Mapping Almond Reservoir Rocks at Stagecoach Draw Field, Southwestern Wyoming: Application of Spectral Decomposition Technique*

Yuri V. Ganshin[1], Scott A.Quillinan[2] and Ronald C. Surdam[2]

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[1]Wyoming State Geological Survey, Laramie, WY (yganshin@uwyo.edu)
[2]Wyoming State Geological Survey, Laramie, WY

Abstract

The application of seismic spectral decomposition delineates thin beds of the upper Almond sandstones at the Stage Coach Draw Field in the Green River Basin Wyoming, and highlights areas for new exploration opportunities. The principal gas production at Stagecoach Draw comes from the upper Almond Sandstone, a marginal marine sandstone that thins and changes to nonmarine deposits west of the field. Current field development, consisting of over 30 wells, has proven that both structural and stratigraphic hydrocarbon trapping occur at approximately 8,000 ft depth along the crest of the southeasterly plunging Sandy Bend Arch. A 3-D seismic survey with approximately 72-mi^2 of subsurface coverage was acquired in 1996 to facilitate field exploitation.

This report presents both structural and stratigraphic interpretations of the seismic data set after it was reprocessed using time-frequency analysis of seismic reflection signals. The extent of the Almond pay sandstones has been mapped in more detail utilizing spectral decomposition (SD) techniques. Reservoir and non-reservoir facies were differentiated by comprehensive, integrated seismic attribute analysis. The integrated work combined seismic with lithology and structural geology. The data comprised gamma-ray logs from 36 wells and 3-D seismic. A strong correlation between seismic frequency content and thickness gradient is shown. The SD method was a valuable aid in enhancing the ability to map thin beds with seismic data acquired in the tight gas sandstone environments of the Rocky Mountain region. Results from this study are important for the reservoir modeling and site characterization phases of Stagecoach Draw Field development. Importantly, it is shown that seismic time-frequency analyses significantly assist in delineating gas saturated reservoir rocks. Lastly, this study identifies a large area southeast of Stage Coach Draw that demonstrates similar seismic attributes with reservoir rocks at the Stage Coach Draw Field.

References

Kovach, P. L., J.L. Caldaro-Baird, and P.J. Wynne, 2003, Stagecoach Draw Field – gas production from the westernmost marine-influenced deposits of the Lewis Seaway transgression into southwestern Wyoming, *in* D.S. Anderson, J.W. Robinson, J.E. Estes-Jackson, and E.B. Coalson, (eds.), Gas in the Rockies: Rocky Mountain Association of Geologists Guidebook, p. 125-144.

Website

Wyoming Oil and Gas Conservation Commission @ http://wogcc.state.wy.us/
(Web accessed 17 June 2010)

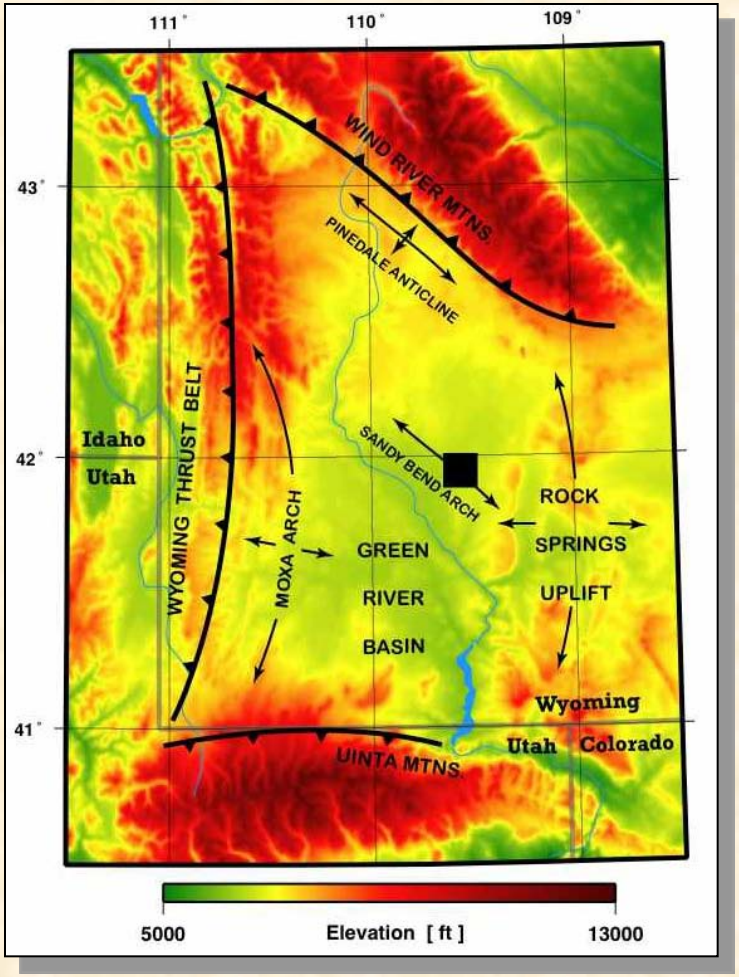
Mapping Almond Reservoir Rocks at Stagecoach Draw Field, Southwestern Wyoming: *Application of Spectral Decomposition Technique*

