Neutron

Applications

Porosity analysis

In clean formations that have pores filled with water or oil, the neutron measurement can be used to derive liquid-filled porosity. This is done using the hydrogen index (HI) concept.

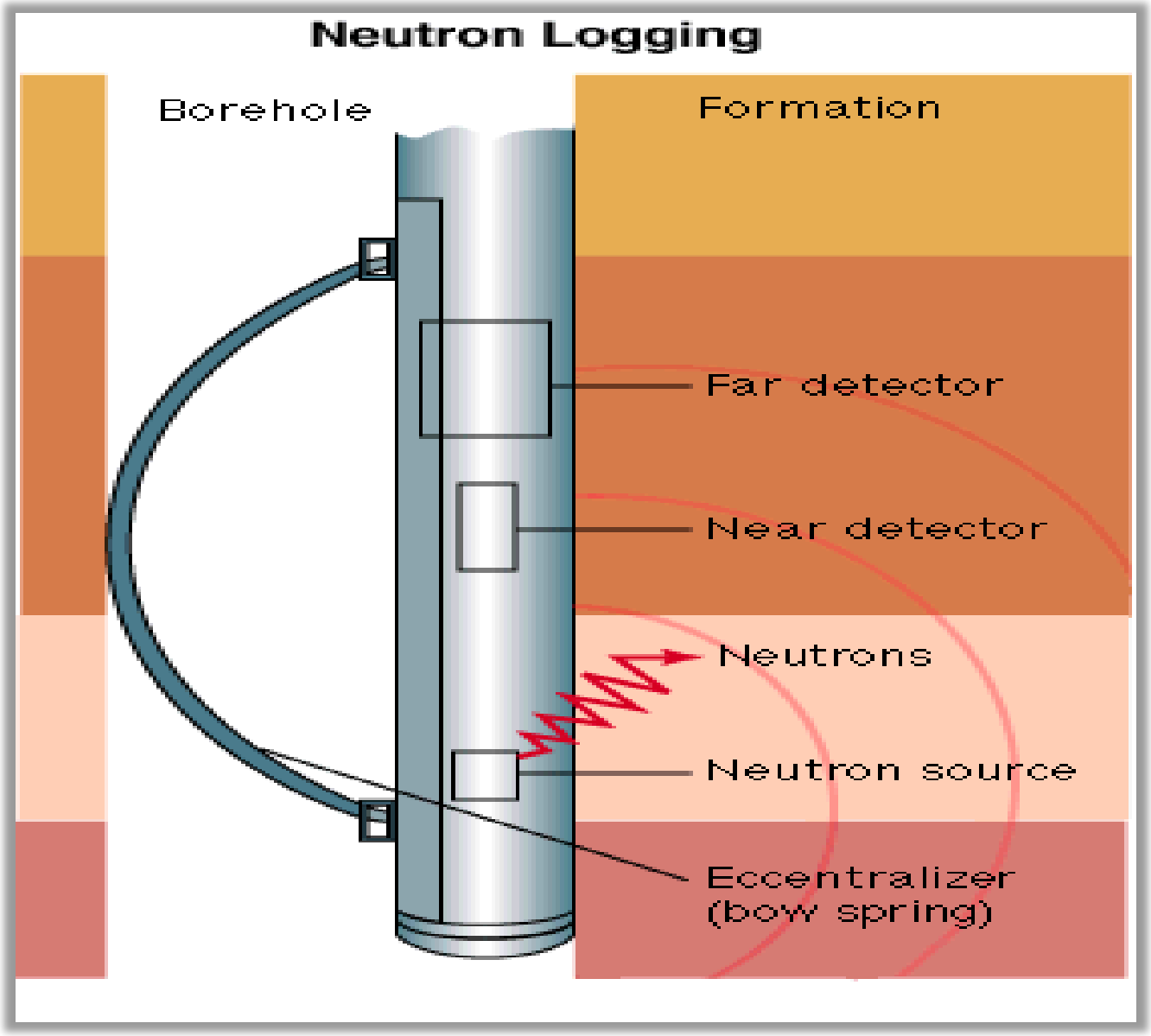
Gas detection

Gas zones (i.e. not liquid-filled) can often be identified by comparing the neutron porosity log with another porosity log, such as a density or sonic log. (Neutron porosity reads much lower than Density and Sonic porosity in gas zones.)

