Cape Breton ruby, a new Canadian gemstone discovery, Cape Breton Island, Nova Scotia

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Abstract: *Ruby was discovered near Frenchvale, Cape Breton, Nova Scotia, in mid-August 2004, in a geological context closely resembling that in the Hunza Valley, Kashmir. Although only relatively low grade stones from this newest Canadian gemstone locality have been recovered so far, the terrain holds promise of quality ruby. The potential for future discoveries in Atlantic Canada are excellent*

Keywords: *marble, Nova Scotia, Precambrian, ruby, skarn*

Introduction

The Frenchvale area in the Boisdale Hills, southeastern Cape Breton Island, contributed carbonate flux to the steel mills of Sydney, Nova Scotia, over several decades. Here, as elsewhere in the extensive Precambrian terrain of Cape Breton, exploration has long been carried out sporadically for metalliferous deposits of lead, zinc, and copper, and more recently for precious metals. Then in mid-August 2004, during the course of a mineral exploration programme, ruby corundum was serendipitously discovered in the environs of a disused quarry at Frenchvale, Cape Breton county.

The village of Frenchvale is located about 18 km west southwest of Sydney (*Figure 1*). The Frenchvale quarry is a boomerang-shaped excavation 0.63 km long east-west, and 0.33 km north-south, located about 0.7 km northwest of the village (*Figure 2*). Readily accessed by a network of secondary roads in the area, the quarry is situated in the midst of the Boisdale Hills, a beautiful, gently rolling terrain intersected by streams and dotted with lakes.

History

During the 1960s Mosher Limestone Ltd., through its affiliate Scotia Limestone Ltd., supplied 'purifying stone', namely limestone and dolomite, the main natural fluxes in

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steel making, to the Sydney Steel works. Iron ore feedstock, not available locally, arrived in Sydney by ship from mines in Newfoundland and Labrador.

Geology

Sir William Dawson made first mention of geological associations in the area in his classic *Acadian Geology* (1855, p. 322) and Weeks (1954) provides an overview of the results of early geological studies.

The results of subsequent work (Barr and Setter, 1986; Hill, 1987, 1989; Barr and Raeside, 1989; Raeside, 1989; Raeside and Barr, 1990) on the Precambrian geology of Cape Breton has led to the reallocation to other units, of some rocks previously assigned to the George River Group (Raeside, 1989), considered the oldest rocks in the region. For example, the migmatite within a gneiss complex at Lime Hill on North Mountain, southwestern

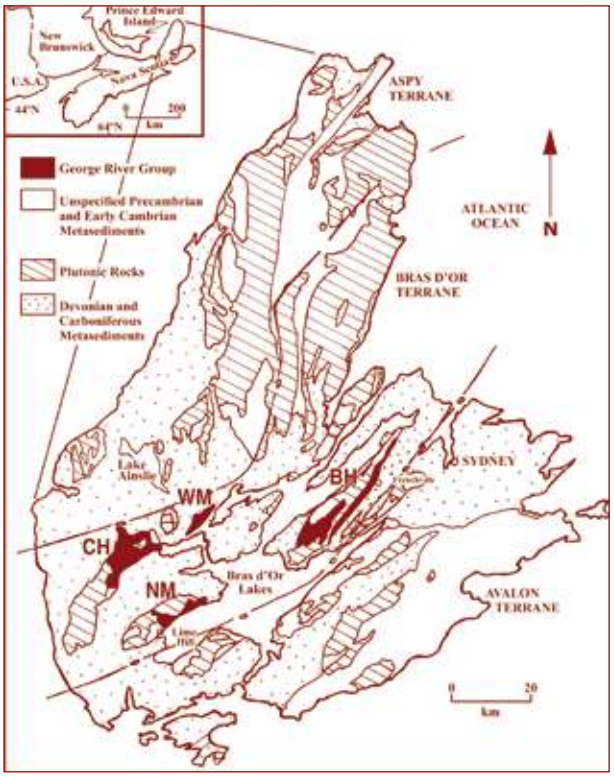

Figure 1: *Sketch map shows the extent of Precambrian metasedimentary rocks on Cape Breton Island; main occurrences of George River Group rocks (BH - Boisdale Hills, NM - North Mountain, CH - Creignish Hills, WM - Whycocomagh Mountain) are restricted to the Bras d' Or tectonostratigraphic terrane (modified from Raeside, 1989).*

