

Diamond Exploration in Finland

The diamond prospective area in Finland is defined as the area where the rocks are Archean in age, the heat flow is low, less than 40 mW/m² and the lithospheric mantle is thick, greater than 200 km. The Finnish part of this Archean area, the Karelian craton, is nearly the same size and has similar geology to the Slave Craton in Canada, where 2 diamond mines are presently operating and with more on the way. The Karelian craton is part of the Karelian-Kola-Kuloi megacraton. It also hosts the Arkhangelsk kimberlite province containing the world-class Lomonosov Diamond Mine, which is currently in production, and the Grib pipe for which plans to mine are well underway (Fig. 1). Other diamond potential rocks in the megacraton include the 1.8 Ga Kemozero layered kimberlite in Russian Karelia and the diamond-bearing lamproites at Kostamuksha, near the Finnish border. The Karelian craton is under-explored given its size and potential and by analogy with other shield areas, and the possibility remains for further and significant diamond discoveries in Finland and European Russia.

Kimberlite was first discovered in Finland in 1964, although it was not identified as kimberlite at the time. Not until 1984, when Ashton Mining of Australia began working with Malmikaivos Oy, a small Finnish mining company and discoverer of Pipe 1, that intensive exploration for diamonds in Finland began. Malmikaivos/Ashton (M/A) were quite successful, and of the 20 kimberlite-related intrusions they discovered in the Kaavi-



Figure 1. Location of kimberlites, carbonatites and alkaline rocks in the Fennoscandian Shield. (Map: Google Earth).

Kuopio area (Fig. 1), all are Group 1 kimberlites and nearly all of these are diamondiferous. Diamet, DeBeers and Rio Tinto round out the other big diamond companies operating in Finland before 2000, but none were as successful as M/A.

One of the main discoveries of M/A was the 2 ha Lahtojoki kimberlite pipe near Kaavi. European Diamonds PLC (EPD) is presently re-evaluating this pipe for diamond grade and has processed 500 tons of a 2500-ton sample taken in the winter of 2004-5. EPD has also sampled extensively in many other parts of the Archean in Finland, having considerable success finding kimberlites, e.g., at Lentiira. Sunrise Diamonds Plc is reassessing some of the other kimberlites in the Kaavi-Kuopio provinces for their diamond content, in a joint venture agreement with Nordic Diamonds Plc. Sunrise Diamonds is also very active in this area and around Kuusamo, exploring for kimberlites based on data from new sampling as well as by access to the Ashton-Diamet database for Finland, through a deal with BHP. Mantle Diamonds Ltd has been sampling extensively in two areas, Kuusamo-Ruka, the Kaavi-Nurmes corridor and is working on a joint project in the claims adjoining Lahtojoki with Gondwana (Investments) SA. Karelian Diamonds Resources Plc (a subsidiary of Conroy Diamonds and Gold Plc) continues to acquire more ground in eastern Finland after recovering encouraging abundances of G9 and G10 pyropes from till samples from the Kuhmo area and is further drilling and sampling the M/A discovered Seitaperä kimberlite north of Kuhmo.

Diamond Exploration Research

The Geological Survey of Finland (GTK) has been conducting R&D work in the field of diamond exploration for well over a decade. The research has focused both on mantle research and regional to local scale heavy mineral surveys. Based on GTK samples and samples provided through collaboration with the diamond exploration companies presently working in Finland, a cross-section of

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the mantle from Kaavi-Kuopio in the SW to Kuhmo to Kuusamo in the NE has been constructed based on the mantle xenocryst record. This cross section shows the thickness of the diamond window over a distance of 600 km across the Karelian Craton. It also shows that the craton edge below Kaavi-Kuopio is structurally different than farther into the craton, with a distinct layered nature to the peridotites as well as a significant component of eclogite. This mantle mapping type of research is essential for diamond explorers working in the area, and the intention is to continue this mapping to the north and east across onto the Russian side of the border.

Studies of diamond indicator mineral dispersion in till have also been carried out in order to contribute to the overall understanding of the Quaternary history in Finland and, more importantly, to provide key information for diamond exploration in Fennoscandia and elsewhere in glaciated terrains.

Diamond Exploration Services

Currently, publicly listed junior companies are the driving force in grass roots diamond exploration worldwide. To implement their working plans, these companies must have promising targets, innovative and skilful management, good funding, and last but not least, access to a competent research facility, preferably located in the same part of the world as their prospect. To facilitate diamond exploration in N. Europe, GTK has built a cutting edge diamond exploration facility, unique inside the E.U.

Since 1994, the Geological Survey of Finland (GTK) has been providing customized, high quality diamond exploration services with complete confidentiality to companies both within Finland and abroad. We specialize in laboratory services and exploration techniques from regional through to prospect scales. To date we have taken and processed over 20,000 quaternary samples for diamond exploration companies including European Diamonds PLC, Karelian Diamond Resources plc., Mantle Diamonds Ltd. and Poplar Resources Ltd.

