Bioremediation Successes in Cold-Weather Climates

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Background/Objectives. Bioremediation, or the enhanced acceleration of microorganisms to facilitate the breakdown of environmental pollutants is an established and effective means for the cleanup in soil, sediment, groundwater, and open water environments in cold-weather climates. Skepticism regarding the ability to bioremediate in cold-weather climates is common due to temperature influences in biological and environmental processes. Constraints imposed by low temperatures can lead to parameter limitations such as a lack, or surplus, of oxygen and/or other nutrients, and physical constraints such as freezing. Despite this perception, bioremediation remains the most cost-efficient and sustainable solution for the destruction of environmental contaminants. The goal of implementing bioremediation programs under these conditions is the same as many cleanup projects – reduction of constituent concentration levels below a regulatory standard to obtain site closure. While biodegradation rates in cold climates are slower than temperate regions, properly designed, executed, and monitored bioremediation projects are extremely effective in contaminant reduction and site restoration.

Approach/Activities. Human and societal activities have introduced industrial chemicals across the globe, including in high-elevations and cold climates, where unforeseen circumstances result in chemical releases to the environment. These man-made and natural chemicals include petroleum hydrocarbons, mineral and crude oils, chlorinated aliphatic, aromatic, and monoaromatic hydrocarbons, and dioxins/polychlorinated biphenyls, all of which are amenable to properly designed and implemented bioremediation strategies. In North America, many sites are situated in glaciated regions with tight soils, shallow water tables, and deep frost conditions for extended periods. Despite these challenges, indigenous cold-adapted microorganisms capable of biodegradation occur in essentially all cold-climate soils, sediments, and waters. Identifying these naturally occurring and available organisms which can potentially be utilized for bioaugmentation is critical in the early stages of site investigations. Establishing effective biostimulation nutrients and amendments are also important in the early-stages of remedial designs. In many cases, these are the same species that occur in temperate climates, but natural selection has yielded viable populations that exist at lower optimal populations compared to temperate climates. Harnessing and enhancing this potential is the backbone of a successful cold-weather bioremediation program.

This presentation highlights and describes essential elements of design and implementation of biostimulation and bioaugmentation programs for compounds in glacial and bedrock terrains in northern-tier states and provinces, including bedrock and karst terrains in the central and midwestern states. Identifying and selecting the proper bioremediation strategy is essential for each individual cleanup project.

Results/Lessons Learned. Successful bioremediation projects can be performed in cold-weather climates despite skepticism concerning the influence of temperature on typical remediation pathways. Understanding and utilizing these primary drivers in natural and chemical processes and reactions is a crucial step. Once understood, it is common to achieve greater than ninety percent (90%) chemical reduction via bioremediation for properly designed and executed projects. This success has been demonstrated for bioaugmentation and biostimulation programs by selecting the appropriate bioremediation strategies across different classes of chemical impacts in the environment.