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Petrology of Ol-Cpx layered units in the Higashi-Akaishi ultramafic body, SW Japan: Close affinity to high Ca boninite

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The Higashi-akaishi ultramafic body (HA) in the Sanbagawa belt, SW Japan, is composed of dunite, wehrlite, olivine-clinopyroxenite and garnet-bearing rocks. The body is regarded as a piece of hanging wall mantle at the deeper part of oceanic-type subduction zone. Understanding of the petrological signature is important to gain insights into the formation of the mantle wedge. We present field and microtextural observations and mineral chemistry of a 250 m-thick section of compositional layering in the central part of the body and link them to the magmatic process and composition related to the formation of the HA body.

The layering in the section form a trend of compositional variation in centimeter to 10m-scales: dunite - wehrlite - olivine-clinopyroxenite. Fo and NiO in olivine and Cr/(Cr+Al) in spinel decrease in accord with this trend. These changes can be explained by fractional crystallization of Cpx following olivine and spinel. So, the dunite in the section can be regarded as a member of Ol-Cpx cumulate.

Olivine shows high Fo (up to 94) and high NiO content (- 0.33 wt%), and Cr-spinel is rich in Cr (Cr/(Cr+Al)=0.65-0.90) and poor in TiO2. Coarse porphyroclasts of Cpx in wehrlite and olivine-clinopyroxenite show highly depleted REE patterns (C1 normalized values of Ce and Yb are 0.1-0.8 and 0.3-2, respectively). The Cpx includes abundant Cr-spinel exsolutions and is most likely to preserve a primary composition crystallized from magma. Later alterations are identified by distinctive REE patterns of Cpx with microtextural features of recrystallization.

The primary chemical compositions of minerals and estimated melts in equilibrium with the Cpx overlap the ranges of high-Ca boninite (HCB); they are less depleted than low-Ca boninite and are more depleted than the Setouchi high Mg andesite. The crystallization of Ol and Cpx is also consistent with a HCB magma. Highly depleted but Ca-rich nature of HCB requires a cumulative partial melting of fertile lherzolite forming harzburgite. Experimental and natural evidence shows that it takes place in hot (close to 1300 oC) and moderately hydrous conditions. Therefore, the HA body can be regarded as a record of a high temperature phase in the Sanbagawa arc evolution.

Present activities of HCB lavas are found in oceanic arc systems (Bonin and Tonga) and in a site of arc-plume interaction (northern edge of Tonga arc). Considering that the HA body is located in the middle of the E-W elongation of the Sanbagawa metamorphic belt, it is likely that the HCB activity produced the cumulate occurred in an island arc system behind which hot asthenospheric mantle was upwelling. This can be related to the Mesozoic high temperature episode in the east Eurasian margin due to a replacement of continental lithosphere by fertile asthenospheric mantle.