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Final Report: Restimulation of Under-stimulated Shallow Gas Zones Coupled With the Installation of Pumping Equipment to Dramatically Accelerate Post-Stimulation Fluid Removal

Activity Period: July 1, 2003 – December 31, 2004

Principal Authors: Karl Kimmich, John Holko

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DISCLAIMER

ABSTRACT

Two shallow gas wells located in Chatauqua County, New York were re-perforated and re-stimulated during the third quarter of 2003. The initial well, Barney 732 was equipped with a pumping unit, and monitored for a total of three months. A pumping unit was installed on the second well, the Griswold 702, in the fourth quarter of 2003. This well was subsequently monitored for a period of 3 months with the pumping unit in place. Both wells eventually reached a point of negligible fluid production and the pumping units were removed and replaced with a tubing plunger system. Monitoring of gas production continued through the end of 2004.

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EXECUTIVE SUMMARY

It was the intent of this project to evaluate a simplistic approach to additional natural gas recovery from existing stripper wells that seem to have un-recovered reserves after approximately 20 years of production. By reviewing wellhead pressures and well logs, it was decided that there should be the potential for additional recovery. If a simple review of easily obtainable data as well as a cost effective stimulation treatment could be utilized, the potential for a dramatic impact of additional reserves from existing stripper wells was worth the effort.

The results of this project are inconclusive. Even though the initial results do not provide a dramatic increase in production, it still may be possible by prolonging the economic life through stimulation to add dramatically to the overall recovery of existing wells. The impact of using existing wells provides a positive environmental and logistical twist to the current search for additional natural gas reserves and deliverability.

EXPERIMENT

Candidate Selection

The 65 wells contained in the Lakeshore Field, Chatauqua County, New York were screened in an attempt to select the best wells for re-stimulation. The wells were ranked by the following prioritized criteria:

1. Low cumulative gas production (ie., high remaining target reserves)
2. High shut-in wellhead pressure (again; high remaining target reserves)
3. Porosity-ft. of Medina/ Whirlpool reservoir (maximum original gas-in-place)
4. Surface access (minimize logistical costs associated with equipment movement)

Two wells were selected based upon the above criteria; Barney 732 and Griswold 702. (Figure 1 and Figure 2 Well Logs Medina Section of Wells)

Fracture Stimulation Design

The fracture stimulation for each well was designed by Universal Well Services to place approximately 65,000 lbs. of 20/40 proppant carried in approximately 650 bbls of gelled water into a selected interval in each well. The design called for the sand to be placed in subsequent stages from a minimum sand concentration of 1 #/gal. up to a maximum sand concentration of 6 #/gal.

Fracture Stimulation Placement

The actual job placement record for each well is attached to this document. Each well was initially reperforated at 2 shots/ft. by Schlumberger Well Services in a 15' interval near the top of the potential pay zone. Then the bottom of each wellbore was filled with pea gravel to a point approximately 10' below the bottom of the new set of perforations. The wells were originally perforated in 1984 with a limited entry scheme – 15-16 single perforations spread out over an interval of approximately 100'.

This reperforation operation was completed in order to ensure that the entire stimulation would be placed within a small interval, thus theoretically maximizing the horizontal extent of the hydraulic fracture in the target formation.

The first stimulation was completed on the Barney 732 on September 5th, 2003 (Figure 3, Figure 4). A packer was placed on 2-7/8" tubing approximately 200' above the perforated interval. The stimulation was successfully conducted through tubing in order to protect the integrity of the twenty-year-old 4-1/2" casing.

The second stimulation was completed on the Griswold 702 on September 19th, 2003 (Figure 5, Figure 6). During the loading of the tubing prior to the placement of the stimulation, pressure was experienced on the tubing/casing annulus. A leak around the packer was suspected and the decision was made to pump down the 4-1/2" casing, without the protection of the tubing. Pressure build-up during the operation resulted in the placement of only 49,000# of proppant, approaching the design volume of 65,000#.

