2004 Parkfield, California, earthquake, Geophysical Research Letters, 36, L04307, doi:10.1029/2008GL036824.

17. Brown, J. R., G. C. Beroza, S. Ide, K. Ohta, D. R. Shelly, S. Y. Schwartz, W. Rabbel, M. Thorwart, and H. Kao (2009), Deep low-frequency earthquakes in tremor localize to the plate interface in multiple subduction zones, Geophysical Research Letters, 36, L19306, doi:10.1029/2009GL040027.

18. Uchide, T., and S. Ide (2010), Scaling of earthquake rupture growth in the Parkfield area: Self-similar growth and suppression by the finite seismogenic layer, J. Geophys. Res., 115, B11302, doi:10.1029/2009JB007122.

19. Ide, S. (2010), Quantifying the time function of nonvolcanic tremor based on a stochastic model, J. Geophys. Res., 115, B08313, doi:10.1029/2009JB000829.

20. Ide, S. (2010), Striations, duration, migration and tidal response in deep tremor, Nature, 466, 356-359, doi:10.1038/nature09251.

21. Baltay, A., S. Ide, G. Prieto, and G. Beroza (2011), Variability in earthquake stress drop and apparent stress, Geophys. Res. Lett., 38, L06303, doi:10.1029/2011GL046698.

22. Ohta, K., and S. Ide (2011), Precise hypocenter distribution of deep low‐frequency earthquakes and its relationship to the local geometry of the subducting plate in the Nankai subduction zone, Japan, J. Geophys. Res., 116, B01308, doi:10.1029/2010JB007857.

23. Tamura, S., and S. Ide (2011), Numerical study of splay faults in subduction zones: The effects of bimaterial interface and free surface, Journal of Geophysical Research, 116, B10309, doi:10.1029/2011JB008283.

24. Aochi, H., and S. Ide (2011), Conceptual multi-scale dynamic rupture model for the 2011 Tohoku earthquake, Earth Planets and Space, 63, 761-765, doi:10.5047/eps.2011.05.008.

25. Nakata, R., R. Ando, T. Hori, and S. Ide (2011), Generation mechanism of slow earthquakes: Numerical analysis based on a dynamic model with brittle-ductile mixed fault heterogeneity, Journal of Geophysical Research, 116, B08308, doi:10.1029/2010JB008188.

26. Ide, S., A. Baltay, and G. C. Beroza (2011), Shallow dynamic overshoot and energetic deep rupture in the 2011 Mw 9.0 Tohoku-Oki earthquake, Science, 332, 1426-1429, doi:10.1126/science.1207020.

27. Okutani, T., and S. Ide (2011), Statistic analysis of swarm activities around the Boso Peninsula, Japan: Slow slip events beneath Tokyo Bay?, Earth Planets Space, 63(5), 419-426, doi:10.5047/eps.2011.02.010.

28. Aso, N., K. Ohta, and S. Ide (2011), Volcanic-like low-frequency earthquakes beneath Osaka Bay in the absence of a volcano, Geophysical Research Letters, 38, L08303, doi:10.1029/2011GL046935.

29. Ide, S. (2012), Variety and spatial heterogeneity of tectonic tremor worldwide, Journal of Geophysical Research, 117, B03302, doi:10.1029/2011JB008840.

(2) Selected Conference Proceedings

1. Ide, S. (2007), Dynamic rupture propagation modeling, Scientific Drilling Journal, 1,

24-26.

(3) Review Papers

1. Beroza, G. C. and S. Ide (2009), Deep tremors and slow quakes, Science, 324, 1025-1026. (Refereed)
2. Beroza, G., and S. Ide (2011), Slow earthquakes and non-volcanic tremor, Annual Review of Earth and Planetary Sciences, 39. (Refereed)

(4) Books

1. Ide, S. (2007), Slip inversion, Volume 4 Earthquake Seismology in Treatise on geophysics, 193-223, Elsevier.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Ide, S., Episodic tremor and slip in Japan, 2008 IRIS Workshop, Stevenson, WA, USA, 2008/06/06, Invited.
2. Ide, S., G. C. Beroza, D. R. Shelly, K. Ohta, J. R. Brown, and K. Imanishi, Are slow slip events more than the cumulative sum of slip in tremor?, AGU Fall Meeting, U31B-03, San Francisco CA, USA, 2008/12/17, Invited.
3. Ide, S., Characteristics & Interpretation of Seismic Slow Earthquakes, Brinson Lecture Series Carnegie Institution of Washington, DTM, Washington DC, USA, 2009/03/04, Invited.
4. Ide, S., Characteristics and interpretation of slow earthquakes, French-Japanese International Workshop on Earthquake Source, Paris-Orleans, France, 2009/10/05, Keynote.
5. Ide, S., Geometrical constraints on world deep tremor, JpGU Meeting 2011, U002-04, Chiba, 2011/05/25, Invited.
6. Ide, S., Interplate and intraplate low-frequency earthquakes in western Japan, Geofliud 2012, Misasa, 2012/03/19, Invited.
7. Ide, S., Rupture dynamics of the 2011 Tohoku earthquake, International Scientific Meeting "Frontiers of Source Studies for the 2011 Tohoku Earthquake", Tokyo, 2012/04/05, Invited.

Plus 19 presentations

(2) Domestic Conferences

8. Ide, S., T. Uchide, Recent progress and future of earthquake slip inversion, JpGU Meeting, S204-002, Chiba, 2006/05/18, Invited.
9. Ide, S.・D. R. Shelly, G. C. Beroza, The Mechanics of Deep Low Frequency Earthquake, Tremor and Slow Slip, S229-018, Chiba, 2007/5/19, Invited.
10. S. Ide, K. Shiomi, K. Mochizuki, T. Tonegawa, G. Kimura,, Split Philippine Sea Plate beneath Western Japan., Geological Society of Japan, C13, Toyama, 2010/09/19, Invited.
11. S. Ide, Striations, duration, migration and tidal response in deep tremor, Seismological Society of Japan, B22-08, Hiroshima, 2010/10/28, Invited.

12. S. Ide, K. Shiomi, K. Mochizuki, T. Tonegawa, G. Kimura, Split Philippine Sea Plate beneath Western Japan, JpGU Meeting, SCG063-06, Chiba, 2011/05/26, Invited.
13. S. Ide, Deep tremor and earthquake predictability, Seismological Society of Japan, C31-01, Shizuoka, 2011/10/14, Invited.
14. S. Ide, Scaling and heterogeneity of earthquakes, The Physical Society of JapanMeeting, 25pBD-2, Nishinomiya, 2012/03/25, Invited.

Plus 6 presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Takahiko Uchide, Student Award, the School of Science, the University of Tokyo, 2008.
· Takahiko Uchide, JSPS research fellow (DC) 2008-2010.
· Kazuaki Ohta, Student Award, the School of Science, the University of Tokyo, 2008.
· Kazuaki Ohta, JSPS research fellow (DC1) 2009-2011.
· Naofumi Aso, JSPS research fellow (DC1) 2012-

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Journal of Geophysical Research, Associate Editor, 2010-present

(2) Academic Societies

· Seismological Society of Japan, Representative, 2010
· Japan Geoscience Union, Representative, 2010

(3) International Conferences

· French-Japanese International Workshop on Earthquake Source, Paris-Orleans, France, 2009/10, Organizing Committee Chair.
· KANAME International Conference on a New Perspective of Great Earthquakes along Subduction Zones, Kochi, 2012/02, Organizing Committee Member.

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· 2007/5/7, Press release, A scaling law for slow earthquakes
· 2007/5/30, Lecture, Unknown earthquake-like phenomena nearby source areas of megathrust earthquakes, Public symposium of earth and planetary science
· 2008/5/10, Lecture, Investigating governing laws of earthquakes, 13th public lecture of the School of Science, the University of Tokyo
· 2010/7/15, Press release, Discovery of complex activity patterns of deep tremor ? Is tremor zone recording relative plate motion?
· 2011/5/20, Press release, Shallow dynamic overshoot and energetic deep rupture in the 2011 Mw 9.0 Tohoku-Oki earthquake

· 2011/12/23, Lecture, Rupture process of the 2011 Mw 9.0 Tohoku-Oki earthquake, Open Campus Lecture, the University of Tokyo.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 3 [M.Sc.: 0, Ph.D.: 2 (U.S.A.: 2, France: 1)]

Foreign Researchers: 0

Sending

Japanese Students: 3 [M.Sc.: 0, Ph.D.: 3 (U.S.A.: 3)]

Japanese Researchers: 0

Visitors from Abroad: 5-10/year

Nobumasa Funamori

I. C.V.

Name： Nobumasa Funamori
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education

B. Sc., Geophysics, University of Tokyo, March, 1991
M. Sc., Geophysics, University of Tokyo, March, 1993
Ph. D., Earth and Planetary Physics, University of Tokyo, September, 1995

Professional Experience

April, 1994 – July, 1996, JSPS Research Fellow, Institute for Solid State Physics, University of Tokyo
August, 1996 – March, 1998, Miller Research Fellow, Department of Geology and Geophysics, University of California, Berkeley
April, 1998 – March, 1999, Instructor (Research Associate), Department of Physics, Keio University
April, 1999 – March, 2000, Lecturer, Department of Erath and Planetary Physics, University of Tokyo
April, 2000 – March, 2004, Lecturer, Department of Erath and Planetary Science, University of Tokyo
March, 2004 –, Associate Professor, Department of Erath and Planetary Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

We have placed a major emphasis on developing new experimental techniques especially "under high pressure" and "with synchrotron X-ray beam". By using new techniques, we have clarified the behavior of various materials (elements, minerals, rocks, and so on) in various forms (crystal, glass, and melt). In recent years, we have focused on silicate glasses under high pressure. Major achievements are as follows.

(1) New techniques for in-situ measurement on silicate glasses under high pressure: We have developed a c-BN gasket for diamond-anvil experiments. The c-BN gasket provides a sample chamber several times thicker than conventional metal gaskets. We have also developed synchrotron X-ray diffraction and absorption techniques to measure structure and density of low-Z noncrystalline materials under high pressure. With these experimental techniques, we have conducted the measurements of (2) and (3).

(2) Structural transformation of SiO_2 glass to 100 GPa: We have successfully measured the structural transformation of SiO_2 glass up to about 100 GPa. The coordination number of Si has been measured for the first time as a function of pressure. It was clarified that the structural transformation between 4-fold and 6-folf coordinated structures occurs at the pressure range from 20 to 35 GPa.

(3) Equation of state of six-fold coordinated SiO_2 glass: We have successfully measured the density of SiO_2 glass up to about 50 GPa. The equation of state (compression

curve) of the six-fold coordinated phase of SiO_2 glass has been determined by combining the density data in our measurements and the sound velocity data available in the literature.

(4) Equation of state of densified SiO_2 glass: Optical-microscope observations have clarified that the fully densified SiO_2 glass, having a densified network of SiO_4 tetrahedra, behaves in an elastic manner. The equation of state of the densified phase of SiO_2 glass has been determined by the observations.

(5) Dissolution of a large amount of helium into SiO_2 glass under high pressure: Optical-microscope observations have clarified that SiO_2 glass is much less compressible than normal when compressed in helium due to the penetration of helium atoms into the interstitial voids of the glass under high pressure. The helium solubility has been estimated to be more than 1.0 mol per mole of SiO_2 glass at 10 GPa.

(6) Differential strain and residual anisotropy in SiO_2 glass: The differential strain of uniaxially compressed SiO_2 glass has been measured by X-ray diffraction up to about 60 GPa. No drop of the differential strain due to the transformation from 4-fold to 6-fold coordinated structures was observed. Huge residual anisotropy, corresponding to a differential stress of about 3 GPa, was found in the decompressed sample.

(7) Buoyancy of magmas in the deep mantle: The buoyancy of magmas in the deep mantle was discussed with available experimental data based on the knowledge on silicate melts and glasses from our own experiments. It is suggested that magmas may be more enriched in FeO and/or depleted in SiO_2 components than previously thought, to be negatively buoyant in the deep mantle.

3. Five Important Papers in your career

1. Funamori, N., T. Yagi, W. Utsumi, T. Kondo, T. Uchida, and M. Funamori (1996), Thermoelastic properties of $MgSiO_3$ perovskite determined by in situ x-ray observations up to 30 GPa and 2000 K, J. Geophys. Res., 101, 8257-8269.

This paper reports an accurate equation of state of $MgSiO_3$ perovskite measured for the first time under lower mantle conditions. This paper has been cited more than 150 times.

2. Funamori, N., T. Yagi, N. Miyajima, and K. Fujino (1997), Transformation in garnet from orthorhombic perovskite to $LiNbO_3$ phase on release of pressure, Science, 275, 513-515.

A new phase transformation from orthorhombic perovskite to lithium niobate structure was found in Al_2O_3-rich silicates upon decompression to ambient pressure. This paper demonstrates that the combination of the two techniques, X-ray diffraction under compression and transmission electron microscopy after decompression, is very powerful for characterizing samples in high-pressure experiments.

3. Funamori, N., and K. Tsuji (2002), Pressure-induced structural change of liquid silicon, Phys. Rev. Lett., 88, 255508.

Significant structural change was observed in liquid Si by using newly developed experimental techniques which doubled the pressure range of X-ray diffraction study for liquid samples. Many experimental studies have been carried out by using those techniques after this paper and a better understanding of structural transformation of liquid has been obtained.

4. Sato, T., and N. Funamori (2010), High-pressure structural transformation of SiO_2 glass up to 100 GPa, Phys. Rev. B, 82, 184102.

Structural transformation of SiO_2 glass was measured up to 100 GPa by using newly developed

experimental techniques to measure density and structure of low-Z noncrystalline materials under high pressure. This paper reports detailed structural information such as the Si-O bond length and coordination number as a function of pressure. This paper has been selected as an Editors' Suggestion.

5. Funamori, N., and T. Sato (2010), Density contrast between silicate melts and crystals in the deep mantle: An integrated view based on static-compression data, Earth Planet. Sci. Lett., 295, 435-440.

The buoyancy of magmas in the deep mantle was discussed with available experimental data based on the knowledge on silicate melts and glasses from our own experiments. It is important that experimentalists proposed an integrated view not by conducting experiments but by checking the reliability of various literature data.

4. Awards and Honors throughout your career

- 1995 Outstanding Student Award in Mineral and Rock Physics, American Geophysical Union, December 11, 1995
- 2001 Award for Young Researchers, Japan Society of High Pressure Science and Technology, November 21, 2001

5. Future Research Plan

In the next ten years, I plan to devote most of my efforts to construct a new beamline for high-pressure experiments in the next generation synchrotron facility. It has been 30 years since Photon Factory (the 2nd generation) was built as the first synchrotron facility in Japan. Since then SPring-8 (the 3rd generation) was built and the both facilities have contributed very much to the progress of high-pressure mineral physics (and a better understanding of the Earth and planetary interiors). The projects to build the 4th generation facilities are now in progress both in Japan and abroad. In Japan, High Energy Accelerator Research Organization (KEK) plans to build and operate KEK-ERL by 2020. In addition to brilliance, spatial coherence will be greatly improved because the ERL is designed to achieve low emittance. In short, the coherent beam of the next generation will make it possible to determine the structure of materials as they are without any requirements of orderliness in the sample because the beam itself has the orderliness, while the conventional beam only determines the ordered structure as a spatial average. Therefore, for example, the three dimensional structure of melts and glasses will be measured directly and, moreover, the movement of elements in samples would be measured directly with the coherent beam. Thus, the high-pressure beamline in the next generation synchrotron facility will open up a new era of high-pressure mineral physics.

Because of my research career, I have a lot of contacts in both high-pressure and synchrotron-radiation communities. My colleagues and I launched a working group "High-Pressure Science with Coherent Synchrotron Radiation" of Japan Society of High Pressure Science and Technology on January 2012 and I serve as representative of the group. This group aims to construct a sophisticated high-pressure beamline in the next generation synchrotron facility. To achieve this, we need about ¥1,000,000,000. Therefore, the high-pressure science to be conducted at the new beamline should be very attractive. Workshops and symposiums have been and will be held to brush up the science with the participation of many invited researchers from synchrotron-radiation community. In turn, I

have explained the importance and potential of high-pressure science and our request to improve the KEK-ERL project in synchrotron-radiation community, through activities such as invited presentations on the future prospects of high-pressure science and the editing of the chapter for high-pressure science in the Design Report of KEK-ERL.

To prepare for the 4th generation, my group has started new research with small-angle X-ray scattering and X-ray phase imaging techniques. The two techniques are new in high-pressure research. We have conducted the research with a small-angle X-ray scattering technique by ourselves, because this research is a natural extension of the research on silicate melts and glasses. We have just started the research on the partial melting or deformation of rocks with an X-ray phase imaging technique in collaboration with specialists of Tohoku Univ.

Besides the above, my group has started exploratory research to clarify the behavior of hydrogen in silicates in collaboration with muon specialists of KEK. Experiments have already been conducted on stishovite and other several samples at all the four major muon facilities around the world, RAL (UK), PSI (Swiss), J-PARC (Japan), and TRIUMF (Canada). We are now writing the first report to be published in a scientific journal. Experiments have so far been conducted only at ambient pressure and room/low temperatures. High-pressure and high-temperature in-situ muon spin rotation experiments will hopefully be conducted in future.

6. Funding Received

(1) JSPS Grants

- Grants-in-Aid for Scientific Research (B), Crystal chemistry study of minerals by high pressure and high temperature in-situ Raman Spectroscopy, 2003 – 2006, ¥14,200,000 (¥3,100,000 in 2006)
- Grants-in-Aid for Exploratory Research, New techniques of fast and micro spectroscopy for measurement of thermophysical properties of materials in the Earth's deep interior, 2007 – 2008, ¥3,400,000
- Grants-in-Aid for Scientific Research (B), Measurement of density and structure of silicate glasses under high pressure, 2008 – 2011, ¥17,420,000
- Grants-in-Aid for Challenging Exploratory Research, Nano-scale inhomogeneity in materials of the Earth's deep interior measured by in-situ small-angle X-ray scattering under high pressure, 2011 – 2012, ¥3,770,000 (¥2,600,000 in 2011)

(2) Cooperative Research

- National Institute for Materials Science, Synthesis of large polycrystalline samples of high-pressure phases of SiO_2, 2010 – 2011, N/A.
- RIKEN, Hydrogen in high-pressure phases of SiO_2, 2011 – 2012, N/A.

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Funamori, N., and T. Sato (2006), Heating in a diamond-anvil cell using relaxation oscillations of a Q-switched Nd:YAG laser, Rev. Sci. Instrum., 77, 093903.

2. Yamada, A., T. Inoue, S. Urakawa, K. Funakoshi, N. Funamori, T. Kikegawa, H. Ohfuji, and T. Irifune (2007), In-situ x-ray experiment on the structure of hydrous Mg-silicate melt under high pressure and high temperature, Geophys. Res. Lett., 34, L10303.

3. Funamori, N., and T. Sato (2008), A cubic boron nitride gasket for diamond-anvil experiments, Rev. Sci. Instrum., 79, 053903.

4. Sato, T., and N. Funamori (2008), High-pressure in situ density measurement of low-Z noncrystalline materials with a diamond-anvil cell by an x-ray absorption method, Rev. Sci. Instrum., 79, 073906.

5. Sato, T., and N. Funamori (2008), Sixfold-coordinated amorphous polymorph of SiO_2 under high pressure, Phys. Rev. Lett., 101, 255502.

6. Funamori, N., and T. Sato (2009), Comment on "Sixfold-coordinated amorphous polymorph of SiO_2 under high pressure" Sato and Funamori reply, Phys. Rev. Lett., 102, 209604.

7. Sato, T., N. Funamori, and T. Kikegawa (2010), High-pressure in situ structure measurement of low-Z noncrystalline materials with a diamond-anvil cell by an x-ray diffraction method, Rev. Sci. Instrum., 81, 043906.

8. Sato, T., and N. Funamori (2010), High-pressure structural transformation of SiO_2 glass up to 100 GPa, Phys. Rev. B, 82, 184102.

9. Funamori, N., and T. Sato (2010), Density contrast between silicate melts and crystals in the deep mantle: An integrated view based on static-compression data, Earth Planet. Sci. Lett., 295, 435-440.

10. Sato, T., N. Funamori, and T. Yagi (2011), Helium penetrates into silica glass and reduces its compressibility, Nature Commun., 2, 345.

11. Yamada, A., T. Inoue, S. Urakawa, K. Funakoshi, N. Funamori, T. Kikegawa, and T. Irifune (2011), In situ x-ray diffraction study on pressure-induced structural changes in hydrous forsterite and enstatite melts, Earth Planet. Sci. Lett., 308, 115-123.

12. Wakabayashi, D., N. Funamori, T. Sato, and T. Taniguchi (2011), Compression behavior of densified SiO_2 glass, Phys. Rev. B, 84, 144103.

(2) Selected Conference Proceedings

1. Funamori (invited), N., T. Sato, and T. Matsuo (2007), A c-BN gasket in diamond-anvil experiments (in Japanese), KEK proceedings 2007-7, 36-39.

2. Funamori (invited), N. (2011), High-pressure planetary science with x-ray nanobeam of ERL (in Japanese), KEK proceedings, 2011-1, 65-69.

(3) Review Papers

Non-refereed

1. Funamori (invited), N. (2010), Study of the Earth's mantle with synchrotron radiation (in Japanese), KEK Summer Challenge Lecture Notes, 4, 47-51.

2. Funamori (invited), N., and T. Sato (2010), Buoyancy of magma in the Earth's deep mantle: Implications from high-pressure in-situ x-ray observations of SiO_2 glass (in Japanese), Photon Factory News, 28-2, 25-29.

3. Sato (invited), T., and N. Funamori (2010), High-pressure transformation of SiO_2 glass, Photon Factory Activity Report 2009 (Part A: Highlight and Facility Report #27), 44-45.

4. Yagi, T., T. Sato, and N. Funamori (2011), Anomalously low compressibility of silica

glass in helium, ISSP Activity Report 2010 (Part A: Highlights), 2.

5. Sato (invited), T., N. Funamori, and T. Yagi (2011), Helium prevents compaction of voids in silica glass under high pressure, Photon Factory Activity Report 2010 (Part A: Highlight and Facility Report #28), 44-45.

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Funamori (invited), N., T. Sato, T. Matsuo, Serch for a new gasket for laser-heated diamond-anvil experiments, The 7th High Pressure Mineral Physics Seminar, May 8 – 12, 2007, Matsushima, Japan.
2. Funamori (invited), N., Measurement of density and structure of disordered materials under high pressure, Gordon Research Conference 2010, High pressure research at, June 27 – July 2, 2010, Holderness, USA.
3. Sato (invited), T., N. Funamori, T. Kikegawa, and T. Yagi, High-pressure behavior of SiO_2 glass, IUCr Commission on High Pressure 2010 Meeting, September 19 – 23, 2010, Gatlinburg, USA.

7 in total

(2) Domestic Conferences

4. Funamori (invited), N., T. Sato, and T. Matsuo, A c-BN gasket in diamond-anvil experiments (in Japanese), PF workshop "New techniques in high-pressure science with synchrotron radiation", November 8 – 9, 2007, Tsukuba.
5. Funamori (invited), N., High-pressure behavior of SiO_2 glass: Achievements and future plans, General Assembly of Condensed Matter Research Center, December 6, 2010, Tsukuba.
6. Funamori (invited), N., High-pressure planetary science with x-ray nanobeam of ERL (in Japanese), PF workshop "ERL science workshop II", April 27 – 28, 2011, Tsukuba.

23 in total

III. Educational Activity (2002-2011)

9. Notable achievements in education

- Sato, T., D1, JSPS Research Fellow, April, 2006
- Sato, T., D3, Poster Award, The 49th High Pressure Conference of Japan, November, 2008
- Sato, T., alumna, Research Associate, Hiroshima University, February, 2011
- Wakabayashi, D., D1, JSPS Research Fellow, April, 2012
- Wakabayashi, D., D1, Grant for Student Presentation at International Conference, Japan Society of High Pressure Science and Technology, July, 2012
- Wakabayashi, D., D1, Poster Award, The 53rd High Pressure Conference of Japan, November, 2012

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

· Councilor, Japan Society of High Pressure Science and Technology, 2006, 2011

· Executive for General Affairs, Japan Society of High Pressure Science and Technology, 2011

· Member, Incorporation Exploratory Committee, Japan Society of High Pressure Science and Technology, 2011

· Representative, Working Group for High-Pressure Science with Coherent Synchrotron Radiation, Japan Society of High Pressure Science and Technology, 2011

· Councilor, Photon Factory User Association, 2010, 2011

· Member, Committee for Educational Beamtime, Photon Factory User Association, 2010, 2011

· Member, Steering Committee for Photon Factory BL-18C, High Energy Accelerator Research Organization, 2009, 2010, 2011

(3) International Conferences

· Member, Program Committee, The 22nd International Conference of High Pressure Science and Technology (AIRAPT-22), 2008, 2009

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 1 [Romania:1]

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 1 [U.S.A.: 1, Germany: 1]

Tsuyoshi Iizuka

I. C.V.

Name： Tsuyoshi Iizuka
Present Position: Lecturer, University of Tokyo, Graduate School of Science

Education

B. Sc., Earth and Planetary Sciences, Tokyo Institute of Technology, March, 2001
M. Sc., Earth and Planetary Sciences, Tokyo Institute of Technology, March, 2003
Ph. D., Earth and Planetary Sciences, Tokyo Institute of Technology, March, 2006

Professional Experience

4/2006-3/2009: Postdoctoral Fellow at the University of Tokyo, funded by JSPS Research Fellowship (SPD).
8/2007-3/2009: Visiting Fellow at the Australian National University.
4/2009-1/2010: Postdoctoral Fellow at the Australian National University, funded by Japan Society of the Promotion of Science (JSPS).
2/2010-3/2011: Postdoctoral Fellow at the Australian National University, funded by Australian Research Council (ARC) Australian Postdoctoral Fellowship.
4/2011-present: Lecturer at the University of Tokyo

II. Scientific Research Activity

2. Major achievements

Development and applications of analytical protocols for solving problems in Earth and Planetary sciences are central to my work. Emphasis has been placed on in situ U-Pb geochronology, geochemistry and Lu-Hf isotopic study of a ubiquitous accessory mineral zircon using laser ablation-inductively coupled plasma mass spectrometry (LA-ICPMS), to understand the evolution of the Earth's crust. My contributions include the discovery of a 4.2 billion years old (Ga) xenocrystic zircon in an orthogneiss from NW Canada (Iizuka et al., 2006). This discovery is the first evidence for extremely old evolved crust outside Australia, where similar ancient zircons have been found. It implies that the Earth had a widespread evolved crust and possibly ocean a few hundred million years (Ma) after the Earth had accreted, considering that the presence of ocean promotes the formation of evolved crust. Another significant outcome of my work is a better understanding of continental growth history. I was the first to measure in situ U-Pb and Lu-Hf isotopes in detrital zircons from large rivers, thereby demonstrating the significance of crustal reworking in continental crust formation, and estimating the growth rate of juvenile continental crust (Iizuka et al., 2005). In addition to my work on zircon, I have applied short-lived ^{182}Hf-^{182}W system to ancient terrestrial whole-rock samples. The results suggested that the silicate Earth did not chemically differentiate within the first 60 Ma of the Solar System, providing new constraints on the timescale of magma ocean solidification and thermal evolution of the young Earth (Iizuka et al., 2010). More recently, I have developed a technique for in situ Sm-Nd isotopic measurement of monazite using LA-ICPMS, and applied to the Earth's oldest detritus at Mt. Narryer and Jack Hills, Western Australia (Iizuka et al., 2011). I have been involved in many international collaborations through application of the developed analytical techniques (e.g., China-Japan collaboration, Shi et al., 2006;

Australia-Zambia-Japan collaboration, Johnson et al., 2007).

3. Five Important Papers in your career

1. Iizuka T., O. Nebel, and M. T. McCulloch (2011), Tracing the provenance and recrystallization processes of the Earth's oldest detritus at Mt. Narryer and Jack Hills, Western Australia: An in situ Sm-Nd isotopic study of monazite, *Earth Planet. Sci. Lett., 308,* 350–358.

This paper provides new constraints on the nature of the Earth's earliest crust.

2. Iizuka T., T. Komiya, S. Rino, S. Maruyama, and T. Hirata (2010), Detrital zircon evidence for Hf isotopic evolution of granitoid crust and continental growth, *Geochim. Cosmochim. Acta 74*, 2450–2472.

In this paper, we showed that crustal reworking is important process in continental crust formation.

3. Iizuka T., K. Horie, T. Komiya, S. Maruyama, T. Hirata, H. Hidaka, and B. F. Windley (2006), 4.2 Ga zircon xenocryst in an Acasta gneiss from northwestern Canada: Evidence for early continental crust, *Geology* 34, 245–248.

This paper was judged by the journal '*Nature*' in its Research Highlights' on 30th March 2006 as one of the most important advances in the whole of Science worldwide for that week.

4. Iizuka T., T. Hirata, T. Komiya, S. Rino, I. Katayama, A. Motoki, and S. Maruyama (2005), U-Pb and Lu-Hf isotope systematics of zircons from the Mississippi River sand: Implications for reworking and growth of continental crust, *Geology 33*, 485–488.

In this work, we estimated the growth rate of the North American continental crust.

5. Iizuka T., and T. Hirata (2005), Improvements of precision and accuracy in *in-situ* Hf isotope microanalysis of zircon using the laser ablation-MC-ICPMS technique. *Chem. Geol. 220*, 121–137.

This paper has been highly cited (127 times).

4. Awards and Honors throughout your career

· Japanese Young Geochemists of the Year (2009).

· Japanese Geological Society Excellent Paper Award (2008).

5. Future Research Plan

I intend to conduct the first study that integrates U-Pb, Hf-W, and Nb-Zr isotopes in meteoritic (eucrite and mesosiderite) zircon. The anticipated outcomes of this research project are:

(1) precise meteoritic zircon U-Pb age.

Chronological knowledge of the accretion and differentiation of asteroids is central to understanding the early evolution of the terrestrial planets and our Solar System. Given the complex geological histories of asteroids or meteorites themselves (e.g., Tera et al., 1997), it is important to determine timing of asteroid igneous events using an isotopic chronometer with a high closure temperature. In addition, a combination of such isotopic chronometer and one

with a lower closure temperature can advance our knowledge of the thermal history of asteroids. Zircon can be dated by the U-Pb isotopes, and has extremely high closure temperature for the U-Pb system (>900 ˚C). As a consequence, meteoritic zircon can yield the absolute timing of crust formation in its parental asteroid. So far, the U-Pb ages of meteoritic and lunar zircons have been measured by SHRIMP (Ireland and Wlotzka, 1992; Misawa et al., 1995; Nemchin et al., 2009) or LA-ICPMS (Hirata, 2001), but their analytical precisions (±>10 Ma) are insufficient to discuss the precise timing of asteroid crust formation nor to compare the U-Pb ages with short-lived isotopic chronometers. By contrast, this study will apply a technique for high precision (±0.1-0.2 Ma) U-Pb isotopic analysis using TIMS (Amelin and Davis, 2006).

(2) $^{182}Hf/^{180}Hf$ and $^{92}Nb/^{93}Nb$ at the time of the zircon crystallization.

^{182}Hf decays to ^{182}W with a half-life of 8.9 Ma. Because Hf is lithophile and W is moderately siderophile, and because W is more incompatible relative to Hf during partial melting of the mantle, the ^{182}Hf-^{182}W isotopic chronometer can be used to constrain the timescales of planetary core formation and early silicate differentiation. ^{92}Nb decays to ^{92}Zr with a half-life of 36 Ma. Similarly, since Nb and Zr (both lithophile) fractionate from each other during mantle partial melting and magmatic crystallization, the ^{92}Nb-^{92}Zr chronometer can place chronological constraints on early silicate differentiation. For these applications to realize full potential, the $^{182}Hf/^{180}Hf$ and $^{92}Nb/^{93}Nb$ values at some known time (during the extinct radionuclides were extant) must be unambiguously fixed.

Zircon is well suited for ^{182}Hf-^{182}W isochron dating (determination of $^{182}Hf/^{180}Hf$ at the time of the zircon crystallization) due to its high Hf/W (Ireland and Bukovanská, 2003; Srinvasan et al., 2008). Since meteoritic zircon with low Nb/Zr is typically associated with ilmenite with high Nb/Zr (Ireland and Wlotzka, 1992; Srinvasan et al., 2008), a combination of zircon and ilmenite Nb-Zr isotope systems is ideal for ^{92}Nb-^{92}Zr isochron dating (determination of $^{92}Nb/^{93}Nb$ at the time of the zircon-ilmenite crystallization) (Yin et al., 2000). These features allow us to apply all U-Pb, Hf-W, and Nb-Zr isotopic chronometers to a single phase zircon as well as its cogenetic ilmenite phase, i.e., all chronometers reflect the same event (no misidentification). Moreover, zircon can retain primary isotopic information through metamorphic processes due to its robustness (no later disturbance). Accordingly, an integration of precise U-Pb, Hf-W and Nb-Zr isotopic data of meteoritic zircon as well as ilmenite is one of the best possible ways to acquire reliable age benchmarks for ^{182}Hf-^{182}W and ^{92}Nb-^{92}Zr isotopic chronometers. Although some have investigated ^{182}Hf-^{182}W or ^{92}Nb-^{92}Zr systems of meteoritic zircons (Yin et al., 2000; Hirata, 2001; Ireland and Bukovanská, 2003; Srinvasan ett al., 2007), no study combining these short-lived isotope systems with precise U-Pb age of meteoritic zircon has yet been made, due to the lack of precise U-Pb isotopic data. The reliable U-Pb age benchmarks for these short-lived isotopic chronometers are essential not only to build a precise and accurate timescale of the early Solar System processes but also to test whether the extinct radionuclides distributed homogeneously or heterogeneously in the early Solar nebula.

6. Funding Received

(1) JSPS Grants

· JSPS, Funding for start-up, 3,250,000 Yen, awarded for 1/4/20011-31/3/2013: The early Solar System chronology and planetary chemistry from isotope systematics of meteorite zircon.

· JSPS, Research Fellowship for Young Scientist–SPD, 9,000,000 Yen, awarded for

1/4/2006-31/3/2009: Early evolution of the Earth's mantle deduced from W isotopes in Eoarchean rocks.

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

· ARC, Australian Postdoctoral Fellowship, AUS$ 325,000 awarded for 1/2/2010-31/1/2013: Deciphering the early Solar System chronology and planetary chemistry using isotope systematics of meteoritic zircon.

