EVIDENCE FOR HYDRATED PHYLLOSILICATES IN HOLDEN CRATER, MARS USING HYPERSPECTRAL CRISM DATA. R. E. Milliken1, J. P. Grotzinger2, S. Murchie3, J. A. Grant4, and the CRISM Team, 1Jet Propulsion Lab/Caltech, 4800 Oak Grove Dr, Pasadena, CA 91109, 2California Institute of Technology, Pasadena, CA, 91125, 3Applied Physics Laboratory, Laurel, MD, 4Smithsonian Institution, Center for Earth and Planetary Studies, 6th at Independence SW, Washington, DC 20560. Ralph.Milliken@jpl.nasa.gov

Introduction: Recent reflectance data returned by the high spatial/spectral resolution CRISM instrument onboard the Mars Reconnaissance Orbiter have provided the first evidence of hydrated materials in distinct stratigraphic units in Holden Crater, Mars. The full spectral resolution of the CRISM instrument utilizes 544 channels to cover a wavelength range of ~0.36 – 4 μm [1], a range that includes fundamental and overtone absorptions related to the presence of H₂O and OH. Here, we discuss observations of these absorptions, indicative of hydrated materials, detected in layered deposits in the southwest portion of Holden Crater in CRISM observation HRS000030AF_07. This image was acquired at full spectral resolution and half spatial resolution (~36 m/pixel).

Background: Holden Crater is approximately 154 km in diameter and was formed during the Noachian within the pre-existing Holden Basin [2-4]. MOC and THEMIS images reveal that light-toned layered sediments exist within the southwest portion of the crater (Figure 1) [5,6]. Major stratigraphic units within the SW portion of Holden Crater include a lower, layered unit that is heavily fractured and intermediate in albedo, a middle, less fractured, higher albedo unit that ranges from massive to finely layered, and an upper low-albedo unit that exhibits crude layering and lacks the conjugate joint sets present in the lower two units. Much of the upper unit is covered by eolian bedforms that may be currently active, indurated and inactive, or a combination of the two. The lower two units may be lacustrine in origin [3,4,6] and represent a depositional setting that is distinct from the upper unit, as described in detail by [4].

Data Reduction & Methods: The CRISM image used for this study has been converted to I/F, photometrically corrected for the incidence angle, atmospherically corrected to a first order (following the method of [7]), and map-projected. The reduced data were then used to calculate band parameters, specifically the band depths near 1.9, 2.2, 2.3, and 2.5 μm, as described by [8]. These band parameters were examined to search for areas of unique or interesting mineralogy that corresponded to the three major stratigraphic units described above. An overlapping HiRISE image was also acquired for this region (image PSP_001468_1535) and was studied to provide a more detailed analysis of the relationships between mineralogy as seen by CRISM and stratigraphy.

Results: CRISM spectra corresponding to exposed regions of the lower, intermediate-albedo unit commonly exhibit absorption features centered near ~1.9 and ~2.3 μm (Figures 2, 3). These features are consistent with the presence of hydrated Mg-Fe bearing phyllosilicates and have been observed in other locations on Mars by the OMEGA experiment [9,10]. These hydrated materials are associated primarily with the reddish-brown outcrops in the RGB composite in Figure 2, whereas spectral features of hydrated phases are weak or absent in the brighter, middle unit (Figures 4, 5). The presence of hydrated materials in the lower unit suggests that this unit 1) represents reworked, previously altered material, 2) deposition of the lower unit in an aqueous environment, possibly lacustrine [4], or 3) post-depositional aqueous alteration of the lower unit via groundwater interaction.

Figure 1. Regional view of the southwest portion of Holden Crater showing the location of CRISM image HRS000030AF_07. The image consists of a CRISM RGB composite (0.749, 0.501, and 0.449 μm, respectively) on top of a THEMIS VIS and day IR mosaic provided by [14].

Figure 2. Close-up view of the CRISM RGB composite in Figure 1. The black arrows point to the deposits corresponding to the highest concentrations of hydrated materials (largest 2.3 μm band depth values).
concentrated in a stratigraphically lower, intermediate-albedo unit in SW Holden Crater, Mars. This lower unit may represent reworked sediments derived from layers deposited in Holden Basin prior to the formation of Holden Crater or deposition and alteration of sediments in an aqueous environment. Compositional and morphological differences between the lower and middle units suggest a change in depositional setting over time [4]. The exposure of layered materials, interesting mineralogical signatures, and geomorphology of SW Holden Crater make it an excellent candidate for the MSL landing site, as proposed by [12,13]. Future work will continue to focus on integrating CRISM, OMEGA, HiRISE, CTX, TES, and THEMIS data to determine the geologic history of this region.

The spectral features of the upper unit are more consistent with mafic minerals (likely pyroxene and olivine) and could represent the composition of the superimposed eolian bedforms, the composition of the upper unit, or spectral mixing between the two. The detection of mafic materials in these low-albedo materials is consistent with observations by THEMIS and TES for this region [11].

Conclusions: Hyperspectral reflectance data acquired by the CRISM instrument reveals that hydrated minerals, likely phyllosilicates, are preferentially