



GEOPHYSICAL CHARACTERIZATION AND BOREHOLE GEOPHYSICAL TOOLS TO AID MONITOR WELL PLACEMENT AND COMPLETION

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- **Borehole geophysics** is the collection of geologic and hydrologic information in wells by lowering and raising probes on a wire
- Much more can be learned by the analysis of a suite of geophysical logs as a group than by the analysis of the same logs individually

GEOHYDROLOGIC CHARACTERIZATION

- **Fractures and water-bearing zones (location and orientation)**
- **Structural features**
- **Lithology and lithologic contacts**
- **Aquifer hydraulic characteristics**
- **Groundwater flow system**
- **Hydraulic head differences**
- **Well construction**

BOREHOLE GEOPHYSICS

- **For new monitor wells**
 - **Proper location to set well screen**
 - **Aquifer characteristics**
 - **Hydraulic connections between monitor wells**

BOREHOLE GEOPHYSICS

- **For existing (domestic) wells**
 - **Well construction characteristics (depth, casing length, water-bearing zones)**
 - **Aquifer hydraulic characteristics**
 - **Water quality**

BOREHOLE GEOPHYSICS STANDARD LOG SUITE

- Caliper
- Natural gamma
- Single-point electric
- Fluid resistivity
- Fluid temperature
- Flowmeter
- Television
- Acoustic televiewer

