Cased Hole Logging

MUDLOGGING, CORING 
AND CASED HOLE 
LOGGING BASICS

Cased Hole Logging

LEARNING OBJECTIVES

By the end of this lesson, you will be able to:

✓ Identify common Cased Hole Logs and understand why the data are needed

✓ Identify the two types of Pulsed Neutron logs and how they can be used for reservoir monitoring over the field life

✓ Identify the basic sensors on the Production Logging Tool (PLT) and why it is run

✓ Understand potential applications of the borehole video camera
CASED HOLE LOGS

- Cased hole tools provide data to understand well bore integrity, fluid flow, and changes in hydrocarbon saturation
- Some of the reasons for cased hole logging are:
  - Depth control
  - Supplementing open hole data,
  - To monitor changes in the formation over time
  - To determine which perforations are producing what fluids at what rate
  - Certain acoustic logs are run to determine cement bond quality and casing condition

BASIC CASED HOLE TOOLS

Basic Cased Hole Tools
BASIC CASED HOLE TOOLS

The GR-CCL Correlation Tool (Gamma Ray-Casing Collar Locator)
- To correlate cased hole and open hole depths

Pulsed Neutron Logs (two types):
1. Pulsed Neutron Capture Log (PNC)
   - Determine Water Saturation in most reservoirs (if salinity known and above 30k ppm)
2. Pulsed Neutron Spectroscopy Log (also called C/O Log)
   - Determine water saturation, Sw, over the reservoir life cycle when water salinity and porosity are known

Cement Bond Log
- Determine the effectiveness of the cement behind casing

Downhole Video Camera
- Determine perforations and casing quality (scaling, corrosion, fractures)

Production Log
- To determine rates of flow and type of fluid produced from specific zones

GAMMA RAY (GR) TOOL

Basic depth control tool – open hole and cased hole
- Gamma rays efficiently penetrate casing
- GR tool is calibrated in API units
- GR tool is run in combination with a collar locator to provide a depth reference for mechanical cased hole services

GR log allows for determination of sands and shales
Vertical resolution: 50cm. Radius of investigation 25cm

A Spectral Gamma Ray tool can be run to separate the total gamma ray response into the primary radioactive components of Uranium, Potassium and Thorium. These data can be used to identify Source Rock and reservoir rock with potassium feldspar.
### Neutron Tools

#### 3 Types of Neutron Detectors

1. **Thermal neutron detector**
   - Senses the density of the lowest energy neutrons – very sensitive to porosity

2. **Epithermal neutron detector**
   - Senses neutrons just above the thermal energy level

3. **Capture gamma ray detector**
   - Sensitive to gamma rays produced by absorption of thermal neutrons – not very sensitive to porosity

### All neutron tools work on the same principle

- Fast neutrons (~5 mev) are continuously emitted by a neutron source. They are slowed by collisions with nuclei in their paths. When they reach lower thermal energies (~0.025 ev) they are absorbed by the nuclei present.
  - H is the most effective in slowing the neutrons
  - Other nuclei common to minerals in the formation scatter neutrons but only absorb small proportions of the energy, Si, Ca, C, O, etc.
MOST COMMON CASED HOLE NEUTRON TOOLS

2 Types of Pulsed Neutron Log

1. Pulsed Neutron Capture (PNC Log)
   - Use when water salinity is known and sufficiently high

2. Pulsed Neutron Spectroscopy (PNS or C/O Log)
   - Use when water salinity is low or unknown

Pulsed Neutron Logs are the most frequently run cased hole log.

Neutron logs are used for formation evaluation measurements through casing for the following reasons:
- To monitor changes in reservoir properties during the reservoir life cycle (particularly Sw)
- To supplement measurements taken in open hole

RESERVOIR MONITORING

Original OWC
RESERVOIR MONITORING: PULSED NEUTRON LOGGING

Example of Time Lapse Response


3025

3050

3075

Original Gas Water Contact

Water invasion

Water invasion

= 1975 base log

PRODUCTION LOGGING WITH THE PRODUCTION LOGGING TOOL

Objective
- Reconciliation of downhole flow with surface rates and reservoir model

Complications
- Borehole deviation
- Multiphase flow
- Flow regime (laminar/turbulent)

What do we want to know?
- Rates of flow/injection: blockages, crossflow
- Type of fluid
- Open perforations

Production Logging Tool (PLT) is also known as the “spinner survey”
- Used to determine where fluid is entering or exiting the wellbore

The sensors on the tool include:
- Impeller (or spinner)
- Thermometer
- Gradiomanometer
PLT LOGGING

Well: Corona 144
PEMEX - Mexico
Fractured Cretaceous Chalks

Well: Chuchupa 14
TEXACO - Colombia
Offshore Sandstones

SLICKLINE PLT TOOL

Weight Bars
Collar Locator
Pressure Sensor
Temperature Sensor
Density Sensor
Flowmeter
Centralizer

Interface Laptop Computer - Tool
FULLBORE SPINNER FLOWMETER

- Closed Position
- Open Position

Centralizer Blades

BoREHOLE TELEVIEWER

- Downhole video camera
- Identify perforations (check depth)
- Reveal degree of scale precipitation and/or corrosion in the casing
- Show cracked casing
NEW CASING WITH PERFORATION

CEMENT BOND LOGGING (CBL)

Objective
- To assess cement quality in terms of zonal isolation
- Location of top of cement
- Effectiveness of repairs (squeeze cementing)

Tools
- Cement Bond Log (CBL): sonic tool
- Ultrasonic Imaging Log (UIL): ultrasonic cement evaluation tool
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