
Introduction: The 420-km-wide Odysseus impact basin on icy Tethys is the largest well-preserved impact basin on the 5 inner classical moons of Saturn. Its formation and subsequent evolution have had a profound ‘impact’ on Tethys’ geology, including possibly the formation of the Ithaca Chasma canyon system [1, 2]. The current state of our understanding of Tethys and Odysseus has been summarized by Schenk et al. [2]. Here we expand on that survey and examine all data sets, including color, topography, stereo, and various oblique, nadir, high-Sun and low-Sun imaging to better understand how this large basin formed and how its history may have affected Tethys.

Odysseus: Multiple Cassini encounters with Tethys resulted in numerous looks at Odysseus (33°, 231°E), with best imaging resolutions of ~250 m/pixel and several color mosaics and stereo sequences allowing for DEM production (Fig. 1). The stereo and DEM reveal a large bowl ~8 km deep (rim-to-floor) with sloping floor materials and an irregular central complex (and also the deepest feature on any of the 5 inner moons [1]).

The basin rim wall and floor is a complex surface with numerous scarps and irregular mounds. No classical rim terraces (except perhaps along northern rim) and no flat-floor deposits or ponded materials similar to large craters on the Moon and Mercury are observed, indicating that, as in all other craters in the Saturn system, impact melt did not occur in large quantities (though minor deposits may occur below the limit of resolution). While melt (i.e., water) can drain into a fractured crater floor, large volumes of melt are unlikely to have disappeared in this way and thus perhaps did not form despite the relatively high mean impact velocities. Another possibility is that any massive aqueous melt sheet would necessarily be capped with substantial, icy debris, perhaps masking it entirely. Some sinuous flow-like textures are evident on the sloping floor units, but the lack of ponded or even flat-lying materials and the presence of numerous scalloped inward-facing scarp-enclosed alcoves high up along the sloping rim wall indicate these materials are more likely ‘dry’ rim sliding materials emplaced during impact.

Figure 1. Three-color orthographic global mosaic (left) and topographic map (right) of Tethys hemisphere centered on Odysseus basin.

Figure 1b. Averaged topographic profile across Odysseus, highlighting bowl shape, rugged central complex and deep central pit.

Figure 2. Oblique high-Sun image from Cassini (orbit 164) showing fracture patterns (dark sinuous lineations) on floor of Odysseus. Central pit is at upper right.

The central complex is a series of angular and ridged massifs (Sheria Montes) flanking a prominent central pit 60-80-km-wide and 4-km-deep relative to the crater floor [2]. Inverse gravity scaling of the peak-to-pit transition diameter (~25 km) on Ganymede and Callisto [3] indicates that craters larger than 75 to 100 km on the Saturnian moons (depending on target) should also be central pits but all craters of this size are dominated by large conical central peaks. Odysseus is the lone exception but occurs well above the predicted diameter. This
The large ~0.6 Gya old 420-km-wide Odysseus impact basin has profoundly affected the geologic evolution of Tethys. Ejecta blanketed much of the surface, especially to the east. An origin by global fracturing in response to the impact cannot be ruled out for Ithaca Chasma. Melt deposits are almost completely lacking, as they are across the Saturn system. Viscous relaxation is documented by late stage fracturing of the basin floor and central pit and by depth/diameter measurements [6]. Given its size, relaxation of Odysseus would involve much of the interior and could have induced global fracturing, and some of the observed fracturing [2] could be related to Odysseus.