

Effect of water content on Ca partitioning between olivine and silicate liquid

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Calcium partitioning between olivine and silicate liquid is examined based on published data of hydrous (N=77, T=940-1290C, P=517bar-20kbar) and anhydrous (N=411, T=1055-1520C, P=1bar-30kbar) experiments for basalts and andesites. Partition coefficients of Mg, Fe, Mn and Ca between olivine and liquid decrease with increasing water content of coexisting silicate liquid at constant T and P. Effect of water content on the partition coefficient of CaO ($D(\text{CaO})$) is the most remarkable. This can be applied as geothermometer based on olivine-liquid partitioning.

At constant temperature, the $D(\text{CaO})$ decreases with increasing water content and increases with increasing pressure. Degree of depression of the $D(\text{CaO})$ at low pressure (~5kbar) is essentially dominated by H₂O content of the liquid. Therefore, the low-Ca olivine can be easily crystallized on water saturated condition at constant T, P and CaO content of the liquid.

Olivine phenocryst in volcanic rocks generally includes 0.1-0.6 wt% CaO. The olivines observed in arc basalts are characterized by low-Ca content (less than 0.25 wt%) compared with those in MORB and OIB (0.2-0.6 wt%) (Sugawara, 2002). It is expected that the low-Ca olivine phenocrysts in arc basalts were coexisted with hydrous silicate liquid on water saturated condition. Water contents for Yakushidake lava in Iwate volcano and 1964 basalt in Miyakejima volcano estimated from 'olivine-liquid geothermometer' are 5wt% and 3wt% at T=1100C, respectively. Those water contents are consistent with H₂O content experimentally determined based on the Ca-Na partitioning between An-rich plagioclase (An~90) and hydrous basaltic liquid (Takagi and Sato, 2002).