Modeling As(III) removal by synthesized FeS coated sand in batch and column systems

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Natural sand coated with synthesized nano-scale FeS has been proposed as a permeable reactive barrier material for use in remediation of arsenic contaminated groundwater in reducing environments. Previous studies on synthesized FeS suggested that arsenite can be removed through redox reactions to form arsenic sulfide minerals at low pH, while at neutral to high pH arsenite is primarily sorbed to the FeS surface [1]. In this study, geochemical modeling software PHREEQC [2] was used to model arsenite retention by FeS coated sand in batch and column systems. The modeled chemical reactions include aqueous speciation, redox reactions, mineral dissolution/precipitation and a simplified surface complexation model (SCM) to account for pH-dependent arsenite sorption. A nonlinear parameter estimation package PEST [3] was used to fit parameters for the SCM based on data from batch experiments. Direct application of the fitted model to column systems produced a much lower breakthrough plateau than exhibited by the experimental data, suggesting that kinetic factors may be controlling the reactive transport behavior of arsenite in the columns. PEST was then coupled with the transport module in PHREEQC to estimate possible rate parameters based on experimental breakthrough data. Results suggest that arsenite reduction and subsequent precipitation as AsS may be rate-limited in the pH5 column, while arsenite sorption to FeS coated sand may be rate-limted in the pH7 and pH9 columns. Model simulations, incorporating the estimated set of kinetic parameters, successfully reproduced the arsenite breakthrough in column experiments.

[1] Gallegos *et al.* (2007) *ES&T* **41,** 7781-7786. [2] Parkhusrt & Appelo (1999) *User's Guide to PHREEQC (v.2)*, U.S. Geological Survey Water-Resources Inv. 99-4259. [3] Watermark Numerical Computing (2004) *PEST Model-Independent Parameter Estimation User Manual, 5th Edition.*

Geogas: Phenomena and application

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Geogas or metals-in-soil-gas as a medium for mineral exploration has been tested for over 15 years in China and significant progress has been made since the development and adoption of liquid collector with active sampling procedure and ICP-MS analytical method. The liquid collectors are very low in trace metals, can be controlled with blanks and be accurately and directly analyzed with ICP-MS.

The pilot study from several known sulphide deposits covered by loess, Tertiary sandstone and quaternary alluvium shows that:

1. The distribution patterns of elements in Geogas coordinate with that in the earth and Crust.

2. Gaseous metal anomalies mainly comprising of Cu, Pb, Zn, Cd, Ni, Sb, Bi, Tl, Au and Ag were observed over almost all sulphide mineralizations covering by transported overburden.

3. The highest Cu and Zn of Geogas above sulphide orebodies can reach over 300ppm and 200ppm per litre gas although the metals in the barren area can often be lower than 1 ppb for Cu and several ppb for Zn.

4. The analytic results of Pb isotopes in a known polymetallic deposits covered by loess and Tertiary sandstone show that the Pb isotope ratios of Geogas in background area are different from that in a single surrounding medium including loess, Tertiary red earth and sandstone, host rocks and ores. Great differences were found between the Pb isotope ratios in anomalous samples above the orebodies and that in background samples, which indicates that some anomalous Pb might add to the Geogas. The ratios of Pb isotopes in Geogas above the mineralizations, which show smallest variation and similar distribution to that in sulphides, give evidence that some metals in anomalous samples originate from deep orebodies.

The Geogas survey was used as a tool to explore mineral deposits including gold, polymetallic and nickel and succeed in prospecting for several polymetallic mineralizations in blind area in the past few years. It can be concluded that Geogas is a natural phenomenon with many mysteries and Geogas survey can be used as a potential and practical tool for mineral exploration in areas with exotic overburdens in future.