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Iizuka T., O. Nebel, and M. T. McCulloch (2011), Tracing the provenance and recrystallization processes of the Earth's oldest detritus at Mt. Narryer and Jack Hills, Western Australia: An in situ Sm-Nd isotopic study of monazite, *Earth Planet. Sci. Lett., 308,* 350–358.
2. Iizuka T., S. M. Eggins, M. T. McCulloch, L. P. J. Kinsley, and G. E. Mortimor (2011), Precise and accurate determination of $^{147}Sm/^{144}Nd$ and $^{143}Nd/^{144}Nd$ in monazite using laser ablation-MC-ICPMS, *Chem. Geol., 282*, 45–57 (2011).
3. Nebel O., P. Z. Vroon, W. van Westrenen, T. Iizuka, and G. R. Davies (2011), The effect of sediment recycling in subduction zones on the Hf isotope character of new arc crust, Banda arc, Indonesia, *Earth Planet. Sci. Lett.,* 303, 240–250 (2011).
4. Amelin Y., A. Kaltenbach, T. Iizuka, C. H. Stirling, T. R. Ireland, M. Petaev, and S. B. Jacobsen (2010), U-Pb chronology of the Solar System's oldest solids with variable $^{238}U/^{235}U$, *Earth Planet. Sci. Lett., 300*, 343–350.
5. Iizuka T., M. T. McCulloch, T. Komiya, T. Shibuya, K. Ohta, H. Ozawa, E. Sugimura, and K. D. Collerson (2010), Monazite geochronology and geochemistry of meta-sediments in the Narryer Gneiss Complex, Western Australia: Constraints on the tectonothermal and provenance, *Contrib. Mineral. Petrol., 160*, 803–823.
6. Iizuka T., S. Nakai, Y. V. Sahoo, A. Takamasa, T. Hirata, and S. Maruyama (2010), The tungsten isotopic composition of Eoarchean rocks: Implications for early silicate differentiation and core-mantle interaction on Earth, *Earth Planet. Sci. Lett., 291*, 189–200.
7. Iizuka T., T. Komiya, S. Rino, S. Maruyama, and T. Hirata (2010), Detrital zircon evidence for Hf isotopic evolution of granitoid crust and continental growth, *Geochim. Cosmochim. Acta, 74*, 2450–2472.
8. Sawaki Y., T. Shibuya, T. Kawai, T. Komiya, S. Omori, T. Iizuka, T. Hirata, B. F. Windley, and S. Maruyama (2010), Imbricated ocean-plate stratigraphy and U-Pb zircon ages from tuff beds in cherts in the Ballantrae complex, SW Scotland, *Geol. Soc. Am. Bullet., 122*, 454–464.
9. Iizuka T., T. Komiya, S. P. Johnson, Y. Kon, S. Maruyama, and T. Hirata (2009), Reworking of Hadean crust in the Acasta gneisses, northwestern Canada: Evidence from in-situ Lu-Hf isotope analysis of zircon, *Chem. Geol., 259*, 230–239.
10. Jagoutz O. E., J. P. Burg, S. Hussian, H. Dawood, T. Pettke, T. Iizuka, and S. Maruyama

(2009), Construction of the granitoid crust of an island arc part I: geochronological and geochemical constraints from the plutonic Kohistan (NW Pakistan), *Contrib. Mineral. Petrol., 158*, 739–755.

11. Sato K., O. Siga Jr., J. A. Silva, I. McReath, L. Dunyi, T. Iizuka, S. Rino, T. Hirata, W. Sproesser, and M. A. S. Basei (2009), In situ analyses of U and Pb in zircon by remotely operated SHRIMP II, and Hf by LA-ICP-MS: an example of dating and genetic evolution of zircon by $^{176}Hf/^{177}Hf$ from the Ita Quarry in the Atuba Complex, SE Brazil, *Geologia USP: Série Cienífica, 9*, 61–69.
12. Johnson S.P., B. De Waele, F. Tembo, C. Katongo, K. Tani, Q. Chang, T. Iizuka, and D. Dunkley (2007), Geochemistry, geochronology and isotopic evolution of the Chewore-Rufunsa Terrane, southern Irumide Belt: A mesoproterozoic, continental margin arc, *J. Petrol., 48*, 1411–1441.
13. Aoki K., T. Iizuka, T. Hirata, S. Maruyama, and M. Terabayashi (2007), Tectonic boundary between the Sanbagawa belt and the Shimanto belt in central Shikoku, Japan, *J. Geol. Soc. Jap., 113,* 171–183.
14. Iizuka T., T. Komiya, Y. Ueno, I. Katayama, Y. Uehara, S. Maruyama, T. Hirata, S. P. Johnson, and J. D. Dunkley (2007), Geology and zircon geochronology of the Acasta Gneiss Complex, northwestern Canada: New constraints on its tectonothermal history, *Precambrian Res., 153*, 179–208 (2007).
15. Yamamoto H., S. Yamamoto, Y. Kaneko, M. Terabayashi, T. Komiya, and T. Iizuka (2007), Imbricate structure of the Luobusa Ophiolite and surrounding rock units, souther Tibet, *J. Asian Earth Sci., 29*, 296–304 (2007).
16. Iizuka T., K. Horie, T. Komiya, S. Maruyama, T. Hirata, H. Hidaka, and B. F. Windley (2006), 4.2 Ga zircon xenocryst in an Acasta gneiss from northwestern Canada: Evidence for early continental crust, *Geology 34*, 245–248.
17. Kusuhashi N., A. Matsumoto, M. Murakami, T. Tagami, T. Hirata, T. Iizuka, T. Handa, and H. Matsuoka (2006), Zircon U-Pb ages from tuff beds of the upper Mesozoic Tetori Group in the Shokawa district, Gifu Prefecture, *Island Arc, 15*, 378–390.
18. Shi R., J. Yang, C. Wu, T. Iizuka, and T. Hirata (2006), Island arc volcanic rocks in the north Qaidam UHP belt, northern Tibet plateau: Evidence for ocean-continent subduction preceding continent-continent subduction, *J. Asian Earth Sci., 34*, 245–248 .

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

1. Iizuka T., T. Komiya, and S. Maruyama (2007), The early Archean Acasta Gneiss Complex: Geological, geochronological and isotopic studies and implications for early crustal evolution. In: *Earth's Oldest Rocks* (eds. Van Kranendonk, M.J., Smithies, H.M., and Bennett, V.). Elsevier, pp. 127−147 (2007).

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Iizuka T., I. H. Campbell, and C. M. Allen, Evolution of the African continental crust from Pb-Hf-O isotope systematics of detrital zircons, *21st VM Goldschmidt Conference*, Prague,

Czech, Aug. 2011.

2. Iizuka T., and M. T. McCulloch, U-Pb age, trace element and Nd isotopes of monazites from metasediments in Mt. Narryer, Western Australia, 5th International Archean Symposium, Perth, Australia, Sep. 2010.

3.

And 9 other presentations.

(2) Domestic Conferences

4. Iizuka T., Nebel O., and McCulloch M. T., No evidence of Hadean continent from monazite, *Japan Geoscience Union-Meeting*, Makuhari, May. 2011.

5. Iizuka T., Early crustal evolution deduced from Hf and W isotope systematics, Japan Geochemical Society Meeting, Hiroshima University, Sep. 2009 (invited lecture by the winner of Japanese Young Geochemist Award).

And 6 other presentations.

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· I have reviewed papers for international journals including *Proceedings of the National Academy of Sciences, Geology, Geochimica et Cosmochimica Acta, Lithos,* and *Precambrian Research*

(2) Academic Societies

(3) International Conferences

· Session Organizer for the session entitled "The first billion years: Assessing the geologic record" in *22nd VM Goldschmidt Conference*,

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Presented a seminar on "Geochemistry" at the Australian Department of Foreign Affairs and Trade, 24 June, 2009.

· Presented a seminar on "Continental Growth History" at the Canberra Japan Club, 25 February, 2009.

12. Internal and External Committee Memberships (2006-2011)

· I have been belonging to Gender Equality Committee in the University of Tokyo.

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and

Researchers Abroad

Hosting
- Foreign Students: 0
- Foreign Researchers: 0

Sending
- Japanese Students: 0
- Japanese Researchers: 1

Visitors from Abroad: 0

Hidemi Tanaka

I. C.V.

Name : Hidemi Tanaka
Present Position: Professor, Lecturer, University of Tokyo, Graduate School of Science

Education

Department of Earth Science, Waseda University, Bsc title March, 1986
Department of Graduate school of Material Science and Engineering, Waseda University, MSc title, 1988
Department of Graduate school of Material Science and Engineering, Waseda University, PhD title, 1992

Professional Experience

1991 - 1994, Research Associate, Department of Earth Science, Waseda University
1994 - 2001, Assistant Professor, Department of Geo/Biosphere Science, Ehime University
2001 - Current, Lecturer, Department of Earth and Planetary Science, University of Tokyo

1997 - 1998, Research Fellow, National Research Institute for Earth Science, and Disaster Prevention (NIED)
1997 - 1998, Research Fellow, Geological Survey of Japan (GSJ)
1998 - 2006, Research Fellow of STA project of terrestrial subsurface structure of the fault zone
1999 - 2000, U.S.Geological Survey Earthquake Hazard Team, Visiting research scientist
2000 - 2003, Research Fellow, Geological Survey of Japan (GSJ/AIST)
2000 - Current, Research Fellow, National Research Institute for Earth Science and Disaster Prevention (NIED)
2000, Research Fellow, Japan Marine Science, and Technology Center (JAMSTEC)
2000-2001, Chief Scientist of Chelung-pu fault zone drilling, Taiwan
2000, Semester Lecturer of Kochi University
2001, Semester Lecturer of Osaka University
2002- 2006, Japan Nuclear Cycle development organization, (JNC) Research Fellow
2004-2005, National Central University (Taiwan), Visiting associate professor.
2006-2007, National Central University (Taiwan), Visiting Professor.

II. Scientific Research Activity

2. Major achievements

I have been focused on material scientific research on brittle fault zone through observations of natural fault zones since 1990. The subject was minor in the geophysical and geological communities until 1995 Kobe earthquake. The research category had explosively recognized since active fault zone drilling project penetrating the Nojima fault, which was activated 1995, Kobe earthquake.

We have been worked on the research of reconstruction of whole-depths geological and geochemical profiles of fault rock along fault zone from seismogenic depth to surface, using the Nojima fault zone drill core (Tanaka et al., 2001, 2007 JGR). The results indicate fault zone (fracture zone) is maximum 10 times wider, and larger volume of pores in the fracture zone,

which was fully filled with alkaline fluids in the middle depths (4 to 7 km depths) than those of shallower and deeper depths. After the project, we felt that knowledge of whole-depth profile of fault rock distribution would not be enough to solve essential problems of seismogenic mechanisms, although it is necessary for understanding fault zone behavior.

Another active fault zone drilling project was conducted at Chelungpu fault zone, which was activated during1999 Chi-chi earthquake, Taiwan. Considering deficiency of the previous Nojima project, we have challenged to solve dynamic mechano-chemical behavior and energy budget problems during high-speed slip, as well as fault zone architecture problems. Tanaka et al., (2006) GRL and Tanaka et al., (2007) GRL estimated energy dissipation by frictional heating during seismic slip based on residual heat signature detected by borehole temperature measurements. Comparing between energy dissipation by seismic wave and that of heat energy, they have concluded that seismic efficiency of Chichi earthquake is less than several percent of total energy dissipated. Fracture energy during seismic slip was also estimated using drill core penetrating Chelungpu fault (Ma et al., 2007), in which precise determination of location of slip surface and surface area analysis were my role.

After two big drilling projects, I still feel deficiency of material science of fault zone to answer "what is the slip zone and surrounding crustal conditions, initiating seismic slip of large earthquake?" which must be one of the most important question for earthquake research, even though the project consumed huge amount of budgets.

Research target is greatly changed from solid to fluid to challenge above question, that is, monitoring chemical and isotope composition in the crustal fluids gushed out from fracture zones along fault, in order to monitor mechano-chemical state of the active fault zones. Development and improvement of full-automatic mass spectrometer have been also ongoing since 2008. New idea, implemented on the mass spectrometer system, has been already patented in Japan. After several years struggling, data acquisition system becomes stable and mechano-chemical monitoring on the fault zone started.

3. Five Important Papers in your career

1. Tanaka, H., and T. Hara (1990), Pre-Miocene dextral movement of Medial Tectonic Line clarified by fault rock texture analysis. *Jour. Geol. Soc. Japan,* **96,** 331 - 334 (in Japanese).

Material analysis of fault zone now becomes a major field of earthquake research. This was the initial scientific paper of this research category in Japan. Mode of dextral brittle deformation of Median Tectonic Line was clarified based on asymmetrical texture developed in brittle fault zone rocks and deduced Miocene Tectonics of SW Japan.

2. Tanaka, H., K. Fujimoto, T. Ohtani, H. Ito, (2001) Structural and chemical characterization of shear zones in the freshly activated Nojima fault, Awaji Island, southwest Japan, *Journal of Geophysical Research,* **106,** 8789-8810.

This is the first scientific report of the fault zone material analysis using recovered cores from active fault zone drilling penetrating the Nojima fault zone at depths, which was activated during 1995 Kobe earthquake. Whole fault zone architecture was reconstructed and chemical conditions in the fault zone at various depths were discussed.

3. Ma, K. F., H. Tanaka, S. R. Song, C. Y. Wang, J. H. Hung, Y. B.Tsai, J. Mori, Y. F. Song, E. C. Yeh, H. Sone, L.W. Kuo, H. Y. Wu, (2006) Slip Zone and Energetics of a Large Earthquake: Results from the Taiwan Chelungpu-fault Drilling Project (TCDP), *Nature,* **444,** doi:10.1038/nature05253.

Although I am the second author, this paper is counted as one of the important papers because main part of the research was done by first author, KF Ma and I. Using recovered core penetrating Chelungpu fault at around 1140 m depths, very thin, active slip surface was determined, and size distribution of fractured grains in the slip zone were precisely measured. Fracture energy was estimated based on the data and efficiency of fracturing during seismic slip was discussed.

4. Tanaka, H., W. M. Chen, C. Y. Wang, K. F. Ma, N. Urata, J. Mori, M. Ando, (2006) Frictional Heat from Faulting of the 1999 Chi-Chi, Taiwan Earthquake. *Geophysical Research Letters,* **33,** L16316, doi:10.1029/2006GL026673.

Positive thermal anomaly was detected from drill hole penetrating north part of Chelungpu fault zone where the largest slip, more than 10 m, was observed. The thermal anomaly was explained as residual heat signature by high-speed slip during the earthquake and we have estimated energy dissipation by frictional heating during seismic slip. Comparing between energy dissipation by seismic wave and that of heat energy, they have concluded that seismic efficiency of Chichi earthquake is less than several percent of total energy dissipated. This was the first paper detecting residual heat from faulting and estimation of heat energy during a large earthquake.

5. Tanaka, H., W. M. Chen, K. Kawabata, N. Urata, (2007) Thermal properties across the Chelungpu fault zone and evaluations of positive thermal anomaly on the slip zones - Are these residual heat from faulting? *Geophysical Research Letters,* **34,** L01309, doi:10.1029/2006GL028153.

Several years after the 1999 Chichi earthquake, deep drilling project was conducted penetrating at middle trace of the Chelungpu fault. Detected positive thermal anomaly was +0.06 degree C. The anomaly was explained by fluctuation of thermal properties across the slip zone by above paper, which, in turn surely confirmed that positive thermal anomaly detected by shallow drilling conducted in 2000 (Tanaka et al 2006) was residual heat from faulting, because fluctuation of thermal properties did not explain the anomaly. The way to estimate heat energy dissipated by a large earthquake was established by the paper.

4. Awards and Honors throughout your career

· Outstanding research and education Prize, National Central University, Taiwan, 2007, 6/10

5. Future Research Plan

It was confirmed through two big drilling projects that solid material science for fault zone had some roles for earthquake research. Reasonable generalization of whole fault zone architecture by repeating the way we did to many fault zones would be worthy. However, the methods and results of this research could have limited potential to challenge essential problems for generation of large earthquakes, as mentioned.

I am challenging to detect traces of mechano-chemical reaction and their fluctuation with time in and around the active fault zones by monitoring chemical and isotope compositions of fault zone fluids.

It is clarified by previous drilling projects that fault zone accompanies certain widths of fracture zones on one side or both sides of slip zone, where permeability is much higher than surrounding host and slip zone rocks. The results indicate that crustal fluids exclusively flow

through the fracture zone rather than surrounding rocks.

Most of the crustal fluids are originated from meteoric water, which is reacted with surrounding host rocks and equilibrated. Thus crustal fluids gushed out from fault zones commonly shows variations of chemical characteristics depending on host rocks surrounding fluid paths or magma chambers nearby. Fluids from deeper origin such as those from seismogenic depth or mantle are also contained in crustal fluids, however, the concentration of them are very low in general. Recent progress of fluid chemistry and improved performance of mass-spectrometer enables to detect very minor amount of crustal fluid of deep origin. However, isotope monitoring has not been an issue for geochemical measurements, so far. It means on-site isotope monitoring for crustal activity was field of wilderness. The machine should have full-automatic gas purification system and keep certain level of accuracy for long period at out-side of laboratory.

Recent technological progress realized that mass-spectrometer (especially for quadrupol type) more accurate, smaller and cheaper. We decided to construct specific mass-spectrometer system, which should have a potential of full automatic, remote and computer controlled purification lines, and continuous data acquisition systems from the fluids by itself. Our concrete targets now are, keeping improvement of full-automatic, high-resolution mass-spectrometer, setting several machines at the natural fault zones, and measuring the chemical and isotope compositions continuously and stably. Diagnostic researches using the data will be the target at the next stage. New ideas obtained during constructions of mass spectrometer was patented in Japan. This research is named as GROWDAS (GROWND WATER DATA ANALYSING SYSTEM) project.

Although stable data acquisition system was almost completed, available GROWDAS is just one settled at Atotsugawa fault zone. Half a year have passed since GROWDAS worked under stable condition, variation of concentrations of oxygen, nitrogen, and carbon dioxide with time, as well as that of helium concentration within several ppm was detected by GROWDAS. Constructing and setting second GROWDAS along the Atotsugawa fault at another site, we will check synchronism of the data variations observed from two locations, and explore implications of chemical variations of fault zone fluids in and around the active fault zone.

6. Funding Received

(1) JSPS Grants

· (B)2 16340128, Near field monitoring of fault zone fluids at Atotsugawa active fault. -Examination of radical reaction, 2004 – 2006, ¥16,700,000-

· (B)2 19340120, Slip zone dynamics-inversion analysis from intra-slip-zone materials, 2007 – 2009, ¥14,300,000-

· (A) 20244082, Ultrafine particle made by a friction-new evolution of material seismology, 2008 – 2010, ¥33,670,000 (COLLABORATOR)

(2) Cooperative Research

(3) Research Contracts

· Agency: Sumiko Consultants Co.LTD, Research Title： Comprehensive research of boring technology penetrating fault zone and chemical and isotope characteristics of fault zone fluid and gas, Period: 2006’ 7’ 1 – 2007’ 3’ 31, Funds: ¥110,000

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Kadono, T., K. Saruwatari, J. Kameda, H. Tanaka, S. Yamamoto, and A. Fujiwara (2006) Surface roughness of alumina fragments caused by hypervelocity impact. *Planetary and Space Science,* **54,** 212-215.

2. Nohara, T., H. Tanaka, K. Watanabe, N. Furukawa, A. Takami (2006) In-situ hydraulic tests in the Active Fault Survey Tunnel, Kamioka Mine, excavated through the active Mozumi-Sukenobu fault zone and their hydrogeological significance. *The Island Arc,* **15,** 537-545.

3. Tanaka, H., W. M. Chen, C. Y. Wang, K. F. Ma, N. Urata, J. Mori, M. Ando, (2006) Frictional Heat from Faulting of the 1999 Chi-Chi, Taiwan Earthquake. *Geophysical Research Letters,* **33,** L16316, doi:10.1029/2006GL026673.

4. Ma, K. F., H. Tanaka, S. R. Song, C. Y. Wang, J. H. Hung, Y. B.Tsai, J. Mori, Y. F. Song, E. C. Yeh, H. Sone, L.W. Kuo, H. Y. Wu, (2006) Slip Zone and Energetics of a Large Earthquake: Results from the Taiwan Chelungpu-fault Drilling Project (TCDP), *Nature,* **444,** doi:10.1038/nature05253.

5. Tanaka, H., W. M. Chen, K. Kawabata, N. Urata, (2007) Thermal properties across the Chelungpu fault zone and evaluations of positive thermal anomaly on the slip zones - Are these residual heat from faulting? *Geophysical Research Letters,* **34,** L01309, doi:10.1029/2006GL028153.

6. Tanaka, H., T. Ito, T. Nohara, M. Ando (2007) Descriptions of meso- and microscopic structures of fault zone rocks obtained from penetrating tunnel across the Mozumi-Sukenobu fault, central Japan, M. Ando Eds.; *in "Geodynamics of Atotsugawa Fault System"*, pp.103-121, TERRAPUB.

7. Kawabata, K., H. Tanaka, G. Kimura (2007) Mass transfer and pressure solution in deformed shale of accretionary complex: Examples from the Shimanto Belt, southwestern Japan, *Journal of Structural Geology,* **29,** 697-711.

8. Tanaka, H., K. Omura, T. Matsuda, R. Ikeda, K. Kobayashi, M. Murakami, K. Shimada (2007) Architectural evolution of the Nojima fault and identification of the activated slip layer by Kobe earthquake, *Journal of Geophysical Research,* **112,** B07304, doi:10.1029/ 2005JB003977.

9. Saito, T., H. Tanaka, (2007) Experimental study on gas emission using fault rock core penetrating Atotsugawa fault, central Japan, *Geochemica Cosmotica Acta*. **71,** 15, p867.

10. Tanaka, H., F.M. Chester, J.J. Mori, C.Y. Wang (2007) Drilling into fault zones, *Tectonophysics,* **443,** doi:10.1016/ j.tecto.2007.03.003 123-125.

11. Fujimoto, K., A. Ueda, T. Ohtani, M. Takahashi , H. Ito, H. Tanaka, A.M. Boullier, (2007) Borehole water and hydrologic model around the Nojima Fault, SW Japan, *Tectonophysics,* **443,** doi:10.1016/ j.tecto.2007.01.015 174-182.

12. Sakaguchi, A., A. Yanagihara, K. Ujiie, H. Tanaka , M. Kameyama, (2007) Thermal maturity of a fold-thrust belt based on vitorinite reflectance analysis in the Western Foothills complex, western Taiwan, *Tectonophysics,* **443,** doi:10.1016/ j.tecto.2007.01.017 220-232.

13. Hashimoto, Y., K. Ujiie, A. Sakaguchi, H. Tanaka, (2007) Characteristics and implication

of clay minerals in the northern and southern parts of the Chelung-pu fault, Taiwan, *Tectonophysics,* **443,** doi:10.1016/ j.tecto.2007.01.024, 233-242.

14. Chen, W. M., H. Tanaka, H. J. Huang, C. B. Lu, C. Y. Lee, C. Y. Wang, (2007) Fluid infiltration associated with seismic faulting: Examining chemical and mineralogical compositions of fault rocks from the active Chelungpu fault, *Tectonophysics,* **443,** doi:10.1016/ j.tecto.2007.01.025, 243-254.
15. Shimada, K., H. Tanaka, T. Saito (2008) Rapid and Simple Measurement of H2 Emission from Active Faults Using Compact Sampling Equipments, Resource Geology **58,** 196-202.
16. Kawabata, K., H. Tanaka, Y. Kitamura, and Ma K-F, (2009) Apparent activation energy and rate-limiting process estimation from natural shale deformed by pressure solution in shallow subduction zone, *Earth and Planetary Science Letters*, **287**, 57-63,
17. Shigematsu, N, Fujimoto, K, Ohtani, T, Shibazaki, B, Tomita, T, Tanaka, H, Miyashita, Y, (2009) Localisation of plastic flow in the mid-crust along a crustal-scale fault: Insight from the Hatagawa Fault Zone, NE Japan, *Journal of Structural Geology,* **31,** 601-614, Doi: 10.1016/j.jsg.2009.04004
18. Lockner, D. A., H. Tanaka, H. Ito, R. Ikeda, K. Omura, H. Naka, (2009) Geometry of the Nojima Fault at Nojima-Hirabayashi, Japan - I. A Simple Damage Structure Inferred from Borehole Core Permeability *Pure and Applied Geophysics*, **166,** 1649-1667, doi: 10.1007/s00024-009-0515-0
19. Moore, D. E., D. A. Lockner, H. Ito, R. Ikeda, H. Tanaka, K. Omura, (2009) Geometry of the Nojima Fault at Nojima-Hirabayashi, Japan - II. Microstructures and their Implications for Permeability and Strength *Pure and Applied Geophysics,* **166,** 1669-1691, Doi: 10.1007/s00024- 009-0513-2.

(2) Selected Conference Proceedings

1. Tanaka, H., M. Sugimoto, S. Terusawa, M. Murakami, F. Tsunomori, (2012) Distribution and chemical characteristics of hotsprings in Japan, Japan Geoscience Union Meeting, SCG70-P04

(3) Review Papers

(4) Books

1. Hidemi Tanaka, Tanio Ito, Tsuyoshi Nohara, Masataka Ando, 2007, Descriptions of meso- and microscopic structures of fault zone rocks obtained from penetrating tunnel across the Mozumi-Sukenobu fault, central Japan, in “Geodynamics of Atotsugawa Fault Sysytem”, TERRAPUB, 103-122 (Refereed)

(5) Patents

1. Patent No. 4805680 “Monitoring apparatus for undergraound gas-water mixed fluids” 2011, August 11. (Domestic)

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

(2) Domestic Conferences

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Kuniyo Kawabata (PhD student of Dr Tanaka), Student Awards American Geophysical Union 2007

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Tectonophysics special issue “Drilling penetrating the fault zone”2007, 446, H. Tanaka, F.M. Chester, J.J. Mori, and C.Y. Wand (Guest Editors), J.P. Burg (Acting Editor-in-Chief)

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 0

Ataru Sakuraba

I. C.V.

Name : Ataru Sakuraba
Present Position: Assistant Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Earth and Planetary Physics, The University of Tokyo, March, 1995
M. Sc., Earth and Planetary Physics, The University of Tokyo, March, 1997
Ph. D., Earth and Planetary Physics, The University of Tokyo, March, 2000

Professional Experience
September, 1998 - March, 2000, Research Fellow (DC2) of Japan Society for Promotion of Science, Department of Earth and Planetary Physics, University of Tokyo
April, 2000 - March, 2002, Research Fellow (PD) of Japan Society for Promotion of Science, Department of Earth and Planetary Science, University of Tokyo
April, 2002 - Assistant Professor, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

I mainly carried out numerical studies on metallic core convection and resulting geodynamo processes using low-viscosity geodynamo models. Most of previous studies used unrealistically high viscosity because of insufficient computational performance, but partly succeeded in producing Earth-like magnetic fields. As highly parallelized computer systems came to be popular, some researchers reported results using lower viscosity but failed to reproduce a dipolar magnetic field (Kageyama et al., 2008) or a strong magnetic field (Christensen & Aubert, Geophys. 2006; Takahashi et al., 2008). I showed that this paradoxical situation in thermally driven low-viscosity dynamo models was caused by wrong boundary conditions for the core-surface temperature, and that a dipolar strong magnetic field and a large-scale votex structure could be reproduced if a physically appropriate boundary condition was applied (Sakuraba & Roberts, 2009). Previous studies tend to use the isothermal boundary condition that has been traditionally adopted in Rayleigh-Benerd convection. However, this condition is not appropriate for the metallic core convection, and instead the heat flux should be given at the core surface touching the thermally less conductive mantle. In my model, I used a uniform heat-flux condition and obtained a numerical solution that had drastically different flow and magnetic-field structures from the conventional isothermal models. The reason why the thermal boundary condition was so important in low-viscosity geodynamo models was discussed in Sakuraba & Roberts (2011), and they explained that the core convection could transit from a weak-field state with small-scale convection to a strong-field state with large-scale convection, enabled by an efficient omega-effect generating a strong toroidal field, which originated in the existence of the temperature difference between the pole and equator because it permitted a strong thermal wind and meridional circulations.

Such low-viscosity models have possibility to resolve short timescales enough to explain geomagnetic secular variations such as the geomagnetic westward drift. My model well reproduces the characteristics for the core surface field near the equator to move westward, but

also shows a weak but significant eastward-drift signal, suggesting that these phenomena should be interpreted by MHD waves. I recently made an attempt to calculate eigenmodes of slow waves in a rotating sphere and tried to explain the geodynamo simulation results and the geomagnetic observations. In the same time range, the geomagnetic dipole shows a clear power-law distribution in the frequency domain. Sakuraba & Hamano (2007) theoretically presented a relationship between the frequency spectrum of the dipole and the wavenumber spectrum of the flow beneath the core surface and confirmed it in numerical simulations. I am going to apply their idea in much lower-viscosity geodynamo model.

3. Five Important Papers in your career

1. Sakuraba, A., and P. H. Roberts (2009), Generation of a strong magnetic field using uniform heat flux at the surface of the core, Nature Geosci., 2, 802-805.

Times cited: 33. They found a dipolar strong-field solution in a low-viscosity regime of the Ekman number of $O(10^{-7})$ and showed importance of the boundary condition for the core-surface temperature that had been overlooked.

2. Sakuraba, A. and Y. Hamano (2007), Turbulent structure in Earth's fluid core inferred from time series of geomagnetic dipole moment, Geophys. Res. Lett., 34, L15308.

Times cited: 4. They showed a theoretical relationship between the frequency spectrum of the magnetic dipole and the wavenumber spectrum of the core surface flow and presented a way to search core turbulence from paleomagnetic data.

3. Sakuraba, A. (2002), Linear magnetoconvection in rotating fluid spheres permeated by a uniform axial magnetic field, Geophys. Astrophys. Fluid Dyn., 96, 291-318.

Times cited: 7. This is the first attempt to make linear analysis of spherical-shell magnetoconvection in the presence of a uniform axial field in a wide parameter space and with various boundary conditions.

4. Sakuraba, A. and M. Kono (2000), Effect of a uniform magnetic field on nonlinear magnetoconvection in a rotating fluid spherical shell, Geophys. Astrophys. Fluid Dyn., 96, 291-318.

Times cited: 8. They clearly showed that the style of magnetoconvection in the presence of a uniform axial field changed from weak-field to strong-field regimes with the increase of the ambient field intensity.

5. Sakuraba, A., and M. Kono (1999), Effect of the inner core on the numerical solution of the magnetohydrodynamic dynamo, Phys. Earth Planet. Int., 111, 105-121.

Times cited: 76. This study is recognized as the first successful attempt to obtain a numerical Earth-type dynamo solution in the whole-sphere setting, which could be applied to ancient Earth that had no inner core.

4. Awards and Honors throughout your career

5. Future Research Plan

As the geomagnetic field reflects electric currents in the metallic core, studies on geomagnetic field structure and mechanisms of geomagnetic time variations are important not only in the core dynamics but in elucidating the structure and thermal state of the deepest

mantle that could affect the core convection. In particular, existence of paleomagnetic data makes it possible to discuss thermal history and evolution of the solid-Earth dynamics. Therefore, I believe that the geomagnetic study as one of the studies of deep Earth like seismology, geodesy and high-pressure physics should be encouraged further. I summarize some research plans in the following:

(1) Improvement of computational models for geodynamo: Modern computers are becoming faster and very large-scale, and highly parallel machines that have more than hundred thousands cores will be more popular in the future. I currently utilize about 10-teraflops capacity of Earth Simulator Center (JAMSTEC) but hope to increase the computational performance using other faster parallel machines. I plan to modify the computational code to be applicable to highly parallel computers.

(2) Estimation of the convective state of the core: I plan to obtain more Earth-like solutions that resemble the geomagnetic field and to estimate the convective state of the core. To do this, more turbulent solutions that have high magnetic Reynolds number and high magnetic/kinetic energy ratio are needed and I tackle this problem by high-resolution, large-scale numerical simulations.

(3) Mechanisms of geomagnetic secular variations: We can judge that a geodynamo model is really Earth-like not only by the spatial magnetic-field structure but by the time variations. Recent satellite geomagnetic observations give opportunity to compare geodynamo models and relatively short timescale geomagnetic secular variations. The targets will be geomagnetic jerks, westward drift and dipole moment variations. I have attempted to explain these phenomena and continue the studies focusing on comparison to lower-viscosity turbulent geodynamo models.

(4) Mechanisms of polarity reversals: The geomagnetic polarity reversal is one of the most drastic global changes observable on the Earth's surface, and its mechanism has been unsolved for many years. There have been some numerical results simulating polarity reversals but all of them are based on highly viscous core convection model. Although increasing integration time in lower-viscosity geodynamo models is still quite a tough problem, I attack this by using high performance computers and aim to obtain information about evolution of solid-Earth dynamics by comparison to paleomagnetic data.

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for Young Scientists (B), Numerical simulations of short-term geomagnetic field secular variations, 2011-2012, 4.3 million yens

· Grant-in-Aid for Young Scientists (B), Mathematical aspect of inviscid MHD dynamos and the fundamental structure of core convection, 2008-2009, 3.5 million yens

· Grant-in-Aid for Scientific Research (A), Determination of energy dissipation in the Earth's dynamo, 2009-2011, as a collaborator (the representative is Yozo Hamano)

· Grant-in-Aid for Scientific Research (A), Understanding turbulence of the Earth's liquid outer core, 2006-2008, as a collaborator (the representative is Yozo Hamano)

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

· Yamada Science Foundation, Support for Long-term Visit, A study on magnetohydrodynamic turbulence of rotating fluids, UCLA, USA, 1 million yens

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Sakuraba, A., P. H. Roberts (2009), Generation of a strong magnetic field using uniform heat flux at the surface of the core, Nature Geosci., 2, 802-805.
2. Sakuraba, A. and Y. Hamano (2007), Turbulent structure in Earth's fluid core inferred from time series of geomagnetic dipole moment, Geophys. Res. Lett., 34, L15308.
3. Sakuraba, A. (2007), A jet-like structure revealed by a numerical simulation of rotating spherical-shell magnetoconvection, J. Fluid Mech., 573, 89-104.
4. Oishi, Y., A. Sakuraba, and Y. Hamano (2007), Numerical method for geodynamo simulations based on Fourier expansion in longitude and finite difference in meridional plane, Phys. Earth Planet. Int., 164, 208-220.
5. Oishi, Y., A. Sakuraba, and Y. Hamano (2007), Implementation of the Fourier Transform Method for Geodynamo Simulation on the Earth Simulator, J. Earth Simulator, 7, 9-15.

(2) Selected Conference Proceedings

(3) Review Papers

1. Sakuraba, A (2010), Effects of the boundary condition for the core-surface temperature on geodynamo (in Japanese), Gekkan Chikyu, 32, 287-293. (Non-refereed)
2. Sakuraba, A (2006), Geomagnetic field and geodynamo (in Japanese), Science Net, Suken Publishing, 28, 14-15. (Non-refereed)

(4) Books

1. 2011-107916, Parallel computing system that performs spherical harmonic transform, and control method and control program for parallel computing system, as an inventor.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Sakuraba, A., Numerical simulations of geomagnetic field variations: from jerks to superchrons, AGU Fall Meeting (San Francisco, USA, 2011.12). Invited presentation
2. Sakuraba, A., Characteristics of low-viscosity models for planetary dynamos, AGU Fall Meeting (San Francisco, USA, 2009.12). Invited presentation
3. Sakuraba, A., Y. Hamano, Turbulent structure in the Earth's core inferred from paleomagnetic power spectrum of the dipole moment, IUGG General Assembly (Perugia, Italy, 2007.7). Regular presentation

Total number of presentation is 15.

(2) Domestic Conferences

4. Sakuraba, A., Nonlinear solutions of inviscid magnetostrophic dynamos, JpGU Meeting (Makuhari, 2011.5). Regular presentation
5. Sakuraba, A., Critical effect of thermal boundary condition at the core-mantle interface on

generation of a strong dipole magnetic field, JpGU Meeting (Makuhari, 2009.5). Regular presentation

6. Sakuraba, A., A mechanism of a jet-like flow in rotating spherical magnetoconvection, JpGU Meeting (Makuhari, 2006.5). Regular presentation

Total number of presentation is 15.

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 0

Ichiko Shimizu

I. C.V.

Name： Ichiko Shimizu
Present Position: Assistant Professor, University of Tokyo, Graduate School of Science

Education
B. Sc. in Geology and Mineralogy, Kyoto University, March 1984
M. Sc. in Geology, University of Tokyo, March 1986
Ph. D. in Geology, University of Tokyo, March 1989

Professional Experience
April 1989 – March 1991, Research Fellow, Department of Geophysics, University of Tokyo
May 1991 – March 1993, Assistant Professor, Department of Geology, University of Tokyo
April 1993 – present, Assistant Professor, Department of Earth and Planetary Science, University of Tokyo

April 1999 – May 1999, Research Scientist, Los Alamos National Laboratory, University of Geology (Berkeley), United States of America

II. Scientific Research Activity

2. Major achievements

The following research projects on rock rheology and microstructures were conducted between 2006 and 2011.

