GLOBAL IMPACT CRATERING RECORD OF SATURN'S MOON DIONE: CONSTRAINING THE GEOLOGICAL HISTORY. M. R. Kirchoff[1] and P. Schenk[2]. [1]Southwest Research Institute, Boulder CO (kirchoff@boulder.swri.edu). [2]Lunar and Planetary Institute, Houston TX (schenk@lpi.usra.edu).

Introduction: Even from *Voyager* imaging, Saturn's moon Dione was recognized to have an interesting and unique geological history recorded on the surface [1-6]. Wispy terrain was identified on Dione's trailing hemisphere, and was tentatively associated with tectonic troughs and ridges identified near the terminator. Furthermore, plains with lower crater densities were also identified and termed "smooth plains." The extent or geologic process behind formation of these terrains, however, was not able to be positively determined from the modest *Voyager* imaging. The *Cassini* ISS cameras have generated higher resolution images and global coverage of several of the Saturnian satellites, including Dione. Analyzing these images will help provide new constraints on the extent and formation of these terrains on Dione and the global geological history. Wagner et al. [7] have initiated examination of Dione's geology with *Cassini* images. They have given a preliminary description and ages of the heavily cratered plains, smooth plains, and wispy terrain, but have not determined the full spatial extent of these terrains, their relationships, or formation processes. Schenk and Moore [8] examined the geology of the smooth plains in more detail, but did not examine their relationship to the other terrains or Dione's global geological history. Here we will focus on the constraints provided by the *global* impact crater distribution on the extent and formation of these terrains, along with the overall geological history.

Methods: The impact crater distributions are compiled from a controlled global mosaic of Dione generated from *Cassini ISS* images (Fig. 1). The global mosaic has a base resolution of 400 m/pixel. Regions of the mosaic that have been (solid outlines) or will be (dashed outlines) used for counting craters are shown in Figure 1. Portions of the surface outside of these regions are not used either because they have a resolution considerably below the mosaic base resolution or have a solar incidence angle that is poor for recognizing craters [see 9]. These regions were also divided into the three different terrains before crater counting began: cratered plains (cp, black), smooth plains (sp, red), and wispy terrain (wt, purple) (Fig. 1). The boundaries of these terrains were subjectively chosen by M. Kirchoff based upon qualitative observations of crater density and surface morphology (e.g., albedo, surface roughness, etc.). In general, cratered plains are distinguished by their relatively higher crater density and lack of any other geological features, smooth plains by their relatively lower crater density and smooth surface appearance, and wispy terrain by their higher albedo and association with ridges and grooves

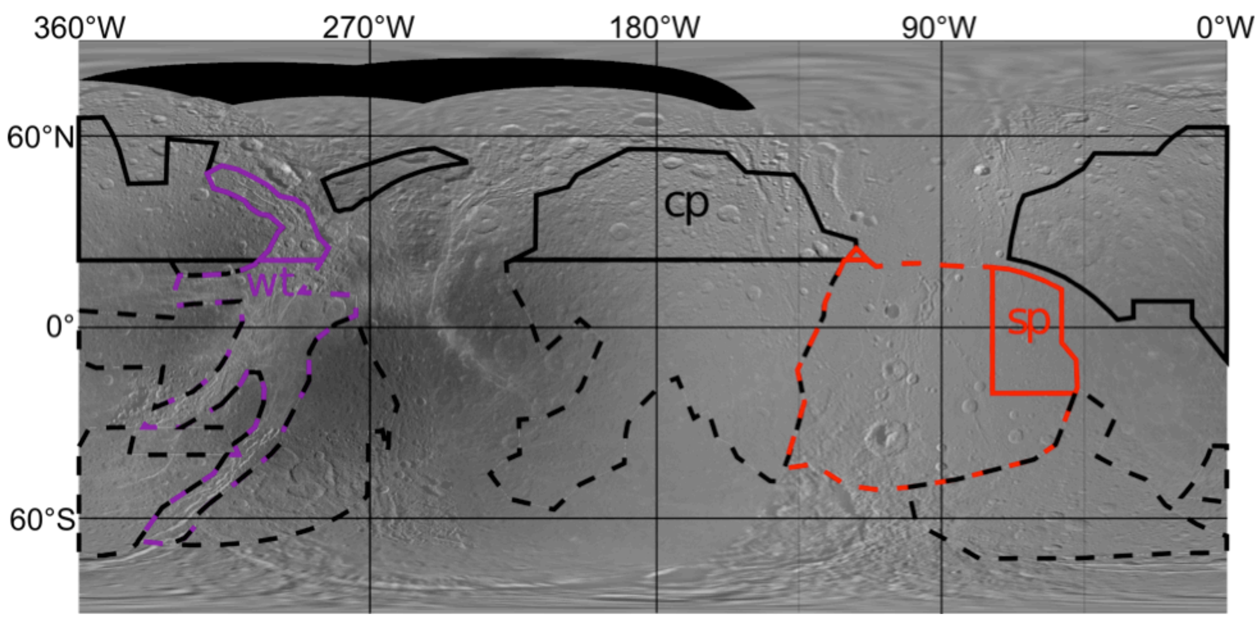

Figure 1. Global mosaic of Dione in simple cylindrical projection. Base resolution is 400 m/pixel. Preliminary crater distributions discussed here (Fig. 2) have been compiled from regions outlined with solid lines. Crater counts to be completed are shown by regions outlined with dashed lines. The three types of terrains are noted by different colors: black – cratered plains (cp), red – smooth plains (sp), purple – wispy terrain (wt).

