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Thermally-Enhanced Biodegradation: Final Step to Rapid Site Closure

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Background/Objectives. In situ thermal remediation (ISTR) is a demonstrated approach for rapid and successful cleanup of NAPL source zones. However, at many sites some dissolved phase contamination can remain associated with the source zones after completion of ISTR. Use of biodegradation processes to “polish” remaining dissolved mass in heated groundwater is a current area of research which spans from evaluating the effect of heat on the release of electron donor from naturally occurring organic material (for reductive dechlorination) to determining the optimal temperature required to promote growth of key organisms (for natural source zone depletion). Study results suggest there are optimal temperatures or temperature ranges where enhancement of biodegradation can occur for different classes of contaminants. This presentation will evaluate data from several thermal case studies to assess the role of residual heat on enhancing degradation processes (post active heating).

Approach/Activities. Traditional application of heat during a thermal project typically targets temperatures at or above the boiling point of water (100C). Research into optimal temperatures to stimulate microbial growth indicates there may be no significant additional benefit to microbial growth/stimulation once temperatures reach above 30C to 40C, and potential detrimental impact to targeted organisms (i.e., die-off) above 60C. While several strategies can be deployed to maintain lower temperature throughout to optimize bioremediation only processes, the focus of this paper is to evaluate the impact of traditional heating and its effect on addressing remaining dissolved phase contaminant both in and around the targeted treatment zone(s) following active heating. Microbial, geochemical and compound specific isotope analysis (CSIA) data were collected from several thermal projects pre- and post-treatment to evaluate the impacts of heat on biodegradation activities.

Results/Lessons Learned. Data from case studies will be presented to show multiple lines of evidence that indicate enhanced degradation processes stemming from heat may play a potentially significant role in polishing residual dissolved phase mass following thermal treatment. Lines of evidence include microbial testing results, geochemical data, CSIA data, and volatile organic compound trend analyses. Data suggest both biological and abiotic processes are active at thermal projects and are therefore mechanisms that are participating in reduction of residual dissolved mass, thereby contributing to the rapid transition to monitored natural attenuation (MNA) and site closure observed at these sites. This can have broader ramifications as incorporating an enhanced degradation polish using residual heat may also allow for shorter heating timeframes, which can lead to a cost savings and more sustainable approach to thermal treatment design.