Well logs

The well logs one of the effective tools to study the properties of the layers below the surface of the earth through the study of their physical properties.

logs of wells used to compare and determine the relations between the rocks under the surface, as well as to determine the porosity of the reservoir rocks and the nature of the fluid and the degree of saturation. The log information proving the form of a diagram or a vertical sequence according to the depths of one or several attributes of the rock layers and fluids.

Conducted well logs in practice through vehicle or car equipped with an electric generator mounted with crane , wire and geophones, there are recording devices inside the car for these data are recorded either through automatically pen moves on graph paper or a special recording device .

Types of well logs

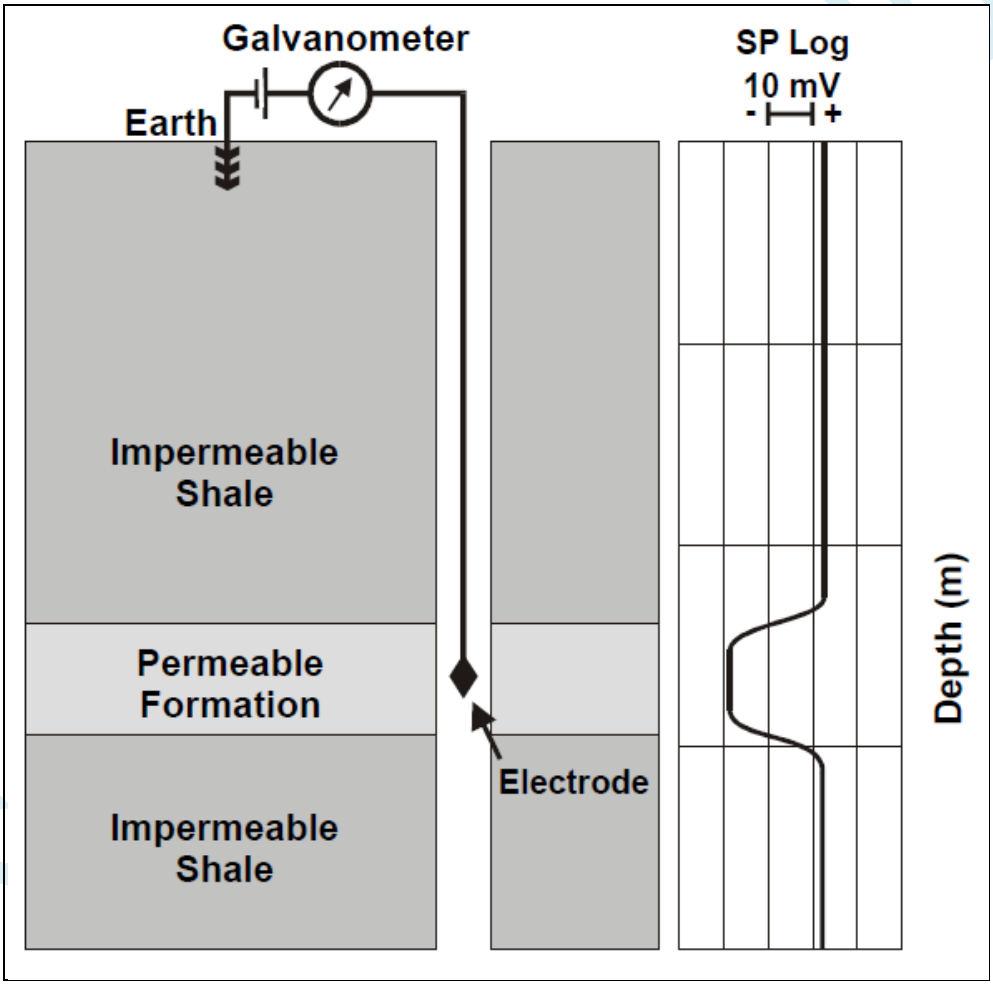
There are many types of logs for multiple properties can be recorded for the rock layers:

