QUARTERLY TECHNICAL PROGRESS REPORT
(31st 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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RESULTS AND DISCUSSION

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

Geology and Engineering

The production database was updated through May 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

Testing and analysis continues on the #33 well. The Nash #33 was completed on December 11, 2002. Through June 30, 2003, it has produced 23,480 BO, 62,708 MCFG and is currently producing 105 BOPD, 525 MCFGD and 425 BWPD. The daily production from the #33 well is shown in Figure 1.

The “H” zone and the toe zone are commingled with a nine-valve gas lift system designed to lift 1500 barrels of fluid per day. Some initial problems were experienced in March due to compressor suction pressure, high line pressure and one leaking valve. Most of these problems were resolved by April 1, 2003 and lift efficiency is being maximized by monitoring the bottom-hole producing pressure.

Nash Draw #36

Evaluation of the completion, stimulation, and production testing and analysis of the Nash Draw #36 horizontal well is continuing. The “H-2” zone, completed from 6333–49 ft, continues to flow. Daily production currently is 88 BOPD, 431 MCFGD, and 33 BWPD. Cumulative production from the “H” zone and toe zones through May 31, 2003 is 87,081 BO, 222.2 MMCFG, and 41,283 BW.

When the “H-2” zone stops flowing the retrievable bridge plug will be removed and production from the toe zone and Mohave zones will be commingled with the “H-2” and tested. A 150 H.P. compressor has been located and moved to location in preparation of installing the gas lift system after commingling.

Workovers

The workover, to add additional “H” pay zone, has been completed on the Nash #12. The workover resulted in an 11 BOPD increase in production, as shown in Figure 2.

3-D Seismic

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 Figure 3.

The second generation seismic structure map (Figure 4) indicates that there is only 55 feet of west to east dip across section 11. The first generation seismic structure map showed 125 feet of west to east dip. This reinterpretation causes a problem with targeting the BHL of the horizontal wells drilled in section 11. The #33 and #36 wells were drilled using the dip exhibited by the first generation seismic survey and followed the "L" zone updip 75 feet to 50 feet. The second generation seismic structure map indicates that these wells only need to go updip +/- 25 feet. Therefore, if the second generation structure map is correct, the #33 and #36 BHL are at the top of the "L" zone or in the bottom of the "K-2". This may explain why the water cut is higher than expected from the #33 well.

Dr. Bob Hardage at the University of Texas Bureau of Economic Geology offers this explanation for the varying structural interpretation. "When depth maps are made from seismic-derived velocities without the benefit of well control to constrain the depth estimates, the maps are usually correct in a relative sense, but rarely yield precise depths. In other words, structural highs are generally structural highs when drilled; structural lows are indeed structural lows, and positive and negative dips are usually correct indications of actual subsurface dips. Thus the depth picture is correct in a relative sense. However, the seismic estimate of the depth of a target can be in error by several tens of feet even though the relative subsurface geometry is correct. This depth error results because of the error bar associated with the estimate of seismic velocity, because the stacking velocity determined early in the seismic data-processing process was not optimal, or because anisotropy results in large differences between horizontal and vertical velocities. As an example, if the selected stacking velocity at image time of 1 second is 10,000 ft/sec, a 2-percent error in velocity estimation will result in a depth error of (+/-) 200 feet.

To improve the depth accuracy of seismic maps, it is essential to incorporate well control into the depth conversion process so that wireline-measured depths of key formation tops can be tagged to seismic image times of those units. With a reasonable amount of well control as constraints, seismic depth maps can often be amazingly accurate, with depth predictions differing from actual depths by less than 10 feet at depths of 8,000 to 12,000 feet.

With this background, the Nash Draw depth maps can now be discussed. The original depth maps that led to the drilling of the 33 and 36 wells into Section 11 were made without any calibration wells in Section 11 to constrain the depth predictions. These first-generation maps were made using seismic-derived velocities across the total image space and control wells that existed only to the east of Section 11. The maps were affected by velocity error bars as the depth predictions moved farther away from each control well. These maps indicated that the depth of the Bone Spring, and units immediately above Bone Spring, decreased toward the west at a rate of about 100 feet per mile. The bottom hole depths of wells 33 and 36 were targeted based on this implied dip rate.

My opinion is that the original depth maps are correct across Section 11 in a relative sense. The Bone

Spring does become shallower to the west, but it is risky to assume that the dip is exactly 100 feet per mile. The error bars associated with the seismic velocities would allow this dip to vary by a few tens of feet over a distance of a mile.

There is now a new seismic survey and new depth maps have been made. The important difference in the depth mapping process with these new data, compared to the original depth mapping, is that there are now two control wells (33 and 36) in Section 11. A Bone Spring depth was provided to the Bureau for each well, and these depth values were used to constrain the new seismic depth predictions. These latter maps indicate the dips of the Bone Spring and the K and L reservoir targets are now about 50 feet per mile across Section 11, not 100 feet per mile as estimated by the first-generation maps.

By definition, these new maps are more reliable depth maps than the first maps IF (and a most important “if”) the Bone Spring depths provided for wells 33 and 36 are correct. If these well depths are incorrect, then the seismic maps are incorrect, again by definition.”

Dip Calibration

To calibrate the dip across section 11, three models were created using actual well data and seismic derived data. Case I uses the actual formation tops from the Nash Draw #13 and #15 wells and two wells located approximately 2 ½ miles to the west. The indicated dip is 70 to 78 ft./mile (Figure 5). There is good agreement with the “L” zone top observed in the #33 and #36 wells and the projected Bone Spring top for each well. In this case the BHL for the #33 and #36 wells are at the top of the “L” zone.

