# The Archean Crust in Canada

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This informal workshop was held at McMaster University, November 14-16, 1975. It was organized by the graduate students of the McMaster Archean Crustal Evolution (ACE) Group with C. Westerman serving as organizational chairman. Altogether, there are six faculty members and twelve M.Sc. and Ph.D. students at McMaster involved in Archean research. The projects include sedimentology, structural mapping, petrology and geochemistry in specified field areas in the Wabigoon greenstone belt and English River gneiss belt of N.W. Ontario and the Abitibi belt of N.E. Ontario.

The workshop concentrated on the granitic and gneissic rock, but some attention was given to supracrustal sequences. The first day concentrated on the tectonic problems in these rocks. A. Goodwin (Toronto) began the session with an overview of Archean belts with special emphasis on the Canadian Shield. Among the many points made, he showed that as a traverse is made from the Abitibi belt in the east to the Wabigoon belt, the Berens River block and the Pikwitonei belt in the west, apparently deeper sections of the Archean crust are exposed. This is suggested by a decrease in the amount of volcanics and a complementary increase in gneissic rocks; also by a decrease in gravity anomalies (from -70 to -10 mgals.) and an increase in magnetic field strength (from -100 to +200 gammas).

K. Collerson (Memorial) presented his views on Canada's oldest (to date) Archean rock on the coast of Labrador. The 3.6 Ga Uivak gneisses were reworked during a 3.1 Ga event, the latter the 12th stage recognized in their history. He showed that the Uivak gneisses contain inclusions of older material, including banded iron formation and layered anorthositic rocks. The lithologic and structural similarities between Labrador and the west coast of Greenland is very strong. (i.e., Uivak-Amitsôq gneisses, Saglik dykes-Amerilik dykes and 3.1 Ga gneisses -Nûk gneisses respectively.)

P. Thurston (Ontario Division of Mines) feels that the Shawmere anorthosite of the Kapuskasing area is Archean in age, and best fits B. Windleys' model of anorthositic development in high grade gneissic terrains, i.e., a basement type development. G. Hanson (SUNY, Stoney Brook) felt that, based on Rare Earth Element (REE) data, this body could well represent a magma chamber, as it showed strong tholeiitic character.

The Quetico gneiss belt in the Dog Lake area contains pelitic quartz gneisses on either side of a migmatite and major E-W shear zone. The metamorphic grade decreases from granulite to andalusite schists in a S-N direction (M. Kehlenbeck, Lakehead). The Quetico-Wabigoon belt boundary appeared to be gradational in this region.

Three talks were devoted to the English River gneiss belt, with presentations by F. Breaks (Ontario Division of Mines), C. Westerman (McMaster) and C. Gower (McMaster). Breaks presented a general overview of the belt based on two summers' reconnaissance mapping by the ODM. Westerman concentrated on the central part of the belt in the Perrault Falls area. Here, he finds the development of domal structures composed both of supracrustals (including banded iron formation and amphibolites still retaining pillow structures) and intrusives. Later granitic intrusives are found between the domes. The high grade gneisses (up to granulite grade) are either a facies of the metasediments or basement on which the sediment were laid. A discussion followed his talk, on the difficulty of recognizing gneisses as supracrustal or intrusive in origin. The problem of the "paranoid paragneiss" (D. M. Shaw) is still with us! On the southern boundary, north of Kenora, Gower finds a cataclastic zone adjacent to the Wabigoon belt. However this may be local, as N. Harris (Toronto) finds no such mylontization at the boundary 50 miles to the east. Elsewhere in his area, Gower has determined that an early tonalitic sequence is followed by two sets of mafic dykes (now represented as deformed amphibolite pods) and finally by late granodiorite intrusives. He believes that there were four periods of deformation in the area. Careful mapping shows that the amount of K-feldspar megacrysts in the tonalitic gneisses increased as the Dallas granodiorite pluton is approached. Gower feels this demonstrates K metasomatism as the cause of their formation.

Three papers were related to the deformational patterns within greenstone belts particularly at supracrustal-intrusive contacts. R. Shegelski (Toronto) gave a detailed structural analysis of the deformation and fracture pattern in Slave province metasediments as a result of quartz-monzonite pluton emplacement. Discussion centered on his concept of the 3-D shape of the intrusive, i.e., massive, mushroom shaped etc. A. Brown (Geological Survey of Canada) described the deformational history in greenstones adjacent to an "expanding" granitic terrain. He drew an analogy between a "scum" that develops on hot milk and the original fracture pattern in the area. This was followed by N-S compression and intrusion of later granitic material. F. Schwerdtner (Toronto), applied the results of his experimental strain deformation studies of his field area in the Wabigoon belt south of Ignace. He favoured a phacolith model for the smaller intrusive bodies which deform the volcanics but was undecided as to whether it would apply to the large batholiths in the area.

The first day ended with a controversial and intriguing talk by W. Brisbin (Manitoba). He pointed out that the Conrad and Moho discontinuities varied from 12-25 Km and 30-40 Km respectively in a N-S direction and that a deeper Conrad complemented a shallower Moho. For example, the English River gneiss belt has a thick upper crust and a thin lower one. He took the Conrad as a base reference and presented a model whereby the crust began as a 10 Km layered series and was increased to 20 Km by the addition of intrusive material from the mantle. He suggested that this would produce a 50 per cent horizontal and a 100 per cent vertical strain and produce the present deformation seen in greenstone belts.