RESULTS AND DISCUSSION

Barney 732

The fluid recovery volume from the Barney 732 was significant and approached the total volume pumped within a few days. Subsequent inspection of the depth of sand in the well with a service rig indicates surprising results; there is no indication of proppant or pea gravel in the wellbore. The pumping unit operation was initiated and fluid recovery volumes from this point forward have been quite low – less than 100 total bbls. The gas production rate has shown no measurable change in comparison to the pre-stimulation rate, approximately 6 mcfd. Fluid level measurements indicated that the wellbore fluid level was near the pump depth. Negligible fluid production led to the removal of the pumping unit and the installation of plunger lift equipment. Monitoring of the gas production through the end of 2004 (Figure 7) indicates no noticeable improvement in production level. The excellent post-stimulation fluid recovery in this partially pressure-depleted reservoir probably indicates that the stimulation did not adequately enter the targeted porosity zone. This seems to be supported by the lack of production enhancement. In addition, the lack of proppant in the wellbore immediately after stimulation supports the theory that the re-stimulation entered the identical fracture plane of the original stimulation – which easily absorbed the deposition of the entire proppant volume. This is a problem for which we know of no simple solution. It is theorized that both the original 1984 and 2003 stimulations were placed outside of the target interval.

Griswold 702

Fluid recovery from the Griswold 702 totalled approximately 2/3 of the total volume pumped – 745 bbls in the 30 days after the re-stimulation. During this time period, the well built surface pressure of approximately 450 psig with a measured fluid level of approximately 1200' over the perforations. Subsequent swab operations resulted in recoveries of an additional 100 bbls of fluid when sand production led to the curtailment of swab operations. The well was sand-pumped and a pumping unit was installed. Within two months of the stimulation a production level of 535 mcf was achieved – greater than any month in the entire production history of the well. Production had declined by the end of 2004 to the 120-150 mcf/month range (Figure 8). Although this rate is disappointing, it remains higher than that historically exhibited by the well. It appears that the re-stimulation was successful in entering a portion of the reservoir that was previously unstimulated. The sudden pressure increase experienced during the re-stimulation that resulted in a premature completion of the job seems to indicate that the proppant was entering a previously unstimulated zone.

CONCLUSION

Trying to design a simple re-completion program to recover additional reserves from existing stripper wells may be economically successful during times of high natural gas prices, but may not be as simple as just adding additional proppant to existing zones. The key to additional recovery will be an ability to define and isolate understimulated zones. Additional technology and research will need to be applied to this review to provide an adequate understanding of the relationship between stimulation and recovery in the Medina Fields of Western, New York. There are no immediate plans to conduct additional re-stimulations in this field. Although there remain a large number of understimulated wells, there appears to be no low-risk method at this time, which would allow isolation and re-stimulation of the unstimulated zones(s). Several new wells will be drilled and completed during 2005 and 2006. During the drilling and completion of these new wells, additional reservoir data will be collected in an attempt to ascertain whether zonal confinement of fracture stimulations in this field is feasible.

