Multiband photometry of Martian Recurring Slope Lineae (RSL) and dust-removed features at Horowitz crater, Mars from TGO/CaSSIS colour observations

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Introduction: Recurring Slope Lineae (RSL) are narrow dark streaks that incrementally lengthen down Martian warm steep slopes [1]. The first RSL observations [1-4] highlighted that their activity occurred during warm seasons and that RSL completely disappeared during winter and recurred annually. This temperature dependence suggested that RSL may be related to flows of liquid water or brines [1-5], possibly fed by groundwater sources [6, 7] or from the deliquescence of hygroscopic salts [8]. However, subsequent extensive and widespread RSL monitoring detected observational evidences incompatible with a water or brine-related origin. Correlations between RSL activity and surface dust, RSL length and surface slope and contemporary RSL lengthening and fading led authors to interpret RSL as dry granular flows [9-12], possibly related to aeolian processes [13, 14]. Although a detailed explanation of the RSL nature and triggering mechanism is still not complete, the latest evidence points further toward a dry mechanism [15].

Here, we investigate the colour properties of RSL at Horowitz crater, Mars, through 4-filter images taken by the Colour and Surface Science Imaging System (CaSSIS, [16]). This location was chosen because it hosts large RSL, resolvable by CaSSIS, and it also hosts dust-devil tracks (DDTs), which are typically dark marks left by the passage of whirlwinds, and regions where thin sheets of surface dust has been partially removed ("dust poor" regions, DPs). Since DDTs and DPs are known as being formed by dust removal and the exposure of underlying, typically ferrous material [17] the comparative colour information provided by CaSSIS may help us understand whether RSL are consistent with dust removed features too. This would contribute to show that RSLs are indeed dry flows of dust and sand. Our comparative photometry is then supported by a photometric modeling approach.

Methodology: We compute the relative reflectance of RSL, DDTs and DPs in the NIR (936.7 nm), RED (836.2 nm), PAN (675.0 nm) and BLU (499.9 nm) BLU CaSSIS filters by ratioing the average I/F within several RSLs, DDTs and DPs regions of interest (ROIs) (Fig. 1D, E) with the average I/F of nearby ROIs with similar illumination conditions [11,12]. In our calculations, we apply a first order atmospheric correction by subtracting the I/F of the darkest pixel of each filter before

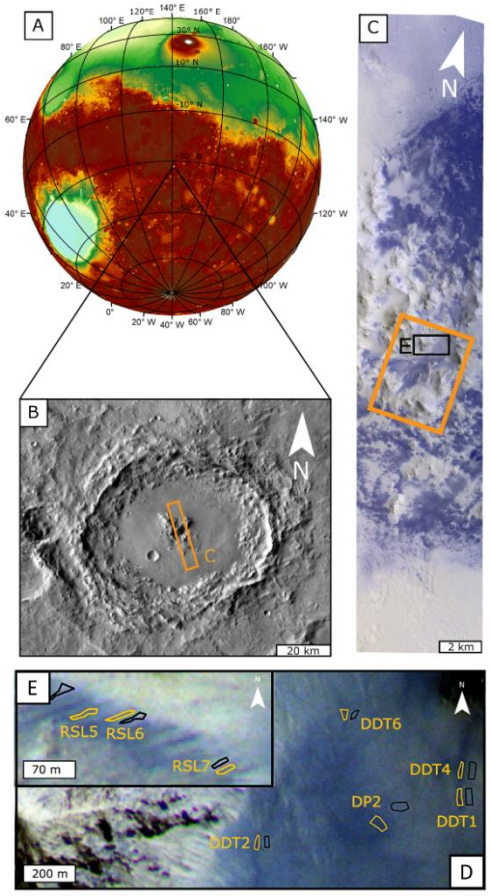

Fig. 1 A) Globe of Mars in colorized elevation showing the location of Horowitz crater. B) Location of the CaSSIS image MY34_005696_214_0 and C) Colour composite of the NIR, PAN and BLU filters. D, E) Closeup view of some examples of RSL and DDTs in this region.

computing the relative reflectance [16,17,18]. The relative albedo profiles are then compared with photometric models of dust deposition derived from the laboratory experiments of [19] and with mixtures of wet and dry Martian terrain simulants derived from [20].

