

## BOOK REVIEWS

TEMPERATURE-OXYGEN FUGACITY TABLES FOR SELECTED GAS MIXTURES IN THE SYSTEM C-H-O AT ONE ATMOSPHERE TOTAL PRESSURE. By P. Deines, R. H. Nafziger, G. C. Ulmer and E. Woermann. Bulletin #88 of the Earth and Mineral Sciences Experiment Station, The Pennsylvania State University, 1974. 129 pages. \$2.00.

Gas-mixing furnaces at one atmosphere represent one of the most reliable and useful methods for investigating anhydrous oxidation-reduction reactions at high temperature. For purposes of data comparison and consistency among the various laboratories using this technique, it is desirable to have available a set of reliable oxygen fugacity tables for different C-H-O gas mixtures. Deines, Nafziger, Ulmer and Woermann have attempted to prepare such tables for the mixtures CO-CO<sub>2</sub>, H<sub>2</sub>-H<sub>2</sub>O, and H<sub>2</sub>-CO<sub>2</sub>.

The first 29 pages of the book include a brief introduction followed by a relatively clear presentation of the methods of calculation. The JANAF TABLES (1965) are used for all the calculations, and the gas mixtures calculated using this data base are compared graphically with those obtained using several earlier data bases. The remainder of the book consists of tables of gas mixtures as a function of oxygen fugacity and temperature for the three systems. Unfortunately, the lengthy tables are labeled only on the first page, making it very easy to read data for the wrong gas system.

Numerous typographical errors and errors in formulation occur in the section on methods of calculating. It is presumed that the errors in equations (4), (7), (17),  $\Delta G_3^\circ$ , (28), (31), and (32) are merely typographical and were not included in the calculations. Recalculating some values for both the CO-CO<sub>2</sub> and H<sub>2</sub>-H<sub>2</sub>O mixtures using the correct formulation yields good agreement with the tables.

The H<sub>2</sub>-CO<sub>2</sub> values are another matter. The method of calculation used is only an approximation because of the necessary presence of methane in all H<sub>2</sub>-CO<sub>2</sub> mixtures. For most mixtures the approximate calculation is sufficiently accurate, but for the more reducing mixtures significant errors are introduced. For example, the tables predict that an initial H<sub>2</sub>/CO<sub>2</sub> ratio of 3.382 will yield an O<sub>2</sub> = 10<sup>-22</sup> at 700°C. Using the correct formulation, taking CH<sub>4</sub> fully into consideration, the actual initial ratio is H<sub>2</sub>/CO<sub>2</sub> = 4.073.

These tables apparently yield usable data over the majority of the *T*-*f*O<sub>2</sub> range that they cover. However, because of the possibility of erroneous calculations in some *T*-*f*O<sub>2</sub> regions, we cannot be confident of the data and can only recommend their use with great caution.

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Much of the research in metamorphic petrology has focused on the interpretation of metamorphic processes. The early work emphasized the mapping of metamorphic isograds, their interpretation in terms of specific equilibrium reactions, and the reconstruction of physical conditions at the peak of metamorphism. Recently, the emphasis has shifted toward the interpretation of metamorphic textures in terms of specific reaction mechanisms, the interpretation and calibration of reaction rates, and the interrelation between mechanical and chemical processes. This recent work has relied heavily on data and concepts drawn from the metallurgical, ceramic, and chemical engineering literature. A major problem for the petrologist desiring to acquaint himself with this field has been the difficulty of mastering this literature, much of it cast in an unfamiliar jargon, with a heavy overprint of mathematics. Few works attempting to summarize this material in a geologic context have been available. This book attempts to fulfill this need. The first chapter provides a general background for what follows; the second summarizes the application of equilibrium thermodynamics to metamorphic reactions; the third briefly reviews work on reaction kinetics and diffusion; the fourth deals with the recognition and interpretation of isograd reactions, and, briefly, with interpretation of reaction textures in terms of reaction mechanisms; the fifth deals with the development of stable metamorphic textures; the sixth reviews the mechanisms of deformation, recovery, and recrystallization in metallurgical systems; the seventh discusses the application of these concepts to metamorphic rocks; and the eighth presents some speculations on the relation between deformation and metamorphism. Throughout, the emphasis is on processes producing structures which can be studied on the scale of the thin section or outcrop; there is virtually no discussion of large-scale deformation mechanisms, or of the factors controlling the regional distribution of metamorphic assemblages. Vernon consistently makes an effort—largely successful—to emphasize the principles underlying metamorphic processes, and to avoid getting bogged down in sorting out discrepancies between experimental data from different laboratories.

The strength of the book is that it is well written, at times almost conversational in tone, and that it presents a simple, readily understood summary of the interpretation of metamorphic processes. The book can be understood by interested petrologists with only a smattering of thermodynamics in their background. This is also the book's chief weakness. In his effort to emphasize concepts, Vernon avoids all discussion of such mundane matters as standard states, blurs the distinction between partial pressure, fugacity, chemical potential, and activity; and in general provides a qualitative treatment far short of thermodynamic rigor. Consequently, although readers will find the book easy to understand, they will also find it an inadequate basis for quantitatively applying thermodynamics, kinetics, or diffusion theory to their own work. For those desiring a qualitative approach, the book will be very helpful, even enjoyable to read; for those wishing a more detailed approach, it will be a disappointment.

METAMORPHIC PROCESSES: REACTIONS AND MICRO-STRUCTURE DEVELOPMENT. By R. H. Vernon. Halsted Press, John Wiley and Sons, New York, 1975. 247 pages. \$18.50.

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