Formation processes of the Ogi picritic intrusive body inferred from the observation of the chilled margin

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The Ogi picritic dolerite intrudes into tuffaceous mudstone on the coast of Sado Island, Japan. The possibility of the mantle origin of the intrusive magma has been pointed out based on the chemical composition of chromian spinel and olivine (Oba and Okada, 1999). However, the chemical composition and intrusive depth of the magma have not been clarified and are still under debate.
Therefore we closely investigated the chilled margin of the intrusion and the multiphase solid inclusions (partially crystallized melt inclusions) in spinel, an early-crystallized mineral from basaltic magmas to clarify the chemical composition of intrusive magmas.
As a result, we found that rhyolitic glassy rocks are distributed in a 50 cm-wide band between the chilled margin and the country rock (tuffaceous mudstone). The glassy rocks show the texture similar to the porphyritic volcanic rocks, but contain the small andesitic pumices, palagonitized volcanic fragments and framboidal pyrites in the glassy matrix with flow structure. The CIPW norms of the glassy rocks are plotted near the cotectic line of quartz and feldspars in the ternary phase diagram in the system Quartz-Albite-Orthoclase (Blundy and Cashman, 2001), suggesting that they were formed by partial melting of the tuffaceous mudstone. In this case, the depth of emplacement of magma is estimated to be about 8–12 km (=200–300 MPa).
The main parts of the intrusion have picritic to komatiitic compositions (14–28 wt% MgO), but the chilled margins have high-Mg basaltic to basaltic andesitic compositions (~10 wt% MgO) and are the most differentiated rocks in the intrusion. This suggests that olivine crystals may have been removed from the periphery of intrusion by flow differentiation (e.g. Simkin, 1967), or that the intrusion of picritic magma may have been preceded by that of basaltic magma forming the chilled margin (e.g. Gibb and Henderson, 1992).
The multiphase solid inclusions in spinel are composed of clinopyroxene, glass and void. The average chemical compositions of them are similar to the whole-rock composition of chilled margin. The FeOtotal/MgO ratios of them are less than 1 (about 0.6–0.7), suggesting that the magma related to the formation of the picritic intrusion was probably in chemical equilibrium with the mantle.
In the simulations of the crystallization process with MELTS software (Gualda and Ghiorso, 2015), olivine should crystallize at the depth less than 300 MPa from magma of the composition of the multiphase solid inclusion. The clinopyroxenes of multiphase solid inclusions in spinel may have crystallized at greater depths.

Keywords: chilled margin, melt inclusion, partial melting, parental magma, spinel

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