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FIRST CaSSIS OBSERVATIONS OF RSL: IMPLICATIONS FOR THEIR ORIGIN AND EVOLUTION

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Abstract

Recurring Slope Lineae (RSL) are narrow, dark features that source from bedrock outcrops and incrementally lengthen down warm Martian steep slopes [1]. In general, most RSL form when temperatures are warm, typically in local spring and summer, fade in cold seasons, when temperatures drop, and recur annually in the same locations [1]. Multiple models have been proposed to explain their origin, but a definitive explanation is still missing. The temperature dependence of RSL activity and their spatial correlation with multi-scale fractures [4] suggests that they may originate from liquid triggered flows [1,2,5,6,7], possibly powered by groundwater sources [4,6,7] while other studies favoured dry mechanisms involving granular flows or dust [3,8-11]. In this abstract we report the first RSL observations performed with the Colour and Surface Stereo Imaging System (CaSSIS, [12]) on board the ESA ExoMars Trace Gas Orbiter mission (TGO), which provides colour images of the surface of Mars in four bands at a resolution of 4.6 m The 74° inclined orbit of TGO allows CaSSIS to image a given location of Mars at different local times, providing the unique opportunity of imaging RSL sites in the morning. These observations are of critical importance in understanding the nature of RSL, indeed: if these features are related to liquids (i.e. via deliquescence), then they should be more stable in the morning and we should see an increased RSL activity. On the contrary, no differences between morning and afternoon observations are expected for dry models.

Dataset

We retrieved all RSL sits imaged by CaSSIS, matching the dataset of [2] with the footprints of all CaSSIS images acquired to date (≈5000). For the 22 matched sites, existing HiRISE images were inspected to visually assess if RSL were big enough to be resolved by CaSSIS. From this survey, we could observe RSL in four sites located in the central peak of Hale crater, Horowitz crater, Coprates Chasma and in Ganges Chasma. The biggest identified ones are those present in Hale crater, Fig (1). This site is the most interesting for our analysis, because it has a CaSSIS observation performed at 11 AM local time and in stereo mode. In addition, this location had a HiRISE image acquired just one month earlier, making it an ideal target to study surface changes not associated with seasonal processes.

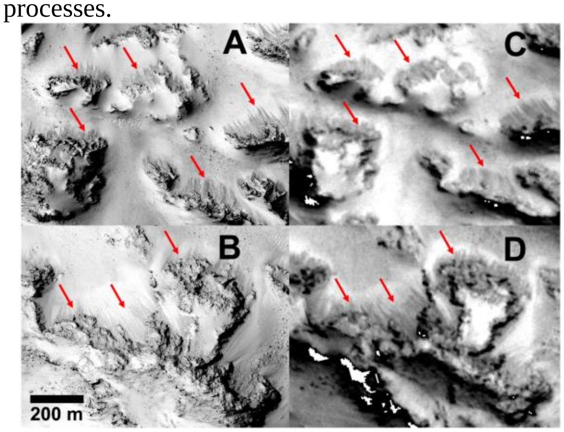

Figure 1 *A) and B) Examples of RSL (red arrows) from HiRISE image ESP_058619_1445. C) and D) corresponding ones in the CaSSIS orthoimage.*

Methodology

From the CaSSIS stereo pair, we obtained a DTM and orthophoto of the overlapping region using the 3DPD photogrammetric pipeline developed in the Padua observatory [14]. We downloaded a HiRISE DTM for the region of interest, and aligned the HiRISE image, DTM and the CaSSIS orthophoto using the georeferencing tool in ArcGIS. We then compared the RSL identified in the HiRISE image (Fig. 2), with their counterparts in the CaSSIS orthoimage. To better assess surface changes, we also compared the CaSSIS orthoimage with the HiRISE images resampled at the resolution of CaSSIS (4.6 m). We then mapped the areal extent of RSL that showed a surface changes between the two datasets. Since the CaSSIS images have a lower spatial resolution, the terminal parts of most RSL and the smallest lineae are not resolved, hence their areal extent is underestimated. As a consequence, the same RSL-covered area is systematically smaller in CaSSIS images. In order to minimize this bias, we used the resampled HiRISE images to measure RSL areas for the afternoon image. Finally, from the HiRISE DTM we obtained a slope map using the algorithm of [13]. An example of this procedure is provided in Fig. (3).

