five volumes may be to bring English-speaking readers up to date on the work of some of their European colleagues. Translations of Russian literature are now fairly readily available and are thus frequently cited, but except for these, reference to the European literature is often completely absent from papers in English.

The present volume is not devoted exclusively to hydrothermal systems but treats carbonate-silicate systems and their relation to problems of carbonatites. A review of high-pressure apparatus is also included, but it is difficult to understand the omission of internally heated vessels used so extensively by Yoder, Burnham, Tuttle, and others when the cold-seal vessels and "Morey bombs" are described in detail. Further criticisms may be made of a style of sentence construction that is often unwieldy and sometimes ambiguous. The text is liberally illustrated, but as with many reference books of this type, most of the figures are too small to serve any practical purpose. Faults, however, are minor in comparison with the overall value of the volume. The author is to be complimented on his most comprehensive and systematic presentation of a large quantity of data. All those associated with any aspects of teaching and research in silicate chemistry will find this and, I am sure, the other four volumes of *Silicate Science* most useful in their work.

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Water in Solid Form

Traité de Glaciologie. LOUIS LLIBOUTRY. Vol. 1, *Glace, Neige, Hydrologie Nivale.* 433 pp., illus. 140 F. Vol. 2, *Glaciers, Variations du Climat, Sols Gelés.* 616 pp., illus. 190 F. Masson, Paris, 1964–65.

Glaciology, defined as the study of snow and ice in all forms, and not simply—as too many still hold—the study of glaciers, has gained considerable momentum in recent years, especially since the commencement of the International Hydrological Decade. Fifty to 80 times more water is stored in solid form than exists in all freshwater bodies. Following on the recognition of the practical importance of snow and ice, glaciology has emerged as an interdisciplinary science which requires an essentially interdepartmental academic training. Consequently the need has arisen for both a basic introductory textbook for the students and a comprehensive, authoritative handbook for the specialist. Lliboutry's massive two-volume work is an admirable effort to provide a handbook. It is well organized and clearly written, and contains many excellent diagrams and photographs.

The author, a geophysicist with a wide range of knowledge and experience, is a professor at the University of Grenoble and director of the laboratory of glaciology at the Centre National de la Recherche Scientifique. In these volumes he reviews, abstracts, and critically discusses an enormous amount of literature, covering not only the easily accessible publications in French, English, and German but also those in Russian, Japanese, and other languages. The sheer task of assembling such a mass of material is formidable. The coverage is up-to-date, reference being made to 1964 and 1965 publications. Each of the 23 well-conceived chapters has its own extensive bibliography. There are, however, instances of criticism of work which is not fully identified in the references, so that it is difficult for the reader to form an independent judgment, and there are a number of minor errors in the references.

The author succeeds in combining theoretical, experimental, and field evidence on a multitude of topics covering the whole field of glaciology. Consideration is given to the physics, mechanics, and petrography of ice; the formation of solid precipitation; snow cover with creep and avalanche problems; snow and ice engineering; heat balance of snow and ice surfaces with associated hydrological and morphological factors; the temperature pattern and heat flow in snow and ice; the characteristics and distribution of glaciers; mass balance; movement; geophysical study techniques; deformation morphology; internal motions and bottom gliding; erosion and deposition of material; glacier fluctuations and the relationship to elimate; the main glaciations with their causes and effects; and frost action in the ground. Though the balance is generally well kept, there are certain cases of over- or under-emphasis; sea ice, for example, deserves a more exhaustive consideration.

The great merit of this treatise, and that which distinguishes it from earlier compendiums, is that it establishes glaciology as the science which treats quantitatively the whole range of processes associated with solid water. The synthesis is contingent upon the continual consideration of physical principles. On occasion the author emphasizes his own opinion on a currently debated problem where it would have been more appropriate simply to report the various ideas as, for example, concerning the sliding of glaciers on their beds. But it is always possible to level some criticisms at a book of such magnitude and diversified scope. These cannot detract from the integral importance of the whole. The *Traité de Glaciologie* is the only comprehensive single work on glaciology, and encompassing, as it does, such a variety of topics from traditionally separated disciplines, it is a landmark in the development of that science.

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Major French Influence

The Development of Technical Education in France, 1500–1850. FREDERICK B. ARTZ. Society for the History of Technology and M.I.T. Press, Cambridge, Mass., 1966. 286 pp. $7.95.

The publication of this volume in 1966 will seem to many an anachronism, since three of the four chapters are essentially unaltered translations of articles written by the author for French historical journals in 1937, 1938, and 1946. As the footnotes reveal all too clearly, Artz has not seriously attempted to bring the results of his research abreast with current knowledge. This is a serious flaw, especially since much has been uncovered that illustrates Artz's themes better and more succinctly, and occasionally contradicts his views. Among the recent works, the most significant is the 700-page volume *Enseignement et diffusion des sciences en France au XVIII^e siècle* (Hermann, Paris, 1964), which covers much of the same ground, but with considerably more evidence taken directly from archival sources. For all practical purposes, one can think of Artz's volume as having been published in 1950.

