BOOK REVIEWS

Hargreaves, D., and Fromson, S. *World Index of Strategic Minerals. Production, Exploitation and Risk.* Aldershot (Gower Publishing Co.) and New York (Facts on File Inc.) 1983. xiii + 300 pp., 68 figs. Price £37·50.

Modern industry demands for its use a wide range of mineral products, some of which, for a variety of reasons, are of strategic importance in times of international stress. This index embraces a far more extensive list than has been usual in recent discussions; for example, a symposium in 1980* considered only the ores of Cu, Ni, Co, Pb, Zn, Sn, W, Cr, Mo, U, and the precious metals, while in 1982 The Materials Forum† dealt with a more restricted list of strategic elements, but added Mn, V, Nb, and the Pt group: however, in this volume, supply of all these elements with, in addition, Al, Sb, Be, Bi, Cd, C (as diamond), Ga, Ge, Li, Mg, Hg, the *REE*, Se, Si, Ta, Te, Ti, and Zr are investigated. At this point the mineralogical or geochemical purist would undoubtedly object to the listing of *elements* as strategic minerals, for very few of them occur in the native state and thus deserve to be recognized as minerals *sensu stricto*. Some mention ought to have been made that the problem is the production and exploitation of the ores and other compounds in the cases of most of the elements. It is nevertheless only fair to admit that the Index is not mineralogical or geochemical in outlook; the aim is to assess from several points of view the chances of obtaining supplies of mineral products, and the risks inherent in the process. The first section of the book explains the principles on which a points system of assessment is based, and here the factors affecting production, transport, use and trade, lead to overall strategic assessment ratings. An independent system considers the country risks, under location, labour, politics, finance, and economics, arriving at a separate rating. Finally, sixty-two major companies are reviewed, including the well-known multinationals.

The authors are both from the directorate of research of Shearson American Express Ltd. David Hargreaves is a mining engineer with experience of mine management and direction as well as mineral product marketing; Sarah Fromson's background is in metallurgy at Cambridge. Together they have made a formidable job of systemizing data for thirty-seven elements, their sources and the factors that affect the winning of them; and this has been done for thiry-four mineral-producing countries. Necessarily, the emphasis is towards the Western and Third worlds; risk assessments can hardly be made for mineral production in China or the USSR and its satellites, having regard to the inadequacy of hard data and the differing political systems. Without attempting here to explain the methods of numerical assessment employed in this survey, some of the conslusions are of sufficient general interest to be worth quoting. As is well known, the largest raw mineral producers are Australia, Canada, South Africa, USA, and USSR, while the list of major refiners and consumers includes France, Germany, Japan, and the UK. The second rank of mineral producers making available substantial quantities on the world market includes Bolivia, Brazil, Chile, Mexico, Peru, Phillippines, Zaïre, and Zambia, while smaller producers with a range of minerals are Cuba, Finland, Indonesia, Malaysia, Papua New Guinea, Spain, Thailand, and Zimbabwe. However, the range of strategic ratings does not entirely agree with this list. Not surprisingly, USA, Canada, and Australia fare best, in a range lying between 4.30 (USA) and 7.30 (Guyana); Japan, in spite of its deficiency in domestic mineral production nevertheless comes out better than average because of its financial strength and industrial discipline. Zaïre, on the other hand, in spite of excellent mineral reserves, scores badly because of poor economic conditions. Most of the underdeveloped mineral-producing nations are bunched between 6.0 and 6.6 because though they have ample resources, capital is lacking to develop them. The highest risk minerals, taking into account all the many factors, emerge from this survey (in decreasing order of risk) as the ores of Cr, Mn, Co, Cu, Pt group, and gold.

This is a valuable reference book, interesting to the mineralogist with economic leanings, very desirable for the economic geographer, essential for the mineral strategist. Much of the information is given in tabular form summarizing 1981 production, reserve estimates (including fossil fuels) as well as the more subjective ratings. The bird's-eye view of the activities of the sixty-two companies is in itself worth having.

KINGSLEY DUNHAM

* *Availability of Strategic Minerals.* Inst. Min. Metall. (1980), 108 pp.

† *Strategic Metals and the United Kingdom.* Inst. Mech. Engr. (1982), 32 pp.

