Appendix I
Borehole Geophysical Data
**OBI/ABI Image Log Summary**

**Hole 18 E Yearling**

Malcolm Pirnie

18 E. Yearling, Maricopa County, Az

Image Features Rotated 11.5 deg E for Magnetic Declination to True North

Feature Dip is from 0 to 90 deg (0 = Horizontal, 90 = Vertical)  
Logged: July 27, 2007

### Optical and Acoustic Image Features Legend

- Major Fracture/Joint - distinct wide fracture/joint continuous around circumference of hole
- Minor Fracture/Joint - thin or discontinuous fracture/joint around circumference of hole
- In-filled Fracture/Joint or Vein
- Bedding - apparent bedding; rock boundary; banding or foliation feature
- Bottom of Casing
- Fluid level in borehole

### VFx Lithology Legend

- Highly Fractured Zone
- Near Vertical Fractures
- Fanglomerate - cemented, rounded clasts
- Conglomerate - mud matrix supported, angular to sub-rounded
- Breccia - cemented, angular fragments

### 18 E. Yearling Well - Image Log Summary

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**3-Arm**

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**VFx Features**

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**Centralized T**

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**Oriented Mag. North**

- Highly Fractured Zone
- Near Vertical Fractures
- Fanglomerate - cemented, rounded clasts
- Conglomerate - mud matrix supported, angular to sub-rounded
- Breccia - cemented, angular fragments

**VFx Lithology Legend**

- Highly Fractured Zone
- Near Vertical Fractures
- Fanglomerate - cemented, rounded clasts
- Conglomerate - mud matrix supported, angular to sub-rounded
- Breccia - cemented, angular fragments

**Depth**

- 18.8" Nominal Circumference
- 6.0" Dia.
335.0

Fluid Level ~352.1'
18 E. Yearling Well - Image Log Summary

18 E Yearling Well Bull's Eye Deviation Plot
Measured Depth = 23.0-483.4 ft.
Closure Distance = 41.17 ft.
Closure Angle = 68.5°
True Vertical Depth = 480.62 ft.
Radius of Curvature Deviation Algorithm
Corrected for 11.5 E Magnetic Declination to True North

18 E Yearling Well E-W Vertical Section Deviation Plot

Measured Depth = 23.0-483.4 ft.
Closure Distance = 41.17 ft.
Closure Angle = 68.5°
True Vertical Depth = 480.62 ft.
Radius of Curvature Deviation Algorithm
Corrected for 11.5 E Magnetic Declination to True North

18 E Yearling Well Closure Section Deviation Plot

Measured Depth = 23.0-483.4 ft.
Closure Distance = 41.17 ft.
Closure Angle = 68.5°
True Vertical Depth = 480.62 ft.
Radius of Curvature Deviation Algorithm
Corrected for 11.5 E Magnetic Declination to True North
Optical and Acoustic Image Summary Legend

Mnemonics and Comments

**3-Arm** = 3-arm mechanical caliper of hole diameter plotted from 5-10 inches (blue line)

**ARI** = Acoustic Reflectance Index or relative rock hardness from ABI Amplitude log. Plotted 0 (soft) to 250 (harder) as green line.

**VFXs** = Near Vertical Fractures, highly fractured zones and Fanglomerate or Breccia zones

**OBI Image-NM** = 2D plot of optical image oriented to magnetic north. Plotted from left to Right N-E-S-W-N

**Features** = Planar features picked on optical or acoustic borehole image shown as colored sinusoid (color designation shown on header) DIPA = dip apparent hole axis

**Centralized TT** = 2D plot of acoustic image travel time with probe position centralized. Plotted from left to Right N-E-S-W-N

**Amplitude** = 2D plot of unfiltered acoustic image amplitude oriented to magnetic north. Plotted from left to Right N-E-S-W-N

**Amplitude-Stat** = 2D plot of acoustic image amplitude with Static Normalization Filtering (can be toggled on/off) Plotted from left to Right N-E-S-W-N

**Amplitude-Dyn1** = 2D plot of acoustic image amplitude with Dynamic 1 Normalization Filtering (can be toggled on/off) Plotted from left to Right N-E-S-W-N

