Preliminary investigations of emerald mineralization in the Regal Ridge area, Finlayson Lake district, southeastern Yukon

Heather L.D. Neufeld, Lee A. Groat and James K. Mortensen
Department of Earth and Ocean Sciences, University of British Columbia[1]

Neufeld, H.L.D., Groat, L.A. and Mortensen, J.K., 2003. Preliminary investigations of emerald mineralization in the Regal Ridge area, Finlayson Lake district, southeastern Yukon. *In:* Yukon Exploration and Geology 2002, D.S. Emond and L.L. Lewis (eds.), Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, p. 281-284.

ABSTRACT

Emerald has recently been discovered in two areas in the northern Cordillera, the Lened area immediately east of the Yukon/NWT border and the Regal Ridge property in the Finlayson Lake district of southeastern Yukon; potential for additional emerald occurrences is thought to be very good. Preliminary results from investigations at Regal Ridge in 2002 reveal a continuum between typical biotite (± muscovite) quartz monzonite to quartz-rich, tourmaline-bearing granitic pegmatite and aplite (locally containing beryl) to quartz-tourmaline veins that either contain emerald or carry emerald in associated alteration envelopes. It is likely (but still unproven) that the chromium in emeralds at Regal Ridge is derived from the mafic metavolcanic host rocks. Detailed petrographic examination of the veins and altered host rocks is aimed at constraining the composition and nature of the mineralizing fluids responsible for formation of the emeralds.

RÉSUMÉ

On a récemment découvert des émeraudes dans deux zones de la Cordillère septentrionale, la région de la propriété minière de Lened, située juste à l’est de la frontière du Yukon et des T.N.-O., et la région de la propriété minière de Regal Ridge dans le district du lac Finlayson, dans le sud-est du Yukon. Le potentiel de découverte d’autres venues d’émeraude y est, par conséquent, très élevé. Les résultats provisoires des travaux de recherche à Regal Ridge en 2002 révélent un continuum : monzonite quartzique à biotite (± muscovite) typique passant à pegmatite et aplite granitiques à tourmaline riche en quartz (contenant ici et là du béryl) pour aboutir à des filons de quartz-tourmaline recelant des émeraudes ou en renfermant dans des enveloppes d’altération associées. Il est probable (mais encore non prouvé) que le chromium dans les émeraudes à Regal Ridge provient des roches encaissantes métavolcaniques mafiques. L’examen pétrographique détaillé des filons et des roches encaissantes altérées vise à mieux définir la composition et la nature des fluides minéralisateurs qui sont à l’origine des émeraudes.

[1]*Vancouver, British Columbia, Canada V6T 1Z4*

INTRODUCTION

In 1998, W. Wengzynowski, while prospecting with Expatriate Resources Ltd., discovered Cr-dominant emeralds near a zoned felsic pluton within the Yukon-Tanana Terrane in the Finlayson Lake district of southeastern Yukon. Subsequent work at this locality (the 'Regal Ridge' showing, Fig. 1, currently held by True North Gems Inc.) has outlined numerous emerald-bearing float trains and six main bedrock sources within a 900 by 400-m area. The geology, mineralogy, and origin of the occurrence are discussed in Groat et al. (2002) and Marshall et al. (in press) and are discussed in detail below.

GEOLOGY AND MINERALOGY

Emerald crystals at Regal Ridge occur where quartz veins cut mica-rich layers in a schist of the Upper Devonian Fire Lake mafic metavolcanic unit (unit DMF of Murphy and Piercey, 2000). At least eight such veins have been discovered, and most are enveloped by a mass of fine, dark tourmaline crystals. The tourmaline crystals are locally associated with minor amounts of scheelite; and small amounts of sulphide minerals, especially chalcopyrite, have been observed within the quartz veins. A zone of sparse, disseminated sulphide minerals appears to coincide with the tourmaline envelope, which is characterized on surface by a pronounced jarosite-dominant gossan. The emerald crystals occur within the tourmaline zones and, rarely, in the quartz veins.

