

Surficial Materials (Diamond Exploration)

Abstract

Minerals associated with diamond source rocks found in glacial sediments indicate presence of a kimberlite. To a certain extent it also gives an evaluation of the potential presence of diamonds. Regional ice advance and retreat pattern knowledge, combined with geophysical analysis, help to find the kimberlites that are the rock formations where diamonds can be found. This map shows the location of surficial materials and gives the general direction of ice flow.

Exploration Methods

The exploration for diamonds involves significant budgets, technical experience and expertise in several fields, such as heavy mineral sampling and processing, mineral identification, indicator mineral chemistry, glacial geology, alluvial deposits, tectonics, large scale geophysics, structural geology, petrology, chemistry and geophysical techniques. All these fields are becoming increasingly sophisticated as diamond exploration activities evolve.

To find Canadian kimberlites, it is necessary to combine the results of the chemistry of mineral indicators, regional ice advance and retreat pattern knowledge, and geophysical analysis such as magnetic anomalies. Because the potential area is quite large, the search for kimberlites is a very slow process.

Following the Ice Advance and Retreat Patterns

Most of Canada has been eroded out by a succession of ice sheets during the last 1.5 million years. All phases of ice flow contributed to the erosion of kimberlites and dispersed debris, including the diamonds, well beyond their source. Flowing ice is not restricted to drainage basins, and ice flow may change directions dramatically. Each advance of the glaciers affects the debris left by the previous one. It is necessary to identify which glacial advance transported particular material.

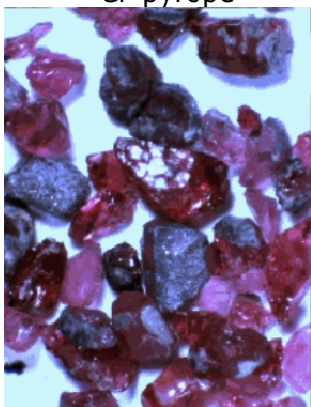
Tracing Indicator Minerals

The indicator mineral technique is based on recognition of distinctive minerals associated with the diamond source rocks. Indicator minerals are used to locate kimberlites rather than trying to find the source, because it is easier to follow the trail of indicator minerals. Mineral indicators are far more abundant than diamonds in a kimberlite, have visually and chemically distinct characteristics, and are more

recognizable. They survive long distance transportation and they are resistant to weathering.

When indicator minerals are found in glacial sediments that indicate the presence of a kimberlite, to a certain extent, give an evaluation of the potential presence of diamonds. The following lists the indicator minerals most commonly used in diamond exploration:

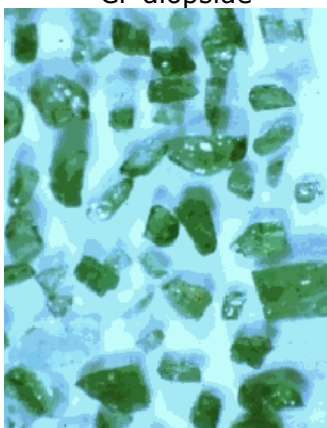
- Cr-pyrope



Cr-pyrope (purple colour)

Source: Canada. Geological Survey of Canada. Terrain Sciences Division.

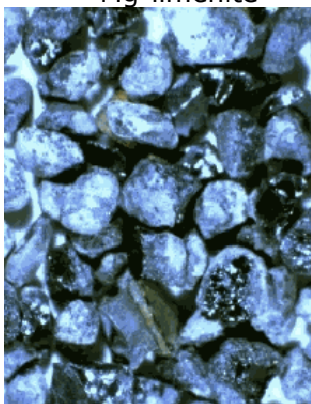
- Cr-diopside



Cr-diopside (emerald green)

Source: Canada. Geological Survey of Canada. Terrain Sciences Division.

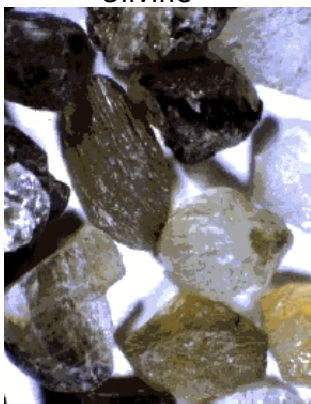
- Mg-ilmenite



Mg-ilmenite (black, conchoidal fracture)

Source: Canada. Geological Survey of Canada. Terrain Sciences Division.

