

# Bridging gap, adding value.



technology developed with



## **A New Generation Full-waveform Sonic Processing & 3D Wellbore Visualization System**



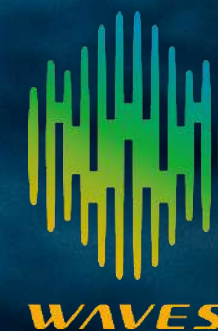
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**Wellbore Acoustics, Visualization &  
Evaluation System**





**WAVES is a new generation sonic data processing, interpretation, and 3D wellbore visualization software package jointly developed by Saudi Aramco & Colchis PetroConsulting.**

Modern full-waveform sonic data contains rich information about the wellbore and formation. Utilizing the waveform data, WAVES provides advanced analysis solutions such as:

- A comprehensive and interactive workflow for processing full-waveform sonic data.
- Advanced fracture evaluation capability that utilizes low-frequency Stoneley waveform data and dipole shear anisotropy analysis.
- The latest tomographic velocity profiling technique, which provides the inverted velocity profiles along the borehole radial / azimuthal direction. This can serve as a new input for in-situ stress field study.
- The latest technology for visualizing wellbores in 3D. It is developed for both data visualization and data integration.

Sonic logging plays an important role in the integrated process of geoscience & engineering. WAVES can be used by Geologists, Petrophysicists, Geophysicists, and Engineers in their respective E&P technical workflows.

- **For Geologists/Petrophysicists:**

Formation Evaluation, Fracture Characterization, Anisotropy, etc.

- **For Geophysicists:**

Provides important inputs for Seismic Well Tie, Rockphysics Modeling, AVO Modeling, etc.

- **For Engineers:**

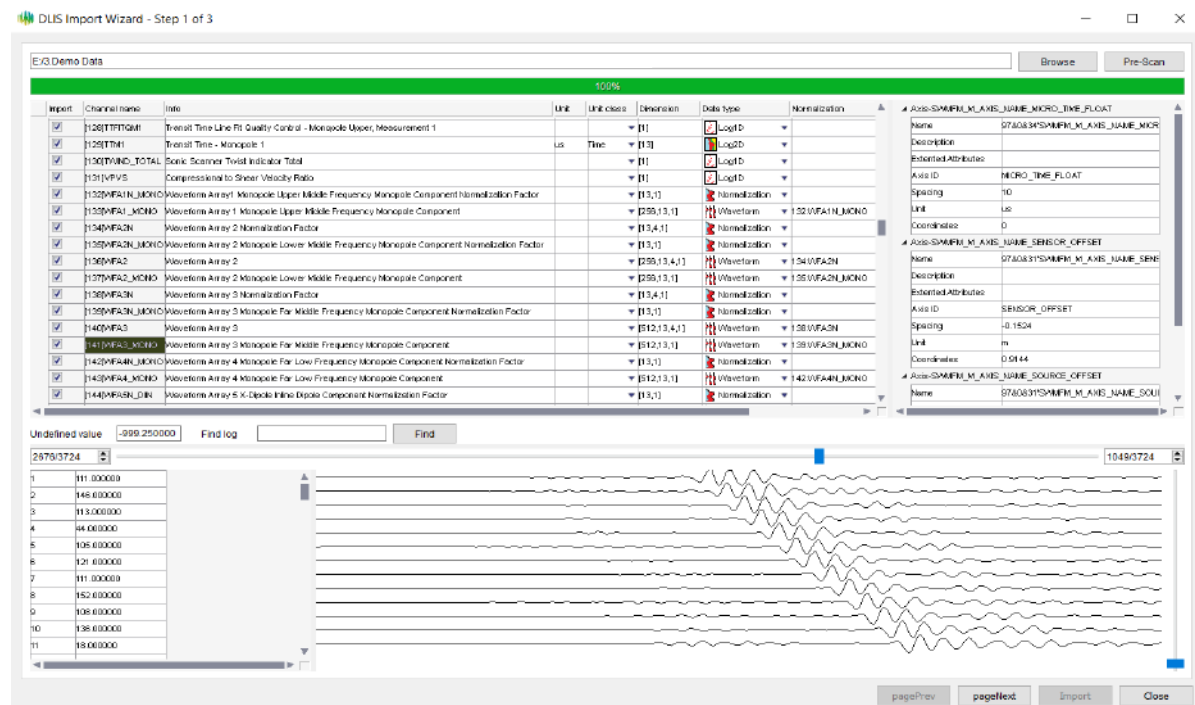
Wellbore Stability Study, Completion Design, Fracking Design, etc.

