Microdiamonds and Indicator Minerals from a Talc Schist Host Rock, French Guiana

Bailey, L.M. [1], Helmstaedt, H.H.[1], Peterson, R.C.[1], Mandarino, J.A.[2], Letendre, J.P.[3]

1. Department of Geological Sciences, Queen's University, Kingston, Ontario, Canada K7L 3N6
2. Royal Ontario Museum, 100 Queen's Park, Toronto, Ontario, Canada, M5S 2C6
3. Golden Star Resources Ltd., 57 High St., Kingston, Georgetown, Guyana. P.O. Box 10313

Introduction

Diamonds along the Inini River in southwestern French Guiana were first reported by the Bureau de Recherches Géologiques et Minières (B.R.G.M.) in 1975 during research conducted under the "Mineral Inventory Program of French Guiana". A definite diamond source rock was discovered by Guyanor Ressources S.A. in 1995 by means of stream sediment sampling, surface mapping, geochemistry and geophysics within a 25 km^2 area in the Inini Greenstone Belt of Central French Guiana. This microdiamond-rich, xenolith-free and highly deformed talc schist with a texture varying from ash tuff to lapilli tuff to breccia has an unusual diamond host rock mineralogy. Characterization of the mineralogy, indicator minerals and diamonds of the talc schist to further constrain the host rock and source of the diamonds is the subject of a MSc. project of L.M.B. currently in progress.

Geologic Setting

The talc schist has an extent of at least 5 km north to south and varies in width from 350 to 1000 metres. Its occurrence is within the Paramaca Series (2.11 +/- 0.09 Ga) (Gruau et al., 1985), which is described as a succession of pre-orogenic ultramafic, mafic, intermediate and acidic lavas and shale-greywacke sediments (Choubert, 1974). The Paramaca greenstone belt is part of an Early Proterozoic mobile belt (~2.2-1.9 Ga) stretching across the northeastern Guiana Shield and including greenstone belts of Suriname, Guyana and Venezuela (the Marowijne Group, Barama-Mazaruni Supergroup and the Carichapo-Pastora Group, respectively) (Gibbs and Barron, 1983; Texeira et al., 1989; Tassinari, 1997). The metavolcanic and metasedimentary sequences within this mobile belt have been deformed and metamorphosed to the greenschist and amphibolite facies.

Gibbs and Barron (1993) reported 'metakimberlites' in the area of the Inini Greenstone belt that are strongly enriched in light rare-earth elements and deficient in the conventional suite of kimberlitic indicator minerals, possibly destroyed during the Trans-Amazonian Orogeny (2.2-1.9 Ga) of deformation and metamorphism. If the talc schist proves to be a non-kimberlitic diamond-host rock, this could also account for the deficiency of traditional kimberlitic indicator minerals.

Samples

Samples for this study consist of drill core from 8 locations to depths varying between 7 to 169 metres and include specimens collected in outcrop at 2 locations in the talc schist. Rock samples from 7 drill holes were processed to yield magnetically-separated heavy mineral concentrate. This concentrate was examined and all diamonds and possible indicator minerals removed. Thin sections were made of drill core from various depths of the remaining hole.

Mineralogy
Macrodiamonds (>1.00 mm) from the talc schist have been reported. In early 1996, processing of 1.8 metric tonnes of soil and saprolite from auger holes yielded 8 macrodiamonds, the largest being 2.4 mm. In mid 1997, an alluvial bulk sample was collected from creeks on, and immediately draining off, the diamondiferous body (13 samples ranging in size from 3 to 17.9 m^3). Thirty-two percent of the sample was processed (27.1 m^3) yielding 5142 macrodiamonds, with the largest stone just over 4.5 mm. Cubic and dodecahedral shapes predominate among macrodiamonds. More than 90% of the population is of industrial quality, and a parcel of diamonds from the talc schist examined by 2 independent researchers has been compared to those from Argyle in Australia and the Mbuji Maji diamonds in Zaire.

