# $^{14}C$ and $^{99}Tc$ Attenuation Based Strategies for Environmental Remediation

PARTNERS

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*Mined clays were modified with organic binding agents to create organoclays that have an extraordinarily high affinity for 99Tc.*

## Technical Summary

$^{14}C$ and $^{99}Tc$ are especially important risk drivers at Sellafield, a nuclear reprocessing and decommissioning facility in the UK, and within the DOE complex because of their large inventory, long radionuclide half-lives (5730 yr for $^{14}C$ and 211,000 years for $^{99}Tc$), and high mobility in the environment stemming from their anionic character. Furthermore, they are among the top three risk drivers at DOE high- and low-level waste disposal sites. The objective of this study is to develop attenuation based strategies for $^{14}C$ and $^{99}Tc$ that would be appropriate for DOE and the Sellafield site. Building on recent discoveries, SRNL and NNL will merge their complementary skills to develop three strategies: 1) $^{14}C$ attenuation using natural organic matter, 2) $^{14}C$ in situ removal from groundwater/surface water by air sparging, and 3) $^{99}TcO_4$- attenuation using highly effective, inexpensive organo-modified clays. The approach involves testing these technologies over a wide range of temporal and spatial scales, including a complementary suite of laboratory, field, and computer-based testbeds. NNL and associated universities bring to this collaboration a new class of reactive transport models, an air sparging $^{14}C$ remediation strategy, and access to samples from another field site to test the robustness of the attenuation based strategies, while SRNL provides experience related to these attenuation based strategies. If successful, this technology will provide an inexpensive solution to environmental remediation problems at six DOE sites and Sellafield.

## Path Forward

- Monitor SRS field demonstration of the organo-clay technology.
- Conduct $^{14}C$ and $^{99}Tc$ laboratory testing of the natural organic matter amendments. Characterize the nature (strength/longevity) of the bond between the radionuclides and the natural organic matter amendment.
- Conduct laboratory testing to evaluate the manipulation of the partial pressure of non-radioactive $CO_2$ to remove $^{14}C$ from groundwater.
- Develop models to optimize technology deployment.

## Key Accomplishments

- Installed field demonstration of sorbent (organo-clay) within the SRS F-Area Tc plume. Presently monitoring results.
- Conducted small angle X-ray scattering (sXAS) analyses of Tc bound to organo-clays that demonstrated Tc existed in the most common form it is found in the environment, $Tc^{VII}O_4$-. The significance of this finding is that this technology can be deployed without significantly changing the natural environment (i.e., converting a naturally oxidized environment into a reducing environment to promote the reductive precipitation of $Tc^{IV}O_2$ sparingly soluble solids).
- Organo-clays had near complete $Tc^{VII}O_4$- removal from groundwater (Kd values were >120,000 L/kg; for comparison, the Kd value of soil is ~1 L/kg).
- Initiated $CO_2$ laboratory sparging testing under Sellafield conditions.

## Key Benefits

- Successful demonstration and deployment of the technology will help address an intractable problem for DOE, reducing the risk associated with $^{14}C$ and $^{99}Tc$ contaminant plumes.
- DOE leveraging of UK investments at NNL will: 1) provide modeling capability to optimize technology deployment, and 2) will utilize NNL's existing infrastructure to test remediation strategies under simulated Sellafield conditions.

For more information on this project or the EM International Program

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