of nature even for quite similar systems such as nearest-neighbor planets. The Soviet Union has systematically pursued exploration of Venus since 1967 with its Venera series of probes. The most recent of these carried imaging experiments that returned the only existing pictures of the planetary surface. The United States program included most recently the highly successful Pioneer orbiter-probe mission in 1978, whose orbiter is still in operation. This book grew out of a post-Pioneer international conference. The timing for a summary book is good, since there has been time for the community to digest the Pioneer results and there will probably not be a new infusion of data of comparable magnitude until the NASA radar mapping orbiter mission of 1988.

The ambitious purpose of this book is to present the whole subject of the planet Venus, and it succeeds. Chapters by Seiff, by Tomasko, and by Taylor, Hunten, and Ksanfomality present the atmospheric thermal structure and treat the question of its maintenance. There is no longer any question about the validity of the greenhouse explanation for the high surface temperature. Measurements of the temperature profile and of the solar flux reaching the planetary surface are firmly in hand. Infrared flux measurements are still uncertain, however, and so is the explanation for the precise value of the subadiabaticity of the lower atmosphere, a crucial quantity controlling atmospheric dynamics. Composition, photochemistry, and clouds and hazes are treated in chapters by von Zahn, Kumar, Niemann, and Prinn, by Krasnopol'sky and Parshev, and by Esposito, Knollenberg, Marov, Toon, and Turco. In spite of a wealth of new information there are still questions about chemical cycles and atmospheric history that will require for their answers more precise composition information and probably also cloud particle composition determinations in situ. Donahue and Pollack review the atmospheric evolution question. Geophysical fluid dynamicists will find from Schubert's chapter that the puzzle of Venus's atmospheric super-rotation is still a puzzle. Truly diagnostic information on momentum transfers has not yet been obtained. Topographic results from the Pioneer radar experiment are discussed by McGill, Warner, Malin, Arvidson, Eliason, Nozette, and Reasenberg. Venus has a unimodal elevation spectrum strikingly different from that of Earth, but horizontal resolution of only 100 to 200 kilometers renders detailed interpretation difficult. The upcoming radar mission will improve the situation. Other chapters discuss geophysics, aeronomy, and interaction with the solar wind. About half the chapters treat specific experimental results, rather than provide summary reviews; most of these chapters are by U.S.S.R. Venera experimenters.

In my opinion this book accurately reflects the state of the subject. It is long and there is overlap among chapters, but opinion is divided on many subjects and different points of view are useful. This book will remain the standard reference on Venus for many years. It is written for an audience of scientists, such as readers of this magazine, and will be particularly rewarding for those involved in terrestrial atmospheric science or geophysics.

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Precambrian Geology

Geological Evolution of the Earth During the Precambrian. LAZARUS J. SALOP. Springer-Verlag, New York, 1983. xii, 460 pp., illus. $65.80. Translated from the Russian edition (Lenigrad, 1982) by V. P. Grudina.

This new book by Lazarus J. Salop, of the All-Union Geological Research Institute in Leningrad, presents a succinct statement on Earth's evolution during the Precambrian. The book consists of an introductory chapter on the methods and principles of Precambrian division; a chapter for each of Salop's six main chronostratigraphic divisions; and a concluding synthesis. The main contribution of the book lies in the description and interpretation of 75 key lithostratigraphic sections as a basis for the recognition of natural stages in the evolution of Precambrian continental crust.

