Oil & Natural Gas Projects
Exploration and Production Technologies

Geomechanical Study of Bakken Formation for Improved Oil Recovery

DE-FC26-08NT0005643

Goal

The goal of this project is to determine the in situ stress and geomechanical properties of the Bakken Formation, and to use these results to increase the success rate of horizontal drilling and hydraulic fracturing to improve the ultimate recovery of this vast oil resource.

Performer

University of North Dakota, Grand Forks, ND 58202-7134

Background

Compared to the success realized in producing crude oil from the Bakken Formation in eastern Montana, the horizontal drilling and hydraulic fracture stimulation technology applied in western North Dakota suffered many more difficulties, and new completion and fracturing technologies had to be developed. The biggest challenges include: (1) the horizontal well could not hit the natural fracture, and (2) the hydraulically generated fractures did not develop longitudinally as designed, but more than often transversely instead. This was attributed to the lack of in-situ stress knowledge and the geological heterogeneity in the Bakken Formation in the North Dakota portion.

The geological heterogeneity and inadequate knowledge of the in situ stresses and other geomechanical parameters of the Bakken Formation resulted in more failures than successes for horizontal well completions in North Dakota. Based on past researching efforts, the following can be concluded:

1. Horizontal well with hydraulic fracturing is a required completion technology for recovering crude oil from the Bakken Formation.
2. Well orientation is the essential factor to the success of hydraulic fracturing and wellbore stability during drilling and production.
3. Hydraulic fracture geometry and orientation (longitudinal, transverse or oblique) is fully controlled by the local in situ stress field and geomechanical properties of the Bakken Formation. More often than not, a longitudinal fracture in design became a transverse or skewed fracture in reality, which eventually killed well productivity and the investment.
4. In situ stress field and geomechanical properties change along the axis of horizontal wells that extend several thousand feet, such as those being drilled in the Bakken Formation.
5. Knowing the in situ stresses and the fundamental geomechanic properties of the rock is the key to designing a successful horizontal well and hydraulic fracture stimulation.

Potential Impacts

The results of this study will provide an application guide for use during horizontal drilling and/or hydraulic

fracturing operations in the Bakken Formation. New technology for in situ stress determination using the Kaiser Effect will be developed and tested for the petroleum industry to improve the horizontal drilling and hydraulic fracturing in the Bakken Formation. With a better knowledge of in situ stresses and related geomechanical parameters, the success rate for drilling and hydraulic fracturing will greatly improve in the Bakken Formation.

Accomplishments

This project was started on 10/1/2008. No technical accomplishments have been recorded to date.

Current Status

This project was started on 10/1/2008. This is a project with 6 tasks to study the in situ stresses and geomechanical properties of the Bakken Formation in order to assist in horizontal drilling and hydraulic fracturing simulation.

The project is currently on Task 2 which includes collecting and screening available data for representative areas and wells within the study area. Data to be collected include cores, core images, digitized geophysical well logs, monthly production, and available petrophysical testing results. A minimum of 5 wells per USGS defined Assessment Unit (AU) will be used to describe the Bakken Formation in a minimum of 3 of the 5 relevant AUs. Analysis of field and well data will be collected to build a geological model of the study area to include factors affecting in situ stresses such as structural features and basin stress history. The in situ stress map for each AU or one in situ stress map for the whole area, as appropriate, will be developed by integrating the field, well, core and lab testing data.

Project Start: October 1, 2008
Project End: September 30, 2011

DOE Contribution: $1,016,626
Performer Contribution: $353,639

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Additional Information

Technology Status Assessment [PDF-59KB]