

Cathodoluminescence characterization of Norsethite $\text{BaMg}(\text{CO}_3)_2$

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Anhydrous double salts of MgCO_3 and BaCO_3 such as norsethite $\text{BaMg}(\text{CO}_3)_2$ have not been investigated up to date with respect to CL properties, whereas CL of dolomite structurally similar to norsethite has been extensively used to geoscience application. In this study, we have measured CL spectra of norsethite and characterize its CL emission centers.

Norsethite sample from Kremikovtsy, Bulgaria was selected for CL spectral measurements. SEM-CL analysis was conducted using an SEM combined with a grating monochromator to measure CL spectra ranging from 300 to 800 nm in 1 nm steps with a temperature controlled stage from -190 to 250 °C. All CL spectra were corrected for the total instrumental response.

Norsethite exhibits a red broad band emission in red region between 570 and 770 nm at room temperature. This emission can be assigned to Mn^{2+} as an activator by comparing with the emissions of other carbonates, but with too low concentration of Fe^{2+} as a quencher. A Gaussian curve fitting of the spectra was carried out to clarify emission components in energy units. One emission component at around 1.93 eV (641 nm) was found without the others related to defect centers. Dolomite has two emission components at 1.84 eV (673 nm) for Mn^{2+} activator in Mg site and another component at 2.15 eV (576 nm) for same activator in Ca site. This fact implies that Ba ions with large ionic size might alternate crystal field strength around Mg site in norsethite structure.

An apatite-halogen based probe for fluid-rock interaction events

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Apatite is a typical accessory mineral in many geological settings and is stable over a wide range of pressure and temperature. Natural apatite usually occurs as a solid solution of three end members, i.e. fluor-, hydroxy- and chlorapatite and therefore reflects the F-Cl-OH activity conditions of its formation. Apatite crystallized during fluid-rock interaction can be used as a fluid probe for halogens as it reflects not only F and Cl, but Br and I concentration in the fluid. Also apatite is rather sensitive to changes in fluid composition, undergoing dissolution-precipitation reactions leading to formation of an apatite with a changed composition. This facilitates constraints on the number of fluid events and the characteristics of their potential sources.

Here, we present a halogen concentration and $\delta^{37}\text{Cl}$ study of apatite from an alteration sequence from a regional-scale metasomatic event (Bamble Sector, SE Norway). The alteration sequence comprises a complete profile from unreacted to fully altered gabbro, close to a shear zone from which a high salinity fluid pervasively altered the gabbro.

Halogens in apatite, measured in-situ by ion microprobe, show marked diversity. Whereas Br concentrations constantly decrease from the least altered (100-500 ppm) to most altered samples (10-20 ppm), F shows the opposite trend, with a constantly increasing concentration from 40-100 ppm to 2000-12000 ppm. Apatite from the most pristine samples shows low F/Cl ratios and high Br/Cl, while apatite from strongly altered samples is characterized by high F/Cl and low Br/Cl ratios. I/Cl ratios show no correlation with alteration.

Apatite from the pristine gabbro has $\delta^{37}\text{Cl}$ values $<+0.4\%$. With increasing alteration $\delta^{37}\text{Cl}$ values increase to as high as $+3.5\%$. Furthermore, there is a strong correlation between $\delta^{37}\text{Cl}$ values and F concentrations within individual apatite crystals.

The observed halogen concentrations and $\delta^{37}\text{Cl}$ values of apatite formed during the metasomatic event can be explained by a single fluid event. Characteristics of the fluid are best represented by apatite from highly altered samples (high $\delta^{37}\text{Cl}$, high F concentrations). Due to interaction with the gabbro this fluid constantly evolves to lower F concentrations and lower $\delta^{37}\text{Cl}$ values.