# Powerful & Easy to Use

## Interactive FWS Processing System

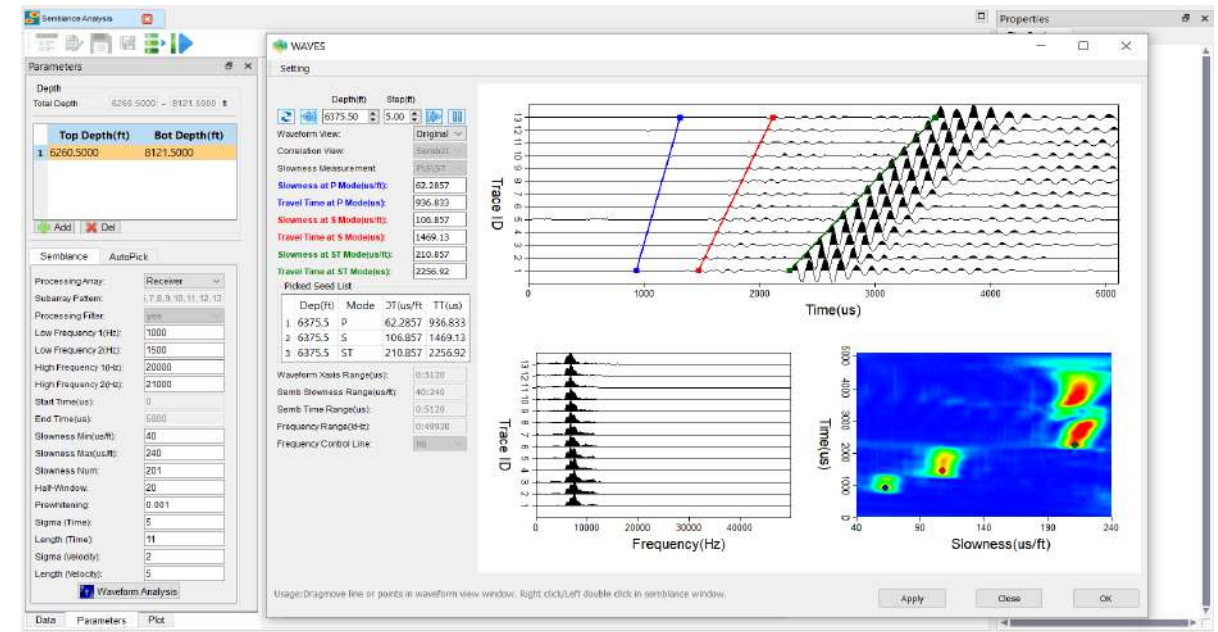
### Powerful DLIS Decoding

- Robust DLIS data unpacking and loading module which supports multiple tool types from different vendors.
- Log curves and sonic waveforms can be previewed before loading into the database.
- This can be used as a field data quality control tool. Data loading is “what you see is what you get”.

