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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DISCLAIMER

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. As part of the project, a field demonstration was undertaken to assess the validity and usefulness of the microbial surface geochemical technique. The surface geochemistry data showed a strong anomaly in the Myrtle Beach area that would justify drilling by itself and even more so in conjunction with the structural interpretation from the 3D seismic data. The Myrtle Beach geochemical survey indicated a good to excellent prospect which was confirmed by drilling.

Presented in this quarterly report is the Case History and Well Summary for the Myrtle Beach area in Burke County, North Dakota. This case history presents the important technical details regarding the geochemistry and the two vertical wells that are part of this field demonstration, and the applicability of these results to other demonstration projects. This format could be duplicated for other demonstration projects and is being used on all subsequent field demonstrations as they near completion.

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LIST OF GRAPHICAL MATERIALS

1.0 EXECUTIVE SUMMARY

Goals and Results

One of the primary goals of this project is to access the usefulness of surface geochemistry in reducing drilling risk. To date various applications of surface geochemistry have been applied to demonstration wells (Vernon, Myrtle Beach and Bagley) with good success in that in all cases except Myrtle Beach the geochemical surveys indicated poor to marginal prospects. The Myrtle Beach survey indicated a good-to-excellent prospect there, which was confirmed by drilling. Myrtle Beach was scheduled to go on production in June of 2003 but has been delayed indefinitely pending engineering analysis of poor results of bringing one well (Lawrence 10-21) back on line. Further work, including a new geochemical survey is scheduled at Myrtle Beach this summer/fall to validate the earlier survey and to extend the sample area. For the record, the two existing wells in Myrtle Beach are shut-in, waiting on pipeline connections. Surface geochemistry recorded the highest positive microbial anomalies we have obtained so far from our geochemistry-sampling program. We have been granted access to the 3-D seismic survey that has been recorded over the area. The next North Dakota demonstration well was delayed until at least the third or fourth quarter of 2003 due to economic conditions.

Applications

The results of the Bear Lake, Vernon, Bagley, and North Dakota geochemical surveys 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 did 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 North Dakota to test the Winnipegosis and Duperow Formations, as well as one in Michigan to test the Silurian or Devonian reef plays in another area. Preliminary results using both the Site Specific Micro Extraction (SPME) and the microbial techniques show good anomaly patterns for the Silurian Niagaran reefs. Activated carbon appears to hold good potential for detecting hydrocarbon anomalies and will be further evaluated in one or more demonstration areas.

2.0 EXPERIMENTAL

2.1 Geochemical Sampling Program – Michigan and North Dakota

The protocols for the geochemical sampling program have now been established. All site locations are recorded using GPS receivers and duplicate samples are being stored at Michigan Tech. In the future, sampling will focus on using activated charcoal to trap soil gases followed by analysis by gas chromatograph. It appears that a technique that uses a known baseline is best since natural samples contain multiple gases that are difficult to interpret.

2.2 Geochemistry Sample Collection – Michigan and North Dakota

All geochemical data collected to date (1100+ samples) has been archived in a MS Access database. This database will be placed online along with interpretive text shortly.

2.3 Geochemical Sampling Program in Myrtle Beach area, North Dakota

The first phase of the surface geochemistry program was initiated in the Myrtle Beach Prospect area in Burke County, North Dakota, taking more than 40 samples for microbial analysis (Figure 1). The stratigraphic column for the North Dakota is shown in Figure 2. It is apparent from the elevated microbial values (diamond symbols on Figure 3 map with microbial count posted below) that we need to go back and sample a larger area to try to obtain samples with lower microbial values off the prospect. In this area, project personnel collected all samples and interpreted the data.

2.4 Seismic Data Program in Myrtle Beach area, North Dakota

An 8 square mile 3D seismic data project was acquired over the Myrtle Beach structure in northwestern Burke County, North Dakota (Figure 3). The feature was initially defined by a grid of 12 2D seismic lines (Figure 4), which led to the drilling of the field discovery well, the Jordan Lawrence #10-21.

2.4.1 2D data Seismic

Figure 4 shows the locations of the 12 2D lines used for the initial subsurface interpretation of the Nisku, Winnipeg, and Winnipegosis in the Myrtle Beach area.

2.4.2 3D data Seismic

The 3D survey (Figure 4) was conducted by Solid State Geophysical Inc., using vibrators with a source line interval of 1320 ft and source point interval of 220 ft. A receiver interval of 880 ft and receiver point interval of 220 ft was used. The data was processed by Tricon Geophysics Inc. in Denver, Colorado and the data quality is considered very good.

The 3D data volume has the following parameters for loading:

Upper Left Line: 1
Upper Left Trace: 133
X: 1418192.75
Y: 688229.63

Upper Right Line: 143
Upper Right Trace 133
X: 1433807.00
Y: 687803.88

Lower Left Line: 1
Lower Left Trace: 1
X: 1417797.00
Y: 673715.00

Lower Right Line: 143
Lower Right Trace: 1
X: 1433411.25
Y : 673289.25

Datum : 1950 ft
32 bit floating point

Number of Lines 143
Number of Traces: 133
Data Length (ms): 2700
SEGY Format

In-line spacing (interval): 110 ft
Cross-line spacing (interval): 110 ft
Sample Rate: 2 ms

Header Information

	Byte Location	Length (Bytes)	
Line (in-line bin #)	9	4	Integer
Trace (cross-line bin #)	13	4	Integer
CDPX Coord:	81	4	Integer
CDPY Coord:	85	4	Integer

The 3D data volume had the following parameters for display when interpreted (e.g., Figure 5):

Datum Name: NAD27
Ellipsoid: CLARKE 1866
Semi-major axis = 6378206.400000, Reciprocal of flattening = 294.97869820
Datum Shift Method: NADCON
Projection System: North Dakota North 3301
Projection Type: Lambert Conformal Conic
False Northing = 0.000 ft, False Easting = 2000000.00 ft
Origin Latitude: 47 0 0.0000 N, Origin Longitude: 100 30 0.0000 W
Southern Parallel = 47 26 0.0000 N, Northern Parallel = 48 44 0.0000 N

2.5 Landgrid Data – North Dakota

The digital public land grid survey for North Dakota was obtained from the North Dakota Geological Survey. County outlines, streams, land use and other culture data were obtained from the TIGER census data web site.

2.6 Well and Log Data – North Dakota

Digital well and scout ticket data for all the wells in North Dakota were obtained from the Oil and Gas Division of the North Dakota Industrial Commission and loaded into a database. Digital files for the Lawrence 10-21 and the Holte 6-21 were obtained from Jordan and are also filed with the Oil and Gas Division. Data was also obtained in the form of hard copy scout tickets, well histories, base maps, and well logs from Jordan and the Denver Earth Resources Library.

2.7 Data Analysis

The digital data has been loaded into our ATLAS 4.0 program and also into GeoGraphix Discovery Software for manipulation of the 3-D seismic data. Preliminary regional structure maps have been constructed for the Devonian Winnipegosis and the Cretaceous Greenhorn formations.

We have begun to process the geochemical samples from the Myrtle Beach Prospect (Burke County, North Dakota) in the Williston Basin using the Gas Chromatograph unit recently set up at Michigan Tech for this purpose. It appears that some of the samples taken contain lignite and we have measured the gas content in several of the samples. It appears that the lignite contains a hydrocarbon signature, which is to be expected since coal is known to adsorb organic gases. In fact, some of the early geochemical gas sampling was done using activated charcoal. Since the Myrtle Beach prospect is adjacent to an abandoned lignite strip mine, it offers an opportunity to investigate a natural geochem sample. Future sampling trips will attempt to specifically recover lignite.

3.0 RESULTS AND DISCUSSION

Demonstration Case History and Well Summary
Myrtle Beach Area, Burke County, North Dakota

3.1 Overview & Prospect Background

Our industry partner initially identified a structural feature in the Myrtle Beach area of North Dakota using 12 2D seismic lines (Figure 4). The Larsen Field discovery well, the Jordan Lawrence #10-21 (api no. 33-013-01313), was drilled to a total depth of 11,550 ft in the Red River "C" and completed as a multi-pay discovery. The well had excellent shows in the Duperow "C" and Winnipegosis formations and also established production in the Gunton and Red River "B" and "C" horizons (Figure 6a-d). The well initially produced oil from the Gunton while waiting on a pipeline connection in order to produce the shut in Red River "B" and "C" horizons. The well is currently shut in.

The Lawrence discovery led to the drilling of the Jordan Holte #6-21 (api no. 33-013-01316), a northwest offset to the Lawrence (Figure 4) to a total depth of 12,515 ft in the Cambrian Deadwood formation. The Holte came in structurally approximately 50 ft low to the Lawrence at the top of the Red River but had encouraging drillstem tests in the Red River "C" and Black Island horizons, both flowing gas to surface and exhibiting good pressures. Although log analysis suggested low water saturations and potentially productive intervals in the Red River "B" and "C" and Gunton horizons (Figures 7a-e), production testing of these zones lead to rapid water encroachment. The well is currently temporarily abandoned.

