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Nature and Potential Causes for 3-μm Absorptions in the Lunar Reflectance Spectrum due to OH/H2O as Discovered by the Moon Mineralogy Mapper on the Chandrayaan-1 Spacecraft

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Absorption spectral features near 3 μm were reported in the Chandrayaan-1 M3 visual-IR spectral data and are interpreted as being caused by OH/HOH in or on the lunar surface (Pieters et al., 2009). These features were confirmed and elaborated on by two other spacecraft observations, by the Cassini VIMS (Clark, 2009) and by EPOXI (Sunshine et al., 2009). The M3 team is exploring the behavior of this complex absorption feature across the lunar surface and is developing hypotheses explaining the physical processes creating the OH/H2O. The behavior of the spectral features, with several parameters, including lighting geometry, temperature, and composition, is under investigation. Early results (McCord et al., 2009, 2010), beyond those presented in the initial discovery articles, indicate apparent complex dependencies not easily disentangled, due to the premature termination of the mission and the inability of M3 to complete its measurement plan. In addition, the parameters being explored are themselves inter-correlated, e.g., temperature with illumination and composition with latitude. As one tactic, independent temperature measurements are being brought to bear to help clarify the effects. A major goal is to use the absorption behavior to help determine the physical process(es) operating. We will review the potential explanations for the presence of OH/HOH spectral features, and suggest models for the M3 observations. Scenarios for water on the Moon include intrinsic water from formation, infall from comets and some meteorites, and solar wind-induced surface chemistry. We are currently concentrating of the surface chemistry process. Solar-wind implantation can provide abundant protons to the lunar soils that consist of minerals and glasses rich in oxygen and are poorly crystalline with very rough and irregular microsurfaces. These chemically active surfaces provided conditions that are known to allow formation of OH/HOH associations, and that may also be temperature and illumination dependent.

Pieters, C. M. and the M3 team, Character and spatial distribution of OH/H2O on the surface of the Moon seen by M3 on Chandrayaan-1; Clark, R. N. Detection of Adsorbed Water and Hydroxyl on the Moon; Sunshine, J. M., Temporal and Spatial Variability of Lunar Hydration as Observed by the Deep Impact Spacecraft; all in Science 326, 2009.

McCord et al., Interpretations of OH/HOH IR Absorptions on the Moon from Chandrayaan-1 Moon Mineralogy Mapper, Am. Geophys. Union Fall Meeting Proceedings, 2009.

McCord et al., Origin of OH/Water on the Lunar Surface Detected by the Moon Mineralogy Mapper, Lunar and Planetary Science Conference Proceedings, 2010.