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NEUTRON LOG

Contents

LOG

- Continuous record as function of depth Of observation made on the rock and fluids of the geological section exposed in a well bore.
- Graphically plotted to scale on narrow paper strip

Neutron Log

- A reaction between radioactive elements emits fast neutrons, which collide with the nuclei of other atoms, most importantly hydrogen nuclei. Detectors count the slowed neutrons deflected back to the tool. An apparent neutron porosity can be obtained based on the hydrogen index.

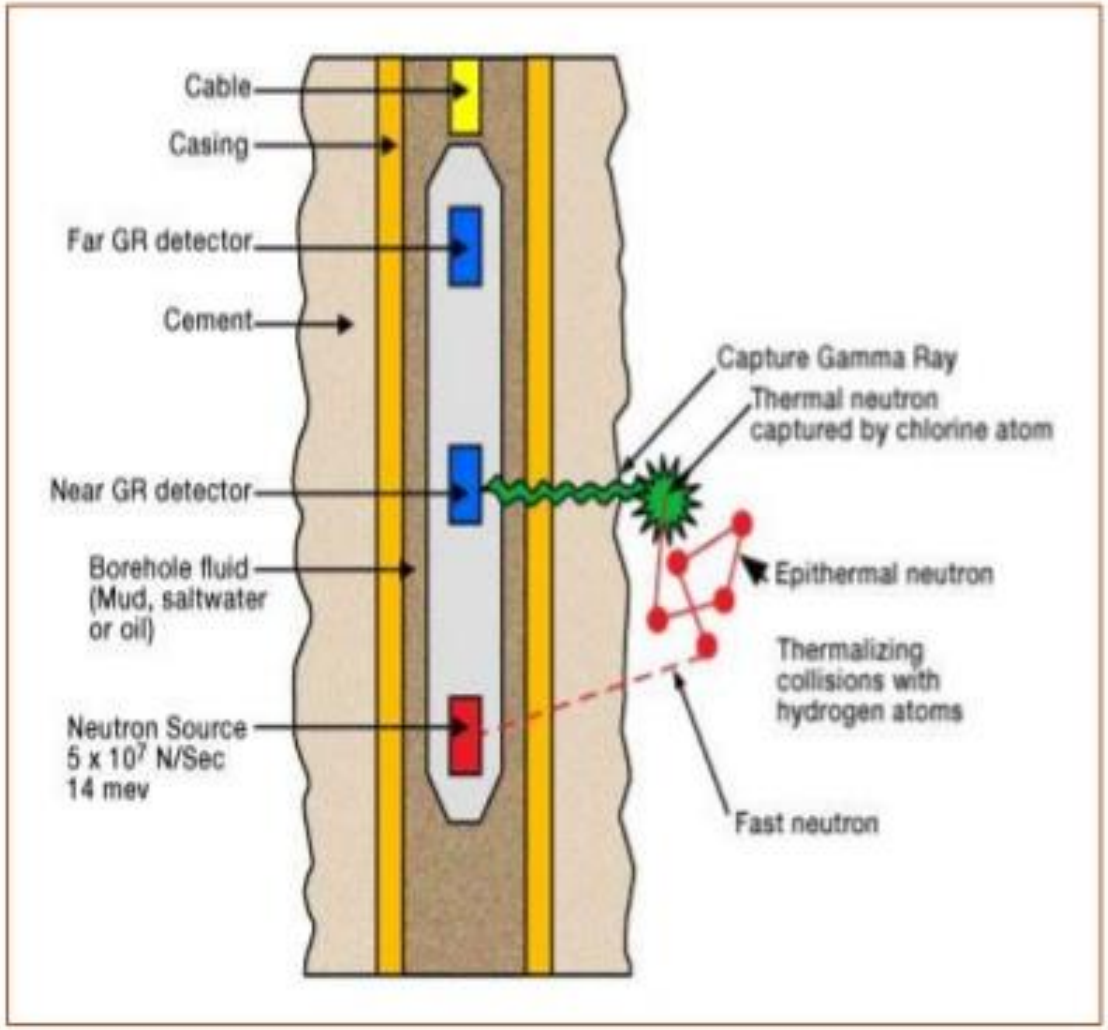
Hydrogen Index

- Hydrogen Index of a material is defined as the partial concentration of hydrogen per unit volume relative to water.
- It is an indication of richness of hydrogen in the formation.

