THE MORPHOMETRY OF LONGITUDINAL STRIATIONS ON LONG RUN-OUT LANDSLIDES AND DLE IMPACT CRATERS ON MARS. A. Pietrek[1], S. Hergarten[1] and T. Kenkmann[1], [1]Institute of Earth and Environmental Sciences - Geology, Albert-Ludwigs-University Freiburg, Germany (alexa.pietrek@geologie.uni-freiburg.de).

Introduction: Distinct longitudinal or radial grooves and ridges (henceforth denoted as “striations”) are a shared morphological feature that is frequently observed on the ejecta of SLE (single layer ejecta) craters, DLE (double layer ejecta) craters [1,2,3] and landslide deposits on Mars [4,5,6,7] and Earth [8,9,10]. While their formation still remains enigmatic, it appears to be a fundamental geologic process during the emplacement of mass movement deposits [11]. Striations form in a variety of geologic settings: rock avalanches on glacial substrate [8], Martian rock avalanches [5,6], volcanic debris flows [9] and ejecta flows [2,3] under both dry and wet conditions and with different rock materials. The similarity of striations is a long standing issue [11,12], yet there is no consensus about the formation mechanism. Furthermore, no study focused on rigorous morphometric comparison of the features on different types of deposits. This study concentrates on the comparison of morphometric characteristics of striations and evaluates the possibility of a common formation mechanism.

Methods: Datasets for two Landslides in Valles Marineris (Coprates Labes (292.2°E, 11.8°S) and Ophir Labes (292.3°E, 11.1°S)) and two DLE crater (Steinheim (190.6°E, 54.5°N) and Bacolor (118.5°E, 33.0°N)) have been prepared and evaluated (see Tab.1). CTX DTMs were processed from stereo pairs using the NASA Ames Stereo Pipeline [13]. HRSC DTM products are available from the Freie Universitaet Berlin and the DLR, Berlin. They were used to supplement data for areas not covered by CTX. The substrate topographies were interpolated from the DTM raster values in the area surrounding the deposits with the Nearest Neighbor interpolation function of ArcMap. The true thicknesses of the deposits were obtained by subtracting the substrate topography from the original DTM. Linear profiles were extracted perpendicular to the longitudinal grooves and ridges at equal distances with a sampling interval of 10 m. Ridges and grooves were identified from local maxima and minima in the profiles. Since ridges and grooves show an identical range of values and characteristics in the preliminary evaluation, only ridges were considered for further analysis. The width of ridges was measured between the trough of the grooves on both sides, while the height of ridges was measured between the peak and the middle height of the neighboring grooves. Additionally the spacing of ridges and their slopes were calculated.

Results:

Morphology: The studied landslides can be structured into the following zones: I) a proximal, chaotic, hummocky region partially formed of slump blocks and II) a distal area of laterally spreading, continuous deposits, distinctly marked by longitudinal striations and perpendicular troughs and ridges.

The inner ejecta layer of the studied DLE impact craters can be structured into I) hummocky deposits at the base of the uplifted rim and partially slumped material, II) a ring of continuous deposits marked by radial striations and concentric ridges and troughs, and III) a visibly thickened, bulky zone, which is usually lacks striations in the distal parts [see also 3]. Profiles perpendicular to the striations on both types of deposits show that the longitudinal ridges are distinctly V-shaped.

Morphometry: The values of ridge slopes, heights and widths scatter over a wide range and apparently at random for all datasets. As a result, the focus of this study lies on the distribution of values rather than the

Tab.1: The studied objects are listed by their deposit type. Ridge widths, heights and slopes are given as the range covered by 50-95% of the values (since the lower boundary is limited by definition). These values serve as measure for the general size of striations and should be regarded with care, since the data has an extremely wide scatter.

Name	Type	Area [km²]	Location	Horizontal CTX resolution [m/px]	Ridge/groove widths [m]	Ridge heights [m]	Ridge slopes [°]	Ridge densities [1/ km]	Ridge Height/Total Thickness
Coprates	Landslide	2317.3	11.8°S, 292.2°E	5.1	350-900	14-50	3-10	2-4	0.08
Ophir West	Landslide		11.1°S, 292.1°E	5.1	180-400	5-12	4-8	4	0.04
Ophir East	Landslide		11.1°S, 292.5°E	5.1	100-250	4-9	3-8	6	0.05
Steinheim	DLE Crater	1945.8	54.5°N, 169.3°W	4.8	180-400	8-15	5-11	5-6	0.08-0.18
Bacolor	DLE Crater	6210.2	33.0°N, 118.5°E	5.5	100-200	4-15	5-15	11	0.05-0.1

comparison of absolute or averaged values The distribution of ridge slope, height and width values do not vary considerably within datasets with distance along the flow. Box plots (e.g. Fig.1) suggest that the distribution of values is similar between the datasets of different study objects, although the absolute median values and the range of values differs. Ridge widths and heights do not correlate well and scatter over a wide range of ratios. Slope values of ridges are lower for landslide deposits. For all datasets, slope values follow a normal-Gaussian distribution.

