Volatile-rich komatiite and picrite inferred from melt inclusions in Cr-spinel beach sand from Gorgona Island, Colombia

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Volatile content of komatiite is a key to constrain thermal evolution of the deep Earth. We report volatile contents with major and trace element compositions of melt inclusions (MIs) in chromian spinel (Cr-spinel) from beach sands of from Gorgona Island, Colombia. Gorgona Island is ˜90 Ma volcanic island, where picrites and the world-youngest komatiites occur. As Cr-spinel is dense and rigid oxide mineral that crystallizes only at early stages of crystallization, it is considered to be a superior container for retaining primitive melt, even including volatiles. Volatile (H2O, CO2, S, F and Cl) and trace element (K2O, Sr, Y, Zr, Nb, Ba, La, Ce, Sm, Dy, Yb) compositions of ˜80 MIs were analyzed by SIMS (Cameca-1280 and 3f, respectively) at WHOI. MIs in the Cr-spinel from Gorgona Is. are classified into three types by their host Cr-spinel compositions such as low-Ti (P-type), high-Ti with high-Cr# (K1-type) and high-Ti with low-Cr# (K2-type). MIs of P-type, K1-type and K2-type are mostly in compositional ranges of picrite, high TiO2 komatiite (some basalt) and low TiO2 komatiite in Gorgona Island, respectively. Water content of P-type MIs is variable, ranging from 0.05 wt% to 0.9 wt%, whereas that of K1- and K2-type MIs is limited (lower than 0.1 wt%). On the other hand, CO2 content of K1-type and K2-type MIs is highly scattered (40 to 4200 ppm), whereas that of P-type is usually lower than 200 ppm. All MIs with high CO2 content (higher than500 ppm) do not contain (shrinkage) bubbles and many of them are low in K2O. Although Cl contents of the ultramafic MIs are highly affected by slight assimilations of seawater and brine, other volatiles are not highly affected. H2O/La, CO2/K2O ratios of MIs are negatively correlated with La/Y ratio, whereas S/Y and F/Sr ratios are relatively constant, indicating that CO2 and H2O degassing occurred during crystallization or that primitive magmas mixed and/or assimilated with drier magma and/or a oceanic crust. Undegassed H2O/La, CO2/K2O, S/Y and F/Sr ratios of komatiitic (picritic) melt are estimated to be ˜1000 (˜2000), ˜40 (˜10), ˜40(˜30) and ˜1.5 (˜1.5), respectively. As estimated H2O/La, CO2/K2O, S/Y and F/Sr ratios of the depleted source mantle of MORB is 500, 0.7, 30 and 1.1, respectively (Salters, V. & Stracke, A. 2004. Geochem. Geophys. Geosys. 5, 2003GC000597), the sources of the komatiite and picrite are highly rich in H2O and CO2 and are comparable in S and F. The primary H2O, CO2 contents of komatiite (picrite) are estimated to be 0.05 (0.04) wt% and 0.6 (0.2) wt%, respectively, using primary La and K2O contents of a previous study (Kerr, A. 2005. Lithos. 84, 77-101). CO2 degassing might also have contributed to eruption of high-density magmas to the surface.

In addition, H2O, S, F and Cl contents in MIs in olivine from a picrite were identical to those of P-type MIs in Cr-spinel, but CO2 in olivine-hosted MIs were considerably lower (˜50 ppm) than those in Cr-spinel. This indicates that entrapment pressure for MIs in Cr-spinel is likely to be greater than that for MIs in olivine. Therefore, in order to evaluate the volatile contents of undegassed magmas from oceanic islands, melt inclusions in Cr-spinel beach sand could be very useful.