Tools

There are three main types of neutron tool, which are:

- The Gamma Ray/Neutron Tool (GNT)
- The Sidewall Neutron Porosity Tool (SNP)
- The Compensated Neutron Log (CNL)


Cable
Casing
Far GR detector
Cement
Near GR detector
Borehole fluid
(Mud, saltwater
or oil)
Neutron Source
5 x 10^7 N/Sec
14 mev
Capture Gamma Ray
Thermal neutron
captured by chlorine atom
Epithermal neutron
Thermalizing
collisions with
hydrogen atoms
Fast neutron

TOOLS

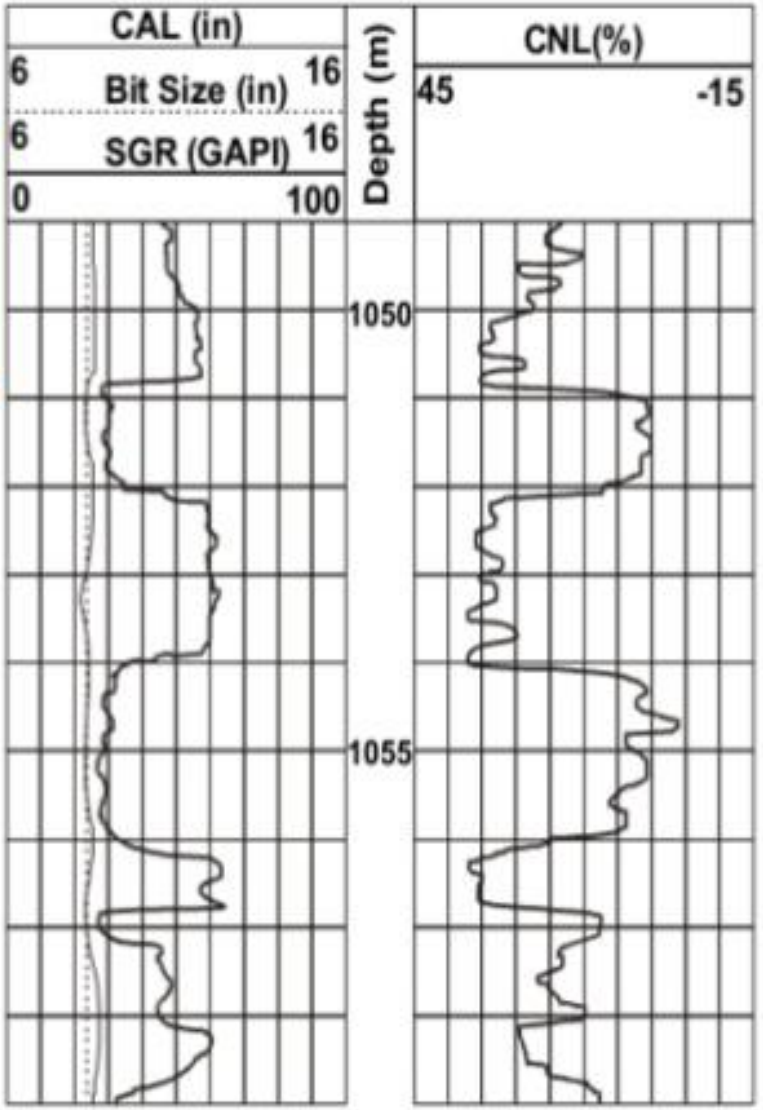
Log Format

- Scale is arithmetic
- Plotted across Track 2 and 3
- Scale is 45(left)-15 Porosity Units
- Showed in Dashed Line
- Generally combined with density, caliper and gamma ray tools

Log Presentation

The scale at the top of the log shows (negative) -15% porosity on the right, 0% about 1/4 of the way over, and 45% porosity on the left. Sandstones have an absolute maximum of about 28% porosity. Shale porosity is much higher, but because the grain size of shale is so small, oil or gas trapped in shale cannot usually be removed by drilling for it, so shale porosity is generally not important.

