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CaSSIS Observations of Polar and Circumpolar Layered Deposits on the Martian Southern Hemisphere

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Abstract

We show observations by TGO's CaSSIS of exposed layered deposits on the northernmost margin of Mars' south polar cap and in circumpolar craters.

1. Introduction

The orbit of the ExoMars Trace Gas Orbiter, with its 74º inclination, was not designed for observations of the Martian polar regions. However, the massive South Polar Layered Deposits (SPLD), the largest water ice reservoir on the planet, extend up to latitudes of just under 71ºS (Fig. 1). The northernmost margin of the SPLD is part of the Ultima Lingula (UL) formation, which has a longitudinal extent between approximately 130º-220ºE and contains numerous locations with outcrops of the internal SPLD bedding, believed to contain a record of recent climate forced by oscillations of Mars' orbital parameters [1-3]. Despite TGO's orbital limitations from the perspective of polar observations, the location of the UL margin makes it an ideal target for TGO's Colour and Stereo Surface Imaging System (CaSSIS, [4]), given the high frequency of passes over a relatively small area (Fig. 1). In addition, many circumpolar craters around both polar regions contain layered deposits that may be connected to the PLD, and that also store a record of climatic variations [5,6]. Here, we will showcase some of the most impressive observations CaSSIS has made of these deposits over its first year of operations. The high density of observations and the numerous stereo-imaging opportunities will lead to a detailed stratigraphic mapping of the UL and circumpolar crater layered deposits, as well as to a description of the relationship between the PLD and the crater deposits.

2. Example Observations

In the first year of TGO's primary science phase, the CaSSIS team acquired and processed more than 500 images of this area of Mars, many of which feature bedding outcrops in stereo. Fig. 1 shows the orbit tracks of one week of imaging during southern summer on Mars Year 34, along with suggested targets by members of the science team. The density of possible coverage here along the orbital limit, which coincides with the UL margin, has allowed a high number of images with only a year of operations.

An example of a layered exposure inside a crater just south of Richardson crater is shown on Fig. 2. In this location, the SPLD layers seem to blend with a layered deposit within the crater, hinting that the Richardson layered deposit could have been caused by flow of the SPLD during warmer periods of Martian climate. When this image was taken, frost was still visible on the surface, and the dark spots and fans that are a product of the sublimation of the seasonal frost can be identified [10,11], many of them occurring on the brighter exposed layers.

Fig. 3 shows the first CaSSIS DTM of the Polar Layered Deposits draped over a HiRISE and a CTX image. This DTM was used by [3] for depth-series analysis that aided in the detection of a climate signal in UL and in the SPLD as a whole. Here, we show an example of tracing of a "Marker Bed" (defined for the NPLD by [11]) across multiple datasets. With enough images of these exposures at different locations within UL and the SPLD, signal-matching algorithms can be combined with bed-tracing to produce detailed stratigraphy of the polar beds, as well as detect unconformities in the record [12].

3. Conclusion and Future Work

The capabilities of the CaSSIS imager, in combination with the orbit of TGO, provide a unique opportunity for detailed stratigraphic mapping of the UL exposures in a relatively short amount of time. Layer tracing and signal-matching, will be applied to define this stratigraphy for UL, and later combined with HiRISE and CTX observations of exposures elsewhere in the SPLD to identify and correlate

individual beds and bed packets throughout the extent of the SPLD.

4. Figures

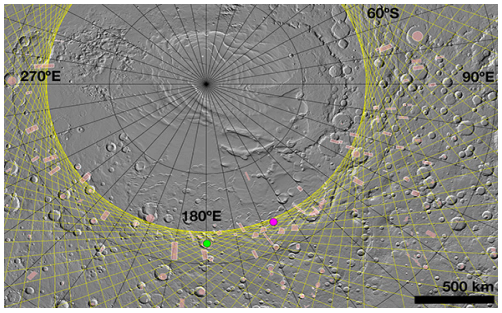

Figure 1. Screenshot of the CaSSIS planning tool (PLAN-C [13]), with the TGO orbit tracks for the first week of Sept. 2018 in polar stereographic projection over the south pole. The background is MOLA shaded relief. Pink stamps are the footprints of CaSSIS target suggestions by the science team. The green dot is the location of the exposure in Fig. 2. The magenta dot is the location of the exposure in Fig. 3.

Acknowledgements

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Figure 2. CaSSIS Image MY34_002091_266_0. SPLD marginal deposits inside a crater overlapping with the south rim of Richardson crater. Frost-covered polar layers are clearly discernible by their differing colours, indicating different amounts of dust in the bed itself or in a draping sublimation lag. The dusty deposit in the center of the image is the crater floor, which lies about 1 km lower in elevation than the darker deposits of the topmost layer of these PLD, on the edges of the image.

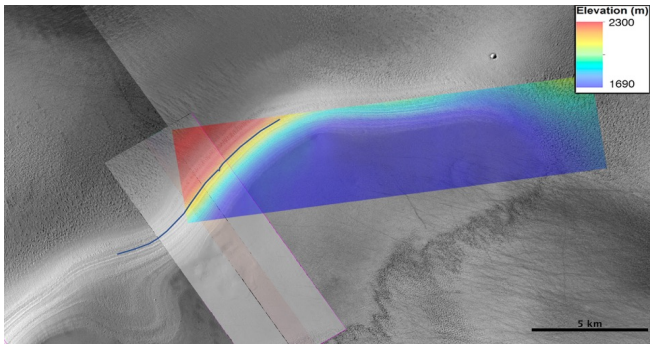

Figure 3. CaSSIS DTM CAS-HMP-MY34_002154_266_1-OPD-01-01. SPLD marginal deposits at the northern edge of Ultima Lingula. The blue line shows the trace of a bed similar in appearance to the Marker Bed of [11], through a CTX image (background), a HiRISE image (ESP_057609_1070), and a CaSSIS composite of the DTM colorized elevation and the image itself in the PAN filter [4].