Ridge densities (number of ridges averaged per km over the profile length) vary between study objects and are not clearly correlated to flow thickness, run-out distance or deposit area. Each studied object has a characteristic peak density that stays relatively constant with run-out distance, although Bacolor and Coprates show a slight increase in values in the distal spreading regions of the flow.

Strikingly the ratios between ridge heights and the total thickness of the flow (*RT* ratio) have a similar distribution in all datasets (Fig.1). The median values all center narrowly between 0.05 and 0.1. The ridge height appears to be dependent on the flow thickness. This is especially evident for Coprates landslide. The west part of the flow, with ~ 350-400 m thickness, has over twice the thickness of the eastern part (~ 150-200 m thickness), but has the same distribution of *RT* ratios and similar median values.

Discussion: The main differencebetween striations are the lower ridge slope values for landslides and the general differences in ridge densities. Ridge densities have characteristic values for each study object, but vary greatly. Further studies on additional landslides and ejecta deposits are necessary to determine what controls the values.

The contrast in slope values might be attributed to differences of the emplacement geometry: the studied landslides were unconfined during emplacement and the widening of ridges (and lowering of slopes) by lateral spreading was not inhibited. Impact craters have a radially spreading, continuous ejecta blanket. Lateral spreading cannot exceed lateral flow. The inhibition of lateral spreading therefore might lead to the steepening of ridge slopes.

The apparently random scatter of ridge slope, height and width values over a wide range is a common characteristic of all study objects. The distribution of values appears to be similar in box plots.

The *RT* ratio is surprisingly constant between 0.05 and 0.1 for all study objects, given the high differences in deposit thickness (10-160 m for ejecta deposits and 100-400 m for landslides deposits). This indicates that the height of ridges is controlled by the flow thickness. The values vary more strongly in the moat region of the impact craters, suggesting that the height of ridges cannot adapt to the rapid change in thickness.

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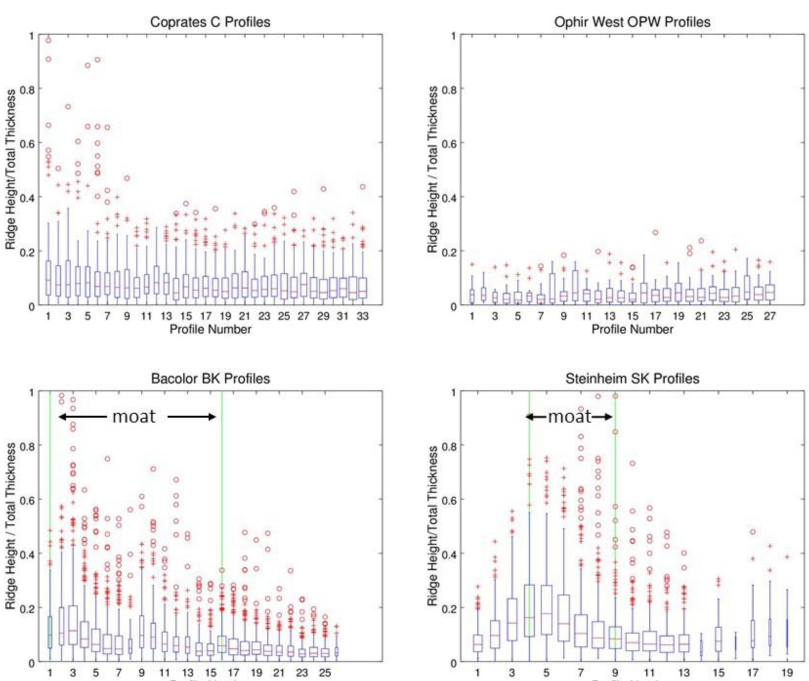

Figure 1: Box plots show the RT ratios of each profile. Upper: The landslides Coprates and Ophir West have very constant distributions with median values ranging narrowly between 0.05 and 0.1. Lower: The radial ridges on the inner impact ejecta deposit of Bacolor and Steinheim have stronger variations of the RT ratio in the thinner moat region , but constant median values of ~0.05-0.1 in the distal zone of the ejecta deposit.