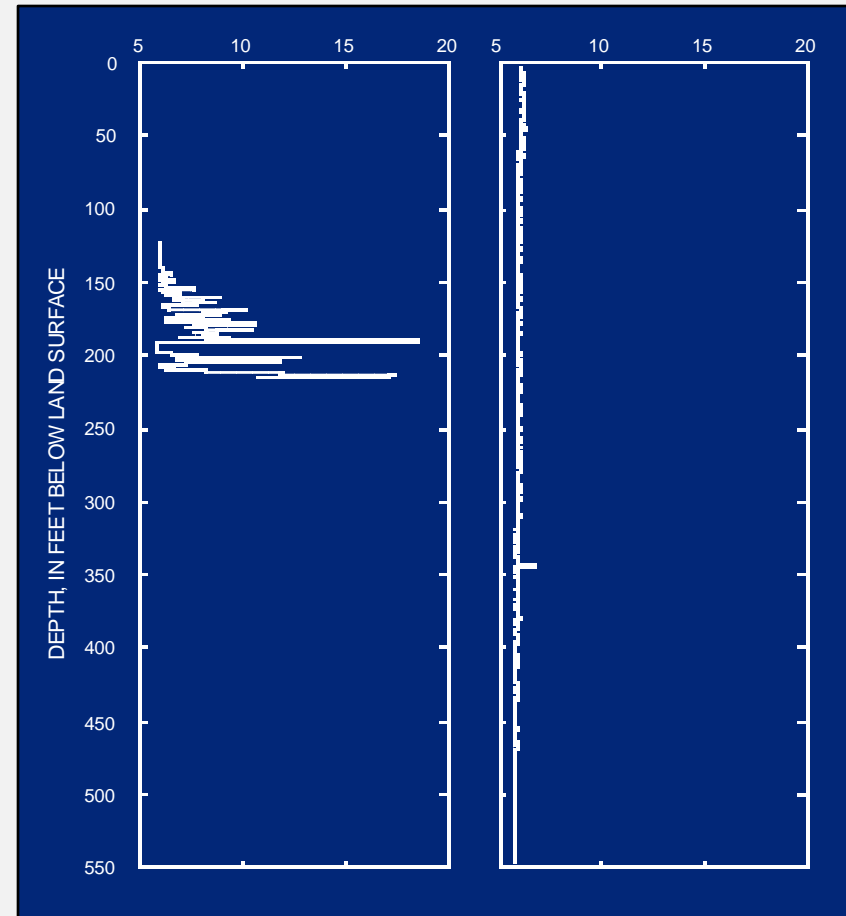


USGS Pennsylvania Water
Science Center Logger

CALIPER LOG

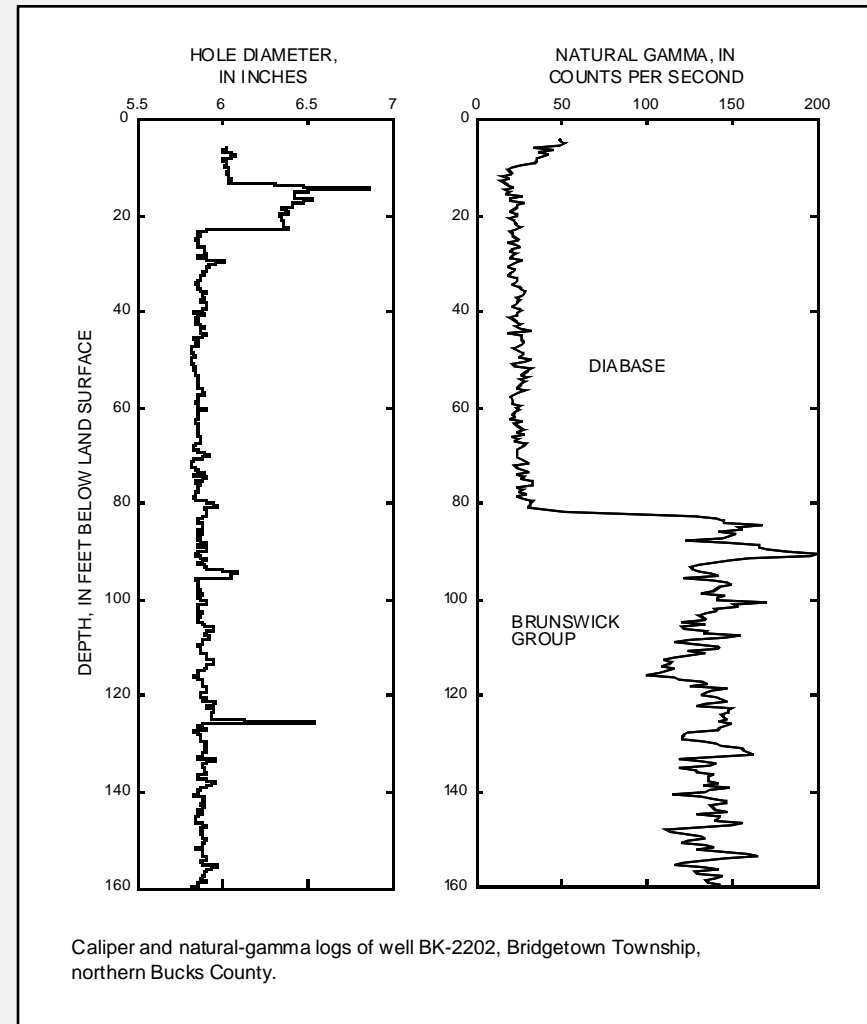
Provides a continuous record of average borehole diameter

Used to identify fractures, water-bearing openings, and changes in lithology



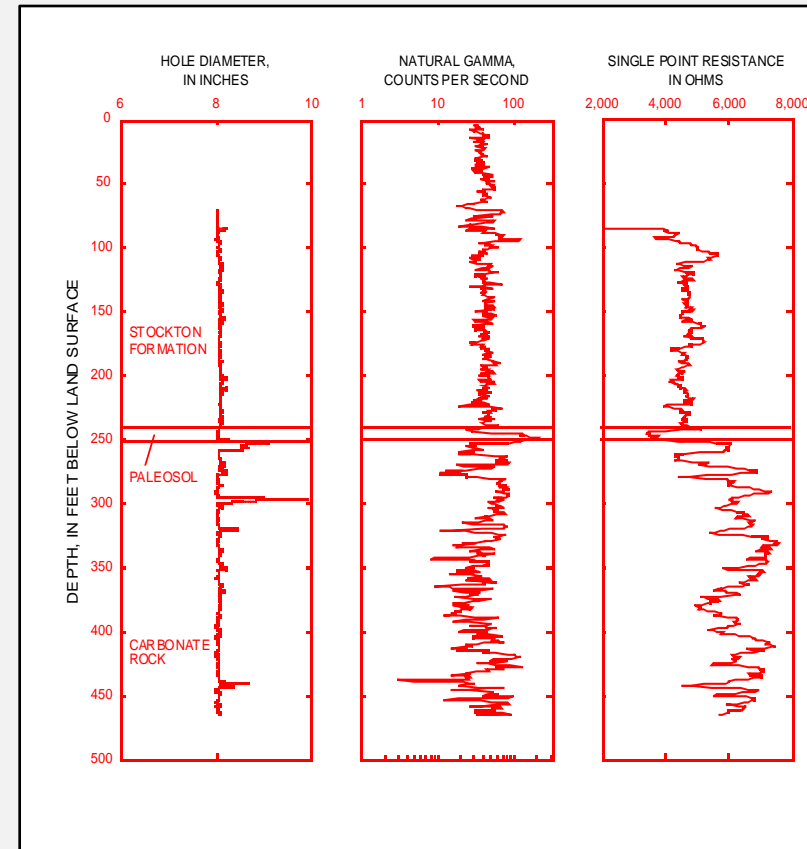
GAMMA LOG

Records the natural-gamma radiation emitted from rocks penetrated by the borehole. The gamma log often is used to define lithology and correlate geologic units between boreholes.



