日本島弧における花崗岩質岩石中モナザイトの化学組成
Geochemistry of monazite in granitic rocks from Japanese island arc

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Monazite is a one of rare earth element (REE)-rich phosphate mineral and commonly occurs in pelitic metamorphic rocks and peraluminous igneous rocks (Williams et al., 2007). Geochemistry of metamorphic monazite has been intensively investigated using laser ablation-inductively coupled plasma-mass spectrometry (LA-ICPMS) and its REE pattern, especially Eu negative anomaly ($[Eu/Eu^*]_N$) and heavy REE (HREE) depletion ($[Gd/Lu]_N$), is linked to the crystallization condition (e.g., Rubatto et al., 2006). In contrast, the geochemical investigation of igneous monazite has been mainly carried out using electron-microprobe analysis (EMP) (e.g., Kelts et al., 2008). Hoshino et al. (2012) analyzed the monazites in granites and pegmatites from Japan by EMP. They found that the ratios of light REE (LREE) to middle REE (MREE) on the monazites are different between ilmenite- and magnetite- series granitic rocks, which was interpreted to reflect the different degree of differentiation. Yet, the determination of Eu and HREE abundances have not been carried out due to the interference and low-concentrations during EMP analysis. In this study, we have used LA-ICP-MS to measure Eu and HREE abundances in the monazites and examined whether Eu anomaly and HREE depletion exhibit consistent variations with LREE or not. The results of monazite REE analysis using LA-ICPMS shows distinct REE patterns between the monazites from ilmenite-series and magnetite-series granitic pegmatites. The Eu negative anomalies of the igneous monazites were significantly large ($[Eu/Eu^*]_N < 10^{-3}$) relative to those of metamorphic monazites. This feature may be used as indicator to distinguish between a monazite in pegmatite and a one in metamorphic rock. Among the monazites of the two series, the $[Eu/Eu^*]_N$ values of ilmenite-series monazites are larger by one or two orders of magnitude than those of magnetite-series monazites. The REE patterns of monazites in ilmenite-series rocks display moderate decrease from La to Gd relative to those of monazites in magnetite-series rocks; in contrast, the monazite REE patterns of ilmenite-series rocks show prominent decrease from Gd to Lu relative to those of magnetite-series rocks. These different features in REE patterns between monazites from ilmenite-series and magnetite-series would reflect the degree of differentiation and imply that the formation of ilmenite-series rocks is attributed to not only assimilation of sediments but also crystal fractionation, especially the fractionation of minerals incorporating HREEs relative to MREEs. The relatively enriched MREE and depleted HREE abundances in ilmenite-series monazite cannot be explained simply by assimilation of subducted sediments, which are enriched in both MREE and HREE (Plank and Langmuir, 1998). This inference is consistent with the differences of O, Sr and Nd isotopic features between two-series granitic rocks (Takagi, 2004). We consider that fractional crystallization of the minerals enriched in HREE relative to MREE (e.g., garnet) subsequent to sedimentary assimilation defines the characteristic monazite REE patterns of the magnetite-series and ilmenite-series granitic rocks in Japanese island arc.

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