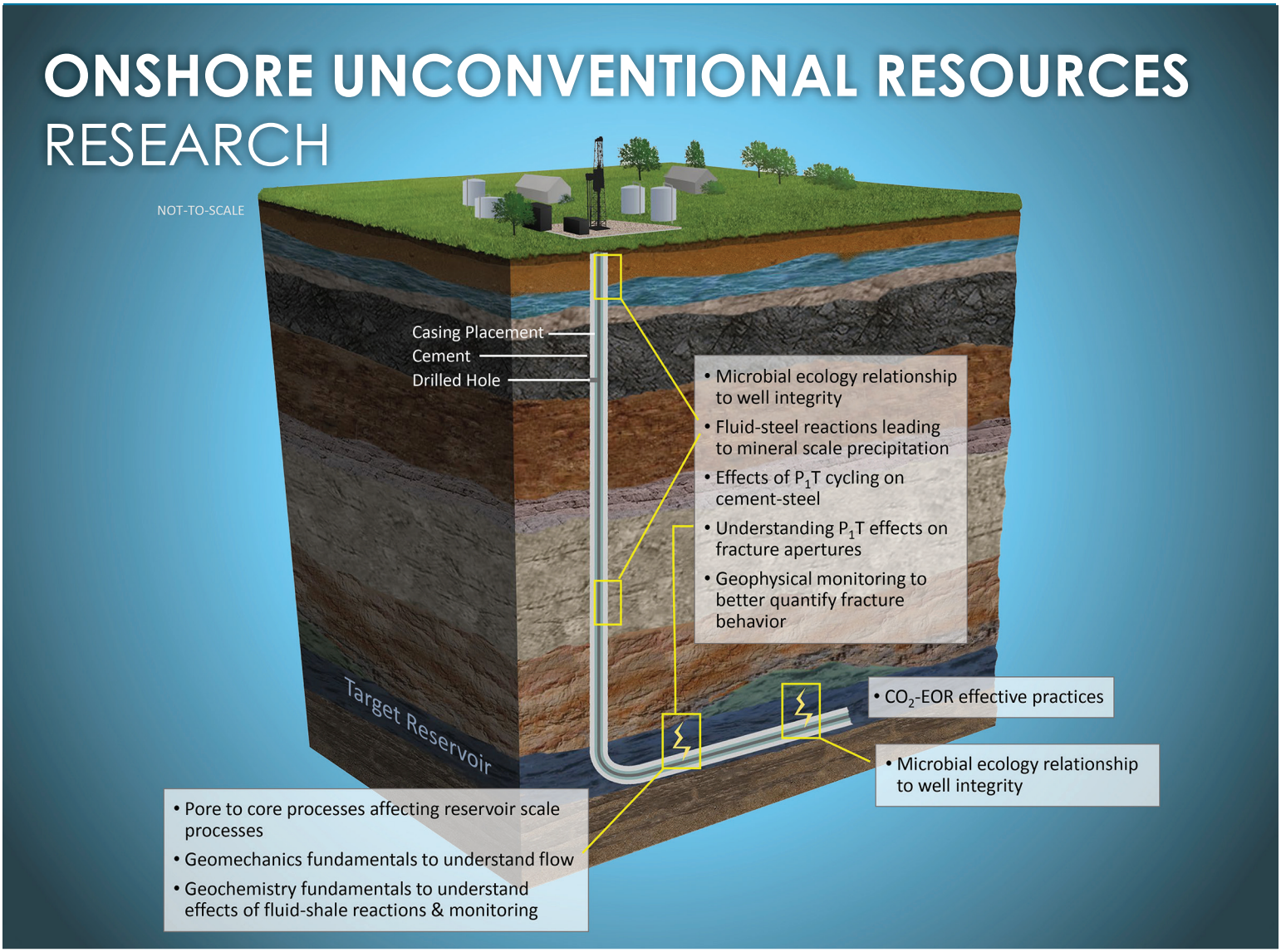
ONSHORE UNCONVENTIONAL RESOURCES RESEARCH



NETL

NATIONAL ENERGY TECHNOLOGY LABORATORY

NETL's Onshore Unconventional Resources research portfolio is a part of the Lab's Oil and Gas Program, which conducts foundational research to improve the production, processing, transportation and storage of the nation's abundant oil and natural gas resources. The Onshore Unconventional Resources portfolio focuses on increasing ultimate recovery from unconventional resources such as shale and other tight formations by engaging in collaborative research.

