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An Investigation of Hydrated Minerals in Jezero Crater

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Abstract

Jezero, an impact crater located in NE Syrtis is home to a large diversity of alteration minerals and fluvial features. The current study aims to map the abundance of rock-bearing mafic minerals in the region and analyze them with the estimated surface thermal inertia and thereby generate a hydrated mineral potential map. It is seen that the crater is made up of a central LCP unit characterized by higher thermal inertia values when compared to its surroundings which are dominant in Fe-rich phyllosilicates. It is evident from the result that the presence of large amounts of LCP deposits are possibly due to erosion from fluvial activities. The LCP spatial distribution indicates that mineral emplacement might have occurred over the volcanic floor due to flow from the western delta.

1. Introduction

Jezero possesses two inflow channels from its north and west, well represented by the fan deposits formed near the entry points and has a single outflow channel located towards its east draining into Isidis. It is considered as a middle to early Noachian (~3.95-3.97 Ga) paleolake system thought to be shaped by the Isidis basin formation [4]. Such formations provide a favourable geological setting to investigate relationships between alteration mineralogy, associated lithology and fluvial geomorphology. Several researchers have been working to identify hydrated mineral signatures in and around Syrtis Major [1,7]. The present study aims to understand the mineralogical distribution in Jezero crater, associated lithological context and thereby generate a hydrated mineral potential map.

2. Methodology

Mineral Potential Mapping: CRISM TRDR radiance data were preprocessed using volcano scan technique (new McGuire wavelengths) [5] for photometric and atmospheric correction. From the list of spectral summary products generated [8], MAF browse product, obtained using the band combinations OLINDEX3, LCPINDEX2 and HCPINDEX2 set to R, G and B respectively was selected for analyzing qualitative mineralogical abundances of major rock forming mafic minerals.

Thermal inertia (TI) mapping: THEMIS IR RDR datasets were used for brightness temperature estimation. Since the effects of albedo and sun-heated slopes get dissipated through the night and thermal contrast due to particle sizes will be at a maximum, night-time THEMIS datasets were used [3]. TI estimation is done using the Mellon thermal model which uses a 7D lookup table containing values of albedo, thermal inertia, surface pressure, dust opacity, latitude, longitude and time of the day [6]. MOLA elevation and TES albedo layers were also served as additional inputs into the model.

3. Results and Discussions

Fig 1(a) shows the mafic mineral abundance map for Jezero crater. The red regions correspond to regions rich in olivine and other Fe-phyllosilicates. The image derived endmembers from this region show a very good spectral match at 1.4, 1.9 and 2.35µm absorption positions with CRISM library spectra of common Fe-Mg smectites like nontronite and saponite giving SFF spectral matching scores of 0.86 and 0.87 respectively (Fig 1(b)). The result corroborates well with the previous observations of Fe-Mg smectites near the western delta region of the crater [2]. The green and cyan regions indicate regions rich in low Ca-pyroxenes (LCP) supported by the spectral matching (1.5-2.4µm) of image derived endmembers with the library spectra of LCP minerals - enstatite and bronzite with SFF spectral matching scores of 0.847 and 0.852 respectively (Fig 1(b)). It is seen here that the central portion and the rim of the crater are dominated with LCP minerals as opposed to Fe-rich phyllosilicate abundance in other regions.