The productivity disparities between the Lawrence and Holte wells resulted in the acquisition of an 8 square mile 3D seismic survey in order to better image the structural configuration of the area and of the wells. It appears from the new seismic data that the Holte is located on the edge of a major west-east trending basement fault in the area that is very likely highly fractured, which is the probable cause of the premature water encroachment. The Black Island sand in the Holte exhibits relatively low porosity (7%) but excellent permeability as indicated by a drillstem test which flowed gas to surface at a rate of 116.4 MCF per day and recovered 9014 ft of formation water and 1480 ft of mud, and mud, gas and condensate cut water (Figure 7e). Logs indicate a 4 ft gas column lies above the water and the interval was deemed too thin to warrant a completion attempt in the Holte well.

The 3D seismic data provides much clearer definition of the Myrtle Beach structure than was available from the 2D data. The feature is a large structural closure at the Winnipeg horizon covering approximately 1,000 acres and bounded on the north by drape over a major down to the north basement fault. Approximately 130 ft of closure is mapped at the Winnipeg Horizon in the Holte (100 ft at the Lawrence), which approximately matches the gas column identified in the Red River "C" horizon in the two wells. The 3D seismic defines a location with approximately 30 ft of structural advantage to the Lawrence well at the Winnipeg horizon and 20 ft of structural advantage at the Winnipegosis (Figure 5, NEW LOC north of Lawrence). This optimum location would have approximately 85 ft of structural advantage to the gas-water contact identified in the Black Island sand in the Holte well.

3.2 GEOCHEMICAL

3.2.1 Microbial

The first phase of the surface geochemistry program was initiated in the Myrtle Beach Prospect area in Burke County, North Dakota, taking more than 40 samples for microbial analysis (refer to diamond symbols in Figure 3).

3.2.2 Geochemical Summary

The first phase of the geochemical survey was carried out in the Myrtle Beach area in 2002 and phase 2 will begin in the third quarter of 2003. The microbial results from the 40+ phase 1 samples were extremely high; higher than any microbial analysis from our Michigan data set.

3.3 SEISMIC

As is typical of Williston Basin seismic data, seismic times do not conform well to known structure due to near surface velocity variations. For this reason a Nesson or near Base of Last Salt geological structure map has been used as a datum for seismic depth mapping. Although the region is sparsely drilled, well control for the Nesson map is relatively good, with a total of 9 Nesson penetrations within and near section 21. Based upon deep formation tops provided by the Lawrence and Holte wells, it was necessary to utilize an interval velocity gradient for depth mapping of the Winnipegosis and Winnipeg (Red River) horizons.

The 3D seismic data provides a clear picture of the structural configuration in the Myrtle Beach area and confirms that the Holte well, in hindsight, was drilled in a position too close to the west-east basement fault. The seismic interpretation shows that as many as five more locations may exist on the Myrtle Beach structure with multi-pay potential. The “NEW LOC” on the Winnipegosis map in Figure 5 is the proposed location of the next well.

3.4 WELL DETAILS - LAWRENCE 10-21 AND HOLTE 6-21

3.4.1 Location

The Jordan Lawrence #10-21 (api no. 33-013-01313) vertical well is located 1980 ft from the south line and 1780 ft from the east line of section 21, T162N, R90W, Burke County, North Dakota. The Jordan Holte #6-21 (api no. 33-013-01316), vertical well is located 1780 ft from the north line and 1780 ft from the west line of section 21, T162N, R90W, Burke County, North Dakota (Figures 3, 4, and 5).

3.4.2 Drilling and Casing History

Wolverine drilling rig #44 drilled the Lawrence well. 9 5/8 inch casing was set at 1537 ft and 5 ½ in casing was set at total depth of 11, 550 ft. The same rig drilled the Holte well. 9 5/8 inch casing was set at 1515 ft and 5 ½ in casing was set at total depth of 12,515 ft.

3.4.3 Open hole testing, coring, mudlogging, and logging

Drillstem tests, mudlogs, and open hole logs were run in both the Lawrence and Holte wells. Refer to Figures 6a-d and 7a-e for presentation of this important information over the pay intervals. Logs were recorded using the Schlumberger Platform Express tool string and included compensated neutron and three detector density, array induction, compensated sonic, and the computer processed cyberlook. A mud log was recorded in each well and included lithology, shows, penetration rate, total gas, and C1 – C4. Drillstem tests were run in both wells and the information for each test is posted on the logs presented in Figures 6 and 7. No cores were taken.

3.4.4 Testing and Completion

The Lawrence well was tested in the Red River "B" and "C" intervals that are presently shut in waiting on a pipeline connection. The well was perforated and initially completed in the Gunton interval to establish oil production from the prospect.

The Lawrence well was first perforated in the Red River "C" zone from 11,326 to 11,330 ft, with 4 shots per foot, cleaned up with 500 gallons of 15% MSR-100 acid, and fractured twice with 4000 gallons of 28% SXE acid and 3000 gallons of gel water additive and then 1000 gallons of 28% acid with an additive. The last two swab runs for this interval recovered 90% water and 10% oil and was making some gas with 10 barrels of load from acid job still to recover. Testing of the "C" interval was halted at this point and a cast iron bridge plug set at 11,320 ft.

The Red River "B" interval was perforated next from 11,249 to 11,254 ft with 4 shots per foot, cleaned up with 500 gallons of 15% MSR-100 acid, and acid fractured. The "B" zone tested at rates of approximately 135 bbls of fluid (25% oil and 75% water) at 1650 pounds after the fracture treatment. The well was officially completed at this time in the new Larson Field from the "B" interval with a flowing initial potential of 3 bbls of oil per day, 5 bbls of water per day, and 1050 MCF gas per day with GOR 350000, oil gravity of 49.9 on a 16/64 choke. Testing resumed 3 months later on the Red River "C" zone and additional perforations were added from 11,338 to 11,348 ft to establish improved rates.

The Lawrence was plugged back to the Gunton and perforated from 11,112 to 11,118 ft with 4 shots per foot. This interval was acidized with 15% HCL acid to establish commercial production. The well had produced approximately 9000 barrels of oil, 70,000 MCF gas, and 800 barrels of water from the Gunton through mid-year 2002.

The Holte well was tested in the Red River "B" and "C", Gunton, and Interlake intervals before being temporarily abandoned. The Red River "C" was perforated from 11,329 to 11,354 ft with 4 shots per foot and acidized with 1500 gallons of 15% HCL. Testing was unsuccessful, therefore, the well was re-perforated from 11,329 to 11,335 ft with 4 shots per foot and acidized with 1000 gallons and 2000 gallons of 15% HCL, respectively, and produced 1% oil cut. The well was plugged back to the Red River "B" and perforated from 11,263 to 11,268 ft with 4 shots per foot and acidized with 1000 gallons of 15% HCL. Fifteen swab runs tested 1% oil cut. The well was plugged back to the Gunton and perforated from 11,129 to 11,134 ft with 4 shots per foot and acidized with 500 gallons of 15% HCL but produced only water. The last test was for the Interlake interval. The well was perforated from 10,786 to 10,794 ft and 10,974 to 10,980 and acidized with 800 and 500 gallons, respectively, of 15% HCL (the Interlake is not shown in Figure 7). Swab runs tested 1% or less of oil and the well was temporarily abandoned.

3.5 Recent Lawrence well testing

The most recent Lawrence well testing started on April 8, 2003 to produce the Red River "B" and "C" zones together, following an approximately 9 month shut in to measure productivity for laying a pipeline. A dip in pressure of the combined "B" and "C" zones confirmed that at least the "C" zone had built back to virgin pressure. However, upon flowing the well, production dropped off quickly, and the well was shut in following less than 30 days of testing. The well started out testing 36 BOPD, 350 MCF gas, and 62 BWPD but after 20 days was producing only 16 BOPD, 50 MCF gas, and 12 BWPD. Production testing and bottomhole pressure test results are being evaluated by the operator.

4.0 CONCLUSION

The next proposed well to be drilled in the Myrtle Beach area (Figure 5) has excellent potential in the Black Island, Red River "C" and "B" and the Gunton intervals, as well as the Duperow "C" and Winnipegosis. A successful well could provide additional subsurface and reservoir data to warrant drilling up to 5 additional 320 acre units, with a primary objective in the Red River "C" and additional potential in the Black Island, Red River "B" and Gunton formations within some of these units. The Myrtle Beach feature thus represents an excellent opportunity to establish significant reserves on a well defined (geochemically, seismically, and from well control), productive feature with multi-pay potential.

The successful acquisition of additional microbial geochemical data beyond the limits of the 3D seismic data set and known structural closure should establish the sub regional microbial background levels as well as delineate possible additional oil and gas potential along the west-east basement fault.

5.0 REFERENCES

Oil & Gas Division, 2002, North Dakota Stratigraphic Column: Bismarck, ND, 1 p.

