Titan and Enceladus : Astrobiological Analogs with Earth

ATHENA COUSTENIS[1]
[1] *LESIA, Observatoire de Paris, 92195 Meudon Cedex, France*

Titan is currently the only confirmed exobiotic environment known to us. It is also perhaps the most intriguing object in our Solar System. Our understanding of Titan, and of its kronian sibling Enceladus, has been greatly enhanced by the data returned by the Cassini-Huygens mission since 2004 and still operating on the spot.
Cassini demonstrated that Titan is a complex world more like the Earth than any other: it has a dense, mostly nitrogen atmosphere with about 2% of methane, and active climate and meteorological cycles where the working fluid, methane, behaves the way that water does on Earth. The combination among these mother molecules produces an exciting organic chemistry in Titan's atmosphere, with hydrocarbons and nitriles (one of the latter, HCN, is a prebiotic molecule). Titan is therefore very rich in organic molecules, which are formed in the upper atmosphere and then deposited on the surface. Its geology, from lakes and seas to broad river valleys, dunes and mountains, while carved in ice is, in its balance of processes, again most like Earth. Beneath this panoply of Earth-like processes an ice crust floats atop what appears to be a liquid water ocean. The organic deposits, in coming into contact with the liquid water in the underground could possibly undergo an aqueous chemistry that could replicate aspects of life's origins. In particular, the surface composition in ices is still under debate. The organic chemistry, climate conditions, meteorology, methane cycle and other aspects of the surface make Titan an extremely important astrobiological place.
Similarly, a strong bioastronomical potential is afforded by Enceladus who is surrounded by an atmosphere created by water and organics ejections coming from the interior at the south pole. The implied requirement for liquid water reservoirs under its surface, significantly broadens the diversity of solar system environments where one might possibly expect conditions suitable for living organisms, and calls for future exploration of the Saturnian system both with orbiting and *in situ* elements. I will discuss our current understanding of the astrobiological aspects of the two satellites as inferred from current and past observations. After the Cassini-Huygens mission, there will remain several unanswered questions which will require a future mission with an optimized orbital tour, specific in situ elements and advanced instrumentation, such as the Titan Saturn System Mission studied in 2008.

Keywords: Titan, Enceladus, astrobiology, ices, Cassini-Huygens, satellites.

References

Coustenis, A., Earth Moon and Planets, 67, 95, 1995.
Coustenis, A., et al., Icarus, accepted, 2010, DOI : 0.1016/j.icarus.2009.11.027.
Flasar, F. M., et al., Science, 308, 975, 2005.
Jennings, D., et al., Astrophys. J. Let. 681, L109, 2008.
Lavvas, P., et al. Plan. Space Sci. 56, 27-99, 2008.

Nixon C., et al., Astrophys. J. Let. 681, L101, 2008.
Nixon, C., et al., Plan. Space Sci. 57, 1573, 2009.
Teanby, N., et al., Icarus 186, 364, 2007.
Vinatier, S., et al., Icarus, 188,120, 2007.
Vinatier, S., et al., Icarus, 205, 559, 2010.