

given. The authors pose several direct questions with each problem, such as the likely source of geochemical anomalies, factors which have influenced anomaly development and recommendations for further work in the area. In the next 100 pages of the book, each of the problems receives clear and extended answers to the questions, and a full discussion of the nature of the problem, why it arises, what precautions should be routinely taken to deal with it, and so on.

For the most part the problems are not esoteric or bizarre, but are examples of the slight but ultimately predictable departures from idealized or simplified models of geochemical dispersion patterns. They are the problems that the practitioner of exploration geochemistry is bound to face in the real world.

The book is organised into groups of problems in the categories of reconnaissance, follow-up, detailed and integrated surveys. Relevant maps, diagrams and tables of data are plentiful. Useful references to pertinent papers in the scientific literature accompany each of the problems. The book also sports an excellent index, an asset that some might have omitted in a book of this type, but which would be sorely missed.

Some prior knowledge of exploration geochemistry is required in order to enjoy and appreciate the value of this book, so it is not for the beginner. It is, however, essential to all those who truly need to have a working knowledge of exploration geochemistry, and it is versatile in its applications. College and university lecturers may opt to use it as a means of formulating instructive exercises and as a source of case histories. Students will undoubtedly find it an excellent self-teaching aid. Exploration professionals will find it illuminating and a useful work of reference.

Handsomely presented throughout and bound in hard cover, 'Practical Problems in Exploration Geochemistry' deserves wide readership in its specialist field.

M. HALE

Hall, A. *Igneous Petrology*. London (Longman), 1987. viii + 573 pp., 366 figs. Price £17.95 (soft cover).

This undergraduate textbook is divided into fifteen chapters. The first seven treat the occurrence, petrological phase equilibria, trace-element distribution, isotopic composition and evolution of igneous rocks and magmas. Of the remainder, six chapters cover the field and tectonic occurrences, chemistry and petrogenesis of magmas that erupt at the present day, and the final two concern anortho-

sites and Alpine peridotites. Much of the material appears in a textbook for the first time.

Major element, microscopic and hand-specimen petrography are not covered, so a second book will be required for these topics. To my mind, even brief remarks on the mineralogical and textural characteristics of the rocks would have been beneficial in making the petrogenetic discussions more tangible, and in demonstrating that these are useful sources of petrogenetic information.

Nonetheless, the author skilfully balances information on field relations, tectonic relations, phase relations, chemistry and isotopes to produce rounded and thoroughly modern discussions of magma genesis, that should prove compelling to keen students. It is a welcome feature that Hall indicates the importance of field relations by the inclusion of numerous simple, but effective maps. It is also welcome to find an appropriate proportion of British field examples in this text. The reference list is extensive (c. 1400 entries) and, though up-to-date and covering predominantly the last 25 years, does not ignore the older literature in which the foundations of modern study were established.

While a reviewer can almost always find that a book lacks some marginal topic (e.g. this one barely mentions extra-terrestrial igneous rocks), it seems to me a serious omission that the new ideas emerging in physical petrology, and particularly in fluid processes in magma chambers, are not dealt with. Perhaps the author feels these matters are still too controversial for undergraduates, but this is to exclude them from the most exciting, topical and rapidly developing aspects of igneous petrology in the 1980s. The next edition must remedy this shortcoming.

Amongst the many textbooks on igneous petrology published in the last decade, the distinction of this one is its price. Congratulations to the author for choosing a publisher who appreciates that undergraduates have limited funds, and accordingly has produced a modestly priced paperback book. I expect buoyant sales and no little competition for Cox, Bell and Pankhurst's *The Interpretation of the Igneous Rocks*.

C. H. DONALDSON

Salkield, L. U. *A Technical History of the Rio Tinto Mines: some notes on exploitation from pre-Phoenician times to the 1950s*. London (Institute of Mining and Metallurgy) 1987, x + 114 pp., 4 maps. Price £15.99.

