DIAMOND EXPLORATION IN CANADA

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ABSTRACT

Demand for both gem and industrial diamonds is very strong. Synthetic production supplies industrial uses, but synthetic gems remain inferior and expensive, so the gem market is largely supplied by mining. Several major mines have been depleted, and the market is receptive to new sources of high quality gems. Canada's Precambrian terrane, extending across the Canadian Shield and under the Phanerozoic cover of the Plains and Hudson Bay, has excellent potential for diamonds, but exploration conditions are difficult due to recent glaciation. Early world exploration, which relied on finding diamonds in alluvial sediments, was adequate to launch pre-1900 production from India, Brazil, and Africa. Exploration success in Canada as in Russia and other more recently discovered sources, however, had to await large investments in effort supported by advanced science and technology. Canadian exploration, in many ways, is similar to that in other regions, relying on analysis of tectonics, indicator minerals, geophysical surveys, and multiple stages of drilling and sampling. Canada differs from other regions in that recent glaciation has caused fresh indicator minerals to be transported hundreds of kilometres. Exploration accelerated in Canada after 1960, first in Ontario and the Arctic Islands, then in Saskatchewan in 1988, and especially after the Chuck Fipke-Stew Blusson discovery at Lac de Gras, Northwest Territories in 1991. Ekati Mine opened in 1998 and Diavik Mine of Rio Tinto and Aber will open in 2003. These mines will bring Canadian output to over 10% of world supply, and will position Canada with Botswana and Russia as world leaders in production of high quality gem diamonds. Other new mines, such as Snap Lake, are possible, as an array of companies, including De Beers, other majors, and several juniors explore sites across the Arctic and in the south from Alberta to Québec.

INTRODUCTION

World demand for diamond is strong. The annual US$0.7 billion market for industrial diamond is now almost exclusively supplied by synthetic production of about 1000 million carats; 1 carat (ct) = 0.2 grams. Gemquality synthetics remain inferior and expensive to produce, so the diamond jewelry trade is supplied by mining natural diamond, derived from kimberlites, lamproites, and placer deposits.

Recent gem diamonds sales have broken records, especially in the United States, where half of all gem diamonds are sold. Annual production of natural diamond, at a cost of about US$2 billion, has exceeded 110 million carats per year, and this production sells for about US$ 8 billion. Botswana, South Africa and Russia dominate the high-quality production market, which is handled mainly in Antwerp and Tel Aviv, while Australia and the Congo are leading suppliers of the low quality stones that are cut in India. The two-thirds of this annual supply of rough that is of gem quality is reduced to between 20 and 30 million carats of polished goods and sold in jewelry for about US$55 billion. The one-third of all natural diamonds produced are used for industrial purposes but these fetch only about 1 % of mining revenue.

De Beers, the world's leading producer, is attempting to re-position itself as supplier of choice rather than custodian of the industry. The company plans to reduce its stockpile, increase marketing, nurture brand recognition, work more cooperatively with clients, and withdraw from open market purchases. Rio Tinto Diamonds, handler of the large Australian output, has resisted a recent attempt by De Beers to buy Ashton and its minority share in Australia's Argyle mine.

A threat to the gem diamond market, comparable to that previously faced by the fur industry, is posed by the association of diamonds with conflict in Africa. This issue has been addressed by a certification scheme that began to be implemented in mid-2000.

In 1998, Canada joined the ranks of high-quality producers, and the new output compensated for production cutbacks due to the depletion of mines in South Africa and Russia.

CANADA'S GEOLOGY AND DIAMOND POTENTIAL

The majority of Canada's landmass has excellent potential for diamond-bearing kimberlites, which typically are small, cylindrical pipes about 0.1 to 1.0

kilometres across that represent high-pressure intrusions from deep within the earth. Pressures at the source depths are adequate for diamond to be formed from the lower-pressure crystal forms of carbon. The old, thick Archean rocks that form the core of the continent are the areas in which kimberlites, as well as lamproites, are most likely to occur, and these can transport fragments of diamond-bearing peridotite and eclogite from about 200 kilometres depth to the earth's surface. Together with the adjacent, somewhat less prospective, younger Precambrian terranes, these ancient rocks extend across the Canadian Shield and under the Phanerozoic cover of the Plains and Hudson Bay, which provides prospective terrane over most of the area from Calgary to Montreal and from the Great Lakes to the Arctic.

