The Zealand Station Beryl (Aquamarine) deposit, west-central NB: mineralogic, geochronologic, and petrogenetic constraints

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ABSTRACT

The Zealand Station aquamarine deposit is one of fourteen beryl deposits in New Brunswick, Canada and is located 30 km northwest of Fredericton, NB. Aquamarine mineralization is structurally-controlled along veins and within an aplitic porphyry dike. The host is the Hawkshaw Granite while the dyke is related to a more fractionated, late-stage off-shoot of the Allandale Granite, both part of the multiphase Pokiok batholith. The granite intrusions have been previously dated at 411 ± 1 Ma by U-Pb titanite and 402 ± 1 Ma by U-Pb monazite, respectfully (Whalen, 1993)..

Keywords: *Aquamarine, Beryl, Pokiok Batholith, Zealand, New Brunswick.*

LOCATION AND GEOLOGY

The Zealand Station beryl deposit is located 30 km northwest of Fredericton, NB, Canada as seen in Figure 1, along the northeastern cusp of the multiphase Devonian Pokiok Batholith that has been mapped as the Hawkshaw Granite, previously dated at 411 ± 1 Ma by U-Pb titanite (Whalen, 1993). The Pokiok Batholith intruded Early Silurian Kingsclear Group metasediments. The Hawkshaw Granite is characterized by pink to grey feldspar porphyritic, medium-grained biotite granite to granodiorite. A late-stage, SE-trending aplite dike is weakly porphyritic, in places pegmatitic, and locally has abundant blue beryl (aquamarine) occurrences in the aplitic groundmass and with very coarse K-feldspar. Located 50 m from the main exposure of the dike is an exposure of a pegmatite phase that is predominately muscovite, quartz, and orthoclase with crystals reaching about 30 cm in size. The pegmatite is evidently related to the aplitic dike.

FIGURE 1. Map of Canada showing location of Zealand Station beryl deposit in New Brunswick.

The host granite and crosscutting dike have a granitic composition (SiO_2 = 67.5 – 82.4 wt%), and using the Frost et al. (2001) classification the FeO*/(FeO*+MgO) ratio is from 0.09 to 0.95 showing the granites are predominantly magnesian and slightly potassic. The MALI diagram shows the host granite and porphyritic aplite dike is approximately calc-alkaline with strong peraluminousity (ASI = 1.23 – 3.76), enhanced by greisenization.

The granite samples typically have partially overlapping compositions to the aplitic dike samples and related phases. The trace-element data has elemental characteristics of S-, fractionate I-, and crustal A-types. For instance, I-type characteristics are evident in the Rb vs. P_2O_5 plot, with both I- and S-type character for the Rb/Nb values (granite = 10.5 - 30.6 ppm and dike = 9.1 - 34.7 ppm), Zr/Y values (granite = 2.1 - 7.5 ppm and dike = 0.9 to 2.5 ppm), Nb/Ta values (granite = N/A-13.4 ppm and dike = 2-10 ppm) and, Nb/Y values (granite = 0.17-0.92 and dike = 0.17-0.65), although have crustal A-type attributes for the Th/Yb values (granite = 2.9-13.2 ppm and dike = 1.0-4.1 ppm). Individual element concentrations show higher Ga (granite = 14-30 ppm and dike = 16-26), moderate Pb (granite = 7-41 ppm and dike = 8-56 ppm), variable Cu (granite = <146 ppm and dike = <38 ppm), and low Zn (granite = 0-86.4 ppm and dike = 0-5.5 ppm).

GEOCHRONOLOGY

The porphyritic aplite dike is 400.5 ± 1.2 Ma using TIMS U-Pb in magmatic zircon (MUN) and at 404 ± 8 Ma using the U-Pb in magmatic monazite by the EPMA technique (UNB): these ages link the aplitic dike to the Allandale Granite phase, previously dated at 402 ± 1 Ma by U-Pb in monazite (Whalen, 1993). The Allandale phase, considered the youngest phase of the Pokiok Batholith, is too young to be related to any of the earlier intrusive phases of the batholith. In addition, two monazite analyses resulted in an age of 510 ± 20 Ma using EPMA indicating a supracrustal xenocrystic origin.

BERYL MINERALIZATION

At the Zealand Station beryl (aquamarine) occurrence, the host granite is altered to greisen in pockets (<3 m wide) and along veins that have associated molybdenite booklets and beryl locally. The quartz-rich veins have two predominant orientations: 135°/90°, and 010°/75°W, and are <5 cm wide and traceable for up to 30 cm, with rare molybdenite pockets <1.5 cm thick. The greisen pods show no regular orientation, although are suggested by Chrzanowski and Elliot (1986) to be associated with nearby fractures in the granite. The veins and greisen pods have up to 5.61 wt. % BeO.

In addition to the secondary beryl in the granite, there is up to 20 vol.% beryl in a portion of the aplitic phase of the dike. Other samples from the aplitic dike and pegmatite show up to 79 ppm Be.
The euhedral beryl is a clear to milky, light to medium blue (aquamarine) and up to 2 cm in diameter.

CRYSTAL STRUCTURE AND GROWTH ZONATION IN BERYL

Eight beryl samples were analysed by EPMA at UNB from the aplitic dike, beryl-bearing quartz veins, and greisen veins. At this deposit, the average H_2O content within the channel site is 1.53 wt.% calculated by (Na_2O + 1.4829)/1.1771 (Lee Groat, pers. commun.). The beryl shows high silica concentration so the excess silica is well-fitted into the Al-octahedral site, along with other common constituents including iron that is shown to be predominantly ferric. The Cr and V average concentrations were 0.0006 apfu (atoms per formula unit) and 0.007 apfu, respectively, so the dominant chromophore is iron. Compositional zonation is evident in all minerals using backscatter imaging, with one sample in particular showing oscillatory zoning; darker zones are a result of decreased iron content. Cross cutting the zonation on the edges of a few grains is a very dark alteration associated with micro-fractures in the beryl crystal, this is the result of higher than average aluminium content.

CONCLUSION

The Zealand Station beryl (aquamarine) deposit is one of fourteen beryl occurrences in New Brunswick. The large aquamarine crystals have been the source of interest from exploration companies, prospectors and collectors since at least the mid-1950s. The purpose of determining the beryl structure and nature of the occurrence is to determine the possibility of quality beryl at the Zealand Station deposit.

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