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Apatite Chemistry and Phosphorus Fugacity in a Differentiated Igneous Intrusion: Correction

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Values of $\Delta G_r°/2.303$ RT for two reactions given by Nash (1972) are incorrect.

For the reaction $Ca_5(PO_4)_3OH + 5/2\ Mg_2SiO_4 + KFe_3AlSi_3O_{10}(OH)_2 + 1/2\ KAlSi_3O_8 + 15/2\ SiO_2 = 5\ CaMgSi_2O_6 + 3/2\ Fe_2SiO_4 + 3/2\ KAlSi_2O_6 + 15/4\ O_2 + 3/2\ H_2O + 3P$ the correct value is

$$\frac{\Delta G_r^0}{2.303\ \text{RT}} = \frac{168,508}{T} - 57.87(\pm 7.2).$$

For the reaction $Ca_5(PO_4)_3OH + 3\ MgAl_2O_4 + 57/4\ SiO_2 + 15/2\ Fe = 15/4\ Fe_2SiO_4 + 1/2\ Mg_2SiO_4 + 2CaMgSi_2O_6 + 3CaAl_2Si_2O_8 + 1/2\ H_2O + 3P$ the correct value is

$$\frac{\Delta G_r^0}{2.303\ \text{RT}} = \frac{51,529}{T} - 20.65(\pm 6.9).$$

The calculated phosphorus fugacities are shifted to higher values of f_p. The equilibrium curves for these two reactions (Nash, 1972, Fig. 1) are shifted, respectively, by the values $\Delta \log f_p = 5478/T + 5.26\ (\pm\ 2.4)$ and $\Delta \log f_p = 2730/T + 7.93\ (\pm\ 2.3)$. It is clear, upon recalculation, that the effects of oxidation state and silica activity on the equilibria are not immediately evident, as previously thought. Although the data of Stormer and Carmichael (1971) indicate a decrease of phosphorus fugacity with decreasing magmatic silica activity, no such simple behavior is indicated by the new curve for Shonkin Sag laccolith which crosses theoretical basalt and rhyolite curves. Contrary to prior conclusions, reduction in oxygen fugacity apparently increases phosphorus fugacity values, as indicated by the equilibria for a basaltic assemblage coexisting with metallic iron.

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