# Melting experiments of hydrous magma-effect of water on the Ca-Na partitioning between plagioclase and melt-

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Calcic plagioclase phenocrysts (An90 or more calcic) are often observed in island arc tholeiite. They are assumed to have crystallized from hydrous and/or calcic magma, but their crystallizing conditions are not constrained partly because the previous hydrous melting experiments did not cover the compositions of the low-K island arc tholeiites. This is why the hydrous melting experiments of island arc tholeiite from the Izu-Oshima volcano were performed to understand the effect of water on the phase relation and the origin of the calcic plagioclase.

Two kinds of relatively undifferentiated basalt, MA43 and MA44, were chosen as starting materials. MA44 (Ca/Na=3, Mg#=44.6) is aphyric and represents the liquid composition. Porphyritic MA43 (Ca/Na=4, Mg#=49.5) was prepared in order to observe the effect of the initial magma composition on the crystallizing plagioclase composition.

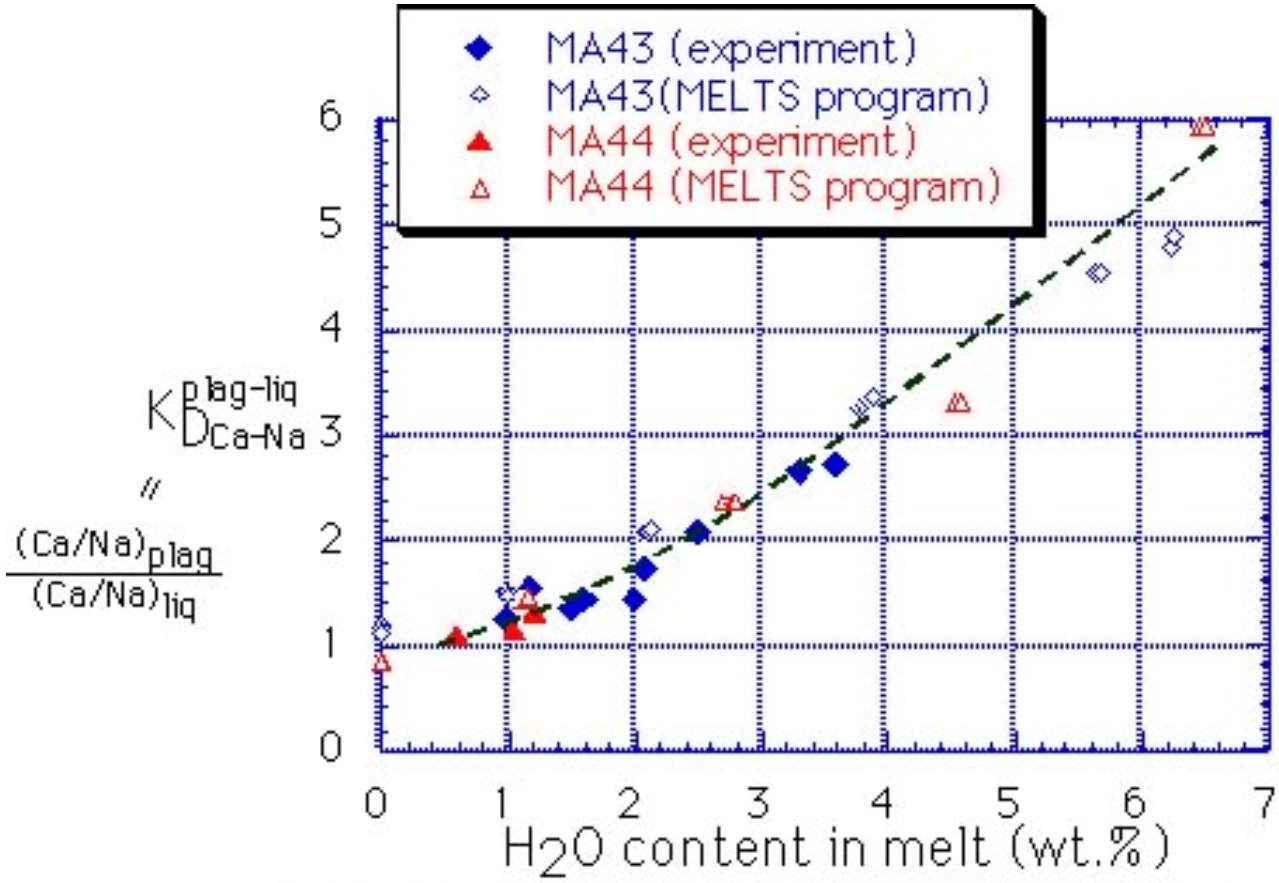
The experiments were performed under 2.5 kbar and Ni-NiO buffer for more than 24 hours using an internally heated pressure vessel.

The liquidus temperatures of both MA43 and MA44 decreased with increasing water in the magma. The plagioclase was consistently the first liquidus phase with increasing water for the porphyritic sample MA43, but augite replaced plagioclase as the first liquidus phase with increasing water for the aphyric MA44. The experimental results were compared with the calculations from the MELTS program (Ghiorso and Sack, 1995), which is the thermodynamic model of magma. It predicted the liquidus temperature of plagioclase lower than the experimental results in the hydrous systems.

However, as for calculating the Ca-Na partitioning coefficient between the plagioclase and melt versus the water content in the melt, it seemed to be reliable (figure). Based on this diagram, more than 3 wt.% of water in the melt is necessary to crystallize An90(=Ca/Na=9) from MA43 and MA44.

As a result of the hydrous melting experiments of the relatively undifferentiated island arc tholeiite from the Izu-Oshima volcano, it is shown that calcic plagioclase can be crystallized from hydrous magma of more than 3 wt.% water in the melt. However, it contradicts the relatively anhydrous nature of the island arc tholeiite. Water also drastically decreases the liquidus temperature of plagioclase compared with the temperature obtained by the pyroxene thermometry (Lindsley, 1983) of more than 1100 degrees centigrade. In order to overcome this apparent contradiction and explain the origin of the calcic plagioclase, a certain kind of open system crystallization, which involves additional calcic magma crystallizing calcic plagioclase under relatively less hydrous conditions, is required.

The correspondence between the results of this study and conventional studies on element partitioning between plagioclase and melt (plagioclase-melt geohygrometer: Housh and Luhr (1991)) was also examined. This model can estimate the water content in a melt from the pair compositions of the coexisting plagioclase and melt based on the experimental results. In this model, two reactions between the plagioclase and hydrous melt are considered, one for albite and another for anorthite. The description of the hydrous melt is based on Ghiorso et al. (1983) and water is included as one of the melt components and then the activity for each component is defined. For that reason, the two reactions are used for the geohygrometer. The equilibrium constant K is theoretically approximated to be lnK=A+B/T (A and B are constants) irrespective of the hydrous and anhydrous conditions. However, the experimental result from this study and the anhydrous experiments from the literature show a systematic shift from the trend of low temperature (less than 1000 degrees centigrade) and hydrous experiments that formulated the model of Housh and Luhr (1991). This suggests an incomplete assessment by Ghiorso et al. (1983) in describing the hydrous melt.




（図）メルト含水量と、メルト-斜長石間のCa/Na分配の関係