Summary Report on Plans for Proposed Department of Earth and Planetary Science

Graduate School of Science
The University of Tokyo

Prepared for External Evaluation
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1 Reorganization of Earth and Planetary Sciences in the Graduate School of Science

It has been proposed that four currently separate and independent Earth and planetary science-related departments---(1) Earth and Planetary Physics, (2) Geology, (3) Geography, and (4) Mineralogy---in the Graduate School of Science of The University of Tokyo should be merged into a single department, within the Graduate School of Science, tentatively named the Department of Earth and Planetary Science.

The primary goals of the proposed new department are to conduct research at an international standard in a wide range of sub-fields of Earth and planetary science, and to establish and maintain an educational program at a similarly high level. The educational program aims to train doctoral-level researchers who can become leading figures in their respective fields. However, it is expected that only about half of the graduate students who receive a Masters degree will continue on to the doctoral course; the remainder will take a variety of positions in government, industry, and education, where it is hoped that they will be able to make significant contributions to society. An important secondary objective of the new department is to contribute directly to society through participation in national and international programs of applied research in areas such as global climate change or mitigating earthquake hazards.

There long has been discussion of the possibility of forming a single department in Earth and planetary sciences in the Graduate School of Science. This was widely recognized to be desirable, as the importance of interdisciplinary research and education in Earth and planetary sciences continues to increase. Also, by forming a single unified department, a ``critical mass'' of researchers could be realized, flexibility in faculty appointments could be enhanced, and administrative efficiency could be improved. However, owing to the administrative procedures followed by Japanese national universities, such a merger requires cumbersome and time-consuming discussions and administrative procedures, so it was natural that there was reluctance to undertake the work needed to carry out such a merger. Actually there was some discussion of the possibility of a merger in the later 1980s, but this never reached a stage where there were serious prospects for its implementation.

1.1 New Kashiwa Campus of The University of Tokyo

At present The University of Tokyo has two main campuses, Hongo (where the Graduate School of Science is located), and Komaba. As part of the overall reorganization and expansion plans, The University of Tokyo is founding a third main campus, in Kashiwa, a suburb of Tokyo. (Until the buildings for the new campus are ready in several years, the various new and existing units that are scheduled to move to Kashiwa will have temporary quarters elsewhere.) A new unit, the Graduate School of Frontier Sciences, has been founded, and will begin to admit students in April 1999. This new Graduate School will move to the Kashiwa campus in several years. A majority of the faculty of this new Graduate School will come from the Graduate School of Engineering, but a significant minority will come from the Graduate School of Science, and some from various other Schools and Institutes. The transfers to the new unit will take place in April 1999, but were effectively decided in late 1997 and early 1998. Several of the present faculty members of the Department of Geography of the Graduate School of Science are slated to be transferred to this new unit, as a result of which the Department of Geography will fall below the number of faculty members necessary for a separate and independent department. Thus some administrative reorganization of the Earth and planetary sciences departments in the Graduate School of Science became necessary, so that, at a minimum, the remaining members of the Department of Geography could be merged into another department.

1.2 Proposal for new Department of Earth and Planetary Science

As discussed above, at least a partial reorganization of the Earth and Planetary Sciences departments in the Graduate School of Science became essential. Initially there was discussion of plans for a small-scale reorganization, in which, for example, only the Geography and Geology departments would be merged. However, after further discussions a broad consensus emerged that the need to perform a reorganization involving the Department of Geography should serve as the catalyst for a merger of all four Earth and planetary science departments in the Graduate School of Science, and that exploratory discussions were warranted.

The trend towards mergers of formerly separate departments in Earth and planetary sciences is global, and is due primarily to the increasingly interdisciplinary nature of research in this field. Notable examples of such mergers in recent years have occurred at MIT, the University of Cambridge, and the ETH Zurich. Our plans are thus broadly consistent with this international trend.

A committee of faculty from all four Earth and planetary science-related departments in the Graduate School of Science was formed in February 1998, and held two meetings each month to discuss various possibilities for a merger. In addition to the designated committee members, all faculty members from the four departments were free to attend as observers. Also minutes of the meetings and related correspondence were broadcast to all faculty in the four departments by email. As a result, all faculty were informed of the progress of discussions, and had a chance to contribute to them. Feedback from the administration of the University and Graduate School of Science was obtained on a continuing basis.

After extensive preliminary discussions, two options emerged in September 1998 as the main choices: (a) a complete merger, or (b) a merger in which the new department would be composed of two semi-autonomous sub-units, one of which would roughly correspond to the present Department of Earth and Planetary Physics, and the second of which would consist of the members of the other departments participating in the merger. The administration strongly stated that only (a) was a viable option, and the key faculty of three departments (Earth and Planetary Physics, Geology, and Geography) agreed to adopt this option. However, as at that time it appeared that the Department of Mineralogy would decline to participate, the merger of the other three departments was approved in principle by the faculty senate of the Graduate School of Science in October 1998. After further discussion, the faculty of the Department of Mineralogy decided to participate in the merger plan, and the merger of all four departments was approved in principle by the Dean and by the November 1998 meeting of the faculty senate of the Graduate School of Science.

Detailed planning for the merger is now being carried out. The plans must be finalized by May 1999. The plans must be approved by the Dean and the Faculty Senate of the Graduate School of Science, and by the University's central administration. As the University of Tokyo is a national university, the plan must then be submitted to the Ministry of Education, Science, Sports, and Culture (referred to as ``Monbusho'' in Japanese), which has ultimate authority. If the plan is approved by Monbusho, and the Ministry of Finance, the merger will take effect in the fiscal year which begins on April 1, 2000.

1.3 Earth and Planetary Sciences at The University of Tokyo

Less than half of the professorial faculty (full professors and associate professors) in Earth and planetary science at the University of Tokyo hold appointments in the Graduate School of Science. We refer to these faculty members as ``core faculty'' in this report.

The remaining faculty, refereed to as ``affiliated faculty'' in this report, hold appointments at one of the following other independent units or institutions.

- the Graduate School of Arts and Sciences at the Komaba Campus of the University (GSAS)

- the Center for Spatial Information Information Science (CSIS)
- the Earthquake Research Institute (ERI)
- the Ocean Research Institute (ORI)
- the Laboratory for Earthquake Chemistry (LEC), an independent unit within the Graduate School of Science which will not be affected by the proposed merger of Earth and planetary science departments
- the new Graduate School of Frontier Sciences (GFS), which will be located at the new Kashiwa Campus
- the Institute of Solid State Physics (ISSP), which will also move to the Kashiwa campus
- the Center for Climate System Research (CCSR)
- the University Museum (UM)
- the Institute of Space and Astronautical Science (ISAS), a national research institute under the direct control of Monbusho (Note that all of the other institutes are part of The University of Tokyo, but ISAS is not. It still supplies affiliated faculty to several departments at The University of Tokyo because its predecessor institute was a part of the university.)

Generally speaking, each of the above institutes is autonomous in its faculty appointments and promotions. Some affiliated faculty from each of the above institutes now participate in the graduate education program in one or more of the four separate department (Earth and Planetary Physics, Geology, Geography, Mineralogy) in the Graduate School of Science, and will participate in the graduate education program of the proposed new Department of Earth and Planetary Science. Note that the status of the above institutes will not be affected by the merger of the four Earth and planetary science departments in the Graduate School of Science.

At some point in the future there may be discussion of a more extensive reorganization of Earth and planetary sciences throughout The University of Tokyo, which would presumably involve some reorganization of at least some of the above institutes. However, such a reorganization is not under active consideration at the present time.

The two government ministries most connected with research in Earth and planetary science are Monbusho and the Science and Technology Agency (STA). These two ministries will be merged in 2001, and preparations are underway at the central government level. As a secondary effect of this merger, changes may occur after 2001 in universities and in government research laboratories. However, at this time it is still not clear what will happen.

2 External evaluation

Before the final proposal for the merger is submitted, an external review will be conducted. As discussed below, the external review will cover (1) plans for the new department; (2) the research and teaching being carried out by the existing four departments. The report of the external review committee will be submitted to the Dean of the Graduate School of Science. The report will be made public, with the exception that any comments about individual faculty members will be kept confidential.

It is expected that the Dean may request changes in the merger plan on the basis of the external review. It is also expected that the faculty will explain concretely the measures adopted in response to the reviewers' comments. In many cases it may not be possible to take action immediately in response to the reviewer's comments. It is therefore expected that progress reports will be published by the faculty two years and four years after the external review, and that a second external review will be held six or seven years after the initial external review.

2.1 Topics to be covered by evaluation

As noted above, an evaluation is being requested not only of the research and teaching being conducted by the present staff, but also of the plans for the merger of the four present Earth sciences departments into one new department. The decision of how and in what form to present its conclusions rests entirely with the external reviewers, and we do not propose to infringe on their prerogatives. However, as a practical matter, the time available for the review is extremely limited. We therefore present, below, some tentative suggestions for the consideration of the external review committee. We also indicate some areas in which we particularly desire to receive the advice of the external reviewers. As external reviews are still quite recent in Japan and the basis of experience is quite small, we draw on the experience of foreign institutions where possible.

2.2 Report of External Review Committee

As the external review committee is being convened by the Dean of the Graduate School of Science, it will report to the Dean. In order to make it most likely that the report can be acted on constructively, we suggest that the external review committee divide its suggestions into the following four categories: (a) suggestions addressed to the four Earth and planetary science departments, (b) suggestions addressed to the Graduate School of Science, (c) suggestions addressed to the central administration of The University of Tokyo, and (d) suggestions addressed to the Ministry of Education, Science, Sports and Culture (Monbusho), to other governments agencies and ministries, and comments in general on the educational and research systems in Japan. Formally speaking, rather than addressing comments directly to Monbusho or the University administration, it seems most appropriate for the committee to address its comments to the Dean, and ask the Dean to call them to the attention of Monbusho or the University administration.

We also suggest that the review committee divide its recommendations into several time frames: (i) recommendations that can be acted upon immediately, (ii) recommendations that might require on the order of one to three years, and (iii) recommendations that might take five to ten years to implement. As discussed below, under the present system faculty of all ranks are tenured, as are supporting staff, so recommendations involving existing faculty or staff are likely to fall into category (iii).

We anticipate the possibility of comments regarding at least topic in area (c), above, namely the present institutional structure of Earth and planetary sciences at The University of Tokyo, in which faculty are divided among several completely autonomous units with no central coordination. Such comments would be valuable. However, the present organizational structure has been established by the University and Monbusho, while the present review is being convened by the Dean of the Graduate School of Science. Therefore no immediate response to comments about the overall organization of Earth and planetary sciences at our University will be possible. However, the report of the external reviewers will be published, so any advice or comments regarding this topic will become a matter of public record, and will be available if and when a university-level reorganization of Earth and planetary science units is conducted.

2.3 Site Visit of External Review Committee

The external review committee will meet from Monday March 15, 1999 through Friday March 19, 1999, with a welcoming reception Sunday night March 14, 1999. The schedule of the meeting and a list of members of the External Review Committee are attached respectively in sections 8 and 9. The first 2.5 days of the review will be devoted to presentation of information to the committee. There will be talks by the faculty, explaining the overall research and educational plans, and there will be poster presentations by graduate students, postdocs, and young faculty. There will also be a tour of the various buildings used by our departments, and informal opportunities to talk to students, postdocs, faculty, and recent graduates will be arranged at mealtimes. A search for up to ten new faculty members at the level of full professor is now being conducted, and a report on this search will be presented to the external review committee on Wednesday afternoon. The opinion of the external reviewers on individual candidates may be requested at this time. As the searches are still underway, confidentiality will be maintained.

The next 1.5 days (the remainder of Wednesday afternoon March 17 and all day Thursday March 18) will be devoted to closed discussion by the external review committee on the drafting of their report. Because of the tight schedule, it is desired, if possible, for the external review committee to complete a rough draft of of their report while they are in Tokyo. If possible, the final editing will be completed by March 31, through the exchange of drafts by email.

The final half-day of the review, the morning of Friday March 19, will be devoted to a presentation of the conclusions of the review committee. This presentation will be divided into two parts. In the first part, the committee will present a report to the present Dean and incoming Dean of the Graduate School of Science, and to a small group of other senior faculty. In the second half, the committee will present its conclusions to the faculty as a whole.

We had hoped to request reviews by mail as supplementary data to be submitted to the external reviewers for use in preparing their report. Unfortunately the tight time schedule (preparations for the external review only began in December 1998) precluded this, with one important exception. The dates for the external review unfortunately overlap with those of the Lunar and Planetary Science Conference in Houston, and almost all of our faculty in planetary science will attend this conference, as will most if not all of the workers in this area that we would otherwise have invited to serve on the external review committee. We therefore requested one worker in this area (see section 9) to serve as a referee by email. This referee's views will be made available to the external review committee for use in preparing their report.

2.4 Criteria for Overall Evaluation

Procedures for external reviews are still not standardized in Japan, although external reviews have become more common in recent years. We therefore have drawn, where possible, on the experience of institutions outside Japan that have widely recognized experience in conducting external reviews.

Northwestern Univ. (Evanston, USA) asks its external reviewers to address the following items when they are evaluating an academic department. Generally speaking, these points also seem appropriate for consideration by our external referees.

- current strengths and weaknesses of the unit

- areas of comparative opportunity
- important future developments in the discipline or profession that need to be addressed
- the relationship of existing faculty and staff resources to these opportunities
- the quality of leadership in the unit
- the adequacy of other resources to carry out the mission of the unit
- the relationship of each unit to other academic (or administrative) areas

Northwestern's policy manual says the result of the external review process should be a plan for phased improvement of a department. The plans that are developed on the basis of the external review should be explicit, realistic, and viable, calling out the best aspirations of the department. New support may be requested, but to the extent possible the review process should identify improvements that can be made using available resources. This general statement also seems appropriate for our review.

2.5 Individual Faculty Data for External Review

As part of the background material for the external review, data on individual faculty research, teaching, and professional service were compiled and edited into a standard format, and sent to the external reviewers in advance. Two formats were adopted. Core faculty provided the following information:

1. Personal data: Date and place of birth, education, professional employment.
2. Representative publications: citations of up to four refereed publications in the period 1994–present, in English, in refereed journals.
3. A statement of current research (about 300–500 words).
4. Honors and awards.
5. Professional service (journal editorships, etc.).
6. A list of doctorate recipients advised by the faculty member for the past ten years.
7. Statistical data on teaching contributions, 1994–present (number of graduate student advisees, number of times serving as examiner for doctoral theses, courses taught for credit, courses taught at other institutions as a visiting instructor).
8. External research funding, 1994–present.
9. Publication list, divided into the following categories:
    1. Refereed papers in English in journals published outside Japan (complete list);
    2. Refereed papers in English in journals published in Japan (complete list);
    3. Refereed papers in English in books and conference proceedings (complete list);
    4. Refereed papers in Japanese (complete list, in principle);

5. Refereed papers in languages other than English and Japanese;
6. Unrefereed books or articles in books;
7. Selected other publications (in principle, up to 10).

10. Abstracts of the (up to) four representative publications listed above (item 2).

All of the above data are in English, except that titles for Japanese language publications were listed in both the original and an English translation. Affiliated faculty were asked to submit data in the above categories 1–7 only. The edited data required about 500 pages for the core faculty, and about 180 pages for the affiliated faculty.

2.6 Research Evaluation

The above data on individual faculty are for consideration by the external evaluators in preparing their report. One of the main categories in which the reviewers' opinion is requested is an evaluation of research.

One possibility would be for the reviewers to rate each faculty member individually, but for several reasons this seems impractical. First, the expertise of the external reviewers is not necessarily equal in all of the areas covered by our new department, so it might be difficult for them to accurately rate individual faculty members whose specialties are far from that of the external reviewers. Second, even if individual ratings were assigned, it is not clear how such information could be put to use.

All faculty members are permanent tenured government employees, and their salaries are determined by civil service regulations. Therefore any hypothetical individual rating of research productivity could not in any case be used in any routine personnel actions under the present system. Under the present system the only occasion for a direct feedback between research productivity and personnel actions is when faculty members are hired or promoted.

Whether or not the present system for faculty salaries and tenure ought to be changed may warrant discussion, but any changes would have to be made at the level of the national government, and would require new legislation by the parliament. Thus this question is outside of our immediate control.

In view of the above considerations, it seems most appropriate for ranking of the research productivity of our new department to be performed on a collective rather than individual basis. As explained below, the new department will be divided into five research groups: (1) Oceanic and Atmospheric Science, (2) Space and Planetary Science, (3) Earth and Planetary System Science,

(4) Solid Earth Science, (5) Geosphere and Biosphere Science. We request the external reviewers to perform research evaluations of each of these five groups. We also request that an evaluation of the research performance of the new department (the core faculty) as a whole be carried out.