**Amplitude-Dyn2** = 2D plot of acoustic image amplitude with Dynamic 2 Normalization Filtering (can be toggled on/off) Plotted from left to Right N-E-S-W-N

**Amp-High Pass** = 2D plot of acoustic image amplitude with High Pass Normalization Filtering (can be toggled on/off) Plotted from left to Right N-E-S-W-N

**3D-OBI** = 3D cylindrical projection of OBI image looking from the North.

**3D-ABI** = 3D cylindrical projection of OBI image looking from the North.

**Tadpole** = tadpole plot of the image feature picks (fractures and bedding planes); plotted from 0 to 90° dip - see legend above. DIPA = dip apparent hole axis

**Magn. Field** = Total magnetic field strength as measured by fluxgate magnetometer in OBI deviation sensor - plotted 0-90 uT. (green line)

**Azimuth** = direction of tool tilt plotted 0 to 360 deg; represents borehole deviation direction (red line)

**Tilt** = tool tilt (vertical = 0° and horizontal = 90°) plotted 0 to 16 deg; represents borehole deviation tilt from vertical. (blue line)

**CA** = Closure angle = horizontal angle from hole to vertical projected collar location; plotted from 0 to 360 deg (dashed green line)

**CD** = Closure Distance = distance in feet in a horizontal plane from the borehole to vertical projected collar location; plotted from 0 to 44 ft. (dotted black line)

Prepared by Robert E. Crowder

Rev 8-3-2007
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<th>CASING RECORD</th>
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<td>K. Mitchell</td>
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| Witnessed By | Malcom Pirnie |
| Recorded By | K. Mitchell |

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Southwest Exploration Services, LLC
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**3D VIEW**

112°
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<td>TYPE FLUID IN HOLE</td>
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**3-D VIEW**
- Depth
- OBI Image
- 0° 90° 180° 270°
- 267°
- 11:10 ft
- 1 ft:10 ft

**2-D VIEW**
- 3-D VIEW
- Depth
- OBI Image
- 0° 90° 180° 270°
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**Well ID:** UPCO - MW-7

**Company:** MALCOM PIRNIE

**County:** MARICOPA

**State:** ARIZONA

**Field:** UPCO

**Location:** A4-38NE, NW, NW 1/4

**Surface:** 20 FT

**Total Depth:** 214.5 FT

**Surface Date:** 10-15-04

**Recorded By:** K. MITCHELL

**Witnessed By:** MALCOM PIRNIE

**Type of Logs:** OPTICAL TELEVIEWER

**Depth Drilled:** 219 FT

**Operating Rig Time:** 8"
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**Operating Rig Time:**
- 8"

**WITNESSED BY:**
- MALCOM PIRNIE

**NORMAL:**
- FIELD UPCO - MW-8
- COMPANY MALCOM PIRNIE

**Location:**
- A(4-3)8 NE, NE, NW 1/4
- MARICOPA COUNTY
- ARIZONA STATE

**Type of Logs:**
- OPTICAL TELEVIEWER
- GE TRWI
- NEUTRON
- DENSITY
- NAT. GAMMA
- E-LOGS
- CALIPER
- OTHER SERVICES

**More:**
- DATE 10-13-04
- TYPE FLUID IN HOLE: FRESH WATER
- TOTAL DEPTH: 262 FT
- DEPTH-LOGGER TO METER 262 FT
- DEPTH-LOGGER TO METER 189 FT
- LEVEL
- DENSITY
- SALINITY
- RUN NO.
- LOG MEAS. FROM TOP OF CASING
- SURFACE 20 FT
- SURFACE 19 FT
- SURFACE 18 FT
- SURFACE 17 FT
- SURFACE 16 FT
- SURFACE 15 FT
- SURFACE 14 FT
- SURFACE 13 FT
- SURFACE 12 FT
- SURFACE 11 FT
- SURFACE 10 FT
- SURFACE 9 FT
- SURFACE 8 FT
- SURFACE 7 FT
- SURFACE 6 FT
- SURFACE 5 FT
- SURFACE 4 FT
- SURFACE 3 FT
- SURFACE 2 FT
- SURFACE 1 FT
- SURFACE 0 FT

