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Efficacy of an In-Well Sonde to Determine Magnetic Susceptibility of Aquifer Sediment as a Predictor of Abiotic Degradation of TCE

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Background/Objectives. Magnetite is a natural component of many aquifer matrices. Abiotic degradation of chlorinated solvents, specifically the chlorinated ethylenes, on magnetite can be an important mechanism for natural attenuation of these contaminants. The quantity of magnetite in aquifer materials can be estimated by measuring the magnetic susceptibility. This is most commonly done using core samples sent to an analytical laboratory for analysis. In the past, if exploratory site characterization had already been completed, then the cost of acquiring core samples often made an evaluation of abiotic degradation on magnetite economically unrealistic. Downhole sondes (probes) that can be lowered into existing PVC monitoring wells are available for the determination of magnetic susceptibility.

Approach/Activities. As part of ESTCP Project ER-201584, a W&R Instruments HM-453S Magnetic Susceptibility Probe was evaluated as an affordable alternative to acquiring and analyzing core samples. The sonde was introduced into ten monitoring wells. The data from the sonde were then compared to data from core samples collected in, or near, the well into which the sonde was lowered. The sonde reports volume magnetic susceptibility in S.I. units. Volume magnetic susceptibility values were converted to mass magnetic susceptibility by dividing by an assumed bulk density of 1,700 kg/m^3 for aquifer material. The working range of the sonde used for this work extends from 4.12E-9 m^3/kg to 4.12E-5 m^3/kg. The sonde was lowered into both 5.1 cm (2 inch) and 10.2 cm (4 inch) inner diameter polyvinyl chloride (PVC) groundwater monitoring wells using a winch and data from the sonde were recorded.

The core samples evaluated in this study were collected and analyzed by others. They were collected using various methods including using a plastic sleeve in conjunction with a push core sampler, a post-hole digger, and from hollow-stem auger boreholes used to install monitoring wells. Core samples were analyzed by either Microbial Insights using a Bartington Magnetic Susceptibility System MS2B Dual Frequency Sensor and a MS3 USB meter or by the USEPA Robert S. Kerr Research Laboratory using a Bartington MS2 Magnetic Susceptibility System.

Results/Lessons Learned. At the five sites that were investigated, the downhole sonde reported values that were similar to values reported on core samples (R^2=0.88). At most wells, the means of the two measurements could not be distinguished at 95% confidence. When the means could be distinguished, they still agreed within a factor of two. If appropriate monitoring wells are available (i.e., non-metallic wells with no downhole metallic components), downhole magnetic susceptibility sondes can provide an alternative to the collection and analysis of borehole core data. These data can be used to evaluate abiotic degradation of PCE, TCE, and *c*DCE on magnetite to help determine if this is a plausible degradation mechanism at a site. Because there were many more data points provided from the sonde compared to core samples, the sonde data provided more certainty in the estimate of average value for magnetic susceptibility. The quality of the data provided by the sonde is adequate to evaluate abiotic degradation of PCE, TCE, and *c*DCE on magnetite.