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Ferrihydrite Stability in the Presence of Near-Saturated Brines on Mars

KAYDRA SR BARBRE, MEGAN ELWOOD MADDEN, ANDREW S. ELWOOD MADDEN AND CAITLIN A. HODGES

University of Oklahoma

Presenting Author: kaydra.s.barbre-1@ou.edu

Investigations of Mars' surface mineralogy have shown an abundance of x-ray amorphous ferric oxide phases such as ferrihydrite alongside large salt deposits. Near-saturated brines are hypothesized to be the primary state of liquid water on Mars due to their lower eutectic temperatures and pressures. While ferrihydrite is common in terrestrial systems on Earth, it typically transforms to more crystalline iron oxide phases, with temperature, pH, and foreign ions in solution influencing the specific mineralogy. Despite ferrihydrite's metastability, it has been detected by Mars rover and satellite missions in Meridiani Planum, Gale Crater, and Jezero Crater salt deposits, and amorphous ferric oxides have been identified within Martian meteorites. We hypothesize that near-saturated brines prolong ferrihydrite stability.

To test this hypothesis, we reacted lab-synthesized 2-line ferrihydrite with near-saturated and 10x diluted solutions of NaCl, $CaCl_2$, $MgCl_2$, $MgSO_4$, $NaNO_3$, Na_2SO_4, Na_2CO_3, $NaClO_3$, and $NaClO_4$ for 30 days, then analyzed the solids with x-ray diffraction and Raman spectroscopy to determine if phase transformation had occurred. We found that ferrihydrite remained stable against transformation in near-saturated sulfate, chloride, and perchlorate brines. Furthermore, ferrihydrite that had been completely dried prior to reacting with brines was more stable than ferrihydrite that was still a slurry. Therefore, ferrihydrite is more likely to be preserved in cold, arid, brine-rich environments on Mars where the ferrihydrite was dehydrated prior to subsequent alteration.

In addition to evaluating ferrihydrite persistence in Mars conditions, we also investigated organic phosphate adsorption on ferrihydrite As a phosphorous and iron rich environment, Mars may have provided the necessary components needed for ancient microbial activities to occur on the surface. Therefore, organophosphorous detection is a potential biosignature. We used Raman spectroscopy to analyze inorganic and organic phosphate sorbed onto ferrihydrite in order to test detection limits and develop analytical protocols. As a phosphorous and iron rich environment, Mars may have provided the necessary components needed for ancient microbial activities to occur on the surface. These results will inform new methods to investigate phosphate sinks, and hence potential habitability in Martian environments using the SuperCam 532 nm laser Raman instrument on Mars Rover *Perseverance.*