New Cr-Spinel Liquidus Thermobarometer for Mafic Anhydrous Melts

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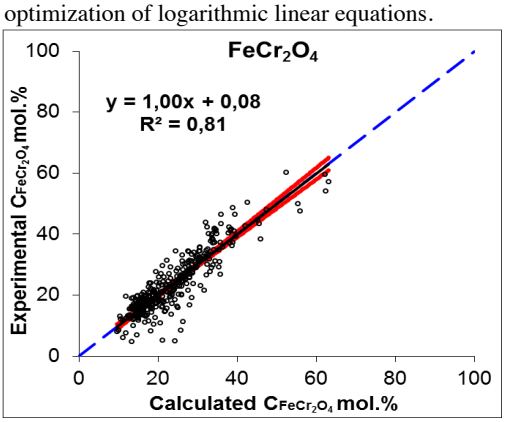
Liquidus thermobarometers for seven spinel end-members have been calibrated using experimental spinel and melt compositions for modeling of chromite - liquid equilibrium. We calculated formation of spinel minals in the following order: $CaAl_2O_4$, $MgAl_2O_4$, $MgCr_2O_4$, $MgFe_2O_4$, $FeAl_2O_4$, $FeCr_2O_4$, $FeFe_2O_4$. This order was set up using the concept of acid-base interactions for Ca^{2+}, Mg^{2+}, Fe^{2+}, Ti^{4+}, Fe^{3+}, Cr^{3+}, Al^{3+} ions. As an example, here is the equation for chromite $FeCr_2O_4$ (Chr) minal:

$$X_{Chr}=\exp((A+\beta P)/T+B+D\lg fO_2+\Sigma J_i X_i+\ln\alpha^*_{FeO}+2\ln\alpha^*_{CrO_{1.5}})$$

where X_{Chr} is the value of the chromite mole fraction, P is the pressure in kbar, T is the absolute temperature in Kelvins, fO_2 is the oxygen fugacity, X_i is the mole fraction of i-th component of the melt. A, β, C, D, E, F, and J_i are the coefficients for corresponding variables, B is the constant, a^*– activity of the initial components in the melt according to network modifiers - network formers model of silicate melt.

Coefficients and constants in the equations were obtained by optimization of exponential equations. This approach provides a better reproduction of experimental compositions than optimization of logarithmic linear equations.



Observed vs. calculated $FeCr_2O_4$ concentrations based on our model (346 experiments in the database[1]). The red lines indicate a confidence interval at 5% significance level (less then ±2 mol.%). Although most of the points lie out of confidence interval, the real value (in this case - $C_{FeCr_2O_4}$) is within this narrow range at 95% probability.

[1] Ariskin A.A., *et al* (1992), *Amer. Miner. V.* **77**, 668-669