Washing and hand sorting of approximately 6 m^3 of material thus far has yielded more than 6 kg of green beryl and emerald. A number of small gems (up to ~0.5 ct; see Fig. 2) have been fashioned from the Regal Ridge samples. It is still too soon to tell if the showing will become an emerald producer; additional work (including bulk sampling) must be completed before the economic potential can be assessed.

Fieldwork in 2002 revealed an apparent continuum at Regal Ridge between typical biotite (± muscovite) quartz monzonite to quartz-rich, tourmaline-bearing granitic pegmatite and aplite (locally containing beryl) to quartz-tourmaline veins that either contain emerald or carry emerald in associated alteration envelopes. Several lines of investigation are underway to further constrain the nature and origin of emerald mineralization at Regal Ridge. These include (1) mineralogy of the regional and vein-scale alteration; (2) geochemistry of the host rocks; (3) geochemistry of the emeralds; (4) fluid inclusion study;

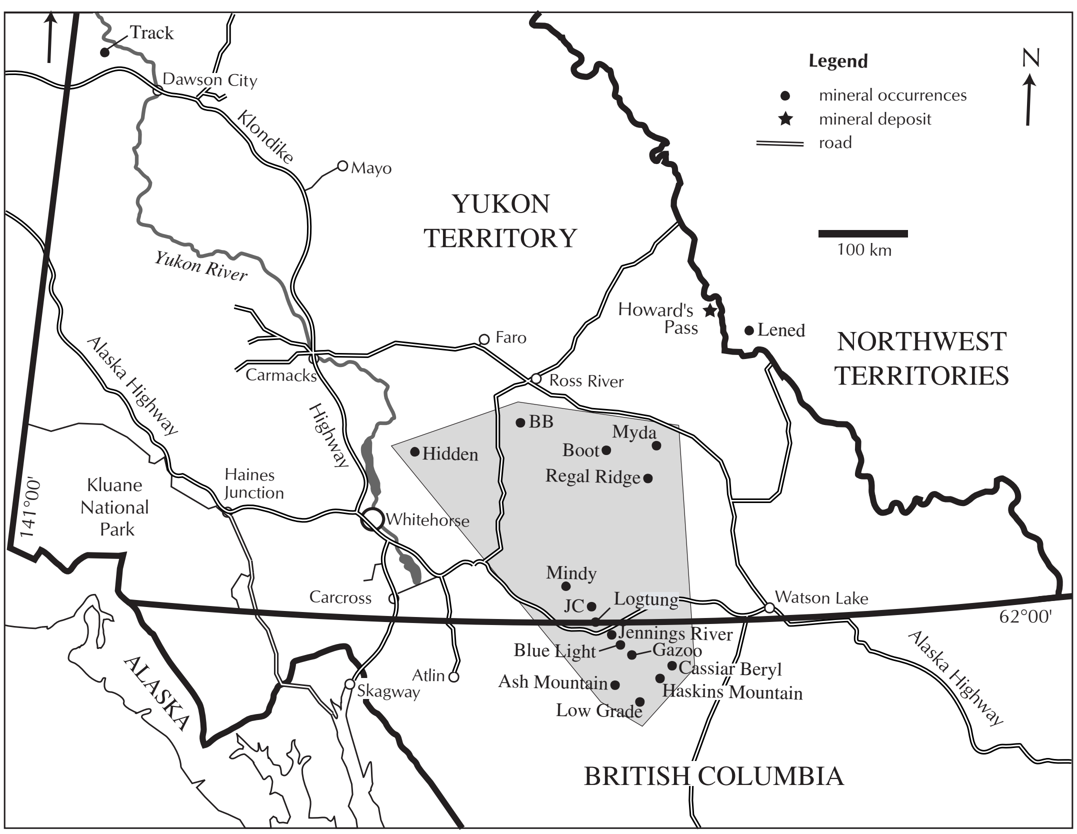

Figure 1. *Map of the Yukon Territory showing reported beryl/beryllium occurrences. The potential beryl/emerald camp is shown in grey.*

(5) stable isotope study; (6) Be-Cr-V-B mobility modelling; (7) beryl precipitation mechanisms; (8) geochronology of intrusives, alteration and veins; and (9) identification of possible geochemical signature of mineralized zones for exploration purposes.

