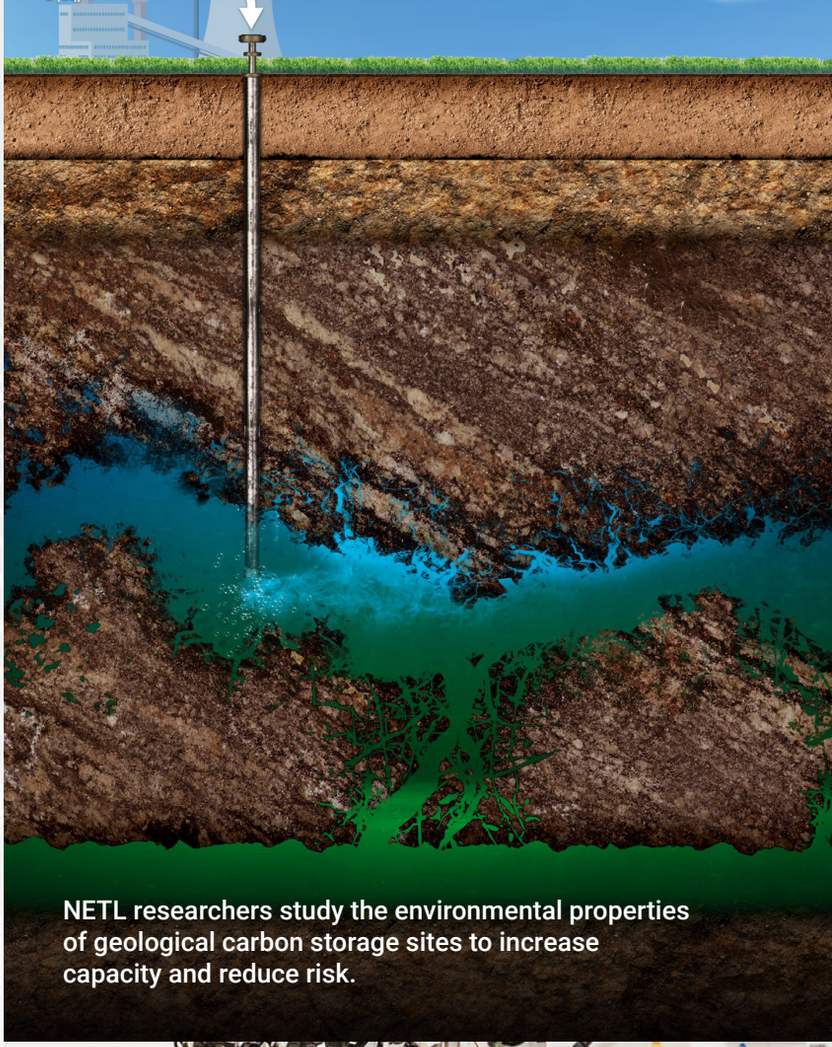
NATIONAL ENERGY TECHNOLOGY LABORATORY

Subsurface Engineering

NETL is advancing subsurface engineering to unlock the full potential of America's underground resources, supporting increased hydrocarbon recovery, critical mineral recovery and efficient resource production. Through a unique combination of geoscience expertise, engineering innovation and advanced simulation capabilities, NETL delivers technologies that help safeguard well integrity, optimize resource extraction and expand domestic supply chains. These efforts help access domestic resources, improve infrastructure resilience and support U.S. energy and economic security.

R&D Applications

- Reservoir Engineering and Enhanced Oil Recovery
- Subsurface Imaging and Monitoring
- Produced Water Management and Reuse
- Well Integrity and Remediation
- Oil and Natural Gas Recovery
- Natural Resource Assessment and Monitoring
- Unconventional Sources for Critical Minerals and Rare Earth Elements
- Geothermal Energy
- Strategic Storage for Hydrogen, Natural Gas and Carbon Dioxide
- Subsurface and Offshore Risk Analysis



NETL researchers study the environmental properties of geological carbon storage sites to increase capacity and reduce risk.

Researchers use the High-Pressure Immersion and Reactive Transport Laboratory to study subsurface systems.