Log Presentation



Calibration

API Neutron Calibration Pit at the University of Houston

- Three blocks of carbonate with accurately known porosities that are filled with fresh water.
- 19% porosity Indiana limestone, API value of 1000 API neutron units.
- The response of the tool is then checked in 1.9% Carthage Marble, 26 % Austin limestone, and 100% fresh water.

Log characteristics

Depth of Investigation:

- 15-25 cm
- Varies with HI and therefore porosity

Vertical Resolution:

- 60cm with SNP
- 40cm with CNL

Applications

- Quantitative
- Qualitative

QUANTITAVE USE

Porosity calculation:

$$Log_{10}\emptyset = \alpha N + B$$

where

Ø= porosity

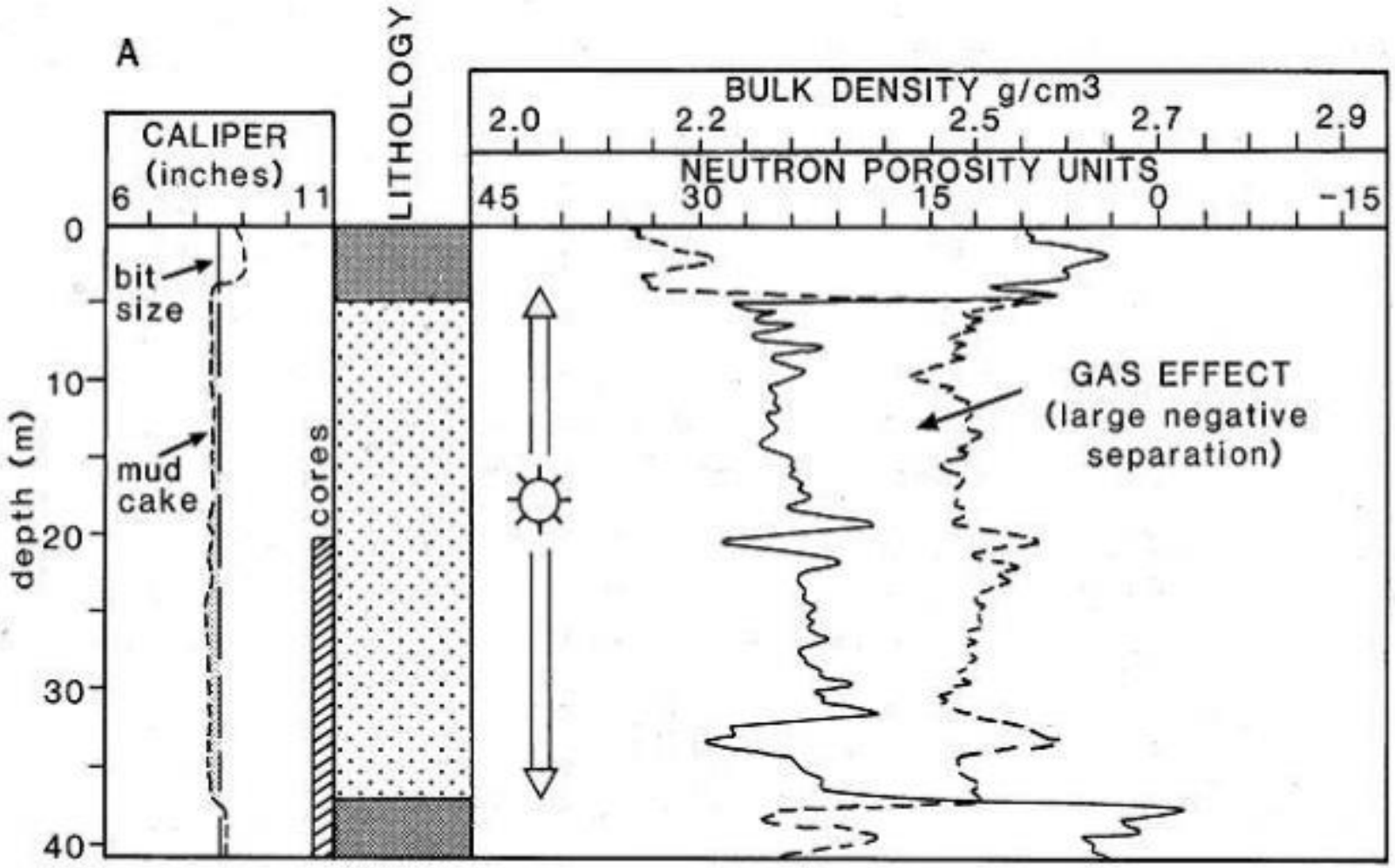
α, B= constants

N=neutron tool reading

QUANTITAVE USE

Hydrocarbon effects on neutron porosity:

- Liquid hydrocarbon (oil) does not affect the tool response
- Hydrocarbon gas has a much lower hydrocarbon index resulting from its low density, hence gives rise to underestimations of neutron porosity



The Hydrocarbon gas effect in the neutron log. (CNL Schlumberger, M H Rider, 1986,.)

QUANTITAVE USE

The Shale Effect on neutron porosity:

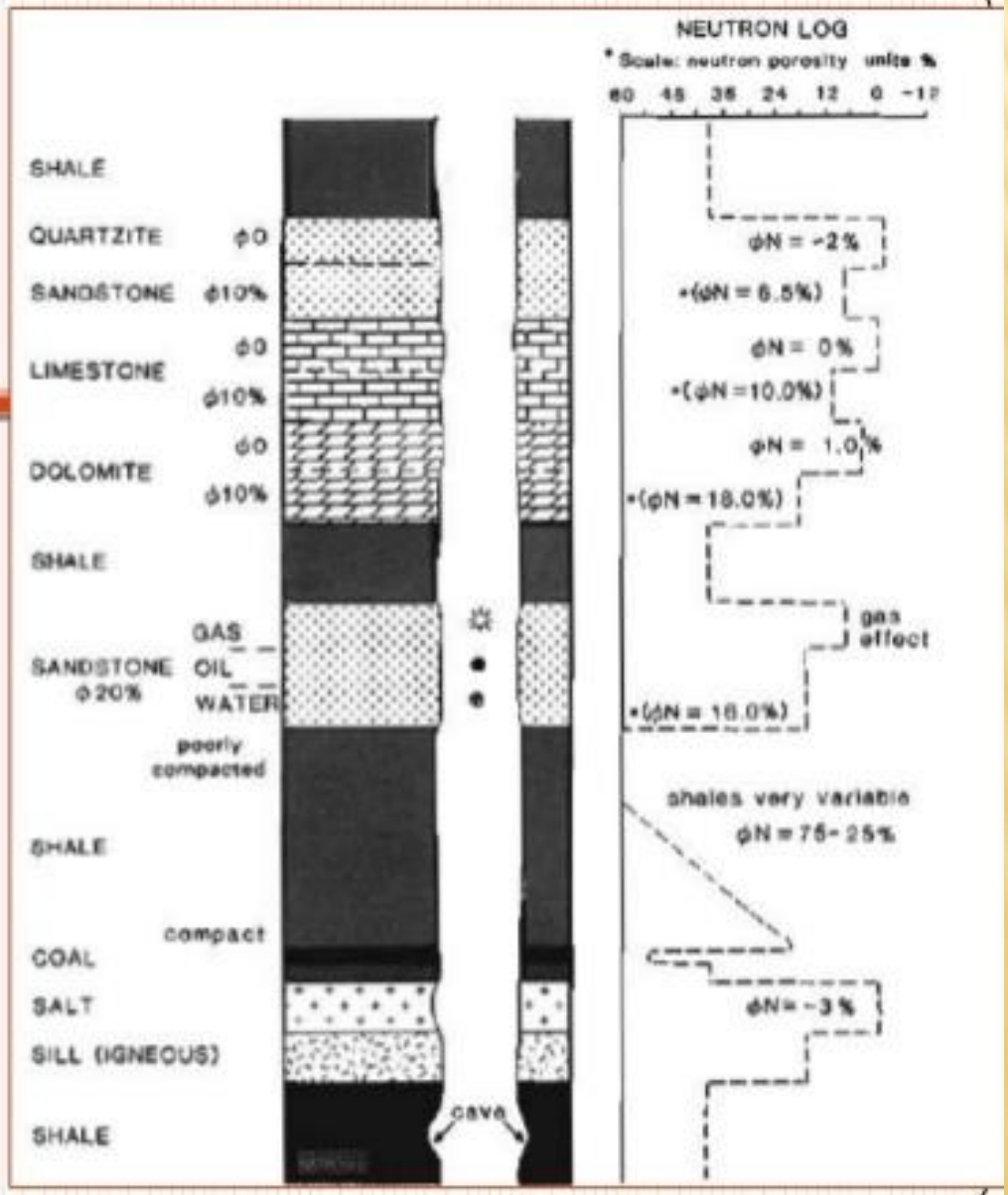
- Increases the hydrogen index of the formation
- Overestimation of Neutron porosity due to bound water

