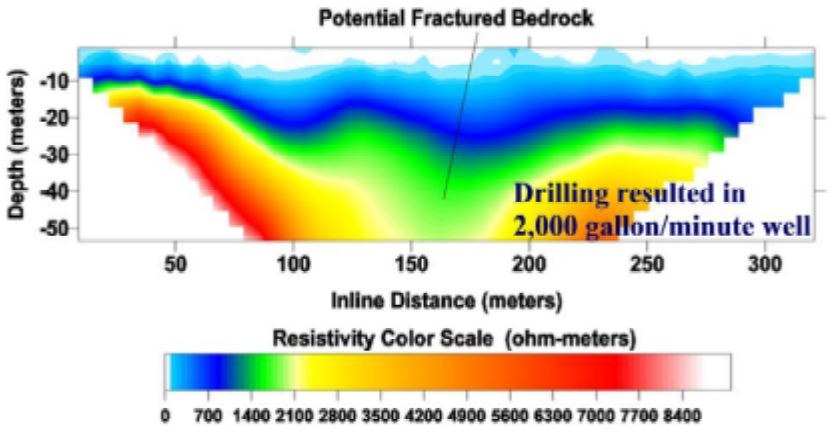
SAIC
An Employee-Owned Company

APPLICATIONS OF GEOPHYSICS TO GROUNDWATER



Science Applications International Corporation (SAIC) has used geophysics for groundwater projects for over 30 years. Geophysical methods generally fall into two groups: surface and borehole.

Surface Geophysical Methods

Surface geophysical methods can be used to identify the depth to water table, locate bedrock faults or fractures, map stratigraphy, and delineate conductive versus nonconductive zones that may be attributed to saturated conditions. SAIC uses a number of surface geophysical techniques including: seismic, electromagnetic (ground-penetrating radar [GPR], frequency, and time domain), direct current (DC) resistivity, magnetotelluric, and magnetic methods.

Depth to Water Table - This is probably the most crucial information required for unconsolidated aquifer development next to the determination of confining layers and general stratigraphy in placing a production well or well field. Seismic, electromagnetics, dc-resistivity, and GPR methods all provide unique information under differing physical site constraints.

Bedrock Faults, Fractures, and Stratigraphy - Stratigraphy is often interrupted or distorted by faulting and fracturing. By identifying these features in the subsurface, well placement can be optimized to increase yields and potentially lessen impacts associated with boundary conditions and resulting cones of depression. In some cases, delineation and enhancement of drilled fractures provide for larger, more productive well fields. Seismic, magnetic, magnetotelluric, electromagnetic, and resistivity methods provide the means to identify faults and fractures in almost every environment.

Conductive Versus Non-conductive Zones - Identifying and delineating conductive zones

Borehole Geophysical Methods

- ✓ Caliper
- ✓ Temperature
- ✓ Resistance
- ✓ Natural Gamma
- ✓ Resistivity
- ✓ Spontaneous Potential
- ✓ Heat-Pulse Flowmeter
- ✓ Video
- ✓ Sonic
- ✓ Optical Televiewer
- ✓ Acoustic Televiewer
- ✓ Water Quality
- ✓ Spectral Gamma
- ✓ Fluid Resistivity
- ✓ Borehole Deviation
- ✓ Magnetic Susceptibility

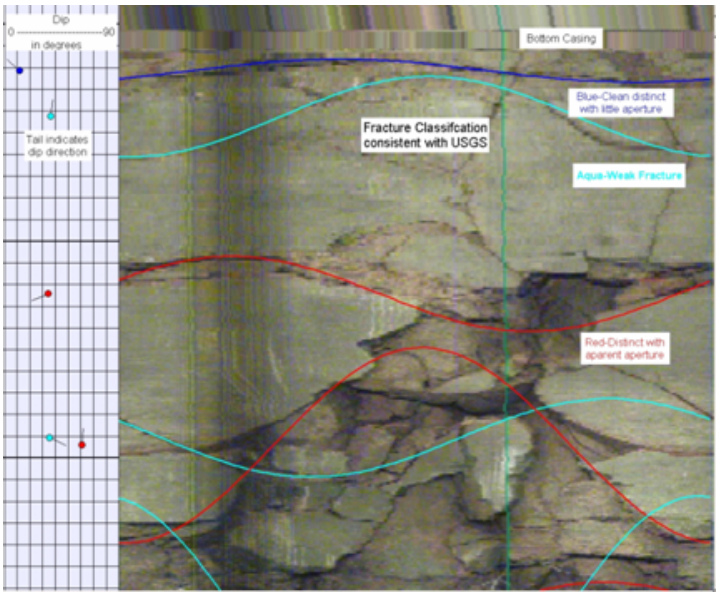
Surface Geophysical Methods

- ✓ Seismic Reflection
- ✓ Electrical Imaging
- ✓ Electromagnetic
- ✓ Time Domain EM
- ✓ Ground-Penetrating Radar
- ✓ Magnetotelluric
- ✓ Seismic Refraction

Geophysical Services
Tel: (800) 944-6778

Science Applications International Corporation

in the subsurface provide an initial reconnaissance for potable water sources. Non-potable, i.e., contaminated, zones are identifiable if a measurable conductivity variation exists between potable and non-potable. Electromagnetic surveying methods—including ground-penetrating radar—provide a cost-effective alternative to intrusive drilling methods for delineation of contaminants and in locating potable sources. Resistivity methods (electrical imaging) provide an additional means in delineating clay/mineral rich zones, saturated versus non-saturated areas below the water table, and depth to bedrock.



Borehole Geophysical Methods

Borehole geophysical methods take physical measurements of the properties within and near the well or borehole. These document important well properties, creating a permanent, unbiased record of well conditions. A variety of well conditions can be measured, depending on the sensor used. Video logs and optical or acoustic televiewer logs can establish a visual record of a well and can be used to measure the strike, dip, and aperature of fractures within a borehole.

Sonic logs can be used to measure the cement bonds (casing and bedrock) ensuring the casing integrity. Multiple offset resistivity measurements can be used to estimate the porosity of a formation.

The amount of clay or sand in the aquifer can be estimated using the **natural gamma** measurements within a well. Boundaries between lithologic units can be identified using **spontaneous potential (SP)** logs. In addition, SP can be used as an indicator of water movement within a well.

Temperature and **flow meter** logs can be used to identify water-bearing zones and in-well flow information important to understanding aquifer properties.

In preparation for abandonment, SAIC can use a **caliper log** to identify fracture zones that may cause problems during abandonment and calculate well volumes accurately to ensure well planned abandonment activities.

In well measurements of **water quality**—including dissolved oxygen, pH, and redox potential—salinity can be made along the entire well, enabling effective well use decision making.

Borehole deviation can be measured with triaxial accelerometers and magneto-meters, ensuring knowledge of the location of the well and producing aquifer features.

SAIC has found borehole logging to be a valuable tool in characterizing subsurface conditions. Information obtained from borehole logging has saved significant amounts of cost to the client by delivering a more comprehensive evaluation of the subsurface.

Center of Geophysical Excellence

SAIC®
An Employee-Owned Company

6310 Allentown Boulevard
Harrisburg, PA 17112
(717) 901-8100 Office
(717) 901-8101Fax

Additional locations in all major U.S. cities.

Service offered through:

www.quality-geophysics.com