

# PROCESSED KIMBERLITE - WATER INTERACTIONS IN DIAMOND MINE WASTE, EKATI DIAMOND MINE™, N.W.T., CANADA

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The Ekati Diamond Mine™, located approximately 300 km northeast of Yellowknife in the Canadian arctic, is Canada's first fully operational commercial diamond mine (Figure 1).

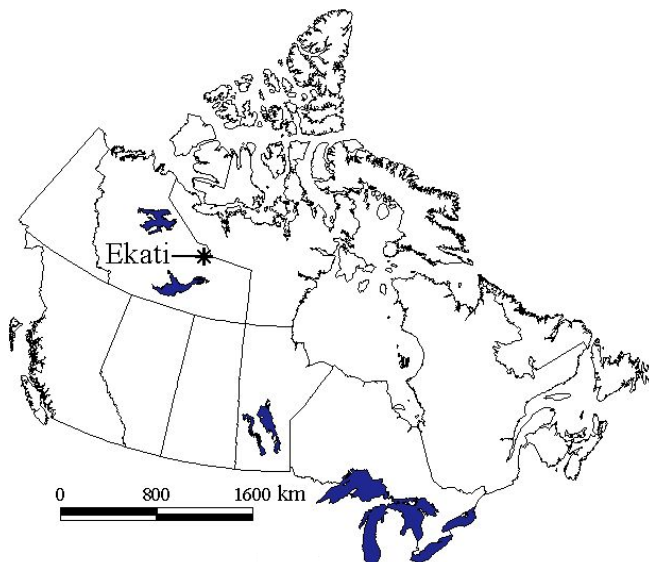


Figure 1: Ekati Diamond Mine™ location

Kimberlite is mined by open pit and processed by crushing and washing, producing a fine-grained waste. The processed kimberlite fines are thickened and then hydraulically pumped to a containment facility located 3 km west of the main mine site. The processed kimberlite storage area, the Long Lake Containment Facility (LLCF), is a former lake basin that has been divided into four cells, each separated by a semi-permeable dyke (Figure 2). These dykes have been designed to help filter suspended material from the containment facility water. The LLCF has been removed from the regional surface drainage system by an impermeable ice-core dam constructed at the outlet to the basin. Any water present in the containment facility is prevented from rejoining the surface water of the region unless physically pumped over the dam.

Low total dissolved solids and little buffering capacity characterize the local surface water, the ultimate recipient of run-off from the storage facility. Surficial

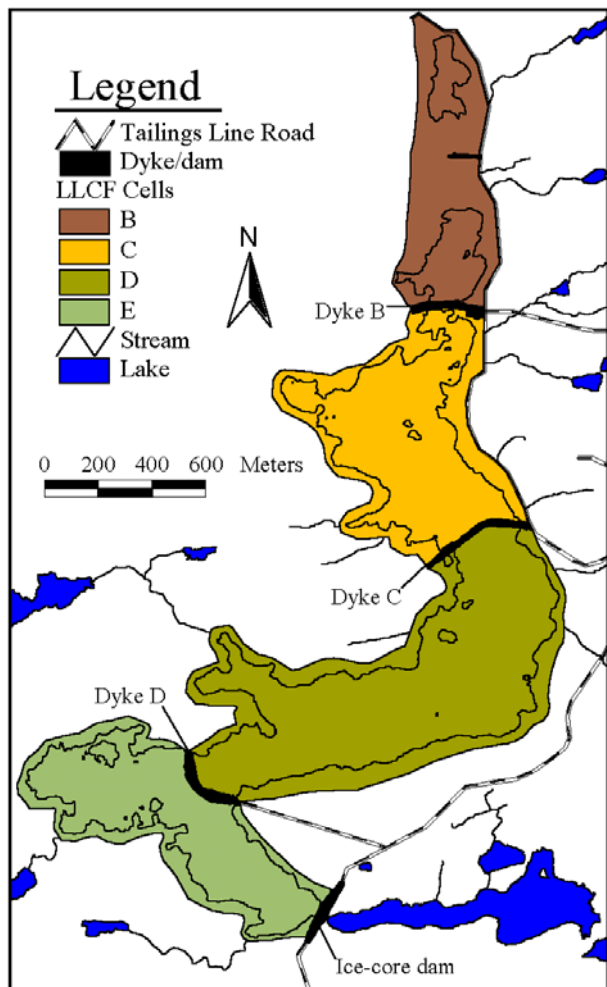


Figure 2: Long Lake Containment Facility

deposition of crushed ultramafic material increases the potential for reaction and dissolution of the minerals in the waste, which results in an increase in dissolved solids in the storage facility water.

