USING RECENT ADVANCES IN 2D SEISMIC TECHNOLOGY AND SURFACE GEOCHEMISTRY TO ECONOMICALLY REDEVELOP A SHALLOW SHELF CARBONATE RESERVOIR: VERNON FIELD, ISABELLA COUNTY, MI.

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ABSTRACT

The principal objective of this demonstration project is to test surface geochemical techniques for detecting trace amounts of light hydrocarbons in pore gases as a means of reducing risk in hydrocarbon exploration and production. During this reporting period, plans were finalized for additional surface geochemical sampling in the new Springdale Prospect field demonstration in Manistee County, Michigan. Plans were also developed to acquire additional surface geochemical data in the vicinity of the Bagley Prospect area in Otsego County, Michigan.

The main news this reporting period is the continued success in the Springdale demonstration area. The State Springdale & O'Driscoll #16-16 and the State Springdale & Herban 12-16 horizontal demonstration wells in Manistee County, Michigan are both flowing nearly 100 barrels of liquid hydrocarbons per day plus gas, which are good wells in Michigan. Reserves have not been established yet. A third horizontal well, the State Springdale & Wilburn 1-21 HD has been drilled and is waiting on completion. Two more horizontal wells have been permitted in the Springdale area by our industry partner.

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Figure 2. Generalized Stratigraphic Column for the Michigan Basin.

Figure 3. Microbial contour map of the Springdale Prospect in Manistee County, Michigan. Hatched gray area represents location of planned 2004 geochemical sampling program. Red well path is St. Springdale & O'Driscoll 16-16 HD1. Large red circles are bottom hole locations (bhl) of horizontal wells; pink circles are bottom hole locations of deviated wells. Green color filled contours indicate high microbial anomalies and yellow color filled contours indicate low anomalies. The change in the microbial anomaly along the path of the St. Springdale and O'Driscoll 16-16 HD1 may represent a fault or stratigraphic facies change.

Figure 4. Detailed Brown Niagaran isopach map in vicinity of Bagley 1-22. Approximate location of geochemical sampling planned for 2004 is shown by the hatched gray box. Contour Interval is 50 ft. Grid spacing is 50 x 50 meters. North is toward the top of the page. The open circles are Niagaran Brown isopach control wells with the thickness posted in feet. Grid lines and labels are sections within T30N-R03W.

1.0 EXECUTIVE SUMMARY

New Findings

The project has located hydrocarbons at the Springdale demonstration site (Figure 1) and has begun production from the State Springdale-O'Driscoll #16-16 and the State Springdale & Herban 12-16 at 100 barrels of oil per day and 100 mcf of gas per day, on average. Production is from the Brown Niagaran (Figure 2). These wells were located on mild geochemical anomalies (Figure 3). A third horizontal well, the State Springdale & Wilburn 1-21 has been drilled along the north lease line in sections 21 and 22 and is waiting to be completed.

Lessons Learned

Again the basic lesson is that geochemical surveys should precede drilling in Michigan prospects. The Springdale success was preceded by a geochemical survey that did not condemn the prospect. In fact, the geochemical survey appears to have located the edge of the reservoir, suggesting that surface geochemical surveys could be a useful tool for planning the orientation and length of laterals in fields or plays being developed using horizontal drilling.

It appears that geochemical surveys over developed fields have to be interpreted with caution due to the disturbances caused by production (e.g. pressure drawdown) which seem to produce negative or apical anomalies in the vicinity of the well bore extending out at least 1/2 mile. Perseverance and patience are also virtues in this type of exploration, as well as adopting a consistent set of sample procedures.

Should Something Else Have Been Done?

We should have stipulated that all project demonstrations had to have surface geochemistry surveys included in the prospectus, that is, as part of the package used to sell the prospect to investors. This would both educate the gas and oil community as to the value of geochemistry as well as insure that we are notified sufficiently in advance of the drilling to make better sampling plans and have an opportunity to conduct a "fill-in" geochemical survey if the original survey shows gaps and/or holes.

Goals and Results

One main goal of this project was to locate and produce hydrocarbons using surface geochemistry as a screening tool. The Springdale project has come close to fulfilling those objectives. We intend to pursue the Springdale demonstration with additional wells and surveys to test areas in the near vicinity. We will also pursue additional geochemical sampling in the Bagley Prospect area in Otsego County, Michigan.

Applications

As mentioned before, the results of the Bear Lake, Vernon, and North Dakota geochemical surveys, and now the Springdale survey, can be applied to other carbonate reservoirs worldwide. In

particular, the application of appropriate surface geochemistry surveys seems warranted based on the work done here, as well as the advice to record the surveys at the same grid density as complementary seismic data. We think that further analysis of the Springdale geochemical results combined with a thorough geological and engineering investigation can shed light on how to go after these types of plays.

Did Data Support Project or Not?