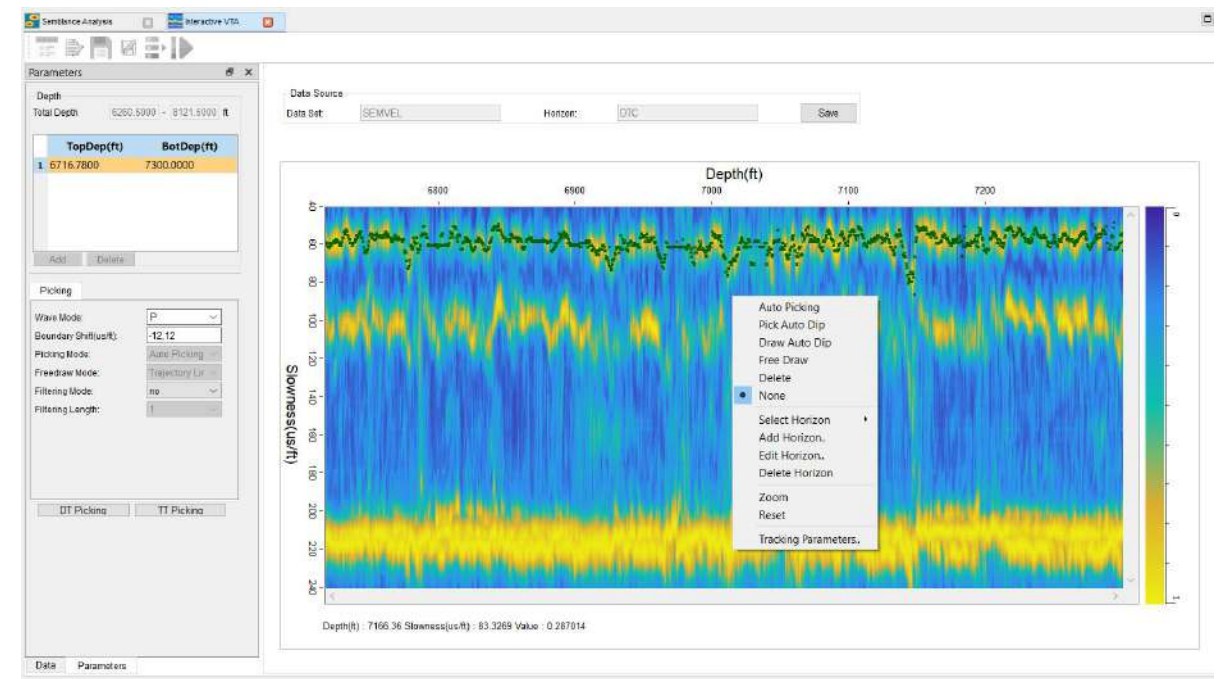


### Interactive Full-waveform Sonic Data Processing

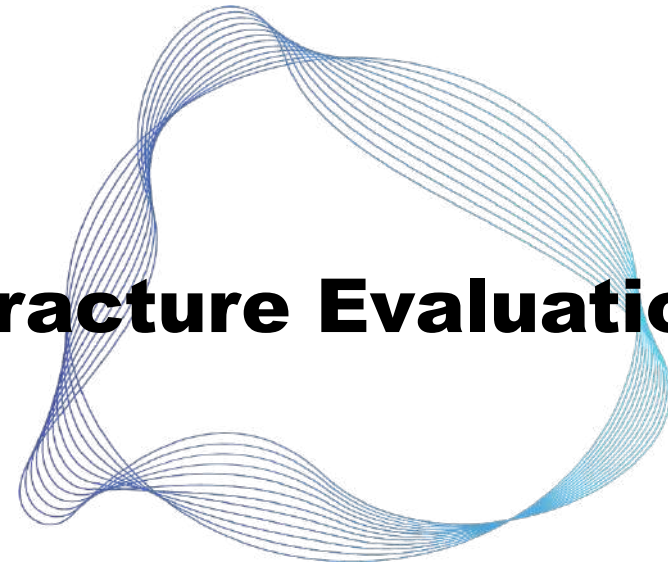
- Users can perform frequency-domain & time-domain analysis of the waveforms on a single shot record at a specific depth point, and scan for information on the propagation time and slowness of the energy clusters of different wave modes.



- The processing system automatically tracks the amplitude events of different wave modes, while providing high-quality interactive editing tools which allow users to combine information with the actual wave field and perform semi-automatic or manual editing of curves to fix errors.