QUALITATIVE USE

Lithology identification:

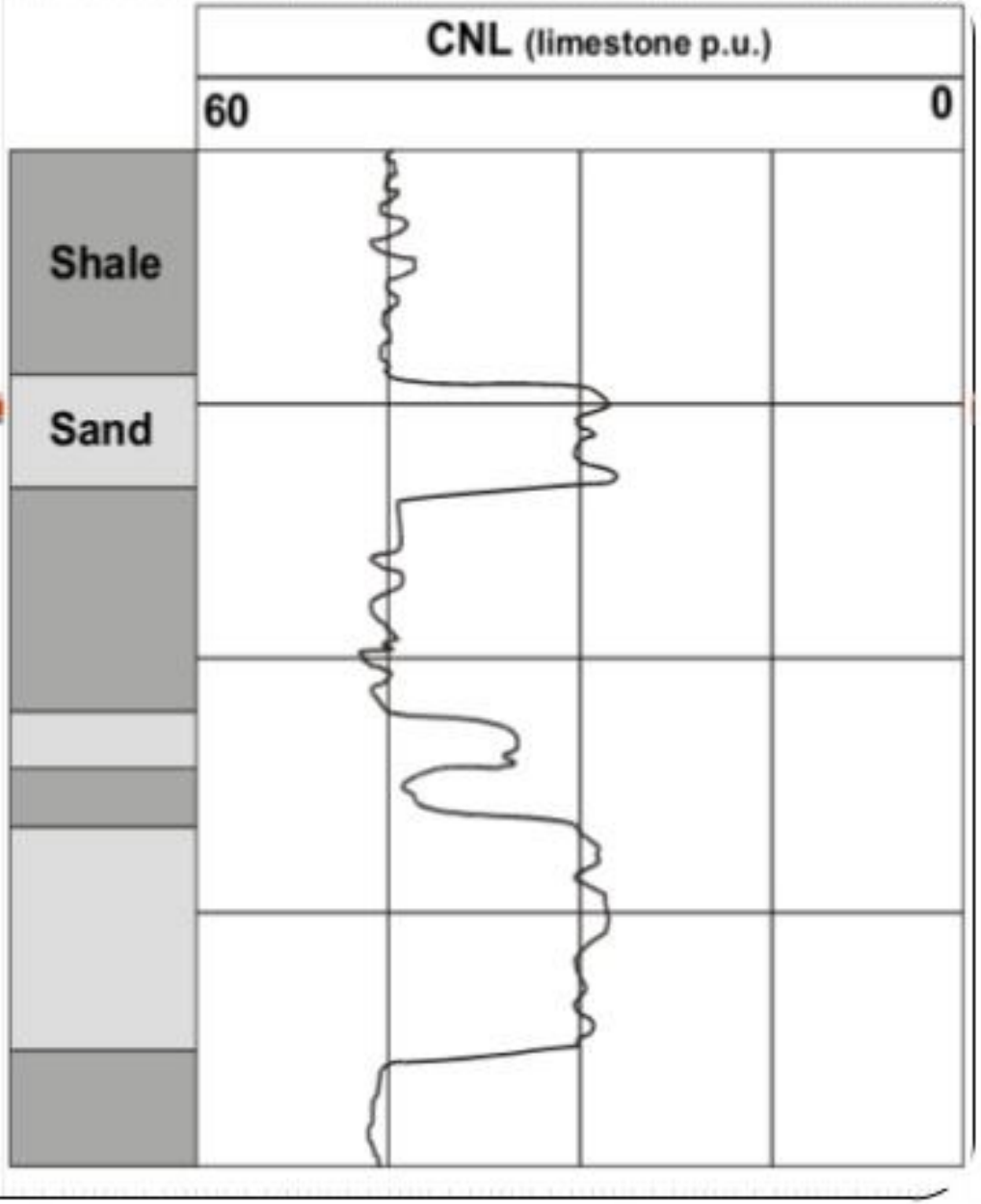
- Shale
- Sand
- Evaporites
- Coal
- Volcanic and Intrusive rock

