HEMATITE INDICATOR OF HIGH WATER TO ROCK RATIO ALTERATION IN GALE CRATER.

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Introduction: In the Sheepbed mudstone of Yellowknife Bay in Gale Crater, diagenetic mineral assemblages have been found by the Curiosity Rover [1] which are the result of intermediate to low water/rock W/R diagenesis [2]. However, at Hematite Ridge on the north, lower slopes of Mt. Sharp (Aeolis Mons) which Curiosity is expected to reach within the current Extended Mission, a different assemblage is predicted. Hematite Ridge is a 200 m wide protruding feature extending 6.5 km NE-SW [3], identified by CRISM as having a hematite-rich signature, contrasting with the clay- and sulfate-rich mineralogy dominating other parts of the Gale Crater Floor and Mt. Sharp [4,5]. Here we propose a model to explain the formation of Hematite Ridge and the associated environmental conditions.

Methods and results: We use CHIM-XPT (M. H. Reed, U. Oregon) to model the different alteration conditions expected at Gale (details see [2]). Dissolution of approximately 70:20:10 % amorphous material, olivine, and basaltic material in an open system within the Sheepbed Member mudstone leads to the smectite and magnetite abundances identified by CheMin XRD at the John Klein and Cumberland sites [2]. These conditions are low-T diagenetic with intermediate W/R, as expected from reactions between pore water and rock, and predominantly form Fe-silicates and magnetite. For the formation of Hematite Ridge, oxidation of an inflowing Fe^{2+}-rich groundwater has been suggested [3]. Our models show that other options are possible.

Water to rock ratio and temperature. High W/R ratio favors Fe-oxide (or hydroxide) formation alongside either Al-oxide/-hydroxide, silica, and/or kaolinite, while more soluble elements (e.g. K, Mg) stay in solution. Thus, especially under exposure to fresh water (i.e. precipitation, surface water) repeated dissolution–precipitation cycles will enhance the Fe-oxide content of the residue. In just one re-dissolution cycle the hematite abundance at very high W/R reaches 50 wt%. Accompanying minerals are Fe-clays (smectite and chlorite). If redox is solely controlled by rock alteration, pyrite would not be present. By this model Hematite Ridge could be explained as the result of near surface, high W/R weathering. However, elevated temperatures, e.g. from a hydrothermal system, could also lead to enhanced Fe-oxide precipitation. In contrast though to the low-T case, pure hematite precipitates would require extremely high W/R.

Hematite Ridge is an important point in Curiosity's investigations and may reveal a new type of weathering palaeoenvironment previously unidentified in Gale Crater.

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