In contrast, the affiliated faculty should be completely excluded from the above research evaluation, as part of the proposed new department in the Graduate School of Science. Individual data on affiliated faculty were provided to the reviewers, but only for purposes of an assessment of the educational program.

2.7 Criteria for Research Evaluation

There is not as yet any standardized method in Japan for research evaluation. It therefore seems appropriate that a system that already is in successful use elsewhere be adopted. The rating system used by the HEFCE (Higher Education Funding Council of England) is the obvious choice. The HEFCE organizes periodic rating exercises in which a panel rates all UK university departments in a given field on a common scale, based on documents submitted by the departments. A key component of the data submitted to the UK ranking panels by individual researchers is a list of four recent representative publications, roughly corresponding to item (2) in the individual data submitted by our faculty.

The 7-level rating scale used in the UK is presented in Table 1. The highest rating is 5*, and successively lower rankings are 5, 4, 3a, 3b, 2, and 1. We propose that the same scale be used in the evaluation of our department. However, ``national excellence'' should refer to the level of research in Japan, not that of the UK. For general reference, the actual UK ratings in 1996 are shown in Table 2. Note however we are neither requesting nor suggesting that our department be compared directly to departments in the UK; this information is just provided to indicate how the UK assessment panel actually applied the scale in Table 1 when they assessed research in Earth and environmental sciences at UK universities.

The HEFCE defines `attainable' levels of excellence as an absolute standard of quality for each field of research that should be independent from the conditions for research within individual departments. The international criterion is a level of excellence that it is reasonable to expect in each research field whether or not there are workers at that level in Japan (or the UK).

Obviously the use of this scale in an evaluation of only one department is less than ideal. It would be best to have data available for all departments in Japan, and to actually carry out a UK-type evaluation exercise. Unfortunately, however, such data are not available at present, so the evaluation of our department must unavoidably be a ``virtual'' exercise. Nevertheless, it is clearly desirable to have some set of standard criteria for use in evaluation of our new department's research performance. Note, however, that several advisory committees to the Japanese government have called for the establishment of a national system for research evaluation; such a system, if and when established, will probably be similar to that of the HEFCE in the UK.

As 6 of the 11 members of the external review committee are based in Japan, the external review committee collectively possesses a reasonably good basis for judging the national level of attainable excellence in Japan, and the external review committee as a whole possesses the knowledge to rate international levels of excellence in the various subfields of Earth and planetary science.

We hope, in addition to ratings for the new department as a whole and the five research groups, also to receive comments from the external reviewers on the quality of research in each group and in the new department as a whole. We also hope to receive suggestion for future directions that would lead to further increases in the level of research being carried out in our department. Rather than just being a rating exercise, it would be most desirable if this review led our department as a whole to take measures in the future to improve in all areas, taking advantage of the suggestions and comments made by the reviewers.

The following information is indicated by the columns in Table 2. The second column is the ranking, on the scale in Table 1. The third column shows the proportion of eligible staff (roughly comparable to our core faculty) for whom data were submitted to the rating exercise, as follows: A: 95 – 100% staff submitted, B: 80 – 94%, C: 60 – 79%, D: 40 – 59%, E: 20 – 39%, F: below 20%. Finally the last column indicates the number of Full Time Equivalent (FTE) staff of each department.

In terms of the data submitted by our department to the external reviewers we fall into category A (95–100% of eligible staff submitted). Data for all full-time permanent academic core faculty who are expected to be members of the new department when it is founded in April 2000 have been submitted to the external reviewers. Data for full professors who will retire by March 2000 (and who therefore will not be members of the new department) have not been submitted. Data for one Research Associate who is expected to move to another position (possibly but not certainly by March 2000) have not been submitted, but even if he were counted as an eligible faculty member, still would be above the 95% level. Data for two Research Associates with three year appointments have not been submitted, as they are not considered part of the core faculty teaching staff.

Rating	Description
5*	Research quality that equates to attainable levels of international excellence in a majority of sub-areas of activity and attainable levels of national excellence in all others.
5	Research quality that equates to attainable levels of international excellence in some sub-areas of activity and to attainable levels of national excellence in virtually all others. (Research quality that equates to attainable levels of international excellence in some sub-areas of activity and to attainable levels of national excellence in virtually all others.)
4	Research quality that equates to attainable levels of national excellence in virtually all sub-areas of activity, possibly showing some evidence of international excellence, or to international level in some and at least national level in a majority. (Research quality that equates to attainable levels of national excellence in virtually all sub-areas of activity, possibly showing some evidence of international excellence, or to international level in some and at least national level in a majority.)
3a	Research quality that equates to attainable levels of national excellence in a substantial majority of the sub-areas of activity, or to international level in some and to national level in others together comprising a majority. (Research quality that equates to attainable levels of national excellence in a majority of the sub-areas of activity, or to international level in some.)
3b	Research quality that equates to attainable levels of national excellence in the majority of sub-areas of activity. (Research quality that equates to attainable levels of national excellence in a majority of the sub-areas of activity, or to international level in some.)
2	Research quality that equates to attainable levels of national excellence in up to half the sub-areas of activity. (Research quality that equates to attainable levels of national excellence in up to half the sub-areas of activity.)
1	Research quality that equates to attainable levels of national excellence in none, or virtually none, of the sub-areas of activity. (Research quality that equates to attainable levels of national excellence in none, or virtually none, of the sub-areas of activity.)

Table 1: The rating scale used for research evaluation in the UK (from the HEFCE web site, http://www.hefce.ac.uk/)

Institution	1996 Rating	Proportion of Staff Selected	Category A Research Active Staff (FTE)
University of Birmingham	3a	C	16.0
Birkbeck College[1]	4	A	7.5
University of Bristol	5	A	25.3
University of Cambridge	5*	B	45.0
Cheltenham and Gloucester CHE	2	B	7.5
University of Derby	2	D	5.0
University of Durham	4	B	18.1
University of East London	3b	A	2.5
University of Greenwich	2	C	15.0
Imperial College of Science, Technology and Medicine	4	C	25.0
Keele University	3a	B	15.5
Kingston University	3b	C	10.0
University of Leeds	5	A	42.0
University of Leicester	4	A	22.2
University of Liverpool	5	B	33.0
University of Luton	2	B	8.0
University of Manchester	4	A	36.5
University of Newcastle upon Tyne	5	A	7.0
Open University	5	D	15.8
University of Oxford	5*	B	22.0
Oxford Brookes University	2	C	8.0
University of Portsmouth	3b	B	20.3
University of Reading	4	B	13.1
Royal Holloway, University of London	4	B	24.7
University of Sheffield	3b	A	13.0
University of Southampton	3a	B	15.1
University College London[2]	4	B	35.5
University of Aberdeen	3b	B	14.0
University of Edinburgh	5	A	49.1
University of Glasgow	3a	B	22.5
University of St Andrews	2	A	7.0
University of Wales, Cardiff	4	A	24.0
The Queen's University of Belfast	3b	C	6.5

Notes:

[1] - Joint submission with University College London

[2] - Joint submission with Birkbeck College

Table 2: Results of 1996 UK Research Assessment Exercise: Earth Sciences and Environmental Sciences (from HEFCE home page)

2.8 Evaluation of Educational Program

We also are asking the external reviewers to evaluate the educational programs of our department. This report contains a discussion of the educational program, a summary of the curriculum, and other related material, including rosters of the core faculty and affiliated faculty participating in the educational program.

We also are arranging a poster presentation, where over twenty posters summarizing current student, postdoc, and junior faculty research will be presented. There will be two one hour core sessions on the first two days of the review, each attended by about half of the presenters. Since the ultimate product of our educational program is the students and young researchers that we train, these poster sessions will allow the external reviewers to get a first hand chance to meet our students, postdocs, and junior faculty and discuss their research.

Our new department will come into existence in April 2000 (if our plans are approved). We have adopted tentative plans for a unified curriculum at the graduate level, with various choices of specializations. However, owing to lack of time, we have not yet adopted plans to restructure undergraduate education. The present (old) system features on undergraduate course for Earth and planetary physics, and a second undergraduate course for students interested in geology, geography, and mineralogy. These two courses will remain in place for students entering their third year of undergraduate studies in April 2000 (the beginning of the third year is the point where students specialize in a particular department). We expect to discuss restructuring of the undergraduate courses, so that more overlap and interaction can occur. However, there is a clear consensus that we want to maintain two separate courses, so that physics/mathematics oriented students can specialize in Earth and planetary physics, while students interested in geology and chemistry can major in the geological sciences course. We do, however, want to encourage students in each of these courses to learn more about the subjects covered by the counterpart course than had been the case when these were completely separate.

Any comments by the reviewers on our educational programs will be welcomed. We have no particular suggestions for the format of the comments, except that we could benefit greatly from the experiences of other institutions where similar mergers of formerly separate Earth and planetary sciences departments have taken place.

3 General Background

In this section we briefly present background information that might be useful for understanding the history and role of our department. The University of Tokyo is the oldest university in Japan. Although it included science departments from the outset, prior to World War II the main purpose of the university was training students who would become government officials. Since 1945 the emphasis on scientific research in universities has steadily increased, and this is now a major priority of the government.

General background on the university is available in the university's pamphlets (in English and Japanese) that were sent to all of the external reviewers. This information will not be repeated here.

3.1 Earth science departments in the Graduate School of Science

At present there are four departments in the general field of Earth and planetary sciences in the Graduate School of Science (Earth and Planetary Physics, Geology, Geography, and Mineralogy). Each of these departments can be traced back to various earlier predecessor departments that are about 100 years old. The detailed histories will not be given here. In addition to the Graduate School of Science, the institutions discussed in Section 1.3also perform research in Earth and planetary science-related fields. In some cases work in Earth and planetary science is the major feature of the programs of those institutions, while in other cases it is only a small part of that institution's total effort.

3.2 Earth science departments in Japan

Almost all education in Earth and planetary science in Japan is carried out at national and public universities. The universities with significant departments in the field of Earth and planetary science are (from North to South): Hokkaido Univ., Hirosaki Univ., Tohoku Univ., Akita Univ., Yamagata Univ., Niigata Univ., Toyama Univ., Kanazawa Univ., Shinshu Univ., Ibaraki Univ., Tsukuba Univ., Chiba Univ., The Univ. of Tokyo, Tokyo Institute of Technology, Tokyo Metropolitan Univ., Shizuoka Univ., Nagoya Univ., Kyoto Univ., Osaka Univ., Osaka Prefectural University, Kobe Univ., Shimane Univ., Okayama Univ., Hiroshima Univ., Kochi Univ., Ehime Univ., Kyushu Univ., Kumamoto Univ., Kagoshima Univ., and Ryukyu Univ. Generally speaking the education at other institutions is somewhat more weighted towards classical fields in geology than that at our university. This, however, is a complex subject and will not be discussed in detail here.

The data in Table 3 show the difference between The University of Tokyo and other universities in terms of their educational roles. Data on authorized (rather than actual) enrollments were easier to obtain, which is why they are shown in this table. There are a total of 1195 undergraduate student enrollments authorized at the above universities in Earth and planetary science. Our university accounts for 58 students, or 5%, of this total. On the other hand, our university accounts for 20% of all the authorized masters degree enrollments, and 22% of all the doctoral enrollments. The authorized number of masters degree students in Earth and planetary science at our university, 123, is twice the number of authorized undergraduate students. This means we must recruit large numbers of students from other universities (or from other departments, such as physics, at our university) to to fill the allowed intake. As a result, there is a great difference in background between some of the graduate students from other universities and our own undergraduates. Due to this significant heterogeneity in the background of the graduate students entering the masters course, flexibility in the curriculum is essential so that students from other universities can make up gaps in their background.

	All Universities	The Univ. of Tokyo	Univ. of Tokyo/ All Universities
Undergraduate	1195	58	0.05
Master	629	123	0.20
Doctor	250	55	0.22

Table 3: Authorized number of students per year in Earth and planetary science

The authorized number of doctoral course students is about half that of the masters course. This means that through voluntary self-selection or weeding out by the faculty, about half the masters students must cease their graduate education and accept employment. At the moment the number of master degree recipients who apply to continue to the doctoral course is slightly lower than the authorized limit. Applications to continue to the doctoral course may be turned down from time to time on the basis of individual shortcomings, but there is at present no need for a systematic winnowing out.

Entrance to the masters degree course of the graduate school is through an examination given each summer for entrance the following April. Both students from our university and other schools take the same examination. Students who received a masters at other universities are allowed to apply to enter directly into the doctoral course; each year a small number (on the order of one to three) are accepted.

Note that undergraduates from our university rarely enter the graduate school at other universities in Japan. This lack of mobility on the part of our undergraduates is probably partly due to the generally higher prestige accorded to The University of Tokyo by Japanese society, and partly due to the relatively better facilities at our university. While it seems desirable for our undergraduates to go elsewhere for graduate school, the current structure of Japanese society and Japanese universities makes this very hard to achieve.

3.3 Student support

Most support for masters and undergraduate students comes from loans, although there also are some scholarships. Under certain circumstances (e.g. if the students become teachers when they graduate) the loans can be forgiven. The top students in the doctoral course can apply for fellowships from the Japan Society for the Promotion of Science (JSPS), an affiliated agency of Monbusho. JSPS fellowships do not have to be repaid. Students can also receive postdoctoral fellowships through the JSPS. As a result of the fact that fellowships are awarded directly to students by the JSPS, it is not necessary for faculty members to raise funds to pay student and postdoctoral salaries. The downside is that faculty have less control over who is awarded fellowships.

3.4 Foreign students

The number of foreign students in Japan jumped rapidly from 1985-1995. Since then it has been static or decreased slightly, as the slow economy has made it harder for foreign students to get part-time jobs (which they need if they do not have scholarships). Scholarships for foreign students funded by private industry have decreased sharply (owing to the economic downturn), and government funding for scholarships is stagnant. The largest number of foreign students in Japan are from China, Korea, and Taiwan. Sometimes we get very good students from these countries, but anecdotal evidence suggests that the best students from these countries tend to go to the US or western Europe. This is probably because (1) universities in those countries are perceived as better, (2) students coming here have to learn Japanese, while English is the language of instruction in many other countries, and (3) post-graduation employment opportunities are relatively limited here for foreign students. Another problem is that many government scholarships for foreign students are awarded by Japanese embassies in various countries, rather than through a systematic procedure. In summary, there are significant problems regarding the current systems for foreign students, but these must be dealt with at a national level rather than at the level of our department.

There are also JSPS fellowships for foreign postdoctoral researchers. These offer attractive stipends. There is a surprisingly low level of interest in these fellowships by applicants from North America or Europe.

3.5 Faculty System

Almost all faculty at Japanese universities are tenured. The three main ranks are full professor, associate professor, and research associate. The duties and privileges of associate professors vary from one university to another. At our university full professors and associate professors in the four Earth and planetary science-related departments are equal insofar as they both are expected to give lectures and serve as advisers for graduate students. (In contrast, at some other universities or in some other departments of our university only full professors are allowed to serve as thesis advisers.) The major difference between full and associate professors in the Graduate School of Science is that the former have much more control over faculty hiring and promotion, and greater administrative duties.

The entry level faculty position is research associate. Research associates teach laboratory courses, but do not give lectures and do not supervise thesis research as official thesis advisers. In many cases research associates are heavily involved as a supplementary adviser, with a full or associate professor as the official adviser. This works well when the official adviser is actively involved, but can lead to problems when the official adviser's role is purely nominal.

There is also another position, (full-time) Lecturer, which is not routinely used. This position falls in the gap between research associate and associate professor. Generally speaking (as used in the Graduate School of Science) this position is practically equivalent to associate professor in terms of rights and responsibilities. Perhaps the most common case for appointment of a Lecturer is an outstanding researcher who meets all of the qualifications for an associate professor but is considerably younger than typical for associate professors.

Note that research associates are not members of the faculty senate of the Graduate School of Science, while professors, associate professors, and lecturers are. Thus professors, associate professors, and lecturers are eligible to vote in elections for the university President, for the Dean, and for other officials, while research associates are not. The monthly faculty senate meetings are divided into two parts, the second of which votes on all appointments of professors, associate professors, and lecturers. Only full professors are allowed to attend the second part of these meetings and vote on appointments and promotions. However, the actual preliminary selection of a candidate is made at the department level and submitted to the faculty senate, and associate professors do participate in these preliminary discussions at the department level for the appointment of associate professors and research associates. The department's decision on hiring a research associate is adopted without a vote by the faculty senate.