- Olivine



Olivine (pale yellow-green)

Source: Canada. Geological Survey of Canada. Terrain Sciences Division.

- chromite (reddish-black, irregular to octahedral crystal shape)
- eclogitic garnet (orange-red)
- in a rare case, diamonds if they are abundant enough

Materials sampled are the medium to very coarse sand-sized fraction of glacial and glaciofluvial sediments, such as tills and eskers, alluvial sediments, soils and eolian sediments. Selected mineral grains are analyzed with an electron microprobe to determine the identification and chemistry of the indicator minerals present. The surface morphology of each grain can provide clues to the distance they traveled, and their mean of transportation. In several cases, the sediments have been

subjected to repeated glacial transports, interglacial and occasionally, pre-glacial fluvial transport. This adds to the difficulty of tracing the elements to the source.

Location of Magnetic Anomalies

Magnetic surveys measure slight changes or perturbations in the earth's magnetic field, the force that aligns a compass needle. These perturbations are anomalies compared to the surrounding areas. Magnetic anomalies can indicate the presence of kimberlite pipes, particularly when the overall study area presents a uniform magnetic field.

The geomagnetic signature of a kimberlite is not unique, but is distinctive. In the Canadian Shield, kimberlites often present a circular anomaly. This anomaly can show a high contrast, low contrast, or no contrast at all with respect to the surrounding magnetic field. The contrast of the magnetic response of a kimberlite pipe with the surrounding rock is dependent of the remanent magnetic field of the pipe. The mineralogy of the pipe can also have an effect on the magnetic signature.

The rock that composes the kimberlites is less resistant to erosion than the surrounding rock, so kimberlites tend to be more affected by erosion than the surrounding rock. This creates depressions over the kimberlites. These depressions are later covered by glacial material or filled by water, which makes kimberlites difficult to detect. The geophysical studies, such as changes in the magnetic field, play an important role in the detection of buried kimberlites. In the Lac de Gras area for example, geophysical methods have been very useful in the detection of kimberlites located under lakes.

Map Sources

Surficial Materials

Fulton, R.J. 1995. Surficial Materials of Canada, Geological Survey of Canada, Map 1880A.

References

Fulton, R.J. (ed.). 1984. Quaternary Stratigraphy of Canada. A Canadian Contribution to IGCP Project 24. Geological Survey of Canada, Paper 84-10.

Fulton, R.J. (Scientific editor). 1989. Quaternary Geology of Canada and Greenland. Geological Survey of Canada, Geology of Canada Series; no. 1. Geological Society of America, Geology of North America Series; VOL. K-01.

Sibrava, V., D.Q. Bowen and G.M. Richmond (eds.). 1986. Quaternary Glaciations in the Northern Hemisphere. Quaternary Science Reviews, The International Multidisciplinary Review Journal, Volume 5. Oxford: Pergamon Press.

Related Web sites (1999 – 2009)

Federal Government

Natural Resources Canada. Earth Sciences Information Centre Catalogue

<http://geoinfo.gsc.nrcan.gc.ca/screens/opacmenu.html>

The Earth Sciences Information Centre (ESIC) holds Canada's largest collection of books, journals, maps and photos in the earth sciences, in print and electronic formats.

Natural Resources Canada. Geological Survey of Canada. Canadian Landscapes

http://gsc.nrcan.gc.ca/landscapes/index_e.php

This collection of photos of Canadian landscapes and landforms is presented as a public service to illustrate the great diversity of Canadian scenery.

Natural Resources Canada. Geological Survey of Canada. Geoscape Vancouver

http://geoscape.nrcan.gc.ca/vancouver/index_e.php

Geoscape Vancouver - Living with our geological landscape

Natural Resources Canada. Geological Survey of Canada. Surficial Geology of the Oak Ridges Moraine

http://gsc.nrcan.gc.ca/hydrogeo/orm/index_e.php

This compilation is based on 1:50 000 mapping by the Geological Survey of Canada and the Ontario Geological Survey.

Natural Resources Canada. Geological Survey of Canada. Surficial Materials of Canada

http://gsc.nrcan.gc.ca/map/1880a/index_e.php

Surficial Materials of Canada - Map 1880A. This map shows the distribution of surficial materials in Canada, on land and in extensive offshore areas, and portrays broad genetic categories of surface materials (alluvial, lacustrine, marine, glacial) and bedrock.