Apatite Hygrometry

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There are several ways to parameterize the relationship between the H content of a mineral and the H content of a melt. For many phases, "Henry's Law" partitioning (controlled by a constant D^H) is adequate, as the incorporation of H into the crystal is mainly a function of the H content of the magma. More complex versions of this model (e.g. where D^H is a function of the major or minor element composition of the crystal) also exist, and describe many systems adequately.

It does not appear that apatite is one such system. Incorporation of H into apatite is as an essential structural constituent (as OH-), and as such is controlled in part by stoichiometry. Fluorine, Cl, and OH all reside on the same site in the lattice, and are therefore in competition for space in the crystal. Assuming stoichiometric totals [1], this means that the abundance of any of these elements is inexorably linked to the others, and none can be treated as Henrian unless the abundances of the others in the melt are invariant.

Because of this, we instead suggest that we model the incorporation of H into apatite using another simple relationship. For the system F and H, we can write an equation: $H_{melt} + F_{ap} \Leftrightarrow H_{ap} + F_{melt}$, and from this a relationship for the equilibrium constant for that reaction. If we are interested in H_{melt}, we can write two nearly independent, equally valid equations (one for H-F exchange, one for H-Cl exchange). These are the basis of the equilibrium exchange model. Given the H, F, and Cl content of an apatite, it should be possible to predict the H, F, and Cl content of the melt with one more piece of information: either the H, F, or Cl content of the melt. That is, we can have the other two X_{melt} if we know one X_{melt}. But without that extra information, we cannot perform magma hygrometry etc. using apatite. In this poster we will compare and contrast the Henrian and equilibrium exchange models, provide tests of the models, and suggest avenues for further research.

[1] Boyce, J.W., J.M. Eiler, and M.C. Channon, 2012, *Am. Min.*, **97**, 1116-1128