A microbial life detection system for space missions

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Why this is important

The search for life in our solar system is among the highest priorities for space science, yet no modern instrument payload (on a rover/spacecraft) is able to definitively detect signs of life. The very recent detection of higher volumes of methane and oxygen on Mars, and the findings of water vapour over the icy surfaces of Europa and Enceladus, are strong indicators for potential habitability. Prof. Lyle Whyte's lab is developing the 'MICRO-life detection platform' to be capable of definitive life detection.

As public and private space sector activity increases, with plans for additional landers and sample caches for return to Earth, it's important that we look for the presence of native microbial life in these environments before irreversible contamination occurs. The search for life in our solar system is among the highest priorities for space science, yet no modern instrument payload (on a rover/spacecraft) is able to definitively detect signs of life. The very recent detection of higher volumes of methane and oxygen on Mars, together with the findings of water vapour over the icy surfaces of Europa and Enceladus, are strong indicators for potential habitability. Therefore, Prof. Lyle Whyte's lab is developing the 'MICRO-life detection platform' to be capable of definitive life detection.

In the past year, the Whyte lab has continued with the successful tests of different life detection instruments, increasing their automation, robustness, and sensitivity in a variety of Arctic subzero environments and desert locations in North America. These environments are considered terrestrial analogs of Mars and the Icy Moons, i.e. Enceladus and Europa. As a future goal, the combination of these instruments will be developed into a fully optimized platform for microbial life detection (the 'MICRO-life detection platform') and is expected to be integrated into future planetary exploration space missions. Specifically, these instruments are:

- **The MagLysis,** an automated biomolecule extraction unit focusing on DNA. DNA is an unambiguous sign of life and must be extracted from microbial cells for successful detection. DNA sequencing is then performed with the MinION, an ultralight and portable DNA sequencer. MinION sequencing in the Canadian High Arctic and North American desert environments showed diverse microbial communities mainly consisting of extremophiles, and also identified a detection limit of 100 cells/g for the MinION as published in Maggiori et al., 2020.
- A **Microbial Activity MicroAssay** (µMAMA), which detects and characterizes living microbial communities based on their metabolic activity using a colourimetric assay. This instrument is able to detect a broad number of metabolisms, including carbon cycling, lithotrophic and anaerobic pathways. This approach yielded positive results with as low as 1000 yeast cells and 4000 bacterial cells.
- The **Cryo-iPlate**, a novel culturing method used to isolate microorganisms from the environment. It allows for culturing of microorganisms in their natural environment and isolation of previously inaccessible microorganisms. Hundreds of diverse and unique Arctic bacterial strains have been cultured in situ using the Cryo-iPlate. This technique has shed light on the traits required for life in extreme cryo-environments, as well as the deep characterization of new microbial strains.

David Touchette, Ianina Altshuler, and Catherine Maggiori (MSI PhD) atop White Glacier on Axel Heiberg Island in the Canadian High Arctic testing an automated ice core drill developed in collaboration with Prof. A. Ellery from U. Carleton as part of a CSA FAST-funded project. (Image credit: David Touchette)