

the review on geometrical aspects of the plastic deformation of metal single crystals, in which R. Maddin and N. K. Chen have summarized the experimental evidence according to the crystal structure of the metal concerned.

The review on the structure of liquid metals, by B. R. T. Frost, is particularly timely because of the interest now being shown in the subject. Both indirect and direct methods of obtaining information about the arrangement of atoms in liquid metals are reviewed in an interesting and comprehensive manner. By contrast, the solidification of metals, by Ursula M. Martius, is more restricted in its scope. It is mainly concerned with the work of the Toronto school and is limited to the solidification of a single phase and in particular to what happens after the crystal nucleus has been formed. A less general title would have been more appropriate for this review.

By and large, however, this is a useful volume that will bear comparison with the best of the earlier ones in the series. It will be used by many metallurgists who would not regard themselves as metal physicists, and it is therefore unfortunate that in their preface the editors stress the idea that there is now a "... distinct study of Metal Physics". In any technology satisfactory development and progress depend upon the continuous assimilation of new knowledge. Metallurgy as we know it to-day exists because knowledge and ideas which at one time seemed far ahead of and remote from practical considerations have been assimilated into 'classical' metallurgy. This process must go on, and nothing should be done that may prevent or delay new discoveries and conceptions in the science of metals from being absorbed into the technology of metallurgy.

A. G. QUARRELL

A GEOCHEMICAL CLASSIC

Geochemistry

By the late Prof. V. M. Goldschmidt. (International Series of Monographs on Physics.) Pp. xi+730. (Oxford: Clarendon Press; London: Oxford University Press, 1954.) 63s. net.

CLARKE'S celebrated "Data of Geochemistry"—still the leading best-seller of the United States Geological Survey—represents the culmination of the first long pioneering stage of geochemistry, a period that was characterized by the accumulation of the outstanding facts on a macro scale. Similarly, this great work by V. M. Goldschmidt is already the unrivalled classic of the second stage of the subject, which was characterized by the discovery of the relations between ionic radii and the distribution and associations of elements, and by the successful application of X-ray and optical spectrography to the many problems associated with 'trace elements'. In these and related fields Goldschmidt was the acknowledged leader. His book is brightly illumined by the high-lights of his own achievements and inspirations, and may be confidently hailed as one of those rare contributions to scientific literature which long remain a delight to read and a potent stimulant to further research. This assessment is unaffected by the fact that geochemistry has already passed its second climax and has entered the third stage of its development, with isotopic investigations now well established in the van of progress. For this

reason the book is unavoidably out of date in some respects, certain chapters having been left unfinished at the time of Goldschmidt's lamented death in 1947. But access to recent work presents no difficulties, whereas for access to the mature thoughts of geochemistry's greatest genius there is no alternative to this inimitable book, in which, moreover, the hitherto unpublished results of Goldschmidt's latest work have been incorporated.

The work of editing and filling in the gaps has been skilfully carried out by Dr. Alex Muir, with the assistance of a number of devoted friends, whose translations and other contributions are fully acknowledged in a preliminary note. At his discretion, and always within square brackets, the editor has here and there added comments on recent advances and references thereto. Most of the gaps were in the first of the two parts into which the book is divided. Part 1 consists of six chapters (one hundred and twenty-five pages) dealing with the scope and development of the subject; the distribution of elements during the evolution of the earth and the crystallization of magmas; the fundamental data required in the quantitative treatment of geochemical processes, in the cosmos as well as in the earth and its various 'spheres'; and finally with the principles of crystal chemistry, this being the part of the subject with which Goldschmidt's name is most intimately associated.

Part 2 deals in fifty-seven sections (nearly six hundred pages) with the abundances, crystal chemistry and distribution of the elements in minerals, ores, rocks, soils, organisms, waters and atmosphere; with their natural circulations; and with relevant data for meteorites and various parts of the cosmos. This bald statement, however, fails to give any idea of the liveliness and exciting quality of these fascinating pages, or of the variety of topics that come under discussion. Under beryllium we learn the reasons for the colour and rarity of emerald. Granitization is discussed under sodium. Silicon introduces the origin of flint and its curious properties, the recognition of which by the craftsmen of the Stone Age laid "the material foundations of modern civilisation". Nitrogen raises the intractable geochemical problems of the Chilean nitrate deposits; Goldschmidt meets the challenge by proposing promising new lines of investigation. It is well known that in 1922 Goldschmidt inferred from geochemical principles the existence of a sulphide-oxide layer between the core and the silicate mantle of the earth. Although current geophysical evidence fails to support this view, as Goldschmidt fully realized, seismologists will be interested to know that he had never wavered in his faith that there must be such a level in the deep interior (p. 526, under sulphur). So one could go on indefinitely. The book has something of value, not only for geologists and mineralogists, but also for scientific workers of every kind from oceanographers and soil chemists to crystallographers and astrophysicists. Moreover, the human significance of geochemistry is not forgotten. Practical applications to mining, metallurgy, chemical industry and agriculture are plentifully scattered through this most generously endowed book.

There will be widespread gratitude to Dr. Muir and his band of helpers for making possible the posthumous publication of this noble work, and to the publishers for a production of which Goldschmidt himself would have felt justly proud.

ARTHUR HOLMES