Detailed observation of subgrained/aggregated sillimanite enclosed in garnet by cathodoluminescence imaging and Raman spectroscopy

Kota Suzuki and Tetsuo Kawakami

Department of Geology and Mineralogy, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan

The polymorphs of Al_2SiO_5 minerals (kyanite, sillimanite and andalusite) are valuable indicators to constrain pressure-temperature (*P-T*) conditions of metamorphic rocks. In the case of metapelitic rocks from the Lützow-Holm Complex (LHC) of East Antarctica, mode of occurrence of kyanite and sillimanite has been investigated in detail [1-5]. Detailed mineralogical investigations revealed that the stable phase of Al_2SiO_5 minerals changed from kyanite to sillimanite during/followed by isothermal decompression [6]. Although the change of stable phase has been confirmed by the distributions of inclusion kyanite and sillimanite combined with the chemical zoning of garnet, no evidence of the phase transition from kyanite to sillimanite has been found from Al_2SiO_5 minerals themselves. Recognizing the phase transition from Al_2SiO_5 minerals themselves enables us to understand the *P-T* changes of metamorphic rocks in more detail [7]. In this context, we previously attempted to find the evidence of phase transition from sillimanite with 420 cm^{-1} Raman peak, however, no evidence of the phase transition was found by detailed TEM observation [6]. In this presentation, we describe subgrained/aggregated sillimanite in a metapelitic sample from Rundvågshetta in the LHC in detail by utilizing cathodoluminescence (CL) imaging combined with Raman spectroscopy.

In a Spr-bearing Opx-Sil-Grt gneiss from Rundvågshetta (sample TK2003010309), kyanite occurs only as inclusion minerals in garnet, whereas sillimanite occurs both as inclusion minerals in garnet and as matrix minerals. Kyanite in garnet is accompanied by sapphirine as reported by [2]. Polyphase mineral inclusion of Ky+Spr+Qtz, devoid of plagioclase and K-feldspar, is newly found in garnet. Subgrained/aggregated sillimanite with slightly different mineral orientations is also enclosed in the same garnet. This subgrained/aggregated sillimanite is similar to that reported by [7], which is interpreted as a result of phase transition from kyanite to sillimanite.

It is reported that kyanite is more luminescent than sillimanite under CL image [8]. Therefore, we utilized CL imaging of Al_2SiO_5 minerals in order to look for possible relic kyanite within the subgrained/aggregated sillimanite. The CL image of the subgrained/aggregated sillimanite showed patchy distribution of luminescent domains. However, Raman peaks characteristic of kyanite was not detected from neither the luminescent domains nor the less luminescent domains.

Quantitative analysis and X-ray elemental mapping by EPMA in this study revealed that the luminescent domains of sillimanite are slightly Cr-rich (0.10-0.12 wt% Cr_2O_3) compared to the less luminescent domains (0.01-0.04 wt% Cr_2O_3). Other trace elements in the sillimanite such as Na, Mg, K, Ca, Ti, Mn and Fe show no significant difference in their concentrations between the luminescent and less luminescent domains. This result indicates that the luminescent domains of sillimanite can be attributed to Cr^{3+} replacing Al^{3+} [9]. The maximum Cr_2O_3 concentration in the luminescent domains of sillimanite is as high as that of kyanite enclosed in the same garnet (up to 0.15 wt% Cr_2O_3). On the other hand, sillimanite without subgrained/aggregated texture is also enclosed in garnet and present in the matrix. Although the CL images of these sillimanite do not show zoning, the Cr_2O_3 concentrations of inclusion sillimanite (0.08-0.14 wt%) and matrix sillimanite (0.06-0.13 wt%) are also high. Since the maximum Cr_2O_3 concentrations in sillimanite are almost the same regardless of the mode of occurrence, it is difficult to discuss whether the subgrained/aggregated texture of sillimanite in this studied sample is a result of phase transition from kyanite to sillimanite [e.g., 7] based on Cr_2O_3 compositions.

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