Enceladus Orbilander

Enceladus is a small, active ice world in which gas and particles from its subsurface ocean are being jetted into space. Conditions at Enceladus thus allow for direct investigation of the habitability of an ocean world and assessment of whether or not it is inhabited. This addresses one of the most fundamental questions in solar system science: is there life beyond Earth and if not, why not? Direct, in situ sampling of plume materials by Cassini showed evidence of water vapor, carbon dioxide, methane, ammonia, complex organic molecules, and various salts, and ongoing hydrothermal activity in Enceladus' rocky core is inferred. However, Cassini flyby velocities were high, leading to fragmentation of large molecules, and ambiguity as to the precise identity of the parent organic molecules. Enceladus Orbilander will sample an extant subsurface ocean through study of freshly ejected plume material originating from a well-characterized location. Orbilander will execute a 1.5-year set of orbits of Enceladus, collecting plume samples from orbit, prior to a two-year landed mission when more voluminous plume material is acquired in both passive and active (i.e., scooping) modes. Approximately ~300 µl of sample can be passively collected in ~10 days on the surface or in a single scoop. There are two main science objectives: 1) to search the plume materials for evidence of life (e.g., via multiple complementary approaches including the detection of amino acids, lipids, polyelectrolyte, and cell-like morphologies) at the level of fidelity necessary for biosignature detection and 2) to obtain geochemical and geophysical context for life detection experiments (e.g., conditions in the ocean, structure/dynamics of the interior, and the structure of the jet vents). In addition to life detection, landed science includes a seismometer and radio science. Orbital science includes laser altimetry, radar sounding, gravity/radio science, thermal and visible imaging, and landing site reconnaissance. Viable launch opportunities on existing heavy-lift launch vehicles occur in 2037, 2038 and during the 2040s; these lead to Enceladus landing during favorable south pole illumination and Earth-communication conditions that begin in the early 2050s. The committee's Recommended Program starts Orbilander in FY29 in support of these launch times.

The Enceladus Orbilander mission study report is available at https://science.nasa.gov/science-red/s3fs-public/atoms/files/Enceladus%20Orbilander.pdf