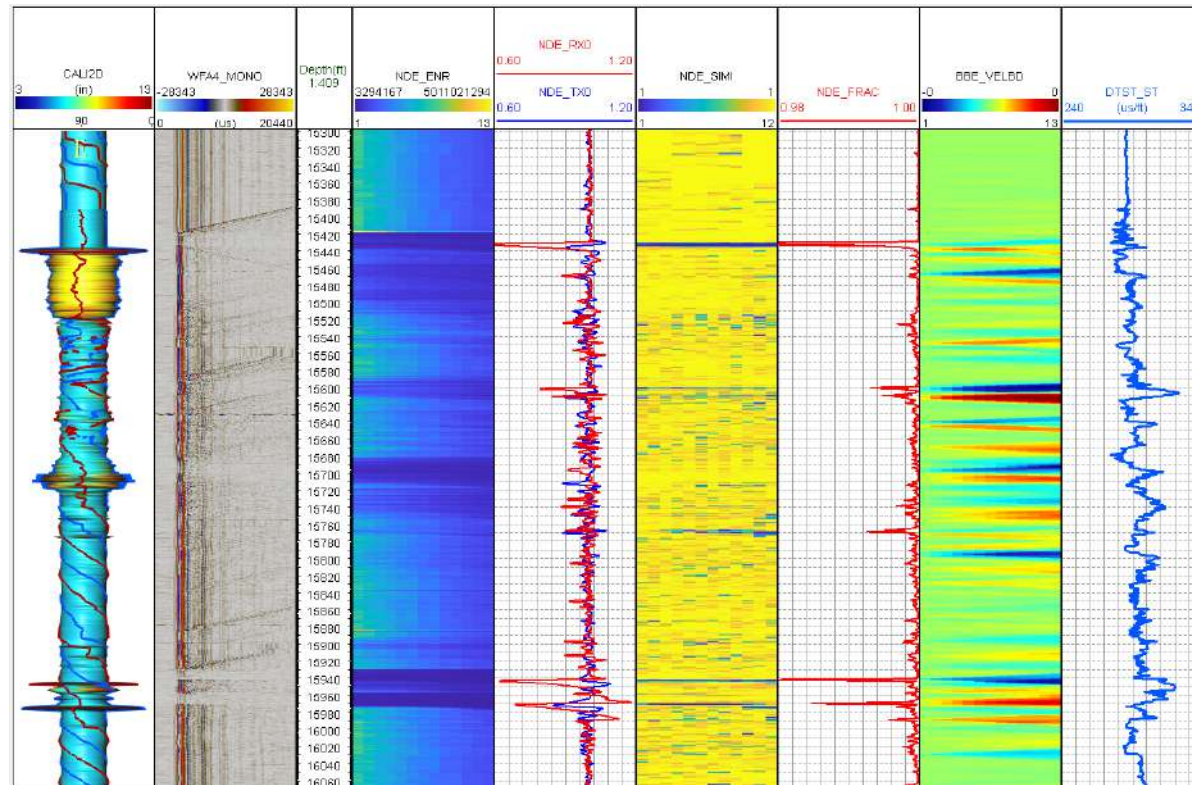


# Fracture Evaluation



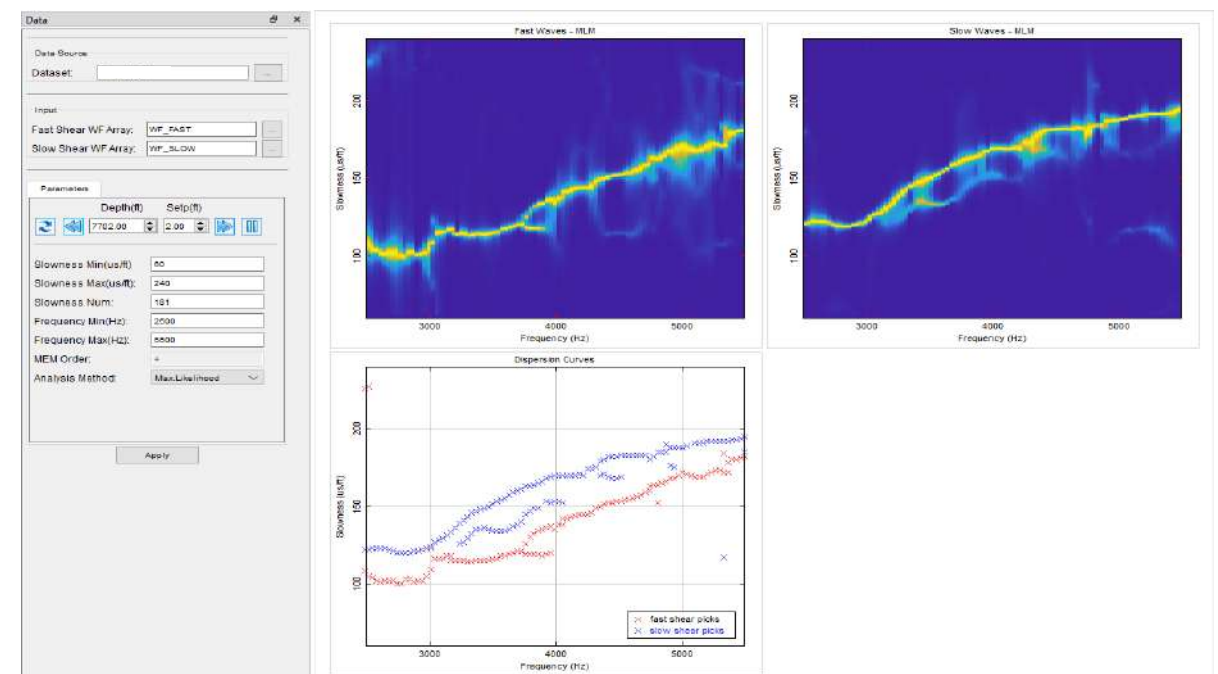
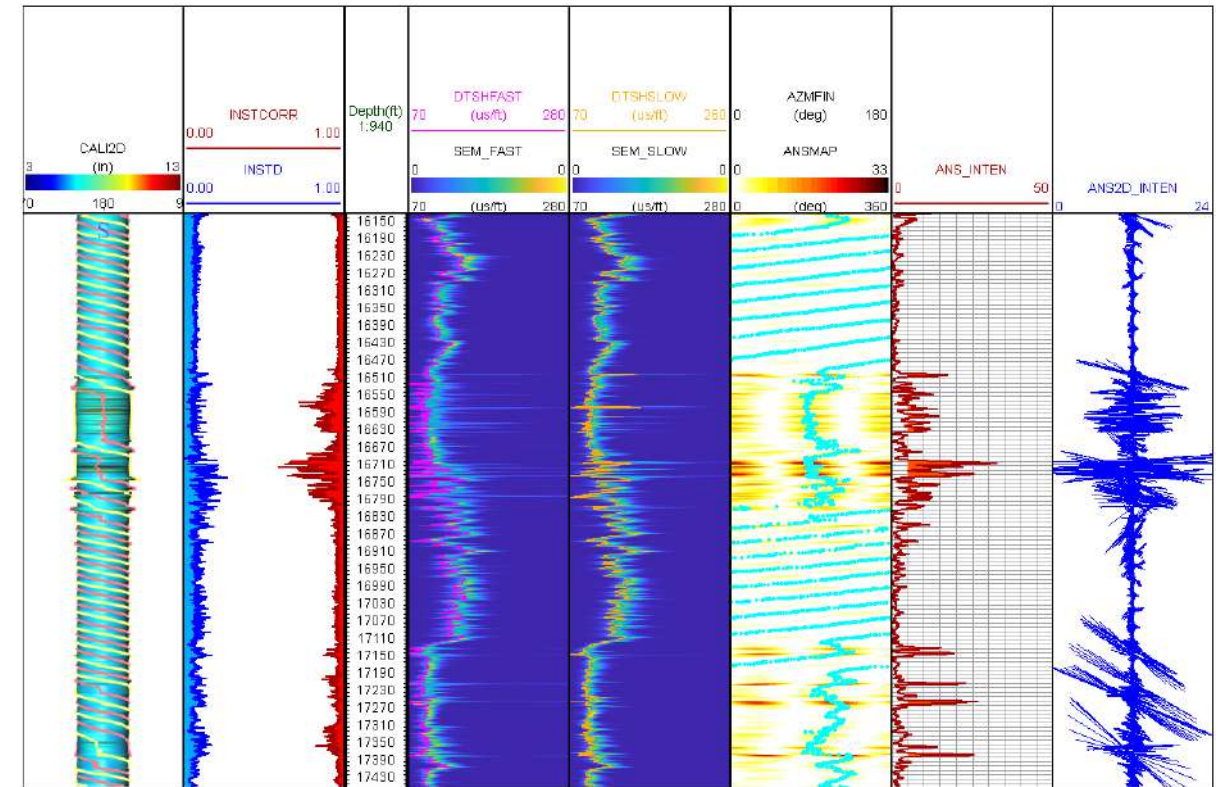
## Low-frequency Stoneley Fracture Analysis

- Inversion techniques are introduced to stabilize the NDE evaluations and to establish fracture indicators from NDE observations.
- It helps to distinguish between formation bed boundaries and open fractures.
- Combined with borehole image log and bed boundary identification technology, the effectiveness of fractures can be analyzed.