Schreyer, W., (ed.) *High-Pressure Researches in Geoscience: Behaviour of Earth Materials at High Pressures and Temperatures.* Stuttgart (E. Schweizerbart'sche Verlagsbuchhandlung

(Nägele u. Obermiller)), 1983. vi+545 pp., 309 figs., 63 tables. Price DM 188/US $86.60.

The papers collected in this text have resulted from a specially funded priority programme organized by Deutsche Forschungsgemeinschaft as a contribution by the Federal Republic of Germany to the International Geodynamics Project. This programme was started in 1974 and the papers published in this volume were presented at its final colloquium in October 1980. At this final colloquium, seven overseas guests were invited who contributed, as specialists in their fields, introductory reviews on the state of the art internationally, and these papers are also included.

The research presented in this volume differs from much high-pressure research in so far as it concentrates on the materials, and the measurement of physical and chemical parameters, while the materials are held at elevated temperatures and pressures. This *in situ* approach differs fundamentally from the more common approach of quenching the material before studying the effects of its exposure to elevated temperatures and pressures.

The text is divided into six sections; Elasticity (four papers), Fracture and Flow (five papers), Structural Behaviour (five papers), Spectral and Thermal Phenomena (seven papers), Electrical Conductivity (seven papers), and Thermodynamics and Equilibria (six papers), and should be of interest to a range of specialists in the fields of geophysics, petrology, materials science, and structural geology. The standard of the individual papers is uniformly high throughout—they are presented in English with English and German summaries. The standardization of units and constants in the text (listed in a table at the end) maintains a consistent format. In my own field, some of the ideas presented challenge the status quo and should form the basis for some healthy arguments. Many of the contributions present new experimental methods and details of apparatus designs are clearly given. Obviously the majority of the work presented is that conducted in Germany during the period 1974–80 and one could criticize the volume for not containing any contributions representative of the work conducted by the excellent high-pressure laboratories elsewhere in Europe and in Australia although the American laboratories are well represented by the contributions from the invited overseas guests.

This text contains a collection of interesting articles which should find a fairly wide readership in geological and other laboratories where high-pressure and temperature experiments are conducted. The content of these papers should stimulate discussion and encourage further research in these fields.

MERVYN E. JONES

Atherton, M. P., and Gribble, C. D., eds. *Migmatites, Melting and Metamorphism.* Nantwich, Cheshire (Shiva Publications Ltd.) and Cambridge, Massachusetts (Birkhauser Boston Inc.), 1983. x+326 pp., 152 figs. Price: hardback £25·00; paperback £12·50.

The twenty-five papers in this well-produced volume represent the proceedings of a meeting of the Geochemical Group of the Mineralogical Society, held at Glasgow University in April 1982. There are six sections: Experimental Studies, Isotopic Studies, Fluid Studies, Field and Related Studies—Migmatites, Field and Related Studies—Other Rock Types, and Synoptic Papers (the latter including five papers presented essentially as abstracts).

An introductory chapter by B. E. Leake outlines the problems and reviews the contributions, and in the experimental section two papers by Wyllie are accompanied by a detailed report from Johannes on the drastic effect of 5 kbar water pressure on simple feldspar systems. Contributions in the isotope section all emphasize the theme of crustal and mantle components and their contribution to many granites. Another recurring theme is the influence of fluids: thus Manning and Pichavant show that the occurence together of F and H_2O can affect anatectic melt generation, and the dominance of H_2O in fluid inclusions in high-grade amphibolite-facies migmatites from Connemara is described by Yardley *et al.*

That many granulite-facies rocks may be residues after partial melting is argued by Powell, who considers that CO_2 flushing from the mantle is likely to be less important than internal buffering and melting. Weaver and Tarney, however, point out that although the Lewisian granulites of Scotland are strongly depleted in the radioactive heat-producing elements (K, Rb, Th, U), the Indian charnockites and Peninsular gneisses are enriched in these elements, and removal of a partial melt during granulite-facies metamorphism cannot explain this. Indeed Weaver and Tarney prefer the concept of a chemically evolving fluid flux in the deep crust. A close relationship between the formation of charnockite and the production of anatectic granite is reported by Friend, who postulates partial melting in advance of a charnockite-forming front.

Other papers of wide interest include that by Pitcher on the 'typology' of granites, relating the different types to their mode of origin and hence to their particular environment. Thus this book affords