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Comparison of SEM-EDS and EPMA-WDS Analysis of Rare Earth Element Containing Minerals from Bokan Mountain, Alaska

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The Bokan Mountain Complex consists of peralkaline granitic intrusions and an associated "vein-dike" system that is enriched in LREEs, HREEs, Y, Zr, Nb, Th, and U and is mineralogically and paragenetically extremely complex (Fig. 1) [1,2]. Throughout the course of the work, SEM-EDS and EMP-WDS were employed to identify REE-containing minerals to create a REE budget for the prospect and determine the relative timing of the mineralizing events. To date, over 25 minerals have been identified which contain significant amounts of rare earth elements (REEs) including fergusonite, various Ti-Nb-Y-oxides (mainly polycrase), pyrochlore, gadolinite, hingganite, Y-Mg-fluosilicate (magnesiorowlandite?), xenotime, iimoriite, bastnaesite, parisite, synchysite, allanite, monazite, and multiple types of unidentifed Ti-Y-HREE-silicates, LREE±F±Ca±Na±Al-silicates, and an unidentified HREE-Nb-Y-oxide [2].

EDS analyses were acquired at 20kV, approximately 1 nA beam current, and 30 seconds live count time. Data was processed with the ThermoFisher Scientific Noran System Seven software package using vendor supplied peak profiles and all data are normalized to 100%. Examination of spectra with known composition suggests it is best to include all REE in the analysis. Once a potential mineral identification was made based on the ratio of elements present, simulated EDS spectra were created with DTSA-II for comparison [3-5].

WDS analyses were acquired with a JEOL 8900 electron microprobe with five spectrometers operated at 20kv, 30 nA current, and a focused spot. The complexity of the mineral assemblage at Bokan Mt required the following elements to be acquired: F, Na, Mg, Al, Si, P, K, Ca, Ti, Mn, Fe, Zn, Y, Zr, Nb, the REEs (La through Lu), Pb, Th, and U. Natural and synthetic mineral standards, the Edinburgh REE glasses, and Smithsonian REE orthophosphates were used for calibration and accuracy checks. A comparison of multipoint background acquisition and mean atomic number background corrections show good agreement down to 1 wt% for most elements. The use of MAN background corrections considerably reduces the analysis time.

The accuracy of SEM-EDS analysis of the Drake and Weill REE glasses [6] for each REE relative of the given value is: La (4%), Ce (10%), Pr (8%), Nd (8%), Sm (8%), Eu (8%), Gd (8%), Tb (8%), Dy (8%), Ho (8%), Er (8%), Tm (8%), Yb (8%), Lu (8%). These glasses were produced to have no interfering peaks. SEM-EDS analyses compared to EMP-WDS of the minerals identified at Bokan Mountain show good agreement for REEs that are a major component of the mineral (>10 wt%) and less agreement when the REE is a minor component (<3 wt%) (Fig. 2). Generally, the SEM-EDS analysis is high compared to WDS analysis, which is likely explained by poor handling of peak overlaps. However,

SEM-EDS analysis has been essential in the reconnaissance of the mineralogical and paragenetic study of the Bokan Mt complex because of the ease with which all major and minor elements can be acquired relative to the time required to acquire 30 elements with EPMA.

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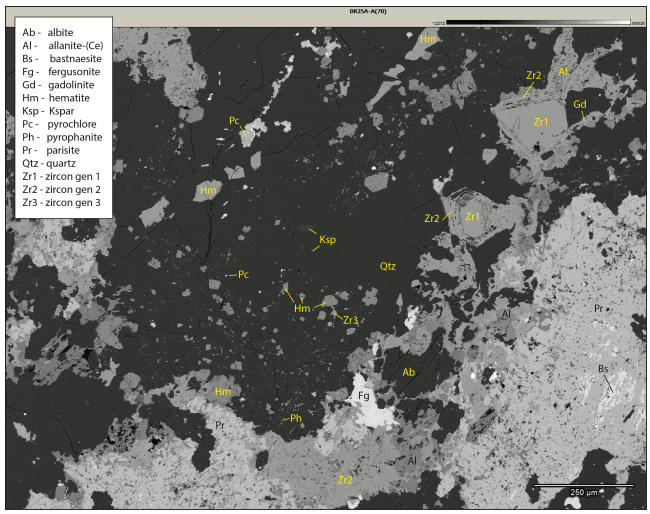

Figure 1. BSE image showing the complex intergrowth of REE minerals. Scale bar is 250 µm.

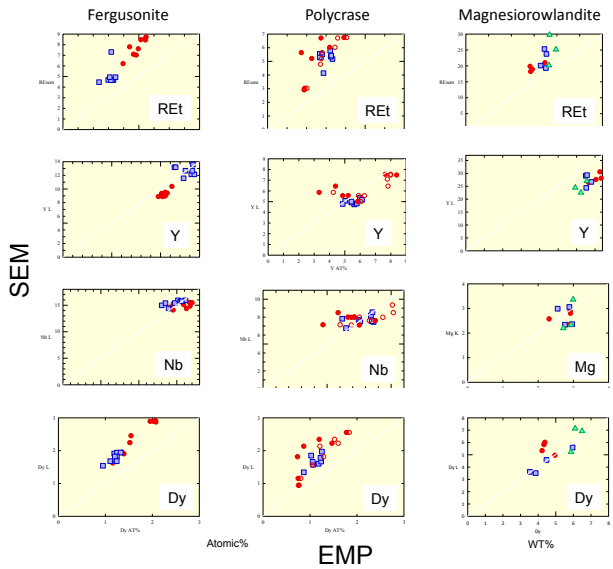

Figure 2. Comparison of SEM-EDS to EMP-WDS data for the minerals fergusonite, polycrase, and magnesiorowlandite.

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