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The Geology of Europa: Exploring a Potentially Habitable Ocean World

Galileo spacecraft data suggest that a global ocean exists beneath the frozen ice surface of Jupiter's moon Europa. Magnetometry data indicates an induced magnetic field at Europa, implying that a salt-water ocean exists today. A paucity of large craters argues for a surface on average only ~40–90 Myr, and two multi-ring structures suggest impacts punched through an ice shell ~20 km thick. Europa's ocean and surface are inherently linked through tidal deformation of the floating ice shell, and tidal flexing and nonsynchronous rotation may generate stresses that fracture and deform the surface to create ridges and bands. Dark spots, domes, and chaos terrain are probably related to tidally driven ice convection, along with partial melting within the ice shell. Europa's geological activity and probable direct contact between its ocean and rocky mantle may permit the chemical ingredients for life to be present within the ocean. Fascinating geology and geophysics, combined with high astrobiological potential, make Europa a top priority for future spacecraft exploration. The Europa Clipper is a mission concept currently being studied by NASA, which would make multiple flybys of Europa from Jupiter orbit, to investigate its potential habitability.