the ENERGY lab

R&D FACTS

EPAct Complementary Program

Unconventional Energy Resources

Background

Natural gas and crude oil provide two-thirds of our Nation's primary energy supply and will continue to do so for at least the next several decades, as the Nation transitions to a more sustainable energy future. The natural gas resource estimated to exist within the United States has expanded significantly, but because this resource is increasingly harder to locate and produce, new technologies are required to extract it.

Under the Energy Policy Act of 2005, the National Energy Technology Laboratory is charged with developing a complementary research program supportive of improving safety and minimizing the environmental impacts of activities related to unconventional natural gas and other petroleum resource exploration and production technology (EPAct 2005, Sec. 999A). This area aligns with the recommendations put forward in the SEAB Federal Research Report on Shale Gas, and efforts amongst Federal agencies to coordinate unconventional oil and gas research (unconventional.energy.gov).

The Energy Policy Act of 2005 Section 999 Complementary R&D Program is being performed by NETL's Office of Research and Development. In the area of unconventional energy resources, research is focused on developing a predictive capability to interpret how the engineered-natural systems that are developed to extract unconventional energy resources behave under various scenarios. The resulting data sets and modeling tools will provide a robust foundation for scientifically-based regulatory decision making and public knowledge.

Goals and Objectives

Unconventional energy resources research through NETL's Office of Research and Development (ORD) is focused on developing the data and modeling tools needed to predict and quantify potential risks associated with oil and gas resources in shale reservoirs that require hydraulic fracturing or other engineering measures to produce. The major areas of focus include:

- Improving estimates of fugitive methane and greenhouse gas emissions;
- Predicting the composition and volumes of water produced during shale gas development;
- Predicting subsurface fluid and gas migration, and
- Evaluating fracture growth and ground motion due to oil and gas operations.

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U.S. DEPARTMENT OF ENERGY

The above research areas require a combination of field monitoring, laboratory experimental and characterization, data mining, and modeling activities, and are being performed by an interdisciplinary team comprised of Federal, contractor, and academic scientists and engineers through the NETL Regional University Alliance.

Project Descriptions

Fugitive Air Emissions and Greenhouse Gases:

NETL efforts focus on improving fugitive emissions factor calculations and field emissions data sets for natural gas operations. The large uncertainty in the emissions factor used for upstream greenhouse gas emissions is being addressed through research to develop an improved method for calculating shale gas greenhouse gas emissions factors that can be applied to various shale gas basins. The limited number of high-quality field data sets representative of shale gas operations is being addressed through collection of field measurements to evaluate both ambient (regional effects) and point-source (specific process component) air emissions, with a focus on the Appalachian Basin for current efforts. Updated emissions factors based on the DOE methodology, and field data from Appalachian Basin monitoring, will reduce uncertainties in the NETL shale gas greenhouse gas life cycle assessment.

NETL's air quality monitoring trailer collecting measurements during active hydraulic fracturing

Produced Water Management:

NETL efforts focus on improving knowledge of produced water volumes and compositions, and influences of different treatment processes on management of produced liquid and solid wastes. The treatment and disposal (or reuse) of produced water is a major issue for hydraulically-fractured shale reservoirs, and is being addressed through developing an understanding of how chemical, biological, and physical factors affect produced water composition under different scenarios. Solid wastes, such as drill cuttings and water treatment residues, need to be disposed of appropriately in order to avoid environmental issues, and NETL is performing laboratory experiments to evaluate the potential for contaminant release from solid wastes under different environmental scenarios. The limited ability to predict the volumes and composition of produced waters from shale gas operations is being addressed through development of a systems-level predictive model for estimating the volumes and composition of produced waters for a shale gas basin.

NETL researcher takes water sample

Subsurface Migration of Gas and Fluids:

NETL efforts focus on an ability to evaluate the influence of wellbores and natural pathways on gas and fluid leakage, and the development of specific tracer tools to track gas and fluid migration in the subsurface. NETL is developing rapid sample processing and analytical chemistry tools for natural geochemical tracers that can be used to identify the sources of fluids and gases in complex geologic systems undergoing energy development. Existing wellbores (that may serve as conduits for fluid and gas migration from depth to shallow systems) are being identified through field magnetic surveys coupled with data mining to evaluate densities and locations of potential leakage pathways. NETL is performing laboratory work to investigate the effect of gas on well cements, and also is performing research to evaluate the effect of drilling on shallow gas distribution in groundwaters.