6.0 FIGURES

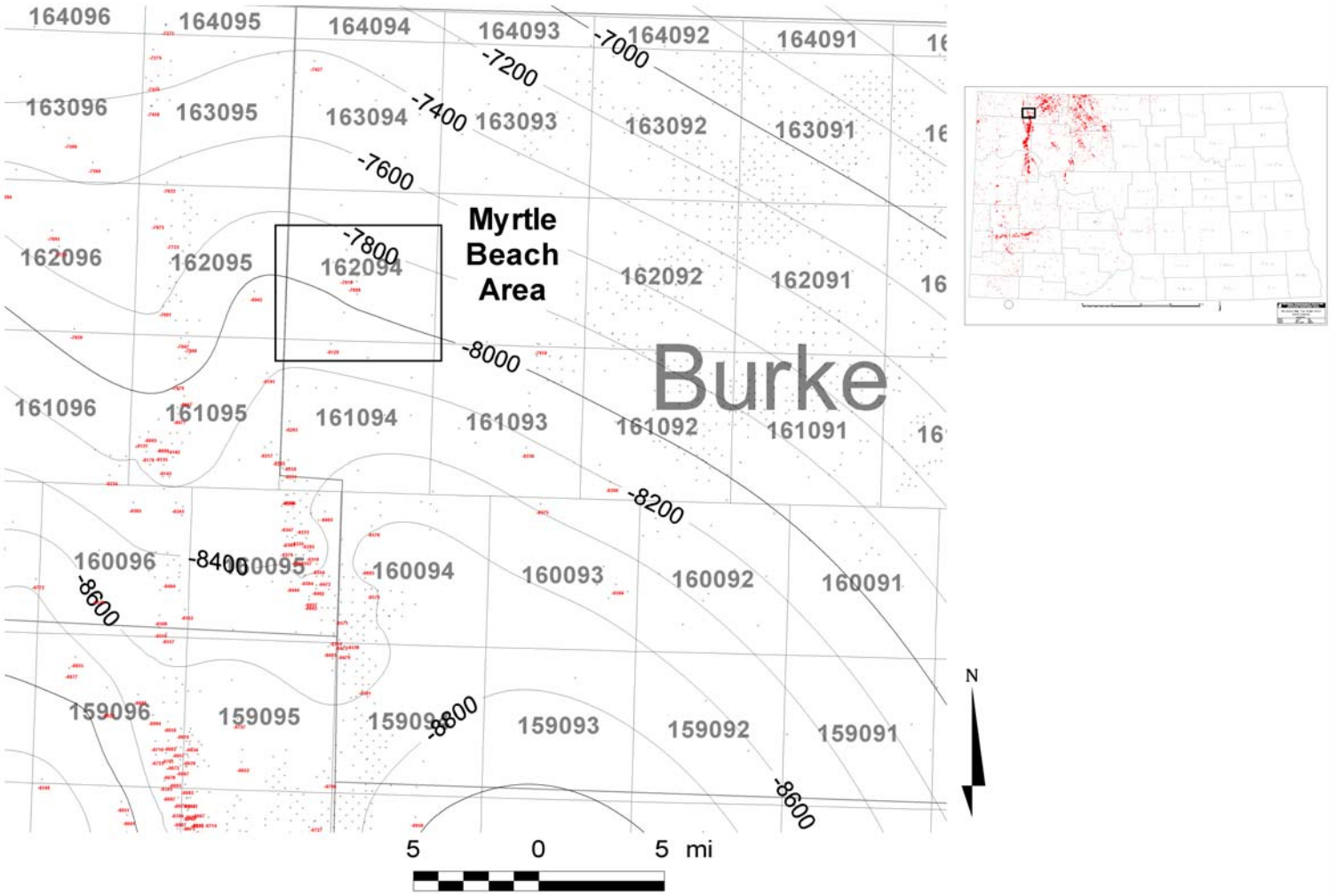

Figure 1. Index map showing location of Myrtle Beach area in Northwestern North Dakota. Structure contours are on the top of the Winnipegosis formation using a contour interval of 200 feet. The gray numbers represent township and range, 162094 is T162N, R94W.

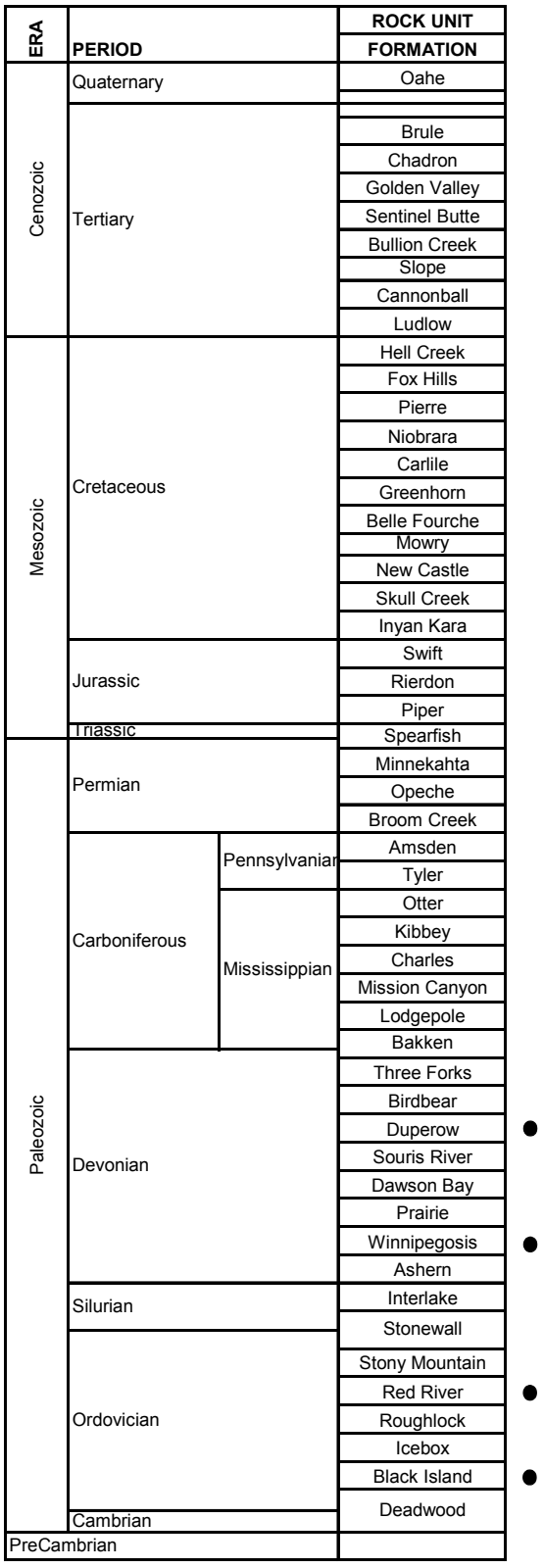

Figure 2. Generalized Stratigraphic Column for the Williston Basin (Oil and Gas Division, 2002). Black dots are key productive intervals in the Myrtle Beach area.

