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Aureum Chaos, Mars – Evidence from water-related minerals

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Abstract

Hyperspectral studies have shown that a variety of water-related minerals is present on the Martian surface. Analyzing these minerals can shed light on prevailing past and ongoing environmental conditions. We identified and mapped hydrated minerals in Aureum Chaos to understand their stratigraphy and geological context based on high resolution short wave infrared data from CRISM, imagery and elevation data. Differently from most sulfate-rich regions on Mars, we could identify phyllosilicate indicating that local conditions could have allowed clay formation after the well-accepted global "phyllosian" era that is assumed for Early Mars. We will present sulfate formation models and relative timing of mineral formation.

1. Datasets

For our spectral analysis, targeted CRISM observations of both full and half resolution (FRT, HRL) were used. Data were processed with the CRISM Analysis Tool (CAT) including atmospheric correction into I/ F [1] and mapping of spectral indices [2]. Spectra were ratioed and compared to CRISM library spectra.

2. Results

Based on CRISM and HRSC DTMs, we found hydrated minerals at 3600 m below datum. Detected mineral groups are monohydrated sulfate (*MHS*; best matching kieserite), hydroxylated ferric sulfate (*HFS*; best matching jarosite), polyhydrated sulfate (*PHS*), ferric oxides and phyllosilicate (best matching nontronite, Fig. 1, 2).

Sulfates are associated with Interior Layered Deposits (ILDs). The nontronite is attributed to chaotic terrain as light toned fractured exposure (Fig. 2E) and to dark, smooth, and indurated mantling. It was identified by its narrow and deep absorptions at 2.29-2.3 µm, 1.42-1.44 µm, 1.93, and 2.4-2.43 µm (Fig. 1B). HFS was identified by absorptions at 2.23 µm, 1.42-1.45 µm and weak 1.93 µm and 2.4 µm bands (Fig. 2B). Kieserite has absorptions at 2.12 µm and a deep absorption at 2.4 µm. Absorptions at 1.42-1.44 µm and at 1.92-1.93 µm indentified PHS. The spectral slope between 1 and 1.3 µm displayed ferric oxide-rich regions [3,4]. These regions are present in sulfate-rich materials and on chaotic terrain mounds. Confirmed by spectral absorptions at 0.5 and 0.9 µm, we detected ferric phases in regions that appear MHS-bearing.

The ILD display three stratigraphic units: The lowest unit (1) shows massive, light-toned MHS (20-650 m thick, Fig. 2C) with intercalated knobby HFS and ferric oxides. The overlying PHS (2) is commonly layered (20-40 m thick, Fig. 2D), smooth to heavily fractured, and partially contains ferric oxides (Fig. 2C-D). Spectrally neutral, distinctly layered, and bumpy cap rock forms the top ((3), 40-300 m thick). Unconformities between the units indicate periods of erosion.

3. Conclusions

Previous polyhydrated sulfate and ferric oxide detections by [5, 6] were confirmed by higher resolution data; further water-related minerals have been identified. ILD stratigraphy is slightly different to observations by [7] for Aram Chaos (different MHS, HFS-signature), but morphology is comparable. Our HFS spectra are similar to spectra of [8] for Juventae Chasma deposits that have been interpreted as dehydrated PHS.

Facies and relative timing of sulfate formation remains undefined. However, a coeval formation of ILD and one sulfate (e.g. PHS), as proposed by [9] for ILDs in Valles Marineris, and its conversion into lower hydrates later on, is conceivable here when considering evaporation in a lake. Overburden pressure could have formed secondary MHS and ferric oxides. Post-ILD sulfate formation by rock alteration through groundwater as proposed by [10] passing through pre-existing sulfate-free ILD material. Water, either as liquid or solid phase, must have reached the maximum elevation at which we see hydration (3600 m below datum).

Since, phyllosilicate is associated with chaotic terrain (Late Hesperian [11]) and with mantling deposits, it could have formed in-situ or is allochthonous, the latter would be conceivable for mantling deposits. Assuming its in-situ formation for those deposits associated with chaotic terrain, would mean local conditions could have allowed clay formation after the Noachian. According to [12], the conservation of HFS and MHS assumes dry conditions with at most short-lived wetting events, hence the preserved HFS and MHS must have formed after the potential in-situ formed clays (requires water for prolonged periods).

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References

[1] McGuire, P.C. et al.: An improvement to the volcano-scan algorithm for atmospheric correction of CRISM and OMEGA spectral data, Planet. Space Sci., 57, pp. 809-815, 2009.

[2] Pelkey, S.M. et al.: CRISM multispectral summary products: Parameterizing mineral diversity on Mars from reflectance, J. Geophys. Res., 112, doi:10.1029/2006JE002831.

[3] Le Deit, L. et al.: Ferric oxides in East Candor Chasma, Valles Marineris (Mars) inferred from analysis of OMEGA/Mars Express data: Identification and geological interpretation, J. Geophys. Res., 113, E07001, doi:10.1029/2007JE002950, 2008.

[4] Mangold, N. et al.: Spectral and geological study of the sulfate-rich region of West Candor Chasma, Mars, Icarus, 194, pp. 519-543, 2008.

