to its final disappearance under the Gulf Coastal Plain in Alabama. No wonder is it that the Appalachians have been the birthplace of many of the great principles of . . . geology."

For purposes of these volumes, the Delaware River is taken as the boundary between the northern and central Appalachians. Therefore, the first volume deals with northwestern New Jersey and the Appalachians to the northeast, whereas the second volume deals with Pennsylvania and the Appalachians to the southwest.

For the first volume, an introduction and the regional geologic map, which is placed near the back of the book to facilitate reference to it, set the stage. The rest of the topical coverage is divided into six sections: 1, Regional Stratigraphy and Paleogeography, with seven papers most of which are review articles about the chief stratigraphic systems of this part of the province; 2, 3, and 4, Stratigraphy and Structural Relationships in the Outer or Northwestern Belt, . . . in the Central Belt, and . . . in the Inner or Southwestern Belt, with five, seven, and three papers, respectively, nearly all of which are about specific areas but a few of which also outline important concepts relating to orogenic events; 5, Igneous and Metamorphic Petrology and Petrogenesis, with seven chapters dealing with radiometric dating, metamorphism, and diverse kinds of igneous activity; and 6, Geophysics, with four articles giving data and interpretations of gravity anomalies, aeromagnetics, and heat flow. The already mentioned generalized geologic map (1:2,500,000) is essentially a U.S. Geological Survey map put on open file in 1968. Although its inclusion in the volume will be of great aid to readers, special attention needs to be directed to the rather peculiar fact that the dash pattern used for the Cambrian and Ordovician rocks "is not intended to represent structural trend lines."

For the second volume, the coverage is divided into four sections, each with its own introduction, and an epilogue. The four sections are: 1 and 2, The Valley and Ridge and Appalachian Plateau—Stratigraphy and Sedimentation, and . . .—Structure and Tectonics, with six papers in each section and about such subjects as depositional sequences, turbidites, "iron sedimentation," kinematic patterns, and estimates of lateral shortening; 3, The Blue Ridge and Reading Prong, with seven papers most of which are reiterations of previously published facts and fancies; and 4, The Piedmont, with ten articles dealing with such diverse subjects as the Martic problem and post-Triassic tectonism. This second volume also includes a regional map near the back. (Perhaps only the reviewer's copy has this map tipped in upside down.) This map (also 1:2,500,000) is a revision by J. C. Reed, Jr., of the appropriate portion of the Tectonic Map of the United States, originally published in 1961 by the U.S. Geological Survey and the American Association of Petroleum Geologists. The epilogue is ended by the posing of questions the answers to which are needed before any truly comprehensive history of the Appalachians may be given. The questions deal with delineation of relationships beyond the currently known boundaries—at depth, to the northeast, to the southwest, and to the southeast—of the province.

As in nearly all such collections of articles, there are marked differences in the quality of the data as well as of the interpretations presented. There are also noteworthy omissions in topical coverage and of contributors. For examples: metallogenesis within the province and possible genetic relationships between Triassic events and earlier Appalachian history are essentially ignored *and* no papers by any of the University of North Carolina geologists who have been and continue to be so actively involved in investigations of the southern Piedmont are included. On the other hand, there is the praiseworthy virtue that both volumes contain papers that give conflicting interpretations and hypotheses to account for the same or apparently similar geological features.

There is a marked contrast between the currency of several of the papers in the first volume and the rather dated character of many of the papers in the second. The dated papers, however, add a historical dimension that makes it seem rather likely that the pair may become attractive to a wider audience than either volume would by itself.

Much of the first volume will gain early plaudits. Much of the second volume will also gain approval by those who are not discouraged from reading all of it because of such statements as "Viva Appalachia" and "The Piedmont has the shape of a wild duck swimming gracefully northward" which occur in the introductory remarks. Papers in both volumes will serve as standard references in the future and will prompt future investigation within the province. A few of the papers will undoubtedly also stimulate further synthesis of data relating not only to the Appalachians but also to other geosynclinal tracts which have undergone mountain-building and associated activities.

Geologists the world over owe a debt of gratitude to the 86 authors and editors who prepared and collected the 63 articles and regional maps that constitute these two volumes, to the geologists to whom the volumes are dedicated—Marland P. Billings, "a pioneer in the renaissance of Appalachian geology . . ." and Ernst Cloos, "who rekindled a spirit of inquiry into Appalachian geology"—and to the several other early Appalachian geologists whose contributions played important roles in promoting the investigations and thoughts recorded in these volumes.

