Stromatolites in Lake Untersee, Antarctica

See movie on course website.

Model for life on Saturn moon's Enceladus?

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Survival strategies of an anoxic microbial ecosystem in Lake Untersee, a potential analog for Enceladus

Nicole Yasmin Wagner, Dale T. Andersen, Aria S. Hahn & Sarah Stewart Johnson 🖂

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The competing hypothesis: geochemical origins

energy conversion cascade

Hypothesis 1: photons are the original power source

Hypothesis 2: geochemical ion gradients are the original power source



Meet Luca, the Ancestor of All Living Things

By NICHOLAS WADE JULY 25, 2016





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nature microbiology

PUBLISHED: 25 JULY 2016 | ARTICLE NUMBER: 16116 | DOI: 10.1038/NMICROBIOL.2016.116

The physiology and habitat of the last universal common ancestor

Madeline C. Weiss[†], Filipa L. Sousa[†], Natalia Mrnjavac, Sinje Neukirchen, Mayo Roettger, Shijulal Nelson-Sathi and William F. Martin*

Most likely habitat of LUCA



Researchers identified 355 LUCA protein families, hinting at an organism that thrived somewhere:

- hot: temperatures $> 60^{\circ}$ C
- rich in H_2 , CO_2 , and iron

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A similar modern environment:



alkaline hydrothermal vents, such as exist today at the Lost City vent field, discovered in 2000.

Lost city hydrothermal vents

See movie on course website.

A geochemical "power outlet"

peridotite + seawater \Rightarrow serpentinite + heat + fluid depleted of H⁺ ions



Porous structure of the rock chimneys at the vents



A nonequilibrium playground for the birth of biochemistry



A plausible hypothesis: Lane and Martin, Cell (2012)

Long-term (> 10^4 yr) imbalances of H⁺ ions persist at the boundaries of rock pores and seawater.

A nonequilibrium playground for the birth of biochemistry



A plausible hypothesis: Lane and Martin, Cell (2012)

Long-term (> 10^4 yr) imbalances of H⁺ ions persist at the boundaries of rock pores and seawater.

The pore walls could have provided the scaffolding for the development of membranes, membrane-bound proteins like ATP synthase, and other biological components.