1. Electrical logs

varies rocks in the conductive of electricity and depend mainly on the presence of fluid, whether water or oil or other gases are trapped between the pores or stuck rocks grains according to the nature of the rocks depending on the degree of permeability or porosity, for example, dry rocks are usually not electrically conductive but on the other hand electrical resistance also depends on the amount of salinity or freshness these fluids, especially water. While longer crystalline rocks igneous and metamorphic and some sedimentary rocks such as gypsum, anhydrite and coal have high electrical resistance, while oil is an organic material it isn't conducts electricity so the electrical resistance becomes dependent on the degree of saturation and concentration of salts in the water.

a. Spontaneous Potential (Self Potential) SP

It is a very simple log that requires only an electrode in the borehole and a reference electrode at the surface. These spontaneous potentials arise from the different access that different formations provide for charge carriers in the borehole and formation fluids, which lead to a spontaneous current flow, and hence to a spontaneous potential difference. The spontaneous potential log is given the generic acronym SP. This sensor is used only in uncased wells filled with mud electrical conductive depends on the difference between the drilling mud salinity and formation water , voltage cause flow ions Na^+ and Cl^- from high concentration to diluted solutions concentration



b. Resistivity log

Resistivity logging is a method of well logging that works by characterizing the rock or sediment in a borehole by measuring its electrical resistivity. Resistivity is a fundamental material property which represents how strongly a material opposes the flow of electric current. The log must run in holes containing electrically conductive mud or water.

Resistivity logging is sometimes used in mineral exploration and water-well drilling, but most commonly for formation evaluation in oil- and gas-well drilling. Most rock materials are essentially insulators, while their enclosed fluids are conductors. Hydrocarbon fluids are an exception, because they are almost infinitely resistive. When a formation is porous and contains salty water, the overall resistivity will be low. When the formation contains hydrocarbon, or contains very low porosity, its resistivity will be high. High resistivity values may indicate a hydrocarbon bearing formation.

Usually while drilling, drilling fluids invade the formation, changes in the resistivity are measured by the tool in the invaded zone. For this reason, several resistivity tools with different investigation lengths are used to measure the formation resistivity. If water based mud is used and oil is displaced, "deeper" resistivity logs will show lower conductivity than the invaded zone. If oil based mud is used and water is displaced, deeper logs will show higher conductivity than the invaded zone. This provides not only an indication of the fluids present, but also, at least quantitatively, whether the formation is permeable or not.

2. Radioactivity log

a.Gamma ray log

Gamma ray logging is a method of measuring naturally occurring gamma radiation to characterize the rock or sediment in a borehole or drill hole. It is a wireline logging method used in mining, mineral exploration, water-well drilling, for formation evaluation in oil and gas well drilling and for other related purposes.[1] Different types of rock emit different amounts and different spectra of natural gamma radiation. In particular, shales usually emit more gamma rays than other sedimentary rocks, such as sandstone, gypsum, salt, coal, dolomite, or limestone because radioactive potassium is a common component in their clay content, and because the cation exchange capacity of clay. This difference in radioactivity between shales and sandstones/carbonate rocks allows the gamma tool to distinguish between shales and non-shales.

