

Volcanic Regimes in Canada

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Book Reviews

Volcanic Regimes in Canada

Edited by W. R. A. Baragar, L. C. Coleman and J. M. Hall
Special Paper 16, 476 p., 1977.
Members \$15.00; non-members \$18.00

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The GAC has performed a noteworthy service in sponsoring a remarkable series of special papers on various aspects of Canadian geology. The recent volume dealing with volcanic regimes should be especially welcomed, not only by Canadians but also by other geologists who, like myself, lack a first-hand acquaintance with ancient igneous rocks and feel the need for an informative compilation of what is known about them. A concise synthesis, consisting of 23 well integrated papers, covers all major groups of volcanic rocks from the oldest Archean greenstones to the youngest lavas of offshore seamounts.

The book is divided into six sections each of which deals with a broad age group and geologic entity. The Cordilleran Region, which has volcanic rocks of both Cenozoic and Mesozoic age, is discussed in three papers. The first of these, a thoughtful overview by Jack Souther, is outstanding in the amount of data it condenses and evaluates in terms of petrologic and tectonic concepts. The two following papers describe individual areas within the province and illustrate the character of the rocks and their structural relations.

The second section deals with the Paleozoic rocks of the Appalachian region. An opening paper by D. F. Strong on the volcanic regime of Newfoundland gives a brief survey of what is known about the rocks and attempts to interpret them according to plate-tectonic models. It argues, among other things, that, despite conflicting compositional evidence, the region was once an island arc. Dealing with another part of the system in New Brunswick, Pajari, Rast, and Stringer come to a similar conclusion on the basis of wretched petrochemical data from a complex assemblage of metamorphosed and highly deformed rocks. Laurent and Hébert give an excellent account of the pillow lavas and ophiolites of Quebec, and they too interpret their rocks in terms of an analogy to modern island arcs, largely on the basis of rocks with intermediate silica contents and 12 per cent Al_2O_3 that they seem to think are andesites!

The section dealing with Proterozoic volcanism opens with an excellent summary by J. M. Moore. Several of the more important provinces are described and the problems of interpreting them are considered in a refreshingly objective manner. By far the most complete description and analysis of the compositional variations of an individual igneous sequence is one provided by Condie and Moore, who have examined the major and trace element compositions of a seven km thick section in western Ontario. Even though the rocks cannot be seen in their true geologic perspective, the trends of compositions are quite instructive. They show a number of remarkable similarities to modern orogenic sequences and the authors have moderate success in relating the magmas to partial melting of sources in the mantle.

P. F. Hoffman and J. C. McGlynn provide an informative and well rea-

soned treatment of a thick sequence of volcanic and related plutonic rocks in the northwestern part of the Canadian Shield. Their descriptions of the structural relations and sequences of rocks should be especially interesting to persons working with Cenozoic rocks, because the sections extend to depths seldom exposed in younger environments.

The section on Archean greenstone belts is the longest and, in some ways, the most interesting in the volume. It starts with an impressive summary of compositional data on the rocks of the Superior Province by A. M. Goodwin. It is difficult to specify the degree to which alteration and differential weathering and erosion have affected the compositions and relative proportions of rock units in exposed sections, but if the answer to the problem of getting representative compositions lies in large numbers of analyses, this work is a model of how it should be done. As L. D. Ayres argues in the following paper, there is much to be learned from studies of lithologic variations about the geologic relations in which the rocks were laid down, and these conditions should be considered in any attempt to interpret the proportions and compositions within a given sequence.

L. Gélinas and his co-workers assess the effects of alteration of Archean rocks and consider the relative merits of a number of possible explanations for the compositional variations in a well sampled and thoroughly analysed stratigraphic section in western Quebec. It is unfortunate that structural information on the regions, which is said to be available, is not given along with the petrologic data, because it would help the reader evaluate the conclusion that the rocks were erupted in a geologic setting similar to that of the Taupo Zone of New Zealand. A second paper by

Gélinas and others discusses the significance of the structural and lithologic features of ultramafic lavas and volcanoclastic rocks in Quebec. This and two other papers on komatiites by Schwarz and Fujiwara and by Schau give a large amount of valuable information on these fascinating rocks.

