

Equilibrium Thermodynamics In Petrology

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Newton Niranjana D. Chatterjee D.G. Fraser Mineralogical Association of Canada Niranjana Chatterjee H.J. Greenwood Mineralogical Association of Canada Jibamitra Ganguly Eric H. Oelkers William M. White Library of Congress

this book presents the fundamental principles of thermodynamics for geosciences based on the author's own courses over a number of years many examples help to understand how mineralogical problems can be solved by applying thermodynamic principles

this textbook and reference outlines the fundamental principles of thermodynamics emphasizing applications in geochemistry the work is distinguished by its comprehensive balanced coverage and its rigorous presentation the authors bring years of teaching experience to the work and have attempted to particularly address those areas where other texts on the subject have provided inadequate coverage a thorough review of the necessary mathematics is presented early on both as a refresher for those with a background in university calculus and for the benefit of those coming to the subject for the first time the text is written for students in advanced undergraduate or graduate level geochemistry as well as for all researchers in this field

today large numbers of geoscientists apply thermodynamic theory to solutions of a variety of problems in earth and planetary sciences for most problems in chemistry the application of thermodynamics is direct and rewarding geoscientists however deal with complex inorganic and organic substances the complexities in the nature of mineralogical substances arise due to their involved crystal structure and multicomponential character as a result thermochemical solutions of many geological planetological problems should be attempted only with a clear understanding of the crystal chemical and thermochemical character of each mineral the subject of physical geochemistry deals with the elucidation and application of physico chemical principles to geosciences thermodynamics of mineral phases and crystalline solutions form an integral part of it developments in mineralogic thermodynamics in recent years have been very encouraging but do not easily reach many geoscientists interested mainly in applications this series is to provide geoscientists and planetary scientists with current information on the developments in thermodynamics of mineral systems and also provide the active researcher in this rapidly developing field with a forum through which he can popularize the important conclusions of his work in the first several volumes we plan to publish original contributions with an abundant supply of background material for the uninitiated reader and thoughtful reviews from a number of researchers on mineralogic thermodynamics on the application of thermochemistry to planetary phase

equilibria including meteorites and on kinetics of geochemical reactions

thermodynamic treatment of mineral equilibria a topic central to mineralogical thermodynamics can be traced back to the turn of the century when j h van t hoff and his associates pioneered in applying thermodynamics to the mineral assemblages observed in the stassfurt salt deposit although other renowned researchers joined forces to develop the subject h e boeke even tried to popularize it by giving an overview of the early developments in his *grundlagen der physikalisch chemischen petrographie* berlin 1915 it remained on the whole an esoteric subject for the majority of the contemporary geological community seen that way mineralogical thermodynamics came of age during the last four decades and evolved very rapidly into a mainstream discipline of geochemistry it has contributed enormously to our understanding of the phase equilibria of mineral systems and has helped put mineralogy and petrology on a firm quantitative basis in the wake of these developments academic curricula now require the students of geology to take a course in basic thermodynamics traditionally offered by the departments of chemistry building on that foundation a supplementary course is generally offered to familiarize the students with diverse mineralogical applications of thermodynamics this book draws from the author's experience in giving such a course and has been tailored to cater to those who have had a previous exposure to the basic concepts of chemical thermodynamics

it has long been realized that the mineral assemblages of igneous and metamorphic rocks may reflect the approach of a rock to chemical equilibrium during its formation however progress in the application of chemical thermodynamics to geological systems has been hindered since the time of bowen and the other early physical chemical petrologists by the recurring quandary of the experimental geologist his systems are complex and are experimentally intractable but if they were not so refractory they would not be there to study at all it is only recently that accurate measurements of the thermodynamic properties of pure or at least well defined minerals melts and volatile fluid phases combined with experimental and theoretical studies of their mixing properties have made it possible to calculate the equilibrium conditions for particular rock systems much work is now in progress to extend the ranges of composition and conditions for which sufficient data exist to enable such calculations to be made moreover the routine availability of the electron microprobe will ensure that the demand for such information will continue to increase the thermodynamic techniques required to apply these data to geological problems are intrinsically simple and merely involve the combination of appropriate standard state data together with corrections for the effects of solution in natural minerals melts or volatile fluids

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based on a university course this book provides an exposition of a large spectrum of geological geochemical and geophysical problems that are amenable to thermodynamic analysis it also includes selected problems in planetary sciences relationships between thermodynamics and microscopic properties particle size effects methods of approximation of thermodynamic properties of minerals and some kinetic ramifications of entropy production the textbook will enable graduate students and researchers alike to develop an appreciation of the fundamental principles of thermodynamics and their wide ranging applications to natural processes and systems

volume 70 of reviews in mineralogy and geochemistry represents an extensive review of the material presented by the invited speakers at a short course on thermodynamics and kinetics of water-rock interaction held prior to the 19th annual V. M. Goldschmidt conference in Davos Switzerland June 19-21 2009 contents thermodynamic databases for water-rock interaction thermodynamics of solid solution aqueous solution systems mineral replacement reactions thermodynamic concepts in modeling sorption at the mineral-water interface surface complexation modeling mineral-fluid equilibria at the molecular scale the link between mineral dissolution-precipitation kinetics and solution chemistry organics in water-rock interactions mineral precipitation kinetics towards an integrated model of weathering climate and biospheric processes approaches to

modeling weathered regolith fluid rock interaction a reactive transport approach
geochemical modeling of reaction paths and geochemical reaction networks

a comprehensive introduction to the geochemist toolbox the basic principles of modern geochemistry in the new edition of william m white s geochemistry undergraduate and graduate students will find each of the core principles of geochemistry covered from defining key principles and methods to examining earth s core composition and exploring organic chemistry and fossil fuels this definitive edition encompasses all the information needed for a solid foundation in the earth sciences for beginners and beyond for researchers and applied scientists this book will act as a useful reference on fundamental theories of geochemistry applications and environmental sciences the new edition includes new chapters on the geochemistry of the earth s surface the critical zone marine geochemistry and applied geochemistry as it relates to environmental applications and geochemical exploration a review of the fundamentals of geochemical thermodynamics and kinetics trace element and organic geochemistry an introduction to radiogenic and stable isotope geochemistry and applications such as geologic time ancient climates and diets of prehistoric people formation of the earth and composition and origins of the core the mantle and the crust new chapters that cover soils and streams the oceans and geochemistry applied to the environment and mineral exploration in this foundational look at geochemistry new learners and professionals will find the answer to the essential principles and techniques of the science behind the earth and its environs

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