COMPANY: Battelle Pacific Northwest Lab

WELL: Wallula Basalt Pilot #1

FIELD: Wildcat

COUNTY: Walla Walla

STATE: Washington

COUNTRY: USA

COMPANY: Battelle Pacific Northwest Lab

100 ft to 4080 ft

Compressional and Shear

DT Computations

Imaging Platform

Sonic Scanner
Log Analyst's Remarks:

OBJECTIVE: PROCESS OPEN H

AVAILABLE INPUT DATA:

- SONIC SCANNER
- Full Config

- FOUR ARM CALIPERS

Data was of good to fair quality.

DATA QUALITY:

- PEX log used as a reference.

DEPTH SHIFT:

- ART Resitivity Data
- GR, Npor, and Poro from Open H

Available input data:

- Process OPEN H

INTERPRETATION SUMMARY:

- The compressional and shear m

DT-SHEAR: The dipole wavelet

for quality assessment.

DT-COMP: The monopole wavelet

was processed from monopole

DATA PROCESSING DETAILS:

- DT-SHEAR: The dipole wavelet

was processed from monopole

log.

- DT-COMP: The monopole wavelet

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Remarks:

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log.
The borehole is moderately enlarged for much of the well.

The borehole is moderately enlarged for much of the well.

Parameters are assumed to be default parameters unless otherwise noted.

Processing Parameters:

Mud slowness was 1.55 mm/s
Shear slowness was 0.16 kHz

GENERAL

Waveforms also contain good to fair formation arrival. DTSM presented

Waveforms also contain good to fair formation arrival. DTSM presented

Graphic Illustration Captions:

Figure 1 - VP vs DTCO shows normal character.

Figure 2 - Vp/Vs DTCO shows normal character.

Figure 3 - Compressional and Shear slowness.

Composite log of Compressional and Shear slowness.

The borehole is moderately enlarged for much of the well.
<table>
<thead>
<tr>
<th>Property</th>
<th>Unit</th>
<th>Value 1</th>
<th>Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>GR 200 – 400 (gAPI)</td>
<td>200</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>Bit Size</td>
<td>(in)</td>
<td>6</td>
<td>16</td>
</tr>
<tr>
<td>AHT90</td>
<td>(ohm.m)</td>
<td>0.2</td>
<td>2000</td>
</tr>
<tr>
<td>AHT60</td>
<td>(ohm.m)</td>
<td>0.2</td>
<td>2000</td>
</tr>
<tr>
<td>AHT30</td>
<td>(ohm.m)</td>
<td>0.2</td>
<td>2000</td>
</tr>
<tr>
<td>AHT20</td>
<td>(ohm.m)</td>
<td>0.2</td>
<td>2000</td>
</tr>
<tr>
<td>DT–Shear (X–D)</td>
<td>(us/ft)</td>
<td>300</td>
<td>0.15</td>
</tr>
<tr>
<td>DT–Compression</td>
<td>(us/ft)</td>
<td>300</td>
<td>0.15</td>
</tr>
<tr>
<td>Poisson's Ratio</td>
<td></td>
<td>0</td>
<td>0.5</td>
</tr>
<tr>
<td>RHOB</td>
<td>(g/cm³)</td>
<td>1.95</td>
<td>2.95</td>
</tr>
<tr>
<td>DT–Shear (X–D)</td>
<td>(us/ft)</td>
<td>PR.DF PR@DataF</td>
<td>PR.DF PR@DataF</td>
</tr>
<tr>
<td>Caliper</td>
<td>(in)</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>ELAN_V</td>
<td>(V/V)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>AHT10</td>
<td>(ohm.m)</td>
<td>0.2</td>
<td>2000</td>
</tr>
</tbody>
</table>
Modular Sonic Imaging Platform

Tool Concept –

- A wide–frequency–band tool that enables formation characterization as:
  - homogeneous or inhomogeneous
  - isotropic or anisotropic
- Long and Short monopole transmitter receiver spacing
- A tool that is fully characterized with predictable acoustics

<table>
<thead>
<tr>
<th>Full–Serv. Tool Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Makeup length</td>
</tr>
<tr>
<td>Weight in air</td>
</tr>
<tr>
<td>Outside diameter</td>
</tr>
<tr>
<td>Transmitter–Receiver offset:</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Number of receiver stations</td>
</tr>
<tr>
<td>Pressure rating</td>
</tr>
<tr>
<td>Temperature rating</td>
</tr>
<tr>
<td>Storage temperature</td>
</tr>
<tr>
<td>Tensile strength</td>
</tr>
<tr>
<td>Max. weight below spacer</td>
</tr>
<tr>
<td>Max. compressional load (for tough logging conditions)</td>
</tr>
<tr>
<td>Shock rating</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Geophysics Applications

- Improved seismic tie
- Improved time/depth relationship
- Better 3D seismic analysis
- Polar anisotropy (VTI)
- Shear synthetics

Geomechanics Applications

- Sanding prediction
- Wellbore stability
- Rock mechanics
- Selective perforating (sand control)

Petrophysics Applications

- Alteration determination
- Radial profiling
- Mechanical properties
- Gas detection