The second day was concerned with the geochemistry of Archean rocks. S. Goldich (Northern Illinois) and G. Hanson presented two papers on the Minnesota Archean rocks. Goldich reviewed his ideas on the evolution of the Morton and Montenideo gneisses, and commented on the discrepencies between Rb/Sr whole rock and U/Pb zircon ages. He felt that the loss of Rb occurred during the breakdown of biotite during high grade metamorphism. Where this had happened, better Rb/Sr isochron statistics resulted, giving the metamorphic ages. Hanson presented REE data for the Minnesota granitic rocks. For the tonalitic gneisses he suggested that the high La/Lu ratio (10-50), negligible Eu anomalies and low K/Rb ratios favour a lower crustal, rather than a mantle source. The patterns of the 1800 m.y. and 2600 m.y. granites were very similar to the gneisses, and thus could be derived from the latter. Hanson felt that in general, REE patterns are powerful tools in discriminating sedimentary/igneous percentage for the younger intrusive bodies.

Data on granitic rocks within the Wabigoon greenstone belt in the Burdett Lake-Lake Despair region were presented by D. Birk (McMaster) and F. Longstaffe (McMaster). Birk felt that the so-called "late" K-rich stocks (such as the one at Burdett Lake) are not significantly different in origin or time of emplacement from the individual plutons that aggregate to form large masses such as the Aulneau dome. A discussion arose over the origin of the K-feldspar megacrysts, so common to these stocks. Birk envisaged a late stage autometamorphic model for their growth. R. Martin (McGill) felt that an equally plausible origin was through K metasomatism with the introduction of new material. Hence the use of experimental feldspar phase equilibria was not warranted. He stated that more attention should be given to the degree of Al ordering in feldspars as it could give much information on the origin of such megacrysts. Longstaffe showed that the Lake Despair area (an apt name for a complicated Archean area?) had, in addition to the "normal" tonalitic gneiss and diorite-granodiorites, a late (?) Na-enriched body composed essentially of oligoclase and/or albite. These units are unusually enriched in Sr and Ba, and show many features similar to rocks reported by Arth and Hanson in Minnesota. It appears that this part of the Canadian Shield may well be an area of late Na-enriched alkaline intrusives.

Two papers were presented on the volcanics and sediments themselves. W. Jolly (Brock) showed that the metamorphic grade in the Abitibi greenstone belt had a regional variation from prehnite-pumpellyite to hornblende-kyanite. J. Crocket and J. Kwong (McMaster) presented their Au analysis from the Kakagi Lake area. All the rock types averaged at approximately one ppb with the ultramafics showing the lowest and the mafic lavas the highest values. An unexpected result was that cherts were among the lowest in their Au values. Jolly suggested that great caution be taken in interpreting the volcanic rock, because of the ever present alteration.

Migmatite from the Manitoba Ni-belt on Superior-Churchill border in the Pikwitonei region gave Rb/Sr ages reflecting both the Archean (2800 m.y.) and Hudsonian times (1700 m.y.) (A. Turek, Windsor). This area seems a good one for some detailed zircon work to supplement the Rb/Sr and K/Ar.

D. Shaw (McMaster) was given the unenviable task of summing up the meeting, which he did with great insight. He presented his "gastronomy of granites" - are they mushrooms, pancake or indeed mushroom omelettes (i.e. composite sheets)? This is, their 3-D shape is very important for discussion of the room problem and crustal thickness. The lack of vertical relief (such as is available in the Greenland and Labrador fjords), leads to many alternate models for granites, and gives little chance of finding conclusive proofs. He felt that the "paranoid paragneiss" could best be treated with good field data, as rhyolitic and dacitic rocks are easily modified chemically during weathering and metamorphism. For future work, Shaw suggested that (a) a great deal more of geochronology be done, (b) that fluid inclusion studies may help interpret erosion depths, and (c) that O isotope studies, so long ignored in Archean rocks, are sorely needed. F. Longstaffe is now involved in such a project as part of his thesis work. Shaw felt that more attention should be paid to the chemical composition of clastic sediments as they appear to be a reasonable source for later intrusives. Finally, he made the point that no one could disagree with, i.e., that *Meaningful* geochemical modelling is impossible unless it is built on a foundation of detailed, high quality field mapping - cooperation between specialists in Archean research is essential!

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**Note**

We regret that the following mistake was made in the Conference Report "Third International Conference on the Physics and Chemistry of Asbestos Minerals" by R. Y. Lamarche which appeared in Vol. 2, No. 4, p. 202. The sentence starting on line 21 of the middle column should read: The asbestos ore-bodies at the Jeffrey, Normandi, Lake Asbestos, British Canadian, King-Beaver and Bell Asbestos mines are all said to occur in partly serpentinized ultramafic rocks that are part of the Lower Paleozoic (probably Lower Ordovician) ophiolitic complexes of the southern Quebec Appalachians while the deposits at the National and Carey Canadian mines are found in a highly serpentinized ultramafic intrusion, known as the Pennington Dyke, whose spatial, genetic and chronologic links with the ophiolite masses themselves have not yet been resolved adequately.