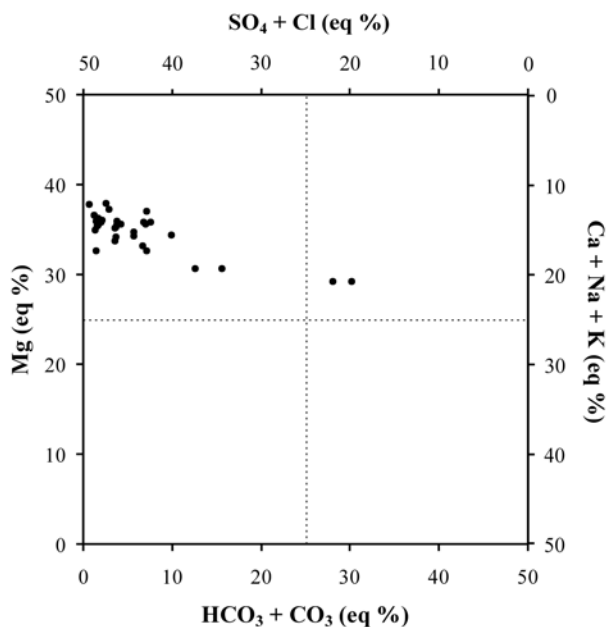
The objective of this study is to investigate the mineral-fluid interactions that are occurring within the LLCF in order to predict how the processed kimberlite will affect the composition of water within the containment facility, with the ultimate goal of evaluating how this method of processed kimberlite disposal could affect down-stream surface water quality in the future.

Samples of kimberlite ore, processed kimberlite fines, and kimberlite fines pore-water were collected over

three field seasons in order to define and characterize the chemical components of the system. Scanning electron microscopy, X-ray diffraction, electron microprobe analysis, as well as static geochemistry tests commonly used in the evaluation of acid-generation potential of mine waste have been used to determine the identity and composition of all minerals. These data will be used together with pore-water analyses and reaction path computer modeling to deduce the minerals and processes that control pore-water chemistry in the containment facility.

Processed kimberlite fines in the study area were derived from the top portion of the Panda pipe and samples of this material were collected from 1995 drill core. The mineralogy of these samples is predominantly serpentine and forsteritic olivine, with lesser amounts of calcite, oxides, enstatite, chrome diopside, phlogopite, garnet, montmorillonite, illite, pyrite and minor amounts of sulphate minerals. Sulphide, sulphate, and carbonate analyses of kimberlite samples indicate concentrations of approximately 0.2-0.22, 0.36-0.48, and 1.55-2.65 weight percent respectively. These results confirm the low amounts of pyrite, sulphate, and calcite observed in thin section.

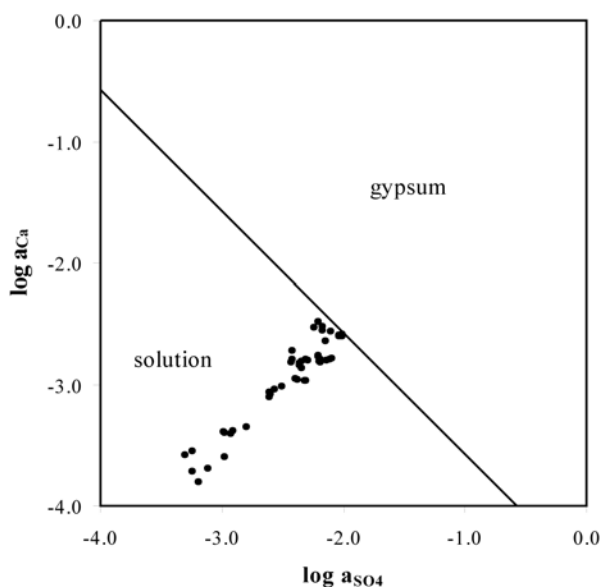
LLCF pore-water chemistry is essentially  $\text{SO}_4$ , Mg, Ca, Na, K, and  $\text{HCO}_3$ ; however Mg and  $\text{SO}_4$  are by far the dominant dissolved constituents (Figure 3). Pore-water



**Figure 3:** Plot comparing the relative contributions of all major dissolved constituents in the LLCF processed kimberlite pore-water.

pH values are approximately neutral, total Fe concentrations do not exceed 3 mg/L, and there is no evidence of iron oxide staining anywhere in the containment facility. As well, sulphide-oxidizing bacteria do not appear to have established significant populations in the processed kimberlite fines at this time. These data suggest that oxidation of sulphide minerals is not active at present. A plot of the activity of  $\text{Ca}^{2+}$  against the activity of  $\text{SO}_4^{2-}$  indicates that gypsum, although a volumetrically minor mineral in the Panda kimberlite, is a significant control on LLCF pore-water quality (Figure 4).

Aqueous solution – mineral stability diagrams and reaction path modeling suggest that, besides sulphate dissolution, the dissolution of serpentine, olivine, and calcite, the possible formation of clay minerals, and evaporation are also important controls on the pore-water chemistry.



**Figure 4:** Gypsum stability diagram showing the composition of LLCF pore-waters. The solid line represents the equilibrium dissolution/precipitation of gypsum.

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