

## **Crystal chemistry and microfeatures of gadolinite imprinted by pegmatite formation and alteration evolution**

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### **ABSTRACT**

Gadolinite [ $\text{REE}_2\text{Fe}^{2+}\text{Be}_2\text{Si}_2\text{O}_{10}$ ] is a common mineral in certain types of rare element and rare earth element (REL-REE) pegmatites. Changes in pegmatite environment during and after gadolinite formation may be devised by studying its crystal-chemical properties and a thorough observation of microfeatures in the mineral matrix. Post-crystallization processes in pegmatite might trigger alteration mechanisms in gadolinite like in other REE-rich pegmatite minerals, whereby various late-magmatic or metasomatic events may affect mineral chemistry. Three gadolinite samples originating from various pegmatite occurrences in southern Norway offer an excellent opportunity in studying post-crystallization evolution of the pegmatites; by determining their crystallographic, chemical, and micro-textural features, imprints of the related processes in the pegmatites have been characterized in this study. Relevant mineral information was collected in recrystallization experiments of fully or slightly metamictized gadolinite samples and subsequent XRD analyses. Micro-Raman spectroscopy, electron microprobe analysis (EMPA), and scanning electron microscope–backscattered electron–energy-dispersive X-ray spectroscopy (SEM-BSE-EDS) analyses were employed to retrieve micro-chemical properties and related micro-textural features of the mineral matrix. With a reference to the gadolinite supergroup, a general alteration path can be envisaged outlining the pegmatite evolution and suggesting the occurrence of the secondary REE mineral phases: altered gadolinite domains prove Ca enrichment with a tendency toward the hingganite composition, while a slight fluorine increase and sporadic secondary fluorite occurrence imply a significant role of fluorine as a complexing agent in the dissolution-reprecipitation mechanism of metasomatic alteration in the mineral. Micro-Raman spectra show improved vibration statistics for the altered gadolinite domains, which could be linked to the substitution of rare earth elements (REE) by Ca and a possible increase of structural ordering within the gadolinite structure, being at the same time an indication of structural healing of metamictized domains by metasomatic processes. A study of microfeatures in the complex silicates like gadolinite proves to be an excellent tool to trace post-crystallization processes in a pegmatitic environment. With a slight redistribution of radionuclides during an alteration in gadolinite, a moderate precaution has to be taken when selecting gadolinite for U-Th-Pb dating.

**Keywords:** Gadolinite-(Y), crystal chemistry, metamictization, alteration domains, metasomatism, pegmatites