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Sandia's Heavy Metal Scavengers

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
for the United States Department of Energy's National Nuclear Security Administration
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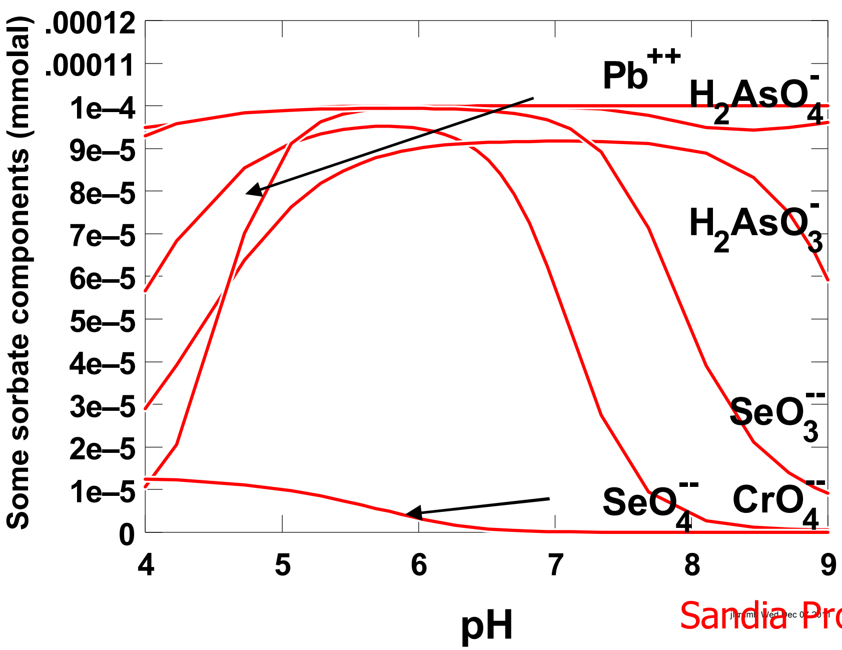
Background

- **Decades of experience in containing and controlling radionuclide migration in natural settings.**
- **Multiple DOE-funded programs to develop water treatment technologies.**

The first step is typically to identify materials that selectively pick up the target pollutant. A common screening metric is the Kd, which is simply the ratio of the concentration of a pollutant that a solid picks up divided by the residual concentration remaining in solution.

