EPSC Abstracts
Vol. 13, EPSC-DPS2019-1029-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Spectral Characteristics of Deposit Stratigraphy at Eberswalde Crater, Mars

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1. Introduction

Within Eberswalde Crater, Mars, is one of the most pristinely preserved branching fluvial deposits observed on the surface of Mars with large outcrops (>>20 m^2) of individual strata exposed in plan-view. Broad scale spectral analysis of the outcrop by [1] and [2] have identified abundant Fe/Mg clays on the erosional front of the deposit. According to [2], the delta front on a broad scale, is composed of a combination of saponite (Mg-rich smectite) and nontronite (Fe^{3+}-rich smectite) irrespective of layering. Questions remain, however, about whether or not the mineralogy changes through the vertical succession of the stratigraphy. A more complete understanding of the spatial variability of the mineralogy of the deposit can help constrain the nature and timing of aqueously altered materials within the crater and the crater catchment [e.g., 3]. High spatial resolution (~18 m/pixel) spectral images from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) aboard the Mars Reconnaissance Orbiter (MRO) can aid in analysis of the broad exposure of individual strata in plan-view, and permit spectral analysis of individual strata. Here we present preliminary mapping and spectral analysis results from exposed strata on the Eberswalde delta front.

2. Methods

The mineralogy of exposed bedding planes was analyzed using reflectance spectroscopy from a Map-Projected Target Reduced Data Record (MTRDR) Full Resolution Targeted (FRT) CRISM product, observation number hrs00003207_07. These targeted hyperspectral products are I/F corrected and map projected with 489 bands ranging from visual spectra to the near infrared (VNIR) [4]. Image ESP_047119_1560 from the High Resolution Imaging Science Experiment (HiRISE) [5], a high spatial resolution (~0.25 m/pixel) optical wavelength camera also aboard the MRO, was used to aid in visual identification of bedding surfaces exposed in plan-view. Both the CRISM and the HiRISE images were carefully georeferenced to Context Camera (CTX) [6] image B21_017911_1559 for parity. CTX is also a high spatial resolution (~6 m/pixel) camera aboard the MRO. We carefully drew regions of interest (ROIs) on continuous planar surfaces in the geospatial analysis software, ENVI, to calculate mean spectra for all pixels within each ROI. Care was taken to ensure bounds of each ROI stayed within the visual bounds of a given stratal surface and covered a sufficient area (>40 pixels) to reduce the effects of instrumental and environmental noise. We then ratioed each mean spectrum by dividing each ROI spectrum by the mean spectrum of an ROI drawn around a region with a bland spectral signature (magenta polygon in Fig. 1B) to further reduce the effects of instrumental noise and martian dust. All mapped stratal surfaces were identified as representing distinct stratigraphic levels from one another (Fig. 1B and C).

3. Results

Our preliminary observations of the reflectance characteristics of the sampled regions indicate minimal variation throughout the stratigraphic section tested (Figure 1B, 1C, and 1D). We payed particular attention to band minima from 2.29-2.37 µm. Subtle differences of minima in this range could indicate different mineral phases including Fe^{3+}-rich smectite with a band minimum centered around 2.29-2.31 µm, Mg-rich centered around 2.33-2.34 µm, and Fe^{2+}-rich centered around 2.35-2.37 µm [7]. All four stratal surfaces showed band minima centered around ~2.30-2.32 µm which indicates all sampled layers are likely composed of Fe^{3+}-rich smectite (e.g., nontronite). However the shape of the absorption features and the negative continuum slope from ~2.25-2.35 µm in each spectrum, both laboratory and CRISM, leaves ambiguity preventing the interpretation that any layers are primarily composed of one clay end-member. This leads us to conclude that the broad scale analytical result reached by [2] is likely correct: the composition is consistent with some combination of saponite and nontronite, and that this trend is consistent from layer to layer within the deposit.

4. Implications

The observation of minimal variability in the vertical succession of strata indicates that the period of aqueous alteration that formed these smectites either occurred before or after transport, but not during. If the period of alteration were to occur during the period of fluvial activity, we would expect to see a transition within the stratal succession from unaltered to altered material (i.e., the stratigraphy of the deposit does not record the progressive chemical weathering of the catchment) [3]. It is worth noting that the dust cover ubiquitous in this region of Mars which makes conclusive interpretations about mineral composition of rocks in this area difficult to make. The absorption features noted here are close to the magnitude of statistical noise, however given the consistency between each spectrum, we contend this is issue does not affect the results presented here.

5. Future Work

We intend to do further robust analysis of the reflectance characteristics present in each of the exposed strata by testing for lateral continuity, and to sample other exposed strata using tailored parameter maps to test for clay-end member variability across the whole exposure. The identification of similar mineral assemblages in the stratigraphy of the Eberswalde deposit has broader implications for our understanding of the Eberswalde fluvial system as discussed above, so we will also analyze the spectral characteristics of the fluvial catchment and use mineral assemblage characteristics observed in the deposit as a basis for comparison. With a more sophisticated understanding of the subtle changes in mineralogy throughout both the catchment and the deposit of the Eberswalde fluvial system, we hope to inform broader unresolved questions, such as whether or not the clays are detrital or authigenic, the formative climate, and fluvial activity residence time.

