BOOK REVIEWS

HESS (H. H.), and POLDERVAART (A.) [1918–64], editors. *Basalts: The Poldervaart Treatise on Rocks of Basaltic Composition.* New York and London (Interscience: John Wiley & Sons, Ltd.), 1968. Vol. 1, xvi+495 pp., 138 figs. Price 205*s*. Vol. 2, viii+401 pp., 132 figs. Price 206*s*.

This comprehensive work on the most widespread of all igneous rocks presents twenty papers by authors each of whom is an expert in his particular field. The variety of topics covered includes the geology of basalts, their mineralogy, petrology, chemistry, and physical properties, and also the problems of their genesis and their recrystallization under metamorphic conditions.

After a memorial to the late Arie Poldervaart, who conceived and organized this treatise, volume 1 opens with a chapter on the forms and structures of extrusive basaltic rocks by Gordon A. Macdonald, who gives an admirable description of the forms of basaltic lava and includes a useful discussion of criteria for determining top and bottom beds and direction of flow. The equivalent chapter on intrusive basaltic rocks by J. J. Frankel is perhaps rather elementary and, in parts, outdated. The mineralogy of basaltic rocks is dealt with very thoroughly by G. M. Brown, and the four main mineral groups, the plagioclase feldspars, pyroxenes, olivines, and opaque oxides, are described at length. One cannot but agree with the statement 'the mineralogist still wedded to the idea that a microscope and some determinative charts will provide an alternative to chemical analysis will find little solace from this account'; this has particular relevance to the clinopyroxenes. The petrography of basaltic rocks and the problems of their classification are described by J. F. G. Wilkinson. Several tables sensibly include not only the chemical, normative, and modal compositions but also give the compositions of the individual phases. Throughout this volume however, but perhaps particularly in this chapter on petrography, one is surprised at the lack of either photomicrographs or thin section drawings illustrating the textures of basalts. The geochemistry of basaltic rocks is fully documented, the major elements by Vincent Manson and the trace elements by Martin Prinz. For the major element study 4300 analyses from the literature were subjected to a screening test setting limits for the chemical composition of basaltic rocks, and of a total of 2123 analyses retained by the test, 1581 are of basalts, 415 are of dolerites, and 127 are of gabbros. Considering only the basalts and dolerites, 479 are nepheline-normative, 521 are olivine-normative, and 996 are quartz-normative: this chapter concludes with an appendix on factor analysis of petrochemical data. Using the same criteria, the trace element data are based on 267 full analyses. The increasingly important field of isotope geochemistry in volcanic rocks is summarized fairly briefly by P. W. Gast though the continental strontium isotope data presented are restricted to results for North America and Asia. Accounts of the experimental work that is doing so much to increase our understanding of the problems of basalts are given by Kenzo Yagi. Reinvestigations of some of the well-known systems such as $CaAl_2Si_2O_8$–$CaMgSi_2O_6$ or $NaAlSi_3O_8$–$CaMgSi_2O_6$ have recently shown that they are not binary, as formerly believed, but are complicated

by the presence of solid solutions in diopside, or albite, or anorthite. Although most basalts crystallized at or near the Earth's surface where the effects of pressures on crystallization can be neglected, most basaltic magmas are probably generated in the upper part of the mantle at high pressures and the effects of such pressures on basaltic rock are considered by D. H. Green. Here the transition from eclogite to gabbro mineral assemblage occurs, via an intermediate assemblage of garnet+plagioclase+pyroxene. Any hypothesis of primitive magmas, and of parental and derivative magmas, must be based on fractionation and partial melting processes occurring at considerable depth, and this chapter establishes clearly that these processes are very different from those at shallow depth. This volume is concluded by consideration of yet another important aspect of experimental work in a chapter by D. L. Hamilton and G. M. Anderson on the effects of water and oxygen pressures in basaltic magmas and related systems, which goes on to include some speculations as to the possible values of these variables under natural conditions.