In Salop's unique time classification the five larger Precambrian units (megacycles—comparable to eras), are separated by first-order global orogenies, named, from oldest to youngest with respective terminal orogeny and age in parentheses, as follows: Archean (Saamian, 3.7 to 3.5 billion years), Paleoprotozoic (Kenoran, 2.8 to 2.6 billion years), Mesoprotozoic (Karelian, 2.0 to 1.9 billion years), Neoprotozoic (Grenville, 1.0 billion years), and Epiprotozoic (Katangan, 0.7 to 0.6 billion years). These units correspond almost exactly to the more conventional fivefold division of the Precambrian. Salop's rejection of the conventional classification is based upon his perception of the Saamian orogeny as the most important turning point in geologic history, separating the Precambrian into its two largest time divisions (megachrones), each with conspicuously distinctive thermal-tectonic regimes. This division, combined with the equally distinctive organic record of the last 570 million years, leads Salop to divide all geologic history into Archean, "dawn of life" (more than 3.5 billion years ago), Protozoic, "primitive life" (3.5 to 0.57 billion years ago), and Phanerozoic, "true (or evident) life" (0.57 billion years ago to the present)—apparently a logical global tectonobiostratigraphic synthesis. However, the synthesis turns on the validity of considering the Saamian orogeny as the key turning point in geologic history. And this will be the parting of the ways for many. According to Salop, Archean rocks, which form basement to all remaining geologic formations, are uniquely characterized by high-grade metamorphism (especially granulites), ubiquitous though irregular granitization and migmatization, and dominance of plastic deformation. In other words, all Earth's high-grade metamorphic terrains are considered by Salop to be older than 3.5 billion years. Many will be surprised to see, for example, that as a result of this unusual interpretation most of the Grenville and much of the Churchill province of the Canadian Shield are classified as more than 3.5 billion years old. The more conventional viewpoint is that high-grade metamorphic rocks have been developed periodically throughout geologic history and thereby lack any first-order temporal significance. According to this view the Saamian orogeny is just one in a series of global orogenies, no more important in the geologic scheme of things than, say, the Kenoran orogeny. In sum, the basis for Salop's classification and terminology appears to be dubious.

The bulk of the book is devoted to the stratigraphic columns. The substance of the columns is neatly summarized in two introductory tables of lithostratigraphic units arranged by era and including individual name, age, and characteristics. The stratigraphic columns and accompanying descriptions provide a useful global compilation of Precambrian lithostratigraphy, the columns illustrating the less-well-known Siberian and European (Russian) platforms in particular. However, some proposed global stratigraphic correlations are highly suspect. Further, Salop proposes global thermal trends that are based on uncritical acceptance of stable isotope interpretations. His system of Precambrian subdivision is based

ultimately on the recognition of natural stages of geologic evolution, that is, large global geologic cycles each comprising a long period of relative tectonic quiescence and a subsequent shorter period of orogeny. Sixteen such orogenies of varying rank are recognized and tabulated, including the orogenies that set off the main Precambrian divisions. Some special plutonic complexes, for example anorthosite and rapakivi granite, occupy particular niches in this scheme of things. These cycles are considered to occur against a background of directed irreversible evolution of Earth. Precambrian crustal evolution is divided by Salop into five stages: protoplanetary (5 to 4.5 billion years ago), permobile (4.5 to 3.5 billion years ago), protoplatformal-protogeosynclinal (3.5 to 2.6 billion years ago), platformal-geosynclinal (labile platforms) (2.6 to 1.9 billion years ago), and platformal-geosynclinal (stable platforms) (1.9 to 0.6 billion years ago).

Salop contends that no satisfactory general tectonic theory exists to explain the diversity of Precambrian geologic phenomena and that such a theory, when conceived, will probably represent some blend of "mobilism" and "fixism." In this regard he is responding on the one hand to modern plate tectonics, and on the other hand to his perception, which I for the most part share, that many Precambrian tectonic elements are firmly rooted in and dependent upon their predecessors. Salop cites, as an example of tectonic longevity and hence "fixism," the basin of the Pacific Ocean, which, he argues, is clearly outlined by the distribution of 1.9-billion-year-old Neoprotozoic geosynclines (fold belts). Thus he contends that the concept of lithospheric plates will contribute in part to an eventual general Precambrian tectonic theory. Salop flirts with but unfortunately does not pursue the potentially fruitful concept of thickening tectospheric "plates" in explanation of irreversible lithostratigraphic-plutonic trends in the Precambrian. Many of his interpretations are seemingly uninfluenced by the earth science "revolution" of recent decades, hence are dated and in some cases irrelevant. He supports the widely held view that many irreversible lithic-organic trends can be explained by postulating the gradual oxidation of the atmosphere and hydrosphere by photosynthesis.

The text contains numerous spelling and grammatical errors. Fortunately they do not prevent basic comprehension.

In conclusion, this book is the product of a diligent and thoughtful field geologist with a commendable capacity for fruitful global synthesis across the immense span of Precambrian time. The voluminous stratigraphic data will be of particular interest to all students of Precambrian geology.

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