(1) Paleo-piezometer using recrystallized grain-size quartz

Based on the theory of dynamic recrystallization under high-temperature dislocation creep (Shimizu, 1998), the steady-state grain size of quartz was evaluated and its dependence on differential stress and temperature was clarified (Shimizu, 2008). The effect of grain boundary energy was incorporated into the latest model (Shimizu, 2012).

(2) Metamorphism and deformation in banded iron formation (BIF)

Microstructures of BIF samples taken from the Yellowknife Greenstone Belt, Canada, were analyzed and chemical profiles were constructed using an X-ray fluorescence (XRF) imaging technique. The process of metamorphic differentiation and the formation mechanisms of meso- and micro-bands were discussed (Katsuta et al., 2012).

(3) Development of laboratory techniques in high-PT deformation experiments

We evaluated the internal friction in a solid-medium apparatus and developed a new method to measure the differential stress in high-PT deformation experiments (Shimizu et al., 2006). A new solid-medium apparatus (Sumitomo Heavy Industries, Ltd., 100 ton press) was developed and installed at the University of Tokyo. Calibration tests were made at pressure conditions up to 1.5 GPa.

(4) Dehydration instability of serpentinites

One of the well-known proposed mechanisms of intermediate-depth earthquakes is dehydration embrittlement of serpentinites. We conducted high-PT deformation experiments of antigorite-serpentinites using gas- and solid-medium apparatuses. In friction experiments of antigorite gouges at a relatively low confining pressure (Pc = 100 MPa), shear-induced

dehydration and subsequent strengthening were observed (Takahashi et al., 2011). In contrast, in compression tests conducted at Pc = 800 MPa, intact antigorite-serpentinites showed drastic dehydration weakening at temperatures above 700ºC (Shimizu, 2010). The deformed samples are currently being analyzed by scanning electron microscopy (SEM-EDS, EBSD), X-ray diffraction (XRD), and X-ray absorption spectroscopy (XAS).

(5) Amorphization of quartz due to friction

To clarify physico-chemical processes at real contacts on fault surfaces, we conducted pin-and-disk sliding tests on quartz. Micro-Raman spectra of quartz disks revealed broadening of the main band and appearance of a coesite-like peak. We concluded that pressure- and strain-induced amorphization was the main cause of velocity weakening (Nakamura et al., 2012).

3. Five Important Papers in your career

1. Shimizu, I., 1992, Nonhydrostatic and nonequilibrium thermodynamics of deformable materials, *Journal of Geophysical Research, 97*, 4587–4597.

This theory solved the long-debated problem of nonhydrostatic thermodynamics. Based on this theory, a kinetic model of pressure solution creep [Shimizu, 1995] was developed.

2. Shimizu, I., 1995, Kinetics of pressure solution creep in quartz: Theoretical considerations, *Tectonophysics, 245*, 121–134.

Pressure solution-and-precipitation is an important deformation mechanism in the Earth's crust. This paper established the flow law of pressure solution creep for quartz rocks.

3. Shimizu, I., 1998, Stress and temperature dependence of recrystallized grain size: A subgrain misorientation model, *Geophysical Research Letter, 25*, 4237–4240.

A universal relation between recrystallized grain size and flow stress in dislocation creep was derived. The result is important in rock rheology.

4. Takei, Y. and Shimizu, I., 2003, The effects of liquid composition, temperature, and pressure on the equilibrium dihedral angles of binary solid-liquid systems inferred from a lattice-like model, *Physics of Earth and Planetary Interiors*, 139, 225-242.

This and the following two papers [Shimizu & Takei, 2005, *Physica B, 362*, 169–179; Shimizu & Takei, 2005, *Acta Materialia, 53*, 811–821] established the statistical thermodynamics of solid–liquid interfaces. Complete wetting of olivine in asthenospheric conditions, which was experimentally confirmed recently, is consistent with our theoretical prediction.

5. Shimizu, I., 2008, Theories and applicability of grain size piezometers: The role of dynamic recrystallization mechanisms, *Journal of Structural Geology, 30*, 899–917. doi:10.1016/j.jsg.2008.03.004.

The theory of dynamic recrystallization [Shimizu, 1998] was further developed and a grain-size piezometer of quartz was proposed. The method can be used to estimate differential stress in the Earth's crust.

4. Awards and Honors throughout your career

· The Geological Society of Japan Young Scientist Award, April 30, 1990."

5. Future Research Plan

In order to explore physico-chemical processes in seismogenic zones, we plan to conduct the following research projects. We will focus on the influence of H2O fluids on brittle-ductile transitional behaviors of rocks in subduction zones.

(a) Mechanism of intra-slab earthquakes

We plan to further study the dehydration instability of serpentinites (as described in 2-(4) above) by experiments, as well as model the process of intra-slab earthquakes. A newly developed solid-medium apparatus will be used to cover high pressure ranges.

(b) Strength of plate boundary megathrusts

The purpose of this study is to construct strength profiles of subduction zone megathrusts based on depth- and materials-dependent rheology of the crust and mantle, and to characterize seismic asperities on the plate interfaces. A preliminary model for the Tohoku-oki plate boundary megathrust was presented at the Japan Geoscience Union Meeting (Shimizu, 2012, JpGU). The results of the following studies will be incorporated into future strength models.

(i) Effects of pore pressure at great depths

In this project, we plan to conduct friction experiments of serpentinites and talc at various confining pressures (Pc), pore pressures (Pp), and temperatures to evaluate the frictional strength of the wedge mantle at high Pp. The gas-medium apparatus at the Hiroshima University (Pc, Pp < 200 MPa) and the liquid-medium apparatus at the Earthquake Research Institute (Pc < 450 MPa, Pp < 400 MPa) will be used. Preliminary studies at room temperature suggested breakdown of the effective stress law at high Pc.

(ii) Shear stress at the down-dip limit of the seismogenic zone

We will apply the grain-size piezometer of wet quartz (Shimizu, 2012) to siliceous rocks in the low-grade parts of the Sanbagawa metamorphic belts, and evaluate the stress states in the ductile region of the ancient plate boundary megathrust. Deformation microstructures and water contents of quartz will be analyzed by SEM-EBSD and micro-FTIR. Carbonaceous material thermometry is used to determine the metamorphic temperature.

6. Funding Received

(1) JSPS Grants

- Grant-in-Aid for Scientific Research (B) “High-PT experimental studies on rheology of serpentinites”, No. 22340148, 2010–2012, Total budget 19,890,000 yen.
- Grant-in-Aid for Scientific Research (B) “Roles of dehydration reactions in seismogenic processes in subduction zones” No. 19340147, 2007–2009, Total budget 19,370,000 yen.
- Grant-in-Aid for Scientific Research (B) “Interaction between fluids and deformation of the Earth’s crust”, No. 16340150, 2004‐2006, Total budget 16,700,000 yen.
- Grant-in-Aid for Scientific Research on Innovative Areas: “Morphologies and physical properties of geofluids”, No. 21109005, 2009–2013, Budget 26,058,500 yen.
- Observation and Research Program for Prediction of Earthquakes and Volcanic Eruptions: “Magmatism and geodynamics in subduction zones”, 2009–, 2260,000 yen.
- Observation and Research Program for Prediction of Earthquakes: “Elementary processes in earthquake generation”, 2004–2008, 2400,000 yen.

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Shimizu I., Watanabe Y., K. Michibayashi, Y. Watanabe, T. Masuda, and M. Kumazawa, 2006. The design and performance of the solid-medium deformation apparatus MK65S: Evaluation of the internal friction, *Japan Journal of Structural Geplogy, No. 49*, 15–26.
2. Shimizu, I., 2008, Theories and applicability of grain size piezometers: The role of dynamic recrystallization mechanisms, *Journal of Structural Geology*, 30, 899-917. doi:10.1016/j.jsg.2008.03.004.
3. Shimizu I., 2010. Connectivity of H2O fluids at depth: In sights from the thermodynamics of interfacial energy, *Japanese Magazine of Mineralogical and Petrological Sciences, 39*, 208–219.
4. Shimizu, I., 2011, Erratum to "Theories and applicability of grain size piezometers: The role of dynamic recrystallization mechanisms" [J Struct Geol 30 (2008) 899−917], *Journal of Structural Geology, 33*, 1136–1137.
5. Tatakahashi, M., Uehara, S., Mizoguchi, K., Shimizu, I., Okazaki, K. and Masuda, K., 2011, On the transient response of serpentine (antigorite) gouge to stepwise changes in slip velocity under high-temperature conditions, *Journal of Geophysical Research, 116*, B10405, doi:10.1029/2010JB008062.
6. Shimizu, I., 2012, Steady-state grain size in dynamic recrystallization of minerals, In: "*Recrystallization"*, edited by Krzysztof Sztwiertnia, InTech, ISBN 978-953-51-0122-2, pp. 371–386.
7. Katsuta N., I. Shimizu, H. Helmstaedt, M. Takano, S. Kawasaki, S., and M. Kumazawa, 2012, Major element distribution in Archean banded iron formation (BIF): Influence of metamorphic differentiation, *Journal of Metamorphic Geology, 30*, 457–472. doi: 10.1111/j.1525-1314.2012.00975.x.
8. Noguchi N., Abduriyim A., Shimizu, I., Kamegata, N., Odake, S. and Kagi, H., 2012, Imaging of internal stress around a mineral inclusion in a sapphire crystal: Application of micro-Raman and photoluminescence spectroscopy, *Journal of Raman Spectroscopy, 43*, DOI: 10.1002/jrs.4161
9. Nakamura Y., J. Muto, H. Nagahama, I. Shimizu, T. Miura, and I. Arakawa, 2012, Amorphization of quartz by friction: Implication to silica-gel lubrication of fault surfaces, *Geophysical Research Letter, 39*. doi:10.1029/2012GL053228

(2) Selected Conference Proceedings

1. Shimizu I., Watanabe Y., Michibayashi K., Takahashi, M. Uehara, S. and Katsuta, N., 2011, Dehydration softening of serpentinite and its roles in the intermediate-depth eartuquakes. *Proceedings of First International Symposium on Geofluids*, "Geofluid Processes in Subducation Zones and Mantle Dynamics", p. 25, Tokyo Institute of Technology, Tokyo, Japan.
2. Uehara, S., Shimizu I., and Okazaki K., 2012, Effects of pore pressure on fault mechanics at brittle-plastic transition zones. *Proceedings of Joint Symposium of Misasa-2012 and Geofluids-2,* "Dynamics and Evolution of the Earth Interior: special emphasis on the role of fluids", p. 34, Misasa, Japan.

(3) Review Papers

1. Kumazawa, M. and I. Shimizu, 2006. Development of the first solid-medium deformation apparatus in Japan: A historical review, *Japan Journal of Structural Geplogy, No. 49*, 5–14. (Refereed)
2. Shimizu I., 2006, Experimental techniques in structural geology, *Japan Journal of Structural Geplogy, No. 49,* 1–4. (Non-refereed)
3. Shimizu I., 2010, Intermediate-depth eartuquakes in subducting slabs and dehydration instability of serpentinite, *Earth Monthly (Chikyu), 32,* 162–166. (Non-refereed)

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Shimizu I., Watanabe Y., Michibayashi K., Takahashi, M. Uehara, S. and Katsuta, N., Dehydration softening of serpentinite and its roles in the intermediate-depth eartuquakes. *First International Symposium on Geofluids, "Geofluid Processes in Subducation Zones and Mantle Dynamics",* Tokyo Institute of Technology, Tokyo, Japan, May 1, 2011 (Invited).
2. Shimizu, I., Y. Watanabe, K. Michibayashi, S. Uehara M. Takahashi and N. Katsuta, 2011, Dehydration softening of serpentinite as a trigger of intermediate-depth earthquakes*, American Geophysical Union Fall Meeting*, (San Francisco, U.S.A., December 15, 2011.
3. Uehara, S., Shimizu I., and Okazaki K., Effects of pore pressure on fault mechanics at brittle-plastic transition zones. *Joint Symposium of Misasa-2012 and Geofluids-2*, Misasa, Japan, March 17–21, 2012 (Invited).

and 2 other talks

(2) Domestic Conferences

30 talks

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Editor of a special volume of “Experimental techniques in structural geology”, *Japan Journal of Structural Geology*, No. 49, 2006.

(2) Academic Societies

· 2007–2009, A member of representatives of the Geological Society of Japan.

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 0

Atsuko Namiki

I. C.V.

Name： Atsuko Namiki
Present Position: Assistant Professor, University of Tokyo, Graduate School of Science

Education
Tohoku University, B. Sc., Geology, March, 1996
University of Tokyo, M. Sc., Geophysics, March, 1998
University of Tokyo, Ph. D., Geophysics, March, 2002

Professional Experience
April, 1998 - December, 1998, Seiko Epson.
April, 2000 - March, 2002, JSPS Research Fellow, Department of Earth Science, University of Tokyo.
April, 2002 - March, 2005, JSPS Research Fellow, Department of Earth Sciences, Kanazawa University.
May, 2003 - September, 2006, Visiting Scientist, Department of Earth and Planetary Sciences, University of California, Berkeley, USA,
October, 2006 - September, 2007, Post doc., AIST.
October 2007 - December, 2009, Technical Assistant, Department of Earth Sciences, Kanazawa University.
April, 2009 - March, 2010, Assistant Professor, Department of Earth and Planetary Science, University of Tokyo.

II. Scientific Research Activity

2. Major achievements

I study the mechanism of volcanic eruptions. Based on fluid dynamics experiments in laboratory, I make simple scalings to describe the eruption dynamics which is applicable to numerical simulations. Volcanoes erupt in various ways. Magmas with similar composition can erupt both ways explosively and as non-explosive lava flows. My goal is to understand the mechanism which determines the eruption styles, and establishes the method to observe the mechanism.

Namiki and Manga (2005) experimentally show that existence of bubbles in magma can determine the explosivity of eruptions. This is because compressibility of the volcanic gasses in bubbles is much higher than that of magma itself. The volcanic gas in the bubbles can expands explosively under the rapid decompression but magma itself does not. This fact is one of the most important results of my achievements. Even when bubbles exist in magmas, bubbly fluids do not expand always explosively. Decompression rate can affect the explosively. Only when the decompression rate is sufficiently high, expansion can become explosive (Namiki and Manga, 2006). The viscosity of magmas also affects the eruption styles (Namiki and Manga, 2008). I conducted these studies as post-doctoral projects in UC Berkeley.

In order to understand the real mechanisms of volcanic eruptions, the theory must be tested by geophysical observations of volcanic eruptions. Accordingly, I and Tsukasa Kobayashi, who was a graduate student at Kanazawa University, began the experiments for airwaves generated

by bubble bursting which are frequently observed during the volcanic eruptions. For simplify, we conducted a series of experiments for airwaves generated by a single bubble bursting. In order to explain the airwaves by bubble bursting, N-shaped waves which are generated by immediate removals of bubble films has been used. Our experiments however show that there is a particular velocity of the bubble film removal which affects the waveform of the airwaves. As a result, the frequency for the bubble bursting becomes lower than that which has been estimated. Applying our model to the Strombolian eruption, we succeeded to explain the low frequency of air waves observed during the eruptions (Kobayashi et al., 2010).

Huge eruption is frequently initiated by reactivation of solidifying magma chambers. In order to understand this pre-eruption process, I and Yasuko Shibano, who was also a graduate student, conducted a series of experiments simulating the process that a fresh basaltic magma intrudes beneath a the dense granular magma. We found a new phenomenon in which the liquid rich layer ascends with maintaining its shape. Estimations based on our experiments suggest that this process can occur in a real magma chamber and must an important process to reactivates the solidifying magma chambers. (Shibano et al. 2012).

I also study mantle dynamics with students (Matsumoto et al. 2006).

3. Five Important Papers in your career

1. Namiki, A. (2012) An empirical scaling of shear-induced outgassing during magma ascent: Intermittent magma ascent causes effective outgassing, *Earth Planet. Sci. Lett.*, *353–354,* 72-81.

The volume fraction of bubbles in a magma is one of the most important parameter to determine the eruption styles of volcanoes. This paper provides, for the first time, the quantitative equation to describe the volume change of the bubbles under the shear deformation around conduit walls.

2. Kobayashi, T., A. Namiki, and I. Sumita (2010), Excitation of airwaves caused by bubble bursting in a cylindrical conduit: Experiments and a model, *J. Geophys. Res.*, *115,* B10201, doi:10.1029/2009JB006828.

In order to understand the mechanism determining eruption styles, we should understand observations using theory. In this paper we explain the low frequency of airwaves observed during the Strombolian eruptions by using theories we formulate based on experiments. This paper is downloaded 529 times and became the second Most Popular Journal Articles in AGU journal (Solid Earth) at the published week.

3. Namiki, A., and M. Manga (2008), Transition between fragmentation and permeable outgassing of low viscosity magmas, *J. Volcanol. Geotherm. Res.*, *169***,** 48-60.

In this paper, we found that bubbly magma under decompression sometimes shrinks by outgassing instead that it expands. We formulate the threshold of expansion and shrink using laboratory experiments.

4. Namiki, A., M. Manga (2005), Response of a bubble bearing viscoelastic fluid to rapid decompression: Implications for explosive volcanic eruptions, *Earth Planet. Sci. Lett., 236,* 269-284.

This paper experimentally shows that existence of bubbles in a magma determines whether eruption becomes explosive.

5. Namiki, A., T. Hatakeyama, A. Toramaru, K. Kurita, and I. Sumita (2003), Bubble size distributions in a convecting layer, *Geophys. Res. Lett.*, *30***,** No. 15, 1784

10.1029/2003GL017156.

By boiling milk and cream, we suggest a method to estimate the conduit process from the bubble distribution within erupted pumices. This paper shows that we can write a paper at a very low prince and without special equipment if we have sufficient ideas.

4. Awards and Honors throughout your career

· Young scientist award from Japan volcanology society, 2007 May.

5. Future Research Plan

I will measure the viscoelasticities of fluid including bubbles and phenocrysts according to the research plan written in the JSPS grant award "Wakate A".

Unsolved scientific questions which should be answered.

Viscoelasticities of a complex fluid: The existence of bubbles in magmas strongly affects eruption styles. We do not however have a method to estimate the loci and volume of bubbles in magmas by geophysical observations. On the other hand, the existence of bubbles in magmas generates buoyancy force and changes viscoelasticity of magma. The ascending velocity of magmas is determined by the balance between the buoyancy force and viscoelastic resistance. We however do not know the buoyancy and viscoelasticity of magmas including bubbles and phenocrysts.

Outgassing: Some amount of volcanic gasses in bubbly magmas can escape to the atmosphere without volcanic eruptions (outgassing). We however do not have equations describing the outgassing volume.

Pressure source of the explosive eruption : The volcanic gasses remained from the outgassing can cause explosive eruption. However, it is not obvious how the gases reach to the vent with maintaining its high pressure. It has been observed in Sakurajima in Japan and Tungurahua in Ecuador that explosive eruptions occur after expansions at the several km depth. (Tameguri, 2002, Kazan, Kumagai et al., 2011 Geophys.Res. Lett.)。It is not obvious how the pressure change at a several km depth can reach the vent and cause explosive eruptions.

Triggered eruptions: According to the statistical aspects large earthquakes trigger volcanic eruptions. Tohoku-Oki earthquake 2011 activated several volcanoes. However, the mechanism by which the earthquakes trigger the volcanic eruption has not been understood.

I thus will conducts following four projects.

· I will conduct the viscoelasticity measurement of viscous fluid which includes bubbles and phenocrysts at high and low frequencies. Based on the high frequency measurements, I will establish the method to estimate the loci and volume of the bubbles in magma from the seismic observations. Based on the low frequency measurements, I will establish the method to estimate the ascending velocity of the bubbly magma.
· Based on the viscoelastic measurements and resulting texture, I will formulate the outgassing volume during the magma ascending.
· Based on the viscoelastic measurements, I will estimate the travel time of the pressure wave and reveal the mechanism that the expansion at the several depth causes the explosive eruption.
· Based on above findings, I will reveal the mechanism of the triggered earthquakes.

6. Funding Received

(1) JSPS Grants

· Wakate B: Revealing the outgassing mechanisms based on fluid experiments: 2007-2008:¥3,540,000-

· Wakate B: Submission of a new mechanism of outgassing: 2009-2010: ¥4,420,000-

· Houga: An intuitive understanding of slow earthquakes based on model experiments: 2011-2012: ¥3,770,000-

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

· The Japan Science Sociely (Sasagawa) 2008

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Kobayashi, T., A. Namiki, and I. Sumita (2010), Excitation of airwaves caused by bubble bursting in a cylindrical conduit: Experiments and a model, *J. Geophys. Res.*, *115,* B10201, doi:10.1029/2009JB006828.
2. Namiki, A., and M. Manga (2008), Transition between fragmentation and permeable outgassing of low viscosity magmas, *J. Volcanol. Geotherm. Res., 169*, 48-60.
3. Namiki, A., and M. Manga (2006), Influence of decompression rate on the expansion velocity and expansion style of bubbly fluids, *J. Geophys. Res., 111,* B11208, doi:10.1029/2005JB004132.
4. Matsumoto, N., A. Namiki, and I. Sumita (2006), Influence of a basal thermal anomaly on mantle convection. *Phys. Earth Planet. Int., 157,* 208-222.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Namiki, A., T. Kobayashi, and I. Sumita, Excitation of airwaves caused by bubble bursting in a cylindrical conduit: Experiments and a model, IUGG (2011) July, Melbourne.

and 3 other presentations

(2) Domestic Conferences

2. Kagoshima, S., and Namiki, A., Experiments on the decompression induced ontgassing during the magma ascending, JpGU, 2011, Makuhari.

and 5 other presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

· During 2002-2009, I worked with three graduate students at Kanazawa University and wrote three papers.

· After 2010, I worked with 6 undergraduate students and obtains data to be published as two papers which are under preparation.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 1

Jun Kameda

I. C.V.

Name： Jun Kameda
Present Position: Project Assistant Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Geology, The University of Tokyo, March, 1998
M. Sc., Geology, The University of Tokyo, March, 2000
Ph. D., Earth and Planetary Science, The University of Tokyo, June, 2004

Professional Experience
April, 2002-Mar., 2004, JSPS researcher DC2, Department of Earth and Planetary Science, The University of University
April, 2004-Mar., 2006, Research support, Department of Earth and Planetary Science, The University of University
April, 2006-Mar., 2009, JSPS researcher PD, Department of Earth and Planetary Science, The University of University
November, 2009-, Project Assistant Professor, Department of Earth and Planetary Science, The University of University

Part-time lecture at Kitazato University (2004)
Part-time lecture at Tsukuba University (2011)

II. Scientific Research Activity

2. Major achievements

My research has been primary focused on 1) characterization of tsunamigenic and seismogenic fault rocks at convergent margins and 2) quantitative examination of diagenesis and dehydration of subducting materials and its influence on seismogenesis, based on mineralogical approaches including XRD and TEM.

1) Detection and quantification of temperature anomaly at a fault zone is crucial to understand past slip behaviors of the fault. I have found several types of mineral transformation reactions possibly progressed by frictional thermogenesis during high-velocity slips on the slip plane. By applying geothermometer and kinetic modeling on these mineral characteristics, I have succeeded in determining slip parameters during faulting.
2) To examine the dehydration behavior of underthrusting materials and its influence on seismogenesis at depths of subduction zones, I investigated mineralogical properties of ocean-floor basalt at a reference site of the Nankai Trough and some exposed basalt rocks within ancient accretionary complexes. Based on these results, I concluded that the diagenesis of oceanic crust is potentially a significant fluid supplier at seismogenic plate interface. I also demonstrated that basalt dehydration causes fracturing of basalt itself, and that such fracturing will be a trigger of earthquake beneath accretionary margins.

In the last two years, I joined two IODP expeditions, CRISP at Costa Rica margin (Exp. 334) and JFAST at the Japan Trench (Exp. 344), as a participant. To get insight into

seismogenic processes at the two convergent margins, mineralogical analysis of the core samples is now underway.

3. Five Important Papers in your career

1. Kameda, J., A., Yamaguchi, S., Saito, H., Sakuma, K., Kawamura, G., Kimura, 2011. A new source of water in seismogenic subduction zones. Geophysical Research Letters, L22306, doi:10.1029/2011GL048883.

This paper demonstrated that the ocean-plate basalt is possibly a significant fluid carrier into the seismogenic plate interface.

2. Yamaguchi, A., A. Sakaguchi, T. Sakamoto, K. Iijima, J. Kameda, G. Kimura, K. Ujiie, F.M. Chester, O. Fabbri, D. Goldsby, A. Tsutsumi, C.F. Li, D. Curewitz, 2011. Progressive illitization in fault gouge caused by seismic slip propagation along a megasplay fault in the Nankai Trough. Geology 39, 995–998.

This paper reported a local progress of smectite-illite conversion within a slip zone at a frontal part of the Nankai margin. This finding will be a key to understanding tsunamigenic faulting mechanisms at shallow subduction zones.

3. Kameda, J., K. Ujiie, A. Yamaguchi, G. Kimura, 2011. Smectite to chlorite conversion by frictional heating along a subduction thrust. Earth and Planetary Science Letters, 305, 161-170.

This paper described another type of conversion reaction in a plate-boundary fault. This approach is a feasible way to quantify thermogenesis upon slip plane.

4. Kameda, J., Y. Yamamoto, G. Kimura, 2010. Smectite swelling in the Miura-Boso accretionary prism: Possible cause for incipient décollement zone formation. Tectonophysics, 494, 75-84.

This paper argued how incipient décollement is formed within relatively homogeneous sedimentary column.

5. Kameda, J., R. Inoguchi, T. Kogure, 2007. Morphological analysis of minute crystals by combining electron back-scattered diffraction (EBSD) and stereographic scanning electron microscopy (SEM). Journal of Microscopy, 228, 358-365.

This paper proposed a new convenient method for morphological analysis of minute crystals by combining EBSD and SEM.

4. Awards and Honors throughout your career

5. Future Research Plan

1, Comprehensive understanding of plate-boundary diagenesis at convergent margins

Diagenesis of underthrusting materials has a first-order influence on mechanical properties of plate-boundary fault at convergent margins. So far, many efforts have been focused on diagenesis of smectite-illite and opal-quartz conversion reaction. Next concern is to extend my focus over entire reactions such as feldspars, zeolites and hydrocarbons. This will be a first step for comprehensive understanding of tectonic processes including seismogenesis at convergent margins.

2, Examination of stability and hydration states of hydrous phases under seismogenic PT conditions

Hydration/dehydration processes of hydrous minerals at plate-boundary is supposed to be directly linked to subduction zone seismogenesis. My next research plan is to investigate stability and hydration states of saponite and opal as a basis to construct more reliable diagenesis model at subduction zone plate boundaries.

3, Verification of "basalt dehydration-induced earthquake" hypothesis

Based on previous works, I hypothesized that dehydration and subsequent fracturing of underthrusting basalt is one of the key processes for nucleation of subduction zone earthquakes. In the coming years, a central target of IODP NantroSEIZE Project is to recover seismogenic fault rocks at depth of the Nankai margin. I want to try to validate the hypothesis above through mineralogical and geochemical analyses by this project.

6. Funding Received

(1) JSPS Grants

· Grant for JSPS Start-up, "Application of mechano-chemistry to transformation reactions of minerals in fault rocks", 2010-2011、3,120,000 Yen.

· Grant for JSPS (PD), "Identification of chirality in kaolinite and evaluation of chiral selectivity on kaolinite edge surfaces", 2006-2008, 3,400,000 Yen.

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Kameda, J., A., Yamaguchi, S., Saito, H., Sakuma, K., Kawamura, G., Kimura, (2011), A new source of water in seismogenic subduction zones, *Geophys. Res. Lett.*, L22306, doi:10.1029/2011GL048883.
2. Kimura, G., A., Yamaguchi, M., Hojo, Y., Kitamura, J., Kameda, K., Ujiie, Y., Hamada, M., Hamahashi, S., Hina (2011), Tectonic mélange as fault rock of subduction plate boundary, *Tectonophys.*, 568–569, 25–38.
3. Yamaguchi, A., A. Sakaguchi, T. Sakamoto, K. Iijima, J. Kameda, G. Kimura, K. Ujiie, F.M. Chester, O. Fabbri, D. Goldsby, A. Tsutsumi, C.F. Li, D. Curewitz (2011), Progressive illitization in fault gouge caused by seismic slip propagation along a megasplay fault in the Nankai Trough, *Geology* 39, 995–998.
4. Watanabe, K., M. Sekiya, J. Kameda, S. Wada, T. Kogure, (2011), Mineralogical characterization of Asian dust collected in Fukuoka, southwest Japan, *Clay Sci.*, 15, 43-51.
5. Kameda, J., K. Ujiie, A. Yamaguchi, G. Kimura, (2011), Smectite to chlorite conversion by frictional heating along a subduction thrust, *Earth Planet. Sci. Lett.*, 305, 161-170.
6. Kameda, J., H. Raimbourg, T. Kogure, G. Kimura, (2011) Low-grade metamorphism around the down-dip limit of seismogenic subduction zones: Examples from an ancient accretionary complex in the Shimanto Belt, Japan, *Tectonophys.*, 502, 383-392.

7. Kameda, J., A. Okamoto, T. Mikouchi, R. Kitagawa, T. Kogure, (2010) The occurrence and structure of vermiform chlorite, *Clay Sci.*, 14, 155-161.

8. Kameda, J., Y. Yamamoto, G. Kimura, (2010) Smectite swelling in the Miura-Boso accretionary prism: Possible cause for incipient décollement zone formation, *Tectonophys.*, 494, 75-84.

9. Suzuki, M., J. Kameda, T. Sasaki, K. Saruwatari, H. Nagasawa, T. Kogure, (2010) Characterization of the multilayered shell of a limpet, Lottia kogamogai (Mollusca: Patellogastropoda), using SEM-EBSD and FIB-TEM. *Jour. Struct. Biol.*, 171, 223-230.

10. Kudo, M., J. Kameda, K. Saruwatari, N. Ozaki, K. Okano, H. Nagasawa, T. Kogure, (2010) Microtexture of larval shell of oyster, Crassostrea nippona: A FIB-TEM study, *Jour. Struct. Biol.*, 169, 1-5.

11. Kameda, J. T. Murakami and H. Sugimori, (2009) Modification to the crystal structure of chlorite during early stage of its dissolution, *Phys. Chem. Miner.*, 36, 537-544.

12. Kogure, T., J. Kameda and V.A. Drits, (2008) Stacking faults with 180 degrees layer rotation in celadonite, an Fe- and Mg-rich dioctahedral mica, *Clay. Clay Miner.*, 56, 612-621.

13. Sato, H., J. Kameda, Y. Fukuda, MA Haga, A Yamagishi, (2008) Chiral bead-like trimer of tris(2,4-phenanedionato)ruthenium(III), *Chem. Lett.*, 37, 716-717.

14. Kameda, J., K. Saruwatari, D. Beaufort, T. Kogure, (2008) Structure and polytypes in vermiform kaolins of diagenetic origin; FIB-TEM analyses, *Eur. Jour. Miner.*, 20, 199-204.

15. Kogure, T., J. Kameda, (2008) Stacking disorder in dioctahedral 2:1 phyllosilicates revealed by high-resolution TEM and XRD simulation, *Zeit. Krist.*, 223, 69-75.

16. Kameda, J., R. Inoguchi, T. Kogure, (2007) Morphological analysis of minute crystals by combining electron back-scattered diffraction (EBSD) and stereographic scanning electron microscopy (SEM). *Jour. Microscopy*, 228, 358-365.

17. Kameda, J., R. Miyawaki, V.A. Drits, T. Kogure, (2007) Polytype and morphological analyses of gumbelite, fibrous magnesium-rich illite, *Clay. Clay Miner.*, 55, 453-466.

18. Kameda, J. R. Miyawaki, R. Kitagawa, T. Kogure, (2007) XRD and HRTEM analysis of the stacking structure in sudoite, di-trioctahedral chlorite, *Am. Miner.*, 92, 1586-1592.

19. Okamoto, K., H. Sato, K. Saruwatari, K. Tamura, J. Kameda, T. Kogure, Y. Umemura, A. Yamagishi, (2007), Persistent phenomena in photocurrent of Niobate nanosheet, *Jour. Phys. Chem. B*, 34, 12827-12833.

20. Kogure, T., J. Kameda, V.A. Drits, (2007), Novel 2:1 structure of phyllosilicates formed by annealing Fe3+, Mg-rich dioctahedral mica, *Am. Miner.*, 92, 1531-1534.

21. Kudoh, Y., J. Kameda and T. Kogure, (2006), Dissolution of brucite on the (001) surface around neutral pH: in-situ AFM observation. *Clay. Clay Miner.*, 54, 598-604.

22. Yoshida, J., K. Saruwatari, J. Kameda, H. Sato, A. Yamagishi, L.S. Sun, M. Corriea, G. Villemure, (2006), Electron transfer through clay monolayer films fabricated by the Langmuir-Blodgett technique, *Langmuir*, 22, 9591-9597.

23. Kogure, T., J. Kameda, T. Matsui, R. Miyawaki, (2006), Stacking structure in disordered talc: interpretation of its X-ray diffraction pattern by using pattern simulation and high-resolution transmission electron microscopy, *Am. Miner.*, 91, 1363-1370.

24. Kogure, T., M. Jige, J. Kameda, A. Yamagishi, R. Kitagawa, (2006) Stacking structures in pyrophyllite revealed by high-resolution transmission electron microscopy (HRTEM), *Am. Miner.*, 91, 1293-1299.

25. Kadono, T., J. Kameda, K. Saruwatari, H. Tanaka, S. Yamamoto and A. Fujiwara, (2006), Surface roughness of alumina fragments caused by hypervelocity impact, *Planet. Space Sci.*, 54, 212-215.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

1. Ujiie, K., A. Tsutsumi, J. Kameda, (2011), Reproduction of thermal pressurization and fluidization of clay-rich fault gouges by high-velocity friction experiments and implications for seismic slip in natural faults, Geology of the earthquake source, The Geological Society of London Special Publication, 359, 267-285.

2. Clay Handbook, 3rd edition, II. 2.6, Chlorite, 54-60.

3. Clay Handbook, 3rd edition, III. 1.3.10, Electron Backscattered Diffraction, 54-55.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Kameda, J., S., Hina, K., Kobayashi, A., Yamaguchi, Y., Hamada, Y., Yamamoto, M., Hamahashi, G., Kimura, Silica diagenesis and its effect on interplate seismicity in cold subduction zones, American Geophysical Union Fall Meeting, 20111205, San Francisco, not invited.

and 3 other talks

(2) Domestic Conferences

2. Kameda, J., Y., Yamamoto, Y., Hamada, G., Kimura, Prograde clay minerals reactions along an ancient frontal thrust, Japan Geoscience Union Meeting, 20110526, Chiba、not invited.

and 4 other talks

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 0

Takehito Suzuki

I. C.V.

Name： Takehito Suzuki
Present Position: Project Assistant Professor, University of Tokyo, Graduate School of Science

Education

B. Sc., Geophysics, The Univerisity of Tokyo, March, 2002
M. Sc., Geophysics, The Univerisity of Tokyo, March, 2004
Ph. D., Geophysics, The Univerisity of Tokyo, March, 2007

Professional Experience

April, 2005-Mar., 2007, JSPS Fellow (DC2), Earthquake Research Institute, the University of Tokyo
April, 2007-Mar., 2008, Researcher (Yamashita Laboratory), Earthquake Research Institute, the University of Tokyo
April, 2008-Nov., 2008, Project Researcher (Yamashita Laboratory), Earthquake Research Institute, the University of Tokyo
Dec, 2008-Mar., 2010, Project Researcher (Kato Laboratory), Earthquake Research Institute, the University of Tokyo
April, 2010-, Project Assistant Professor, the University of Tokyo, Graduate School of Science

II. Scientific Research Activity

2. Major achievements

I have employed analytical and numerical methods to explain a number of aspects of dynamic earthquake rupture process in a unified way. As examples of such abundant aspects, we can mention ordinary earthquakes and slow earthquakes: among earthquakes, there are ordinary earthquakes radiating seismic waves, while we also observe slow earthquakes radiating negligibly small energy by the seismic waves. Though many researchers have constructed each model for each aspect for its explanation, such variety should be understood in a single framework because they are all “earthquakes”. Firstly, I have explained such many aspects, which cannot be understood with an assumption of an elastic material, by introducing an interaction among heat, fluid pressure and inelastic pore creation (Suzuki and Yamashita, 2007-2010). I introduced two nondimensional numbers with the framework with an assumption of a one-dimensional fault: I introduced S_u describing relative strength of the effect of the inelastic pore creation to that of the heat, and S'_u describing relative strength of the effect of fluid flow to that of the heat. With these two nondimensional numbers and an initial shear stress acting on the fault plane, many aspects of the dynamic earthquake rupture process can be understood simply. Larger S_u means stronger resistance for fault slip, while larger S'_u makes such effect act more slowly. Therefore, for example, ordinary earthquakes are concluded to have relatively small S_u and S'_u, while slow earthquakes have relatively large S_u and S'_u.

