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Introduction

The 22nd annual Institute on Lake Superior Geology gathered May 3 to 7, 1976 in stately St. Paul, Minnesota under the sponsorship of the Minnesota Geological Survey. Some 225 delegates were attracted from as remote as San Francisco and Florida to hear 60 papers dealing with the Lake Superior region. Two themes dominated the proceedings: a symposium on the geology and geochemistry of early Precambrian rocks; a session on engineering and environmental geology. This synopsis of the conference will be biased in favour of the Precambrian session - a more balanced treatment is available as published abstracts (order from: Publications Sales, Minnesota Geological Survey, 1633 Eustis St., St. Paul, Minnesota 55108, $5.00 and tax).

The technical sessions were preceded by two exceptionally well organized field trips - the Minnesota River Valley trip choreographed by S. S. Goldich, G. B. Morey, V. R. Murthy and a trip to the Engineering and Pleistocene Geology in the Twin Cities area convened by C. R. Nelson, D. H. Yardley and S. E. Chernicoff. Even after the proceeding got underway in the ballrooms of the Radisson St. Paul Hotel, the walls were still ringing with praises for the excellent German cuisine and abundant beer encountered by the geotourists.

Technical Sessions

Both the field trips and subsequent technical papers revealed the contrast in geological logistics north and south of the Ontario-Minnesota border. Our American counterparts conduct very intensive studies (e.g., the Minnesota River Valley) on very limited outcrop exposure and must resort to some extensive extrapolations.
R. W. Ojakangas (Minnesota: 'Anatomy of a well covered greenstone belt, N.W. Minnesota") was hampered by up to 500 ft. of glacial till masking the Birchdale-Indus area: much of his data was gleaned from 80 exploration drill holes while a large span of iron formation was postulated from magnetometer highs.
R. S. Maass (Wisconsin) unravelled a complex banded Archean gneiss-dyke regime along the Wisconsin river on the basis of three outcops mapped in scales of feet.

In sharp contrast, the field reports of Canadian workers (C. F. Gower, McMaster - English River Gneisses; M. M. Kehlenbeck, Lakehead - Quetico-Wabigoon boundary) were overexposed in outcrop information. Whereas our American colleagues can concentrate on subtle patterns in geochronology, rare earths, etc., we Canadians are saddled with some fundamental mapping to complete. The "English River Gneiss Belt" has now been subdivided into a northern high grade metagraywacke-metasiltstone sequence and a southern pre- to syntectonic felsic plutonic terrane (G. P. Beakhouse, Manitoba). The "gregarious pink batholiths" within the Wabigoon and Quetico belts remain essentially unmapped. When tackled they prove to be complex aggregates of plutonic-gneissic-volcanic phases as unpredictable as the "gneiss" belt.

Geochemical information is now forthcoming for those Ontario regions having corresponding field control. The weighted mean element composition of the Geotraverse area compares closely both to previous Superior Province compilations and to the Ukranian Shield with the exception of lower K_2O and higher CaO (A.M. Goodwin, Toronto). Granitoids from both the English River gneisses (C.L. Chou, Toronto) and from the Kenoran plutons within the greenstones show high K/Rb ratios. The Kenoran plutons (D. Birk, McMaster) are further characterized by the high Sr, Ba and low Rb/Sr, $(Sr^{87}/Sr^{86})_i$ generally attributed to the "early" sodic granites of other Shield areas (Glikson and Lambert, 1976). Are Glikson's models of secular trends in chemistry and granitoid recycling applicable to the Canadian Archean?

The low initial strontium ratios in this last Archean granitoid episode dictates against recycling (S. Moorbath, 1975). Participants in a discussion initiated by A. M. Goodwin (Toronto) Thursday morning, wrestled with possible non-mantle origins of such low ratios but failed to reach accord.

E. C. Perry, Jr. (N. Illinois) hinted at 3.7 b.y. life remnants in amphibolite facies supercrustals of Isua, West Greenland based on graphic carbon associated with iron formation. This biogenetic interpretation for iron formation got strong petrographic support from M. S. Lougheed (Bowling Green) whose lucid slides documented the progression of transport, deposition, and diagenesis of biogenic carbonates, silica tests and algal hash to form the iron ioxide-chert laminae. His photomicrographs of "footballs" and "basketballs" of siliceous microorganisms in the Gunflint Formation were most convincing. F. M. Swain (Minnesota) reported straight chain hydrocarbons up to C_{11} detectable in the volatiles of 42 Precambrian drill cores - but preferred a juvenile igneous explanation.

D. L. Southwick (Macalaster) gave the first Ontario-Minnesota report of a garnet-tourmaline-cordierite-sapphirine assemblage in contact schists of the Vermilion Batholith. His excellent petrographic slides could have benefited from some electron microprobe confirmation.

REE patterns are possibly not as stable as previously supposed. Data from the nebulitic Morton Gneiss (G. N. Hanson, Stony Brook) suggests mobilization of REE at least on the scale of centimetres under metamorphic metasomatic environments. Metasomatism was demonstrated by other workers by the density distribution of microcline-perthite megacrysts outward from a tonalite-granodiorite batholith (C. F. Gower, McMaster) and by the growth of such megacrysts within mafic enclaves - the classic *dents de cheval*.