The neutron log shows porosities of different lithologies. (after Rider, 1986).

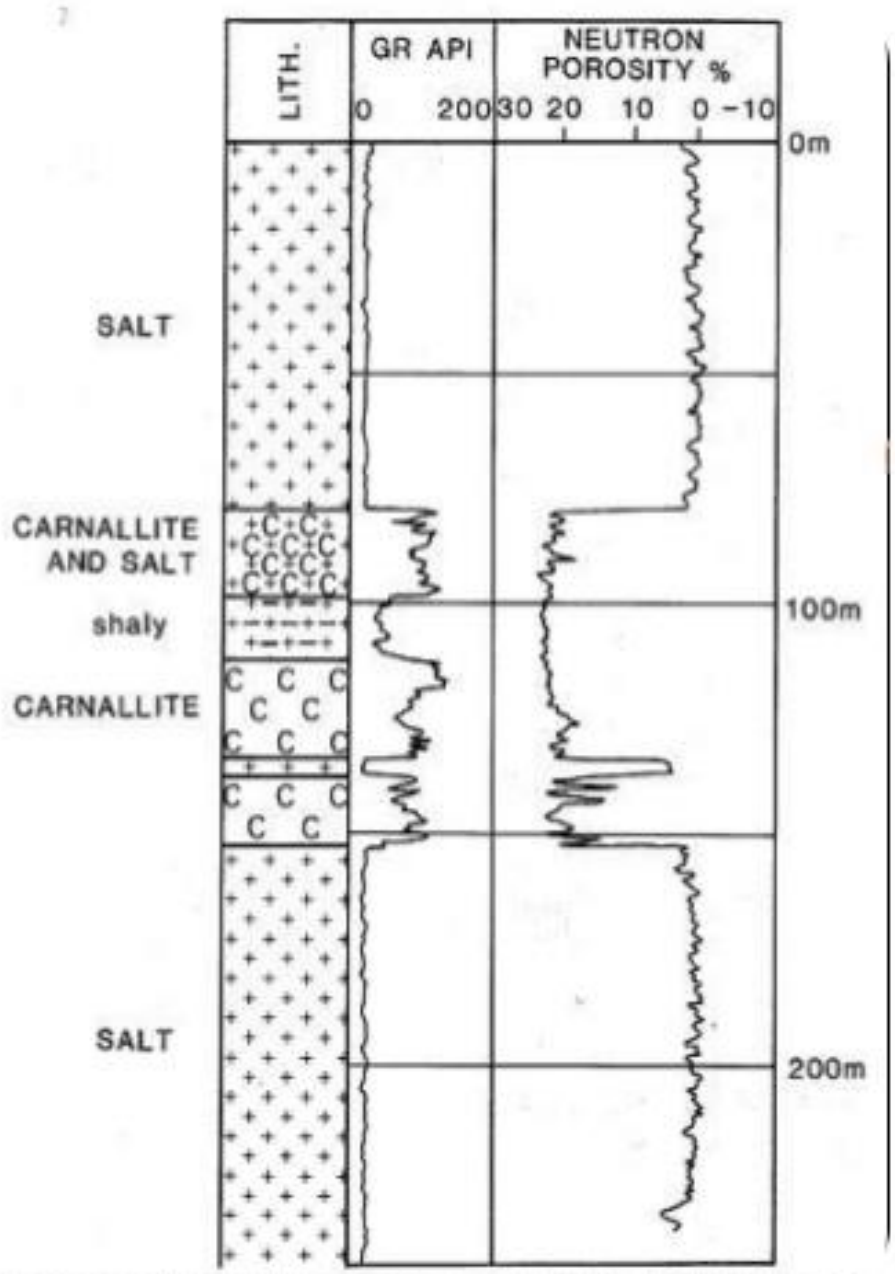


The neutron log response to mixtures of shales and sandstones.

(After Dr. Paul Glover.)



Neutron log response to evaporites (after Rider, 1997).