I have also tackled damage (microcrack generation) effect by extending the idea of inelastic pore creation. Introducing a damage tensor into understanding of the dynamic earthquake rupture process is important. A number of researchers in the field of seismology have assumed scalar variables to treat the damage effect. However, the damage has information

about density, orientation, and mode, and the scalar variables are not enough to represent its effect. By introducing the damage tensor, various behaviors around the fault plane, which were outside of the scope of my previous studies, have been understood simply and systematically. In particular, the ratio of the smallest eigenvalue for the damage tensor to the largest one plays an important role to understand damage orientations and diversity observed for secondary faulting behavior. If this ratio is unity, the damage orientation distribution is isotropic. On the other hand, if it takes a value zero, all of the microcracks show the same orientation and strongly anisotropic distribution. Additionally, intermediate cases can also be described by this ratio. Orientations of maximum microcracks in natural faults and secondary faulting behavior (pulverization and branch development) can be understood in terms of the ratio. For example, if the ratio is near unity, damage distribution is almost isotropic and pulverization is expected; on the other hand, if the ratio is near zero, characteristic orientations appear clearly and branch development will be observed.

3. Five Important Papers in your career

1. Suzuki, T. and T. Yamashita (2010), Nondimensional control parameters governing the behavior of one-dimensional fault slip: Effects of shear heating, inelastic pore creation, and fluid flow, *J. Geophys. Res.*, *115*, B02303, doi:10.1029/2009JB006557

Two nondimensional parameters associated with an interaction among heat, fluid pressure and inelastic pore creation are derived and system behavior is understood in terms of the parameters. Studies of such interaction have been unified by this study.

2. Suzuki, T. and T. Yamashita (2009), Dynamic modeling of slow earthquakes based on thermoporoelastic effects and inelastic generation of pores, *J. Geophys. Res.*, *114*, B00A04, doi:10.1029/2008JB006042

An idea that fluid is related to slow earthquakes has been firstly proofed quantitatively by this study.

3. Suzuki, T. and T. Yamashita (2008), Nonlinear effects of temperature, fluid pressure, and inelastic porosity on dynamic fault slip and fault tip propagation: Emergence of slip strengthening and pulse-like fault slip, *J. Geophys. Res.*, *113*, B07304, doi:10.1029/2008JB005581

The model with a nondimensional parameter derived for a 1-D problem is expanded for a 2-D problem and it succeeded in explaining many aspects of dynamic fault slip such as pulse like slip.

4. Suzuki, T. and T. Yamashita (2007), Understanding of slip-weakening and -strengthening in a single framework of modeling and its seismological implications, *Geophys. Res. Lett.*, *34*, L13303, doi:10.1029/2007GL030260

A nondimensional parameter about an interaction among heat, fluid pressure and inelastic pore creation is derived with an assumption of negligible fluid flow. It succeeded in explaining slip-strengthening and –weakening in a unified way.

5. Suzuki, T. and T. Yamashita (2006), Nonlinear thermoporoelastic effects on dynamic earthquake rupture, *J. Geophys. Res.*, *111(B3)*, B03307, doi:10.1029/2005JB003810

An interaction between heat and fluid pressure is shown to produce a characteristic length scale, which concludes that comparison between laboratory experimental results and observations of natural fault zone is difficult.

4. Awards and Honors throughout your career

5. Future Research Plan

1. The damage tensor model should be extended to represent “real” pulverization and branch development. The unified understanding from nucleation of earthquake fault slip to secondary faulting in terms of the damage is the main theme here. As mentioned in Major achievements, I have understood pulverization and branch development in terms of difference in a parameter by assuming a damage tensor. However, since the system has been assumed to be isotropic and homogeneous, such behaviors are not actual ones, but only their “tendency” has been shown. In future works, I should reproduce such behaviors in numerical calculations. If the branch development occurs, for example, stress drop will be given on the new branch fault plane. It is important here that we need no assumption about pulverization and/or branch development a priori.

Combining the model obtained here with previous studies with assumed pulverization and assumed branch is required. In particular, spontaneous cessation of rupture-tip growth and rupture velocity reduction should be treated. In addition to these studies, seismic wave radiation change due to pulverization and/or branch development should also be investigated for preventing disasters.

2. Earthquake cycle is also an important topic. Many researchers have considered that a time interval between two consecutive dynamic earthquakes is determined by a time scale in which accumulated strain approaches to fault strength. However, such simple model cannot explain diversity for earthquake cycle. In addition, rocks constructing crust are not complete elastic material. An interaction among heat, fluid pressure and inelastic pore creation, which has been investigated in Suzuki and Yamashita (2007-2010) in detail for a single event as mentioned in achievements, can overcome these problems. I will apply this interaction to the interval between dynamic earthquake slips to clarify a mechanism determining dynamic earthquake moments and interval duration.

The topic mentioned here is also important from mathematical and/or physical viewpoints. In particular, comparison with reaction-diffusion system (RDS) should be done. Though many researchers have investigated such a system and the model with the interaction among heat, fluid pressure and inelastic pore creation has the same governing equation system as RDS, enough comparison with RDS has not been performed from a seismological viewpoint. In addition, since the RDS including qualitatively different behaviors like earthquakes (dynamic) and interval between them (quasi-static) has not been treated in spite of its necessity, expected outcomes will have not only seismological, but also physical significance.

6. Funding Received

(1) JSPS Grants

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Yamashita, T. and T. Suzuki (2011), Dynamic modeling of slow slip coupled with tremor, *J. Geophys. Res.*, *116*, B05301, doi:10.1029/2010JB008136
2. Suzuki, T. and T. Yamashita (2010), Nondimensional control parameters governing the behavior of one-dimensional fault slip: Effects of shear heating, inelastic pore creation, and fluid flow, *J. Geophys. Res.*, *115*, B02303, doi:10.1029/2009JB006557
3. Suzuki, T. and T. Yamashita (2009), Dynamic modeling of slow earthquakes based on thermoporoelastic effects and inelastic generation of pores, *J. Geophys. Res.*, *114*, B00A04, doi:10.1029/2008JB006042
4. Yamashita, T. and T. Suzuki (2009), Quasi-static fault slip on an interface between poroelastic media with different hydraulic diffusivity: A generation mechanism of afterslip, *J. Geophys. Res.*, *114*, B03405, doi:10.1029/2008JB005930
5. Suzuki, T. and T. Yamashita (2008), Nonlinear effects of temperature, fluid pressure, and inelastic porosity on dynamic fault slip and fault tip propagation: Emergence of slip strengthening and pulse-like fault slip, *J. Geophys. Res.*, *113*, B07304, doi:10.1029/2008JB005581
6. Suzuki, T. and T. Yamashita (2007), Understanding of slip-weakening and -strengthening in a single framework of modeling and its seismological implications, *Geophys. Res. Lett.*, *34*, L13303, doi:10.1029/2007GL030260
7. Suzuki, T. and T. Yamashita (2006), Nonlinear thermoporoelastic effects on dynamic earthquake rupture, *J. Geophys. Res.*, *111(B3)*, B03307, doi:10.1029/2005JB003810

(2) Selected Conference Proceedings

1. Suzuki, T. (2010), Effect of Off-fault Damage Evolution on Dynamic Earthquake Slip Behavior in Terms of Energy Change, *Proceedings of 7th ACES International Workshop*, pp. 26
2. Suzuki, T. and T. Yamashita (2009), Nondimensional Control Parameters Governing Dynamic Fault Slip Behavior, *Proceedings of French-Japanese Workshop on Earthquake Source*, pp. 59
3. Suzuki, T. and T. Yamashita (2007), Diversity of dynamic earthquake slip controlled by a single nondimensional parameter, *Proceedings of the Workshop on Numerical Modeling of Earthquake Source Dynamics*, Faculty of Mathematics, Physics and Informatics Comenius University and Geophysical Institute Slovak Academy of Sciences, pp. 46

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Suzuki, T. (2011), Modes of Microcracks Generated by Dynamic Fault Tip Growth and their Implication for the Secondary Faulting, *2011 AGU Fall Meeting*, 5-9 December, San Francisco, USA
2. Suzuki, T. (2011), Understanding of dynamic Fault Slip behavior in Terms of Damage and

Energy Release Tensors, *8th Annual Meeting of AOGS,* 8-12 August, Taipei, Taiwan

Total: 13

(2) Domestic Conferences

3. Suzuki, T. (2011), Constructing a dynamic framework of earthquake rupture process in terms of inelastic effect, JpGU Meeting 2011, 20-25 May, Chiba (invited)
4. Suzuki, T. and T. Yamashita (2008), The single nondimensional parameter controlling the dynamic fault slip behavior, JpGU Meeting 2008, 25-30 May, Chiba (invited)

Total: 14

III. Educational Activity (2002-2011)

9. Notable achievements in education

- I have supervised so far 17 M.Sc. students and 8 Ph.D. students; 11 graduates out of them are now engaged in scientific pursuit at universities and government/private research institutions. My first graduate student, Yoshihiro Niwa (now an Associate Professor of the University of Tokyo Ocean Alliance), in particular, was awarded the Okada Prize of the Oceanographic Society of Japan for 2004.
- My undergraduate course lecture "Physical Oceanography" is constantly highly rated by attending students.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

- Newspaper article (page 11, 11/29/2009, The Nikkei) (Though only the name of Prof. Yamashita was in the article, the content is a result of joint study between him and me.)

12. Internal and External Committee Memberships (2006-2011)

- Attendance and discussion at Management and Research Promotion Committee for MEXT project "Seismic Linkage Around the Nankai Trough" (on behalf of Associate Prof. Kato) (10/14/2009)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending
    Japanese Students: 0
    Japanese Researchers: 0
Visitors from Abroad: 0

Geosphere and Biosphere Science Group

Tetsuro Urabe

I. C.V.

Name： Tetsuro Urabe
Present Position: Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Geology/Mineralogy, The University of Tokyo, June, 1971
M. Sc., Geology, The University of Tokyo, March, 1973
Ph. D., Geology, The University of Tokyo, March, 1976

Professional Experience
April, 1976-Mar., 1985, Assistant Professor, Department of Geology, The University of Tokyo, Japan
April, 1979-Mar., 1981, Visiting Researcher, Department of Geology, University of Toronto, Canada
April, 1985-Mar., 1992, Senior Research Geologist, Geological Survey of Japan (GSJ)
April, 1992-Mar., 1996, Chief, Experimental Mineralogy Section, GSJ
April, 1996-Jun., 2000, Chief Geologist, Geological Survey of Japan (GSJ)
July, 2000-, Professor, Graduate School of Science, The University of Tokyo, Japan
April, 2006-Mar., 2007, Chair, Department of Earth and Planetary Science, The University of Tokyo
Apr., 2007- , Honorary Professor, The University of Air, Chiba
Apr., 2008- , Vice Executive Director, Ocean Alliance, The University of Tokyo
Aug., 2011- , Member, Commission on the Limits of the Continental Shelf (CLCS), UNCLOS
Aug., 2011- , Counselor, Ministry of Foreign Affairs, Japan

II. Scientific Research Activity

2. Major achievements

I’ve been the principal investigator for several sea-going projects; namely, Japan-France STARMER Project during 1987-1992, Japan-US Ridge Flux Project during 1993-1998, and Archean Park Project during 2000-2005, all funded by “Special Coordination Fund for Promoting Science and Technology”. On the basis of the results of these projects, I’m currently leading TAIGA Project (2008 - 2012) that stands for both “big river” and "Trans-crustal Advection and In-situ biogeochemical processes of Global sub-seafloor Aquifer". The project (total fund=14million US$) is funded by Grants-in-Aid for Scientific Research on Innovative Areas, MEXT.

The members of these projects played significant roles to the research on seafloor hydrothermal activity as the duration of these projects coincides with the period of emerging and maturing stages of the research field in Japan and the world. Besides, the discovery of hydrothermally active sites around Japan promoted the social movements for the excavation of these mineral resources in future.

The basic hypothesis of the TAIGA Project is that four different types of “sub-seafloor rivers” that carry four different inorganic substances such as sulfur, methane (carbon), hydrogen, and iron (Fe(II)) support individual deep biosphere beneath the seafloor. The results (Takai &

Nakamura, 2010, 2011; Nakamura et al., 2010; Kawagucci et al. 2010) revealed that the prediction made by McCollom and Shock (1997) who estimated the available chemical energy based on thermodynamic calculation is valid and there is intimate relationship among the nature of the aquifer systems, chemistry of hydrothermal fluids and chemosynthetic microbial communities.

The application of age determination techniques such as U-Th series disequilibrium radioactive decay and Electron Spin Resonance (ESR) methods to several hydrothermal areas makes it possible to correlate the age of hydrothermal activity and the age of migration of mega-faunas that is measured by molecular-biological methods.

Finally, as was described in "Declaration On Science and the Use of Scientific Knowledge" (ICSU Meeting in Budapest, 1999), all the scientists should be aware of their responsibility for the formation of sustainable society. I've been involved in establishing a trans-disciplinary group (currently 250 members) on ocean study; Ocean Alliance (OA) in the University of Tokyo. As a member of the "epistemic community" on ocean, I advised the formation of new Mining Act for the exploration and development for seafloor resources with colleagues from the OA. Furthermore, as a member of "Commission on the Limit of Continental Shelf" (CLCS), I use my geological science and scientific knowledge to evaluate and recommend the limit of continental shelf of coastal states.

3. Five Important Papers in your career

1. Kawada, Y., N.Seama and T.Urabe (2011) The role of seamounts in the transport of heat and fluids: Relations among seamount size, circulation patterns, and crustal heat flow, Earth. Planet. Sci. Lett.306,55-65.（citation 2）

It is widely believed that the fluid circulation does no be sustained if the host oceanic crust is older than 65Ma. However, seamount, if existed, plays an important role to transfer heat and material to/from the old oceanic crust.

2. Higashi Y, Sunamura M, Kitamura K, Nakamura K, Kurusu Y, Ishibashi J, Urabe T, Maruyama A (2004) Microbial diversity in hydrothermal surface to subsurface environments of Suiyo Seamount, Izu-Bonin Arc, using a catheter-type in situ growth chamber, FEMS Microbiol. Ecol., 47 (3): 327-336 （citation 26）

This paper first discovered the vertical zonation of chemosynthetic microbial communities (mainly Archaea) using in-situ incubator system which is inserted to man-made and natural black smokers.

3. Urabe, T., E. T. Baker, J. Ishibashi, R. A. Feely, K. Marumo, G. J. Massoth, A. Maruyama, K. Shitashima, K. Okamura, J. E. Lupton, A. Sonoda, T. Yamazaki, M. Aoki, J. Gendron, R. Greene, Y. Kaiho, K. Kisimoto, G. Lebon, T. Matsumoto, (1995), The Effect of Magmatic Activity on Hydrothermal Venting Along the Superfast-Spreading East Pacific Rise, Science, 269, 1092-1095. （citation 56）

This paper describes the results of 500km-long survey over superfast-spreading southern East Pacific Rise on the frequency of hydrothermal activity. The results indicate the chemical flux of the hydrothermal activity is proportional to the spreading rate.

4. Urabe, T. and Kusakabe, M. (1990) Barite silica chimneys from the Sumisu Rift, Izu-Bonin arc. Earth. Planet. Sci. Lett., 100, 283-290. （citation 43）

This paper describes various types of hydrothermal products along the Izu-Bonin arc system

and new setting for hydrothermal activity.

5. Urabe, T. (1985) Aluminous granite as a source magma of hydrothermal ore deposits: an experimental study. Economic Geology, 80, 148-157. （citation 68）

This high temperature - high pressure experiment indicates that the partition of base metals between granitic melt (magma) and coexisting hydrothermal fluid (magmatic fluid) have high value when the ratio alkali/alumina in magma is less than 1. The results can be used for exploration of base metal resources.

4. Awards and Honors throughout your career

· Jan., 1986 Society of Resource Geology Award on paper entitled “Magmatic hydrothermal system and formation of copper-lead-zinc deposits”.

· July, 1994 100 Researchers in Japan by Agency of Industrial Science and Technology, Japan

· March, 2008 Resource Geology Journal Best Article Award: (Marumo, K., T.Urabe, A.Goto, Y.Takano, and M.Nakaseama (2008) Mineralogy and isotope geochemistry of active submarine hydrothermal field at Suiyo seamount, Izu-Bonin Arc, West Pacific Ocean, Resource Geol., 58, 220-248.)

5. Future Research Plan

I’m going to retire at the end of March 2013 and not suitable to explain my research which will be done in this Department in future. However, I’m applying a Grant-in-Aid program to publish the results of TAIGA project in 2013.

6. Funding Received

(1) JSPS Grants

· TAIGA Project (2008 - 2012) "Trans-crustal Advection and In-situ biogeochemical processes of Global sub-seafloor Aquifer". Grants-in-Aid for Scientific Research on Innovative Areas (total fund=14million US$)

· Japan-New Zealand Bilateral Cooperation, Grants-in-Aid for Scientific Research, (30,000 US$)

(2) Cooperative Research

· There is an extensive research cooperation under the framework of the TAIGA project. These institutions include; Atmospheric and Ocean Research Institute, University of Tokyo, Earthquake Research Institute, University of Tokyo, JAMSTEC, Okayama University, Osaka City University, Kyushu University, Tokyo University of Pharmaceutical and Life Science University, Yokohama National University, Kobe University, National Polar Research Institute, Senshu University, Okayama Science University, Hokkaido University, Hiroshima University, and others.

(3) Research Contracts

(4) Grants and Gifts

· I’ve been receiving as Vice Executive Director of UT Ocean Alliance, from Nippon Foundation in two separate funds for collaborative ocean research and ocean education 3.2 million US$ in total per year.

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Nitahara,S, S.Kato, T.Urabe, A.Usui, and A.Yamagishi (2011) Molecular characterization of the microbial community in hydrogenetic ferromanganese crusts of the Takuyo-Daigo Seamount, northwest Pacific, FEMS Microbiol. Lett.,V.321,121–129, DOI: 10.1111/j.1574-6968.2011.02323.x

2. Mori,K, K. Suzuki, T. Urabe,, M. Sugihara, K. Tanaka, M. Hamada and S.Hanada (2011) Thioprofundum hispidum sp. nov., an obligately chemolithoautotrophic sulfur-oxidizing gammaproteobacterium isolated from the hydrothermal field on Suiyo Seamount, and proposal of Thioalkalispiraceae fam. nov. in the order Chromatiales, Intern. Jour.Syst Evol. Microbiol. (2011), 61, 2412–2418 DOI 10.1099/ijs.0.026963-0

3. Kawada, Y., N.Seama and T.Urabe (2011) The role of seamounts in the transport of heat and fluids: Relations among seamount size, circulation patterns, and crustal heat flow, Earth. Planet. Sci. Lett.306,55-65.

4. Yanagawa, K., M. Sunamura, M.A. Lever, Y. Morono, A. Hiruta, O. Ishizaki, R. Matsumoto, T. Urabe, and F. Inagaki (2011) Niche Separation of Methanotrophic Archaea (ANME-1 and -2) in Methane-Seep Sediments of the Eastern Japan Sea Offshore Joetsu, Geomicrobiology Journal, 28: 2, 118-129 (DOI: 10.1080/01490451003709334).

5. Nishizawa, M., S.Maruyama, T.Urabe, N.Takahata and Y.Sano (2010) Micro-scale (1.5mm) sulphur isotope analysis of contemporary and early Archean pyrite, Rapid Commun. Mass Spectrom. ; 24: 1397–1404, DOI: 10.1002/rcm.4517

6. Urabe, T., Okino,K., Sunamura,M., Ishibashi,J., Takai,K.,& Suzuki,K. (2009) Trans-crustal advections and in-situ biogeochemical processes of global seafloor aquifer; the sub-seafloor TAIGA, Jour. Geography, 118(6), 1027-1036 (In Japanese with English abstract).

7. Mori, K.,Yamaguchi, K.,Sakiyama, Y., Urabe, T., and Suzuki, K. (2009) Caldisericum exile gen. nov., sp nov., an anaerobic, thermophilic, filamentous bacterium of a novel bacterial phylum, Caldiserica phyl. nov., originally called the candidate phylum OP5, and description of Caldisericaceae fam. nov., Caldisericales ord. nov and Caldisericia classis nov., Internat. Jour. Syst. Evol. Microbiol., 59, 2894-2898.

8. Kato,S.,K.Yanagawa, M.Sunamura, Y.Takano, J.Ishibashi, T.Kakegawa, M.Utsumi, T.Yamanaka, T.Toki, T.Noguchi, K.Kobayashi, A.Moroi, H.Kimura, Y.Kawarabayasi, K.Marumo,T.Urabe and A.Yamagishi (2009) Abundance of *Zetaproteobacteria* within crustal fluids in back-arc hydrothermal fields of the Southern Mariana Trough, Environmental Microbiol., 11, 3210-3222. doi: 10.1111/j.1462- 2920.2009.02031.x

9. Kato, S., Hara, K., Kasai, H., Teramura, T., Sunamura, M., Ishibashi, J., Kakegawa, T., Yamanaka, T., Kimura, H., Marumo, K., Urabe, T., and Yamagishi, A. (2009a) Spatial distribution, diversity and composition of bacterial communities in sub-seafloor fluids at a deep-sea hydrothermal field of the Suiyo Seamount, Deep-Sea Res., Pt.I , 56(10), 1844-1855.

10. Yanagawa, K., Sunamura, M., Morono, Y., Futagami, T., de Beer, D., Urabe, T., Boetius, A., Inagaki, F. (2009) Distribution of metabolically active microbial communities in CO2-rich marine sediments, Geochim. Cosmochim. Acta, 73, A1472-A1472 (Abstr.)

11. Ishihara, S., Urabe,T., Vo Tien Dung(2009)Indium contents in zinc ores in northern Vietnam, Shigen Chishitu, **59**(1), 73～81 (In Japanese with English Abstract)

12. Mori,K, M. Sunamura, K. Yanagawa, J. Ishibashi, Y. Miyoshi, T. Iino, K. Suzuki, and T.Urabe (2008)First cultivation and ecological investigation of a bacterium affiliated with the candidate phylum OP5 from hot springs, Applied and Environmental Microbiology,74. 6223-6229.
13. Marumo, K., T.Urabe, A.Goto, Y.Takano, and M.Nakaseama (2008) Mineralogy and isotope geochemistry of active submarine hydrothermal field at Suiyo seamount, Izu-Bonin Arc, West Pacific Ocean, Resource Geol., 58, 220-248 (Best Article Award).
14. Urabe,T., H.Chiba, and Y.Kato (2008) IMA Kobe 2006 Special Issue: Seafloor hydrothermal deposits of arc-backarc systems in western Pacific, Resource Geol., 58, 205 (Preface).
15. Mori, K., A. Maruyama, T. Urabe, K.Suzuki, and S. Hanada (2008) *Archaeoglobus infectus* sp.nov.a novel thermophilic, chemolithoautotrophic archaeon isolated from a deep-sea rock collected at Suiyo Seamount, Izu-Bonin Arc, western Pacific Ocean, Int. J. Syst. Evol. Microbiol., 58, 810-816.,
16. Ishihara,S., T. Urabe, Y. Watanabe (2008)Non-ferrous mineral resources in Vietnam, Shigen Chishitu, 58(1), 27-36. (In Japanese with English Abstract)
17. Urabe, T. (2007)Seafloor volcanic eruption and hydrothermal activity, Kagaku (Science), 77(12),1297-1299 (In Japanese)
18. Tanaka, A., S. Rosat, K. Kisimoto, and T. Urabe (2007), High-resolution bathymetry using Alvin scanning sonar at the Southern East Pacific Rise and its implication to the formation of collapsed lava lakes, Earth Planets and Space, 59, 245-249.
19. Ishibashi, J., K.Marumo, A.Maruyama, and T. Urabe(2007) Direct access to the sub-vent biosphere by shallow drilling, Oceanography, 20,(1), 24-25.
20. Kinoshita M, Kawada Y, Tanaka A, Urabe T(2006) Recharge/discharge interface of a secondary hydrothermal circulation in the Suiyo Seamount of the Izu-Bonin arc, identified by submersible-operated heat flow measurements, Earth. Planet.Sci. Lett., 245, 498-508.
21. Takano, Y., K. Kobayashi, Y. Edazawa, T. Urabe, and K. Marumo (2006), Sub-vent biosphere: Phosphatase activities in 308 deep-sea hydrothermal systems at Suiyo Seamount, Izu-Bonin Arc, Western Pacific Ocean, Origins of Life and Evolution of the Biosphere, 36, 316-318.

(2) Selected Conference Proceedings

1. Urabe, T. (2011) Big rivers (TAIGA) beneath the seafloor - What did we learn from Project TAIGA on sub-seafloor aquifer and biosphere?, Conference Proc. 111-141, KOFST, Korea, 282pp. 2011 Dasan Conference “Restless Earth and Life on the Edge”

(3) Review Papers

I wrote seven review papers in Japanese during the period.

(4) Books

1. Matsumoto, R., Urabe, T., & Tajika, E. (2007)”Evolution of Planet Earth” University of the Air, 254pp. (In Japanese)
2. Behrmann, J.H., Yang, J. & CoZone Working Group (2007) Convergent Plate Boundaries and Collision Zones. In: Harms, U., Koeberl, C. & Zoback, M.D. (eds.): Continental Scientific Drilling; a decade of progress and challenges for the future. Springer, Heidelberg, pp. 289-334.
3. Editing :R.H. Sillitoe (2010) “Exploration and Discovery of Base- and Precious-Metal

Deposits in the Circum-Pacific Region - A 2010 Perspective" Volume editor. by T.Urabe, Resource Geology Special Issue No. 22, 139p., 2010 (March, 2011)

and three other publications in Japanese.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Urabe, T., Anhydrite zone as an indicator of hydrothermal reservoir beneath Kuroko-type deposits as observed at Suiyo Seamount, Izu-Bonin Arc, Western Pacific, 33th Intern. Geol. Congress, (Oslo , 2008/8)
2. Urabe, T. , Hydrothermal activity on Arc Volcanism observed at Suiyo Seamount, Izu-Bonin Arc, Western Pacific, (Tongji University, China, 2009.10) (invited)
3. Urabe, T., "An overview of seafloor massive sulfide deposits in island-arc setting; their origin, exploration and development" Symposium of Korean Society of Economic & Environmental Geology, （Daegu, Korea; 2010/4）(invited)
4. Urabe, T., "Is mining of Seafloor Massive Sulfide deposits economically feasible?"(KORDI symposium, Korea) (2010.4.30) (invited)
5. Urabe, T., "Various styles of hydrothermal mineralization in Izu-Bonin-Mariana arc and Okinawa Trough, Japan-New Zealand Symposium on Seafloor Mineral Resources, Tokyo (201.11)
6. Urabe, T. (2011) Big rivers (TAIGA) beneath the seafloor - What did we learn from Project TAIGA on sub-seafloor aquifer and biosphere?, 2011 Dasan Conference "Restless Earth and Life on the Edge" (invited)

(2) Domestic Conferences

9 inviged talks in Japanese

III. Educational Activity (2002-2011)

9. Notable achievements in education

· I supervised 2-3 undergraduate students, 2-3 graduate students (Master's degree) annually, and 3 doctoral candidates.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Resource Geology journal

(2) Academic Societies

· President, board member, Society of Resource Geology

· Chair, J-DESC continental drilling division

· Section-board member, solid earth, JPGU

· Board member, Japan Ocean Policy Society

(3) International Conferences

· International Mineralogical Association, 19th General Meeting Program Committee, vice chairperson

· Japan-New Zealand Workshop on Seafloor Resource in 2010, organizer

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

[Newspaper articles]

· 2008/1 Seafloor metal resources, NIKKEI

· 2008/2 Seafloor hydrothermal deposits, Nature Digest

· 2008/3 Basic Ocean Act, Sankei NP

· 2008/3 Seafloor hydrothermal deposits, Tokyo NP

· 2008.1.25, Seafloor metal resources, NIKKEI

· 2008.9.21, Seafloor metal resources, NIKKEI

· 2008.4.7, Cradle of life on seafloor, Asahi NP

· 2009.2.2. 10 year plan for seafloor resources, NIKKEI

· 2010.8.15. Book review by T.Urabe, NIKKEI

· 2010.4.13. Seafloor resources Nippon Construction NP

[On TV program]

· 2008.2.19, dream resources, TV Tokyo

· 2008.7.21, World Business Satellite, TV Tokyo

· 2009.8.17, Rare metals, NHK

· 2010.10.18. Seafloor metal resources, News23, TBS

· 2012.1.7. Seafloor metal resources, Science Zero, NHK-E-tele

[Public lecture at school]

· 2008/4, Shizuoka Kita Super Science HighSchool

· 2007/11, Omiya high School

· 2009.6.11, Aoto Elementary School

· 2009.10.28 Toride Daiichi High School

· 2011.9.24 Oizumi Junior High School

· 2012.9.29. Same as above.

12. Internal and External Committee Memberships (2006-2011)

[External Committee]

· Member, Advisory Committee to Prime Minister on the Extension of Continental Shelf of Japan

· Chair, Mining Division, Integrated National Committee on Resource and Energy Policy, MITI

· Chair & Vice Chair, Committee for Effective Use of Seafloor Resources, MEXT

· Member, External Evaluation Committee of JOGMEC

· Member, Deep Sea Exploration Committee, JOGMEC
· Member, Committee for Ocean Policy, MILT
· Project Cooperation Member, Science Council of Japan

[Internal Committee]

· Vice Executive Director, Ocean Alliance, University of Tokyo
· Disciplinary Committee for Faculty Members, University of Tokyo
· Disciplinary Committee for Students, University of Tokyo
· Chair and Vice Chair, Entrance Examination Committee, Graduate School of Science

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting
Foreign Students: 0
Foreign Researchers: 0
Sending
Japanese Students: 10 [Vietnam, USA, Canada, Germany]
Japanese Researchers: 2 [U.S.A.: 1, Canada:1]
Visitors from Abroad: 20

Kazuyoshi Endo

I. C.V.

Name： Kazuyoshi Endo
Present Position: Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Geology, March, 1985, University of Tokyo
M. Sc., Geology, March, 1987, University of Tokyo
Ph. D., Geology, July, 1992, University of Glasgow

Professional Experience
April, 1992-Mar., 1993, Research Fellow, Department of Geology, University of Tokyo
April, 1993-May, 2002, Assistant Professor, Department of Geology, University of Tokyo
June, 2002-Mar., 2010, Associate Professor, Graduate School of Life and Environmental Sciences, Tsukuba University, Japan
April, 2010-, Professor, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

(1) acidic shell proteins and the "calcite-aragonite problem"

Some of the major achievements of Endo lab stemmed from the isolation of acidic shell matrix proteins from living scallop shells. With the attribute of interacting with calcium ions, acidic shell proteins had long been considered important in biomineralization, but no one could isolate and sequence them. In late 1990's Isao Sarashina and I purified and sequenced one such protein for the first time, and named it MSP-1 (molluscan shell protein-1). Based on the amino acid sequence of MSP-1, we could obtain from the pearl oyster *Pinctada fucata* an even more acidic shell matrix protein that we named Aspein. We found that Aspein is theoretically the most acidic protein on earth, containing 60 % aspartic acid residues (Asp), and that it is contained in the calcitic prismatic shell layer, but is not contained in the aragonitic nacreous layer. From *in vitro* crystallization experiments, we demonstrated that Aspein induces calcite precipitation from a solution containing Mg ions, which would otherwise precipitate aragonite. We thus hypothesized that Aspein is the agent that gives the answer to the "calcite-aragonite problem". We are now trying to confirm this by *in vivo* functional analyses. Meanwhile, we found that amino acid sequences of Aspein are very variable among closely related species, and that accumulation of Asp residues, rather than a specific arrangement of them, is required for the function of Aspein. To make a basis for further systematic studies, we participated in the pearl oyster genome project, and recently published a draft genome of *Pinctada fucata*,

(2) mechanisms of shell coiling in gastropods

Most spirals are made by life, and a life-made spiral is always an equiangular spiral. Nautiloid shells are the prominent examples, but in fact all the molluscan shells as well as brachiopod shells are approximated by an equiangular spiral. How this mathematical regularity is achieved has been a mystery. We recently found in the pond snail *Lymnaea stagnalis* that the growth factor Dpp, a protein that controls local proliferation of cells, is asymmetrically expressed in the shell gland, from which the first shell is precipitated. Inspection of the

expression patterns of *dpp* (Dpp gene) in mantle tissues, which produce adult shells, indicated that *dpp* is asymmetrically expressed in the pond snail, but is not expressed at all in the limpet *Patella vulgata*, which produces an uncoiled shell. Treatment of the pond snail embryos with a chemical that inhibit the function of Dpp induced formation of an uncoiled shell, instead of a normal coiled shell. Taken together, we hypothesize that Dpp is, and was, one of the crucial factors controlling the spiral shell growth in gastropods, and in molluscs at large, including the extinct heteromorph ammonites.

3. Five Important Papers in your career

1. Shimizu, K., I. Sarashina, H. Kagi, and K. Endo (2011), Possible functions of Dpp in gastropod shell formation and shell coiling, *Dev. Genes Evol.* 221, 59–68.（ISI citation : 1）

The first experimental demonstration that Dpp controls the spiral shell growth in gastropods

2. Endo, K., Y. Noguchi, R. Ueshima, and H. T. Jacobs (2005), Novel Repetitive Structures, Deviant Protein-encoding Sequences and Unidentified ORFs in the Mitochondrial Genome of the Brachiopod *Lingula anatina*, *J. Mol. Evol.* 61, 36-53.（ISI citation：14）

Characterization of an unorthodox animal mitochondrial genome, showing evidence for recombination in animal mitochondrial DNA

3. Tsukamoto, D., I. Sarashina, and K. Endo (2004), Structure and expression of an unusually acidic matrix protein of pearl oyster shells, *Biochem. Biophys. Res. Comm*., 320, 1175-1180. （ISI citation：85）

Advocated a possible solution to the "calcite-aragonite problem" based on the complete sequence and the expression patterns of the ultra-acidic shell matrix protein Aspein

4. Saito, M., S. Kojima, and Endo, K. (2000), Mitochondrial COI sequences of brachiopods: genetic code shared with protostomes and limits of utility for phylogenetic reconstruction, *Mol. Phyl. Evol*., 15, 331-344. （ISI citation：20）

Demonstrated temporal saturation patterns of nucleotide substitutions in the mitochondrial DNA based on molecular phylogenetic analyses and good fossil record of brachiopods.