SINGLE-POINT RESISTANCE ELECTRIC LOG

Electrical resistance increases with grain size and decreases with borehole diameter, density of water-bearing fractures, and increasing dissolved-solids concentration of borehole fluid



FLUID TEMPERATURE LOG

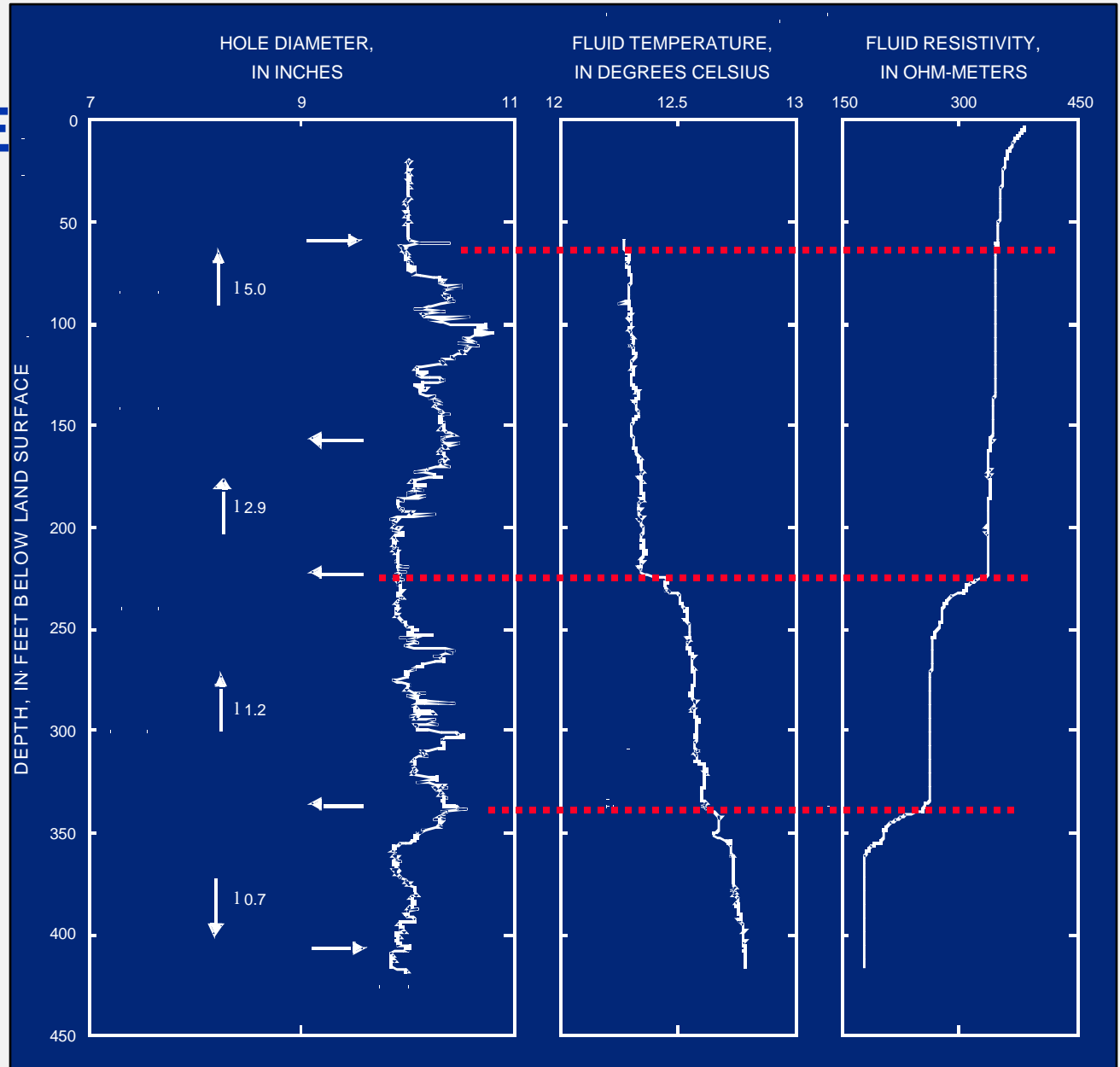
Provides a continuous record of the temperature of the fluid in the borehole.

FLUID RESISTIVITY LOG

Measures the electrical resistance (fluid conductivity) of fluid in the borehole. Logs reflect changes in the dissolved-solids concentration of the borehole fluid.

