The Diavik Kimberlites – Lac de Gras, Northwest Territories, Canada

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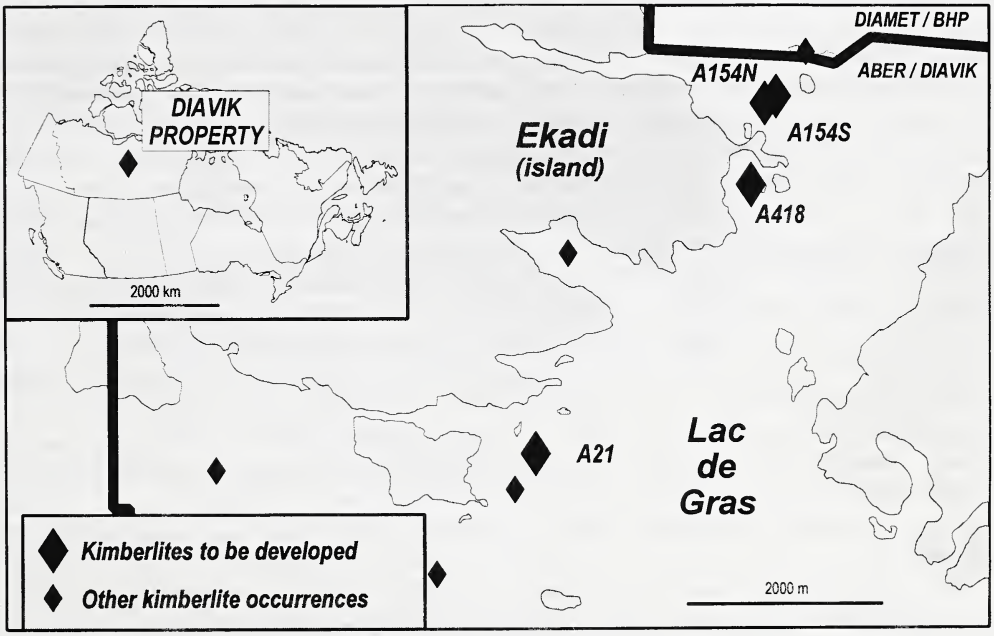
The Diavik Diamond Project comprises planned development of four high grade diamond-bearing kimberlite intrusions of Eocene age. The kimberlites occur as small (< 2 ha), steep sided 'pipes', and are hosted in a complex of Archæan granitoids and micaceous meta-sediments of the cratonic Slave Structural Province.

The Diavik Project area is located approximately 300 km northeast of the City of Yellowknife and some 30 km southeast of the BHP/Diamet Ekati Mine in Northwest Territories, Canada. The four kimberlite occurrences are located beneath the waters of Lac de Gras (Figure 1), adjacent to the Ekadi ('Fat Island', in Dogrib) shoreline. The existing camp is, and the proposed mine site will be, located on Ekadi.

Figure 1: Project Locality Map



The Diavik claim block, originally encompassing 230 400 hectares, was staked by Aber Resources Ltd. and partners in late 1991 and early 1992. In 1992 a joint venture was formed between Aber Resources and partners, and Kennecott Canada Inc. (now Kennecott Canada Exploration Inc.), to explore the Diavik claims. Diavik Diamond Mines Inc. (DDMI) was established in 1996 to develop the joint venture prospects. The property is held 60% by DDMI and 40% by Aber.

Exploration on the Diavik claims has discovered forty-nine kimberlite occurrences, of which twenty-two are diamond bearing. The exploration process relies upon airborne and surface geophysical surveys and sampling of the glacial regolith for heavy 'indicator' minerals (HM), followed by confirmation drilling.

The Diavik resource currently comprises four kimberlite pipes: A154 North and A154 South, which are located approximately 150 m apart; A418, some 850 m southwest of A154 South; and A21, 4km southwest of A418 (Figure 1). All four occurrences display good electromagnetic signatures typical of thin conductive disks; A154 North and A21 also have coincident weak magnetic lows with respect to background. A well-developed HM indicator train trends west-northwest from A21: this, together with the attendant geophysical signatures, led to its discovery in April, 1994. A145 South and A154 North were discovered shortly thereafter, and A418 followed in the spring of 1995.

The kimberlites intrude an assemblage of Late Archæan plutonic rocks that represent the final stabilising event in the formation of the Slave Craton (Davis *et al.*, 1994). Most of the granitic rocks are peraluminous S-type granites and granodiorites, which the authors correlate with syn- to post-deformational (2599-2580 Ma) plutonic suites described by Davis *et al.* (1994). The A21 host rocks comprise granodioritic to tonalitic granites, and resemble regional 2615-2600 Ma syn- to late-deformational intrusive suites (Kjarsgaard and Wyllie, 1994). The granites of the A154 and A418 area contain numerous xenoliths and rafts of peraluminous quartz biotite schist, interpreted as fragments of metamorphosed Yellowknife Supergroup sediments. At least four suites of Proterozoic diabase dykes (up to 12m wide) occur in the region (LeCheminant and van Breemen, 1994), and represent the last intrusive events prior to the emplacement of the Diavik kimberlites.

