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# Determining the deep crustal composition of Japan island arc using xenoliths

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Understanding the composition of the continental crust is central for deciphering its evolutionary history. The composition of the deep continental crust has been inferred by combining seismic data and chemical data for metamorphic rocks and xenoliths. Seismic wave speed reflects the density of the underground which is governed by the major elements. Thus, seismic data provide insights into the structure and major element composition of the continental crust, but no constraints on the trace element composition. By contrast, analyses of metamorphic rocks and xenoliths are the best methods to measure the major and trace elements of the deep continental crust, but the occurrence of these rocks is restricted.

So far, the deep crustal composition has been extensively investigated for continental regions, but that for island arc remains poorly constrained. Because seismic data show differences in the thickness and the major element composition between continental shields and island arcs, it is important to independently determine the deep crustal compositions of island arcs. For this purpose, we have analyzed ca. 100 xenolith samples from Ichinomegata in Akita and Takashima in Saga for the major and trace element abundances.

The major element concentrations were measured by XRF, whereas the trace element concentrations were measured by LA-ICPMS.

The major element measurements revealed that the analyzed xenoliths from Ichinomegata have compositions ranging from ultramafic to intermediate, whereas those from Takashima are ultramafic to felsic. The trace element data for the Ichinomegata and Takashima mafic xenoliths indicate that these rocks are depleted in high field strength elements (HFSE) such as Nb,Ta,Zr,Hf, and enriched in large ion lithophile elements including Pb. The observed geochemical features are well explained by the generation of the lower crust of Japan island arc by fluid-related partial melting of the mantle wedge. When the data for the Japanese mafic xenolith samples are compared with those for the average lower (mafic) continental crust that is mainly based on analyses of metamorphic rocks and xenoliths from continental regions (Fig. 1), it is evident that the Japanese xenolith samples are less enriched in most incompatible elements, despite their similar SiO2 contents to the average lower continental crust. In addition, the relative depletion in the Japanese samples is more relevant for HFSE. These findings may indicate a higher degree of mantle partial melting due to more efficient fluid supply in Japanese subduction zones relative to settings where most lower continental crusts were generated. Notably, the Japanese mafic xenolith samples have similar U contents to that of the average lower continental crust. It is well known that U behaves as a fluid-mobile element under oxidative conditions, but as a fluid-immobile element under reducing conditions. Also, it has been indicated that about 2.2 Ga, the Earth's surface changed from reducing to oxidative environments. Taking these into account, the agreement in U contents together with different contents in other most incompatible elements can be interpreted as reflecting that the significant part of the lower continental crust was formed when the Earth's surface was under reduced conditions and, therefore, U behaved as a fluid-immobile element during dehydration processes. We found that among the analyzed xenolith samples in this study, major and trace element abundances are weakly correlated. Although we need to investigate more xenolith samples from various areas to verify this inference, such correlation would be useful to combine seismic data and chemical data for rock samples to develop a model of the deep crustal composition of Japan island arc.

Keywords: Xenolith, Ichinomegata, Takashima, Neutrino, island arc, crustal composition

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