Figure 1

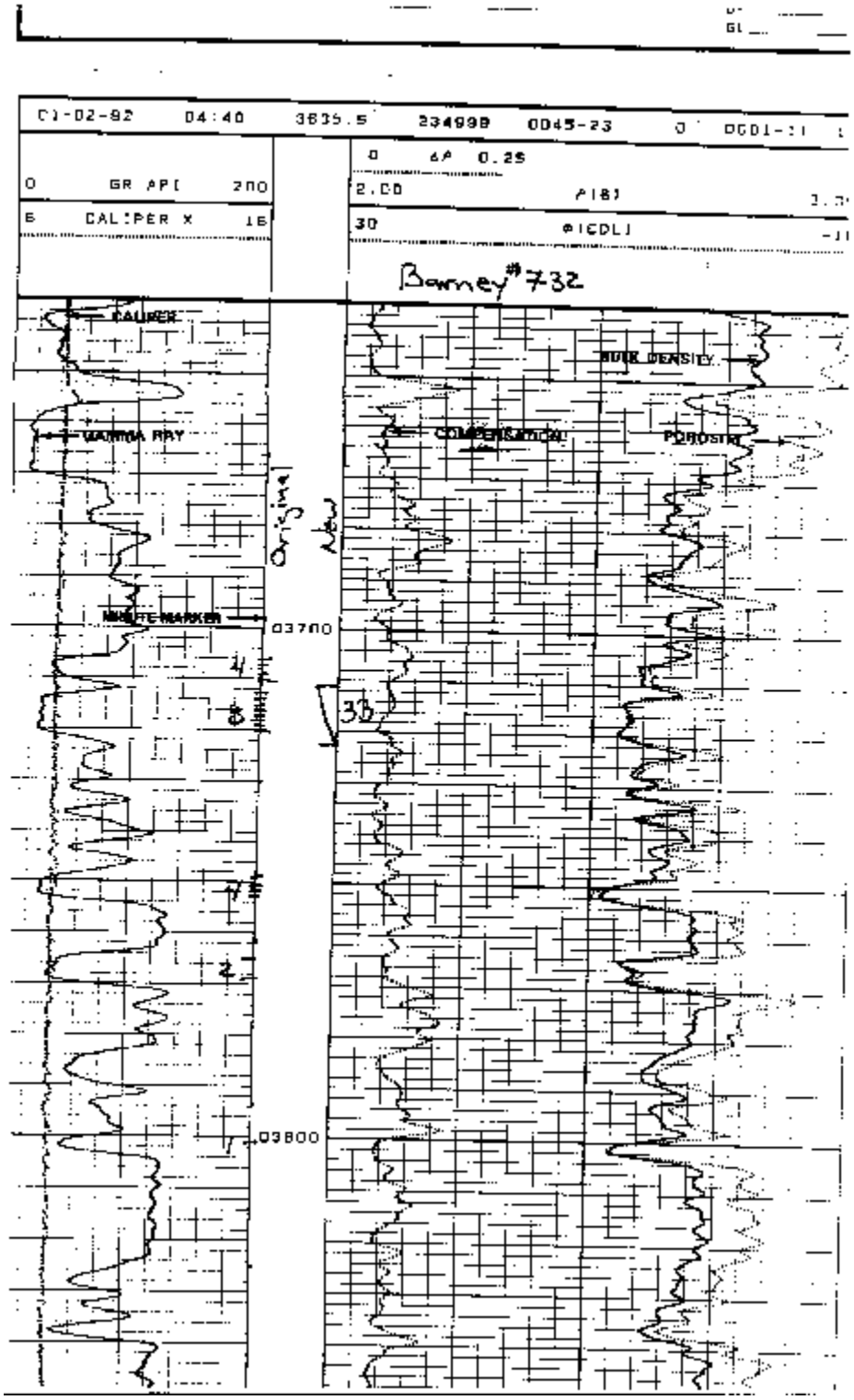

01-02-92 04:40 3635.5 234998 0045-23
0 GR API 200
6 CALIPER X 16
0 ΔP 0.25
2.00 PIBI
30 ΦICDLI
Barney #732
CALIPER
GAMMA RAY
BULK DENSITY
COMPENSATED
POROSITY
Original
New
MARKER
03700
03800

