Wet and dry basalts from Sumisu caldera, Izu-Bonin arc, Japan, and their degrees of melting in the source mantle

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Basalt-basaltic andesite (less than 55 wt % SiO2) and dacite-rhyolite (66-74 wt % SiO2) are predominant eruptive products in Sumisu caldera volcano, Izu-Bonin arc, Japan, and rocks having SiO2 contents of 60-66 wt % have not been discovered. Basalts (50-53 wt % SiO2) from the pre-caldera edifice, and its subarial remnant Sumisu island, contain 4~8.5 wt % MgO; variations of major and trace element compositions are relatively large in the basalt-basalt intervals. The most-magnesian basalt (8.5 % MgO), as well as some of the other basalts, contain low Zr (20-30 ppm), which cannot yield basalts containing higher Zr (30-40 ppm) through fractionation and/or assimilation. On the other hand, we recognised that high- and low-Zr basalts have differing phenocryst assemblages, distinct phenocryst chemistries of olivine, plagioclase and pyroxene, different depletion of REE (rare earth element) patterns, and differing fluid mobile-element/immobile-element ratios. Estimated primary olivine compositions are more magnesian (more than Fo91) and thus more depleted in low-Zr basalts compared to those in high-Zr basalts (Fo~90). Low-Zr basalts contain up to 5 vol % augite, but many high-Zr basalts are free of augite, which appears only in their evolved stage. Ol-augite and two-pyroxene thermometers suggest 1100-1200C for the high-Zr basalts, but the ol-aug thermometer does not work satisfactory in the low-Zr basalts. The wt. % of H2O will have a strong influence on the basalt crystallisation and the performance of the ol-aug thermometer. Hydrous basalts crystallize olivine followed by augite and plagioclase, producing the former assemblage. Dry basalts, in contrast, crystallize plagioclase just after olivine appears on the liquidus, yielding the latter assemblage without augite. Moreover, the low-Zr basalts have higher Ba/La and Ba/Zr ratios than the high-Zr basalts. We suggest that both dry and wet primary basalts existed in the Sumisu magmatic system, each having different trace element concentrations and mineral chemistry and assemblages. This could have been caused by differences of water content and degrees of partial melting in the source mantle as well as in their basaltic partial melts. The lower content of Zr and light REE and magnesian primary olivines in the wet basalt could therefore have resulted from a higher degree of partial melting (~20 %) of a hydrous source mantle compared to ~10 % melting of a dry source mantle.