QUARTERLY TECHNICAL PROGRESS REPORT
(33rd Quarter)

**ADVANCED OIL RECOVERY TECHNOLOGIES FOR IMPROVED
RECOVERY FROM SLOPE BASIN CLASTIC RESERVOIRS,
NASH DRAW BRUSHY CANYON POOL, EDDY COUNTY, NM**

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ABSTRACT

The overall objective of this project is to demonstrate that a development program based on advanced reservoir management methods can significantly improve oil recovery at the Nash Draw Pool (NDP). The plan includes developing a control area using standard reservoir management techniques and comparing its performance to an area developed using advanced reservoir management methods. Specific goals are (1) to demonstrate that an advanced development drilling and pressure maintenance program can significantly improve oil recovery compared to existing technology applications and (2) to transfer these advanced methodologies to oil and gas producers in the Permian Basin and elsewhere throughout the U.S. oil and gas industry.

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EXECUTIVE SUMMARY

The use of the Advanced Log Analysis techniques developed from the NDP project have proven useful in defining additional productive zones and refining completion techniques. The Advanced Log Analysis program proved to be especially helpful in locating and evaluating potential recompletion intervals, which has resulted in low development costs with only small incremental increases in lifting costs. To develop additional reserves at lower costs, zones behind pipe in existing wells were evaluated using techniques developed for the Brushy Canyon interval. Log analysis techniques developed in Phase I have been used to complete a total of thirteen of the NDP wells in uphole zones. Four wells were recompleted in 1999, which allowed the development of economical reserves during a period of low crude oil prices. An additional four wells were recompleted during 2000, which resulted in 123,462 BO and 453,424 MCFG reserves being added at a development cost of \$1.57 per B.O.E. Two wells, #29 and #38 were recompleted in 2001 which added 7,000 BO and 18 MMCFG to the reserves at a cost of \$9.70 per BOE. NDP Wells #1, #12, #15 and #20 were completed in uphole zones during 2002-03 which added 128,000 BO and 150 MMCFG to the reserves at a cost of \$1.64 per BOE.

The NDP #36 well toe zone was completed in October 2001, then restimulated in April 2002. During the workover an additional zone in the deviated section of the well was added. Cumulative production through November 2003 is 99,806 BO, 305.25 MMCFG and 45,120 BW.

The NDP #33 well toe zone and "H" zone were completed in December 2002. Cumulative production through November 2003 is 36,330 BO, 147.571 MMCFG and 108,961 BW. A workover was started in November to deepen the well and open additional pay in the toe zone.

Continued interpretation of the original 3-D seismic survey using the results from drilling NDP Well #36 and #33 has resulted in a more complete characterization of the Brushy Canyon reservoir. The new 3-D seismic survey has refined the original interpretation and added at least two (2) targets for additional development.

INTRODUCTION

The Nash Draw Pool (NDP) in Eddy County, New Mexico produces oil and associated gas from the Permian (Guadalupian) Brushy Canyon Formation. The Brushy Canyon is a relatively new producer in the Delaware Basin of West Texas, with most drilling having occurred since the late 1980s and many discoveries occurring in the 1990s. Regionally, the fine-grained sandstones of the Brushy Canyon contain as much as 400-800 MMbbls of oil-in-place and thus this formation represents a significant reservoir interval in the Permian Basin. However, low permeability and petrophysical heterogeneity limit primary recovery to only 10-16%.

The NDP is one of the project sites in the Department of Energy (DOE) Class III field demonstration program for slope-basin clastic reservoirs. The objective of the NDP Class III project is to demonstrate that an advanced development drilling and pressure maintenance program can significantly improve oil recovery compared to existing technology applications. A further goal of the project is to transfer these advanced methodologies to oil and gas producers in the Permian Basin and elsewhere throughout the U.S. oil and gas industry.

In the first phase of the NDP project, an integrated reservoir characterization study was performed to better understand the nature of Brushy Canyon production and to explore options for enhanced recovery. Results obtained in the NDP project indicate that a combination of early pressure maintenance (gas injection) and secondary carbon dioxide flooding may maximize production in these complex, laterally variable reservoirs. Because of low permeabilities involved and high water-to-oil relative permeabilities, the use of gas instead of water is suggested as preferable as an oil-mobilizing agent.

Phase II is directed toward enhancing the ultimate recovery from the project. The plan includes directional/horizontal drilling of new wells in order to develop reserves under surface-restricted areas and potash mines and evaluation of prospects of early pressure maintenance.

RESULTS AND DISCUSSION

This is the thirty-third technical progress report on this project. Results obtained to date are summarized.

Geology and Engineering

The production database was updated through November 2003. This data was added to the history of each well to update the decline curves and to project ultimate recoveries as well as to assess the effects of interference and production strategies.

Nash Draw #33

The analysis of the second seismic survey has shown that the toe zone lies at the top of the “L” zone. This has resulted in a “K” and “K-2” zone completion with characteristically high water cuts and low oil cuts. To correct this situation a deepening operation was designed to extend the openhole section 111.25 m (365 feet) while dropping the TVD 15.24 m (50 feet) deeper.

In November 2003 the well was extended to a measured depth (MD) of 3029.11 m (9938 ft.), by extending the open hole from 2917.86 m (9573 ft.) to 3029.11 m (9938 ft.), total 111.25 m (365 ft.) (Figure 1). The true vertical depth (TVD) changed from -2053.04 m (-6735.68 ft.) to -2069.55 m (-6789.83 ft.), a total of 16.51 m (54.18 ft.) (Figure 2).

