

GEOLOGY AND EXPLORATION OF KIMBERLITES ON THE BHP / DIA MET CLAIMS, LAC DE GRAS REGION, NORTHWEST TERRITORIES, CANADA

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A total of thirty nine kimberlites have been discovered on the BHP / Dia Met claim block ("Exeter Lake Property") located 300 kilometers NNE of Yellowknife, Northwest Territories, Canada. This paper describes the regional setting and geology of the kimberlites and summarizes the exploration methods used by the BHP / Dia Met joint venture.

The Lac de Gras kimberlites intrude the Slave Structural Province (Fig.1), one of several Archean cratons which represent continental nuclei for the geological evolution of North America. The Slave is a relatively small craton (180,000 km²) with an extensive and unique history. In addition to containing the earth's oldest known rocks (3.96 Ga), the Slave differs significantly from younger Archean granite-greenstone terranes in its constituent rocks and contacts with bordering Proterozoic orogenic belts. Recent multidisciplinary studies have produced compelling evidence favoring a subduction-accretionary model for the formation of the Slave craton (Davis et al., 1994).

Archean rocks in the property area can be divided into three broad lithostratigraphic groups: metasedimentary schists, migmatites and various syn- and post-tectonic intrusive complexes. Five Proterozoic dike swarms with ages varying from 2.4 - 1.27 Ga intrude the Archean sequence. The diabase and gabbro dikes vary in width from 5m to 100m and are often continuous for hundreds of kilometers.

Kimberlites are the only Phanerozoic rocks known in the Lac de Gras region, although fossil-bearing mudstone xenoliths within the kimberlite indicate that sediments must have formed a thin veneer over the older rocks at the time of kimberlite emplacement. Fossils from the xenoliths include dinoflagellates, pollen, spores, wood and teleost fish parts and provide evidence that the kimberlites were emplaced in early Tertiary time (Nassichuk and McIntyre, 1995). A Rb/Sr isochron yielded an Eocene age of approximately 52 Ma for phlogopite within one of the kimberlites.

Till is the most extensive glacial deposit in the Lac de Gras area and correlates with late Wisconsinan Laurentide Ice. Glaciofluvial deposits are widespread and take the form of eskers and related kames. Direction of glacial transport likely took place first to the southwest, followed by flow to the west and most recently by flow to the northwest.

In comparison with South African kimberlites, the Exeter Lake property kimberlites exhibit several petrologic differences. Firstly, many of the kimberlite craters are intact. Secondly, the diatreme facies kimberlites only locally contain more than 15 volume % country rock fragments, and are typically olivine-rich with up to 50 volume % olivine. Hypabyssal kimberlites on the property have mineral assemblages comparable to the Group I South African kimberlites but intrude into upper diatreme zones in some pipes. Several of the pipes contain crater facies which grade downwards with gradually decreasing quartz contents, increasing olivine contents and increasing grain size into coarse grained olivine-rich kimberlites. These

characteristics reflect the different exposure levels and possibly different emplacement mechanisms than South African pipes.

The early stages of exploration for diamonds in the NWT consisted of territory-wide regional heavy mineral sampling from fluvial and glaciofluvial sediments on a scale of tens of kilometers. Initial ground geophysical test surveys pinpointed the target under Point Lake and prompted the flying of the entire property with helicopter-borne total field magnetics (TFM), electromagnetics (EM), and very low frequency electromagnetics (VLF). The numerous targets defined from the airborne geophysics were prioritized for drilling by collecting till samples at 250 m intervals along lines perpendicular to the dominant ice flow direction. The extent and chemistry of the indicator mineral (pyrope and eclogitic garnets, chromites, ilmenites, chrome diopsides) dispersion trains were evaluated. Ground geophysics including TFM, EM, VLF, gravity, seismic and ground penetrating radar have enabled more precise kimberlite/non-kimberlite target discrimination and estimates of pipe size.

Core drilling programs have been used to confirm 36 of the 39 kimberlites on the Exeter Lake Property and have provided samples for microdiamond and kimberlite indicator mineral analysis. Targets were drilled with an eighty percent success rate and in most cases with a single hole that also provided a check on the interpreted perimeter outlines. A few of the kimberlites crop out and were confirmed as a result of geological mapping, and therefore were sampled from the surface. However, most of the known pipes are overlain by lake water and sediments.

