Min-Traps for Collection and Analysis of Reactive Iron Sulfide Minerals for Abiotic CVOC Degradation

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Background/Objectives. The degradation of chlorinated compounds by reactive minerals (e.g., iron sulfides) is a subject of much active research (Whiting et al. 2014, He et al. 2015, etc.). However, cost-effective tools to evaluate these treatment processes in field applications are limited, and collection of samples to evaluate in situ mineral formation is costly due to drilling requirements. The Min-Trap® is a simple and cost-effective approach for the collection of samples to directly confirm the formation of reactive minerals in situ without the need for drilling.

Approach/Activities. Development and testing of the Min-Trap was initially conducted in the laboratory by simulating mineral precipitation scenarios, including co-precipitation of arsenic with iron oxides under oxidizing conditions and precipitation of iron sulfide minerals under sulfate reducing conditions. These laboratory studies supported refinement of the Min-Trap design and evaluation of the utility of specific analytical methods, including weak acid soluble iron, strong acid soluble iron, acid volatile sulfide/chromium extractable sulfide (collectively referred to as AMIBA), and scanning electron microscopy-energy dispersive spectroscopy (SEM/EDS). Based on these results, a comprehensive demonstration and validation program, funded by the Environmental Security Technology Certification Program (ESTCP), was completed that included a 6-month tank test and field testing at multiple chlorinated solvent remediation sites.

Results/Lessons Learned. At all sites SEM/EDS and AMIBA results confirmed that Min-Traps successfully captured reduced iron and sulfide minerals being precipitated in the area where remediation fluids were injected, and the results support the following summary statements:

- The Min-Trap results correspond with expected results based on geochemical conditions.
- The minimum deployment time for Min-Traps was determined to be two months.
- Min-Trap samples are stable for at least 2 weeks.
- The data from Min-Traps and traditional soil core collection methods are comparable.
- The spatial variability in Min-Trap results correspond with expected results based on
- geochemical conditions.
- Min-Traps are applicable for moderate-to-high flux unconsolidated geologic settings.
- Targeted microbial community characterization can be performed from Min-Trap samples.
- Abiotic reaction rates can be measured from Min-Trap samples.

In addition, the data provide insight into geochemical changes that impact reactive iron sulfide precipitation over time; specifically: 1) the variability in iron sulfide mineral precipitation processes over time, 2) the correlation between the abundance of precipitates in core samples and Min-Traps, 3) the variability in mineral precipitation processes at different locations, 4) the correlation of mineral precipitation processes with groundwater geochemical data, and 5) the

utility of Min-Trap data to support the evaluation of remedy performance and impact remedial decision making.