

the remaining elements, the described deposits are located, and map references are given relative to latitude and longitude, and to the nearest minute of arc.

Professor Smirnov deserves warm congratulations for producing this notable addition to the literature of ore deposits and of mineral paragenesis; and due credit should also go to his translator, Professor D. A. Brown of the Australian National University for the faultless English of this lengthy work.

KINGSLEY DUNHAM

Bowen (R.) and Gunatilaka (A.). *Copper: its Geology and Economics*. London (Applied Science Publishers Ltd.), 1977. 366 pp., 33 tables. Price £25.00.

This is a welcome review of all aspects of copper from its prehistory, through geochemistry, global tectonics, structure, petrology, and stratigraphical control of natural concentrations to the economics of exploitation. In his introduction, Professor Paul Bartholomé of Liège remarks that economic geology requires a better comprehension of the physico-chemical and biological processes that together build its framework, and justly claims that this book emphasizes processes rather than descriptions. The authors, both in the Geology Department of the University of Zambia, Lusaka, are in one of the great producing areas of the world, but their data, drawn from a very wide range of sources, gives a balanced picture of all the principal types of copper deposit, without unduly stressing the controversial stratiform ores of the Central African Copper Belt. Chapter 1, 'The World of Copper', is a concise summary, almost an abstract, of the subject-matter. In their discussion of the relationship between copper mineralization and plate tectonics, the authors take a more sophisticated view than some, and do not rely on subducted oceanic crust as the sole or even the principal source of the metal. This is wise, for the great deposits of the western U.S.A. can hardly be explained in this way; nor, of course, can those of Africa. There are four long chapters devoted to (i) the plutonic association (most space properly goes to the 'porphyry' type here); (ii) the hydrothermal vein association, including breccia pipes; (iii) the stratiform mode; and (iv) the volcanogenic-sedimentary (island arc) type. Useful check lists of the major deposits in the western literature are given for each association and the bibliographies, though omitting many works of historical interest in the evolution of ideas, are comprehensive for the past decade. One curious effect of this is the absence of much reference to secondary enrichment; perhaps this is no longer so important in the mass-mining of

low-grade ores. The chapters dealing with the copper industry will be useful in widening the horizons of geologists. They contain extended reference, in addition to describing present day copper technology from the ore to the metal, to the proposed ocean-floor mining of cupriferous manganese nodules, and the attendant problems of international law. There is an appendix listing 156 copper-bearing minerals, of which only ten are regarded as of great economic significance; tenanite should not be included in this latter list and is, incidentally, incorrectly spelled. The chief interest of this book to the mineralogist is not, of course, this list; it is the excellent view that it gives of the state of thought in the mid 1970s about the processes that have concentrated copper in the earth's crust into workable deposits.

KINGSLEY DUNHAM

Guarascio (M.), David (M.), and Huijbregts (C.), editors. *Advanced Geostatistics in the Mining Industry*. Dordrecht, Holland (D. Reidel Publishing Co.), 1976. xvi + 461 pp., 126 figs. Price Dfl. 105.00 (\$39.50).

This book is a collection of twenty-eight papers presented at the NATO Advanced Study Institute held at the Instituto di Geologia Applicata of the University of Rome, Italy, 13-25 October 1975, some ten years after the publication of Professor G. Matheron's doctoral thesis *Les variables Régionalisées et leur estimation*. Since that time, Matheron and his co-workers at the Centre de Morphologie Mathématique, Fontainebleau, continue to extend the theory of geostatistics and have educated very many mining engineers and geologists in the techniques that they have developed. The papers in this volume¹ represent an excellent state-of-the-art review of work in this field drawn mainly from the experiences of the French school of geostatistics.

'Geostatistics' has a special meaning in this field, and should not be confused with the usage of the term frequently encountered in the Anglo-American geological literature where it usually stands for the use of conventional statistical methods in geology, except in the context of ore-reserve evaluation. Matheron's theory of Regionalized Variables is concerned with the behaviour of random variables (e.g. ore grade) where this behaviour is itself a function of spatial position. Classical statistics do not take the spatial location into account. The most important areas of application of the geostatistical theory have been in ore-reserve estimation, the miner being concerned with

¹ A full list has already appeared in *Mineralogical Abstracts*, 78-126.