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, a new field demonstration, Springdale Prospect in Manistee County, Michigan was begun to assess the validity and usefulness of the microbial surface geochemical technique. The surface geochemistry data showed a fair-to-good microbial anomaly that may indicate the presence of a fault or stratigraphic facies change across the drilling path.

The surface geochemistry sampling at the original Bear Lake demonstration site was updated several months after the prospect was confirmed and production begun. As expected, the anomaly appears to be diminishing as the positive (apical) anomaly is replaced by a negative (edge) anomaly, probably due to the pressure draw-down in the reservoir.

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1.0 EXECUTIVE SUMMARY

New Findings

A microbial geochemical survey over the new Springdale Prospect in Manistee County, Michigan, has produced an anomaly map that suggests the presence of a fault crossing the projected path of the horizontal well planned for that prospect. A follow-up geochemical survey over the Bear Lake prospect is showing the beginning of a negative (edge) anomaly, consistent with the lowering of reservoir pressures as the reef is produced.

Lessons Learned

The basic lesson is that geochemical surveys should precede drilling in Michigan prospects. It is difficult to convince companies of the value of conducting surveys, but the results to date have been consistent, only marginal results (e.g. gas/oil) show when the geochemical anomaly is mediocre.

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

The principal goal this period was to increase the number of geochemical surveys and demonstration wells in various parts of the Michigan Basin. In addition to the previous demonstrations at Vernon, Bear Lake and Bagley Fields in Michigan and Myrtle Beach in North Dakota, we started work on a new demonstration site in the Springdale Prospect in Manistee County, Michigan. This is a pinnacle reef, similar to Bear Lake, and a surface geochemical survey was conducted over the site in September, 2003. In addition, the Bear Lake study was extended to the South in order to include the Charlich-Fauble 2-9 (permit number 48113) lateral well path.

Applications

As mentioned before, the results of the Bear Lake, Vernon, Bagley, 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 complimentary seismic data. The shallow-shelf and reef carbonates in the Permian Basin, the mid-continent, and Rocky Mountains (e.g. Williston basin) are logical targets for application of these techniques.

Did Data Support Project or Not?

The surface geochemistry data continues to support the demonstration projects quite well: it predicted that the demonstration wells would likely encounter or not encounter hydrocarbons. In other words, the geochemistry showed strong anomalies (Bear Lake and Myrtle Beach) that would justify drilling on the basis of that data alone and even more so in conjunction with the seismic and subsurface well data.

Future Work

More geochemical work will be done in conjunction with further field demonstrations as part of this project in Michigan and North Dakota. New demonstration wells are planned for Michigan to test the Silurian or Devonian reef plays. Preliminary results using both the charcoal adsorption and the microbial techniques show good anomaly patterns for the Silurian Niagaran reefs. Activated carbon sampling will be further evaluated in one or more demonstration areas.

2.0 EXPERIMENTAL

2.1 Geochemical Sampling Program – Michigan

In this reporting period (July-September, 2003) the geochemical sampling program was extended with surveys conducted over three field sites in Michigan: Bear Lake, Springdale and Charlton 6 (Figure 1). Bear Lake and Springdale are part of demonstration wells designed to test Silurian Reefs (Figure 2). Charlton 6 is a Silurian Reef that is part of another study, but is of interest because it is presently at the end of its primary production and is scheduled for gas (CO₂) injection. We intend to monitor this field as it is filled to see if we can detect any changes in the gas emissions (surface geochemical signature) as it is repressurized.

Two types of samples were collected: soil sample for microbial analysis by Geo-Microbial Technologies (GMT) and activated charcoal for analysis at MTU. The soil samples were collected at depths of nominally 8 inches as per GMT protocols. The charcoal samples were buried 36 inches deep in glass vials with fine mesh screens over the tops and left in the ground 2-3 weeks. The samples will be analyzed by gas chromatography.

2.2 Data Analysis

As mentioned before, 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.

3.0 RESULTS AND DISCUSSION

Analysis of the project surface geochemical data has begun to show 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 (Figure 3). And the surveys over the pinnacle reefs show that these structures appear to be well suited for geochemical imaging (Figures 4, 5, and 6). 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 (see Report 16 in this series).

4.0 CONCLUSIONS

The geochemical sampling program has been the main activity over this reporting period and has produced some positive results, particularly over the Springdale demonstration site. It appears to show an abrupt transition from high to low values directly across the path of the proposed well. It would appear that additional sampling on a tighter grid would be useful here but we should reconcile the present data with the drilling results first. Drilling the Springdale demonstration is scheduled for Fall 2003.

The additional microbial sampling over the Bear Lake prospect has considerably widened the coverage there. It appears that the discovery well is now producing a negative (halo) anomaly due to the pressure draw-down and this is reflected in the microbial data. However several relative highs were picked up in the new survey that bear further investigation, preferably by 2d seismic lines to see if there is any structure associated with them.

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. The extensive geochemical sampling over Vernon Field is now seen in retrospect to have defined a large negative anomaly associated with the entire field, indicating that it was a poor candidate for further development, a result confirmed by the drilling of the Smock 13-23-HD1 test well.

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

Seaman, C. C., 2003, Application of solid-phase microextraction technology in surface geochemical exploration: M. S. thesis, Michigan Technological University, Houghton, MI, 100 p.

6.0 FIGURES

Figure 1. Index map showing locations of all geochemical sampling in Michigan.

PERIOD	EPOCH	Rock Groups	Formations	Lithology	
QUATERNARY			Red Beds		
JURASSIC			Grand River Fm.		
PENN.	LATE	GRAND RAPIDS	Saginaw Fm.		
	EARLY		Bayport Ls.		
MISS.	LATE		Michigan		
	EARLY		Marshall Fm.		
			Coldwater Sh.		
MISS./DEV UNDIVIDED			Ellsworth Sh (W.)		
DEVONIAN	LATE	TRAVERSE	Antrim Sh. (E.)		
	MIDDLE		Squaw Bay Ls		
			Alpena Ls		
		Bell Sh			
		Rogers City Ls			
	DETROIT RIVER	Dundee Ls			
		Lucas Fm.			
		Amherstburg Fm.			
SILURIAN	EARLY	BASS ISLANDS	Bois Blanc Fm.		
			Garden Island Fm.		
	LATE		SALINA	G Unit	
				F Evaporites	
				E Unit	
D Evaporite					
C Unit					
B Evaporite					
A-2 Carbonate					
A-2 Evaporite					
MIDDLE	NIAGARA	A-1 Carbonate			
		A-1 Evaporite			
		Brown Niagaran			
		Gray Niagaran			
ORDOVICIAN	LATE	TRENTON - BLACK RIVER	White Niagaran		
			Clinton Sh.		
	MIDDLE	PRAIRIE du CHEIN	Cabot Head Sh		
			Manitoulin Dol.		
CAMBRIAN	LATE	LAKE SUPERIOR	Queenston Sh		
			Utica Sh		
	EARLY & MID.		Collinwood Sh.		
			Trenton Group		
			Glenwood		
			St. Peter Ss		
			Shakopee Dol.		
			New Richmond Ss.		
			Oneota Dol.		
			Trempealeau Fm.		
			Franconia Ss.		
			Dresbach Ss.		
			Eau Claire Fm.		
			Mt. Simon Ss.		
			Jacobsville Ss.		

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