

Metamorphism and Metamorphic Belts

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Arctic Geology

Edited by Max G. Pitcher
*American Association of
 Petroleum Geologists Memoir 19,*
 747 p., 1973.
 \$27.00.

Reviewed by A. D. Miall
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 Petroleum Geology*
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This volume is the proceedings, published after an extended gestation period, of the Second International Symposium on Arctic Geology held in San Francisco, February 1-4, 1971. At least, it purports to be the proceedings, but of the 147 papers listed in the abstracts of this Symposium, only 69 are represented in the final volume, four of them in summary form. There is, in addition, no record of the discussions which took place at the Symposium. Considering the controversial nature of some of the papers, particularly those dealing with the evolution of the Arctic Ocean Basin, this is a pity, for it means we are deprived of some lively reading.

What we are left with is a collection of important regional papers covering every major circum-Arctic region (plus some regions that barely qualify even as banana-belt Arctic, such as the South Nahanni River) and including a major series of contributions from the U.S.S.R. The reproduction and editorial work is up to the usual high A.A.P.G. standards, and the reviewer has been unable, so far, to find a single typographical error. But the effort has come so late! Mackenzie pipeline advocates may go down the spout, plate tectonics theorists may founder, other Symposia may interpose, in fact anything may happen in a two and a half year publication delay. Whatever the reason for the delay it is unfortunate, for several of the papers were rendered out of date before they appeared, by later work in the same field, often by the same author. For example H. P. Trettin's discussion of the Early Paleozoic rocks of the

northern Canadian Arctic Islands was expanded and updated in his contribution to the G.A.C. publication "Tectonic Styles in Canada", which was published in 1972. Similarly, P. F. Friend's discussion of the Svalbard Devonian rocks has been replaced by a detailed report co-authored with M. Moody-Stuart and published by Norsk Polarinstitut, also in 1972. Other examples could be given.

In spite of all these limitations "Arctic Geology" will serve as a valuable reference work for many years, just as did its predecessor, the proceedings of the first Arctic Symposium. Much of the data, particularly that pertaining to the U.S.S.R., are not readily obtainable elsewhere, and this alone gives the volume a considerable value.

The breakdown of papers is as follows: regional geology of Canada - seven, Nordic countries - seven U.S.S.R. - 24, Alaska - seven. Comparisons in the North Atlantic borders - five papers, Evolution of the Arctic Ocean Basin - 12 papers, and finally seven papers on economic and political aspects of the Arctic petroleum industry. To give some idea of what is missing from the programme of the original Symposium, the following is a list of authors dealing predominantly with Canadian content, whose papers are not present in this volume: Caldwell, Drummond, Hemstock, Henao-Londano, Hills, Hunt and Woodward, Jeletzky, Johnson, Klován and Embry, Mountjoy, Trettin (second paper), Waterhouse.

In summary, a nice thing to have on your shelf, especially if you can persuade someone else to pay for it.

MS received, June 10, 1974.

Metamorphism and Metamorphic Belts

by A. Miyashiro
George Allen and Unwin, London,
 479 p., 1973.
 \$28.70.

Reviewed by E. D. Ghent
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This book represents a translation and up-dated revision of the author's book "Metamorphic rocks and metamorphic belts (in Japanese)" which was published in 1965 by Iwanami Shoten (Tokyo). The author's introduction is dated October 1972.

According to the author's introduction, the emphasis is on the synthesis of mineralogic, petrologic and tectonic aspects of metamorphism and is not intended to be an advanced treatment of thermodynamic and structural aspects.

Part I, "Basis of metamorphic petrology (135 p.)" treats basic concepts of metamorphic petrology and geology. Part II, "Progressive metamorphism (175 p.)", deals with the progressive mineral changes and their diversity in regional metamorphism. Part III, "Metamorphism and crustal evolution (100 p.)", deals with the tectonic aspects of regional, ocean-floor and transform fault metamorphism in relation to the evolution of the crust and lithosphere. An appendix, "History of the study of metamorphism (12 p.)", is included.

The references (27 p.) include about 800 items with very few entries later than 1971.

Figures, tables, and chemical equations are numbered with reference to chapter numbers. These can be located reasonably well by referring to page numbers of chapters in the index.

Many of the figures are half-page geologic maps. In most cases the scale is sufficient to show the relationships clearly. In a few cases, for example, the distribution of Alpine regional metamorphism in Figure

14-2, p. 343, the pattern does not show up clearly.

