RadEMSL

A collaborative atmosphere where visiting users and EMSL scientists from different disciplines foster an environment where research strategies and approaches benefit from a variety of perspectives.

RadEMSL is designed to accelerate scientific discovery and deepen the understanding of the chemical fate and transport of radionuclides in terrestrial and subsurface ecosystems.

The caliber of research, instruments and access to EMSL staff scientists at this modern laboratory is drawing top radiochemistry scientists from around the world. The co-location of a user facility for radiochemistry and a full suite of state-of-the-art instrumentation is unique in the United States, and it is one of just a few such user facilities worldwide.

The spectroscopic and imaging instruments at this laboratory are ideally designed for the study of contaminated environmental materials and examination of radionuclides and chemical signatures. RadEMSL offers nuclear magnetic resonance capabilities and surface science capabilities, such X-ray photoelectron spectroscopy, electron microscopy, electron microprobe, transmission electron microscopy, scanning electron microscopy and more.

RadEMSL is an environment where multiple experimental approaches coupled with computational techniques are encouraged. Investigating problems at an integrated, cross-disciplinary level encourages holistic understanding, which ultimately provides policy makers the information they need to make sound remediation choices.

Take a virtual tour of RadEMSL:
http://tour.pnnl.gov/radiochem.html

About EMSL

EMSL, a Department of Energy national scientific user facility located at Pacific Northwest National Laboratory, provides integrated experimental and computational resources for discovery and technological innovation in the environmental molecular sciences to support the needs of DOE and the nation. EMSL is funded by DOE's Office of Biological and Environmental Research.

EMSL's distinctive focus on integrating computational and experimental capabilities, as well as collaborating among disciplines, yields a strong, synergistic scientific environment. Bringing together experts and an unparalleled collection of state-of-the-art instruments under one roof, EMSL has helped thousands of researchers use a multidisciplinary, collaborative approach to solve some of the most important and complex national scientific challenges in energy and environmental sciences.

To learn more about EMSL, the science conducted at EMSL, as well as the instruments and expertise available to users, visit www.emsl.pnnl.gov.

Become an EMSL User

Researchers are invited to access the world-class capabilities and collaborate with the internationally recognized experts at EMSL via its peer-reviewed proposal process. To submit a proposal, follow the steps outlined on the EMSL website (www.emsl.pnnl.gov) under User Access. Current and potential EMSL users are encouraged to respond to Calls for Proposals. However, unique research proposals that fall outside the Calls for Proposal focus may be submitted at any time.

Applicants are encouraged to submit proposals for use of EMSL's capabilities in combination with each other with an emphasis on integrating computational and experimental instruments. In general, users whose open research proposals are accepted may use EMSL resources free of charge. Open research is loosely defined as science and engineering research for which the resulting information is published and shared broadly within the scientific community.