Case II uses the actual data from the #13 and #15 wells and the first generation seismic data. The indicated dip ranges from 81 ft./mile to 124 ft./mile (Figure 6). The observed formation tops in the #33 and #36 wells do not fit this dip model, indicating the dip is too steep. The BHL of the #33 and #36 wells is in the middle of the “L” section.

Case III uses the actual data from the #13 and #15 wells and the second generation seismic data. The indicated dip ranges from 43 ft./mile to 51 ft./mile (Figure 7). The observed formation tops in the #33 and #36 wells appear to be above the projected formation tops, indicating the dip is too flat. The BHL of the #33 well is above the “L” zone and the BHL of the #36 well is just below the top of the “L” zone.

The true dip across section 11 appears to be 50 ft./mile to 70 ft./mile with the BHL of the #33 and #36 wells lying at the top of the “L” zone. Assuming the fracture stimulation treatments did not grow down into the “L” zone and only the “K” and “K-2” are contributing, a high water cut would be expected from these completions. This is confirmed by using the characterization model prepared on the #15 using only the “K” and “K-2” zones. Initial production rates are calculated to be 122 BOPD and 511 BWPD, 80% water cut. The #33 well is producing a 80% water cut, confirming the production is coming primarily from the “K” and “K-2” zones. The #33 and #36 wells may need to be drilled deeper into the “L” zone and recompleted.

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. Another application is being modeled for a Bone Spring prospect in Lea County.

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 May 2002. Evaluation of the completion, stimulation, and production testing and analysis of the Nash Draw #33 horizontal well is continuing. The Nash Draw #33 production matches the model from the #15 “K” and “K-2” indicating production is coming from zones above the “L” zone. 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.

Figure 1. Nash Draw #33 daily production.

Figure 2. Nash Draw #12 oil production.

Figure 3. “L” zone amplitude anomaly in the NE/4 of section 12.

Figure 4. Second generation seismic structure map.

Figure 5. West to East dip using well control.

Table 1

SECTION 11 DIP - WELL CONTROL

		<u>X</u>	<u>Y</u>	<u>Z</u>		<u>DIP</u>
TELEDYNE 4 #1	TBS	-16170	11220	-3685	TEL4 X ND13	78.97FT/MI.
ND #13	TBS	-3534	7595	-3874		
SPUD STATE #1	TBS	-16160	760	-3715	SPUD X ND 15	70.21FT/MI.
ND #15	TBS	-4805	5270	-3866		
SPUD STATE #1	TL	-16160	760	-3625		69.28FT/MI.
ND #15	TL	-4805	5270	-3774		
TELEDYNE 4 #1	TL	-16170	11220	-3610		70.62FT/MI.
ND #13	TL	-3534	7595	-3779		
ND #33	BHL	-8297	7947	-3734		
ND #36	BHL	-6980	8380	-3763		
ND #33	TL	-6595	6546	-3757		
	TBS	-6595	6546	-3845		
ND #36	TL	-4482	7098	-3768		
	TBS	-4482	7098	-3856

Figure 6. West to east dip using 1st generation seismic data.

Table 2

SECTION 11 DIP - 1st GENERATION SEISMIC

		<u>X</u>	<u>Y</u>	<u>Z</u>	<u>DIP</u>
SEISMIC N-WL	TBS	-10560	10210	-3759	NW X ND13 86.42FT/MI.
ND #13	TBS	-3534	7595	-3874	
SEISMIC S-WL	TBS	-10560	6030	-3731	SW X ND 15 123.86FT/MI.
ND #15	TBS	-4805	5270	-3866	
SEISMIC S-WL	TL	-10560	6030	-3643	120.19FT/MI.
ND #15	TL	-4805	5270	-3774	
SEISMIC N-WL	TL	-10560	10210	-3671	81.16FT/MI.
ND #13	TL	-3534	7595	-3779	
ND #33	BHL	-8297	7947	-3734	
ND #36	BHL	-6980	8380	-3763	
ND #33	TL	-6595	6546	-3757	
	TBS	-6595	6546	-3845	
ND #36	TL	-4482	7098	-3768	
	TBS	-4482	7098	-3856

Figure 7. West to east dip using 2nd generation seismic data.

Table 3

SECTION 11 DIP - 2nd GENERATION SEISMIC

		<u>X</u>	<u>Y</u>	<u>Z</u>	<u>DIP</u>
SEISMIC N-WL	TBS	-10560	10210	-3810	NW X ND13 48.10FT/MI.
ND #13	TBS	-3534	7595	-3874	
SEISMIC S-WL	TBS	-10560	6030	-3810	SW X ND 15 51.38FT/MI.
ND #15	TBS	-4805	5270	-3866	
SEISMIC S-WL	TL	-10560	6030	-3722	47.71FT/MI.
ND #15	TL	-4805	5270	-3774	
SEISMIC N-WL	TL	-10560	10210	-3722	42.84FT/MI.
ND #13	TL	-3534	7595	-3779	
ND #33	BHL	-8297	7947	-3734	
ND #36	BHL	-6980	8380	-3763	
ND #33	TL	-6595	6546	-3757	
	TBS	-6595	6546	-3845	
ND #36	TL	-4482	7098	-3768	
	TBS	-4482	7098	-3856	