

CHARACTERIZING NANOPHASE MATERIALS ON MARS: SPECTROSCOPIC STUDIES OF ALLOPHANE AND IMOGOLITE

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Allophane is an amorphous or poorly crystalline hydrous aluminosilicate material. Allophane's chemical structure represents a hollow nanosphere, 5-6 nm in diameter with 4-7 large pores in the structure. Identification of allophane and other amorphous and nanophase minerals on Mars has provided clues about the aqueous geochemical environment there. These materials likely represent partially altered or leached basaltic ash and therefore, could represent a geologic marker for where water was present on the Martian surface; as well as indicate regions of climate change, where surface water was not present long enough or sufficiently warm to form clays. Characterization of these materials is important for increasing spectral recognition capabilities using visible/near-infrared (VNIR) and thermal infrared (TIR) spectra of Mars. A suite of synthetic allophane samples was created using a method that has been modified to produce allophane with Fe isomorphically substituted for Al in octahedral coordination. Compositions of the materials range from high-Si allophane (molar Al:Si = 1:2) to protoimogolite (Al:Si = 2:1), with Fe³⁺ and Fe²⁺ isomorphically substituted for Al from 0-10 mol% of total Al. These compositions span the range observed in natural terrestrial allophanes. Fe K-edge X-ray absorption spectroscopy provided information on the speciation and electrochemical and structural position of Fe in the framework. Fourier transform infrared spectroscopy confirmed syntheses and demonstrated changes in infrared spectroscopic signature with Fe substitution. VNIR reflectance spectra and TIR Thermal infrared emissivity spectra were also collected for direct comparison to Martian data. By increasing spectral recognition capacities of nanophase materials, more accurate estimates can be made on the aqueous geochemical environment of Mars.