Experimental fluid-aided alteration of magnetite in IOA deposits

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Trace elements in Mt have been widely used to decipher the genesis of iron oxide-apatite (IOA) deposits[1]. However, the Mt trace element chemistry from various IOA deposits is too variable to allow for a genetic comparison. IOA deposits are believed to have formed at ~800 °C. Under these conditions the Mt should contain high amounts of Ti and V[2]. However, this is inconsistent with natural observations of Mt from IOA deposits, which can contain extremely low amounts of Ti (down to 100 ppm). Recent study[3] has shown that textures and trace-element compositions (e.g., Ilm lamellae and Ti) in Mt from iron skarn deposits can be modified via coupled dissolution-reprecipitation (DRP) processes.

In order to test whether fluid-aided alteration of Mt could occur in IOA systems, unaltered, Ti- and V-rich Mt (~1.4 wt.% TiO_2 and ~0.3 wt.% V_2O_3) fragments, collected from an IOA ore (SE China), have been used in a series of metasomatism experiments, involving Na-and Ca-bearing saline fluids (both F- or Cl-bearing). Mt + fluid were loaded into Pt capsules and arc-welded shut. Experiments were run at 400, 600, and 800 °C and 100 MPa under Ni–NiO oxidizing conditions. In the 600 and 800 °C NaCl- and $CaCl_2$-bearing experiments, Ti (but not V) was partly leached out in altered areas of the Mt. In experiments at 400, 600, and 800 °C, involving NaF-bearing fluids, some Mt grains are partially replaced by CaF_2, titanite, and rutile. In all NaF-bearing experiments, the altered Mt contains much lower Ti, but the V content remains the same compared with the starting Mt.

The results from these experiments indicate that Ti concentrations in the Mt have been significantly modified. However, the V content shows no change in concentration during the DRP process. These results suggest that the high V and low Ti content in the Mt from some IOA deposits could be formed by a metasomatic process involving a Cl- or F-bearing fluid and primary Mt. In addition, this study also show that high field strength elements (e.g., Ti) are extremely soluble in Cl- and F-bearing fluids at 100 MPa over a wide range of temperatures typical for IOA and skarn ore deposits.

[1] Dare et al. (2014) Mineral Deposita, 49, 785-796
[2] Nadoll et al. (2014) Ore Geo Rev, 61, 1-32
[3] Hu et al. (2015) Eco Geo, vol 110, 1-8)