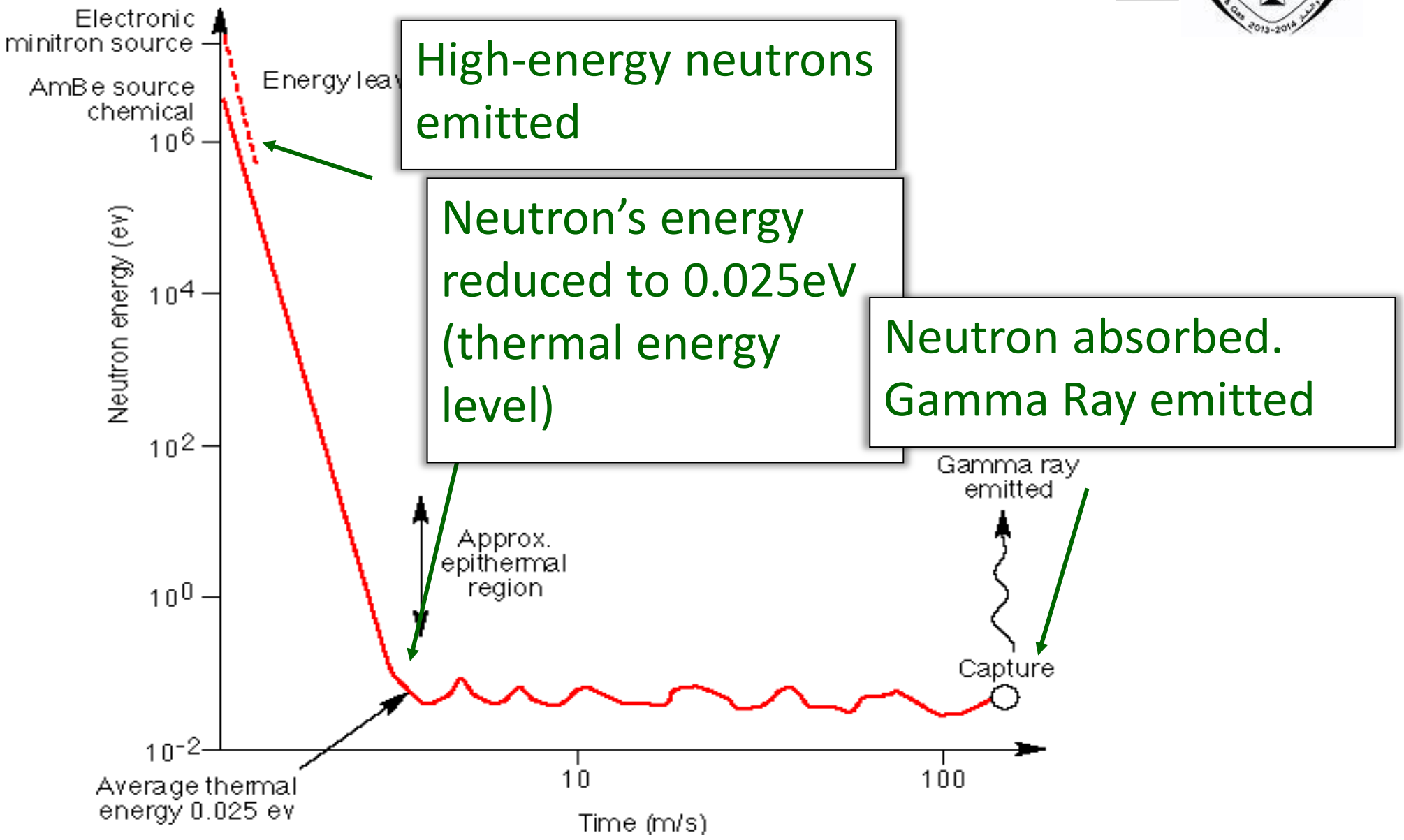
Lithology

By combining the density/neutron tool information, it is possible to get a good estimate of likely formation lithology.

Neutron Logging Tool Principle



The life of a Neutron



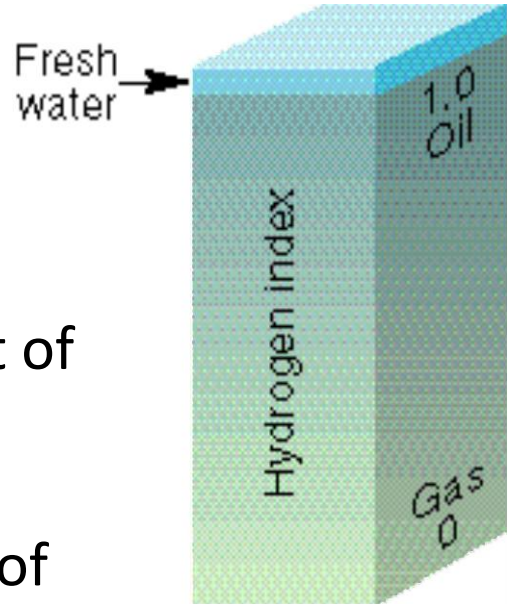
High-energy neutrons emitted

Neutron's energy reduced to 0.025eV (thermal energy level)