Development of this potential, however, has been made difficult by the effects of the Ice Age. Because glaciation of Canada occurred only 10 000 years ago, most of the country is blanketed by homogenized soil parent materials. Kimberlite pipes are recessive, and in almost all cases are hidden by this cover. Further, there has not been time for diamond and other more resistant minerals to concentrate in streams where they could form placer deposits that would reveal the diamond potential of an area.

CANADIAN DIAMOND EXPLORATION

Recognition of diamonds in alluvial sediments and upstream tracing of these diamonds supported the centuries-old trade in diamonds from India, and led to discovery of diamonds in Brazil in the 1700s and in Africa in the late 1860s. However, discovery of major diamond sources during the mid- to late-1900s, in Russia, then Australia, then Canada, required advanced science and technology as well as large investments.

Diamond exploration programs target favourable Archean terrane, focus the search by sampling sediments for kimberlite indicator minerals, use airborne geophysical surveys to identify drill targets, then carry out multiple stages of drilling and bulk sampling of kimberlite or an allied rock such as lamproite to define the resource. In Canada, diamond exploration was originally launched by discovery of a few diamonds in alluvial sediments and soils of the Great Lakes region in the late 1800s. Enthusiasm waned when there were no more promising discoveries of alluvial diamonds or *in situ* kimberlite. Exploration success awaited developments in science and technology. The tectonic criteria for priority setting and the array of the modern exploration approach begin with indicator mineral sampling. In Canada's recently glaciated surficial environment, a knowledge of glacial history and selection of appropriate sandy materials for sampling is required to interpret the distinctive sand-sized kimberlite indicator minerals that have been glacially transported hundreds of kilometres from source.

With the aid of investment, science, technology, and perseverance, progress in Canada accelerated after 1960. This was led by work by De Beers and others in Ontario and the Arctic Islands, as well as in 1998 in Saskatchewan. Most important, however, was work by Canadian prospectors Chuck Fipke and Stew Blusson, whose decade-long search culminated when their company, Dia Met, joined with BHP to make a kimberlite find at the center of the Slave Craton at Lac de Gras in the Northwest Territories in 1991. Since then, hundreds of kimberlites have been found on the Slave Craton, and additional finds have been made elsewhere in the north. In addition, exploration has been very active across the south, from Alberta to Labrador, including such areas as the Buffalo Head Hills of Alberta, the Attawapiskat area in Ontario, the buried kimberlite volcanoes of the Fort a la Come camp of Saskatchewan, the Ungava Bay area of northern Quebec, and northeastern Manitoba. Canadian diamond exploration expenditures rose from a few million to a peak of over US$100 million per year in the mid1990s but have now leveled off at about US$50 million per year. More than two-thirds of these funds are committed to exploration in the Northwest Territories.

CANADA'S DIAMOND INDUSTRY

Canada's Ekati Mine, built by BHP and Dia Met in the Lac de Gras area of the Northwest Territories, was completed in 1998 at a cost of about US$1 billion; it employs about 600 people. Five kimberlites out of 125 on the property make up the current 78 Mt (million tonnes) resource. According to the mining plan, the mine is expected to produce about 4 million carats per year from ore with values of about US$100/ct and 1 ct/t. Thus average revenue is expected to be about US$0.5 billion dollars; early production figures have exceeded expectations. Just over one third of the Ekati production is being marketed by De Beers.

Rio Tinto Diamonds and Aber Diamond Corporation are currently constructing the Diavik Mine. It is similar in scale to Ekati, and expected to start producing in 2003 at the rate of 7 million carats per year with an estimated value of US$ 70/ct, which represents a half billion dollars of revenue per year. The Diavik mining plan is based on a resource of nearly 40 Mt that occurs in 4 out of more than 50 kimberlites found on the property. Average grade is 4 ct/t. Aber has entered a marketing arrangement with Tiffany & Company.

There are several candidates for a third Canadian diamond mine. **In** mid-2000, De Beers acquired Winspear Diamonds Inc., co-owner with Aber of the Snap Lake property in the Northwest Territories, originally found by tracing glacial boulders. Snap Lake is a sheet-like dyke rather than a pipe, and has on the order of 40 Mt of kimberlite containing 1.7 ct/t of diamonds worth about US$120/ct. A significant mine, smaller than Ekati, could

result. There are other promising projects as well, so Canada's output within a few years is expected to rise from the present level of about 5% of world supply to more than 10%. With income of more than US$1 billion dollars per year, diamonds will make a significant contribution to Canada's total annual mineral production, which Natural Resources Canada currently lists as US$12 billion in nonfuel materials. In addition to mining, the new Canadian diamond cutting industry is marketing stones under the Canadian banner.

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