

# PROJECT facts

Natural Gas and Oil  
Programs

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U.S. DEPARTMENT OF ENERGY  
OFFICE OF FOSSIL ENERGY  
NATIONAL ENERGY TECHNOLOGY LABORATORY



## IDENTIFYING AND REMEDIATING HIGH WATER PRODUCTION PROBLEMS IN BASIN CENTERED FORMATIONS

### PARTNERS

**Advanced Resources  
International (ARI)**

**Schlumberger, Inc.**

**BP America**

### Goal

To characterize the nature, distribution and flow paths of moveable fluids in the subsurface of the Greater Green River basin (GGRB) and Wind River basin (WRB). The project goals were to improve resource characterization, develop water remediation strategies and enhance gas recoveries in these resource-rich basins.

### Background

Tight fractured gas reservoirs are plagued by interstitial and formation brines that readily overcome gas production during high gas flow rates. The water tends to be drawn into and upward along joint and fault planes and into the well bore. This essentially floods the gas migration system. Structure and stress play an important role in enhancing fracture permeability and plumbing system dynamics. This project was an effort to evaluate a specific formation and basin's hydrology and interaction between gas and water bearing horizons, and to develop a methodology to assess the effects, determining if remediation techniques can be designed to circumvent future water problems.

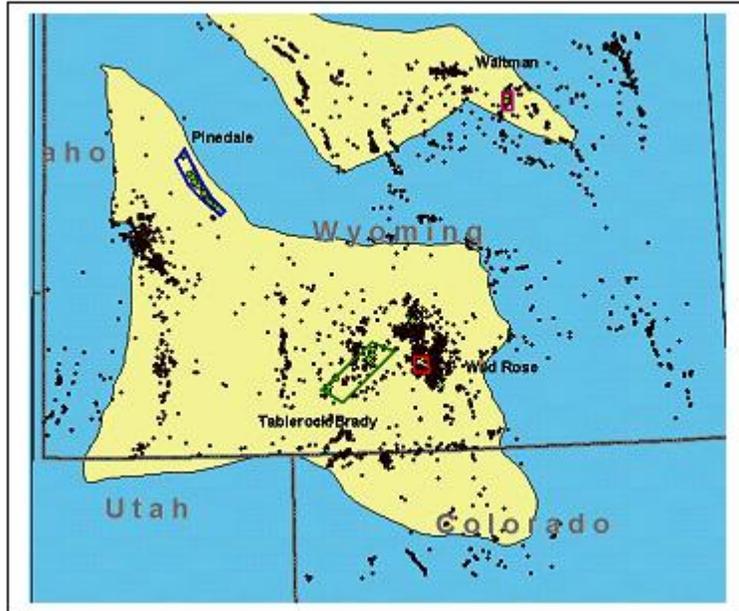
The project results have identified changes in water composition and modes of occurrence for the Wind and Green River Basins of the Rocky Mountains. Water composition data from the 3,000 wells has been applied to deduce depositional environments and alterations to the formation waters, and to construct models describing the distribution and movements of the waters in the reservoir. The models can be used to devise strategies for the avoidance or remediation of moveable waters in the subsurface.

### Project Impact

The results of this project have the potential to reduce costs and improve production rates and life for similar formations in the western basins. The results showing the chemical distribution of formation water will assist industry in better well log interpretation of gas and water saturations in the tight gas bearing reservoir rocks. The anomalous fresh water that occurs deeper in the formations has lead to erroneous gas saturation estimates and as a result more water production from these areas. The results will allow the petroleum industry to accomplish a more detailed analysis of the formations to determine better completion intervals and reduce costs of producing gas. The concepts and approaches generated also offer potential for the development of completion technologies to enhance permeability within tight fields.



Oil and gas exploration and development are progressive processes that are hugely dependent on historical data and experience for successful results. Data pertaining to the chemical and electrical properties of intra-formational waters is also crucial but has been difficult to effectively access. This is no longer the case as a primary output of this project is a robust database amassing thousands of formation water analyses.



