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Mantle physico-chemical conditions beneath the Japan arcs constrained by chemical composition of volcanic rocks

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Chemical compositions of arc magmas in subduction zones are thought to reflect several processes, such as fluid contribution derived from subducting slabs, mantle melting, and crystallization and fractionation at crustal level. By using isotopic systematics, the amount and origin of slab-derived fluids beneath the Japan arcs have been quantified with a fairly good accuracy, which give a ”Geochemical Map” regarding the distribution of slab-derived fluid, as well as melting P-T condition, in the mantle wedge [1,2]. In this study, we try to construct ”Geochemical Map” regarding the mantle physic-chemical condition beneath the Japan arcs, based on such approaches.

Considering the amount of slab-derived fluid and its origin, we forward estimated the chemical compositions of slab-derived fluid, fluid-added mantle and subsequently generated magma. Then we can inversely evaluate the melting condition by optimizing the prediction with the observed magma compositions. In this model, there are several uncertainties involved in this estimation, such as compositional range of subducting materials, partition coefficients among melt-water-solid, which have been considered to evaluate the fitting accuracy [2].

As a result, we have obtained the melting conditions (melting degree; proportion of sp- and gt-lherzolites) together with fluid contribution, all of which have been quantified with uncertainties. For instance, in the mantle wedge beneath central Japan, relatively low degrees of dominantly garnet-lherzolite (plus minor spinel-lherzolite) melting at near-solidus has been identified [2]. These calculations suggest that the melting conditions can be inferred with a fairly good resolution (melting degree ˜ 5 %; proportion of sp- and gt-lhs. ˜ 10 %), especially when coupled with fluid contribution determined independently by isotopic systematics. Based on this modeling, we discuss the mantle condition beneath Japan arcs and its global implications.

[1] Nakamura and Iwamori, 2009, Gond. Res., [2] Nakamura and Iwamori, 2013, CMP

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