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Crater size distributions on Ganymede and Callisto: fundamental issues

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Crater size distributions on the two largest Jovian satellites Ganymede and Callisto and the origin of impactors are subject of intense and controversial debates. In this paper, we reinvestigate crater size distributions measured in surface units derived from a recently published global geologic map, based on Voyager and Galileo SSI images at a scale of 1 km/pxl (Collins G. C. et al. (2013), U. S. Geol. Surv., Sci. Inv. Map 3237). These units are used as a context to units mapped in more detail at higher resolution in Galileo SSI images. We focus on the following fundamental issues: (1) Similarity between shapes of crater distributions on the Galilean satellites and on inner solar system bodies; (2) production versus equilibrium distributions; (3) apex/antapex variations in crater distributions. First, our results show a strong similarity in shape between the crater distributions on the most densely cratered regions on Ganymede and Callisto with those in the lunar highlands. We conclude that the shape of the crater distributions on these two Jovian satellites implies the craters were preferentially formed from members of a collisionally evolved projectile family, derived either from Main Belt asteroids as candidates of impactors on the Jovian satellites, or from projectiles stemming from the outer solar system which have undergone collisional evolution, resulting in a size distribution similar to those of Main Belt asteroids. Second, the complex shape of the crater distributions on Ganymede and Callisto indicates they are mostly production distributions and can be used to infer the underlying shape of the projectile size distribution. Locally, equilibrium distributions occur, especially at smaller sub-kilometer diameters. Third, the most densely cratered regions on both satellites do not show apex-antapex variations in crater frequency, as inferred for bodies from heliocentric orbits (e.g., Zahnle K. et al. (2003), Icarus 163, 263-289). This indicates that these craters were predominantly formed by bodies in planetocentric orbits, as maintained by Horedt and Neukum (1984, JGR 89 (B12), 10,405-10,410), or, alternatively, Ganymede and Callisto were rotating non-synchronously at early times (Zahnle et al., 2003). A forth issue is the stability of the shape of crater distributions with time, indicating a stable size distribution of impactors. Our results show that the shape of crater distributions was more or less stable, derived from the record of craters between 2 and 100 km diameters. To examine this topic in more detail, a global coverage of higher resolution imaging data is needed which will be provided by the JANUS camera data aboard ESA's future JUICE mission to Jupiter and Ganymede (Palumbo et al. (2014), LPSC XLV, abstr. No. 2094; Plaut et al. (2014), LPSC XLV, abstr. No. 2717).