Cape Breton, contains "... minor spinel- and corundum-bearing neosomes..." (Raeside, 1989). This earliest discovery of corundum on the island is in a unit within the Bras d'Or terrane viewed by Raeside and Barr (1990) as distinct from the George River Group *(Figure 1).* For the purpose of this report, however, the term is retained in order to highlight areas of particular interest in the exploration for Cape Breton rubies. The focus here is on a small window of the George River Group, centred in the Boisdale Hills, a locality which Milligan (1970) considered as the type. This report is based on over four months geological mapping and sampling, and a follow-up drilling programme as part of an on-going mineral exploration programme within a 4000 Ha claim block in the Boisdale Hills held by Mount Cameron Minerals Inc. (MCMI). Mineral collecting is prohibited in this claim block without the permission of MCMI.

Although no type section has been formally proposed for the George River Group, the term has been loosely applied to many interbedded carbonate and clastic and minor volcanic rocks of variable metamorphic grade on Cape Breton Island. As noted above, the informal type locality is the Boisdale Hills, where a Late Precambrian sequence of schists, gneisses and siliceous dolomitic marbles has been regionally metamorphosed to upper amphibolite facies. These rocks are intruded by predominantly late stage shallow level hybrid igneous dykes and sills ranging from granite through hornblende diorite to diabase. Ratio of metasediments to intrusives is estimated at 3 : 1.

Results of radiometric age determinations reported by White *et al.* (1994) identify the intrusive igneous rocks from the northern Boisdale Hills as late Cambrian to early Ordovician. In the environs of Frenchvale quarry, upper amphibolite grade metamorphism is represented by the presence of two-mica schist, garnetiferous (grossular-andradite, so-called 'grandite')-sillimanite-andalusite gneiss, and in metacarbonates in the quarry itself, by the presence of corundum and a suite of calc-silicate minerals. Both fault-bounded and intrusive contacts with