Photo by Alan J. Ver Ploeg, WSGS

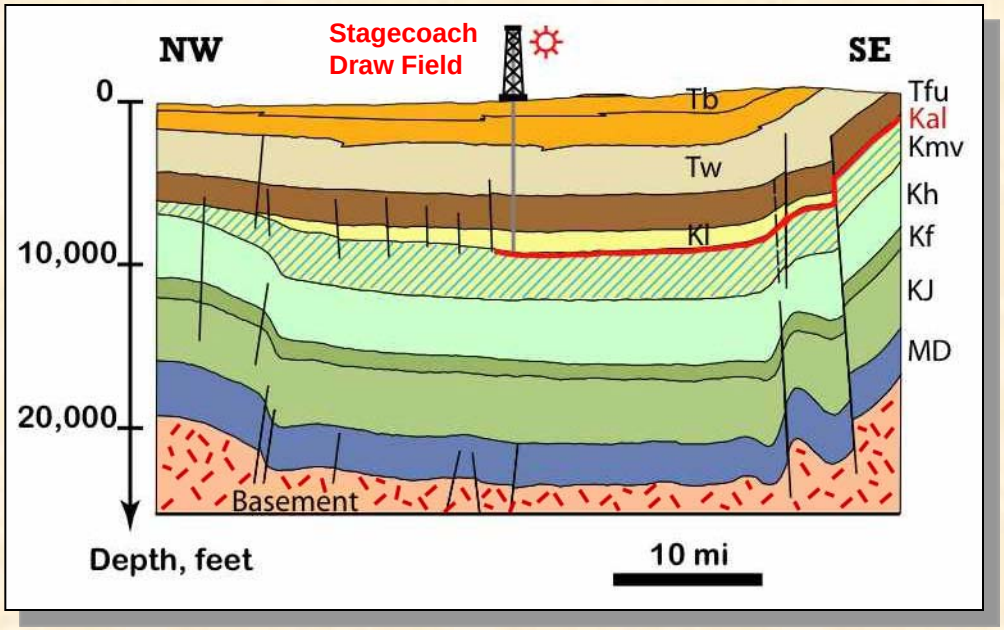
Yuri Ganshin, Scott Quillinan, Ron Surdam
Wyoming State Geological Survey, Laramie WY

Thanks for the cooperation of WesternGeco

Structural framework of the study area within the Green River Basin, Wyoming



Generalized geologic cross section through the Green River Basin over the Sandy Bend Arch