It is nonetheless very useful. Historical works do not age as quickly as much of scientific research. The book is a mine of bibliographical references to articles in obscure journals, of factual information concerning French educational theories and practices, and,

above all, of cryptic comments that are exciting historical puzzles crying out for explanation. If read sympathetically and corrected for its numerous typographical errors, the book could easily become the spawning ground for important new studies of the history of scientific and technical education.

The general subject of the work is of obvious significance. It was in France, and by about 1800, that modern patterns of scientific and technological education were first practiced successfully, only to be borrowed and adapted to local conditions by all other industrialized countries in the world. The Ecole Polytechnique is only the most famous of institutions that served as a model for important innovations like Liebig's introduction of the chemical laboratory into German education and the founding of West Point and Rensselaer Polytechnic Institute in this country. By making science a prerequisite for technical education, the French profoundly challenged and eventually overturned the traditional practice of learning through emulation of the accomplished master-craftsmen. More than any other single factor, the adoption of the new patterns elaborated in France was responsible for the creation of applied science as well as for the transformation of engineering from a skilled trade to a learned profession.

Artz traces the roots of this revolution principally to the mercantilistic aspirations of the emerging nation-state, and its prominence in France to the paternalistic traditions set by Colbert. The new type of educational institution was first successfully established for the military profession and for mining and civil engineers, all of whom came under the control of the state apparatus. Far from reversing the trends begun in the Old Regime, the Revolution developed them by centralizing and democratizing instructional structures and by promoting scientific and technological pursuits as a viable alternative to professions based upon a classical and clerical education. After a brief setback during the early period of the Restoration, Artz perceives a continuation of these trends, closely linked now to a political ideology of liberalism. He ends his book rather abruptly, leaving the reader unprepared to puzzle out the reasons for France's relative decline as a technological leader of the Western world despite its increasingly liberal and anticlerical policies since 1850. To solve this problem, a new work is required.

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Second Quantization and Magnetism

Methods in the Quantum Theory of Magnetism. SERGEI V. TYABLIKOV. Translated from the Russian edition (Moscow, 1965) by Albin Tybulewicz. Plenum Press, New York, 1967. 370 pp., illus. $13.50.

This is a book marked strongly by the style of the Bogoliubov school of theoretical physics; it is a book organized around and developed from a central methodological theme. Tyablikov employs the Heisenberg model of magnetic insulators as a foil for the exposition of the techniques of modern statistical mechanics, as adapted from quantum field theory. In fact a large fraction of the book is devoted to what might be called "second quantized statistical mechanics," with only occasional reference to magnetism. After an introductory descriptive chapter on magnetism, Tyablikov devotes the second chapter to second quantization, the operator form of perturbation theory, and the properties of spin operators. The third chapter treats density matrices and the Wick-Bloch-de Dominicis theorem. In the fourth chapter Tyablikov discusses the "method of approximate second quantization," which consists of the truncation of the commutation relations of the relevant operators. Finally, in the fifth chapter, Tyablikov obtains spin wave theory as an application of the "method of approximation second quantization." This chapter is the most physical in the book, with sections on spin waves in isotropic Heisenberg ferromagnets, in antiferromagnets, and in helical structures, on the ground state of the antiferromagnet, and on ferromagnetic resonance. The sixth chapter, on molecular field theory and perturbation theory at high temperatures, dramatically illustrates the highly formal structure of the book. Tyablikov first presents and proves Peierls's general theorem that the free energy is smaller than the quantity

$$-\beta^{-1}\Sigma_i \exp(-\beta < i \mid \mathrm{H} \mid i >).$$

He then presents and proves a similar theorem of Bogoliubov. Finally, applying this variational theorem to the ferromagnet, he obtains the free energy function of molecular field theory! The seventh chapter returns again to general formalism, developing the theory of thermodynamic, two-time Green's functions. As is the preference of the Russian authors, the emphasis is on the retarded and advanced Green's functions, as contrasted to the causal Green's functions which are generally favored here (the relations between the two Green's functions are sufficiently simple that no appreciable inconvenience is caused by this choice). The eighth and last chapter develops a number of applications of the Green's function methods: to magnetization curves, specific heat, resonance line shapes, neutron scattering, and similar matters.

Throughout, Tyablikov refers to recent literature in some detail, and he concludes his discussions with brief citations of other work which he has not actually covered, in a style very similar to that of the annual *Magnetic Materials Digest*. This is a unique and helpful feature of the book. In addition, the book is well written and expertly translated, so that it reads smoothly and easily.

I am afraid that the audience for this book will be limited, and that is a pity. For those who are unfamiliar with the methods it is probably preferable to study them in their simpler applications to fermion or boson systems. And for those who already know the mathematical techniques the physics in the book perhaps is spread too thinly. But for readers who have an inactive familiarity with second quantized statistical mechanics, and who are interested in magnetic insulators, this is an authoritative and lucid account of current theory.

Interest in spin waves currently is shifting to the form of the spectral weight function at elevated temperatures, particularly in the neighborhood of the Curie temperature. This interest will undoubtedly increase as inelastic neutron scattering experiments provide additional data. The theory discussed by Tyablikov provides the only known approach to this problem, and the popularity of his book is apt to increase steadily over the next few years.

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