Reservoir Characterization

- Improved shallow reading
device point selection (CMR*
magnetic resonance tool, MDT*
modular formation dynamics
tester, etc.) based on formation alteration
- Improved reserves estimates
- Maximized drawdown
### Features
- Robust measurement of compressional and shear slowness ($\Delta T_C$ and $\Delta T_S$)
- Increased logging speed
- Multiple monopole transmitter and receiver spacing
- High fidelity wideband waveform and dispersion curves
- Large receiver array
- Predictable acoustics
- Cement bond log (CBL) and variable density log (VDL) measurement
- Improved behind casing measurement with CBL/VDL simultaneous acquisition
- Extremely robust electronic package

### Benefits
- Reduced uncertainty
- Decreased operating time
- Eliminated multiple frequency passes
- Fewer “no log” intervals
- Reduction of operating risk
- Eliminated separate run for cement evaluation
- Real-time decision making made possible with wellsite quicklook reports
- Real-time quality control

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### Quality Control Projection Logs

#### Slowness Time Coherency Log

![Slowness Time Coherency Log](image1)

#### Slowness Frequency Analysis Log

![Slowness Frequency Analysis Log](image2)
Technical Paper References:

**SPWLA 1884889**

**SPWLA 1534256**

Output Channels From This Processing:

**DESCRIPTION OF BASIC MSIP OUTPUT CURVES**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DT1R</td>
<td>DT–Shear from Y-Dipole – Receiver Array</td>
</tr>
<tr>
<td>DT1T</td>
<td>DT–Shear from Y-Dipole – Transmitter Array</td>
</tr>
<tr>
<td>CHR1</td>
<td>Peak Coherence for Y-Dipole – Receiver Array</td>
</tr>
<tr>
<td>CHT1</td>
<td>Peak Coherence for Y-Dipole – Transmitter Array</td>
</tr>
<tr>
<td>SPR1</td>
<td>STC Slowness Projection for Y-Dipole – Receiver Array</td>
</tr>
<tr>
<td>SPT1</td>
<td>STC Slowness Projection for Y-Dipole – Transmitter Array</td>
</tr>
<tr>
<td>DT1R</td>
<td>DT–Shear from X-Dipole – Receiver Array</td>
</tr>
<tr>
<td>DT1T</td>
<td>DT–Shear from X-Dipole – Transmitter Array</td>
</tr>
</tbody>
</table>
CHR2  Peak Coherence for X-Dipole Receiver Array
CPT2  Peak Coherence for X-Dipole Transmitter Array
SPR2  STC Slowness Projection for X-Dipole Receiver Array
SPT2  STC Slowness Projection for X-Dipole Transmitter Array

DT3R  DT-Stoneley from Monopole-Far-LF Receiver Array
DT3T  DT-Stoneley from Monopole-Far-LF Transmitter Array
DTST  DT-Stoneley from Monopole-Far-LF Average of Receiver and Transmitter Arrays
CHR3  Peak Coherence for Monopole-Far-LF Receiver Array
CHR3  Peak Coherence for Monopole-Far-LF Transmitter Array
SPR3  STC Slowness Projection for Monopole-Far-LF Receiver Array
SPT3  STC Slowness Projection for Monopole-Far-LF Transmitter Array

SPR4  STC Slowness Projection for Monopole-Far-8K Receiver Array
SPT4  STC Slowness Projection for Monopole-Far-8K Transmitter Array

DTRP  DT-Compressional from Monopole-Far-8K Receiver Array
DTRT  DT-Compressional from Monopole-Far-8K Transmitter Array
DTSR  DT-Compressional from Monopole-Far-8K Average of Receiver and Transmitter Arrays

CHRP  Peak Coherence for Monopole-Far-8K Receiver Array
CHTP  Peak Coherence for Monopole-Far-8K Transmitter Array

DTSM  A general name for DT-Shear
DTCO  A general name for DT-Compressional

DTEXR  DT-Shear from Fast or Slow dipole waveforms processing in BestDt Receiver Array
DTEXT  DT-Shear from Fast or Slow dipole waveforms processing in BestDt Transmitter Array

DTSM_FAST  Fast DT-Shear from "Post-Anisotropy" processing
DTSM_SLOW  Slow DT-Shear from "Post-Anisotropy" processing

CHREX  Peak Coherence for Fast or Slow dipole waveforms processing in BestDt Receiver Array
CHTEX  Peak Coherence for Fast or Slow dipole waveforms processing in BestDt Transmitter Array

SPREX  STC Slowness Projection for Fast or Slow dipole waveforms processing in BestDt Receiver Array
SPTEX  STC Slowness Projection for Fast or Slow dipole waveforms processing in BestDt Transmitter Array

TISH  Shear Total Travel Time
TICO  Compressional Total Travel Time

VPVS  (DT-Shear/Dt-Compressional ratio)
PR  (POISSON RATIO=((0.5*VPVS*VPVS)-1)/(VPVS*VPVS -1))

>>>>>>LOGGING MODES>>>>>>

BASIC CONFIGURATION / CONCISE MODE:
   MU -- Monopole Upper
   ML -- Monopole Lower

FULL CONFIGURATION / ALL MODE:
   MU -- Monopole Upper
   ML -- Monopole Lower
   MF -- Monopole Far
   XD_DIIN -- X-Dipole In-Line
   XD_DIOF -- X-Dipole Off-Line
   YD_DIIN -- Y-Dipole In-Line
   YD_DIOF -- Y-Dipole Off-Line

(Note: Availability of XDIN, XDOF, YDIN and YDOF waveforms are necessary for Anisotropy analysis).