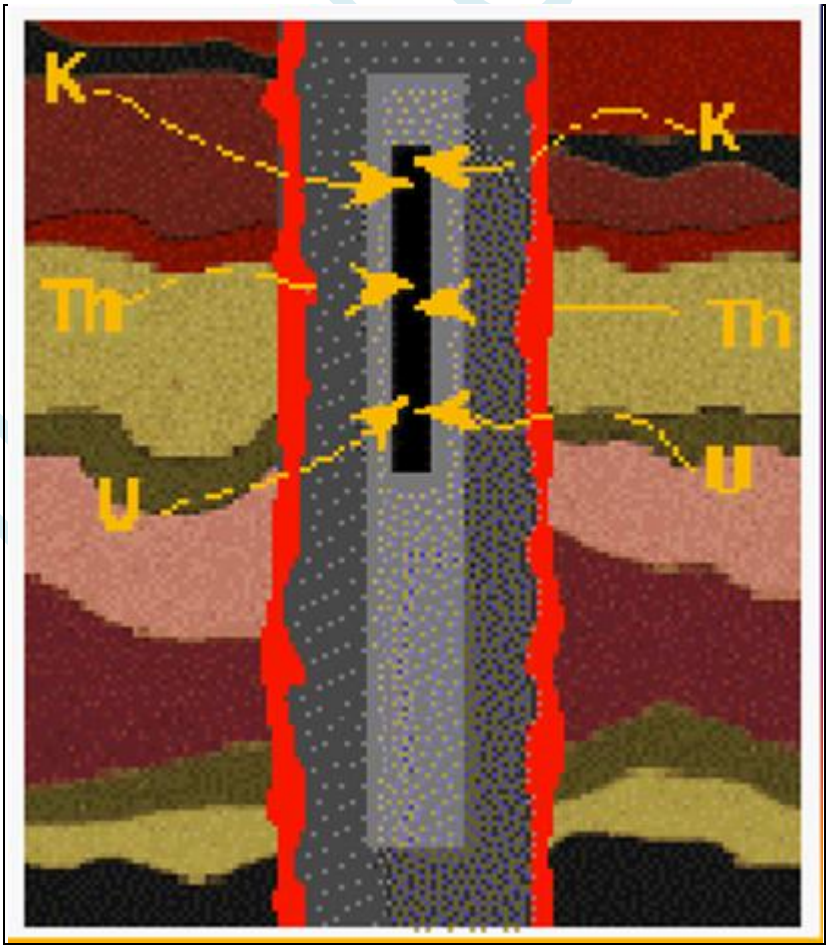
The gamma ray log, like other types of well logging, is done by lowering an instrument down the drill hole and recording gamma radiation variation with depth. In the United

States, the device most commonly records measurements at 1/2-foot intervals. Gamma radiation is usually recorded in API units.

Three elements and their decay chains are responsible for the radiation emitted by rock: potassium, thorium and uranium. Shales often contain potassium as part of their clay content, and tend to absorb uranium and thorium as well. A common gamma-ray log records the total radiation.

.An advantage of the gamma log over some other types of well logs is that it works through the steel and cement walls of cased boreholes. Although concrete and steel absorb some of the gamma radiation, enough travels through the steel and cement to allow qualitative determinations.

Sometimes non-shale also have elevated levels of gamma radiation. Sandstone can contain uranium mineralization, potassium feldspar, clay filling, or rock fragments that cause it to have higher-than usual gamma readings. Coal and dolomite may contain absorbed uranium. Evaporite deposits may contain potassium minerals such as carnallite. When this is the case, spectral gamma ray logging can be done to identify these anomalies.



b.Neutron Log

Neutron Log is another kind of radioactive logs . It uses chemical or pulsed sources to produce fast neutrons .These neutrons radiate into formation & collide with nuclei of the atoms they encounter. The process slows down fast neutron to a thermal state, which ultimately captured by a nucleus with induces gamma ray emitted. The thermal neutron count rates and induced gamma rays can be recorded to estimate hydrogen content

3.Density log

Density logging is a well logging tool that can provide a continuous record of a formation's bulk density along the length of a borehole. In geology, bulk density is a function of the density of the minerals forming a rock (i.e. matrix) and the fluid enclosed in the pore spaces. This is one of three well logging tools that are commonly used to calculate porosity, the other two being sonic logging and neutron porosity logging

This method is the most reliable porosity indicator for sandstones and limestones because their density is well-known. On the other hand, the density of clay minerals such as mudstone is highly variable, depending on depositional environment, overburden pressure, type of clay mineral and many other factors. A fluid bulk density of 1 g/cm³ is appropriate where the water is fresh but highly saline water has a slightly higher density and lower values should be used for hydrocarbon reservoirs, depending on the hydrocarbon density and residual saturation.

4.Sonic log

Sonic logging is a well logging tool that provides a formation's interval transit time, designated as Δt, which is a measure of a formation's capacity to transmit seismic waves. Geologically, this capacity varies with lithology and rock textures, most notably decreasing with an increasing effective porosity. This means that a sonic log can be used to calculate the porosity of a formation if the seismic velocity of the rock matrix, and pore fluid, are known, which is very useful for hydrocarbon exploration.