

E.C. Hansen (Strain Facies, Springer Verlag, 1971).

The description of folds and related structures is fairly exhaustive but there is no attempt to give a quantitative estimate of strain magnitude.

Although major structures are clearly underlined on the map, the superposition of fabric symbols on the lithology tends to blur the details of the picture. A separate structural map would have allowed a more complete representation of fabric elements. Nevertheless the reader can see from the text that large folds are correlated with minor structures and an attempt is even made to correlate deformations in the Tafjord area with those described further east by other authors.

The folding mechanism invoked to explain the two main folds generations (F_1 and F_2) is slip parallel to the axial plane. One may question the appropriateness of discussing the folding mechanisms of Precambrian folds strongly reoriented during a Caledonian event.

Basic petrographic data have not been included in the printed memoir, but the reader can refer to the thesis. All metamorphic assemblages presented are convincingly related to the various deformation episodes but no attempt is made to give an estimate of PT conditions during the main metamorphism (related to F_1 folds). Given evidence tends to show that an intermediate pressure type amphibolite facies metamorphism was superposed on a pre-existing granulite facies metamorphism.

The stratigraphic position of anorthosites, eclogites and ultramafic rocks in the metasediments is clearly established and convincing arguments are presented to show that these rocks have been involved in the same metamorphic and tectonic events as the country rocks.

In spite of the various metamorphic episodes and considerable strain they have suffered, these rocks still retain part of their original mineralogy and the author clearly correlates various metamorphic assemblages to corresponding deformation episodes, or as is the case for coronitic assemblages to postkinematic metamorphism.

Unfortunately, relict pyrope, enstatite and forsterite in mafic and

ultramafic rocks are attributed to a pre- F_1 metamorphic history, whereas they could well belong to the original igneous assemblage.

The puzzling problem of relic Svecofennian K-Ar ages of hornblendes in contradiction with Caledonian U-Pb ages on nearby eclogites is tentatively attributed to excess argon in Tafjord hornblende, although one should not discard the possibility that Hareidland eclogites are younger than those of Tafjord. This point is not clearly documented in the text.

In the final discussion, the author favors a common origin for eclogites, ultramafics and anorthosites which show compositional variations resembling those found in layered complexes. Strain analysis might help to reconstruct the dimension and shape of an hypothetical mafic-ultramafic complex. This will solve the main question as to whether this kind of anorthosite results from a particular type of intrusion (sills?) or belongs to an extremely flattened stratiform complex.

To summarize these comments, the good structural and stratigraphic framework given by this study constitutes a valuable basis for further petrologic studies on polycyclic mafic, ultramafic and anorthositic rocks.

MS received July 28, 1978

Marine Manganese Deposits

Edited by G.P. Glasby
Elsevier Scientific Publishing
Company, 523 p., 1977.
Dfl. 127.00 (U.S. \$49.00)

Reviewed by Gordon A. Gross
Geological Survey of Canada
601 Booth Street
Ottawa, Ontario K1A 0E8

G.P. Glasby and 23 other eminent authorities on manganese nodules have collaborated in the preparation of an exceptionally useful reference volume for resource, marine and environmental geologists, and for all in industry and government who are concerned with future mineral supply and development. In 14 well organized chapters the authors have succeeded in presenting a considerable amount of good data, timely evaluation and interpretation of relevant scientific research and knowledge, and an appreciation of the status and level of understanding of manganese nodule occurrences throughout the world. Data and interpretation are dealt with concisely and objectively in the volume for subject material ranging from an historical introduction to manganese-iron nodule investigations; the distribution and geochemistry of deep-sea, shallow-water, continental, lacustrine, and fossil nodules; the morphology, internal characteristics, mineralogy, rates of accretion of the nodules; the form of manganese and iron in marine sediments and the mechanisms of removal of manganese, iron and other trace metals from sea water; extractive metallurgy; to environmental, legal and economic aspects of nodule mining.

