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Maturing of deeper parts of Island Arc due to infiltration of slab-derived components

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Elemental and material exchanges between the uppermost mantle/the lower crustal materials and slab-derived fluids/melts beneath Island Arc are a key to understand the origins and diversities of arc magmas and their spatial and temporal evolutions. It is, however, not usually clear the relationships between the mantle processes and the overlying arc-related magmas. Many studies of ophiolites have revealed that many of them formed in the so-called supra-subduction zone (SSZ) setting, which are characterized by the presence of arc-related igneous rocks in the volcanic sequences. Shervais (2003 G3 200GC000080) reviewed the petrological and geochemical signatures of SSZ ophiolites and suggested that SSZ ophiolites experienced a sequence of events during their evolution in response to the change in tectonic settings from oceanic lithosphere formed at mid-ocean ridges to the initiation of subduction as follows: birth, youth, maturity, death and resurrection. Field and petrological observations in SSZ ophiolites, therefore, provide constraints on processes such as partial melting and melt-rock reactions during the infiltration of slab-derived fluids/melts. The Jurassic ophiolites in Alpine-Apennine mountain belt in the west commonly display MORB geochemistry, whereas the Late Jurassic-Cretaceous ophiolites in the Tauride-Pontide, Zagros, and Himalayan mountain belts to the east show geochemical affinities characteristic of SSZ environments. The Mirdita ophiolite in the northern Albania displays MORB and SSZ affinities in the Western and Eastern belts, respectively (Dilek et al., 2008 Lithos 100, 17 4-209, and references therein). Chemical compositions of dike complex in the SSZ (eastern) belt change from older basalt to basaltic andesite-andesite-dacite to late-stage boninitic rocks. The basement of the mantle section of the SSZ part is clinopyroxene-bearing harzburgite to lherzolite (Beqiraj et al., 2000 Explor. Minning Geol., 9, 149-156) whereas the harzburgite and dunite are dominant in the uppermost section. Clinopyroxenes in cpx-bearing harzburgites are characterized by depleted in LREEs and other incompatible elements, indicating a simple residue after partial melting and melt extraction expected for adiabatic mantle materials beneath the mid-ocean ridges. It is interesting to note that silicate mineral inclusions, such as amphibole, orthopyroxene and clinopyroxene, within chromian spinels are commonly found in harzburgites near dunite. Orthopyroxenite are frequently observed in the uppermost section of the mantle sequence and cut the lithological boundary between dunite and harzburgite, indicating the later products in the mantle section. Some orthopyroxenites locally contain amphibole and/or clinopyroxene. These rocks were formed by partial melting and melt-mantle interactions due to infiltration of slab-derived hydrous fluids/melts. Some of orthopyroxenites (and also opx-rich peridotites) were formed by replacement of the preexisting olivine-rich litholgoies. Formation of secondary orthopyroxene will result in selective storages of HFSEs relative to neighbor elements in incompatible element diagrams. Secondary orthopyroxene, i.e., silica enrichment in the mantle, is also frequently observed in subarc mantle xenoliths (Papua New Guinea, McInnes et al., 2001 EPSL 188, 169-183; Philippines, Arai et al., 2004 J. Petrol. 45, 369-389; Spain, Arai et al., 2003 Proc. Jap. Acad. 45, 369-389; Kamchatka, Ishimaru et al., 2007 J. Petrol. 48, 395-433). Harzburgite-dunite-orthopyroxenite suite represents melt-residua relations and melt migration patterns in the mantle wedge during the incipient arc construction stage.

Keywords: Island Arc, magma, mantle, ophiolite, trace elements