Efficiently Integrating Seismic Data into the Geosteering Process to Accurately Position Wells for Increased Production*

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Search and Discovery Article #42061 (2017)**
Posted May 8, 2017

*Adapted from oral presentation given at AAPG 2017 Annual Convention & Exhibition, Houston, Texas, April 2-5, 2017

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Abstract

In unconventional reservoirs, drilling highly deviated or horizontal wells, operators need to make adjustments to the target locations in order to stay in the zone of interest. Geosteering tools provide techniques to determine where the well is located within a specific formation and predict the geology ahead of the bit to aid in directing the well's position. However, these tools rely heavily on well information to feed their decisions. Integrating geophysical data into the geosteering process can provide additional insight to the reservoir structure and stratigraphy allowing for more accurate positioning of the well to improve operational efficiency and profitability. This work will examine how new techniques can provide highly efficient workflows for incorporating seismic volumes, horizons and faults into the geosteering process. As a well is drilled, additional well data is acquired and well correlations are made. The ability to accurately update geophysical data from time to depth and build a consistent three dimensional interpretation of the subsurface in real time provides new insights on where to steer to potential targets and avoid hazards in front of the bit. We will review examples of how this methodology enables new workflows for the geosteerers and asset team members to better collaborate and efficiently leverage the value of seismic data to target the optimal portion of the reservoir. Integrating all of the available subsurface data into a consistent model will greatly improve the chance for a well's success resulting in reduced drilling costs and increased production.

Efficiently integrating seismic data into the geosteering process to accurately position wells for increased production

AAPG 2017

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Outline

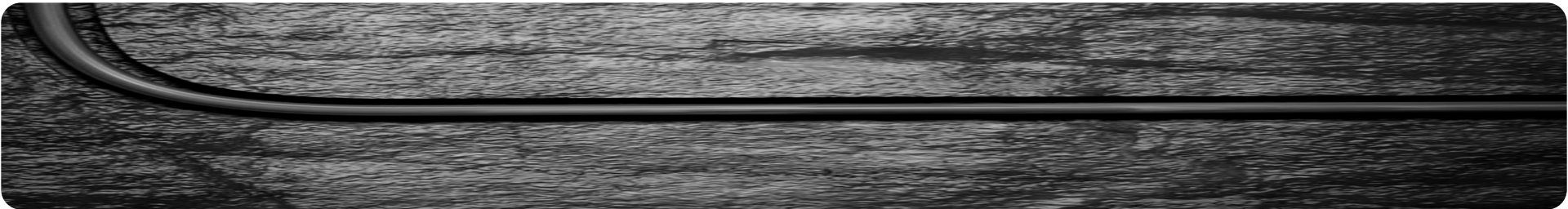
- What is Geosteering
- Geosteering limitations
- New techniques to improve workflow
- Integrating subsurface interpretation into geosteering
- Taking advantage of seismic data
- How methodology improves geosteering decisions

Image: Joel Duff

What is Geosteering?

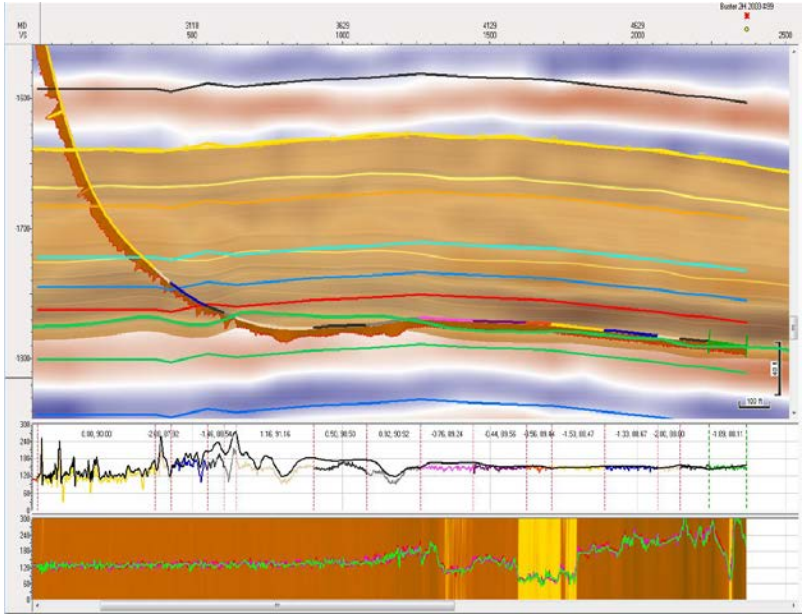
Accurately and efficiently land and steer the well along a target of interest

- Geological interpretation performed in real-time
- Ability to maintain horizontal well within pre-defined geological layer
- Describe stratigraphic location of the wellbore as drilling progresses
- Adjusting well trajectory from the original plan



