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A shallow salt pond analog for aqueous alteration on ancient Mars: Spectroscopy, mineralogy, and geochemistry of sediments from Antarctica's Dry Valleys

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Abstract

Understanding past and present aqueous activity on Mars is critical to constraining martian aqueous geochemistry and habitability, and to searching for life on Mars. Assemblages of minerals observed at or near the martian surface include phyllosilicates, sulfates, iron oxides/hydroxides, and chlorides, all of which are indicative of a complex history of aqueous activity and alteration in the martian past. Furthermore, features observed on parts of the martian surface suggest present-day activity of subsurface brines and at least transient liquid water. Terrestrial analogs for younger and colder (Hesperian–Amazonian) martian geologic and climatic conditions are available in the McMurdo Dry Valleys (MDV) of Antarctica and provide opportunities for improved understanding of more recent aqueous activity on Mars. Here, we study the VXE-6 intermittent brine pond site from Wright Valley in the MDV region and use coordinated spectroscopy, X-ray diffraction, and elemental analyses to characterize the mineralogy and chemistry of surface sediments that have evolved in response to aqueous activity at this site. We find that brine pond activity results in mineral assemblages akin to aqueous alteration products associated with younger sites on Mars. In particular, surficial chlorides, a transition layer of poorly crystalline aluminosilicates and iron oxides/hydroxides, and a deeper gypsum-rich interval within the upper 10 cm of sediment are closely related at this Antarctic brine pond site. Activity of the Antarctic brine pond and associated mineral formation presents a process analog for chemical alteration on the martian surface during episodes of transient liquid water activity during the late Hesperian and/or more recently. Our results provide a relevant example of how aqueous activity in a cold and dry Mars-like climate may explain the co-occurrence of chlorides, clays, iron oxides/hydroxides, and sulfates observed on Mars.

Keywords: Mars, McMurdo Dry Valleys, Antarctica, sulfates, chlorides, clays, brine pond, aqueous alteration, geochemistry, spectroscopy; Earth Analogs for Martian Geological Materials and Processes