SANS – An Iron Oxide Based Scavenger

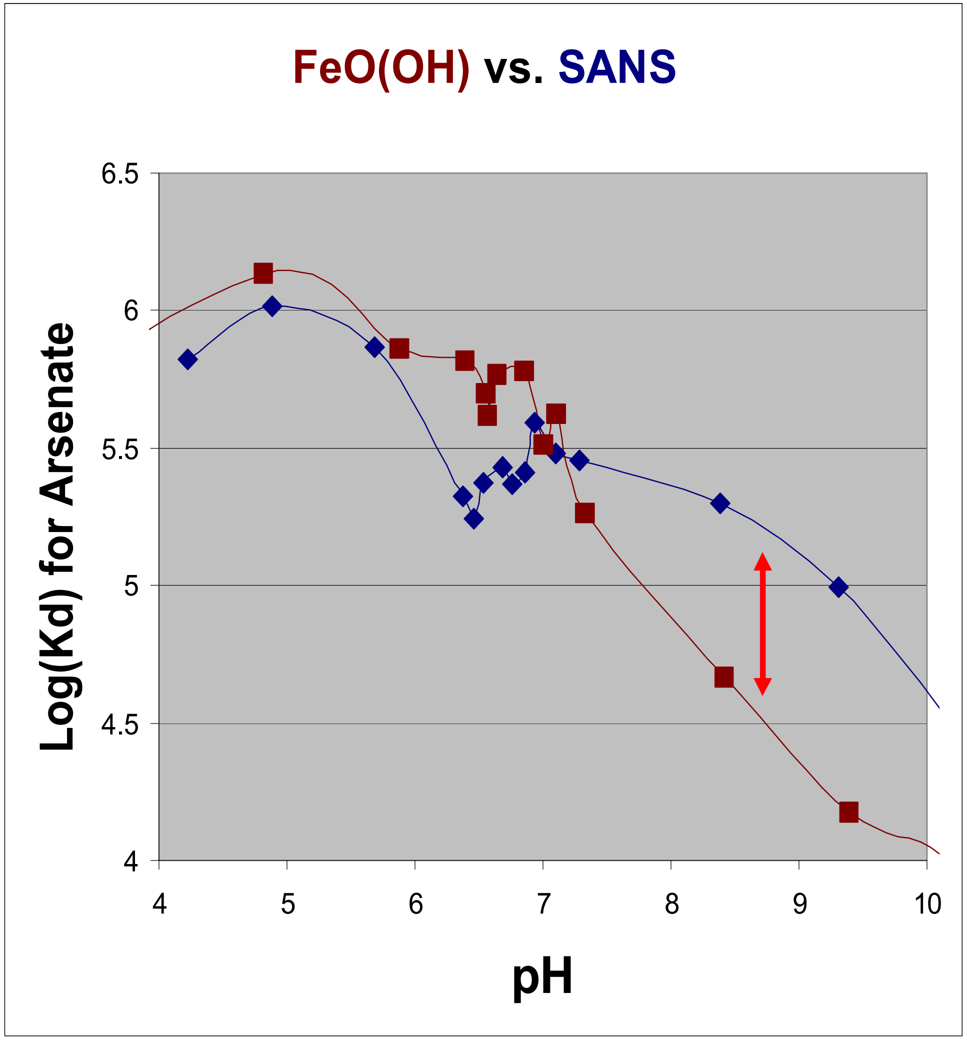
- **Developed by Sandia to address new EPA <u>arsenic</u> drinking water regulations – multiple patents issued.**
- **Copper hydroxy-arsenate is exceedingly insoluble and iron oxides are known to sorb arsenic, and many other metals, over a broad pH range.**



SANS: *<u>hydrous iron oxide plus copper</u>*, combines both approaches to arsenic capture.

(REACT model of metal sorption on FeO(OH)

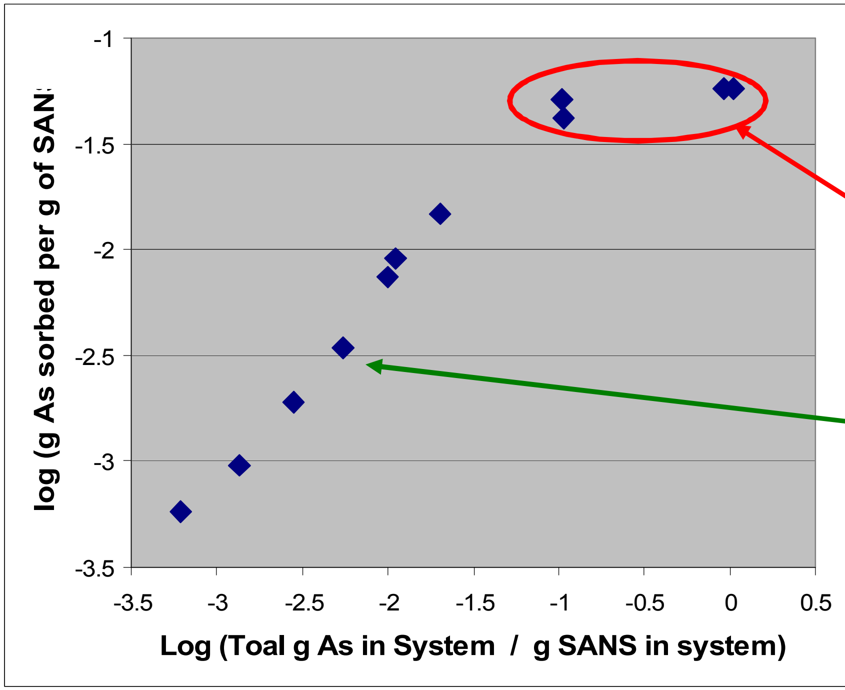
SANS Performance



Early tests showed SANS was superior to untreated hydrous iron oxide filter media available at the time -particularly in moderately basic ground waters here in the Southwest.

SANS also performed well in column tests at water systems in both New Mexico and Texas.

Commercial Applications of SANS



Industrial wastes will have more arsenic than groundwaters.

