Microbial Metabolic Exploration from Extreme Environments for Bioremediation and Energy Recovery

Center: ERC for Bio-mediated and Bio-inspired Geotechnics (CBBG)

Achievement Date: 2016

Outcome/Accomplishment:
The Microbial Metabolic Exploration (MME) project contributes to the exploration of extreme environments to harvest novel microorganisms useful for biotechnological applications. This year, MME focused on the microbial conversion of carbon monoxide (CO), and CO-containing gases (generated from combustion of recalcitrant biomass waste) to biofuels and commodity chemicals. Achievements include the systematic enrichment (see Figure 1) of microorganisms from extreme environments that convert CO into acetic acid and biofuels (i.e., ethanol and hydrogen). Explored environments include high pH locations in Oman and the bottom of the ocean in California (~30 m deep). In addition, MME has established methods to enrich microbial communities and isolate microorganisms from extreme environments.

Impact and Benefits:
CO-consuming cultures are important for bioremediation of polluted areas and conversion of biomass waste (Environmental Protection and Restoration), as well as generation of alternative energy (Resource Development). In addition, enrichment and isolation protocols established by MME will be useful to harness microorganisms with other microbial metabolic activities useful to other projects in CBBG.

Figure 1. Microbial community structure of transfers (T) made during the CO-enrichment process of volcanic sand. “T5-an” metabolizes CO to hydrogen (H2), ethanol and acetic acid. Ae: aerobic. An: anaerobic.

Explanation and Background:
Extreme environments are understudied. Nonetheless they harbor microorganisms with microbial metabolic reactions useful for geotechnical and biotechnology applications. An advantage of these extremophiles over common microorganisms is their resistance to harsh conditions. Examples of application of extremophiles in industry include production of carbonate for cementation at high pH, conversion of organic waste to methane at high temperature, and conversion of toxic gases, such as CO. CO-oxidizers enriched from extreme environments contribute to the sustainable production of biofuels and feedstock chemicals from CO generated in the gasification of recalcitrant biomass waste (e.g., forestry, agriculture and municipal waste). Moreover, the MME project establishes protocols to explore, identify and isolate novel extremophiles that can be used to bioremediate other toxic pollutants (e.g., chlorinated compounds), to harness energy (e.g., methane, hydrogen and ethanol) and other possible processes that can be useful to enhance infrastructure or to aid other important industries such as the mining one.