HOW TO ASSESS THE BIO IN BIOPROCESSES? CONTRIBUTIONS OF MICROBIAL COMMUNITY PROFILING TO MINE PERMITTING, OPERATIONS, AND RECLAMATION ACTIVITIES FROM THE PAST 5 YEARS.

Vanessa Friesen[1], Jordyn Bergsveinson[1], and Monique Haakensen[1]
[1] Contango Strategies, Saskatoon, Saskatchewan, S7N 4N1

Key Words: Innovation, environment, evidence-based decision making, genomics, bioremediation, passive water treatment, biofouling, MCP testing

Microbes are the driving force in many processes, acting as catalysts to facilitate biogeochemical reactions that influence mining operations and remediation efforts. Despite this influence, microbes have often been overlooked in mining-associated processes. Historically, this has largely been due to the inability to effectively test and interpret mining-associated microbiological samples and data in a way that is useful to inform decisions. However, technology has advanced dramatically over the past 5 years, and genetic (genomic) and growth-based microbial community profile (MCP) testing is now being applied to diverse mining processes and reclamation activities to inform and de-risk decision making (Fig. 1).

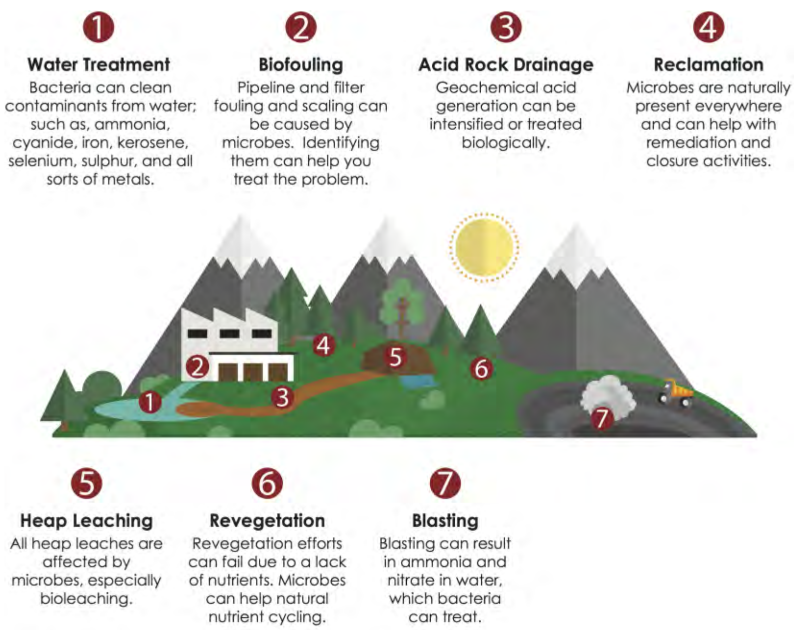

Fig. 1 – Examples of how microbes impact the mining sector

Microbial community profiling is now being used globally to aid mines with remediation, water treatment, consultation on acid rock drainage, and process optimization. The current state of technology is presented here as mini case studies from the past 5 years with example applications of MCP testing in mine settings. Examples range from permitting, design and optimization of reclamation activities, and treatment and prevention of fouling in operational processes.

Case study 1: Treatment and prevention of fouling in operational processes

Biofouling can occur when microorganisms accumulate on surfaces, blocking pipes and filters, and preventing process flow. To effectively treat and prevent biofouling, the microorganisms responsible for the build up need to be identified to determine treatment and mitigation strategies, as well as putative sources of the problematic organisms. Historically, identification may have been overlooked, and the problem would be addressed as a black box, or sometimes microscopic or metabolic testing may be attempted, which are unable to provide the resolution needed to identify the culprit organisms.

The selected case study is an example of identifying biofilms that were building up on distribution and picket fences in settlers used to separate copper from a pregnant leach solution. The build-up was problematic for process flow and required routine removal. Identification of the problematic organism through genetic MCP testing enabled recommendations for treatment and future prevention, as well as identified putative sources of the organism in the process.

Case study 2: Selection of plants for ammonia treatment during operations

A constructed wetland was being designed for operational treatment of ammonia (from blasting residues) for an underground mine in Canada. Ammonia oxidation is a process performed by bacteria in the wetland, but these bacteria are often found associated with the roots of plants. In order to effectively select the best plant sources for the wetland (i.e., those which would bring along beneficial bacteria with them), the microbial populations hosted by the roots of native *Typha* and *Phragmites* from different borrow sources near the construction site were compared with MCP testing.

