STRATEGIC MAP FOR EXPLORING THE OCEAN-WORLD ENCELADUS.

B. Sherwood, Jet Propulsion Laboratory, California Institute of Technology
(M/S 321-625, 4800 Oak Grove Dr, Pasadena CA 91109, brent.sherwood@jpl.nasa.gov).

Introduction: Cassini's discovery of jets emitting salty water from the interior of Saturn's small moon Enceladus is one of its most astounding results to date. The measured presence of salts and organic species in the resulting plume, the finding that the jet activity is valved by tidal stretching at apocrone, the modeled lifetime of E-ring particles, and the gravitational inference of a long-lived, large water reservoir in contact with the rock core all indicate that Enceladus meets today's textbook conditions for habitability: liquid water, biologically available elements, a source of energy, and longevity of conducive conditions. Enceladus is among the best places in our solar system to search for direct evidence of biomarkers.

Exploring an ocean world: Of those places, Enceladus also proffers the simplest access by a flight mission to the telltale molecules, ions, isotopes, and even potential cytofragments, due to its plume continuously expressing material from the ocean directly into space. In situ mass spectroscopy of the plume, plume sample return, in situ investigation of plume fallback deposits on the surface, direct sulcus and vent exploration, and eventually submarining exploration of the ocean can all be envisioned.

However, the strategic urgency and feasibility of building a consensus to plan and fund elaborate in situ exploration of this ocean world will hinge on promising results revealed by new data. As with most strategic maps, the very first steps are pivotal.

Two relatively straightforward mission concepts – one Discovery-class and one New Frontiers-class – are obvious: 1) flythrough plume analysis by gas and particle mass spectrometers, essentially re-making the Cassini INMS and CDA measurements but with modern, high-resolution instruments; 2) collection of plume ice particles, dust, and gas upon Stardust-like flythrough, followed by their retrieval to Earth for comprehensive analysis in terrestrial laboratories.

Building a strategic map: These and other mission waypoints on an integrated strategic map each require unique capabilities, address focused science questions, and yield results important for setting priorities and making subsequent investments. However, overlaid on this logical sequence are important, even overwhelming and mutually competing programmatic constraints: astrobiology pursuits at other ocean worlds and Mars, and spectroscopy of exoplanet atmospheres; cadence of realistic opportunities for mission selections and of formal science-community planning cycles via Decadal Surveys; and what could be called programmatic and even popular impatience to await interim results before vectoring investments in enabling capabilities. As with Mars for many years, the anticipation of interesting eventual results may be a key driver of strategic intent, able to withstand absence of validation for many years.

Key enabling elements include: coherent sequence of science questions addressable by various type of mission; technologies that mature at the right time to enable both mission performance and approval (e.g., planetary protection); integrated concepts whose cost estimates survive review; community momentum and international partnerships.

Decision levers and opportunities for action: Analysis of how these elements deploy across the strategic map yields a short list of specific decision pressure points for the next two decades. Using these opportunities the community may systematically prosecute the grand objective of finding and exploring an alien ecosystem within the working lifetime of today's graduate students. If missed, however, progress toward an epochal age of ocean exploration will be episodic, haphazard, and slow. The windows for making significant advances are sparse, and much remains to be done to prepare to take advantage of them.