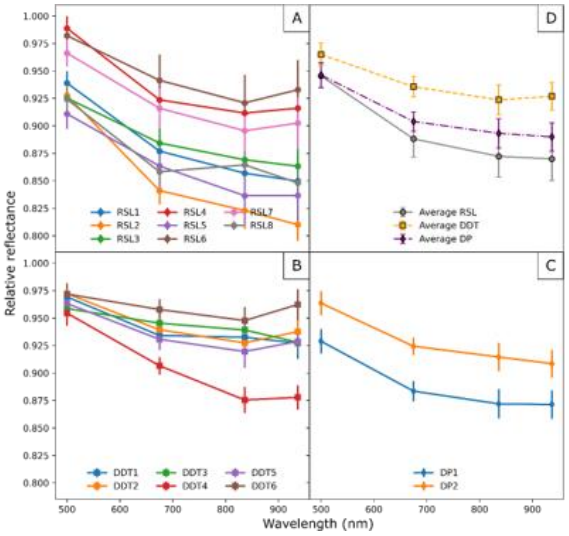

Fig. 2. Relative reflectance of A) RSL B) DDTs and C) DP ROIs with respect to nearby materials and D) corresponding average profiles.

Results: RSL, DDTs and DPs have similar relative reflectance profiles (Fig. 2A, C) within errors, i.e., they are all brighter in the BLU than in the PAN, RED and NIR filters (Fig. 2D). While there is some variability in the latter three bands, there is no significant spectral features that characterize either RSL or DDTs or DPs. In addition, photometric models of dust fallout provide significantly better fits than mixtures of dry and wet Mmrtian soil simulants (Fig. 3).

Discussion and conclusions: The comparison between relative photometry of RSLs, DDTs and DPs show that they have qualitatively similar relative reflectances in the CaSSIS filters, suggesting that they may have a similar origin. In particular, the higher BLU with respect to PAN, RED and NIR relative reflectance may suggest that the reflectance profiles of both features could be consistent with a ratio between a ferrous material (numerator), exposed by the removal of a ferric surface material such as the Martian dust (denominator). This picture is quantitively supported by comparison with photometric model of dust fallout, that consistently provide better fits to the observed relative reflectances than mixtures of dry and wet Martian soils.

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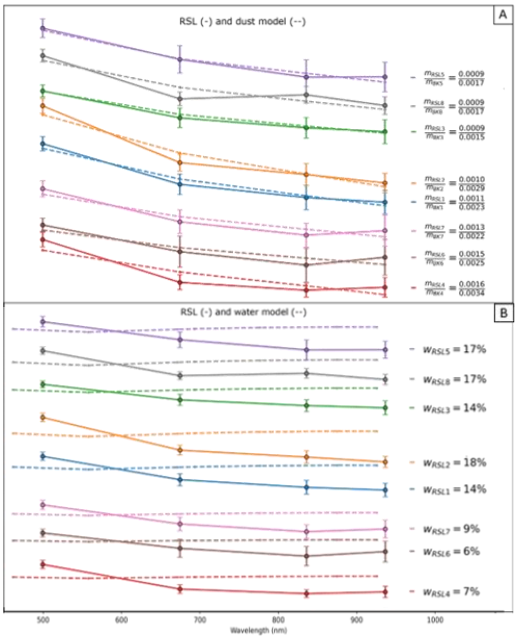

Fig. 3. A) RSL and best-fit dust fallout models. The legend reports the estimated dust content (g/cm^2) for the RSL (numerator) and corresponding nearby material (denominator). B) RSL and best-fit water models. The legend reports the best-fit water content (%).

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