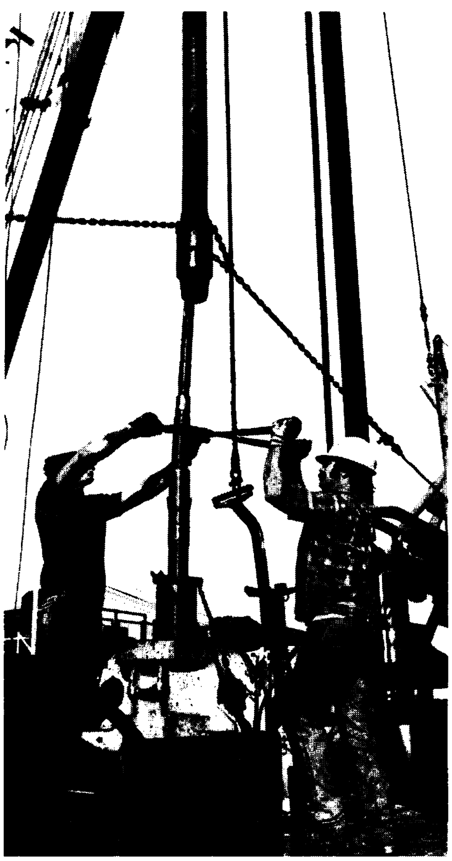
ment of the best science, which requires the questioning of conventional wisdom.

Try chapter 20, "The great dying," about the development of ideas, based on evidence from all over the world, that a catastrophe at the end of Cretaceous time caused extinction of many species and how (p. 358) "the cores of *Glomar Challenger* are now being called as witness if a meteor has murdered the dinosaurs." Hsü avers that this shows that evolutionary changes are controlled to a considerable degree by accidental disasters, not by a continual competition between organisms as Darwin proposed, and he goes on to a criticism of the philosophy of social Darwinism.

This is a very individual, opinionated book, and you may end up arguing with it in places, but it is not dull. The book includes many personal stories. Some of them are trivial, regarding such matters as Dan Karig's ability to do minor home repairs or the instance when Hsü and Dan McKenzie did not recognize each other in an airport. Others represent tragedies, like the exclusion of a great scientist, Bruce Heezen, from his institution because of conflicting egos and a mistake he made, or such as the sad death of Seymour Schlanger.



"Taking a wire-line core on *Glomar Challenger*. The roughnecks have already unscrewed the drill string near its upper end, and secured the core barrel to a clamp on the rig floor. Then they had to unscrew the "overshot" (a hook-like device) at the end of the sandline, which had been sent down to fish out the core barrel from the bottom of the hole. After this was done, the core barrel could be taken out of the drill string, as shown here." [From *Challenger at Sea*]

Who should read this book? Any scientist or non-scientist with some familiarity with geology probably would enjoy it. Students in geology would see how modern concepts developed and observe a more personal side of their science; they also would be amazed at the freewheeling style of funding and planning in marine geology that prevailed in the late 1960s. Those were days of exploration, when we knew so little that we could be confident of new discoveries. Furthermore, support was easily available for field programs, unlike today, when proposals need to be tightly thought out, precisely planned, and carefully defended.

I started by indicating misgivings about the title. A more accurate (but, I suppose, much less rousing) one might be "A Personal View of the Development of Geology and the Significance of the Deep Sea Drilling Project." Two major technological systems that revolutionized our knowledge of marine geology were developed in the mid-to-late 1960s, the research submersible *Alvin* (1964) and the deep-sea drillship *Glomar Challenger* (1968). In some form they are still working (*Glomar Challenger* in a reincarnation as the *JOIDES Resolution*). This may be the time to write their history, and a fine history of *Alvin* was recently published (*Water Baby: The Story of Alvin*, by Victoria Kaharl, Oxford University Press, 1990). The history of the *Glomar Challenger* and the Deep Sea Drilling Project still needs to be written, perhaps by someone who was more closely and continuously involved than Hsü. However, *Challenger at Sea* is informative, interesting, and provocative, and, as a personal history of the workings of a science, it is superb.

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Earth's Early Life

The Proterozoic Biosphere. A Multidisciplinary Study. J. WILLIAM SCHOPF and CORNELIS KLEIN, Eds. Cambridge University Press, New York, 1992. xxiv, 1348 pp., illus. $195.

Oliver Morton, writing in *The Economist*, likened the study of Precambrian fossils to psychoanalysis, in which practitioners "seek . . . in ill-remembered childhood the forces that shape the adult mind." The simile is apt. Life was born in the Archean and matured during the Proterozoic, and so did the continents, oceans, and atmosphere. Earth's early memory is incomplete and colored by later tectonic and evolutionary events; yet present-day Earth is very much the product of its Precambrian development.

Fifteen years ago, J. William Schopf organized the Precambrian Paleobiology Research Group (PPRG) to study Earth's infancy as recorded in Archean rocks and bacterial physiology. The result was *Earth's Earliest Biosphere*, a splendid volume full of creative interdisciplinary effort. Now the PPRG is back with a gargantuan account of Earth's coming of age during the long (2500 to 540 million years before present) Proterozoic Eon. Data on Proterozoic life and geology far outweigh those available for the Archean. Whereas a handful of microfossils, two dozen stromatolite localities, and a smattering of isotopic analyses constitute the entire Archean paleontological record, Proterozoic evolution is documented by hundreds of microfossil assemblages, more than a thousand carbon isotopic determinations, a remarkable abundance of stromatolites, diverse biomarker organic molecules, and (near its end) animal remains. Additionally, the molecular, ultrastructural, and morphological variation found among living protists and animals greatly enriches the body of relevant biological data. The authors of this volume have worked hard to present a comprehensive overview of this mass of information.

The Proterozoic Biosphere has many merits. Without exception, the contributing authors are distinguished scientists whose interpretations warrant serious consideration. Annotated lists of published fossil occurrences and biogeochemical data, as well as an extensive bibliography, provide ready access to an extensive and often scattered literature. This information provides an important first line of attack for anyone interested in Precambrian life, though the compilations are current only to mid-1988. In the case of carbonaceous macrofossils and Ediacaran animals, the rate of new discovery is low enough that the treatment remains more or less current, but known occurrences of Proterozoic microfossils have increased by 25 percent over the past four years—with important consequences for some of the book's conclusions.

Many chapters in *The Proterozoic Biosphere* are tantalizingly, even frustratingly, brief. Brevity is a art not easily mastered, and too many of the chapters read like extended abstracts. The most successful miniatures are found in the sections on biogeochemistry and modern microbial-mat communities; the concise primer on molecular and isotopic biogeochemistry by Summons and Hayes is particularly elegant. The presentation by Beukes and Klein of a provocative model for the deposition of iron formations is also required reading, although those inspired by the condensed version will want to seek out more complete arguments published elsewhere. Kirschvink's reconstruction of Neoproterozoic and Cambrian plate positions also excites special interest, being published (but not written) in the wake of recent plate reconstructions that currently invigorate the study of Neoproterozoic tectonics.

Perhaps the most important new data are those on the carbon isotopic composition of Proterozoic kerogens, analyzed by Strauss and others. By measuring the H/C of kerogens and using that ratio to correct isotopic data for diagenetic alteration (or, when $H/C < 0.2$, to eliminate samples from further consideration), these authors have produced an extremely useful picture of large-scale variation in the carbon isotopic composition of organic matter through Precambrian time. Coupled with data from carbonates, this provides a potentially powerful means of addressing questions such as the CO_2 and oxidation history of the atmosphere—a theme developed more recently by DesMarais *et al.* (*Nature* **359**, 605–609 [1992]). Because few samples were drawn from any single basin, the PPRG data cannot be applied to one of the most rapidly developing areas in Proterozoic biogeochemistry, the documentation of relatively fine-scale stratigraphic variation in $\delta^{13}C$ within Proterozoic successions. This, in turn, makes it difficult to correlate the kerogen data with tectonic, climatic, or biological events that may have influenced the Proterozoic carbon cycle.

