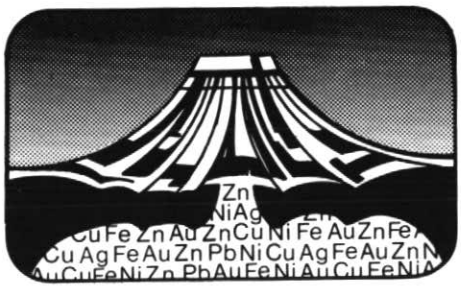

Vulcan's Forge Western Branch

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The fifth G.A.C. Cordilleran Section Symposium at the Bayshore Inn in Vancouver, February 8th and 9th, dealt with the theme, "Volcanic Geology and Mineral Deposits of the Canadian Cordillera" which matched heightened interest in these subjects in the west.

Over 700 geologists attended, of which some 60 per cent were local but there was broad representation from the Cordilleran U.S.A. and Extra Cordilleran Canada. The careful planning by the committee led to a high degree of congruence of interests and goals with unanimous attendance and attention. One of the good features of these Cordilleran Section symposia, particularly evident at this one, is the meshing of theory and fact, mega-think and detail, areal geology and metallogeny, esoteric and applied geology. This has stimulated geological thinking in exploration and a good case could be made that the Fourth Symposium on sedimentary rocks and related deposits led directly to discovery. It also appears to have stimulated thinking among non-exploration geologists of applied aspects of their science. However, the success of the symposia has its penalties. It has resulted in the very large attendance with corresponding inhibition of discussion on the floor and poor visibility of slides from the back of the large room. Organizers of future symposia should give some thought to these problems.

The outline of the Fifth Symposium was as shown in the table. The foregoing programme achieved most of the objectives of the planners. It was characterized by wide accord on the major premises on earth, petrogenic and metallogenic models. Souther's overview of these subjects was certainly most effectively and handsomely illustrated (Figs. 1, 2). Souther, Dickinson, and Lipman all emphasized the tremendous diversity of magmas that could be generated under continental convergent plate margin in which mantle, depleted

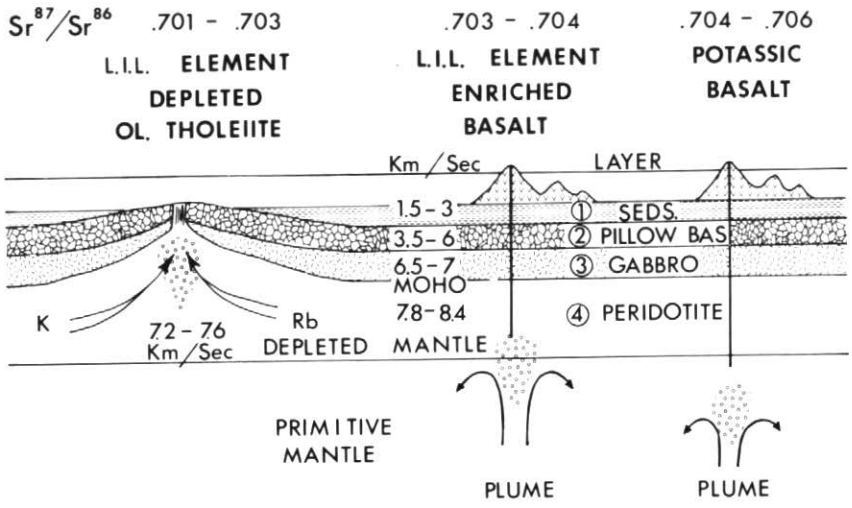

Figure 1
A conceptual model of the oceanic environment showing the difference in major element and isotope abundances in mid-ocean ridge and oceanic island basalts (J. G. Souther).

