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CaSSIS – First images from science orbit

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Abstract

CaSSIS (Colour and Stereo Surface Imaging System) is the main imaging system for the ExoMars Trace Gas Orbiter (TGO) mission. The instrument was completed in October 2015 and launched in March 2016 [1]. This abstract describes the current status of CaSSIS and provides a first assessment of its observations from the start of the primary science mission.

1. Introduction

The objectives of CaSSIS are to (1) characterize sites 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 characterizing local (down to ~10 m) slopes.

The technical aims foreseen were to (1) acquire imaging observations at a scale of <5 m/px, (2) produce images in 4 broad-band colours optimized for Mars photometry, (3) acquire a swath width >8 km, and (4) obtain quasi-simultaneous stereo pairs over the full swath width for high res. digital terrain models. These, combined with programmatic constraints, drove the design. The concept was discussed at EPSC in 2014 [1]. A full instrument description has been provided [2]. Details on the on-ground calibration of the instrument are provided in [3]. Spectral-image simulations to assess the colour and spatial capabilities of the instrument are shown in [4]. The full payload is described in [5].

CaSSIS was first switched-on on 7 April 2016 just over 3 weeks after launch and the first images of Mars in the Mars Capture Orbit (MCO) were acquired on 22 November 2016. CaSSIS was switched off during the aerobraking phase but re-booted on 20 March 2018. A flight software update was completed and transition to nominal imaging was made in April 2018. This paper will report on the latest imaging and show examples.

2. Observations

CaSSIS can acquire up to 3 compressed images per orbit. The number of images is controlled by the total data volume allocation and the time needed to compress. The time of passage of the spacecraft over the nightside is usually used to compress. The lossless compression gives a typical compression of 1.75:1. In the early phase of the mission, the data volume is such that high compression ratios (CR) are not normally needed and CR values of 3 are usual producing very high quality data. At times of very high data volume, raw uncompressed data can be obtained which may also be useful for calibration purposes.

In a typical one-week cycle at high data rate, CaSSIS will acquire around 100 targets. In our current observing plans, roughly half are acquired in stereo. The instrument has experienced some glitches such that imaging has not been continuous in the first weeks but the situation has been improving as more experience has been gained with commanding and control. At the time of writing, roughly 75% of the images are being acquired as planned. A further flight software update is expected to resolve several of the outstanding issues.

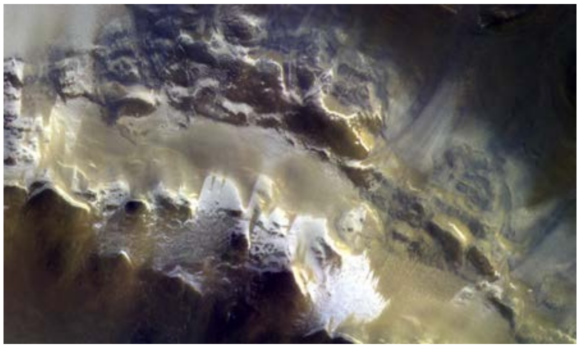

Figure 1: Image of the rim of Korolev crater produced by combining the RED, PAN, and BLU channels of the CaSSIS image.

The image of the rim of Korolev crater (Figure 1) shows an example from the first medium term plan (MTP001). The image is a colour-composite using the RED, PAN, and BLU channels and was produced using ISIS3 and SPICE kernels that have now been optimized to account for instrument distortion and the telescope rotation mechanism. It is expected that production of these types of products will shortly become routine. Further improvement in the flat-field and bias subtraction are also to be expected.

Image acquisitions so far have been of a wide variety of target, although southern polar targets have been taken more frequently because of the current L_s (start of southern spring). Targets thus far have included layering in Terby crater (Figure 2), exposed layers in Hebes Chasma, dune fields in Herschel crater, and exposed bedrock in the southern highlands. Under clear conditions, the images acquired at 4.5 m/px are sharp and provide good contrast in PAN, RED and NIR. As expected the data in the BLU channel have the lowest signal to noise (SNR) but nonetheless provide good data. Binning of the BLU to 2x2 may become a standard mode for future observations to ensure good SNR.

The stereo pairs acquired so far have been reasonably well aligned despite the image timing not being finalized at this stage. Results from these first stereo acquisitions will be reported elsewhere.

3. Summary and Conclusions

The CaSSIS images under reasonable illumination conditions are of high quality. Both the colour and stereo capabilities of CaSSIS have been demonstrated in the initial phase. We expect CaSSIS to play an important role in investigations of surface properties over the coming years.

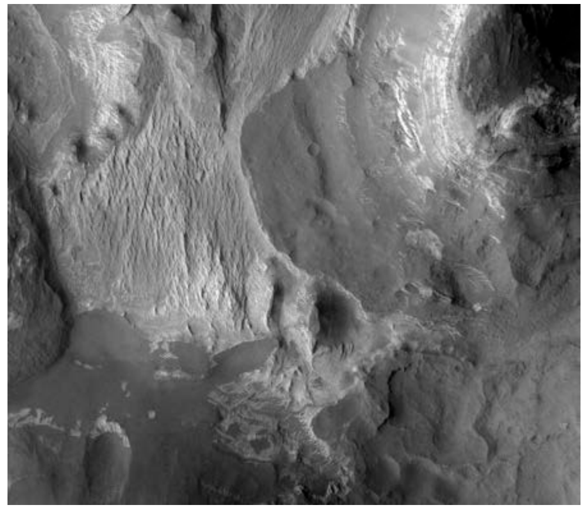

Figure 2: RED channel image of a part of Terby crater.

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