PELCAPs: Permeable Environmental Leaching Capsules for *In Situ* Evaluation of Contaminant Immobilization in Soil

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- **Remediation strategies focused on contaminant immobilization must demonstrate:**
  - **Decreased soluble contaminant.**
  - **Increased contaminant in poorly soluble phase.**
  - **Evidence for long-term stability.**
- **There is a need for low-cost, nondestructive techniques to evaluate the above.**
- **Polymer-encapsulated soils (PELCAPS; Fig. 1) were leached continuously in surface and groundwaters at two field sites.**
- **Contaminant leaching behavior was well-described by a diffusion equation that enabled the quantitative estimation of contaminant mobility under actual site geochemical conditions (Fig. 2).**
- **This proof-of-principle study established the baseline feasibility of a generic nondestructive *in situ* assay technique for quantifying immobilized contaminants on soils and sediments using permeable environmental leaching capsules.**
- **Convenient test for large numbers of soils and soil treatments.**

Figure 1

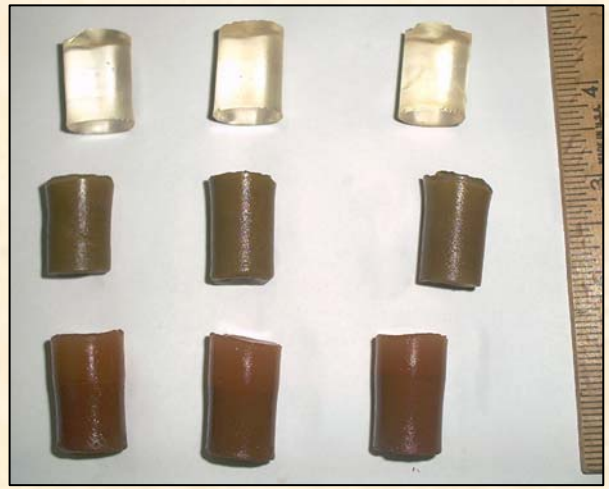
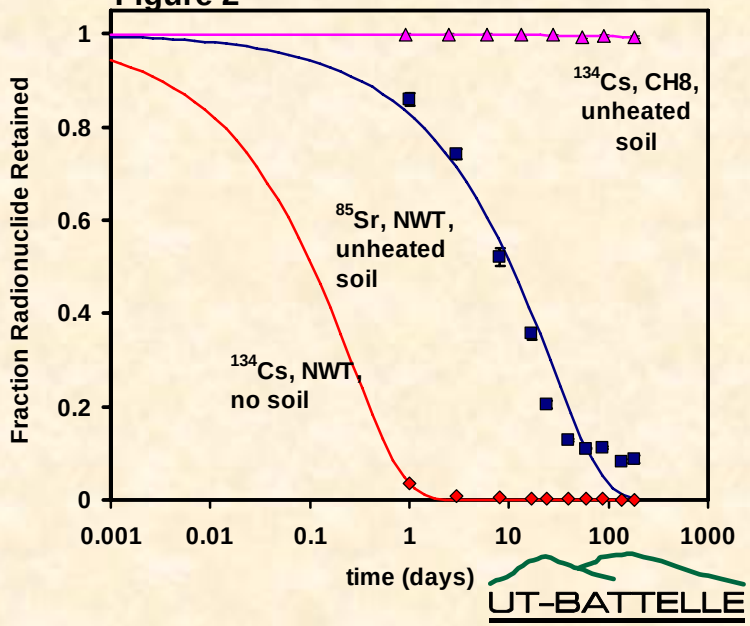


Figure 2



Permeable Environmental Leaching Capsules (PELCAPs) for *In Situ* Evaluation of Contaminant Immobilization in Soil

We encapsulated radioisotope-spiked soil within a water-permeable polyacrylamide matrix cast in a small cylindrical geometry (≈ 5 cm^3) to measure the persistence of immobilized soil contaminants. As a proof-of-principle, soils contained within these permeable environmental leaching capsules (PELCAPs) were labeled with either ^{85}Sr or ^{134}Cs and were leached in both laboratory tests and continuously in situ with ground and stream waters at two field sites on the Oak Ridge Reservation. Groups of PELCAPs were retrieved, assayed nondestructively for radioisotopes via gamma spectroscopy, and then replaced in ground and surface water repeatedly over a six month period. PELCAPs that contained no soil readily and quantitatively leached either ^{85}Sr or ^{134}Cs into laboratory extractants or ground or surface water with effective diffusion coefficients (D_{eff}) of (1.14 ± 0.06) and (4.8 ± 0.2) × 10^{-6} cm^2/s, respectively. PELCAPs containing thermally-treated soil quantitatively retained both isotopes in the field tests and in laboratory sequential extractions. PELCAPs containing untreated soil readily leached >90% of ^{85}Sr but <1% of ^{134}Cs during field leaching at both sites. Soils were quantitatively retained in the PELCAP polymer matrix and maintained their cation exchange capacities during the exposure period. Permeable polymer encapsulation methods, such as PELCAPs, offer the potential capability to conveniently test large numbers of soils and soil treatments for contaminant release and uptake under actual field environmental conditions.

Reference:

Spalding, B. P. and S. C. Brooks. *in press*. Permeable environmental leaching capsules (PELCAPs) for in situ evaluation of contaminant immobilization in soil. Environ. Sci. Technol.