

METAGENOMIC ANALYSIS OF THE ANOXIC BASIN OF LAKE UNTERSEE AS AN ENCELADUS ANALOG. N. Y. Wagner¹, A. S. Hahn², D. T. Andersen³, M. C. Vanderwilt¹, S. S. Johnson¹, ¹Johnson Biosignatures Lab, Georgetown University, Washington DC, USA (3700 O St. NW, Regents 511, Washington, DC 20057. nyw5@georgetown.edu), ²Koonkie Cloud Services Inc., Vancouver, Canada, ³Carl Sagan Center, SETI Institute, Mountain View, CA, USA

Introduction: Under ocean worlds conditions on Enceladus, it has been shown that biological methane production may be possible [1]. Also, the possibility of methanogenesis on Europa has been hypothesized [2]. Given the potential for methanogenesis on the icy moons of Saturn and Jupiter, we are exploring the range of life capable of survival in an extremely methane-rich terrestrial analog.

Lake Untersee as an Ocean Worlds Analog: Lake Untersee is located in Queen Maud Land, East Antarctica. It is perennially covered in 3 meters of ice and closed off from the outside world by the Anuchin glacier. The lake contains an aerobic basin and anoxic basin (Figure 1). The aerobic basin has been measured to be up to 169m deep with a constant temperature of 0.25°C. It contains a well-mixed water column. The anoxic basin has a maximum depth of 100m. While the top 50m of the anoxic basin are well-mixed, similar to the aerobic basin [4], the level of dissolved oxygen (DO) drops from 70-75m. Below this suboxic region is a uniformly anoxic environment (Figure 2). These anoxic waters comprise one of the most methane-rich naturally-occurring aquatic ecosystems on Earth, with CH₄ levels reaching as high as 21.8 ± 1.4 mmol L⁻¹ [3].

Using Lake Untersee as an analog allows us to study the chemosynthetic pathways used by life forms that dwell in an extreme environment that bears strong similarities to ocean worlds that are characterized by bodies of water permanently covered in ice, with low temperature, a lack of oxygen, and the presence of methane as a potential energy source.

Sample Collection: From October to December of 2018, we collected samples from Lake Untersee using sterile techniques. Microbes were concentrated from approximately 100mL of water into ~200μL of Tris using a CP Select (InnovaPrep). DNA was extracted in quadruplicates using custom protocols from samples collected from ~92m and ~99m in depth (the anoxic zone) (Figure 2), as well as a sediment sample from the bottom of the water column (~100m in depth).

Genomic Characterization: Metagenomic analysis was used to build taxonomic profiles of these samples and identify potential gene clusters and emergent pathways developed as adaptation mechanisms to this cold, methane-rich environment.

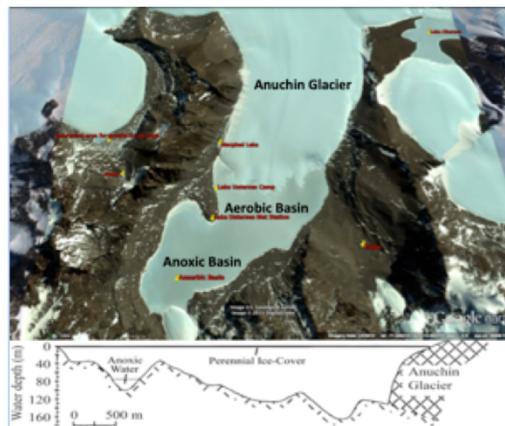


Fig 1. An aerial view and depth profile of the aerobic and anoxic basins of Lake Untersee [4].

References:

- [1] Taubner, Ruth-Sophie, et al. *Nature Communications*, vol. 9, no. 1, 27 Feb. 2018,.
- [2] Seckbach, J. Kluwer Academic Publishers, 2004.
- [3] Wand, Ulrich, et al. *Limnology and Oceanography*, vol. 51, no. 2, 2006, pp.1180–1194
- [4] Bevington, James, et al. *Antarctic Science*, vol. 30, no. 6, 2018, pp. 333–344.