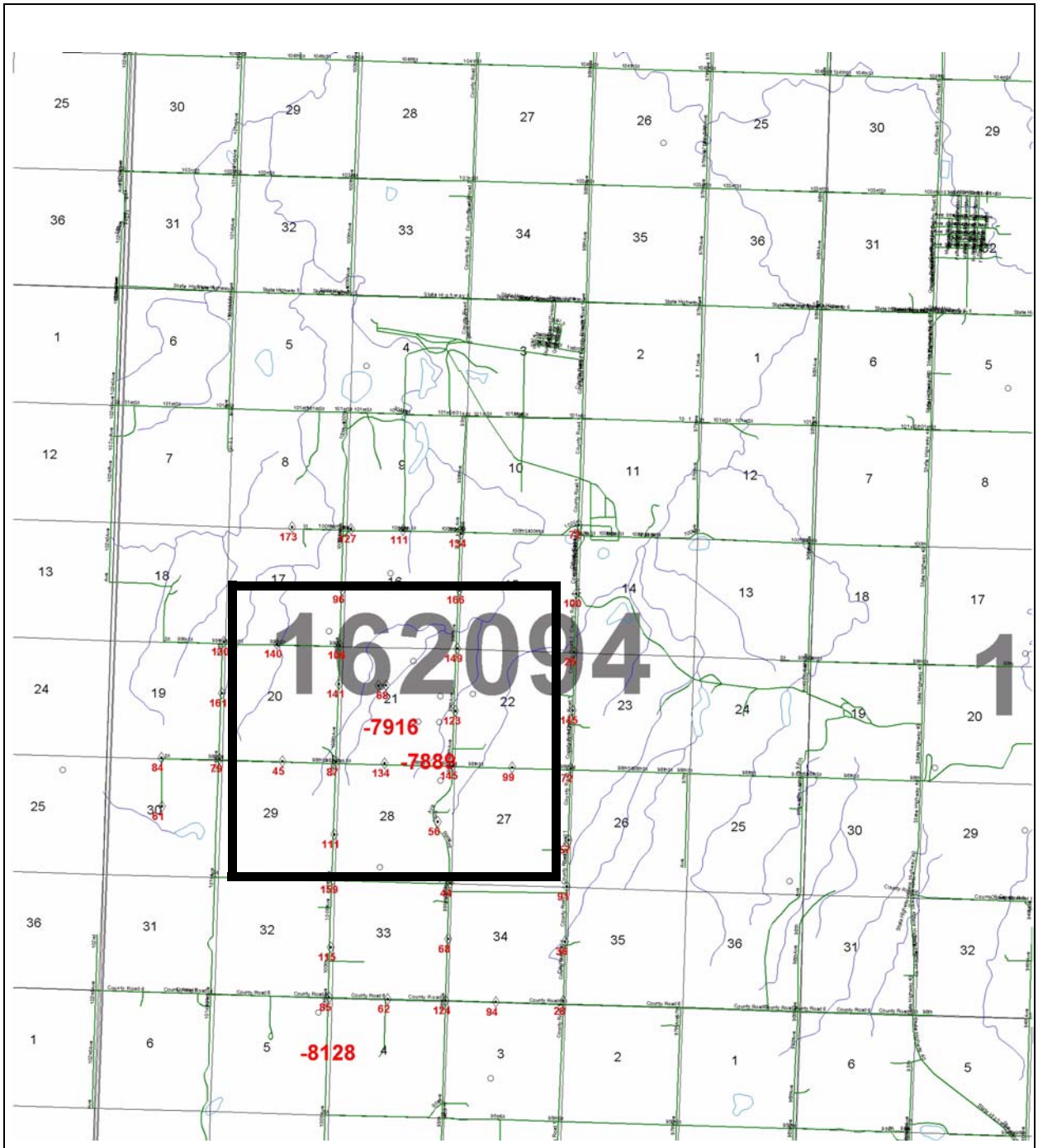

Figure 3. Microbial sample locations in the Myrtle Beach area. Microbial counts posted in red below sample location. Black outline is location of 3D seismic survey. Blue lines are rivers and lakes, Green lines are roads, subsea Winnipegosis tops for 3 deep wells posted in red. North is toward top of map.

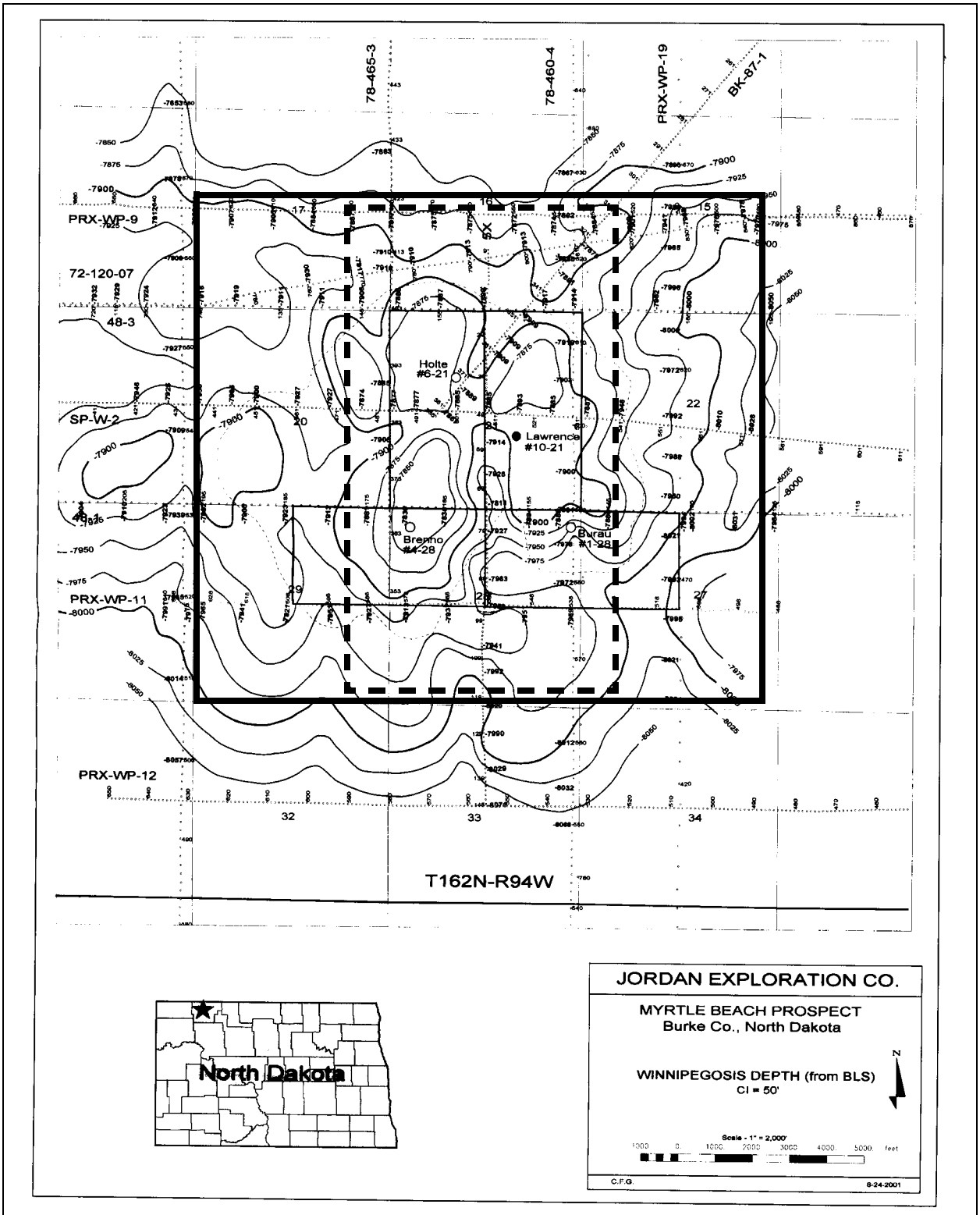

Figure 4. Myrtle Beach, North Dakota 2D seismic line location map with structure contours on the Winnipegosis formation, CI=25 feet. Black outline is location of 3D seismic survey. Dashed outline is location of 3D map shown in Figure 5.

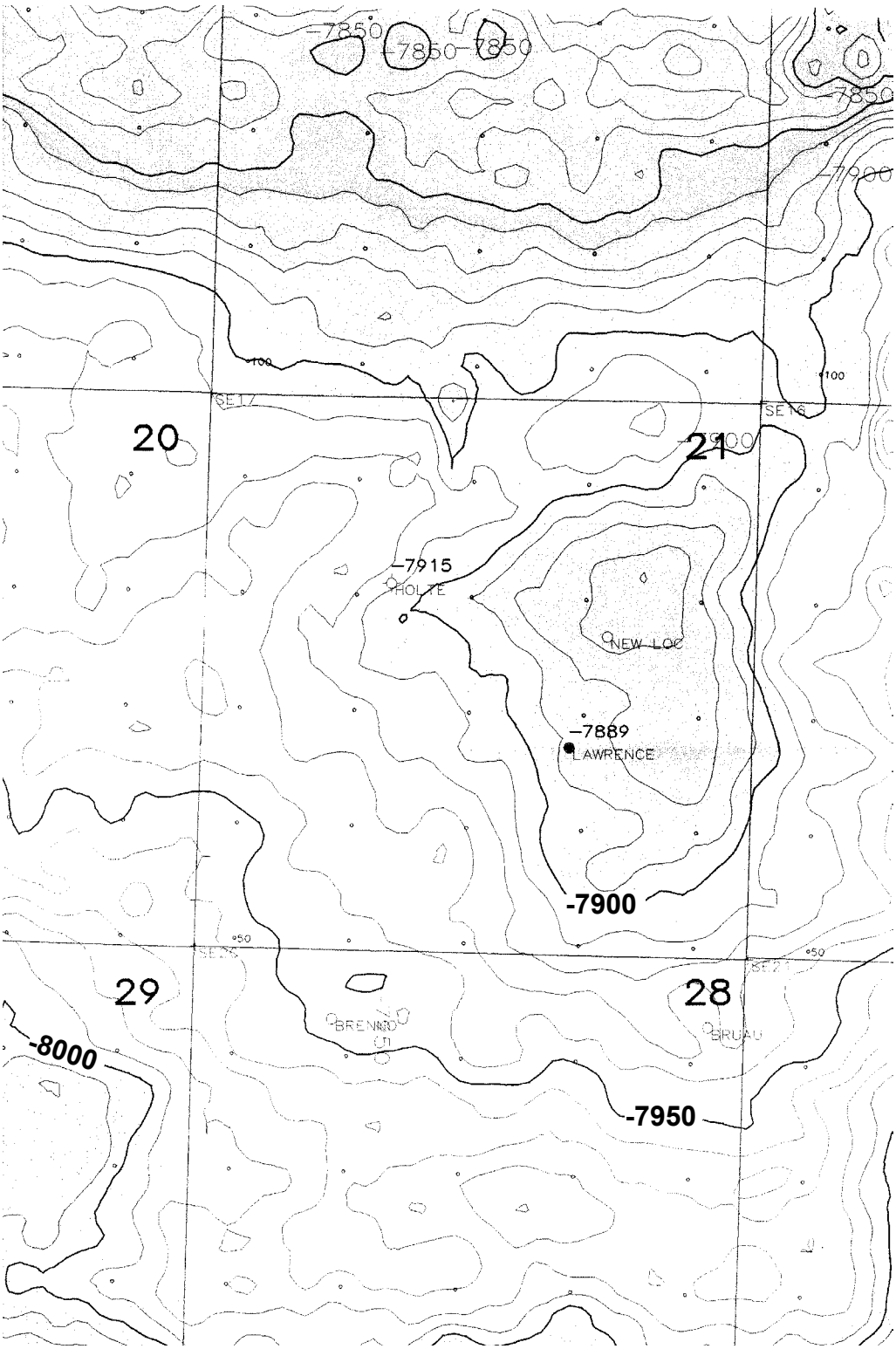

Figure 5. Myrtle Beach 3D seismic structure map (in depth) on Winnipegosis, CI=10 feet, North is toward the top of the page. Subsea value is posted above well spots. Map is hung from the base of last salt (Nessen). "NEW LOC" is next proposed drilling location.

