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

Cooperative Agreement Number DE-FC22-93BC14987

The University of Kansas Center for Research Inc.

November 1, 1995

Budget Period #1 Duration from 09/18/94 - 09/17/96
Budget Period #2 Duration from 09/18/96 - 09/17/98

DOE Estimate Cost of Project $3,169,252

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DOE Project Officer
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Bartlesville Project Office

Reporting Period 07/01/95 - 09/30/95
(4th Quarterly Report)

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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.

Project Status

The project began in September of 1994, and will run through 1998.

Project Description

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.

The project is an effort to make Kansas producers more aware of potentially useful technologies and to demonstrate in actual oil field operations how to apply
them. For many producers, especially independents, such information is important for continued production. A major emphasis of the Kansas project will be collaboration of University scientists and engineers with the independent producers and service companies operating in the state. An extensive technology transfer effort will be undertaken to inform other operators of the results of the project. In addition to traditional technology transfer methods (e.g., reports; trade, professional, and technical publications; workshops; and seminars) a public domain relational database and computerized display package will be made available through the Internet and other means of digital access.

Summary of Technical Progress

General Overview.--Progress is reported for the period from 1 July 1995 to 30 September 1995. Work in this quarter has continued to concentrate on reservoir characterization (Task 1.2), with the continuation of initial technology transfer efforts (Task 1.3). The second well was successfully drilled, cored, logged, and tested. The remaining well should be drilled during the next quarter. Work on reservoir characterization (Task 1.2) is progressing, and related technology transfer has been initiated and should accelerate into 1996.

Task I.1 - Acquisition and Consolidation of Available Data (Target Completion Date: 4/2/95). Delayed Completion (12/30/95).

Summary of work in last quarter.--Acquisition and consolidation of existing geologic, digital log, and production data is complete. After protracted permitting and scheduling problems, the second of three new wells was drilled during the quarter. The #1 Foos "A-P" Twin was spud on 8/4/95 and completed on 9/1/95. Daily drilling and completion reports are attached. An excellent core was recovered along with a good log suite and test information. The cores from both new wells have provided valuable new insight into the Mississippian reservoir at Schaben Field. The new cores will be examined in detail and compared with previously existing cores from both Schaben and Bindley fields. Included in the detailed examination will be minipermeameter work. Ritchie Exploration as operator is pushing to expedite the permitting and drilling for the last well. Subject to hole conditions and tool availability we are still working on running a magnetic resonance imaging log (MRI) in the remaining well.

Summary of planned work for next quarter.--The completion of this task has continued to be delayed by a contentious operator, but only one well remains and should be drilled this quarter.

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

Summary of work in last quarter.--During the last quarter we have concentrated on generating a detailed geologic reservoir characterization for the northern part of the Schaben Field (in and around 30-19S-21W). Geologic reservoir
characterization work has used both the "pseudoseismic" technique and the computer workstation to recognize and map small faults and complex stratigraphic geometries within the reservoir units. This work is being integrated with the data from the new wells, and with analysis of engineering data. The work is nearly complete and will form the basis for an initial reservoir simulation for Schaben Field.

Summary of planned work for next quarter.-- Analysis of data from the remaining new well along with development of a descriptive reservoir model will continue. Engineering analysis and initial simulation efforts are underway and preliminary results should be available during the coming quarter.

Task 1.3 - Technology Transfer (Target Completion Date: 8/4/96).

Summary of work in last quarter.-- Technology transfer continues to increase and should be well underway in the first and second quarters of 1996. Presentations are scheduled for the Platform Carbonates Workshop to be held in Norman, Oklahoma (3/96), and for the Carbonate Reservoir Session at the national AAPG meeting (5/96).

Summary of planned work for next quarter.-- An additional presentation and workshop will be prepared for a Northern Midcontinent-PTTC conference on exploration and development tools tentatively scheduled for the first half of 1996. A manuscript for the "pseudoseismic approach" is nearly complete and will be submitted. We will continue our work with Kansas operators on application of the technologies developed as part of the Class II project.
#1 Foos "A-P" Twin  
895' FSL & 895' FWL  
Section 31-19S-21W  
Ness County, Kansas  
1993 Production Package  
Field: B. Dills  
Office: B. Mathiesen  
Elevation: 2260' G.L. 2269' K.B.