[5] NoeDobrea, E. et al.: Correlations between hematite and sulfates in the chaotic terrain east of Valles Marineris, Icarus, 193, pp. 516-534, 2008.

[6] Glotch, T.D. and Rogers, D.A.: Evidence for aqueous deposition of hematite- and sulfate-rich light-toned layered deposits in Aureum and Iani Chaos, Mars, J. Geophys. Res., 112, 06001, doi: 10.1029/2006JE002863, 2007.

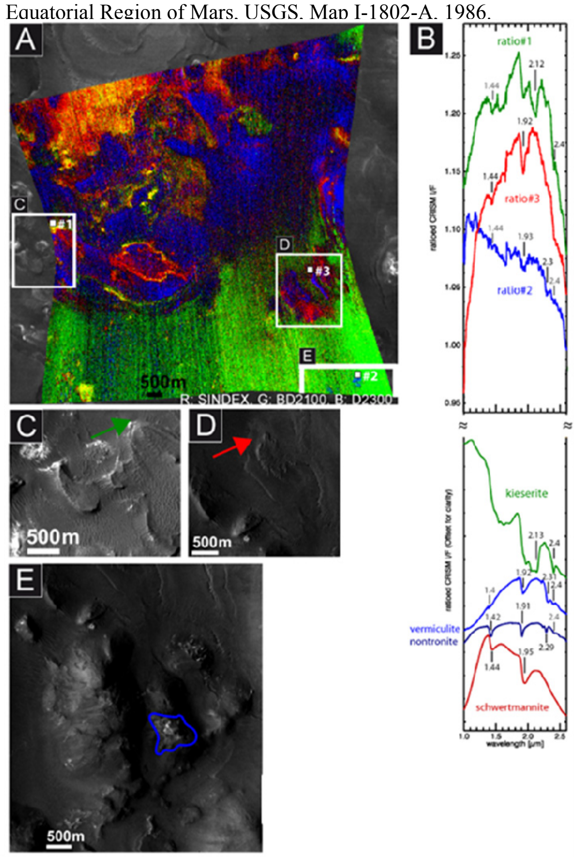
[7] Lichtenberg, K.: et al.: Stratigraphy of Hydrated Sulfates in the Sedimentary Deposits of Aram Chaos, Mars, J. Geophys. Res., JE003353, 2010.

[8] Bishop, J.L. et al.: Mineralogy of Juventae Chasma: Sulfates in the light-toned mounds, mafic minerals in the bedrock, and hydrated silica and hydroxylated ferric sulfate on the plateau, J. Geophys. Res., 114, doi:10.1029/2009JE003352, 2009.

[9] Roach L.H. et al.: Diagenetic haematite and sulfate assemblages in Valles Marineris, Icarus, 207, 659-674, 2010.

[10] Andrews-Hanna, J.C. et al.: Meridiani Planum and the global hydrology of Mars. Nature, 446, 163-166, 2007.

[11] Scott, D.H. and Tanaka, K.L.: Geologic Map of the Western Equatorial Region of Mars. USGS. Map I-1802-A. 1986.



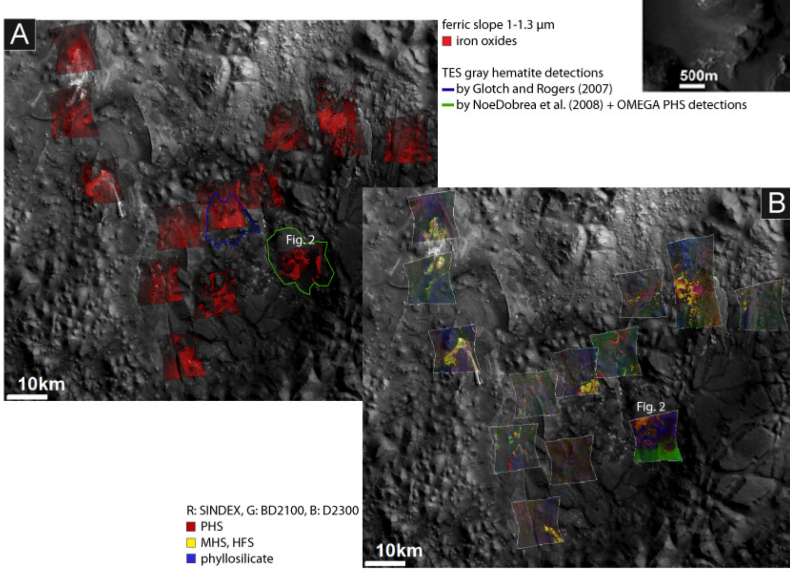


Figure 1 (left): Detected ferric oxides (A) and hydrated minerals (B).
Figure 2 (above): Identified phyllosilicate and sulfate outcrops (A, C-E) with respective ratio and library spectra (B).

[12] Tosca, N.J. and Knoll, A.H., Juvenile chemical sediments and the long term persistence of water at the surface of Mars, Earth Planet. Sci. Lett., 286, 379-386, 2009.