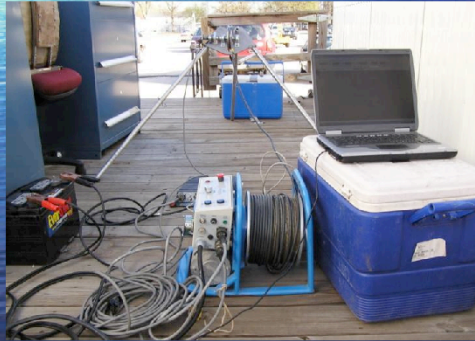


Borehole Geophysics Applied to Bedrock Hydrogeologic Evaluations



Don Bussey, CPG-08847
USEPA/ERT – Las Vegas, Nevada
bussey.don@epa.gov



Borehole Geophysical Tools:

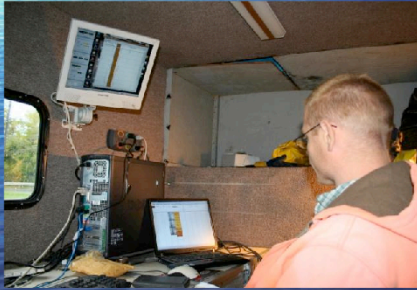
Hydrogeologic Bedrock Groundwater Assessments

- Natural Gamma
- Temperature
- Caliper
- Conductivity/Resistivity
- Borehole Video
- Heat-Pulse Flowmeter
- Optical and Acoustical Televiwer
- Borehole Deviation

Oil and Gas Well Abandonments

- Casing Collar Locator (Magnetic)
- Cement Bond (Acoustic)





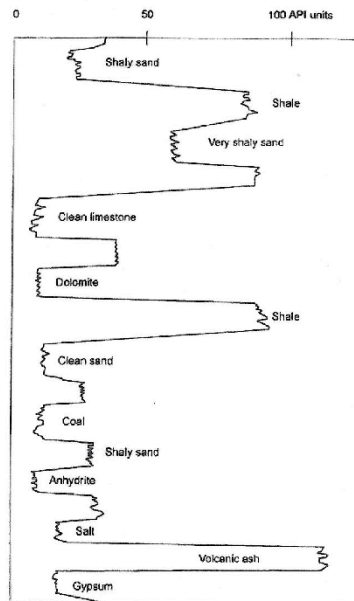
Natural Gamma Logging



Gamma logging is useful in evaluating stratigraphic sequences and for borehole to borehole correlation. Can be used in open or cased boreholes.