History:

Set 8 5/8" surface casing at 332' with 185 sacks. Set new 5 1/2", 14# production casing at 4444' with 155 sacks EA-2 with 5% Calseal, 18% salt, and 3/4% Halad 322. Baker Port Collar at 1470'; and cemented to surface with 173 sacks of 65/35 poz, 6% gel and 1/4# flocele. Cement circulated. Ran correlation log. PBTD 4418', 4' of fillup on top of insert.  
Distance from KB to Bradenhead = 11.35'  
Length of shoe joint = 21.76'

COMPLETION REPORT

8-25-95 Ran Correlation log. 4' fillup on top of insert. MIRU double drum. Ran port collar opener and tubing. Found port collar at 1470'. Pressured casing to 1000#, held. Opened port collar and cemented with 173 sacks 65/35 poz, 6% gel, 1/4# flocele. Cement circulated. No KCC man on location. Talked to Richard Lacey with KCC about cementing. Closed port collar and pressured up casing, held. Pulled tubing and opener. SDON.

9-1-95 Swabbed hole dry to 4418'. Loaded hole with 10 barrels lease water. Fluid level at approximately 4000'. Perforated 4400' to 4404' 3 shots per foot SSB. Fluid level at 3400'. Made five pulls and recovered 24.63 barrels, muddy water. Fluid staying at 3400'. Let set for 30 minutes, fluid level at 2800'. Swabbed one hour, six pulls recovered 36.32 barrels. Fluid level at 3050'. Water clean, clean gassy oil, less than 1% oil. SDOWE.

9-5-95 Fluid level at 1500' from surface, 2900' of fillup with 30' of oil on top, 1% oil. Ran packer and tubing and set packer at 4371'. Took injection rate, one barrel per minute at 1000#. Mixed 50 sacks Common cement and squeezed perforations at 4400' to 4404', 3.5 barrels in formation, approximately 18 sacks. Pressured to 1500#, released packer and washed cement out of tubing. Pressured back up, held. Washed cement out of casing. Washed out to insert. Laid down two joints and set packer at 4371', pressured to 1200#, held. Pulled tubing and packer. SDON.
9-7-95 Swabbed down to 4000’. Perforated 4393’ to 4394.5’.
Swabbed down to 4390’. Swab tested:

<table>
<thead>
<tr>
<th>Duration</th>
<th>Condition</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 minutes</td>
<td>Dry</td>
<td></td>
</tr>
<tr>
<td>1 1/2 hour</td>
<td>Dry</td>
<td></td>
</tr>
<tr>
<td>2 1/2 hour</td>
<td>20’ fluid, 50% oil</td>
<td></td>
</tr>
</tbody>
</table>

Acidized with 250 gallons INS 7.5% double Fe. Could not get acid to go. Pressured casing to 1700#, 100# drop every five minutes. Got 1.5 barrels acid in. Acid on bottom 3.5 hours. Closed casing in with 1500#. SDON.

9-8-95 Casing on vacuum. Fluid level at 1575’ from surface. Swabbed one hour and recovered 66 barrels, trace of oil. Fluid staying at 2050’. Ran packer and tubing. Set packer at 4347’. Pressured annulus and took injection rate: four barrels per minute at 600#. Squeezed with 50 sacks Common cement, staged to 1000#. Let set for 30 minutes, pressured to 1500#, held. Approximately 13 sacks in formation. Released pressure and washed tubing out. Set packer pressure to 1500#, held. Pulled tubing and packer. Loaded casing and pressured to 200#. SDON.

9-11-95 Ran 4 7/8” bit and tubing. Drilled cement from 4347’ to 4399.5’ and circulated clean. Pulled tubing and bit. Swabbed casing down to 2000’. Perforated 4394’ to 4395.5’, four shots per foot, six shots. Checked TD at 4399.5’. Ran 23’ of tail pipe, packer, and tubing. Set packer at 4371’. Swabbed down to 4370’, 30 minutes - dry. SDON.

9-12-95 Fluid level at 4020’, 350’ of fillup with 260’ oil on top, 75% oil. 30 minute test - dry. Acidized with 250 gallons 7 1/2% INS, double Fe. Spotted one barrel acid. Max pressure 1700#. With 1/2 barrel acid in feeding at 1200# at eight gallons per minute. With 2.5 barrels acid in formation, pressure 0#. Treated at eight gallons per minute, instant vacuum. Total load 31.3 barrels. After 30 minutes fluid level 1700’ from surface. Swabbed back 46.34 barrels, 8% oil. Fluid level at 2500’. Let set 30 minutes, fluid level at 1500’. Swab tested:

<table>
<thead>
<tr>
<th>Hour</th>
<th>Pulls</th>
<th>Recovered</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7</td>
<td>42.16 bbls, 7% oil, fluid level 2700’</td>
</tr>
<tr>
<td>2</td>
<td>4</td>
<td>25.46 bbls, 8% oil, fluid level 2950’</td>
</tr>
</tbody>
</table>

Shut down 20 minutes to empty swab tank, fluid level at 1600’, 110.96 barrels swabbed back. Pulled tubing and packer, closed well in. SDON.
RITCHIE EXPLORATION, INC.
125 N. Market - Suite 1000
Wichita, Kansas 67202-1775
316-267-4375 FAX: 316-267-3026

#1 Foos "A-P" Twin
895' FSL & 895' FWL
Section 31-19S-21W
Ness County, Kansas
1993 Production Package
API# 15-135-23,898
Duke Rig 4
Field: R. Milford
Office: B. Mathiesen
Ref. Well: REI's #1 Foos "A-P", C SW SW, Sec. 31-19S-21W
Elevation: 2260' G.L. 2269' K.B.