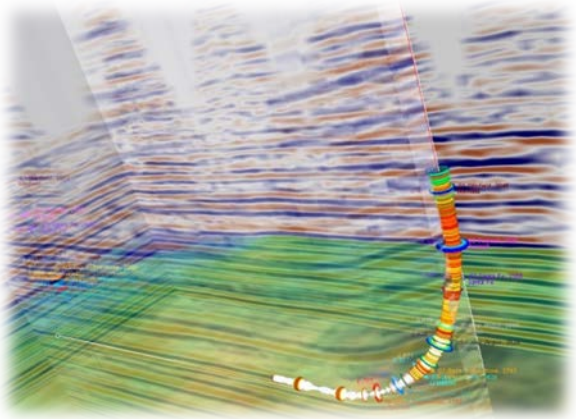
Typical Geosteering Limitations

- Most tools rely solely on correlating well logs
- Stand alone application – not integrated into the interpretation
- Some support integrating subsurface models but tend to be static models
- Collaboration with geologists and geophysicists more difficult
- Duplication of information in multiple tools
- Response time slowed when problems are encountered



New Techniques to Enhance Geosteering Workflows

- Leverage G&G interpretation directly in geosteering tool
- Easily visualize the seismic volumes, horizons and faults to provide insights to key targets and potential obstacles
- Ability to accurately convert geophysical data from time to depth
- Subsurface and velocity models easy to update and maintain by geosteerer
- Build a consistent three dimensional interpretation of the subsurface in real time

