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NATIONAL REPORT FOR CANADA ON VOLCANOLOGY

Compiled by
W. R. A. BARAGAR

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ON

VOLCANOLOGY

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NATIONAL REPORT FOR CANADA ON VOLCANOLOGY

W. R. A. Baragar

Abstract

Volcanological research in Canada has increased drastically in recent years. This report presents an overview of current activities in Canada with an extensive bibliography containing over 200 references related to volcanology.

Résumé

Ce rapport donne une vue d'ensemble des études de vulcanologie au Canada; discipline qui accuse de nos jours une évolution marquée. On y trouve de plus une bibliographie d'au-delà 200 titres relatifs à ce domaine.

Introduction

Volcanology as a distinct science does not have a long history in Canada as is evident from the lack of previous national reports in this field. An absence of active volcanoes with the associated hazards to human life and industry which they pose has rendered the need for volcanological studies in Canada a matter of secondary concern. Such work as was done was generally a byproduct of routine geological investigations performed in the course of field mapping. Within the last ten years volcanological research in Canada has increased dramatically and now few earth science institutions are without some form of volcanological research program. The two factors chiefly responsible for this remarkable change were: (1) the development of the plate tectonics hypothesis, and (2) the recognition of the volcanological nature of most ore deposits. The lack of active volcanoes, although no longer a deterrent to research, does limit its application largely to paleovolcanology. Hence, in Canada it is primarily a geological rather than a geophysical science.

In 1965, in response to the growing interest in volcanology in Canada, a subcommittee on volcanology was added to the family of subcommittees subservient to the Associate Committee on Geodesy and Geophysics; the national body responsible for liaison with the International Union of Geodesy and Geophysics (IUGG). This subcommittee, representing subdisciplines and regions across Canada, compiled reports on volcanological research in Canada which were published annually in the Canadian Geophysical Bulletin. In 1974 the Associate Committee was dissolved and its liaison responsibilities were passed to a newly organized Canadian National Committee for the International Union of Geodesy and Geophysics. Concurrently the Canadian Geophysical Union was formed as a joint division of the Canadian Associates of Physicists and the Geological Association of Canada carrying with it most of the disciplines represented by the former subcommittees. The domestic responsibilities for volcanology, because of its dominant geological bias, were assumed by a newly formed Volcanology Division of the Geological Association of Canada. Its purpose is to encourage research and to promote communication among scientists engaged in studies of volcanic rocks. Representation for volcanology on the new Canadian National Committee for the International Union of Geodesy and Geophysics is shared by the Canadian Geophysics Union and the Volcanology Division.

During the period covered by this report (1971-1975) the composition of the Volcanology Subcommittee varied somewhat because of overlapping terms of membership. Following are members who served the subcommittee at some time during the period:

J. M. Ade-Hall, Department of Geology, Dalhousie University

H. Baadsgaard, Department of Geology, University of Alberta, Edmonton

W. R. A. Baragar, Geological Survey of Canada, Ottawa, Chairman

J. Boldy, Freeport Canadian Exploration Company Sulphur

B. N. Church, British Columbia Department of Mines and Petroleum Resources

L. C. Coleman, Department of Geology, University of Saskatchewan, Saskatoon

G. L. Cumming, Department of Physics, University of Alberta

J. J. Fawcett, Department of Geology, University of Toronto

B. M. Gunn, Departement de Géologie, Université de Montréal

R. Y. Lamarche, Departement de Richisses Naturelle du Québec

G. Stevens, Department of Geology, Acadia University

F. Aumento, Department of Geology, Dalhousie University

Approved for publication: April 1975.

The Volcanology Division, inaugurated May 22, 1974, elected as its first executive the following:

Chairman: A.M. Goodwin,
University of Toronto

Vice-Chairman: J.G. Souther,
Geological Survey of Canada, Vancouver

Secretary-Treasurer: J.J. Fawcett,
University of Toronto

Regional Councillor West: L. Ayres,
University of Manitoba

Regional Councillor Control: L. Gelinas,
Ecole Polytechnique, Montréal

Regional Councillor East: D.F. Strong,
Memorial University of Newfoundland

Councillor Geophysic-Oceanography: R. Chase,
University of British Columbia

Industry Representative: G.W. Mannard,
Texas Gulf Sulphur, Toronto

Past Chairman: W.R.A. Baragar,
(appointment for this term to ensure continuity with former subcommittee).