**Type Log:**
- LOG MEAS. FROM TOP OF CASING
- ABOVE PERM. DATUM
- ELEVATION
- TYPE FLUID IN HOLE: FRESH WATER

**Other Services:**
- BW OBI Image
- 3-D VIEW
- Depth

**Operators:**
- WITNESSED BY
- OPERATING RIG TIME

**Permanent Datum:**
- TWP 4N
- RGE 3E
- SEC 8

**Recorded By:**
- K. MITCHELL

**Density:**
- 20 FT

**Total Depth:**
- 262 FT
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## ATV Imaging Summary Log

**Hole MW-9**

Malcolm Pirnie  
UPCO Project, Maricopa County, Az

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**Image Logs Rotated 12 deg E for Magnetic Declination to True North**  
Feature Dip is from 0 to 90 deg (0 = Horizontal, 90 = Vertical)  
Logged: Jan 25, 2005

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**Optical and Acoustic Image Features Legend**

- Minor fracture - thin or discontinuous fracture/joint around circumference of hole

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<th>Amplitude-rot 348</th>
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---

**Features**

- Optical and Acoustic Image Features

---

**Caliper**

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**Rock Hardness**

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**ARI**

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**Azimuth**

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**Travel Time-rot 348**

<table>
<thead>
<tr>
<th>Travel Time-rot 348</th>
<th>0°</th>
<th>90°</th>
<th>180°</th>
<th>270°</th>
<th>0°</th>
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</thead>
</table>

---

**Dep: 1:2.5**

<table>
<thead>
<tr>
<th>Dep: 1:2.5</th>
<th>Travel Time-rot 348</th>
<th>Amplitude-rot 348</th>
</tr>
</thead>
</table>

---

**DIPA**

- Depth: 1:2.5

---

**Optical and Acoustic Image Features Legend**

- Minor fracture - thin or discontinuous fracture/joint around circumference of hole
**ATV Image Summary Legend**

**Mnemonics and Comments**

**ATV Image-rot 348** = 2D plot of optical image rotated 12 E for magnetic declination to true north. Plotted from left to Right N-E-S-W-N

**Features** = planar features picked on optical borehole image shown as colored sinusoid (color designation shown on header) DIPA = dip apparent hole axis

**Travel Time-rot 348** = 2D plot of acoustic image travel time rotated 12 E for magnetic declination to true north. Plotted from left to Right N-E-S-W-N

**Amplitude-rot 348** = 2D plot of acoustic image amplitude rotated 12 E for magnetic declination to true north. Plotted from left to Right N-E-S-W-N

**3D-North** = 3D cylindrical projection of OBI image looking from the north

**3D-East** = 3D cylindrical projection of OBI image looking from the east

**TI - mean** = Acoustic Travel Time Median Value - normalized acoustic caliper

**ARI** = Acoustic Reflectance Index - normalized Median acoustic amplitude

**Rock Hardness** = profile of normalized rock hardness with 100% being acoustic hardest rock & 0% being softest rock

**Amplitude-rot 348** = 2D plot of acoustic image amplitude rotated 12 E for magnetic declination to true north. Plotted from left to Right N-E-S-W-N

**Azimuth** = direction of tool tilt plotted 0 to 360 deg; represents borehole deviation direction (red line)

**Tilt** = tool tilt (vertical = 0 and horizontal = 90) plotted 0 to 16 deg; represents borehole deviation tilt from vertical. (blue line)

**Caliper** = single arm caliper log of hole diameter in inches

---

Prepared by Robert E. Crowder
Rev 2-28-2005
Image Logs Rotated 12 deg E for Magnetic Declination to True North
Feature Dip is from 0 to 90 deg (0 = Horizontal, 90 = Vertical)  Logged: December 11, 2005

OBI & ATV Imaging Summary Log
Hole MW-11

Malcolm Pirnie  UPCO Project, Maricopa County, Az

Depth 1in: 2.5ft  VFx  OBI Image-rotated 348  Travel Time-rot 348  Amplitude-rot 348  3D-North  3D-East  3D-North  3D-East  DIPT
0°  90°  180°  270°  0°  0°  90°  180°  270°  0°  0°  90°  180°  270°  0°

