

Preface

For more than a century students of the evolution of the living and nonliving parts of the Earth have known that life influences the physical and chemical characteristics of the planet. Nevertheless, the dominant paradigm in earth sciences has been that inexorable inorganic forces, such as changing energy output from the Sun, collisions of the Earth with extraterrestrial bodies, continental drift, or orbital element variations have been the principal driving forces behind climate change, and that life is more buffeted by these forces than the reverse. About twenty years ago, James Lovelock and Lynn Margulis coined the phrase the *Gaia hypothesis* to suggest not only that life has a greater influence on the evolution of the Earth than is typically assumed across most earth science disciplines but also that life serves as an active control system. In fact, they suggest that life on Earth provides a cybernetic, homeostatic feedback system, leading to stabilization of global temperature, chemical composition, and so forth.

When first introduced in the early 1970s, the Gaia hypothesis attracted the most attention from theologians interested in the possibility that the Earth controlled its environment on purpose (i.e., teleological implications), from those looking for “oneness” in nature, and from those defending polluting industries, for whom the Gaia hypothesis provided a convenient excuse whereby some collective set of natural processes would largely offset any potential damages from human disturbance to earth systems. Although none of these aspects was underlined in the scientific work of Lovelock and Margulis, these nonscientific side issues diverted attention in the scientific community away from a serious analysis of the Gaia hypothesis and its implications. By the mid 1980s, Gaia advocates and detractors began a series of critiques and counter critiques, often carried out through third parties such as television documentary producers. One of us (Schneider), having been party to such a debate, came to realize the absurdity of the situation in which an interesting and controversial idea like the Gaia hypothesis was being debated largely in nonscientific forums, if at all. Schneider discussed this unfortunate circumstance with Juan Roederer of the University of Alaska, a prominent member of the American Geophysical Union (AGU). Dr. Roederer suggested that an AGU-sponsored Chapman Conference be convened on the Gaia hypothesis, and he further recommended that Dr. Glenn Shaw of the University of Alaska, who had already published some interesting ideas on biogenic sulfur, the sulfur cycle, and its potential for climate control, help organize the meeting. Shaw and Schneider began to formulate an agenda and a proposal in 1986. It soon became apparent that biological expertise was needed, for which the advice of one of us (Boston,

a microbial ecologist) was sought. It became clear in a matter of weeks that Boston's contribution to the planning process was fundamental, and thus she joined Shaw and Schneider as coconveners of the meeting.

The proposal to the AGU for a Chapman Conference was not accepted without scientific detractors. It was deemed controversial, and several objections were raised to it both within the AGU council and by outside scientists. It is to the credit of that council that despite some of these criticisms, many of them based on the early perceptions of the Gaia hypothesis as nonscience, the council approved holding a Chapman Conference on the subject, provided outside funding was obtained. We gratefully acknowledge the efforts of Hassan Virji, of the Climate Dynamics section of the Atmospheric Science Division of the National Science Foundation, not only for his section's contribution to the Chapman Conference but also for serving as the organizer at the National Science Foundation (NSF) for obtaining funds from other sections of NSF. That principal grant made the meeting possible. However, widespread interest across a dozen disciplines of science and philosophy was represented at the meeting, and this broad interest led to a full week's agenda, which created another financial burden. Since the coconveners were anxious to have state-of-the-art reviews of the many disciplines relevant to the study of the biological, chemical, geological, and climatic aspects of Earth's evolution, as well as to have many graduate students attend a meeting that would treat so many diverse subjects in depth, it was important to bring a substantial number of students and others without travel funds to the meeting. Our financial crisis was resolved at the eleventh hour by the generous intercession of Dr. Charles Zrackett from the MITRE Corporation, whose timely grant allowed us to fund, at least partially, all the graduate students and invited overview paper authors who were able to attend. Finally; producing typescripts of verbal transcripts also required grant assistance, for which we gratefully acknowledge Dr. Shelby Tilford of the Office of Space Science and Applications, Earth Science and Applications Division of the National Aeronautics and Space Administration, whose support made it possible for this volume to be produced.

The meeting itself, held in March 1988 in San Diego, was an illustrious event. Review papers were presented on the Gaia hypothesis, on a Darwinian critique of the Gaia hypothesis, on various physical, chemical, and biological processes that are organic or inorganically driven, on models of stable and unstable systems, on carbon-oxygen-nitrogen-sulfur cycles, on soil processes, mineral weathering, fire effects, Earth-asteroid or comet collisions, epistemology (i.e., a session on the philosophy of science), and a political perspective from Congressman George Brown.

Such a diversity of papers, such a multiplicity of topics, jargon, styles, and scientific approaches produced a meeting that taxed the interdisciplinary skills of all participants. Some talks were differential equation-laden, whereas others assumed a knowledge of nineteenth-century evolutionary theory or twentieth-century philosophy of science. Panel discussion sections at the end of each of these sections helped clarify unclear issues or allowed focus on basic concepts.

This volume also suffers, admittedly, from the inclusion of heterogeneous pa-

pers with differing jargon, presentation styles, and content, and it requires some analytic skill for full comprehension by the reader. Although we have not included discussion sessions in this volume, we did insist that the papers be “dejargonized” to the extent possible. The papers include a wide range of presentational styles, from *Scientific American* style, popularized presentations to that which fits the standards of technical journals. Some of the material across this spectrum of presentational styles overlaps, and we hope enough material is covered in different ways to allow this volume to be useful for both scientifically interested nonscientists as well as professional readers. Moreover, since this volume appears almost three years after the initial meeting, much has been learned since the San Diego event in 1988. While this delay is regrettable, in that a comprehensive reader on Gaia science was not immediately available in the wake of the enthusiasm generated by the Chapman Conference, it is advantageous because the discoveries of the subsequent three years and the growing body of literature are accounted for in this volume. We believe the delay will be amply compensated for by the updated information contained in most chapters in this volume. In any case, compiling articles from so diverse a group necessitated a long delay, which we opportunistically used to ask the authors to keep their papers current to the winter of 1991.

Finally, we wish to acknowledge once again the efforts of the AGU in sponsoring the Chapman Conference, Glenn Shaw in helping us with the initial proposal, Mary Rickel of the National Center for Atmospheric Research (NCAR) for handling much of the administrative detail in advance of the meeting, at the meeting, and for a heroic effort in reading galley proofs and keeping track of missing figures and a myriad of loose ends in preparing this volume, and not least the NSF, MITRE Corporation, and the National Aeronautics and Space Administration for their financial support. In addition, we wish to thank Susan Mikkelsen for her efforts in transcribing the tapes from the meeting. We also thank NCAR for contributing some of Schneider’s and Rickel’s time without overhead, as well as for allowing use of the mails and other amenities of NCAR—which is sponsored by NSF.

Stephen H. Schneider*
National Center for Atmospheric Research**
P.O. Box 3000
Boulder, Colorado 80307

Penelope J. Boston*
Complex Systems Research Inc.
P.O. Box 11320
Boulder, Colorado 80301

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