3.5.1 Criteria for appointments and promotions

The number of authorized positions for full professors, associate professors, and research associates is fixed. Roughly speaking, the ratio is 1.0:0.9:0.7 at present. A faculty member can be promoted (1) when he or she is considered eligible, and (2) there is a vacant billet at a higher level.

The written rules on appointments and promotions are surprisingly scarce, but there is much precedent to serve as a guide. Thus the situation is something like that of the unwritten constitution that governs the UK, which can be inferred from precedent. Some of these precedents extend throughout the Graduate School of Science, while others vary from department to department and even within the same department. One of the challenges facing our proposed new department is how to harmonize standards and practices in this area, while at the same time respecting to the extent possible the traditions of the various academic disciplines represented in the new department.

One of the precedents that generally holds true is that age is regarded as an important (although not always inviolable) criterion for appointment or promotion. For example, internal promotions from associate professor to full professor are rarely if ever made much before the age of 45 in the Graduate School of Science, and 35 years of age is the approximate normal floor for appointments as associate professor (with some exceptions). Appointments of full professors from outside the department can be made at age 40 or up, and there are some cases where somewhat younger candidates with outstanding records have been appointed. (Affiliated research institutes, generally speaking, also view age as one important factor in appointments and promotions, although their implicit minimum age limits may be several years lower than those of the Graduate School of Science.)

Internal promotions are not automatic by any means, and particularly in recent years there has been a tendency towards more stringent scrutiny of candidates' research records. One important question is what criteria should be emphasized in evaluating the research record of a candidate. For example, our new department will be formed by merging four existing departments. In some of the subgroups of these departments there were longstanding patterns of publication in leading international journals. On the other hand, in some other groups publications were primarily in domestic Japanese journals, in either English or Japanese.

There are difficult and important questions of policy regarding which the members of the external review committee are likely to have valuable advice for us. Should our new department insist on a standard of international publication in all cases? How should publications in primarily domestic journals be viewed? To what extent is it appropriate to use bibliometric data, such as citation indices, as criteria in faculty personnel decisions? How much variability in criteria is appropriate depending on the research field? If a uniform global standard is to be adopted should it be adopted immediately or should it be phased in over a period of years?

3.5.2 Faculty career paths

Several decades ago it was common for graduates of The University of Tokyo to be hired here as research associates, be promoted steadily, and retire from this university without ever having been employed or studied at another university. Such a career path can still occasionally be found, but is much rarer now. It is generally accepted as desirable for graduates of this university who become research associates to leave for positions as associate professors elsewhere. They might then be hired back after several years elsewhere. This is less desirable than hiring graduates of other universities, but is still a step in the right direction. One problem is that in some fields (especially certain areas of geophysics) the number of other universities within Japan from which we can hire is quite small. Also, in many cases even where regional universities have excellent faculty, the level of students may (on average) be lower than The University of Tokyo (due to the way undergraduate entrance examinations are organized nationally). Also, the teaching loads are higher at regional universities, and resources scarcer, so it is very difficult for regional universities to consistently turn out graduates at the same level as those of The University of Tokyo. These are important problems that must be solved on a national level. Until progress can be made it will be difficult to greatly increase the proportion of our faculty who are graduates of other universities.

3.5.3 Tenure system

With certain exceptions (see below) all faculty here are tenured. This includes research associates, who may be hired at the age of around 30 when they still have a small number of publications. If all goes well they will publish good work and be hired as associate professors within 5 or 10 years, either in our department, an affiliated institute of this university, another university, or a government agency. However, in the worst case if his or her career does not develop satisfactorily, a research associate can spend his or her entire career until retirement in this position. (The mandatory retirement age is 60, but will be phased up to 65 over the next ten to fifteen years.) This does not happen often, but does occasionally happen.

The ratio of professors to associate professors to research associates was 1:1:2 as recently as 15 years ago, but has now changed to 1:0.9:0.7, as noted above. This means that research associate positions (which are the entry level positions for young researchers) are much scarcer than previously. If an unproductive holder of this position occupies it for 30 years, this is a barrier to the opportunities that should be given to several successive generations of young researchers.

As a partial solution to this problem the new Graduate School of Frontier Science (of the new Kashiwa campus) will appoint all research associates for a fixed five year term, renewable at most once, rather than with tenure. This will solve the problem of research associates remaining in that position until mandatory retirement, but will also make the research associate position somewhat less attractive to applicants. It remains to be seen, whether, under these circumstances, top-quality candidates will apply for such term-limited research associate positions.

The system of 10-year term limits for research associate positions will not be immediately adopted by the Graduate School of Science, but may be adopted later if it proves successful in the Graduate School of Frontier Science. However, the Graduate School of Science has adopted a system whereby a few research associate positions may be awarded for three-year terms, while the remainder continue to be permanent. One such temporary 3-year appointment of a research associate has currently been made in the Department of Earth and Planetary Physics, and another in the Department of Mineralogy. The holders of these 3-year posts are not included in the rosters of faculty members submitted to the external review committee.

One other exception to the rule that appointments are tenured involves non-Japanese citizens, as discussed below.

3.5.4 Foreign faculty

Faculty of Japanese national and public universities are classified as civil servants. Foreign citizens cannot in general be hired as civil servants, but a special law was passed in 1982 making an exception for university professors. This law was directed at two problems: (1) making it possible for 2nd or 3rd generation Korean or Chinese residents of Japan to be hired as faculty members (Japanese law regarding citizenship is similar to German law, so they do not automatically become citizens despite having been born and educated here.); (2) the opening of university positions to scholars from outside Japan. The new law gave universities the option of appointing foreign faculty either permanently (i.e. on an equal basis with Japanese citizens) or for a fixed term (usually 3 or 5 years) which could be renewed or terminated at the option of the university. Several other leading universities required all foreign faculty appointments to be term-limited, but the University of Tokyo allowed each School or research institute to make a decision between term-limited and tenured appointments on a case-by-case basis. The first tenured foreign faculty member in Japan was an associate professor appointed by the Department of Earth and Planetary Physics of the Graduate School of Science in 1984, who continues to hold that position. Despite this successful example, no further tenured foreign faculty have been appointed in Earth and planetary science-related departments.

It is desirable to increase the number of foreign faculty members if qualified applicants can be attracted. There are several practical problems to be overcome, especially those involving the need for foreign faculty members to make an investment of time to learn the Japanese language, but this is not an insurmountable problem, and further efforts should be made in this area.

3.6 Reform of the Graduate School

A major reform of the status of the graduate school was made starting in 1992 (called ``daigakuin juutenka'' in Japanese). Until that time the undergraduate school (``Faculty of Science'') was the principal body to which core faculty were appointed, and the graduate school was an administrative appendage. Under the reform the Graduate School of Science (or similar Graduate Schools in Law, Engineering, and so on) were made the main administrative entity, and the undergraduate school became an administrative appendage. At the same time, the budget for the various major universities where the graduate school had been reformed in this way was increased relative to smaller universities where such reforms were not made. Also, the number of faculty billets for full and associate professors was increased, and the number of billets for research associates was decreased, as discussed above. This did not result in automatic promotions for existing research associates, as it was permitted to balance an excess of research associates by a corresponding shortfall in the number of full and associate professors. Also, the authorized number of masters degree students was greatly increased as part of this reform.

Generally speaking the reform appears to have been reasonably successful, but there are some problems, such as the shortage of positions for young researchers. We will present further data on this reform, particularly as it affected students, to the external review committee.

4 Staff and Organization of New Department

The faculty of the proposed new Department of Earth and Planetary Science in the Graduate School of Science will, as discussed above, be comprised initially of the faculty of the following present departments: (1) Earth and Planetary Physics, (2) Geology, (3) Geography, (4) Mineralogy. One other Earth and planetary sciences-related unit in the Graduate School of Science, the Laboratory for Earthquake Chemistry, is not involved in the merger of these four departments and will remain independent.

The initial organization of the new department had to be chosen with several factors in mind. First, division into groups should be based on commonality of scientific research interests. Second, as there will be on the order of 60 faculty members, groups should each consist of on the order of 10–15 faculty members for ease of management. Third, every faculty member from the four old departments (except for those who will retire) has to belong to one of the groups in the new department; personal preferences of each faculty member were respected to the greatest extent possible when there was more than one logical possibility. Fourth, a variety of institutional factors, history, personal interactions and similar factors had to be taken into account. Finally, it is desirable for each of the groups in the new department to contain members from more than one of the four previous departments whenever possible.

Obviously not all of the above factors could be satisfied perfectly, so the organization of the new department inevitably involves some compromises. The final decision on the division of the new department into groups was made by the senior faculty of the new department, on the basis of consultation with the junior and mid-level faculty. The new department will be divided at the outset into the five groups shown in Table 4. The assignment of each present faculty member of the four existing departments (with the exception of three full professors scheduled to retire in March 2000, two Research Associates on three year appointments, and one Research Associate expected to move to a new position, possibly by March 2000) are shown in this table.

The total number of positions of each group is not shown in Table 4 for several reasons. First, several vacant faculty positions are now being advertised, as discussed below. Second, the application to Monbusho for permission to found the new department will request several new positions, and until Monbusho makes a final decision on this matter we cannot know the total number of positions that will be available to the new department.

Table 4 shows the members of each group by order of faculty rank, with members of equal rank listed in alphabetical order. (It is perhaps of interest to note that in internal university documents in Japanese, faculty members of the same rank would be ordered with by date of appointment to that rank.) The faculty rank is indicated in the second column of Table 4, and the existing department to which the faculty member currently belongs is listed in the third column (see legend at end of table for explanation of abbreviations). The research field of each faculty member is shown in the last column.

Name	Rank	Dept.	Specialty
Oceanic and Atmospheric Science Group			
Yamagata, Toshio	P	EPP	Ocean-Atmosphere Dynamics
Hibiya, Toshiyuki	AP	EPP	Physical Oceanography
Matsuda, Yoshihisa	AP	EPP	Atmospheric Dynamics, Planetary Atmospheres
Yasuda, Ichiro	AP	EPP	Physical Oceanography
Kita, Kazuyuki	RA	EPP	Atmospheric Physics and Chemistry
Masumoto, Yukio	RA	EPP	Physical Oceanography
Nakamura, Hisashi	RA	EPP	Atmospheric Physics
Space and Planetary Science Group			
Hoshino, Masahiro	P	EPP	Space Physics
Miyamoto, Masamichi	P	Min.	Evolution of Planetary Materials
Sugiura, Naoji	P	EPP	Planetary Science
Terasawa, Toshio	P	EPP	Space Physics
Hayashi, Kanji	AP	EPP	Magnetospheric physics
Hiyagon, Hajime	AP	EPP	Cosmochemistry
Iwagami, Naomoto	AP	EPP	Atmospheric Physics and Chemistry
Nakamura, Masato	AP	EPP	Plasma Physics in the Solar System
Sasaki, Sho	AP	Geol.	Theoretical Planetary Science and Planetary Geology
Mikouchi, Takashi	RA	Min.	Mineralogy
Miura, Akira	RA	EPP	Magnetospheric Physics
Sugita, Seiji	RA	EPP	Planetary Science
Yamamoto, Takashi	RA	EPP	Solar-Terrestrial Physics
Earth and Planetary System Science Group			
Hamano, Yozo	P	EPP	Solid dynamics
Abe, Yutaka	AP	EPP	Planetary Physics
Kayanne, Hajime	AP	Geogr.	Physical Geography
Kurita, Kei	AP	EPP	Physics of the Earth and Planetary Interiors
Matsumoto, Jun	AP	Geogr.	Physical Geography
Nagahara, Hiroko	AP	Geol.	Petrology and Meteoritics
Tada, Ryuji	AP	Geol.	Sedimentology and Paleooceanography
Tajika, Eiichi	RA	Geol.	Planetary Science
Solid Earth Science Group			
Kimura, Gaku	P	Geol.	Tectonics and structural geology
Matsu'ura, Mitsuhiro	P	EPP	Seismology
Geller, Robert J.	AP	EPP	Seismology
Ikeda, Yasutaka	AP	Geogr.	Physical Geography
Iwamori, Hikaru	AP	Geol.	Petrology
Funamori, Nobumasa	L	EPP	Mineral Physics
Ashi, Juichiro	RA	Geol.	Sedimentary Geology
Mochizuki, Eiji	RA	EPP	Seismology
Shimizu, Ichiko	RA	RA	Earth Material Science

Organization of the Core Faculty of the new Department (cont'd).

Name	Rank	Dept.	Specialty
Geosphere and Biosphere Science Group			
Matsumoto, Ryo	P	Geol.	Sedimentary Petrology
Tanabe, Kazushige	P	Geol.	Paleontology
Kogure, Toshihiro	AP	Min.	Mineralogy
Murakami, Takashi	AP	Min.	Environmental Mineralogy
Oji, Tatsuo	AP	Geol.	Paleontology
Sugiyama, Kazumasa	AP	Min.	Mineralogy
Endo, Kazuyoshi	RA	Geol.	Geobiology
Inui, Akira	RA	Geol.	Geosphere Mineralogy
Ogihara, Shigenori	RA	Geol.	Geobiology

Explanation of Rank Abbreviations.

Abbreviation	Faculty Rank
P	Professor
AP	Associate Professor
L	Lecturer (Full-time)
RA	Research Associate

Explanation of Department Abbreviations.

Abbreviation	Department
EPP	Earth & Planetary Physics
Geol.	Geology
Geogr.	Geography
Min.	Mineralogy

Table 4: Organization of the Core Faculty of the new Department.

As time goes on, there should be periodic re-examinations of the boundaries between groups, the membership of the groups, and the number of faculty positions allocated to each group. It is our general intention that rather than continuous discussion and reexamination of these questions, there should be reviews at periodic intervals, say seven years or so, in connection with future external evaluations. As the initial structure of the new department reflects a variety of compromise, the first such reexamination, seven years from now, is particularly likely to lead to rather widespread recommendations for change.

4.1 Role of Research Groups in Decision Making

As the new department has not yet begun operation, we do not yet have firm rules governing all points, but there is a general consensus regarding the roles of the various groups. First, the number of positions assigned to each group will not be allowed to vary freely. For example, it might be possible for a faculty member, by mutual agreement, to switch from one group to another, but in that case the number of positions assigned to each group would not change; some compensating adjustment would be required. Second, the groups will be semi-autonomous, but not totally autonomous, in personnel decisions. Probably searches for associate professors and research associates will be made by search committees composed primarily of faculty from the group with the vacancy, but including one faculty member from each of the other groups. The role of the non-specialist members of search committees will be primarily to ensure quality control and commonality of standards. In the case of searches for full professors, probably the responsibility will rest collectively with the full professors of the department, but if the number of full professors increases to 20 or more some subset will have to be appointed as a search committee for ease of administration.

By recent custom, all vacant faculty positions in the Graduate School of Science must be advertised, including cases where an internal promotion is a possibility. (An internal promotion from full-time Lecturer to Associate Professor, a rare event, could be an exception to the need for a full search, as the decision would probably be based on a review of the candidate's performance.) Note that the practices of the Graduate School of Science differ from those of some of the university's research institutes, where internal promotions to full professor from associate professor are made without an open search.

Search committees are appointed by the department chairman after consultation with key faculty, and their membership is discussed and approved by the faculty meetings of the department. Search committees do not have the power to make a final decision to select a candidate, but must report to the faculty of the department. Traditionally, the faculty members at the same or higher level as position being filled have a right to some say in the final approval of the choice of a candidate. However, generally speaking, decisions of search committees are approved by the department as a whole, partly due to informal consultations during the search process. As discussed above, candidates for positions as full professors, associate professors, or full-time lecturers must be approved by a vote of the full professors of the Graduate School of Science, while the decision of the department is final in the case of appointment of Research Associates.

The budget for running costs received by the department will be largely used for common items such as the library, the department office, heating, gas, water, telephones, and similar costs. The balance will be apportioned to each group according to the number of faculty members. The groups will use a share of these funds to pay common costs such as photocopying, and the remainder will then be given in equal shares to each faculty member. Probably the amount which each individual can use freely will be around 500,000 Yen per year. This is insufficient for most research needs, so faculty must generally make attempts to obtain funds from grants and outside agencies. The outside funding received by each faculty member is shown in the individual data that were submitted to the external review committee.

4.2 Current Faculty Search

In connection for the proposed formation of the new department, a search for faculty members at the level of full professor is now being held. The positions being advertised include (1) positions now vacant, (2) positions that will become vacant in March 2000 due to retirements, but which we are being allowed to fill now, (3) positions where there is no vacancy now in terms of the total number of authorized faculty personnel, but where the authorized number of full professors has not yet been appointed. Thus a total of nine positions is being advertised, but in order to appoint nine full professors at least three would have to be the result of internal promotions. However, in no case is any particular position predetermined to be reserved for internal promotion; all internal candidates have to compete with external applicants on a strictly equal footing.