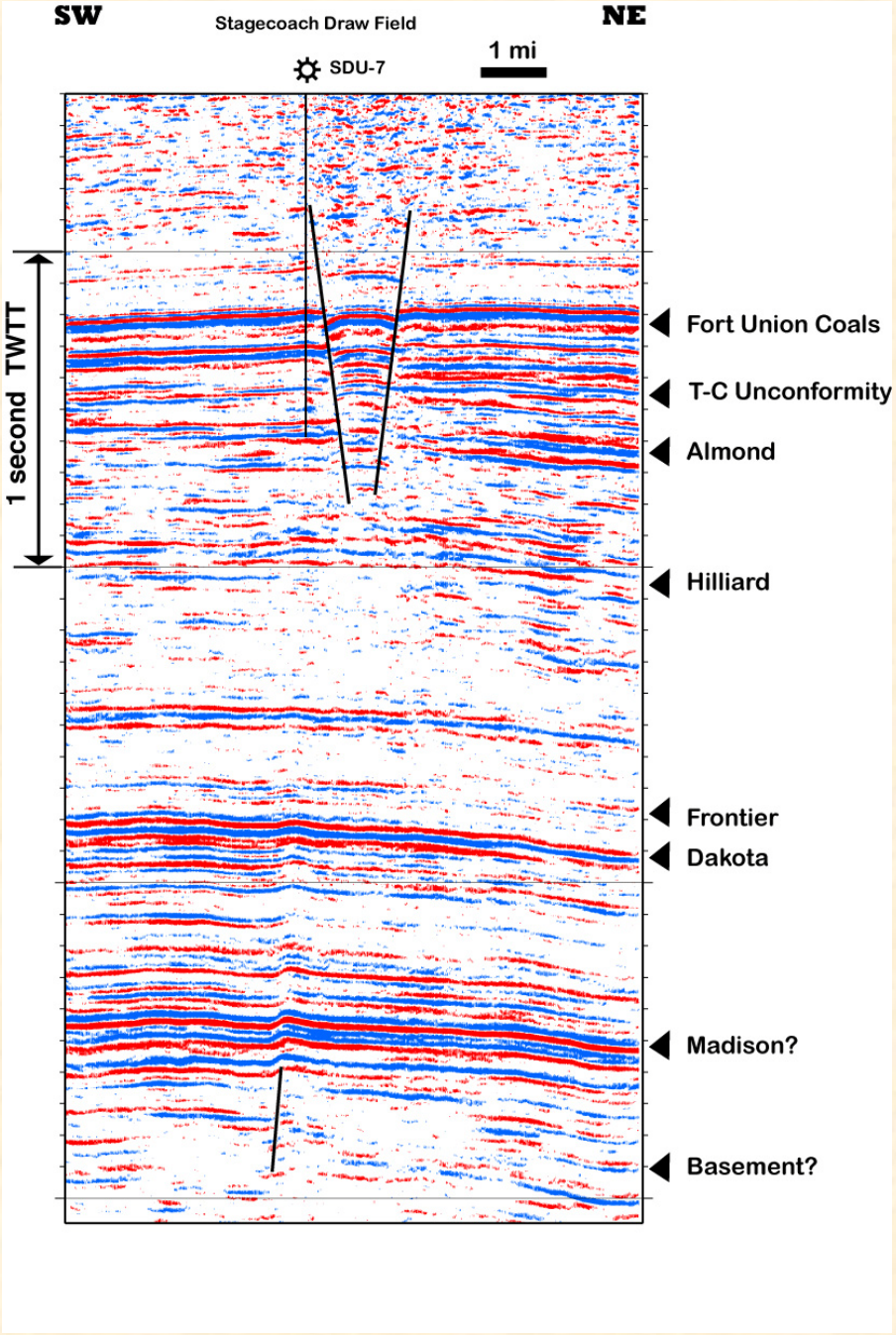
Field Facts

- Discovered in 1994, total 38 wells, completed 24
- Pay zone - upper Almond (possibly lower Almond and Ericson sandstone)
- Estimated ultimate recovery may exceed 50 BCF of gas
- Porosity for the reservoir facies: 12% - 17%
- Permeability: 0.01 md - 50 md
- Reservoir water saturation: 30% - 60%, increase in the downdip direction
- Compartmentalized, sheet-like reservoir architecture
  (combined structural and stratigraphic variations)
- Commercial pay thickness ranges 10 to 40 feet
- The Almond shoreline complex pinches out to the west
- The keystone graben splits the prospect area into two parts
- North of the keystone graben exhibits poor producing characteristics
- 3-D seismic survey was acquired over the field in 1996

SOURCE

Wyoming Oil and Gas Conservation Commission @ http://wogcc.state.wy.us/

Paul Kovach, Julia Caldaro-Baird, and Peter Wynne in Chapter 10 of *Gas in the Rockies*, 2001



Vertical time-section from the 3-D seismic amplitude volume across Stagecoach Draw Field.

Seismic data provided by WesternGeco
Interpretation of the data is that of the authors

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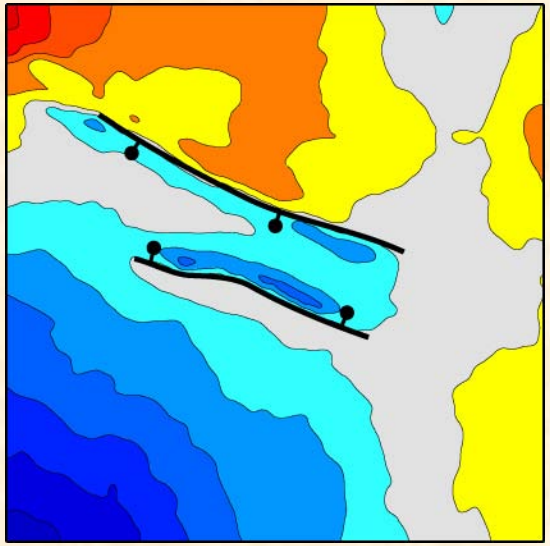
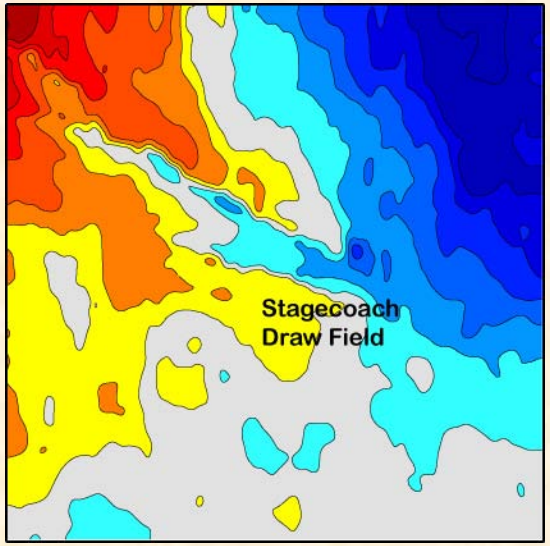
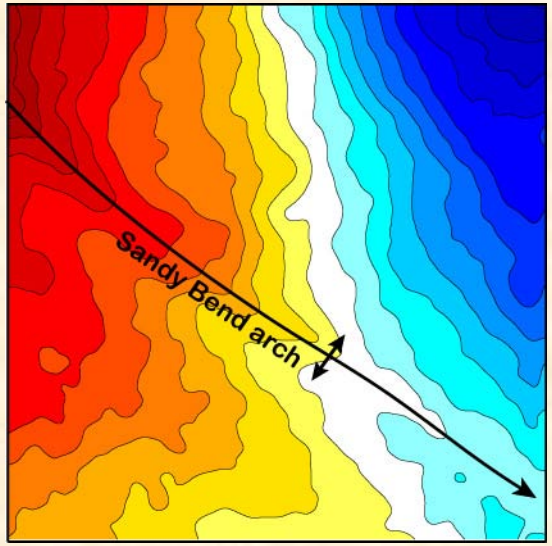
Horizon structure maps color-coded with relative elevation