GR Log

General GR Response

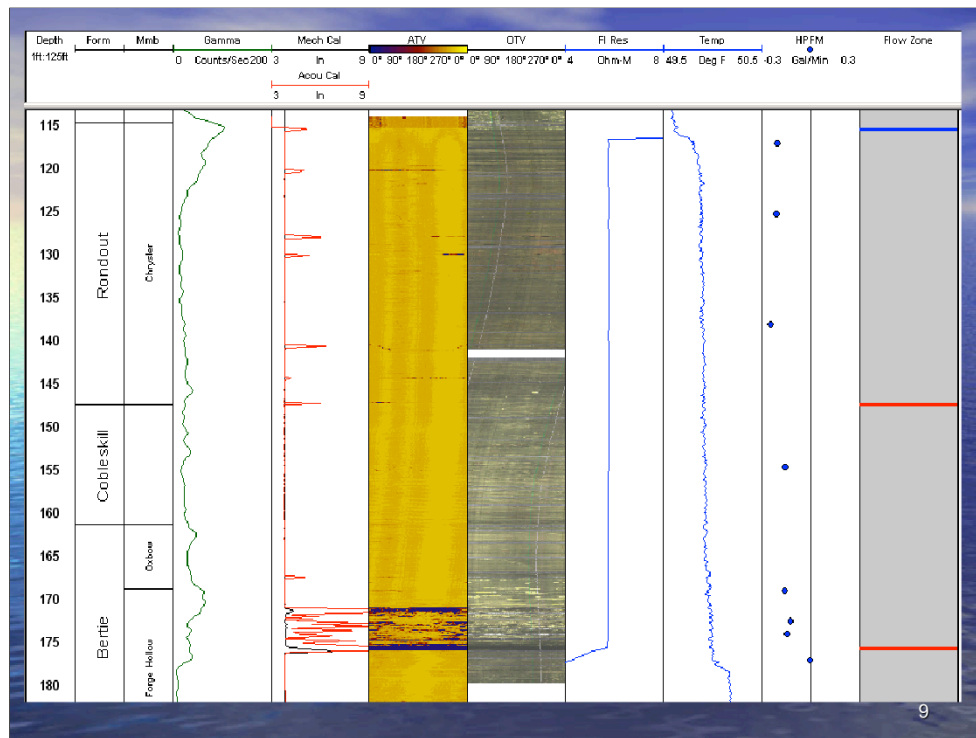




Temperature Logging

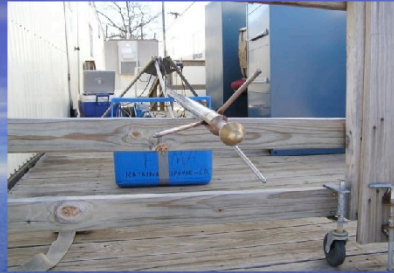


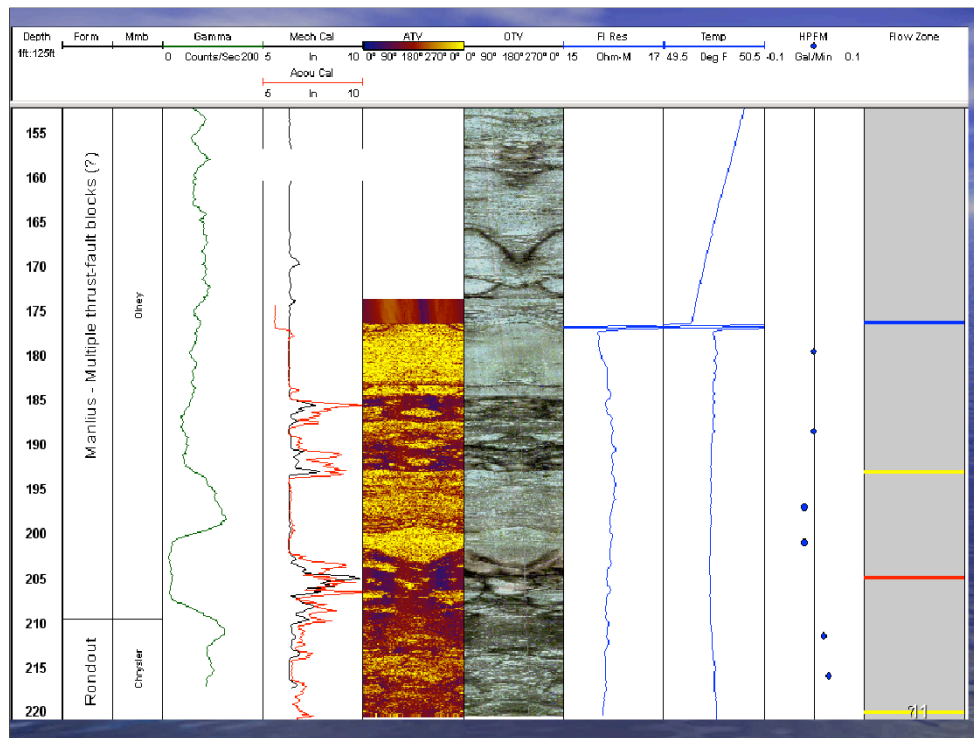
Temperature logging can aid in detection of groundwater flow in or out of a borehole.



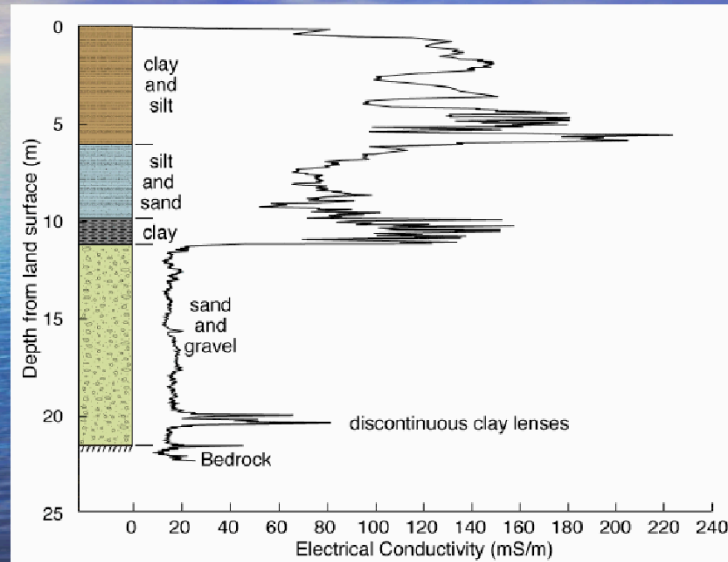
Caliper Logging

Caliper logging measures borehole diameter, useful in detecting fractures or voids in **open-hole bedrock** boreholes.





Electrical Conductivity Logging



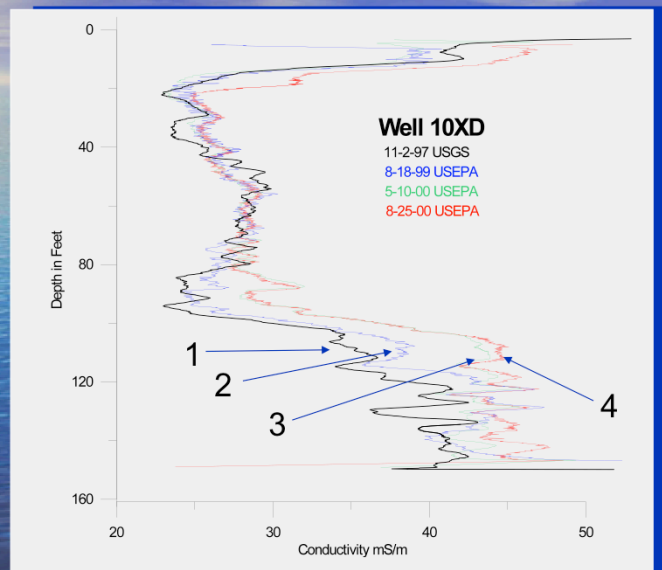
12

Once again we are mentioning water, and water is a big “drain” on GPR signals.

Dielectric permittivity is the ability to store & transmit energy where conductivity is the ability to conduct current. As conductivity increases, the penetration depth also decreases. This is because the electromagnetic energy is more quickly dissipated into heat, causing a loss in signal strength at depth.

Conductivity of materials (the ability to transmit energy – differs from RDP in that it is incapable of storing energy)

Conductivity Case Study



Borehole Video Logging

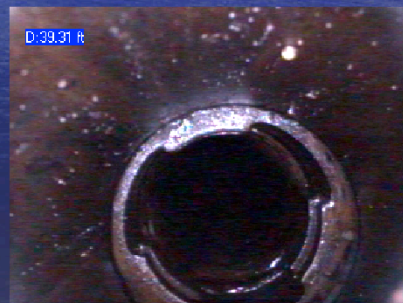
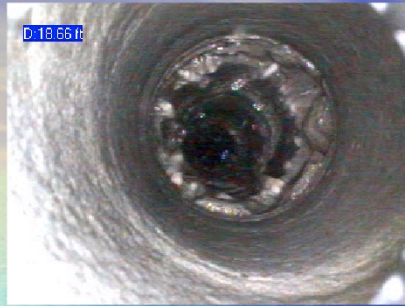
Borehole video logging provides a visual picture of borehole conditions.