The submissions of members of the Volcanology Subcommittee and the executive of the Volcanology Division contained in the successive issues of the Canadian Geophysical Bulletin since 1971 (Vols. 24 to 27) are the best record of Canadian endeavours in volcanology for the period covered by this report. A brief summary of activities and an extensive bibliography follow.

Current Activities

Activities in Canada of a volcanological nature are numerous and diverse. No report of this nature can do justice to them all. Accordingly they have been grouped on a somewhat arbitrary basis; partly by geological age and province, and partly by specialty.

The Modern Regime

Under this heading are included activities that can be related directly to the present era of plate tectonic movements; not surprisingly they are centred on the east and west coasts.

Volcanism in the western Cordillera from at least the early Mesozoic to Recent times has been integrated, virtually successfully, into a plate tectonics model of the Pacific Region. Credit is due to the co-operative research of the Geological Survey, the British Columbia Department of Mines and Petroleum Resources, and the University of British Columbia. A number of current stratigraphic and petrochemical studies, mainly on Mesozoic and Tertiary volcanics, are continuing to reinforce the model. A unique feature of the Cordillera in comparison with the rest of Canada is the presence of a number of recent, potentially active volcanoes. Detailed studies of some of these, most notably Mount Edziza, by the Geological Survey are closing an important gap in knowledge of the circum-pacific ring of volcanoes. In addition, this work has a social aspect in that hazards to the public from possible future eruptions can only be evaluated on the basis of sound scientific data which these studies are now providing.

On the east coast oceanographic studies by the Bedford Institute of Oceanography and Dalhousie University have furnished a wealth of data on volcanism of the Mid-Atlantic Ridge and more recently by Dalhousie on the intraplate islands of Bermuda and the Azores. The two institutions were involved with JOIDES during the summer of 1974 in the "Deep Drill 1974" program wherein five deep holes were drilled into the volcanic basement of the Atlantic near the Mid-Atlantic Ridge at 36°N. Investigators in a number of institutions across Canada are participating in studies of the core with the auxiliary benefit to the science of drawing a broad segment of the discipline into the forefront of the new developments and thinking. Geochemical studies on oceanic islands and island arcs being done at the University of Montreal have brought together an immense pool of data on the volcanic rocks of these features.

The Early Geosynclines

Volcanic rocks of Paleozoic and Proterozoic geosynclines, which have many of the attributes of plate-generated volcanism of more recent times, are more difficult to interpret in terms of the modern concepts because of their remoteness from known plate movements.

The Appalachian Geosyncline has been attributed to a former opening and closing of the Atlantic Ocean. Recent and current studies on ophiolites and the volcanic belts of western Newfoundland, notably at Memorial University are providing much new data relevant to this interpretation. Calc-alkaline volcanic rocks of New Brunswick, which in the modern context are generated at converging plate margins, are being investigated at the University of New Brunswick and the University of Montreal.

Volcanism in some of the major Proterozoic geosynclines – Circum-Ungava, Coronation, and Grenville – has been and is continuing to be of prime interest. Former work by the Geological Survey and the Québec Department of Natural Resources in the Circum-Ungava Geosyncline indicated that the Labrador Trough, at least, was ensialic and thus difficult to reconcile with a plate tectonics model. The volcanic rocks were found to be mainly oceanic in character and calc-alkaline rocks, the hallmark of subduction zones, were essentially lacking. Current work by the Geological Survey in the Cape Smith belt has uncovered sufficient new exposure of calc-alkaline rocks to warrant a re-examination of previous views. Volcanic rocks of the Coronation Geosyncline presently being examined by the Geological Survey are found to be dominated by enormous thicknesses of late-orogenic, intermediate to felsic lavas and ignimbrites in much the manner of the Andean Cordillera. Their origin might, by analogy, be amenable to a plate tectonics interpretation.