Tertiary Fort Union

Cretaceous Almond

Cretaceous Dakota

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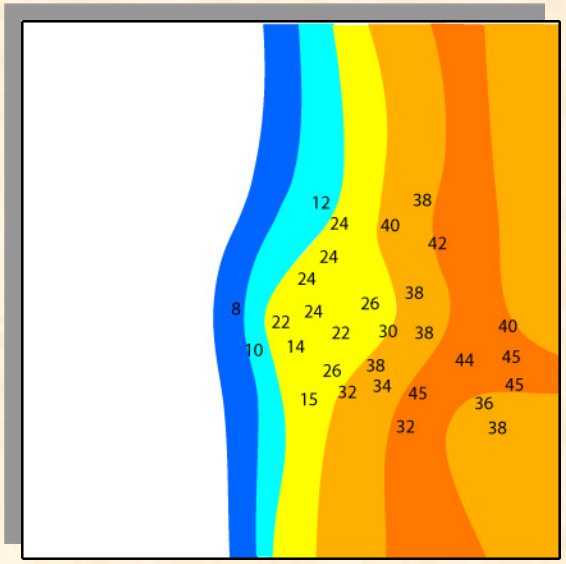
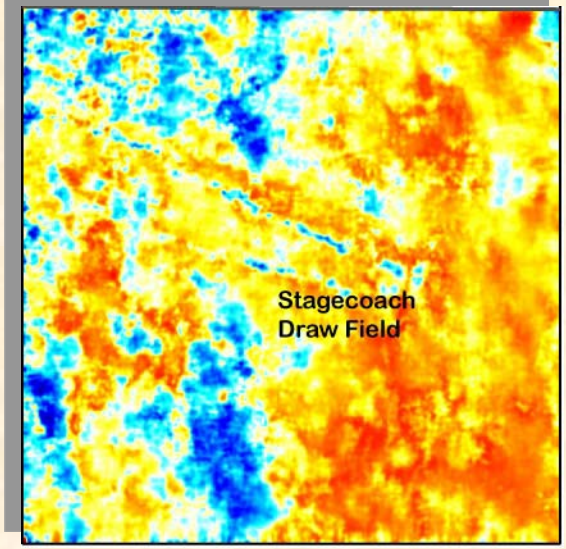
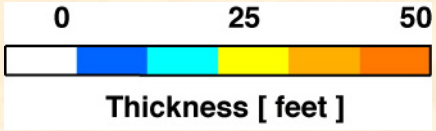
Isopach map
measured for the upper Almond unit



Seismic frequency
calculated for the upper Almond seismic horizon





Seismic data provided by WesternGeco
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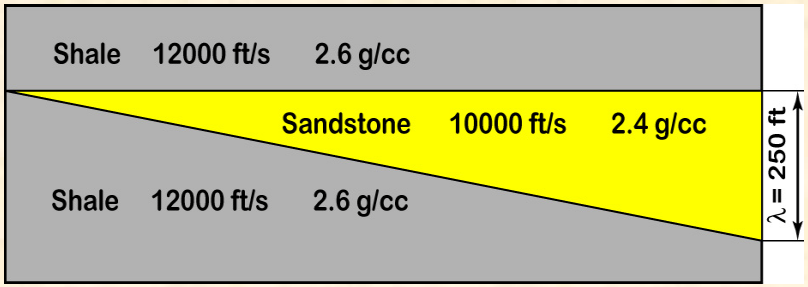
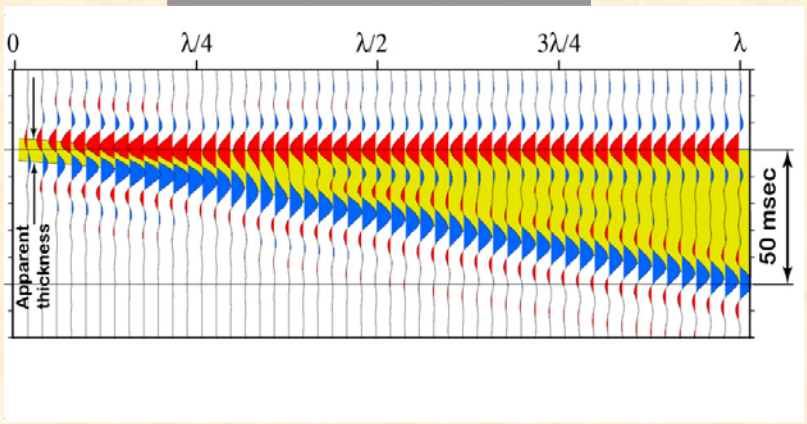
Model



