DISR Observations of Craters at Titan at the Huygens Landing Site: Insights Anticipated. P. D. Lanagan[1], P. H. Smith[1], M. Tomasko[2], L. R. Doose[2], and B. Rizk[2]., [1]Lunar and Planetary Laboratory; University of Arizona; 1415 N 6th St.; Tucson AZ 85705 (planagan@lpl.arizona.edu), [2] Lunar and Planetary Laboratory; University of Arizona; 1629 E. University Blvd.; Tucson AZ 85721.

Introduction: Observations of impact craters have been used to provide constraints on geologic and atmospheric processes active on solar system surfaces. Images to be obtained by the Huygens's probe Descent Imager/Spectral Radiometer (DISR) [1] may provide the first close-up look at Titan's impact craters. This work lays out a road map for such analysis.

Background: At the time of this writing, observations of Titan's surface at resolutions useful for detecting impact craters have been sparse. The Cassini spacecraft has imaged selected portions of Titan at resolutions of ~1km/pixel and has detected several circular features with diameters up to ~500 km [2]. However, since those features were imaged at low phase angles, shading from topography is not evident, so topographic similarities of these features to impact craters cannot yet be confirmed [3].

Previous workers have used a variety of observations and dynamical models to constrain Titan's crater production rate. In the Saturnian system, two populations of impactors, one heliocentric and one planetocentric, are thought to have created craters on Saturnian satellites [4], although some workers have suggested the evidence for two separate populations to be weak [5]. The size-frequency of Population I impactors has been estimated by interpolating from size-frequency statistics of Iapetus and Rhea [e.g. 6] and calculated from dynamical models [e.g. 7]. The disruption of Hyperion, which is in a 4:3 orbital resonance with Titan, would likely have resulted in a number of planetocentric impactors upon Titan [8].

A paucity of small craters is expected on Titan due to screening effects of the atmosphere. Although the surface pressure of Titan is only 1.5 times that of Earth, given the satellite's lower gravity, the atmosphere is dense when compared to the atmospheres of terrestrial planets (with the exception of Venus). Numerical models which neglect ablation, impactor internal friction after initial breakup, and post-impact crater slumping predict a detectable turn-down in small crater production rates at diameters of 20-40 km for the present atmosphere [9]. Models which incorporate internal friction of the impactor due to the compression of porous bodies predict a turndown in the crater production function for diameters as low as 6–8 km for the current titanian atmosphere [10].

Data and Data Analysis: The Descent Imager/Spectral Radiometer instrument on the Huygens probe will image the surface of Titan in the vicinity of the Huygens landing site at resolutions higher than that of ISS on the Cassini spacecraft. DISR will produce panoramas at resolutions of 20–1000 m/pixel covering areas of ~2×10^1 – 5×10^4 km^2, respectively [1].

Size-frequency statistics of observed impact craters will be obtained for regions over the Huygens landing site. Additionally, the spatial distribution of impactors will be compared using the Z-statistic (the ratio of the difference between the measured and expected mean distance between craters and the expected standard deviation for the mean distance assuming a Poisson process), the spatial distribution of craters can be quantitatively determined to be uniform, random, or clustered [e.g. 11].

Will Huygens see an area large enough to be statistically likely to see impact craters? Extrapolating from the impact crater population of Rhea, [12] estimated the odds of DISR imaging a crater to be on the order of 30%. Estimates for present-day primary cratering rates for titanian craters of diameters > 10 km range from 1.3×10^{-15} [4] to 2.4×10^{-14} [7] craters per year per km^2. If the region imaged by Huygens is 1 Gy old, then, assuming no atmospheric screening effects or post-impact slumping, we would expect 0.06–1.2 craters in a 5×10^4 km^2 area. A 3 Gy old surface covering the same area would be expected to have 0.18 – 3.6 craters. Since the predicted Huygens's landing site is close to the boundary between the leading and trailing hemispheres, hemispheric cratering asymmetries are neglected here.

Discussion: Studies of small titanian craters may provide constraints regarding ages of titanian surfaces relative to reach other, ages of surfaces relative to notable events in the saturnian system, the density of the atmosphere in the past, :

Absolute ages for titanian surfaces will be difficult to derive with confidence given the uncertainty in Titan's cratering rate and the likely small sampling of impact craters by DISR (assuming Titan has been resurfaced at least once since accretion). However, relative ages of geologic units may be determined if the estimated present-day cratering rates are underestimates or if Titan has not undergone significant resurfacing. Observations of Titan from the Hubble Space

Telescope [13] and Cassini ISS/VIMS [3, 14] indicate that Titan's surface is broadly subdivided into "bright" and "dark" units. While the exact natures of these units are unclear at the time of this writing, for the purposes of this discussion, we will consider these albedo units to be distinct geologic units. If Huygens images both bright and dark terrains, a difference in crater density between these units may be detected if they are of different ages.

Planetocentric impactors from Hyperion may be expected to saturate the surface with craters [8], so a paucity of craters identified in DISR images will indicate that titanian surfaces have been resurfaced since that event.

A plethora of small craters with diameters < 6-8 km may result from one or more of the following: (1) the cratered surface predates the breakup of Hyperion, (2) that the titanian atmosphere was less dense in the past [10], and/or (3) the disruption of bolides in the atmosphere over the region imaged [9, 10].

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