LABORATORY RESULTS AND GENESIS

Fluid inclusion data indicate that the emerald precipitated from a fluid whose maximum salinities were 3 wt% NaCl equivalent. The oxygen isotopic composition of the emerald is variable (12.3 to 14.8‰), but there is little difference in corresponding δD values (-57.3 and -59.8‰, respectively). This suggests formation from an isotopically homogeneous fluid. The $\delta^{18}O$ values for coexisting quartz and tourmaline from the quartz veins yield temperatures of formation of approximately 365 and 498°C, respectively. Based on fluid inclusion isochoric data, these temperatures correspond to pressures of 1.0 to 2.5 kbar, and inferred depths of 3 to 7.7 km (Marshall et al, in press).

The close proximity of the granite suggests that it is likely the source of the beryllium in the formation of emerald, although the present Be concentration in the granite is low (12 and 13.2 ppm). Electron microprobe analyses show that Cr (average of 85 analyses is 3208 ppm) is the predominant chromophore in emerald from this occurrence. The source of the Cr is thought to be the host schist (520 ppm Cr). An $^{40}Ar/^{39}Ar$ age of 109 Ma obtained on phlogopite from the schist is not significantly different in age from the U-Pb ages of ca. 112 Ma reported for the granite pluton (Mortensen 1999; J.K. Mortensen and D.C. Murphy, pers. comm., 2002). This is interpreted to reflect either a thermal overprint age related to the event that produced the emeralds, or cooling following intrusion of the adjacent pluton, or both.

Figure 2. *Cut emerald from the Regal Ridge property. For scale, the largest rectangular cut gem in right centre of photo is approximately 5 mm in length. Photo courtesy of True North Gems Inc.*

LENED PROPERTY

In 1997 R. Berdahl, an independent prospector from Whitehorse, Yukon, discovered Vanadium-dominant emeralds near the Lened pluton in the southwestern Northwest Territories (Fig. 1). Emerald crystals at Lened are transparent to translucent, pale green in colour, and are up to 2.0 cm in length (L. Walton and R. Berdahl, pers. comm., 2002). Some yellow-green, and some darker-green crystals have been found.

The emerald crystals at Lened occur in quartz-carbonate veins within a garnet-diopside skarn. The skarn is hosted within the Rabbitkettle Formation which overlies Earn Group black shales. The skarn and the later veins are the result of contact metamorphism related to the adjacent 93 Ma Lened granitic pluton.

Fluid inclusion studies from emerald at Lened reveal the presence of two distinct fluids: a CO_2-bearing fluid related to emerald precipitation and a later brine limited to quartz crystals. The CO_2-bearing fluid is dominantly a dilute aqueous brine with approximately 4.5 mole percent CO_2 and minor amounts of CH_4, N_2, and H_2S. Formational pressures range up to 3.85 MPa and are limited by the presence of andalusite in the pluton. Formational temperatures of approximately 200-690°C are constrained by fluid inclusion homogenization temperatures and isochore intersections with the 3.85 MPa pressure maximum (Marshall et al, in press). Oxygen isotope, fluid compositions, formational pressures and temperatures are similar to those for the Regal Ridge occurrence.

