floor spreading. Those with a measure of skepticism will find it difficult to see how their reflection profiles unequivocally bolster this concept, however.

As Coleman correctly declares, the value of this volume lies not only in the collection of contemporary papers it houses on perhaps the most geologically significant area of our globe, but also in the battleground it provides for rival geotectonic theories. The conflict centers about the essential processes involved in the creation of crustal and upper mantle masses. Are they associated with lateral shifts of great and small lithospheric plates constructed at oceanic ridges, as in the global plate tectonic or sea floor spreading view, or with in situ vertical transitions that are manifestations of upper mantle and crustal changes, as in the "fixist" or classical geosynclinalist view? Or—a possible way around these proposals—are the processes related to the expanding earth championed by Carey? Carey, for reasons unknown to me, refuses to fully draw his sword, as he only presents an abstract of his views. Thus, in this volume, the fascinating concept of an expanding earth is quickly retired by its own general.

In contrast, Pushcharovsky, a firm fixist, confronts the "mobilists," the defenders of the global tectonics camp, along a broad front. To a man, the mobilists virtually ignore this challenge and the mostly unstated but implied ones by several of Pushcharovsky's Soviet colleagues. I suspect that the answering silence of the spreaders is simply a measure of their lack of interest in attacking older concepts that seem to systematically ill-treat or ignore those newer findings in marine geology and geophysics, seismology, and igneous petrology and geochemistry that laid the cornerstones for the present wide acceptance of sea floor spreading and global plate tectonics. It is significant that aspects, if not the totality, of sea floor spreading models are endorsed by Gorshov to concoct the eruptive magmas of the Kuril arc and by Fedotov to account for its seismicity.

Although the mobilists are in general agreement among themselves, the fixists are divided into two factions according to whether continentalization or oceanization is regarded as the essential process in the fabrication of crustal rocks. Gnibidenko explains the essence of these hypotheses and how they dominate Soviet thinking about the crustal evolution of the Pacific basin and its perimeter (the cynical reader will smile when he reads the footnote attached to his article). Dickinson best relates how the mechanical, magmatic, and depositional consequence of moving lithospheric plates dominates Occidental and Austral thinking about these same problems. For those who are not steeped in the jargon of the mobilist, I suggest a prior reading of Gill and Gorton's paper on the crustal evolution of eastern Melanesia.

This volume is indispensable for all serious students of the Pacific basin, especially those who have a special interest in its western periphery. For those who simply wish to enhance and update their comprehension of island-arc geology, or who thirst to read about plate tectonics in action, a reading of the book will be greatly rewarding.

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## A View of the Uniformity Principle

**The Nature of the Stratigraphical Record.** DEREK V. AGER. Halsted (Wiley), New York, 1973. xiv, 114 pp., illus. + plates. $9.50.

Stratigraphy deals with description and interpretation of stratified rocks, and the stratigraphic record, although a fraction of the earth's bulk, is the repository of much of earth history. How that record is read depends upon the stratigrapher, the rocks and fossils with which he is familiar, his breadth of experience, and the stratigraphic philosophy that guided his training. Commonly, we are so immersed in the details of local problems that we do not take time to examine the premises upon which our solutions are based. Consequently it is appropriate to step back occasionally for a broader view of the stratigraphic record and of the means we use to interpret it.

Ager's book is not a stratigraphic treatise, for, despite its promising title, it deals with only selected aspects of the stratigraphic record. In fact, the book is a collection of eight short essays that deal with the persistence of certain facies; the fallibility of the fossil record; stratigraphic gaps; the catastrophic nature of the stratigraphic record and uniformitarianism; the relative independence of sedimentation and subsidence; the "golden spike principle"; and the phenomena controlling accumulation of the record itself. Appropriately, examples are drawn from Ager's experience and, although identifying himself modestly as a nonstratigrapher, he justifies his stratigraphic comments immodestly by noting that "the noncombatant usually has a clearer picture of the battle than the soldiers actually engaged in the fighting."

In his first essay, Ager comments on the wide and essentially synchronous distribution of distinctive lithic facies such as the Cretaceous chalk, the Germanic Trias, the Upper Carboniferous coal measures, and the Old Red Sandstone of Devonian age. Although it might have been appropriate to note that most of these facies are also widespread at other stratigraphic levels, the conclusion that "at certain times in earth history particular types of sedimentary environments were prevalent over vast areas of the earth's surface" is agreeable, if somewhat anticlimactic.

Ager brings greater expertise to an essay that deals with biologic aspects of the stratigraphic record. He notes the ubiquity of certain fossils and the widespread congruence between fossils and lithic facies; comments on inadequacies of reconstructed faunal provinces; considers favorably the "punctuated equilibria" evolutionary model of Gould; and discusses sudden or mass extinctions. Observations on these subjects lead to the catchy, but curious, conclusion that "paleontologists cannot live by uniformitarianism alone." Aspersions are also cast on the uniformity principle at other places, but Ager nowhere says what he understands that principle to be. One gathers, however, that he understands uniformitarianism to imply not only that processes that acted on the earth and its biosphere in the past are the same that operate today, but that they have always operated at the same rate and on the same scale. Presumably, mass extinctions, periods of apparently accelerated organic evolution, turbidity flows, and the widespread accumulation of Pleistocene glacier ice can be regarded as catastrophic and nonuniformitarian because they imply rates of development or scales of coverage different from those affected by the same processes today. It is doubtful, however, that many geologists share Ager's limiting view of uniformitarianism, particularly because of the extensive airing that principle has had

in the recent literature (G. G. Simpson, in *The Fabric of Geology*, C. C. Albritton, Jr., Ed., Freeman, Cooper, 1963, pp. 24–47, and D. B. Kitts, *ibid.*, pp. 49–68). Simpson's comment that the "immanent characteristics of the material universe have not changed in the course of time" seems a more useful statement of the uniformity principle and, if acceptable, would dispel the need for the catastrophes and nonuniformitarian happenings that Ager reads from the stratigraphic record.