*Field study area.*

## Results

Preliminary work was presented in May 2003 at the American Association of Petroleum Geologists (AAPG) in Salt Lake City, Utah. A high level of interest in water production problems for basin centered formations was reiterated by numerous operators' attendance at the poster session of this preliminary work. Companies viewing the poster session included: British Petroleum (BP), Shell, Norwest, Compton, Exxon, LJ Oil and Trueblood Resources, among others.

The final product is a highly usable digital database of nearly 8,000 water analysis results from over 3,200 wells. It spans nearly eight decades of exploration and production activity across two states (Wyoming and Colorado) and numerous productive basins including the strategically important Greater Green and Wind River Basin areas. Compilation of this data into a single database, with removal of duplicate and invalid analyses, opens the data to access by a broad audience of users with interests in resource assessment, formation evaluation, prospect generation and exploitation of tight formation gas. A digital atlas showing the distribution of the data and some specific analyses has been constructed using Arc Reader. The digital atlas has query and limited mapping capability for users without ready access to Geographic Information Systems (GIS) software. GIS techniques were used extensively in the project. A CD containing the database and digital atlas is being created and will be available soon through the NETL CD ordering system.

This database and other geologic studies have allowed Advanced Resources International (ARI) to construct regional atlases and conceptual models of

producible water. These products and the field work will provide useful information to gas operators in the Rocky Mountain area that will help them better evaluate potentially productive zones, explain poor productivity (including unexpected high water production), and reduce risks when completing future wells.

Detailed analysis of specific formations in the Wild Rose Field indicates a definite geochemical difference in formation water that can cause a misinterpretation of gas saturations during well log analysis. The results would indicate higher than actual gas saturations if the chemistry of the reservoirs was not known.

Results of the water survey were presented at the AAPG Hedberg Conference in Vail, CO, at the end of April, 2005.

The database has undergone a detailed QA/QC to verify all analytical results and is available on the NETL website. The final report is listed below under "Additional Information".

The Wild Rose field within the Wamsutter area of the Greater Green River basin was used for the field demonstration. A dual porosity, stress-dependent reservoir model was applied to delineate areas where higher water production can be expected. The model incorporates data from petrophysics, rock mechanics, structural maps, production data, discrete fracture analyses, and boundary element analyses.

Water is an operational issue for lower Almond and Ericson intervals, and factors controlling distribution of water are not well understood. BP has provided access to data in the Wamsutter area, including historical water data, wireline logs, production logs, drilling reports, rock mechanics information, seismic synthetics, vertical seismic profile (VSP) data and 3-D seismic data. Schlumberger has completed the formation evaluation and production logging efforts to show how the chemistry can be used to better identify the fresh water distribution and improve selection of completion intervals to reduce water production.

## **Current Status and Remaining Tasks**

This project has been completed. The database is now available for download - The Rocky Mountain Basins Produced Water Database. A CD containing the final report, the database, and the digital atlas is being created and will be available soon through the NETL CD ordering system.



## CONTACTS

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## PROJECT DATA

**DE-FC26-02NT41437**  
Apr. 1, 2002-Dec. 30, 2005

**Total Project Value**  
\$725,977

**DOE/Non-DOE Share**  
\$547,647/\$178,330

## CUSTOMER SERVICE

**1-800-553-7681**

## WEBSITE

**[www.netl.doe.gov](http://www.netl.doe.gov)**

## Additional Information

December, 2005: Final Report [PDF-7.44MB] (This report contains some links that can only be utilized through the project CD. The CD is currently being processed and will be available soon. The CD will contain the database and the digital atlas.)

September, 2005: Rocky Mountain Basins Produced Water Database.

AAPG Hedberg Conference Presentation at Vail, Colorado on April 28, 2005 - "Understanding, Exploring and Developing Tight Gas Sands" [PowerPoint-2642KB].