Time-space distribution and genetic diversity of ophiolites, accreted greenstones and alpine peridotites in Japan

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Types of the mafic-ultramafic, mantle-originated magmatism on Earth are classified as follows (Fig. 1): (1) **Alpine peridotite** - a mostly solid intrusion of low-temperature, not or slightly melted lherzolitic (fertile) mantle diapir into the lower part of the continental crust. (2) **Layered intrusion** - a large body of magma that intruded into the middle or upper part of the continental crust (and solidified *in situ*) with or without *flood basalt* lavas and regional dike complex. Although not exposed, they may be originated in partially melted mantle diapirs of varying temperatures that stopped beneath the crust. **Oceanic plateau** is another subtype of this magmatism. This magmatism forms large igneous provinces (LIPs), but the source mantle is never exposed. (3) **Ophiolite** - partially melted mantle diapir of varying temperature that ascended to the ocean floor, producing basaltic lavas and gabbroic cumulates that form oceanic crust at spreading centers either in mid-oceanic ridges (MOR) or in supra-subduction zones (SSZ). Compensative residual peridotite (lherzolite to depleted harzburgite) is widely exposed. The evolved SSZ crust yields granites that may serve as an embryo of continental crust. (4) **Ultramafic lavas** - very high temperature mantle diapir mostly melted and largely extruded onto either continental or oceanic crust and solidified as lava flows of komatiite, meimechite and some (ferro-) picrite. This type of magmatism is often associated with LIPs. Plutonic counterpart of this magmatism may be represented by concentrically zoned, mafic-ultramafic intrusions such as so-called **Alaskan-type** plutons.

Japan constitutes an accretionary orogenic belt that developed through the recent 500 million years. Ophiolites, accreted greenstones (fragments of seamounts or oceanic plateaus), ultramafic lavas, and an alpine peridotite occur in this archipelago, although continental mafic layered intrusions and Alaskan-type plutons are absent. Japanese ophiolites show oceanward (structurally downward) younging polarity, ranging in age from early Paleozoic (e.g. Oeyama ophiolite) to Cenozoic (e.g. Mineoka ophiolite). They not only include products of the two major global ophiolite pulses (early Paleozoic and Mesozoic), but also bear those of the other ages (late Paleozoic and Cenozoic). The greenstones are mostly of late Paleozoic ages and occurring in Jurassic accretionary complexes, but Mesozoic greenstones are also abundant in Hokkaido (Sorachi) and the outer zone of Southwest Japan (Mikabu) (Ishiwatari et al. 2003; GSL Spec Publ. 218, 597-).

Ophiolites are divided into three types (L, H and DH) by the degree of melting of the mantle section and crystallization sequence of the cumulate rocks. The three full-membered ophiolites in Japan belong to separate types; Poroshiri (L), Yakuno (H) and Horokanai (DH), indicating wide petrologic diversity of Japanese ophiolites (*ibid*.). The least depleted peridotite occurs in Horoman (Hokkaido) as an alpine-type peridotite that intruded beneath the Hidaka island arc crust in late Cenozoic (Takezawa et al. 2000; GCA, 64, 695-). Accreted greenstones in the Mino-Tamba, Sorachi, and Mikabu belts are thought to be fragments of the oceanic plateau as evidenced by their vast extent of the outcrops as well as HIMU-like chemistry of the volcanic rocks (Sakakibara et al. 1999; MGSJ, 52, 1-; Tatsumi et al. 1998; Geology, 26, 151; 2000; Geology, 28, 580-; Ichiyama et al. 2008; Lithos, 100, 127-). They also include komatiite, meimechite and ferropicrite that are characteristically associated with LIPs (Ichiyama et al. 2006; Lithos, 89, 47-; 2012; Geology, 40, 411-). On the other hand, the Oku-Niikappu greenstone complex of the Sorachi belt includes boninitic and calc-alkaline rocks that indicates oceanic island arc origin (Ueda & Miyashita, 2005; Isl. Arc, 14, 582-).

Thus, the Japanese mafic-ultramafic complexes provide samples of widely variable magmatism in the ancient oceanic areas.

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**Fig. 1.** Types of terrestrial mantle-origin magmatism. Temperature of mantle upwelling (corresponding to the degree of melting of the plume) roughly increases from left to right, but is widely variable in the middle two cases.