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BOOK REVIEWS

Mineral-Water Interface Geochemistry, Reviews in Mineralogy, Volume 23, edited by M. F. Hochella, Jr. and A. F. White, Mineralogical Society of America, Washington, D.C., 1990, 603 pp., softbound, US$20.00.

Mineral-Water Interface Geochemistry, volume 23 of the Mineralogical Society of America, Reviews in Mineralogy series, is a compilation of papers from a Short Course held at the 1989 Geological Society of America annual meeting. The book is an up-to-date summary of the physical processes and chemical reactions that occur at the mineral-water interface. It consists of 14 chapters, written by 18 authors, representing five countries. Authors include chemists, geochemists, geologists, material scientists, and soil scientists, emphasizing the truly interdisciplinary nature of the topic. Practical problems that involve the mineral-water interface include radioactive and toxic waste distribution, diagenesis, ore deposit formation, cycling of elements, weathering, and mineral leaching.

The quality of the chapters in the volume is excellent, with many useful and recent references in a field that has grown exponentially in the last ten years. Recent advances in mineral-water interface geochemistry have been aided by the new surface analytical techniques now available. This discipline is young, and few examples of applications to natural systems have yet been described. The book contains general overviews as well as specific chapters, and is therefore appropriate for researchers in the field of solid-solution interactions as well as students who are interested in learning more about this subject.

Excluding the introduction (Chapter 1) the subject matter is divided into four sections: 1) general microscopic or atomistic theories and techniques, 2) adsorption processes and the associated models, 3) dissolution and precipitation mechanisms, and 4) surficial heterogeneous oxidation and reduction.

The first section (Chapters 2, 3) discusses microscopic theories and surface analytical techniques. In Chapter 2, A. C. Lasaga presents a good discussion of the difference between surface- versus transport-controlled mineral growth. He also discusses the importance of transition state theory, *ab-initio* considerations, molecular dynamics and Monte Carlo calculations when trying to deduce reaction mechanisms occurring at the mineral-water interface. M. F. Hochella, Jr.'s Chapter 3 is an excellent summary of the many possible surface analytical techniques available, mentioning advantages and limitations of each method. These techniques provide detailed information about surface chemical composition, surface fine-scale morphology and microtopography, and surface atomic structure.

The second section (Chapters 4–8) discusses adsorption processes and associated models. G. A. Park (Chapter 4) discusses thermodynamic considerations in relation to adsorption, emphasizing the importance of surface free energy. He also compares physical (outer sphere) versus chemical (inner sphere) adsorption, and discusses the different possible techniques for determining the point of zero charge (PZC). Oswald ripening and its relation to metastability is also discussed. In J. A. Davis and D. B. Kent's Chapter 5 there is an excellent summary of surface complexation models, which are the constant capacitance, double-, triple- and four-layer models. Also included is a good discussion of surface area determination and microporosity. The authors emphasize the complexity of these models in relation to natural systems, and it remains to be seen if these models can be refined enough to be used as a predictive tool. G. Sposito (Chapter 6) describes molecular adsorption models using statistical mechanics and diffuse double-layer models. These include both the modified Guoy Chapman theory and the Bragg Williams approximation. In Chapter 7, P. W. Schindler discusses adsorption of metals and organics ligands (ternary complexes). He shows that adsorption can be described in three basic ways: hydrophobic expulsion, electrostatic attraction, and surface complexation. G. E. Brown, Jr. (Chapter 8) describes the use of spectroscopy to study surface structure at the mineral-water interface. The uses and limitations of X-ray absorption spectroscopy (XAS) are discussed in detail, and examples of its application include Co adsorption on γ-Al_2O_3, FeOOH, TiO_2, SiO_2, kaolinite and calcite, and Pb adsorption on γ-Al_2O_3 and FeOOH.

The third section (Chapters 9–11) discusses dissolution and precipitation mechanisms important at the mineral-water interface. J.-W. Zhang and G. H. Nancollas describe the kinetics of crystal growth and dissolution, including a good discussion on nucleation. They also describe three different experimental methods (free drift method, pontentiostatic, and constant composition) for determining rates of reaction and reaction mechanisms. In Chapter 10, W. H. Casey and B. Bunker discuss leaching of minerals and glasses during dissolution. Among the topics covered are: 1) the relationship between dissolution of a mineral and the formation of a leached layer (congruent versus incongruent dissolution), 2) factors that affect the development of a leached layer, including pH, structure, solution composition, and temperature, and 3) classification of leaching reactions affecting oxides, minerals, and glasses on the basis of water dissociation, bonding character, and mobility of mass. J. G. Hering and W. Stumm describe the surface controlled dissolution model and apply it to reductive and oxidative dissolution of minerals. Many examples of both reductive and oxidative dissolution are discussed, including the effects of organics on mineral dissolution. The importance of oxidation and reduction reactions is then illustrated by discussing the natural iron cycle.

The fourth and final section (Chapters 12–14) describes surficial, heterogeneous oxidation and reduction. In Chapter 12, A. F. White discusses electrochemical effects on iron oxide and iron-containing minerals (where the iron remains immobile) emphasizing solid state electron transfer reactions. There is also a discussion of the oxidation and reduction of micas and clay minerals, which could be of particular interest to clay mineralogists (although a typographic error lists the structure of 2:1 phyllosilicates as two octahedral sheets and one tetrahedral sheet). G. M. Bancroft and M. M. Hyland's Chapter 13 discusses spectroscopic studies of adsorption, oxidation, and reduction reactions that occur at sulfide surfaces in contact with aqueous solutions. The use of X-ray photoelectron spectroscopy (XPS) to observe sulfide surfaces is discussed in some detail. The description and documentation of polysulfide formation when S^{2-} is oxidized to SO_4^{2-} is a good example of the applications of surface techniques to aid in understanding reaction mechanisms. In Chapter 14, T. D. Waite reviews reactions that are induced or assisted by light, and emphasizes semiconductors. He classifies these photoredox reactions into three types, depending on the nature of the chromophore.

This volume is well organized and contains few typographic errors. Most chapters are clear and well written. The quality of the volume is consistent with the high quality of the series, and for the price of $20 it should be on bookshelves of people with an interest in the mineral-water interface.

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