

## BOOK REVIEWS

ENTSTEHUNG UND STOFFBESTAND DER SALZLAGERSTÄTTEN, by O. BRAITSCH: Springer, 1962, viii+232 pages, 47 figures, DM 56, unbound.

For petrologists interested in the application of phase equilibria, salt minerals and salt deposits occupy a special place, and not for historical reasons alone. No other group of minerals shows the effectiveness of the approach formulated by Gibbs more convincingly. Van t'Hoff could not have made a more propitious choice when he began to apply phase rule principles some 67 years ago.

Braitsch is following in Van t'Hoff's footsteps and has written a fresh, stimulating and challenging monograph on marine salt deposits, no small accomplishment in this much-plowed field. His own contributions, some since published elsewhere, are clearly evident.

The introductory chapter contains a list of minerals found in marine salt deposits, their optical and x-ray properties and principal occurrences. This is a critical summary in which the origin of data is given and inconsistencies are carefully pointed out and corrected where possible. A number of glaring errors in the literature have also been eliminated.

Chapter B summarizes data on the stability of salt minerals and the compositions of the coexisting solutions. It begins with a discussion of the system  $\text{CaSO}_4\text{-H}_2\text{O}$  and builds up to the five-component system  $\text{NaCl-KCl-MgCl}_2\text{-Na}_2\text{SO}_4\text{-H}_2\text{O}$ , based on the summary of D'Ans (1933) as well as the more recent data of Autenrieth and Braune and others. It does not, however, include much of the recent Russian data. Braitsch presents stable as well as metastable equilibria and uses the graphical procedures developed by Jänecke. His chief contribution lies in the fact that he calculates the effects of many evaporation and crystallization paths, using a matrix method to determine the stoichiometric coefficients of the participating phases. This method is neat, particularly when a computer is available, and is applicable to many similar problems of igneous and metamorphic systems.

The third chapter is concerned with physico-chemical models and discusses precipitation from sea water under a variety of conditions. A number of possible paths are calculated, such as isothermal equilibrium crystallization with or without metastability, fractional crystallization, crystallization in a temperature gradient and so on. The effects of postdepositional changes are separated into thermal metamorphism, including solutions derived from dehydrations, and metamorphism caused by encroaching undersaturated solutions. The effect of inflowing solutions is given for a number of compositions and temperatures and is illustrated for the decomposition of carnallite. An important section of this chapter is concerned with the behavior of bromine and strontium. Bromine has been used for stratigraphic correlations and as indicator of the degree of evaporation. Braitsch presents new data (since published in English) for the distribution of bromine for a variety of bulk compositions and temperatures.

In Chapter D a number of sections of natural salt deposits are interpreted with the aid of the models developed in the previous chapter. The examples are almost exclusively taken from the Stassfurt and Werra series of the Permian of Germany. Braitsch elucidates such problems as the absence of kainite in presumably primary profiles, the impoverishment of many deposits in  $\text{MgSO}_4$ , the preponderance of sylvite and the formation of rhythmic halite-sylvite sequences. The effects of isochemical metamorphism are analyzed with reference to the sylvite-kieserite-halite horizons ("Flockensalz") of the Werra series. Encroaching solutions are thought to be responsible for the vanthoffite-löweite-langbeinite assemblages of the "Stassfurter Sattel" (with kainite caps), as well as the anhydrite-sylvite-halite horizons of the Stassfurt series. Bromine concentrations are presented for a

number of halites, sylvites and carnallites and their reliability as paleochemical indicators is evaluated.

Chapter E contains assorted topics, such as the behavior of boron and iron as well as a summary of the mineralogy and chemistry of the clay minerals of German salt deposits.

Geologic conclusions and a number of unanswered questions form the last chapter. Kieserite-carnallite and bromine ratios are proposed as geothermometers and origins of solutions involved in recrystallizations are postulated.

This monograph has much to offer not only to saline geologists and geochemists, but also to igneous and metamorphic petrologists. Salt mineral assemblages differ from most other rocks in that solid solution is much less extensive. Frequently more phases are present than components and petrogenetic grids can be constructed with a much finer mesh. Chemical equilibrium (stable and metastable) is established even under sedimentary conditions. Environmental changes are reflected readily in the assemblages. Braitsch's book could do much to seduce petrologists who consider salt deposits beneath their dignity to have a closer look.

It is an easy task to find faults of omission. I shall mention just two: the haphazard and very spotty coverage of the non-German literature and the rather cavalier references to non-marine salt deposits. After all, some *are* commercially important and all present exceedingly interesting geological problems. More serious perhaps is the fact that one important message of J. W. Gibbs has not yet come through to many salt geochemists: the fact that mineral equilibria are governed not so much by bulk compositions, as by the chemical potentials of the components involved. There remains much work to be done. The elegant summary presented by Braitsch has made this work easier.

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AN INTRODUCTION TO CLAY COLLOID CHEMISTRY. H. VAN OLPHEN. Interscience Publishers, a division of John Wiley & Sons, Inc., New York, London, 1963. 301 pp. \$10.00.

The classical concepts of colloid chemistry are described in simple, easily understood language and are then related to the specific behavior characteristics of the clay colloid systems.

The interrelations between the various silicate structures, their counter ions, and the dispersing media are presented as a succession of essays in explanation of stability, peptization, rheological properties, engineering properties, and chemical reactivities.

The book is designed primarily to afford specialized information about the colloid science which is of interest to geologists, soil scientists, and engineers, as presented by one sympathetic with those interests.

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