Escape erosion and relaxation of craters on Pluto

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Pluto and its major satellite Charon will be the most distant objects ever visited when NASA's *New Horizons* spacecraft flies past them in mid-2015. Both bodies should have suffered impacts from other transneptunian objects, though those impacts are of much lower velocity than typical on giant-planet satellites. *New Horizons* will image the illuminated hemispheres of Pluto and Charon seen at closest approach at better than 0.5 km/pix and 1.0 km/pix, respectively.

We compare new different predictions of the impactor population on Pluto and Charon, including the effects of escape erosion from Pluto, and examine the crater size distributions those impactors would produce over the range observable to the imagers on *New Horizons*. The impact distribution models diverge the most for craters smaller than 10 km.

We expect the crater size distribution on Charon to be determined by the impactor distribution and the rheology of the surface. Inverting the Charon size distribution seen by *New Horizons* will then constrain the overall size frequency distribution in the Kuiper belt, and the location of any break in that size frequency distribution.

However, owing to escape erosion, craters on Pluto may be much more modified than on Charon. To constrain this modification, we present a range of possible Pluto crater distributions, as a function of impactor distribution, atmospheric escape rate, and surface ice viscosity.

Pluto's atmosphere is primarily made of molecular nitrogen and is currently escaping at between 10^{27} and 10^{28} N_2/s according to model estimates. To sustain these escape rates for 3.5 billion years, a global layer of N_2 ice 0.3 to 3 km thick would need to have sublimated from the surface. We show that this gradual mass loss could have erased many of the smaller craters on Pluto, especially craters with diameters smaller than 10 km. This sublimation erosion process does not occur on Charon, which has a water ice surface and no observed atmosphere.

We also show that if the first kilometer of Pluto's surface has a low viscosity similar to pure N_2 ice, then craters larger than 10 km may have significantly relaxed by viscous forces. If so, then large craters on Pluto would have been sufficiently shallow to allow sublimation erosion to erase them as well. As a result, Pluto is predicted to have very few craters larger than 10 km. This compares well with Neptune's moon Triton, which has a similar N_2 ice surface, atmospheric escape rate many orders of magnitude slower than Pluto, and no observed craters larger than 25 km diameter. Craters on Charon's water ice surface would not experience this relaxation, as water ice has a very high viscosity at Charon's surface temperature.

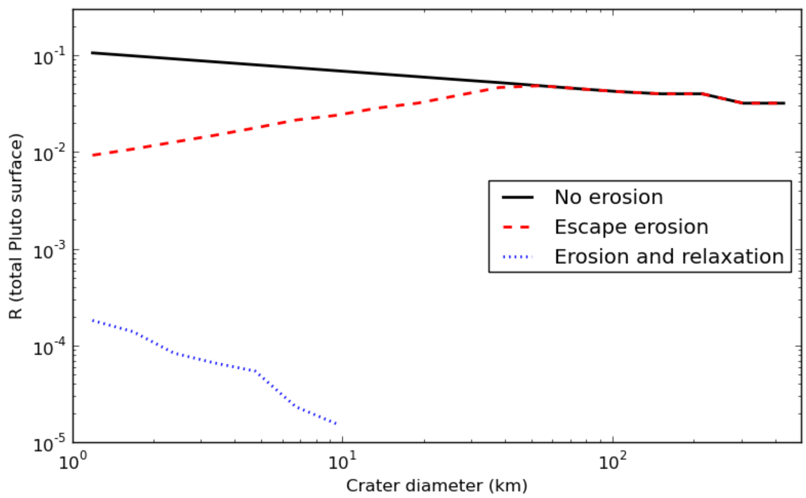

Figure: Possible relative size frequency distributions (R) of craters on Pluto. The solid line represents craters predicted from the impactor flux, the dashed line shows those craters modified by escape erosion, and the dotted line shows the craters relaxed with low viscosity nitrogen ice and modified by escape erosion.