FLUID TEMPERATURE AND FLUID RESISTIVITY LOGS

Where would you set the screen?



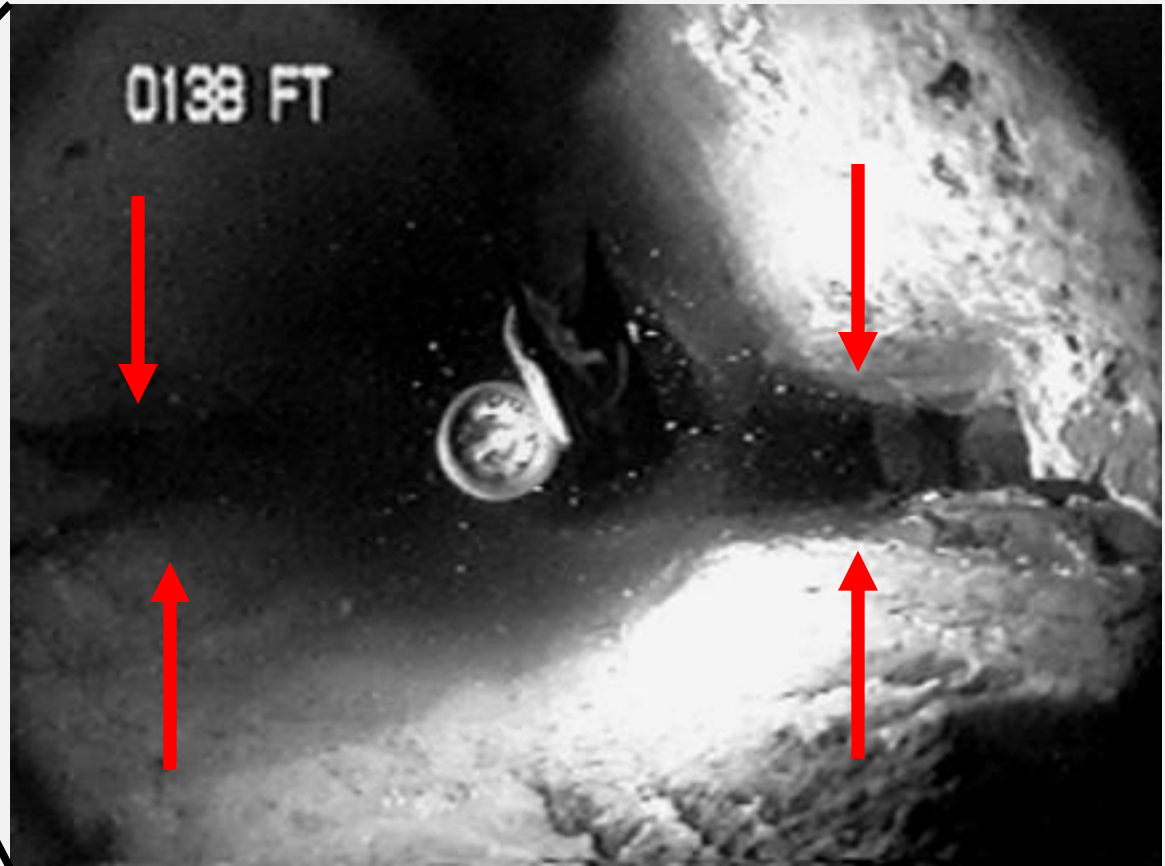
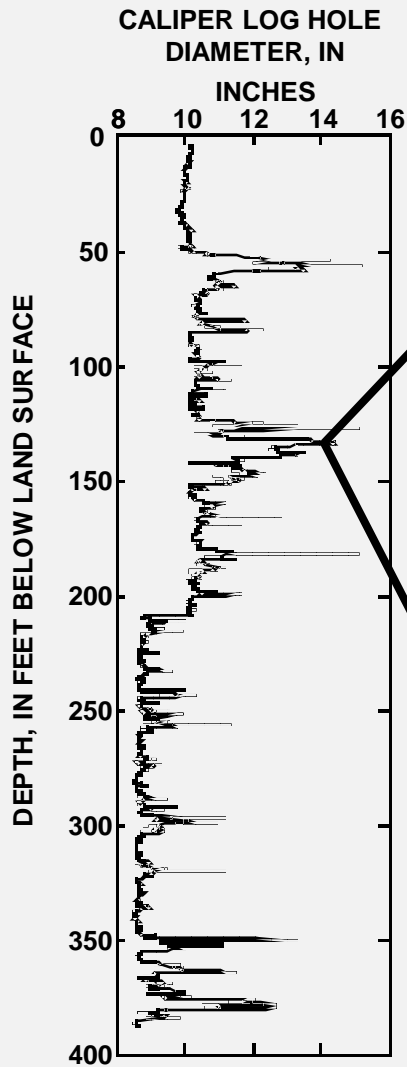
WELL BK-1845, WARMINSTER TOWNSHIP, BUCKS COUNTY