5. Sarashina, I., and K. Endo (1998), Primary structure of the soluble matrix protein of scallop shell: Implications for calcium carbonate biomineralization, *Am. Mineral.*, 83, 1510-1515. （ISI citation：62）

The first determination of the amino acid sequence for an acidic shell matrix protein

4. Awards and Honors throughout your career

- Kazuyoshi Endo, Molecular biological and biomineralogical studies of invertebrates, Academic Award, The Palaeontological Society of Japan, 23 June 2006
- Michiko Saito and Kazuyoshi Endo, Molecular phylogenetics and morphological evolution of laqueoid brachiopods, The Best Paper Award, The Palaeontological Society of Japan, 21 June 2002.

5. Future Research Plan

While studying isolation and characterization of genes and proteins responsible for the morphogenesis and shell formation in molluscs and brachiopods, we also currently pursue our

studies on molluscan molecular phylogeny. Through those studies, I aim to establish model animal systems, including pearl oyster (bivalves), pond snail (gastropods), and *Lingula* (brachiopods), to investigate evo-devo aspects of those lophotrochozoans, which have been neglected in animal evolutionary biology. By integrating outcomes of the evolutionary developmental studies of those animals with data from geological and fossil record, I plan to make clear the realities of the "Cambrian explosion".

We demonstrated using antibodies that shell matrix proteins are preserved in Pleistocene fossil materials. We are now trying to sequence the fossil proteins using mass spectrometry. Through these studies, we establish the methods of analyzing amino acid sequences of fossil proteins so as to study genealogical relationships of extinct organisms, direct traces of molecular evolution, as well as processes of molecular taphonomy. Eventually, these technologies shall find applications in archeology and anthropology.

Concerning mechanisms and evolution of biomineralization, I consider that the *in vivo* functional analyses of skeletal matrix proteins are the most important, and will have the largest impact in this field at large. To this end, I plan to pursue systematic gene knock out experiments using the above mentioned model animal systems, for which a genome project is now going on. I also plan to work, involving genome sequencing, on such protists as foraminifers and radiolarians, which have a mineralized skeleton and originated in the Cambrian.

To further develop the above mentioned research plans in a more organized way, and to investigate possible causal relationships with temporal changes of environmental factors, I organized a research group involving a total of about 50 researchers, including biologists, geologists, geochemist, geophysicists, and mathematicians, and started to apply to a big governmental grant from last year. The project is dubbed "paleogenomics". In brief, this project aims at integrating such studies as secular changes of geoenvironments, metallomics, organic geochemistry, and genome biology, so as to make clear the co-evolution processes between Life and Earth. We plan to reconstruct ancient genomes by comparisons of genome data of living organisms as well as by direct sequencing of ancient DNA, and from the biological functions estimated from the reconstructed genomes, we plan investigate the evolutionary processes of life on ancient Earth. Through this project, we plan to study life in the anoxic era, origin of photosynthesis, snowball Earth and the origin of metazoa, Cambrian explosion, and evolution of tetrapods and humans.

6. Funding Received

(1) JSPS Grants

- Grant-in-Aid for challenging Exploratory Research, "Analyses of the primary structure of the fossil proteins using Mass Spectrometry" (principal investigator)(April, 2011 - March, 2014: 3.64 million yen)
- Grant-in-Aid for Scientific Research (B), "Functional analyses of molluscan shell protein genes using transgenic techniques" (principal investigator) (April, 2011 - March, 2016: 49.66 million yen)
- Grant-in-Aid for Scientific Research (A), "Phylogenetic and biomineral studies about egg shell proteins of turtles" (principal investigator) (April, 2008 - March, 2011: 17.81 million yen)
- Grant-in-Aid for Scientific Research (S), **"**Systematic identification of genes involved in molluscan shell formation**"** (principal investigator) (April, 2003 - March, 2007: 106.21 million yen)

· Grant-in-Aid for Scientific Research (A), “Left and Right handed ness in snails: ecological functions and long-term dynamics” (partial charge)(April, 2012 - March, 2018: 9.49 million yen for 2012)

· Grant-in-Aid for Scientific Research (B), “Marine environments of Cold-house Earth and Hot-house Earth: high resolution analysis of responses in life history traits of molluscs” (partial charge)(April, 2011 - March, 2014: 17.68 million yen for 2011 and 2012)

· Grant-in-Aid for Scientific Research (B), “Left and Right handed ness in snails: dynamic equilibria and adaptive evolution” (partial charge)(April, 2008 - March, 2012: 14.43 million yen)

· Grant-in-Aid for Scientific Research (B), “High resolution analysis of life-environment interactions using micro-growth lines in living and fossil shells” (partial charge)(April, 2008 - March, 2011: 18.59 million yen for 2011 and 2012)

· Grant-in-Aid for Scientific Research (B), “Left and Right handed ness in snails: mechanisms of co-occurrence and phylogeny” (partial charge)(April, 2004 - March, 2008: 14.08 million yen)

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Shimizu, K., I. Sarashina, H. Kagi, and K. Endo (2011), Possible functions of Dpp in gastropod shell formation and shell coiling. *Development, Genes and Evolution*, 221, 59–68.

2. Nishizawa, A., I. Sarashina, Y. Tsujimoto, M. Iijima, and K. Endo (2010), Artificial fertilization, early development and chromosome numbers in the brachiopod *Lingula anatina*. Special Papers in *Palaeontology*, 84, 309-316.

3. Ando, H., Y. Kunitomo, I. Sarashina, M. Iijima, K. Endo, and K. Sashida (2009) Intraspecific variations in the ITS region of Recent radiolarians. Earth Evolution Sciences, 3, 37-44.

4. Nishi, M., I. Sarashina, M. Iijima, R. Hirayama, and K. Endo (2009), Phylogenetic position of turtles among reptiles: evidence from immunological comparisons of eggshell matrices. *Earth Evolution Sciences*, 3, 45-51.

5. Sarashina, I., Y. Kunitomo, S. Chiba, M. Iijima, and K. Endo (2008), Preservation of the shell matrix protein Dermatopontin in 1500-year-old land snail fossils from the Bonin islands. *Organic Geochemistry*, 39, 1742-1746.

6. Iijima, M., I. Sarashina, T. Takeuchi, and K. Endo (2008), Expression patterns of engrailed and dpp in the gastropod *Lymnaea stagnalis*. *Development, Genes and Evolution*, 218, 237–251.

7. Takeuchi, T., I. Sarashina, M. Iijima, and K. Endo (2008), In vitro regulation of CaCO3 crystal polymorphism by the highly acidic molluscan shell protein Aspein. *FEBS Letters*, 582, 591-596.

8. Reyment, R. A., K. Endo, and Y. Tsujimoto (2007), A note on heterogeneity in northern

Pacific populations of the brachiopod species *Lingula anatina* Lamarck. Science Report, Earth Evolution Sciences, University of Tsukuba, 1, 33-36.

9. Kunitomo, Y., I. Sarashina, M. Iijima, K. Endo, and K. Sashida (2006), Molecular phylogeny of acantharian and polycystine radiolarians based on ribosomal DNA sequences, and some comparisons with data from the fossil record. *European Journal of Protistology*, 42, 143-153.
10. Iijima, M., N. Akiba, I. Sarashina, S. Kuratani, and K. Endo (2006), Evolution of Hox genes in molluscs: a comparison among seven morphologically diverse classes. *Journal of Molluscan Studies*, 72, 259-266.
11. Suzuki, S., R. E. Kopp, T. Kogure, A. Suga, K. Takai, S. Tsuchida, N. Ozaki, K. Endo, J. Hashimoto, Y. Kato, C. Mizota, T. Hirata, H. Chiba, K. H. Nealson, K. Horikoshi, and J. L. Kirschvink, (2006), Sclerite formation in the hydrothermal-vent "scaly-foot" gastropod—possible control of iron sulfide biomineralization by the animal. *Earth & Planetary Science Letter*, 242, 39-50.
12. Sarashina, I., H. Yamaguchi, T. Haga, M. Iijima, S. Chiba, and K. Endo (2006), Molecular Evolution and Functionally Important Structures of Molluscan Dermatopontin: Implications for the Origins of Molluscan Shell Matrix Proteins. *Journal of Molecular Evolution*, 62, 307-318.
13. Takeuchi, T. and K. Endo (2006), Biphasic and dually coordinated expression of the genes encoding major shell matrix proteins in the pearl oyster *Pinctada fucata*. *Marine Biotechnology*, 8, 52-61.

(2) Selected Conference Proceedings

(3) Review Papers

1. Sarashina, I. and Endo, K. (2006) Skeletal matrix proteins of invertebrate animals: Implication for the origin of metazoan biomineralization. Paleontological Research, 10, 311-336. （refereed）

(4) Books

1. K. Endo and I. Sarashina, Japanese translation of "Life's solution" by Simon Conway Morris, 2010, Kodansha, Tokyo.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Endo, K. Artificial fertilization in *Lingula anatina*: a portal to brachiopod developmental genetics. 6th International Brachiopod Congress, Melbourne, 5 February 2010. (invited talk)
2. Endo, K.: Hypotheses surrounding the calcite-aragonite problem. Gordon Research Conference on Biomineralization, 17 August 2010, Colby-Sawyer College, NH, USA. (invited talk)
3. Endo, K., Multiple origins of animal skeletons and dynamic adaptive evolution documented by molluscan shell matrix proteins. Palaeontological Association Annual Meeting half-day symposium 'Biomineralisation – the Hard Part of Palaeontology', Glasgow, U.K., 19 December 2008. (invited talk)
4. Endo, K. and I. Sarashina: Multiple origins of animal skeletons and dynamic adaptive

evolution documented by molluscan shell matrix proteins. International Symposium "From Genome to Snowball Earth, Metazoan Evolution and Habitable Planets: Multidisciplinary Relations", MIRAIKAN, Odaiba, Tokyo, 29 September -3 October 2008. (invited talk)

5. Shimizu, K., I. Sarashina, T. Kudoh and K. Endo, Molecular mechanisms and evolution of shell coiling in gastropods, 5th Eeast Asian Federation of Ecological Societies International Congress, (Otsu, Shiga, 2012.3).
6. Shimizu, K., I. Sarashina, H. Kagi and K. Endo, Possible functions of Dpp in gastropod shell formation and shell coiling, The 13th European Society for Evolutionary Biology conference (Tubingen, German, 2011.8).
7. Isowa. Y, I. Sarashina and K. Endo, Molecular evolution of the shell matrix protein Aspein in pterioid bivalves,The International Symposium on Pearl Research (Tokyo, Japan, 2011.10).
8. K. Endo, I. Sarashina, S. Chiba, and T. Takao: Phylogeny estimation based on fossil protein sequences: a case of extinct land snails from the bonin islands. International Palaeontological Congress 2 July 2010 London, Royal School of Mines, Imperial College.
9. Yukinobu Isowa, Isao Sarashina and Kazuyoshi Endo, Molecular evolution of the shell matrix protein Aspein in pterioid bivalves, International Symposium on Biodiversity Sciences 2010, (Nagoya, Japan, 2010. 8).
10. Kazuyoshi Endo, Takeshi Takeuchi, Yukinobu Isowa and Isao Sarashina, Structure, function and evolution of shell matrix proteins in the pearl oyster *Pinctada fucata*Marine International Symposium on Marine Genomics. Hotel Kaiho, Naha, Okinawa, 16 December 2009.

(2) Domestic Conferences

11. Kazuyoshi Endo, Perspectives on molecular paleontology, Annual Meeting of the Palaeontological Society of Japan, 30 June 2007. (invited talk)

And 38 other presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

· During the 8 years as an associate professor at Tsukuba University, I was the advisor for 7 BSc, 7 MSc, and 2 PhD students. One of the ex-students who took the PhD is continuing research as a postdoc at Okinawa Institute of Science and Technology. After moving to Tokyo University two years ago, I have one MSc and 6 PhD students. It is notable that three of those were awarded and monopolized the best poster awards at the annual meeting of the Palaeontological Society of Japan in June 2012. One of those three was also awarded the best poster award at the joint Meeting of the 59th Ecological Society of Japan and the 5th East Asian Federation of Ecological Societies International Congress in March 2012, and another of those three was also awarded the best poster award at the Annual Meeting of the Sedimentological Society of Japan in June 2012.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Editor and Vice-Editor, Paleontological Research
· Associate Editor, Iden (Genetics)

(2) Academic Societies

· Councillor, Paleontological Society of Japan
· Member of Standing Committee, Paleontological Society of Japan
· Councillor, Society of Evolutionary Studies, Japan
· Delegate, Japan Geoscience Union
· Science Board Member, Japan Geoscience Union

(3) International Conferences

· International Paleontological Cogress 5

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Press release: Feb.2012 Deciphered the pearl oyster genome, Cooperation with companies: 2011- Collaboration on pearly oyster genomes with Mikimoto
· Public talks: 9 November 2009 “Genes that form shells.” Suginami Science Museum.
· Public talks: Jan.2007 “Cambrian Explosion” Kyoto Forum.

12. Internal and External Committee Memberships (2006-2011)

· Member, IPA committee under IUGS committee of Earth and Planetary Science Committee, Science Council of Japan
· Peer Review Committee Member, Grant-in-Aid for Scientific Research , JSPS (genome biology)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting
Foreign Students: 1 [M.Sc.: 0, Ph.D.: 1 (China: 1)]
Foreign Researchers: 4 [Sweden: 1, Germany: 1, China: 1, Indonesia: 1]
Sending
Japanese Students: 2 [M.Sc.: 0, Ph.D.: 2]
Japanese Researchers: 1 [U.S.A.: 1]
Visitors from Abroad: 2 [U.S.A.: 1, South Africa: 1]

Takashi Murakami

I. C.V.

Name： Takashi Murakami
Present Position: Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Geology, The University of Tokyo, March, 1975
M. Sc., Mineralogy, The University of Tokyo, March, 1977
Ph.D., Mineralogy, The University of Tokyo, March, 1980

Professional Experience
April,1981-July, 1985, Research Associate, Japan Atomic Energy Research Institute
July, 1985-July, 1987, Post-Doctoral Fellow, Department of Geology, The University of New Mexico
July, 1987-Mar., 1989, Research Associate, Japan Atomic Energy Research Institute
April, 1989-Mar., 1990, Visiting Scientist, Australian Nuclear Science and Technology Organisation
April, 1990-Mar., 1993, Senior Research Associate, Japan Atomic Energy Research Institute
April, 1993-Mar., 1995, Associate Professor, Department of Earth Science, Ehime University
April, 1995-June, 1999, Associate Professor, Graduate School of Science, The University of Tokyo,
June, 1999-, Professor, Graduate School of Science, The University of Tokyo

II. Scientific Research Activity

2. Major achievements

The analysis of mineral-water-atmosphere interactions have allowed us to work on the evolution of atmosphere, especially oxygen evolution, in the Neoarchean and the Paleoproterozoic. Our research was achieved through laboratory experiments, paleosols (ancient weathering profiles) and geochemical modeling.

2-1. Processes and kinetics of mineral dissolution under different O_2 conditions. Under modern atmosphere, Fe(II) dissolved from primary minerals is instantaneously oxidized to Fe(III) that precipitates as Fe(III) oxides, and does not flow out of the system. On the other hand, at 10^{-5} atm of partial pressure of atmospheric oxygen (pO_2), dissolved Fe(II) is not oxidized; portion of the dissolved Fe(II) forms Mg- and Fe(II)-bearing smectite and other portion flows out of the system. The pO_2 levels have been found to have no effects on mineral dissolution rates.

2-2. Weathering processes under low O_2 conditions in the field. We found Fe(II)-rich smectite, formed by anoxic, modern weathering, in a drill core of granite at 400 m deep. This suggests that the Neoarchean and the Paleoproterozoic weathering could have had similar formation processes, as also expected by the above experiments. Biotite layers inserted in chlorite layers in a 2.5 Ga paleosol formed under anoxic atmosphere have revealed that part of primary chlorite was altered to Fe(II)-bearing smectite during weathering, and then, the smectite to biotite by hydrothermal fluids containing K.

2-3. The effects of pO_2 level on Fe(II) oxidation rate. The Fe(II) oxidation rate under O_2

conditions has been determined: the rate is faster at < 10^{-3} atm of pO_2 than that expected by the famous, classic rate law by Stumm and Lee. The mechanisms of the new rate law has been proposed.

2-4. Chemical compositions of paleosols and atmospheric oxygen levels. We have found that a value of parameter f (a ratio of Fe(III) precipitated to Fe(II) dissolved from minerals) can be obtained from the chemical compositions of paleosols; we can apply the Fe(II) oxidation rate to paleosols and estimate pO_2 levels if we have values of parameter f. The application has indicated that pO_2 increased gradually, linearly on the logarithmic scale, from < ~ 10^{-6} to > ~ 10^{-3} atm between 2.5 and 2.0 Ga.

2-5. Fe redistribution by mineral dissolution in an open system and under different O_2 conditions and its modeling. The experiments simulate Fe redistribution during natural weathering under low O_2 conditions. We have found that the f value is quantitatively related to the oxidation state of the dissolution system and that the f - pO_2 relationships can be applied to paleosols.

2-6. The evolution of atmospheric oxygen revealed by weathering model. The weathering model considering mineral dissolution rate, Fe(II) oxidation rate and water flow rate has clarified the f - pO_2 relationships. The model was applied to the f values of paleosols, suggesting the long-term increase pattern of atmospheric oxygen similar to that discussed above.

3. Five Important Papers in your career

1. Murakami, T., B. Sreenivas, S. Das Sharma, H. Sugimori (2011), Quantification of atmospheric oxygen levels during the Paleoproterozoic using paleosol compositions and iron oxidation kinetics, Geochim. Cosmochim. Acta, 75, 3982-4004.

Long-term, quantitative increase-pattern of atmospheric oxygen in the Paleoproterozoic has been firstly proposed by applying Fe(II) oxidation kinetics to mineral-water-atmosphere interactions.

2. Murakami, T., S. Utsunomiya, Y. Imazu, N. Prasad (2001), Direct evidence of late Archean to early Proterozoic anoxic atmosphere from a product of 2.5 Ga old weathering, Earth Planet Sci. Lett, 184, 523-528.

The finding of Ce^{3+}-phosphate in a 2.5 Ga paleosol, suggesting anoxic atmosphere. The article was introduced in the Editor's Choice of Science.

3. Finch, R., T. Murakami (1999), Systematics and paragenesis of uranium minerals, Rev. Miner, 38, 91-179.

Comprehensive reviews on uranium minerals. Cited more than 200.

4. Murakami, T., T. Ohnuki, H. Isobe, T. Sato (1997), Mobility of uranium during weathering, Am. Miner, 82, 888-899.

Nano-mineralization may control element transport in a long term even when water is undersaturated with respect to the mineral. The concept of post adsorption has been firstly introduced. Cited more than 100.

5. Murakami, T., B. C. Chakoumakos, R. C. Ewing, G. R. Lumpkin, W. J. Weber (1991), Alpha-decay event damage in zircon, Am. Miner, 76, 1510-1532.

The processes and mechanisms of metamictization is comprehensively described. The model used is explained in the mineralogy textbook that is most frequently used in the world. Cited

more than 200.

4. Awards and Honors throughout your career

- Takashi Murakami, Fellow, the Mineralogical Society of America, Nov., 2002
- Takashi Murakami, the Japan Association of Mineralogical Sciences Award, the Japan Association of Mineralogical Sciences, Sept., 2004
- Takashi Murakami, the Clay Science Society Award, the Clay Science Society of Japan, Aug., 2005

5. Future Research Plan

We will continue to work on the evolution of atmospheric oxygen and carbon dioxide in the Neoarchean and the Paleoproterozoic through the analysis of mineral-water-atmosphere interactions. We will start a new project, the effects of nano-minerals on element transport at the Earth surface.

5-1. The evolution of atmospheric carbon dioxide revealed by the chemical compositions of paleosols. In spite of the weaker luminosity in the early Earth than the modern, the climate was usually moderate (faint young Sun paradox, Kasting, 1987) because of atmospheric CO_2. The pCO_2 levels in the early Earth are still in debate: >100 PAL at 2.8−2.0 Ga (Kasting, 1987; Haqq-Misra et al., 2008) or <100 PAL at 2.7−1.8 Ga (Rye et al., 1995; Sheldon, 2006). We will obtain the cation concentrations of porewaters during weathering from the chemical compositions of paleosols and estimate pCO_2 levels at the time of weathering. The formation age of the Cooper Lake and Pronto paleosols is similar to that of the beginning of the Huronian glaciation, and we can estimate the pCO_2 level at the beginning of the glaciation.

5-2. The evolution of atmospheric oxygen estimated by changes in the concentrations of trace elements with age. The concentrations of trace elements (Cr, Co, Ni, Cu, Zn, W, V, Mo, Cd) supplied from the continents to the oceans are closely related to pO_2 levels (Anbar, 2006). The increase in Mo and Cr in the oceans in the Neoarchean and the Paleoproterozoic is attributed to the increase in pO_2 (Kendall et al., 2010; Konhauser et al., 2011). We will analyze the trace element concentrations of paleosols and oceanic sediments, and examine how the trace element concentrations are related between the paleosols and oceanic sediments and to the evolution of atmospheric oxygen. Because most of the above trace elements are contained in pyrite, we will dissolve pyrite as a function of pO_2 in a glove box, which can tell us how the trace elements are redistributed during pyrite dissolution and whether or not the continental weathering explains the redistribution between continent and ocean.

5-3. The evolution of atmospheric oxygen estimated by light rare earth elements (LREEs). Ce precipitates as Ce(IV) oxide and the other LREEs as phosphates during oxic weathering (Braun et al., 1990) while all LREEs precipitate as phosphates during anoxic weathering (Murakami et al., 2001). This is because Ce is not oxidized to Ce(IV) under low O_2 conditions. We will analyze Ce in phosphates of paleosols formed at 2.8-1.8 Ga and estimate the evolution of atmospheric O_2.

5-4. The effects of nano-minerals on element transport at the Earth surface. Nano-minerals, formed by mineral-water-atmosphere interactions, is ubiquitous at the Earth surface, has high ability of metal adsorption, and is generally meta-stable. Ferrihydrite, most abundant nano-mineral, is transformed to stable hematite and goethite in a few years to a few tens of years in natural systems. Ferrihydrite facilitates metal transport as colloid (Novikov et al., 2006)

or retards it by transformation which, at the same time, precipitates adsorbed metal (post-adsorption phenomena, Murakami et al., 2001). We will examine the change in behavior of trace elements such as Cu, Zn and Pb as a function of transformation and model the transport of trace elements in groundwater.

6. Funding Received

(1) JSPS Grants

· Grants-in-Aid for Scientific Research (C), Fe oxidation rate and biotite dissolution: relationships between the evolution of atmospheric oxygen and mineral weathering under low O_2 conditions, 2006-2007 fiscal years, 3,820,000 yen.

· Grants-in-Aid for Scientific Research (B), Quantitative estimation of atmospheric oxygen rise in the Paleoproterozoic: Fe behavior under low O_2 conditions, 2009-2011 fiscal years, 17,940,000 yen.

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

· Y. Tsurusaki, 1,000,000 yen.

· A. Nagase, 500,000 yen.

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Murakami, T., Kasama, T., Utsunomiya, S. (2011) Early Proterozoic weathering processes under low O2 conditions reconstructed from a 2.45-Ga paleosol in Pronto, Canada, American Mineralogist, 96, 1613-1623.
2. Yokoyama, T. Nakashima, S., Murakami, T., Mercury, L., Kirino, Y. (2011) Solute distribution in porous rhyolite as evaluated by sequential centrifugation, Applied Geochemistry, 26, 1524-1534.
3. Murakami, T., Sreenivas, B., Das Sharma, S., Sugimori, H. (2011) Quantification of atmospheric oxygen levels during the Paleoproterozoic using paleosol compositions and iron oxidation kinetics, Geochimica et Cosmochimica Acta, 75, 3982-4004.
4. Sugimori, H., Kanzaki, Y., Yokota, K., Murakami, T. (2011) Nonlinear dependence of the oxidation rate of Fe(II) on dissolved oxygen under low O2 conditions in aqueous solutions, Journal of Mineralogical and Petrological Sciences, 106, 142-152.
5. Tsukimura, K., Suzuki, M., Suzuki, Y., Murakami, T. (2010) Kinetic theory of crystallization of nanoparticles, Crystal Growth & Design, 10, 3596-3607.
6. Tanaka, K., Takahashi, Y., Horie, K, Shimizu, H., Murakami, T. (2010) Determination of the oxidation state of radiogenic Pb in natural zircon using X-ray absorption near-edge structure, Physics and Chemistry of Minerals, 37, 249-254.
7. Sugimori, H., Yokoyama, T., Murakami, T. (2009) Kinetics of biotite dissolution and Fe behavior under low O2 conditions and their implications for Precambrian weathering, Geochimica et Cosmochimica Acta, 73, 3767-3781.
8. Kameda, J., Sugimori, H., Murakami, T. (2009) Modification to the crystal structure of

chlorite during early stages of its dissolution, Physics and Chemistry of Minerals, 36, 537-544.

9. Ichimura, K., Murakami, T. (2009) Formation of rare earth phosphate minerals in 2.45-Ga paleosol, Journal of Mineralogical and Petrological Sciences, 104, 86-91.
10. Sugimori, H., Iwatsuki, T., Murakami, T. (2008) Chlorite and biotite weathering, Fe2+-rich corrensite formation, and Fe behavior under low PO2 conditions and their implication for Precambrian weathering, American Mineralogist 93, 1080-1089.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Murakami, T., B. Sreenivas, S. Das Sharma, Relation of Redox-Sensitive Elements in Precambrian Paleosols to Atmospheric Oxygen Evolution、the International Mineralogical Association、2006, Kobe (Invited)
2. Murakami, T., Controlling Factors of Long-Term U(VI) Transport in Field, American Geophysical Union, 2006, Baltimore, MD (Invited)

And 19 others

(2) Domestic Conferences

3. Murakami, T., B. Sreenivas, The rise of atmospheric oxygen in the Paleoproterozoic, Japan Geoscience Union, 2009, Makuhari (Invited)
4. Murakami, T., Mineral dissolution rate and Fe oxidation rate under low O_2 conditions, the Geochemical Society of Japan, 2009, Hiroshima (Invited)
5. Murakami, T., The structures and chemistries of minerals and solutions at the mineral-water interfaces, the Geochemical Society of Japan, 2008, Tokyo (Invited)

And 30 others

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Two associate professors of national universities

· One associate professor of an European university

· One research associate of a national university

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Editor in Chief, Journal of Mineralogical and Petrological Sciences

· Advisory Board member, Elements

(2) Academic Societies

· Council member, the Japan Association of Mineralogical Sciences

· Vice president, the Japan Association of Mineralogical Sciences

· Chair of Future Plan Committee, the Japan Association of Mineralogical Sciences

· Council member, the Clay Science Society of Japan

(3) International Conferences

· Chair of Financial Committee, the 19th General Meeting of the International Mineralogical Association

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

· Member of No. 111 Mineral Application Committee, Japan Society for the Promotion of Science

· Member of Review Committee, Japan Atomic Energy Agency

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 1 [M.Sc.: 0, Ph.D.: 1 (Chili: 1)]

Foreign Researchers: 1 [India: 1]

Sending

Japanese Students: 2 [M.Sc.: 0, Ph.D.: 2]

Japanese Researchers: 2

Visitors from Abroad: several

Toshihiro Kogure

I. C.V.

Name： Toshihiro Kogure
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Earth Science, The University of Tokyo, March, 1981
M. Sc., Mineralogy, The University of Tokyo, March, 1983
Ph. D., Mineralogy, The University of Tokyo, October, 1996

Professional Experience
April, 1983 – July, 1987, Researcher, Nippon Sheet Glass Co., Ltd.
July, 1987 – Dec., 1988, Visiting Research Fellow, Department of Materials Science and Engineering, Massachusetts Institute of Technology
Dec., 1988 – Jan., 1996, Senior Research Fellow, Nippon Sheet Glass Co., Ltd.
Jan., 1996 – July, 1998, Research Associate, Graduate School of Science, The University of Tokyo
July, 1998 –, Associate Professor, Graduate School of Science, The University of Tokyo

II. Scientific Research Activity

2. Major achievements

(1) Fundamental mechanism of biomineralization

On the terrestrial surface, activity of organisms generates considerable amounts of inorganic substance as their hard tissues. Such substances or process are called biominerals or biomineralization. Biomineralization influences carbon cycles on the surface environment, by forming a large quantity of calcium carbonate. Fossil record in the earth history is also mainly the results of biomineralization. Hence understanding of the fundamental mechanism of biomineralization must be very important in our field. We started the research of biomineralization from the mineralogical perspective, around 2001. Especially our application titled “understanding of the mechanism of biomineralization through the analysis of organic-inorganic interaction” has been accepted as JSPS Grant-in-Aid for Creative Scientific Research during 2005-2009. Using this budget, we could equipped several important instruments for the research, including a focused-ion-beam (FIB) instrument by which we can make thin-film specimens for transmission electron microscopy (TEM) from any parts of interest in samples. Using this FIB-TEM technique and others, we focused mainly on the elucidation of mineralogical or crystallographic features of fine structures in molluscan shells and their formation mechanisms. The major results include i) the crystallographic feature and formation mechanism of the nacre, ii) analyses of the multi-layered structure of the larval shell, and iii) mineralogical aspects of other shell microstructures including the prismatic and crossed-lamellar structures. These results have been presented as 23 original papers in international journals during 2006-2011.

(2) Fine structures of clay minerals and related layered materials

Clay minerals are abundant in biosphere, and important and intimate materials for our

life. However, the real structures of many clay minerals have not been elucidated completely, mainly due to their small particle size and variance of the structures with high density of defects. We have been investigating the atomic structures of clay minerals for more than 15 years in this department, mainly using advanced electron microscopic techniques. This research is highly international, working with scientists in US, Russia, France, Czech, Korea, etc. During 2006-2011, we published 16 papers with respect to the structures and formation mechanisms of clay minerals on international journals. Especially during this period, we presented several important results for clay minerals and related minerals by combination of high-resolution TEM imaging of the clay structure and simulation of XRD patterns.

(3) Developments of new techniques using electron beam to investigate minerals

Besides, we published several important papers in which new electron microscopic techniques were presented for mineralogy and earth and planetary material sciences, including Cs-corrected electron microscopy and new sample preparation techniques.

3. Five Important Papers in your career

1. Kogure, T. and J. F. Banfield (1998), Direct identification of the six polytypes of chlorite characterized by semi-random stacking, *Am. Mineral.*, 83, 925-930.

This paper is almost the first to report that high-resolution TEM imaging along the Yi-axis of phyllosilicates is important and practical to analyze the stacking structures. Time cited: 19

2. Kogure, T. and A. Inoue (2005), Determination of defect structures in kaolin minerals by High-Resolution Transmission Electron Microscopy (HRTEM), *Am. Mineral.*, 90, 85-89.

This paper first reported the truth of stacking faults in kaolinite, one of the most abundant clay minerals, by using high-resolution transmission electron microscopy. Times cited: 22

3. Kogure, T., M. Jige, J. Kameda, A. Yamagishi, and R. Kitagawa (2006), Stacking structures in pyrophyllite revealed by high-resolution transmission electron microscopy (HRTEM), *Am. Mineral.*, 91, 1293-1299.

By combining HRTEM and simulation of diffraction, the true structure in pyrophyllite has been elucidated. Times cited: 11

4. Suzuki, M., K. Saruwatari, T. Kogure, Y. Yamamoto, T. Nishimura, T. Kato, and H. Nagasawa (2009), An acidic matrix protein, Pif, is a key macromolecule for nacre formation, *Science*, 325, 1388-1390.

A new protein was extracted from the nacreous layer of pearl oyster, and its structure and functions were analyzed. Times cited: 84

5. Saruwatari, K., T. Matsui, H. Mukai, H. Nagasawa, and T. Kogure (2009), Nucleation and growth of aragonite crystals at the growth front of nacres in pearl oyster, *Pinctada fucata*, *Biomaterials*, 30, 3028-3034.

Formation mechanism of the crystallographic feature of the nacreous layer has been proposed from the EBSD and FIB-TEM techniques. Time cited: 15

4. Awards and Honors throughout your career

· Toshihiro Kogure, the CSSJ Award, “Investigation of fine structures in clay minerals using transmission electron microscopy”, the Clay Science Society of Japan, September 13, 2007.

· Toshihiro Kogure, the Mineralogical Society Award, “Research of phyllosilicates using

high-resolution electron microscopy", Mineralogical Society of Japan, September 22, 2007.

- Kazuko Saruwatari, Junji Akai, and Toshihiro Kogure, Research Paper Award, "crystal orientation analyses of biominerals using Kikuchi patterns in TEM. *Journal of Mineralogical and Petrological Sciences*, 103, 16-22., Japan Association of Mineralogical Sciences, September 24, 2010.
- Toshihiro Kogure, Jackson Mid-Career Clay Scientist Award, the Clay Mineral Society (USA), June 10, 2010.

5. Future Research Plan

(1) Fine structures of clay minerals and related layered materials

Although we have elucidated true structures of a number of clay minerals so far using advanced electron microscopy, there are still unsolved and debating issues for the structures of clay. The most serious obstacle to observe the atomic structures in clay minerals with high-resolution transmission electron microscopy (HRTEM) is radiation damage of the structures by high-energy electrons. Clay minerals are generally very beam-sensitive materials and their HRTEM imaging is difficult without dedicated electron microscopes and skilled operation which have been satisfied to some extent in our laboratory. However, for future and higher-level researches, probably we need to find techniques as a "break-through" against the radiation damage of clay.

Recently we have started collaboration with a laboratory in Osaka University where a new TEM is being developed. The TEM has a new computer-control system by which HRTEM images can be recorded with an electron dose far smaller than those with conventional electron microscopes. Using this TEM with the "minimal dose system", recently we have succeeded in recording clear high-resolution images of halloysite, a species of kaolin group minerals and their HRTEM images have never been obtained using conventional TEMs. Using such new techniques and innovations, we want to continue leading the world in the research of the structures of clay minerals and related layered materials.

(2) Investigation of adsorption mechanisms of heavy metal ions to supracrustal materials with the development of high-spatial resolution analytical techniques

Solution for the contamination of land with radioactive materials by Fukushima nuclear plant accident is the emergent problem in this country. Beside the development of practical technologies for the effective decontamination, we need to advance the fundamental science for the understanding the interaction between radioactive elements, for instance cesium ion (Cs^+), and supracrustal materials including clay minerals which is the major constituent of soils. Furthermore, contamination of soils with lead (Pb), arsenic (As), cadmium (Cd), etc. through industrial disposal is also an important application of this research. Besides, the understanding of interaction between supracrustal materials and rare earth elements is also important in recent resource problem.

I believe that in order to advance this science field we need to develop a high-spatial resolution analytical technique to identify, for instance, the clay mineral species which really adsorb such heavy metal ions in soils or surface materials. Generally clay minerals are so fine that it is not easy to find effectively the clay particles which really adsorb heavy metal ions in the contaminated soils. Now we have several instruments useful for such analysis in our laboratory, including FE-SEM, FIB and TEM and accumulation of knowledge and know-how through the research of clay minerals for a long period. I would like to start this research project for the next decade with collaboration with domestic and foreign researchers, in order to

contribute the emergent problems in this country as mentioned above.