The Thursday session terminated in a thought-provoking banquet lecture by

Eugene M. Shoemaker (California Institute of Technology) on the accretion and cratering history of the solar system. Superimposed cratering as illustrated by moon photos will progressively mask earlier craters (example: Crater Korolev) until a "saturated surface" or steady state distribution is reached. Thus the present moon surface topography dating at 3.3 b.y. documents only the vestige of a major cratering event - probably the "tail end sweep up" from the birth of the planets at 4.6 b.y. Shoemaker suggests that most of the earth's current radius was achieved in the first 200 m.y. of accretion. Volatiles and alkalis were plated on during the tail end of the cratering episode. Crustal material was not "sweated out" from the mantle but rather was a later addition. Archean geologists should take note of this potential source for low strontium ratios.

Saturation cratering for the Archean earth puts an upper age limit on isotopic systems but also implies world wide vestiges of "old" ages. Zircon ages of 3.5 b.y. are now reported for tonalite-granite gneisses of the Watersmeet area, N. Michigan (Z. E. Peterman, U.S.G.S.). We anticipate similar old ages from the English River gneisses.

Concluding Remarks

The Institute on Lake Superior Geology conferences have grown in recent years sufficiently to require synchronous sessions. The same time has seen a proliferation of conferences with overlapping regions and themes, (annual Geotraverse, Toronto; Archean Crust in Canada, Nov. 1975, Hamilton). Perhaps a restructuring of the Institute and the branching of an Archean Division with its separate and annual Archean conference could accommodate this multiplicity of meetings and tighten the conference theme.

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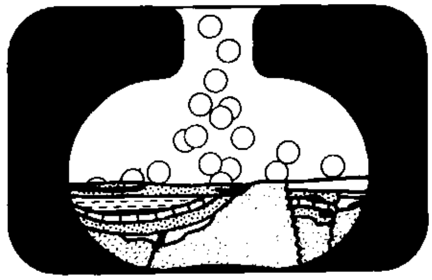

Exploration Geochemistry in the Appalachians

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The Association of Exploration Geochemists holds major international symposia every other year, with a venue in North America every fourth year. The concept of regional meetings arose to allow continuity of contact between geochemists, especially since relatively few North American members are able to travel to the Sixth International Symposium which is to be held in Sydney, Australia this year. The first regional meeting "Exploration Geochemisty in the Appalachians" was held on the University of New Brunswick campus on April 22 and 23, 1976, with field excursions to mining properties in New Brunswick on April 20 to 21 and 23 to 24. The Chairman of the Organizing Committee for the meeting was G. J. S. Govett.

The technical programme was attended by 190 delegates from eight Canadian provinces, 14 U.S. states, France, Sweden, and the U.K. representing mining companies, universities, provincial and state organizations, the U.S. Geological Survey, the Geological Survey of Canada, and the Swedish Geological Survey. The keynote address - "New Brunswick: where it all began" - was given by Dr. H. E. Hawkes and recounted some of the early history of exploration geochemistry, including the world's first regional drainage survey he led in New Brunswick in 1953-1955. The address complemented the speech by the Hon. R. C. Boudreau, Minister of Natural Resources of the Province of New Brunswick which reviewed the state of the mining industry in the Province today.

The technical papers illustrated that in northern latitudes the usefulness of drainage surveys in exploration is limited in many cases by several environmental factors: a general lack of fine-grained stream sediment suitable for analysis; frequent high concentrations of Fe and Mn oxides that scavenge other metallic elements; and ubiquitous organic material that also tends to concentrate metals. An outstanding paper given by J-O. Larsson (Geological Survey of Sweden), "Organic Stream Sediments in Regional Geochemical Prospecting, Precambrian Pajala District, North Sweden", demonstrated how these adverse conditions can be overcome and, indeed, used to advantage. The drainage reconnaissance technique described is based upon deliberate collection of organic rather than mineral samples; the samples are ashed and - in Larsson's work - analyzed by X-ray fluorescence for Y, U, Th, Zr, Zn, Rb, and W, and by emission spectroscopy for Pb, Zn, Mo, Co, Mn, Ni, Mg, V, Ti, Ca, Ba, Sr, Ag, Bi, As, Sn, Be, and Cr. The results from more than 10,000 samples collected over an area of 8,000 km^2 (3,000 sq. mi.) showed that the wide availability of organic samples allowed the desired sample density to be maintained. Moreover, the high trace element content in organic material is an enormous analytical advantage (e.g., the mean background for U is 22 ppm compared to background in mineral sediment of around one ppm), and the anomalies are also more homogeneous and extensive. All analytical data in the paper are corrected for the effect of variable Fe, Mn, and organic content by step-wise regression analysis.

The survey described by Larsson is a model of integrated exploration where final interpretations are based on the drainage data, regional geology, quarternary geology, aeromagnetic and aeroradiometric surveys, and heavy mineral analysis in tills - all plotted on 1:50,000 maps. (The routine integration of all available exploration techniques is a gratifying trend evident in a number of other papers providing case history data). Another potentially valuable innovation described in Larsson's paper is a detailed follow-up technique based