Ideally the search for faculty positions would not have begun until after the external review was conducted, but, due to time constraints it was impossible to wait. The decision to form the new department was only taken in late November, 1998, and the plan for the new department must be submitted by the Graduate School of Science to the university administration by the end of May 1999. As several new positions will be requested, it is desirable to fill all authorized positions, particularly those at the level of full professor, by this time.

Once a successful candidate for full professor is decided upon by the department after its screening of the pool of applicants, a formal search committee must be set up by the faculty senate of the Graduate School of Science, which meets monthly, except for August. The formal search committee (note that this is a separate body from the department's internal search committee, although there is some overlap in membership) must wait until (at least) the next month's meeting to propose a candidate, and the vote on the candidate takes place the following month. (Note that there is a separate formal search committee for each position.) Thus to have a candidate approved by May, a formal search committee must be set up in March. Working backwards, it thus was necessary for the search to close in early February for the department to have time for internal deliberations.

It would ideally be desirable to have all of the positions for full professors filled by the end of May, when the Graduate School of Science will submit the plan for the new department to the university administration. However, amendments to the plan for the new department can be made until it is submitted to Monbusho by the university at the end of July, 1999. Thus new faculty appointed at the June or July meetings of the faculty senate of the Graduate School of Science can be included in an amended version of the plan by submitting their names to the university administration. Appointments that have not been approved by the July meeting of the faculty senate will be too late to be included in the plan to be submitted to Monbusho by the university administration at the end of July 1999. Thus May 1999 is the absolute deadline for asking the faculty senate of the Graduate School of Science to set up a formal search committee in order to have a candidate appointed by the July 1999 meeting of the faculty senate of the Graduate School of Science, thereby allowing the appointee to be listed in the final document to be submitted to Monbusho.

Despite the time pressures, the department is committed to maintaining strict standards for appointments, and positions will not be filled if qualified candidates are not available. The opinion of the external review committee will be requested in cases where a single successful candidate for a vacant position has already been selected by the department. (As these nominations are just now being submitted to the faculty senate of the Graduate School of Science, the members of the external review committee will be asked to maintain confidentiality.) A report on the status of the searches for the remaining positions (those where the department has not yet selected a single successful candidate) will be made to the external review committee, but names of the candidates under consideration will not be disclosed. We plan to discuss setting up a mechanism whereby we can obtain the opinions of the members of the external review committee (either collectively or on an individual basis) as additional successful candidates are selected by the various searches now in progress.

4.2.1 Procedures followed in current search

The search was announced in Japan by widespread distribution of the search announcement. A notice for the vacant positions was also posted on the home page of the Geology Department, with links to this announcement on the home pages of the other existing departments. The Japanese language version of this announcement is at http://www.geol.s.u-tokyo.ac.jp/koubo.html and the English language version is at http://www.geol.s.u-tokyo.ac.jp/search.html. An advertisement (Table 5) was published in *Nature* and *Eos*.

FACULTY POSITIONS IN EARTH AND PLANETARY SCIENCES AT THE UNIVERSITY OF TOKYO
The Graduate School of Science of the University of Tokyo is conducting searches for full professors in the following fields: (1) Atmospheric physics, (2) Physical oceanography, (3) Dynamics of the Earth system, (4) Dynamics of the Earth's surface environment, (5) Structure of the Earth's interior, (6) Dynamics of the Earth's interior, (7) Geosphere material science, (8) Chemical evolution of the geosphere and and biosphere, and (9) Biosphere material science. Successful candidates are expected to achieve fluency in the Japanese language sufficient for giving lectures and performing administrative duties within several years. For further details and an explanation of application procedures see http://www.geol.s.u-tokyo.ac.jp/search.html or contact: Faculty Search in Earth and Planetary Sciences, Graduate School of Science, University of Tokyo, Bunkyo-ku, Tokyo 113-0033, JAPAN., FAX: +81-3-3818-3247, e-mail: search@global.geoph.s.u-tokyo.ac.jp . Deadline for receipt of applications is February 12, 1999.

Table 5: Advertisement that appeared in *Nature* (December 24/31, 1998 issue) and *Eos* (January 5, 1999 and January 12, 1999 issues).

The positions advertised were listed in a table on the home page, which is reproduced in Table 6. The positions listed as ``to be filled in future'' are generally contingent on obtaining positions from Monbusho.

As explained in the next section in more detail, the regulations of Monbusho require that each position for a full professor must be assigned a specific name, e.g. ``dynamics of the Earth system.'' These names are not regarded as rigid constraints, but are interpreted rather broadly in carrying out faculty searches. However, the use of these names is required in administrative procedures such as applications to Monbusho for permission for the new department.

Group/Laboratory	Current Professor or Search Status
Oceanic and Atmospheric Sciences Group	
Atmospheric Physics	This search
Physical Oceanography	This search
Climate Dynamics	T. Yamagata
Ocean-Atmosphere Material Circulation Physics	To be filled in future
Space and Planetary Science Group	
Space Physics	M. Hoshino
Magnetospheric Physics	T. Terasawa
Observational Planetology	To be filled in future
Comparative Planetology	N. Sugiura
Planetary Material Sciences	M. Miyamoto
Earth and Planetary System Science Group	
Analysis of the Earth and Planetary System	Y. Hamano
Evolution of the Earth and Planetary System	To be filled in future
Dynamics of the Earth System	This search
Dynamics of the Earth's surface environment	This search
Solid Earth Science Group	
Structure of the Earth's Interior	This search
Dynamics of the Earth's Interior	This search*
Global Tectonics	G. Kimura
Magma Dynamics	Search Closed
Evolutionary Geomorphology	To be filled in future
Physics of Seismogenesis	M. Matsu'ura
Geosphere and Biosphere Science Group	
Evolution of the Geosphere	R. Matsumoto
Geosphere Material Science	This search
Chemical Evolution of the Geosphere and Biosphere	This search
Biosphere Material Science	This search
Evolutionary Paleobiology	K. Tanabe

* Announced as a separate search within Japan, but included here for simplicity.

Table 6: Proposed organization of new department, as envisioned at the time of search announcement (December 1998)

4.3 Affiliated faculty

Table 7 lists the ``affiliated faculty'' of our proposed new department, except that faculty members who will not (due to retirement or job changes) be serving in April 2000 are excluded. The faculty members listed here are presently participating in graduate education (sometimes also undergraduate education) in one or more of the present Earth and planetary sciences departments (Earth and Planetary Physics, Geology, Geography, Mineralogy). This participation takes the form of teaching graduate lecture courses and seminars, and advising graduate students on their thesis research for the masters and doctoral degrees. We use the term ``affiliated faculty '' as a blanket term, but there actually are several different administrative categories under which these members fall. Also, a few of the faculty members listed in Table 7 do not hold any formal joint appointment in the Graduate School of Science, but simply informally participate in graduate instruction on a continuing basis. Not all of the affiliated faculty in Table 7 will necessarily be included in our application for permission to found the new department, but those not formally listed will be able to continue their participation in graduate education.

The actual appointments and promotions of affiliated faculty are completely under the control of their respective institutes. Our university has no official corresponding to the Vice President and Provost of a U.S. university, who has the power to review all proposed faculty appointments throughout the university. Thus there is no central coordination or control. There is a formal procedure that has to be followed in order for affiliated faculty to receive their joint teaching appointment in the Graduate School of Science, but this is essentially a formality rather than a rigorous review of qualifications of the faculty member. In practice fewer problems result than might be expected, as there is some general agreement on overall academic standards. Nevertheless, we anticipate this is one area where the external review committee may wish to offer comments or suggestions.

The faculty members in Table 7 are listed in alphabetical order. Their affiliation (the institute where they hold their main appointment) is shown in the second column, and their faculty rank in the third column. Abbreviations are explained in the legend at the end of the table. The fourth column shows the research specialty of each faculty member. In the case of the new Graduate School of Frontier Science (which will ultimately be at the new Kashiwa campus), the unit to which a faculty member will move on April 1, as well as his new rank at that time, is shown, rather than his current affiliation. All of the various instutions shown in the second column are units of our university, except the Institute of Space and Astronautical Science (ISAS) which is directly under the control of Monbusho. The reason ISAS is alone among external institutes in having its faculty serve as affiliated faculty of our department is historical: the predecessor institute of ISAS was a research institute within The University of Tokyo.

Name	Affiliation	Rank	Specialty
Abe, Katsuyuki	ERI	P	Earthquake Seismology
Arai, Yoshio	GSAS	P	Human Geography
Fujii, Toshitsugu	ERI	P	Petrology
Fujimoto, Hiromi	ORI	AP	Submarine Geophysics
Fujiwara, Akira	ISAS	AP	Planetary Physics
Fukao, Yoshio	ERI	P	Seismology
Hayakawa, Hajime	ISAS	AP	Space Physics
Hirata, Naoshi	ERI	P	Observational Seismology
Ida, Yoshiaki	ERI	P	Volcano Geophysics
Igarashi, George	LEC	AP	Geochemistry, Crustal Dynamics
Ishii, Hiroshi	ERI	P	Crustal Dynamics and Solid Geophysics
Ishii, Teruaki	ORI	AP	Ocean Floor Geotectonics
Iwasaki, Takaya	ERI	P	Controlled Seismology
Kagiyama, Tsuneomi	ERI	AP	Physics of the Earth and Planetary Interiors
Kanazawa, Toshihiko	ERI	P	Marine Seismology
Kaneoka, Ichiro	ERI	P	Chemical Volcanology
Kasahara, Junzo	ERI	P	Marine Seismology
Kato, Teruyuki	ERI	AP	Crustal Dynamics
Kawabe, Masaki	ORI	AP	Physical Oceanography
Kawakatsu, Hitoshi	ERI	AP	Seismology
Kikuchi, Masayuki	ERI	P	Seismology
Kimoto, Masahide	CCSR	AP	Climate System Dynamics
Kimura, Ryuji	ORI	P	Geophysical fluid dynamics
Koike, Isao	ORI	P	Physical Geography
Koketsu, Kazuki	ERI	AP	Engineering Seismology and Strong Motion Seismology
Koyaguchi, Takehiro	GFS	AP	Volcanology and Geophysical Fluid Dynamics
Kudo, Kazuyoshi	ERI	AP	Strong-motion Seismology
Matsubara, Hiroshi	GSAS	AP	Human Geography
Matsui, Takafumi	GFS	P	Comparative Planetology
Miyatake, Takashi	ERI	AP	Seismology
Mizutani, Hitoshi	ISAS	P	Planetology
Morita, Yuichi	ERI	AP	Seismology
Mukai, Toshifumi	ISAS	P	Planetary Magnetospheric Physics
Nagao, Keisuke	LEC	P	Geochemistry
Nagata, Junji	GSAS	AP	Human Geography
Nakada, Setsuya	ERI	AP	Volcanology
Nakai, Shun'ichi	ERI	AP	Geochemistry
Nakajima, Teruyuki	CCSR	P	Atmospheric Physics, Remote Sensing
Niino, Hiroshi	ORI	AP	Geophysical Fluid Dynamics
Notsu, Kenji	LEC	P	Geochemistry
Numaguti, Atsushi	CCSR	AP	Climate Dynamics, Hydrological Cycle
Ogawa, Masaki	GSAS	AP	Mantle Dynamics
Oguchi, Takashi	CSIS	AP	Geomorphology
Ohmori, Hiroo	GFS	P	Physical Geography

Roster of Affiliated Faculty (cont'd)

Name	Affiliation	Rank	Specialty
Ohnaka Mitiyasu	ERI	P	Experimental Seismology
Okubo, Shuhei	ERI	P	Geodesy, Geodynamics
Oyama, Koh-ichiro	ISAS	P	Dynamics and Structure of the Ionosphere and Thermosphere
Saito, Yoshifumi	ISAS	AP	Plasma Physics
Sasai, Yoichi	ERI	AP	Geo-electromagnetism
Sato, Hiroshi	ERI	AP	Structural Geology
Seno, Tetsuzo	ERI	P	Earthquakes and Tectonics
Shimazaki, Kunihiko	ERI	P	Basic and Theoretical Seismology
Sugimoto, Takashige	ORI	P	Physical and Environmental Oceanography for Fisheries
Suginohara, Nobuo	CCSR	P	Dynamics of the Oceans
Sumi, Akimasa	CCSR	P	Climate System Dynamics
Tagai, Tokuhei	UM	P	Modulated Structure of Minerals
Taira, Asahiko	ORI	P	Marine Geology
Taira, Keisuke	ORI	P	Physical Oceanography
Takahashi, Masaaki	CCSR	P	Atmospheric Dynamics
Takano, Kiyoshi	ERI	AP	Computer Networking Seismology
Takeo, Minoru	ERI	P	Seismology
Tamaki, Kensaku	ORI	P	Ocean Floor Geotectonics
Taniuchi, Toru	GSAS	P	Human Geography
Tokuyama, Hidekazu	ORI	AP	Ocean Floor Geotectonics
Toriumi, Mitsuhiro	GFS	P	Earth Material Science
Tsuji, Yoshinobu	ERI	AP	Physical Oceanography
Tsukuda, Tameshige	ERI	AP	Physics of the Earth and Planetary Interiors
Uematsu, Mitsuo	ORI	AP	Bio-Geochemistry
Urabe, Taku	ERI	AP	Seismology
Utada, Hisashi	ERI	AP	Geo-electromagnetism
Watanabe, Hidefumi	ERI	P	Volcanolo Geophysics
Yagi, Takehiko	ISSP	P	High Pressure Mineral Physics
Yamano, Makoto	ERI	AP	Geothermics, Tectonophysics
Yamashina, Ken'ichiro	ERI	AP	Physics of Volcanos and Earthquakes
Yamashita, Teruo	ERI	P	Seismology
Yoshida, Shingo	ERI	AP	Seismology and Tectonophysics
Yoshii, Toshikatsu	ERI	P	Seismology

Abbreviations for Institutional Affiliation

Abbreviation	Institution Name
CCSR	Center for Climate System Research
CSIS	Center for Spatial Information Science
ERI	Earthquake Research Institute
GFS	Graduate School of Frontier Sciences (Kashiwa Campus)
GSAS	Graduate School of Arts and Sciences (Komaba Campus)
ISAS	Institute of Space and Astronautical Science
ISSP	Institute of Solid State Physics
LEC	Laboratory for Earthquake Chemistry, Graduate School of Science
ORI	Ocean Research Institute
UM	University Museum

Abbreviations for Faculty Ranks

Abbreviation	Rank
P	Professor
AP	Associate Professor

height

Table 7: Roster of Affiliated Faculty

5 Scope of the Core Faculty Research Groups

As discussed above, the core department will be divided into five semi-autonomous groups. This section discusses the overall scientific areas covered by each group, and also the details of each area that the groups intend to cover. These may or may not correspond to the activities now being conducted by present faculty. In cases where they do not, the groups have given some thought to how changes can be effected through changes in faculty personnel. However, such changes will involve evolution over a time scale of five to ten years, and cannot be achieved more quickly.

As explained above, under the rules of Monbusho, each full professor's billet must correspond to a named subfield with a particular description. If these names and descriptions were strictly enforced, undesirable rigidity could result. However, these subfields will be interpreted relatively freely when faculty personnel actions are being carried out.

It is difficult to generalize, as each group's circumstances and scientific topics are different, but it is generally understood that there will not be drastic changes in the balance of the various subfields in each group in the short term. For example, the Ocean and Atmospheric Sciences Group contains faculty in both meteorology and physical oceanography. These researchers naturally interact, but the fields are separate, and a balance will be maintained. Similarly, the space and planetary science group will maintain a balance between space physics and solid planets/cosmochemistry, and the Solid Earth Science Group will maintain a balance between solid Earth geophysics and geology. In all cases we of course will strive to increase the extent of interaction between related subfields (this is one of the main benefits expected from forming a single department) but the various traditions and distinct natures of the respective subfields will also be respected.

5.1 Oceanic and Atmospheric Science Group

Our planet Earth is unique simply because it is covered by moisture evaporated from the ground and oceans. Since the oceans of this planet occupy more than 70% of the global surface, this planet is sometimes called an ``aqua-planet.'' Water absorbs radiation from the Sun quite effectively and has a large specific heat; it releases/absorbs large latent heat by changing its phase. In addition, it is extremely solvent and fluid. It is all those characteristics that have introduced rich daily weather, seasonal changes and climate variations into our planet. Another unique evolution of our civilization is due to those natural changes of our environment; building a society less vulnerable to natural disasters has been a major motive for our evolution. Now, anthropogenic effects appear to have crucial impact on those variations after the industrial revolution.