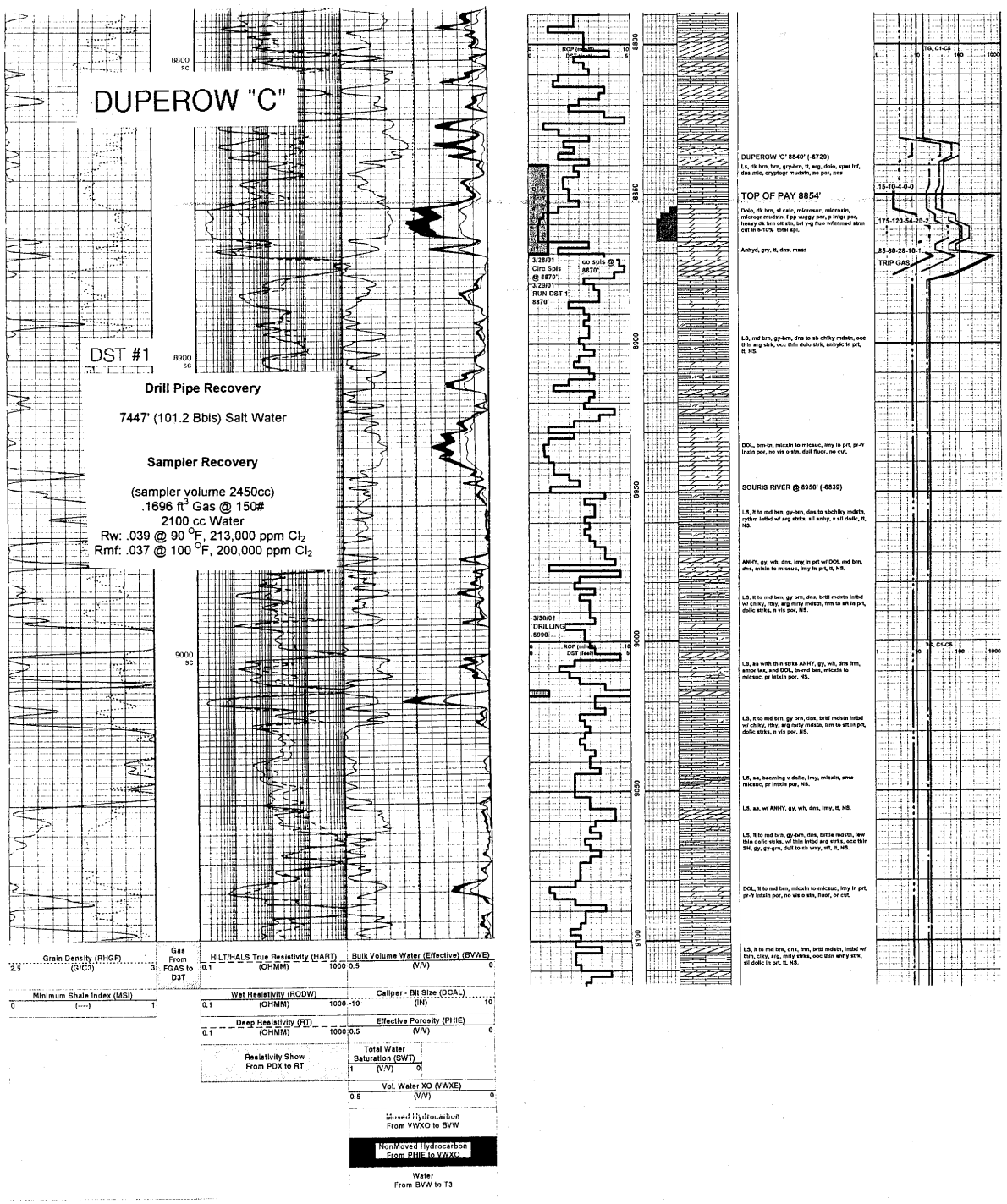

Figure 6a. Annotated log and mudlog from Lawrence #10-21 well, showing the Duperow "C" formation.

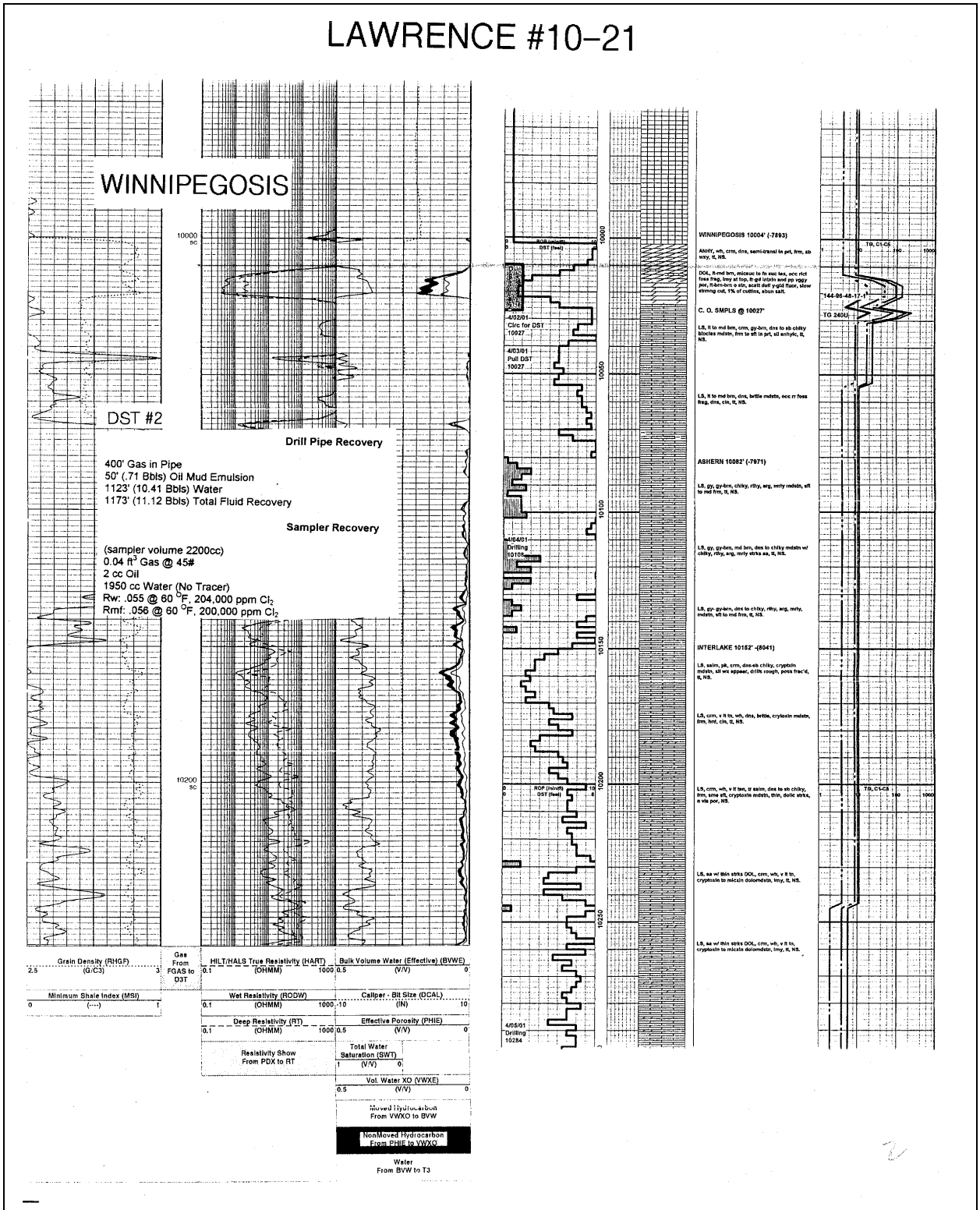

Figure 6b. Annotated log and mudlog from Lawrence #10-21 well, showing the Winnipegosis formation.

