Clinopyroxene mineralogy of ophiolitic ankaramites

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A typical ankaramite contains a large amount of clinopyroxene phenocrysts, which are more abundant than olivine. Williams et al. (1982) defined ankaramite as basalts with abnormally high phenocrystic augite. Kushiro (1963, 1969) showed that the single phase crystallization of clinopyroxene occurs under a limited range of very high temperature at pressure range less than 20 kb in basalt systems. This means that the ankaramite is a representative rock having useful information on early stage crystallization of primary basaltic magmas. Additionally, the phenocrystic cores of clinopyroxene with high Mg# (>0.85) and high Cr contents (>0.025), in equilibrium with those in upper mantle peridotites, are evidently informative on their magma source (Fig. 1). Here we present a case study of ophiolitic ankaramite using the Mitsuishi ankaramite data (Nishijima et al., 2002), and will discuss on the host magma types and a possible source mantle signature for the ankaramites.

The Mitsuishi ankaramites were sampled from tectonic slices of greenstones in the Cretaceous accretionary complex in the Mitsuishi area, central-axial zone of Hokkaido, Japan. The clinopyroxene phenocrysts are euhedral mega-crystals up to 2.0 cm in diameter, ranging from 16 to 57 vol.% (Fig. 2). Based on the color of clinopyroxenes and the vol.% of olivine phenocrysts, the Mitsuishi ankaramites are classified into the following 4 subtypes; green clinopyroxene ankaramite (type 1), green clinopyroxene-olivine ankaramite (type 2), black clinopyroxene ankaramite (type 3), and black clinopyroxene-olivine ankaramite (type 4). The clinopyroxene cores in the types 1 and 2 ankaramites are characterized by a tholeiitic magma signature, whereas those in the types 3 and 4 ankaramites are alkaline one. The clinopyroxenes from the olivine-poor types 1 and 3 clearly display a clinopyroxene-single phase fractionation trend on the Cr-Mg# correlation diagrams.

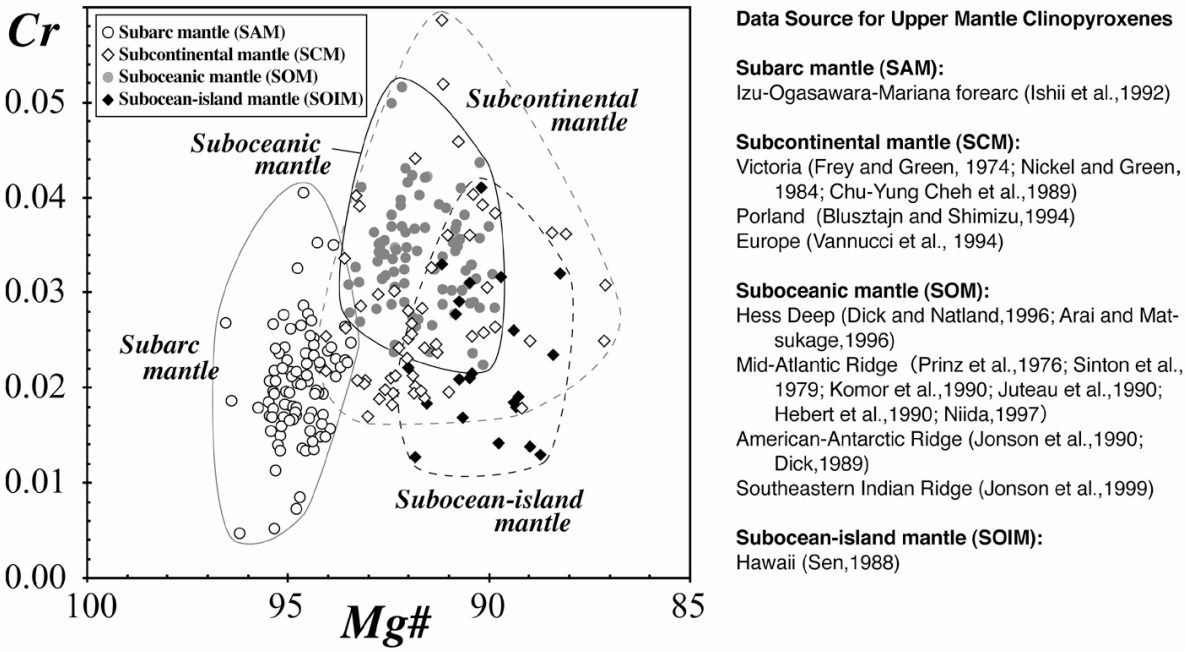

Fig.1 Cr-Mg# compositional range for upper mantle clinopyroxenes .

