Diamond Potential in British Columbia - Progress Report

by George J. Simandl

INTRODUCTION

This is a progress report covering the first phase of a two-year project, aiming at documenting the diamond potential of British Columbia. This study expands upon the use of well-established exploration methods as described by Fipke *et al.* (1995) which are largely based on the well established "Diamondiferous Mantle Root" model and Clifford's Rule.

CONCEPTS AND REVIEW

British Columbia (BC), is located on the western margin of North America, and has a complex tectonic history. It is commonly described in terms of the margin of the North American continent, adjacent pericratonic and displaced terranes, and accreted superterranes. It remains to be established if basement rocks of a similar age and nature as those which underlie the diamond occurrences in Alberta extend into the northeastern portions of British Columbia.

The main concentration of alkali rocks, such as carbonatites, kimberlites, lamproites, and alkaline complexes and syenite gneises, approximately follow the margin of the North American continent (Pell, 1994).

Diamonds were reported in samples from Jack (Lens Mountain) and Mark (Valenciennes River) diatremes. A single microdiamond was also reported from a poorly described breccia within the Xeno carbonatite complex, which is located within the Kechika area. Macrodiamonds were reported within the Cranbrook cluster, from the Bonus and Ram 5 and 6 diatremes.

The tectonic setting and regional geology of the diamond occurrences in BC does not match that of the classical diamond-producing shield areas such as occur in South Africa and the Northwest Territories. Published analyses of the indicator minerals in BC are scarce and limited to a few pipes. The diamond placer potential of the province was never seriously assessed.

Blue schist and eclogite-facies rocks, interpreted as subduction zone related, and alkali basalts containing mantle xenoliths are also present, however, the mineralogy of these facies (Erdmer *et al.* 1998) and mantle xenoliths, where documented, suggests that Pressure-Temperature (PT) conditions for their source areas lie outside of the diamond stability field.

The diamond potential of the province and the significance of the reported microdiamond occurrences in British Columbia can be defined in terms of the traditional "deep keel model", also called the "diamondiferous Mantel Root Model" as described by Haggerty (1986), Boyd and Gurney (1986), Helmstaed and Gurney (1995, Kirkley *et al.* (1991) and Mitchell (1991), and possibly by the modified version of the "subduction zone diamond model" (ES -model) as described by Baron *et al.* (1994) and Barrows *et al.* (1996). Recent discoveries of potentially economic diamond occurrences in non-traditional lithologies in Ontario and elsewhere (Lefebvre *et al.* 2003; Janse, 1994; Xu *et al.*, 1992; Bai, 1993 and Kytayma *et al.* 2001) indicate that exploration geologists should keep an open mind and be ready to test unconventional hypotheses.

Some of the key concepts highlighted above are already published in an electronic form (Simandl, 2003).

FIELD AND LABORATORY WORK IN PROGRESS

In 2003, the fieldwork was concentrated in three areas: in Fernie region (southeastern BC) that contains a group of garnet-bearing diatremes (Figure 1), Kechika (Northern BC) and Fort St. John, (northeastern BC).

Garnet-bearing diatremes

Most of the alkaline rocks documented in British Columbia do not contain garnets which originated in the man-

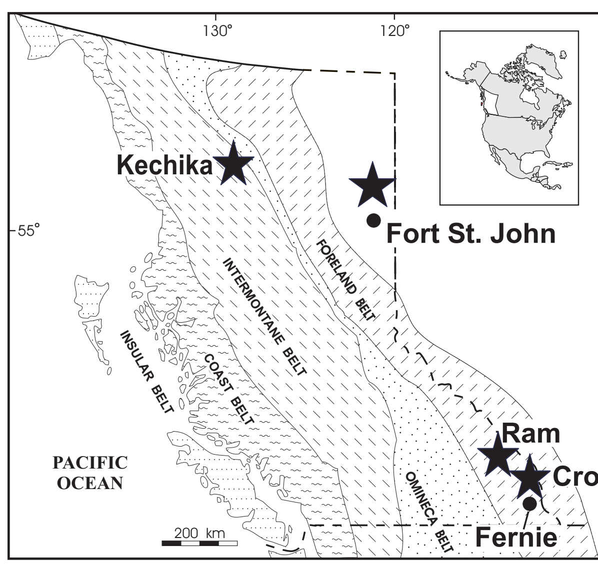

Figure 1: Location of ongoing field and laboratory work in progress. 1) Cross and Ram (pyrop-containing) diatremes, 2) Kechika area, 3) Northeastern British Columbia (east -northeast of Fort St. John).

tle or indicate depths in excess of 50 kilometres. Two garnet-bearing diatremes, Cross and Ram 6, were examined in 2003. The Cross kimberlite was studied by Smith *et al.* (1988) and Hall (1991). Ram 6 diatreme was described by Dr. McCallum in several private, technical reports.

