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TITLE: IMPROVED OIL RECOVERY IN MISSISSIPPIAN CARBONATE RESERVOIRS OF KANSAS -- NEAR TERM -- CLASS 2

Cooperative Agreement No.: DE-FC22-93BC14987

Contractor Name and Address: The University of Kansas Center for Research Inc.

Date of Report: February 4, 1997

Award Date: September 18, 1994

DOE Cost of Project: \$ 3,169,252 (Budget Period 1 09/18/94 -- 09/17/96)

Principal Investigators: Timothy R. Carr (Program Manager)
Don W. Green
G. Paul Willhite

Project Manager: Chandra Nautiyal, Bartlesville Project Office

Reporting Period: October 1, 1996 -- December 31, 1996

OBJECTIVES

The objective of this project is to demonstrate incremental reserves from Osagian and Meramecian (Mississippian) dolomite reservoirs in western Kansas through application of reservoir characterization to identify areas of unrecovered mobile oil. The project addresses producibility problems in two fields: Specific reservoirs target the Schaben Field in Ness County, Kansas, and the Bindley Field in Hodgeman County, Kansas. The producibility problems to be addressed include inadequate reservoir characterization, drilling and completion design problems, non-optimum recovery efficiency. The results of this project will be disseminated through various technology transfer activities.

At the Schaben demonstration site, the Kansas team will conduct a field project to demonstrate better approaches to identify bypassed oil within and between reservoir units. The approach will include:

- Advanced integrated reservoir description and characterization, including integration of existing data, and drilling, logging, coring and testing three new wells through the reservoir intervals. Advanced reservoir techniques will include high-resolution core description, petrophysical analysis of pore system attributes, and geostatistical analysis and 3D visualization of interwell heterogeneity.
- Computer applications will be used to manage, map, and describe the reservoir. Computer simulations will be used to design better recovery processes, and identify potential incremental reserves.
- Comparison of the reservoir geology and field performance of the Schaben Field with the previously described by slightly younger Bindley Field in adjacent Hodgeman, County.
- Drilling of new wells between older wells (infill drilling) to contact missed zones;
- Demonstration of improved reservoir management techniques, and of incremental recovery through potential deepening and recompletion of existing wells and targeted infill drilling.

SUMMARY OF TECHNICAL PROGRESS

Progress is reported for the period from 1 October 1996 to 31 December 1996. Work in this quarter has continued to concentrate on the reservoir simulation (Task 1.2), and technology transfer efforts (Task 1.3).

Task I.1 -- Acquisition and Consolidation of Available Data (Target Completion Date: 4/2/95). Delayed Completion (3/31/96).

This task is complete except for the continuing addition of production data from the demonstration site.

Task I.2 -- Reservoir Characterization (Target Completion Date: 3/3/96) Delayed Completion (10/15/96).

The geologic reservoir characterization for the Schaben Field is complete and has been presented at several national and regional meetings. Much of the geologic and production data, including maps, cross-sections and core analyses, is available on-line at the reservoir, lease and well levels. The Uniform Resource Locator {URL} is <http://www.kgs.ukans.edu/DPA/Schaben/schabenMain.html>.

A reservoir simulation study for the Schaben Field is nearly complete. Production history for 34 years was matched at the field level and small adjustments at the well level are underway. The study is being performed using a Silicon Graphics workstation with the Western Atlas VIP Executive simulation software, and a PC using USDOE's BOAST 3. Both packages are conventional black oil simulators, equipped with a graphics interface. The simulation models are being used to investigate and predict different enhanced oil recovery processes in an effort to optimize oil recovery.

When the reservoir simulation is complete we can evaluate the results develop reservoir management techniques, and evaluate the potential for deepening and recompletion of existing wells and targeted infill drilling.

Task I.3 -- Technology Transfer (Target Completion Date: 8/4/96).

Technology transfer is an ongoing process that includes access to information through the Internet, almost daily inquires and formal presentations. The manuscript (Hopkins, Carr and Feldman, 1996) on the pseudoseismic approach as demonstrated at Schaben Field was presented and published as part of the proceedings related to the Gulf Coast SEPM conference entitled STRATIGRAPHIC ANALYSIS UTILIZING ADVANCED GEOPHYSICAL, WIRELINE AND BOREHOLE TECHNOLOGY FOR PETROLEUM EXPLORATION AND PRODUCTION. A presentation was given at the San Joaquin Geological Society (Bakersfield, CA; December 10) on application of pseudoseismic and PFEFFER to reservoir description. Presentations are scheduled for the Annual Meeting of the American Association of Petroleum Geologists on April 9 (Guy and others, 1997) and the Tertiary Oil Recovery Conference on March 20.

We will continue our work with Kansas operators on application of the technologies developed as part of the Class II project. We are providing access to the digital data and results from the project through an on-line (Internet) accessible format.

REFERENCES

- 1996 Hopkins, J. F., T. R. Carr, H. R. Feldman, Pseudoseismic Transforms of Wireline Logs: A Seismic Approach to Petrophysical Sequence Stratigraphy, *in* J. A. Pacht, R. E. Sheriff and B. F. Perkins, eds., Stratigraphic Analysis Utilizing Advanced Geophysical, Wireline and Borehole Technology for Petroleum Exploration and Production: Gulf Coast SEPM Seventeenth Annual Research Conference, p. 133-144.
- 1997, Guy, W. J., T. R. Carr, E. K. Franseen, S. Bhattacharya, and S. Beaty, Combination of magnetic resonance and classic petrophysical techniques to determine pore geometry and characterization of a complex heterogeneous carbonate reservoir: American Association of Petroleum Geologists Annual Meeting Abstracts, Dallas.

APPENDIX A

AAPG ABSTRACT: Combination of Magnetic Resonance and Classic Petrophysical Techniques to Determine Pore Geometry and Characterization of a Complex Heterogeneous Carbonate Reservoir

GUY, WILLARD J., TIMOTHY R. CARR, EVAN K. FRANSEEN, SAIBEL BHATTACHARYA, and SCOTT BEATY, Kansas Geological Survey, Lawrence, Ks.

As part of a USDOE and industry funded Class 2 project within the Schaben Field, Ness County, Kansas, the Kansas Geological Survey has evaluated a combination of petrophysical tools for characterization of complex heterogeneous cherty dolomite reservoirs. Production in the Schaben Field is from the Mississippian (Osagian) cherty dolomite beneath a major Pennsylvanian-Mississippian unconformity.

The petrophysical evaluation of three recently drilled and older wells within Schaben Field has included traditional core analysis, air-brine capillary measurements, thin section petrography, photography and relative permeability measurements. Significant new technology includes mini-permeameter, the PFEFFER wire-line log analysis plot (resistivity vs. porosity); and magnetic resonance measurements on selected saturated and unsaturated core samples to determine the "effective" porosity, free fluid percentage, bound water percentage and irreducible water saturation.

The primary problem in the evaluation of Mississippian fields in Kansas is how to determine the "effective" porosity in a cherty dolomite with fine intercrystalline porosity and variable amounts of secondary vugular, moldic, micro and solution porosity. This study indicates that the majority of the dolomite reservoir with intercrystalline porosity is an effective oil reservoir while the dolomite reservoir with the more highly visual vugular porosity is not always well connected and may not be an effective oil reservoir.