W. T. Jolly describes the relations between Archean lavas and intrusive bodies in the Abitibi Greenstone Belt of Ontario and Quebec. The trends from tholeiitic to calc-alkaline compositions that developed in both places resemble to a remarkable degree those seen in Cenozoic orogenic suites. Jolly uses mass balance calculations to relate the trends to fractionation in shallow reservoirs, but the lack of trace-element data make the interpretation less convincing than it might be. The structural setting of Archean volcanism is considered in a paper by M. B. Lambert, who shows that the distribution of igneous rocks and sedimentary basins in the Slave Province has been controlled by long-continued faulting. The evolution of the system with time is illustrated by examples from several thick sections through the belt.

Many of the features of Archean volcanism are synthesized by H. D. B. Wilson and M. G. Morrice, who propose that the sequences of lavas, intrusions, and ore mineralization are consistent throughout the shield. The patterns are explained as the result of progressive crystallization of gigantic bodies of magma produced by a meteoritic bombardment similar to that which has been proposed to explain postulated magmatic oceans on the moon. One problem that will be apparent to geologists working with younger rocks is the marked similarity of the Archean compositional sequences to those observed in Cenozoic rocks that could not have been the products of such catastrophic events.

W. R. A. Baragar presents an excellent survey of volcanism on the stable crust and distinguishes three types of rocks that have distinctive volcanic forms, geochemical compositions, and tectonic relations. From comparisons with modern analogues, he concludes that the plateau basalts are related to plumes and crustal rifting. J. C. Green arrives at a similar interpretation of the Keweenaw rocks of the Lake Superior region. Both papers are loaded with concise

information, and whether or not one likes the interpretations, the data are invaluable.

The final section, which deals with the oceanic regime, consists of three papers, one by J. M. Hall and his co-workers on the oceanic crust adjacent to Canada, one by D. B. Clarke on the Tertiary province of Baffin Island, and the last by K. D. Sullivan and C. E. Keen on the Newfoundland seamounts. All three are concerned with problems of the evolution of the oceanic lithosphere and island chains.

The volume is very well organized. Apart from a few annoying grammatical errors, such as the inverted use of adjectives and nouns (e.g., "granite intrusives," "andesite volcanics"), the editors have put together a very readable book. Overall, the most disappointing part of the book is the herd instinct of the authors and their tendency to use analytical data, much of it of miserable quality, as a substitute for a thoughtful analysis of geologic evidence. There is an almost comical pattern in many of the papers. A group of rocks is described with only passing mention of their geologic relations; wildly scattered compositions are plotted on AMF and alkali-silica diagrams, and the rocks are thereby interpreted as coming from an island arc, hot spot, or spreading axis. On this sort of evidence, authors deduce subduction zones, plate motions, opening and closing of oceans, or even planetary catastrophes. The reader who views the volume from the outside and is impressed by the remarkable features of ancient volcanic regimes cannot help but feel that much more would be learned if the efforts expended in forcing rocks into fashionable models were devoted to an impartial analysis of what was really going on when the rocks were laid down.

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The Evolution of North America

By Philip B. King
Princeton University Press, 197 p., 1977
(2nd Edition).
 Cloth U.S. \$25.00, Paper U.S. \$9.50

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Readers familiar with the first edition of *The Evolution of North America* will find the second edition remarkably similar and will have to read very carefully to find the revisions. The book has not been re-planned in the light of plate tectonic interpretations of North America. It is only eight pages longer than the first edition, and with few exceptions, uses the same Chapter and Section headings as the 1959 edition. The revisions therefore, mostly consist of small deletions and additions to individual sections or paragraphs as demanded by our present understanding of plate tectonics. The result does not integrate plate tectonics into the "Evolution of North America" as broadly as one might wish.

The original strengths of the book remain, however, and it is a superbly readable synthesis of North American geology. The anecdotes concerning some of the early explorers and geologists continue to enliven the book and entertain the reader. The absolute minimum of jargon and local stratigraphic terminology make the book easily readable by beginning students onward. The illustrations, now all in metric, consist entirely of hand-lettered line drawings, identical in style to those in the first edition. About 23 are new, 11 significantly altered and 9 deleted making a new total of 109. In many of them, the lettering almost blurs into the legend, or is superimposed on the legend, in a manner that detracts from the usefulness of the illustrations. They consist mostly of maps and cross-sections, and one could perhaps have asked for more "sequential" diagrams demonstrating the inferred evolution of various areas - there are only about eight such diagrams in the book.