Introduction to Earth and Planetary System Science
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New View of Earth, Planets and Humans

Springer
More than 10 years have passed since the beginning of the twenty-first century, and problems associated with the global environment, resources, and the world economy have been distinctly realized. It is highly desirable to create long-term safety and a sustainable human society by solving these serious problems.

Is it possible to build a sustainable society? How can we construct such a society? Human society greatly influences the earth’s environment, causing such problems as global warming, acid rain, and destruction of the ozone layer. Thus, it is inferred that long-term safety and a stable human society cannot be established without a scientific understanding of the earth’s surface environment and the earth’s interior as it influences the surface environment. We should consider what human society ought to do in the near future based on scientific understanding of interactions between humans and nature.

What are the nature–human interactions? The basic study that can give us the answer to these questions is earth system science, which has been developed significantly in the last 20 years. According to earth system science, the earth system consists of subsystems such as the atmosphere, hydrosphere, geosphere (lithosphere), biosphere, and humans, and earth system science clarifies the interactions among these subsystems. Matter and energy are circulating, and the total earth system has been irreversibly changing with time since the birth of the system. Earth system science can clarify the evolution of the earth system as well as the modern earth system.

Twenty years ago I described an outline of the earth system in Introduction to the Earth System (1992) (in Japanese). Following this publication, earth system science has developed considerably. For example, a great deal of information on solar planets, the relationship between the solar planets and earth, and the origin and evolution of earth and the solar system have been elucidated, clearly indicating that the earth system is open to external systems (the solar system; universe). In addition to the influence of the external (solar) system on the origin and evolution of the earth system, the materials, temperature distribution, and hot and cold plumes in the solid interior of the earth have been investigated by high-temperature and high-pressure experiments, three-dimensional seismic wave tomography, multi-element and multi-isotope analyses, and radiometric age dating of earth materials and solar system
materials (e.g., Martian rocks). Further, global climate change from ancient times to the present and global material cycles (e.g., the global carbon cycle) have been studied by computer simulations and isotopic and chemical analyses. It can be said that earth system science is developing and is changing to earth and planetary system science. Thus, in this book, the intention is to present earth and planetary system science including topics that are not in my earlier publication, *Introduction to Earth System Science*. For example, plate tectonics and plume tectonics are briefly described in this book (Chap. 3) because the earth’s surface environment where humans and organisms are living are greatly influenced by these tectonics. In addition, the relationship between humans and organisms, which has been extensively investigated (origin of life, evolution of biota, mass extinction, underground biosphere) has been included (Chap. 6). In the last chapter (Chap. 7), the relationship between the earth system and nature (earth and the planets) is considered. Earlier views regarding the earth and nature are summarized and compared with the views presented here (earth and planetary system sciences, earth and planet co-oriented human society).

This book has arisen mainly from several courses on Earth and Planetary System Science and Earth’s Environmental and Resources Problems for undergraduate and graduate students at Keio University and also from many classes at other universities (The University of Tokyo, Gakushuin University, Nihon University, Hiroshima University, Yamaguchi University, Tokushima University, Kyoto University, Shizuoka University, Tsukuba University, Yamagata University, Tohoku University, and Akita University). In these courses during the last 30 years, I received many comments, questions, and responses from numerous undergraduate and graduate students. Discussions with them have allowed me to develop and clarify the ideas presented here, particularly the earth’s environmental co-oriented society (Chap. 7).

In writing this book I am greatly indebted to many people in the Geology Department of The University of Tokyo, the Applied Chemistry Department of Keio University, the Geology Department of Tokyo Gakugei University, and the Department of Earth and Planetary Science of Harvard University.

I express my great appreciation for the late professors emeriti T. Tatsumi of The University of Tokyo, advisor for my Ph.D. thesis in 1974, and T. Watanabe of The University of Tokyo for teaching me economic geology (ore genesis) and isotope geochemistry. They showed that the integration of each discipline of earth sciences is necessary and very important in order to deeply understand the nature of the earth’s environment and resources in relation to geological, geochemical, and geological processes. Drs. Y. Kajiwara, T. Nakano, and K. Fujimoto read the manuscript and gave me useful critical comments. I very much appreciate Ms. M. Aizawa, Ms. N. Katayama, and Ms. K. Suga for their skillful and patient word processing. Ms. M. Shimizu and Ms. M. Komatsu of The University of Tokyo Press and Mr. Ken Kimlicka of Springer Japan edited with care the manuscripts for the Japanese version of the books *Introduction to Earth System Science* and *Introduction to Earth and Planetary System Science* and the English version of *Introduction to Earth and Planetary System Science*, respectively.
I want to dedicate this book to my wife, Midori Shikazono, and two daughters, Chikako and Hisako Shikazono, and to my parents, Naoharu and Yoshiko Shikazono, who have patiently provided understanding and moral support during the more than 30 years of my academic research and teaching.

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