Explanation for Borehole-Geophysical Logs

Borehole-geophysical logs are acquired when tools capable of measuring various physical properties of subsurface materials are lowered into a well. By comparing combinations of different logs, geologist can interpret the types of materials penetrated by the well. The interpreted lithology is based on the borehole-geophysical logs and may differ from the drillers log and/or cuttings log.

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Natural Gamma and E-Logs

The natural gamma log measures the amount of naturally occurring gamma radiation inside the well. It is measured in units defined by the American Petroleum Institute (API). Higher numbers indicate increased clay content.

The caliper tool measures the diameter of the well in inches, which can be used to determine borehole conditions, identify fracture zones, and locate washouts (where the borehole has eroded away to a larger diameter).

The single-point resistance (SPR), 16-inch normal (16N), 64-inch normal (64N), and 48-inch lateral (Lateral) logs record how easily electrical current will flow through the materials surrounding the well. Rocks and sediments are generally poor conductors

of electricity, so most of the current will flow through water in the pore spaces. The response will depend on the amount of water present (which is related to the porosity) and the quality of the water (more dissolved solids in the water results in lower resistivity). The SPR log measures the resistance (in ohms) at a single point in the well. The 16N, 64N, and Lateral logs measure resistivity (in ohm-meters) with electrodes spaced 16, 64, and 48 inches apart, respectively. Wider electrode spacing allows deeper current penetration into the surrounding material, but reduces vertical resolution.

The fluid resistivity log [Res(fl)] records the resistivity (in ohm-meters) of the fluid in the well. The fluid resistivity can be used to estimate water quality.

The temperature log (Temp) records the temperature of the fluid in the well (in degrees Fahrenheit) and is useful for identifying layers where water is flowing into or out of the well.

Sonic Log

The sonic tool measures the time it takes a sound wave to travel one foot through the material surrounding the well. The travel time is measured by two receivers on the tool with a spacing of one foot. Travel time is dependent on the density of the material and can be used to estimate porosity and locate fracture zones. Delta-T is the travel time, measured in microseconds per foot (uSec/ft). Por(Son) is the estimated porosity of the surrounding material, based on the density of limestone ($2.71 g/cm^3$). It is commonly called the limestone-equivalent porosity. Time(N) and Time(F) record the time needed for the sound wave to reach the near and far receivers on the tool, respectively. The difference between these measurements is the travel time (Delta-T).