HEATPULSE FLOWMETER

- Measures rate and direction of borehole flow under static conditions
- Measures contribution of individual fractures under pumping conditions
- Differences in hydraulic head
- Delineates transmissive fractures
- Defines relative vertical hydraulic gradients



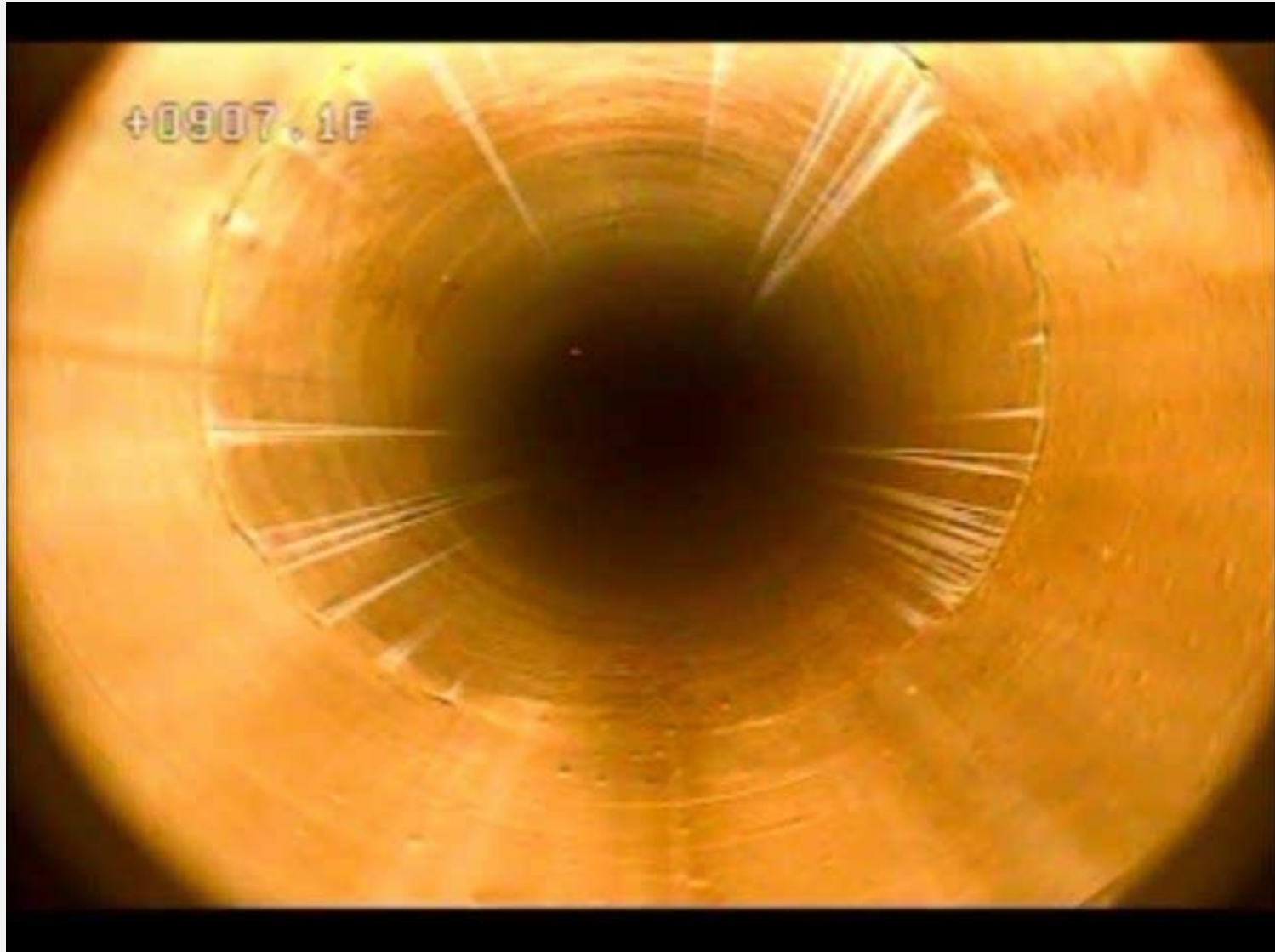
BOREHOLE TELEVISION



VERTICAL FRACTURE IN WELL AT 138 FEET BELOW TOP OF CASING

