Chapter(10)

Sonic Log:

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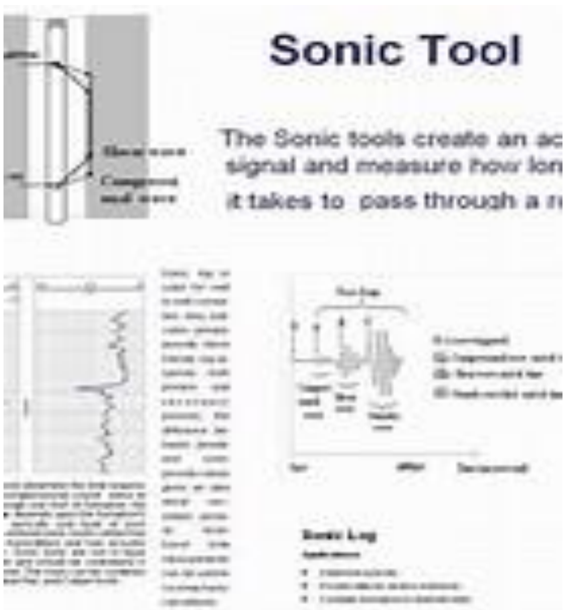


The *Sonic Log* measures the acoustic transit time, Δt, of a compressional sound wave traveling through the porous formation. The logging tool consists of one or more transmitters and a series of receivers. The transmitters act as sources of the acoustic signals which are detected by the receivers. The time required for the signal to travel through one foot of the rock formation is the acoustic transit time, Δt. The acoustic travel time, then, is the reciprocal of the sonic velocity through the formation. The units of Δt are micro-seconds/ft (μsec/ft) or millionths of a second per foot.

There are several ways to interpret the sonic log measurements. One of the most common interpretation formulae is the Wyllie Time-Average Equation:

$$\phi sl=\Delta tsl-\Delta tma/ \Delta tf-\Delta tma \text{………Equ….1}$$

Where:

- ϕ_{sl} is the porosity from the sonic log (log measurement) , fraction
- Δt_{sl} is value of the acoustic transit time measured by the sonic log, μsec/ft
- Δt_{ma} is value of the acoustic transit time of the rock matrix measured in the laboratory, μsec/ft
- Δt_{f} is value of the acoustic transit time saturating fluid measured in the laboratory, μsec/ft
  - The presence of hydrocarbons in the reservoir rock results in an over prediction of porosity measured by the sonic log and some corrections may be required. These corrections take the form:
    - Gas:$\phi sonic=0.7\ \phi sl$………….Eq2
    - Gas:$\phi sonic=0.7\ \phi sl$………….Eq3

or,for oil

……………………Oil:$\varphi sonic=0.9\ \varphi sl$…………Eq4

Table 1- has typical values of the acoustic transit time for different reservoir formations and commonly encountered reservoir fluids.

Table(1)-Typical Acoustic Transit Times for Sonic Log Interpretation

Heading	Δt_{ma} (μsec/ft) Range	Δt_{ma} (μsec/ft) Commonly Used	Δt_f (μsec/ft) Range	Δt_f (μsec/ft) Commonly Used
Sandstone	55.5 – 51.0	55.5 or 51.0	------	--------
Limestone	47.8 – 43.5	47.5	------	------
Dolomite	43.5	43.5	------	------
Anhydrite	50.0	50.0	------	------
Salt Formation	66.7	67.0	------	------
Fresh Water Based Drilling Fluid	------	------	189.0	189.0
Salt Water Based Drilling Fluid	------	------	185.0	185.0
Gas	------	------	920.0	920.0
Oil	------	------	230.0	230.0
Casing (Iron)	------	------	57.0	57.0

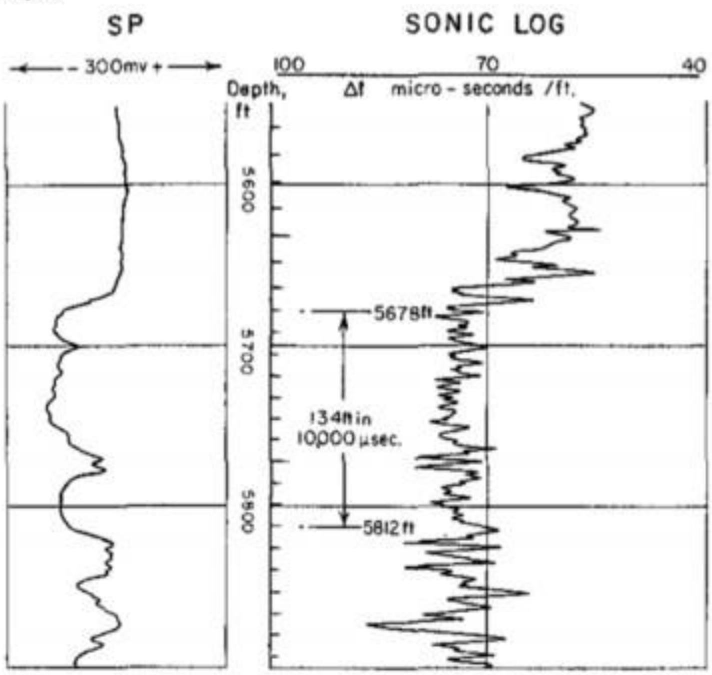
Other empirically based equations exit for sonic log interpretation. One form of an alternative equation is

$\varphi sonic = C * \{(\Delta tsl - \Delta tma)/(\Delta tsl)$……………..Eq(5)

In this equation, the value of C is in the range of 0.625 to 0.700 and is determined by calibrating the equation to known porosity, such as, to core data when a well is both cored and logged. In Equation 3.12 and Equation 3.13, φsonic is the final interpreted porosity from the sonic log.

Q: Find the porosity from sonic log for interval of sand stone(5678ft-5812ft)….we the fluid is fresh water.

5. Estimate the average porosity of the thick sand interval shown on the sonic log of figure below. (20 pts).



[Wyllie's Equation: $\emptyset = (\Delta t - \Delta t_{ma})/(\Delta t_f - \Delta t_{ma})$. Δt_{ma}=55.5 μsec/ft for sandstone; the average fluid slowness Δt_f used is 189 μsec/ft; Δt is called internal travel time or slowness, μsec/ft]

Answer:

$\phi sl = \Delta tsl - \Delta tma / \Delta tf - \Delta tma$

The average Δtlog (μsec/ft) fore interval (5678-5812)ft=80 μsec/ft .

Δtf for fluid fresh water=189 μsec/ft

The bed is sandstone so Δtma from table=55.5μsec/ft.

i.e ϕsl=(80 μsec/ft-55.5μsec/ft)/(189 μsec/ft-55.5μsec/ft

=24.5/133.5=0.184=18%

This porosity is the primery porosity

Total porosity=φT

$\varphi T=(\varphi N+\varphi d)/2$ for oil zone

φT= sequar root of$(\varphi N+\varphi d)/2$ for gase zone

……………………………………………………………….

Secondary porosity= Total porosity-Sonic porosity

This mean the fractures, dissolution…etc.