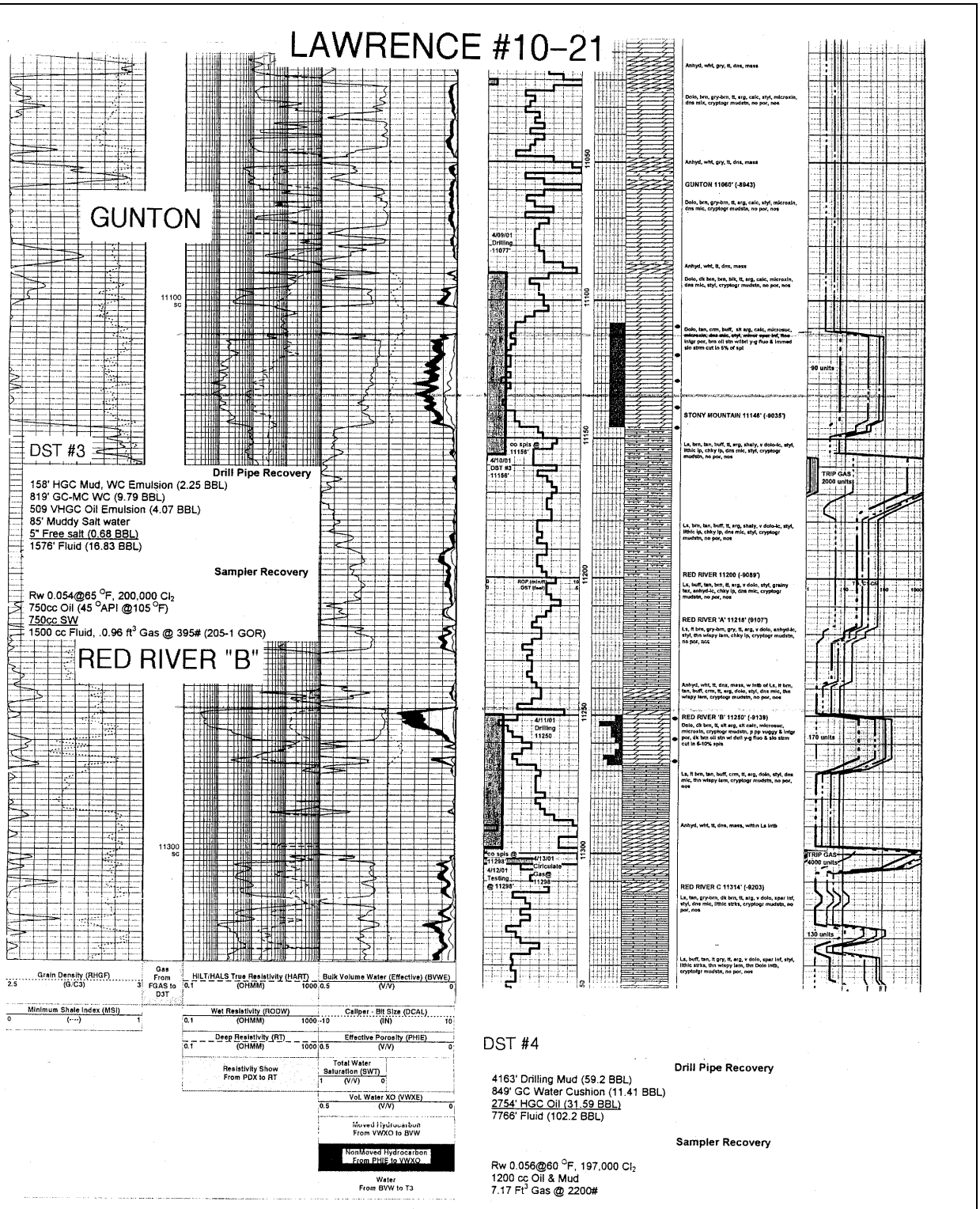

Figure 6c. Annotated log and mudlog from Lawrence #10-21 well, showing the Gunton and Red River "B" formations.

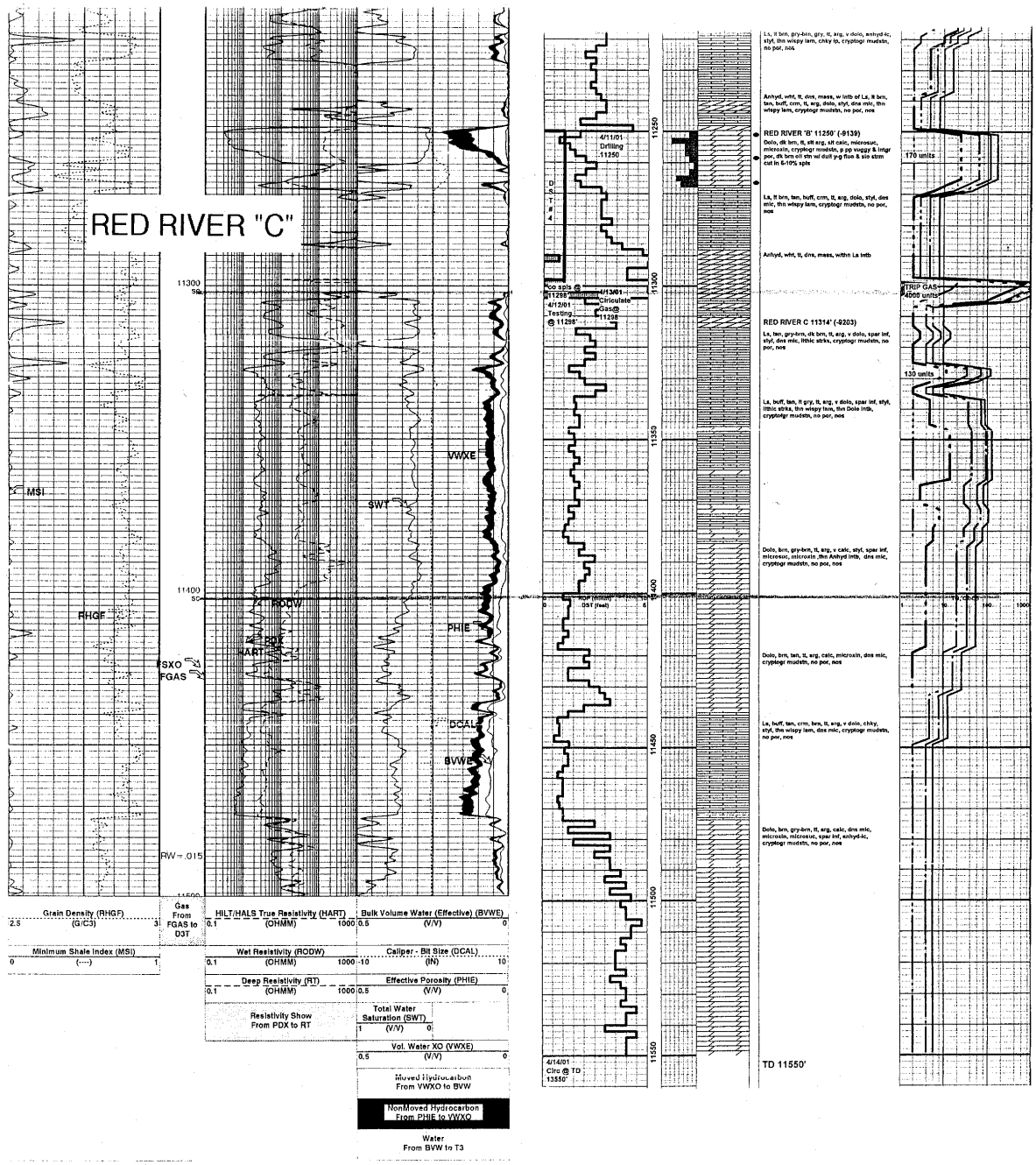

Figure 6d. Annotated log and mudlog from Lawrence #10-21 well, showing the Red River “C” formation.

