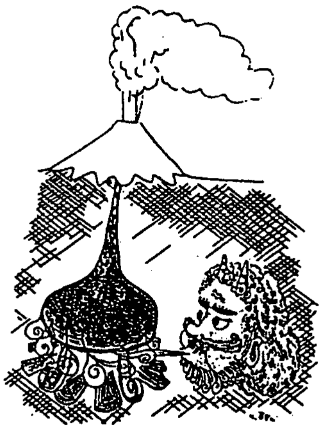

ASH FALL

Newsletter of the Volcanology Division
Geological Association of Canada

ASH FALL # 21

March, 1989

ACTIVITIES

Field Trip #19, April 29 to May 14, 1989, arrangements have been finalized. Les Coleman has reported that schedules have been mailed to the 27 participants.

CONFERENCES

G.A.C. Annual Meeting, Montreal, May 1989.

IAVCEI June 25-July 1, 1989, Santa Fe, New Mexico

ASH FALL BOUQUETS

"Glowing Cloud Award" to the producers of "Miracle Planet" for superb photography and graphics for a geoscience educational series. "Volcanic Bomb" award to the writers of Miracle Planet for a variety of statements such as "travertine is artificial marble".

CONTRIBUTIONS

Two contributions are included as separate papers for the membership with this newsletter.

Contributions to Ash Fall are welcomed and should be sent to:

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Victoria, B.C. V8Y 3A5

Phone (604) 658-2366
FAX (604) 658-5289

RESEARCH SURVEY

The time has come again to update volcanological research projects for 1988-89. A letter and form supplied by Tark Hamilton have been included with this issue.

INVESTIGATIONS OF PLEISTOCENE AND RECENT VOLCANISM IN THE FORT SELKIRK AREA, YUKON TERRITORY

By
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February 10, 1989

During July of 1988, I investigated a Pleistocene volcano located approximately 7 km east of Fort Selkirk, Yukon (62°45'N, 137°15'W). The mountain is located on the east side of Yukon River immediately upstream from the Pelly River confluence. The volcano is part of the Selkirk Group, basaltic lava flows that fill the Yukon valley extensively in this area. The Selkirk Group ranges in age from approximately 1.5 Ma to recent. The investigation was a part of regional Quaternary geology mapping of Carmacks map area (115 I). This small volcanic edifice is about 2 km in maximum diameter and has about 200 m of relief above the valley floor. It proved to be almost entirely composed of hyaloclastites: pillow basalts, pillow-tuff breccias, and tuff breccias. The presence of hyaloclastites throughout the mountain plus the presence of exotic pebbles throughout these deposits led me to conclude that this edifice was erupted beneath an ice sheet, probably during the mid or early Pleistocene. This work is detailed in Current Research, Part E, Geological Survey of Canada Paper 89-1E, p. 251-256. I will be returning to the mountain this summer (1989) with colleagues to carry out further studies.

I will also be examining Volcano Mountain about 21 km to the north (62°56'N, 136°23'W). The eruptive history of this very fresh appearing cindercone has not been determined. Oral tradition among local native people, as collected by anthropologist and colleague Ruth Gotthardt, indicates that the mountain may have last erupted as recently as the 1880's. We hope to document the most recent eruption of this volcano plus construct an eruptive history this summer.

PEARCE ELEMENT RATIOS: A PARADIGM FOR THE TESTING OF PETROLOGIC HYPOTHESES

J.K. RUSSELL*, C.R. STANLEY**, AND JIM NICHOLLS**

INTRODUCTION:

New ideas in science are generally presented as postulates or hypotheses which purport to explain the structure of data sets or to expand existing theory. In igneous petrology the data sets usually include some combination of petrographic observations, whole rock chemical analyses, and phase chemistry. The data are the basis for questions and answers concerning the relationships between rock types or the origins of related rocks. As they are formulated, hypotheses are merely conjectures because they have not necessarily been subjected to any true tests. For example, most geologists who have made their own observations on igneous rocks and then looked for an petrogenetic explanation for those observations have probably felt the frustration of facing more than one possible explanation. There is generally no shortage of hypotheses when it comes to explaining variations in mineralogy and chemistry of igneous rocks. There is however a shortage of methods with which to test these postulates rigorously. In fact, in addition to providing new ideas it is the job of scientists to find adequate tests of hypotheses. In a compelling manner, Popper (1959) laid out the following challenge:

" But these marvellously imaginative and bold conjectures or *anticipations* of ours are carefully and soberly controlled by systematic tests. Once put forward, none of our anticipations are dogmatically upheld. Our method of research is not to defend them in order to prove how right we were. On the contrary we try to overthrow them. Using all the weapons of our logical, mathematical, and technical armoury, we try to prove that our anticipations were false-"

In adopting this philosophy, the scientist switches from trying to prove that he's right, to acccepting the responsibility of proving his postulates are wrong. In this manner science is able to safeguard its integrity against the multitude of new and ill-founded hypotheses. It is implicit in this approach, that the scientist have as many tests as possible at his disposal and that he use them. Pearce element ratios (Pearce, 1968) provide a means of testing virtually any hypotheses that involve mass transfer processes. Our research has investigated the use of Pearce element ratios in the study of igneous processes. Below we have summarized some of our ideas and the IBM-compatible programs we have developed.

PEARCE ELEMENT RATIOS:

Pearce element ratios are defined as having a constituent in their denominator that is conserved in a system undergoing change. The element ratios are calculated in two steps. All wt. % oxides are first converted to the element fractions, e_i, by:

$$e_i = W_i A_i / MW_i$$

* University of British Columbia, ** University of Calgary

where W_i, A_i, and MW_i are the wt. %, the number of cations in the oxide formula and the molecular weight of oxide i. The Pearce element ratio of i is:

$$r_i = e_i / e_z$$

where z is the requisite conserved element.

