Reservoir Characterization and Initialization at Little Mitchell Creek

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Outline

• Objectives of the project
• Geological and geophysical results
• Progress of dynamic model
• Conclusion
Objectives:

1. Minnelusa formation structure, and lateral and vertical sandbody geometry
2. Reservoir quality, good sand zones, tight zones, and porosity
3. Dynamic modeling and prediction
4. Suggestions for infill drillings
5. Suggestions for flood improvement
Little Mitchell Creek (LMC) township:
S14, 52 N & 69W

LMC:
— 7 oil producers
— 3 water injectors
— Total 21 wells
Target formation at LMC: Minnelusa B sandstone

The B sand isopach map at LMC (G. George, 2011)
upper B sand
lower B sand

Cross sections through wells
Background of Little Mitchell Creek

- Discovery well: #15-1
  - 1966/12, 100% oil, no water, no gas
  - 1972/02, first produced water
  - 1994/10, stop production
  - 2007/07-2010/11, converted to water injector
- 1969/09, first water produced from the field
- 1970/01- 1986/06, water injection through #WI-1
- 1986/06- present, #15-5 converted to water injector
- Field data:
  - Cumulative oil: 10,701,165 bbls; water: 10,706,033 bbls
  - Total cumulative liquid: 21407198 bbls
  - Cumulative Injected water: 27,251,367 bbls
  - Water cut: >90 %
  - OOIP: 15,6000,000 STB (Charles R. Smith, 1968)
    34,905,012 bbls (Gene R. George, 2011)
  - 2013/05: 2,553 bbls oil, 27,908 bbls water, inj. water 42,910 bbls
Total oil: 10,701,165 bbls
water: 10,706,033 bbls
gas: 41,796 Mcf
Inj. water: 27,251,367 bbls

2013/May:
2,553 bbls oil
27,908 bbls water
Inj. 42,910 bbls water

Driving forces:
— Natural aquifer
— Injected water
Oil, water, and injected water distribution at wells
Data sets

3D Seismic data:
— covers 7.38 sq miles,
— 253 Inlines x 293 Xlines, 55’X55’
21 wells, logs: DT, GR, ILD/LLD, DST, etc.
Core analysis: #15-1 and #15-8
Production data
Geological and Geophysical Results

Seismic analysis previously reported and peer reviewed:

- 2012/05/30 to EORI, Laramie, WY
- 2012/06/12 to Osborn, Laramie, WY
- 2012/07/10 to Minnelusa Consortium, Casper, WY
- 2012/07/24 to TAB meeting, Laramie, WY
- 2012/12/24 to Osborn, San Antonio, TX
- 2013/01/10, to TAB meeting, Denver, CO
- 2013/01/23 to Minnelusa Consortium, Dallas, TX
- 2013/06/07 to Minnelusa Workshop I, Gillette, WY

1. Current seismic data can identify the Minnelusa top (7400’) and the B dolomite, the reservoir bottom.
2. Seismic data can distinguish the areal extent of the reservoir from the tight rubble zones.
3. Reservoir trap feature: 
The reservoir is delineated by the updip tight rubble zones to the east. 
Another tight rubble zone at the western downdip edge of the reservoir.
4. Vertical variation of reservoir quality
5. Sand body extent and connectivity. No significant flow barrier within the field. Over 80% of well logs match the seismic interpretation.
6. Infill drilling options: the northeast one will be drilled this year.
7. Potential natural aquifers estimated based on seismic analysis
8. Reservoir geometric structure for dynamic model developed by conventional approaches integrated with seismic analysis
Initialization of Dynamic model

1. Porosity calculation at well logs

Correlation between core porosity and DT porosity.
2. Core porosity & permeability

Winland_527087

\[ K_{\text{core}} \text{ vs. } \Phi_{\text{core}} \]

- \( K_v \)
- \( K_h \)
- \( \text{Winland}_3.5 \)
- \( \text{Winland}_0.5 \)
- \( \text{Winland}_8.0 \)
- \( \text{Winland}_{15.0} \)
- \( \text{Winland}_{20} \)
- \( \text{Winland}_{25} \)
3. Original pressure from DST

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<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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<td>well name</td>
<td>DST date</td>
<td>Interpreted reservoir pressure, Psi</td>
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<td>Depth for the interpreted reservoir pressure, ft</td>
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\[ S_w = \left( \frac{a \times R_w}{R_t \times \phi^m} \right)^{1/n} \]

a: Tortuosity factor
m: cementation exponent
n: saturation exponent
Rt: formation resistivity
Rw: formation water resistivity

4. Saturation calculation at wells

Estimate Rw, m and n with Pickett plots
5. Vertical flow units identified from well logs
The upper B Dol. is absent in most of the field.

The flow paths in the upper B sand and the lower B sand are connected in most of the field.
6. Structure model and flow units

Subsurfaces:
- Minnelusa
- UB sand
- UB dolomite
- LB sand
- B dolomite

I27: north-south
J44: west-east
Cross sections of the structure model
Conclusion

• The Geological and Geophysical characterization of the reservoir was completed, cross checked by dynamic data (ongoing), and peer reviewed.

• Structure model and property model almost done, and will be finished by the end of August.

• Reservoir initialization are ongoing.
Future work

• Complete the reservoir initialization by the end of August of 2013.

• History match and prediction are estimated by the end of this year.