

Geosphere and Biosphere Science

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Outline of 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.

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.

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.

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.

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".

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