Liquid Water-Ammonia Habitats on Titan from the Release of Biothermal Energy ?

David Grinspoon
Department of Space Studies
Southwest Research Institute
1050 Walnut St., Suite 420, Boulder CO 80302
U.S.A.
david@boulder.swri.edu

Dirk Schulze-Makuch
Department of Geological Sciences
Washington State University, Pullman, WA 99164
U.S.A.

In conditions where the ability to sustain liquid microenvironments is a key limitation on survival, then adaptive pressures could lead to a large percentage of the free energy of exothermic metabolic reactions going towards heating the immediate environments of organisms. On Earth, glacial melting from biothermal energy released by algal metabolism has been reported[1], as has been the influence of marine microorganisms on the melting of Arctic pack ice[2]. Microbial colonization occurs in cryoconite holes on glaciers[3] and in basal glacial melt waters[4].

If significant biological activity is present on Titan, then biothermal energy could be contributing to the abundant near-surface melting which may be implied by early Cassini imaging and radar data. The ultimate source of this surface or subsurface energy release would be solar ultraviolet radiation: high altitude photochemistry produces compounds like C_2H_2 which fall to the surface. Metabolic reactions using C_2H_2 and H_2 to produce CH_4 would be highly exothermic, and could also explain how the global methane inventory is maintained against photochemical destruction.

If surface or subsurface organisms are able to take advantage of upper atmospheric photochemistry, through the continuous downward transport of high energy compounds such as acetylene, they would have vast energy reserves at their disposal which could be used, in part, to maintain the liquid environments conducive to life.

1. Gerdel, R.W. & Drouet, F. *Trans Am. Microsc. Soc.* **79**, 256-272 (1960).
2. Leck, C. et al. *EOS* **85,** 25, 30, 32 (2004).
3. Wharton, R.A. et al. . *Bioscience* **35**, 499-503.
4. Souchez, R.et al. *Geophys. Res. Lett.* **22**, 41-44 (1995).