The Means of Production: Methylotrophy, Acetogenesis, and the Reverse Citric Acid Cycle in the Coast Range Ophiolite Microbial Observatory (CROMO)

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Serpentinites are known to support microbial communities that feed off of the products of serpentinization (e.g. methane, H_2 gas), while adapted to harsh environmental conditions such as high pH and low dissolved inorganic carbon (DIC) availability. However, the biochemistry of microbial populations that inhabit these environments is understudied and complicated by overlapping biotic and abiotic processes. The aim of this study was to identify potential sources of carbon and methods of primary production in an environment that is depleted of soluable inorganic carbon, to characterize the flow of metabolites within the microbial communities in this environment, and to describe overlapping biogenic and abiogenic processes impacting carbon cycling in serpentinizing rock.

We applied metagenomics, metatransciptomics, and metabolomics techniques to environmental biomass samples taken from the Coast Range Ophiolite Microbial Observatory (CROMO), a subsurface observatory consisting of a series of twelve wells drilled into an actively serpentinizing ophiolite in the California Coast Range. DNA and RNA sequence data from the CROMO wells suggests that methylotrophy, acetogenesis via the Wood-Ljungdahl pathway, and the reverse citric acid (reverse TCA) cycle are key pathways of primary production in the microbial communities at CROMO. Putative identification of several intermediate metabolites involved in these processes supports this hypothesis. The dissimilatory oxidation of formaldehyde by methylotrophs may provide formate and CO_2 to acetogens, thus mitigating conditions of limiting DIC. Our results are promising regarding the future use of metabolomics techniques in this and other serpentinizing environments, for the identification of biomarkers and metabolic pathways.