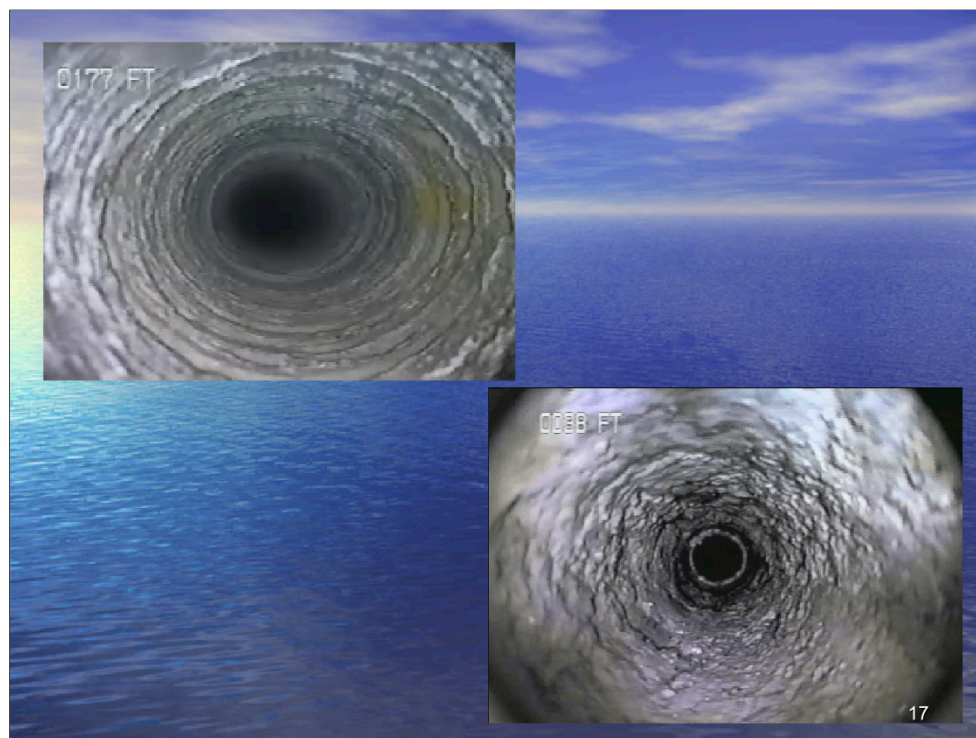
Useful in identifying fractures, voids, cascading water, well/boring blockage and other downhole trouble shooting.

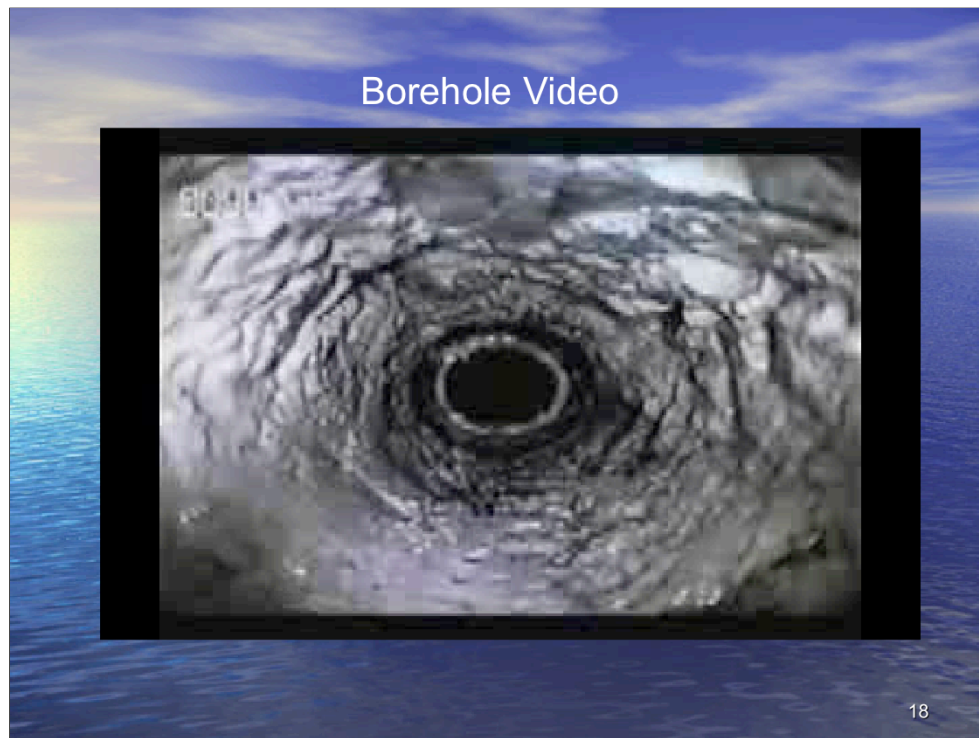




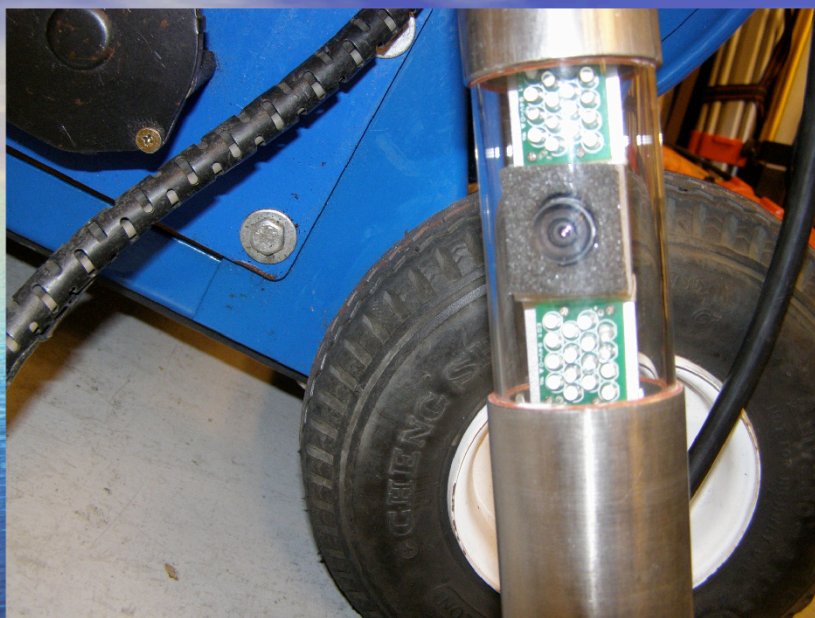
15







This is a video of a borehole video camera going down a open rock well. There are several instances of water coming into the well from the side, most of them are just dribbles of water. At the end of the video water is shooting out of the right side of the hole wall. Notice the difference between this and the optical televiewer.



