Book Reviews

Phase Equilibria in Multicomponent Systems. By L. S. PALATNIK and A. I. LANDAU. Edited by JOSEPH JAFFE, Chairman, Department of Chemical Engineering, Newark College of Engineering. Holt, Rinehart and Winston, Inc., 383 Madison Ave., New York, N. Y. 10017. 1964. x + 454 pp. 16 × 23.5 cm. $15.00.

In their preface, the authors state that they "have attempted to develop a general topo-analytical theory of multicomponent systems. . . to meet the practical demands for rational methods of representing and investigating multicomponent systems." With this purpose, they consider in a very general and abstract manner the analytical interrelations of the variables in such systems subject to the conditions of heterogeneous equilibrium, and, both analytically and "geometrically," the relations between equilibrium states of the system and hence between adjacent regions of the "space" of its phase diagram. With complete generality as the aim, elaborate, cumbersome classifications and terminologies are constructed, making the reading difficult and tedious.

A whole chapter (II) deals with "the generalized center-of-gravity (or lever) rule," including equations for transformations of units and weighed down with strange terminology. Chapter III applies the "generalized center-of-gravity and lever rules" to schematic simple ternary phase diagrams (isobaric temperature–composition relations of condensed phases) which are already completely clear and familiar in a host of textbooks. Much better would have been a single example of the value of such "generalizing" in an application to some five- or six-component system which we do not clearly "see."

This is the trouble with the book. Extremely elaborate and abstract generalizations are developed, necessitating a great variety of symbols and new, arbitrary definitions to be kept in mind during the reading. Through all this the hard-worked reader expects and hopes always to be rewarded with a demonstration of the value of what has been done in problems not already perfectly clear and familiar without these abstractions. But all the "examples" given (which are to begin with merely schematic and hypothetical) reach no further than already familiar relations; namely, systems of two, three or four components, and, at most, higher-order systems restricted to simple eutectic cases with or without limited solid solution—relations all of which are already worked out and familiar. A certain part of the clearer and simpler of the results deduced may be found well presented in an article by A. Prince ("The Application of Topology to Phase Diagrams," *Metallurgical Reviews*, **8,** 213 (1963)), which was based essentially on the original publications of Palatnik and Landau; this article may be recommended as some introduction to the book.

Chapters IV and V continue with "complete systems of thermodynamic equations" for the relations between equilibrium states. Included in Chapter V is a discussion of the situation, arising from composition restrictions in some of the phases of a system, in which we may have different simultaneous values of the variance for different groups of phases of the total state, relations already referred to in other books as "lower order equilibria" but not so identified or acknowledged in this book.

Some of the arguments and results are not clear, the difficulty being augmented by numerous minor errors which may have entered through translation and printing. Empirical and theoretical relations at times are treated equivalently, and it is not clear that deductions from equations in terms of the "dimensions" of equilibrium states necessarily have physical significance. Thus, we find an isobaric temperature–composition diagram (p. 258) for a ternary system in three separate liquid phases which supposedly become critically identical simultaneously at a single critical point of the diagram. Such a point, with a negative variance according to the Phase Rule, is physically impossible in the sense in which we use the word "impossible" in the Phase Rule. Yet this diagram is reproduced, without comment, even in Prince's article.

Most of the actual topological relations are developed in the last three chapters, which are by themselves excellent; the authors even suggest that these can be studied without the preceding "theoretical" development. Their titles are: VI, "Boundary Equations for Adjacent Phase Regions and the Contact Rule for Phase Regions"; VII, "Fundamental Laws Governing the Geometric Structure of Phase Diagrams and their Regular and Irregular Sections"; VIII, "Methods of Constructing Plane Polythermal Sections of Phase Diagrams of Multicomponent Eutectic Systems."

Again, however, the "examples" in these sections are already clear without the use of what is here constructed. The book would have been much more valuable if it had contained at least one real example of the value of these methods in reducing the data for a high-order system, in representing the equilibria graphically, and in interpreting the relations. The reviewer had long looked forward to this book, with the hope of just such information on the help to be expected from topological principles, especially for understanding better some of the recent Russian work in fused salt systems. But while the thorough work in this book is to be recognized and admired, this practical aspect is missing in it.

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Data of Geochemistry. Sixth Edition. Chapter L. Phase-Equilibrium Relations of the Common Rock-Forming Oxides Except Water. By GEORGE W. MOREY and MICHAEL FLEISCHER, Technical Editor. Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 1964. ix + 158 pp. 23 × 29 cm. $1.25.

This "chapter" in the series planned for the sixth edition of "Data of Geochemistry" is a substantial, highly condensed book. It selects, organizes, and interrelates the most significant aspects of our information on the phase equilibria of nine oxides (Na_2O, K_2O, MgO, CaO, FeO, Al_2O_3, Fe_2O_3, SiO_2, TiO_2), which make up 98% of the earth's crust. If we count systems of from one to nine components, these oxides furnish 501 systems for study. Of course our actual information is far from exhaustive, and this book presents phase equilibrium information on the nine individual oxides, twenty-five binary and thirty ternary systems, parts of eighteen quaternary systems, and very small parts of five quinary systems. The material is presented by means of one or more diagrams for each system, with tables of numerical values for significant invariant points, and with excellent explanatory text.

The presentation is well ordered and organized, and the interrelation between the lower- and the higher-order systems is brought out clearly and effectively. Information is brought up to date, and in this respect the first section, on the separate oxides themselves, is particularly valuable.

There are some minor slips and inconsistencies in some of the diagrams and in the relation between text and diagrams; but some of the latter difficulties may be due to the brevity of the presentation and to the fact that the diagrams cannot show all the phase information, particularly with respect to solid solution formation. Because of the complexity of some of the diagrams the author has wisely and effectively introduced some text-book explanations here and there. The most extensive of these is a discussion near the end, based on Bowen's classical paper (1915) on the system albite–diopside–anorthite, an essentially ternary section of a quinary system. Bowen's discussion is strictly for ternary diagrams, and its inclusion at the end of this book, under quinary systems, will have the effect of appearing unnecessary and simply misplaced to those who know what it is about, and of being confusing and misleading for those readers who need the discussion.

As a systematic presentation of fundamental data of geochemistry, this book serves its purpose very well and should prove to be a valuable reference.

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