Proper construction of Pearce element ratios removes the effects of closure that are so apparent in conventional Harker-type variation diagrams. Consequently, variations in Pearce element ratios are guaranteed to be related to the actual elemental variations in the system. The observed element variations are also more easily related to mineral stoichiometry. The result is that Pearce element ratios are an effective means of determining whether the members of a rock suite are comagmatic and can illustrate the causes of chemical diversity in comagmatic suites. In this way Pearce element ratio diagrams provide unambiguous tests of petrologic hypotheses.

TESTING PETROLOGIC HYPOTHESES:

Discussion of a suite of rock analyses in terms of magmatic differentiation, implies that the compositions are derived from a single lineage. Rather than take this assumption *a priori* Pearce element ratios provide an effective means of testing this hypothesis by constructing ratios of conserved elements. These element ratios should be single valued (within analytical uncertainty) if the rock suite is comagmatic and if both the numerator and denominator elements were truly conserved.

Element ratios comprising numerator elements which are not conserved throughout the mass transfer process will vary in direct accordance with the stoichiometry of the mass transfer process. For example, if the magma is undergoing differentiation by fractional crystallization, the variations in Pearce element ratios will reflect the phases being removed as well as the compositions and proportions of these phases. Conversely, by examining the nature of the chemical variation seen in Pearce element ratios it is possible to unambiguously ascertain the stoichiometry of the process and constrain the actual identity of the mass transfer process.

In our work we have established three types of Pearce element ratio diagrams used to test petrologic hypotheses. These are:

i) Conserved Constituent Diagrams: to test whether a suite of rocks are cogenetic.

ii) Hypothesis Test Diagrams: to test whether the accumulation or loss of a specific phase assemblage can explain the observed compositional variations.

iii) Discrimination Diagrams: to test whether the observed chemical variations require that a specific phase be involved, and to estimate the extent of that involvement.

SOFTWARE DEVELOPMENTS:

To employ Pearce element ratios requires two computational exercises. Firstly, there is the straightforward, if tedious, conversion of wt. % data to a Pearce element ratio basis. Secondly, there is determining the nature of the variation diagram that will best test each hypothesis. We offer a set of four computer programs to facilitate the use of Pearce element ratio diagrams. PEARCE.PLOT is an interactive, graphics-aided program to aid in the calculation of Pearce element ratios and the analysis of data sets. AXISHT and AXISDS are computer programs to help determine the optimal axes coefficients of Hypothesis Test and Discrimination Diagrams, respectively. It is our hope that other scientists will use these programs to expand the application of Pearce element ratio diagrams. Finally, AXISGV is designed to determine the vector displacements of phases on any specified Pearce element diagram. We anticipate that the current theory on Pearce element ratios and these user friendly programs will allow petrologists to test petrologic hypotheses more rigorously than ever before. The programs described above are available from the University of Calgary or University of British Columbia for $15.00 CDN.

FUTURE DEVELOPMENTS and SHORT COURSE:

Pearce element ratios are useful in the analysis of all mass transfer processes in which there is a conserved variable. Therefore it is reasonable to expect that Pearce element ratios will find increasing use in other fields than the study of magmatic differentiation processes. Pearce element ratios could be used to extract trace element distribution coefficients from experimental data, to determine the phase assemblage in small experimental charges where only the glass can be analysed, to characterize the effects of diffusion, or to study the stoichiometry of metasomatic alteration processes.

To encourage the use of Pearce element ratios and to stimulate further development, we are running a G.A.C. sponsored shortcourse at the 1990 G.A.C. - M.A.C. annual meeting in Vancouver, B.C. Tentatively, the course is planned as a two-day series of lectures and tutored manual and computer-aided exercises. Further information will be circulated with the 1990 conference details.

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SURVEY OF CANADIAN VOLCANOLOGICAL RESEARCH FOR 1988-1989:

Dear Colleague:

On behalf of the Volcanology Division of the GAC, I invite you to summarize your volcanological research activities for inclusion in volume 41 of the Canadian Geophysical Bulletin. Any projects dealing with volcanology, petrology and related topics are appropriate. This annual survey reports VGP work by researchers in Canadian institutions and corporations or work by foreign researchers that focusses on aspects Canadian volcanic geology.

My thanks to those of you who took the time to fill out the forms and respond last year. Because of your participation, over 76 respondents; 1988 was the best reported year to date. Nonetheless, much active research has still gone unreported, particularly those programs conducted or funded by private corporations. For those division members who have contacts with other active researchers, please copy the questionnaire and pass it on.

Yours truly,

Tark Hamilton

Tark Hamilton
Special Councillor on Research

SURVEY OF CANADIAN VOLCANOLOGICAL RESEARCH FOR 1988-1989: GAC VOLCANOLOGY DIVISION FOR CANADIAN GEOPHYSICAL BULLETIN Vol.41

Please distribute to active researchers and reply by April 15 to: Dr. T.S. Hamilton, Geological Survey of Canada, Pacific Geoscience Centre, P.O. Box 6000, Sidney, B.C., V8L 4B2

RESEARCHER(S): TELEPHONE: ( )-

AFFILIATION/ADDRESS: PROJECT STATUS: NEW ONGOING COMPLETING

TITLE OF PROJECT/STUDY:

OBJECTIVES:

METHODS/DATA:

PROGRESS/SIGNIFICANT FINDINGS:

PLANS FOR FUTURE WORK:

LIST OF VOLCANOLOGICAL PUBLICATIONS FOR (1988 -1989):

METHODS/DATA:

PROGRESS/SIGNIFICANT FINDINGS:

PLANS FOR FUTURE WORK:

LIST OF VOLCANOLOGICAL PUBLICATIONS FOR (1987 -1988):