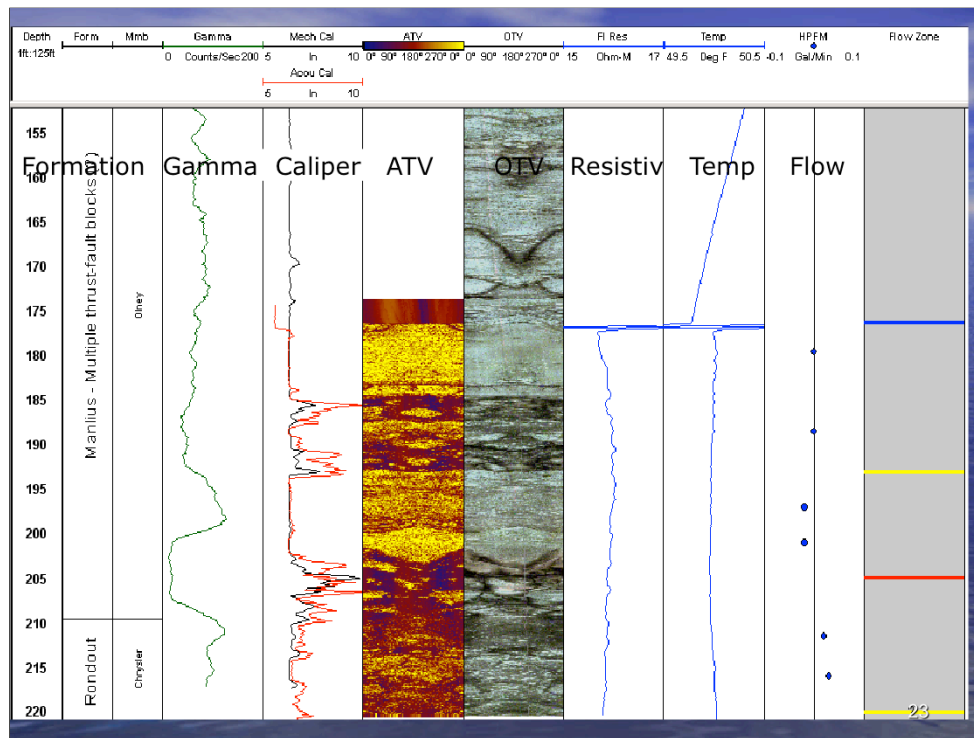


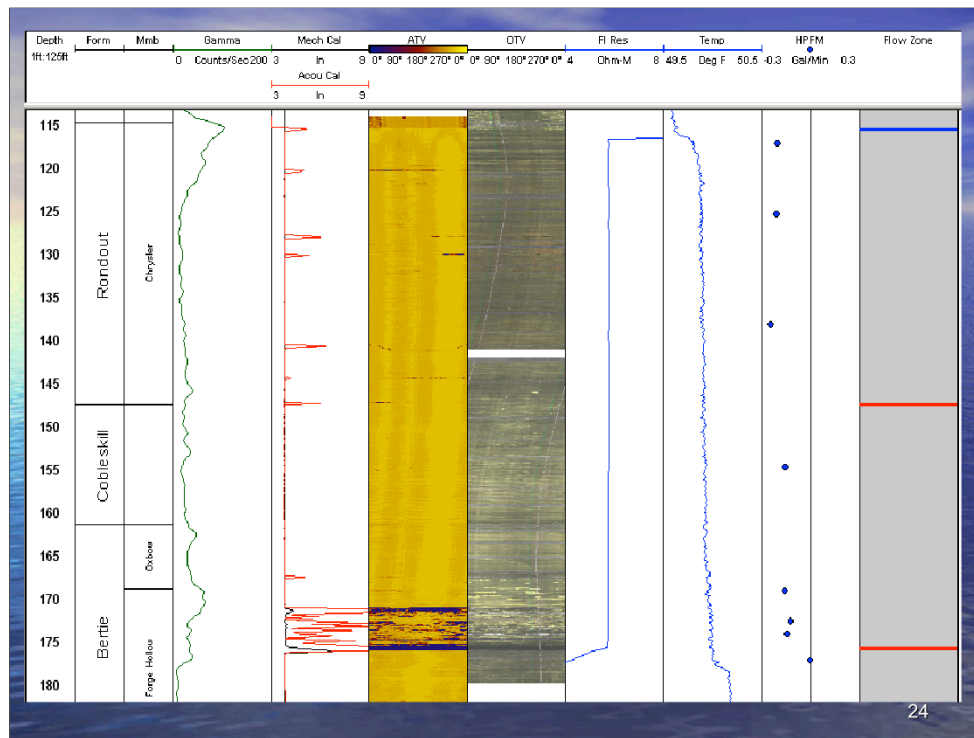
Optical and Acoustical Televviewer Logging

- Televviewer logging presents a 360-degree acoustical or optical digital borehole representation.
- Useful in evaluating fractures, bedding, and voids.
- Strike and dip of fractures can also be calculated.



