Petrology of the arc peridotite xenoliths: Implications for geochemical evolution of the wedge mantle

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The mantle xenoliths from the arc, where is convergent plate boundary, are less reported than those from other settings, i.e. the ocean floor, continental region and oceanic hotspots. Especially the mantle xenoliths carried by the arc magmas in a narrow sense are rare on the earth (e.g., Erlich et al., 1979; Richard, 1986; Ninomiya and Arai, 1992; Abe et al., 1992; Abe, 1997) . Then we have poor information, especially on trace-element geochemistry, of the upper mantle processes beneath the arc. It is, however, very important to consider about the evolution of the hole earth lithosphere. It is also important for understanding the arc magmatism to learn the constitution of the wedge mantle where the arc magmas are produced.

In this work, the sub-arc peridotite xenoliths from four arcs, Northeastern and Southwestern Japan, Kuril-Kamchatka and Luzon-Taiwan arcs, are examined petrologically and geochemically in detail. Their textures indicate that the arc peridotites can be basically classified into three types, fine-grained slightly deformed equigranular type (Type I), deformed and recrystallized coarse-grained equigranular to porphyroclastic type (Type II) and relatively deformed and recrystallized porphyroclastic type (Type III). This classification is somewhat different from the standard one for the mantle xenoliths from other tectonic settings, e.g., continental and oceanic xenoliths (Mercier and Nicolas, 1975; protogranular, porphyroclastic and equigranular). Mineral chemistry of the arc peridotites for major elements is closely correlated with their texture to some extent; Type I peridotite is fertile with low Cr# of spinel (<0.25), Type II peridotite is more refractory with high Cr# of spinel (0.25-0.40) than Type I.

The 51 clinopyroxenes in peridotite xenoliths from the arcs are annualized by secondary ion mass spectrometer (SIMS; at Tokyo Institute of Technology), and compared with those in abyssal peridotites (Johnson et al., 1990) and the peridotite xenoliths from other tectonic settings, such as continental regions (e.g., Witt-Eickschen and Harte, 1994; Blusztajn and Shimizu, 1994). The arc clinopyroxenes are clearly different from those in peridotites from other tectonic settings (Fig. 1). Geochemical characteristics of the sub-arc mantle clinopyroxenes are not apparently related to the degree of hydration, and are rather constant irrespective of locality and other characteristics. The REE patterns vary from LREE-depleted to flat or slightly LREE-enriched, and their $(Ce/Yb)_N$ (subscript N = chondrite-normalized) varies widely from 0.04 to 4.0. On the other hand the Ti/Zr weight ratio is rather constant in the whole samples examined, around 100. Clinopyroxenes in the arc peridotite xenoliths are intermediate in Ce and Sr contents, and $(Ce/Yb)_N$ and Ti/Zr ratios between those from abyssal peridotites and those from continental areas and oceanic hotspots. Furthermore the most fertile group of arc peridotites are similar in the clinopyroxene chemistry to the most fertile group of abyssal peridotites. The peridotite xenoliths from Japan and other arcs possibly had evolved from a source peridotite common to abyssal peridotite through a different process. The geochemical characteristics of arc mantle peridotites had been established by kind of partial melting promoted by influx (so called influx melting; Ozawa and Shimizu, 1995) from subducted slab, to have constant chemical characteristics due to regional mantle wedge process.

Clinopyroxene

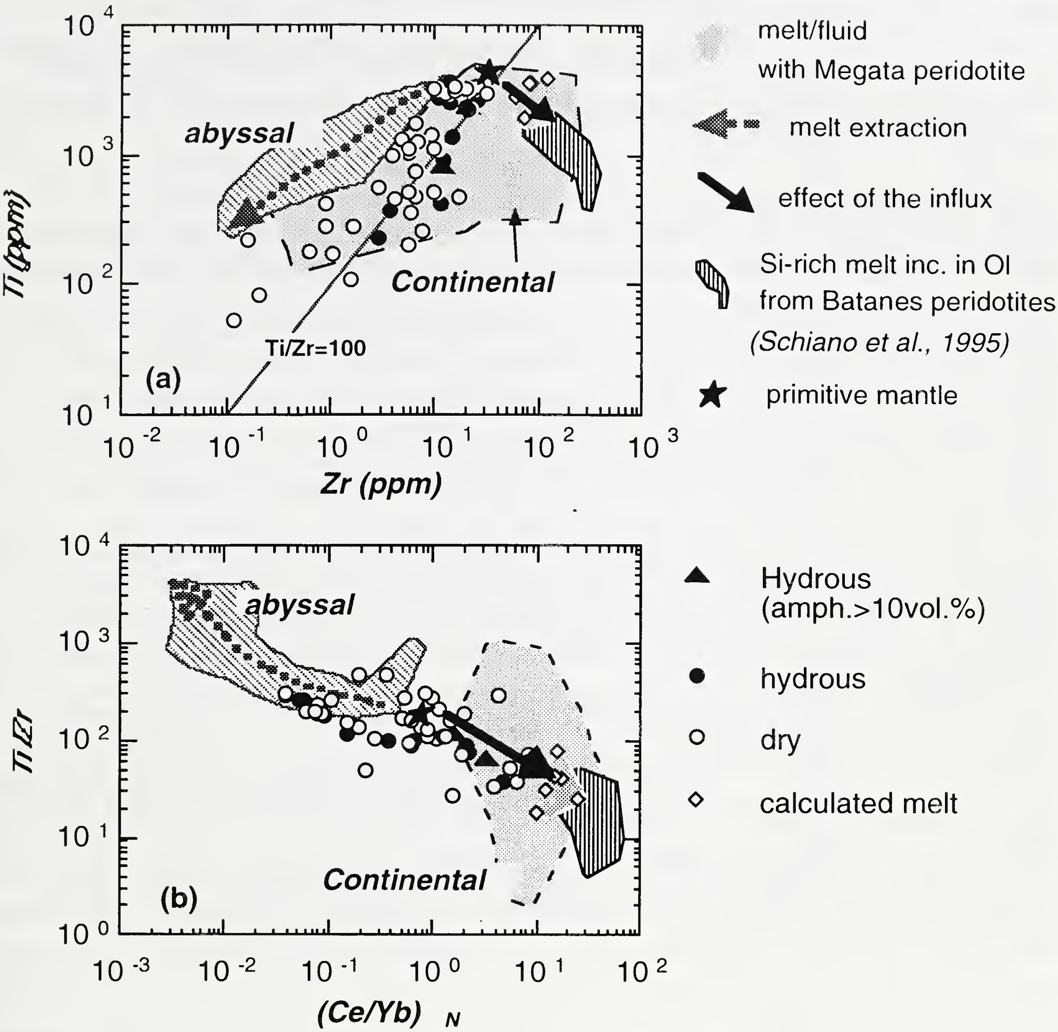

Fig. 1 Relationships between (a) Ti and Zr contents and (b) Ti/Zr weight ratio and (Ce/Yb)N ratio in clinopyroxene from arc mantle peridotites. The trend can be explained by a melt extraction process combined with pollution of melt/fluid. The simple melt extraction trend may be simulated by the trend of abyssal peridotites. The composition of influx added may be similar to that of Si-rich melt inclusion in Batan peridotite xenoliths (Schiano et al., 1995) or of melt/fluid calculated to be in equilibrium with arc peridotites in this study. Primitive mantle is after Sun (1982).

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