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Impact crater frequencies on planetary surfaces as a stratigraphic tool: application to Jupiter's largest satellite Ganymede

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Impact craters on the solid surfaces of planets and their moons play an important role in studies concerning the geologic evolution of these bodies [1][2]: (1) Geologic time is recorded in, and correlated with, the size-frequency distribution of impact craters superimposed on geologic units or landforms. (2) A crater size-frequency distribution (henceforth termed CSFD) not only records geologic time but also represents the imprint of the size-frequency distribution of bodies which impacted the surface of a planet or a moon in a given time.

Absolute ages, measured in units of Giga-years (Ga), can only be obtained by calibrating crater frequencies with radiometric ages of rock material from a known location. So far this has only been possible for the Moon, based on rocks collected in the Apollo mission [1], and, with a much less degree of certainty since specific locatios are not known, for Mars and asteroids such as (4) Vesta. Material ejected in impacts from these bodies was found on Earth as meteorites which could be dated [3, and references therein]. For all other bodies, absolute ages can only be estimated from cratering chronology models based on cratering rates [2][4][5] and, therefore, are highly model-dependent. So far, no consensus has been reached which projectile family is dominant and what chronology model is the most likely one for planets and satellites in the outer solar system.

The three icy Galilean satellites of Jupiter, Europa, Ganymede and Callisto show a wide range in surface morphologies, inferring different evolutionary paths varying from satellite to satellite. These bodies were imaged by the cameras aboard the Voyager (two flybys in 1979) and Galileo (Jupiter orbiter, 1995 – 2003) spacecraft. In this work we concentrate on Ganymede, the largest natural satellite in the solar system. Our primary goal is to use crater distributions for stratigraphic purposes in order to derive relative ages from crater counts. Secondly, we use crater distributions to infer potential impactor families which were responsible to create the craters. In order to carry out geologic mapping, we reprocess Voyager and Galileo images to create global, regional and local mosaics. These image products can further be used in connection with imagery from ESA's future JUICE (JUpiter ICy Moons Explorer) mission to Jupiter and the Galilean satellites, specifically in its Ganymede orbiting phase [6]. Geologic mapping for the purpose of crater counts is based on the most up-to-date global geologic map by [7]. The software tool ArcGIS is used for geologic mapping as well as crater counting. We concentrate our detailed geologic mapping of Ganymede at higher resolution, based on Galileo image coverage, on (1) varieties of dark, densely cratered material, (2) bright, tectonically resurfaced areas, (3) areas of potential cryovolcanism, (4) bright, ice-rich rayed impact craters, and (5) erosional features.

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