Data Repository Item for "Diverse aqueous environments on ancient Mars revealed in the southern highlands" (J. J. Wray et al.)

METHODS

CRISM collects data in two modes: hyperspectral (544 spectral channels, ~18 or 36 meters/pixel) and multispectral (72 channels, 200 meters/pixel). For both modes, spectral summary parameters are used to map the strengths of spectral absorptions indicative of particular mineral classes (Pelkey et al., 2007). Figs. 3B,C,E,F, DR1 and DR2 use parameters that track Fe/Mg-phyllosilicates (red), Al-phyllosilicates (green), and H₂O (blue); Fig. 3A uses a similar combination except that blue represents low-calcium pyroxene. Fig. 4B uses parameters tracking sulfates (red), monohydrated sulfates (green), and H₂O (blue). The maps in Figs. 3A, DR3B, and DR5B—as well as the spectra in Fig. DR7—have been processed using the spatial and spectral noise-filtering algorithm of Parente (2008).

For hyperspectral images, browse products displaying combinations of summary parameters in a standard stretch are available at <u>http://crism-map.jhuapl.edu</u>. We have examined these browse products for all images in our regions of interest (Fig. 1) released to the PDS through June 2008, in search of spatially contiguous areas with absorptions characteristic of H_2O - or OH-bearing minerals. The presence of these absorptions is subsequently confirmed by plotting spectra, which are visually compared to library spectra (Clark et al., 2007; Murchie et al., 2007) for mineral identification. For regional context, we have also surveyed all multispectral map tiles in the regions of interest released through September 2008, and have examined newer hyperspectral observations in areas where hydrated minerals were found by our initial survey.

Simple atmospheric and photometric corrections are applied to CRISM I/F spectra (Mustard et al., 2008). The spectra shown are ratios between hydrated mineral exposures and areas of low spectral contrast in the same scene. Spectral ratios suppress residual artifacts of instrument calibration and atmospheric removal (Mustard et al., 2008) while accentuating unique spectral signatures in the numerator spectra. Spectrum 6 in Fig. 2A was used as the ratio denominator for spectrum 7, in order to isolate the signature consistent with gypsum in 7. We have interpolated over strong, narrow spikes that were obvious artifacts. Narrow absorptions at 2.00 and 2.06 μ m visible in many ratio spectra are artifacts of atmospheric calibration, but deeper bands at 1.9-1.95 μ m are likely H₂O-related absorptions in hydrated minerals. Vertical dashed lines in Figs. 2, DR4, and DR7 are provided to aid visual comparisons between the spectra shown; in Figs. 2A,B these are at 1.40, 2.20, and 2.30 μ m, whereas in each panel of Fig. DR4 and in Fig. DR7 they are positioned at the wavelengths of spectral absorptions seen in both the CRISM spectra and library spectra.

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Figure DR1. Clays exposed by small craters in Noachis. A: CRISM multispectral data strips with Fe/Mgphyllosilicate (red) overlain on THEMIS Daytime IR mosaic. A large crater in the southwest corner exposes phyllosilicate in its eastern wall, while smaller craters have phyllosilicate-bearing ejecta (arrows). These craters have bright halos in THEMIS Night IR data (B), likely indicating a relatively young age. C: Fresh D~1 km crater from the northernmost arrow in (A); note well-preserved ejecta with radial striations (CTX P21_009284_1649; 15.3°S, 52.5°E). D: D~300 m crater with bright ejecta containing Al-clay (green/cyan), from outside area shown in (A) (FRT000060CF on CTX P08_003997_1613; 19.4°S, 47.2°E). North is up in all panels.



Figure DR2. Clay-bearing crater fill in Sirenum. A: CRISM multispectral data strips with Fe/Mg-phyllosilicate (red) shown on IR albedo, with THEMIS Daytime IR mosaic as background. Note ring of clays (arrow). Scale bar is 25 km. Clay-bearing deposits are also visible ~50 km to the northwest on the intercrater plains. B: HiRISE image (PSP_010901_1510; 28.9°S, 172.9°W) shows the ring corresponds to light-toned materials filling a D~7 km crater, overlain by a darker, spectrally bland deposit. Box outlines image C: Higher resolution reveals polygonal fractures in clay-bearing materials and boulders shedding from more resistant cap unit. North is up in all panels.



Figure DR3. Clays and chlorides in Sirenum. A: Mosaic of THEMIS images I08956002 and I07895002; chloride-bearing materials appear blue in these band 8/7/5 DCS images (Osterloo et al., 2008). White box outlines panel B: CRISM FRT 9AAA (33.4°S, 143.8°W) parameter maps; yellow box outlines area shown in Fig. 3D. Red indicates Fe/Mg-phyllosilicates. As noted by Murchie et al. (2009), chloride-bearing materials have an unusually weak 3 μ m hydration band and a uniform positive slope from 1 to 2.6 μ m. Here, green tracks the inverse of the 3 μ m band depth, and blue tracks the slope from 1.8 to 2.5 μ m; therefore, areas appearing cyan (i.e., both blue and green) are inferred to contain chlorides. North is up.



Figure DR4. Spectra of sulfates and adjacent Fe/Mg-phyllosilicate in Noachis and Sisyphi Montes, with library spectra offset and scaled for comparison. A: (1) Southern Noachis intracrater deposit (FRT00008431); (2) vermiculite; (3) saponite. B: (1) Floor of same Noachis crater (Fig. DR5) as in (A) (FRT00006073); (2) hexahydrite (MgSO₄· 6H₂O); (3) botryogen (MgFe³⁺[SO₄]₂[OH]· 7H₂O); (4) stilbite (zeolite). C: (1) Sisyphi Montes hilltop (FRT00007AE6); (2) bassanite (CaSO₄· 0.5H₂O); (3) gypsum (CaSO₄· 2H₂O); (4) kainite (MgSO₄· KCl· 3H₂O). Compare also the library spectra shown in (B).



Figure DR5. Noachis crater floor with phyllosilicates and sulfates. A: Viking MDIM context showing a mesa (perhaps partially comprising ejecta from smaller crater) on floor of large crater. White box outlines panel B: Fe/Mg-phyllosilicates (red) and other hydrated materials including sulfates (blue). Phyllosilicates are exposed in the mesa walls, while sulfates appear in light-toned outcrops northeast of the mesa (FRT00006073 [top] and FRT00008431 [bottom] on CTX P08_003972_1306; 49.3°S, 14.5°E). Yellow boxes outline areas shown in other figures, and arrows point to source locations for spectra. North is up.



Figure DR6. Interbedded clays and sulfates in Columbus crater. A: Sulfate (purple) and kaolinite group clay (green) are found interbedded (arrows) in the wall of a D~800 m crater excavating through the layered materials within Columbus (FRT00007D87; 28.5°S, 166.0°W). Fig. DR7 shows spectra from each layer. B: Image showing the same area with arrows at same positions. Box outlines area shown in Fig. 4C, where interbedded layers exposed by a D~1 km crater are too narrow for CRISM to resolve (MOC R0900336).



Figure DR7. Interbedded clays and sulfates in Columbus crater. Numbered spectra correspond to numbered arrows in Fig. DR6 (spectrum 4 is a 76-pixel average including points eastward of arrow 4, all of which appear stratigraphically equivalent). Spectrum 1 resembles polyhydrated sulfate and spectrum 4 a kaolinite group clay; spectra 2 and 3 are mixtures of both components, but spectrum 3 appears sulfate-dominated while 2 appears more clay-dominated (compare bands at ~2.2 μ m).