Many of the important technical developments associated with mining and metallurgy in Europe and the Spanish Colonial domains have originated

through the experience gained in the exploitation of the great mineral deposits located in the Iberian Peninsula. Archaeological evidence shows that by the Third Millennium BC mining was in progress and that copper, tin, iron, silver and gold were valuable commodities which were being traded during the later Bronze Age. These metals formed an important component of the Phoenician economy and, no doubt, were a strategic consideration which led the Carthaginians, and later the Romans, to fight for the control of the Iberian Peninsula.

With the arrival of the Romans, organised mining on a large scale commenced, making use of all the technical knowledge than at the disposal of the Roman Empire. The two most famous areas in which mining activity was focused were the auriferous provinces of Leon and Asturias in north-western Spain and the Andevallo of south-western Spain. In the Andalusian district of Huelva at Rio Tinto, copper-bearing pyritic ores with gossanous cappings containing valuable concentrations of gold and silver provided the basis for an extensive mining operation by the Romans. A significant contribution to the knowledge of ancient mining and metallurgy in this region has been made by Beno Rothenberg and Antonio Blanco-Freijeiro in their work published in 1981.

Leonard Salkield had a long and intimate professional association with the metallurgical operations of the Rio Tinto Company where he worked from 1930 until 1962. The history which has been compiled as a result of his personal researches provides a particular insight into the technical developments in metallurgy at Rio Tinto since its re-discovery in the 16th Century, although the pre-Roman and Roman periods are not neglected. Certainly the most significant contribution has been made in the discussion of the metallurgical innovations which were made during the 19th Century and the way in which the ores were classified and treated both for the production of copper and, later, for the extraction of sulphur for the chemical industry. Both pyro-metallurgical and hydro-metallurgical processes are discussed and some of the environmental consequences which resulted from the large-scale smelting and leaching operations which were entailed. Aspects of technical development are supplemented by historical notes on the influence of German and Norwegian contributions to extractive metallurgy, including discussions of the Doetsch processes and the Orkla process. Chapters on the early mining operations of the Rio Tinto Company and the infrastructure which was established for the effective undertaking of the enterprise are also included.

Readers with an interest in the history of min-

ing technology and metallurgy in Spain will find Salkield's history a valuable reference which has taken shape, no doubt, due to the dedicated interest of the editor, Maurice Cahalan.

C. HALLS

Friedrich, G. H., Genkin, A. D., Naldrett, A. J., Ridge, J. D., Sillitoe, R. H. and Vokes, F. M., eds. *Geology and Metallurgy of Copper Deposits* (Special Publication No. 4 of the Society of Geology Applied to Mineral Deposits). Berlin, Heidelberg and New York (Springer-Verlag), 1986. xiv + 592 pp., 50 maps. Price DM 198.00.

This publication contains 40 papers which were presented at a symposium on copper deposits at the 27th International Geological Congress held in Moscow in 1984. Four major environments of copper mineralisation are covered: those in mafic and ultramafic igneous complexes (11 papers), porphyry copper-molybdenum deposits (9 papers), deposits of a volcanic-hydrothermal association (6 papers), and sediment-hosted deposits (14 papers) [M.A. 87M/5451, 5584, 5623].

Although exploration and research activity has tended to move away from copper deposits in recent years, this is still a useful publication, providing an up-to-date account of several aspects of copper mineralisation and describing several examples from the Soviet Union. Not surprisingly, the style and quality of the papers are variable. However there are some particularly informative reviews of the geology and genesis of several important deposits, including those at Kambalda, Sudbury, and in the Iberian pyrite belt. Although agreement amongst several authors is apparent in some areas, in others there are some interesting differences in opinion. Thus the majority of papers on sediment-hosted copper deposits suggest associated red beds as a plausible source for the copper and diagenesis as the key process influencing mineral precipitation. On the other hand the role of assimilation in the generation of sulphides in komatiites and layered igneous intrusions is not agreed and various lines of evidence are put forward to support or refute this mechanism of ore formation.

The book is well-produced and contains numerous diagrams; however a significant number of the maps have no scale. It is a pity that it has taken so long to appear but there is enough in this publication to make it an important source of information for those working in the field of copper mineralisation.

D. H. M. ALDERTON