22

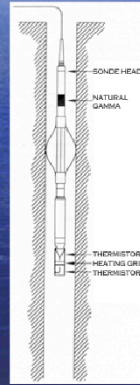


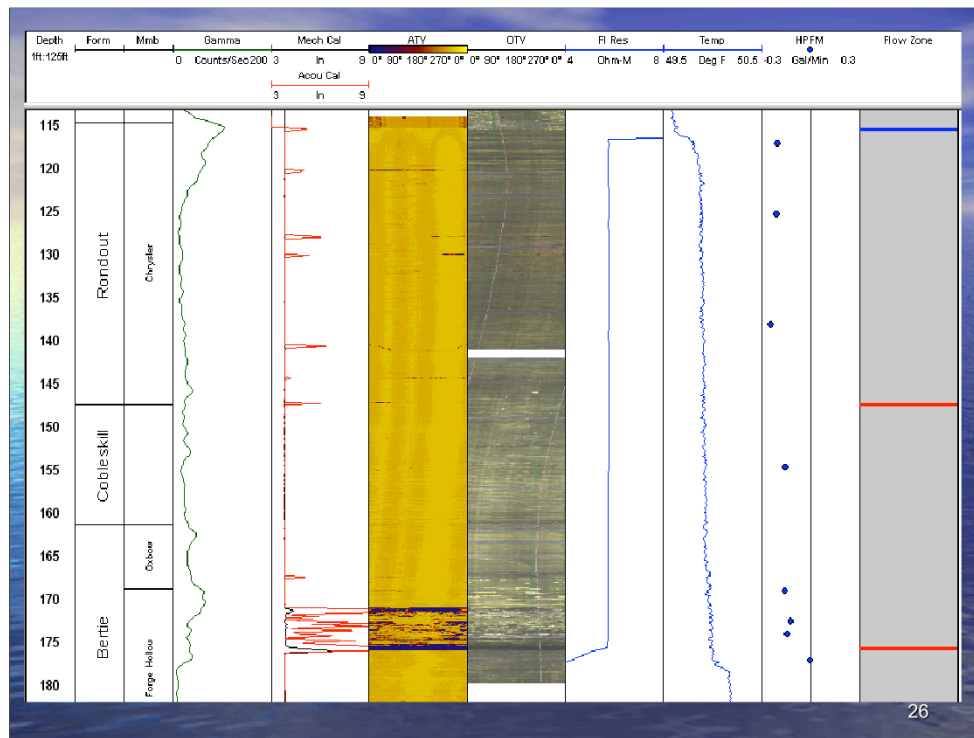


Heat-Pulse Flowmeter Logging

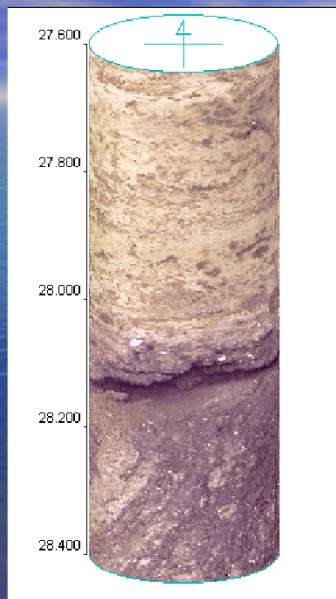
Heat-pulse Flowmeter logging is used to measure vertical flow within a well at discrete vertical intervals (> 0.1 gpm).

Useful in determining depths where water may be entering or leaving a borehole.





Virtual Core Using Optical Televiewer Data

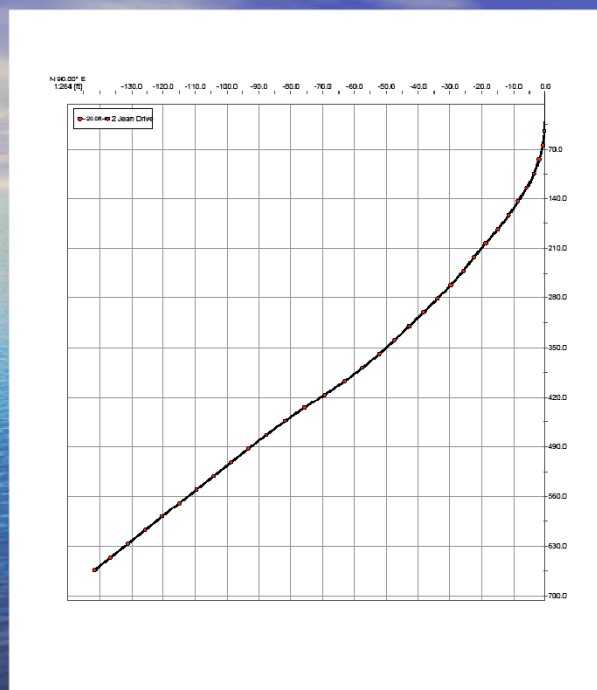


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This is a video from an Optical televiewer in an open rock borehole. While it looks like a core it is actually a video of the walls of the hole. What you are seeing is actually the inside of the hole as the televiewer rotates.

Borehole Deviation Logging

- Useful to determine borehole deviation
- Useful to evaluate whether packer assemblies can be utilized downhole



Well Depth >700 feet
 Well Base Elev. Difference
 650 feet
 Deviation 143 feet
 0.215 ft/ft



Hager GeoScience Inc.

Geophysical Logging Record:
3D Deviation Plot

Site: Dewey Landfill

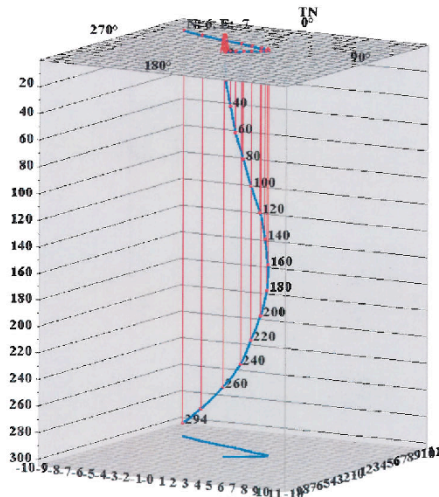
Boring #: MW-

Location: Nassau, NY

Date Logged: 8- -11

Client: Lockheed-Martin

Logged By: MC, JB, KS





Hager GeoScience Inc.