Heavy mineral concentrate from the small amount of drill core available for the present study yielded 49 microdiamonds recovered from core of 2 drill holes. The majority of diamonds are derived from one drill hole, DDAC-05. All concentrate yielded variable amounts of spinel and garnet.

The 49 microdiamonds range in size from 0.25 to 1.00 mm and have an average size of 0.5 mm. The majority are either delicate aggregates with rounded knobs or are broken fragments. Body colour varies from white to off-white to yellow to pale brown. Inclusions are abundant, the most common being black, opaque minerals. Intergrown with some diamonds are sulphides and garnet.

Subhedral to anhedral chromian spinel (0.2-1.5 mm) displays corona textures with sharp contacts between an internal core and polycrystalline rim. A total of 212 garnets greater than 0.2 mm were recovered from both the diamondiferous and non-diamondiferous core. Colour ranges from pink to orange to orange-brown, to mauve. Preliminary microprobe results of 51 garnets from the diamond-bearing core reveal a chemical range of CaO (0.06 to 9.28 wt %) and Cr_2O_3 (0.00 to 11.16) and a compositional range from almandine to almandine-pyrope to pyrope. Plotting chromium versus calcium defines distinct compositional populations: Lherzolitic-type garnets predominate, with a subordinate eclogitic group and a poorly-represented subcalcic harzburgitic population.

The drill core mineral suite is dominated by varying amounts of actinolite, clinochlore, phlogopite, magnesiohornblende, cummingtonite, calcite, dolomite, magnesite, diopside, enstatite and sulphides with minor ilmenite, rutile, anatase, corundum, tourmaline and magnetite. Talc, chlorite and carbonate are found to be the dominant minerals in thin section. Clinochlore pseudomorphs after pyroxene(?) in some of the sections impart a porphyroblastic texture. A dominant schistosity with at least one overprinted crenulation cleavage suggests a history of multiple deformation.

Host Rock
Most of the primary structures and textures within the talc schist have been destroyed by intense shearing, hydrothermal alteration, weathering and regional metamorphism, thus making identification of the original rock type very difficult. The following possibilities are considered: (1) a primary kimberlitic or lamproitic intrusion, (2) an unusually thick kimberlite sill, (3) a paleoplacer deposit, (4) a low-grade metamorphic kimberlite pyroclastic or epiclastic deposit (5) a retrograde assemblage from a high-pressure ultrabasic complex.

The mineral assemblage is compatible with a metamorphosed ultramafic precursor, hence the possibility exists that the body represents an unusually thick kimberlite sill. The overall areal extent and thickness of the body, however, make it unlikely that it is a metamorphosed kimberlite/lamproite dyke or pipe.

If the talc schist represents a paleoplacer deposit, it would explain the absence of abundant chromian diopside and ilmenite and the survival of only garnet and chromite as indicator minerals. Heavy minerals from various sources could be concentrated by paleocurrents and would thus provide false ‘trends’ in relation to diamond potential. It would be expected to find great variation in diamond grade within a paleoplacer deposit. Variation in diamond grade within the talc schist has not yet been firmly established. Thus far, no diamonds recovered from the talc schist display any evidence of radiation damage commonly found among diamonds once buried in a sedimentary sequence. The delicate diamond morphology and ultrabasic nature of the talc schist are also inconsistent with this mode of origin.

The extent of the body, the presence of some indicator minerals and a texture in outcrop varying from ash tuff to lapilli tuff to volcaniclastic breccia are compatible with a kimberlitic pyroclastic or epiclastic precursor. It is possible that subsequent metamorphism and deformation obliterated any original internal structure in the host rock, such as bedding. The delicate diamond morphology in the talc schist could be consistent with this type of formation as it is possible that the abundant microdiamonds are a product of fragmentation of larger diamonds during explosive episodes.

If the talc schist represents part of a layered ultrabasic massif, large tectonic transport would have been required to emplace the host rock into the surrounding metavolcanic and metasedimentary rocks which show no apparent high-pressure history. If this is the case, one might also expect relict igneous layering to be preserved.

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