Features
DIPA
0°  90°  180°  270°  0°

Bottom of Conductor Casing = 18.0'
In-filled fracture/joint with white or light colored material

Major fracture - distinct wide fracture/joint continuous around circumference of hole

Bedding - apparent bedding; rock boundary; banding or foliation feature

Fluid level in borehole

Unclassified - planar feature continuous around circumference - type of feature not determined: may be a: 1) fracture; 2) bedding feature; etc.

Minor fracture - thin or discontinuous fracture/joint around circumference of hole

Optical and Acoustic Image Features Legend

VFx Lithology Legend

Highly Fractured Zone
Near Vertical Fractures
Fanglomerate - cemented, rounded clasts
### Optical and Acoustic Image Summary Legend

**Mnemonics and Comments**

<table>
<thead>
<tr>
<th>Mnemonic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBI Image-rot 348</td>
<td>2D plot of optical image rotated 12 E for magnetic declination to true north. Plotted from left to Right N-E-S-W-N</td>
</tr>
<tr>
<td>Features</td>
<td>Planar features picked on optical borehole image shown as colored sinusoid (color designation shown on header) DIPA = dip apparent hole axis</td>
</tr>
<tr>
<td>VFxs</td>
<td>Near Vertical Fractures, highly fractured zones and Fanglomerate or Breccia zones</td>
</tr>
<tr>
<td>Travel Time-rot 348</td>
<td>2D plot of acoustic image travel time rotated 12 E for magnetic declination to true north. Plotted from left to Right N-E-S-W-N</td>
</tr>
<tr>
<td>Amplitude-rot 348</td>
<td>2D plot of acoustic image amplitude rotated 12 E for magnetic declination to true north. Plotted from left to Right N-E-S-W-N</td>
</tr>
<tr>
<td>3D-North</td>
<td>3D cylindrical projection of OBI image looking from the north</td>
</tr>
<tr>
<td>3D-East</td>
<td>3D cylindrical projection of OBI image looking from the east</td>
</tr>
<tr>
<td>Tadpole</td>
<td>Tadpole plot of the image feature picks (fractures and bedding planes); plotted from 0 to 90 dip - see legend above. DIPT = True orientation; features corrected for hole deviation</td>
</tr>
<tr>
<td>Azimuth</td>
<td>Direction of tool tilt plotted 0 to 360 deg; represents borehole deviation direction (red line)</td>
</tr>
<tr>
<td>Tilt</td>
<td>Tool tilt (vertical = 0 and horizontal = 90) plotted 0 to 16 deg; represents borehole deviation tilt from vertical. (blue line)</td>
</tr>
</tbody>
</table>

Prepared by Robert E. Crowder  
Rev 2-07-2006
OBI & ATV Imaging Summary Log

Hole MW-12
Malcolm Pirnie  UPCO Project, Maricopa County, Az

Image Logs Rotated 12 deg E for Magnetic Declination to True North
Feature Dip is from 0 to 90 deg (0 = Horizontal, 90 = Vertical)  Logged: December 11, 2005

OBI Image-rotated 348

<table>
<thead>
<tr>
<th>Depth</th>
<th>VFx</th>
<th>OBI Image-rotated 348</th>
<th>Travel Time-rot 348</th>
<th>Amplitude-rot 348</th>
<th>3D-North</th>
<th>3D-East</th>
<th>Tadpole</th>
<th>Azimuth</th>
</tr>
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<tbody>
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</tbody>
</table>

Features

DIPA

Bottom of Surface Conductor ~20.4'
Fluid Level = ~210.4
### Optical and Acoustic Image Features Legend

