

The Petrologic Case for a Fluid-Present High-Grade Metamorphism

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Our recent phase equilibrium experiments (Aranovich and Newton, 1996, 1997) have demonstrated a tremendous effect of dissolved strong electrolytes on lowering water activity in concentrated aqueous solutions at pressures above 4-5 kbar. Although a complex function of T, P, and composition of the fluid phase, the $a(\text{H}_2\text{O})$ may, to a good approximation, be represented by a simple relationship corresponding to a completely ionised solution: $a(\text{H}_2\text{O}) = X_2(\text{H}_2\text{O})$. New experimental data on the upper stability limit of Phlogopite + Quartz (Aranovich and Newton, 1998) indicate that the alternative anhydrous assemblage Enstatite + K-feldspar is stable to a significantly lower temperatures than it was thought before. Propagated into the water activity estimates based on geothermobarometry of high-grade metamorphic assemblages, this finding leads to the $a(\text{H}_2\text{O})$ values 2-3 times greater than most previous estimates. Using a provisional calibration of mixing properties of the ternary $\text{H}_2\text{O}-\text{CO}_2-\text{NaCl}$ fluid it can be demonstrated that the new $a(\text{H}_2\text{O})$ estimates for the high-grade metamorphic assemblages may be readily reconciled with a model fluid of the composition (in terms of the mole fractions, X_i): $X_{\text{H}_2\text{O}}=0.7$, $X_{\text{CO}_2}=0.1$, $X_{\text{NaCl}}=0.2$. As the CO_2 activity in the ternary fluid is affected

most by the presence of strong electrolyte, this relatively low- CO_2 model fluid would stabilize calcite bearing assemblages to a considerably higher temperatures than the binary $\text{H}_2\text{O}-\text{CO}_2$ fluid of the same $\text{CO}_2/(\text{CO}_2+\text{H}_2\text{O})$ molar ratio. This eliminates a previously reported controversy between fluid composition estimates for the adjacent calc-silicate and metapelite rocks. The amount of the externally derived fluid required to decompose biotite at the P-T conditions characteristic of amphibolite - granulite interface is about 5 volume percent of the rock. Similar fluid/rock ratios are sufficient for extensive (diatexite-producing) melting of the quartzo-feldspathic rocks. Evidently, this amount of penetrating fluid will noticeably disturb neither the oxygen isotope ratio of silicate rock nor the carbon isotope ratio of calcareous rock.

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