Contact EMSL

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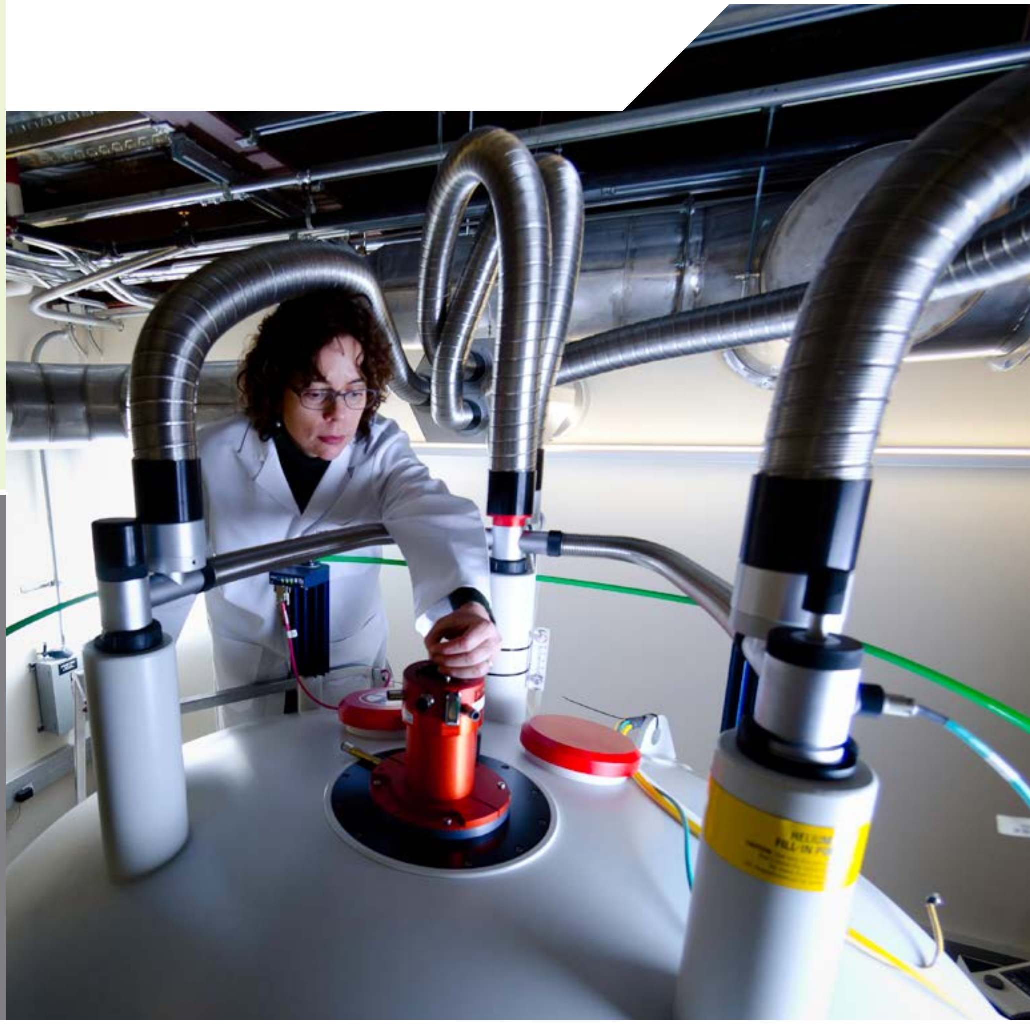
EMSL