Figure 2

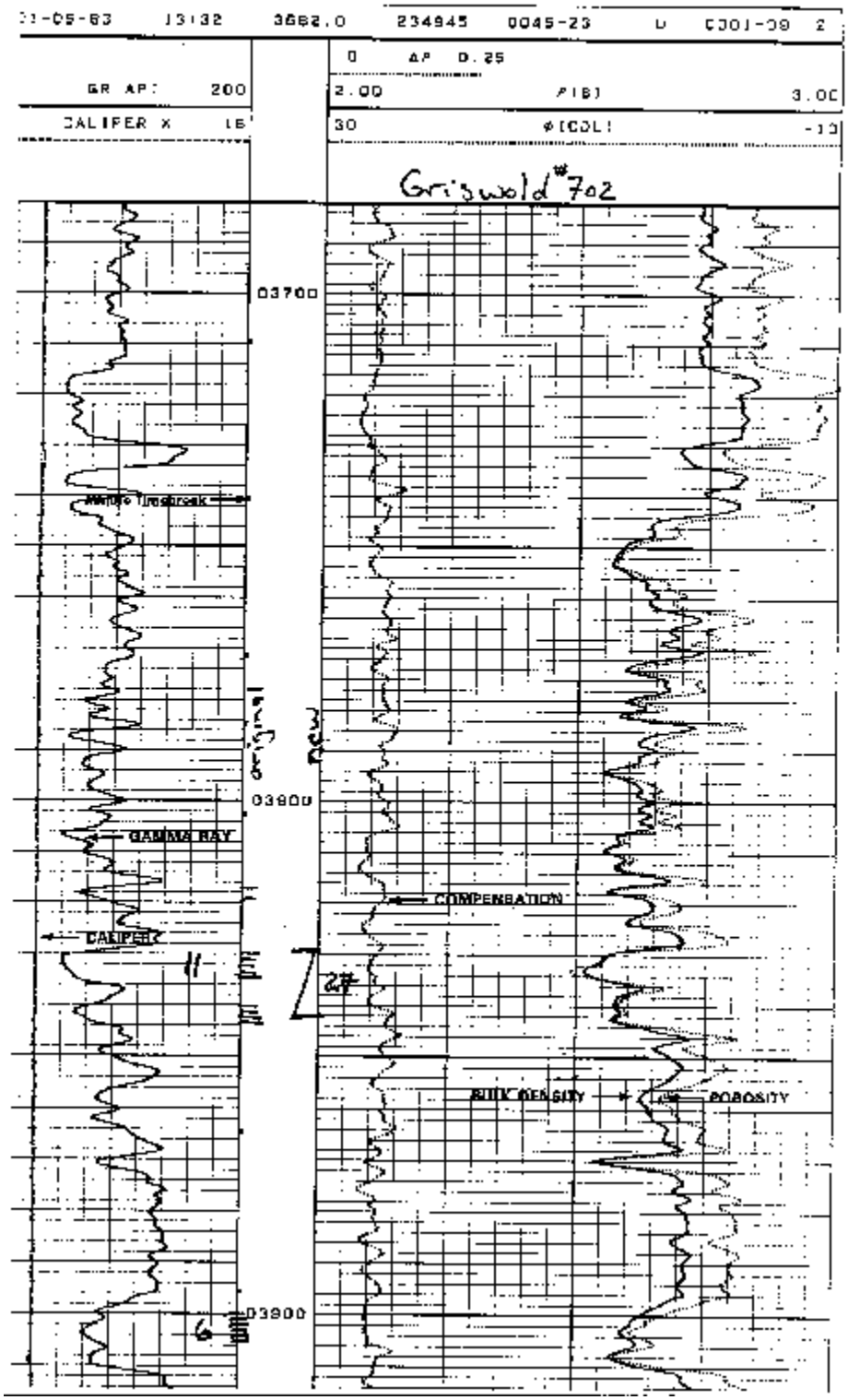

Griswold #702
03700
03800
03900
GAMMA RAY
CALIPER
COMPENSATION
BULK DENSITY
POROSITY

Figure 3

Lion Energy

Date:	**9/5/03**
Well:	**Frank R. Barney #1 - 732**
Location:	**Chautauqua County, NY**
Perforations:	**3,706'-3,722' 33 Holes**
Packer Depth:	**3212'**
Job Description:	**Water frac through 2 7/8" tubing. 40# Linear Gel**