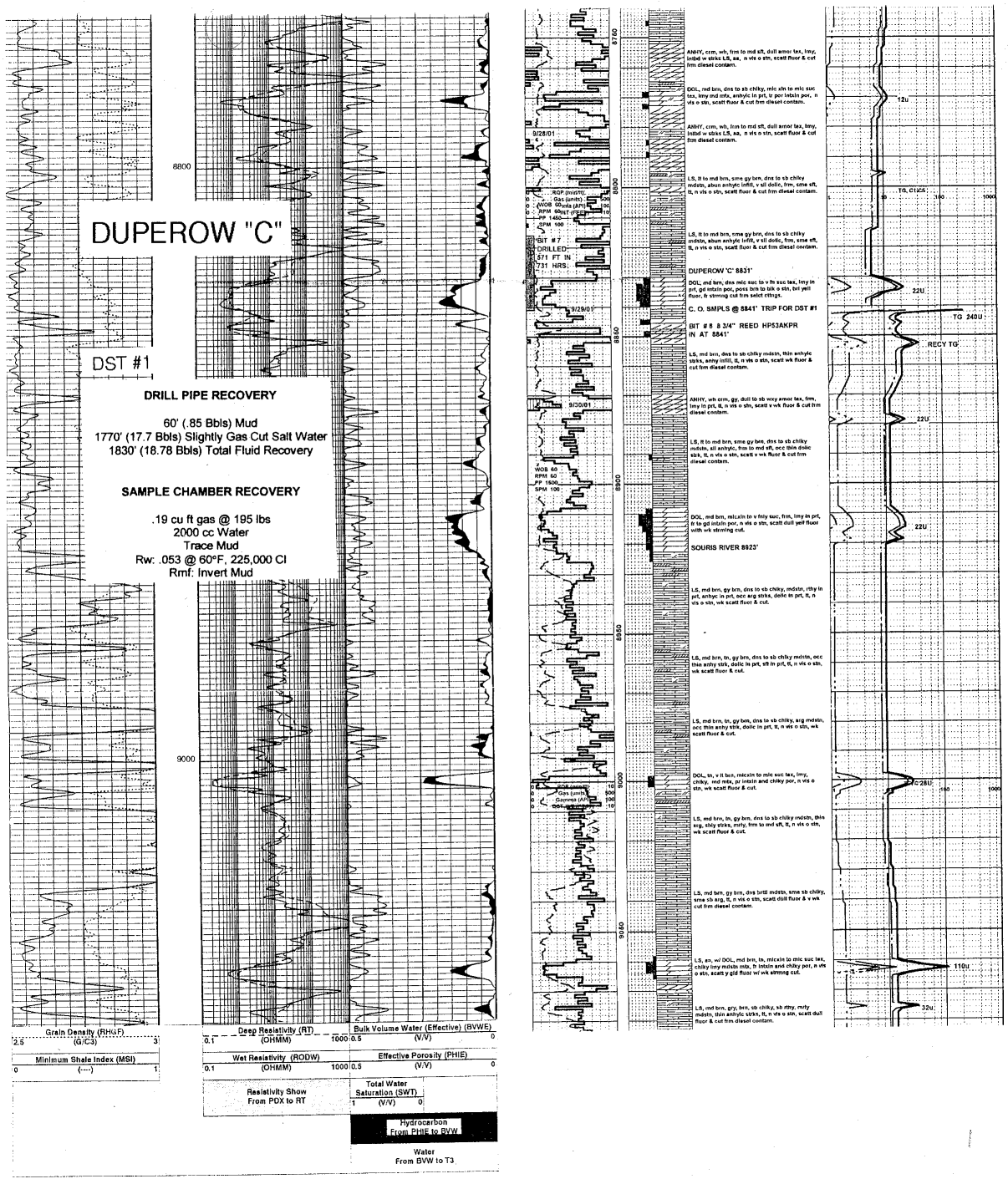

Figure 7a. Annotated log and mudlog from Holte #6-21 well, showing the Duperow “C” formation.

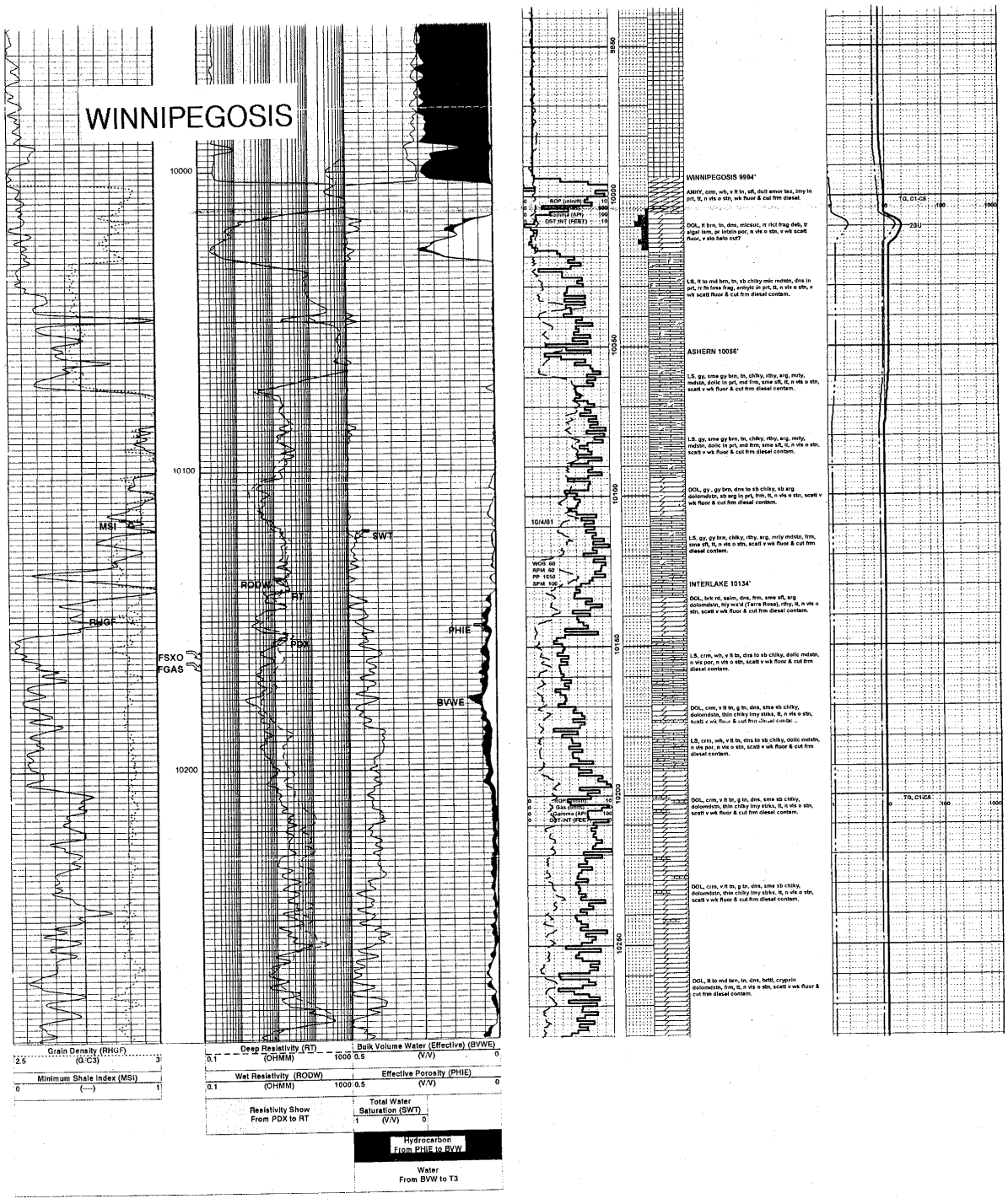

Figure 7b. Annotated log and mudlog from Holte #6-21 well, showing the Winnipegosis formation.

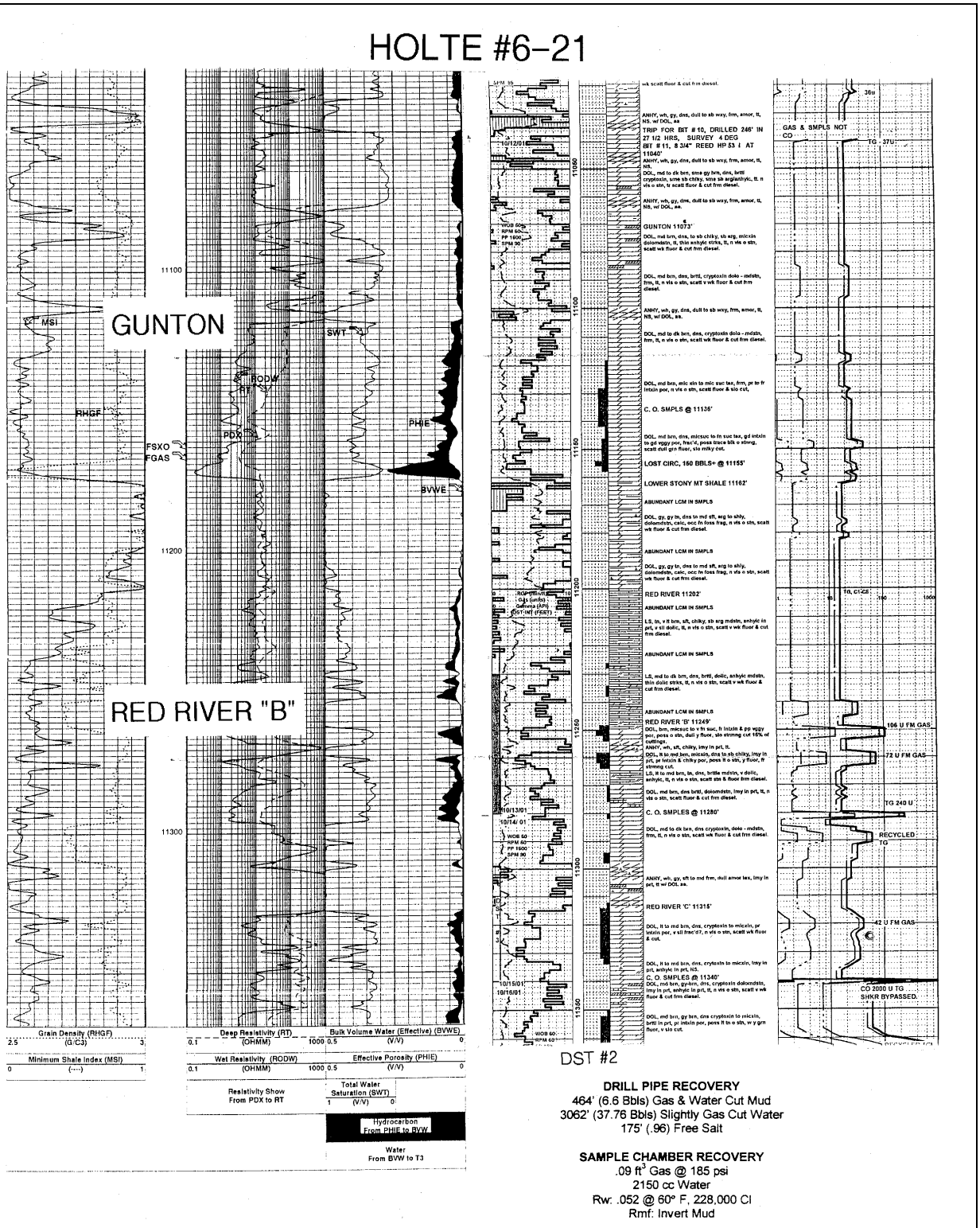

Figure 7c. Annotated log and mudlog from Holte #6-21 well, showing the Gunton and Red River “B” formations.