Grenville geosynclinal volcanic rocks have been shown to comprise a thick assemblage of mafic to felsic calc-alkaline rocks by recent and continuing stratigraphic and geochemical studies of Carleton University and the Geological Survey. Although chemically analogous to modern island arcs, limited exposures make their interpretation difficult.

Archean Greenstone Belts

Archean greenstone belts are characteristically composed of thick sequences of mafic to felsic volcanic cycles – predominantly subaqueous – with variable amounts of interfingering and overlying greywackes and shales. They are chemically analogous to modern island arcs but their tectonic setting and structural style are unique. Fragmentary evidence suggests that they may have been deposited, in part, on a sialic crust. Some workers believe that they were formed by a primitive type of plate tectonics.

Geochemical and stratigraphic studies have been done on many of these belts and this work is continuing at a good rate, most notably at the University of Manitoba, the University of Toronto, the Ontario Division of Mines, the Geological Survey, and the Quebec Department of Natural Resources. Basin analysis, a relatively new technique in volcanic belts, is being employed successfully in the Abitibi and other belts, greatly aided by recognition of the environmental significance of facies changes in iron-formation or "exhalite" and in the identification of volcanic centres. Discovery of ultramafic lava flows in the Abitibi belt by geologists of the Ontario Division of Mines and the University of Toronto has added a new facet of interest to Archean volcanology which is being pursued at a number of centres. As a result several additional occurrences of ultramafic flows have come to light in the Abitibi belt and in an entirely new locality, the Prince Albert belt, Melville Peninsula in the Subarctic. Well preserved primary textures, including quench textures, found recently in Archean lavas from several localities by scientists of Ecole Polytechnique and Queen's University will likely produce some interesting advances in Archean petrography.

Volcanism of the Stable Crustal Platforms

Plateau basalts are the principal representatives of this type of volcanism. In Canada the major provinces are the Coppermine River, the Keweenawan, the Seal Lake, and the Natkusiak of Proterozoic age, and basalts of Miocene age of central British Columbia. All have been recently studied or are presently being studied by the Geological Survey. Although known to be related to tensional faults, the place of these basalts in the global tectonic system is still obscure.

Economic Geology

Concepts relating ore deposits and volcanism have developed rapidly in recent years and have expanded to include a great diversity of ores. Broadly-speaking volcanogenic ore may be (1) a "stratigraphic" unit within the host volcanic assemblage, or (2) a part of the subvolcanic "feeder" system. The type of ore seems to be a function of stratigraphic position and/or nature of the volcanic or subvolcanic associate. Thus study of volcanic stratigraphy has become an important adjunct to prospecting and is being pursued by mining companies, universities, and government agencies alike.

The volcanic belts of principal current interest in Canada are the Mesozoic volcanic and subvolcanic assemblages of the Cordillera, the Paleozoic volcanics of the Appalachians, and the Archean greenstone belts. In the Cordillera much of the work is related to the subvolcanic phases, for example the "porphyry coppers", whereas in the Appalachians and the Archean it is primarily directed at "stratigraphic" ores. The latter commonly are a facies of "exhalite", and basin analysis has a very direct application in the search for ore.

Ancillary Studies

Paleomagnetic and geochronology studies being performed at a number of laboratories in Canada are contributing indirectly to volcanology by helping to formulate the tectonic framework into which past volcanic events can be fitted. More directly they are of value in correlation. Work on low-grade metamorphism being done at Brock University, University of British Columbia, Memorial University, and elsewhere is helping to define the conditions and effects of diagenesis on volcanic rocks. Most important in this regard, especially in geochemistry, are the likely changes in composition of the rocks attending diagenesis. Experimental studies on the petrology of volcanic rocks are being conducted at the University of Western Ontario, University of Alberta, and the University of New Brunswick.

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