Abiotic and Biotic Degradation of TCE by Aquifer Materials from the California Middlefield-Ellis-Whisman (“MEW”) Site

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Background/Objectives. Tetrachloroethylene (PCE) and trichloroethylene (TCE) have been heavily used as commercial and industrial solvents for decades. PCE and TCE are toxic and are among the most frequently detected groundwater contaminants. Natural attenuation of PCE and TCE has been extensively studied and is widely accepted to contribute to PCE and TCE biodegradation. It is still unclear, however, whether abiotic degradation of PCE and TCE by reduced iron (Fe) minerals, natural organic matter, and reduced sulfur species contributes to natural attenuation. Of these reactions, reduction by reduced Fe minerals has been discussed as a particularly promising pathway for natural attenuation of chlorinated solvents. Here we present findings on the reduction of PCE and TCE using soil samples collected from the Middlefield-Ellis-Whisman (“MEW”) superfund site in Mountain View, California. The site consists of an approximately one square mile chlorinated solvents groundwater plume containing TCE and its daughter products *cis*-1,2-dichloroethene (*cis*-1,2-DCE) and vinyl chloride (VC).

Approach/Activities. We collected direct-push soil cores and nearby groundwater samples from four locations within the MEW TCE plume. Groundwater samples were collected from monitoring wells located within the groundwater plume, and characterized for dissolved Fe(II) and sulfide, dissolved oxygen, pH, and ORP in the field prior to shipment to The University of Iowa (Iowa). Soil cores were selected from the saturated aquifer materials and vacuum sealed in the field to maintain anoxic conditions. At Iowa, we used wet chemical extractions, x-ray diffraction, and Mössbauer spectroscopy to identify the minerals present in aquifer materials. Soil samples were tested for Fe(II), total Fe, and acid volatile sulfides. We also analyzed the groundwater samples for major anions, dissolved metals, dissolved organic carbon, and alkalinity. Microcosm experiments were conducted with no amendments, as well as with abiotic Fe(II) and sulfide amendments to evaluate TCE degradation. A subset of abiotic experiments will be conducted on heat-killed (Tyndallized) soil suspensions. Biological experiments will be conducted with added sulfate and electron donor amendments, and dechlorination rates will be compared from biologically active and heat-killed experiments.

Results/Lessons Learned. The overall objectives of our work is to investigate whether significant abiotic reduction of TCE occurs in MEW aquifer material, and if the rate of abiotic TCE degradation is fast enough to contribute to natural attenuation of TCE to benign products at field-relevant rates. Furthermore, through both abiotic and biological experiments, we will explore whether the biogeochemical production of sulfide and Fe(II) is capable of enhancing abiotic reduction. Our goal is to establish a framework by which characterization of select aquifer materials could be used by site managers to infer the likelihood of attenuation of TCE by abiotic degradation.