example, *Geologie, Zeitschrift für angewandte Geologie*, and *Hallesches Jahrbuch für mitteldeutsche Erdgeschichte* are not West German serials but East German. The *Geologische Rundschau* is not a society, but a journal published by the Geologische Vereinigung of West Germany, which happens to be shown on the next line in the listing. The very important geological map of southwestern Germany at the scale of 1 : 600,000, revised and published in 1954 by the Geologisches Landesamt Baden-Württemberg, is not mentioned. The geological map of Austria at the scale of 1 : 500,000, prepared by Vetters and published by the Geologische Bundesanstalt in 1923 and reportedly revised in 1968, is not cited.

In his preface, Rutten includes an engaging invitation to American geologists to visit Western Europe for geological field trips and other pleasures. He speaks of road maps, guidebooks, accommodations, and cost, and ends with reassurances concerning the quality of drinking water and bottled milk.

FREDERICK BETZ, JR.
Coastal Plains Center for Marine Development Services, Washington, D.C.

Thermodynamics

The Computation of Chemical Equilibria. F. VAN ZEGGEREN and S. H. STOREY. Cambridge University Press, New York, 1970. xiv, 178 pp. $8.50.

This book deals with the following problem in thermodynamics: Consider a macroscopic system of one or more phases which (i) is free of external macroscopic fields of force, of anisotropic stress, and of the effects of curvature; (ii) is at all times closed; (iii) has at all times a composition defined by the mole numbers of a set of chemical species; (iv) is at all times in thermal and hydrostatic equilibrium; and (v) is initially not in chemical equilibrium. Now let this system reach chemical equilibrium at prescribed values of temperature and pressure (or, less often, of temperature and volume), imposed of course by suitable manipulation of external conditions. The problem then is: for any particular case, defined by numerical values of the initial mole numbers and of the final temperature and pressure (or volume), compute, from appropriate data, the numerical values of the final mole numbers. The needed data consist of the standard free energies, at the final temperature, of the species involved, or equivalent information in terms of equilibrium constants. To obtain the solution from these data alone one must neglect effects of pressure upon the chemical potentials of species present in condensed phases.

Awareness of this problem goes back more than half a century, and in the early 1940's a drive to solve it efficiently began in Germany, under the goad of rocket technology. Since then, this and other needs have led to impressive growth of the subject, mostly in the United States. Today the chief applications are to propellants and rocket motors, explosives, chemical processing, and biology, as in the study of cell chemistry, of the formation in nature of organic compounds from inorganic, and so of the origin of life. In all but the simplest cases the computations are impracticable manually. Their development could therefore not have occurred without the concomitant development of computers, and the authors even suggest that the latter development owes something to the former.

The authors group the techniques now available into two main types: (i) optimization methods, and (ii) methods based on the solution of nonlinear equations. Methods of type i proceed by finding the values of the mole numbers that make the value of the Gibbs (or in the temperature-volume case, the Helmholtz) free energy a minimum. Methods of type ii usually consist in solving the mass-action equations for the individual reaction-equilibria known or assumed to subsist. The boundary between the two types is not sharp, in that for instance a procedure starting out to minimize Gibbs free energy may lead to a set of nonlinear equations needing to be solved (this case is allocated to type ii). The two types are of course logically equivalent, and the authors give a proof confirming this.

In two central chapters the methods belonging to the respective types are individually discussed. This discussion is especially valuable for its running comparison of merits and defects of the various methods. The main conclusions from this comparison are usefully summarized in a table near the end of the book (p. 156). The discussion is valuable further for its copious and knowledgeable references to the literature. There is a bibliography of 154 items, of which 106 date from 1960 or later.

In their preface the authors express the hope that the book will be useful in three ways: as a guide to the available methods, for those who have specific problems to solve; as a graduate level text, particularly for students of chemical engineering; and as a summary of the current state of the field. This reviewer believes the authors have succeeded in the first and third objectives but not in the second. The main reason for the failure is that no specific examples are worked out in the text, and no problems are given for students to work. A further reason is, regrettably, the sloppiness of a good deal of the thermodynamic discussion, especially in chapter 1, entitled "Foundations." Thus the steps leading to the formula (1.2.26) for the chemical potential of a species in an ideal gas—a formula fundamental to most of the sequel—are specious.

FREDERICK O. KOENIG
Department of Chemistry, Stanford University, Stanford, California

Sulfur Metabolism

The Biochemistry of Inorganic Compounds of Sulphur. A. B. ROY and P. A. TRUDINGER. Cambridge University Press, New York, 1970. xvi, 400 pp., illus. $18.50.

The appearance of this book at this time insures that a similar book written ten years hence will have answers, now lacking, to many problems in the biochemistry of inorganic sulfur compounds. The book is needed and well done. What is known, and not known, of the biochemistry of inorganic sulfur compounds is presented in a lucid, accurate, and well-organized manner. The coverage of the biochemical literature within the self-defined limits of the book appears essentially complete as judged from the sections within the ken of the reviewer. For the most part the authors are content with a direct reporting of the literature, and little attempt at synthesis is made. This is understandable in light of the primitive state of knowledge of many of the areas discussed. The authors are cautious in their conclusions and gentle, perhaps sometimes too gentle, in their criticisms.

The book starts with a brief consideration of the nomenclature of sulfur-containing compounds which not only is