Manganese as indicator for strongly oxidizing aqueous environments in Gale crater, Mars

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Over the course of its mission, the NASA Curiosity Mars rover has traversed ~20 km over ~330 m of elevation. Over this stratigraphy, manganese abundance in rocks has varied significantly, and some anomalously high Mn abundances well above igneous values have been observed [1-2]. To concentrate Mn in rocks and sediments requires both water and strongly oxidizing conditions [3]. High manganese has been observed in a variety of geologic settings in Gale crater including as a possible surface coating [1], fracture fills [2], and embedded in fine grained lacustrine sediments [4-6]. Some instances are clearly diagenetic [e.g., 2] while others may be either authigenic or diagenetic [4-6]. In all instances, the appearance of Mn point to episodes of strongly oxidizing fluids within Gale, both when the lake was extant and also post lithification of its sediments, suggesting a long history of variable redox conditions in this region. Recent observations of Mn within sandstones supports the hypothesis that the Gale lake may have been redox stratified [7] and that these manganiferous materials formed in shallow, oxidized lakewaters [4-5]. Such environments on Earth are both habitable and inhabited; the discovery of a similar environment on Mars opens up intriguing possibilities for habitability that were previously not recognized.

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