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for Scientific Research (B) (representative), Investigation of the structures of inorganic macromolecules and their aggregates on the earth, 2005-2007, JPY 16,060K

· Grant-in-Aid for Creative Scientific Research (collaborator), understanding of the mechanism of biomineralization through the analysis of organic-inorganic interaction, 2005-2009, JPY 86,400K

· Grant-in-Aid for Scientific Research (B) (collaborator), Precise reconstruction of the history of organism-environment interactions using the growth lines in living and fossil shells, 2008-2009, JPY 500 K

· Grant-in-Aid for Scientific Research (B) (collaborator), Fabrication of high-performance inorganic-organic hybrid gel films using the structural change induced by external fields, 2008-2010, JPY 1,560 K

· Grant-in-Aid for Scientific Research (B) (collaborator), Survey and identification of clay minerals with structural chirality, 2008-2010, JPY 780K

· Grant-in-Aid for Scientific Research on Innovative Areas (collaborator), Understanding of the slip mechanism of faults inducing great earthquakes from material science researches, 2009-2011, JPY 5,540K

· Grant-in-Aid for Scientific Research (C) (collaborator), Elucidation of the mechanism of the grain-boundary development and grain-size reduction in mylonite, 2009-2011, JPY 3,086K

· Grant-in-Aid for Scientific Research (B) (collaborator), Quantitative estimation of the change of the oxygen concentration in the early Proterozoic era: Behavior of iron by the weathering with extremely low oxygen content, 2009-2011, JPY 700K

· Grant-in-Aid for Scientific Research (A) (collaborator), , 2010, JPY 491K

· Grant-in-Aid for Scientific Research (S) (collaborator), Understanding of the mechanisms of calcification in marine organisms to maintain our environments, 2010-2011, JPY 19,800K

· Grant-in-Aid for Scientific Research (B) (collaborator), Fabrication of electrolyte membrane for the fuel battery working at a moderate temperature using inorganic solid acid nano-complex and aromatic polymer, 2010-2011, JPY 715K

(2) Cooperative Research

· JSPS Joint Research Projects (Korea), Characterization of Microbially Fe(III) Reduced Smectite by Transmission Electron Microscopy (TEM), 2009-2011, JPY 2,273K

(3) Research Contracts

· Japan Science and Technology Agency, Strategic Basic Research Programs (CREST) (collaborator), Development of energy-saving electronic devices 2006-2007, JPY 2,730K

· Japan Science and Technology Agency, Strategic Basic Research Programs (CREST) (collaborator), Fabrication of chiral metal-complex network films and development of VCD/RAS concurrent measuring technique, 2006-2007, JPY 2,366K

· National Institute for Materials Science, Characterization of crystalline films grown on nanosheets using TEM, 2009, JPY 980K

· The National Institute of Advanced Industrial Science and Technology (AIST), Technology survey of the safety at the nuclear fuel cycle plants: High-resolution TEM analyses of colloid

particles in ground water, 2010-2011, JPY 11,550K

· Japan Science and Technology Agency, Strategic Basic Research Programs (CREST), Analysis of nanosheet-film interfaces using electron-beam techniques, 2010-2011, JPY 2,730K

(4) Grants and Gifts

· Hirose Co., Ltd., Teaching of the characterization techniques of clay and soil, JPY 100K

· Astec Co., Ltd., Teaching of analytical techniques for the decontamination of soil, JPY 2,500K

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Suzuki, Y., R.E. Kopp, T. Kogure, A. Suga, K. Takai, S. Tsuchida, N. Ozaki, K. Endo, J. Hashimoto, Y. Kato, C. Mizota, T. Hirata, H. Chiba, K.H. Nealson, K. Horikoshi, and J.L. Kirschvink (2006), Sclerite formation in the hydrothermal-vent "scaly-foot" gastropod - possible control of iron sulfide biomineralization by the animal, *Earth Plan. Sci. Lett.*, 242, 39-50, doi: 10.1016/j.epsl.2005.11.029.

2. Kogure, T., M. Jige, J. Kameda, A. Yamagishi, and R. Kitagawa (2006), Stacking structures in pyrophyllite revealed by high-resolution transmission electron microscopy (HRTEM), *Am. Mineral.*, 91, 1293-1299, doi: 10.2138/am.2006.1997.

3. Kogure, T., J. Kameda, T. Matsui, and R. Miyawaki (2006), Stacking structure in disordered talc: interpretation of its X-ray diffraction pattern by using pattern simulation and high-resolution transmission electron microscopy, *Am. Mineral.*, 91, 1363-1370, doi: 10.2138/am.2006.2196.

4. Matsuda, A., M. Sakai, T. Kogure, Tadanaga, and M. Tatsumisago (2006), External-field hot-water treatments of sol-gel derived SiO_2-TiO_2 coatings for surface nanostructure control - A review, *J. Ceram. Soc. Jpn*, 114, 26-35, doi: 10.2109/jcersj.114.26.

5. Madhusoodana, C.D., K. Kameshima, A. Nakajima, K. Okada, T. Kogure, and K.J.D. MacKenzie (2006), Synthesis of high surface area Al-coating mesoporous silica from calcined and acid leached kaolinites as the precursors, *J. Colloid Interface Sci.*, 297, 724-731, doi: 10.1016/j.jcis.2005.10.051.

6. Katagiri, K., G. Harada, A. Matsuda, T. Kogure, H. Muto, and M. Sakai (2006), Effects of addition of supramolecular assembly on the anatase nanocrystalline precipitation of sol-gel derived SiO_2-TiO_2 coating films by hot-water treatment, *J. Nanosci. Nanotechnol.*, 6, 1802-1806, doi: 10.1166/jnn.2006.218.

7. Sato, K., Y. Kumagai, T. Kogure, K. Watari, and J. Tanaka (2006), Polymorph and orientation control of calcium carbonate crystals achieved by organic matrices, *J. Ceram. Soc. Jpn.*, 114, 754-759, doi: 10.2109/jcersj.114.754.

8. Kudoh, Y., J. Kameda, and T. Kogure (2006), Dissolution of brucite on the (001) surface around neutral pH: *in-situ* AFM observation, *Clays Clay Miner.*, 54, 598-604, doi: 10.1346/CCMN.2006.0540506.

9. Suzuki, M., H. Nagasawa, and T. Kogure (2006), Synthesis and structure of hollow calcite particles, *Cryst. Growth Des.*, 6, 2004-2006, doi: 10.1021/cg0602921.

10. Sugawara, A., A. Oichi, H. Suzuki, Y. Shigesato, T. Kogure, and T. Kato (2006),

Assembled structure of nanoparticles in polymer/calcium carbonate thin-film composites formed by the cooperation of chitosan and poly(aspartate), *J. Polym. Sci.* Pol. Chem., 44, 5153-5160, doi: 10.1002/pola.21604.

11. Saruwatari, K., N. Ozaki, H. Nagasawa, and T. Kogure (2006), Crystallographic alignments in coccolith (*pleurochrysis carterae*) revealed by electron back-scattered diffraction (EBSD), *Am. Mineral.*, 91, 1937-1940, doi: 10.2138/am.2006.2391.

12. Okamoto, K., H. Sato, K. Saruwatari, K. Tamura, J. Kameda, T. Kogure, Y. Umemura, and A. Yamagishi (2007), Persistent phenomena in photocurrent of niobate nanosheets, *J. Phys. Chem. C*, 111, 12827-12833, doi: 10.1021/jp073380k.

13. Kogure, T. (2007), Imaging of dioctahedral 2:1 layers by high-resolution transmission electron microscopy (HRTEM): possibility of recording the dehydroxylate, *Am. Mineral.*, 92, 1368-1373, doi: 10.2138/am.2007.2539.

14. Kameda, J., R. Miyawaki, R. Kitagawa, and T. Kogure (2007), XRD and HRTEM analyses of stacking structure in sudoite, di-trioctahedral chlorite, *Am. Mineral.*, 92, 1586-1592, doi: 10.2138/am.2007.2410.

15. Kogure, T., J. Kameda, and V.A. Drits (2007), Novel 2:1 structure of phyllosilicates formed by annealing Fe^{3+}, Mg-rich dioctahedral mica, *Am. Mineral.*, 92, 1531-1534, doi: 10.2138/am.2007.2667.

16. Kameda, J., R. Miyawaki, V.A. Drits, and T. Kogure (2007), Polytype and morphological analyses of gumbelite, fibrous magnesium-rich illite, *Clay Clay Miner.*, 5, 453-466, doi: 10.1346/CCMN.2007.0550501.

17. Kameda, J., R. Inoguchi, D.J. Prior, and T. Kogure (2007), Morphological analyses of minute crystals by using stereo-photogrammetric scanning electron microscopy and electron back-scattered diffraction, *J. Microscopy*, 228, 358-365, doi: 10.1111/j.1365-2818.2007.01854.x.

18. Shibata, T., K. Fukuda, Y. Ebina, T. Kogure, and T. Sasaki (2008), One-nanometer-thick seed layer of unilamellar nanosheets promotes oriented growth of oxide crystal films, *Adv. Mater.* 20, 231-235, doi: 10.1002/adma.200701381.

19. Kogure, T. and J. Kameda (2008), High-resolution TEM and XRD simulation of stacking disorder in 2:1 phyllosilicates, *Zeit. Kristallogr.*, 223, 69-75, doi: 10.1524/zkri.2008.0004.

20. Saruwatari, K., J. Akai, Y. Fukumori, N. Ozaki, H. Nagasawa, and T. Kogure (2008), Crystal orientation analyses of biominerals using Kikuchi patterns in TEM, *J. Mineral. Petrol. Sci.*, 103, 16-22, doi: 10.2465/jmps.070611.

21. Matsuda, A., K. Kobayashi, T. Kogure, M. Sakai, T. Tadanaga, T. Minami, and M. Tatsumisago (2008), Characterization of ramiform precipitates formed on SiO_2-TiO_2 gel coatings by electric field hot water treatment, *J. Non-Cryst. Solids*, 354, 1263-1266, doi: 10.1016/j.jnoncrysol.2006.12.126.

22. Zhang, H., H. Kikuchi, T. Kogure, and E. Kusano (2008), Growth of carbon with vertically aligned nanoscale flake structure in capacitivity coupled rf glow discharge, *Vacuum*, 82, 754-759, doi: 10.1016/j.vacuum.2007.11.001.

23. Sato, H., K. Okamoto, K. Tamura, H. Yamada, K. Saruwatari, T. Kogure, and A. Yamagishi (2008), A heterojunction photodiode operating at inorganic nanosheet interfaces, *Appl. Phys. Express*, 1, 035001, doi: 10.1143/APEX.1.035001.

24. Kameda, J., K. Saruwatari, D. Beaufort, and T. Kogure (2008), Textures and polytypes in vermiform kaolins diagenetically formed in a sandstone reservoir: a FIB-TEM

investigation, *Euro. J. Mineral.*, 20, 199-204, doi: 10.1127/0935-1221/2008/0020-1806.

25. Johnston, C., J.E. Kogel, D. Bish, T. Kogure, and H. Murray (2008), Low-temperature FTIR study of kaolin-group minerals, *Clays Clay Miner.*, 56, 470-485, doi: 10.1346/CCMN.2008.0560408.

26. Saruwatari, K., N. Ozaki, H. Nagasawa, and T. Kogure (2008), Comparison of crystallographic orientations between living (*Emiliania huxleyi* and *Gephyrocapsa oceanica*) and fossil (*Watznaueria barnesiae*) coccoliths using electron microscopes, *Am. Mineral.*, 93, 1670-1677, doi: 10.2138/am.2008.2924.

27. Kogure, T., J. Kameda, and V.A. Drits (2008), Stacking faults with 180° layer rotation in celadonite, iron and magnesium-rich dioctahedral mica, *Clays Clay Miner.*, 56, 612-621, doi: 10.1346/CCMN.2008.0560602.

28. Matsuda, A., T. Kikuchi, R. Murayama, T. Kogure, K. Katagiri, H.Muto, and M. Sakai (2009), Formation of photocatalytic novel oxide crystallites with Al:Ti=1:1 in Al_2O_3-TiO_2 gels by mechanochemical treatment, *J. Nanosci. Nanotechnol.*, 9, 342-349, doi: 10.1166/jnn.2009.J052.

29. Saruwatari, K., T. Matsui, H. Mukai, H. Nagasawa and T. Kogure (2009), Nucleation and growth of aragonite crystals at the growth front of nacres in pearl oyster, *Pinctada fucata*, *Biomaterials*, 30, 3028-3034, doi: 10.1016/j.biomaterials.2009.03.011.

30. Suzuki, M., K. Saruwatari, T. Kogure, Y. Yamamoto, T. Nishimura, T. Kato and H. Nagasawa (2009), An acidic matrix protein, Pif, is a key macromolecule for nacre formation, *Science*, 325, 1388-1390, doi: 10.1126/science.1173793.

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35. Rozhdestvenskaya, I. V., T. Kogure, E. Abe and V.A. Drits (2009), A structural model for charoite, *Miner. Mag.*, 73, 883-890, doi: 10.1180/minmag.2009.073.2.883.

36. Suzuki, Y., R. Matsunaga, H. Sato, T. Kogure, A. Yamagishie, and J. Kawamata (2009), Non-centrosymmetric behavior of a clay film ion-exchanged with chiral metal complexes, *Chem. Commun.*, 45, 6964-6966, doi: 10.1039/b908806g.

37. Kudo, M., J. Kameda, K. Saruwatari, N. Ozaki, K. Okano, H. Nagasawa, and T. Kogure (2010), Microtexture of larval shell of oyster, *Crassostrea nippona*: a FIB-TEM study, *J. Struct. Biol.*, 169, 1-5, doi: 10.1016/j.jsb.2009.07.014.

38. Kogure, T., C.T. Johnston, J.E. Kogel, and D. Bish (2010), Stacking disorder in a sedimentary kaolinite, *Clays Clay Miner.*, 58, 63-72, doi: 10.1346/CCMN.2010.0580106.

39. Kogure, T. and E. Okunishi (2010), Cs-corrected HAADF-STEM imaging of silicate minerals, *J. Electron Microsc.*, 59, 263-271, doi: 10.1093/jmicro/dfq003.

40. Suzuki, M., J. Kameda, T. Sasaki, K. Saruwatari, H. Nagasawa, and T. Kogure (2010), Characterization of the multilayered shell of a limpet, *Lottia kogamogai* (Mollusca: Patellogastropoda), using SEM–EBSD and FIB–TEM techniques, *J. Struct. Biol.*, 171, 223-230, doi: 10.1016/j.jsb.2010.04.008.

41. Okumura, T., M. Suzuki, H. Nagasawa, and T. Kogure (2010), Characteristics of biogenic calcite in the prismatic layer of a pearl oyster, *Pinctada fucata*, *Micron*, 41, 821-826, doi: 10.1016/j.micron.2010.05.004.

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43. Kameda, J., A. Okamoto, T. Mikouchi, R. Kitagawa, and T. Kogure (2010), The occurrence and structure of vermiform chlorite", *Clay Science*, 14, 155-161.

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47. Shibata, T., Y. Ebina, T. Ohnishi, K. Takada, T. Kogure, and T. Sasaki (2010), Fabrication of Anatase Thin Film with Perfect c-Axis Orientation on Glass Substrate Promoted by a Two-Dimensional Perovskite Nanosheet Seed Layer, *Cryst. Growth Des.*, 10, 3787-3793, doi: 10.1021/cg1006204.

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49. Watanabe, K., M. Sekiya, J. Kameda, S. I. Wada, and T. Kogure (2011), Mineralogical characterization of asian dust collected in Fukuoka, southwest Japan, *Clay Sci.*, 15, 43-51.

50. Kogure, T. (2011), Stacking disorder in kaolinite revealed by HRTEM: A review, *Clay Sci.*, 15, 3-11.

51. Sato, A., S. Nagasaka, K. Furihata, S. Nagata, I. Arai, K. Saruwatari, T. Kogure, S. Sakuda, and H. Nagasawa (2011), Glycolytic Intermediates Induce Amorphous Calcium Carbonate Formation in Crustaceans, *Nat. Chem. Biol.*, 7, 197-199, doi: 10.1038/nchembio.532.

52. Kayano, K., K. Saruwatari, T. Kogure, and Yoshihiro Shiraiwa (2011), Effect of Coccolith Polysaccharides Isolated from the Coccolithophorid, Emiliania huxleyi, on Calcite Crystal Formation in In Vitro $CaCO_3$ Crystallization, *Marine Biotechnology*, 13, 83-92, doi: 10.1007/s10126-010-9272-4.

53. Yokoo, N., M. Suzuki, K. Saruwatari, H. Aoki, K. Watanabe, H. Nagasawa, and T. Kogure (2011), Microstructures of the larval shell of a pearl oyster, *Pinctada fucata*, investigated by FIB-TEM technique, *Am. Mineral.*, 96, 1020-1027, doi: 10.2138/am.2011.3657.

54. Kameda, J., H. Raimbourg, T. Kogure, and G. Kimura (2011), Low-grade metamorphism around the down-dip limit of seismogenic subduction zone: An example from an ancient accretionary complex, the Shimanto Belt, Japan, Tectonophysics, 502, 383-392, doi: 10.1016/j.tecto.2011.02.010.

55. Raimbourg, H., T. Kogure, and T. Toyoshima (2011), Crystal bending, subgrain boundaries development and recrystallization in orthopyroxene during granulite-facies deformation, *Contrib. Mineral. Petrol.*, 162, 1093-1111, doi: 10.1007/s00410-011-0642-3.

56. Kogure, T., K. Mori, Y. Kimura, and Y. Takai (2011), Unraveling the stacking structure in tubular halloysite using a new TEM with computer-assisted minimal-dose system, *Am. Mineral.*, 96, 1776-1780, doi: 10.2138/am.2011.3907.

57. Saruwatari, K., Y. Tanaka, H. Nagasawa, and T. Kogure (2011), Crystallographic variability and uniformity in Cretaceous heterococcoliths, *Eur. J. Mineral.*, 23, 519-528, doi: 10.1127/0935-1221/2011/0023-2129.

58. Hayashi A., N. Yokoo, H. Nagasawa, T. Nakamura, T. Watanabe, and T. Kogure (2011), Crystallographic characterization of the crossed lamellar structure in the bivalve *Meretrix lamarckii* using electron beam techniques, *J. Struct. Biol.*, 176, 91-96, doi: 10.1016/j.jsb.2011.06.011.

59. Okudaira K., T. Kato, T. Isobe, S. Matsushita, T. Kogure, and A. Nakajima (2011), Wettability conversion and surface friction force variation of polycrystalline rutile ceramics under UV illumination, *J. Photoch. Photobio. A*, 222, 64-69, doi: 10.1016/j.jphotochem.2011.05.002.

60. Suzuki M., A. Iwashima, N. Tsutsui, T. Ohira, T. Kogure, and H. Nagasawa (2011), Identification and characterization of a calcium carbonate-binding protein, Blue Mussel Shell Protein (BMSP), from the nacreous layer, *ChemBioChem*, 12, 2478-2487, doi: 10.1002/cbic.201100317.

61. Suzuki M., T. Kogure, S. Weiner, and L. Addadi (2011), Formation of aragonite crystals in the crossed lamellar microstructure of limpet shells, *Cryst. Growth Des.*, 11, 4850-4859, doi: 10.1021/cg2010997.

62. Ohno, Y., K. Tomita, Y. Komatsubara, T. Taniguchi, K. Katsumata, N. Matsushita, T. Kogure, and K. Okada (2011), Pseudo-cube shaped brookite (TiO_2) nanocrystals synthesized by an oleate-modified hydrothermal growth method, *Cryst. Growth Des.*, 11, 4831-4836, doi: 10.1021/cg2006265.

63. Suzuki, M., T. Okumura, H. Nagasawa, and T. Kogure (2011), Localization of Intracrystalline Organic Macromolecules in Mollusk Shells, *J. Cryst. Growth*, 337, 24-29, doi: 10.1016/j.jcrysgro.2011.10.013.

(2) Selected Conference Proceedings

(3) Review Papers

1. Kogure, T. (2008), Application of optimum HRTEM noise filters in mineralogy and related sciences, *Microscopy and Analysis Nanotechnology Suppliment, November*, S11-S14. (Referred)

2. Kogure, T., H.Mukai, N. Yokoo, T. Okumura, and E. Fujii (2010), Biomineral Photo Gallery, *Iden*, July, 2-8.

3. Kogure, T. (2010), Mineralogical and crystallographical characterization of biominerals, *Iden*, July, 29-35.

4. Suzuki, M., T. Kogure, and H. Nagasawa (2010), Molecular mechanism to form pearls in

pearl oyster: Discovery of acidic matrix protein, Pif, *Kagaku-to-Seibutsu*, 48, 310-312. (Referred)

5. Suzuki, M., T. Kogure, and H. Nagasawa (2010), New insight into the mechanism undeylying biominralization of pearl formation by discovery of a key macromolecule, Pif., *Bioscience & Industry*, 68, 102-108. (Referred)
6. Suzuki M., T. Kogure, and H. Nagasawa (2010), How is the structure to brighten pearls formed? – Discovery of the related protein Pif, *Kagaku*, Iwanami Shoten, Publishers, 80, 125-127. (Referred)
7. Kogure T. (2010), Strucrural analysis of charoite using high resolution transmission electron microscopy - unveiled 30-years mystery of the gemstone, *Expected Materials for the Future*, December, 1-5.
8. Kogure, T. (2011), Stacking Disorder in Phyllosilicates Revealed by High-Resolution TEM and XRD Simulation, *J. Cryst. Soc. Jpn.*, 53, 52-57. (Referred)

(4) Books

1. Kogure, T. and K. Saruwatari (2007), Structure analyses of biominerals − Recent results for calcium carbonates −, Development of New Functional Materials Inspired by Biomineralization, edited by T. Kato, pp. 172-181, CMC Publishing Co., Ltd., Tokyo.
2. Kogure, T. (2011), Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), *Handbook of Analytical Chemistry: Revised 6th Edition*, edited by The Japan Society for Analytical Chemistry, pp. 194-197, Maruzen Publishing Co., Ltd., Tokyo.

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. T. Kogure, Determination of Stacking Structures in Kaolin and Other Beam-sensitive Phyllosilicate Minerals by High-Resolution Transmission Electron Microscopy (HRTEM), 16th International Microscopy Congress (IMC), Sep. 3-8, 2006, Sapporo, Japan. (Invited)
2. T. Kogure, Applications Electron Back-Scattered Diffraction (EBSD) in clay mineralogy, 43rd Annual Meeting of The Clay Minerals Society with the Annual Meeting of the Groupe Français des Argiles (French Clay Group), June 3-7, 2006, Oleron Island, France. (Invited)
3. T. Kogure and E. Okunishi, Application of Cs-corrected high-resolution STEM to silicate mineralogy, 9th Asia-Pacific Microscopy Conference (APMC9), Nov. 2-7, 2008, ICC Jeju, Jeju island, Korea. (Invited)
4. T. Kogure, High-resolution electron microscopy of silicates; its history and future", "Investigation of layered materials using HRTEM and XRD simulations, invited lectures in International Graduate School under the Elitenetzwerk Bayern Structure, Reactivity and Properties of Oxide Materials, Apr. 2-6, 2009, Bayerisches GeoInstitut (BGI), Bayreuth, Germany. (Invited)
5. T. Kogure, Visualization of Stacking disorder in kaolinite by HRTEM, 14th International Clay Conference, June 14-20, 2009, Castellaneta Marina, Italy. (Invited)
6. T. Kogure, Novel 2:1 layers formed by dehydroxylating (Fe3+, Mg)-rich dioctahedral mica, 25th European Crystallographic Meeting (ECM), Aug. 16-21, 2009, Istanbul,

Turkey. (Invited)

7. T. Kogure, Clays in TEM, 2010 CMS Jackson Award lecture, 2010 SEA-CSSJ-CMS Trilateral Meeting on Clays, June 8-10, 2010, Seville, Spain. (Invited)
8. T. Kogure, J. Kameda, K. Watanabe, Structural Nanoanalyses of Specified Regions in Clay and Soil Using FIB Technique, Asian Clay, Sep. 6, 2010, Nagoya, Japan. (Invited)
9. T. Kogure, J. Kameda, D. Beaufort, H. Raimbourg, Structure Nanoanalyses of Specified Regions in Minerals, Rocks and Soils through SEM-FIB-TEM Sequence, The 17th IFSM International Microscopy Congress, Sep. 19-24, 2010, Rio de Janeiro, Brazil. (Invited)
10. T. Kogure, M. Suzuki, N. Yokoo, T. Okumura, H. Nagasawa, Distribution and role of intracrystalline organic macromolecules in molluscan shells, The International Symposium on Pearl Research, Oct. 5, 2011, The University of Tokyo, Tokyo, Japan. (Invited)

Besides the above 10 invited presentations, there are **20** regular presentations.

(2) Domestic Conferences

11. T. Kogure, Crystal growth of calcium carbonates in shell, The 18th Workshop on Society of Inorganic Materials, Japan, Dec., 2008, Kogakuin University, Tokyo. (Invited)
12. Kogure, T., M. Suzuki, N. Yokoo, T. Okumura, and H. Nagasawa, Calcium carbonate – biomacromolecules hybrid structures found in shells, The 24th Autumn Meeting on Ceramic Society of Japan, Sep. 7, 2011, Hokkaido University, Hokkaido. (Invited)

Besides the above 2 invited presentations, there are **68** regular presentations.

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· Clays and Clay Minerals, Associate Editor, 2007-2011
· Japanese Magazine of Mineralogical and Petrological Sciences, Editor, 2006-2011
· Clay Science, Editor, 2006-2011

(2) Academic Societies

· The Mineralogical Society of Japan, Councilor, 2006
· Japan Association of Mineralogical Sciences, Councilor, 2007-2008, 2010-2011
· The Clay Science Society of Japan, Councilor, 2007-2010
· Japanese Society of Microscopy, Councilor, 2006-2011
· AIPEA Nomenclature Committee Member (Representative in Japan), 2007-2011
· The Electron Microscopy College (Lecture Meeting) sponsored by The Japanese Society of Microscopy, Chairman, 2010-2011

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· T. Kogure, Feb 18, 2012, Science- ZERO “Fukushima nuclear accident #6 - Seek solutions to radiological decontamination in soil and water -”, NHK educational channel.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 1 [M.Sc.: 0, Ph.D.: (Korea: 1)]

Foreign Researchers: 0

Sending

Japanese Students: 4 [M.Sc.: 0, Ph.D.: 4 (U.S.A.: 2, Denmark: 1, Israel: 1)]

Japanese Researchers: 1 [Israel]

Visitors from Abroad: 4 [Russian: 1, Spanish: 1, Korean: 1, and French: 1]

Yohey Suzuki

I. C.V.

Name： Yohey Suzuki
Present Position: Associate Professor, University of Tokyo, Graduate School of Science

Education
B. Sc., Waseda University, Mineral Resource Engineering, March, 1996
M. Sc., University of Tokyo, Graduate School of Science, March, 1998
Ph. D., University of Wisconsin–Madison, Geology & Geophysics Department. May, 2002

Professional Experience
June, 2002-September., 2005, Research Scientist, Frontier Research System for Extremophiles, Japan Agency for Marine-Earth & Technology Center (JAMSTEC)
October, 2005-Mar., 2011, Research Scientist, Geological Survey of Japan, Advanced Industrial Science & Technology (AIST)
April, 2011-, Associate Professor, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

(1) Microbial impacts on the mobility of uranium near the Earth's surface

The redox reactions of uranium control the global cycle of uranium. Although the oxidation of uranium is kinetically fast, the reduction of uranium is kinetically inhibited and needs catalysis. It remains uncertain whether uranium reduction is biologically mediated. By integrating multi-disciplinary approaches including nano-meter scale mineralogical characterizations and DNA sequencing of microbial populations, it was clearly demonstrated that microorganisms play dominant roles in catalyzing uranium reduction and precipitation of uraninite nanoparticles.

(2) Novel endosymbiosis and biomineralization around the deep-sea hydrothermal vents

Deep-sea hydrothermal vents harbor chemosynthetic ecosystems, which are significantly different from photosynthetic ones. By using compound-specific carbon isotopic analysis and phylogenetic identification of microbial cells in the gill tissues, *Alviniconcha* gastropods dominantly populating the Western Pacific have a novel endosymbiotic system depending on autotrophy via the reductive tricarboxylic acid cycle. A novel biomineralization involving iron sulfide minerals was demonstrated for the scaly-foot gastropod by nano-meter scale mineralogical identification and mechanical measurements.

(3) Geomicrobiological investigations of the terrestrial subsurface

Multiple lines of evidence suggest that the terrestrial subsurface harbors microbial ecosystems as abundantly as the surface counterpart. However, it is technically difficult to access the deep biosphere, without contamination from the surface biosphere. It is also concerned that introducing oxygenated drilling fluid alters chemical conditions. To minimize drilling disturbance, drilling fluid was filter-sterilized and deoxygenated, and 350-m deep core was obtained from Miocene consolidated sediments. From the core, high activities of denitrification were detected, which suggests that the redox states of the terrestrial subsurface were not so reducing as previously considered.

3. Five Important Papers in your career

1. Suzuki, Y., T. Suko, H. Yoshioka, M. Takahashi, K. Nanba, U. Tsunogai, N. Takeno, K. Ito (2009), Biogeochemical profiles in deep sedimentary rocks in an inland fore-arc basin, Central Japan. Chemical Geology, 259, 107-119.

The establishment of a new drilling procedure for the deep biosphere (2 citations).

2. Suzuki, Y., R.E. Kopp, T. Kogure, A. Suga, K. Takai, S. Tsuchida, N. Ozaki, K. Endo, J. Hashimoto, Y. Kato, C. Mizota, T. Hirata, H. Chiba, K.H. Nealson, K. Horikoshi, J.L. Kirschvink (2006), Sclerite formation in the hydrothermal -vent "scaly-foot" gastropod - possible control on iron sulfide biomineralization by the animal. Earth and Planetary Science Letters, 242, 39-50.

The discovery of pyrite nanoparticles in nature (19 citations).

3. Suzuki, Y., T. Sasaki, M. Suzuki, Y. Nogi, T. Miwa, K. Takai, K.H. Nealson, K. Horikoshi (2005), Novel Chemoautotrophic Endosymbiosis Between a Member of the *Epsilonproteobacteria* and the Hydrothermal-Vent Gastropod *Alviniconcha* aff. *hessleri* (Gastropoda:Provannidae) from the Indian Ocean. Applied and Environmental Microbiology, 71, 5440-5450

The discovery of autotrophic endosymbiosis other than Calvin-Benson cycle (33 citations).

4. Suzuki, Y., S.D. Kelly, K.M. Kemner, J.F. Banfield (2003), Microbial populations stimulated for hexavalent uranium reduction in uranium contaminated sediment. Applied and Environmental Microbiology, 69, 1337-1346.

Multi-disciplinary approaches revealed key microbial players for uranium precipitation (110 Citations).

5. Suzuki Y., S.D. Kelly, K.M. Kemner, J.F. Banfield (2002), Nanometer-size products of uranium bioreduction. Nature, 419, 134.

The emergence of nanogeoscience was partly due to this finding (183 citations).

4. Awards and Honors throughout your career

· September 2010, Japan Association of Mineralogical Sciences, Young Investigator Award

5. Future Research Plan

Life is ubiquitous not only in the near-surface environment where sunlight is converted into biological energy via photosynthesis, but also in the deep-sea and subsurface associated with chemical fluxes that sustain chemosynthesis. Prior to the emergence of photosynthetic microorganisms, primary production was mainly based on chemoautotrophy without stable supply of organic matter and oxidants other than CO_2. The deep subsurface is analogous to the surface of early Earth with respect to limited supply of photosynthetic products. The phylogeny and physiology of prokaryotes thriving in the deep subsurface and the physicochemical properties of their habitat will be investigated to learn how primitive prokaryotes can harness energy and oxidants from rock-water interactions. In addition, Precambrian geological records analogous to the deep subsurface will be characterized to constrain atmosphere-water-rock-life interactions as well as to search mineralogical biosignatures.

Recent advances in nanotechnology have enabled us to grasp nanometer-scale mineralogical features. Consequently, it has been recognized that nanometer-scale mineral assemblages shape the front of biogeochemical cycles and ecosystems. Particularly, pyrite nanoparticles are ubiquitous throughout the Earth's history and may have provided catalytic surface and energy sources for the primitive forms of life. As the photovoltaic behavior of pyrite is neglected in any theories for the origin of life, experiments with pyrite nanoparticles under conditions that mimic prebiotic Earth (ca. 4000 Ma) will be conducted.

DNA sequencing is a powerful tool to identify organisms regardless of their phenotypic traits, which led to the discovery of the domain Achaea. As far as DNA has been preserved over geological periods, DNA sequencing can be used to clarify the phylogeny of extinct organisms. It is well established that DNA strongly binds to amorphous silica under high-salt conditions. Since the advent of silica-encrusted planktons such as radiolaria and diatom, the majority of ocean floor has been covered with siliceous sediments. It will be studied whether fossil DNA has been preserved in biogenic silica minerals to establish a new biostratigraphy and proxies for paleoenvironments.

6. Funding Received

(1) JSPS Grants

· Grant-in Aid for Challenging Exploratory Research (H23～H24), Microbially mediated metabolisms involving C1 compounds in deep-sea sediments, ¥900,000.

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

· IODP Post-cruise Research Support・JAMSTEC（H23～H25）Exp.329 South Pacific Gyre Microbiology, ¥2,500,000.

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Nakagawa, S., F. Inagaki, Y. Suzuki, O.S. Steinsbu, M.A. Lever, K.Takai, B. Engelen, Y. Saka, C.G. Weat, K. Horikoshi and Integrated Ocean Drilling Program Expedition 301 Scientists (2006), Microbial community in black rust exposed to hot ridge flank crustal fluid. Applied and Environmental Microbiology, 72, 6789-6799.
2. Suzuki, Y., S. Kojima, H. Watanabe, M. Suzuki, S. Tsuchida, T. Nunoura, H. Hirayama, K. Takai, K.H. Nealson, K. Horikoshi (2006), Single host and symbiont lineages of hydrothermal-vent gastropods, *Ifremeria nautilei* (Provannidae): Biogeography and evolution. Marine Ecology-Progress Series, 315, 167-175.
3. Suzuki, Y., S. Kojima, T. Sasaki, M. Suzuki, H. Watanabe, T. Utsumi, H. Urakawa, S. Tsuchida, T. Nunoura, H. Hirayama, K. Takai, K.H. Nealson, K. Horikoshi (2006), Host-symbiont relationships in hydrothermal gastropods of the genus *Alviniconcha* from the South West Pacific. Applied and Environmental Microbiology 72, 1388-1393.
4. Suzuki, Y., R.E. Kopp, T. Kogure, A. Suga, K. Takai, S. Tsuchida, N. Ozaki, K. Endo, J. Hashimoto, Y. Kato, C. Mizota, T. Hirata, H. Chiba, K.H. Nealson, K. Horikoshi, J.L. Kirschvink (2006), Sclerite formation in the hydrothermal-vent "scaly-foot" gastropod -

possible control on iron sulfide biomineralization by the animal. Earth and Planetary Science Letters 242, 39-50

5. Nunoura, T., H. Oida, M. Miyazaki, Y. Suzuki, K. Takai, K. Horikoshi (2007), *Desulfothermus okinawensis* sp. nov., a thermophic and heterotrophic sulfate-reducing bacterium isolated from a deep-sea hydrothermal field. International Journal of Systematic and Evolutionary Microbiology, 57, 2360-2364.

6. Nunoura, T., H. Oida, M. Miyazaki, Y. Suzuki, K. Takai, K. Horikoshi (2007), *Marinitoga okinawensis* sp. nov., a novel thermophic and anaerobic heterotroph isolated from a deep-sea hydrothermal field, Sounthern Okinawa Trough. International Journal of Systematic and Evolutionary Microbiology, 57, 467-471.

7. Nunoura, T., M. Miyazaki, Y. Suzuki (2008), *Thermoslfidibacter takaii* gen. nov., sp. nov., a thermophic sulfur-oxidizing chemoautotroph isolated from a deep-sea hydrothermal field, Sountern Okinawa Trough. International Journal of Systematic and Evolutionary Microbiology, 58, 676-681.

8. Nunoura, T., M. Miyazaki, Y. Suzuki, K. Takai, K. Horikoshi (2008), *Hydrogenivirga okinawensis* sp. nov., a thermophic hydrogen-oxidizing, sulfur-reducing chemoautotroph isolated from a deep-sea hydrothermal field in the Southern Okinawa Trough. International Journal of Systematic and Evolutionary Microbiology, 58, 659-665.