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>VFx</td>
<td>Near Vertical Fractures, highly fractured zones and Fanglomerate or Breccia zones</td>
</tr>
<tr>
<td>Mfn</td>
<td>Minor fracture - thin or discontinuous fracture/joint around circumference of hole</td>
</tr>
<tr>
<td>Unclassified</td>
<td>Unclassified - planar feature continuous around circumference - type of feature not determined: may be a: 1) fracture; 2) bedding feature; etc.</td>
</tr>
<tr>
<td>Fluid level</td>
<td>Fluid level in borehole</td>
</tr>
<tr>
<td>Bedding</td>
<td>Bedding - apparent bedding; rock boundary; banding or foliation feature</td>
</tr>
<tr>
<td>Major fracture</td>
<td>Major fracture - distinct wide fracture/joint continuous around circumference of hole</td>
</tr>
<tr>
<td>In-filled fractures/joints with white or light colored material</td>
<td>In-filled fractures/joints with white or light colored material</td>
</tr>
</tbody>
</table>

### Optical and Acoustic Image Summary Legend

#### Mnemonics and Comments

- **OBI Image-rot 348**: 2D plot of optical image rotated 12 E for magnetic declination to true north. Plotted from left to Right N-E-S-W-N
- **Features**: planar features picked on optical borehole image shown as colored sinusoid (color designation shown on header) DIPA = dip apparent hole axis
- **VFxs**: Near Vertical Fractures
- **Travel Time-rot 348**: 2D plot of acoustic image travel time rotated 12 E for magnetic declination to true north. Plotted from left to Right N-E-S-W-N
- **Amplitude-rot 348**: 2D plot of acoustic image amplitude rotated 12 E for magnetic declination to true north. Plotted from left to Right N-E-S-W-N
- **3D-North**: 3D cylindrical projection of OBI image looking from the north
- **3D-East**: 3D cylindrical projection of OBI image looking from the east
- **Tadpole**: tadpole plot of the image feature picks (fractures and bedding planes); plotted from 0 to 90 dip - see legend above. DIPT = True orientation; features corrected for hole deviation
- **Azimuth**: direction of tool tilt plotted 0 to 360 deg; represents borehole deviation direction (red line)
Tilt: Tool tilt (vertical = 0 and horizontal = 90) plotted 0 to 16 deg; represents borehole deviation tilt from vertical. (blue line)
# OBI/ABI Image Log Summary

**Hole MW-13**

*Malcolm Pirnie, Phoenix, Maricopa County, Az*

---

**Image Features Rotated 11.5 deg E for Magnetic Declination to True North**

**Feature Dip is from 0 to 90 deg (0 = Horizontal, 90 = Vertical)**

**Logged: June 13, 2008**

---

### Optical and Acoustic Image Features Legend

- In-filled Fracture/joint or vein
- Major fracture - distinct wide fracture/joint continuous around circumference of hole
- Bedding - apparent bedding; rock boundary; banding or foliation feature
- Fluid level in borehole
- Unclassified - planar feature continuous around circumference - type of feature not determined: may be a: 1) fracture; 2) bedding feature; etc.
- Distinct probable fracture/joint continuous over a portion of the circumference of hole - usually terminated at another fracture intersection
- Minor fracture - thin or discontinuous fracture/joint around circumference of hole
- Bottom of Casing

---

### VFx Lithology Legend

- Breccia or Conglomerate
- Large Vugs/Vesicles (> 6”)
- Medium Vugs/Vesicles (2-6”)
- Small Vugs/Vesicles (< 2”)
- >2 Near Vertical Fxs

---

### Depth (ft)

<table>
<thead>
<tr>
<th>Creation</th>
<th>Picks</th>
<th>DIPA</th>
<th>Image-NM</th>
<th>Centralized TT</th>
<th>Amplitude</th>
<th>3D-OBI</th>
<th>3D-ABI</th>
<th>Features</th>
<th>Tilt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth</td>
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</table>

### VFx

- Caliper
- Min Acoustic Caliper
- Max Acoustic Caliper
- Ave Acoustic Caliper
- Breakouts

