

Contract No. G-05-031

“Geomechanical Study of Bakken Formation Nesson Anticline, Williams County, ND”

Submitted by **University of North Dakota**

Principal Investigator: Dr. Zhengwen Zeng

PARTICIPANTS

| Sponsor | Cost Share |
|------------------------------------|-------------------|
| Encore Acquisition Company | \$ 20,000 |
| Hess Corporation | \$ 20,000 |
| Marathon Oil Corporation | \$ 20,000 |
| St. Mary Land Exploration Company | \$ 20,000 |
| Whiting Petroleum Corporation | \$ 20,000 |
| North Dakota Industrial Commission | <u>\$ 100,000</u> |
| Total Project Cost | \$ 200,000 |

Project Schedule – 24 months
Contract Date – April 16, 2008
Start Date – January 1, 2008
Completion Date – December 31, 2009

Project Deliverables:
Status Report: June 30, 2008 ✓
Status Report: December 31, 2008 ✓
Status Report: June 30, 2009
Final Report: December 31, 2009

OBJECTIVE/STATEMENT OF WORK:

This project has four objectives:

1. Determine the in-situ stress field of the targeted formation for better design of horizontal wells and hydraulic fracturing.
2. Measure the geomechanical properties, such as rock strength, to improve well stability during both drilling and production stages;
3. Develop local geomechanical laboratory capacities to serve the state and the regional demand; and
4. Establish lab facilities to teach lab classes for courses that include geomechanics components.

STATUS

Contract executed with the condition that the applicant obtain a dollar for dollar match from industry. The applicant provided evidence that commitments totaling \$100,000 had been received.

The December 31, 2008 progress report was received. During the July 1, 2008 through December 31, 2008 time period the following work was completed:

1. Completed two papers on Bakken formation geomechanics:
 - a. Geomechanical study of Bakken formation for improved oil recovery,
 - b. Geomechanical stability assessment of Williston Basin formations for petroleum production and CO2 sequestration
2. Estimated the average in-situ stresses (overburden pressure and horizontal stress) of the Bakken formation in the ND Williston Basin
3. Developed and tested an alternative triaxial geomechanical testing method,
4. Built a portable Bakken Shale core sampling system,

5. Completed core observation and fracture description of all the 22 industrial partners' cored Bakken Formation rocks. These core description and microfracture observation set up the foundation for future in-depth study.

Using Bakken well logs, average Bakken formation in-situ stresses were estimated based on the results of all 22 Bakken wells. While this provides some lights in the in-situ stress fields, more detailed study is on-going based on each of these 22 wells. One of the major components in this project is an alternative method for lab geomechanical tests under reservoir conditions (temperature, pore pressure, and in-situ stresses). This method has been successfully developed, tested and verified. A portable shale core sampling system was designed and built so as to be used in the NDGS Core Library for plugging 1-in diameter by 2-in long Bakken samples for geomechanical tests. The portable core sample system has been completed and tested using a reference shale sample. On going efforts are focused on obtaining the Bakken shale samples for the testing.

Prior to the August 6, 2009 meeting the Oil and Gas Research Program Technical Advisor met with the principal investigator. Mr. Fischer's summary report to the Council stated the following:

- Laboratory is complete and operational.
- An alternative triaxial testing system has been developed:
 - a) Pumps, core holder and oven
 - b) Control and data acquisition system
- Research team has finished core observation and fracture description core;
- Using Bakken well logs, average Bakken formation in-situ stresses have been estimated for cored wells in study;
- Laboratory tests are underway and will continue;
- Approximately 4 papers have been published in journals and/or presented at national and international conferences. (Copies of these papers are available in the Commission files.)
- As a result of this program an additional (approximately) 1 million dollars have been contributed to the program; additional funds are anticipated;
- This program has been incorporated into a "North Dakota Center of Excellence" program;
- The program has attracted new students to UND (around 10 new students (1/2 are at the graduate level); additional student interest has been identified, including transfers from other universities; some students have had to be turned down at this time to allow for program and growth to be able to accommodate them.