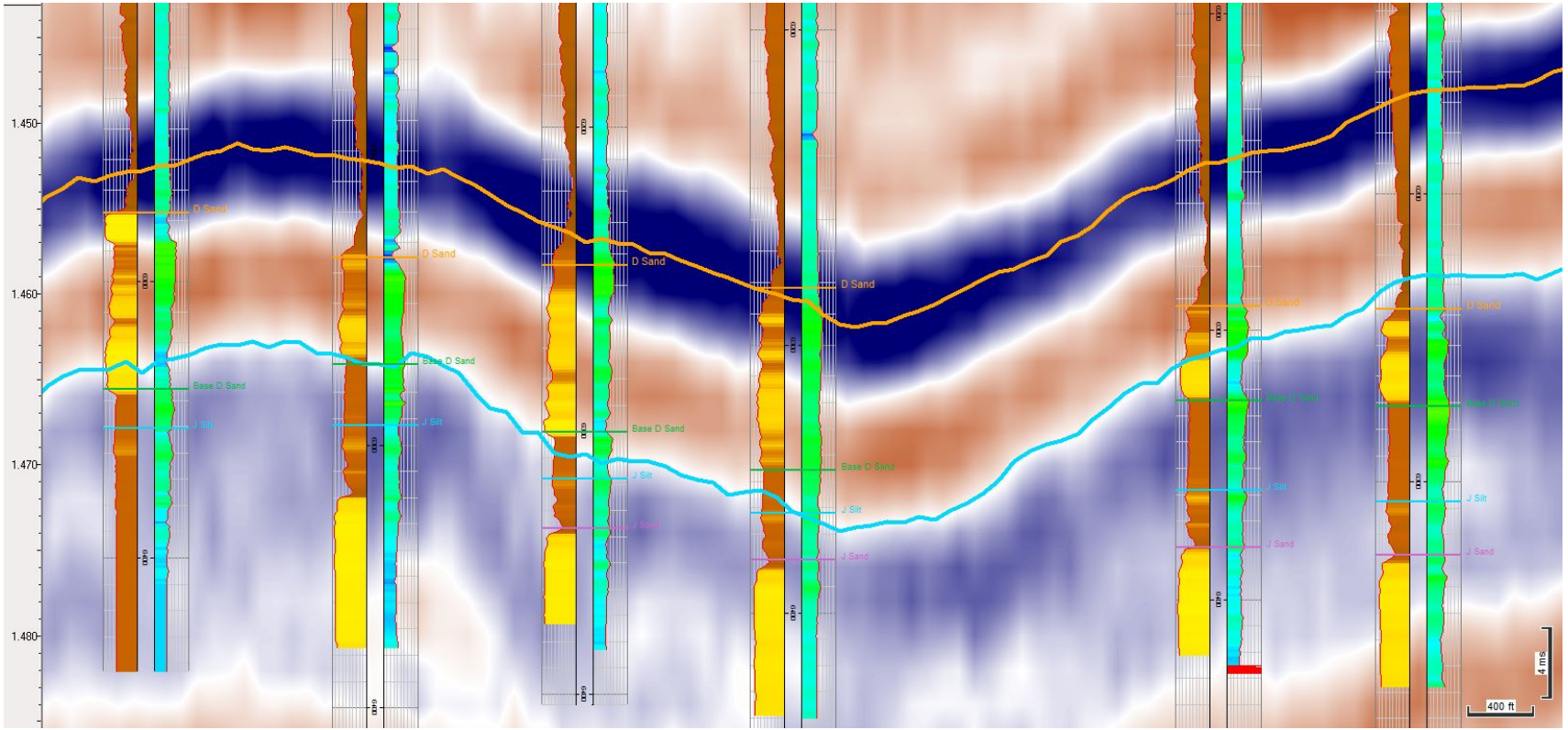


Efficiently convert geophysical data from time to depth

Depth Conversion designed for Interpreters & Geosteerers

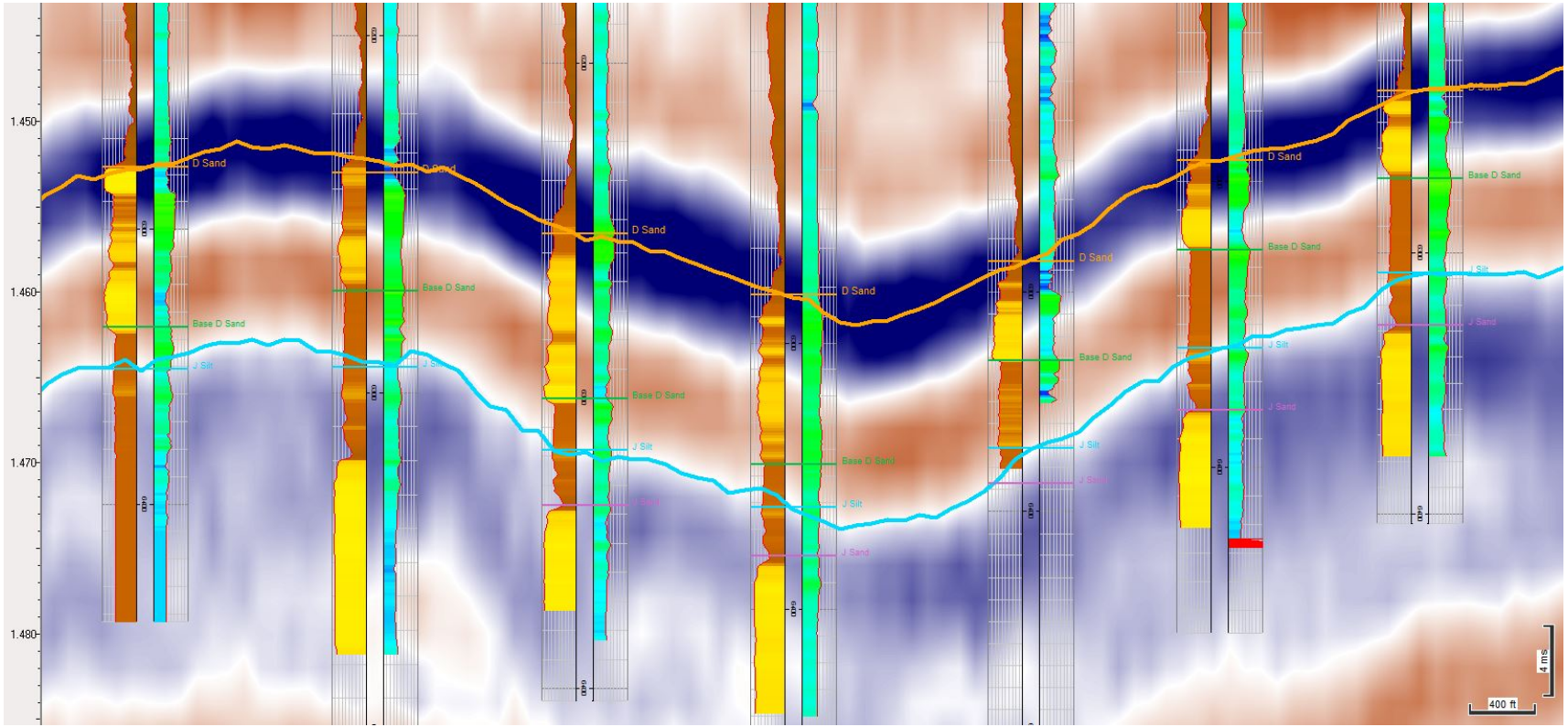
- Velocity model relies on traditional interpretation data
- Associate time horizons and well tops to define the velocity components
- Define framework rules for how surfaces interact
- Model will automatically convert data on-the-fly from time to depth or depth to time
- As Well Tops and/or Horizons are interpreted the model is easily refreshed to reflect the latest changes
- All of the views are immediately updated to provide feedback for fast decision making