Acknowledgements

CMH acknowledges helpful discussion from Ben Cardenas, Katelyn Frizzell, Kathleen Hoza, Christina Seeger, and the rest of the Western Washington University Martains.

References: [1] Poulet F., et al., (2014) *Icarus, 231*, 65-76. [2] Milliken R. E. and Bish D. L., (2010) *Phil. Mag., 90*, 14-28. [3] Goudge T. A., et al., (2015) *JGR: Planets, 120*, 775-808. [4] Murchie S., et al., (2007) *JGR: Planets, 112*, E5. [5] McEwen A. S., et al., (2007) *JGR: Planets, 112*, E5. [6] Malin M. C., et al., (2007) *JGR: Planets, 112*, E5. [7] Bishop J. L., et al., (2008) *Clay Minerals, 43.1*. . [8] Kokaly et al., (2017) *USGS Spectral Library Version 7: USGS Data Series 1035, 61.*

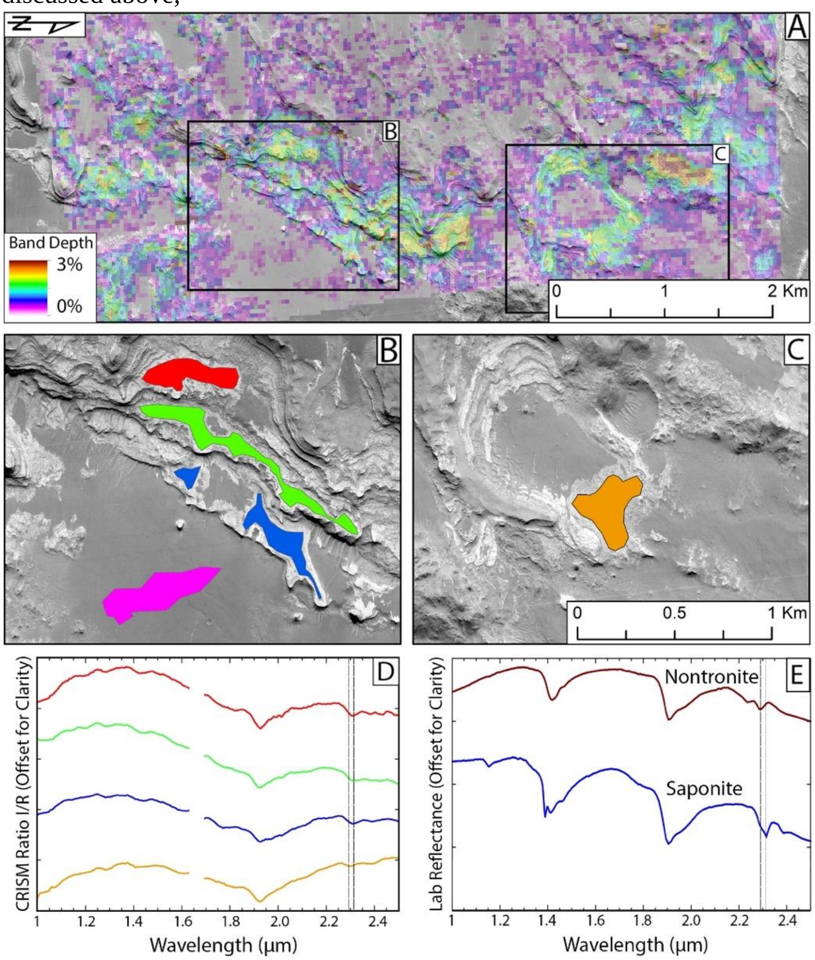

Fig. 1: (A) HiRISE observation ESP_047119_1560 with CRISM hydration parameter map BD1900R2 overlain. Colors correspond to water absorption band depth at the 1.9 µm wavelength expressed as a percent. Insets correspond to labeled panels. North is indicated and is consistent for all maps. (B) Same HiRISE observation as (A) with three of four ROIs on stratal surfaces overlain (red, green, and blue). Magenta ROI indicates the region with a bland spectral signature used to ratio other ROI spectra. (C) Same as (B) with the remaining ROI in orange. Spatial scale is the same for (B) and (C). (D) Ratioed ROI spectra from 1 µm to 2.5 µm. Spectra are ordered according to their inferred place in deposit stratal succession with oldest displayed in orange and youngest in red. Dashed vertical lines correspond to the absorption features for nontronite and saponite shown in (E). (E) Example laboratory spectra of relevant minerals. Laboratory spectra are from the USGS spectral library [10].