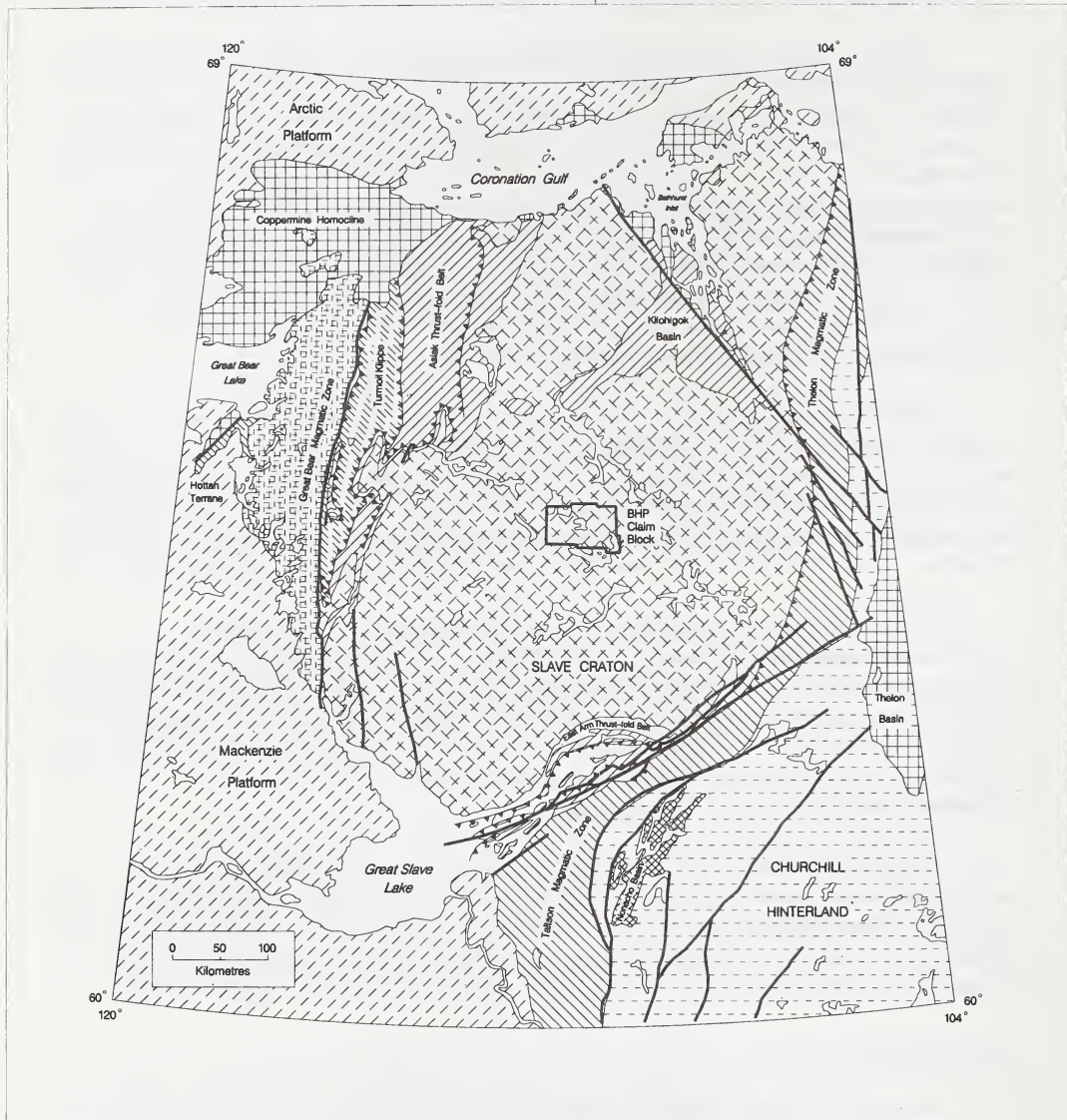
Kimberlite pipes were selected for initial bulk sampling primarily based on microdiamond and indicator mineral analyses of the core or surface samples. Perimeter outlines from ground geophysics provided a means for designing reverse circulation drill hole (15 and 27 cm bit diameter) patterns to obtain representative initial bulk samples without the need for delineation core drilling. The samples (typically 50 to 200 tonnes) were processed in a 10 tonne per hour dense media separation plant which was constructed on site. Fifteen of the thirty nine kimberlite pipes have been bulk sampled to date.

Large bulk samples up to about 7,000 tonnes have been processed on site from underground workings and large diameter reverse circulation drilling programs for more accurate estimation of diamond grade and quality. Tonnage estimates have been refined through delineation core drilling. Commercial quantities and qualities of diamonds have been indicated for five pipes on the Exeter Lake Property and the project is currently at feasibility stage.

REFERENCES

- Davis, W.J., Fryer, B.J. and King, J.E. (1994) Geochemistry and evolution of Late Archean plutonism and its significance to the tectonic development of the Slave craton. *Precambrian Research*, 67, 207-241.
- Nassichuk, W.W. and McIntyre, D.J. (1995) Cretaceous and Tertiary fossils discovered in kimberlites at Lac de Gras in the Slave Province, Northwest Territories. In *Current Research 1995-B*, Geological Survey of Canada, p. 109-114.

Figure 1. Map showing the geological setting of the BHP / Dia Met Exeter Lake Property.



Source:

GSC Open File 2559 "Geology, Slave Craton and Environs, District of Mackenzie, NWT"

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Location of the Slave craton