Job Summary

Average Slurry Rate	19.8bpm
Maximum Slurry Rate	23.4bpm
Slurry Volume	29,482gals
Sand Total	648sacks
Average Sand Concentration	2.8Lbm/Gal
Maximum Sand Concentration	5.4Lbm/Gal
Average Pressure	3374psi
Maximum Pressure	4198psi

Figure 4

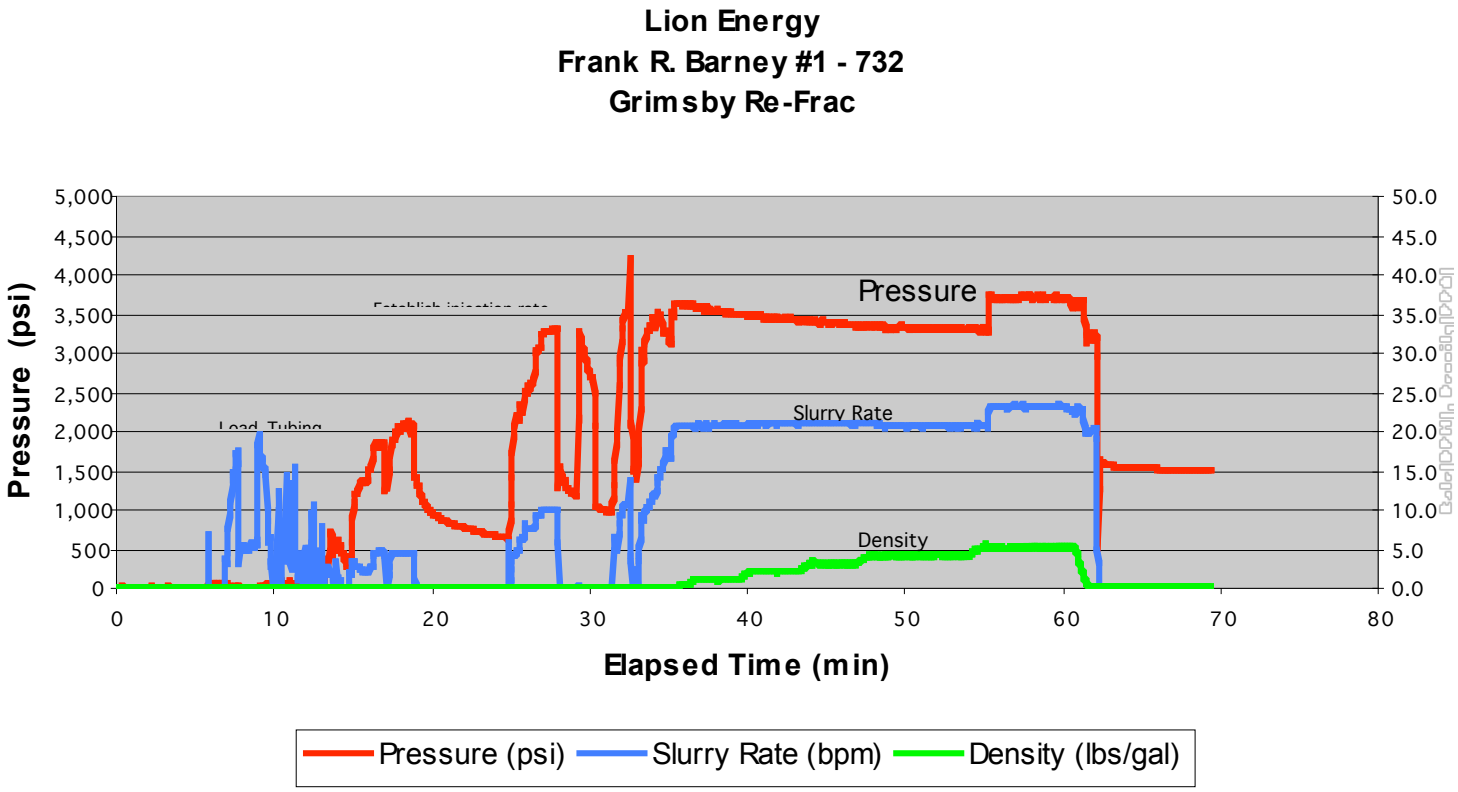

Lion Energy
Frank R. Barney #1 - 732
Grimsby Re-Frac
Pressure (psi)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0
10
20
30
40
50
60
70
80
Pressure
Slurry Rate
Density
Elapsed Time (min)
Pressure (psi)
Slurry Rate (bpm)
Density (lbs/gal)

Figure 5

Lion Energy

Date:	**9/19/03**
Well:	**R.Griswold #1 - 702**
Location:	**Chautauqua County, NY**
Perforations:	**3,829' - 3,842' 27 Holes**
Job Description:	**Water frac through 41/2" Casing, 30#-40# Linear Gel**

Job Summary

Average Slurry Rate	18.4bpm	
Maximum Slurry Rate	21.2bpm	
Slurry Volume	31,247gals	
Sand Total	490sacks	(Appx. 420 Sacks in Formation)
Average Sand Concentration	2.0Lbm/Gal	
Maximum Sand Concentration	4.2Lbm/Gal	
Average Pressure	3483psi	
Maximum Pressure	4170psi	