This group will be devoted to high-level education as well as research on those oceanic and atmospheric phenomena of various space and time scales from breaking internal waves to centennial global climate changes. The efforts will contribute to enhancing our basic knowledge on predictability of oceanic and atmospheric phenomena of great societal concern. To be more specific, this group, through data analysis, analytical methods, global modeling and field observations when necessary, encourages development of our understanding of oceanic and atmospheric flows and turbulence, ocean-atmosphere coupled phenomena generating climate variations, circulation of various oceanic and atmospheric substances such as ozone, carbon and fresh water.

In order to fulfill above purposes, we introduce the following four research subgroups and proceed to realization of world leading research and education in the realm of oceanic and atmospheric science.

5.1.1 Atmospheric Physics

The atmospheric phenomena observed on Earth and other planets range over various scales and involve various physical processes, such as dynamical, radiative and cloud physical ones. With a special emphasis on the dynamical process, this group will devote their efforts to enhancing research and education of atmospheric physics. In particular, the atmospheric phenomena ranging from the general circulation to the meso-scale phenomena are investigated using analytical methods, numerical models and various dataset. Our definite objective is to make clear dynamical mechanisms working in the troposphere and/or the stratosphere as well as to advance the predictability study. Outcomes from this group will be particularly beneficial to daily life of the society. In addition to such rather direct contribution, the group wishes to contribute to planetary science by clarifying unknown mechanisms of various interesting phenomena in other planets.

5.1.2 Physical Oceanography

This research group will devote their major efforts to understanding as well as educating various physical processes such as eddy-eddy interaction, eddy-mean flow interaction and turbulent mixed-layer dynamic in the ocean. Those processes that are crucial to accurate modeling of the large-scale ocean general circulation are clarified through analytical and numerical study as well as analysis of in situ and remote sensing data. Areas of current particular interest are interaction between mesoscale eddies and global ocean currents and parameterization of diapycnal mixing processes caused by breaking internal waves, and advanced modeling of the ocean surface mixed layer to be embedded in next-generation general circulation models.

5.1.3 Climate Dynamics

This research group focuses on understanding climate variations on seasonal-to-centennial time scales. Particular emphasis is laid on roles of the ocean on climate. Phenomena to be addressed actively in cooperation with the world climate research community are, for example, interannual variations such as El Nino/Southern Oscillation, variations of the Kuroshio and their link with the Pacific climate changes, decadal/interdecadal climate events and variations of the oceanic lateral and meridional circulation. Developing various tools from simple conceptual models to realistic general circulation models including ocean-atmosphere coupled models as well as stand-alone ocean models, major physical processes causing climate changes will be clarified in order to enhance predictability of those phenomena with vast societal impact. Synthesis of global ocean-atmosphere data with models is also encouraged in this group in order to produce high-level researchers needed in this field.

5.1.4 Ocean-Atmosphere Material Circulation Physics

This group is devoted to studying as well as educating circulation of substances in the atmosphere and oceans using observational methods, data analyses and models of various degrees of freedom. On the atmospheric side, major targets are to study composition, distribution, chemical transformation and variability of atmospheric constituents such as ozone and so-called greenhouse gases. Addressed on the oceanic side are the oceanic thermohaline processes, water-mass formation and circulation of oceanic substances such as fresh water, salt, nutrients and carbon. This group will interact actively with the other three group which provide information on ocean-atmosphere flow field with its variability.

5.2 Space and Planetary Science Group

This group will study the planets, their interiors, surfaces, atmospheres, and magnetospheres, the heliosphere, and space, aiming at a comprehensive understanding of elementary physical processes, structures, compositions, dynamics, and their mutual interactions. Numerical simulation, laboratory experiments, and analyses of extra-terrestrial materials such as meteorites, as well as in situ observations on balloons, sounding rockets, and spacecraft will be conducted. Since ``Space and Planetary Science'' encompasses a variety of fields in scope, it is of course impossible to cover all the subjects only by the internal members of the group. Close collaborations with the members of the other groups in the Department of Earth and Planetary Sciences as well as in the Institute of Space and Astronautical Science will be conducted in various levels and scales (among individual researchers, among research groups, and also in educational plans for graduate students).

This group consists of five subgroups, ``Space Physics,'' ``Magnetospheric Physics,'' ``Observational Planetology,'' ``Comparative Planetology,'' and ``Planetary Material Science.'' It is noted that there are varieties of research status in different disciplines covered by these five subgroups: With Japanese successful spacecraft projects, ``Akebono'' and ``Geotail,'' studies in the relating subgroups (Space Physics and Magnetospheric Physics) are at the top level in the international research community. A remarkable achievement has also been made in the field of isotopic studies of meteorites using an ion microprobe and gas mass spectrometry. The research activities within the group which relate to planetary exploration, though being at the highest level in Japan, are on the developing stage in the international standard. As rapid progresses in the Japan's commitment on various planetary/lunar/asteroid scientific missions, we expect that these fields in Japan will certainly grow in coming years. Our members are taking important roles in these ongoing and future planetary missions.

5.2.1 Space Physics

This subgroup has made, and will continue its contribution to the studies of fundamental processes in space, such as plasma heating/acceleration and transport/mixing processes in various plasma environments including shock waves, current sheets, velocity shear layers, and plasma discontinuities. From the space plasma research over three decades, it has become clear that the solar system works as the primary plasma laboratory in which these various plasma processes can be studied with great generality: For example, the study of shock waves in the solar system has given far-reaching impacts on the understanding of the origin of cosmic ray particles, which is now believed to be attributable to supernova shocks. Studies of the present and primordial solar wind as well as its interaction with the planets and interstellar matter, having interdisciplinary research interest, are among the important subjects to be covered by this subgroup,

5.2.2 Magnetospheric Physics

This subgroup has the main research target in physical structures, interaction processes and dynamics of magnetospheres around compact celestial objects, such as the Earth, planets, comets, the Sun, and primordial stellar systems. One of the major physical processes, which has experienced enormous attention in magnetospheric physics community, is magnetic reconnection. Recent observations of solar flares as well as magnetospheric substorms have provided quantitative evidence for magnetic reconnection processes playing major roles in cosmic plasmas. While this subgroup has gotten scientific achievements so far mainly in traditional fields of magnetospheric research, such as the studies of reconnection, auroral substorms, magnetosphere-ionosphere coupling, it will also cover new research fields, such as studies of accretion disks and magnetohydrodynamic jet formation around proto-stars and various cosmic environments.

5.2.3 Observational Planetology

According to recent development of the space technology, both in-situ observations and the remote sensing of planets have become key tools to understand the formation and evolution of the solar system and its planets (atmospheres, crusts, and interiors). This subgroup conducts feasibility studies and mission design for planetary exploration, sensor development as well as data analyses and interpretations for such missions. The research activities of this subgroup are also going to cover observations of both external planetary and proto-planetary systems, which will be conducted under the close collaborations with astronomers and astrophysicists in other institutions (National Astronomical Observatory, for example).

5.2.4 Comparative Planetology

This subgroup conducts studies of the internal structures and surface features of various bodies in the solar system (Earth-like planets, Jovian-type planets, icy satellites, comets and asteroids), and physics of impacts among these bodies and associated crater formation processes. Other fields being covered by this subgroup are the origin of the solar system, atmospheres of terrestrial planets, surface geological features of terrestrial planets, origin of interplanetary, interstellar and ring dust, formation of Jovian planets, and evolution of asteroids. Studies of comets are also an important field shearing research interests with other subgroups. The members of this subgroup have also taken an initiative in the Japan's interplanetary dust exploration project.

5.2.5 Planetary Material Sciences

In order to understand the early history of the solar system, this subgroup conducts mineralogical, petrological, chemical and isotopic studies on various types of extra-terrestrial materials corresponding to different localities and different stages of the solar system evolution, such as primitive meteorites, differentiated meteorites, lunar and Martian meteorites, cosmic dusts, and so on. Techniques of micro-analyses using EPMA (electron-probe-micro-analyzer), SEM (scanning electron microscope), TEM (transmission electron microscope), SIMS (secondary ion mass spectrometer, or ion microprobe), and FT-IR/Laser-Raman spectroscopic methods have been and will continue to be essential to proceed these studies. The ion microprobe technique, which was recently introduced and developed by the members and has already borne fruitful results, will increase its importance both in elemental and isotopic studies of extra-terrestrial materials, such as studies of REE (rare-earth-elements), stable isotopes (e.g., oxygen), and radiogenic isotopes (e.g., chronology based on short-lived radionuclides).

5.3 Earth and Planetary System Science Group

The Earth and Planetary System Science Group aims to establish a new scientific field which stresses the viewpoint of studying the planet Earth as well as other planets as a single system composed of intimately coupled multiple domains. We will treat individual phenomenon on and within the earth and other planets from this point of view to understand stability, variability, and evolutionary trends of the planetary system and their surface environment. Our group consists of the following four subgroups: Analysis of the Earth and planetary system, Evolution of the Earth and planetary system, Dynamics of the Earth system, and Dynamics of the Earth's surface environment.

5.3.1 Analysis of the Earth and planetary system

This subgroup aims to specify operational processes of the interactions between multiple domains of the earth and planetary system by means of theory, observation and experiments, and to explore the mechanism to stabilize and maintain present condition of the system.

(a) We investigate dynamics and evolution of the earth and planetary interiors. For the investigation on the fluid motion of the core, joining the Ocean Hemisphere Network Project, we are constructing networks of geomagnetic stations both on islands in the Pacific and on the sea floor. The long-term observation (more than a year) and paleomagnetic studies are planned. Theoretical study on modeling the geomagnetic variations due to the disturbance of the earth's rotation is carried out. Laboratory experiments are also made, of which results are compared with the theoretical investigations to infer that the thermal insulating effect of the continents with tectosphere affects the pattern of the mantle convection.

(b) We want to reveal the mechanisms that yield the characteristics of each terrestrial planet. The surface processes on the earth and planetary system are strongly dependent on interactions among multi-spheres, which includes planetary climatology, planetary tectonics, and early evolution of the planets. We theoretically investigate the feedback among the surface reactions and atmospheric chemistry. The role of plate tectonics on the surface environment is also investigated. Thermal and mechanical evolution of Moon's and other planets' crust and lithosphere, surface processes in the early evolution of planet are also our concern, particularly the formation of Martian atmosphere during accretion.

(c) Stability, variability, and evolutionary trends of the Earth and other terrestrial planets, specifically their climates and surface environments (atmosphere, ocean, biosphere, crust, and upper mantle) are investigated from theoretical viewpoints, such as energy transport and geochemical cycles between the subsystems of the planets, on a variety of timescales. Relationships and constraints among the atmospheric, volcanic, and thermal evolution are studied. We develop models of geochemical cycle of carbon on various time scales to reconstruct the climate evolution in a long range and climate change in short scale during the Earth's history.

5.3.2 Evolution of the Earth and planetary system

This subgroup aims to investigate evolution of the earth, solar, and satellite systems from the viewpoints of material, chemical, thermal, and mechanical evolution by means of theory, observation and experiments, and to clarify the roles of each domain and interactions among them during the course of the evolution of the systems.

(a) Planetary craters played a particular role on the dynamic, tectonic, and chemical evolution of the earth, solar, and satellite systems. With the aid of knowledge on volcanology and sedimentology, planetary craters are analyzed to deduce its formation mechanism, which includes the observation on Martian craters as the Mars Imaging Camera group of Nozomi Japanese probe. Other geomorphologies and thermal evolution of mars and icy satellites are studied including the development of phase diagram of materials. These studies require better understanding on volcanology and physical properties of magmas on the earth, and therefore, vesiculation, magma transport, and rheology and elasticity of partially-molten rocks are experimentally and theoretically studied.

(b) Chemical evolution of the solar and earth systems is one of our major concerns, particularly chemical evolution of condensed phase through interactions between gas and liquid. These study give information on evolutionary time scale through kinetics of reactions. It includes an inverse approach such as petrologic, mineralogical, and isotopic study on chondritic materials to find critical records on the process took place in the early solar nebula. We also make a forward approach such as modeling of reaction processes that are responsible for the observed chemical characteristics. It includes various kinetic processes such as evaporation, condensation, crystallization and melting. Experimental studies on the kinetic reactions are carried out to get reaction parameters.

5.3.3 Dynamics of the Earth system

This subgroup aims to reconstruct past changes of global system on various temporal and spatial scales on the basis of geological and observational analyses, and to explore their relations among multiple domains by quantitative evaluation of energy transport and chemical cycling.

We want to understand the dynamics of global climatic and environmental systems, their stability, and the mechanism(s) which stabilize the global surface environment as habitable for lives based on the reconstruction of past changes from geological records synthesized with theoretical studies. The research targets includes i) the centennial- to millennial-scale abrupt climatic changes, and their dynamics with special emphasis on testing stability of global climatic system under Quaternary interglacial conditions and exploring possibility of near future abrupt climatic changes in response to increasing greenhouse warming caused by human races, ii) the stability and recovery processes of global environmental systems against catastrophic perturbation associated with asteroid impacts such as K/T impact, and iii) the dynamics of global ocean anoxia during Phanerozoic and their possible relation with abrupt climatic changes and mass extinctions.

5.3.4 Dynamics of the Earth's surface environment

This subgroup aims to understand regional as well as temporal variability of the surface environment on the earth where interaction of multiple domains is very active, and to explore causes of such variability through analysis and reconstruction of the surface environment using climatological, ecological, geomorphological and geological methods.

(a) Monsoon is a particular climate system generated by multiple interaction among land, ocean and atmosphere on the earth surface. One of the main topics is the global-scale climatology on the seasonal and interannual changes of monsoon during recent observation period, mainly over the Asian monsoon region. Also we analyze the global-scale heavy rainfall, which will contribute to the disaster prevention, as well as to the paleo-climatology related to reconstruction of past fluvial geomorphic process.

(b) Coral reefs and coastal processes give information on the biological, physical, chemical and geological interactions, which can be understood through field monitoring. Ecological zonation of reef creatures is compared with physical parameters and this relation is traced back to the geological past. Carbon and nutrient cycles accompanying with community metabolism are monitored and compared with CO flux. The role of coral reefs /coastal ecosystems is one of our main topic with relation to the global changes. We also investigate the environmental changes by corals/coral reefs with timescales of 100 to 100,000 years by excavating coral reefs and coastal plains. By applying geochemical method, the research leads to evaluate the role of tropical oceans in the long-term climate changes.

(c) The mechanisms and regional diversity of the earth surface processes interacting climate, water, topography, vegetation, human activities are analyzed by taking field observation data. The response of the earth surface to the environmental changes in various temporal and spatial scales in the past, present and future is studied.

5.4 Solid Earth Science Group

The solid Earth is a very large-scale complex system, consisting of the crust, mantle, outer core and inner core which are different, both physically a nd chemically, from each other. This group aims to reveal the complex structure, composition and state of the Earth's interior and to achieve a better and more unified understanding of the various geophysical, geochemical and geological processes operating on different temporal and spatial scales. In order to fulfill the above purposes, the six subgroups, named Structure of the Earth's Interior, Dynamics of the Earth's Interior, Magma Dynamics, Global Tectonics, Dynamic Geomorphology and Earthquake Physics, will be set up in this group. The first three subgroups mainly focus on structure and processes in the deep interior. The central subject is how the internal structure prescribes the dynamic processes and how the dynamic processes evolve the internal structure. This subject will be addressed from three different viewpoints of seismology, geodynamics and material science. The latter three subgroups mainly focus on structure and processes in the Earth's surface. The central subject is how we can construct a unifying theory that can rationally explain complexity and diversity in tectonic structure and crustal activities including earthquake occurrence, volcanic eruption and mountain building. This subject will be addressed from geophysical, geological and geomorphological points of view. Another essential subject is thermo-mechanical coupling between mantle dynamic processes and crustal dynamic processes. The three subgroups, Dynamics of the Earth's Interior, Magma Dynamics and Global Tectonics, will collaborate with each other to address this subject. Solid Earth Science covers diverse research fields. Therefore, the education of Solid Earth Science in Graduate Course will be conducted in collaboration with many faculty members in Ocean Research Institute and Earthquake Research Institute.

5.4.1 Structure of the Earth's Interior

The goal of this subgroup is to determine the the structure (density, compressibility, rigidity, viscosity, pressure, and temperature), composition, and state of the Earth's interior. The main approaches used by this group will be seismological observations and high-pressure laboratory experiments on minerals. In order to obtain the most accurate possible models of the structure of the Earth's interior, we should directly analyze seismic waveforms, as opposed to using only secondary data such as travel times or surface wave phase velocities. In order to analyze seismic waveforms we need efficient and accurate methods for calculating synthetic seismograms. Our subgroup has developed such computational techniques, and now is in the process of applying them to actual data to invert for 3-D Earth structure. Determining the Earth's 3-D structure has important implications for geodynamics. In order to be able to interpret these data properly, we need better knowledge of the behavior of minerals at the pressures and temperatures in the Earth's interior. This subgroup will study mineral physics experimentally using facilities such as SPRING-8.