Geophysical Logging Record:

Bull's Eye Deviation Plot

Site: Dewey Landfill

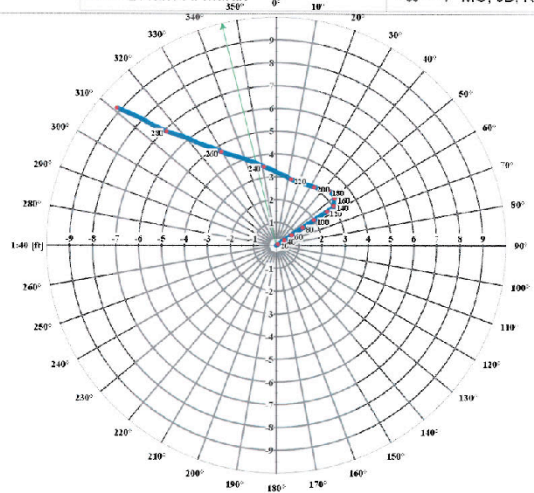
Boring #: MW-3

Location: Nassau, NY

Date Logged: 8-16-11

Client: Lockheed-Martin

Logged By: MC, JB, KS



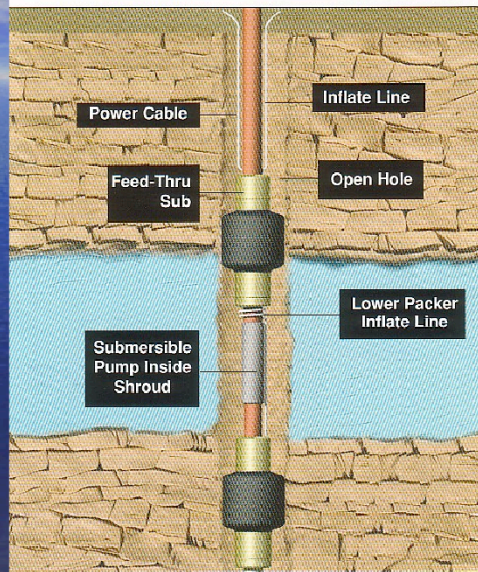
Borehole Geophysical Data - Uses

- Packer Test Design
- Discrete-zone Multi-level Assembly Design (Westbay, Flute, Solinist , etc.)
- Groundwater Sampling Strategy (Discussed in Case Studies)

Groundwater Straddle Packer Testing



Obtain sample from
between Packers



34



Discrete-zone Multi-level Assembly Design

35



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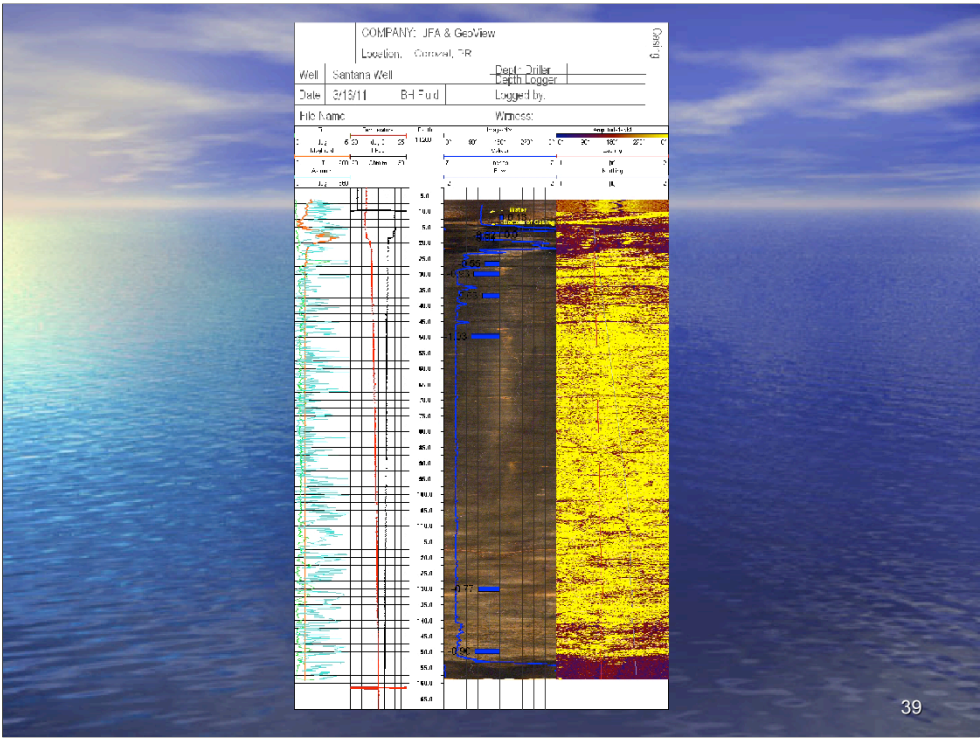
37