Seismic Response



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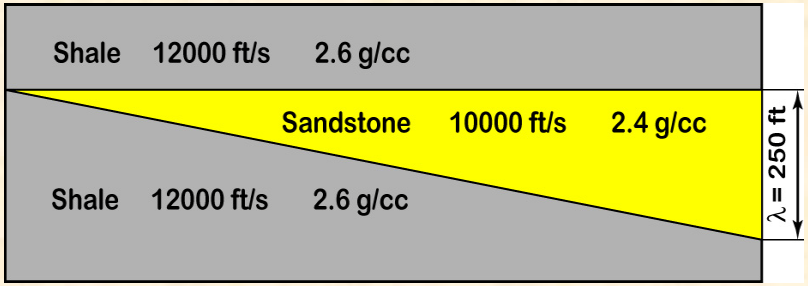
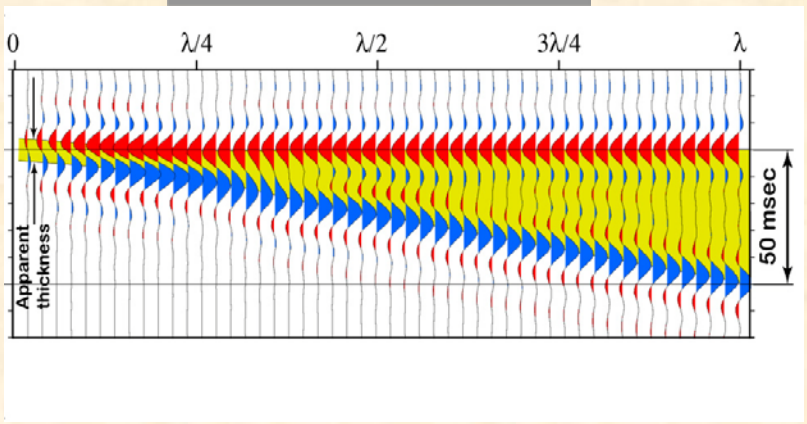
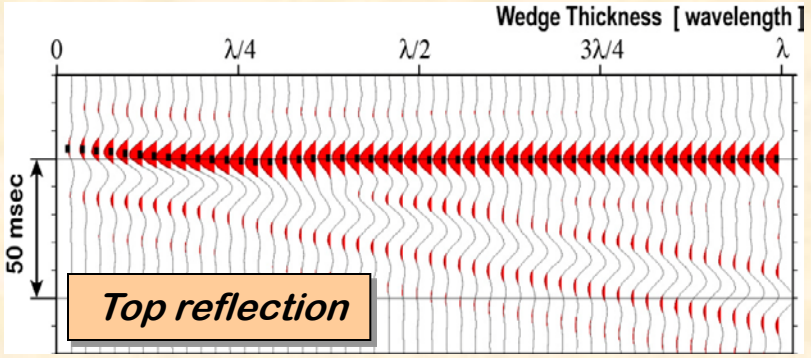
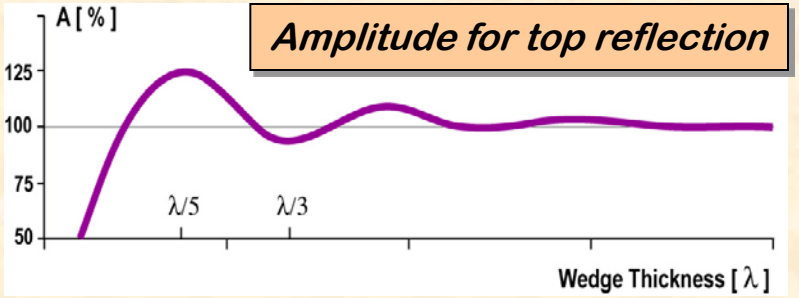
Model