## Dipole Shear Anisotropy Analysis

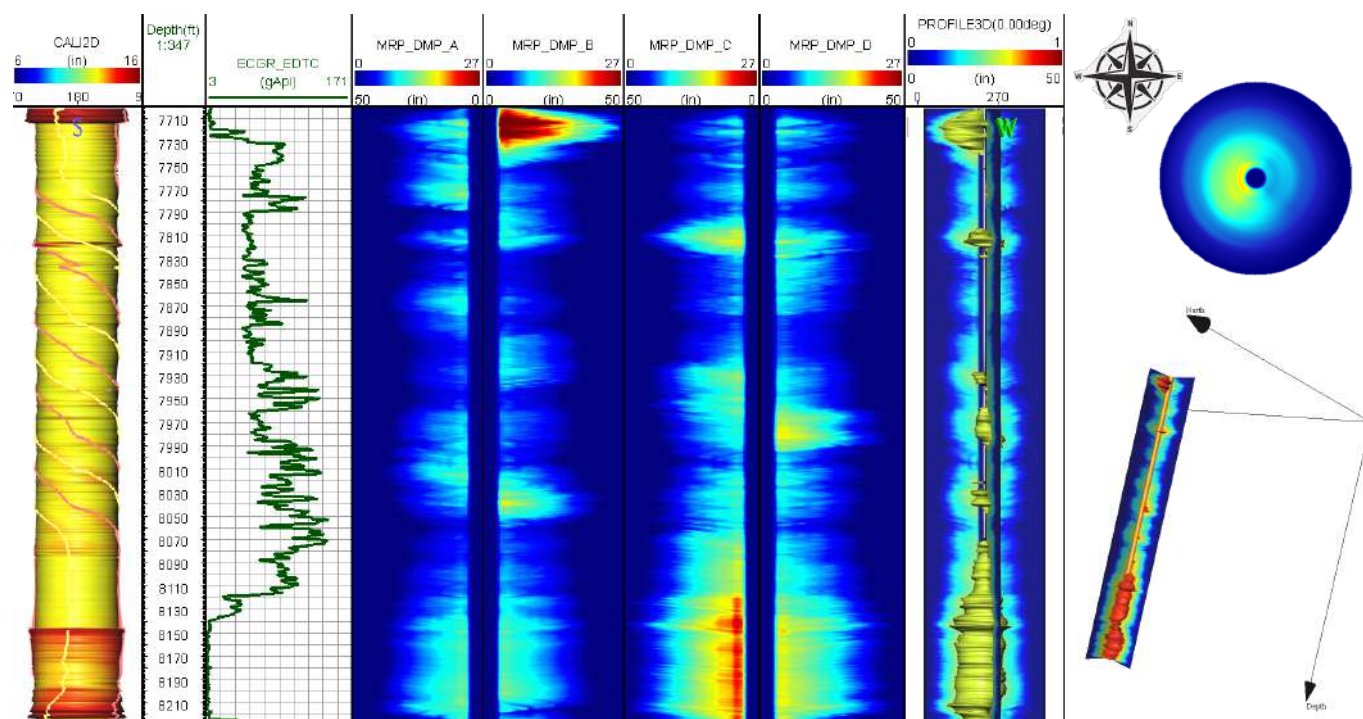
- Fast and slow shear velocities can be accurately extracted, and anisotropy and dispersion can be analyzed.
- It helps to interpret the direction of high angle fracture and maximum horizontal principal stress.



