Geochemical Characteristics of Mantle Peridotite Beneath a Mature Arc

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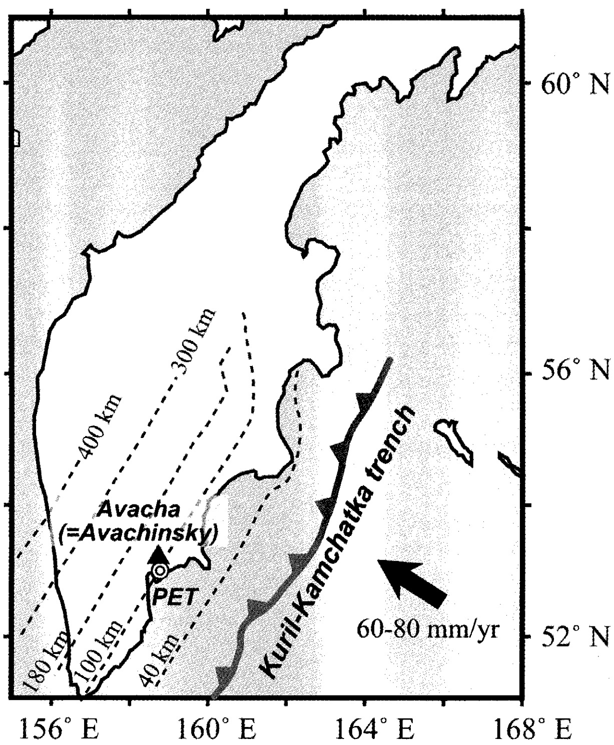
Kamchatka arc is a mature arc, and the Pacific plate is subducting at relatively rapid rates (60-80 mm/yr) beneath the southern part of Kamchatka Peninsula from the Kuril-Kamchatka trench. There are three volcanic chains with the distance from 200 km, 320 km, and 400 km (Tatsumi *et al.* 1994). Avacha volcano is located at the southern Kamchatka Peninsula and on the frontal chain that forms the volcanic front, and the depth to the subducting slab is about 120 km there (Figure 1) (Gorbatov *et al.* 1997). Peridotite xenoliths from Avacha volcano are useful to understand the mantle materials, processes, and magma genesis beneath the mature arc.



The peridotite xenoliths from Avacha volcano, are mainly harzburgite with highly depleted character; high Fo (90-92) of olivine, high Cr# (0.5-0.7) of spinel and low modal clinopyroxene (< 1 vol.%). This harzburgite is the one of the most refractory peridotite xenoliths from arc setting (Figure 2; Arai *et al.*, submitted). Avacha peridotites are metasomatized by SiO_2-rich component in various extent and secondary orthopyroxenes replacing olivine are observed (Arai *et al.*, 2003). Geochemical characteristics of residual spinel lherzolite have been discussed, although those of highly depleted spinel harzburgite have not been described in detail. Trace-element compositions of

