

## Metamorphism

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Volume 3, Number 2, May 1976

URI: [https://id.erudit.org/iderudit/geocan03\\_02rv03](https://id.erudit.org/iderudit/geocan03_02rv03)

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**Publisher(s)**

The Geological Association of Canada

**ISSN**

0315-0941 (print)  
unknown (digital)

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**Cite this review**

Skippen, G. B. (1976). Review of [Metamorphism]. *Geoscience Canada*, 3(2), 133–134.

### 3. Metallogeniya (Metallogeny)

By I. G. Magak'yan

304 p., Nedra, Moscow, 1974.

Price 3.15 roubles.

In contrast to items #1 and 2, this book is relatively easy reading and was prepared by the Armenian Academician Magak'yan primarily as a textbook for university courses. After a very brief introduction summarizing the history of metallogeny and its concepts, the metallogeny of geotectonic regions of the world, arranged chronologically from the oldest to the youngest, is described. The description of each region is necessarily very brief (e.g., 3½ pages are devoted to the Canadian Shield), but due to the curious absence of any similar work in English this part of Magak'yan's book can be warmly recommended to the North American geologists seeking elementary information on the metallogeny of, e.g., the Siberian Shield, Sino-Korean Shield or the Norwegian-Appalachian belt. Bibliography conveniently follows description of each area and it usually contains at least one fundamental local work.

The second part of the book deals with metallogeny of selected metals. Principal mineralization types are described and world distribution of the largest ore deposits is recorded.

MS received January 12, 1976.

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## Metamorphism

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By H. G. F. Winkler

Springer-Verlag, New York,

Heidelberg, Berlin

320 p., 1975.

\$9.80.

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The first edition of this widely-read book appeared in 1965 and has undergone substantial revisions in the Second and now Third Editions. Unlike the previous editions, which were translated from German into English, the Third Edition has been written in English with editing by Dr. Edgar Froese of the Geological Survey of Canada.

One of the most significant changes in the Third Edition is the emphasis given to a few key mineral reactions as a means of subdividing the range of metamorphic conditions. This is a more comprehensible approach than presenting a few representative ACF or AFM projections to define metamorphic facies and subfacies. The problem with such projections is that hundreds of diagrams are needed to describe all possible phase relations in rocks as complex as calcsilicates or pelites. This change in emphasis from projections to mineral reactions as a means of introducing students to metamorphic petrology is described by Professor Winkler as an abandonment of the facies principle. *Abandonment* is perhaps too strong a word since mineral reactions are implicit in the definitions of facies and subfacies and constant reference to the classical metamorphic facies is made throughout the text. The importance of identifying the specific reactions by which minerals appear or disappear in the field is underlined in the text by the introduction of a new term, *isoreactiongrad*. The use of this term is advocated for those cases in which a specific reaction can be assigned to an isograd.

The introductory chapters of the textbook are similar to the previous edition except for a somewhat laborious chapter drawing the line of demarcation between diagenesis and

metamorphism. The introductory section also defines four major subdivisions of metamorphism on the basis of mineral reactions that occur widely in the field and that have been calibrated experimentally. These subdivisions are called very low grade, low grade, medium grade and high grade metamorphism and correspond respectively to the traditional zeolite, greenschist, amphibolite and granulite facies. Separate chapters are then devoted to detailed descriptions of the metamorphism of carbonates, marls, ultramafic rocks, mafic rocks, graywackes and pelites. From a Canadian point of view, it is unfortunate that this list could not have been expanded to include iron formations. Chapters are also presented in the later part of the book on granulites, eclogites, and anatexis. Of particular note is the terminology applied to rocks from the granulite facies. Because of ambiguities in the term, *granulite*, a new term, *granolite*, is introduced for those rocks that contain minerals diagnostic of granulite facies metamorphism. The term, *granoblastite*, is used for rocks from the granulite facies that lack diagnostic mineral assemblages.