Depth Conversion – Time domain with wells displayed using TD charts



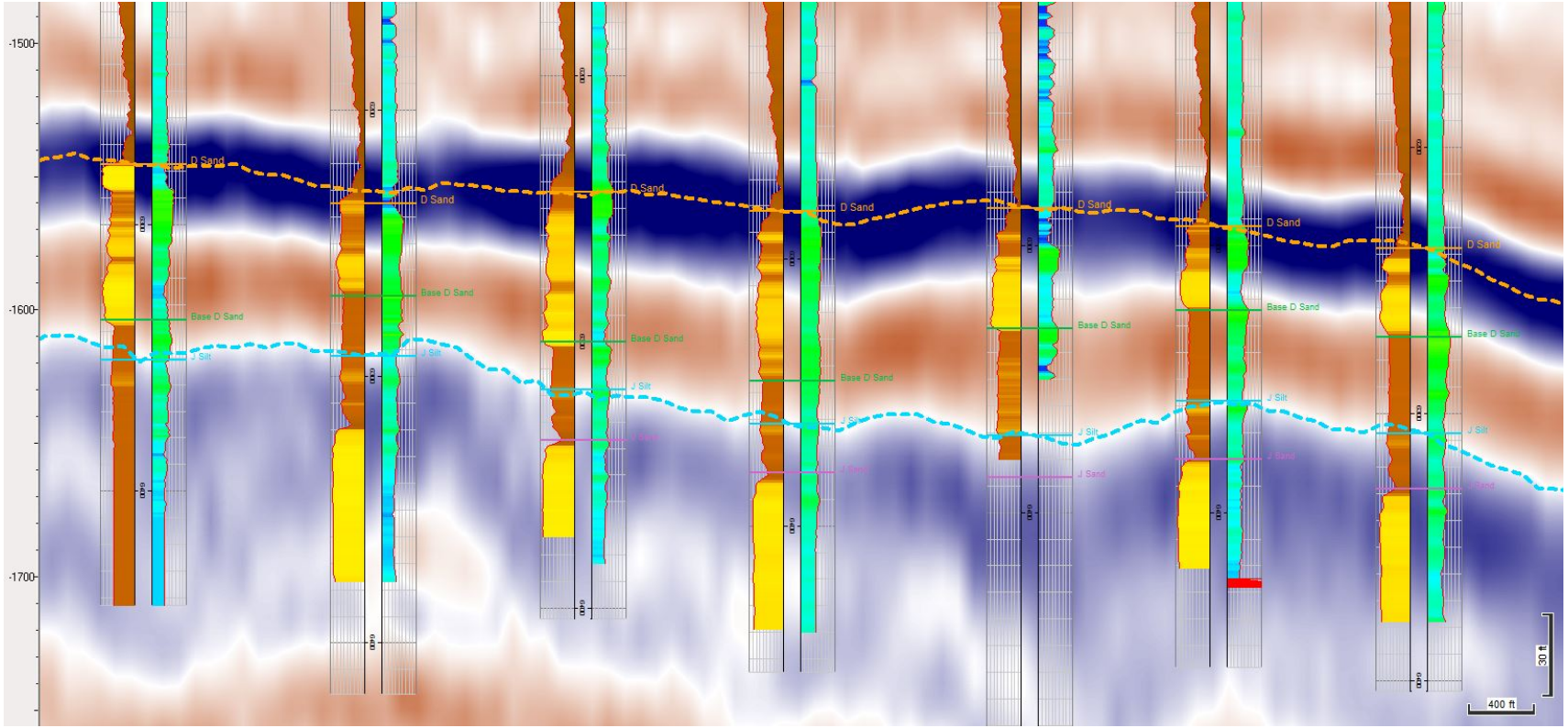
Time

Depth Conversion – Time domain with wells displayed using velocity model