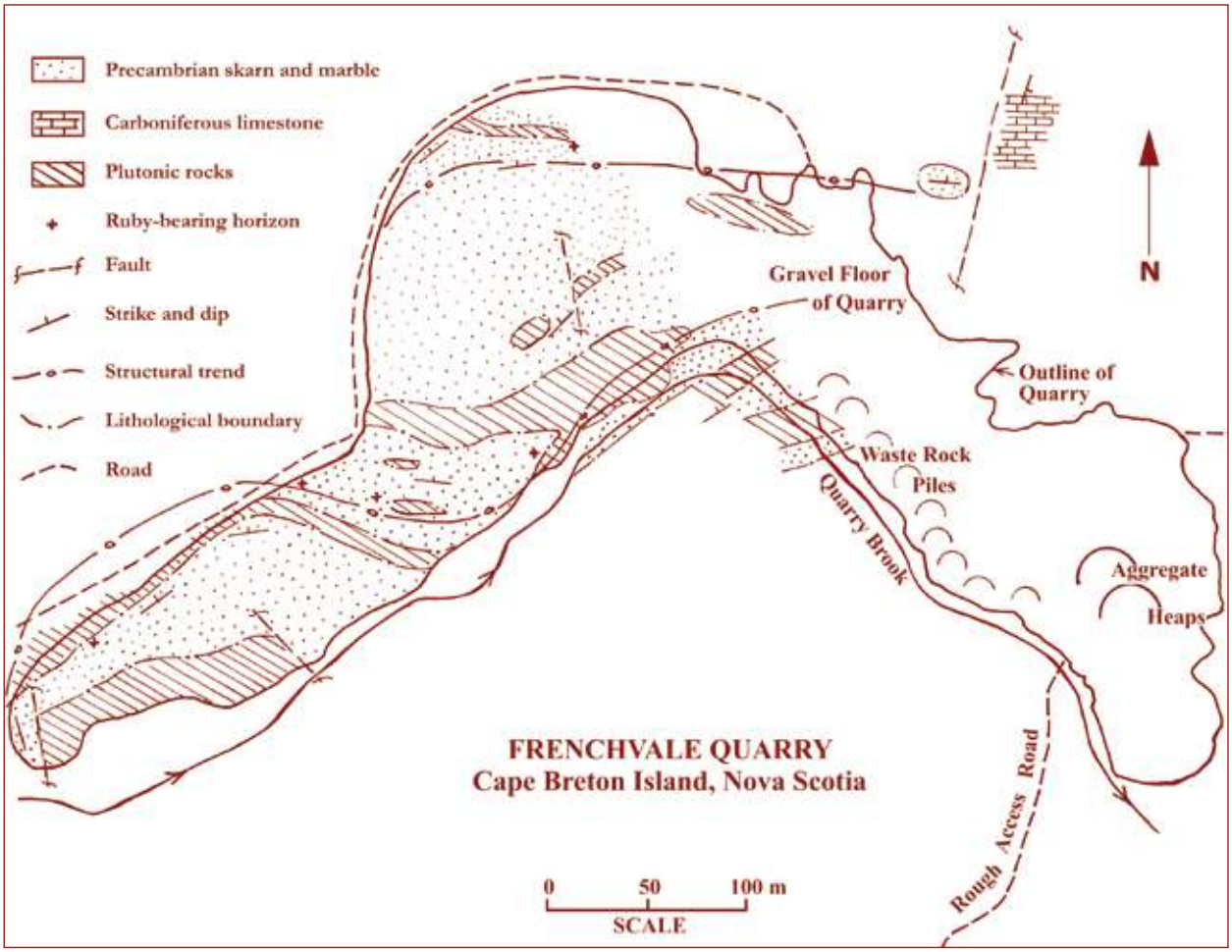

Figure 2: *Geological sketch map of Frenchvale quarry, situated 0.7 km northwest of the village of Frenchvale, and approximately 18.7 km west southwest of Sydney, Cape Breton Island, Nova Scotia.*

Figure 3: *Discovery specimen (untrimmed) of prismatic (1.2 cm diameter) ruby in skarn from the northeast wall of Frenchvale quarry. Photograph by D. Mossman.*

country rock metasediments are encountered in the area. The largest fault occurs near the east end of the quarry and separates Carboniferous limestones from the more ancient skarns of the quarry *(Figure 2).*

Lower grade (in part retrograde) metamorphism is evident in chloritization, development of talc, widespread silicification and serpentinization, and the presence of exsolved aluminium hydroxides in corundum (Schmetzer, 1987). Overall the metasediments have been made over into skarn, or more specifically 'skarnoid rocks', a term describing relatively fine-grained, iron-poor, calc-silicate rocks which reflect the compositional control of the original sediment (Einaudi *et al.*, 1981). Skarns and skarnoid

Table I: *Minerals from the George River Group, Frenchvale and environs, Cape Breton Island (this study; Chatterjee, 1977; Hill, 1989)*

Andalusite	Orthoclase
Antigorite	Pargasite
Apatite	Phlogopite
Biotite	Plagioclase (peristerite and anorthite)`
Calcite	Prehnite
Chalcopyrite	Pyrite
Chlorite	Pyrrhotite
Cordierite	Quartz
Corundum	Scapolite
Diopside	Serpentine
Dolomite	Sillimanite
Epidote	Sphalerite
Forsterite	Sphene
Garnet ('grandite')	Spinel
Goethite	Talc
Graphite	Titanite (sphene)
Hematite	Tremolite-actinolite
Magnetite	Vesuvianite
Marcasite	Wollastonite
Monticellite	Zoisite
Muscovite (including var. fuchsite)	

rocks develop in response to either localized contact metamorphism adjacent to an igneous intrusion, or regional metamorphism whereby mineral changes in the rocks occur over an extensive area. The latter hypothesis is believed to apply to the ruby occurrences at Frenchvale (*Figure 3*). Unlike classic skarns, however, the Frenchvale metacarbonates are not dominated by garnet and pyroxene.