9. Takai, K., T. Nunoura, J. Ishibashi, J. Lupton, R. Suzuki, H. Hamasaki, Y. Ueno, S. Kawagucci, T. Gamo, Y. Suzuki, H. Hirayama, K. Horikoshi K (2008), Variability in the microbial communities and hydrothermal fluid chemistry at the newly discovered Mariner hydrothermal field, southern Lau Basin. Journal of Geophysical Research, 113, G02031

10. Suzuki, Y., T. Suko, H. Yoshioka, M. Takahashi, K. Nanba, U. Tsunogai, N. Takeno, K. Ito (2009), Biogeochemical profiles in deep sedimentary rocks in an inland fore-arc basin, Central Japan. Chemical Geology, 259, 107-119

11. Suzuki, Y., M. Suzuki, S. Tsuchida, K. Takai, K. Horikoshi, A.J. Southward, W.A. Newman, T. Yamaguchi T (2009), Molecular investigations of the stalked barnacle *Vulcanolepas osheai* and the epibiotic bacteria from the Brothers Caldera, Kermadec Arc, New Zealand. Journal of the Marine Biological Association of the United Kingdom, 89, 727-733.

12. Tsukimura, K., Y. Suzuki, M. Suzuki, T. Murakami (2010), Transformation of ferrihydrite to goethite or hematite: kinetic theory. Kinetic Theory of Crystallization of Nanoparticles. Crystal Growth & Design, 10, 3596-3607.

13. Reynolds, K., H. Watanabe, E. Strong, T. Sasaki, K. Uematsu, H. Miyake, S. Kojima, Y. Suzuki, K. Fujikura, S. Kim, C. Young (2010), New Molluscan Larval Form: Brooding and Development in a Hydrothermal Vent Gastropod, *Ifremeria nautilei* (Provannidae). Biological Bulletin, 219, 7-11.

14. Fukuda, A., Hagiwara, H., T. Ishimura, M. Kouduka, S. Ioka, Y. Amano, U. Tsunogai, Y. Suzuki, T. Mizuno (2010) Geomicrobiological properties of ultra-deep granitic groundwater from the Mizunami Underground Research Laboratory (MIU), central Japan. Microbial Ecology, 60, 214-225.

15. Tsuchida, S., Y. Suzuki., Y. Fujiwara, M. Kawato, K. Uematsu, T. Yamanaka, C. Mizota, H. Yamamoto (2011), Ebibiotic association between filamentous bacteria and the vent-associated galatheid crab, *Shinkai crosnieri* (Decapoda: Anomura). Journal of the Marine Biological Association of the United Kingdom 92, 23-32.

16. Hirayama, H., Y. Suzuki, M. Abe, M. Miyazaki, H. Makita, F. Inagaki, K. Uematsu, K.

Takai (2011), *Methylothermus subterraneus* sp. nov., a moderately thermophilic methanotrophic bacterium from a terrestrial subsurface hot aquifer in Japan. International Journal of Systematic and Evolutionary Microbiology 61, 2646-2653.

(2) Selected Conference Proceedings

1. Suzuki, Y., T. Suko, N. Takeno, K. Ito (2008), Biogeochemical and microbiological site-characterization of deep geological environments. Proceedings of 12th International High-Level Radioactive Waste Management Conference, 179-183
2. Ito, K., Y. Suzuki, T. Suko, N. Takeno (2008), Conceptual groundwater flow modeling from non-disturbing in sedimentary rocks. Proceedings of 12th International High-Level Radioactive Waste Management Conference, 165-171.

(3) Review Papers

1. Suzuki, Y., T. Suko (2006), Geomicrobiological factors that control uranium mobility in the environment: Update on recent advances in the bioremediation of uranium-contaminated sites. Journal of Mineralogical and Peterological Sciences, 101, 299-307. (Refereed)
2. Suzuki, Y. (2011), Challenges to Explore the Terrestrial Subsurface Biosphere in Japan. Journal of Japanese Society for Extremophiles, 10, 77-82. (Non-refereed)

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Suzuki Y., S.D. Shelly, K. Kemner, J.F. Banfield (2006), Geomicrobiological factors controlling uranium mobility in natural systems. 19th General Meeting of the International Mineralogical Association, Kobe.（Invited）
2. Suzuki, Y. (2007), Diverse endosymbioses in *Alviniconcha* gastropods. Workshop on biogeochemical interaction at deep-sea vents. Woods Hole, MA.（Invited）
3. Suzuki, Y. (2009), Microbiological depth profiles of subterranean sedimentary rocks revealed by an aseptic drilling procedure. ICDP Workshop: Integration of Deep Biosphere Research into ICDP. Potsdam, Germany.（Invited）
4. Suzuki, Y. (2009), Microbial diversity in inactive chimney structures from deep-sea hydrothermal systems. Workshop on deep-sea mining of seafloor massive sulfides: a reality for science and society in the 21st century. Woods Hole, MA. （Invited）

Total 8 presentations

(2) Domestic Conferences

5. Suzuki, Y. Mineral – water – life interactions within the biosphere on earth. Japan Association of Mineralogical Sciences 2010 Annual Meeting, October 2010, Matsue, Shimane, Japan （Invited）
6. Suzuki, Y. Biomineralization of protective, iron-sulfide exoskeletons of a hydrothermal vent snail: Modern analogue for the evolution of Cambrian metazoan skeletons. 5th Deep-sea Bioforum, November 2006, Minato-ku, Tokyo, Japan (Invited)

Total 13 domestic presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

· 2008 International Symposium on Subsurface Microbiology (ISSM), steering committee member and session convener.

· 2008 Goldschmidt Geochemistry Conference, session convener.

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

· Integrated Ocean Drilling Program (IODP) Science Steering & Evaluation Panel (SSEP) committee member (2009～2011)

· Integrated Ocean Drilling Program (IODP) Proposal Evaluation Panel (PEP) committee member (2011～)

· Japan Drilling Earth Science Consortium IODP domestic steering committee member (2011～)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 4

Takanobu Tsuihiji

I. C.V.

Name： Takanobu Tsuihiji
Present Position: Lecturer, Graduate School of Science, University of Tokyo

Education

B. Sc., Department of Biology (Zoology), University of Tokyo, March, 1996
B. Sc., Department of Geology (Geology and Mineralogy), University of Tokyo, March, 1998
Ph. D., Department of Geology and Geophysics, Yale University, May, 2004

Professional Experience

September, 2004-February, 2006, Postdoctoral Fellow, Division of Amphibians and Reptiles, Department of Zoology, Field Museum of Natural History, Chicago, Illinois, U.S.A.
February, 2007-March, 2008, Japan Society of Promotion of Science Research Abroad
Postdoctoral Fellow, Department of Biomedical Science, College of Osteopathic Medicine, Ohio University, Athens, Ohio, U.S.A.
April, 2008-March, 2010, Japan Society of Promotion of Science Postdoctoral Fellow, Department of Geology and Paleontology, National Museum of Nature and Science, Tokyo, Japan
August, 2010-February, 2012, Postdoctoral Fellow, Department of Geology and Paleontology, National Museum of Nature and Science, Tokyo, Japan
February, 2012 -, Lecturer, Graduate School of Science, University of Tokyo

II. Scientific Research Activity

2. Major achievements

From 2006 through 2011, I mainly worked on (1) the evolution of the neck morphology in reptiles including avian and non-avian dinosaurs, (2) dinosaurs from the Mongolian Gobi Desert, and (3) research based on micro-CT scan data. Through these projects, I approached macro-evolution of vertebrae morphology through combining neontological data obtained through dissections and fossil data obtained through geological field work.

In the project (1), I focused on the neck because this body region represents a key innovation of tatrapods that has enabled them to react promptly to environmental stimulations and explore efficient feeding strategies by providing high mobility to the head that accommodates the feeding organ (mouth) and sensory organs (such as eyes). First, I studied the neck and trunk regionalization of snakes, which have a body plan of apparently lacking the distinction of the neck from the trunk, based on observations on their axial myology. As a result, I demonstrated that snakes still retain a myologically-distinct neck region whereas the trunk, not the neck, contributes most to their elongated precloacal region. Second, I reconstructed attachment sites of neck muscles in the occipital regions of the skull in two clades of dinosaurs, Marginocephalia and Theropoda, and discuss the functional significance of such anatomical arrangements. Finally, I continued my project on the evolution of the cervical vertebrae in dinosaurs. For example, I established the homology of fused anterior cervical vertebrae so called the cervical bar in ceratopsid dinosaurs with elements in other dinosaurs.

In the project (2), I joined geological and paleontological expeditions in the Gobi Desert

and worked on obtained specimens, especially Cretaceous theropod dinosaurs. In particular, I studied the morphology of a juvenile specimen of the tyrannosaurid *Tarbosaurus bataar* in detail, and examined the effect of the ontogenetic change in the skeletal morphology on the phylogenetic analysis of this clade of theropods. In the project (3), I analyzed the morphology of the brain and inner ear endocasts of Mongolian dinosaurs by utilizing the CT scanner and digital 3D reconstruction techniques. The morphology of these structures reflect the sensitivity to environmental stimulation and ability of integrating such information of an animal, thus providing clues for biological activities of fossil anima that is normally difficult to infer. In my research, for example, I demonstrated that *Avimimus*, a non-avian theropod, had already acquired the modern avian-type brain morphology before the origin of flight in the theropod lineage.

In addition to those projects, I started working on the survey of Mesozoic terrestrial strata and their vertebrae fossils. In particular, I joined the geological field work on the lower Cretaceous vertebrate localities in Shimokoshikijima Island, Kagoshima Prefecture, and described an isolated tooth of a theropod dinosaur found in one locality.

3. Five Important Papers in your career

1. Tsuihiji, T., M. Kearney, and O. Rieppel (2006), First report of a pectoral girdle muscle in snakes, with comments on the snake cervico-dorsal boundary, *Copeia 2006*(2), 206-215.

This paper demonstrated, for the first time, the presence of a structure associated with the pectoral girdle in snakes, which had been considered to be completely lost.

2. Tsuihiji, T. and P .J. Makovicky (2007), Homology of the neoceratopsian cervical bar elements, *J. Paleontol., 81*(5), 1132-1138.

This paper clarified the homology and evolution of an enigmatic element present in a clade of dinosaurs.

3. Tsuihiji, T. (2007), Homologies of the *longissimus*, *iliocostalis*, and hypaxial muscles in the anterior presacral region of extant Diapsida, *J. Morphol., 268*(11), 986-1020.

This paper established homologies of the axial muscles in the neck and trunk among reptiles including birds in detail, making it possible to apply the information to paleontological studies.

4. Tsuihiji, T. (2010), Reconstructions of the axial muscle insertions in the occipital region of dinosaurs: evaluations of past hypotheses on Marginocephalia and Tyrannosauridae using the Extant Phylogenetic Bracket approach, *Anat. Rec., 293*(8), 1360-1386.

This paper rigorously tested previous anatomical reconstructions based on detailed observation in extant animals.

5. Tsuihiji, T., M. Watabe, K. Tsogtbaatar, T. Tsubamoto, R. Barsbold, S. Suzuki, A. H. Lee, R. C. Ridgely, Y. Kawahara, and L. M. Witmer (2011), Cranial osteology of a juvenile specimen of *Tarbosaurusu bataar* (Theropoda: Tyrannosauridae) from the Nemegt Formation (Upper Cretaceous) of Bugin Tsav, Mongolia, *J. Vert. Paleontol., 31*(3), 497-517.

Featured article for the issue.

4. Awards and Honors throughout your career

· Philip M. Orville Prize (for outstanding research and scholarship in earth sciences) from

Graduate School of Arts and Sciences, Yale University, May, 2003

· George Gaylord Simpson Prize (for an exceptional paper concerning evolution and the fossil record) from the Peabody Museum of Natural History, Yale University, May 2004

5. Future Research Plan

I am planning on pursuing the following research projects:

(1) I will reconstruct the evolutionary patterns of the musculoskeletal system of the neck in the clade Archosauria based on the myological data in extant reptiles including birds as well as the evolutionary sequence of osteological characteristics of the neck and occiput in fossil species. The neck in archosaurs underwent major morphological changes, from the plesiomorphic condition represented, for example, by extant crocodylians to the derived condition of a highly mobile neck consisting of numerous cervical vertebrae observed in extant birds. These morphological changes likely accumulated gradually in the extinct lineage of archosaurs, especially dinosaurs. To fully understand the evolution of the neck, therefore, it is necessary to analyze the evolution of the osteological characteristics in the fossil record. By tracing evolutionary changes osteological characters related to the myological structures, such as the morphology of muscle attachment sites, I will attempt to clarify the anatomical changes in the neck including the muscle system in the neck in archosaurs.

(2) I will continue on the project on dinosaurs from the Mongolian dinosaurs. First, I will continue to analyze the morphology of the brain and inner ear endocasts by utilizing the micro CT scanner. For example, several skulls of different growth series have been found for a certain hadrosaur (herbivorous dinosaur). For this species, I will analyze the growth patterns of the brain and inner ear morphology. Based on data on changes in the relative size of each part in these structures, I will expect to infer the ontogenetic changes in sensory and neurological functions governed by the respective part. I will also produce an embryonic, ontogenetic series of extant dinosaurs, birds (for example, the chicken), and scanned it in the micro CT scanner to obtained data on the growth changes in the brain and inner ear morphology. Based on comparison between such extant and fossil data, I will analyze evolution of ontogenetic changes of these structures in Dinosauria.

In the next step, I will conduct morphological phylogenetic analyses of dinosaurs by incorporating new data on brain and inner ears, as well as on other body parts, and test previously proposed phylogenetic hypotheses on these animals. In particular, a consensus has not emerged for the phylogenetic relationships within the clade of coelurosaurian theropods that include birds. By incorporating data on brain and inner ears that have rarely been utilized in phylogenetic analyses, I will shed a new light on this issue. Through expeditions to the Gobi Desert, my colleagues and I have found well-preserved specimens of Cretaceous coelurosaurians. New morphological data obtained from these new specimens are expected to play an important role in clarifying the phylogeny of these dinosaurs

6. Funding Received

(1) JSPS Grants

· Grant-in-Aid for JSPS Fellows, 2008-2010, 1,100,000 yen per year

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Tsuihiji, T., M. Kearney, and O. Rieppel (2006), First report of a pectoral girdle muscle in snakes, with comments on the snake cervico-dorsal boundary, *Copeia, 2006*(2), 206-215.
2. Tsuihiji, T. and P .J. Makovicky (2007), Homology of the neoceratopsian cervical bar elements, *J. Paleontol., 81*(5), 1132-1138.
3. Tsuihiji, T. (2007), Homologies of the *longissimus*, *iliocostalis*, and hypaxial muscles in the anterior presacral region of extant Diapsida, *J. Morphol., 268*(11), 986-1020.
4. Watabe, M., T. Tsuihiji, S. Suzuki, and K. Tsogtbaatar (2009), The first discovery of pterosaurs from the Upper Cretaceous of Mongolia, *Acta Palaeontol. Pol., 54*(2), 231-242.
5. Shimada, K., T. Tsuihiji, T. Sato, and Y. Hasegawa (2010), A remarkable case of a shark-bitten elasmosaurid plesiosaur, *J. Vert. Paleontol., 30*(2), 592-597.
6. Tsuihiji, T. (2010), Reconstructions of the axial muscle insertions in the occipital region of dinosaurs: evaluations of past hypotheses on Marginocephalia and Tyrannosauridae using the Extant Phylogenetic Bracket approach, *Anat. Rec., 293*(8), 1360-1386.
7. Tsuihiji, T., M. Watabe, K. Tsogtbaatar, T. Tsubamoto, R. Barsbold, S. Suzuki, A. H. Lee, R. C. Ridgely, Y. Kawahara, and L. M. Witmer (2011), Cranial osteology of a juvenile specimen of *Tarbosaurusu bataar* (Theropoda: Tyrannosauridae) from the Nemegt Formation (Upper Cretaceous) of Bugin Tsav, Mongolia, *J. Vert. Paleontol., 31*(3), 497-517.
8. Noro, M., H. Yuguchi, T. Sato, T. Tsuihiji, S. Yonei-Tamura, H. Yokoyama, Y. Wakamatsu, and K. Tamura, K (2011), Role of paraxial mesoderm in limb/flank regionalization of the trunk lateral plate, *Dev. Dyn., 240*(7), 1639-1649.
9. Miyake, Y., M. Aramaki, T. Komatsu, T. Tsuihiji, M. Manabe, and R. Hirayama (2011), Depositional facies containing non-marine vertebrate fossils in the Upper Cretaceous Himenoura Group on the Koshikijima Islands, Kagoshima, Japan, *J. Sedimentol. Soc. Jap. 70*(2), 62.

(2) Selected Conference Proceedings

(3) Review Papers

1. Tsuihiji, T., (2009), How to read the evolutionary tree of dinosaurs, *Milsil, 2*(2), 12-14. (non-reviewed article, in Japanese)
2. Tsuihiji, T., (2010), From dinosaurs to birds – evolution of the brain and neck, *Kagaku, 80*(11), 1109-1113. (non-reviewed article, in Japanese)

(4) Books

(All coauthored)

1. Dictionary of Paleontology (2010, Asakura Publishing Company, 12 items, reviewed, in Japanese)
2. Guidebook of BONES (2009, Gunma Museum of Natural History, non-reviewed, in Japanese)
3. Guidebook of Dinosaur Expo 2011 (2011, Asahi Newspaper Company, 12 articles, non-reviewed, in Japanse)

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Saurischia) braincase from the Lower Cretaceous of the eastern Gobi Desert in Mongolia. 71th Annual Meeting, Society of Vertebrate Paleontology, November 2-5, 2011, Las Vegas, Nevada, U.S.A. (general session)

And 11 other presentations

(2) Domestic Conferences

2. Tsuihiji, T., and M. Manabe. Production of a 3D digital atlas of a pterosaur *Anganguera piscator* based on micro-CT scan data. 160th Meeting, Paleontological Society of Japan, January 28-30, 2011, Kochi University, Kochi, Japan. (general session)

And 2 other presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

(3) International Conferences

· Member of the organization committee, 4th International Symposium of the International Geoscience Programme Project No. 507 (December, 2009)

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

[Public lectures]

· "Environmental adaptations of dinosaurs clarified through anatomical reconstructions" (Suginami Science Center, Tokyo, February 28, 2009)

· "*Stegosaurus* and its allies" （Shizuoka Science Center Ru・Ku・Ru, Shizuoka, February 6, 2011）

· "Biology of dinosaurs – from anatomy reconstructions to growth and evolution" （Symposium on Dinosaur Fossils in Tamba, Shiki no Mori Lifelong Learning Center, Hyogo, October 22, 2011）

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and

Researchers Abroad

Hosting
- Foreign Students: 0
- Foreign Researchers: 0

Sending
- Japanese Students: 0
- Japanese Researchers: 0

Visitors from Abroad: 0

Shigenori Ogihara

I. C.V.

Name : Shigenori OGIHARA
Present Position: Assistant Professor, University of Tokyo, Graduate School of Science

Education

B. Sc., Mineralogy, March, 1984 Tohoku University, Department of Science
M. Sc., Mineralogy and Sedimentary Petrology, March, 1986 Tohoku University, Department of Science
Ph. D., Mineralogy and Sedimentary Petrology, March, 1989 The University of Tokyo, Graduate School of Science

Professional Experience

April, 1989-
Assistant Professor, Department of The University of Tokyo, Graduate School of Science

II. Scientific Research Activity

2. Major achievements

(1) Research of the zeolitization during early diagensis

The volcanic glasses in the silisic tuffs changes to clinoptiloite and analcime with increasing of burial depth during early diagenesis. The author clarified phase change mechanism of volcanic glass to clinoptiloite, and clinoptilolite to analcime. Na-K type clinoptilolite changed to Na-type clinoptilolite by cation exchange mechanism before phase change. Na-clinoptiolite was once dissolved, and analcime precipitated at the space after Na-clinoptilolite dissolved. We clarified that the phase change mechanism of the clinoptilolite to analcime can be explained as microdissolution-precipitation by the SEM observation and EDS analysis

(2) Research of the phosphorite from oil Tertiary at the districts along Japan Sea

The difference of Japanese oil Tertiary (Onnagawa and Hunakawa formation) and Montery F. (West Coast of USA) is lack of phosphate facies in Japanese oil Tertiary. This is a

This has been a mystery for years for a geologist. We discovered independently the horizon in which phosphate nodules could be discovered from the Funakawa formation. The author analyzed the phosphate nodule inorganically and organically, and pointed out the importance of the role which the bacteria in the accumulation process of the phosphorus in the sediment.

(3) Research of the chemosynthtic community at the cold-seep carbonate environment

The wonderful limestone was an old mystery for the Cretaceous geologist (paleontologist) of Hokkaido. The author conducted carbonate carbon isotope analysis and biomarker analysis about two or more limestone bodies, and proved that these are cold-seep limestones. Furthermore, the crowd of anaerobic methane-oxidizing Archea was specified.

Authorization of the cold-seep limestone by a biomarker used crocetane and pentamethylicosane (PMI) and ether bond C40-isoprenoid which are the membrane lipid origin of anaerobic methane oxidation Archea. In order that these compounds may classify remarkably the isotope of the methane used by anaerobic methane oxidation Archea, it is the feature to have

unusually light carbon isotope composition. We detected the ketone which showed extremely light carbon isotope composition from two cold-seep limestone bodies of Hokkaido. About the origin of these compounds, a possibility of being the membrane lipid origin of anaerobic methane oxidation Archea was shown from carbon isotope composition. We advocated that these compounds were compounds which can be used for anaerobic methane oxidation authorization.

3. Five Important Papers in your career

1. S. Ogihara and Iijima, A. (1989), Clinoptilolite to heulandite transformation in burial diagenesis, In "Zeolite Facts, Figures, Future" Jaobs, P.A. & Santen, R.A. eds. Elsevier, Amsterdam, 491-500.
2. S.Ogihara (1996), Diagenetic transformation of clinoptilolite to analcime in silicic tuffs of Hokkaido Japan, *Minerallium Deposita,* 30, 548-553.

These papers clarified that the phase change mechanism of the clinoptilolite to analcime can be explained as microdissolution-precipitation by the SEM observation and EDS analysis

3. S. Ogihara (1999), Geochemical characteristics of phosphorite and carbonate nodules from the Miocene Funakawa Formation, western margin of the Yokote Basin, northeast Japan, *Sedimentary Geology*, 123, 255-268.

The author analyzed the phosphate nodule inorganically and organically, and pointed out the importance of the role which the bacteria in the accumulation process of the phosphorus in the sediment.

4. S.Ogihara (2005), Evolution of the chemosynthetic community in a cold-seep carbonate precipitating environment, *Kaseki,* 78,40-46.
5. S, Ogihara. (2008), An organic geochemical investigation of cold seep carbonates from central Hokkaido, northern Japan, *Geochemical Journal,* 42, 421-427.

We detected the ketone which showed extremely light carbon isotope composition from two cold-seep limestone bodies of Hokkaido, and advocated that these compounds were compounds which can be used for anaerobic methane oxidation authorization.

4. Awards and Honors throughout your career

· S. Yamakita, N. Kadota, R. Tada, S. Ogihara, E. Tajika and Y. Hamada, Geological Society Japan, Koto Prize, 2000.

5. Future Research Plan

(1) Research on the methane hydrate of the Japan Sea

The Research Consortium for the Study of Shallow Gas Hydrates: RC-SGH was started in this October. I will take charge of analysis of sediment, especially organic geochemical analysis. The purpose of my research is to clarify time change of a methane flux by quantifying a biomarker characteristic of a methane flux. We clarify three-dimensional distribution of a biomarker, think together with change of the geographical feature by extensive seepage of methane, and clarify historical changes of a methane flux. For the move mechanism elucidation of a hydrate, I analyze the hydrate itself and show clearly what kind of compound it is moving together with. The hydrate of the Sea of Japan is white. If the hydrate is moving

with oil, it should become yellow (brown), for example, differs greatly as compared with the hydrate from the Mackenzie delta.

We argue as compared with the data of other areas.

Furthermore, I conduct biomarker analysis on the theme of the environmental change of the Sea of Japan using the Sea of Japan superficial deposit extracted simultaneously with a hydrate sample. Especially the dark color layer (TL layer) frequently inserted into a sediment is the characteristic sediment which recorded the environmental perturbation of the Sea of Japan. Inorganic organic geochemistry analysis is conducted about these, and it argues about the environmental change of the Sea of Japan together with the time theory which the associate established.

(2) Research of the chemosynthtic community at the cold-seep carbonate environment

Methane oxidation Archea which lives together with a sulfate reducer and is performing methane oxidation is classified into ANME-1 and ANME-II (and ANME-III) from gene information. It is possible to classify these according to biomarker analysis similarly.

Classifying especially about a geological sample is possible only by biomarker analysis. In earlier literature, ANME-1 was detected from the old time such as Devonian age.

As opposed to this, the view that ANME-II extended distribution after the Eocene is common. I have analyzed organic geochemically the cold-seep carbonate of a Hokkaido chalk for years. And the idea that diffusion of ANME-II has developed by this at the time of the oceanic anoxic event in Aptian/ Albian boundary was suggested. This opinion is proved based on detailed analysis. The samples used for research are the sample extracted by the field survey over 20 years or more, and a sample of the National Science Museum collection. From these samples, an ANME kind is specified by analyzing the membrane lipid of methane oxidation Archea. Using an analysis result and the age information on a sample, the time when ANME-II extended distribution by the chalk system of Hokkaido is specified.

There are many mysteries about the paleoecology of *Inoceramus*. We examine in detail the microbe biomarker detected from *Inoceramus* based on the hypothesis that *Inoceramus* was a chemosynthetic.

6. Funding Received

(1) JSPS Grants

- Grant-in-Aid for Scientific Research (C) Evolution and diffusion of a microbe accompanying paleoenvironment change 2006-2007 ¥3700000
- Grant-in-Aid for Scientific Research (C) Paleoecology of *Inoceramus* clarified by a biomarker 2011-2013 ¥3620000

(2) Cooperative Research

(3) Research Contracts

(4) Grants and Gifts

- Research support of University of Tokyo role of guano at the formation of phosporite 2007 ¥2000000
- Research support of Tokyo Chigaku Kyoukai Organic Geochemical study of Chilean Saltpeter 2010 ¥500000

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Ogihara, S. and Y. Kakuwa (2007), Composition of diamondite in black shale alternated with Bedded chert, *Res.Org. Geochem.*, 22,19-30.
2. Ogihara, S. (2007), Highly branched isoprenoid hydrocarbon from Lake Cingtao, *Res.Org. Geochem.*, 22, 57-64.
3. Ogihara.S., R. Matsumoto and Y. Chen (2007), An organic geochemical study of KP-2 core on the mud volcano at Nankai Trough, *J. of Geochemical Exploration,* 95, 81-87.
4. Takeuchi, R., R. Matsumoto, S. Ogihara and H. Machiyama (2007), Methane-induced dolomite "chimneys" on the Kuroshima Knoll, Ryukyu island, Japan, *J. of Geochemical Exploration*, 95, 16-28.
5. S, Ogihara (2008), An organic geochemical investigation of cold seep carbonates from central Hokkaido, northern Japan, *Geochemical Journal*, 42, 421-427.
6. Ogihara, S. and T. Hirasawa (2008), GC/MS analysis of C10-C13alkylbenzenes, *Res.Org. Geochem*. , 23, 131-138.
7. Sugiyama, K. and S. Ogihara（2008),Series of natural zeolites (1)clinoptiloliteand heulandite, *Zeolite*, 25, 155-161.
8. Ogihara, S., T. Ishizaki and R. Matsumoto(2009), Oganic Geochemical study of sediment core sample collected from Natsushima 06-19 Cruise, *Journal of Geography*, 119, 128-135.
9. Ogihara, S. (2010) Composition of anaerobic methane oxidizing Archea at the methane seep site around Japan,*Res.Org. Geochem.,* 26, 129-138.
10. Ogihara, S. (2011) GC/MS analysis of diamondite in black shale alternated with bedded chert, *Res.Org. Geochem.,* 27, 149-154.

(2) Selected Conference Proceedings

(3) Review Papers

1. Ogihara, S.（2009）, Composition of methane oxidation Archea by biomarker analysis, *Monthly Chikyu,* 31 (9), 520-514. Non-refereed

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. S. Ogihara The role of bacteria in the formation of phosphorite nodules from Late Pleistocene Kusu Basin, northern Kyushu, Japan. 17 th International Sedimentary Congress 8/28-9/1 2006 Hukuoka. Regular

(2) Domestic Conferences

2. Ogihara, S. Geochemical study of methane-seep carbonate at Izura, Annual meeting of Japan Organic Geochemical Scoiety, 27th Symposium 8/5-8/7 2009 Matsue General

and 9 other talks

III. Educational Activity (2002-2011)

9. Notable achievements in education

· The result of practice of analytical equipment for graduate student was contributed to the paper. Ogihara, S and T. Hirasawa(2008), GC/MS analysis of C10-C13alkylbenzenes, *Res.Org. Geochem*. , 23, 131-138.

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· 2003-2004 Head of the secretariat, Japan Organic Geochemical Society

· 2005-2006 Assistant head of the secretariat, Japan Organic Geochemical Society

· 2011 Executive secretary, Carbonate Colloquium

(2) Academic Societies

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 0

Foreign Researchers: 0

Sending

Japanese Students: 0

Japanese Researchers: 0

Visitors from Abroad: 0

Michinari Sunamura

I. C.V.

Name： Michinari Sunamura
Present Position: Assistant Professor, University of Tokyo, Graduate School of Science

Education

B. Ag., Aquaculture, The University of Tokyo, March, 1992
M. Ag., Aquatic biology, The University of Tokyo, March, 1994
Ph. D., Aquatic biology, The University of Tokyo, March, 1997

Professional Experience

Sep, 1997-Sep., 2001, Research Fellow, Mitsubisi Kasei Institute of Life Scicence
Sep, 2001-Mar., 2003, Post doctoral fellow, Department of No. 7, Advanced and Industrial Science and Technology
April, 2003-, Assistant Professor, Department of Earth and Planetary Science, The university of Tokyo

II. Scientific Research Activity

2. Major achievements

Microbial ecosystem is influenced by various environmental factors, such as energy source, oxygen, minerals, habitats, and interaction among organisms. On the other hand, microbial ecosystems have affected environments and various chemical reactions on the earth throughout the long history of the earth.

My recent research objectives are to determine the biogeochemical carbon, nitrogen, sulfur flux across the seafloor, especially to quantify the interaction between geochemical factors and microbial populations. For this purpose, 1.) I developed and introduce novel microscopic methods to quantify microbial communities at a single cell level, 2.) I investigated the microbial community structures and quantify microbial communities around the hydrothermal and methane seep area, and 3.) I investigated the heat and chemical flux across the seafloor and biogeochemical cycle around the deep-sea hydrothermal and methane seep fields.

1.) Development of quantification methods for environmental microbes at a single cell level. High accuracy or high throughput analysis of cells at a single cell level is recommended to adapt the era of next generation sequencers. We developed a Rainbow-FISH method, which enables to simultaneous analysis of 7 different microbial phylotypes in the natural environment at a single cell level (Sunamura & Maruyama 2006). In addition, we introduce several novel observation techniques and high throughput analysis technique, e.g. CARD-FISH, Gold labeling FISH, SEM-EDS-FISH, MAR-FISH, and flow cytometry, and applied to natural environment.

2.) Microbial community structures and activities in the deep sea. Based on our analytical methods, we investigated distribution, quantification of cell density, activity, and meta-genome analysis of the most abundant and important oceanic-thiotroph named SUP05 phylotype, which was first described in Suiyo seamount hydrothermal plume (Sunamura et al. 2004) In addition, other thiotrophic oxidizer, iron oxidizer, methane oxidizers were investigated at various hytrothermal systems and methane seep sediment, i.e. hot spring (Hirayama et al. 2007, Mori et al. 2008), southern Mariana trough (Kato et al. 2009), and Okinawa trough (Yanagawa et al.

2012), and Japan sea (Yanagawa et al. 2011).

3.) Estimation of chemical flux across seafloor and geochemical cycling around seafloor. The chemical flux across the sea floor is estimated by heat flux measurement and modeling. We started to direct measurement of chemical and biological flux across seafloor by high resolution 3D observation of deep sea using autonomus underwater vihcle with Kochi Univ. and JAMSTEC.

3. Five Important Papers in your career

1. Sunamura, M., Y. Higashi, C. Miyako, J. Ishibashi, and A. Maruyama (2004), Two Bacteria phylotypes are predominant in the Suiyo Seamount hydrothermal plume, *Applied and Environmental Microbiology*, *70*(2), 1190-1198.

Total citation in Web of Science: 53. First finding of most abundant sulfur oxidizer SUP05 in the seawater.

2. Sunamura, M., A. Maruyama, T. Tsuji, and R. Kurane (2003), Spectral imaging detection and counting of microbial cells in marine sediment, *J. Microbiol. Meth.*, *53*, 57-65.

Total citation in Web of Science: 11. Development of detection method for sediment microbes using fluorescent spectrum.

3. Mori, K., M. Sunamura, K. Yanagawa, J.-i. Ishibashi, Y. Miyoshi, T. Iino, K.-i. Suzuki, and T. Urabe (2008), First Cultivation and Ecological Investigation of a Bacterium Affiliated with the Candidate Phylum OP5 from Hot Springs_, *Applied and Environmental Microbiology*, *74*, 6223-6229.

Total citation in Web of Science: 12. First finding and isolation of microbe at a novel phylum level.

4. Hirayama, H., M. Sunamura, K. Takai, T. Nunoura, T. Noguchi, H. Oida, Y. Furushima, H. Yamamoto, T. Oomori, and K. Horikoshi (2007), Culture-Dependent and -Independent Characterization of Microbial Communities Associated with a Shallow Submarine Hydrothermal System Occurring within a Coral Reef off Taketomi Island, Japan, *Applied and Environmental Microbiology*, *73*, 7642-7656.

Total citation in Web of Science: 31. Community structure analysis in shallow water hydrothermal system in photosynthetic zone.

5. Yanagawa, K., Morono, Y., de Beer, D., Haeckel, M., Sunamura, M., Futagami, T., Hoshino, T., Terada, T., Nakamura, K., Urabe, T., Rehder, G., Boetius, A. and Inagaki, F. (2012), Metabolically active microbial communities in marine sediment under high-CO2 and low-pH extremes, *ISME J.*, in press

Total citation in Web of Science: 0. Microbial adaptation and ecological signatures in liquid CO2 containing marine sediment for future CO2 strage plan beneath the seafloor.

4. Awards and Honors throughout your career

5. Future Research Plan

Physiological and genomic information of microbes is rapidly increasing because of rapid and cheap determination of genome sequences by next generation sequencers. To apply these information to the development of earth sciences, quantitative analysis takes an important role

to combine the functions with biogeochemical cycles. My research plan in next decade is the quantification of the biogeochemical and ecological flux across the seafloor to investigate the relationship between the earth and microbial communities.

(1) High accuracy and resolution 3D-observation of deep sea water column structures: Observation and sampling of deep sea has been conducted using wired sensor systems e.g.CTD, XBT, and ROV. Autonomous underwater vehicle is useful tool for deep sea researches because it offers us broad area observation with quick, high resolution, and high accuracy observation. We are planning to develop observatory methods for deep sea with JAMSTEC and Kochi University. Our plan include 1.1) efficient data treatment, calculation, and presentation of in situ sensors, 1.2) high density of sampling by novel water sampler and developing high throughput microbial analysis for a lots of water samples, 1.3) development of in situ microbial cell analyzer, and 1.4.) developing methods for 3D water column analysis using acoustic imaging techniques with AUV. Using these data, we will estimate the biogeochemical flux across the seafloor. We are planning to apply fund for in situ microbial sensors and research cruises using AUV "Urashima".

