

Mid-IR Spectroscopy of Perchlorates. D. P. Summers¹, R. C. Quinn², V. C. Gulick³ and Jason Angell³, ¹SETI Institute (c/o NASA Ames Research Center, Mail Stop 239-4, Moffett Field, CA 94035, dsummers@CarlSaganCenter.org), ²NASA Ames Research Center (Mail Stop 239-4, Moffett Field, CA 94035, richard.c.quinn@nasa.gov), ³SETI Institute (vguilick@seti.org).

The presence of perchlorates and other oxyhalides on Mars needs to be considered in the context of habitability and the preservation of biomarkers on Mars. Zent and McKay [1], suggested that "activated halides" could play a role in the oxidizing nature of martian soils. More recently, perchlorate was recognized by researchers as one of a number of oxidized salts present in the Atacama Desert [2, 3], but the roles of perchlorate and perchlorate formation as they may relate to the presence and preservation of organics on Mars have not been thoroughly explored. Following the discovery of perchlorate on Mars during the Phoenix Mission [4], products formed by perchlorate radiolysis were shown to reproduce the results of the Viking Biology Experiments [5]. The reactive intermediates and secondary products that are formed in processes that generate and decompose perchlorate may have significant impacts on the chemistry of surface materials, soil habitability, preservation of biomarkers, and the ability to analyze organics.

The recent detection of perchlorate, and likely other oxychlorine species, in the subsurface (~5cm) within ancient sedimentary deposits sampled by MSL [6] indicates that the formation and presence of reactive oxidants on Mars may not be limited to UV-processes in the regolith, as previously suggested [1, 7]. Results suggest that there are major spatial variations in oxidant distributions, even for samples collected in very close proximity (e.g., MSL John Klein and Cumberland samples). Data indicate the presence of different types of perchlorates, other oxychlorine species, and possibly other oxidants including ROS [6]. Suggesting that the chemical alteration of geological materials is more extensive and complex than previously thought.

To support the detection and characterization of perchlorates on Mars, K^+ , Na^+ , Ca^{2+} , Mg^{2+} , Fe^{2+} , Fe^{3+} , and Al^{3+} perchlorate salts were studied to provide spectral data for detecting and characterizing their possible presence. To extend earlier work to the mid-IR [8], they were characterized by IR microscopy (Figure 1) and Raman spectroscopy (Figure 2). This included anhydrous samples, samples with adsorbed water, and samples exposed to humidity during analysis to observe changes. With divalent cations, changes during hydration of peaks due to water at $\sim 1600\text{ cm}^{-2}$ and $\sim 5100\text{-}5200\text{ cm}^{-2}$ showed evidence of different peaks and different states (see Figure 1).

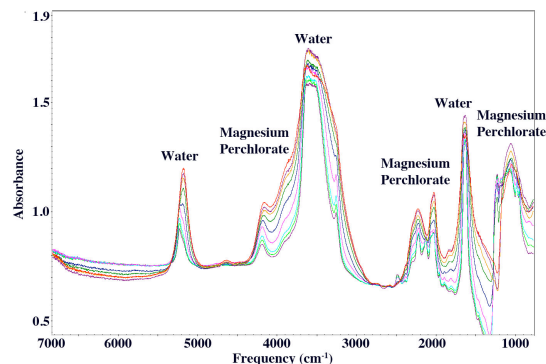


Figure 1. IR spectra of a particle of magnesium perchlorate as it takes up water from the air.

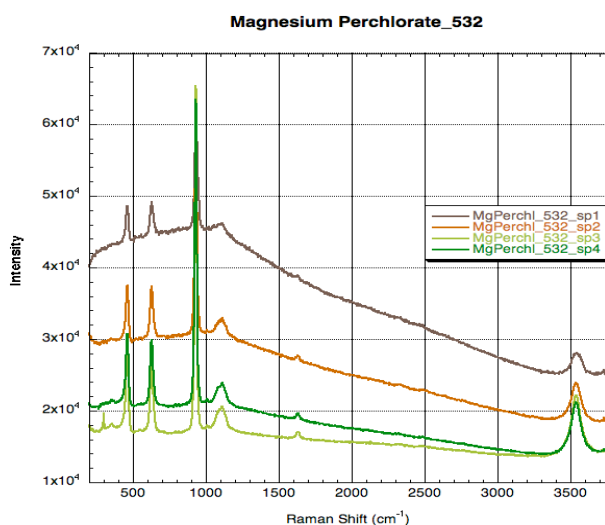


Figure 2. Raman spectra of magnesium perchlorate using a laser excitation of 532nm. Peak near 3500 cm^{-1} is due to chemically bound water of hydration.

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