Volume 2 of this treatise (pagination is continuous from Volume 1) starts with an account by J. E. Nafe and C. L. Drake of the physical properties of rocks of basaltic composition and deals with the pressure and temperature dependence of elastic properties, the velocity-density relationship, and the refractive indices of basaltic glasses. This is followed by a discussion mainly from a theoretical viewpoint of the cooling and solidification of igneous rocks by J. C. Jaeger. The spatial relations of basaltic magmas in island arcs and the associated geophysical features are described by A. Sugimura, who treats not only the chemical composition but also the 'geotectonic position' of volcanoes. It is suggested that the generation of basaltic magmas and the occurrence of intermediate earthquakes are two different phenomena originating from a common source of energy and that their distribution pattern is thus antipathetic. The rhythmic and cryptic layering in mafic and ultramafic plutons is described and interpreted by the late L. R. Wager. The history of the recognition and realization of the significance of layering in igneous rocks is reviewed, each of the terms used is defined, and the processes by which layering may be produced are discussed in detail. Major aspects of the genesis of igneous rocks as a result of the differentiation of basalt magmas are included in a necessarily lengthy review by H. Kuno. Starting from three types of parental magma, three series of igneous rocks are considered: tholeiite series, high-alumina basalt series, and alkali rock series, the first two being further arbitrarily divided into two subseries according to their degree of concentration of total iron; it is considered that calc-alkali rock suites may start from any of the three parental magmas and require enrichment in water, which would result in a rise of the oxygen partial pressure of the magma. It has long been recognized by petrographers that the variation from basalt to andesite is continuous and there are many examples of rocks whose proper classification is difficult to determine: this transitional group of rocks, the basaltic andesites, is considered in detail by R. R. Coats, who concludes that the three interacting factors controlling the varieties of andesite and basaltic andesite are the nature of the primary basaltic magma, the degree of iron enrichment during differentiation, and the amount and type of contamination. The problems of spilites and spilitic rocks are reviewed and discussed by G. C. Amstutz who proposes the

restriction of the term spilite to volcanic rocks of basaltic composition with distinct types of primary fabric (here illustrated by photomicrographs). The preferred hypothesis for their origin considers them as resulting from the transfer and differentiation of constituents in a separate aqueous phase during primary crystallization, the hydrous nature of the melt being either a result of primary differentiation or due to contamination. In reviewing the eclogite problem and the many theories as to their origin, W. R. Church adheres to the original nomenclature of Haüy, who defined them as metamorphic rocks composed essentially of omphacite (jadeite-bearing pyroxene) and garnet. The metamorphism, mainly regional, of mafic rocks is summarized succinctly by A. Miyashiro. Particular attention is given to the mineralogy of metabasites, especially the amphiboles. The concluding chapter, by D. H. Green, deals with the origin of basaltic magmas: they are considered to be derived by partial melting within a somewhat inhomogeneous mantle of peridotitic composition, but there is no clear attempt to relate the type of magma produced with the three parental magmas discussed in the chapter on the differentiation of basaltic magmas.

Some of the authors seem uncertain as to whether to deal with intrusive rock bodies that formed from basalt magma, in particular the large differentiated sills. The lack of any consideration of amygdaloidal minerals and of the evolution of basalt plateau areas and shield volcanoes would seem to be major omissions.

The production and printing is uniformly excellent and very few errors of typography were noticed. The line-drawings are clear but the presentation is less fortunate in the several 'plates', which are in fact printed as text-figures and which lack contrast. In the review copy, plate 8 (p. 13) of entrail pahoehoe appears to have been taken in a fog and in plate 4 (p. 73) the 'distant mountain capped by a thick curved dolerite sheet' is a uniform light grey.

The authority and general high quality of exposition of the contributions in this treatise will cause these two volumes to be an essential item in all geological libraries, but the price of £20. 11*s.* (almost 6*d.* per page) regrettably puts them beyond the reach of many individual petrologists.

R. A. HOWIE

SEDERHOLM (J. J.). *Selected Works: Granites and Migmatites.* Edinburgh (Oliver and Boyd), 1967, 608 pp., 207 text-figs., 17 pls., 8 coloured maps. Price £15. 15*s.*

This splendidly produced book contains seven of the most important publications of J. J. Sederholm. There is also an outline of Sederholm's life and work by Pentti Eskola (this in itself is a valuable appreciative document), together with a bibliography of Sederholm's works, a list of no less than 146 titles.

The selection is well made, for it is fully representative of Sederholm's achievements. His classic paper 'On granite and gneiss', which was published in 1907, appears as an English translation for the first time. In this he shows how the history of events in the immensely complicated terrains of schists, gneisses, and granites can be read by a reasoned appraisal of the detailed relations to be seen in the field and