Scientific Innovation Through Integration

RadEMSL

One-of-a-Kind Suite of Radiochemistry Capabilities



www.emsl.pnnl.gov

RadEMSL

Sample Receiving and Preparation/Analytical Chemistry Laboratory

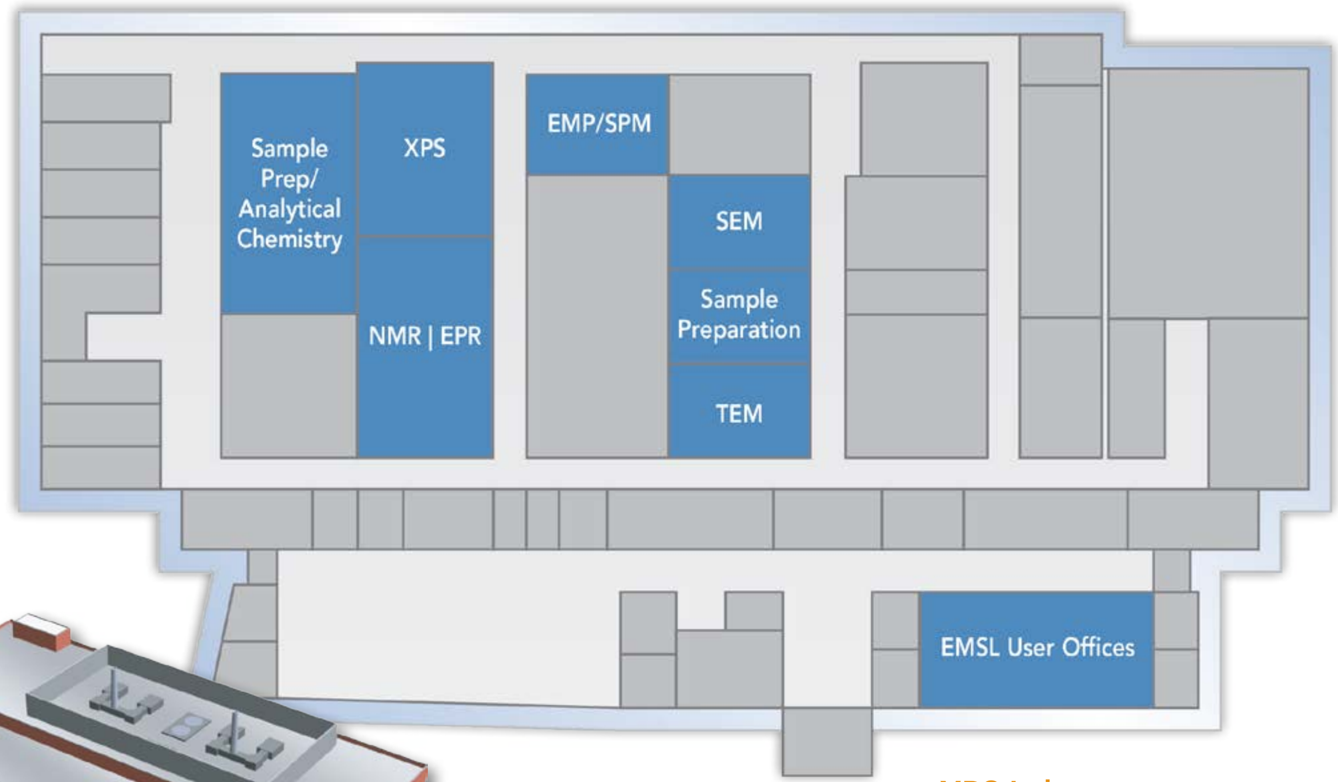
This lab houses analytical instruments for measuring chemical concentration and speciation, as well as facilities for the preparation of both liquid and solid radiological samples for further analysis. The instruments include:

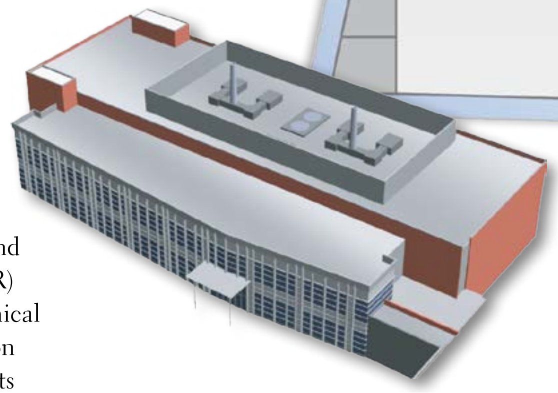
- Four dual-station environmental chambers
- Inductively coupled plasma mass spectrometer (ICP-MS)
- Liquid scintillation counter
- Micro X-ray diffractometer
- Elemental analyzer (CHNOS)
- Ion chromatography

NMR and EPR Laboratory

The magnetic resonance suite features nuclear magnetic resonance (NMR) and electron paramagnetic resonance (EPR) spectrometers for elucidating the chemical structure and electronic state of solution or solid phase samples. The instruments include:

- NMR – Bruker 750-MHz 89-mm wide-bore
- NMR – Magnex 100-MHz 130-mm ultra-wide-bore
- EPR – Bruker ESP 300E CW with X, S, Q-band