This testing allowed for the selection of *Typha* from two different borrow sources for use in the constructed treatment wetland. Two sources were selected because the types of ammonia-oxidizing organisms were different in these borrow locations, and therefore inclusion of both increases the diversity of organisms that can perform the needed function in the wetland. In the context of treatment wetlands, the diversity of microbes present that can perform a desired function (in this case, ammonia oxidation/nitrification) can be regarded as a measure of robustness to treat the water under a wider range of conditions and changes in water chemistry.

Case study 3: Assessment of passive water treatment potential and testing through freeze-thaw for permitting

A mine project in the Northwest Territories is predicted to have seepage in closure that requires treatment. To assist in permitting, a site assessment was performed to delineate attenuation of constituents of concern that are occurring in a natural wetland on site, to inform site-specific design and testing of constructed treatment wetlands for closure.

Microbial communities were assessed along a watershed that receives seeps that are naturally high in arsenic, alongside other analyses for physicochemical parameters at the site. Using this information from the site assessment, a passive treatment wetland was designed and constructed at pilot scale to mimic natural conditions at the site that were found to improve arsenic treatment. The pilot-scale design successfully achieved targeted reducing and oxidizing conditions (in treatment cells designed for these respective conditions as part of a treatment train), and demonstrated the stability of key microbes through a freeze thaw cycle (Fig. 2). With historical tools, the microbial aspects of natural attenuation at the site and subsequent pilot-scale designs and testing through a freeze thaw cycle would have been poorly defined, leading to the inability to predict robustness and optimize performance.

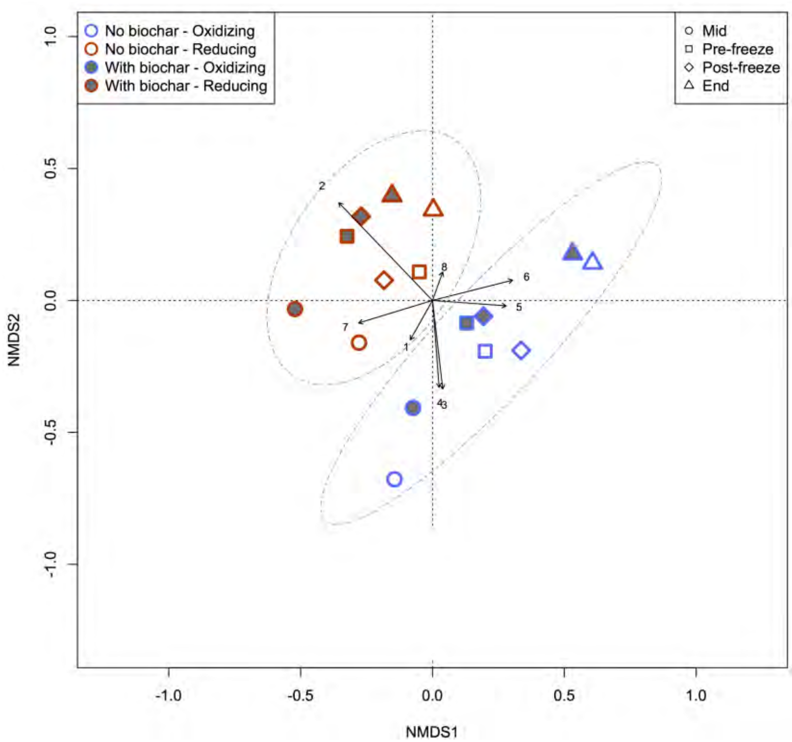

Fig. 2 – Microbial populations in pilot-scale treatment wetlands through freeze-thaw testing

Multivariate statistical analysis can be used to suggest relationships between microbial populations in different wetland designs over time and through a freeze-thaw cycle. Oxidizing and reducing conditions targeted in the treatment wetlands are outlined with dotted ellipses.

41st CLRA National Annual General Meeting and Conference

McIntyre Arena, Timmins, Ontario

June 26-29, 2016

PROCEEDINGS

Canadian Land Reclamation Association

Association canadienne de réhabilitation des sites dégradés