That the record is incomplete and has accumulated or been rearranged spasmodically rather than gradually in many places is stratigraphic commonplace. However, it is wise occasionally to emphasize these facts, as Ager does in his third and fourth essays. Nevertheless there is danger in overemphasis, for it is certainly true that more time is represented than unrepresented in some sections, and much stratigraphic endeavor is directed toward filling in the gaps in one section through correlation with others in which there is a record of the missing intervals. Further, in view of the supernatural taint that "catastrophism" acquired as geologic philosophy was developing, it is unfortunate to revive the word merely as an antonym for "gradualism," no matter how correct this may be in a dictionary sense. However they may seem to newscasters and those unhappy enough to live in the path of one, there is little about hurricanes, windstorms, mudslides, avalanches, turbidity flows, or sudden glacier surges that is catastrophic on the scale of geologic time. Perhaps the stratigraphic record in many places is largely a record of spasmodic events, and not of the placid intervals between them. But to view such a record as catastrophic, or to insist, as Ager does in his fifth essay, that we take a catastrophic view of the uniformity principle itself suggests that there is something unnatural about the spasmodic events themselves, something that cannot be understood from a study of modern processes and phenomena. If stratigraphers assume that the scale and rate on which geologic processes operate have remained constant with time it is necessary to remind them that the record indicates this not to be so. But stratigraphers of the reviewer's acquaintance make no such assumption, so one wonders why Ager pummels this straw man so vigorously.

The summary chapter of Ager's rather personal memoir suggests that anomalous features of the stratigraphic record enumerated in preceding essays can perhaps be understood in the framework of global tectonics, which is also viewed in a quasicatastrophic light. It might as well have been pointed out, of course, that global tectonics ought to be justified in terms of the stratigraphic record.

*The Nature of the Stratigraphical Record* is provocative reading, particularly as it provides insight into a view of the uniformity principle that is different from that held by many stratigraphers. There are a few minor errors (the "main road of America," joining Chicago and Los Angeles, must surely be U.S. Highway 66 of song and fable, not Highway 70, as asserted on p. 6), and some illustrations are not particularly clear. But these defects do not detract from an otherwise stimulating book that is recommended as fireside reading for a winter night, or as a pleasant diversion on a rainy day when it's impossible to get into the field.

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## Paleoclimatology

**Climatic Fluctuations of the Ice Age.** BURKHARD FRENZEL. Translated from the German edition (Braunschweig, 1967) by A. E. M. Nairn. The Press of Case Western Reserve University, Cleveland, Ohio, 1973. xxiv, 306 pp., illus. $22.50.

This valuable publication brings to the attention of English-speaking scientists the Eurasian evidence of environmental conditions during the warm and cold episodes of the late Cenozoic. The number of glaciations that occurred in Europe and North America during this era was until quite recently thought to be three or four. It is now believed that there were at least ten such events in central Europe. Frenzel has limited his treatment to the Pleistocene, defined as the last 1.0 to 1.5 million years, and has chosen to avoid hypothetical arguments and concentrate instead on setting out the rich paleobotanical data from which climatic inferences are drawn.

The work begins with useful prefaces and a brief climatic survey, followed by an examination of methods of relative and absolute dating; amino acid dating is not mentioned. Qualitative and quantitative methods of determining ancient climates are surveyed involving $^{16}O/^{18}O$, glacial and periglacial sediments, permafrost, fossil soils, dendrochronology, and pollen analysis. The palynological section has some discussion of the traditional difficulties of the relative percentage method which is somewhat incongruous because of the omission of any mention of "absolute" methods of pollen counting, which would answer many of the problems raised. The use of palynological data from entomophilous species (such as ivy, holly, and mistletoe) for precise local paleotemperature values (including winter temperatures) is not mentioned.

A short chapter sets out the evidence obtained by the dating methods for widespread synchrony of climatic fluctuations, including the Allerød–Two Creeks case. Frenzel makes it clear that he does not expect different climates subjected simultaneously to the same impulse to react in necessarily similar ways. Later in the book evidence for synchronous climatic changes in northern and southern Africa, and subsequently for worldwide climatic synchrony, is presented.

Evidence of the principal climatic fluctuations derived from paleobotany (with the relevant fossil permafrost and soils data) is given at length, with a large number of valuable maps of the past distribution of climatically sensitive plants (though some of the maps are wasteful of space). The strong similarity in the vegetational successions between several interglacials (and the Holocene) emerges clearly from this synthetic treatment; it is surprising in this context that the current debate among Holocene phytogeographers about human impact on the late Flandrian development of heaths and sphagnum bogs in northern Europe does not refer more often to this interglacial parallelism.

Frenzel clearly illustrates how in Europe there were successively cooler and drier climates at the height of the cold episodes, and relates this increasingly continental climate to progressive mountain uplift. A detailed examination is made of the paleotemperatures of the last cold episode throughout Europe.

In the final chapter, on the climatic fluctuations of the last cold period, Frenzel extends his survey beyond the confines of Europe and Russia. By contrast with his account of these areas, which because of his language abilities and knowledge of the literature is of great value to readers from other regions, his comments on North American glacial geology rely on outdated