# A New Tool for Near Borehole Stress Field & Rock Mechanics Analysis

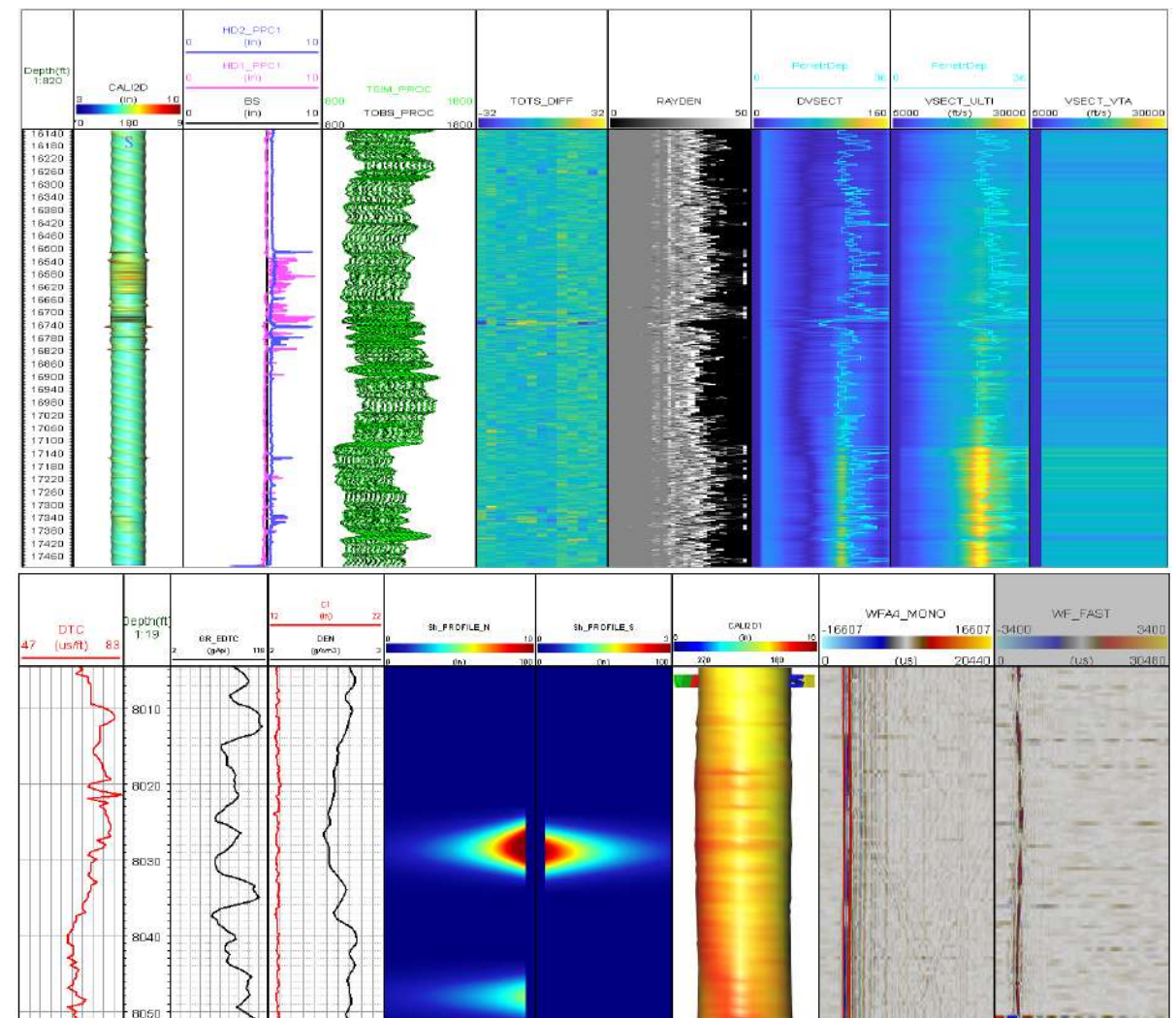
## Azimuthal / Radial P Wave Velocity Profiling

- Azimuth p-wave tomography velocity profile inversion provides radial and multidirectional velocity profiles, which can be used to image near-wellbore drilling damage and study in-situ stress fields.



## P & Dipole Wave Radial Velocity Profiling

- Velocity profile inversion of p-wave and dipole s-wave tomography provide radial velocity variation profile.
- It helps to understand near-wellbore alteration (shear stiffness) caused by several factors, such as overbalance drilling, borehole stress concentrations, shale swelling, near-wellbore mechanical damage, and mud invasion of permeable formations.
- It helps to identify the suitable depth of fluid sampling and to complete a well for optimum production.