In regard to the Springdale project, the geochemical survey did not condemn it, but neither did it produce the kind of high anomalies that we have seen elsewhere (North Dakota, for example).

Future Work

More geochemical work will be done in conjunction with further field demonstrations as part of this project in the Springdale and Bagley areas in Michigan. New demonstration wells are planned for Michigan to test the Silurian reef play. Preliminary results using both the charcoal adsorption and the microbial techniques show good anomaly patterns for the Silurian Niagaran reefs.

2.0 EXPERIMENTAL

2.1 Geochemical Sampling Program – Michigan

The geochemical program will be focused now on Springdale, through the summer and fall of 2004 (Figure 3). A wider area will be surveyed and new sampling techniques may be tested. In addition, a survey will be conducted in the Bagley Prospect area (Figure 4).

2.2 Data Analysis

We have been analyzing duplicate samples from the surface geochemistry surveys at MTU using gas chromatography and comparing the result with the commercial microbial results. Full details of this comparative approach will be presented when sufficient data has been collected.

Microbial samples will be taken in the Springdale and Bagley areas according to the instructions of Geo-Microbial Technologies (Ochelata, Oklahoma). These soil samples will be taken from an average depth of 8 inches and placed into paper bags with roll-down tops provided by GMT. The samples consist of approximately 4 ounces of soil. Immediately after collection, the samples will be shipped overnight to GMT for analysis of butane-consuming microbes.

3.0 RESULTS AND DISCUSSION

Analysis of the geology of the Springdale prospect will continue in the aftermath of the successful wells there. The focus will be on the critical steps involved in discovering this play and the role of surface geochemistry. We plan to produce a detailed geological model for this field and integrate the geochemical data into it.

Analysis of the project surface geochemical data has now shown some significant results. The major findings are that the large-scale survey at Vernon Field, conducted early on in this project, appears now to be best interpreted as a halo anomaly over a depleted field (refer to Figure 7, Technical Annual Report #15122R20, April 2003-March 2004). The surveys over the pinnacle reefs show that these structures appear to be well suited for geochemical imaging (refer to Figures 5 and 9, Technical Annual Report #15122R20, April 2003-March 2004). We obtained good positive apical anomalies over several structures in the reef trend that were confirmed by drilling. We also obtained our best results in the form of very good apical anomalies over the Williston Basin test site (refer to Figure 11, Technical Annual Report #15122R20, April 2003-March 2004).

A recent Oil and Gas Journal article on the evolution of surface geochemical exploration concluded that the best use of surface geochemistry is to determine where not to drill a well (Davidson, 2004). Our Vernon Field well results support a corollary observation that mild geochemical anomalies over depleted fields may simply be background noise and not an indicator of producible hydrocarbons. In addition, the Springdale survey in the vicinity of the State Springdale & O'Driscoll 16-16 horizontal well path showed an abrupt transition from high to low microbial values at the approximate position where the well exited the reservoir. It would appear that this microbial transition marked the reservoir boundary since no reservoir was encountered in the horizontal well beyond this point. Surface geochemistry might be a useful tool for determining the limits of fields or plays being developed using horizontal well bores and could aid in the layout of well locations and the length of planned horizontal laterals.

4.0 CONCLUSIONS

The positive results from the Springdale wells show that live hydrocarbons can still be recovered in the Michigan Basin by small companies. We now need to establish the reserves and see if there are any further plays in the area. This work will likely stretch out over at least two years, but it is likely that much can be accomplished this summer and fall, year 5 of this project. Thus, we should have a good case history to write up for the final report. In addition, the Springdale play will be presented at various meetings and symposia, including PTTC workshops in the coming years. The main questions now are: 1. the size of the reserves, 2. the presence of additional fields nearby, and 3. details of the geology, including the type of trap and how to locate them. It would appear that additional sampling on a tighter grid would be useful at Springdale, but we should reconcile the present data with the drilling results first.

In general, the geochemical program is proving a valuable addition to the demonstration program in this project. We have mapped both positive and negative anomalies over the demonstration sites and have been able to correlate these observations with production. In general the negative anomalies correlate with produced fields or with reefs that are currently pumping. Positive anomalies occur over prospects that have not been drilled and where at least shows of hydrocarbons were encountered in the subsequent tests.

We have also developed a sampling and analysis protocol for surface geochemistry based on retrieval of activated carbon and analysis by gas chromatography. This technique is still being developed, but side-by-side comparisons with the microbial data can be used to compare the efficiency and accuracy (consistency) of the technique. If the activated carbon technique proves accurate, it has the advantage of being lower cost and more adaptable to routine application by small operators. We will emphasize this aspect of the project in our future reports.

5.0 REFERENCES

Davidson, M. J., 2004, Evolution of scientific surface geochemical exploration: Oil & Gas Journal, v. 102.23, June 21, 2004, p 35-38.

6.0 FIGURES

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