Elementary Thermodynamics for Geologists: by B. J. Wood and D. G. Fraser. P. xiii, 303, 37 figs., 9 tables. Oxford, 1976 (Oxford University Press, hardbound $12.50, paperback $6.50).—In recent years there have appeared an increasing number of geological papers soundly based in thermodynamics. For the many geologists who have not been trained in classical thermodynamics, it is becoming increasingly difficult to understand such papers. Although several excellent textbooks of thermodynamics do exist, they do not seem to be widely used by geologists, perhaps because their examples and exercises are far removed from geologic interest. This book attempts — with a good deal of success — to provide an elementary introduction to the basic principles of thermodynamics as applied to contemporary petrological problems. It is not intended to be a conventional thermodynamics textbook, and indeed it is not. Formal definitions and derivations have been omitted in favor of operational definitions and worked examples. Throughout the text, the emphasis is on using selected examples to illustrate how thermodynamic principles can be used to solve petrologic problems.

The first and second chapters provide the meager amount of classical thermodynamics and background material (definitions, standard states, activities, and fugacities of pure phases) which is given in the text. Chapter three is devoted to a discussion of the chemical potentials and activities of components in multicomponent phases and to several types of solution models (both ideal and real) which can be used to estimate thermodynamic properties. The authors stress the point that although most silicate solid solutions are non-ideal, simple calculations based on ideal

mixing often work quite well for most purposes. The fourth chapter uses the principles developed in the preceding chapters to establish the thermodynamic basis for geothermometry and geobarometry. Here, as in other chapters, this section is not intended to be a complete summary of potential geothermometers and barometers but rather to illustrate through selected examples (for example, Al_2O_3 contents of orthopyroxene coexisting with garnet, Fe–Mg exchange equilibria, "Nicholls-Carmichael" approach to solid-melt equilibria) the principles and problems involved in applying them to natural rocks. Chapter five is devoted to the thermodynamic properties of simple silicate melts and to some of the mixing models (for example, Tempin; Toop and Samis) that have been proposed to describe their behavior. The sixth chapter deals primarily with the principles governing the behavior of components present in small amounts and how the distribution of trace elements between solids and melts can be used as a monitor of igneous evolution. The seventh and final chapter discusses several ways in which the thermodynamic properties of pure phases may be determined or estimated. Emphasis here is placed on the extraction of internally consistent enthalpy and entropy of reaction from "bracketed" phase equilibrium studies. Each chapter is concluded with a brief summary and some very useful problems along with their solutions. An appendix, which in this reviewer's opinion should have been expanded into a separate chapter, briefly discusses the general thermodynamic properties of gases and tabulates fugacity coefficients for H_2O and CO_2. Some topics presently receiving considerable attention such as the equilibrium thermodynamics of aqueous solutions, ionic equilibria, and the (nonequilibrium) principles of kinetics and diffusion are not discussed. Some types of equilibria, such as mixed-volatile (H_2O–CO_2) reactions, are only briefly mentioned.

Although the text could, in places, be a little better organized, it is for the most part well-written, and interested petrologists with some thermodynamic background will find it easy to understand. The strength of the book is that it utilizes relevant geologic problems to illustrate thermodynamics. The major weakness is that it really is "elementary." For those who are well-versed in thermodynamics or for those wishing a more detailed, rigorous approach, the book is likely to be a disappointment. On the other extreme, students wishing to obtain a solid background in thermodynamics and petrology will find it to be an inadequate basis for a thorough understanding of the subject and will want to refer to supplemental material. It is somewhat unfortunate that the text, especially chapters 1, 2, and 3, does not direct the reader to the several excellent sources of classical thermodynamics. The large number of geologists falling between these extremes, however, should find the book most helpful and enjoyable — either as a review or as an introduction to the power of thermodynamics in geology.

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