Astrobiology News November 2018: Searching for Extant Life in the Outer Solar System

My focus during the summer was on some of the scientific and ethical issues involved in the exploration of Mars. This month, I will turn my attention to the cold worlds of the outer Solar System. The best candidate worlds for hosting environments that might support life beyond Earth in our Solar System may not be planets, but moons of the gas and ice giant planets. The journal *Astrobiology* just published a NASA Roadmap for the exploration of "ocean worlds" in our Solar System.¹ Here an "ocean world" primarily refers to a world that is known or suspected to harbor vast subsurface bodies of liquid, which are deemed plausible environments to support life.² The overarching goal of the NASA Outer Planets Assessment Group Roadmap to Ocean Worlds (ROW) is to "identify ocean worlds, characterize their oceans, evaluate their habitability, search for life, and ultimately understand any life we find."

The first part of this goal - identifying ocean worlds – has already met with considerable success over the past few decades, with the development of numerous techniques for assessing the presence of subsurface oceans on icy worlds.³ ROW outlines the types of synergistic investigations combining robotic missions and Earth-based research efforts needed to make further progress. It finds the confirmed ocean worlds Enceladus, Titan, and Europa, as well as the candidate ocean world of Triton, to be the highest priority targets for exploration in the next decade.

For Saturn's moon Enceladus, where *Cassini* spacecraft measurements have established a potentially habitable subsurface ocean, ROW recommends a series of missions to further assess habitability and search for signs of life. Likewise, several mission concepts are being explored to ascertain the habitability of subsurface oceans on Jupiter's moon Europa and Saturn's moon Titan, as well as Titan's surface lakes or seas of liquid methane and ethane. Although the presence of a subsurface ocean on Neptune's moon Triton has yet to be established, ROW identifies this world as the highest priority among the candidate ocean worlds because of the extraordinary hints of activity discovered by the *Voyager* spacecraft. I know I'll never forget seeing some of the first images of the spectacular geyser-like plumes emanating from Triton when I was at JPL for *Voyager 2*'s encounter with Neptune on August 25, 1989!

To design a coherent program of exploring the ocean worlds, ROW finds that significant input is needed from Earth studies; in particular, collaborations between Earth oceanographers and planetary scientists studying extraterrestrial oceans need to be developed that extend oceanographic studies to a greater spectrum of conditions. Our home planet provides diverse ocean settings that can provide a wealth of information on a broad range of environments, which may be relevant to other ocean worlds.

Given that any life populating subsurface oceans on distant icy worlds of the outer Solar System is likely to be "simple" life, why all the interest? There are many answers to this question of course, but perhaps one of the most compelling reasons is that discovering a second genesis of life within our Solar System would greatly increase expectations that the origin of life is very common in our Universe. Our understanding of the requirements for biological life could be dramatically reshaped by whatever may lurk on these cold, remote worlds. On that note, I encourage you to check out the multifaceted theological and ethical reflections on a gamut of possibilities regarding life in our Solar System and beyond in *Astrotheology Science and Theology Meet Extraterrestrial Life*, which was launched at Berkeley late last month!⁴

Until next month,

Grace

¹ Hendrix, A. R. et al., "The NASA Roadmap to Ocean Worlds," *Astrobiology*, Published Online:13 Oct 2018 <u>https://doi.org/10.1089/ast.2018.1955</u>

² Note "liquid" does not necessarily equate to "water," and need not necessarily be subsurface. The *Cassini-Huygens* mission established the presence of large bodies of liquid methane and ethane on the surface of Saturn's moon, Titan.

³ In one of my earliest Astrobiology postings to the CLP (see the August 2013 entry under theclergyletterproject.org/Resources/Astrobiology.html), I mentioned Guy Consolmagno's theoretical work exploring the possibility of a subsurface ocean on Europa. Guy is the current Director of the Vatican Observatory and the 2014 recipient of the Carl Sagan Medal. The new Roadmap cites one of Guy's papers among the earliest

work on this topic (Consolmagno, G.J., and Lewis, J.S. 1978, "The evolution of icy satellite interiors and surfaces," *Icarus* 149: 133 – 159.)

⁴ Ted Peters, ed., with M. Hewlett, J. M. Moritz, and R. J. Russell, *Astrotheology Science and Theology Meet Extraterrestrial Life* (Eugene, OR: Wipf and Stock Publishers, 2018).