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Aurora and Airglow

Atmospheric Emissions. Proceedings of a NATO Advanced Study Institute, Ås, Norway, July–Aug. 1968. BILLY M. MCCORMAC and ANDERS OMHOLT, Eds. Van Nostrand Reinhold, New York, 1969. xii, 564 pp., illus. $25.95.

This book is a delightful festschrift in disguise. The book actually is based upon the proceedings of the NATO Advanced Study Institute on the Aurora and Airglow. The organizers of the institute, however, selected the occasion to honor that dynamic explorer of the geomagnetic and upper atmospheric processes Sidney Chapman, who at 80 is as fully endowed with enthusiasm as on the day when the reviewer first encountered him at an auroral conference in 1949 in London, Ontario. I remember the occasion well because at that time Chapman gave a speech honoring the 84th birthday of the principal guest, another grand pioneer of auroral phenomena, Carl Störmer. In subsequent years I found myself one of those 59 collaborators in 109 papers who have been privileged to work with Chapman.

In the lead paper in the volume at hand Chapman sketches the development of auroral science from 1600 to 1965, noting the highlights and the evolution of concepts, culminating in the intense burst of activity resulting from the programs of the International Geophysical Year. Despite the remarkable changes in the ensemble of observational facts and successions of theories, he concludes with the observation that his talk must end in a question

mark: "the golden age of complete understanding of auroral science is perhaps still in the somewhat distant future."

The contents of the book do not comprise an introduction to the subject of atmospheric emissions, nor were they intended to. The book contains a very well balanced assembly of contributions by renowned scientists on topics of current observational and theoretical interest. The first 351 pages deal with auroral characteristics, observational material obtained from observations from the ground, aircraft, rocket, and satellites, and with the fundamental causes of the aurora. The remaining 210 pages are oriented to the upper atmospheric airglow, covering well both observational and theoretical aspects.

I recommend the book both for persons having general interests in geophysics and for the research specialist in upper atmospheric phenomena.

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Water as a Solid

The Chemical Physics of Ice. N. H. FLETCHER. Cambridge University Press, New York, 1970. xii, 272 pp. + plates. $13.50. Cambridge Monographs on Physics.

Considering the great abundance and universal significance of water, and the fact that about one-half of all fresh water on earth is in the solid state, there is a remarkable lack of coherent textbooks about ice. Thus it is inevitable that this new work by a respected author will find ready and widespread acceptance.

The author's declared aim is twofold: to provide a text on chemical physics for graduate students and advanced undergraduates, using ice to illustrate the application and interrelation of basic principles in quantum mechanics and solid state physics, and to set out established knowledge of the chemical physics of ice for the benefit of those who are interested in ice as a material.

The idea of using ice as a model solid for teaching purposes seems excellent in conception, and probably there will be only minor argument about the execution. However, there are many texts on physics and chemistry but few on ice, and this book is likely to be judged mainly on its merits as a monograph on ice.

The first chapter deals with the structure and properties of the water molecule, and from this base there follows an exposition of the structure and energy of ordinary ice and ice polymorphs; the structure of liquid water and the freezing process; growth of crystals from the vapor and the melt; and thermal properties and lattice dynamics. After this treatment for perfect crystals there is a discussion of defects, impurities, and diffusion, and the book concludes with chapters on mechanical and electrical properties of single crystals.

The text is orderly and economical, marshaling theoretical arguments and experimental facts so as to develop results with the logical progression of retrospect. In the chapters dealing with freezing and crystal growth the author writes with obvious zest on his own research specialties. The chapters on mechanical and electrical properties are less satisfying, but adequate. The general style is stark and uncompromising, and although this may be consistent with the author's aims it could be disconcerting to readers lacking background in physical chemistry. Symbols are not always defined as they occur, and there is no glossary of notation. The author follows his own preference in units, which does not conform completely to the international system.

Fletcher's book complements the recent book *Structure and Properties of Waters* by Eisenberg and Kauzmann (reviewed in *Science* 14 Nov. 1969), which devotes about one-third of its length to ice and achieves a comfortable style for readers from other disciplines without in any way compromising its content. Neither of these books treats polycrystalline ice, and neither attempts a comprehensive compilation of data; a successor to Dorsey's 30-year-old compendium still remains to be written.

The Chemical Physics of Ice fills a long-standing need for a basic text on the physics of ice. It can be recommended as an invaluable grounding and guide to the literature for physicists and chemists, and with some reservations for engineers, geologists, and biologists interested in ice.

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Books Received

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