EPSC Abstracts
Vol. 13, EPSC-DPS2019-1160-2, 2019
EPSC-DPS Joint Meeting 2019

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

A summary of observations by the CaSSIS imaging system onboard ESA's ExoMars Trace Gas Orbiter

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1. Introduction

The ExoMars Trace Gas Orbiter (TGO) was launched on 14 March 2016 and entered Mars orbit on 19 October 2016. The spacecraft reached its primary science orbit (360 km x 420 km; inclination = 74°) on 9 April 2018. TGO carries a high-resolution colour and stereo camera system called the Colour and Stereo Surface Imaging System (CaSSIS). The objectives of CaSSIS are to (1) characterise sites on the Martian surface which have been identified as potential sources of trace gases, (2) investigate dynamic surface processes (e.g. sublimation, erosional processes, volcanism) which may help to constrain the atmospheric gas inventory, and (3) certify potential future landing sites by characterising local slopes (down to ~10 m).

The instrument capabilities include (1) acquisition of images at scales as small as 4.5 m/px, (2) production of images in 4 broad-band colours optimised for Mars photometry, (3) acquisition of a swath up to 9.5 km in width, and (4) acquisition of quasi-simultaneous stereo pairs over the full swath width for high res. digital terrain models. A full instrument description is provided in [1], and details about the ground calibration in [2]. Spectral-image simulations to assess the colour and spatial capabilities of CaSSIS are in [3], with recommended colour display combinations given in [4]. The full payload of TGO is described in [5]. Photometric correction of instrument data is presented in [6].

Current Data Set: CaSSIS has been acquiring data regularly since 28 April 2018. A planet-encircling dust event limited surface visibility between mid-June and the end of August 2018 with steady improvement in atmospheric transmission thereafter. Initially only targets along the ground-track could be acquired, but starting in September 2018, targeted observations began by rolling the spacecraft up to 5°. The number of acquisitions per day strongly depends on data rate and the imaging mode used, but typically 16 images per day are acquired of which roughly half are stereo pairs. TGO is not in a Sun-synchronous orbit and hence image mode choices are optimized to account for the specific lighting conditions. Between 8 Sept 2018 and 29 Dec 2018 alone, 2354 images were attempted (a stereo pair counts as 2) with a 90.5% completion rate. A wavelet data compression scheme is available providing both lossless and lossy compression. Lossless compression currently averages a compression ratio of about 1.75:1. Lossy compression factors of up to 6 have been used with no obvious loss in image quality. Errors in the rotation mechanism have been evident since 9 Mar 2019 that are currently restricting use of the mechanism to produce stereo pairs. However, more than 1400 stereo pairs have so far been acquired. The data are currently being prepared for release through ESA's Planetary Science Archive.

2. Examples of Observations

CaSSIS has proven to be extremely useful in identifying light-toned deposits. An example is shown in Figure 1 which was acquired in Terra Cimmeria SE of Ma'adim Vallis. The BLU filter of CaSSIS is acquired as standard and is used in combination with the PAN and either the RED or NIR filters to produce colour products. In Figure 1, the colour stereo pair is shown and provides information on topography and stratigraphic relations. The light-toned material appears over a range of elevations. The craters also show windtails of dust that is of slightly different colour indicating a prevailing direction.

Figure 1 Light-toned deposits in the Terra Cimmeria region SE of Ma'adim Vallis.

Figure 2 shows an observation from the Cydonia region. Gullies have formed and, at their bases, we see evidence of debris flows or rock avalanches. The bright blue colour in CaSSIS images is usually evidence of basaltic/ferrous-bearing materials and may not be related to the gully formation.

3. Summary and Conclusions

CaSSIS is proving to be a very capable colour imager for revealing diversity on the surface of Mars. The non-Sun-synchronous orbit is providing opportunities for comparisons with previous imagers that have fixed lighting conditions (particular at low angles). The stereo capability (although currently suspended) has already provided remarkable products and are currently being regularly turned in the local digital terrain models for analysis [7].

Figure 2 Observation MY34_005601_141 showing gullies in a crater with clear evidence of material flow into the base of the crater.

Acknowledgements

The authors thank the spacecraft and instrument engineering teams for the successful completion and operation of CaSSIS. CaSSIS is a project of the University of Bern funded through the Swiss Space Office via ESA's PRODEX programme. The instrument hardware development was also supported by the Italian Space Agency (ASI) (ASI-INAF agreement no.I/018/12/0), INAF/Astronomical Observatory of Padova, and the Space Research Center (CBK) in Warsaw. Support from SGF (Budapest), the University of Arizona (Lunar and Planetary Lab.) and NASA are also gratefully acknowledged.

References

[1] Thomas, N. et al. (2017) Space Sci. Rev., 212, 1897. [2] Roloff, V. et al. (2017) Space Sci. Rev., 212, 1871. [3] Tornabene, L.L. et al. (2018) Space Sci. Rev., 214, 18. [4] Tornabene, L.L., et al. (2019) Mars 9 Conference [5] Vago, J., et al. (2015), Solar System Research, 49, 518-528. [6] Pommerol, A. et al. (2019) Mars 9 Conference [7] Simioni, E. et al. (2019) this conf.