Good correlation was observed between offset logs and the observed drilling rates and sample shows through the “L” zone. The samples showed a high concentration of the ceramic proppant used in the fracture stimulation treatment. The percentage of proppant in the samples ranged from +90% initially to 10% at T.D. The drilling of the induced fracture indicated that the fracture orientation was longitudinal, the fracture extended down into the “L” zone and the induced fracture length approximated the design length of 121.92 m (400 ft.).

Apparently the “L” zone was stimulated during the initial completion and additional stimulation would not be beneficial. With the “L” zone stimulated, the production does not match the characterization of a good “L” zone completion. The question now is whether or not a good “L” zone was there, as predicted by the seismic data. A reinterpretation of the second 3-D seismic data set utilizing different amplitude attributes is being evaluated.

To enhance production, a completion of three intervals in the heel area is being planned. The intervals are at a MD of 2721.26-2722.18 m (8928-31 ft), 2467.97-2466.89 m (8097-8100 ft) and 2323.50-2324.41 m (7623-26 ft) (Fig. 3). Each zone will be perforated with six shots per foot, acidized with 15,141.64 l (4,000 gallons) 7.5% NEFE acid and the three zones fracture stimulated with 38,101.76 kg (84,000 pounds) of 16-30 sand and 27,215.54 kg (60,000 pounds) of ceramic proppant. Results will be reported in the next quarterly report.

Nash Draw #36

The second generation seismic shows the #36 well toe zone is completed at the top of the “L” zone and probably did not achieve penetration through all of the “L” zone pay. Initial testing showed good oil cuts, but final testing showed high water cuts consistent with “K” and “K-2” characterization.

A deepening operation has been designed to extend the openhole section 613.87 m (2014 ft) while dropping the TVD 15.24 m (50 ft) deeper. This should place the BHL at the bottom of the “L” zone porosity interval and allow fracture stimulation of the “L” zone.

A openhole packer assembly will be used to isolate the new openhole section from the

previously completed toe zone. A packer seat will be attempted in the tighter upper “L” section, generally in the upper 7 feet of the “L” interval. A groove will be hydrojetted into the lower “L” interval to create a stress point to control fracture initiation.

This workover is scheduled after the #33 deepening is completed and tested. A representation of the proposed wellbore configuration is presented in Figure 4. The new openhole section is shown as the black portion at the tip of the wellbore.

Nash Draw #34

The preliminary interpretation of the second generation 3-D seismic survey has yielded a drilling target in the NE/4 of section 12. A well is being planned from the #19 location to the NE/4 of section 12 as shown in Fig. 5.

Upon the successful completion of the #33 and #36 deepenings and confirmation that the “L” zone is as productive as the seismic predicts, the #34 well will be drilled through the NE/4 of section 12-T23S-R29E. The well is designed to be a directional/horizontal well with the directional section intersecting the “L” zone approximately 426.72 m (1400 ft) northeast of the surface location at an azimuth of 51.98°. After intersecting the “L” zone the wellbore will continue horizontally to an approximate BHL at 121.92 m (400 ft) FSL and 121.92 m (400 ft) FEL of section 1. The bottomhole location is projected to be 548.64 m (1800 ft) east and 969.80 m (3181.74 ft) north of the surface location, a total of 1114.05 m (3655 ft) from the surface location at an azimuth of 25.50°. A representation of the proposed wellbore path is presented in Fig. 6.

Other Applications

Strata has applied the characterization and 3-D seismic technology developed from the Nash Draw Project to two other fields in Eddy County and a new prospect west of the Nash Draw Unit. Another application is being modeled for a Bone Spring prospect in Lea County.

Two wells are being planned in the Forty Niner Ridge Field based on seismic interpretation using the Nash Draw parameters. The Forty-Niner Ridge Field is approximately three miles east of the Nash Draw Unit.

Internet Homepage

The web site for the Nash Draw Project can be accessed at <http://baervan.nmt.edu/nashdraw/>. The site includes a project summary, list of participants, summary of the technical team, technical transfer including quarterly and annual reports, and future plans and current activities.

Technology Transfer

Disseminating technical information generated during the course of this project is a prime objective of the project. A summary of technology transfer activities during this quarter is outlined below.

Web Site: <http://baervan.nmt.edu/nashdraw/>

EXPERIMENTAL RESULTS

No experiments are associated with this project.

CONCLUSION

The production database was updated through November 2003. Evaluation of the completion, stimulation, and production testing and analysis of the Nash Draw #33 horizontal well is continuing. The Nash Draw #33 deepening did not add additional production, but did confirm the structure and fracture geometry. Analysis of the seismic data has identified a target in the NE/4 of section 12 for the drilling of the next deviated/horizontal well. The web site for the Nash Draw Project is online and can be accessed at <http://baervan.nmt.edu/nashdraw/>. Technology transfer activities are outlined on this web site.

Fig. 1. Nash Draw #33 wellbore extension.

Fig. 2. Nash Draw #33 wellbore path, with new open hole from -4160 ft to -4513.

Fig. 3. Nash Draw #33 planned heel zone completions, 8928-31 ft, 8097-8100 ft and 7623-26 ft.

Nash Draw #36 Deepening

Fig. 4. Nash Draw #36 proposed wellbore extension.

Fig. 5. “L” zone amplitude anomaly in the NE/4 of section 12.

Fig. 6. Nash Draw #34 proposed wellbore path.