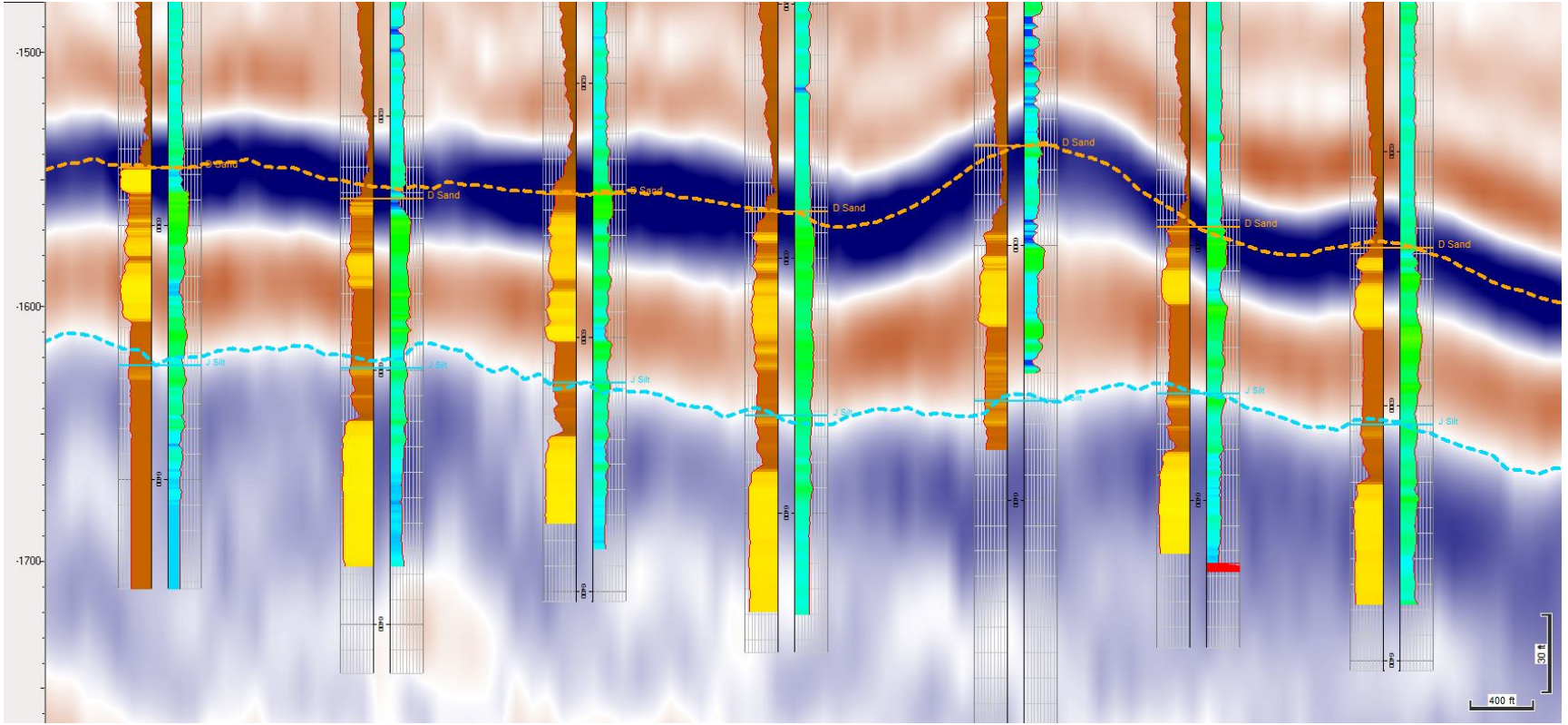
Time

Depth Conversion – Depth domain with seismic data using velocity model



Depth

Depth Conversion – Automatically update