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**Infilling and tectonic evolution of mega-basins in the Solar System: A look at Caloris
and Sputnik Planitia**

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ABSTRACT

Throughout the Solar System, large infilled basins exhibit a variety of infilling processes, encompassing sedimentary mechanisms (i.e. aeolian or aqueous) and upwelling of material from beneath the basin floor (i.e. mantle pluming, cryovolcanism, mud volcanism, springs). This study compares two such basins, Sputnik Planitia (1000 km diameter) on Pluto and Caloris Basin (1500 km diameter) on Mercury, both believed to have been infilled through upwelling from the basin floor, facilitated by reduced lithosphere thickness directly below. As Mercury and Pluto represent opposite ends of the planetary spectrum (small silicate planet vs icy dwarf planet), this comparative analysis aims to advance our understanding of impact-induced mechanisms and subsequent infilling.

Although their volume and thickness are comparable, their infill composition starkly contrast; nitrogen ice in Sputnik and basaltic lava in Caloris. This is due to the ice water-water ocean composition of Pluto's lithosphere-mantle boundary and the rocky composition of Mercury's. The infill of Sputnik is at least 3 km thick and is relatively flat. The perimeter of Sputnik is characterized by a smooth, radially asymmetrical, forebulge which has been retained in many places. In contrast, the infill within Caloris is at least 3.5 km thick and shows a highly variable topography, exhibiting high bulges that exceed the height of the basin rim, as well as a central depression. Both infills contain a plethora of deformational features such as faults, polygons, vents and mounds. Although each basin has their own unique geological history, comparing their deformational features (i.e. faults and bulge topography) provides particular insight into the intricate interplay of composition, gravity and volume in driving subsidence (whether faulting induced or isostatic) on planetary bodies. Furthermore, the likelihood of ongoing convection within Sputnik has wide ranging ramifications to our understanding of geological processes in the outer solar system.

This work further refines the framework for interpreting the subsurface architecture (i.e. fault geometry, lithosphere thickness and nature of the mantle-lithosphere boundary) beneath these basins. It also provides insights into the relationship between magma and water/cryomagma pluming beneath deep basins (i.e. volcanism vs. cryovolcanism). Due to the imminent arrival of BepiColombo in Mercury's orbit in 2025, categorizing and comparing these infilled basins will enhance our capacity to interpret the geophysical and topographical data expected from the Mercury Planetary Orbiter (MPO).