Tracing magma homogenization in granite genesis by Sr and Nd isotope microanalyses: A case from the Busetsu granite, Japan

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The Busetsu granite pluton in Aichi, Japan is characterized by S-type granite affinity, which is uncommon in the Japan arc. The whole rock chemistry indicates that this peraluminous composition is attributed to a significant contribution from supracrustal rocks (Ishihara and Chappell, 2007). However, how the sedimentary component was involved and when it occurred still remain unclear. Chemical and isotopic micro-analyses of individual mineral grains within rocks are essential to trace the magma evolution. In this study, we present a comprehensive geochemical and Sr-Nd isotope study for whole rock, plagioclase and monazite samples from the Busetsu pluton. Major and trace element chemistry were conducted by an electron microprobe analyzer and a laser ablation-inductively coupled plasma mass spectrometers (LA-ICPMS), whereas Sr-Nd isotope analyses were performed on a (LA-)multicollector-ICPMS.

The monazite grains in the studied samples yielded concordant $^{206}Pb/^{238}U$ ages of ~ 68 Ma, suggesting a coeval plutonism. The $[^{143}Nd/^{144}Nd]_{68Ma}$ values of analyzed monazite grains range from 0.51225 ± 0.00004 to 0.51208 ± 0.00005, but most of them are identical within analytical uncertainty. In contrast, plagioclase grains, showing oscillatory zoning or core/rim structure, in the same samples recorded significant variations in $^{87}Sr/^{86}Sr$. The variations within single grains are up to ~0.003, while the differences between the whole-rock $[^{87}Sr/^{86}Sr]_i$ are at most 0.0006. We also found that the $^{87}Sr/^{86}Sr$ ratios of rim domains are generally identical within single rock samples; whereas some core domains have significantly higher or lower $^{87}Sr/^{86}Sr$ ratios than the rim domains. Moreover, no correlation between whole-rock $[^{87}Sr/^{86}Sr]_i$ and chemical compositions was observed, suggesting that fractional crystallization and different sources contribute to the compositional variation in varying degrees. Assuming a series of magma differentiation, it is suggested that more and less radiogenic components existed in the early stage of magma differentiation and that magma homogenization proceeded during magma emplacement associated with fractional crystallization.