BOREHOLE TELEVISION

Corehole in Marcellus Shale Play

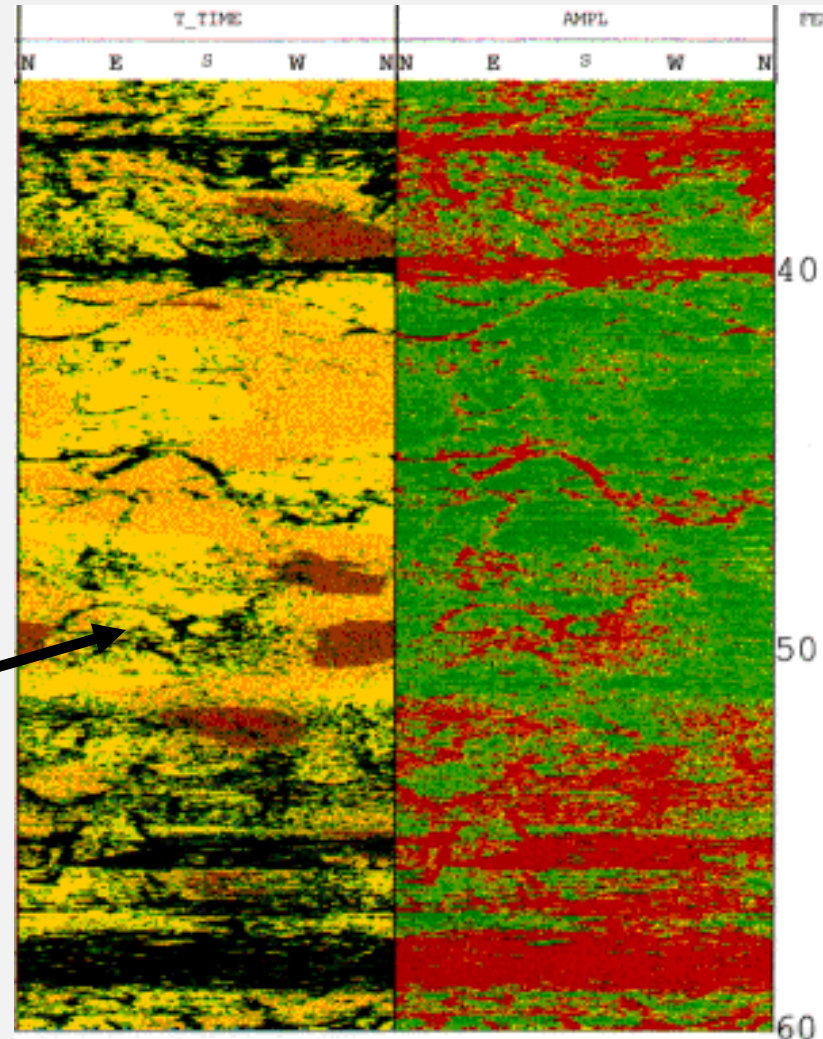
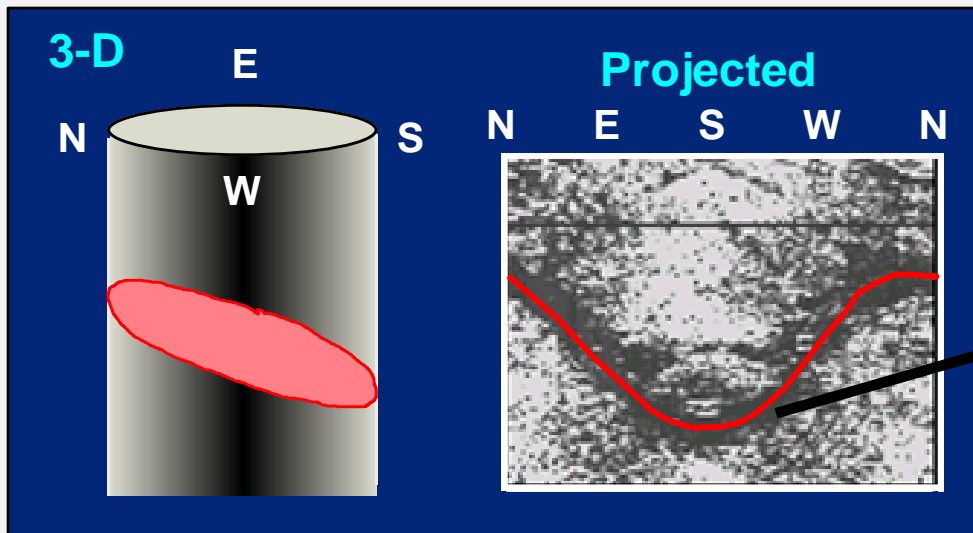


The **acoustic borehole televiewer** log is a magnetically oriented, 360°, photograph-like image of the acoustic reflectivity of the borehole wall. Digital images from the televiewer are recorded by the computer collecting logging data.