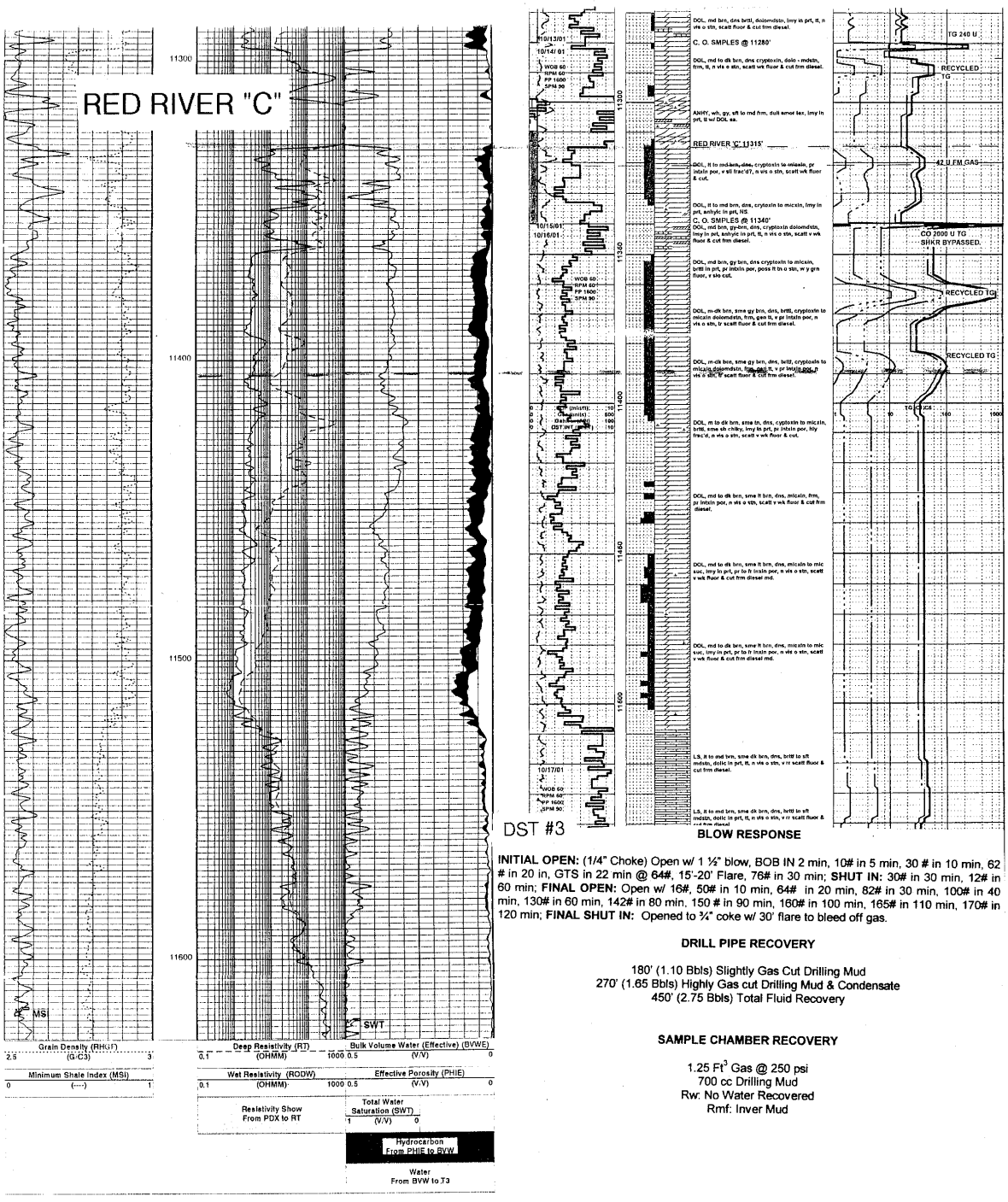

Figure 7d. Annotated log and mudlog from Holte #6-21 well, showing the Red River "C" formation.

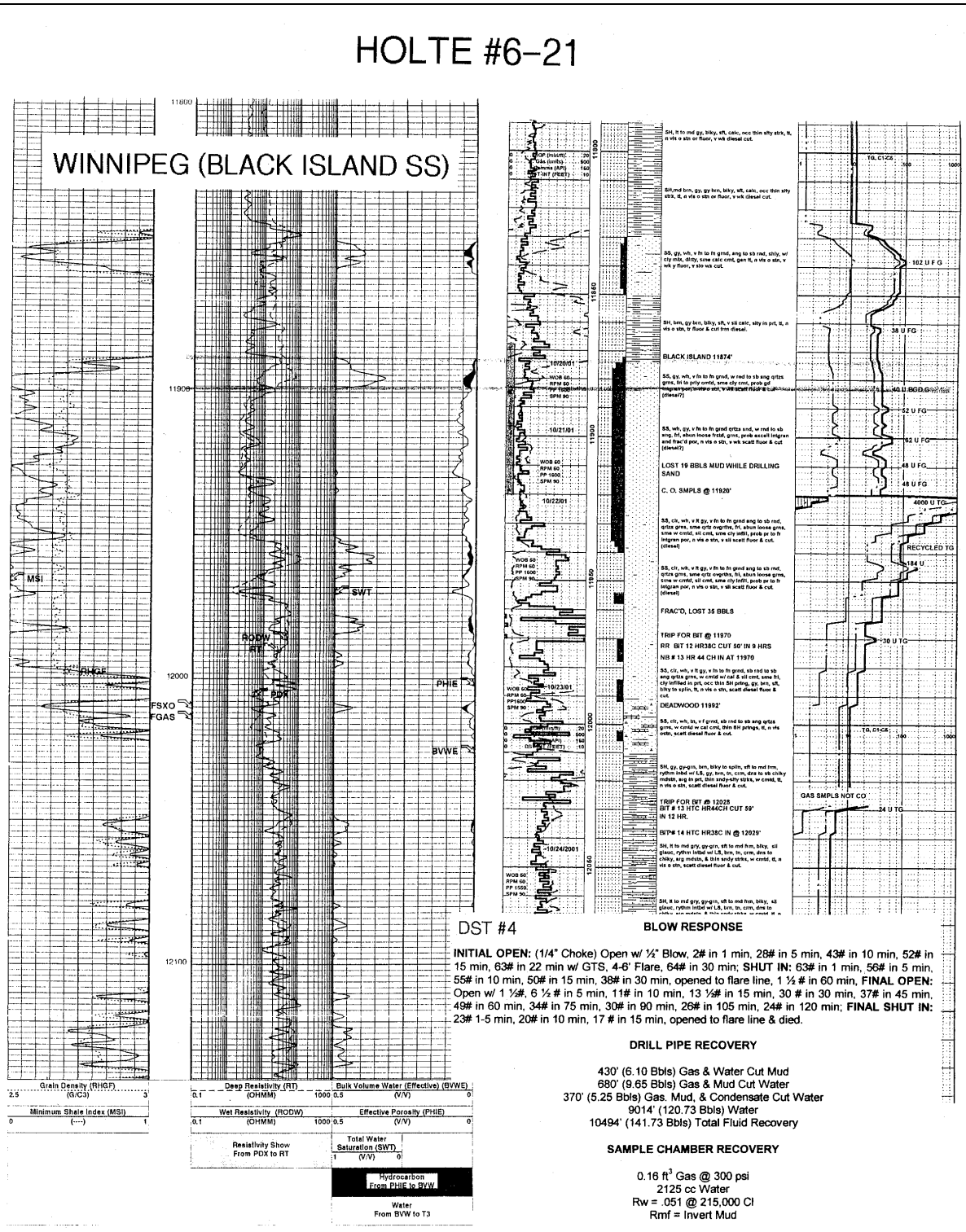

Figure 7e. Annotated log and mudlog from Holte #6-21 well, showing the Winnipeg (Black Island SS) formation.