Application of Functional Genomics to Improve Chlorinated Ethene Bioremediation Processes

David R. Johnson
Department of Civil and Environmental Engineering
University of California, Berkeley

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Abstract

Chlorinated ethenes are among the most prevalent contaminants of groundwater resources and pose a significant threat to human and ecological health. Remediating these resources with traditional pump-and-treat strategies is both technically challenging and costly. Fortunately, strategies that utilize natural microorganisms to degrade these pollutants in situ have now been developed and applied with success. Of particular interest is to utilize members of the *Dehalococcoides* group of bacteria because they are the only known organisms that can completely degrade fully chlorinated ethenes to non-toxic end products. Although significant progress has been made, there is now a need for effective methods to both optimize and monitor the performance of *Dehalococcoides*-based bioremediation systems.

To begin to address these needs, this research applied functional genomics tools to improve our understanding of *Dehalococcoides ethenogenes* strain 195. Specifically, transcriptomics were analyzed by whole-genome microarrays while proteomics were analyzed by liquid chromatography coupled with tandem mass spectrometry. These tools were applied during periods of maximal and repressed activity in order to identify factors that can potentially limit dechlorination. This approach successfully identified cobalamin (vitamin B₁₂) as a key factor controlling dechlorination activity and revealed novel strategies for minimizing cobalamin deficiencies within bioremediation systems. In addition, these studies identified mRNA and peptide biomarkers that could be used to quantitatively assess the physiological state of strain 195 within uncharacterized systems.

The results of this research demonstrate that functional genomics can dramatically accelerate our understanding of reductive dechlorinating bacteria important for bioremediation applications. There is now a need for more collaborative efforts between the fields of genome sciences and environmental problems.