Unconventional Resource Prediction Using Machine Learning

NETL's Unconventional Rare Earth Element and Critical Minerals Resource Assessment Tool uses machine learning-based analysis of key subsurface properties and geologic characteristics to predict resource prospects throughout the country. This model helped uncover the largest unconventional deposit of magnetic rare earth elements in the U.S. The models have been expanded for use for groundwater, hydrocarbons, geothermal and more.

Research Highlights

Research Reduces Risk in Tertiary Oil Recovery and In-Situ Critical Minerals Recovery

Strengths in modeling and artificial intelligence (AI) allow NETL to enable American energy security in oil and natural gas and critical minerals recovery. Through measured information that quantifies how a system works or responds to an event compared to known technical principles, researchers can evaluate system economics to develop estimates of reservoir reserves. The models and scans can help increase domestic oil supplies while reducing environmental and safety risks.

Foamed Wellbore Cement for Deepwater Conditions

NETL completed an assessment report regarding foamed cement for offshore wells. Foamed cements are ultra-low density systems that are usually employed in formations unable to support the pressure exerted by conventional cement slurries. The work will help to bridge the gap between cement as tested in a laboratory and the cement that is pumped in field applications. Ultimately, this research provides industry with the knowledge needed to ensure the safe operation of deep and ultradeep offshore wells.

The National Risk Assessment Partnership (NRAP) Reduces Uncertainty and Cost

NETL led the creation of NRAP's suite of open-source risk assessment tools for fluid migration and wellbore integrity, which have been adopted by more than 100 domestic and international stakeholders, including industry, universities and regulators. These tools are widely used for subsurface project planning, particularly in storage and resource development. NRAP's work reduces uncertainty in risk and liability, decreases costs for operators, and expedites risk evaluation.

Subsurface Trend Analysis (STA) Method and Tool

The STA workflow uses deep learning and AI-informed image segmentation to predict and analyze subsurface and offshore conditions. The STA has demonstrated the ability to extract and accurately label images with 90% to 95% accuracy, improving subsurface property analysis for resources, geohazard predictions and real-time drilling risk reductions. This information increases safety and efficiency of operations while reducing risk and cost.

Publications

- Fritz, A. G., Tarka, T. J., & Mauter, M. S. (2023). Assessing the economic viability of unconventional rare earth element feedstocks. Nature Sustainability, 6(9), 1103-1112. https://doi.org/10.1038/s41893-023-01145-1.
- Goodman Hanson, A., Kutchko, B., Lackey, G., Gulliver, D., Strazisar, B. R., Tinker, K. A., Wright, R., Haeri, F., Huerta, N., Baek, S., Bagwell, C., de Toledo Camargo, J., Freeman, G., Kuang, W., Torgeson, J., White, J., Buscheck, T. A., Castelletto, N., & Smith, M. (2022). Subsurface Hydrogen and Natural Gas Storage (State of Knowledge and Research Recommendations Report). https://doi.org/10.2172/1846632.
- Mark-Moser, M., Miller, R., Rose, K., & Bauer, J. (2020). Subsurface Trend Analysis domains for the northern Gulf of Mexico. https://doi.org/10.18141/1606228.
- Pantaleone, S., Choisser, A. C., Marcelli, O., Rose, K., Morkner, P. (2024). Prospective Seal Name Catalog for U.S. Sedimentary Basins V1.0, https://edx.netl.doe.gov/dataset/prospective-seal-name-catalog-for-us-sedimentary-basins, DOI: 10.18141/2311187.
- Wang, Z., Dilmore, R. M., & Harbert, W. (2020). Inferring CO_2 saturation from synthetic surface seismic and downhole monitoring data using machine learning for leakage detection at CO_2 sequestration sites. International Journal of Greenhouse Gas Control, 100, 103115. https://doi.org/10.1016/j.ijggc.2020.103115.

NETL is a U.S. Department of Energy (DOE) national laboratory dedicated to innovating and accelerating the nation's energy solutions in hydrocarbon, geothermal energy and critical minerals production. With research sites in Albany, Oregon; Morgantown, West Virginia; and Pittsburgh, Pennsylvania, NETL operates as one laboratory to create advanced energy technologies that support DOE's mission and enable affordable, reliable and secure energy to fuel human prosperity.

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