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INVESTIGATION OF FRESH IMPACT CRATER DEPTHS ON TITAN

Abstract

Saturn's largest moon, Titan, is the only planetary body in our solar system, besides Earth, that has liquid (methane) on its surface. NASA's Cassini mission mapped the surface of Titan and detected an unusually low number of impact craters, compared to other (airless) icy moons. This low count is likely the result of erosion and deposition altering the crater morphologies, such that they are unrecognizable from orbit. Cassini data also shows morphological indicators of fluvial erosion and aeolian infill in Titan's craters. As a result, we don't know the original, 'uneroded' morphology of Titan's impact craters. This information would allow us to constrain the amount of erosion that has occurred since their formation. A comparison of Titan crater depths to craters on similarly sized but airless icy moons has provided some evidence of erosional processes on Titan. The impact craters on Titan are hundreds of metres shallower than those on Ganymede and Callisto, icy moons of Jupiter. However, this result is based on the assumption that the initial crater depths on Titan are comparable to similarly sized craters on Ganymede and Callisto. Given the potentially different compositions of their surfaces (methane clathrate vs. water ice) and thermal structures of their interiors, this may be a poor assumption. As a result, we need models of more realistic "fresh" Titan craters; numerical modeling of impact crater formation allows for an improved understanding of these crater morphologies. This study will simulate impact crater formation on Titan using the impact-Simplified Arbitrary Lagrangian Eulerian (iSALE) shock physics code. The simulations will explore how varying Titan's crustal properties affects the crater depths over a range of diameters. We will investigate a range of thicknesses for its ice crust (40–100 km), as well as a range of thermal gradients in the ice crust (3–10 K/km). The resulting depths of fresh Titan impact craters will then be compared to the observed depths of craters on Titan, to determine the extent by which erosion has shaped its surface. This study has applications to NASA's Dragonfly mission, which is currently planned to launch in 2027. This robotic rotorcraft mission will explore an impact crater named Selk (among other sites) and study the prebiotic chemistry of Titan there.