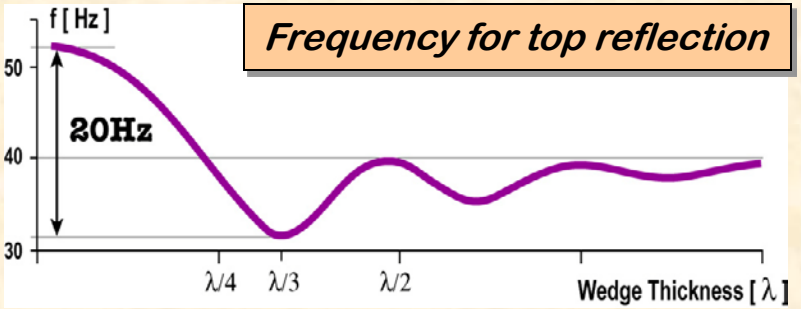


Seismic Response









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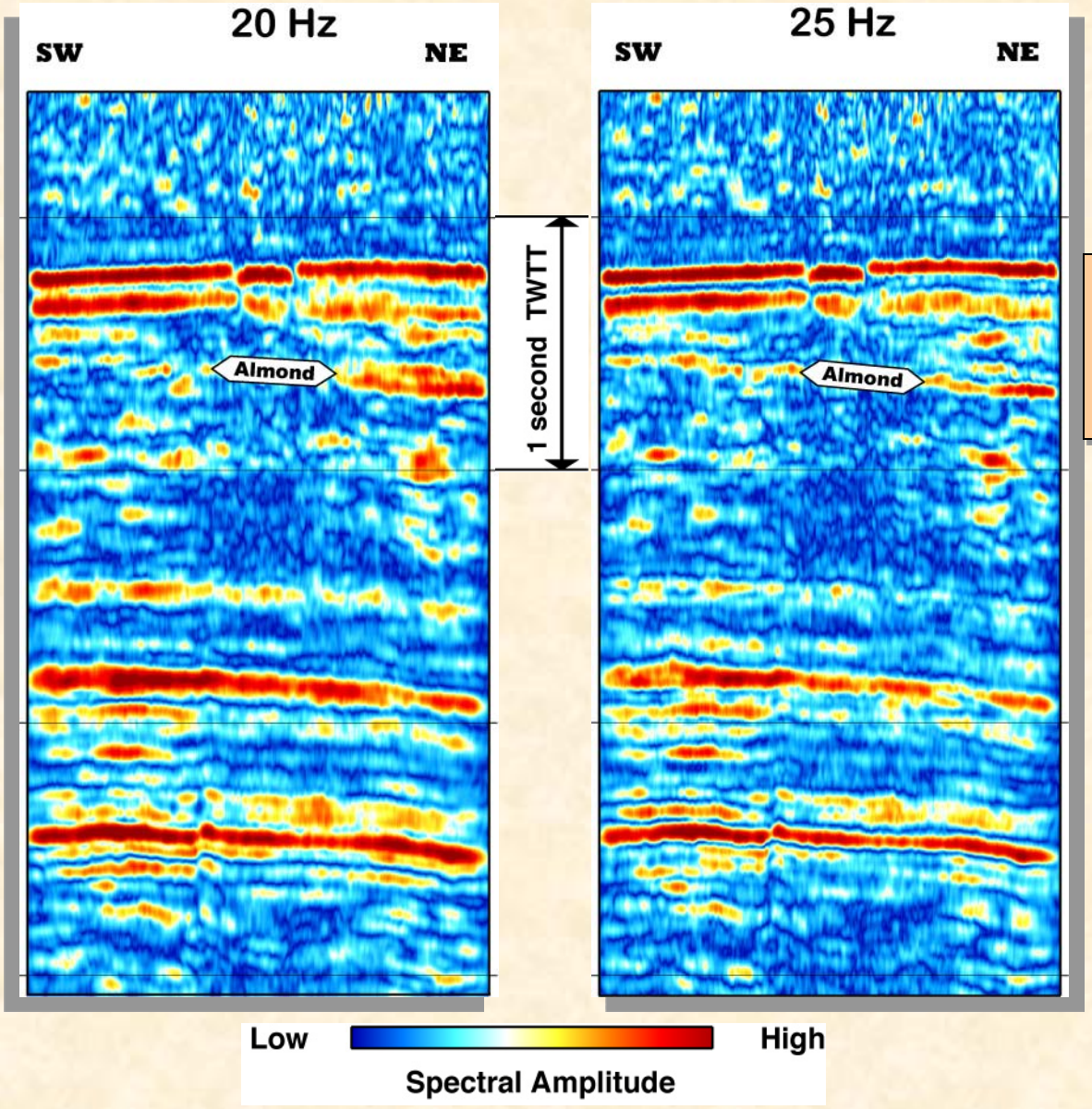

Isofrequency sections from spectrally decomposed 3-D seismic volume across the Stagecoach Draw Field

Seismic data provided by WesternGeco
Interpretation of the data is that of the authors

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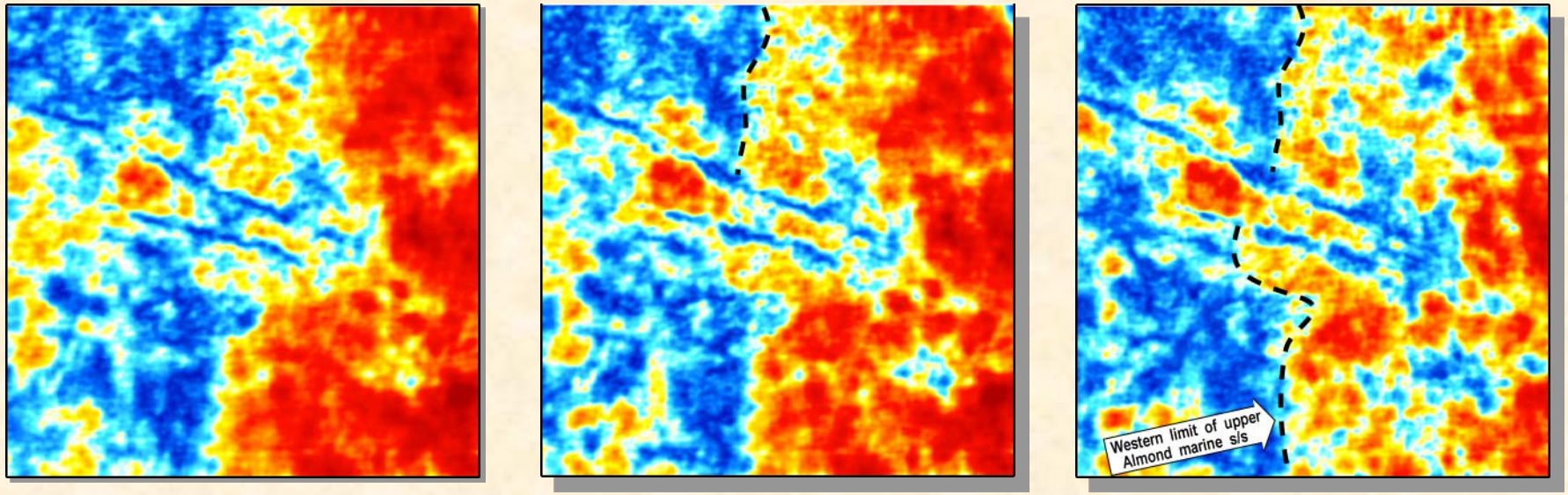
Spectral amplitude maps of the Almond stratigraphic interval