5.4.2 Dynamics of the Earth's Interior

From a dynamical point of view the solid Earth operates as three coupled convective systems in the fluid outer core, the subsolidus mantle and the outermost solid shell. In the outer core magnetohydrodynamic motions generate the geomagnetic field. In the mantle, in addition to the global-scale thermal convections that would be responsible to plate tectonics, there exist local-scale thermal plumes that cause hot-spot volcanism. In the Earth's surface global plate motions with accretion of new plate areas at ocean ridges and consumption of old plate areas at ocean trenchs are driven by gravitational forces arising from thermal contraction associated with cooling. This subgroup aims to quantitatively understand the dynamic processes of these convective systems and to reveal the mechanisms of interaction between them, namely the viscous, magnetic and topographic coupling at the core-mantle boundary and the viscous and thermo-mechanical coupling between plates and mantle convection, through the analysis of geophysical and geological data and the large-scale computer simulation based on geophysical and geochemical models. In order to achieve this goal, collaboration with the other subgroups, Structure of the Earth's Interior and Magma Dynamics, is necessary.

5.4.3 Global Tectonics

Tectonics is concerned with the nature and causes of the large-scale deformation of the lithosphere, ranging from the large deformations seen in mountain belts in plate boundary zones to the long wave deformation of plate interiors. Microscopic scale deformation is also very important to understand a basic process of tectonics. Oceanic tectonics is a science of the Mesozoic and Cenozoic, whereas continental tectonics takes us back to the Archean. Definite objective of this subgroup is to make clear the problem of how the lithosphere shortens, extends and flexes and how bulk deformations are accomplished in the brittle upper crust, the ductile lower crust and in the mantle lithosphere. Areas of current particular interest are tectonics of plate convergent zones and its evolution through earth history.

5.4.4 Magma Dynamics

Magma is a product of melting of the Earth's and planetary interiors, which plays an important role in material and energy transportation, hence in the evolution of the Earth and the planets. The research targets of this group range from a microscopic scale such as behavior of elements and molecules in the magma, to a global scale phenomena as a field of magma generation, such as mantle convection-melting systems. Consequently, a wide spectrum of methods and approaches will be used: for example, spectroscopic observations of solid and melt, field survey and sampling of rocks, high-pressure and temperature experiments, numerical modeling of the processes. Combining all the available methods and data, the role of magma in the Earth's and planetary systems will be analyzed.

5.4.5 Dynamic Geomorphology

The formation and evolution of the Earth's landforms have been one of the most important subjects in Earth sciences, but are not yet fully understood. A real understanding of the Earth's morphology, in turn, is a key to revealing geologic processes acting on other planets, because most of observational data are of surface morphology that were obtained by remote-sensing methods. Topography of the Earth is formed both by endogenic processes (plate interaction, magmatic activity, etc.) and by exogenic processes (weathering, erosion, etc.). The formation of larger scale topography is controlled by progressively deeper Earth's properties such as density, temperature, and rheology. Therefore, a real understanding of the Earth's morphology requires highly multi-disciplinary collaboration by scientists from different fields of Earth sciences. This research group will consist of researchers from geomorphology, marine geology, and solid Earth physics. By combining geologic/geophysical observations and modeling, we will attempt to understand the Earth's morphology from an essentially new point of view.

5.4.6 Earthquake Physics

The scientific goal of earthquake physics is the understanding of the entire physical process of earthquake generation, consisting of tectonic loading due to relative plate motion, quasi-static rupture nucleation, dynamic rupture propagation and stopping, and fault lithification and healing. In order to achieve this goal, this subgroup will conduct research and education in mechanics of earthquakes, physics of earthquake rupture, crustal deformation due to faulting, theory and application of geophysical data inversion, and computer simulation of earthquake generation cycles. The education of earthquake physics in Graduate Course will be conducted in collaboration with faculty members in Earthquake Research Institute. In the research of computer simulation, collaboration with Crustal Activity Modeling Group of Earth Simulator Project promoted by STA (Science and Technology Agency of Japan) and Microscopic Simulation Group of ACES (APEC Cooperation for Earthquake Simulation) will be strengthened.

5.5 Geosphere and Biosphere Science Group

The Earth is a unique planet in the solar system, on which life was sired and has been nourished. On the geosphere and biosphere, the outermost layer of the earth, various interactions have been operated among lithosphere, hydrosphere, atmosphere, and biosphere over a long geologic history.

This group will conduct research and education on the formation of geosphere materials, the evolution of the geosphere, the origin and evolution of life, and the fundamental processes of geosphere-biosphere interactions. This research will be based mainly on field observation, analysis of geological, mineralogical, and paleontological samples, and laboratory experiments using various techniques such as transmission electron microscopy, scanning electron microscopy, atomic force microscopy, electron probe and energy dispersion X-ray microanalyses, X-ray diffraction analysis, gas- and ICP-mass spectrometry, gas-chromatography, and amino-acid and DNA sequence analyses. The methodology and objectives of study in this group are, therefore, partly common with those in other groups, especially those of Earth and Planetary System Science and of Solid Earth Science, but we have a stronger intention to explore the interdisciplinary field between Earth Science and Biological Science than the other groups. Our research field has also an intimate relationship with human activity, since it focuses on the co-evolution between geosphere environments and life.

Nowadays, human society is facing serious problems such as the explosive increase of population, global warming, rapid decrease of biological species diversity, and chemical pollution of the geosphere and biosphere environments. These remarkably rapid environmental changes (we call these changes the ``Late Quaternary Crisis'') have undoubtedly been caused by recent human activity. Based on analyses of major geologic and biologic events that occurred repeatedly through the Earth's history, we will compare the magnitude and speed of these recent environmental changes with those of geologic events. Furthermore, we will present a scientific message for the establishment of a better relationship between human society and the surrounding geo- and bio-sphere environments in the 21st century.

5.5.1 Evolution of the Geosphere

This subgroup aims to reconstruct the environmental evolution of the geosphere (the combination of the lithosphere, hydrosphere, and atmosphere) based on both field observations and laboratory experiments, from the viewpoint of sedimentology and geochemistry. This subgroup's work has the overall aim of clarifying the interrelation of the geosphere, biosphere, and the Earth's interior throughout the 4.6 billion years of the Earth's history. One of the important projects in this subgroup is to present a general model of the short-term and long-term evolution of the geosphere, in terms of bio-productivity change, development of sedimentary basin and carbonate precipitation, and formation/dissociation of marine gas hydrates.

5.5.2 Geosphere Material Science

This subgroup will focus on the structure of materials (mainly minerals) at the Earth's surface, their formation mechanisms, and the fundamental processes of interaction between geosphere materials and solutions. This research will be investigated on the nanometer scale by X-ray diffraction analysis, electron microscopy, and related techniques. Currently important subjects are 1) crystal-chemical properties of geosphere materials such as zeolite, 2) atomic-resolution transmission electron microscopic studies of minerals and their fine structures, 3) fundamental dissolution and weathering reactions of silicate minerals and their effects on elemental transport, and 4) weathering in the Precambrian and the evolution of the atmosphere.

5.5.3 Chemical Evolution of the Geosphere and Biosphere

This subgroup will study the origin and evolution of the chemical condition of the geosphere and biosphere in relation to the evolution of life, through the analysis of the origin of chemical variation of constituents of the geosphere and biosphere, processes and mechanism of transportation, concentration, and dispersion of materials, and microbial activity and organic production of geosphere and biosphere materials.

5.5.4 Biosphere Material Science

This subgroup will focus on the elemental reaction mechanisms between biological and inorganic materials down to the atomic and molecular level in order to better understand the origin of life and the interactions between life and the environment in the geosphere and biosphere. A specific focus involves study of organic–inorganic interactions and interface structures between biomolecules and crystals in the process of biomineralization.

5.5.5 Paleobiology

This subgroup will focus on biological aspects of extinct organisms based on comparative analysis of fossils and extant organisms. Its major goals are to better elucidate the tempo, mode and mechanism of morphological evolution of life throughout the Earth's history, and the role of life in the formation and evolution of the geosphere. Currently important subjects are 1) Study of early evolution and phylogeny of marine invertebrates with sufficient fossil record based on embryological, molecular biological, and paleontological data, 2) Life history of extant and fossil organisms using shell growth lines and stable isotopes, 3) Paleontological consideration on recovery of bio–diversity after mass extinction, and 4) Evolution of predator–prey relation after the ``Mesozoic Marine Revolution.''

6 Administrative aspects

6.1 Space

The new department will be formed by merging four separate departments. Three of the departments, Geology, Geography, and Mineralogy, have their offices and laboratories in Building No. 5 of the Graduate School of Science. The offices of the faculty and graduate students of the Department of Earth and Planetary Physics are on the 7th and 8th floors of the newly constructed Building No. 1 of the Graduate School of Science. However, the laboratory, classroom, and library space of the Department of Earth and Planetary Physics is still in Building No. 3 of the Graduate School of Science. As Buildings No. 3 and No. 5 are more than 1000 m apart, the integration of the new department into a single unit is greatly hampered by this physical separation.

The present Building No. 1 of the Graduate School of Science is built on the site of part of the original Building No. 1 of the Graduate School of Science, which is being demolished in stages. The plan for the construction of the new Building No. 1 is divided into three stages. As soon as each stage was completed, the next stage was supposed to begin by demolishing the next segment of the old Building No. 1, so that construction of the next segment of the new building could begin. The first stage of the new Building No. 1 was completed in March 1998. Unfortunately, the remainder of the old Building No. 1 is now being used temporarily by the new Graduate School of Frontier Science (until construction of the Kashiwa campus can be completed), so the next phase of construction of the new Building No. 1 is on hold. Until construction of the new Building No. 1 can be completed, our new department will be physically separated, which will greatly hamper our ability to functions as a single unit. We regard completion of construction of the new building as the top priority request of our new department for physical facilities.

A walking tour for the external review committee will be conducted on Tuesday March 16, so that they can get a feel for the present situation.

6.2 Libraries

The combined library holdings of the new department meet our present needs. However, electronic media are becoming increasingly important and this is an area where we still do not have formalized collection development policies. The library holdings of the new department will be split between the No. 3 and No. 5 Buildings, which is a major inconvenience. Integrating the collections in conjunction with the next phase construction of the new No. 1 Building (or securing nearby space) is a high priority. The librarian for the present Earth and Planetary Physics collection will retire soon, and obtaining a replacement is a high priority.

It should be noted that the library collections of the various departments in the Graduate School of Science are separate. Since 1987 the Library Committee of the School has been proposing that a new integrated library for the School as a whole be constructed near the present No. 1 building. There is no opposition to this plan, but it is not viewed as a high priority, and there are no immediate prospects for its implementation.

6.3 Supporting staff

The number of supporting clerical staff provided as permanent civil service employees is insufficient, but we are able to employ additional staff of a high quality on a contract basis. Employment of technicians on a civil service basis is almost impossible. Several technicians who were hired in the past are still employed, but contribute relatively little to the present needs of the department. As they are civil servants, they cannot be redeployed and replaced by other employees more suited to our present requirements. As a result the faculty (particularly the research associates) are forced to perform tasks (e.g. those related to the workstations and local area networks) that ideally should be performed by technicians. We do, however, have one part-time contract employee who works as a system administrator.

7 Curriculum

7.1 Curriculum of Graduate Course in Earth and Planetary Science

This section list the courses for the graduate school curriculum of the proposed new department.

The abbreviation MC means Masters degree course, and DC means Doctoral course.

Introductory Courses

Subjects	Units	Remarks
Methods of Data Analysis I	2	MC
Methods of Data Analysis II	2	MC
Mathematical Methods in Geophysics I	2	MC
Mathematical Methods in Geophysics II	2	MC
Solid Earth Mechanics I	2	MC
Solid Earth Mechanics II	2	MC
Geophysical Fluid Dynamics I	2	MC
Geophysical Fluid Dynamics II	2	MC
Thermodynamics of Solids	2	MC
Earth and Planetary Chronology	2	MC
Introduction to Earth and Planetary Material Science	2	MC
Introduction to Physical Geology	2	MC
Introduction to Space Physics	2	MC
Introduction to Comparative Planetology	2	MC
Introduction to Earth and Planetary System Science	2	MC
Introduction to Geosphere and Biosphere Science	2	MC

Basic Courses

Subjects	Units	Remarks
Atmospheric Physics I	2	MC
Atmospheric Physics II	2	MC
Physical Oceanography I	2	MC
Physical Oceanography II	2	MC
Climate Dynamics I	2	MC
Ocean-Atmosphere Material Circulation Science I	2	MC
Space Plasma Physics	2	MC
Magnetospheric Physics	2	MC
Observation Technologies for Planetary Atmosphere	2	MC
Formation and Evolution of Planets	2	MC
Planetary Isotope Science	2	MC
Analysis of the Earth and Planetary System	2	MC
Evolution of the Earth and Planetary System I	2	MC
Evolution of the Earth and Planetary System II	2	MC

Basic Courses (contd)

Subjects	Units	Remarks
Dynamics of the Earth System I	2	MC
Dynamics of the Earth System II	2	MC
Dynamics of the Earth's Surface Environment I	2	MC
Dynamics of the Earth's Surface Environment II	2	MC
Geochemical Cycle I	2	MC
Geochemical Cycle II	2	MC
Theory of Seismic Waves	2	MC
Structure of the Earth's Interior I	2	MC
Dynamics of the Earth's Interior I	2	MC
Geo-electromagnetism I	2	MC
Magma Dynamics I	2	MC
Volcano Science I	2	MC
Global Tectonics I	2	MC
Rheology of the Earth	2	MC
Dynamic Geomorphology I	2	MC
Dynamic Geomorphology II	2	MC
Earthquake Physics I	2	MC
Earthquake Physics II	2	MC
Evolution of Geosphere	2	MC
Sedimentary Geology	2	MC
Diffraction Crystallography	2	MC
Environmental Mineralogy	2	MC
Material Transport in Geosphere	2	MC
Evolution of Chemical Environment in Biosphere	2	MC
Analysis of Biosphere Materials	2	MC
Mechanisms of Biomineralization	2	MC
Evolutionary Paleobiology	2	MC
Evolution of Biosphere	2	MC

Advanced Courses

Subjects	Units	Remarks
Atmospheric Physics III	2	MC/DC
Atmospheric Physics IV	2	MC/DC
Physical Oceanography III	2	MC/DC
Physical Oceanography IV	2	MC/DC
Climate Dynamics II	2	MC/DC
Ocean-Atmosphere Material Circulation Physics II	2	MC/DC
Space Physics I-II	2	MC/DC
Planetary Magnetospheric Physics I-II	2	MC/DC
Observational Planetology I-II	2	MC/DC
Comparative Planetology I-II	2	MC/DC
Cosmic and Planetary Material Science I-II	2	MC/DC

Advanced Courses (contd)

Subjects	Units	Remarks
Earth and Planetary System Science I-VI	2	MC/DC
Geographical Information Science	2	MC/DC
Regional Human Ecology	2	MC/DC
Structure of the Earth's Interior II-III	2	MC/DC
Dynamics of the Earth's Interior II-III	2	MC/DC
Geo-electromagnetism II-III	2	MC/DC
Magma Dynamics II-III	2	MC/DC
Volcano Science II-III	2	MC/DC
Global Tectonics II-III	2	MC/DC
Submarine Earth Science I-II	2	MC/DC
Dynamic Geomorphology III-IV	2	MC/DC
Earthquake Physics III-IV	2	MC/DC
Geosphere and Biosphere Science I-VI	2	MC/DC

Special Lectures

Subjects	Units	Remarks
Special Lecture on Oceanic and Atmospheric Sciences I-IV	1	DC/MC
Special Lecture on Space and Planetary Science I-IV	1	DC/MC
Special Lecture on Earth and Planetary System Science I-IV	1	DC/MC
Special Lecture on Solid Earth Science I-IV	1	DC/MC
Special Lecture on Geosphere and Biosphere Science I-IV	1	DC/MC

Laboratories

Subjects	Units	Remarks
Field Work in Earth Science	2	MC
Laboratory in Geophysical Observation	2	MC
Laboratory in Instrumental Analysis	2	MC
Laboratory in Information Processing	2	MC

Special Subjects

Subjects	Units	Remarks
Field Excursion I	1	MC
Field Excursion II	1	DC
Seminar on Current Scientific Literature I	2	Required in MC
Seminar on Current Scientific Literature II	3	Required in DC
Colloquium I	2	Required in MC
Colloquium II	3	Required in DC
Research in Earth and Planetary Science I	10	Required in MC
Research in Earth and Planetary Science II	10	Required in DC

7.2 Descriptions of Courses

7.2.1 Introductory Courses

Methods of Data Analysis I. Introduction to spectrum analysis and time series analysis and their application to problems in Earth and Planetary Science.