Mineralogy

Many minerals, including some relatively exotic species, have been identified (Chatterjee, 1977; Hill, 1989) in the George River Group metasediments (*Table I*). Dolomite and to a much lesser extent, calcite, are of course major components of the purest marbles; fine-grained, disseminated flake graphite is virtually ubiquitous. Calc-silicate minerals, for the most part coarse-grained, are widely developed especially in what were originally impure limestones/marbles but which have undergone a measure of silicification. In these, a relict banding and sporadic stylolitization suggest the original stratification, and wollastonite, scapolite and vesuvianite are common.

Metamorphic mineral assemblages are characteristic of upper amphibolite grade facies (Chatterjee, 1977). Forsterite (usually heavily serpentinized), diopside, and tremolite are widespread in the metacarbonates. Spinel has likewise been reported (Chatterjee, in Milligan, 1970) though not seen by the writers. In gneiss, sillimanite and andalusite can accompany phlogopite and/or biotite, muscovite and plagioclase, attesting to a former high temperature, low pressure

regime. Various minerals, including sulphides, quartz, calcite, talc, serpentine, scheelite and tourmaline (schorl) are common in the vicinity of shear zones which provided the channels for a relatively late stage non-focused flow of mineralizing fluids.

Retrograde metamorphic minerals are locally conspicuous, a good illustration being green chromian-muscovite (fuchsite), which commonly envelopes corundum crystals. As a result of weathering, goethite, magnesite, and kaolin are locally abundant. Among sulphides, pyrrhotite, pyrite and marcasite are of widespread occurrence, with chalcopyrite least evident.

Cape Breton ruby

Here, we follow Hughes' (1997, p. 401) carefully considered recommendation that "... all corundums of a red colour, regardless of its depth or intensity should be termed rubies, just as was done prior to the 20th century." Cape Breton ruby was first recognized in mid-August 2004 as pea-sized crystals more or less enveloped by fuchsite along the northeastern rim of the Frenchvale quarry. Outcrops of ruby-bearing rock were subsequently identified at several other locations in the quarry and environs.

Corundum at Frenchvale ranges from white to dark grey, but rose, purple, red-violet and various shades of lavender are the most prevalent (*Figures 4* and *5*). More than one colour can occur at any given locality; several very small blue crystalline portions within red corundum have been recovered. The term 'oriental amethyst' has been suggested for the purple variety. However, the true nature of corundum being now well understood (Hughes, 1997), use of such a misleading term serves little purpose.

Figure 4: *A Cape Breton ruby (~ 1 ct) cut by Hans Durstling and set in a gold ring by Donald Baird. Photograph by D. Mossman.*

Comparing the colours of faceted Cape Breton ruby under various light sources reveals weak change of colour effects, with tungsten light producing the strongest rose red. Refractive indices of rose red crystals at the discovery site give $n_e = 1.766$, $n_o = 1.776$, values characteristic of the middle of the field for the mineral.

Typically, the crystals have a 'fat' rather than flat habit. However, tabular to blocky hexagonal prisms are common as are various pinacoid combinations with well-developed rhombohedron faces. Flattened bladed crystals are less common. On fold limbs, ruby crystals tend to be oriented parallel to the foliation of the enclosing rock, having been deformed at the same time as the enclosing rock.

Cape Breton ruby shows rhombohedral parting and prominent basal parting, the former giving nearly cubic angles. Only one imperfectly developed set of needle-like rutile inclusions has been observed, although prismatic rutile crystals (to 0.5 mm dia), and less often pyrite, occur around the rims of ruby crystals at some localities. Exsolved diaspore and/or boehmite are present (John Emmett, pers. comm., 2004) and doubtless contribute to the opacity/translucency of the stones. Heat treatment carried out under oxidizing conditions for 12 hours at 980°C and more, result in a colour change to bright pink, but at the cost of complete opacity.

Deformation was a late stage geological event. Indications are that some Cape Breton rubies initially formed as a progressive stage of amphibolite facies metamorphism. Then, a second generation crystallized as a consequence of retrograde metamorphism. A third mode of occurrence of corundum at Frenchvale is its presence in several small

granitic pegmatites, and this suggests that the mineral may also have been locally produced under conditions of partial anatexis at the peak of metamorphism by the breakdown of muscovite to corundum, K-feldspar and water.

