Recovering initial CO_2 content of island-arc magmas from experimental homogenization of melt inclusions in olivine at high H_2O pressure

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Accurate quantification of bulk CO_2 in melt inclusions (MIs) requires their complete homogenization, which is notoriously difficult especially for primitive island-arc MIs. We applied a novel experimental approach for homogenization of MIs in olivine by their hydration during re-equilibration of olivine grains within a hydrous matrix melt at high-pressure. The experiments were performed with partly crystallized and almost completely dehydrated (H_2O = 0-1 wt.%) MIs in high-Fo (85-91 mol.%) olivine from a Klyuchevskoy volcano lava sample, Kamchatka. MIs were treated for 24 hours at temperature of 1150ºC, pressures of 300 and 500 MPa and oxygen fugacity ranging from NNO to QFM+3.3.

The H_2O and CO_2 contents in the MIs glasses after hydration experiments were found to correlate positively with each other and negatively with the volume of fluid bubble, reflecting increasing internal pressure and CO_2 solubility in MIs with increasing melt hydration. Complete dissolution of fluid bubbles (homogenization) in the Klyuchevskoy MIs was achieved when the H_2O content in MIs reached 4-5 wt.%. The CO_2 content in the homogenized inclusions is 3800±140 ppm, and CO_2/Nb = 3000±420, which are the highest values reported so far for typical middle-K primitive island arc melts. The estimated CO_2 content in the mantle source beneath Klyuchevskoy is ~450 ppm with 78-89 % of this amount being likely derived from the subducting slab. This experimental approach can be used to reconstruct initial CO_2 content along with H_2O, S and the entire elemental composition of MIs in olivine from any type of volcanic rock, if temperature, redox conditions and pressure, which need to be simulated experimentally, are independently estimated.