15 Hz

20 Hz

25 Hz



Low — High

Spectral Amplitude

N

1 mi

Seismic data provided by WesternGeco
Interpretation of the data is that of the authors

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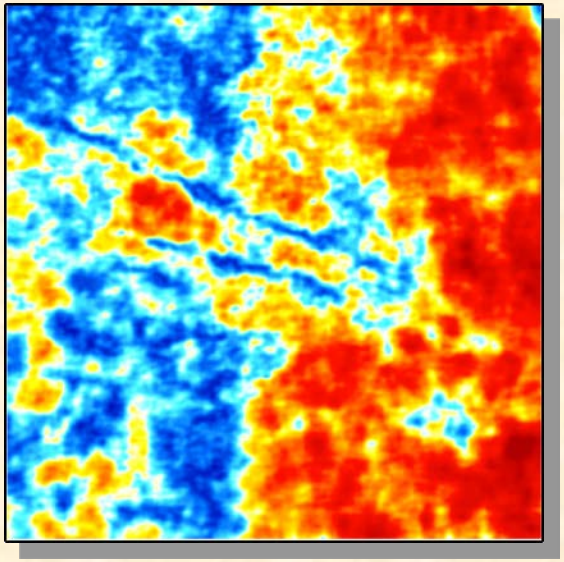
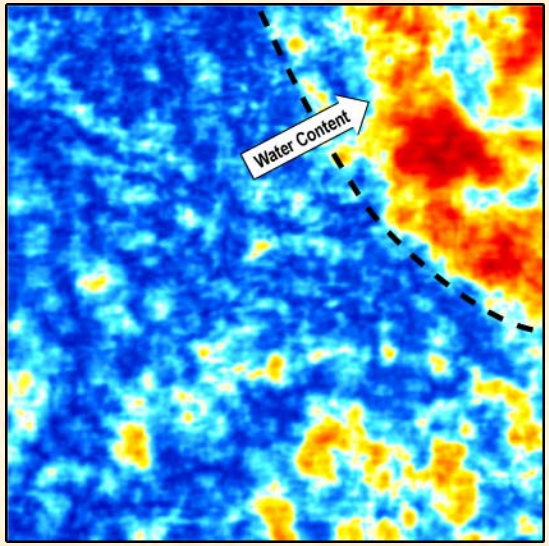
Horizon maps selected from the 20-Hz isofrequency volume

Almond horizon



Almond + 50 milliseconds



Low — High

Spectral Amplitude

N

1 mi

Seismic data provided by WesternGeco
Interpretation of the data is that of the authors

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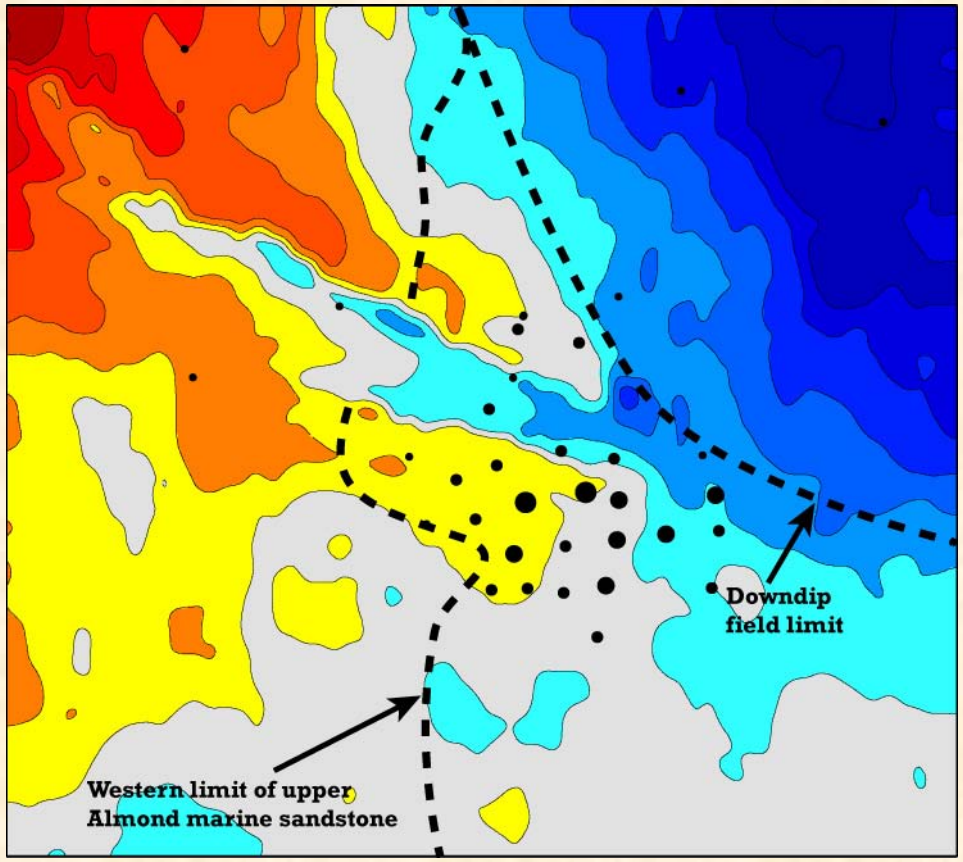
Structure map of the Almond horizon with the interpreted gas play boundary



