

# Review for the study of material recycling at subduction zone employing the isotope and trace element compositions

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The material recycling at subduction zone has been a focus of attention since Armstrong (1968) because it is critical to understanding mantle-crust recycling. He suggested that the subduction process is a unique mechanism whereby crustal components can be introduced back into the mantle, and slab derived materials are added to the mantle wedge from the subducting slab inducing generation of island arc magma. During last two decades, the studies of geochemistry and high pressure and temperature experiment have given well understanding of material recycling at subduction zone. These studies can be applied to the genetic estimations of fluids exist in the crust of subduction zone so that those of studies can be an important information for the geophysical studies at subduction zone. Therefore, I will present a review of the studies, especially from a geochemical point of view.

Incompatible element, which are partitioned more to liquid phase than solid phase, and isotopic compositions of magmas generated in subduction zone (island arc magma; IAM) show a distinguishable characteristic compared with mid ocean ridge basalt (MORB). Incompatible element is divided into large ion lithophile elements (LILE) and high field strength elements (HFSE). LILE (mobile elements, e.g. Cs, Rb, Ba) and HFSE (immobile elements, e.g. Ti, Nb, Zr) have large and small ionic radius, respectively, and low and high nominal cation charge, respectively. LILE and HFSE are enriched and depleted, respectively in IAM compared with MORB (e.g. Wood et al., 1979). From this observations, it was inferred that the chemical characteristics of IAM was caused by addition of fluid or melt enriched in water generated from subducting slab to the mantle wedge (e.g. Fyfe & McBirney, 1975). In contrast, possibility of inputting the mantle component, which generates oceanic island basalt, to the mantle wedge was also emphasized on the bases of the similar enriched character of incompatible element and isotope compositions (e.g. Stern and Ito, 1983). However, Borwn et al. (1983) detected  $^{10}\text{Be}$ , which is formed by spallation of O and N in the atmosphere, from IAM. This observation clearly proves the addition of slab materials to the mantle wedge. Nakamura et al. (1985) showed that degrees of enrichment of LILE and depletion of HFSE decrease from fore to back arc side. They explained the observation by that relatively more LILE was extracted from subducting slab by fluid than HFSE, and concluded that subducting slab is dehydrated during subduction process. Afterward, the relationship between the ratios of mobile and immobile elements and depth to the slab have been observed from many other subduction zone (e.g. Miller et al., 1994; Ishikawa & Nakamura, 1994; Shibata & Nakamura, 1997), and it was generally accepted that the fluid released by dehydration of subducting slab added to the mantle wedge and induces generation of IAM. Although, Tatsumi (1986) emphasized that the dehydration of the subducting slab is completed before it reaches at the depth below the volcanic front, Peacock (1990) suggested that the subducting slab can dehydrate at the deeper region by the numerical calculation with the parameters of subduction rate, thickness, temperature of the slab and thermal gradient of mantle wedge. Recently, stability at different P-T conditions and partitioning of incompatible elements for hydrous minerals, which are considered as a carrier of water in the slab, are getting established by mainly high P-T experiments (e.g. Brenan et al., 1995). Furthermore, chemical signal, which indicates the releasing the fluid cause by break down of certain hydrous mineral, was also observe form geochemical study (e.g. Shibata and Nakamura, 1997). However, most of the studies introduced in this paper are still rather qualitative. To elucidate the discussions of mantle - crust recycling, quantitative studies are required in the future.