THE SHALLOW SFD SLOPE OF SMALLER (*D* < 10 KM) IMPACT CRATERS ON PLUTO AND CHARON: IMPLICATIONS FOR IMPACTOR POPULATIONS AND TERRAIN AGES

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Introduction: The craters observed during the New Horizons flyby of the Pluto system currently provide the most extensive empirical constraints on the size-frequency distribution of smaller impactors in the distant outer solar system [1-4]. Additionally, some surfaces on Pluto and Charon are likely ~4 billion years old [4-6], thus the crater record provides key information on the size-frequency distribution of KBOs at the end of the accretionary and rearrangement epochs of the early solar system.

Size-frequency distribution slopes: We do not observe large numbers of small craters despite adequate resolution to do so. The size-frequency distribution (SFD) slope is on average close to -3 for craters larger than ~13 km in diameter, but the distribution has a much shallower slope, with an average around -1.6, for craters smaller than this break diameter. We find a significant paucity of small craters ($\lesssim$ ~13 km in diameter). This observation cannot be explained solely by geological resurfacing (as will be discussed in the talk), and implies a deficit of small KBOs ($\lesssim$ 1-2 km in diameter). These shallow SFD slopes at small sizes are more consistent with scenarios of solar system formation where planetesimals grow rapidly to ~100-km-size and experience less collisional erosion, leaving behind fewer small impactors [e.g., 7-8,1].

Crater Populations and Surface Ages: Impact craters on Pluto and Charon also help us understand the surface ages and geologic evolution of the Pluto system bodies. Pluto's terrains display a diversity of crater retention ages, indicating ongoing geologic activity and various styles of resurfacing (both exogenic and endogenic). Charon's informally named Vulcan Planum (Fig. 1) did experience resurfacing, but crater densities suggest this is also a relatively ancient surface with most of the major resurfacing events occurring early in Charon's history.

In this talk we will present results quantifying the crater populations and examine their geologic context. Figure 1 shows a summary of Charon crater data compared with various predictions and models. Although the absolute impactor flux levels carry uncertainty, the closest fit models (the G16 knee model [6] for craters larger than ~13 km and the Z03 model [9]) suggest that the surface of Charon is quite ancient, close to 4 Gyr [2,4].

Figure 1. View of Charon's Vulcan Planum at ~630 m px^{-1}.