A distinguishing feature of the first PPRG book was its focus on the integration of biological, paleobiological, geological, and geochemical data. Though not entirely missing from *The Proterozoic Biosphere*, data integration has been deemphasized in favor of data presentation. In consequence, though the study can fairly claim to be multidisciplinary, it is not interdisciplinary. The intellectual interplay among chapters is remarkably low, and this ends up sacrificing much of the vitality that marked the first PPRG effort. The need for integration is particularly apparent in several otherwise excellent sections where a marriage of geological and actualistic data would have illuminated both. The insightful chapters on microbial mats include useful discussions of how microbial physiology informs our interpretation of Proterozoic biogeochemistry, but there is little discussion of mat sedimentology, lithification, microbial taxonomy, or taphonomy—all necessary for interpreting the overwhelmingly dominant features of the paleobiological record in Proterozoic stromatolites, microfossils, and petrographic fabrics. Chapman's articulate review of algal phylogeny includes insights from molecular phylogeny but says little about the fossils that can link comparative biology to the Proterozoic record.

Perhaps the most controversial chapter in *The Proterozoic Biosphere* is Schopf's quantitative analysis of the Proterozoic microfossil record. Employing no fewer than 35 graphs, he argues that both prokaryotic and eukaryotic species richness reached their Proterozoic maxima about 900 million years ago, following which biological diversity decreased throughout the final 350 million years of the Neoproterozoic Era. Before reading this paper, I was convinced that the Proterozoic diversity of eukaryotic microfossils peaked just prior to a major extinction about 570 million years ago and that sampling problems prohibit evolutionarily meaningful analyses of prokaryote diversity. I still am. Understanding how Schopf arrived at his very different conclusion is an engaging exercise, and well worth the effort. Solution of the puzzle requires that the reader look carefully at the taxonomic framework adopted for the classification of simple leiosphaerid acritarchs (and read the taxonomic revision of these fossils by Jankauskas and colleagues presented in *Mikrofossilii Dokambriya SSSR*, Nauka, Leningrad, 1989), consider how the paleoecology and paleoenvironmental sampling influence compilations, and read up on those more than 500 Neoproterozoic fossil occurrences that don't figure in Schopf's calculations.

Consumer protection forces me to note the poor production quality of *The Proterozoic Biosphere*. For reasons beyond the control of the authors and editors, the book's many photographs—potentially among its most valuable features—are dark and grainy.

Vignettes: Human Genetics

Record[s] of genetic disorders are illustrated in ancient Egyptian statues and engravings since the days of the Pharaohs more than 4,000 years B.C. An example is the group statue of the dwarf Seneb from the Old Kingdom (4th Dynasty) which records all his family. Seneb is an example of a prosperous ancient Egyptian dwarf who attained a high position and was chief of all the palace dwarfs and was married to a great lady of the court.

—*Samia A. Temtamy*

[Ronald A.] Fisher's children, as often happens in geneticists' families, were used as subjects for the blood group studies and were frequently attacked by the "asp" to provide blood samples. Thus, they knew their Rh types. . . . June Posy, one of Fisher's seven daughters, told me of the consequences of her sister Elizabeth discovering that she was rhesus negative. When she was proposed to by her future husband she was concerned that, as they were planning to go to Africa, any rhesus positive offspring might create serious medical problems. She therefore said to him "I will marry you if it is God's will for me to do so." God's will was to be that her future husband should be Rh negative—and he was, just a sixteen percent chance. To my knowledge this must have been the first case of assortative mating on the basis of properly established genotypes.

—*Walter F. Bodmer*

In the United States, we use the term "closet liberal" to denote a person with a liberal political philosophy who for various reasons keeps his or her views quiet. I suggest that in the past many geneticists with a strong interest in the genetics of their own species backed off from an involvement because of the apparent difficulty of making significant genetic contributions through the study of humans. Now that barrier no longer exists, and the "closet" human geneticists are coming out of the closet.

—*James V. Neel*

From *The History and Development of Human Genetics: Progress in Different Countries*, proceedings of an international conference held in Washington, DC (Krishna R. Dronamraju, Ed.; World Scientific)

Schopf's illustrations of new microfossils from the 3500-million-year-old Warrawoona Group, compelling in the original, are indecipherable as printed here. Many graphs are also difficult to read. One editor's name is even misspelled on the cover. In addition, the price tag encourages rumination on how a little thought and a diskette or two could have trimmed the book's bulk by half, increased the space available for thoughtful essays, and reduced the price to a level where more scientists could afford a copy.

Despite its shortcomings, however, *The Proterozoic Biosphere* is an important resource that should find its way into libraries. Anyone with a serious interest in the half of recorded Earth history encompassed by the Proterozoic Eon will want to consult it for data compilations, references, and skeletal discussions of life's evolutionary maturation.

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