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Stratigraphy and Surface Ages on Iapetus and other Saturnian Satellites

N. Schmedemann (1), G. Neukum (1), T. Denk (1) and R. Wagner (2)

(1) Institute of Geosciences, Freie Universitaet Berlin, Germany, (2) Institute of Planetary Research, DLR Berlin, Germany, (nico.schmedemann@fu-berlin.de)

The examination of the geologic history of the Saturnian satellites is a major goal of the Cassini imaging experiment (ISS). Crater counting for the determination of model ages is a powerful tool to understand stratigraphic relationships between different terrain units.

We assume that Iapetus holds a lunarlike cratering record. That is indicated by the shapes of the measured crater-size frequency distributions which follow very closely the distribution of earth's moon on an interval of three orders of magnitude in crater size [1]. This fact implies a similar behavior of the target material as well. To take into account different impact velocities between earth's moon and the Saturnian satellites, we have to shift the lunar-size frequency distribution horizontally to match our measurements. In case of Iapetus the lunar curve is shifted by a factor of 5.6 to smaller crater diameters. The shift in vertical direction is the indicator for the age of the measured surface unit.

An age of 4.5622 to 4.5647 Gyr was published for Iapetus by [2] based on [3]. A cooling time of about 100 Myr is assumed for creation of a rigid crust, capable to hold the cratering record [2]. Hence we use the oldest surface units as marker horizons to calibrate our dating technique for Iapetus and other mid-sized Saturnian satellites.

Following the models of [2] and [1], an age of 4.4 Gyr is expected for the oldest parts of Iapetus's surface. Based on these models, we measured different ages at neighboring morphologic units. A small part of the equatorial ridge near 96˚W longitude and an "average" dark terrain sample north of the ridge shows densely cratered surfaces

which represent the most ancient areas ($\sim$4.4 Gyr). The central areas of two basins on the leading side at 34˚N/80˚W and 20˚N/20˚W, as well as another basin on the trailing side at 40˚S/260˚W are featuring slightly younger ages of about 4.3 Gyr. The "landslide" crater (diameter $\sim$120 km; 6˚N/36˚W) and the landslide itself are sparsely cratered with a model age of 4.1 Gyr. These might be among the youngest areas on Iapetus. The examination of the most recent data (targeted flyby on Sep 10, 2007, [4]) with spatial resolutions down to 10 m/pxl revealed a set of relatively bright and therefore presumably young craters on the dark side. From this data set we estimated the timescale and development of the darkening process. It was approximated by a power function which shows a steep drop at the youngest ages. The crater brightness drops to 1/3 of the initial value in the order of 10^5 yr and to 1/5 in the order of 10^7 yr. The transition to the complete darkening is hard to define but is in the order of about 1 Gyr.

In addition we will present data of other landslides and average areas on the bright trailing side of Iapetus. Furthermore, data of the major units of other Saturnian satellites like Mimas and Enceladus will be presented for comparison with Iapetus. Mimas is characterized by heavily cratered plains, which indicates a high surface age similar to Iapetus. Enceladus, on the contrary, contains areas of very young age, but also terrains which have been formed billions of years ago.

References:

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