(Fig. 1). M. Kirchoff also compared our chosen terrain boundaries to those interpreted from *Voyager* images, where applicable, for further validation. From these regions the diameter and position of the crater is then recorded.

Preliminary Results: Preliminary results of our crater counts are presented in the relative (R) size-frequency distribution plot format [10] (Fig. 2). The R-plot normalizes our distributions to a distribution with differential slope equal to -3 and the R-value is a relative indication of crater density. One unexpected result implied by these data is that the wispy terrain could have fewer craters with D < 10 km than the cratered or smooth plains. Meanwhile, for these small diameters the cratered and smooth plains appear to have a similar density of craters. Finally, as crater diameters increase, R-values increase for the wispy terrain, decrease for the smooth plains and remain relatively flat for the cratered plains.

Discussion and Future Work: The trends in R-values shown in Figure 2 for the smooth plains and wispy terrain could have some interesting implications for geological activity on Dione. For the wispy terrain, the lower R-values for D < 10 km may indicate this terrain is younger than the cratered or smooth plains and that the tectonic resurfacing possibly associated with this terrain [1-7] happened after any smooth plains resurfacing. Rather, the similar R-values for D > 20 km argues this terrain is equally old. Since tectonic resurfacing, however, is more efficient at erasing small craters, the younger relative age implied by the lower small crater density might be the more likely hypothesis.

In the smooth plains, the crater density for D < 10 km is similar to the cratered plains, but then drops off to much lower values for D > 10 km. One implication from this trend is that the terrain was resurfaced, as inferred from other geological observations [1-8], and the small crater flux was high enough to bring the density back to the cratered plains density, while the large crater flux was not. A reason for this difference in flux could be that the small crater flux is due to a different impactor population than the large crater flux, and the two fluxes changed separately. For example, planetocentric impactors could be the source for small impactors, while the larger impactors could possibly be heliocentric ecliptic comets [e.g., 11, 12]. In this case, the planetocentric impactor flux may have remained steady or increased, while the comet flux decreased or remained steady. Another source for an increased flux of small craters could be secondaries from nearby Evander basin. The trend in R-values may also be a result of the resurfacing mechanism only removing larger craters. What type of mechanism this would be, however, is hard to envision. Nevertheless, for either scenario, the density of the larger craters, which are

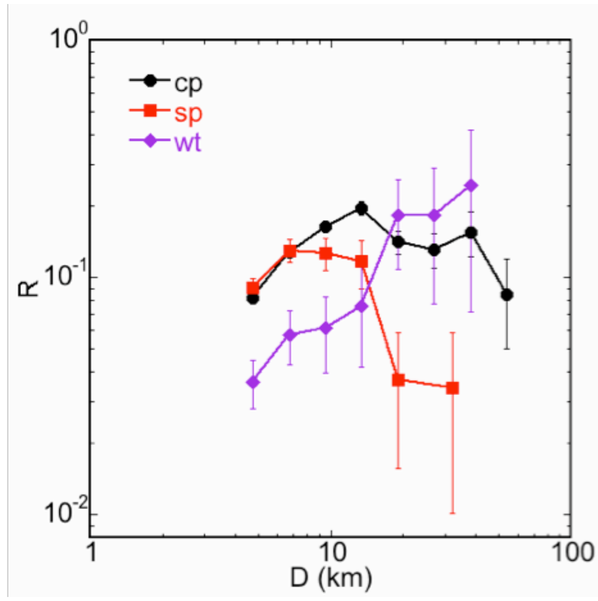

Figure 2. Relative (R) size-frequency impact crater distributions for terrains on Dione. ± √*N* error bars are given (N is the number of craters in a bin). cp – cratered plains, sp – smooth plains, wt – wispy terrain.

fully removed and replaced in both cases, would indicate the relative age of this terrain. Therefore, from the similar R-values of the small craters in the wispy terrain and the large craters in the smooth plains, the resurfacing of the smooth plains may be at approximately the same time as the tectonic resurfacing (Fig. 2).

These interpretations, however, could be strengthened by additional data, especially for the wispy terrain and smooth plains. Therefore, we will continue the counts in the dashed regions in Figure 1 to obtain a more complete picture of the distributions in all of the terrains. These additional counts will also allow us to test if the increase in the small crater density in the smooth plains is due to secondaries from Evander through analyzing the variation in density with distance from Evander.

References: [1] Smith, B.A., et al. (1981) *Science* **212**, p. 163-191. [2] Smith, B.A., et al. (1982) *Science* **215**, p. 504-537. [3] Plescia, J.B. and J.M. Boyce (1982) *Nature* **295**, p. 285-290. [4] Plescia, J.B. (1983) *Icarus* **56**, p. 255-277. [5] Moore, J.M. (1984) *Icarus* **59**, p. 205-220. [6] Morrison, D., et al. (1984) in *Saturn*. Univ. Arizona Press, p. 609-639. [7] Wagner, R., et al. (2006). *Lunar Planet. Sci. XXXVII*. abst# 1805. [8] Schenk, P.M. and J.M. Moore (2009). *Lunar Planet. Sci. XL*. abst# 2465. [9] Kirchoff, M.R. and P. Schenk (2009) *Icarus* **202**, p. 656-668. [10] Crater Analysis Techniques Working Group (1979) *Icarus* **37**, p. 467-474. [11] Chapman, C.R. and W.B. McKinnon (1986) in *Satellites*. Univ. Arizona Press, p. 492-580. [12] Zahnle, K., et al. (2003) *Icarus* **163**, p. 263-289.