LANDSLIDES IN THE SERENITY CHASMA REGION, CHARON.

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Landslides on Icy Bodies: Landslides have been identified throughout the solar system, and their morphologies provide critical information about the material properties of surfaces. Landslide features have been identified on several icy bodies, including Europa [e.g., 1, 2, 3], Ganymede [e.g., 2, 4], Callisto [2, 5], Dione [6], Tethys [7], Rhea [7], Iapetus [7], Phoebe [8], Miranda [9], Triton [1, 10], and Charon [11].

Temperature changes due to localized flash heating during landslide motion may affect friction coefficients of the landslide material on icy satellites. Evidence for this phenomenon has been found on Iapetus [7]. As the temperature of the landslide ice increases, approaching its melting temperature, the coefficient of friction decreases, causing material to slide further from its source. This process creates long-runout landslides. As summarized in [7], Iapetus landslide geometries suggest that the friction coefficients were as low as 0.1. These values are associated with temperatures near the melting point of H_2O ice.

Landslides can be identified in spacecraft imagery based on their morphologies [e.g., 7]. As discussed in [7], during a landslide event, a concave alcove with a fresh scarp face forms in response to the removal of material along the slope. Additionally, material making up the landslide often exhibits a different texture relative to the surrounding terrain. For example, this texture may appear smoother than the surrounding terrain if the landslide consists of unconsolidated material. Alternatively, the material may appear more blocky than the surrounding terrain if the landslide material is made up of more rocky and consolidated materials. In both cases, the material exhibits a lower cratering density than the surrounding terrain, and it may overprint features (e.g., craters, faults, etc.). Additionally, landslide deposits can be identified based on their lobate tongue shaped fronts and lateral margins.

Testing for Flash Heating: Like other icy satellites, Charon also exhibits landslides [11]. We investigated the hypothesis that flash heating induced friction-reduction occurred within these landslides during motion, similar to landslides on Iapetus. If this hypothesis is supported, then flash heating may be a common process during mass wasting events elsewhere on Charon, and on other outer solar system icy bodies. Although Charon's surface temperature (~53 K) is substially lower than the melting temperature of H_2O ice, mass movement of material may temporarily and significantly increase temperatures.

We estimated the friction coefficients of Charon's landslides by using measured geometries. We used stereo imagery covering Serenity Chasma (this place-name and others in this abstract are informal) to measure the geometries of these features using the Quantum Geographic Information System (QGIS) software [12]. The height of the scarp face from where the landslide material is sourced, termed drop height (H), was compared to the horizontal length of a landslide, termed runout length (L). The friction coefficients can be estimated as the ratio H/L [13]. The calculated values were then compared to those estimated in laboratory deformation experiments of H_2O ice at various temperatures.

Based on laboratory results associated with conditions most similar for Charon's present day surface environment, the friction coefficient of water ice is expected to be within the range of 0.55 - 0.76 [e.g., 14, 15, 16]. Frictional heating has been shown to decrease these values to 0.29 - 0.64 for 223 K ice, and even lower to 0.16 - 0.49 for 263 K ice [16]. Therefore, if flash heating took place during Charon's landslide emplacement, then we expect friction coefficients to be between 0.16 and 0.49.

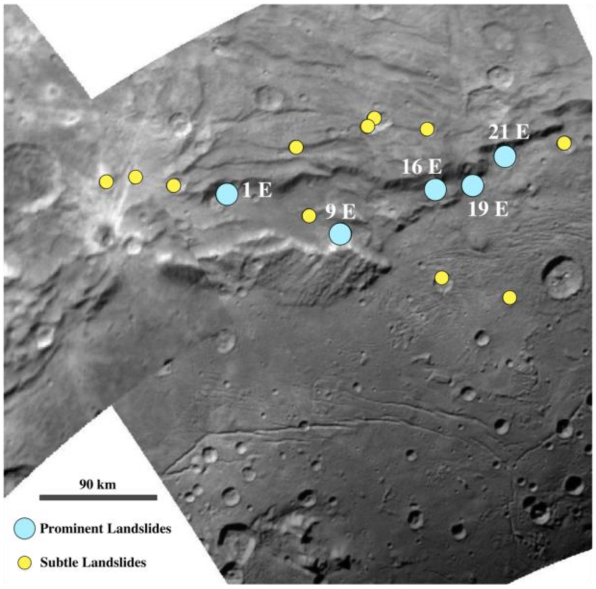

Figure 1: Identified landslides on Charon. The images included in this figure are LORRI images 0299168968 (left) and 0299175682 (right), with image resolutions of 856 m/px and 408 m/px, respectively.