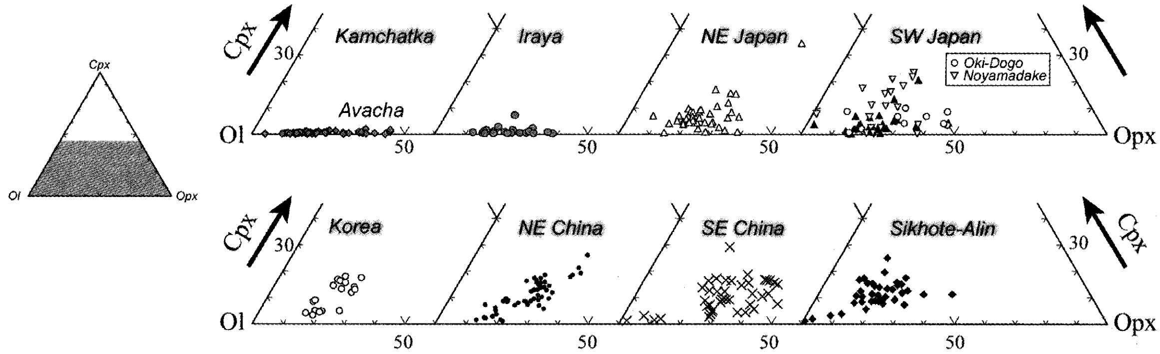


Figure 2 Modal amounts of olivine, orthopyroxene and clinopyroxene in spinel peridotite xenoliths from the Western Pacific. Note that the peridotite on average gradually changes from depleted harzburgite in the frontal side of arc (Avacha and Iraya) to fertile lherzolite in continent (Korea, Sikhote-Alin and China) through Japan arcs. Date source is Arai *et al.* (submitted) and references there in.

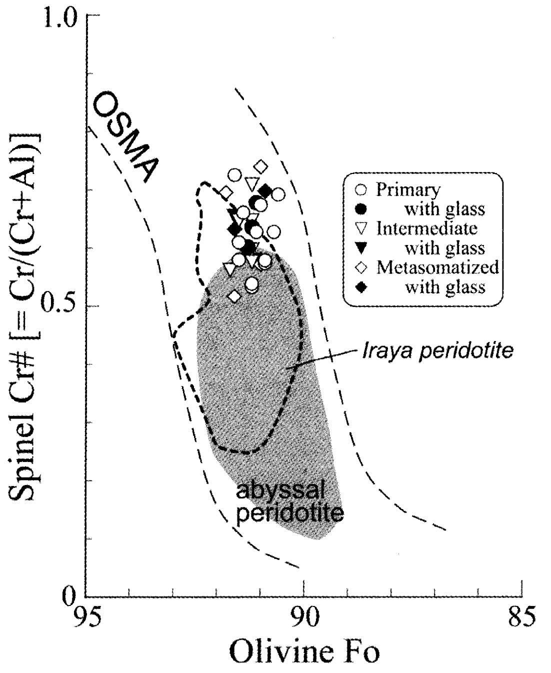


Figure 3 Relationships between the Fo content of olivine and Cr# of chromian spinel in Avacha xenoliths. OSMA, olivine-spinel-mantle array, is a residual trend of spinel peridotite (Arai, 1994). Shaded area represents abyssal peridotites (Arai, 1994). Bold-dashed line shows the area of the composition of coarse-grained peridotite from Iraya volcano, the Luzon Arc, Philippines (Arai & Kida, 2000).

bulk-rock peridotites are controlled by grain-boundary component, but are determined by composition of glasses, related with metasomatism, if any. The grain-boundary component is quite important to determine the geochemical characteristics of highly depleted spinel harzburgite without clinopyroxene and glass.

The Fo content of olivine is lower at a given Cr# of coexisting spinel in the Avacha peridotite than in ordinary peridotite (Figure 3). This characteristic is not related with the formation of secondary orthopyroxene at the expense of olivine, because there are no obvious relationships between the modal amounts of secondary orthopyroxene and the mineral and bulk-rock compositions. There is discrepancy between relatively low Fo content of olivine and other petrological features in the Avacha peridotite, for example, high Cr# of spinel and low abundance of HREE. The most refractory peridotite, which has high Cr# and low HREE, has relatively low Fo content of olivine and higher LREE. Then the Avacha peridotites are residue after influx melting of upper mantle peridotite.

Metasomatism has occurred after influx melting, and crystallized secondary orthopyroxene at the expense of olivine. There are two types of secondary orthopyroxene; one has complicated grain boundary, and the other is euhedral to subhedral and sometimes accompanying interstitial amphibole and silicic glass. The texture and chemistry of the secondary phases suggest SiO_2-oversaturated character of the metasomatic agent. The metasomatism by SiO_2-rich material has been reported from other arc, for example, Iraya volcano, Luzon arc (e.g., Schiano *et al.*, 1995, Arai & Kida, 2000), Papua New Guinea (Grégoire *et al.*, 2001) and Patagonia (Kilian & Stern, 2002). The silica enrichment is an important phenomenon in the sub-arc mantle.

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