

Location of Kimberlites

Abstract

Kimberlites are rock formation where diamonds can be found. Diamonds form at a depth greater than 150 kilometres within the earth. After their formation, diamonds are carried to the surface of the earth by strong volcanic activity. This mixture of magma, transported rock and diamonds forms pipes called kimberlites as it reaches the surface.

Formation of Diamonds

Diamonds form at a depth greater than 150 kilometres within the earth. They have crystallized, probably episodically, throughout the formation of the earth. Diamonds form in distinctive parent rocks. That also includes several characteristic minerals. Those minerals are very important as indicators in diamond exploration activities.

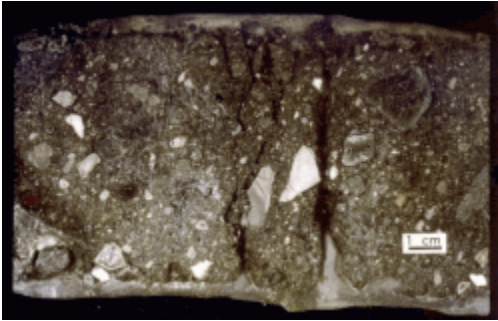
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What are Kimberlites?

Definition

Kimberlites are the rock formation where diamonds can be found. The name kimberlite comes from the town of Kimberly, in South Africa, considered, last century, as the world centre for diamond mining. Kimberly was the site of the first diamonds found in a rock.

Kimberlites are classed as a variety of potassic volcanic rocks, and consist of minerals, rock fragments and magmatic components. The matrix that makes up kimberlites contains olivine, phlogopite, carbonate, serpentine, diopside, ilmenite and several other minerals. Kimberlites also contain fragments of the upper mantle rocks.



Example of kimberlite breccia

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

Size and Shape

The size of a kimberlite is rather small. Its surface covers an area between less than 0.5 hectare and 150 hectares. A kimberlite is composed of three parts: the roots, the diatreme and the crater.

Located at about two to three kilometres below the surface, the roots make up the bottom part of the kimberlite pipe. Their shape is irregular with a vertical extent of about 0.5 kilometres.

The diatreme consist of the middle part of the kimberlite and contains the bulk of the pipe. This is where most of the diamonds can be found. The vertical extent is about one to two kilometres.

The third part of a kimberlite is the crater. This upper part of the pipe, located at the surface, is the eruptive volcanic crater.

Formation

Kimberlites are emplaced by a gaseous explosion. Within the magma, a large amount of dissolved gas is present under great pressure. A few kilometres below the surface, these gases expand as they approach the surface, causing explosions. Those explosions generate a very rapid ascent of the magma through the mantle. The speed increases near the surface and can reach several hundred kilometres per hour. As the magma penetrates crustal rock, the pipe widens to a conical shape, and becomes a kimberlite pipe.

The expansion of the gases rapidly cools the magma and as a result, few thermal reactions occur. The temperature, being sufficiently low in relation to the pressure, allows the diamonds to resist conversion to graphite, and to remain intact.

Location of Kimberlites

The geographical distribution of kimberlites is not random. The factor that governs the location of kimberlites is the thickness of old rocks located at the core of continents. These old cores are called Archean cratons, rocks older than 2.5 billion years. These cratons have reached stability and gone through very little deformation for a prolonged period. Kimberlites are concentrated in the portion of Earth's crust where these cratons are located. Kimberlites occur in clusters of several pipes, and the pipes in a cluster are typically at most tens of kilometres apart.

In Canada, the continental landmass covers one of the greatest extents of Archean craton in the world. Old stable cratons underlay the Canadian Shield, as well as in the Northwest Territories (Somerset Island and Mackenzie Mountains), Alberta (British Columbia - Alberta Rocky Mountains area), Saskatchewan, Manitoba, Ontario and Quebec. All these areas offer a highly prospective geological environment for diamonds.

Erosion of Kimberlites

Most kimberlites have been partly eroded by the action of earth surface processes. As the erosion progresses, the kimberlite releases material, including diamonds. The released material is washed away into secondary deposits called alluvial deposits, such as river gravel, beach terrace, and even off-shore marine deposits on the sea floor. Water, ice and gravity act as the means of transportation. If the concentration of diamonds is high enough, these secondary deposits can become economically profitable for diamond exploitation. However, the primary source is the kimberlite itself.

Last century, in Africa, diamonds were found in alluvial gravel, and later, in shoreline deposits and offshore marine gravel. During the 1860s, the first discoveries of diamonds in the rock that became known as kimberlite brought geologists and diamond explorers to understand that diamonds were derived from kimberlites, and the diamonds found in gravel, have been washed from this source.

The presence of an alluvial secondary deposit implies the existence of a kimberlite pipes upstream in the drainage area. In North America however, this conclusion does not apply because the advancing glaciers have dispersed the material that was eroded before and during the glaciation during the Ice Age. In this case, the kimberlites are located "up-ice": independently of the actual drainage basin area. Until Professor W.H. Hobbs of the University of Wisconsin recognized this process in 1899, it remained a mystery why no diamond deposits of commercial importance had been found in Canada.

Evaluation of the Diamond Content of a Kimberlite

Kimberlites are not all diamond bearing or economically viable. When a kimberlite is found, it is necessary to evaluate its diamond content: concentration (carats per ton), the size of the deposit, and also, the size and the quality of the diamonds. These two last characteristics are important to know because in the diamond mining industry, the product is valued in term of individual pieces.

In a kimberlite, there is a relationship between the quantity of diamonds and the abundance of fragments from the mantle host rock where diamonds form. To determine diamond content, tons of rock are collected from the top of the pipe and processed. If diamonds are found, drilling and petrological examinations will give the extent of the deposit and information about the diamond content. Between 5000 to 10 000 carats of diamonds are needed to fully evaluate a deposit. A diamond concentration that would allow an economic development of a mine would be around 0.5 carat per ton; a very good one would be in the range of 2 to 4 carats per ton. The distribution of diamond size and quality also need to be determined to be able to select a development strategy like surface excavation or underground mining.

Map Sources

Kimberlites in Canada

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Related Web sites (1999 – 2009)

Federal Government

Natural Resources Canada. Minerals and Metals Sector. Canadian Minerals Yearbook
<http://www.nrcan-rncan.gc.ca/mms-smm/busi-indu/cmy-amc-eng.htm>
Each year, the Minerals and Metals Sector (MMS) of Natural Resources Canada undertakes a comprehensive review of developments in the mineral industry and publishes the results as the Canadian Minerals Yearbook.

Natural Resources Canada. Minerals and Metals Sector. Topics. Minerals and Metals
<http://www.nrcan-rncan.gc.ca/mms-smm/index-eng.htm>
Use the following links to explore our information resources.

Overview of Trends in Canadian Mineral Exploration. Canadian Intergovernmental Working Group on the Mineral Industry, Fall 1998
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