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Mechanism of Apatite Dissolution

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The weathering of apatite is the foundation of the phosphorus cycle and essential to life, yet little is known about the nanoscale mechanisms driving apatite weathering. Deciphering nanoscale dissolution in apatite is a major step to understand phosphate behaviour in planetary systems, which is key to the origins of life. For example, the abundance and high suspected solubility of apatite on Mars could have been determinant in promoting the development of Martian life. Recent research on the weathering of silicate minerals at the nanoscale has provided compelling evidence of a relatively new chemical weathering model referred to as coupled interfacial dissolution-reprecipitation (CIDR) mechanism[1]. We hypothesize that this mechanism could be broadened to phosphate minerals. To test this hypothesis, we investigated the micro- to nanoscale response to dissolution in apatite minerals.

we performed a set of flow-through experiments designed to create optimal surface weathering of apatite minerals. Prismatic apatites ($Ca_5(PO_4)_3(F,Cl,OH)$) were hydrolyzed in a HNO_3-H_2O solution at a pH of 3, ambient temperature, and 1 bar for 10 days in a 3D- printed mixed flow reactor. Effluent concentrations of P revealed that steady state dissolution of 5.95 mmol P/g Ap was reached after 4 days, leading to a dissolution rate of of 4.86E-5 mmol Ap/hr. We are probing crystallographic changes using pre- and post-atomic parameters modifications using single-crystal XRD. Ongoing characterization of the I0Ī0 surface using SEM, HRTEM and Grazing-Incidence XRD allows us to determine the physical and chemical transformation of the apatite surface upon weathering.

REFERENCES

[1] An EFTEM/HRTEM high-resolution study of the near surface of labradorite feldspar altered at acid pH: evidence for interfacial dissolution-reprecipitation. Hellmann, R., Penisson, J.M., Hervig, R.L., Thomassin, J.H. and Abrioux, M.F. (2003) Physics and Chemistry of Minerals 30, 192-197.