Cross kimberlite

Overall, the field observations are in line with previously published data. Two distinct mantle xenoliths containing olivine, spinel, Cr-diopside, orthopyroxene and deeply colored pyrope garnets were recovered by a University of Victoria student Danae Voormeij. Both xenoliths were studied petrographically and provide textural information that is not available from indicator mineral studies. One of these xenoliths holds promise for pressure and temperature determination. Laboratory work on garnets pyroxenes, spinels and Cr-diopside is in progress.

RAM 6 pipe

Located north of Elkford, the Ram 6 pipe was at least once described as an kimberlite and was reported to be diamondiferous (Allan, 1999 and George Cross News Letter, 1994). The pipe is not well exposed. During the 2003 field season regolith that overlies this pipe was examined in the field and sampled. One sample was washed and pre-concentrated by panning. It contains variety of indicator minerals. Some of the garnets are deeply colored, as is typical of lherzolitic garnets (probably G9 and G8), but no obvious G10 garnets were identified. A number of other garnets recovered are yellow orange or pink-colored and some of these pale garnets may be of eclogitic affinity. Spinel, ilmenite, Cr-diopside, amber-colored mica, orhopyroxene and amphibole were other minerals tentatively identified in the field. Mineral composition will determine if this diatreme can be classified as lamproite, kimberlite or if it belongs to one of the lamprophyre clan lithologies. Assuming equilibrium conditions, "single grain" Cr-diopside geothermobarometry could be also used to determine if this diatreme sampled the diamond stability field.

KECHIKA AREA

Alkaline rocks of the Kechika area were previously described in literature and explored intensively for REE, niobium and tantalum and fluorite. A boulder train along Camp Creek was identified near RAR-5 carbonatite. It contains a variety of green-colored lithologies, including breccias of diatreme facies, tentatively classified in the field as aillikite. These boulders are similar in appearance to a rock from which a diamond was reported by Pacific Ridge Resources (Roberts, 2002), but vary in mineralogy and texture. Some of the boulders are angular, and approach 2 metres in their largest dimension. They contain the following minerals: a bright green mineral in trace concentrations (probably Cr-bearing clinopyroxene), a black pyroxene (probably salite), spinel (possibly Cr-rich), amphibole (?) and some phlogopite/biotite macrocrysts. Garnet was not observed in the field, but it is possible that it will be found in thin sections. The mineralogy needs to be confirmed by microscopic analysis to classify these unusual rocks. Cr-spinel and Cr-mica were previously reported from the RAR-5 diatreme and related rocks. Five stream sediment samples for heavy mineral analyses were collected in the general area. These samples were screened to less than 4 mm, deslimed, and manually pre-concentrated by panning to reduce transportation and processing cost and to permit backpacking. Additional laboratory screening was completed in house. Heavy liquids are used to improve the quality of the concentrate before handpicking.

FORT ST. JOHN AREA

Several stream sediment and glaciofluvial and glaciolacustrine samples were collected in the Fort St. John area, where indicator minerals were previously reported by the industry. For example, the Tyran Transport-Esau Gravel Pit, east of Fort St. John was previously sampled by Stapleton (1997). As is expected throughout most of the northeastern portion of British Columbia, garnets were observed during the sampling. Most of the garnets are probably derived from metamorphic rocks and originated within the Canadian Precambrian Shield. This is in line with the high-pink, granite pebble content of some of the gravel deposits. However, small volcanic pebbles that are similar to Quesnelia rocks were also observed. Eclogitic garnets, if present, may be difficult to distinguish from metamorphic garnets. Where possible, all collected samples for heavy mineral analyses were screened to less than 4 mm, deslimed, and manually pre-concentrated by panning to reduce processing and transportation costs and to permit backpacking. Additional laboratory screaning was completed in house. Heavy liquid separation is contracted out and concentrates will be handpicked in-house.

One of positive byproducts of this fieldwork is identification of visible gold and relatively abundant subrounded to rounded zircons in some of the collected samples. In the past, the area was covered by a large glacial lake (Mathews, 1980) and the related drainage may have some placer gold potential.

ARCHEAN BASEMENT IN NORTHEASTERN BC

The nature and age of the basement under northeastern British Columbia are poorly constrained. Current basement maps are based largely on geological and geophysical extrapolations but suggest that Archean rocks may be present in portions of northeastern British Columbia. They are based on the pioneering work of Hoffman (1988) and Ross *et al.*(1991). Only three basement dates are shown in northeastern BC (Villeneuve *et al.* 1993). Age dating of the basement is needed to establish the diamond potential of this part of the province in terms of the "diamondiferous mantle root" model and Clifford's rule.

Forty-seven oil and gas wells, which are reported to reach the basement in northeastern BC, were selected for preliminary investigations to help clarify the age of the basement in that part of the province. If suitable lithologies have been cut by drilling, ten or more of these holes will be sampled for age dating. The regular zircon dating method is not applicable, because the containers with drill-hole cuttings contain less than 3 cm^3 of sample per 10 metres of borehole. Ion probe U-Pb geochronology on zircons will have to be used. If Archean, or at least Precambrian ages are encountered, the diamond exploration potential of northeastern BC will be greatly enhanced.

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