Figure 6

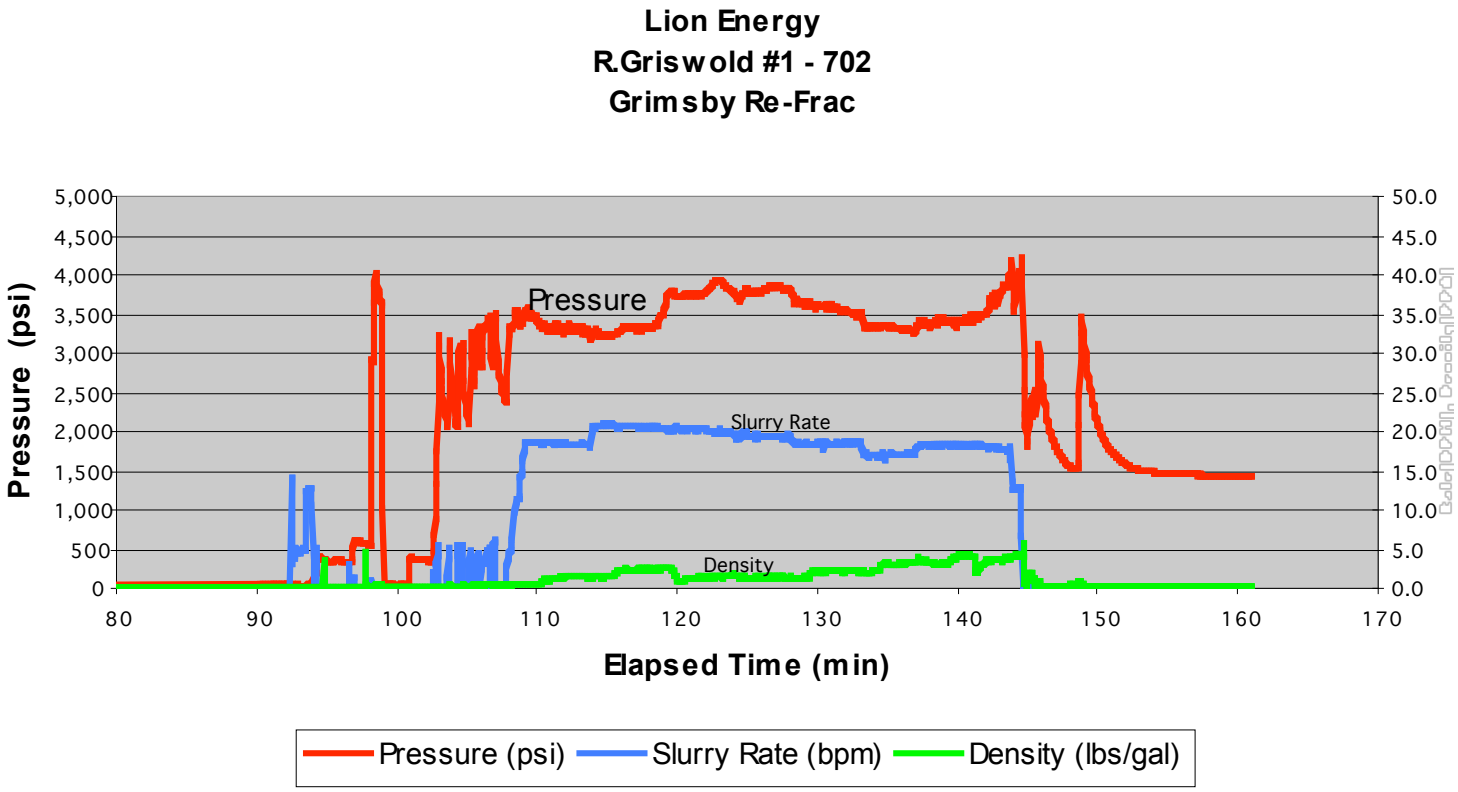

Lion Energy
R.Griswold #1 - 702
Grimsby Re-Frac
Pressure (psi)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Pressure
Slurry Rate
Density
80
90
100
110
120
130
140
150
160
170
Elapsed Time (min)
Pressure (psi)
Slurry Rate (bpm)
Density (lbs/gal)

