Role of adakitic magma in producing EMI and EMII reservoirs

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Chemical evolution of the solid Earth is one of the important issues for earth science and thus has been studied by many researchers. Based on isotopic studies for ocean island basalts (OIBs), it has been revealed that there are at least four geochemically separated reservoirs existing within the mantle. Among these reservoirs, EMI and EMII have been considered closely relating to lower and upper continental crust materials, respectively. Major processes, which responsible to recycling of these materials back into the mantle, have been inferred to be delamination and subduction. If so, these are independent processes. However, isotopic trends of some hot spots (e.g., Kerguelen) require the existence both of EMI and EMII components in their source mantle regions. Thus, elucidation of a genetic relation between these components is essential to understand mantle reservoirs.

There is a general consensus that the subduction process is essential to produce these reservoirs. However, modern subduction zones should not appropriate to investigate a genetic linkage between EMI and EMII, because geochemical reservoirs are related to not modern cold subduction process but ancient hot subduction process. Hence, unusual hot subduction zones were selected as a modern analogue of ancient subduction zones. These subduction zones are characterized by the occurrence of adakitic magmas. Thus, we focused on adakitic magmas to examine the relation between EMI and EMII components.

Trace elements compositions of adakitic magma from Aleutian, Cascades Mexico, Panama, Costa Rica, Austral Chile, NE and SW Japan indicate that slab melting and subsequent magma differentiation can fractionate Sr and Rb effectively. Based on this observation, we propose a model suggesting that the adakitic magma and its plagioclase fractionated magma with ages ca. 2.5 Ga can be EMI and EMII components, respectively. Thus, we conclude that slab melting and subsequent crystal fractionation played an essential role to produce EMI and EMII components.

Re-Os systematics of 3.3 Ga Nondweni-Commondale komatiites, Kaapvaal Craton, South Africa

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Mesoarchean komatiite-bearing greenstones, like those of Nondweni and Commondale occur along the eastern margin of the Kaapvaal craton. The Nondweni Group, a 16.5 km thick volcanic sequence including komatiite, komatiitic basalt, basalt, andesite and volcanogenic sediments has unique high-Si, low-Mg, pyroxene spinifex-textured komatiite. The Nondweni komatiites can be divided into a high-Ti (Ti/Zr of 90) and a low-Ti (Ti/Zr of 65) group that have similar major element compositions (SiO_2 = 49 to 51 wt%; Al_2O_3 = 6 to 7 wt%; MgO = 19 to 21 wt%; CaO/Al_2O_3 = 1.2 to 1.5) but very different Re-Os systematics. The low-Ti group has lower Os (0.06 to 0.16 ppb) and higher Re content (0.27 to 0.65 ppb) than the high-Ti group (Os = 0.41 to 1.04 ppb; Re = 0.012 to 0.056 ppb) which leads to very different $^{187}Re/^{188}Os$ (low-Ti = 22 to 47; high-Ti = 0.13 to 4.3). A Re-Os isochron age (controlled by the low-Ti group) of 3331±53 Ma and a supra-chondritic initial $^{187}Os/^{188}Os$ (controlled by the high-Ti group) of 0.1160±0.0103 (γ_{Os} of +11.5±10) was obtained.

Supracrustal rocks from the Commondale area comprise a distinctive ultradepleted suite of olivine phyric komatiites, olivine and orthopyroxene spinifex-textured komatiites and aphyric chills. The occurrence is characterized by high MgO liquids (26-32 wt%) of higher than usual SiO_2 (48-52 wt%), cumulates with olivine core compositions of $Fo_{96.6}$, and boninite-like Al/Ti and LILE depletion. Re contents are exceptionally low (0.02-0.09 ppb) for their Os content (1-2 ppb) and lead to low $^{187}Re/^{188}Os$ (0.09 to 0.4) and a precise, chondritic initial $^{187}Os/^{188}Os$ of 0.1047±0.0017 (γ_{Os} of +0.6±1.6).

The Nondweni greenstone belt appears to have been affected by crustal contamination as indicated by the elevated initial Os isotopic composition and slightly low ε_{Nd} (+0.5) of the komatiites and a correlation between decreasing initial ε_{Nd} and MgO. The Commondale greenstone belt, with a chondritic initial Os isotopic composition and an initial ε_{Nd} of +2, shows no crustal influence. Both occurrences are distinct from other komatiites in their high SiO_2 contents, pyroxene spinifex, and for Commondale, its boninite-like composition. We suggest that these 2 greenstones formed in a subduction setting along the eastern margin of the craton, Nondweni perhaps from a subduction-enriched source and Commondale from a highly depleted source.