Case Study

Santana Community Production Well

Corozal, Puerto Rico





Case Study

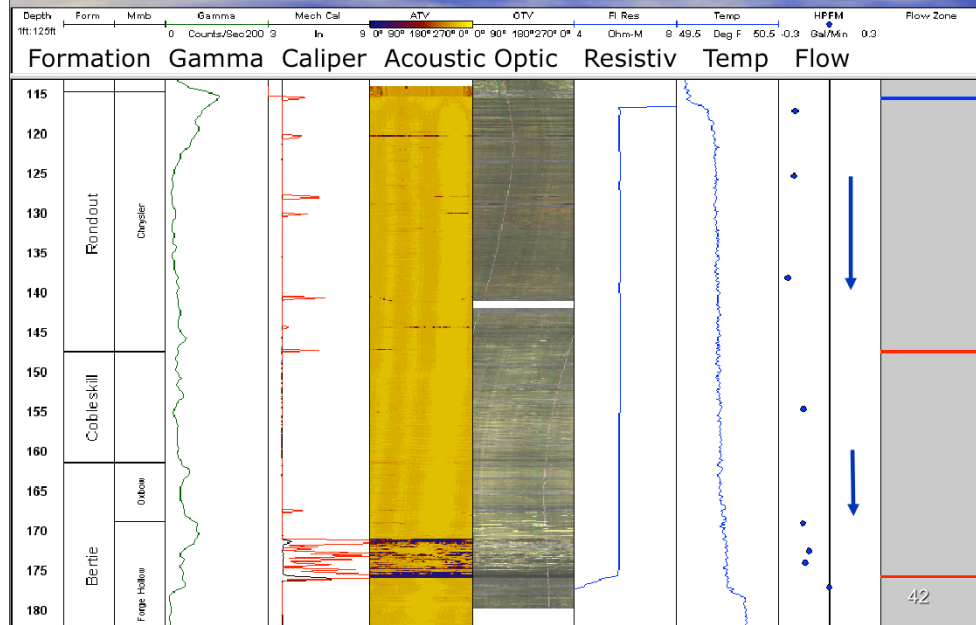
Cayuga County Groundwater Contamination Site

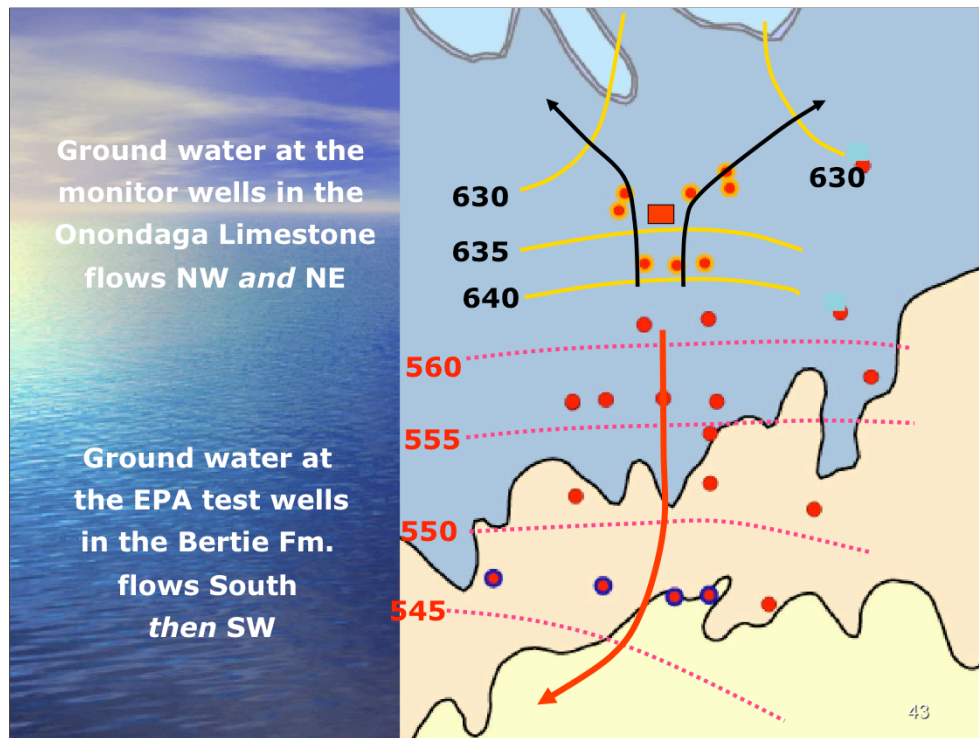
Cayuga County, New York



40

Geophysical, Stratigraphic, and Flow-Zone Logs EPA-1





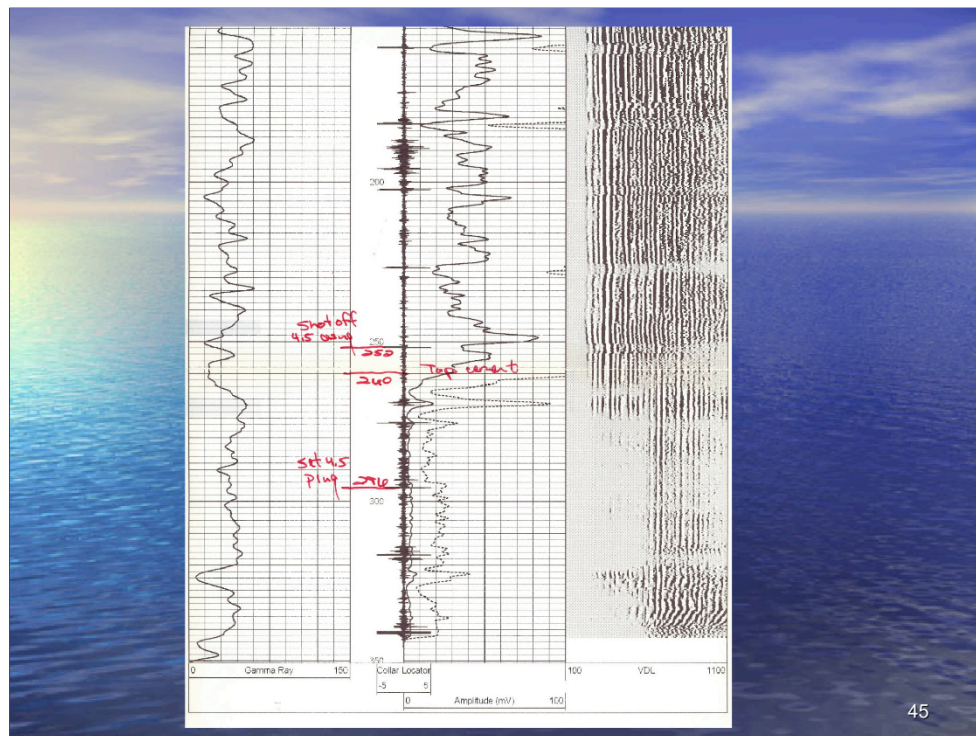
Oil & Gas Well Abandonment Applications Casing Collar Locator and Cement Bond Logging

Used in the oil and gas industry during borehole abandonment.

