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Surface Ages and Impact Crater Size-Frequency Distribution (SFD) on Mimas

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The examination of the geologic history of the saturnian satellites is a major goal of the Cassini imaging experiment (ISS) [1]. Crater counting for the determination of model ages is a powerful tool to understand stratigraphic relationships between different terrain units. For the first time we were able to date the crater Herschel by crater counting on high resolution images from the Cassini flyby on Mimas in February 2010. In conjunction with older data sets [2], [3] we determined absolute stratigrathic points for the analysis of the geologic evolution of Mimas. We also found evidence for at least one, possibly more large impact structures besides Herschel.
Mimas appears to hold a lunar-like cratering record [2], [5]. That is indicated by the shapes of the measured crater SFD, which is equivalent to the lunar crater SFD characteristics over an interval of three orders of magnitude in crater size, taking into account the correction for different impact conditions. This fact implies a similar behavior of the target material as well. To account for different impact velocities between Earth's moon and the saturnian satellites, a horizontal shift is applied. A shift of the lunar curve by a factor of 4.1 to smaller crater diameters gives a good match to our measurements. Differences in vertical direction indicate age differences of the measured surface units. By measuring cumulative crater frequencies on several areas we obtained relative surface ages, which also can be converted into absolute model ages. For this purpose we apply a chronology function characterized by a lunar-like impactor flux [2], [3], [4].
Based on the models of [3] and [4], we derived surfaces ages for the heavily cratered plains and the interior of the prominent crater Herschel on Mimas. We found the cumulative crater frequency of the inner portions of the crater Herschel and its proximal ejecta blankets right at the crater rim to be about a factor of 6 lower than on Mimas's heavily cratered plains.The difference is equivalent to an age difference of about 250 Ma. The absolute age of Herschel is roughly 4.1 Ga, while the heavily cratered plains are approximately 4.3 Ga old. Furthermore, there was no indication of a relative enlargement of craters from higher impact velocities on Mimas's leading side compared to its trailing side. We also have not observed a pronounced apex/-antapex asymmetry [5] in crater frequencies for craters >1km in diameter. Craters >1km in diameter are still in production on Mimas's heavily cratered plains. This strongly supports the planetocentric impactor model [5]. About 150 km SE of Herschel we probed an area by crater counting and found a depletion at small crater sizes below 900 m diameter. Depending on the depth/diameter ratio [6] this observation can be interpreted as blanketing effect possibly caused by ejecta (thickness $\leq$ 130 m) from the Herschel impact event. Finally we found morphologic evidence for an impact basin of 153 km diameter northeast of Herschel (135 km diameter [7]). This basin is highly degraded and seems to have a complex structure with several nonconcentric rings (possibly individual impact events). Evidences for another large basin northwest of Herschel will also be presented.
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