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In situ observation of complete miscibility between magmas and H2O fluids

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Knowledge of structures of magmas is important to model the evolution of the earth's interior. Much efforts have been made to understand structure of magmas by measuring properties of glasses quenched from high temperature and pressure conditions. Properties of silicates melts have been found to be different from those of quenched glasses (1). Therefore, the direct measurement of melts at high temperature and pressure conditions is desirable. Based on chemistry of partial melts of H2O-saturated mantle peridotite, we have suggested structures of hydrous melts should change drastically with an increasing pressure (2). A series of direct observation of complete miscibility in H2O and an island arc andesite has been conducted using Bassett's type externally heated diamond anvil cell (DAC, (3)). The starting material is an andesitic scoria which was erupted from the east frank of Fuji volcano at 1707 (Ho-2). There is less than 1 volume % crystals in the sample. Chemical characteristics of the andesite (61.9 wt.% SiO2, 1% TiO2, 17.1% Al2O3, 6.3% FeO*, 2.4% MgO, 5.7% CaO, 3.8 % Na2O, 1.8% K2O) is calc-alkaline andesite of Miyashiro, and of high alumina basalt series of Kuno , and midium K of Gill. Hydrous glasses were produced through melting of Fuji 1707 andesite powders and 2 weight % water at 1 GPa and 1300 C for 1 hour with piston cylinder type high pressure apparatus. For direct observation using DAC, chips of the quenched glass were loaded into a sample room of Rhenium gaskets with distilled water and an air bubble. Upon heating the air bubble is found to deminish into the H2O fluid at a homegenious temperature, depending on a bulk density of H2O. This allows us to estimate the pressure and temperature path inside of the sample room using eqation of state of H2O. Subsequent heating produces a single fluid phase with a small amount of crystalline phases left (Figure 1). Upon decompression or cooling, at around 1 GPa and 950 C, the single supercritical fluid suddenly becomes milky (Figure 2) and is separated into two fluids (Figure 3), and they are coalesced to larger glubules of H2O rich andesitic melts surrounded by silicate rich H2O fluid (Figure 4). Such a supercritical behaviour has been reported in the albite and H2O system (4) and the SiO2-Al2O3-Na2O-K2O-CaO-MgO system (5). Whether such a supercritical behaviour occurs between H2O fluids and magmas equiribrated with mantle peridotite system remains uncertain. This study is the first observation of a supercritical behavior of natural andesite. It is difficult to melt basaltic compositions in Bassett type DAC due to its temperature limitation of 1050 C.The Fuji 1707 eruption produced ejecta in a compositional range from basalt to rhyolite (49 SiO2 weight % to 70). We will examine the supercritical temperature and pressure conditions from andesite to rhyolite in order to estimate the PT conditions of possible supercritical fluid in the basalt-H2O system.

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