Observations and Data: Based on visual inspection of New Horizons LOng-Range Reconnaissance Imager (LORRI) images, we identified five "prominent landslides” in the Serenity Chasma region. We define “prominent landslides” as landslides that are large enough in available images to be measured. We refer to each landslide based on its longitudinal location (Longitude 1, 9, 16, 19, and 21 E Landslides) (*Fig. 1*).

In addition to these prominent landslides, we also identified "subtle landslides”, which are smaller, and/or covered by lower resolution images than the prominent landslides. Subtle landslides are not suitable for their geometries to be measured. These landslides are located within impact craters and at the bases of small fault scarps.

Longitude 1 E Landslide: This feature is located at 20° N latitude, and consists of at least three lobes of material on the large, south facing wall of Serenity Chasma. The vertical extent of these lobes is 2.8 km from the concave alcove along the associated fault scarp. The maximum runout length of this landslide is 15.7 km. The geometries of the lobes within this landslide infers that the friction coefficient was 0.18 during formation.

Longitude 9 E Landslide: This landslide sits at the base of the large north-facing wall of Serenity Chasma, 65 km to the southeast of the Longitude 1 E Landslide. This landslide is located at 17° N latitude, and is made up of at least four lobes of material, with two overprinting lobes on the eastern end of the landslide. The vertical extent of this landslide is 6.7 km. The overprinting lobe on the east region of the landslide has a runout length of 21.5 km. The geometry of these three lobes suggests that the landslides' friction coefficient was 0.31 during formation.

Longitude 16 E Landslide: The Longitude 16 Landslide is located on Serenity Chasma's south-facing wall, at 20° N Latitude. This feature is made up of at least two lobes of material. The vertical extent of these lobes are 4.5 km in height. The runout lengths of these lobes are similar, with a maximum runout length of 21.3 km. The geometry of these lobes suggests that the landslides' friction coefficient was 0.21.

Longitude 19 E Landslide: The Longitude 19 Landslide feature is also present at the base of the large, south-facing rim of Serenity Chasma at 21° N latitude. This feature consists of a single lobe of material and has a vertical extent of 3.6 km. The runout length is 24.6 km, and the associated coefficient of friction was 0.15.

Longitude 21 E Landslide: This feature is located 25 km east of the Longitude 19 E Landslide, on the same south-facing Serenity Chasma wall. Like the Longitude 19 E Landslide, this feature also exhibits only one observable lobe of material. The vertical extent of this feature is 3.1 km, and the runout length is 17.0 km. Based on these values, the coefficient of friction for material in this landslide was 0.18.

Results and Future Work: The friction coefficients ranged from 0.15 – 0.31 for material in Charon’s landslides (*Fig. 2*). These values are consistent with those of water ice near its melting temperature. Therefore, we find it likely that flash heating took place during landslide implacement in the Serenity Chasma region. These friction coefficients are low compared to most terrestrial and martian landslides and those of Callisto and Rhea. Instead, Charon’s landslides are more similar to the long-runout landslides on Iapetus.

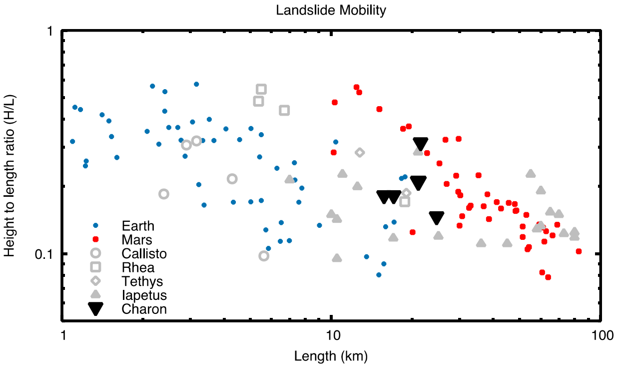

Figure 2: Comparison of landslide geometries on different planetary bodies. Charon’s landslides indicate friction coefficients, given by H/L, that range from 0.15 – 0.31. This figure is an updated version from [7].

Future work will include calculating friction coefficients of Charon’s near surface using exposed normal fault geometries. Friction coefficients inferred from normal fault scarps will provide an *in situ* estimate for Charon’s lithospheric friction coefficient, allowing for a more detailed comparison with landslide inferred values.

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