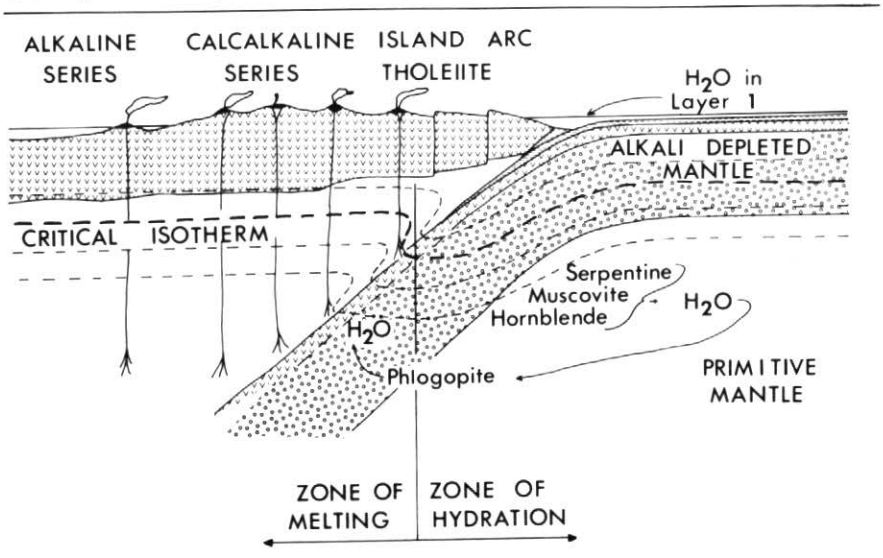

Figure 2
A conceptual model of the continental margin environment showing the relationship between magma series and depth to a zone partial melting controlled by release of water along a subduction zone (J. G. Souther).

Introduction
Overview of volcanic environments, styles and processes that lead to sulphide segregation (J. G. Souther).

Classification of volcanic rocks and their tectonic implications (W. R. A. Baragar).

Sulphide deposits formed in volcanic terranes (R. V. Kirkham).

Preorogenic "Oceanic" Volcanism
Review of processes and styles of oceanic volcanism (A. McBirney)

The distribution of oceanic volcanic rocks in the Canadian Cordillera (J. W. H. Monger)

Characteristics of sulphide deposits associated with oceanic volcanic rocks (L. A. Clark)

Britannia, a deformed Mesozoic volcanogenic copper-zinc deposit (J. G. Payne, J. A. Bratt, B. G. Stone)

Isotopic differences between arc and oceanic volcanic rocks – a review (J. E. Armstrong)

Synorogenic "Arc" Volcanism
A review of arc volcanism (W. R. Dickinson)

Arc type volcanic rocks in the Canadian Cordillera (H. Gabrielse)

Isotopic differences between arc and oceanic volcanic rocks – a review (J. E. Armstrong)

Western Mines, an example of sulphide related to Paleozoic arc volcanism (B. Spencer)

Geology of the Nicola volcanics and related mineralization at Aspen Grove, B.C. (V. A. G. Preto)

Seneca deposit ,an example of Kuroko mineralization (R. Watanabe)

The Nikolai Greenstone in the Wrangell Mountains, Alaska (E. M. MacKevett, Jr. and D. H. Richter)

Late Orogenic "Terrestrial" Volcanism
Terrestrial volcanism in North America – relation to crustal plate motions and old lithosphere (P. Lipman)

Distribution of terrestrial volcanic suites in space and time in the Canadian Cordillera (H. W. Tipper)

The Lake Bennett cauldron subsidence complex, B.C. and Y.T. (M. B. Lambert)

White Lake Basin, an example of graben development and volcanism (B. N. Church)

Structural setting of Cenozoic volcanic and sedimentary rocks of British Columbia (W. H. Mathews)

The Nikolai Greenstone in the Wrangell Mountains, Alaska (E. M. MacKevett, Jr. and D. H. Richter)

Alteration Processes of Volcanic Rocks
Submarine weathering processes as the onset of alteration of volcanic rocks (Y. R. Nayudu)

Alteration of volcanic rocks – a review with Cordilleran examples (P. B. Read)

Low grade alteration assemblages in the Hazelton Group and their relation to stratigraphy (T. A. Richards)

Archean Volcanism and Metallogeny
Archean volcanism and metallogeny – are there Cordilleran analogues? (R Ridler)

A model for Archean volcanogenic massive sulphide deposits (G. Mannard)

Synopsis
Vulcan's forge – a synopsis of Cordilleran opinion (A. Sutherland Brown)

mantle, lower and upper continental crust, oceanic crust and sediments are all capable of being thrown into the crucible. However they cautioned that very similar rocks could have had very different geneses and histories although both Lipman and Armstrong demonstrated that an isotopic signature was impressed on magmas traversing the upper crust. Dickinson and Souther appeared to disagree on whether primary magmas generated at equivalent distance behind a trench would or would not be identical regardless of the thickness of crust etc. The great preponderance of oceanic volcanism was touched on by McBirney, Lipman, and Armstrong, as were certain similarities between the magma trends of oceanic islands and non-orogenic continental volcanism. McBirney drew attention to problems in generating magnetic signatures at spreading centres and elaborated on variation possible in dyke intrusions with different spreading rates. He had some fun with mantle plumes and finished by pointing out the difficulty of explaining the generation of terrains like the Galapagos platform by the present paradigm. Dickinson stated the need for a very thorough recycling of materials in the outer mantle and crust and Armstrong emphasized that very efficient mixing had, and is taking place. The only really different model of spreading centre and oceanic island was given by Nayudu during the course of his talk on submarine weathering. He envisaged a growing tholoid mass sheathed with a hyaloclastite carapace intruded by pillows.

