Geophysical Research Abstracts
Vol. 20, EGU2018-17958, 2018
EGU General Assembly 2018
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Longitudinal striations on Martian long run-out landslides and ejecta blankets: a common formation mechanism?

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The formation of longitudinal ridges and grooves on both Martian and Terrestrial long run-out landslides and the ejecta blankets of some Martian impact craters is a yet unexplained feature. Since it has long been noted that those deposits share many other morphological features like perpendicular graben and compressive ridges, the idea that there might be a common emplacement process gained popularity in recent times. In the light of those findings, we conducted a morphometric study of topographic tracks across longitudinal striations on Martian landslides and DLE and SLE craters to evaluate the possibility of a common formation mechanism. The topography tracks were extracted from DTMs generated from high-resolution CTX ($\sim$ 5 m/px) and HiRISE ($\sim$ 0.5 m/px) data. We decomposed the signal with Fourier analysis and found a power law dependency of power spectral density on wavenumber for all profiles. The data was fitted using a Maximum Likelihood method in the form $S(f) = \gamma + \alpha f^{-\beta}$ (where $S(f)$ is the power spectral density, f is the wavenumber, γ is noise, α is a scaling factor and β the power law exponent). The power law dependence inherently means that the topography of longitudinal striations is scale-invariant, e.g. there is no "characteristic width" that can be used to describe those structures. Instead, the power law exponent can be interpreted as surface roughness, since a higher slope of the power law means greater importance of longer wavelengths. The comparison of the data yielded some interesting relationships: A) the overall range of values for the power law exponent for all deposits is between $\beta = 1.5$ and $\beta = 3.5$. Each deposit has a characteristic, smaller range of values for β. B) the power law exponents of topography tracks in parallel direction to the striation are in the same range as the power law exponents of tracks in perpendicular orientation. However, while topography usually can be well characterized by self-similar fractional Brownian motion, the topography of the studied deposits appears to be self-affine. In other words, the topography in longitudinal direction appears to be an homogeneously scaled version of the topography in perpendicular direction. C) the topography of the terrain surrounding each individual deposit has power law exponents that are again in a close range to the values of profiles across striations. This implies that the roughness of striations is possibly inherited from the substrate of the deposits. D) there is no systematic difference between the power law exponents for landslides or ejecta blankets, or the relationships between longitudinal/perpendicular tracks and the surrounding terrain. It can be concluded that our study does not exclude a common formation mechanism. Therefore the next step of our investigation will be to evaluate whether the self-affine property is compatible with known emplacement mechanisms.