CRUSTAL STRIPPING BY LARGE IMPACTS ON ASTEROID 1 CERES.

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Introduction: Before the arrival of NASA's Dawn spacecraft, the surface of 1 Ceres was expected to largely devoid of craters [1] due to the fast viscous relaxation timescales of icy materials. Upon arrival, however, Dawn revealed an asteroid with many well preserved craters on the surface [2]. However, the largest craters on the body, akin in size to to the Rheasilvia and Veneneia basins on 4 Vesta [3], are not readily observable in Dawn returned data. Either Ceres has coincidentally managed to avoid very large scale collisions, a very unlikely scenario [4], or somehow surficial evidence of the largest basins on the body has been subsequently erased, either through viscous relaxation or overprinting. Some evidence of the largest basins on the body may exist in the form of very large low topography regions on Ceres [5] that spatially correspond with anomalously low Bouguer gravity signatures [6].

Ceres is likely differentiated [7], with a denser rocky core overlain by a volatile and salt rich, less dense crust. The diameter at which craters transition from simple, bowl-shaped morphologies to more complex morphologies suggests that there is a significant amount of ice in the near surface [8]. If Ceres is indeed differentiated, with a lower density crust above a higher density core, the largest impacts into the body may significantly alter the local structure, leaving behind a gravity signature. Specifically, large impacts have the ability to strip away low density crustal material [Fig. 1], leaving behind a compensated gravity anomaly after relaxation. We investigate this process using numerical models of impacts into Ceres.

Numerical Modeling: We model the formation of large basins on a Ceres like asteroid using the iSALE-2D shock physics code [9-11]. Ceres is represented as a layered target, with a water ice/hydrated-silicate mixture low density crust on top of a silicate core. Material thermodynamics are addressed using the ANEOS equation of state package, and material mixing assumes an intimate combination of species in thermal and physical equilibrium following [12]. For the low density crust, we employ an ice-like rheology [13] modified to include ice-like visco-elastic-plastic behavior [14,15]. We investigate the degree of crustal stripping that occurs.

Results: The largest expected impacts strip a considerable amount of material from Ceres' near surface. In some simulations, the crust is reduced by as much as 75% of its original thickness. This magnitude of crustal stripping has suggests that, if Ceres does have an internally differentiated density structure, the largest impacts should leave behind fairly strong, detectable gravity anomalies, even after compensation. Varying crustal thickness, crustal composition, and impact parameters (size, angle, and velocity) can change the depth and width of the stripped region. We investigate this parameter space using both 2D and 3D impact models.

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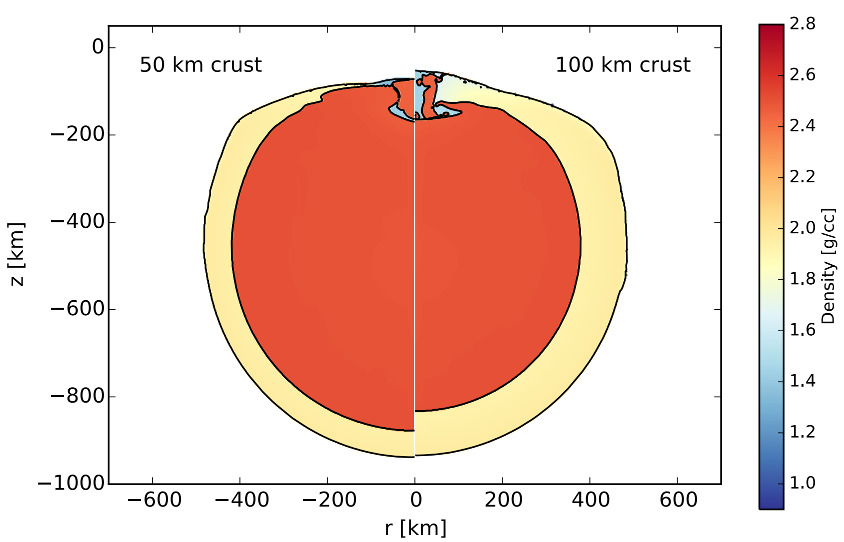

Figure 1: Crustal stripping on a Ceres like target with a 50% water ice/50% hydrated silicate low density crust with initial thicknesses of 50 (left) and 100 (right) km, following a vertical impact with a 90 km diameter silicate impactor at 5 km s^{-1}.

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