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## **Oil & Natural Gas Projects**

### **Exploration & Production Technologies**

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#### **Innovative Methodology for Detection of Fractured Controlled Sweet Spots in the Northern Appalachians**

**DE-AC26-00NT40698**

##### **Goal**

The goal is to demonstrate integrative technologies that can improve industry success in finding and developing natural gas reserves in naturally-fractured reservoirs in the northern Appalachian basin, and in particular, the Trenton/Black River play in New York State.

##### **Background:**

The current effort is a continuance of earlier remote sensing and field data acquisition, analysis and integration to determine what geological structures and stress were controlling the distribution of gas in the deeper formations in New York State. The objective was to integrate and correlate features utilizing the latest geologic, geophysical and geochemical tools available to the petroleum industry to determine if a methodology could be developed to more efficiently target gas-bearing dolomitized fractures and faulted drilling targets.

The project is now in the phase two and a well of opportunity has been identified that will allow more information to be gathered than originally planned due to the horizontal design and cost share the company is providing. The cost share will allow core samples to be collected in both the producing and non-producing portion of the reservoir that will allow comparison of the characteristics controlling gas distribution. Integrating the core data with well logs will provide significant data that can be used to better interpret the seismic signature of the reservoir in both cases and the result used to more efficiently explore and develop this resource into deeper parts of the Appalachian Basin.

##### **Performers:**

State University of New York (SUNY) – Project management and all research products  
Quest Energy, Inc. – analyzed seismic with SUNY  
PRJ, Inc. – procured and analyzed aeromagnetics  
New York State Energy Research and Development Authority (NYSERDA)  
– contributed funding to Phase I research for seismic procurement and some field work

##### **Location:**

Buffalo, New York 14260  
Steuben County, New York

##### **Project Impact:**

This project will demonstrate a methodology for integrating data from innovative structural geology studies, remote sensing, 2-D seismic data and soil gas surveys to identify areas of intense natural fracturing that indicate potential fracture plays. An infill demonstration horizontal well into a faulted structural graben will provide core and well logs for verification of the producing horizon and reservoir parameters for future development of these resources in the Appalachian Basin.

##### **Results:**

Procured and analyzed high resolution aeromagnetics that showed east-north-east (ENE) trending

radiants in the area;

Integrated the aeromagnetics with EarthSat (1997) lineaments and found that ENE-and NS-trending lineaments correspond to basement features inferred from the aeromagnetics, whereas E-W lineaments do not in the immediate study area;

Determined that topographic lineaments and ASTER lineaments confirm, in a general way, the lineaments from Earth-Sat;

Prepared structure contour maps that showed that the east-west (E-W) lineaments correspond to shallow level Alleghenian salt-cored folds and associated thrusts (such as the Fir Tree Anticline);

Carried out detailed surface structural analyses at over 800 sites, which confirmed the general lineament trends; and

Analyzed four north-south (NS) seismic lines in the area and found that an array of faults cut the unit. The process being demonstrated in this project uses relatively inexpensive data in an innovative manner to detect areas of high natural fracture density that are likely to lead to commercial gas production from low permeability tight-gas formations. Researchers are evaluating an area of 760 square miles near Ithaca, New York, for a fraction of the cost of 3-D seismic. Integration of these methodologies allows discrimination among the lineament trends and allows fault trends observed on 2-D seismic to be extrapolated away from the seismic line.

The study determined that some faults are Paleozoic-opening age, since they extend only from Precambrian (PC) basement into the lowest Phanerozoic reflectors. Other faults extend from the PC up into the Cambrian reflectors, still others extend into the Ordovician units. Some faults are restricted to Trenton/Black River reflectors, and these are thought to be related to fluid circulation. A few faults extend through the entire section, and some are restricted to the Silurian salt and higher reflectors.

Soil gas anomalies along North to South traverses show that generally the ENE-trending lineaments are leaking significant gas, whereas the EW trending lineaments are not.

Integrating the lineaments, seismic, structure and soil gas indicates that in this region the basement controlled faults that trend ENE can be recognized on aeromagnetic maps, geologic structure and with soil gas surveys. These faults allowed fluid migration which resulted in the porosity now being exploited as the Trenton/Black River play.

**Current Status and Remaining Tasks:**

Phase II (drilling verification) A memorandum of understanding has been put in place between all of the participants to obtain core from the horizontal well and a suite of logs to confirm the location in the producing interval. Currently the well is planned for February, 2006.

The detailed costs have been verified for one to two cores in the fractured dolomite reservoir in the Quackenbush Field. The current increase in service company costs which include the coring, logging and sampling are greater than the monies remaining for the phase 2 effort. The site is an infill well that is offset to the northeast by one vertical and one horizontal producing wells, and to the southwest by a horizontal Trenton formation gas well. Well spacing on the horizontal wells is 640 acres (1 sq. mile).

**Project Start:** June 1, 2000

**Project End:** June 30, 2005

**DOE Contribution:** \$827,505

**Performer Contribution:** \$775,810

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**Additional Information:**

Surface Fracture Image

Exposed Fracture Image

**Pertinent Publications:**

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Travis Nelson, John Fountain, and Robert Jacobi, 2004, The relationship of state-wide soil gas surveys to fracture data and lineaments: delineation of subsurface structures related to hydrocarbons: Geol. Soc. Am., (Washington) Abstracts with programs, v. 36, n. 2, p. 146.

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"Characteristics of Trenton/Black River structures in the Finger Lakes: Progress Report" by Robert D. Jacobi, John Fountain, Courtney Lugert, Travis Nelson, Gerald Smith, and Industrial Associates at the Central New York Association of Professional Geologists 2003 Spring Symposium; Syracuse, NY; April 2, 2003.