Equilibrium Thermodynamics In Petrology

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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

today large numbers of geoscientists apply thermodynamic theory to solu tions 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 multicomponental 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 thermody namics 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 develop ments 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 back ground 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 tum 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 thermo dynamics 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 ecluilibrium 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 cluandary 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 ecluilibrium conditions for particular rock systems much work is now in progress to extend the ranges of com position 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 techniclues recluired 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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provides a general introduction to minerology through a study of basic concept principles and techniques of the discipline and also through focused analysis of specific minerals explains the relationship between chemical composition internal structure and physical properties of crystalline matter

cd rom contains many animations that deal with three dimensional concepts brief text pages for 104 of the most common minerals diagrams illustrations etc

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 equilbria 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

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