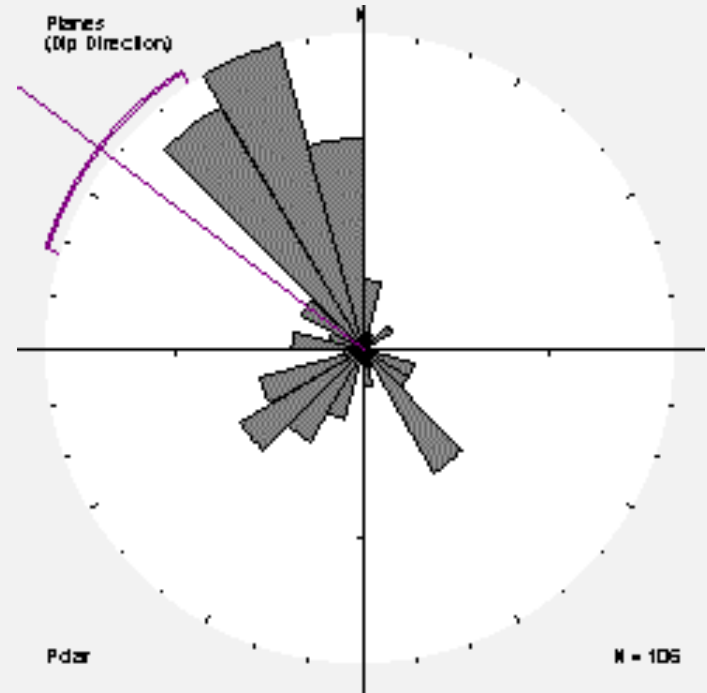
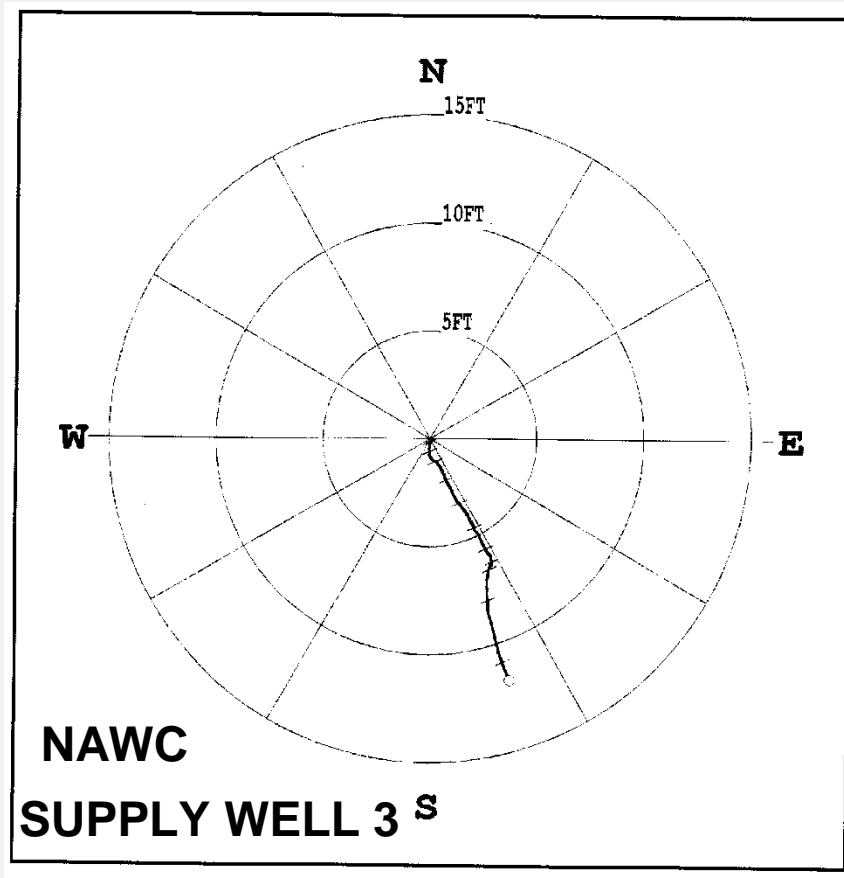
ACOUSTIC TELEVIEWER

Televviewer logs indicate the location and strike and dip of fractures and lithologic contacts