DRILLING REPORT

<table>
<thead>
<tr>
<th>SAMPLE TOPS</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anhydrite</td>
<td>1501' (+768)</td>
</tr>
<tr>
<td>B/Anhy</td>
<td>1535' (+734)</td>
</tr>
<tr>
<td>Heebner</td>
<td>3756'(-1497)</td>
</tr>
<tr>
<td>Lansing</td>
<td>3814'(-1545)</td>
</tr>
<tr>
<td>B/KC</td>
<td>4124'(-1855)</td>
</tr>
<tr>
<td>Pawnee</td>
<td>4232'(-1963)</td>
</tr>
<tr>
<td>Fort Scott</td>
<td>4311'(-2042)</td>
</tr>
<tr>
<td>Cherokee</td>
<td>4334'(-2065)</td>
</tr>
<tr>
<td>Miss</td>
<td>4395'(-2126)</td>
</tr>
<tr>
<td>RTD</td>
<td>4445'(-2176)</td>
</tr>
</tbody>
</table>

Ref. ELECTRIC LOG TOPS | Well
Anhydrite | 1504' (+765) | -1  | Anhydrite | 1536' (+733) | flat |
B/Anhy | 1536' (+733) | flat | Heebner | 3766'(-1497) | +2  |
Lansing | 3812'(-1543) | +3  | Lansing | 4122'(-1853) | +4  |
B/KC | 4122'(-1853) | +4  | B/KC | 4228'(-1959) | +6  |
Pawnee | 4228'(-1959) | +6  | Pawnee | 4310'(-2041) | +6  |
Fort Scott | 4332'(-2063) | +5  | Fort Scott | 4432'(-2063) | +5  |
Cherokee | 4332'(-2063) | +5  | Cherokee | 4432'(-2063) | +5  |
Miss | 4393'(-2124) | +6  | Miss | 4445'(-2176) | +6  |
RTD | 4445'(-2176) | +6  |

8-4-95 Spud at 4:45 p.m. Ran 8 joints (320.62') of 2 3/8 5/8" surface casing set at 332.62' with 185 sacks 60/40 pozmix, 2% gel, 3% CC. Cement circulated. Complete at 10:30 p.m.
8-5-95 Drilled plug at 6:30 a.m.
8-6-95 Drilling at 2222'.
8-7-95 Drilling at 2965'.
8-8-95 Drilling at 3555'.
8-9-95 Drilling at 4070'.
8-10-95 DST #1 from 4295' to 4330' (Fort Scott). Recovered 20' of gas in pipe and 30' of very slight oil cut mud (3% oil, 97% mud).
   TFP: 44-44#/30'; ISIP: 986#/30';
   FFP: 52-52#/30'; FSIP: 895#/30'.
8-11-95 Depth 4421'. Cored 34' from 4387' to 4421'. Core barrel jammed. Tripped out of hole. Recovered 32' of core. Approximately 8' Conglomerate shale and chert on top, 24' of mostly Dolomite and chert with good vug porosity bleeding oil. Cored 20.5' from 4421' to 4441.5'. Core barrel jammed. Tripped out of hole. Recovered 20.5'. 12' of mostly dolomite and chert. Top 7' bleeding oil, 12' of mostly barren porosity, 1.5' shale.
8-12-95  Reemed hole from 4387' to 4441.5'. Cut 3.5' with rotary bit. Ran electric logs.

8-13-95  DST #2 from 4412' to 4424' (Electric log measurements) (Mississippi). Recovered 150' very slightly oil specked muddy water, 2000' very slightly oil specked water. IFP: 218-729#/20"; ISIP: 1255#/20"; FFP: 767-1055#/20"; FSIP: 1255#/20".

Ran 106 joints of new 14# 5 1/2" production casing set at 4444' with 115 sacks EA-2 with 5% Calseal, 18% salt, and 3/4% Halad 322. 15 sacks in the rathole. Plug down at 4:07 p.m. Float held. Baker port collar at 1470'. Waiting on completion.