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Age of the arc lower crust from mafic enclaves in the Tanzawa tonalites, Izu Arc, Japan

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The continental lower crust comprises approximately half of the bulk continental crust and plays a significant role in making the continents. According to seismic observations and studies of crustal xenoliths, the continental lower crust is thought to consist of amphibolites and/or granulite (Christensen and Moony, 1995). However, petrology and chronology of the continental lower crust still remain open questions because it is usually not exposed on the surface of the continent.

To obtain the relevance and age constraints of the continental lower crust from common occurrence of granitic rocks, we propose a new method of U-Pb zircon dating from mafic enclaves in granites with LA-ICP-MS. Zircons can survive and retain their crystallization ages even in the metamorphic overprints and magmatic modifications. In this study we collected the mafic enclaves in Tanzawa tonalites (4-5 Ma by SHRIMP: Tani et al., 2010), in the Izu collision zone, Japan. The Tanzawa tonalites are intrusive to gabbro (5-6 Ma: Tani et al., 2010) and Tanzawa group (basalt detritus in 3-17 Ma: Aoike, 1997). The mafic enclaves show textures, which suggest mixing with the surrounding tonalite. SiO₂ content in mafic enclaves varies from 46.99 to 58.26 wt%. The enclaves are considered to have two or more origins because of their various lithologies from amphibolite to doleritic basalt. We separated 355 zircon grains from nine mafic enclaves and 46 grains from the host tonalite and analysed them using LA-ICP-MS at Kyoto University and Advanced Industrial Science and Technology.

The zircon age population from tonalite show relatively narrow range distribution around 5 Ma, resulting in mean age of 4.7 ± 1.5 Ma, which corresponds to the U-Pb zircon ages previously determined by SHRIMP (Tani et al., 2010). While the zircon age population from mafic enclaves in tonalite show wide range distribution from 5 to 43 Ma, most of zircons yielded around 5 Ma. This result implies that the mafic enclaves were affected and/or mixed with the tonalitic magma at when the mafic enclaves were incorporated. Zircons of ages older than 5 Ma in the mafic enclaves would be originated from rocks surrounding the Tanzawa tonalites. Because the Tanzawa group (3-17Ma) and the gabbro suite (5-6Ma) are intruded by the Tanzawa tonalites, they are probably the origin of the zircons which yielded around 6-20Ma. On the other hand, the zircons showing older than 20Ma have to be originated except from the Tanzawa group and the gabbro suite. Because Tanzawa group is the juvenile arc basalt on the Philippine Sea Plate plate, there is nothing except the arc lower crust beneath Tanzawa tonalitic pluton which is older than Tanzawa group. Thus, the zircons which yielded 20-43Ma must be originated from the arc lower crust. The oldest zircon age (42.9 ± 8.6 Ma) implies that the arc lower crust formed by at least 42.9 ± 8.6 Ma. It is correspond to the estimate that proto-Izu-Bonin arc had initiated subduction by 48Ma (Seno and Maruyama, 1984). Our result from this study implies that the zircon U-Pb dating for mafic enclave in continental crust can provide a new data for age distribution of the continental lower crust.

Keywords: continental lower crust, mafic enclave, zircon, U-Pb dating, LA-ICP-MS, granite