Methods of Data Analysis II. Introduction to the basic theory of geophysical data inversion and its application to problems in Earth and Planetary Science.

Mathematical Methods in Geophysics I. Basic equations governing various phenomena and processes in Earth Science and their mathematical treatments are explained in detail.

Mathematical Methods in Geophysics II. Outlines of the basic methods of numerical analysis, the finite difference method, the finite element method, and the boundary element method, are given with a brief review of matrix algebra.

Solid Earth Mechanics I. Basic concepts in continuum mechanics, basic equations in elasticity, and analytical solutions of some basic problems in Solid Earth Science.

Solid Earth Mechanics II. Potential theory, mechanics of viscous fluids, and the basic equations of heat and material transfer are given as the foundations of mantle dynamics.

Geophysical Fluid Dynamics I. The basic equations of fluid dynamics on a rotating system are discussed based on the basic equations of non-rotating fluid dynamics. Waves in the atmosphere and ocean are described.

Geophysical Fluid Dynamics II. Instability theory in fluid dynamics on a rotating system is discussed, with emphasis on the barotropic and baroclinic instabilities working in the atmosphere and ocean.

Thermodynamics of Solids. Introduction to thermodynamics of Earth materials, with emphasis on phase equilibrium and element partitioning in rocks as polycrystalline solids, rock–melt systems, and rock–aqueous fluid systems.

Earth and Planetary Chronology. Principles of radiometric dating of Earth and planetary materials, correlation and compilation of stratigraphic records, construction of the geological time table, and methods for estimating absolute ages of strata are explained with examples.

Introduction to Material Science of the Earth and Planets. Characteristics of elements, minerals, and rocks in the Earth's are explained, and physicochemical processes governing their distribution and circulation are discussed.

Introduction to Physical Geology. Basic concepts and framework of structural geology and sedimentology are given with various field examples.

Introduction to Space Physics. A general review of key observations for the understanding of space and magnetospheric phenomena is given in the light of basic concepts from electromagnetism, statistical physics, as well as elementary plasma physics.

Introduction to Comparative Planetology. A summary of basic data on planetary science such as astronomical observations, material analyses, morphology/geology, and internal structure is given. Also important fundamental processes in planetary sciences will be explained.

Introduction to Earth and Planetary System Science. Basic concepts of Earth and planetary system science; foundations of system analysis; characteristics of subsystems of the earth and planetary system; examples of multisphere interactions.

Introduction to Geosphere and Biosphere Science. Basic concepts and methods for investigating the structure, composition and secular variation of the geosphere and biosphere on the basis of observations at outcrops and laboratory analyses of rock, mineral and fossil specimens.

7.2.2 Basic Courses

Atmospheric Physics I. Phenomena in the atmosphere such as convection, meso-scale phenomena and tropical cyclones are described and their mechanisms are discussed.

Atmospheric Physics II. The vertical propagation of waves and their nonlinear behavior (interaction between waves and mean flow) in the middle atmosphere are explained. The influence of wave activity on general circulation is also discussed.

Physical Oceanography I. Fundamental processes in the ocean such as the interaction between mesoscale eddies and global ocean circulation, diapycnal mixing processes caused by breaking internal waves, and advanced modeling of the ocean surface mixed layer are discussed.

Physical Oceanography II. Detailed discussion of the theory of wind-driven ocean circulation and thermohaline ocean circulation. Important findings from recent field observations are introduced.

Climate Dynamics I. The interaction between the atmosphere and ocean is discussed, with emphasis on observations of El Nino in the tropical ocean and decadal oscillations in the extratropics.

Ocean-Atmosphere Material Circulation Science I. Structure, circulation and variability of oceanic substances such as water, heat, salt and carbon, their interaction with the atmosphere, and fundamental physical, chemical and biological processes in the ocean.

Space Plasma Physics. Physical phenomena in space plasma environments are discussed with the goal of developing a unified picture covering both fluid and particle aspects.

Magnetospheric Physics. Physical processes of the structure and transition of the magnetosphere are discussed, combining recent findings from observations of cosmic plasma and electric and magnetic fields. New and as yet unsolved issues are discussed, and their solutions are sought.

Observation Technologies for Planetary Atmospheres. Optical remote measurement methods for planetary atmospheres and methods for inverting the data to obtain models are considered, and chemical/dynamic process of the atmosphere are discussed, based on observed data.

Formation and Evolution of Planets. Basic and applied theories of the formation and evolution of bodies in the solar system are discussed.

Planetary Isotope Science. Basic and applied theories are discussed for dating of extraterrestrial rocks and minerals as well as for understanding the origin and evolution of the Earth and other planets based on abundance ratios, including data for radiogenic isotopes.

Analysis of the Earth and Planetary System. Analysis of multi-sphere interactions from the viewpoint of energy, angular momentum, and material transport. Stabilizing and destabilizing processes in the Earth and planetary systems.

Evolution of the Earth and Planetary System I. Elementary processes on energy and material transport governing the evolution of the Earth and planetary system. Formation and evolution of the solar system, planet-satellite systems, the Earth's structure, and the interior of planets and satellites.

Evolution of the Earth and Planetary System II. Age, isotopic compositions, and chemical composition of the constituents of the Earth and planetary systems. End constraints on the evolution of the Earth and planetary system.

Dynamics of the Earth System I. Introduction to global paleoenvironmental changes on various temporal and spatial scales reconstructed from geological and geochemical data, and their relation with changes in the Earth's interior as well as those outside the Earth. The relationship between global paleoenvironmental changes and energy transport and chemical cycling within the Earth system is also discussed to understand the mechanism of global environmental changes.

Dynamics of the Earth System II. Introduction to methods for quantitatively reconstructing paleoenvironment using geological, geochemical, and paleontological proxies extracted from geological substances, including fossils and sediments. Explanation of the basic principles for application of the proxies and demonstration of the effectiveness, limits, and future problems of these methods using actual examples.

Dynamics of the Earth's Surface Environment I. Dynamic structure and basic processes of the Earth's surface environment and their regional variations. Principles of physical geography and their application to the analysis of Earth surface processes.

Dynamics of the Earth's Surface Environment II. Dynamic relations and processes operating among the geosphere, atmosphere, hydrosphere and biosphere on the Earth's surface. History and controlling factors of changes in recent geological time for the last several tens of thousands of years. Present and future changes induced by human activity on both local and global scales.

Geochemical Cycle I. Introduction to the basic processes of bio-geochemical cycling within the Earth system, their evolution and variation throughout Earth history, and their controlling factors.

Geochemical Cycle II. Processes and controlling factors of carbon and associated bioelements cycles among the geosphere, atmosphere, hydrosphere and biosphere on the Earth's surface. Human-induced modification and future changes on local as well as global scales.

Theory of Seismic Waves. Quantitative description of the radiation, propagation, and attenuation of seismic waves in the Earth's interior on the basis of elasticity theory.

Structure of the Earth's Interior I. The structure, composition, and state of the Earth's interior are systematically explained based on the techniques of seismic wave inversion and high-pressure laboratory experiments.

Dynamics of the Earth's Interior I. Mantle dynamics (convection and plumes) and ridge and subduction processes are explained on the basis of the fundamental equations governing them.

Geo-electromagnetism I. Foundations of core dynamics and geodynamo processes and the origin and change of the Earth's magnetic field are discussed on the basis of observational data.

Magma Dynamics I. Composition of the crust, mantle and core and the role of magma in element partitioning and material transport in the Earth's interior are discussed on the basis of observational, experimental, and theoretical work.

Volcano Science I. The mechanisms of migration and concentration of magma and associated volcanic activity in near-surface regions and observational technique are discussed.

Global Tectonics I. Present-day global plate motion, ridge and subduction processes, and the formation and evolution of continental crust through the Earth's history are explained on the basis of analyses of tectonic structure, surface topography, and other geological and geophysical data.

Rheology of the Earth. Foundamental processes of deformation on various scales from mineral composition to tectonic structure are explained, and the mechanical behavior of rocks in solid-state flow and fracture is discussed from the viewpoint of material science.

Dynamic Geomorphology I. Geomorphology of land forms including a global survey of large-scale landforms developed by plate interactions; endogenous and exogenous processes in landform evolution and the roles of denudation and isostasy in long-term landform stability.

Dynamic Geomorphology II. Geomorphology of the ocean-bottom including remote- and proximal-sensing methods for observing ocean-bottom topography, and the morphology, structure, and evolution of passive and active continental margins, ocean ridges, and large-scale seamounts and plateaus.

Earthquake Physics I. Mechanics of seismic sources, including body force equivalents, moment tensor, mechanical representation of seismic sources, radiation of seismic waves, and kinematic fault models.

Earthquake Physics II. The earthquake generation cycle, which consists of tectonic loading, quasi-static nucleation, dynamic rupture propagation, stopping and subsequent fault healing, is explained in a systematic way on the basis of rock fracture physics, fault mechanics, and plate dynamics.

Evolution of Geosphere. New concepts and methods for reconstructing the environmental evolution of the geosphere (lithosphere, hydrosphere and atmosphere combined) since the Neoproterozoic, based on primary geologic data such as sedimentary facies and isotopic variations of fossils. Major topics include high resolution isotopic stratigraphy, sea-level change, carbonate factory, carbon cycle, and marine gas hydrates.

Sedimentary Geology. Origin of sediments and sedimentary rocks in terms of the development of sedimentary basins and depositional systems through geologic history. Major topics are (1) basin development controlled by tectonics and eustasy, (2) controlling factors of chemical weathering, (3) development of depositional systems, (4) diagenesis in various tectonic settings, and (5) origin of sedimentary ore deposits such as petroleum, natural gas, and bauxite.

Diffraction Crystallography. Fundamental principles and experimental methods of X-ray and electrons diffraction, and their application to minerals and inorganic materials including properties of X-ray and electrons, interactions of X-ray and electrons with materials, intensity of diffracted beams and corrections, calculation of structure factors, Fourier transforms, Patterson functions, and structure determination and refinement.

Environmental Mineralogy. Stability relationships between minerals and water, solubility of minerals, structures of interfaces between minerals and water, mechanisms and rates of mineral dissolution with the goal of understanding mineral-water-atmosphere interactions. Difference between Precambrian and modern weathering, mass transport, and global cycles of some elements are also explained.

Material Transport in the Geosphere. Current understanding of chemical variation of constituents of the geosphere, and evolution of chemical condition of the geosphere will be overviewed; actual instances of processes and mechanism of transport, concentration and dispersion of elements will be reviewed.

Evolution of Chemical Environment in the Biosphere. Latest knowledge on evolution of the chemical condition of the Earth's surface will be reviewed with particular emphasis on the significance of microbial activity and organic production of substances to the origin of chemical condition of the biosphere.

Analysis of Biosphere Materials. Practical techniques for studying biomolecules and inorganic materials involved in organic-inorganic interactions. Biochemistry, molecular biology and spectroscopic techniques for characterization of the structure and functions of macromolecules, such as proteins and nucleic acids are explained. Electron microscopy, atomic force microscopy, and various beam technologies are also introduced for analyses of the surface and inter-grain character of interacting mineral crystals.

Mechanisms of Biomineralization. Introduction to formations of hard tissues and biominerals observed in the biosphere, and related reaction mechanisms between biological and inorganic materials. Recent results on the interfacial structures between macromolecules and crystal surfaces and their interactions in atomic or molecular scale are explained.

Evolutionary Paleobiology. Methodology for understanding paleobiological aspects of extinct organisms from comparative analysis of fossils and living organisms is explained based mainly on the study of marine invertebrates. Recent knowledge of the morphological evolution, phylogenetic systematics, paleoeocology, functional morphology, and life history in paleorganims is introduced for better understanding of the relationship between geosphere environments and organisms over a long geologic history.

Evolution of the Biosphere. Evolutionary history of biota from their origin to the present and ``coevolution'' with the Earth's environments. Major biotic events include evolution of prokaryotes and eukaryotes, the Cambrian explosion, diversification and mass extinctions, paleobiogeography, and Mesozoic marine revolution. Paleontologic evidence and the possible explanations for these events are discussed.

7.2.3 Advanced Courses

Atmospheric Physics III. The basis of atmospheric radiation and satellite remote sensing of the terrestrial atmospheric system is explained. Radiative transfer, optical properies of the atmosphere and their influence on climate are discussed.

Atmospheric Physics IV. Meteorology of various planets in the solar system and the unified theory of general circulation of planetary atmospheres are described. Characteristic atmospheric phenomena of each planet are discussed.

Physical Oceanography III. Method for field observations designed to clarify the velocity field as well as the density field in the ocean are discussed. Important findings from recent field observations are introduced.

Physical Oceanography IV. Generation and propagation processes are discussed for ocean waves ranging from capillary waves with periods of less than a second to low-frequency planetary waves with periods of up to several years. Special attention is directed to their crucial roles in realistic models of the ocean.

Climate Dynamics II. The mechanism of atmospheric general circulation is discussed. In light of the energy balance of atmosphere and ground surface, mass balance and momentum balance, the connection of atmospheric circulation with various processes (radiation, clouds, turbulence and ground surface) is discussed.

Ocean-Atmosphere Material Circulation Science II. Observational evidence and methods, theory and modeling of the composition, changes and variability in atmospheric substances such as carbon dioxide and ozone, and their interaction with the ocean is discussed.

Space Physics I-II. Non-linear and/or non-thermal phenomena such as the formation of shock wave in space plasma accompanied by particle acceleration processes are surveyed and physical laws regulating these phenomena are discussed. Energy conversion processes of plasma/magnetic field are discussed based on the most recent findings of the space plasma observations.

Planetary Magnetospheric Physics I-II. The process of magnetic field reconnection is surveyed, and the interaction between the Earth/planets and solar wind is discussed based on knowledge obtained from observations. The most recent findings from the observations of the interaction between the Earth/planets and solar wind are surveyed, and the dynamics of the planetary magnetosphere is elucidated.

Observational Planetology I-II. Basic knowledge for the observations as well as observational technologies now in development are discussed. Methods for observing planets in other solar systems as well as of planets achievement in this field to date are also discussed.

Comparative Planetology I. Internal structure, surface topography and atmospheric composition of the terrestrial planets and the Moon are discussed. Various topics such as the structure and evolution of jovian planets, icy planets, comets, and Kuiper-belt objects are discussed.

Cosmic and Planetary Material Science I-II. Evolution of cosmic and planetary material is discussed based on the achievements in research on extraterrestrial materials and computer simulations. Origin of elements and formation processes of the solar system are discussed based on physical, chemical, petrological, mineralogical and isotopic information on planetary materials such as meteorites, lunar and martian rocks (meteorites), and cosmic dust.

Earth and Planetary Science I-VI. Advanced courses on up to date examples of analysis of the Earth and Planetary System, evolution of the Earth and Planetary System, dynamics of the Earth System, and dynamics of the Earth's surface environment.

Geographical Information Science. An introduction to Geographical Information Systems (GIS) which are tools for analyzing natural and human processes on the Earth's surface. Applications of GIS to Earth surface system analysis. Basic and advanced techniques for GIS.

Regional Human Ecology. Regional variation and changes in human ecology as combined products of natural and social/economical/cultural environments.

Structure of the Earth's Interior II-III. Advanced courses on Structure of the Earth's Interior, including the topics on the three dimensional structure of the crust and mantle; the structure of the core-mantle boundary layer; the inversion of seismological or electro-magnetic data for estimating the Earth's structure; and the composition and state of the Earth's interior inferred from high-pressure laboratory experiments and thermodynamics.

Dynamics of the Earth's Interior II-III. Advanced courses on Dynamics of the Earth's Interior, including the physical modeling of mantle convection, plumes and plate motion, the physical modeling of the geodynamo, and core-mantle interaction

Geo-electromagnetism II-III. Advanced courses on Geo-electromagnetism, including the origin of geomagnetic field, long-term variation of geomagnetic field, geo-electromagnetic structure of the Earth, and observation of the geo-electromagnetic field.

Magma Dynamics II-III. Advanced courses on Magma Dynamics, including convection, diffusion and phase transition-separation (melting and melt segregation) in the Earth's interior, transport and fractionation of mass and energy, and implications for the evolution of the Earth.