N

1 mi

High Structural Elevation Low

Seismic data provided by WesternGeco
Interpretation of the data is that of the authors

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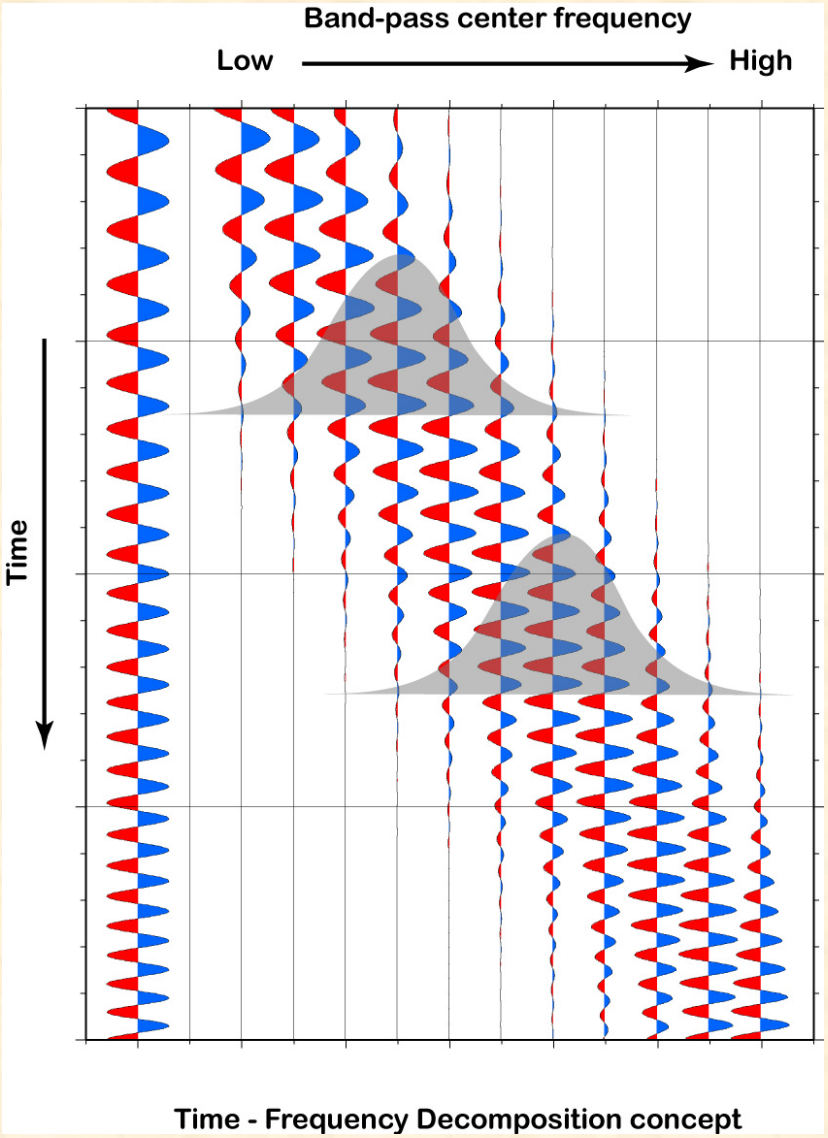
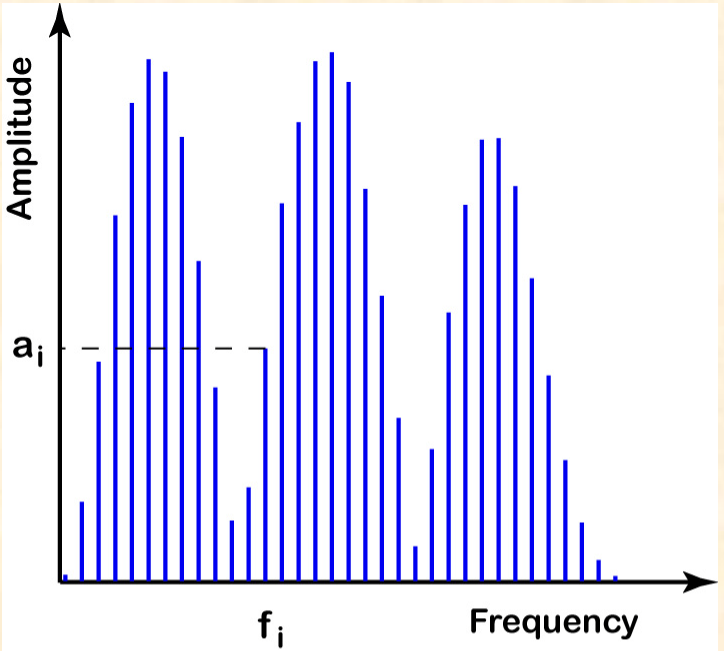
Summary

- The Spectral decomposition technique proved to be a valuable application in mapping the thinning Upper Almond Bar at Stagecoach Draw Field
- Identified the western limit and the approximate downdip limit
- Highlights large unexplored area to the south of current production with high gas potential

Thank You!





$$\bar{f} = \frac{a_1 f_1 + a_2 f_2 + \ldots + a_n f_n}{a_1 + a_2 + \ldots + a_n}$$

Weighted Mean Frequency

Mean Frequency

Center Frequency