seismic with change to well pick

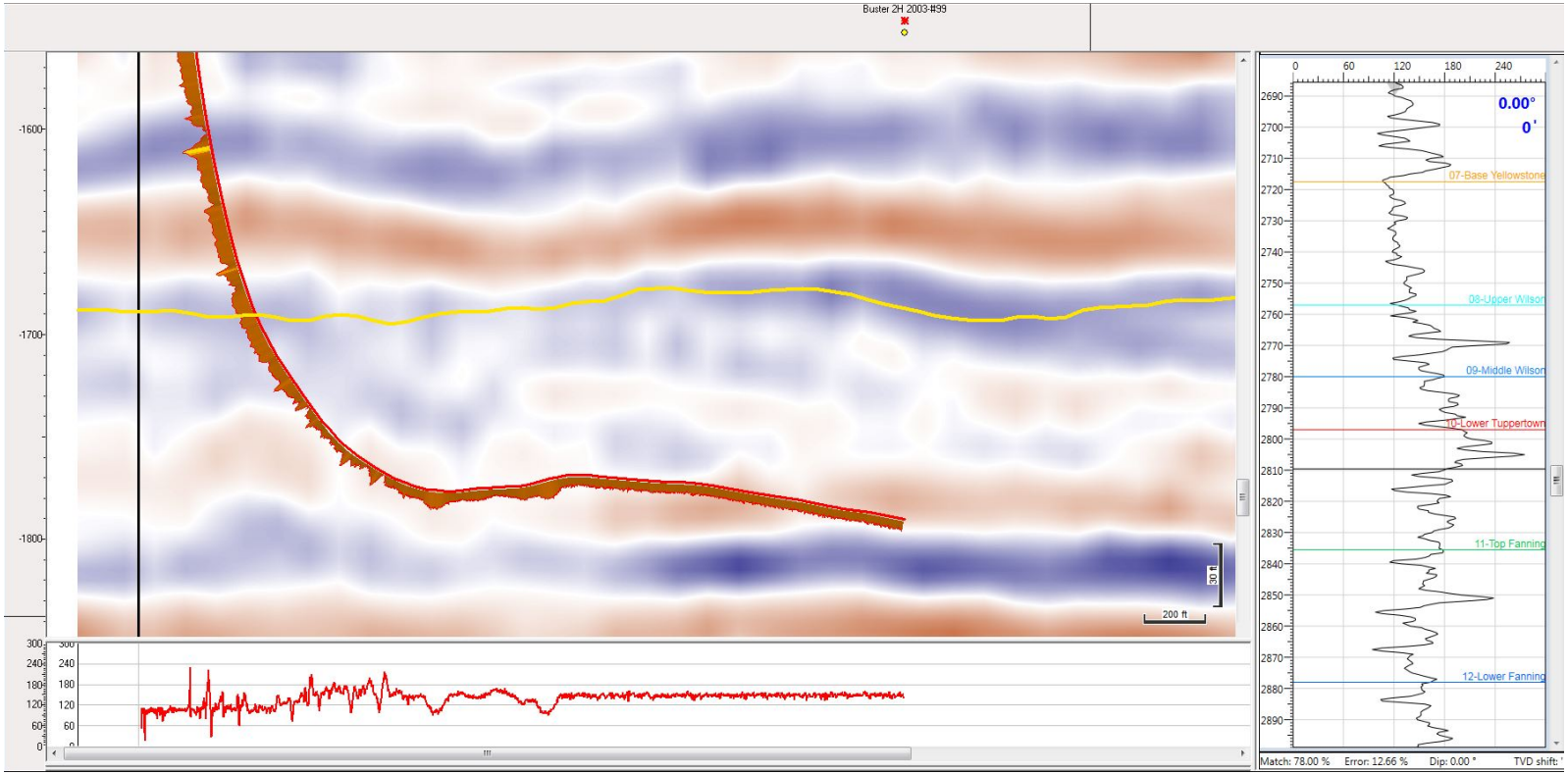


Depth

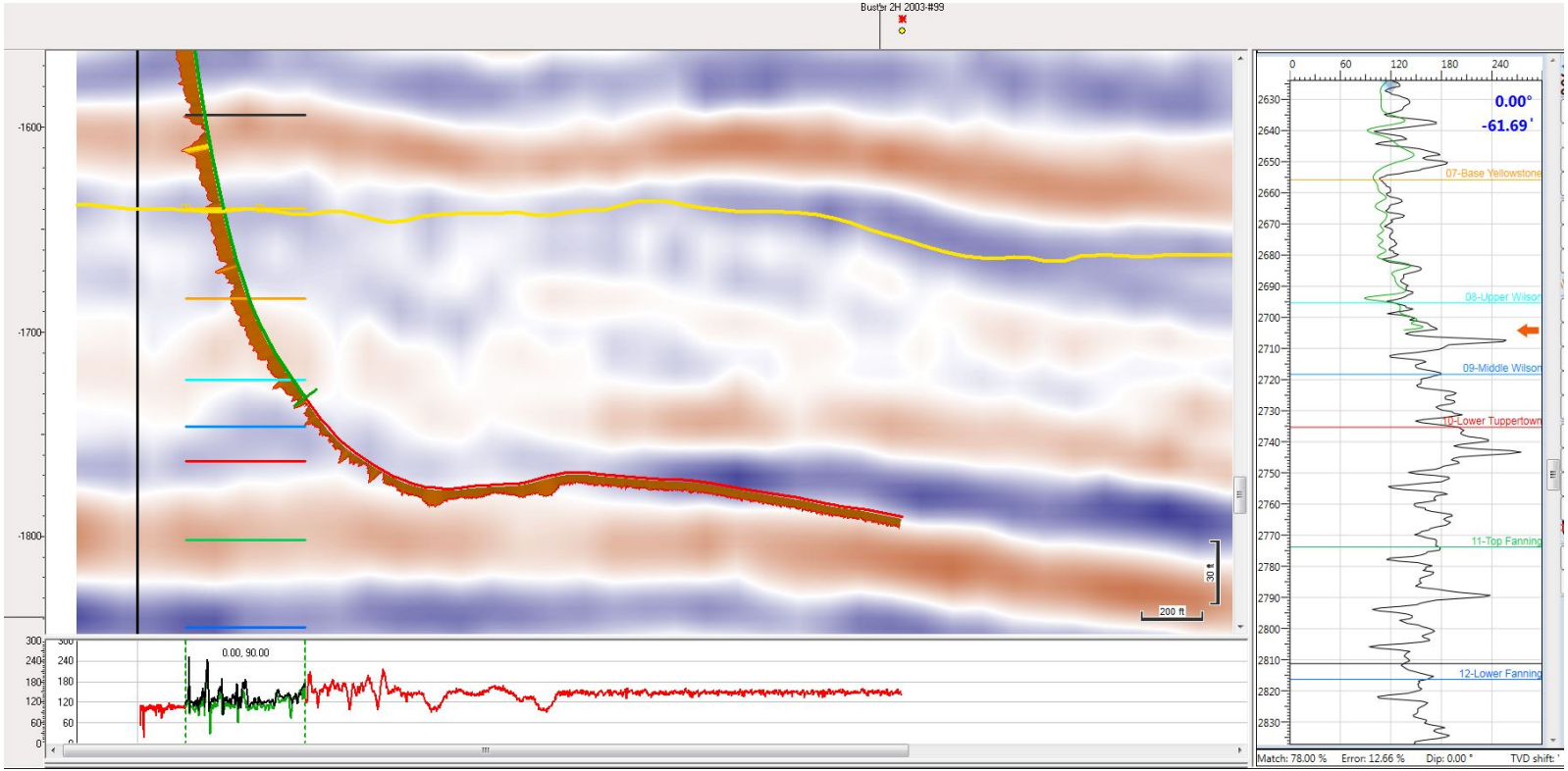
Depth Conversion workflows enabled in Geosteering