Media will eventually saturate.

Evan though at low As levels a Kd approach predicts linear uptake - Kd x As(aq) = As (solid).

Competition from other dissolved species also impact system design:

Species	*Kd @ 10^{-3} molar*
HAsO4--	$10^{5.36}$
H4SiO4	$10^{3.35}$
H2PO4-	$10^{4.06}$
H3BO3	$10^{1.74}$
HCO3-	$10^{3.52}$
F-	$10^{2.16}$

Knowing material costs and maximum achievable loadings are important economic drivers in designing pollution control systems

Sandia Proprietary - Patent Caution

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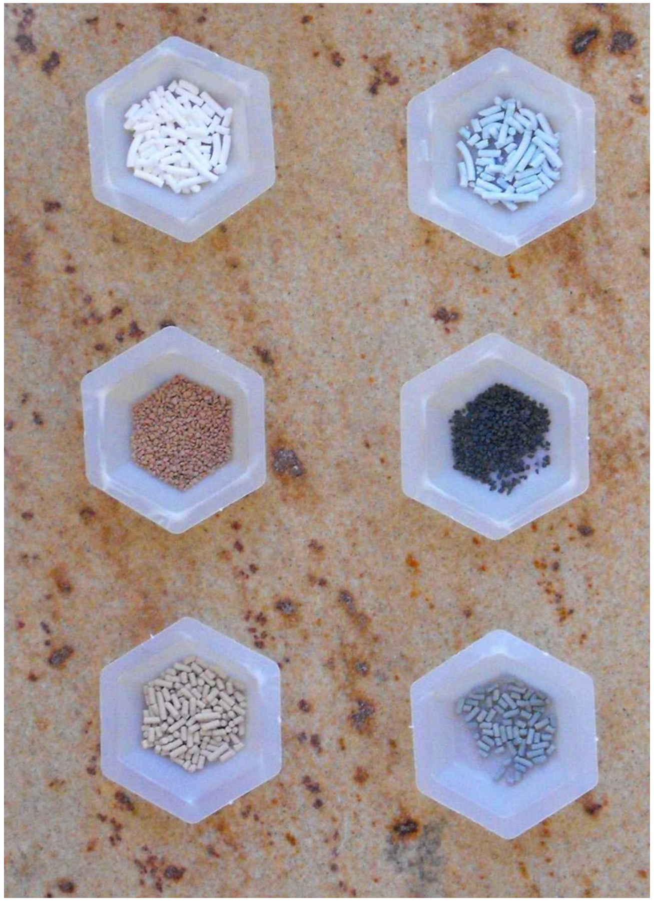
Modified Aluminosilicate Substrates



Previous Sandia studies with zeolites suggest that they might be modified to capture heavy metals – successfully tested for Hg.

The same chemistry that allows them to capture Hg suggests they could also capture Pb and Cd.

Layered Metal Oxide Sorbants

Initially developed to capture radioiodine and technetium from the processing of used nuclear fuel

Principally useful for capture of anionic pollutants

1. Traditional transition metal hydrotalcites: "$Mg_6Al_2(OH)_{18}$"

Kd, I^- up to $10^{4.0}$; Kd IO_3^- up to $10^{4.8}$, Kd TcO_4^- up to $10^{3.4}$

2. Non-traditional heavy (non-toxic) metal-oxide layered materials*

Kd, I^- up to $10^{4.2}$ Kd IO_3^- up to $10^{4.9}$ Kd TcO_4^- up to 337

Kd As up to $10^{7.7}$ Kd Se up to $10^{3.9}$ Kd ClO_4^- up to 21

Kd Nd up to $10^{4.6}$ Kd Hg up to 622

*For comparisons on an atom for atom basis with sorbants comprised of light atoms (Al, Si, etc.) multiply Kd values by about 5.

Conclusions

- Multiple options have been identified depending on the pollutant in question and the environment in which they must function.
- Each class of materials contains numerous structural variations (at the atomic level) with widely differing properties.
- Because of the structural diversity considerable additional work is needed to optimize performance envelopes, quantify loading capacities and characterize uptake rates.
- Most materials are synthesized as fine powders so finding appropriate binders are a universal concern.