Results

We analysed the first morning observations of RSL performed by CaSSIS and compared them with HiRISE ones acquired, just 1 month before, in the afternoon. In general, we do not observe wide surface changes between the two images, although the smallest RSL could be unresolved. In those few sites where changes occurred, RSL lengthened until reaching slope angles near 28-30°, in agreement with those already found by [9], hence typical of granular flows [9]. On the contrary, RSL that had already reached slopes near 28-30° in the HiRISE image, acquired 1 month before, remained static. Such behaviour is more consistent with flows of granular material rather than with the deliquescence of salts or water flows. In addition, the RSL observed through CaSSIS are restricted to the same slopes where they are observed with HiRISE, while a more pervasive activity on all available slopes should be expected in case of deliquescence. To conclude, this preliminary analysis seems to indicate a limited role of deliquescence and water in RSL formation in Hale crater, in agreement with what already proposed by other authors [9,10]. More observations and extensive mapping are needed to corroborate this hypothesis.

Acknowledgments

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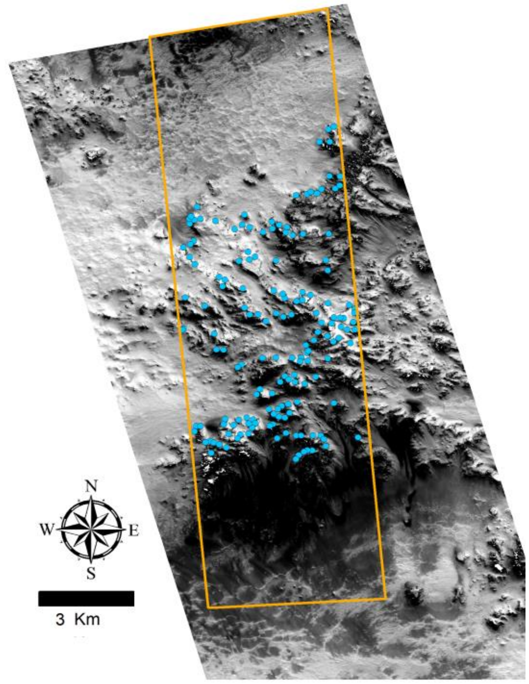

Figure 2 *CaSSIS image of Hale crater central peak. Cyan dots indicate RSL sites identified in the HiRISE image ESP_058619_1445. The orange polygon depicts the footprint of the HiRISE image.*

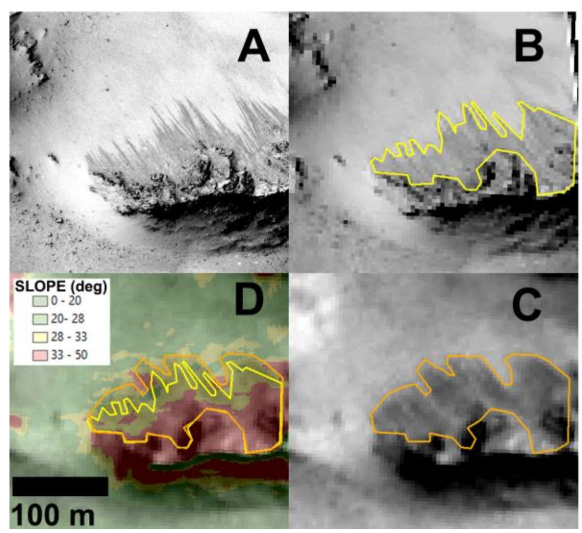

Figure 3 *Example RSL surface change mapping. A) RSL site in HiRISE image ESP_058619_1445. B) Approximate mapping of the area covered by RSL in the resampled HiRISE image. C) Approximate mapping of RSL area in CaSSIS image. D) Mapped areas shown in a slope map obtained from the HiRISE DTM.*