(2) Study on constraint of deep sea and deep sea hydrothermal microbial ecosystems: SUP05 phylotype is most abundant sulfur oxidizer in the ocean. They appear in deep sea hydrothermal plumes and oxygen minimum zone and influence on sulfur, carbon, and nitrogen cycles. I'm planning to determine the community structure variation and their activities for the quantification of their effect on biogeochemical cycles. These data will be useful to consider the ocean anoxic events and snow ball earth events in earth's history. I also plan to investigate the microbial activity and community in extra deep sea, more than 6,000m in deep through the collabolation with JAMSTEC. We will study on the mechanisms of adaptation of microbial community against high pressure and relations between microbial community and energy flow, especially from the sediment resuspension by earthquake. Moreover, I started to research the relation between microbiological community and wethering process of rocks through a collaboration with TITEC.

6. Funding Received

(1) JSPS Grants

- Grand in aid for young scientist (B) A study on constraint of chemolithoautotrophic microbial communitiesin deep-sea methane seep and hydrothermal area. H17-18、3,500,000JPY
- Grand in aid for fundamental research (B), representative: Prof. T. Urabe, Tolerant effect of microbes against high temperature by absorption on hydrothermal mineral surfaces. H18-19
- Grand in aid for fundamental research (A) representative: Prof.K. Kogure, A Study on molecular ecology of non-extremephile archaea in middle and deep sea. H18-20, 1,500,000JPY
- Grand in aid for fundamental research (C) representative: Assistant Prof.S. Ogiwara. Microbial evolution and dispersal with paleoenvironmental changes. H18-20
- Grand in aid for fundamental research（A）representative: Prof.R. Matsumoto, A total study on the methane hydrate and methane seeps on eastern Japan sea. H19-22
- Grand in aid for innovation scientific area " Project TAIGA" Research group A02, Biogeochemical effect on TAIGA to deep sea.H20-24,127,000,000JPY

(2) Cooperative Research

(3) Research Contracts

· AIST (Original client: the Ministry of the Environment), An investigation of analytical and measurement methods for environmental microbial communities. 2008-2009, 2,500,000JPY

(4) Grants and Gifts

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Sunamura, M., and A. Maruyama (2006), A digital imaging procedure for seven-probe-labeling FISH (Rainbow-FISH) and its application to estuarine microbial communities, *FEMS Microb. Ecol.*, *55*, 159-166.
2. Kitazawa, K., Oji, T., and Michinari Sunamura. (2007) Food composition of crinoids (crinoidea: echinodermata) in relation to stalk length and fan density: their paleoecological implications. *Mar. Biol., 152,* 959-968
3. Hirayama, H., M. Sunamura, K. Takai, T. Nunoura, T. Noguchi, H. Oida, Y. Furushima, H. Yamamoto, T. Oomori, and K. Horikoshi (2007), Culture-Dependent and -Independent Characterization of Microbial Communities Associated with a Shallow Submarine Hydrothermal System Occurring within a Coral Reef off Taketomi Island, Japan, *Applied and Environmental Microbiology*, *73*, 7642-7656.
4. Mori, K., M. Sunamura, K. Yanagawa, J.-i. Ishibashi, Y. Miyoshi, T. Iino, K.-i. Suzuki, and T. Urabe (2008), First Cultivation and Ecological Investigation of a Bacterium Affiliated with the Candidate Phylum OP5 from Hot Springs_, *Applied and Environmental Microbiology*, *74*, 6223-6229.
5. Kato, S., K. Hara, H. Kasai, T. Teramura, M. Sunamura, J. Ishibashi, T. Kakegawa, T. Yamanaka, H. Kimura, K. Marumo, T. Urabe, and A. Yamagishi (2009), Spatial distribution, diversity and composition of bacterial communities in sub-seafloor fluids at a deep-sea hydrothermal field of the Suiyo Seamount, *Deep-Sea Research Part I-Oceanographic Research Papers*, *56*(10), 1844-1855.
6. Kato, S., K. Yanagawa, M. Sunamura, Y. Takano, J. i. Ishibashi, T. Kakegawa, M. Utsumi, T. Yamanaka, T. Toki, T. Noguchi, K. Kobayashi, A. Moroi, H. Kimura, Y. Kawarabayasi, K. Marumo, T. Urabe, and A. Yamagishi (2009), Abundance of Zetaproteobacteria within crustal fluids in back-arc hydrothermal fields of the Southern Mariana Trough, *Environ Microbiol*, *11*, 3210-3222.
7. Yanagawa, K., M. Sunamura, M. A. Lever, Y. Morono, A. Hiruta, O. Ishizaki, R. Matsumoto, T. Urabe, and F. Inagaki (2011), Niche Separation of Methanotrophic Archaea (ANME-1 and -2) in Methane-Seep Sediments of the Eastern Japan Sea Offshore Joetsu, *Geomicrobiol. J.*, *28*, 118-129.

(2) Selected Conference Proceedings

(3) Review Papers

(4) Books

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Michinari Sunamura, Microbial population fed on deep-sea hydrothermal plumes , Okazaki Biology Conferences, Okazaki, Sep 2006 (Invited)
2. Michinari Sunamura, Takroh Noguchi, Kei Okamura, and Hiroyuki Yamamoto, Close correlation between Microbe and Geochemical composition in North-Western Pacific hydrothermal plume, 2010 InterRidgeJ Symposium, Kashiwa, Japan, Nov. 2010 (Invited)

and 7 other presentations

(2) Domestic Conferences

29 presentations

III. Educational Activity (2002-2011)

9. Notable achievements in education

· Student poster prize for Japan Bioimaging society, Katsunori Yanagawa et al. 2007

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

(2) Academic Societies

· Steering committee member for the 22nd meeting for Japanese society of Microbial Ecology, 2006

· A committee member of Program for Underground and subseafloor microbes in scientific promoter section, Japanese earth drilling consortium. 2006-2009

· A committee member of the election administration committee for Japan Geoscience Union. 2008, 2011

· Councilor for Japanese Society of Microbial Ecology. (2008-2011)

· A steering committee member for InterRidge (2010-)

(3) International Conferences

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Plan and hold symposium on Earth & Planetary Science, for High school & colledge students. Held in 2007, 2008, 2009, 2011

· Planed and held symposium by young scientists in faculty of Science. Held in 2006

· Supervised the educational video program planned by Japanese society of Microbial Ecology. 2010

12. Internal and External Committee Memberships (2006-2011)

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and

Researchers Abroad

Hosting
- Foreign Students: 0
- Foreign Researchers: 2

Sending
- Japanese Students: 0
- Japanese Researchers: 6

Visitors from Abroad: 0

Kazushige Tanabe

I. C.V.

Name : Kazushige Tanabe

Present Position: (retired on Mar. 31, 2012; now Emeritus Professor): Professor, University of Tokyo, Graduate School of Science

Education

B. Education., Geology, Yokohama National University, June, 1970
M. Sc., Geology, March, Kyushu University, 1973
Ph. D., Geology, March, Kyushu University, 1976

Professional Experience

April, 1976-Mar., 1980, Assistant Professor, Department of Geology, Kyushu University
April, 1980-Sept., 1986, Associate Professor, Department of Earth Science, Ehime University
Oct., 2009-April 1992, Associate Professor, Geological Institute, University of Tokyo
May, 1992-Mar.,1993, Professor, School of Science, University of Tokyo
April, 2011-, Professor, Graduate School of Science, University of Tokyo

Mar., 1991-Dec., 1991: Visiting Researcher at the American Museum of Natural History and Ohio University, USA

II. Scientific Research Activity

2. Major achievements

(1) High time resolution construction of the organism-environment interaction by using modern and fossil mollusks shell miroincrements.

Sclerochronological analysis of marked and recovered specimens of modern intertidal bivalve mollusks from the Japanese coasts revealed the presence of lunar day and annual increments, allowing us to mark calendar dates in the internal shell sequence. Based on this evidence, environmental factors controlling the shell microgrowth patterns of bivalves were analyzed quantitatively in the live-caught shells of *Phacosoma japonicum* and *Mytilus galloprovincialis* from Tokyo Bay, central Japan. The results show that seawater temperature is the main controlling factor for shell growth, though a number of mutually related environmental factors such as salinity and food availability also affect shell growth. Furthermore, sclerochronological analysis of 29 fossil shells of *P. japonicum* with known ^{14}C ages recovered from various sites in Japan demonstrated that the temporal trends of the life history traits (e.g., length of the growth period and the mean lunar daily growth rate at a given age) are strongly correlated with climate change in mid-latitude parts of East Asia over the past 8000 years. This fact, indicates that *P. japonicum* has changed its life history traits in response to Holocene terrestrial and coastal climate change. These results were published in the international jounals (*Marine Ecology Progress Series, Palaeogeography, Palaeoclimatology, Palaeoeecology, Aquatic Ecology*).

(2) High time resolution chronostratigraphy and spatio-temporal faunal analysis for the marine Cretaceous deposits in the Northeastern Pacific regions.

Marine Cretaceous deposits in the circum-North Pacific regions (Hokkaido, northern

California, southern Alaska, and Vancouver Island) were investigated to reveal the integrated chronostratigraphy such as magnetostratigraphy, micro- and mega-biostratigraphy, and chemostratigraphy). As a result, an almost complete chronostratigraphy ranging from the Hauterivian to the middle Turonian was established for the sequence exposed in the North Foik Cottonwood Creek, northern California (Fernando et al. 2011; *Island Arc*). We, furthermore, present high-resolution carbon-isotope and degree of pyritization (DOP) data from marine mid-Cretaceous sequences that formed along the continental margins of North America and Asia below the northeastern and northwestern Pacific Ocean. The predominance of low DOP values in these areas revealed that the continental margins of the Pacific Ocean were oxic for most of theOceanic Anoxic Event 2 interval 94 million years ago (Takashima et al. 2011: *Nature Communications*). Our analysis of macrofaunas from the Northern Pacific (Tanabe et al. 2008: *Jour. Paleontology*; Iba et al. 2011: *Geology*) also demonstrated that a turnover from belemnites to the modern types of cephalopods already occurred about 35 m.y. before the Cretaceous−Paleogene event in the North Pacific.

(3) Research on ammonoid early ontogeny

Sequence of embryonic shell development in Mesozoic ammonoid cephalopods was described for the first time on the basis of SEM and EDS examinations of exceptionally well preserved fossil materials retaining original aragonite shell mineralogy and microstructure that were recovered from Hokkaido, Russia, Poland, and USA (Tanabe et al. 2009: *Amer. Mus. Novitates*; Tanabe et al. 2010: *Tokai Univ. Press*). Based on the obtained results, reproductive strategy and early life history of ammonoids were considered by comparing with those of other modern and fossil cephalopods.

3. Five Important Papers in your career

1. Tanabe, K., 1979: Palaeoecological analysis of ammonoid assemblages in the Turonian *Scaphites* facies of Hokkaido, Japan. *Palaeontology*, 22, 609-630.

Turonian ammonoid assemblages from the Cretaceous fore-arc basin deposits in Hokkaido, Japan were analyzed paleoecologically, with special reference to their mode of occurrence, preservation, spatial distribution, and species diversity. As a result, it was revealed that distribution patterns of individual species are closely related to the lithofaicies, suggesting a variety of habitats and modes of life in Cretaceous ammonoids. This paper has been continuously cited in paleoecological text-books and papers during the last three decades (total number of citations in ISI index journals is 47).

2. Tanabe, K., N. H. Landman, R. H. Mapes, and C. J. Faulkner, 1993: Analysis of a Carboniferous embryonic ammonoid assemblage from Kansas, U.S.A.- Implications for ammonoid embryology. *Lethaia*, 26, 215-224.

We reported, for the first time, a clustered occurrence of minute ammonoids without a nepionic constriction from the Carboniferous of Kansas, USA. SEM observations of these minute ammonoids indicate that they laid as egg masses, developed as embryonic shells within egg capsules, and mass-killed before hatching. Thus, our discovery provided a firm evidence to support the direct development model of ammonoids, and strongly suggest that ammonoids had *r*-type reproductive strategy that was characterized by a large number of offspring and a short embryonic stage. This paper has been cited 25 times in the ISI-index journals.

3. Landman, N. H., J. K. Cochran, D. M. Rye, K. Tanabe, and J. M. Arnold, 1994: Early life history of *Nautilus*: evidence from isotopic analysis of aquarium-reared specimens.

Paleobiology, 20, 40--51.

The life history and ecology of *Nautilus* (externally shelled cephalopods) have long been unknown, owing much to their relatively deep-water habitats in the tropical SW Pacific. We analyzed the oxygen isotopic compositions of the septa of specimens raised in aquaria under controlled temperature conditions. Our results indicate that both embryonic and postembryonic septa are secreted with the same temperature-dependent fractionation of aragonite relative to water. The $\delta^{18}O$ values of the septa thus provide a reliable means of determining the water temperature in which the septa form. The increase in $\delta^{18}O$ values in postembryonic septa commonly observed in specimens capture in a wild, accordingly, reflects a migration into a colder, deeper water after hatching. This study provides a firm basis to study the life history and habitat of extinct shelled cephalopods such as nautilids and ammonoids based on stable isotopic analysis, and has been cited 36 times in the ISI-index journals..

4. Landman, N. H., K. Tanabe, and Y.Shigeta, 1996: Embryonic development, in *Ammonoid Paleobiology*, edited by N. H. Landman, K. Tanabe, and R. A. Davis, Plenum Press, New York, pp. 343-405.

Current knowledge on the ammonoid embryonic shell morphology, ornament, and internal shell structure is described on the basis of previously published data and our own observations which over major taxa from the Devonian to the Cretaceous. Based on these data, sequence of embryonic shell development, post-hatching mode of life, and reproductive strategy of ammonoids are discussed. This paper is the first comprehensive summary of the ammonoid early ontogeny and development, and has been cited 42 times in the ISI-index journals.

5. Schöne, B.R., K. Tanabe, D.L. Dettman, and S. Sato, 2003: Environmental controls on shell growth rates and $\delta^{18}O$ of the shallow-marine bivalve mollusk *Phacosoma japonicum* in Japan. *Marine Biology*, 142, 473-485, doi: 10.1007/s00227-002-0970-y.

Environmental factors controlling the shell microgrowth of bivalve mollusks were examined in a venerid *Phacosoma japonicum* (Reeve) from the Japanese coasts as a model species. Slecrochronological analyses of marked and recovered specimens from the Seto Inland Sea indicate that a pair of two microgrowth lines and two microgrowth increments is produced every lunar day. This finding makes it possible to assign exact calendar dates to each portion of the shell. Combined analysis of sclerochronology and shell oxygen isotopic ratios reveals that the growing period of this species is controlled mainly by surface temperatures over the wide geographic range of distribution, and that the lunar day incremental growth patterns in summer reflect the strength of summer monsoon. This study provides a firm basis for high time resolution analysis for the biotic response to the past, present and future marine climate change. This paper has been cited 56 times in the ISI-index journals.

4. Awards and Honors throughout your career

- Jan. 31, 1975. Best Paper Award, Palaeontological Society of Japan
- Jan. 29, 1982. Research Award, Palaeontological Society of Japan
- June12, 2010. Society Award (Yokoyama Medal), Palaeontological Society of Japan
- Oct. 2, 2011. The Paleontological Society, Fellow

5. Future Research Plan

I have retired from the University of Tokyo on March 31, 2012, so that this item is unnecessary for outside review of the Department of Earth and Planetary Science.

6. Funding Received

(1) JSPS Grants

· Grant-In-Aid for Scientific Research (C). Planning and research for 7th International Symposium, Cephalopods-Present Past, Sapporo, 2007. Research interval: 2006. Project no.: 18634009. Total amount of subsidy: 2,400,000 JPY

· Grant-In-Aid for Scientific Research (B). Project title: High time resolution chronostratigraphy and spatio-temporal faunal analysis for the marine Cretaceous deposits in the Northeastern Pacific regions. Research interval: 2006-2008. Project no.: 18403013. Total amount of subsidy: 16,580,000 JPY

· Grant-In-Aid for Scientific Research (B). Project title: High time resolution construction of the organism-environment interaction by using modern and fossil mollusks shell miroincrements. Research interval: 2008-2010. Project no.:20340143. Total amount of subsidy: 18,590,000 JPY

· Grant-In-Aid for Scientific Research (B). Project title: High resolution analysis on the response of life history traits to marine environment during the ice- and green house- ages. Research interval: 2011-2013. Project no.: 23340157. Total amount of subsidy: 15,900,000JPY

(2) Cooperative Research

· JSPS Bilateral Joint Project (Japan and Germany). Project title: High resolution analysis of marine climate dynamics in the northern Hemisphere based on bivalve sclerochronology and biogeochemistry. Research interval: 2010-2011. Total amount of subsidy: 4,870,000JPY

(3) Research Contracts

(4) Grants and Gifts

· Grant for operating 7th International Symposium, Cephalopods-Present Past, Sapporo, 2007. Inoue Foundation for Science. Total amount of subsidy: 700,000JPY

· Grant for operating 7th International Symposium, Cephalopods-Present Past, Sapporo, 2007. Kao Foundation. Total amount of subsidy: 100,000JPY

· Grant for operating 7th International Symposium, Cephalopods-Present Past, Sapporo, 2007. Tokyo Geographical Society. Total amount of subsidy: 300,000JPY

(5) Other

7. Publications and Patents (2006-2011)

(1) Refereed Original Papers

1. Tanabe, K., Y. Hikida, and Y. Iba, 2006: Two coleoid jaws from the Upper Cretaceous of Hokkaido, Japan. Journal of Paleontology, 80(1), 135-147.
2. Landman, N.H., C.J. Tsujita, W.A. Cobban, N.L. Larson, K. Tanabe, and R. L. Flemming, 2006: Jaws of Late Cretaceous placenticeratid ammonites: how preservation affects the interpretation of morphology. American Museum Novitates, 3500, 1-48.
3. Hayashida, N. and K. Tanabe, 2006: The mode of life and taxonomic relationship of a Japanese Miocene pectinid bivalve *Nanaochlamys notoensis.* Paleontological Research, 10(1), 1-10.

4. Landman, N.H., K. Polizzotto, R.H. Mapes and K. Tanabe, 2006: Cameral membranes in prolecanitid ammonoids from the Permian Arcturus Formation, Nevada. Lethaia, 39(4), 365-379, doi: 10.1080/002411601008395.

5. Miyaji, T., K. Tanabe and B.R. Schöne, 2007: Environmental controls on daily shell growth of *Phacosoma japonicum* (Bivalvia: Veneridae) from Japan. Marine Ecology Progress Series, 336, 141-150.

6. Jenkins, R., Y. Hikida, Y., A. Kaim, and K. Tanabe, 2007: Methane-flux-dependent lateral faunal changes in a Late Cretaceous chemosymbiotic assemblage from the Nakagawa area of Hokkaido, Japan. Geobiology 5, 127-139, doi:10.1111/j.1472-4669.2007.00106.x.

7. Kulicki, C., K. Tanabe, and N.H. Landman, 2007: Primary structure of the connecting ring of ammonoids and its preservation. Acta Palaeontologica Polonica 52 (4), 823-827.

8. Zakharov, Y.D., Y. Shigeta, K. Tanabe, Y. Iba, O.P. Smyshlyava, A.M. Popov, T.A. Velivetskaya and T.B. Afanasyeva, 2007: Campanian climatic change: isotopic evidence from Far east, North America, North Atlantic and Western Europe. Acta Geologica Sinica, 81, 1049-1069.

9. Tanabe, K., P. Trask, R. Ross, Y. Hikida, 2008: Late Cretaceous octobrachiate coeloid jaws from the circum-North Pacific regions. Journal of Paleontology, 82, 2, 429-439.

10. Ubukata, T., K. Tanabe, Y. Shigeta and H. Maeda, 2008: Piggyback whorls: a new theoretical morphologic model reveals constructional linkages among morphological characters in ammonoids. Acta Palaeontologica Polonica, 53 (1), 113-128.

11. Kaim, A., Y. Kobayashi, H. Echizenya, R.G. Jenkins and K. Tanabe, 2008: Chemosynthesis-based associations on Cretaceous plesiosaurid carcasses. Acta Palaeontologica Polonica, 53(1) 53(1), 97-104.

12. Jenkins, R.G., Y. Hikida, Y. Chikaraishi, N. Ohkouchi, and K. Tanabe, 2008: Microbially induced formation of coated grains in the Late Cretaceous methane-seep deposits of the Nakagawa area, Hokkaido, northern Japan. Island Arc, 17, 261-269, doi: 10.1111/j.1440-1738.2008.00616.x.

13. Tanabe, K., C. Kulicki, and N.H. Landman, 2008: Development of the embryonic shell structure of Mesozoic ammonoids. American Museum Novitates, 3621, 1-19.

14. Gupta, N.S., D.E.G. Briggs, N.H. Landman, K. Tanabe and R.E. Summons, 2008: Molecular structure of organic components in cephalopods: evidence from oxidative cross linking in fossil marine invertebrates. Organic Geochemistry, 39, 1405-1414, doi: 10.1016/j.orggeochem2008.06.008.

15. Nemoto, T. and K. Tanabe, 2008: New record of a rhyncholite (cephalopod upper jaw element) from the Maastrichtian of Hokkaido, Japan. Paleontological Research, 12(3), 303-306.

16. Iba, Y., S. Sano, P.W. Skelton, H. Kagi, and K. Tanabe, 2009: First record of Late Albian canaliculated rudist from northern California and re-assessment of *Durania? californica* Anderson, 1958. Cretaceous Research,30, 540-546, DOI: 10.1016/j.cretres.2008.10.001.

17. Yamamoto, A., K. Tanabe,. and Y. Isozaki, 2009: Lower Cretaceous fresh-water stromatolites from northern Kyushu, Japan. Paleontological Research, 13, 139-149.

18. Kruta, I., I. Rouget, N.H. Landman, K. Tanabe, and F. Cecca, 2009: Aptychi microstructure in Late Cretaceous Ancyloceratina (Ammonoidea). Lethaia, 42, 312-321, doi: 10.1111/j.1502-3931.2009.00154.x, 2.

19. Tada, Y., K. Fujikura, K. Oguri, H. Kitazato, and K. Tanabe, 2010: In situ fluorochrome calcein marking of deep-sea mollusks using a new growth chamber. Aquatic Ecology, 44, 217-222. doi: 10.1007/s10452-009-9290-3.

20. Miyaji, T., K. Tanabe, Y. Matsushima, S. Sato, Y. Yokoyama, H. Matsuzaki, 2010: Response of daily and annual shell growth patterns of the intertidal bivalve *Phacosoma japonicum* to Holocene coastal climate change in Japan. Palaeogeography, Palaeoclimatology, Palaeoecology, 286, 107-120. doi: 10.1016/j.palaeo.2009.11.032.

21. Ubukata, Y., K. Tanabe, Y. Shigeta, H. Maeda, and R.H. Mapes, 2010: Eigenshape analysis of ammonoid sutures. Lethaia, 43, 266-277. doi:10.1111/j.1502-3931.2009.00191.x.

22. Mapes, R.H., L.A. Doguzhaeva, H. Mutvei, N.H. Landman, and K. Tanabe, 2010: The oldest known (Lower Carboniferous-Namurian) protoconch of a rostrum-bearing coleoid (Cephalopoda) from Arkansas, USA: phylogenetic and paleobiogeographic implications. Ferrantia, 59, 114-125.

23. Tanabe, K. and Y. Hikida, 2010: Jaws of a new species of *Nanaimoteuthis* (Coleoidea: Vampyromorphida) from the Turonian of Hokkaido, Japan. Paleontological Research, 14, 145-150. doi:10.2517/1342-8144-14.2.145.

24. Shigeta, Y., K. Tanabe, and M. Izukura, 2010: *Gaudryceras izumiense* Matsumoto and Morozumi, a Maastrichtian ammonoid from Hokkaido and Alaska and its biostratigraphic implications. Paleontological Research, 14,196-201. doi:10.2517/1342-8144-14.3.202.

25. Okaniwa, Y., T. Miyaji, T. Sasaki, and K. Tanabe, 2010: Shell growth and reproductive cycle of the Mediterranean mussel *Mytilus galloprovincialis* in Tokyo Bay. Plankton and Benthos Research, 5(Supplement), 44-50.

26. Tanabe, K., 2011: The feeding habits of ammonites. Science, 331, 37-38. doi 10.1126/science.1201002.

27. Takashima, R., H. Nishi, T. Yamanaka, T. Tomosugi, A. G. Fernando,' K. Tanabe, K. Moriya, F. Kawabe, and K. Hayashi, 2011: Prevailing oxic environments in the Pacific Ocean during the mid-Cretaceous Oceanic Anoxic Event 2 Nature Communications, 2:21x, doi:10.1038/ncomms1233.

28. Iba, Y., J. Mutterlose, K. Tanabe, S. Sano, A. Misaki, and K. Terada, 2011: Belemnite extinction and the origin of modern cephalopods 35 my prior to the K-P event. Geology, 39; 483–486; doi:10.1130/G31724.1

29. Fernando, A.G. S., H. Nishi, K.Tanabe, K. Moriya,Y. Iba, K. Kodama, M.A. Murphy, and H. Okada, 2011: Calcareous nannofossil biostratigraphic study of forearc basin sediments: The Lower to Upper Cretaceous Budden Canyon Formation (Great Valley Sequence), northern California, USA. Island Arc, 20, 346-370, doi:10.1111/j.1440-1738.2011.00770.x

30. Iba, Y., S. Sano, and K.Tanabe, 2011: A Tethyan bivalve, *Neithea* (Cretaceous pectinid) from northern California. Paleontological Research, 15, 79-84; doi:10.2517/1342-8144-15.2.079

(2) Selected Conference Proceedings

1. Tanabe, K., C. Kulicki, N.H. Landman, and A. Kaim, 2010: Tuberculate micro-ornamentation on embryonic shells of Mesozoic ammonoids: Microstructure, taxonomic variation, and morphogenesis. In Tanabe, K., Y. Shigeta, T. Sasaki, and H. Hirano (eds.) Proceedings of the 7th International Symposium, Cephalopods-Present and Past. Tokai Univ. Press, Tokyo, pp. 105-121.

2. Sasaki, T., S. Shigeno, and K. Tanabe, 2010: Anatomy of living *Nautilus*: Reevaluation of primitiveness and comparison with Coleoidea. In Tanabe, K., Y. Shigeta, T. Sasaki, and H. Hirano (eds.) Cephalopods-Present and Past. Proceedings of the 7th International Symposium. Tokai Univ. Press, Tokyo, pp. 35-66.

3. Kashiyama, Y., N.O. Ogawa, Y. Chikaraishi, N. Kashiyama, S. Sakai, K. Tanabe, and N. Ohkouchi., 2010: Reconstructing the life history of modern and fossil nautiloids based on the nitrogen isotopic composition of shell organic matter and amino acids. In Tanabe, K., Y. Shigeta, T. Sasaki, and H. Hirano (eds.) Cephalopods-Present and Past. Proceedings of the 7th International Symposium. Tokai Univ. Press, Tokyo, pp. 67-75.

4. Fuchs, D. and K. Tanabe, 2010: Re-investigation of the shell morphology and ultrastructure of the Late Cretaceous spirulid coleoid *Naefia matsumotoi.* In Tanabe, K., Y. Shigeta, T. Sasaki, and H. Hirano (eds.) Cephalopods-Present and Past. Proceedings of the 7th International Symposium. Tokai Univ. Press, Tokyo, pp. 195-207.

(3) Review Papers

1. Takahashi, A., Y. Hikida, R.G. Jenkins, and K. Tanabe, 2007: Stratigraphy and megafauna of the Upper Cretaceous Yezo Supergroup in the Teshionakagawa area, northern Hokkaido, Japan. Excursion Guidebook, The 7th International Symposium, Cephalopods-Present and Past. Bull. Mikasa City Mus., 11, 25-59.

2. Ito, Y., R. Jenkins, T. Ichikawa, T. Sasaki, and K. Tanabe, 2008: Catalogue of type and cited specimens in the Department of Historical Geology and Paleontology of the University Museum The University of Tokyo, Part 5. The University Museum, The University of Tokyo, Material Reports, no. 74, 1-179.

(4) Books

1. Tanabe, K., Y. Shigeta, T. Sasaki, and H. Hirano (eds.), 2010. Cephalopods-Present and Past. Proceedings of the 7th International Symposium. Tokai Univ. Press, Tokyo

2. The Palaeontological Society of Japan (corresponding editors, Tanabe, K. and H. Kitazato), 2010. Encyclopedia of paleontology, 2nd Edition. Asakura Book Co., Tokyo (in Japanese).

(5) Patents

8. Selected Conference Presentations and Data on total number of presentations

(1) International Conferences

1. Tanabe, K., C. Kulicki, and N. H. Landman, Development of the embryonic shell structure in Mesozoic Ammonoidea. Seventh International Symposium, Cephalopods－Present and Past. Sept. 15, 2007. Hokkaido University Conference Hall, Sapporo. 「invited oral presentation」

2. Tanabe, K., P. Trask, R. Ross, and Y. Hikida, Late Cretaceous large octobrachiate coleoid jaws from the circum-North Pacific regions. Seventh International Symposium, Cephalopods －Present and Past. Sept. 16, 2007. Hokkaido University Conference Hall, Sapporo.「regular oral presentation」

3. Miyaji, T., Tanabe, K., Matsushima, M., Sato,S., Yokoyama, Y. and Matsuzaki, H., Response of daily and annual shell growth patterns of a shallow marine bivalve to Holocene coastal climate change in Japan: a case study on *Phacosoma japonocum* (Veneridae). 2nd International Sclerochronology Conference. July 26, 2010. University of Mainz, Mainz, Germany. 「regular oral presentation by K. Tanabe)

4. Tanabe, K., Comparative morphology of modern and fossil coleoid jaw apparatuses. 4th International Symposium on Coleoid Cephalophods. Sept. 7, 2011. State Museum of Stuttgart, Stuttgart, Germany.「invited oral presentation」

And other 7 talks

(2) Domestic Conferences

5. Tanabe, K., Development of the embryonic shell structure in Mesozoic Ammonoidea, 3rd Biomineralization Workshop. Dec. 2008. Graduate School of Agriculture and Fisheries, University of Tokyo.「regular oral presentation」
6. Tanabe, K., N. H. Landman,I. Kurta, and Gupta, N.S., Restoration of ammonoid jaw apparatus by considering taphonomy. Palaeontological Society of Japan, 158th Regular meeting. University of Ryukyu, Naha City. Jan. 2009.

And other 15 talks

III. Educational Activity (2002-2011)

9. Notable achievements in education

(1). List of graduate students who received a Ph.D. under my supervision.

	Name	Year	Current position
·	Kazuyoshi Moriya	2002	Post-doctoralFellow of Kanazawa University
·	Robert G. Jenkins	2005	JSPS Post-Doctoral Fellow at Yokohama Natn. University
·	Yasuhiro Iba	2008	Assistant Professor of Hokkaido University
·	Shiho Katsuno	2008	Researcher of Eisai Co.
·	Tsuzumi Miyaji	2008	Post-doctoral Fellow at Hokkaido University
·	Tai Kubo	2008	Researcher of Fukui Prefectural Dinosaur Museum
·	Koji Seike	2009	Assistant Professor of the AORI, University of Tokyo
·	Yohei Tada	2009	Technical employee of Japan Isotope Analytical Co.
·	Yuta Shiino	2009	Assistant Professor of University Museum, Univ. of Tokyo

(2). Number of graduate students who received M.Sc. under my supervision = 15

(3). Honors and award receipt records of graduate students and Post-doctoral fellows.

· Koji Seike. Best poster award from the Palaeontological Society of Japan. Jun. 2005.

· Yohei Tada. Best poster award from the Palaeontological Society of Japan. Jun. 2005.

· Robert G. Jenkins. Best poster award from the Palaeontological Society of Japan. Jan. 2007.

· Koji Seike. Best oral presentation award from the Sedimentological Society of japan. Mar. 2007

· Yuta Shiino. Best paper award from the Palaeontological Society of Japan. Jun. 2008.

· Yasuhiro Nakajima. Best poster award from the Palaeontological Society of Japan. Jan. 2008

· Yasuhiro Iba. Research Award (Ph.D) from the Graduate School of Science, University of Tokyo, Mar. 2008.

· Yasuhiro Iba. Inoue Research Award for Young Scientists. Jan., 2009.

· Yuta Shiino. The Award of the Alwyn Williams Fund. The 6th International Brachiopod

Congress, Melbourne, Australia. Feb., 2010.

· Kentaro Izumi. Research Award (M.Sc.) from the Graduate School of Science, University of Tokyo. Mar. 2012.

(4). Activity as a judge of dissertation by foreign scientists

· Christian Klug (Universität Zurich, Switzerland), dissertation for habilitation. 2007

· René Hoffmann (Frei Universit ät Berli, Germany), dissertation for Ph.D. 2009

IV. External Activities

10. Contributions to Academic Community (2002-2011)

(1) Journals editorships, etc.

· 2006-2008, The Island Arc, Editorial Advisory Board

· 2006 -2011, Paleontological Research, Associate editor

(2) Academic Societies

· 2006－present Palaeontological Society of Japan, Councilor

· 2006－present Member of the Organizing Committee, Japan Geoscience Union

· 2010. International Palaeontological Association, Nominations Committee member for 2011-2012

(3) International Conferences

· 2007. 7th International Symposium, Cephalopods－Present and Past (Hokkaido University, Sapporo, Japan, Sept. 14-17, 2007), Organizing Committee and Scientific Committee members.

· 2010. 8th International Symposium, Cephalopods－Present and Past (University of Burgundy and CNRS, Dijon, France, Aug. 30-Sept. 3, 2010), Scientific Committee member.

· 2010. 2nd International Sclerochronology Conference (ISC2010) (University of Mainz, Mainz, Germany, July 24-28, 2010), Organizing Committee member

· 2011. 4th International Symposium "Coleoid Cephalopods Through Time" (State Museum of Stuttgart, Stuttgart, Germany, Sept. 6-9, 2011), Scientific Board member

· 2011-. 9th International Symposium, Cephalopods－Present and Past (Universität Zürich, Switzerland, Sept. 4-14, 2014), Scientific Committee member

11. Outreach Activity (2006-2011) Cooperation with or Contributions to Society, etc.

· Nature and ammonites of Nakagawa Town, Hokkaido. Public lecture at the Nakagawa Town, Hokkaido. September, 2007.

· Paleobiology of ammonites. Public lecture at the Suginami Ward Science Hall, Tokyo. March, 2008.

· High-resolution ecological and environmental recors preserved in bivalve mollusk shell increments. Public lecture at the National Museum of Nature and Science, Tokyo. November, 2010.

· Dinosaur-Era animal's last meal found in its mouth . Discovery News, USA. January., 2011.

· Biological aspects of ammonites. Public lecture at the Historical Museum of Hokkaido,

Sapporo. November, 2011.

· Ammonoid Paleobiology. Atsuo Fukada Memorial Symposium, Fukada Geological Institute, Tokyo. December, 2011.

12. Internal and External Committee Memberships (2006-2011)

[External Committee]

· 2007. A judging committee of JSPS doctoral and post-doctoral Fellows.

· 2010. A judging committee of JSPS Scientific Research Grant.

[Internal Committee]

· 2006-2011. Committee member of the University Museum

· 2008. Chair of the Department of Earth and Planetary Science, School of Science

· 2009. Chair of the Department of Earth and Planetary Science, Graduate School of Science

V. International Exchange Activities (2002-2011)

13. Hosting Foreign Students and Researchers/Sending Students and Researchers Abroad

Hosting

Foreign Students: 2 [M.Sc.: 0, Ph.D.: 2 (Sweden: 1, Germany: 1)

Foreign Researchers: 6 [Germany: 2, Poland: 2, Sweden: 2]

Sending

Japanese Students: 1 [M.Sc.: 0, Ph.D.: 1]

Japanese Researchers: 2

Visitors from Abroad: 3