Volcano Science II-III. Advanced courses on Volcano Science, including volcanic activity, volcano-geophysics, volcano-tectonics, and observation and analysis of volcanic phenomena.

Global Tectonics II-III. Advanced courses of Global Tectonics, including global plate motion, plate interaction and orogenic processes, and evolution (formation, modification, and consumption) of continental crust.

Submarine Earth Science I-II. Advanced courses on structure and evolution of oceanic lithosphere, and various technologies for observing the ocean floors.

Dynamic Geomorphology III-IV. Advanced courses on dynamic geomorphology, including tectonic geomorphology, analyses of active geologic structure on continents and the sea floor, and planetary morphology.

Earthquake Physics III–IV. Advanced courses on Earthquake Physics, including seismic activity, crustal movement, earthquake rupture processes, seismotectonics, and fault material science.

Geosphere and Biosphere Science I–VI. Recent topics related to geo- and bio-spheres science are discussed.

7.2.4 Special Lectures

Special Lecture on Oceanic and Atmospheric Sciences I–IV. Intensive courses on current topics in Oceanic and Atmospheric Sciences.

Special Lecture on Space and Planetary Science I–IV. Intensive courses on current topics in Space and Planetary Science.

Special Lecture on Earth and Planetary System Science I–IV. Intensive courses on current topics in Earth and Planetary System Science.

Special Lecture on Solid Earth Science I–IV. Intensive courses on current topics in Solid Earth Science.

Special Lecture on Geosphere and Biosphere Science I–IV. Intensive courses on current topics in Geosphere and Biosphere Science.

7.2.5 Laboratories

Field Work in Earth Science. Training in field research in Earth Science, including observation, description, measurement and analysis of rocks, geologic structures, landforms, fossils, and the Earth's surface environments.

Laboratory in Geophysical Observation. Training in geophysical observation, including principles of seismograph, gravitometer, GPS, elementary knowledge of electric and electronic circuits, and field practice.

Laboratory in Instrumental Analyses. Practice for chemical and isotopic analyses using modern instruments (e.g., X-ray spectrometer, electron beam analyzers, mass spectrometer).

Laboratory in Information Processing. Training in information processing, including data processing, text processing, and network management.

7.2.6 Special Subjects

Field Excursion I–II. Visit localities related to recent research topics in Earth science; examine and discuss the validity of conclusion derived from the field survey.

Seminar on Current Scientific Literature I–II. Critical review of research papers and discussion on various subjects in Earth and Planetary Science.

Colloquium I–II.

Research in Earth and Planetary Science I–II.

7.3 Curriculum of Undergraduate Course

There are separate undergraduate courses in Earth and Planetary Physics and in Geological Sciences. All undergraduates spend their first and second year at the Komaba Campus (the General Culture Course in the College of Arts and Sciences) and their third and fourth years at the Hongo campus. Beginning in the 4th semester (the second semester of the second undergraduate year) specialized courses depending on the choice of major subject are prescribed.

In the 4th semester of the General Culture Course (the 1st and 2nd years), 20 units in total are required for special subjects. In the Special Course (the 3rd and 4th years), 60 units in total are required for special subjects.

7.3.1 Earth and Planetary Physics Course

Special Subjects in the General Culture Course

Subjects	Units	Academic Year
[Required Subjects: 16 units]		
Mathematics for Physics I	4	2
Exercise in Mathematics for Physics I	2	2
Lecture on Physical Experiments	2	2
Exercise in Physics I	2	2
Electromagnetism	4	2
Analytic Mechanics and Quantum Theory	2	2
[Elective Subjects]		
Introduction to Astronomy	2	2
Introduction to Geophysics	2	2
Chemical Thermodynamics	4	2
Inorganic Chemistry I	2	2
Information Mathematics	2	2
Formal Language Theory	2	2

Special Courses (the 3rd and 4th year)

Subjects	Units	Academic Year
[Required Subjects: 12 units]		
Introduction to Solid Earth Physics	2	3
Introduction to Planetary Physics	2	3
Geophysical Fluid Dynamics	2	3
Exercise in Earth and Planetary Physics	3	3
Experiments in Earth and Planetary Physics	3	3
[Elective Required Subjects: 28 units]		
Physics of the Solid Earth	2	3
Earth and Planetary Magnetohydrodynamics	2	3
Methods of Numerical Analysis	2	3
Earth and Planetary Material Science	2	3
Quantum Mechanics I	2	3
Quantum Mechanics II	2	3
Statistical Mechanics I	2	3
Statistical Mechanics I	2	3
Mathematics for Physics II	2	3
Fluid Mechanics	2	3
Exercise in Physics I	1.5	3
Exercise in Physics II	1.5	3
Atmospheric Physics	2	4
Physical Oceanography	2	4
Climate Dynamics	2	4
Ocean-Atmosphere Material Science	2	4
Atmospheric Photochemistry and Physics	2	4
Magnetospheric Physics	2	4
Space Physics	2	4
Physics of Earthquakes	2	4
Physics of the Earth and Planetary Interiors	2	4
Physics of the Earth and Planetary System	2	4
Theory of Earth and Planetary Evolution	2	4
Senior Project in Earth and Planetary Physics I	2	4
Senior Project in Earth and Planetary Physics II	2	4
[Elective Subjects]		
Introduction to Space Science	2	3
Introduction to Planetary Science	2	4
Methods of Geophysical Observation I	2	4
Methods of Geophysical Observation II	2	4
Mathematical Methods in Geophysics I	2	4
Mathematical Methods in Geophysics II	2	4

7.3.2 Geological Sciences Course

Special Subjects in the General Culture Course

Subjects	Units	Academic Year
[Required Subjects: 8 units]		
Introduction to Geology	2	2
Introduction to Mineralogy	2	2
Introduction to Physical Geography	2	2
Introduction to Earth and Planetary Physics	2	2
[Elective Subjects]		
Chemical Thermodynamics	4	2
Introduction to Astronomy	2	2
Introduction to Biochemistry I	2	2
Information Mathematics	2	2
Formal Language Theory	2	2
Mathematical Methods in Physics I	4	2
Exercise in Mathematical Methods in Physics I	1	2
Analytic Mechanics and Quantum Theory	2	2
Inorganic Chemistry I	2	2
Analytical Chemistry I	2	2
Invertebrate Zoology	2	2
Biostatistics	2	2
Environmental Plant Physiology	2	2
Human Biology	2	2
Human Geography	2	2
Introduction to Regional Geography	2	2

Special Courses (the 3rd and 4th years)

Subjects	Units	Academic Year
[Required Subjects: 15 units]		
Geological Mapping	2	3
Exercise of Geological Mapping	2	3
Field Work in Geoscience	2	3
Field Excursion in Geoscience	1	3
Seminar in Geoscience	4	4
Research Work in Geosciences	4	4
[Elective Required Subject Group]		
(Geology and Mineralogy Group: 10 units)		
Laboratory Work in Mineralogy	2	3
Rock Forming Minerals	2	3
Exercises of Rock Forming Minerals	1	3
Geological Surveying	3	3
Laboratory Work in Geology	2	3

Special Courses (cont'd) (the 3rd and 4th years)

Subjects	Units	Academic Year
(Geography Group: 11 units)		
Geographical Information Science with Exercises	3	3
Studies in Photo-interpretation with Exercises	3	3
Exercise in Geography	1	3
Field Work in Geography	2	3
Research Work in Geography	2	3
[Elective Subjects]		
Physical Regional Geography	2	3
Physical Environmental Geography	2	3
Hydrology	2	3
Geomorphology	2	3
Climatology	2	3
Mineralogy	2	3
Crystallography	2	3
Petrology	2	3
Historical Geology	2	3
Introduction to Paleontology	2	3
Structural Geology	2	3
Sedimentology	2	3
Chemical Geology	2	4
Quaternary Science	2	4
Special Lecture in Geography I	2	4
Special Lecture in Geography II	2	4
Regional Geography I	2	4
Regional Geography II	2	4
Economic and Environmental Geology	2	4
Planetary Geology	2	4
Paleontology	2	4
Plate Tectonics	2	4
Exercise in Physical Geography	2	3
Laboratory Work in Physical Geography	2	3
Laboratory Work in Crystallography	2	3
Fundamental Exercise in Geoscience I	2	3
Exercise in Stratigraphy	2	3
Exercise in Sedimentary Petrology	2	3
Laboratory Work in Paleontology	2	3
Exercise in Structural Petrology	2	3
Field Excursion in Geology I	2	3
Field Work in Geography	2	3
Fundamental Exercise in Geoscience II	2	4
Laboratory Work in Economic and Environmental Geology	2	4
Laboratory Work in Chemical Mineralogy	2	4
Exercise in Planet-forming Materials	2	4
Laboratory Work in Sedimentology	2	4
Field Excursion in Geology II	2	4

8 Final Program for Review Committee Meeting

- Sunday March 14, 1999
  - 1900–2100 Welcoming party, Sofitel Hotel
- Monday March 15
  - 0800–0900 Breakfast (Review Committee + some faculty, at Hotel)
  - 1000–1220 Meeting (All meetings in Bldg. No. 1 of Graduate School of Science) Meeting from 1000–1140 in Room Number 206, 2nd floor
    - 1000–1010 Prof. H. Suematsu, Dean of Graduate School of Science (Introduction)
    - 1010–1100 Prof. Y. Hamano (Overview of plans for the new Department, 40 min + 10 min questions)
    - 1100–1140 Dr. D. Swinbanks, President, Nature Japan K.K. (External Review in Japan, 30 min + 10 min questions)
    - 1140–1150 Break
    - 1150–1220 General discussion of procedures for conducting the review (Chair: Prof. I. Kushiro, Okayama Univ., Chairman of Review Committee), Room number 709, 7th floor. All meetings were held in this room, excepting the poster talks, which were held in Room 710, and the opening and concluding sessions, which were held in Room 206.
  - 1230–1315 Lunch (Members of External Review Committee + 10–15 faculty, students, postdocs, at Sanjo Kaikan)
  - 1330-–1730 Meeting
    - 1330-–1500 Space and Planetary Science Group
      - 1330–1400 Prof. T. Terasawa, Overview (20 min + 10 min questions)
      - 1400–1420 Prof. M. Nakamura (15 min + 5 min questions)
      - 1420–1440 Prof. M. Hoshino (15 min + 5 min questions)
      - 1440–1500 Dr. J. Newton (15 min + 5 min questions)
    - 1500–1600 Poster Session I (Research presentations by students, postdocs, and junior faculty), Room 710
    - 1600–1730 Oceanic and Atmospheric Science Group
      - 1600–1630 Prof. T. Yamagata, Overview (20 min + 10 min questions)

        - 1630–1650 Prof. T. Yamagata, Research presentation (15 min + 5 min questions)
        - 1650–1710 Prof. Y. Matsuda (15 min + 5 min questions)
        - 1710–1730 Prof. T. Hibiya (15 min + 5 min questions)
    - 1730–1800 Further discussion of procedures for conducting the review (Chair: Prof. Kushiro)

  1900–2100 Dinner (Members of Review Committee plus faculty, students, postdocs, and alumni)

- Tuesday March 16
  - 0730–0830 Breakfast (Review Committee, at Hotel)
  - 0930–1215 Meeting
    - 0930–1100 Earth and Planetary System Science Group
      - 0930–1000 Prof. R. Tada, Overview (20 min + 10 min questions)
      - 1000–1020 Prof. Y. Hamano (15 min + 5 min questions)
      - 1020–1040 Prof. R. Tada, Research presentation (15 min + 5 min questions)
      - 1040–1100 Prof. J. Matsumoto (15 min + 5 min questions)
    - 1100–1115 Break
    - 1115–1215 Solid Earth Science Group, Part I
      - 1115–1145 Prof. M. Matsu'ura, Overview (20 min + 10 min questions)
      - 1145–1200 Prof. G. Kimura (10 min + 5 min questions)
      - 1200–1215 Prof. Y. Ikeda (10 min + 5 min questions)
  - 1230–1315 Lunch (Members of Review Committee + 10–15 faculty, students, postdocs, at Sanjo Kaikan)
  - 1330–1530 Meeting
    - 1330–1400 Solid Earth Science Group, Part II
      - 1330–1345 Prof. H. Iwamori (10 min + 5 min questions)
      - 1345–1400 Prof. R. J. Geller (10 min + 5 min questions)
    - 1400–1530 Geosphere and Biosphere Group
      - 1400–1430 Prof. K. Tanabe, Overview (20 min + 10 min questions)
      - 1430–1450 Prof. R. Matsumoto (15 min + 5 min questions)
      - 1450–1510 Prof. T. Murakami (15 min + 5 min questions)

        - 1510–1530 Dr. K. Endo (15 min + 5 min questions)
    - 1530–1630 Poster Session II (Research presentations by students, postdocs, and junior faculty), Room 710
    - 1645–1845 Tour of Facilities and Buildings (Bldgs. #3 and #5 of the Graduate School of Science)

1930–2130 Dinner (Members of Review Committee plus faculty, students, postdocs, alumni)

- Wednesday March 17
    - 730AM–830AM Breakfast (Review Committee, at Hotel)
    - 0930––1200 Meeting
        - 0930–1130 Prof. R. Matsumoto, Discussion of organization, rules, procedures for faculty appointments, etc. of new department (talk interspersed with questions and general discussion)
        - 1130––1200 Prof. M. Matsu'ura, Graduate and undergraduate education (Part I of talk, which was interspersed with general discussion)
    - 1215–1315 Lunch (members + 10–15 faculty, students, postdocs, Sanjo Kaikan)
    - 1330––1800 Meeting
        - 1330––1430 Prof. M. Matsu'ura, Graduate and undergraduate education (Part II of talk, which was interspersed with general discussion)
        - 1430–1445 Break
        - 1445–1530 Prof. G. Kimura, Report on current status of faculty search
        - 1430–1800 Session of Review Committee to discuss conclusions and clarify matters of fact (attended by Profs. G. Kimura and R.J. Geller from UT side),
    - 1900––2100 Dinner (at Sofitel, Members of Review Committee + faculty)
- Thursday March 18
    - 0730–0830 Breakfast (Review Committee, at hotel)
    - 0930–1800 Executive Session (Bento lunch) Drafting of report. Check for factual errors by University of Tokyo side, but otherwise all comments are the responsibility of Review Committee
    - 1900–2100 Closing dinner (Totenko)

    - Changes in draft report made in discussion were typed, and all members of the Review Committee were supplied with an updated version of the draft of the report on the morning of Friday March 19 (draft was left at their hotel rooms overnight, or given to one committee member who did not stay at the hotel when he arrived for the meeting on Friday morning).
- Friday March 19
    - 0700–0800 Breakfast (Review Committee, at Hotel)
    - 0830–1030 Meeting of Review Committee to complete drafting of report
    - 1030–1045 Break
    - 1045–1200 Meeting open to all faculty, Room 206

  Oral presentation of conclusions of review. Prof. Kushiro presented summarized the recommendations, speaking in Japanese. Prof. Southwood gave presented the Review Committee's conclusions regarding teaching, and Prof. Kennett presented the Review Committee's conclusions regarding research.

- 1230–1330 Lunch at Sanjo Kaikan (Attended by Review Committee, members of internal committee for organizing the review, and supporting staff for the review).
- Close of Review

9 Members of Review Committee

Prof. Brian Kennett

Research School of Earth Sciences, The Australian National University

Prof. Ikuo Kushiro (Chairman)

Institute for Study of the Earth's Interior, Okayama University, Misasa

Prof. Roger B. Lukas

Dept. of Oceanography, University of Hawaii

Prof. Syukuro Manabe

Institute for Global Change Research, Frontier Research System for Global Change, Tokyo

Prof. Judith A. McKenzie

Geological Institute ETH-Zentrum, Zurich

Prof. J. Casey Moore

Earth Science, University of California, Santa Cruz

Prof. Jun Nishimura

Yamagata Academy of Technology

Prof. Eiji Ohtani

Institute of Mineralogy, Petrology, and Economic Geology, Faculty of Science, Tohoku University

Prof. Hakuyu Okada

Oyo Corporation, Kyushu Branch

Prof. Tetsuo Sasao

National Astronomical Observatory

Prof. David J. Southwood

European Space Agency (ESA)

Due to the special circumstance that all of the faculty members in planetary science were attending the Lunar and Planetary Science Conference in Houston during the time of the Review, the Review Committee was unable to meet with any of the faculty members in that field. An expert referee in that field (Prof. B. Fegley, Washington Univ., St. Louis) therefore was asked to inform the Review Committee of his view of activity by faculty members in this field. His confidential report was made available to the Review Committee and is indirectly reflected in this report, although he did not participate in the drafting of this report.