OTHER PROPERTIES, BRITISH COLUMBIA AND YUKON

A review of assessment reports (BC MINFILE Mineral Inventory, 2001, *www.em.gov.bc.ca/Mining/Geolsurv/Minfile/default.htm;* and Yukon MINFILE, 2001) and other published and unpublished reports shows that numerous other beryllium and beryl occurrences exist in southern Yukon and northern British Columbia (Fig. 1). Analyses of a scheelite-bearing scapolite skarn at the Myda claim (Yukon MINFILE, 2001, 105G 071), approximately 20 km south of the Crown occurrence, show 0.05 to 0.09 wt% BeO. Beryl has also been reported from the Logtung W-Mo deposit (Yukon MINFILE, 2001, 105B 039), the JC (Viola) Sn-bearing skarn claims (Yukon MINFILE, 2001, 105B 040), and the Ice Lakes area (Groat et al. 1995), all in southern Yukon just north of the British Columbian-Yukon border. Beryl has also been reported from the following showings and prospects in northern British Columbia (listed west to east): Jennings River (British Columbia MINFILE, 2001, 104O 028), Ash Mountain (104O 021), Blue Light (104O 005), Gazoo (104O 045), Low Grade (104P 026), Haskins Mountain (104P 020), and Cassiar Beryl (104P 024). Most of these are associated with Cretaceous plutons, in particular the Cassiar Batholith.

CONCLUSION

At both the Regal Ridge and Lened showings, and at the Logtung beryl occurrence in southern Yukon, the Be is associated with elevated concentrations of W (including W skarn); the geochemical reasons for this association are unclear, but it also suggests a possible genetic association with intrusions.

In most emerald-producing nations, emeralds come from a number of mines within a mineralized region. The discovery of emerald at Regal Ridge and Lened along with numerous reports of anomalous levels of Be and/or the presence of beryl in the northern Cordillera suggest the potential for more emerald occurrences in the Yukon, western Northwest Territories, and northern British Columbia. This area could represent one (or possibly more) distinct beryl/emerald camp(s), as has been recognized at other places in the world.

ACKNOWLEDGEMENTS

This work results from field work which was generously funded by True North Gems Inc., the Yukon Geology Program, and the National Sciences and Engineering Research Council (NSERC). The authors would like to thank Ron Berdahl for allowing access to the Lened property, and Lori Walton for sharing her knowledge of the Lened property.

REFERENCES

BC MINFILE Mineral Inventory, 2001. British Columbia Ministry of Energy & Mines.

Groat, L.A., Marshall, D.D., Giuliani, G., Murphy, D.C., Piercey, S.J., Jambor, J.L., Mortensen, J.K., Ercit, T.S., Gault, R.A., Mattey, D.P., Schwartz, D.P., Maluski, H., Wise, M.A., Wengzynowski, W. and Eaton, W.D., 2002. Mineralogical and geochemical study of the Regal Ridge showing emeralds, southeastern Yukon. Canadian Mineralogist, vol. 40, no. 5, p. 1313-1338.

Marshall, D.D., Groat, L.A., Giuliani, G., Murphy, D.C., Mattey, D., Ercit, T.S., Wise, M.A., Wengzynowski, W. and Eaton, W.D., 2003 (in press). Pressure, temperature, and fluid conditions during emerald precipitation, Southeastern Yukon: Fluid inclusion and stable isotope evidence. Chemical Geology, vol. 186.

Mortensen, J.K., 1999. YUKONAGE, an isotopic age database for the Yukon Territory. *In:* Yukon Digital Geology. S.P. Gordey and A.J. Makepeace (eds.). Geological Survey of Canada, Open File D3826, and Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada, Open File 1999-1(D).

Murphy, D.C. and Piercey, S.J. (2000). Syn-mineralization faults and their re-activation, Finlayson Lake massive sulphide district, Yukon-Tanana Terrane, southeastern Yukon. *In:* Yukon Exploration and Geology 1999, D.S. Emond and L.H. Weston, (eds.), Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada (55-66).

Yukon MINFILE, 2001. R. Deklerk (comp.) Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada.