

Redox state of magmas based on Mn partitioning into apatite

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Oxidation state, and consequently oxygen fugacity (fO_2), of igneous systems, within the terrestrial planets, is an important variable for understanding planetary-scale processes. Everything from core formation, stability of mantle phases, atmospheric compositions and even the origin of life itself may be dependent upon fO_2 [1].

Recent modelling studies have suggested that apatite [$Ca_5(PO_4)_3(F,Cl,OH)$], a mineral found in terrestrial, lunar, and martian rocks may be a good proxy for understanding redox conditions in planetary interiors. In particular, the partitioning of redox sensitive elements, such as Mn, between apatite and coexisting melts is thought to be strongly dependant on fO_2 [2,3]; as such, characterisation of the crystal chemistry of apatite might provide information on fO_2 conditions in parental melts formed deep within planetary interiors.

Our experimental design investigates the potential of a Mn-in-apatite oxy-geobarometer by exploring how the partitioning of Mn into apatite, from a silicate melt, varies as a function of fO_2 . Experiments were carried out in piston cylinder apparatus using a double capsule technique to control fO_2 . Apatite was grown from a mix of tri-calcium phosphate ($Ca_3(PO_4)_2$) and $CaCl_2$ in melts of a haplogranitic composition and doped with various proportions of manganese oxide.

The resulting apatite grains and coexisting glasses were analysed using a Cameca SX-100 electron microprobe to obtain both major and minor element compositions.

Preliminary results from this study, indicate that fO_2 is an important control on partitioning of Mn into apatite, and point towards a positive use of Mn partitioning as an oxy-geobarometer. Ongoing research is focusing on exploring other physio-chemical controls on Mn partitioning into apatite, so that a quantified redox-sensor model may be developed.

[1] Righter, K. et al. *Am. Mineral.* 2016, 101 (9), 1928. [2] Righter, K. et al. In *LPSC XLVII*; 2016; pp 3–3. [3] Miles, A. J. et al. *Geoch Cosmoch. Acta*; 2014, 132, 101.