- As new geosteering data is acquired and interpreted the velocity model automatically updates
- Can see a consistent view of the subsurface model which is built on the integration of both the geophysical and geological interpretations
- Better understand changes or variations in formation thicknesses for framework model
- Clearly see where faults may be encountered
- Use a variety of seismic attributes which may be potential drilling targets

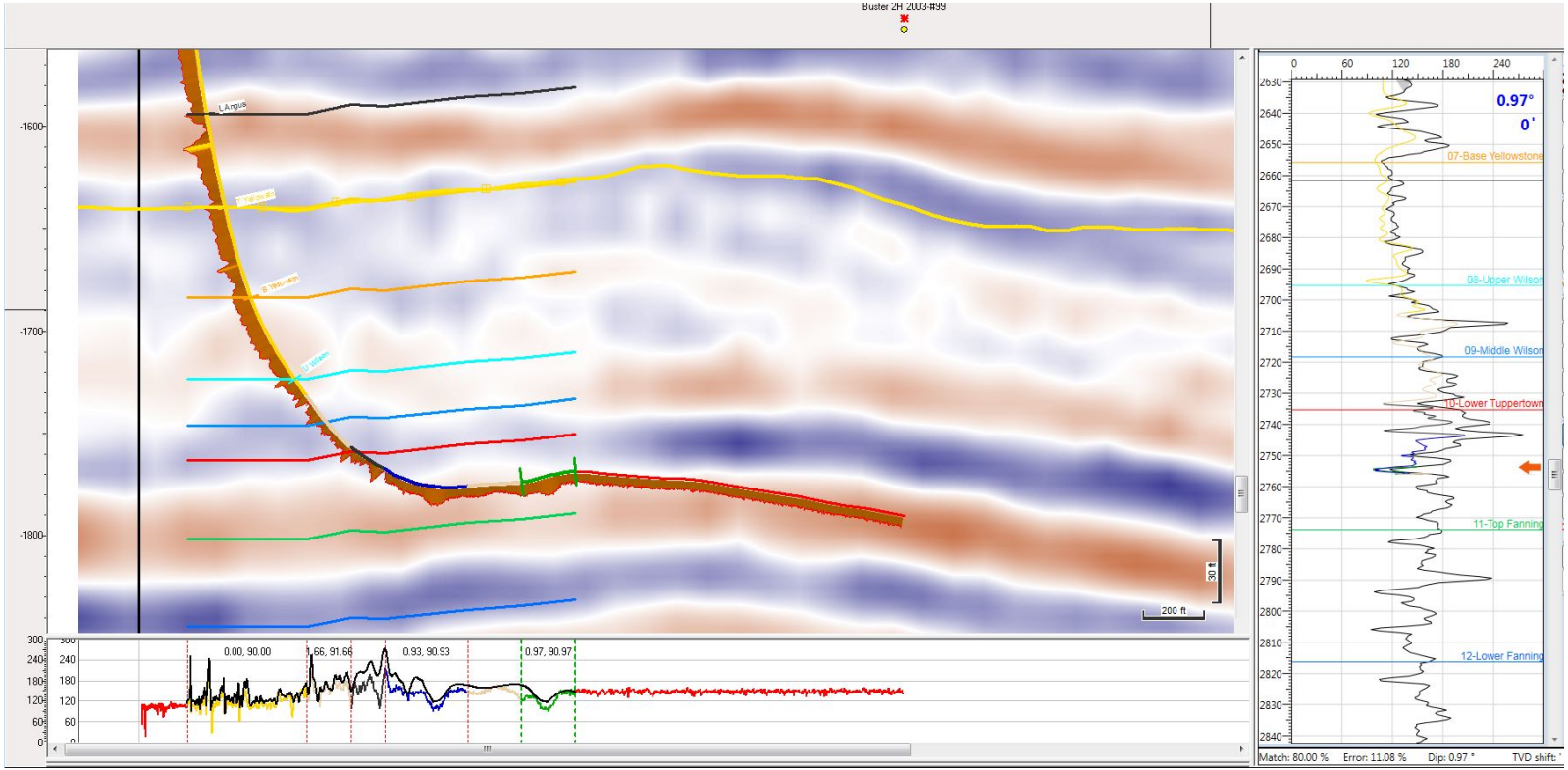
Geosteering – Drilling well prior to geosteering correlation



