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The Fe-loop experiments provide new constraints for the olivine-melt Fe2+-Mg partitioning model improvement

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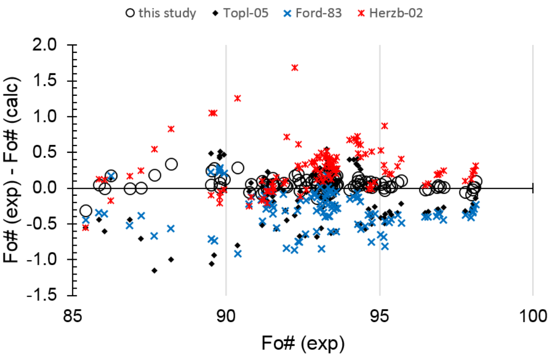

Numerous studies show, that the Fe–Mg exchange coefficient, $K_d^{Fe2+\text{-}Mg} = (X_{FeO}^{OL}/X_{FeO}^{melt})/(X_{MgO}^{OL}/X_{MgO}^{melt})$ is mostly independent of melt composition. In a recent study, [1] presented the results of experiments on olivine-melt equilibrium conducted in a wide fO_2-temperature-pressure range both with dry and water-containing melts, which support the negligible effects of pressure, temperature, and melt composition on this coefficient.

The goal of the present study was to check if $K_d^{Fe2+\text{-}Mg}$ is compositionally independent and improve existing models. We produced more than 100 pairs of coexisting olivine and silicate melts of a wide compositional range. Hawaiian, Icelandic and Norilsk picrites used as starting compositions. Modified lamproites from the Gaussberg volcano represent highly alkaline melts. To exclude the uncertainty following from ferric/ferrous determination, the experiments were conducted at fO_2 well below IW buffer, where the fraction of Fe^{3+} in total Fe in silicate melts is negligible. The samples on iron wire loops were equilibrated with H_2-CO_2-Ar gas mixture in 1 atm vertical tube furnace in the temperature range 1200-1500 °C. To keep a high level of alkalis in silicate melts in such reduced conditions a few runs were conducted with crucible-supported loop technique [2].

On average, the experimental $K_d^{Fe2+\text{-}Mg}$ values are in excellent agreement with those found in Blundy's (2020) experiments. From this point of view, our experiments strongly support previous findings. However, our data clearly demonstrates that the melt composition does affect $K_d^{Fe2+\text{-}Mg}$ values. The most popular and frequently used models of Fe-Mg partitioning tested and compared based on our experimental dataset (Fig. 1).

We suggest the new equation for $K_d^{Fe2+\text{-}Mg}$. The equation supports the minor effect of temperature, but the compositional dependence on Si, Ti, Al, Ca, K and Na of this coefficient is evident. It can be used for more precise estimates of parental or primary melt compositions than with previously published models. The new equations suggested for K^{Fe2+} and K^{Mg} partition coefficients may be used as possible geothermometers for high magnesian and highly alkaline mafic melts.

[1] Blundy J., et al. (2020) *CMP* 175:103.

[2] Borisov, A., et al. (2006) *AM* 91, 762-771.