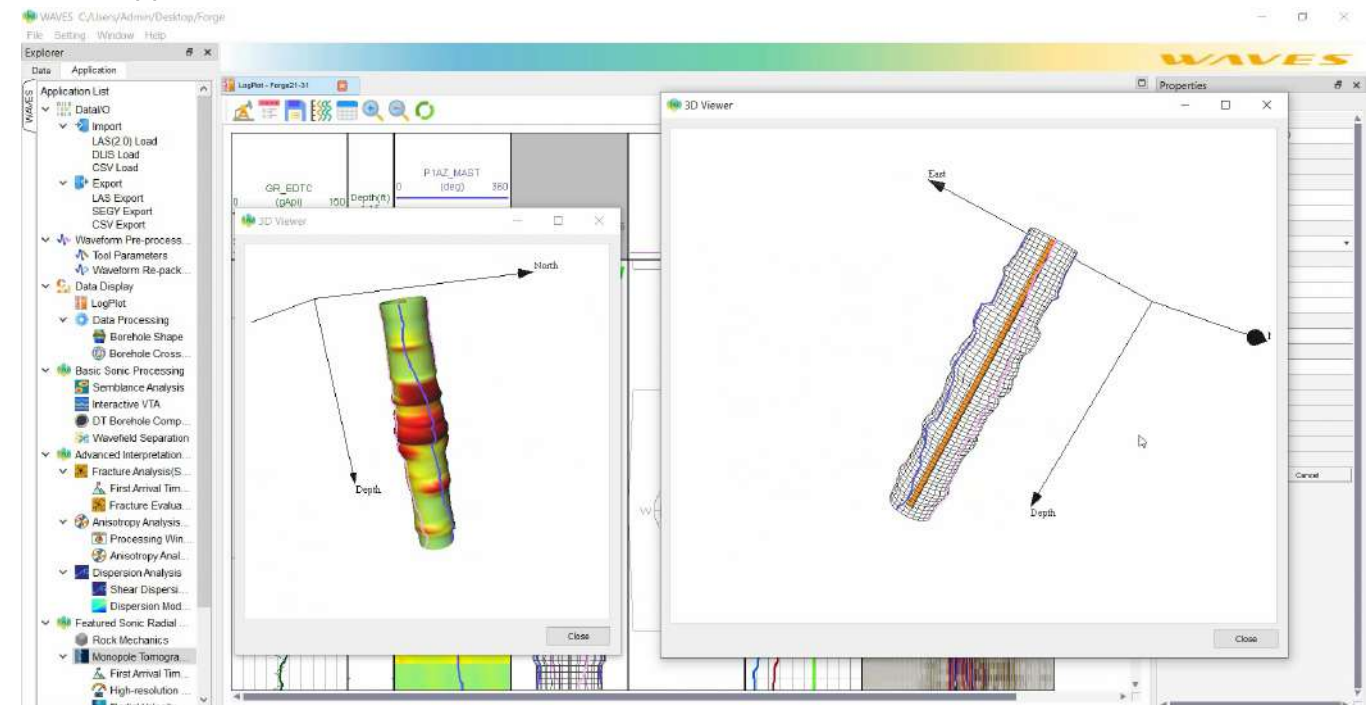
## Rock Mechanics Property Calculation

- The rock mechanics module provides dynamic and static elastic parameter conversion as well as engineering parameters such as Bulk and Young's modulus and Poisson's ratio.

# 3D Borehole Visualization & Integrated Interpretation

- Single caliper curve or bi-caliper curves with tool azimuth can be gridded and compiled as a 3-dimensional borehole mesh.
- It can be rotated to scout for borehole rugosity or borehole breakout phenomenon.
- A borehole geometric or electrical image can be assigned as the color skin on top of the mesh grid.
- Tool Azimuth can be displayed as a 3-dimension curve on top of the mesh grid.

- Through “3D Pin”, the model can be detached and turned into a mini 3D model.
- By freely rotating the model or zooming in / out in 3-dimension, one can locate a relevant camera angle and capture the best borehole image for engineers.
- We keep improving this 3D borehole visualization function, more data types will be supported.



- A composite plot can be created for integrated interpretation.
- This will provide high-quality input for subsequent completion engineering designs, perforations, and horizontal wells.