Figure 7

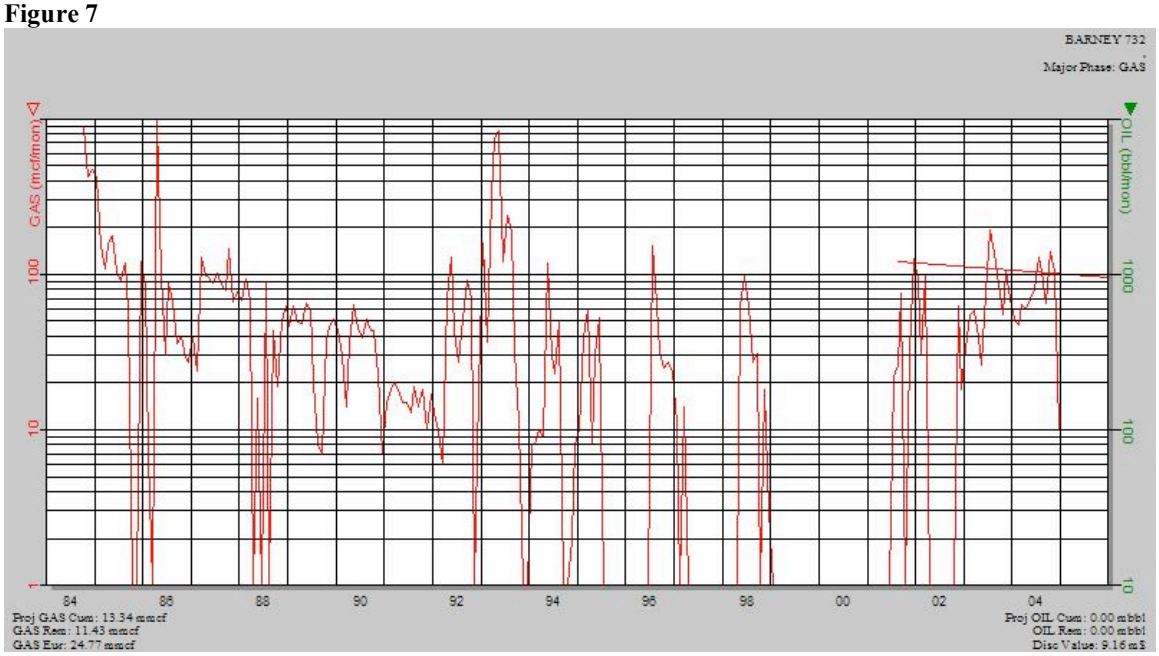
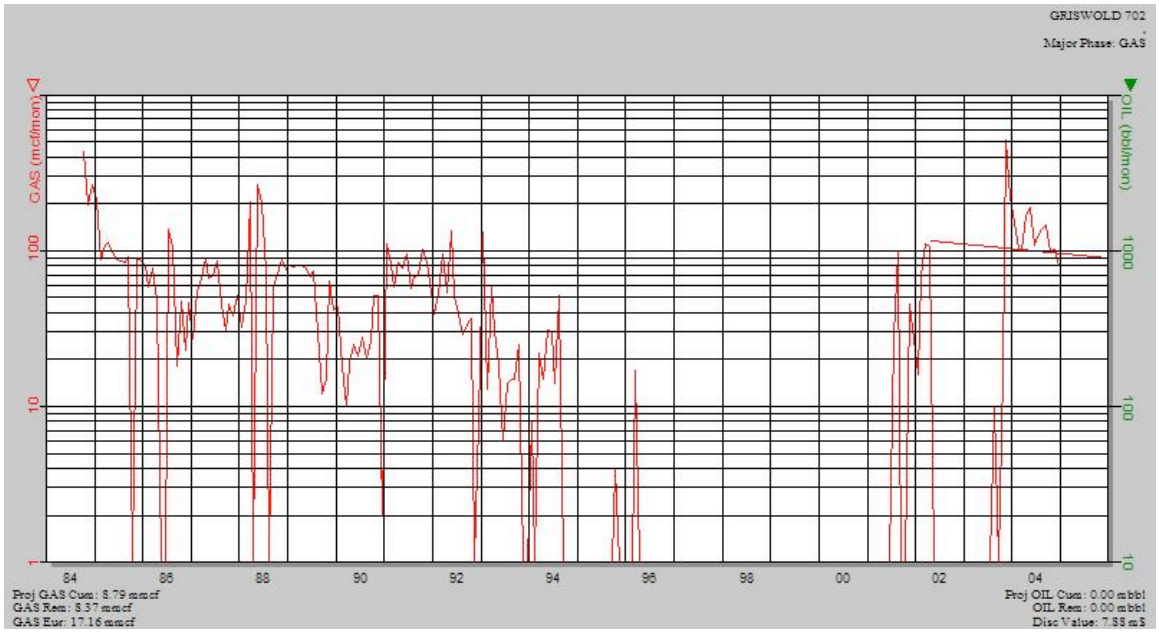

BARNEY 732
Major Phase: GAS
GAS (mcf/mon)
OIL (bbl/mon)
100
10
1
1000
100
10
84
86
88
90
92
94
96
98
00
02
04
Proj GAS Cum: 13.34 mmcf
GAS Rem: 11.43 mmcf
GAS Eur: 24.77 mmcf
Proj OIL Cum: 0.00 mbbl
OIL Rem: 0.00 mbbl
Disc Value: 9.16 m$

Figure 8


GRISWOLD 702
Major Phase: GAS
GAS (mcf/mon)
OIL (bbl/mon)
100
10
1
1000
100
10
84
86
88
90
92
94
96
98
00
02
04
Proj GAS Cum: 8.79 mmcf
GAS Rem: 8.37 mmcf
GAS Ult: 17.16 mmcf
Proj OIL Cum: 0.00 mbbl
OIL Rem: 0.00 mbbl
Disc Value: 7.88 m$