To have attempted comprehensive treatment of such an expansive subject over the years 1972 to 1977 when research and publication "mushroomed" in this field was a bold undertaking, yet the authors have succeeded in presenting an understanding in depth of genetic problems and the scope of working knowledge, and point out critical aspects and the direction which future investigations should follow. Because of thorough

effort put into the treatment of the chosen topics, the volume provides an index to the character of current research on nodules and reveals important perception and detail on a wide variety of highly specialized material. The synthesis and relevance of much of this specialized work for answering basic questions pertinent to successful mining of manganese nodules is to a great extent left to the reader. The book provides a review and clear perspective of the content of a voluminous literature but presents little new data that was not published during the period of its preparation. The detailed treatment of the mineralogy of manganese nodules is of special scientific interest. The urgent and critical need for devising a geological model that integrates and defines the role of the wide variety of parameters influential in the formation of manganese-iron nodules is still a challenge for further interdisciplinary collaboration.

It is readily apparent from this index work that sample sites and specific data on nodule composition are extremely sparse and widespread considering the vast area of ocean floor where nodules occur. The authors, like other investigators in the field, are forced to extrapolate and project their concepts and conclusions about nodule character, composition, formation and distribution far beyond the limits of the local geological environments properly represented by sample sites. The book indicates the very limited data on nodule distribution, composition and abundance on which resource estimates must be based. It is doubtful whether a satisfactory and dependable geological model for guiding nodule mining and utilization can be devised until such time as adequate and more systematic sample data are available. The authors have demonstrated that parts of the geological model for manganese nodule formation are being clearly and sometimes elaborately defined but the interrelationship of these geological parameters has not been demonstrated.

MS received August 31, 1978

Exploration and Mining Geology

By William C. Peters
John Wiley and Sons, 696 p., 1978
\$24.60

Reviewed by J.V. Guy-Bray
Inco Metals Company
1 First Canadian Place
Toronto, Ontario M5X 1C4

The dullest dust-jacket in recent memory conceals a first-class textbook for practicing economic geologists. Nowhere else are the many disciplines and techniques of this complex trade so well presented.

Peters is a former mining industry geologist, now teaching. His long experience of mineral deposits is combined with an understanding of the latest concepts, and his lively wisdom lightens every chapter of this weighty text.

Can applied geology be learned from books? Even McKinstry wrote one. His, like Forrester's, is out of print and its details though not its principles are dated; Lahee's is not an economic text. Peter fills a gap with his comprehensive guide to a modernised profession.

He does not provide exhaustive coverage of every topic or give detailed how-to-do-it descriptions of exploration practice. That would be impossible in a single book and misleading in a continuously evolving profession. Instead he identifies the principles of each subject and indicates its problems, conveying a point of view rather than operating instructions, with reminders for seasoned professionals and truly excellent references for further study. The technique is effective and respects the intelligence and individualism of his prospective readers.

After a concise historical perspective, Part One reviews the elements of mineral deposit occurrence and weathering, and of metallogeny. A recurring problem in synoptic works is to decide how much background to include. Peters treats us to an idiosyncratic but stimulating tour of the major items in a working geologist's

warehouse of facts and ideas, while also using the review to relate theory to practical application by citing examples. Sacred cows are few – traditional western U.S. preoccupations with "plumbing" and gossans are kept under control – and exploration appears as the lively art it should be.

Part Two covers engineering and mining in sufficient detail to permit a geologist to work effectively with his colleagues; Three provides a framework of economics, including mineral policies, law, taxation, and financial evaluation methods.

Part Four (one third of the book) carries the reader through every step of the mineral exploration process: data evaluation, reconnaissance, mapping (surface and underground), geophysics, geochemistry, drilling, sampling, and reporting. It is sound, clear, practical, thorough, and supported throughout by references and common sense: "We often drown in data, seldom in information, never in facts".

Part Five reviews the geologist's role in exploration and mining, emphasizing his economic functions not merely in property evaluation but in interpreting for management the geological probabilities, the balance between opportunity and risk: geology as the *business* of resource development.

Peters closes with eight appendices (abbreviations, symbols; data sources; reporting format; geologic time; SI units; environmental guidelines; index maps), 35 pages of references, and a good index.

This book will remind you of principles, refresh your knowledge of techniques, and leave you new ideas to exploit. Wiley's usual quality is evident throughout (except for a whopping transposition on the title page). The illustrations, mainly line drawings, amplify rather than merely decorate. For students and others Peters is the ideal introduction to mining industry geology: for professionals his work will be a valued reference for everything from field sampling to operations research.

MS received August 8, 1978