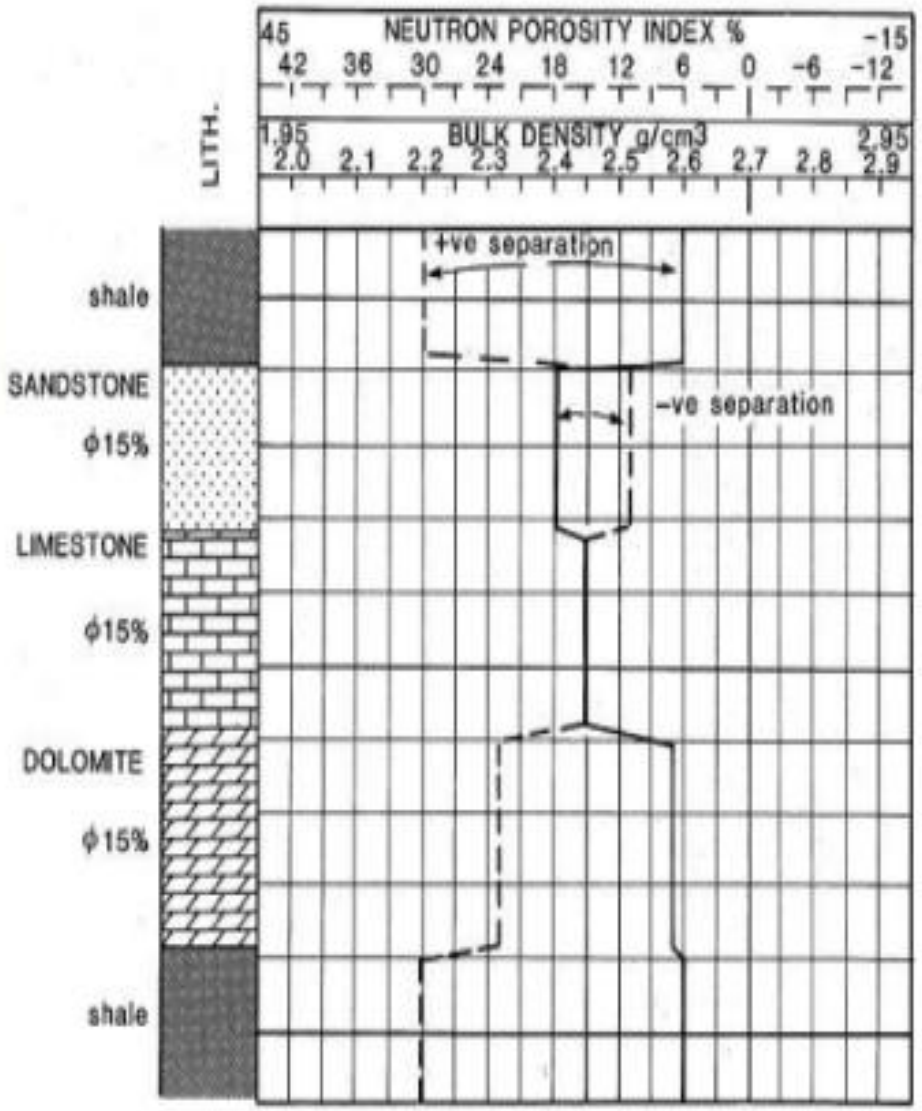


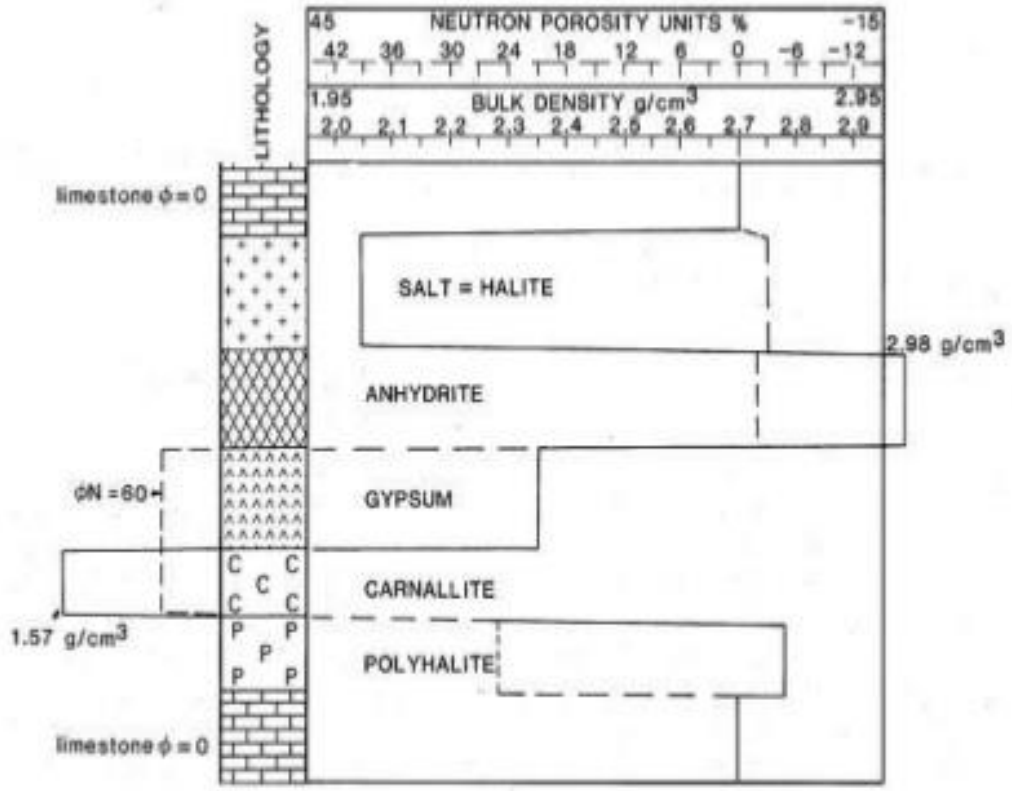
The Neutron-Density Combination

Clean Formations

- No separation for pure limestones
- Small negative separation for clean sandstones.
- Moderate positive separation for pure dolomites

The density-neutron combination idealized responses.





Distinctive evaporites on a density-neutron log.
(M H Rider,1986,.)

Conclusion

- The neutron-density combination is best lithology indicator for most formations
- Shales and shaliness and evaporites can be identified
- Clean formations and even matrix type can be suggested

References

Engler.T.W.(2011). Neutron Logs-Lecture Notes For PET.370.

Glover. P. The Neutron Log- Petrophysicist MSc Course Notes .pp.152-171.

Rider.M.H. (1986, 1987).The Geochemical Interpretation Of Well Logs.pp.106-118.

Serra.O.(1984).Fundamentals of well-log Interpretation.p.135.

http://ipims.com/data/fe11/G4426.asp?UserID=&Code=30025