BOREHOLE DEVIATION

STRUCTURAL ORIENTATION



BOREHOLE FLUID SAMPLER

- **Wireline sampler**
- **Captures borehole fluid from a discrete depth**
- **Largest sampler collects up to 1 liter of fluid**



AQUIFER-ISOLATION (PACKER) TESTS

- Isolation of individual fractures or fracture zones
- Hydraulic properties with depth (K, specific capacity)
- Hydraulic connections
 - Around borehole
 - To other boreholes
- Discrete-depth water samples



ANALYSIS OF A SUITE OF BOREHOLE GEOPHYSICAL LOGS

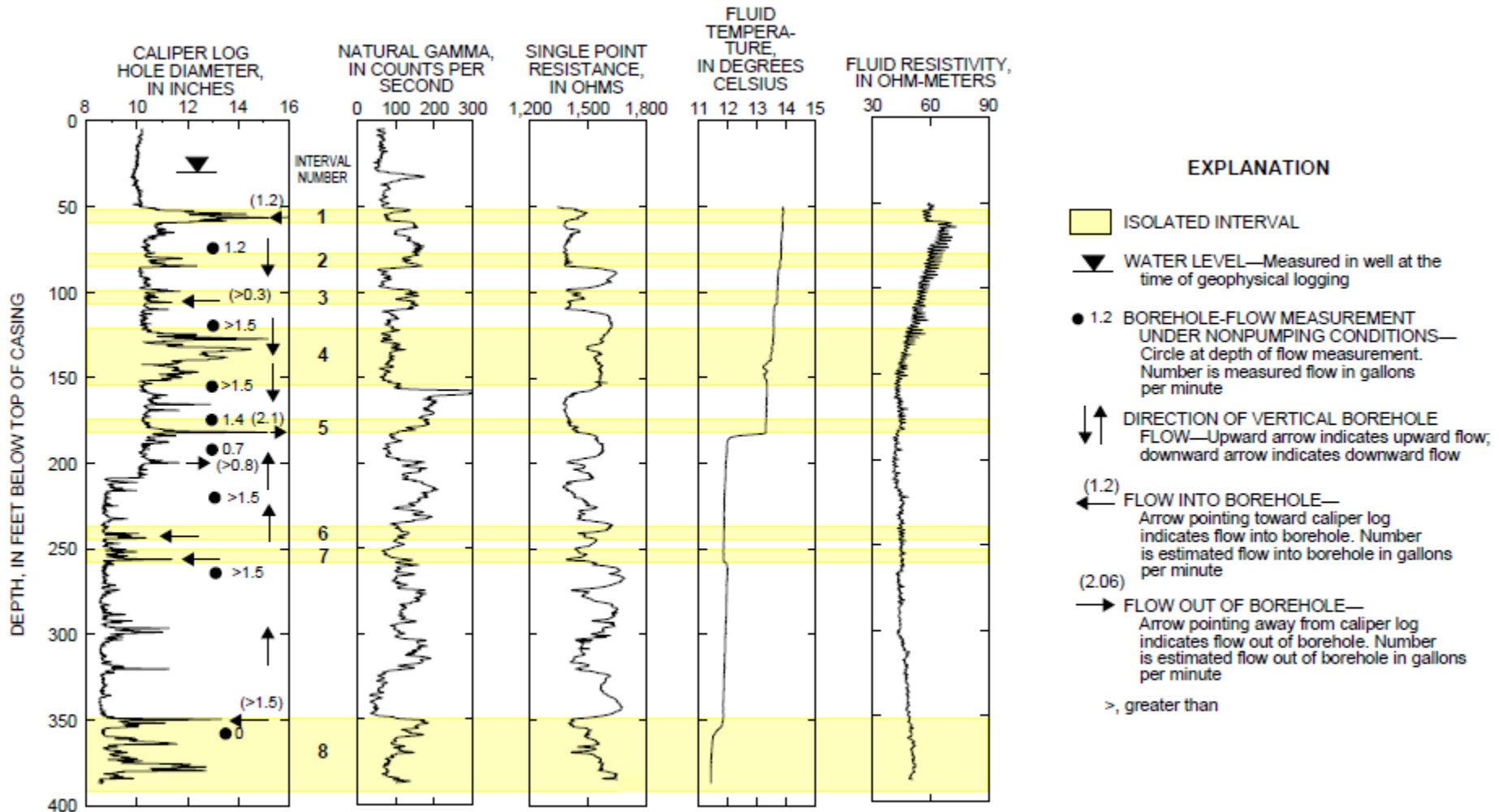


Figure 4. Borehole geophysical logs for supply well 1 (MG-209), Willow Grove Naval Air Station/Joint Reserve Base, Horsham Township, Montgomery County, Pennsylvania.