The maximum content of Cr exceeds 0.02 cations for all types 1 to 4, attaining to the Cr concentration range of upper mantle clinopyroxenes. The Mg# is less than 0.92 for all types 1 to 4, suggesting a fertile mantle peridotite for their magma source. It can be estimated that the magma source peridotites for the alkaline types 3 and 4 are more fertile than those for the tholeiitic types 1 and 2 (Fig. 3). In comparison with the clinopyroxene data published, the Mitsuishi ankaramite clinopyroxenes are far from those in island-arc type ankaramites (Barsdell, 1988) . Tholeiitic types 1 and 2 ankaramite clinopyroxenes range from those in sub-oceanic mantle peridotites (MARK: Niida, 1997, AAR: Dick, 1989) to more fertile than those in sub-continental xenoliths (San Carlos: Frey, 1978) and those in the hot-spot type Hawaiian ankaramites (Frey et al., 1991). Alkaline types 3 and 4 ankaramite clinopyroxenes are more fertile than tholeiitic types 1 and 2.

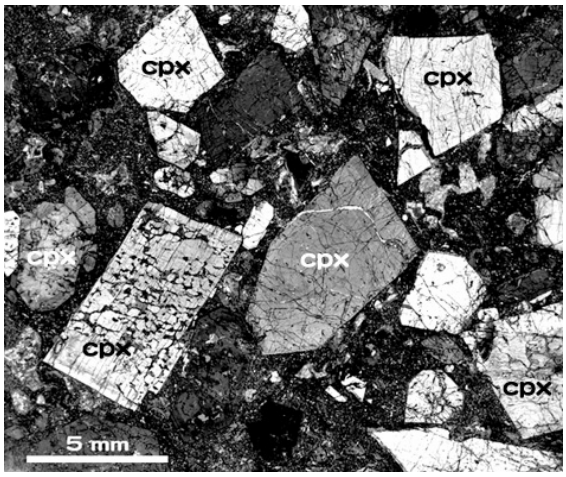

Fig. 2 Photomicrograph of the Mitsuishi ankramite (Type 3), showing a highly phyric texture with euhedral megacrysts of clinopyroxene (cpx). Crossed-polarized lights. Sample No. 0188-6.

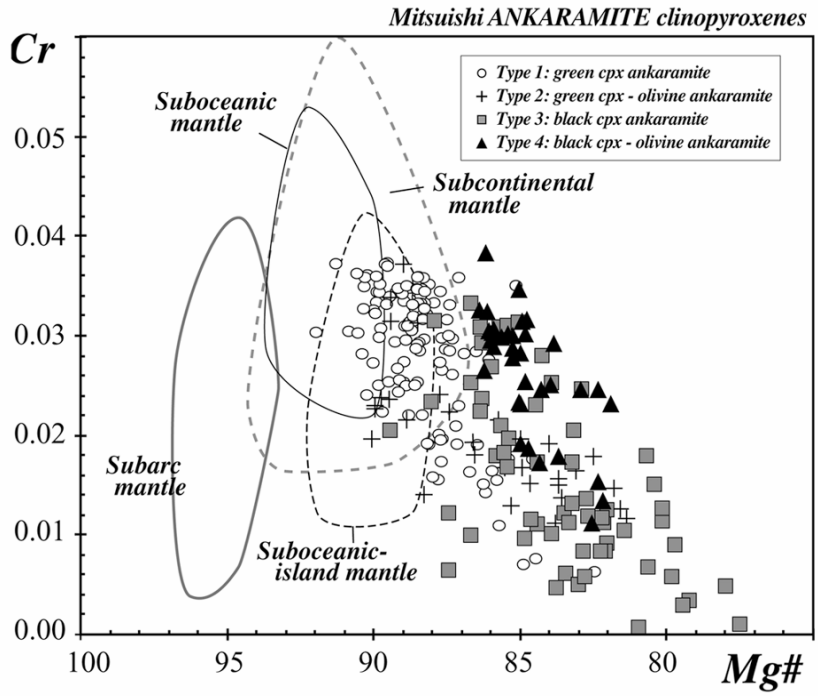

Fig. 3 Cr-Mg# compositional variations for clinopyroxenes of the Mitsuishi ankaramite types 1, 2, 3, and 4. The types 1 and 2 clinopyroxenes with high Cr (>0.02) overlap in Mg# ranges of clinopyroxenes from suboceanic, suboceanic-island and subcontinental mantle.