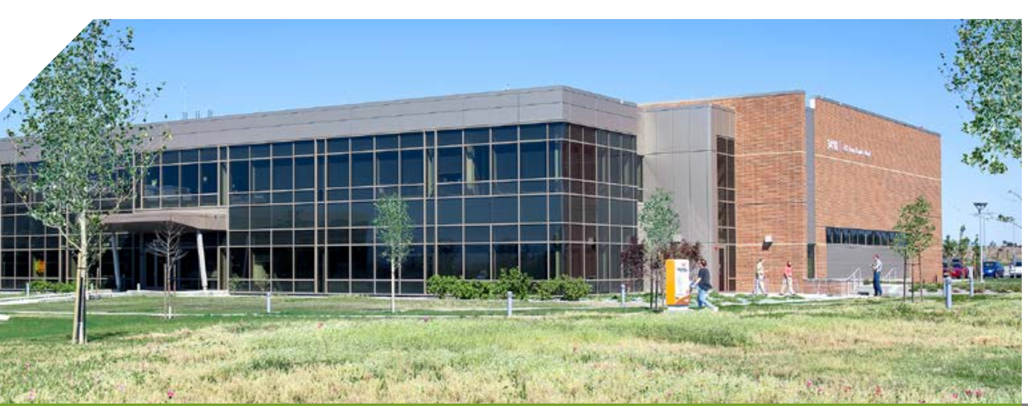




TEM Laboratory

The transmission electron microscopy (TEM) lab delivers atomic resolution of biogeochemical spatial associations and mineral identification, and oxidation state determination. This lab has:

- TEM – JEOL ARM 200F



SEM Laboratory

The scanning electron microscopy (SEM) lab images sample surfaces for spatial associations of mineral grains; location of the contaminant within minerals, along fractures or within the pore space between adjacent minerals; and preparation of samples for TEM analysis. The instruments include:

- FIB/SEM – FEI Quanta 3D FEG
- SEM – JEOL 7600F

EMP and SPM Laboratory

The instruments in this lab, an electron microprobe (EMP) and scanning probe microscope (SPM), image and map the chemical composition of solid samples at high resolution for spatially resolved mineral identification, associations and elemental composition. The instruments include:

- EMP – JEOL JXA-8530F microanalyzer
- SPM – DI Nanoscope IV atomic force microscope

XPS Laboratory

This lab houses an X-ray photoelectron spectrometer (XPS) with attached environmental chamber. It analyzes solid radiological samples for surface sensitive elemental and oxidation state determinations. This lab has:

- XPS – Kratos Axis 165/Ultra with attached environmental chamber

Electron Microscopy Sample Preparation Laboratory

This lab offers advanced sample preparation equipment for SEM and TEM analysis, including microtomes, ion mills, sputter coater, carbon coater and polishers.

Molecular Science Computing

The advanced high-performance computing resources include petaflop supercomputer and scalable computational chemistry software. This capability includes:

- Cascade — 3.4 petaflop supercomputer
- NWChem — www.nwchem-sw.org

A New Path for Radionuclide Sequestration

Part of the mission of the Department of Energy's Office of Biological and Environmental Research is the development of bioremediation strategies to either remove contaminants or impede their mobility in the environment. Technetium-99, a byproduct of plutonium processing, is among the high-priority radionuclides requiring environmental controls. To help tackle this problem, a team of scientists measured reduction of soluble pertechnetate ($^{99}TcO_4^-$) by nano zerovalent iron (nZVI) pre-exposed to sulfide (S^{2-}) in simulated Hanford Site groundwater. nZVI promotes microbial reduction of sulfate (SO_4^{2-}) to S^{2-} and offers a promising and sustainable method for generating S^{2-} in the environment. The scientists used a combination of microscopy, diffraction and spectroscopy capabilities, and conceptual modeling for a fundamental geochemical understanding of Tc sequestration as new sulfide compounds developed in the presence of nZVI; as well as offered an alternative remediation strategy. The scientists examined the evolution of mineral phases during the changing sulfidation states by combining EMSL's capabilities and X-ray absorption spectroscopy at the Stanford Synchrotron Radiation Lightsource. They coupled this work to Tc sequestration kinetics under incremental sulfur/iron ratios. Their results showed the importance of iron sulfide in Tc sequestration and how sulfidation of nZVI can direct TcO_4^- sequestration products from Tc(IV) oxide – which is highly susceptible to reoxidation – to Tc(IV) sulfide phases, providing a more favorable sequestration pathway.

Participants: Oregon Health & Science University, Stanford Synchrotron Radiation Lightsource and EMSL

Reference: Fan et al. 2013. *Environmental Science & Technology* 47(10):5302-5310.