THE EFFECTS OF PAST AND CURRENT GEOLOGIC PROCESSES OBSERVED BY THE CASSIS IMAGER ONBOARD ESA'S EXOMARS TRACE GAS ORBITER. N. Thomas[1], G. Cremonese[2], J. Perry[3], M. Almeida[1], M. Banaszkiewicz[4], J.N. Bapst[3], P. Becerra[1], J.C. Bridges[5], S. Byrne[3], S. Conway[6], V. Da Deppo[7], S. Debei[8], M.R. El-Maarry[9], A. Fennema[3], K. Gwinner[10], E. Hauber[10], R. Heyd[3], C.J. Hansen[11], A. Ivanov[12], L. Keszthelyi[13], R. Kirk[13], W. Kofman[4], R. Kuzmin[14], A. Lucchetti[2], N. Mangold[6], C. Marriner[15], L. Marinangeli[16], M. Massironi[17], G. McArthur[3], A.S. McEwen[3], C. Okubo[13], P. Orleanski[3], M. Pajola[2], A. Parkes Bowen[5], M.R. Patel[15], A. Pommerol[1], G. Portyankina[18], R. Pozzobon[17], M.J. Read[1], C. Schaller[3], P.-A. Tesson[3], L. Tornabene[19], S. Tulyakov[20], P. Wajer[4], P. Witek[4], J. Wray[21], and R. Ziethe[1*].
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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: the Colour and Stereo Surface Imaging System (CaSSIS) [1]. 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) that 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 acquisition of images (1) at scales of ~4.5 m/px, (2) in 4 broad-band colours optimised for Mars photometry, (3) with swathes up to 9.5 km in width, and (4) with quasi-simultaneous stereo pairs over the full swath width for high res. digital terrain models. A full instrument description is provided in [2], and details about the ground calibration in [3]. Spectral-image simulations to assess the colour and spatial capabilities of CaSSIS are in [4], with recommended colour display combinations given 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. Initially only targets along the ground-track could be acquired, but from Sept. 2018, targeted observations began by rolling the spacecraft up to 5°. Typically 16 images per day are acquired of which roughly half have been stereo pairs. TGO is not in a Sun-synchronous orbit and hence image mode choices are optimized to account for the specific lighting conditions. A 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.

Example observations: There are now over 5500 successful observations in the CaSSIS database. 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. Here are three examples showing evidence of past and present geologic activity.

Mawrth Vallis has been proposed as a candidate landing site on several occasions and significant work has been performed in support of this [7]. The region contains some of the largest outcrops of phyllosilicate-rich rocks on Mars and exhibits numerous light-toned clay-rich units [8]. CaSSIS observations reveal some of these light-toned deposits at full resolution (Figure 1) and concurrent stereo imaging of several sites has also been acquired which should place stricter constraints on, for example, the stratigraphic relationships identified by Loizeau et al. [8]. In Figure 1, the light-toned blue deposits are clearly evident and in the stereo image, their relationship to the capping material is visible. The stratigraphic relationship is not, however, straightforward to interpret. For example, the incising channel reveals light-toned material at different elevations from close to the base of the channel to just underneath the highest levels in the image.

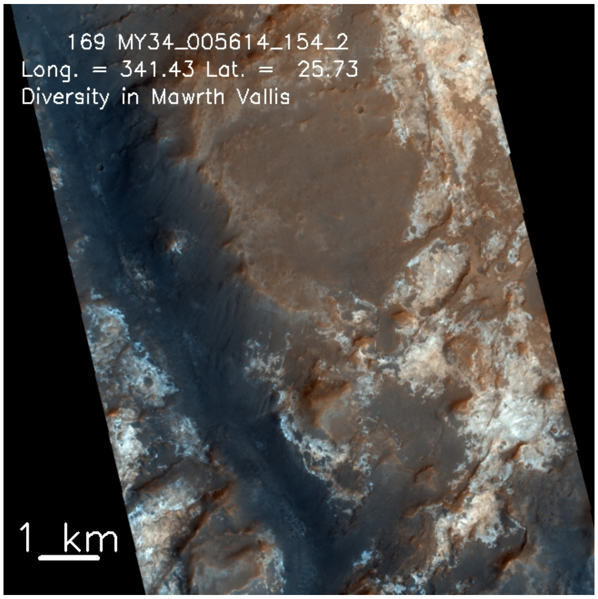

Figure 1 Image MY34_005614_154 of Mawrth Vallis (341.4E, 25.73N).

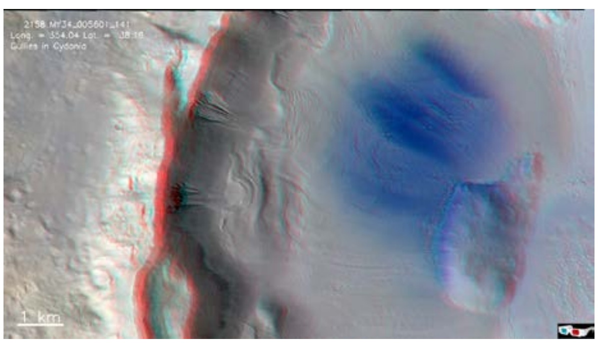

Figure 2 Image MY34_005601_141. Gullies in a crater wall in the Cydonia region. Material is evident from landslides at the base. This is a stereo anaglyph.

In Figure 2, we see an example of the use of stereo imagery. Gullies are evident in the crater wall and, at their bases, we see evidence of debris flows or rock avalanches. The bright blue colour is usually evidence of dust deposits in CaSSIS images and may not be related to the gullies. The anaglyph shows the pile up resulting from the landslide. A digital terrain model could be used to determine the total mass removed.

An example of CaSSIS observations of currently active processes is given in Figure 3 which shows dunes in Hale Crater. Dust has collected in a couple of small areas around the crater rim. The stereo pair shows that some material has accumulated around the degraded rim and has also formed barchan-like dunes on the slope descending into the crater bottom.

CaSSIS observations of slope streaks [9], south polar layered deposits [10], Ladon basin [11], south polar fan activity [12] and the ExoMars landing site are also being presented at Mars 9 and/or EPSC. The data are being released through ESA's Planetary Science Archive.

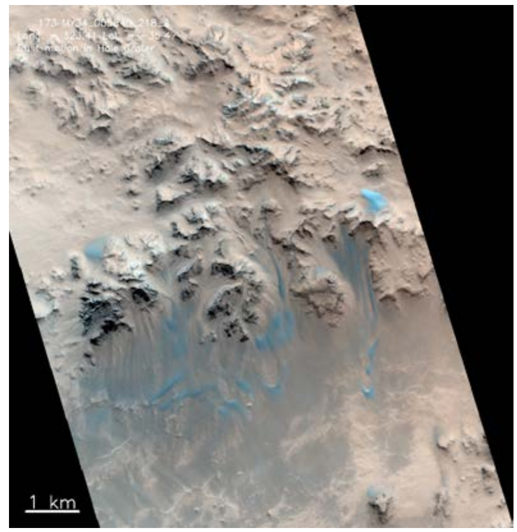

Figure 3 Rim of Hale crater (MY34_005640_218) showing material producing barchan-like structures (particular evident on the right hand side of the image in blue).

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