# DETERMINING SIGNATURES OF MICROBIAL LIFE IN DIFFERENT ENVIRONMENTS USING MICROBIAL FUEL CELLS.

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**Introduction:** The detection of chemical and physical signatures of microbial life on Mars or other solar system bodies is likely to remain controversial because of the challenge to distinguish these signatures from those produced by abiotic processes. For any successful life-detection mission it is essential to send instruments aimed at generalized in-situ life detection of extant life to complement the chemical and physical analyses taking place. We are working towards developing microbial fuel cells (MFCs) as life-detection instruments to measure microbial metabolism.

Microbial metabolism is a universal characteristic of life. Metabolism involves electron flow (redox) reactions among organic or inorganic substrates, which can be detected via chemical or electrical means. Changes in oxidation state can be investigated using electrochemical techniques such as fuel cells, which measure electrical current produced by redox reactions. Environmental samples from habitable niches should contain everything necessary to produce current flow, i.e., catalysts (microorganisms) and fuel (nutrients). MFCs can also probe for starving and/or inactive organisms in less habitable areas by artificially adding a fuel to drive growth.

We used half-cell setups with a three-electrode system to determine abiotic and biotic signatures in standard potting soil. Carbon felt electrodes were poised at a potential of +400 mV and consistent sampling of current was measured at the electrode throughout our experiments. More current was generated in half-cells with potting soil compared to the sterilized control. Other experiments were done using sterilized potting soil with the addition of a model microorganism, *Shewanella oneidensis* at different cell densities. The addition of fewer cells leads to greater current indicating microbial growth is constrained by resources, so less can be more for detection purposes.

Full cell tests were also conducted to complement the results of our half-cell experiments. Standard potting soil was inoculated into the anode chamber of the full cells with 50 mM $K_3Fe(CN)_6$ in the cathodic chamber. Voltage across a 10 Ω resistor was measured and recorded every 5 minutes with a multimeter. Results from control experiments were compared with experiments done adding a fuel source in the anodic chamber for metabolic stimulation of the endogenous microbial communities. The addition of lactate in our anodic chambers resulted in voltage an order of a magnitude higher. We are currently expanding our work with both electrochemical systems to test soils and sediments from extreme environments (e.g. Atacama Desert, deep ocean subsurface) along with Mars simulant soils.