Natural gas from shales has the potential to significantly increase America's energy security, reduce greenhouse gas emissions and lower prices for consumers. Although shale gas has been produced in the United State for many decades, it was not considered to be a significant resource until the last decade, when new horizontal drilling and hydraulic fracturing technology facilitated economic production.

NETL's Research & Innovation Center (RIC) focuses on a basin-specific strategy, which is expected to assist in identifying key production factors across multiple scales, from the nano- to pore to core- to reservoir-scale. This research portfolio specifically addresses early-stage research to improve production from onshore unconventional resources and evaluate opportunities for application of secondary stimulation fluids for enhanced unconventional recovery.

ONSHORE UNCONVENTIONAL RESOURCES RESEARCH

The Onshore Unconventional Resources research portfolio consists of two main focus areas: understanding fundamental properties of shale and ensuring wellbore integrity.

FUNDAMENTALS OF SHALE RESEARCH

Unconventional oil and gas (UOG) wells experience significant declines in oil and gas production after the first year on-line. Understanding the fundamental processes occurring within the fractured shales during hydraulic fracturing and production will provide a technical basis for the design of improved reservoir management procedures to enhance hydrocarbon recovery.

Improved knowledge of how shales respond mechanically and chemically and understanding the influence of microbial processes on mechanical and chemical phenomena will lead to improved decision-making during completions and production.

RIC Onshore portfolio projects address the following fundamental properties and processes with the goal of identifying changes to fracturing design and reservoir management to enhance hydrocarbon recovery:

- Knowledge of fracture shearing behavior and proppant embedment in shales with different organic and mineral content.
- Collection, documentation and dissemination of basic properties of unconventional reservoir cores that can be shared with and used by industrial and other stakeholders.
- Documentation of how chemical reactions between fracturing fluids and shale affect hydrocarbon flow pathways within shale fractures and pores.
- Distinguishing sources of dissolved constituents in produced waters that can provide insight on reservoir geochemical reactions that affect matrix and fracture porosity and permeability.
- Identification of microbiological processes that affect hydrocarbon flow within the reservoir.
- Updates to existing fracture modeling codes to account for dynamic pressure and temperature changes during hydraulic fracturing that will lead towards improved understanding of fracture behavior.
- Improved methods for leveraging geophysical signals associated with hydraulic fracturing to develop a better understanding of how to monitor near-well fracture networks and hydrocarbon recovery from unconventional reservoirs.
- Quantifying enhanced oil recovery with CO_2 to optimize oil production.

WELLBORE INTEGRITY

Chemical and mechanical processes are anticipated to affect unconventional wellbore integrity during drilling, completions and production. Research and development focused on understanding steel integrity, the formation of cracks between steel and cement and the strength of cement during curation will contribute towards improved well design that can secure the integrity of unconventional wells and extend well lifetime.

Ensuring wellbore integrity during all phases of upstream UOG development will result in improved performance of the well and will minimize costs associated with well workovers, leading to increases in ultimate hydrocarbon recovery for unconventional reservoirs. RIC Onshore portfolio projects address the following issues that, once addressed, can assist in improved wellbore design and management for enhanced recovery:

- Identification of microbiological processes that affect wellbore casing and hydrocarbon flow within the well.
- Identification of mechanisms that control scale precipitation along the steel casing.
- Measurement of parameters that quantify the potential for loss of seal between the casing and cement, or cement and host rock, due to thermal cycling of fluids.
- Identification and development of new methods for properly measuring the strength of cement.

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