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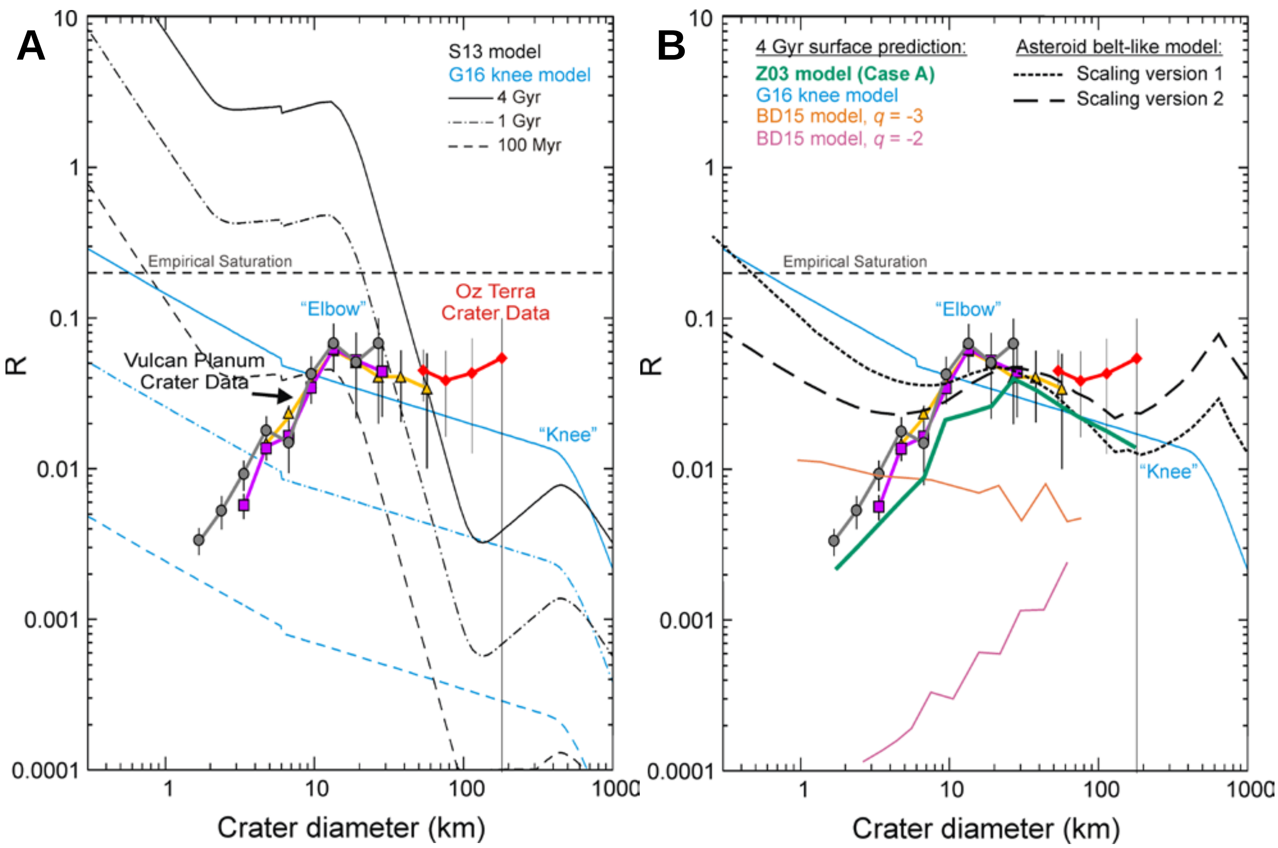

Figure 2. Charon crater SFDs and impactor population models.

(**A**) Charon crater data for two regions, Vulcan Planum (3 image datasets at 622, 410, and 154 m/px, each truncated below a 10 pixel resolution cutoff) and Oz Terra (one image dataset at 865 m/px, truncated for crater smaller than 30 km due to unfavorable lighting [3]). Also shown are predictions for crater populations from two impactor flux models (curves), shown for three different age surfaces [6,10] . The G16 knee model [6] uses observational constraints to set the SFD slope for Kuiper belt objects larger than ~100 km in diameter, and bends to a shallower slope (for all subpopulations) below that size [6,11,12] .

(**B**) The same crater data shown with three other models of impactor flux all for a 4 Gyr old surface [9,13] (the knee model from panel A is included for reference) and two different scalings for a collisional evolution model of the asteroid belt [14,15].

The crater data do not match the slopes predicted from classic collisional evolution models (in which heliocentric collisions among small bodies like asteroids or KBOs produce copious fragments and a wavy distribution with an average SFD slope of approximately -3) and does not look like the asteroid belt at small sizes. Z03 is based on on the young surfaces of Europa and Ganymede and their 4-Gyr prediction most closely follows the shape of the Charon crater SFDs and is similar in overall crater density to the knee model between 20 km $\lesssim D \lesssim$ 100 km [9] . The BD15 predicted crater densities fall about an order of magnitude below the knee model, but the −2 slope inspired by the icy satellite craters again is more similar to that seen for P&C's smaller craters [13] . The P&C crater data are inconsistent with the S13 model, which is calibrated to two occultations of small (d ~ 0.5 km) KBOs [16,17], when converted into Charon crater densities [6] . The slope from the S13 collisional evolution model is generally quite steep and it does not consistently match the P&C crater densities over any diameter range (for any of the 3 surface ages shown).