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Enceladus, global topography and implications

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Cassini-based stereo-derived topography of Saturn's moon Enceladus (diameter ∼500 km) reveals the nature of large-scale surface depressions. The most pronounced depression detected so far (the topographic model still covers less than half of the body) is located in a region close to the equator (15°S, 210°E). It is elongated with dimensions of 240 km (NW-SE direction) and 150 km (perpendicular to that), respectively, and up to 1.5 km deep. In contrast, the depression centered on Enceladus' active south polar region is approximately circular, has an average depth of ∼ 700 m, and extends to 65°S (∼ 220 km diameter). While the south polar depression is young the equatorial depression must be old. It comprises both young resurfaced terrain, which has formed regardless of the boundaries of the depression, and older cratered terrain. We favor an endogenic origin of the equatorial depression. It may have formed involving plume related local melting of a ∼20 km thick water ice layer below a relatively thin (as compared to the dimensions of the depression) lithosphere. Alternatively, it may have formed in response to an intrinsic density anomaly in Enceladus' core or, even likely, to an irregularly shaped core, which has to have a bulge of 0.5-1 km (which is less than 1% of the core radius) in order to compensate the mass deficiency of the depression. The latter hypothesis is in particular attractive because it simply explains why the depression still exists today. In addition, it supports the idea that Enceladus is not fully differentiated. An impact origin of the depression is less likely because an impact basin of this scale is expected to relax over time but this did not happen. Also, there is a lack of relict rim portions, which would relax last of all.