CLAY AND MAGNETITE FORMATION AT YELLOWKNIFE BAY, MARS.

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Introduction: The Curiosity Rover of Mars Science Laboratory, has analysed a set of mudstones at the Yellowknife Bay locality of Gale Crater, that record a history of deposition within a habitable, fluvio-lacustrine environment followed by low T alteration [1,2,3]. The composition and mineralogical information preserved in the sediments provide a unique opportunity to determine the nature of the environment. In particular we aim to constrain the mineral reactions, Water/Rock ratios, pH, and redox associated with the saponite-, magnetite-bearing assemblage identified by CheMin in the Sheepbed mudstone [2] and compare to martian clay compositions in the Lafayette nakhlite [4]. The presence of cm-scale ridges, which have a more Mg-rich composition than the surrounding mudstone [3,5], suggest that the diagenetic fluids changed in composition as alteration progressed. An important factor in our alteration model is the presence of amorphous material and olivine, together with secondary phases in the drilled samples [2].

Methods: We use a 2 stage fluid model, with an initial Deccan-type brine composition [6] which reacts with the known rock compositions - using ChemCam and APXS data e.g. [5,7] – to produce a pore fluid. We use average phyllosilicate composition in our model to deal with the limitations in thermodynamic databases. CHIM-XPT was used for the modelling [8], code which has been used extensively in basaltic environments.

Results: Initial reaction of the early brine with Gale basaltic compositions creates reactants dominated by chlorite. This early diagenetic phase may correspond to the formation of the Mg-Fe rich ridges. Subsequent reaction of the resultant fluid separated at a W/R of 100, produced a fluid that we then reacted with a range of different mineral and amorphous mixtures and T, W/R conditions. A mixture of 70 % amorphous phase, 20 % olivine and 10 % host rock produced a clay-Fe oxide dominated assemblage, similar to that in Sheepbed.

Conclusions: The Sheepbed pore fluid caused inhomogeneous dissolution at W/R100-1000 of an amorphous phase and olivine within the fine grained sediment, with minor overall host rock contribution. This led to the clay-magnetite assemblage observed at Yellowknife Bay [2]. The clay has a similar composition to ferric saponite and gel in the nakhlites [4].

References: [1] Grotzinger J. P. et al. 2014. *Science*, 343: DOI: 10.1126/science.1242777. [2] Vaniman D. T. et al. 2014. *Science*, 343:10.1126/science1243480. [3] McLennan S. M. et al. 2014. *Science*, 343: doi: 10.1126/science.1244734. [4] Hicks L. J. et al. 2014. *GCA*:136, 194-210. [5] Leveille R.J.et al 2014. *JGR*, (subm.). [6] Minissale, A. O et al. 2000. *EPSL*, 181, 377–394. [7] Gellert R. J. et al. 2013. Abst. #1432. 44th *Lunar Planet. Sci. Conf.* [8] Reed M. H. et al. 2010. User Guide for CHIM-XPT. University of Oregon.