Geophysical Research Abstracts
Vol. 13, EGU2011-9703, 2011
EGU General Assembly 2011

Melt composition variations in subduction initiation magmatism: constraints from the peridotites of the Izu-Bonin-Mariana forearc and the Eastern Mirdita ophiolite (Albania)

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Compared with comprehensive studies on arc-related volcanic rocks, there have been few studies of the mantle evolution related to igneous activity in the earliest stages of subduction initiation. Detailed geological and geochemical work on several "supra-subduction zone ophiolites" has revealed the presence of distinct peridotite units within the mantle section of ophiolites: a MORB-like unit and a highly refractory unit (e.g. Batanova and Sobolev, 2000 Geology; Choi et al., 2008 Contrib Mineral. Petrol). These lithological variations and their relationships can be explained by a shift in tectonic setting from MOR to island arc. It should be noted, however, that the tectonic setting of ophiolites is still controversial. The temporal and spatial variation of magmatism in the Izu-Bonin-Mariana (IBM) arc has been well documented by DSDP-ODP drillings, dredges and direct sampling using submersibles and ROVs (e.g. Fryer, 1996 Rev. Geophysics). Reagan et al. (2010 G-cubed) reported that MORB-like basalts were the most prevalent volcanic rocks in the IBM forearc region, followed by boninitic magmatisms. They postulated that the MORB-like tholeiitic basalts were the first lavas to erupt after the oceanic plate began to subduct and termed them "forearc basalt (FAB)". Peridotites sampled directly from the IBM forearc are crucial to understanding subduction systems. Parkinson and Pearce (1998 J. Petrol.) examined peridotites from IBM serpentine seamounts and pointed out that both oxidized dunites and harzburgites in the Torishima Seamount formed at supra-subduction zone environments, whereas reduced harzburgites and oxidized dunite from the Conical Seamount formed at separate conditions: residual MORB-like mantle origin and supra-subduction origin, respectively. A similar scenario for the Conical Seamount was also proposed to explain the origin of the South Chamorro Seamount (Zanetti et al., 2006 ofioliti). We examined peridotites recovered from an exhumed crust/mantle section exposed along the landward slopes of the northern Izu-Bonin Trench (Morishita et al., 2011 Geology). Based on the Cr# (=Cr/(Cr+Al) atomic ratio) of spinel, two distinctive groups, (1) High-Cr# (> 0.8) dunite and (2) Medium-Cr# (0.4-0.6) dunite, occur close to each other and are associated with refractory harzburgite. Two distinctive melts were in equilibrium with these dunites: a boninitic melt for the High-Cr# dunite and a MORB-like melt for the Medium-Cr# dunite. The TiO2 content of the latter melt is lower than typical MORB compositions. We suggest that the Medium-Cr# dunite was a melt conduit for a FAB that was erupted at the inception of subduction. We also examined mantle section of a supra-subduction ophiolite, the Eastern Mirdita ophiolite (EMO), Albania (Morishita et al., 2011 Lithos). Structurally, cpx porphyroclast-bearing harzburgite (Cpx-harzburgite) occurs in the lower parts of the peridotite massifs, whereas harzburgite and dunite are more abundant towards the upper parts. The Cpx-harzburgites were formed as the residue of less-flux partial melting, which are similar to those in abyssal peridotites from MOR systems. On the other hand, harzburgites were produced as a result of enhanced partial melting of depleted peridotites due to infiltration of hydrous LREE-enriched fluids/melts. We emphasize here that high-Cr# spinel-bearing dunite and medium-Cr# spinel-bearing dunite occur in refractory harzburgite of the EMO. Lithological variations (dunite and harzburgite) and their geochemical relationships in the EMO are very similar to those in the IBM forearc peridotites. The wide range of variation in dunites from the IBM forearc and the uppermost section of the EMO probably reflects changing melt compositions from MORB-like melts to boninitic melts in the forearc setting due to an increase of slab-derived hydrous fluids/melts during subduction initiation. If the "MORB-like" FAB is a ubiquitous phenomenon during the initiation of subduction, we should reconsider our interpretation of the ophiolites.