

Structure and evolution of the lower crust constrained from alkaline basalts and xenoliths in southwest Japan

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The continental crust is unique to the Earth and, in spite of its small mass, is geochemically an important reservoir, concentrating about half of the radiogenic heat producing elements. In order to understand the differentiation history of the Earth, it is essential to decipher how and when the continental crust has been formed.

In contrast to the upper continental crust, which has been well surveyed with direct means, the lower continental crust is largely unknown in terms of composition, mineralogy and age distribution of formation. In this study, we investigate the xenoliths that have been derived possibly from the lower crust, in terms of petrology (mineral assemblages and their composition, modal abundances and bulk composition) and geochronology (zircon U-Pb age dating of both the xenoliths and the host basalt). Study area is located on the Kibi Plateau in southwest Japan. The xenoliths are classified into 4 types by petrography and EPMA analysis; Type 1, pyroxenite; Type 2, eclogitic gabbro; Type 3, anorthosite; Type 4, kyanite/garnet-bearing felsic granulite. Pseudosection and mineral stability analyses were performed by a thermodynamic program "Perplex". These analyses have revealed that pyroxenite is stable beneath the Moho and its seismic velocity estimated from pseudosection ranges from 7.23 to 7.65 km/s. Therefore pyroxenite corresponds to the olivine-pyroxenite layer under the Moho. Gabbro was formed at 8-10 kbar and 873-940 K and its velocity is higher than pyroxenite. Granulite is stable at 7.5- kbar and about 1000 K and its velocity is very low. In spite of the density gap between the eclogitic gabbro and granulite (3900 and 2740 kg/m³), the analysis suggests that the felsic granulite exhibits a higher equilibration pressure and may even underlay the eclogitic gabbro. Moreover, composition of the lower crust becomes more felsic than previously thought.

Ages of the eclogitic gabbro xenolith and the host basalt coincide, showing 70 Ma. It is argued that the subducted sediments (now appear as felsic granulites) were subducted and underplated to the bottom of the lower crust during the last 30 million years or so. If such a mechanism operates worldwide, then the continental crust may have an intermediate to felsic composition even without a hypothetical process of lower crustal delimitation.

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