

netic radiation, cosmic rays, or seismic disturbances.

One of the most difficult, abstract, and enticing problems has been the attempt to formulate a quantum theory of gravitation. Peter Bergmann, in his article "Status of canonical quantization," presents a summary of three likely approaches to such a theory: the Schrödinger approach, the Hamilton-Jacobi or superspace approach, and the Feynman path (thin sandwich) approach. Why bother to quantize gravity at all? As Bergmann sums them up, the principal motivations are: the likelihood that if most physical fields are quantum fields gravitation will be no exception, and the expectation that a fully elaborated quantum theory of gravitation will be far more than a routine replica of other known quantum field theories.

In recent years there has been a great deal of experimental activity along astrophysical lines, due in no small part to a rapidly developing technological capability. In his article "The recent renaissance of observational cosmology," D. W. Sciama elaborates on two of the most exciting discoveries in the history of astronomy—both in the year 1965—the quasistellar sources of large red shift and the cosmic blackbody radiation.

Some other articles in the collection concentrate on details of a more mathematical nature. In "Twistors, symplectic structure and Lagrange's identity," Crampin and Pirani show that Penrose's twistors can be understood very simply in terms of the natural symplectic structure of the cotangent bundle of the manifold of space-time. "Applications of SU(2) technique in general relativity" by Moshe Carmeli is another article in which recent theoretical constructs (in this case, the Newman-Penrose constants) in relativity theory are elucidated in terms of standard mathematical constructs.

Peter Szekeres discusses a treatment of the gravitational field equations for the propagation of gravitational waves in a material medium analogous to the macroscopic treatment of Maxwell's equations. He derives "macroscopic" Bianchi identities for the Weyl tensor and a "dielectric constant of gravitation."

A general relativistic kinetic theory of gases provides a way of completing the Einstein equations for a material system without the need for an equation of state. In addition such a theory is of considerable astrophysical interest

—for example, analysis of the cosmic blackbody radiation. Jürgen Ehlers gives a brief survey of the present state of relativistic kinetic theory and a list of references suitable for further study in the subject.

There are a total of 36 contributed articles. Most of the articles are not suitable reading for the nonexpert in relativity and gravitation, one exception being Sciama's article on cosmology. For the expert, the book is useful (though not absolutely necessary).

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Guide to Volcanology

Volcanic Landforms and Surface Features. A Photographic Atlas and Glossary. JACK GREEN and NICHOLAS M. SHORT, Eds. Springer-Verlag, New York, 1971. xxvi, 520 pp. \$32.

This handsome volume consists primarily of approximately 425 excellent photographs of terrestrial volcanic features and 8 of features on the moon, contributed by 90 different persons and institutions all over the world in addition to the editors. Each has an explanatory caption ranging from a few lines to half a page long. The photographs are arranged in categories, such as phenomenology of eruptions (views of active lava flows, fountains, lakes, glowing avalanches, and so on), calderas, volcanic cones (external form and internal structure), craters, domes, spines, necks, features of mud flows, lava flows, and pyroclastic deposits, erosional features in volcanic rocks, geysers and other hydrothermal phenomena, and lunar features.

The volume starts with a brief summary of volcanic processes, products, and structures by the late Arie Poldervaart. Particularly good features are a very short summary of the factors involved in eruptive behavior of gas-charged magma and an excellent bibliography. A few errors, such as the interchanging of figures 3 and 4 and symbols in figure 10, no doubt are due to the fact that proofs could not be checked by the author.

The endpapers of the book are a map showing the "principal" calderas and active subaerial and submarine volcanoes of the world.

Pages 457–513 are a glossary of volcanic and related terms, which the editors credit largely to the unpublished

third edition of the American Geological Institute's *Glossary of Geology and Related Sciences*. Comments have been added by Green. The glossary certainly will be useful to readers not already acquainted with volcanic terminology, and occasionally even to specialists.

The editors state that their primary purpose was to assemble for comparative and illustrative purposes, as an aid in teaching geology and geophysics (perhaps particularly geomorphology) and in interpreting photographs of objects on the surface of the moon and inner planets, a photographic record of nearly all types of terrestrial volcanic surface features that have thus far been described. This objective has been admirably achieved. It is questionable, however, whether the editors have achieved their further goal of keeping the book simple and general enough to be useful at the secondary school level or to the nonprofessional, except as a picture book. Probably unavoidably, too many technical terms have been used. Thus, for instance, few secondary school students or teachers, and for that matter not even all petrologists, will know what is meant by ijolite without looking it up, and it is not listed in the glossary. But to put the text wholly in terms familiar to the secondary school student would have greatly reduced its usefulness to geologists and college students of geology.

Some errors, mostly minor, are scattered through the text. For example, the structures shown in plate 149A are a consolidation effect known as "dendritic" lava, not lava cascades as is stated; Katmai Caldera (plate 101B) is now generally believed to have formed principally by collapse, not by explosion; Haleakala Crater (plate 27B) has been shown to be primarily erosional, not the result of "some explosion and much subsidence"; sharkskin pahoehoe (plate 145B) is formed by escaping gas bubbles, not by the pulling apart of plastic surfaces. A few names of persons are misspelled. Such errors will probably not be important to most readers, but persons using the material for research purposes should check the original literature.

This is a volume that most persons with a close interest in volcanoes will want to own and that all persons engaged in the interpretation of photographs of lunar and other planetary features should own and study.

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