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Zircon solubility in silicate melts: a re-evaluation

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Experiments on zircon crystallization from synthetic melts have been made at 1 atmosphere in a wide range of non-granitic compositions with index M= (Na + K + 2 Ca)/(Al Si) varying from 0 (no alkalis, no CaO) to 3.5 and temperature range 1150-1500˚C, with the aim of obtaining an extended data set on the zircon solubility in melts. Concentration of Zr in experimental glasses, measured with EMPA varied from 4540 to 61370 wt ppm. Separate effects of TiO_2, Fe oxides and SiO_2 on the Zr solubility have been evaluated. The newly obtained subset, consisted of 67 experimental points was combined with the 62 data points from the literature to derive an empirical equation relating Zr solubility with silicate melt composition and absolute temperature T:

log Zr (ppm) = 4.322·B – 4338.8/T(K) + 6.456, where B is the following ratio of the oxide mole fractions in the melts:

$B = 0.14(X_{TiO2}/X_{SiO2}) + 1.3(X_{CaO}/X_{SiO2}) + 1.5(X_{Na2O}/X_{SiO2}) - 4.5(X_{K2O}/X_{SiO2}) - 2.7(X_{Al2O3}/X_{SiO2})^2 + (X_{MgO}/X_{SiO2})^2 - 3.7(X_{CaO}/X_{SiO2})^2 + 75(X_{K2O}/X_{SiO2})^2$.

The new equation predicts log (Zr, melt) with a standard error of 0.104, which is equivalent to ca 24% error for the entire Zr concentration range covered by experiments (155-61370 ppm of Zr) and performs much better on the dataset than the previously published equations. It is particularly suited for evaluating a likelihood of zircon crystallization from evolving basaltic magmas. Such evaluation done on the well constrained experiments from the literature indicates that even near-solidus crystallization of zircon in deeply evolved initially basaltic melts is highly unlikely in dry liquids although cannot be completely ruled out and may even be quite plausible in the water-containing ones.

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