of Columbium (1958), edited by B. W. Gonser and E. M. Sherwood, *Columbium Metallurgy* (1961), edited by D. L. Douglass and F. W. Kunz, and a monograph entitled *Tantalum and Niobium* (1959), by G. L. Miller.

The book under review, *Columbium and Tantalum*, consists of 14 chapters written by different authors, all members or former members of the Union Carbide organization. It is a monograph in which all the available information on the subject has been systematically assembled rather than the proceedings of a symposium in which individual contributors report the results of their own research. Union Carbide's Metals Research Laboratory (Niagara Falls, N.Y.), has been one of the most active among the organizations responsible for the very rapid development of columbium and tantalum technology. This guarantees that all those who contributed chapters are recognized authorities in their fields.

The main emphasis is on the metallurgy of columbium and tantalum base alloys, including the pure metals. Consolidation by powder metallurgy and vacuum melting, mechanical working and joining of the metals and their alloys, their physical and mechanical properties, their corrosion and electrochemical behavior, their reaction with atmospheric gases, their alloying behavior, and their metallography are discussed in the principal chapters of the book. In addition, three introductory chapters treat the occurrence and preparation of ores, the extraction and separation of columbium and tantalum, and the methods of reducing their compounds into metals, and three final chapters give a cursory and necessarily incomplete discussion of the analytical chemistry, the applications, and the chemistry of the compounds of the metals.

In many chapters the authors have included data from unpublished work at the Metals Research Laboratory. By using these data, they have often succeeded in bringing order into the confused picture that has resulted from contradictory data in the literature. This must be considered one of the most valuable features of a book that will be an indispensable reference volume for all those actively engaged in work on columbium and tantalum metallurgy.

F. V. LENEL
Department of Materials Engineering, Rensselaer Polytechnic Institute

Geological Processes

Physical Geochemistry. F. Gordon Smith. Addison-Wesley, Reading, Mass., 1963. x + 624 pp. Illus. $15.

Physical chemistry is being applied widely to geological problems, with major emphasis on physical geology, and, in most departments of geology, a course in physical chemistry is now required for an advanced degree in physical geology. Increasingly, this requirement is being met by courses given in geology departments. It is gratifying, therefore, that this book, the first textbook entitled *Physical Geochemistry*, originated in a department of geology. The author teaches in the department of geological sciences at the University of Toronto.

Smith clearly states in his preface that he intended the book to apply only to the geochemical problems of igneous petrology and (related) mineral deposits. Thus, it is unfortunate that he used a general title. Even for this restricted scope, his theoretical treatment (part 1) is inadequate. There is a chapter on the structure of matter, three on crystals, a short one on liquids, a very brief chapter (three pages) on gases and gaseous solutions, and a comprehensive discussion of heterogeneous equilibrium and phase diagrams. There is no systematic or adequate treatment of such topics as thermodynamic principles or laws, thermodynamic properties of naturally occurring materials, the properties of solutions, chemical kinetics, chemical statistics, and Eh-pH relations.

Part 2 is largely a presentation of systems (silicate-water-sulfide) and discussions of their application to problems of petrogenesis and ore formation, but four chapters in the section appear to be out of place. The one on geothermometry and geobarometry is not a compilation but a discussion of the theory of the methods used; this chapter might have been more appropriately placed in part 1. Chapters 15, 16, and 17 are largely concerned with the chemical composition of igneous rocks and ore deposits of the earth's crust. This is descriptive geochemistry and might well have been omitted.

At the beginning of chapter 10 there is a table in which are listed 28 of the "more important silicate phase diagrams of petrogenetic interest," complete with literature references. Diagrams for only nine of these are reproduced, but diagrams for ten systems not listed in the table are given, mostly without any credit line or reference in the text or in the legend. For the majority of these diagrams, and for those in chapter 12, it is impossible to tell whether they were taken directly from the literature, whether they have been modified, or, in a few cases, whether they are calculated or hypothetical diagrams.

If one wishes to teach a course that has just the scope of the one taught at the University of Toronto, he will find it very convenient to have available, in one volume, the pertinent data and references given here. But those who wish to include other material will prefer a more comprehensive treatment of the physical chemistry of geological processes, for with a more comprehensive textbook each instructor can choose the material he wishes to use.

EARL INGERSON
Department of Geology, University of Texas

Astronomy

Stars and Galaxies. Birth, ageing, and death in the universe. Thornton Page, Ed. Prentice-Hall, Englewood Cliffs, N.J., 1962. xiii + 163 pp. Illus. Paper, $1.95; cloth, $3.95.

Innovation in astronomical concepts and techniques has doubled the number of articles published in each volume of the *Astrophysical Journal* since 1950. During these years, all of today's large radio telescopes have been constructed and the radio data have been integrated into the mainstream of astrophysical thought. We could only guess about the existence of cold interstellar hydrogen before its 21-centimeter radiation was detected in 1951; subsequent observations have given us a radically new picture of galactic structure and galactic motions. In this same period radio observations revealed that sources scattered all about the sky are radiating prodigiously by poorly understood nonthermal processes.

During these same years, astronomers who worked at optical wavelengths have raised photoelectric techniques to a new order of sophistication. Image intensifiers have borne their first fruits in observations of sources too faint to be studied otherwise. The use of electronic computers has become routine in the reduction of large quantities of observational data and in the construction of