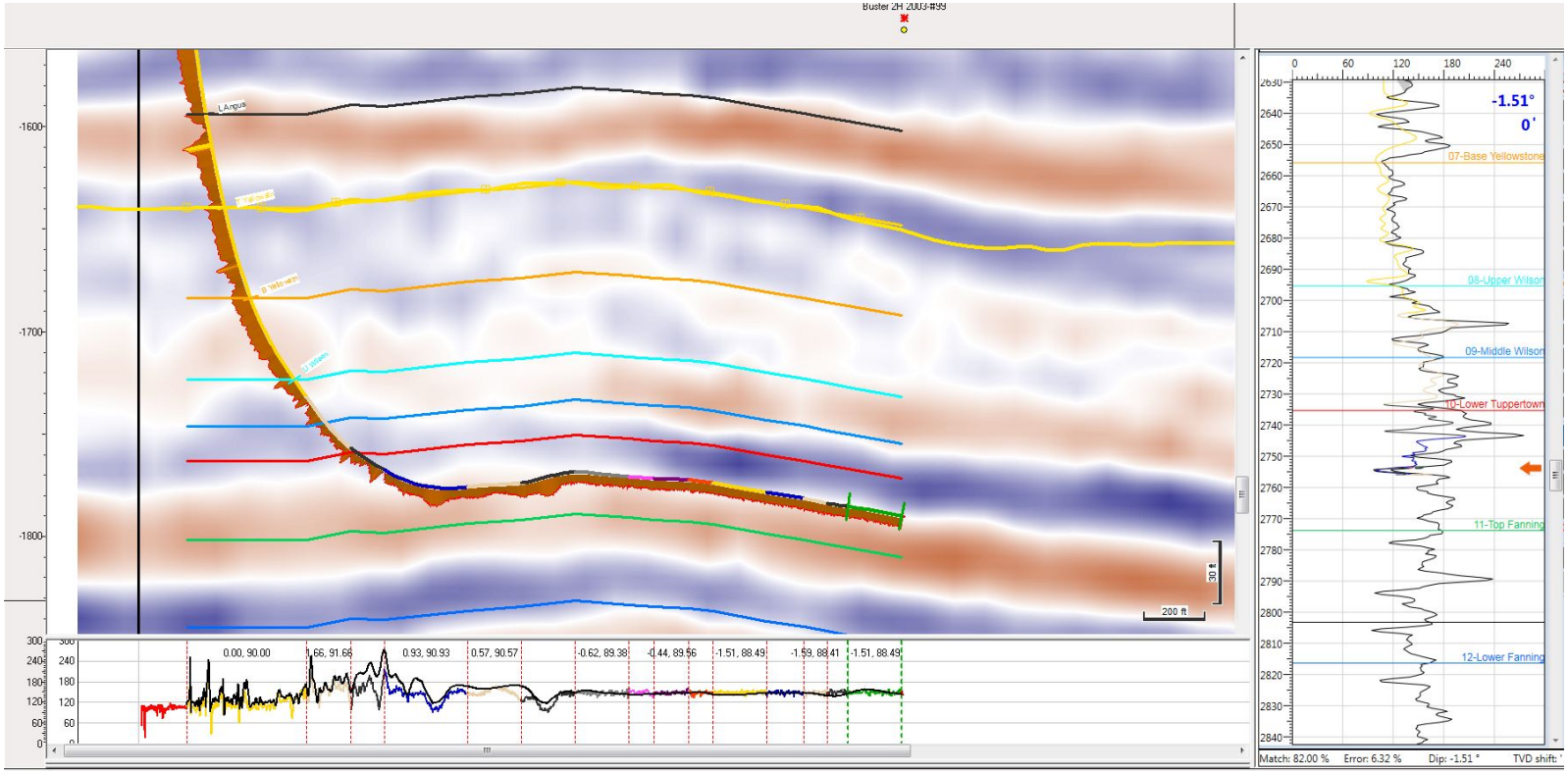
Geosteering – Initial geosteering correlation triggers velocity model



Geosteering – Additional geosteering segments correlated updating velocity



Geosteering – Completed interpretation



Depth Conversion workflows in Geosteering

Land wells more accurately

- As Geosteerer correlates drilling and reference wells the velocity model immediately is updated
- Corresponding horizons/structural maps are updated providing feedback in determining possible changes in landing depths

Better Position Wells in Zone

- All of the Structural and Thickness maps are automatically built using all of the wells and seismic data in the region
- Geosteering correlations feed the velocity model for complete understanding of location within zone of interest
- Leverage a variety of seismic attributes that are indicators of reservoir quality
- Understand location of seismically interpreted faults

Targeting the Sweet Spot with Seismic

- Multi-disciplinary approach
- Better predictive model
- Ability to refine the model while drilling
- Greater percentage of wellbore in the zone
- More accurate predrill plans