The kimberlite diatremes are dominated by volcaniclastic units. These include pyroclastic rocks comprising tephra derived from direct airfall and pyroclastic flow mechanisms, as well as abundant units resulting from debris flow return of unconsolidated (tuff ring) tephra and crater rim xenolith materials. The pyroclastic rocks include tuffs, breccias and some 'welded' tuffs, whilst debris flows range from tephra dominated 'kimberlite' to xenolith material dominated mudflows and breccias. Units range in scale (cm to >15m), and occur as massive, graded and bedded/laminated lithologies.
Progressive enlargement / deepening of the diatremes with successive eruptions has resulted in the downward-stoping of the volcaniclastic pile, and superposition of younger units upon the earlier deposits. Arcuate micro-faults downthrown toward pipe centres, as well as the deep (> 400 m) presence of coniferous woods and ubiquitous volcaniclastic autoliths attest to the downward migration of the volcanic pile. Local zones of chaotic texture and more prolific alteration are evidence of the fluidisation / gas streaming effects of multiple events. Hypabyssal kimberlite is volumetrically insignificant, and occurs as deep magmatic feeders to the pipes and as contact intrusions along the pipe margins. Flow differentiation is observed in some cases, and a 1 m wide 'vesicular' dyke has been intersected north of A21. No classic "tuffisitic" kimberlite types (TK or TKB, *sensu* Clement and Skinner, 1985 and Mitchell, 1995) have been recognised in the Diavik occurrences.

The volcaniclastic kimberlites comprise primary magmatic kimberlitic minerals and their relics, mantle xenoliths and xenocrysts and crustal xenoliths (intact and disaggregated). Olivine megacrysts are ubiquitos, and are the primary indicator of sorting and grading within the volcaniclastic pile. The magmatic minerals are largely altered to serpentine, calcite and Mg-smectites; phlogopite and perovskite are sufficiently fresh to date. Some relict olivine phenocrysts and possible monticellite? have been recognised petrographically. The mantle xenoliths / xenocrysts include materials of both eclogitic and peridotitic parageneses, as well as some phlogopite, (garnet) and ilmenite megacrysts. The crustal component is dominated by a suite of xenoliths which derive from Phanerozoic platform sediments extant in the region during kimberlite emplacement. Dominated by mudrock types (with rare siltstones), these xenoliths are present as angular (lithified) to soft sediment, plastically deformed mudclast fragments. The xenoliths appear to represent an (apparently) continuous Cretaceous stratigraphy on the basis of palynologic assemblages. These mudrocks frequently comprise a disaggregated matrix to the debris flow derived kimberlite units and contain equivalent palynologic assemblages to the xenoliths. Unequivocal discrimination of the xenolithic and kimberlitic clays requires PIMA or XRD analysis. A subordinate crustal xenolith component includes some deep granulite / eclogite facies xenoliths and the more common variably altered host rock granite, schist and diabase xenoliths (generally < 2%).

The described broad assemblages are found in various proportions in each of the kimberlites, though in various proportions. Some peculiar differences are observed between the pipes, for example the 'magnetic' unit responsible for the magnetic character of A154 North. Located below approximately 160m from surface, this interval is composed of a massive, fresh, medium to coarse-grained and vertically extensive kimberlite 'tuff'. The magnetic character and 'welded' nature of the unit suggests this interval of the kimberlite remained at elevated temperatures for a period following emplacement (incomplete adiabatic cooling), permitting more extensive oxidation during serpentinisation of olivine and resulting in the formation of abundant magnetite.

Evaluation of the four project kimberlites has included campaigns of delineation drilling (from surface and underground), grade control drilling ('mini-bulk' samples) and underground development for the acquisition of 'bulk' samples. Delineation drilling has provided volume estimates for the Diavik pipes to a depth of 400 m below the lake surface. Mini-bulk sampling programs have comprised large diameter core drilling (1995 – 1997, >50 tonnes). Underground bulk sampling acquired + 10,000 carat parcels from the A154 South and A418 kimberlites, and has allowed characterisation of the diamond populations with respect to price. The estimated resource for the Diavik kimberlite pipes, based upon the above work campaigns and recent geologic modeling is summarized in Table 1. Mine construction is scheduled to begin in the year 2000, subject to the completion of a feasibility study and receipt of the necessary environmental and regulatory approval. Mine production is currently scheduled for 2001.

Table 1: Summary of Estimated Resource

Pipe	Resource* *(Mt)*	Grade *(cpt)*	Price *(US$/ct)*	Value *(US$/t)*
A418	8.9	3.8	58	220
A154 S	11.4	4.6	63	290
A154 N	11.5	1.9	35	-
A21	5.5	2.7	38	-

*Resource to mean sea level, (approximately 415 m below lake surface).

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