Rafelski. Nearly all of the material presented in these papers is based on measurements in atomic or molecular hydrogen and deuterium, the most interesting and basic systems in which the data can be interpreted with little ambiguity. The experiments provide unique information hardly accessible in other investigations and underline the important role of muons in these fields.

The last section of the book is equal in length to the other three. Its topic is muon spin rotation or resonance. In contrast to the preceding sections, most of the contributions (by A. M. Stoneham, D. Richter, H. Teichler, E. Karlsson, M. Leon, P. F. Meier, and E. Roduner) are not comprehensive for certain subfields but group reports from the world's leading meson factories in the United States, Canada, and Switzerland. The majority of studies seem to be devoted to positive muons in metals. This may be because μ^+ particles retain their polarization in a metallic environment quite well. Muons behave here like light protons.

In fact, scientific interest in the behavior of hydrogen in metals is still growing. The muon spin rotation technique could well fill an important gap regarding processes in the microsecond-to-nanosecond time scale and shed some light on the quantum nature of muon diffusion in metals. Altogether this section is a lively account of the ongoing activities in a rapidly developing field.

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Mineralogic Thermodynamics

Thermodynamics of Minerals and Melts. R. C. NEWTON, A. NAVROTSKY, and B. J. WOOD, Eds. Springer-Verlag, New York, 1981. xii, 304 pp., illus. $39.80. Advances in Physical Geochemistry, vol. 1.

The potential for the quantitative application of thermodynamic data and principles to the solution of petrologic and mineralogic problems is great and widely recognized among earth scientists. For example, given equations of state for silicate liquids and for the solid phases that crystallize from them, phase diagrams describing the melting phenomena of rocks could be calculated and the evolution of melts in planetary interiors or on planetary surfaces could be modeled without the need, as is now the case, for detailed experimentation on each composition that might be encountered. In metamorphic petrology, knowledge of the equations of state of the mineral phases found in a rock can permit precise determination of the values of such variables as the pressure and temperature at which the rock formed, essential information for deciphering the geological history of the region from which the rock came.

A number of developments in the last 30 years have stimulated a large amount of interest in such applications of thermodynamic principles. Some of the more important developments have been the introduction of apparatus and techniques for routine phase equilibrium experimentation at pressures above 1 atmosphere and in the presence of volatiles, the development and availability of the electron microprobe, the growth of the study of stable isotope geochemistry, the introduction of equations of state adequate to model the solution chemistry of naturally occurring minerals and silicate melts, and improvements and developments in high-temperature calorimetry applicable to silicates.

That this is a rapidly developing field is amply demonstrated by the bewildering number of workshops, symposiums, textbooks, handbooks, and monographs that have recently appeared on the subject. *Thermodynamics of Minerals and Melts* is the first of a promised series of books (Advances in Physical Geochemistry) that will provide a forum for the publication of original contributions and reviews on topics in mineral thermodynamics and kinetics and on their application to problems in earth and planetary sciences.

The book is divided into two major sections. The first deals with the thermodynamics of mineral systems. The papers in this section cover a wide range of topics, including the principles and application of stable isotope geothermometry, the development and application of the garnet-plagioclase-Al_2SiO_5-quartz geobarometer using the best available phase equilibrium and calorimetric data, and the inversion of phase equilibrium data obtained between 1 atmosphere and 40 kilobars to a self-consistent set of equations of state for pyroxenes in the system $Mg_2Si_2O_6$-$CaMgSi_2O_6$. The papers are generally informative and well written, but nonspecialists will have trouble with many of them. My only disappointment is that the authors have chosen, for the most part, to limit themselves to characterizations of the thermodynamics of mineral systems and have stopped short of applying their contributions to geological problems even when it is clear that such applications are possible.

The second section of the book, on the thermodynamics of melt systems, contains excellent papers on a wide range of topics; especially important are those papers on thermodynamic modeling of silicate melts and glasses. Here again there is little emphasis on the applications of the thermodynamic models to geological problems. In this case, however, it is clear that this reflects, at least in part, the state of the art in the application of thermodynamics to melt-bearing systems; the current emphasis is on reproducing simple experimentally determined phase diagrams and on developing appropriate solution models for molten silicates. It is a curious irony, however, that the one paper that takes an empirical approach to modeling crystallization of silicate melts and eschews a fundamental approach based on thermodynamics is successful not only in reproducing simple phase diagrams but also in predicting the crystallization behavior of complex natural silicate melts. The reader is left to wonder when the fundamental approach will reach this stage.

In summary, the appearance of this book and the series it begins are timely in view of the growth and interest in the theory and application of thermodynamics to petrology and mineralogy. This book is not for beginners or for those interested primarily in seeing how thermodynamics can be applied to geological problems, but for researchers and advanced students in mineralogy and petrology many of the papers will be required reading.

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Eocene and Earlier Deposits

Advances in San Juan Basin Paleontology. SPENCER G. LUCAS, J. KEITH RIGBY, JR., and BARRY S. KUES, Eds. University of New Mexico Press, Albuquerque, 1981. xii, 394 pp., illus. $27.50.

During the latest Cretaceous and the early Tertiary the San Juan Basin, in the northwestern corner of New Mexico, was the site of deposition of a thick sequence of terrestrial sediments. Although particularly well known for their concentrations of fossils of Paleocene age, documenting the evolution of mammal-dominated faunas immediately after the extinction of the dinosaurs, these strata have also yielded records of Cretaceous and Eocene biotas.