Minnelusa Field Development Using 3D Seismic Data
Powder River Basin, Wyoming

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Benefits of Seismic in Field Development

What additional information does seismic bring to field development strategy?

1. Increased spatial (lateral) and temporal (vertical) resolution of reservoir mapping
   - Area, thickness, rock volume

2. Estimation of reservoir rock properties

3. Seismic attribute correlation to well performance

4. Operational design of secondary recovery
   - Injector placement
   - Off-take placement
This presentation addresses the benefit of increased spatial (lateral) and temporal (vertical) resolution using three-dimensional (3D) seismic data in Minnelusa field development.

A case history of Donkey Creek North Minnelusa Oil Field, T50N-R68W, Crook County, Wyoming demonstrates that acquiring high quality 3D seismic data directly benefits strategic placement of well bores to increase oil production in both primary and secondary recovery programs.
Minnelusa Type Log

~ 300 feet
Most Minnelusa accumulations are a combination of structural and stratigraphic trapping configurations.

- Opechee shale truncation of uppermost sandstone
- Geomorphology – eolian sandstone deposition
- Lateral diagenetic facies changes
- Structural relief

V.E. 20:1 Regional dip rate: 1-2 degrees

~ 300 feet
Critical Issues to Successfully Finding and Developing Minnelusa Oil Accumulations

- Defining trapping configuration
  - Traps not filled to spill point
  - Opeche shale, geomorphic, or diagenetic
- Proper identification of seismic amplitude anomalies
  - Thick Opeche shale (trap) vs. porous sand (reservoir)
  - Which sand – A, Upper B, B, intra-B, or C?
- Local structural regime
  - 4-way (Timber Creek)
  - Sand diagenesis on structural nose
  - Faulted (not common)
What attribute does 3D seismic data need to possess to best determine sand body vertical and horizontal extents?

*Bandwidth*

or put another way….

*High Frequency*
Seismic differentiation of sands and opeche siltstone

Frederick, 1991
Synthetic Seismic Model Based Upon Well Control

Typical Seismic Frequency Bandwidth – 12-18-60-70 Hertz

Frederick, 1991
Synthetic Seismic Model of From Well Control

High Seismic Frequency Bandwidth – 12-18-90-110 Hertz

Frederick, 1991
Synthetic Seismic Bandwidth Comparison
Seismic differentiation of sands and opeche siltstone

Frederick, 1991
Seismic Data - Bandwidth Comparison
Industry average vs. high frequency acquisition

Frederick, 1991
Donkey Creek North Minnelusa Upper B Sand Field
Upper B and (Lower) B Sand Trends
Minnelusa Formation Trapping Styles

Donkey Creek North Trap
Donkey Creek North - Upper B Sand Reservoir Interpretation, circa 1982
Donkey Creek North– Upper B Sand Reservoir
Pre - 3D Seismic Interpretation 1992
Results of Donkey Creek North 3D Seismic Survey

Pre 3D seismic interpretation based on subsurface well control

Post 3D seismic interpretation - sand does not extend eastward, but actually extends northward and wraps around dry hole

No eastward extent of Upper B sand
West - East Seismic Traverse
Upper B Sand to B Sand Transition

Upper B sand
Depositional thinning of Upper B sand
B sand
West - East Geologic Cross Section
Upper B Sand to B Sand Transition

Upper B sand depositional thinning against thick B sand body
Seismic Traverse Through Strong Amplitude Anomaly (Upper B Sand)
Post 3D Drilling Results
Federal 34-18 and Federal 21-19

Upper B sand

Post 3D seismic survey
Upper B sand porosity encountered in both the 34-18 and 21-19. The 21-19 was converted to a water injector
Donkey Creek North – Upper B Sand Reservoir
3D Seismic Interpretation 1994

Combined seismic and subsurface well bore interpretation

Upper B sand seismic trough amplitude
Projected secondary recovery (1994)  
(pre-unitization)

Barrels of oil / month

YEAR
1980  84  88  92  96  2000  04

FIELD PRODUCTION

HISTORICAL

WATERFLOOD FORECAST
Field Production – Post 3D Development

Waterflood performance forecast - 1994

Field production through March 2014
Summary

Spatial (lateral) and temporal (vertical) resolution provided by the acquisition of high quality (broad bandwidth, high frequency) three-dimensional (3D) seismic data in combination with wellbore rock property and production performance information contributes significantly to the economic value of both primary and secondary oil recovery in Minnelusa oil fields.
References

