U. S. Department of Energy

Office of Science

Environmental Remediation Sciences Program

Hydrogel-Encapsulated Soil To Measure Uranium Attenuation In Situ

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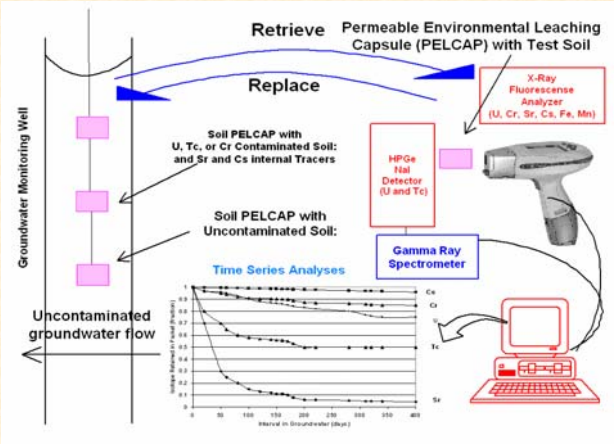
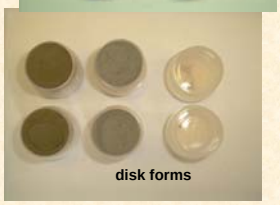
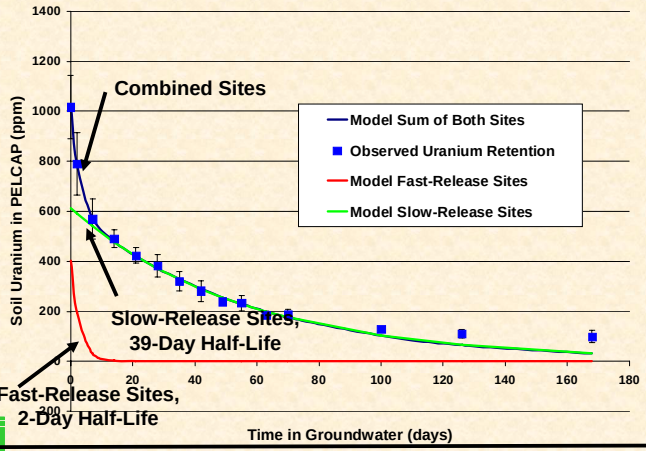
Permeable Environmental Leaching Capsules (PELCAPs) - A Tool To Monitor Soil Contaminant Behavior In Situ



Hydrogel-Encapsulated Soils Are Assayed Non-Destructively for Many Contaminants, Including Uranium, To Follow Adsorbed Contaminants In Situ Over Extended Intervals



Kinetic Model Calculated 60% of Total Soil Uranium in a Slow-Release Sites (39-Day Retention Half-Life) and the Remainder in Fast-Release Sites (2-Day Retention Half-Life) For One Untreated Soil.



A Simple Kinetic Model Is Used to Describe In Situ Uranium Leaching Employing Slow- and Rapid-Release Fractions

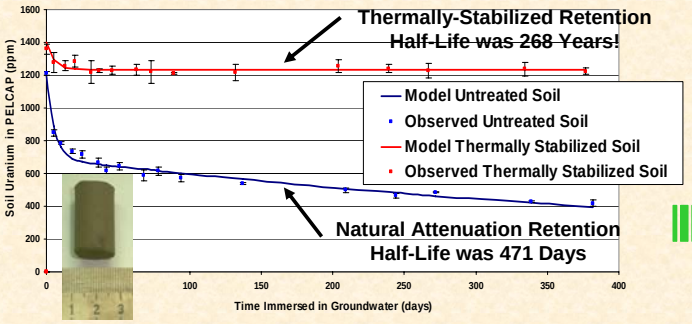
Kinetic model provides objective method to compare treatments (natural attenuation, bioreduction, pH manipulation, etc.) and soils.

$$C_t = N \cdot C_0 \cdot e^{-k_1 \cdot t} + (1-N) \cdot C_0 \cdot e^{-k_2 \cdot t}$$

Where:
C_t = Retained uranium concentration (ppm) at time, t,
N = fraction of total uranium in slow-release form,
C_0 = total starting soil uranium (ppm),
k_1 and k_2 = kinetic constants (day^{-1}) for the slow and rapid release forms,
t = leaching or immersion time (days)

A "good" treatment has a large N (most uranium in slow-release fraction) and a small k_1 (slow release is very slow)!

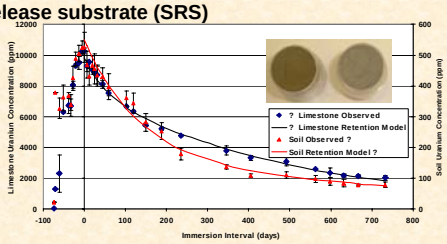
In Situ Leaching Performance of Naturally Attenuated Uranium Can Be Compared With Various Soil Treatments (e.g., Thermal Stabilization)



Key Benefit of Hydrogel-Encapsulated Soils Is the Capability To Measure Long-Term Immobilization of Uranium

PELCAPs Are Being Used To Compare Long-Term In Situ Performance of Various IFRC Tests:

- Bio-reduction with ethanol
- Bio-reduction with slow-release substrate (SRS)
- Imposed pH manipulation
- Natural attenuation
- Phosphate immobilization



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