The GTK Research Laboratory has developed high recovery separation techniques for kimberlite and diamond indicator minerals, including preconcentration by GTK modified Knelson concentrators (3" and 4.5")

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Figure 2. GTK has developed high recovery separation techniques for indicator minerals, including duplicated preconcentration with a modified Knelson concentrator. (Photo: GTK).

(Fig. 2), heavy medium removal of light minerals and dry magnetic separation of magnetite from the heavy fraction. The technique allows rapid and routine processing of reconnaissance and regional scale exploration samples, maintaining a constant 90% recovery rate for the critical pyrope garnet and Cpx grains in the 0.25 to 0.50 mm grain size range (Fig. 3). Logistic, quality and efficiency procedures include e.g., mass reduction through pre-concentration in a dedicated plant designed specifically to prevent cross-contamination. For till samples rich in magnetite, low intensity wet magnetic separation is conducted prior to the preconcentration. Microscope observation services conducted by highly experienced skilled pickers are also available.

Our JEOL JSM 5900-LV scanning electron microscope with attached EDS-analyzer (Fig. 4) can be used to confirm the optical recognition of indicators and give a rapid initial estimate of composition without



Figure 3. Kimberlitic indicator minerals and diamonds. (Photo: Jari Väättäinen, GTK).

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Figure 4. All indicator grains are confirmed by an EDS equipped Jeol JSM-5900LV scanning electron microscope. (Photo: Jari Väättäinen, GTK).

coating or preparation of the grains. Thus, it is also an ideal instrument for morphological and textural studies of kimberlite and diamond indicators. An example is the SEM image of an indicator chromite from the Seitaperä kimberlite in eastern Finland shown in Figure 5. The outer rim of the grain exhibits enrichment in TiO_2 compared to the core.

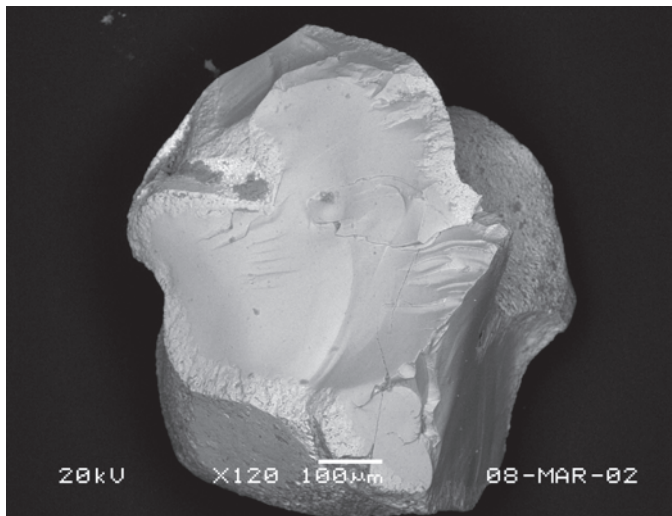


Figure 5. A backscattered electron image of a kimberlitic chromite grain where the outer rim exhibits enrichment in TiO_2 compared to the grain core.

For mineralogical studies our Cameca SX100 microprobe (Fig. 6) offers rapid and cost effective quantitative analysis of indicator minerals. Special software allows trace element analysis, such as Ni in garnets, down to levels of 10 ppm. Routine inexpensive express analysis of chromite and chrome pyrope is a new option.

We offer the following laboratory scale processing services for Quaternary samples. The unit weight of samples to be processed by a 3" Knelson concentrator is 15kg of material finer than 1 mm (or 2 mm). For a 4.5" concentrator the corresponding weight can vary between



Figure 6. Cameca SX50 microprobe offers rapid and cost-effective quantitative analysis of indicator minerals. (Photo: Jari Väättäinen, GTK).

30 and 45 kg. The processing includes:

- Removal of material coarser than 1 mm (or 2 mm) by wet sieving.
- Wet magnetic separation of magnetite.
- Modified Knelson preconcentration.
- Dry magnetic separation of magnetite.
- Dry sieving separation of the 0.25 – 0.50 mm and 0.50 – 1 mm (or 2 mm) fractions.
- Heavy liquid separation (methylene iodide, d 3.3 or less if required) of the 0.25 – 0.50 mm and 0.50 – 1 mm (or 2 mm) fractions.

The sample turn-around-time for the processing described above is 14 days for each delivery of 30 till samples. Or if no preconcentration is needed, we can also start directly from preconcentrates provided by the client. The heavy medium separations and mineral analyses (microprobe and SEM) are done at the GTK laboratories in Espoo, near the city of Helsinki.

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