The greatest weakness (or strength, depending on the approach of the reader) in the book is the lack of some theoretical material that is pertinent to the subject. There is little consideration given to thermodynamic theory although this theory is essential for correlating laboratory studies on idealized, end-member minerals with field data involving phases of varying compositions. A chapter entitled, *Factors of Metamorphism*, attempts to discuss the mechanics of metamorphic rocks without the benefit of theoretical constraints. Thus, it is possible to dismiss "tectonic overpressures" because rock strengths are negligible under metamorphic conditions but at the same time to allow "internally created gas overpressures" of "perhaps some 1000 bars" in these same rocks with negligible strength. Statements of this type would have been easier to accept if they had been presented in the context of some basic principles of mechanics.

In conclusion, it may be said that the book provides the best available summary of field and laboratory data for metamorphic rocks in spite of numerous typographical errors. It will be particularly useful when used in conjunction with a short text by Dr. Froese on the theoretical aspects of metamorphic petrology that is soon to be published by the Geological Survey.

MS received February 4, 1976.

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## Petroleum and Global Tectonics

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Edited by A. G. Fischer and S. Judson  
*Princeton University Press, 1975, 322 p.*  
 \$16.50.

Reviewed by David W. Morrow  
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The impact of plate tectonic theory on the search for petroleum was the central theme of the 109th meeting of the Princeton University Conference. Nine papers by contributors from universities and from industry are contained in this volume. Papers form two groups and represent the bulk of the material presented at the conference. The first six papers are concerned with the theory of plate tectonics and basin development. The remaining three papers discuss in detail factors that govern the maturation of petroleum from organic material in sedimentary basins around the world.

An introductory review paper by Edward Bullard delineates the history of plate tectonic theory and explains how the predictive power of plate theory has led to increased public interest and funding for geologically oriented research, particularly towards marine geology.

In an excellent contribution, Jason Morgan demonstrates that much of the heat loss of ocean crust must occur by convection, possibly from thermal springs along the seafloor, rather than by conduction. His arguments are based on the fittings of seafloor heat flow data and seafloor elevation data to mathematical models of heat loss and thermal contraction of oceanic lithosphere. Unfortunately, this paper appears to be the victim of an editorial mistake. It ends rather abruptly on page 42 and Figure 8 on page 41 is not referenced, suggesting that some of the text has been inadvertently left out.

The next four papers are devoted to the description, classification and development of sedimentary basins. Alfred Fischer proposes a genetic plate tectonic classification of basins and discusses, with examples, the interrelated processes involved in the

formation of each basin type. Plots of subsidence and sediment accumulation versus time are effective in showing the role of sediment loading in the maintenance of basins. David Kinsman presents an interesting analysis of continental rift basins and of shelf basins flanking rifts. He suggests that erosionally truncated and rifted early continental thermal bulges later subside and become submerged continental terraces after their separation by a juvenile ocean. These terraces are the precursors of Atlantic-type continental shelves. James Lowell and his colleagues follow with a detailed account of the development of the rift zone along the Red Sea between the Nubian and Arabian plates. They suggest that the southern part of the rift zone is formed by two concurrently spreading rifts and show structural and seismic cross-sections with geophysical data to support this view. They consider the porous continental sandstones deposited during pre-rift arching and sealed by overlying salt of the early rifting stage to be among the best potential reservoir facies of the Red Sea Rift. Joseph Curray in the longest contribution to the volume, turns the reader's attention towards the sedimentology of sediments in basins. He emphasizes that sedimentation patterns of the Holocene are atypical because of the rapid post-glacial marine transgression. In particular, most of the world's broad shelf areas were built up by sandy regressive near-shore deposits that have since been drowned.

The final three papers deal specifically with the origin of petroleum. Gordon Erdman discusses known factors such as rates of burial and syndepositional oxidation that influence the abiogenic maturation of organic material to hydrocarbons that form petroleum. He also demonstrates that lipids (i.e., animal fats) are more productive of petroleum hydrocarbons than are the other two major classes of natural organic compounds: proteins and carbohydrates. Erdman might be criticized for using only one analysis of kerobitumen with which to stoichiometrically balance his organic reactions rather than an average of several analyses from different areas. The striking correlation between high geothermal gradients and the occurrence of petroleum in many areas around the world is shown by Douglas