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LANDFORM EVOLUTION MODELING OF SEDIMENTARY PROCESSES ON ICY WORLDS: THE CASES OF HYPERION AND HELENE

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Sedimentary activity (erosion, transportation and deposition) is a major landscape-shaping process on many icy worlds of the outer solar system for which an understanding of this process is central to their geologic characterizations. Several recent studies, lead by the authors, have identified the effects of sedimentary activity on icy satellite landforms and recognized the role of mass wasting and volatile loss and redistribution in the evolution of these features. We apply state of the art, physics based, landform evolution modeling to icy satellite sedimentary landforms in order to fully quantitatively characterize how their morphologies change with time, and what their present appearances imply for the initial abundance and distribution of loose material, volatiles, and refractories in original pristine landforms. We will present results of our landform evolution modeling to the development of the landscapes of the Saturnian moons of Hyperion and Helene. Our current conclusions for Hyperion are that its unique appearance can be explained in part by the loss to space of ballistic ejecta during impact events. In order to create the smooth surfaces and the reticulate, honeycomb pattern of narrow divides between old craters, appreciable subsequent modification of crater morphology must occur through mass-wasting processes accompanied by sublimation, probably facilitated by the loss of CO_2 as a component of the relief-supporting matrix of the bedrock. This mass wasting effectively destroys small craters, at least in part accounting for the paucity of sub-kilometer craters on Hyperion. Helene's unusual morphology consists of broad depressions (modified large craters) and a generally smooth surface patterned with streaks and grooves. The streaks appear to be oriented down-gradient, as are the grooves. This pattern suggests intensive mass-wasting as a dominant process. Our initial modeling of this surface suggests a Bingham-like rheological behavior for the loose down-slope-moving material. Interestingly, as a Bingham flow, the models indicate that aperiodic "intermittent" behavior to be present, suggesting that periods of quiet steady landform evolution are punctuated short periods of active surface readjustment.

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