---

### MW-13 ABI-OBI

---

**Image Features Rotated 11.5 deg E for Magnetic Declination to True North**

**Feature Dip is from 0 to 90 deg (0 = Horizontal, 90 = Vertical)**

**Logged: June 13, 2008**
**MW-13 ABI-OBI**

**Breakouts**
- Ave Acoustic Caliper: 2 in
- Max Acoustic Caliper: 6 in
- Min Acoustic Caliper: 2 in

**Caliper**
- Centralized TT: 2 in

**Amplitude-High Pass**
- Oriented Mag North

**CD**
- 0 [ft] 4

**Gravity**
- 0.8 g 1.2

**Maga.Field**
- 0 μT 90

**Azimuth**
- 0 deg 360

**Features**
- DIPT
- Tilt

**MW-13-ABI-OBI Image Summary Bull's Eye Deviation Plot**

Measured Depth = 4.0 to 501.4 ft.
Closure Distance = 2.58 ft.
Closure Angle = 46.26 deg
True Vertical Depth = 501.40 ft.
Radius of Curvature Deviation Algorithm
Corrected for 11 deg E Magnetic Declination to True North

Version 8.1-08, RECC
**Optical and Acoustic Image Summary Legend**

- **Picks** = planar features picked on optical or acoustic borehole image shown as colored sinusoid (color designation shown on header)
  - DIPA = dip apparent hole axis

- **VFxs** = Near Vertical Fractures, highly fractured zones and Fanglomerate or Breccia zones

**Mnemonics and Comments**

- Measured Depth = 4.0 to 501.4 ft.
- Closure Distance = 2.58 ft.
- Closure Angle = 46.26 deg
- True Vertical Depth = 501.40 ft.
- Radius of Curvature Deviation Algorithm Corrected for 11 deg E Magnetic Declination to True North
ARI = Acoustic Reflectance Index or relative rock hardness from ABI Amplitude log. Plotted 0 (soft) to 1500 (harder) as green line.

OBI Image-NM = 2D plot of optical image oriented to magnetic north. Plotted from left to Right N-E-S-W-N

Centralized TT = 2D plot of acoustic image travel time with probe position centralized. Plotted from left to Right N-E-S-W-N

3-Arm = 3-arm mechanical caliper of hole diameter plotted from 2-6 inches (blue line)

Min-Acoustic Caliper = minimum acoustic caliper of hole diameter calculated from Travel Time data and plotted as orange line from 2 to 6 inches.

Max-Acoustic Caliper = maximum acoustic caliper of hole diameter calculated from Travel Time data and plotted as purple line from 2 to 6 inches.

Avg-Acoustic Caliper = average acoustic caliper of hole diameter calculated from Travel Time data and plotted as bright green line from 2 to 6 inches.

Breakouts = pink shaded zone between Avg-Acoustic Caliper and Max-Acoustic Caliper calculated from Travel Time data showing borehole enlargement.

Amplitude = 2D plot of unfiltered acoustic image amplitude oriented to magnetic north. Plotted from left to Right N-E-S-W-N

Amp-High Pass = 2D plot of acoustic image amplitude with High Pass Normalization Filtering (can be toggled on/off) Plotted from left to Right N-E-S-W-N

3D-OBI = 3D cylindrical projection of OBI image looking from the North.

3D-ABI = 3D cylindrical projection of OBI image looking from the North.

Tadpole = tadpole plot of the image feature picks (fractures and bedding planes); plotted from 0 to 90 dip - see legend above. DIPT = True orientation; features corrected for hole deviation

Magn. Field = Total magnetic field strength as measured by fluxgate magnetometer in OBI or ABI deviation sensor - plotted 0-90 uT. (green line)

Gravity = Total gravity (probe acceleration) as measured by 3-axis accelerometers in ABI deviation sensor - plotted 0.8-1.2 g. (brown line)

Azimuth = direction of tool tilt plotted 0 to 360 deg; represents borehole deviation direction (red line)

Tilt = tool tilt (vertical = 0 and horizontal = 90) plotted 0 to 8 deg; represents borehole deviation tilt from vertical. (blue line)

CA = Closure angle. = horizontal angle from hole to vertical projected collar location; plotted from 0 to 360 deg (dashed green line)

CD = Closure Distance. = distance in feet in a horizontal plane from the borehole to vertical projected collar location; plotted from 0 to 4 ft. (dotted black line)

Prepared by Robert E. Crowder
Rev 8-1-2008