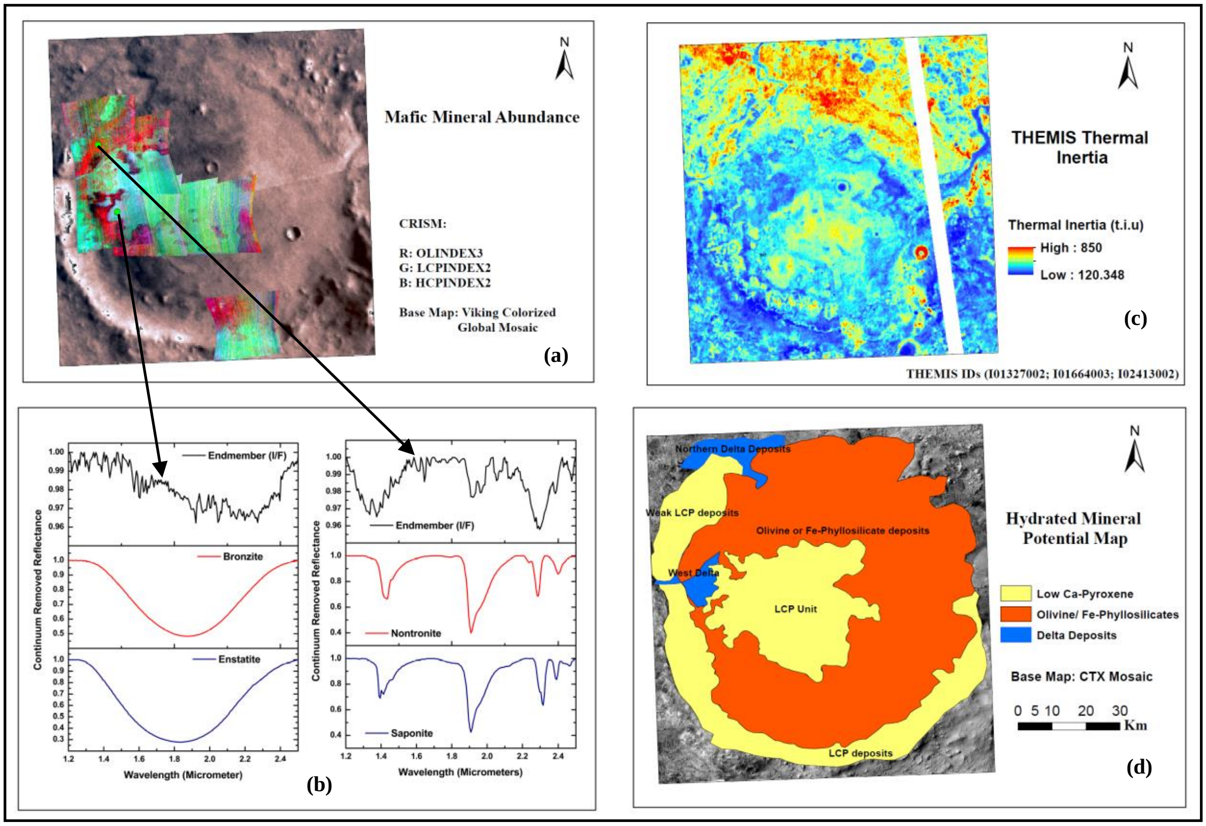

Fig 1 (a) Mafic mineral abundance of Jezero crater (b) Comparison of image derived endmember spectra with CRISM library spectra for mafic mineral abundances (c) THEMIS derived thermal inertia (d) Hydrated mineral potential map of Jezero crater

The fact that hydration in LCP units tends to significantly increase thermal conductivity and hence increase thermal response time is well supported by larger TI values in the central LCP unit when compared to other regions in the crater. Surface thermal inertia observations are found to corroborate very well spatially with observed mineralogical abundances (Fig 1(c)). Fig 1(d) shows the hydrated mineral potential in the region.

4. Conclusions

The large abundances of Fe-phyllosilicates and LCP units as observed in this study support the fact that flowing water has played a key role in shaping the geology and geomorphology of the crater. The presence of large amount of LCP deposits may also indicate that the crater was under constant erosion due to fluvial activities and their spatial distribution also points towards possible emplacement of the minerals over the crater volcanic floor during flow entry through the western fan. The fact that such a hydrologically rich site exists in a basaltic volcanic construct like Syrtis Major is quite intriguing, thereby making this place an interesting one to study on the Martian surface.

Acknowledgements

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References

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