



Solubility of fluor-apatite in silicate-bearing solutions at 1.0 GPa, 800°C

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Apatite is the most common phosphorous-bearing accessory phase in the earth's crust. When present as an accessory phase, apatite may be the principal rare-earth element (REE) reservoir. The role of apatite in the REE geochemistry during metamorphic fluid rock interaction depends on its solubility in crustal fluids, which is poorly understood. We measured the solubility of Durango fluor-apatite ($\text{Ca}_5(\text{PO}_4)_3\text{F}$) in silicate bearing fluids at 800°C and 1.0 GPa using a piston-cylinder apparatus with NaCl-graphite furnaces. A single crystal was loaded into a 1.6 mm OD Pt inner capsule, which was crimped, perforated and then placed in a 3.5 OD Pt outer capsule with ultra pure H_2O and powdered albite or quartz. Solubility was determined by the weight loss of the apatite grain after 24 hrs.

Apatite solubility in pure H_2O is 0.20 (2) millimolal. In H_2O - $\text{NaAlSi}_3\text{O}_8$ fluids apatite solubility rises with increasing concentrations of $\text{NaAlSi}_3\text{O}_8$ from 0.5 (2) millimolal at 4.91 wt% $\text{NaAlSi}_3\text{O}_8$ to 1.4 (2) at 9.125 wt% $\text{NaAlSi}_3\text{O}_8$. At 11wt% $\text{NaAlSi}_3\text{O}_8$ a melt phase becomes stable, nucleating as spheres chiefly in the outer capsule. Apatite solubility is suppressed in H_2O - SiO_2 fluids, decreasing from 0.12 (2) at 0.481 wt% SiO_2 to below detection at 2.177 wt%. Our current detection limit utilizing the weight loss method is 0.01 millimolal.

Our results demonstrate that apatite solubility rises with increasing concentrations of $\text{NaAlSi}_3\text{O}_8$ to a greater extent than in a solution of NaCl of the same molality but, it decreases with increasing SiO_2 . This suggests that the additional components Na and Al, rather than Si, promote complexing. Such complexes (e.g., NaHPO_3^- , AlHPO_4^+) could explain apatite veins high-grade granulite terranes and metasomatic rocks, without invoking chloride-bearing solutions, which have been previously shown

to greatly enhance apatite solubility. A significant finding of the present work is that solute phosphate stabilizes an aluminosilicate melt, at concentrations of the feldspar component which, otherwise, would be entirely dissolved in the aqueous fluid phase.