AN OLIVINE-MELT THERMOMETER BASED ON D_{NI}, WITH NO DEPENDENCE ON H_2O IN THE MELT: NEW EXPERIMENTAL EVIDENCE

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A new olivine-melt thermometer introduced in [1], which is based on the partitioning of Ni ($D_{Ni}^{ol/liq}$) at crustal conditions (<1 GPa), was hypothesized to have a negligible dependence on dissolved H2O content in the melt. This partitioning behavior is in marked contrast to thermometers based on $D_{Mg}^{ol/liq}$. In this study, new olivine-melt equilibrium experiments were conducted on a basaltic glass (9.6 wt% MgO; 352 ppm Ni) under hydrous conditions at 0.5GPa and anhydrous conditions at 1 bar and 0.5 GPa to compare the effect of dissolved H_2O in the melt on $D_{Mg}^{ol/liq}$ and $D_{Ni}^{ol/liq}$. The Ni-thermometer in [1], calibrated on 123 1-bar olivine-melt experiments in the literature, recovers the experimental temperatures for all experimental runs (including hydrous runs where the melts contained at least 4.4 wt% H_2O) within an average of 14 degrees, less than the 1-sigma error of the Ni-thermometer (±29˚C). In contrast, the Mg-thermometer recovers the anhydrous experimental temperatures within error (±26˚C), but overestimates the experimental temperatures under hydrous conditions by +88 to +141 degrees. This result underscores that $D_{Ni}^{ol/liq}$ has a negligible dependence on dissolved water content in the melt (up to at least 4.4 wt% H_2O), as opposed to $D_{Mg}^{ol/liq}$ which displays a strong dependence. It is proposed that the olivine-melt thermometer based on $D_{Ni}^{ol/liq}$ can be applied to hydrous arc basalts at depths < 1 GPa without corrections for dissolved water in the melt or pressure.

[1] Pu et al. (2017) Am. Min. 102, 750-765.