BOOK REVIEWS

Smirnov (V. I.), editor. *Ore Deposits of the USSR*. London (Pitman Publishing), 1977. Vol. I, 352 pp., 135 figs. Price £12·00. Vol. II, 424 pp., 163 figs. Price £14·00. Vol. III, 492 pp., 174 figs. Price £16·50. Set of three volumes, price £38·00. (M.A. 77-2550.)

The appearance of a comprehensive and authoritative work in English on the principal ore deposits and energy mineral deposits other than coal and petroleum in the Soviet Union must be hailed as a considerable occasion. Since the great prospecting drive began in the 1920s, a huge literature in Russian has grown up but except through the efforts of the late Charles Davidson and of Eugene Alexandrov, this has unfortunately remained largely inaccessible to non-Russian readers. These three volumes deserve to rank with *Ore Deposits of the Western States* (the Lindgren Volume), published by the American Institution of Mining and Metallurgical Engineers in 1933, or *Ore Deposits of the United States 1933-1967* (the Graton-Sales Volume), published by the same organization in 1968. The Lindgren Volume followed the highly influential textbook on *Mineral Deposits* published by Professor Lindgren, and in the same way, Academician Smirnov's English-language version of his *Geology of Mineral Deposits* summed up for us his philosophy of the subject as recently as 1976.

More than forty-two eminent contributors have prepared the chapters, which are arranged to deal with the minerals of an element or group of elements. Volume I covers iron (for which no less than thirty-two districts are described), manganese, chromium, titanium, and aluminium. Judged by the magnitude of its iron and steel industry, the Soviet Union is now the leading iron-ore producer in the world. The genetic types include metamorphic ores like those of the Krivoi Rog basin, of pre-Cambrian age; magmatic and contact-metasomatic ore of Caledonian to Hercynian affinities, and extensive marine and continental sediments ranging from Jurassic to Neogene age. Volume II covers the base metals nickel, cobalt, copper, lead, zinc, antimony, mercury, and also the deposits of uranium. For the last-mentioned element this is certainly the first time that a conspectus of deposits in Russia has been made available; the numerous associations with volcanic activity old and new, and the sub-volcanic environment are an interesting contribution to the general subject of uranium paragenesis. For the lead-zinc ores, the authors maintain that the major portion were formed under deep-seated conditions, but they admit both the possibility of forming stratiform deposits on the sea-floor by volcanogenic processes and during carbonate sedimentation. Stratiform copper deposits, like those of the Dzhezkazgan red sandstones, are held to originate in marginal parts of troughs which have been superimposed on platform areas. Volume III covers the precious metals gold, silver, and platinum, together with molybdenum, tungsten, tin, lithium, caesium, tantalum, niobium, rare earth elements, strontium, germanium, and concludes with a useful chapter on elements dispersed in other minerals, including rhenium, selenium, tellurium, cadmium, gallium, thallium, indium, and scandium. The omission of barium and fluorine from the list of elements covered is perhaps strange, since barytes and fluorspar deposits in general present problems and associations similar to those of the sulphide and oxide ores, rather than to the evaporites.

For the reader interested in the paragenesis of minerals, these volumes make very interesting reading; many familiar groupings, well known in other parts of the world, are clearly there, with a few not so familiar. Among these the tin deposits of the supra-intrusive zone occur in close proximity to gold-bearing areas as a normal association, found in places as widely scattered as Chukotka, Kolyma, Yakutia, the Amur region, Primor'e, and Transbaikalia. Another strikingly frequent associate of tin ore is indium as a disseminated element. There can be no doubt that Greater Russia has a mineral wealth consistent with its size, but for those interested in the broader aspects of global resources, it is perhaps to be regretted that while grades of ores are mentioned, no data on past production (such as is consistently given in the Graton-Sales Volume) or on estimated potential (such as appears in United States Geological Survey Professional Paper 820) has been included. It is hard to believe, in view of the obviously strong mineral position of the U.S.S.R., that the publication of such data at least in general terms would be prejudicial to Russian interests, to any greater extent than it is in the case of the United States and other countries that make a practice of it.

The volumes are copiously illustrated with line drawings in a consistent style. Some of these illustrate exceedingly complex geology; for example V. Gal'chenko's diagrams of a bertrandite-phenakite deposit for which, incidentally, no locality is disclosed. Localities are not stated for the deposits described as typifying the occurrence of uranium and of beryllium, but for

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; tennantite 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 Mathematique, 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 volume[1] 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.