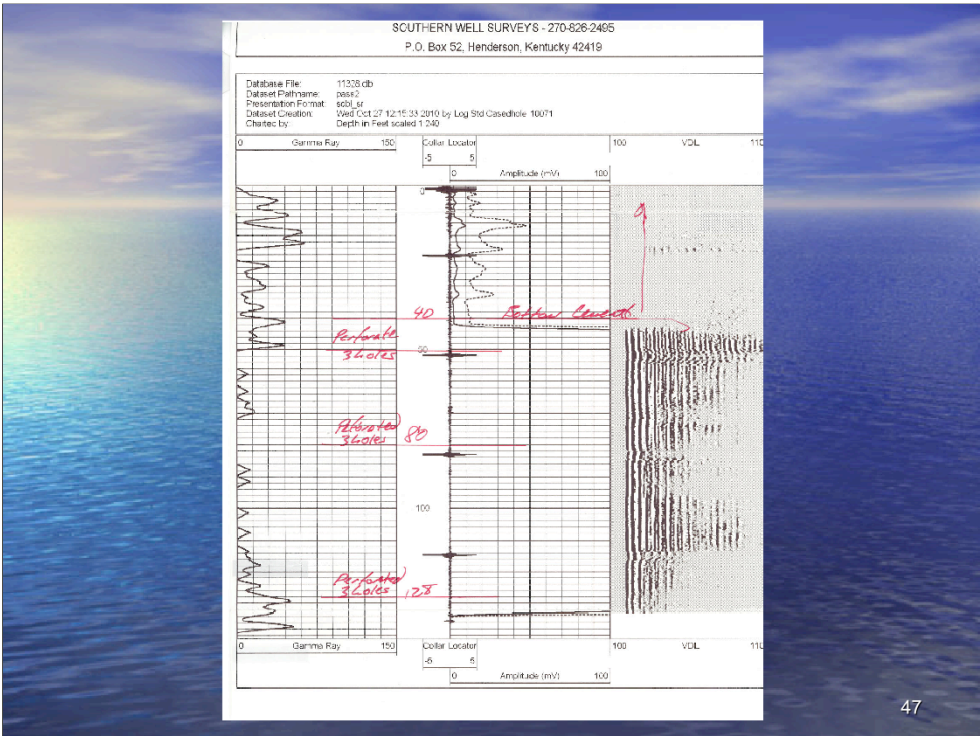
Casing Collar logs (magnetic) used to identify casing collars for targeting during casing shoot offs.

Cement Bond logs (acoustic) identify presence of cement behind logged casing – useful during casing perforating.

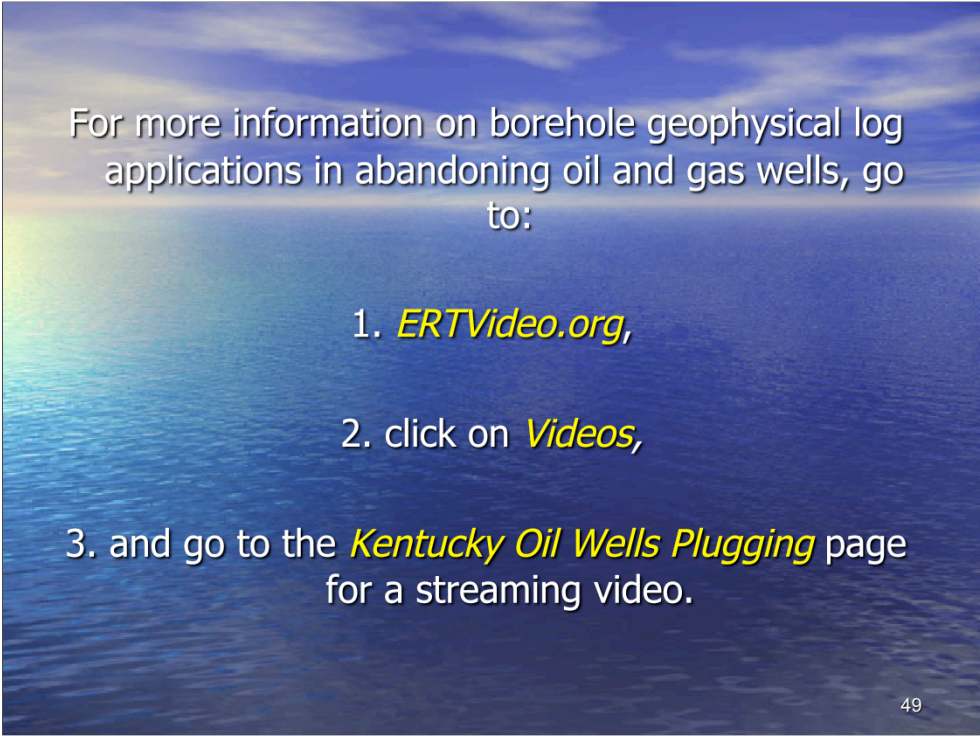
Cement Bond logs also utilized in Underground Injection well evaluation.











For more information on borehole geophysical log applications in abandoning oil and gas wells, go to:

1. ERTVideo.org,
2. click on [Videos](#),
3. and go to the [Kentucky Oil Wells Plugging](#) page for a streaming video.

Conclusion

Know Your Borehole !

Borehole Geophysics can help Understanding
Geology, Hydrogeology, and Chemistry in Bedrock
Geologic Settings



Don Bussey, CPG-08847

USEPA-ERT/Las Vegas

bussey.don@epa.gov