During an extensive shallow drilling programme undertaken by MCMI in late 2004, true stratigraphic thicknesses of 15 m or more of ruby-bearing skarn were intersected immediately north and west of the Frenchvale quarry. Results of drilling confirm that ruby crystallized at specific horizons in the metamorphic sequence at Frenchvale – in some instances remote from intrusive rocks. Further, oblique, non-faulted contacts between ruby-containing horizons and granodiorite supply additional evidence in support of the concept that regional metamorphism and not contact metamorphism played the major role in ruby genesis. This finding has important implications for further exploration in the region, because together with the presence of corundum in the gneiss complex at North Mountain (Lime Hill), it means that rubies may be found in the George River Group whether igneous intrusions are present or not.

Comparison with ruby from the Hunza Valley

The corundum-muscovite association common at several ruby localities in Frenchvale, along with other principal characteristics of the deposit, highlights the remarkable resemblance to the Hunza, Kashmir, occurrences (Okrusch *et al.*, 1976, Hughes, 1997; Hammer, 2004). Evidently, at the old Hunza mines much of the material recovered was cracked and had more value as specimens than as rough, although some was suitable for producing cabochons or carvings. This contrasts with the much higher quality material presently being recovered from modern workings a few kilometres distant (Syed M. Shah, pers. comm., 2005). Cape Breton ruby shares the following geological and gemmological characteristics with ruby from Hunza:

1. Primary deposits consist of a siliceous corundum-bearing marble enclosed in gneisses and mica schist;
2. Colour, red to deep purple, violet to purple, some blue; most crystals are opaque to translucent;
3. Stones show a strong chromium spectrum;
4. Crystal habits are generally prisms, rhombohedra or bi-pyramids with development of pinacoid faces;
5. Strong fluorescence in red to orange-red; long wavelength UV response stronger than short wavelength;
6. Cavities and negative crystals are common inclusions;
7. Some crystals are coated with a thin waxy 'veneer' of translucent white mica and talc;
8. Corundum forms intercalations within garnetiferous mica schists and biotite-plagioclase gneisses, which are cut by pegmatites and aplite dykes;
9. A green scaly mineral closely associated with ruby is muscovite which contains traces of Cr (and V) (O'Donoghue, 1988, p. 164).

Conclusions

Cape Breton ruby is an exciting new gemstone find in Atlantic Canada. Aside from a few detrital grains of ruby found in British Columbia, and rumours of gem quality sapphire in the Northwest Territories and the Yukon, Ontario, is usually said to have Canada's most important corundum deposits, especially sapphire from several counties, albeit in small quantities as gems (Hughes, 1997). There is also an exciting new find of ruby from Baffin Island (Brad Wilson, pers. comm., 2006), certainly one of the more challenging gemmological exploration frontiers.

In Precambrian times, western Scotland and eastern Canada were probably very close, and Cartwright *et al.* (1985) have documented an area in Lewisian gneiss near Stoer, northern Scotland, of (pink) corundum associated with staurolite in a chromian muscovite matrix, although the Scottish gneiss is Archean and considerably older than the Late Precambrian

Figure 5: Pendant of Cape Breton ruby set in silver; fashioned by Hans Durstling. Photograph by F. Isenor.

metamorphic sequences in Cape Breton.

Although faceted Cape Breton rubies are not at present of the finest quality, they are attractive and may eventually support a vigorous local market in jewellery. Collectors, too, will find mineral specimens of interest. Prospects for future field discoveries in Atlantic Canada are excellent, especially if, as Raeside and Barr (1989) postulate, units equivalent to the Bras d'Or terrane exist in southern New Brunswick and in Newfoundland. Certainly on Cape Breton Island, lithologies traditionally considered to belong to the George River Group deserve close attention, especially the stream and glacial gravel deposits. It will be worthwhile also to bear in mind the analogy with Hunza, Kashmir, an area in which newer prospects within kilometres of old workings are currently producing high quality rubies and sapphires.

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