Analysis and models for apatite OH, and a potential magmatic P-T path

R. CHRIS TACKER[1]

[1]NC Museum of Natural Sciences, 11 West Jones St., Raleigh NC, USA 27601-1029; christopher.tacker@naturalsciences.org

Models for apatite solid solutions offer a single internally consistent means for examining fluid behavior from the surface to the mantle. Analysis of the OH apatite component persents one challenge for this goal.

FTIR shows several different OH moieties, a minor OH oriented perpendicular to the c-axis, and one or two carbonate subsitutions on the OH site. Speaking strictly, models of OH in apatite assume OH in apatite is equivalent to the OH in the hydroxylapatite endmember (at 3572 cm^{-1}). However, this is minor contribution to the spectra, if not completely absent. Other cationic and anionic substitutions shift the 3572 cm^{-1} absorbance to lower wavenumbers. Analyses that rely on total OH may overestimate water concentrations.

Electron microprobe analysis, even when properly accounting for halogen diffusion, typically overestimates OH content by calculating normative OH=1-Cl-F. This number is a maximum value, as the site on the sixfold axis may also contain vacancies, carbonate and oxygen. OH calculated from probe analyses will reliably overestimate OH, and derived water concentrations.

Measured OH concentrations mean little outside of a thermodynamic context. In the simple tricalcium phosphate-molten calcium salts systems, OH exchange with fluorine and chlorine is highly temperature dependent. OH exchange with chlorine shows pressure dependence as well. Calculations using H_2O-HCl-HF exchange show similar results. Models that do not explicitly account for temperature and pressure will underestimate water contents at lower, near solidus temperature, and overestimate at higher temperature.

The application of a thermodynamic model must be integrated to petrography. Yet there is a reward for the trouble of these calculations: Buried in the P-T dependence of apatite compositions is a potential magmatic P-T path recorded by apatite inclusions. Some worked examples will be presented. The assumption of ideal mixing in the Hap-ClAp-FAp solid solution will be weighed.