I feel that I can recommend the book strongly for its synthesis of metamorphism, magmatism and structure within the framework of plate tectonics. The cosmopolitan view of metamorphism is a rare gift among modern petrologists. Readers of Professor Miyashiro's previous papers will be gratified to find a clear statement of his important views on metamorphism in a single volume in English. His summary of the metamorphic geology of Japan and other areas unfamiliar to the readers is of great value.

The book contains few typographic errors; I counted eight. There are a few other minor errors; for example, on p. 63, R. W. White did not demonstrate constancy of chemical composition with metamorphic grade.

My additional comments about the book are few. One reservation that I have is about the book's organization. For example, a person not versed in metamorphism will have to follow a series of cross-references to get a complete statement about the granulite facies. This will limit the usefulness of the book for some students.

I was surprised to find, that among the 800 references, Turner's book on metamorphic petrology published in 1968 and Winkler's paper on abolition of metamorphic facies (1970) were not cited. These works represent divergent views on the definition and usefulness of metamorphic facies. In addition, a paper on facies series by Hietanen (1967) was not commented upon.

With regard to most of Professor Miyashiro's views on definition of individual metamorphic facies I am in accord. His argument that a facies should be based on mineral paragenetic relationships and not field occurrence is particularly well taken.

His restricted definition of eclogite facies to assemblages of clinopyroxene (omphacite) + magnesian garnet + quartz (or kyanite) would exclude many eclogites from blueschist terranes, which often differ in chemistry from associated blueschist metabasalts.

Recognizing that such rocks may represent Ps-T conditions transitional to the eclogite facies, as defined above, is highly significant.

My personal view is that the blueschist facies is just as properly defined as any other metamorphic facies (p. 68), but the opposing view is held by several other authors other than Professor Miyashiro.

The metamorphism of the Akaishi Mountains, Japan (p. 140) is of the "burial type" and is inferred to have taken place under a geothermal gradient of 75-175°C. Km⁻¹. Many petrologists have inferred that the source of heat in burial metamorphic rocks is internal not external. Consequently, many petrologists would probably not include geothermal gradients of this magnitude within the limits of burial metamorphism.

The book is a welcome addition to the science of metamorphic petrology. It comes at a particular appropriate time when many petrologists are speculating about the larger scale features of the earth and geophysicists and structural geologists are interested in the P-T constraints in tectonic belts. For these people, as well as the student who is interested in the interrelationships of metamorphism, magmatism and plate tectonics, this book is "must" reading.

References

- Hietanen, A., 1967, On the facies in various types of metamorphism. *Jour. Geol.*, v. 75, p. 187-214.
- Turner, F. J., 1968, *Metamorphic petrology*. McGraw-Hill, New York, 386 p.
- Winkler, H. G. F., 1970, Abolition of metamorphic facies, introduction of the four divisions of metamorphic stages, and a classification based on isograds in common rocks. *Neue Jahrb. Mineral., Monatsh.*, v. 5, p. 189-248.

MS received, April 30, 1974.

Thermodynamics of Rock-forming Crystalline Solutions

by S. K. Saxena
Springer-Verlag, New York, 188 p., 1973.
 \$17.80.

Reviewed by W. S. Fyfe
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This book is the ninth volume in the Springer series on minerals, rocks and inorganic materials. The topic considered is one of immense importance in modern petrology and one of more than usual difficulty. In the naturally complex chemical environment, the majority of minerals form from solutions or mixtures and are themselves mixtures. The products of igneous and metamorphic processes are normally solid solutions and the record of equilibrium factors is recorded in such solutions. This record is vital to the appreciation of pressure-temperature or tectonic history of rocks. Early work in experimental petrology was much concerned with simple systems but as we search for more precise information from rocks, it is the solid solutions that must be understood in detail.

The basic problem in the physical chemistry of all solutions is to find equations that will describe the chemical potential of all species present over all ranges of concentrations. From these we hope to extrapolate and interpolate from more limited data. It is quite impossible to do the infinite number of experiments required for natural mixtures. Thus, one must welcome a book that attempts to set out the present state of the art, an art which has developed rapidly with the common availability of computers.

The introductory parts of the book are devoted to the general principles of the problem and the description of the general relations for the various classes of solutions, ideal, regular, and the like. These relations lead to the general concepts of miscibility