In contrast to the general agreement on the foregoing subjects, there was a divergence in the subject of petrologic classification. Barager presented what I suppose could be called an official Canadian view, in which classification is dependant on normative composition. Church *en passant* gave a differing view based more on physical character, major oxide relationships and traditional names. Church's scheme has a certain acceptance in the west and it will be interesting to watch their relative fortunes. However, it is at least as likely that A. L. Strekeisen and the I.U.G.S. Committee on Systematics of Igneous Rocks will produce an international classification, the product of compromise, after which I would not be a bit surprised if such lovely, if esoteric names as tristanite and pantellerite are subducted to reappear as say trachyandesite and soda rhyolite.

Regarding other nomenclature we were again subjected to a vast array of semi-synonyms applying to plate tectonics and particularly to terms for convergent plate margins. Here we had consuming margin, Benioff Zone, subduction zone, seismic zone, site of plate consumption and my favourite, consumptive environment (not a sanitorium).

Monger, Gabrielse and Tipper of the G.S.C. lucidly discussed the distribution in the Canadian Cordillera of volcanic rocks of possible oceanic origin, arc, and terrestial origin respectively. The main problem was Monger's task. Are there in fact oceanic suites? In the face of non-diagnostic chemical analyses and virtually no isotopic data he had to base his opinion of geological factors such as lack of known basement to a suite, general petrologic character and association with ultramafic bodies and extensive chert. By these criteria, much of the late Paleozoic rocks of the Intermontane Belt as well as the Eocene Metchosin of southern Vancouver Island may well be oceanic. The Triassic Karmutsen Group of the Insular Belt was thought by Gabrielse and by Souther to be part of an island arc suite. The Nikolai Greenstones of the same age and similar petrology is judged by MacKevett, and Richter of the U.S.G.S. to be a subaerial succession to the surprise of many of us.

Preto, Church and Lambert presented examples from arc and post-orogenic terrestial settings and demonstrated the need for detailed mapping in these locales for satisfactory interpretations. Lambert's beautiful example of an Eocene resurgent caldron was outstanding. Church's unravelling of the complicated petrogeneses of Eocene White Lake Basin was covered briefly by him in favour of comparison with similar suites in similar settings. Preto's study of the Nicola is the sort necessary for effective geological deduction to be applied to discovery of buried mineral deposits in this copper-rich but intensely prospected terrain.

W. H. Mathews discussed the structural setting of Cenozoic volcanic rocks in B.C. He demonstrated the lack of relief on the unconformity underlying the Eocene succession and contrasted this with the development of topographic highs adjacent to depositional basins during the eruption period. He also described the thermal metamorphism of gneissic basement during the period of eruption.

In addition to Nayudu's talk on submarine weathering, Read described sub-greenshist alteration in volcanic rocks in widely separated parts of the Cordillera. He showed that superficially unchanged rocks and their contained mineral deposits had commonly re-equilibrated at conditions of four kilobars and 300°C. Richards demonstrated a low grade metamorphic zoning with depth in Hazelton Group and a critical dependance on the nature of the strata, whether marine or non-marine, volcanic or sedimentary.

Between the economic geologists a consistent picture developed without obvious collusion or intent. Kirkham described the tectonic setting and types of sulphide deposits of a volcanic terrain. Clark described deposits of the Troodos massif in Cyprus since there are no known examples in the Canadian Cordillera. Ridler described Archean metallogeny and Mannard gave a good description and comparison of relatively recently discovered massive sulphide deposits in the Archean. Three Phanerozoic volcanic massive sulphide deposits in the Canadian Cordillera were described. Spencer dealt with Western Mines and its Permian arc setting, Watanabe with the Seneca deposit in a Jurassic arc setting, and Payne, Bratt and Stone with Britannia in a Cretaceous arc setting. Watanabe also gave much comparative material on Kuroko deposits of the Neogene Green Tuff region of Japan.

It was evident from the foregoing talks that we had a gradation of characteristics between Archean and

Neogene deposits with Cordilleran examples being transitional. This applied with respect not only to the presence or amount of pyrrhotite, barite, anhydrite, and lead but also to the nature of the alteration pipe whether chloritic or silicic. Changes in the tectonic regime, the atmosphere, the general degree of metamorphism, and additions of radiogenic lead to the system appear to offer explanations for this evolution.

Surprising perhaps, was the relatively scant discussion of distal stratiform volcanogenic mineral deposits, copper in basic lavas, the nature and origin of Sustut Copper deposits, or the meaning of the relative zoning of massive sulphide and porphyry deposits in the Canadian Cordillera.

These were two well-spent days to even the most well informed. One wonders what the Cordilleran Section will do for an encore.

MS received, March 8, 1974.