Predicting Fracture Growth and Ground Motion:

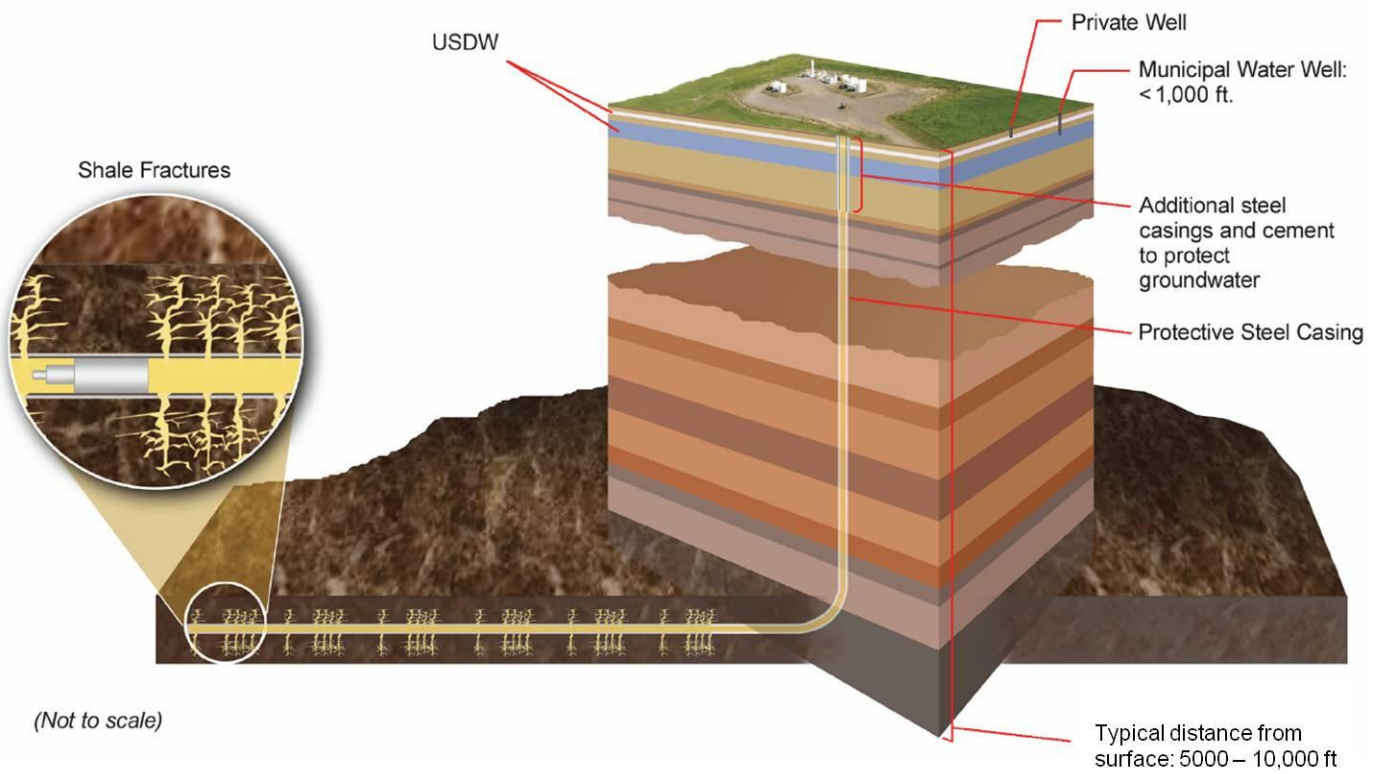
NETL efforts focus on evaluating implications of fracture growth during hydraulic fracturing, and induced seismicity related to unconventional oil and gas development. Our current ability to verify the extent of fracture growth out-of-zone remains limited, and NETL is using existing commercial software to develop fracture models that represent vertical and horizontal extents of fractures outside of the target zone, validated by field microseismic data. This information will be used to evaluate whether new fractures can intersect with other leakage pathways to the surface (such as existing wellbores). NETL also is evaluating the science base behind observed induced seismic events due to oil and gas-related activities.

Benefits

- Unbiased information to policymakers and the public.
- Objective baselines established for Marcellus shale environmental monitoring.
  - Near-term and long-term impacts documented.
  - Inventory of emissions.
  - Data sets that detail the composition of fluids produced during hydraulic fracturing.
  - Models of subsurface systems.
- New tools that allow rapid predictions of possible safety and environmental impacts associated with unexpected events.
- Quantitative assessments that characterize geologic system behavior.
- New tools for predicting the behavior of the geologic system during shale gas development.
- Optimized production from tight gas formations, shales, coalbeds, hydrates, and more.

Recent Accomplishments

- NETL's models (verified with field-based microseismic measurements) have demonstrated the infeasibility of hydraulic fractures extending to drinking water aquifers for most places in the Marcellus Shale and several other shale formations. These validated/calibrated models are being used to predict the possibility of release of gases through combined fracture/wellbore pathways.
- NETL's methodology for calculating emissions factors for methane release during upstream shale gas activities is in the final stages of development, and the new value will be used to update the NETL shale gas greenhouse gas life cycle analysis.
- NETL developed a rapid-throughput analysis technique for analyzing natural tracers as indicators of fluid leakage from shale gas systems (strontium isotopes). These techniques decrease sample processing and analysis time by an order of magnitude (one day versus one week to process a sample set). The method is currently undergoing external peer review.



Schematic of hydraulically-fractured shale gas system

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