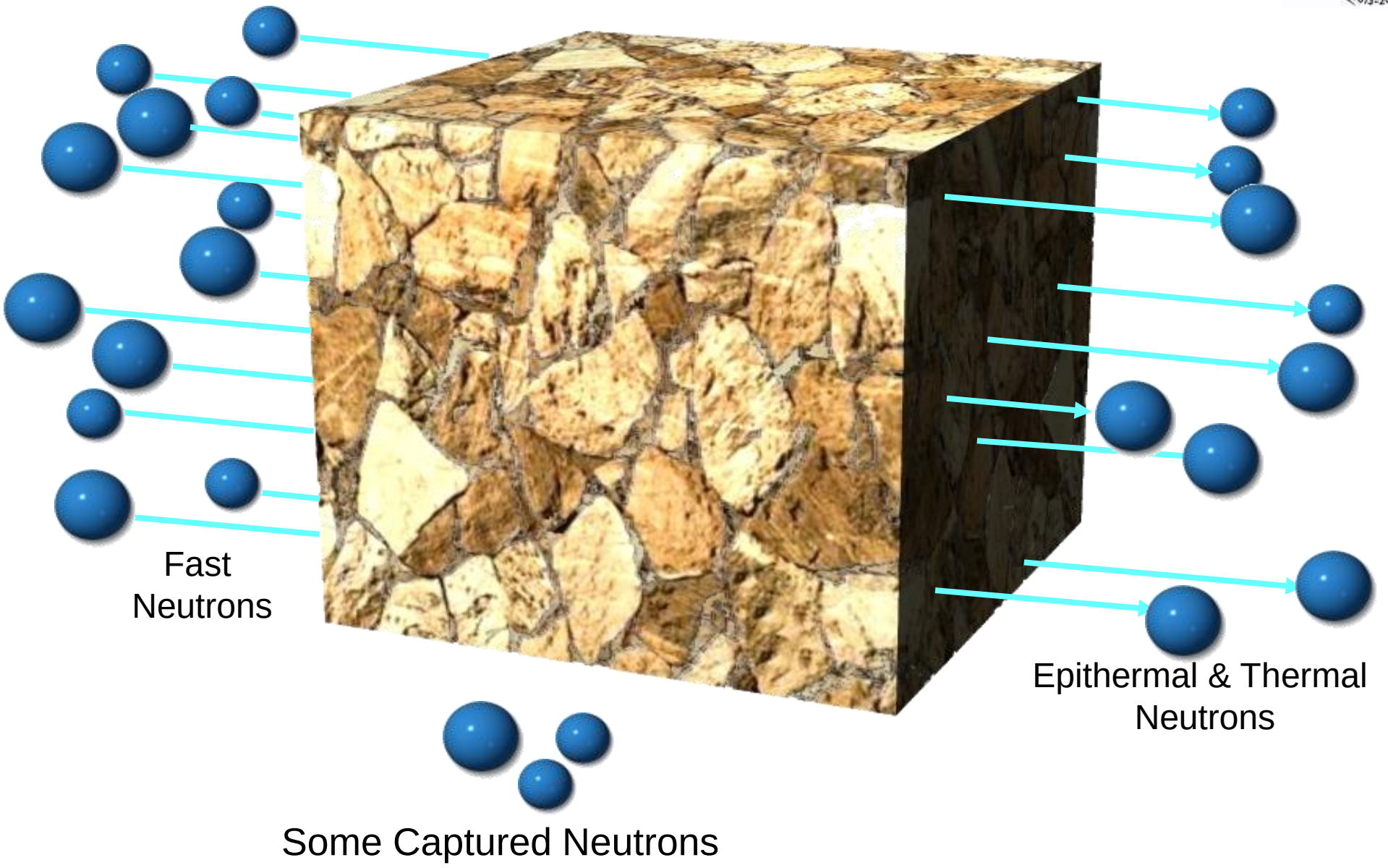
Neutron absorbed. Gamma Ray emitted

Hydrogen Index

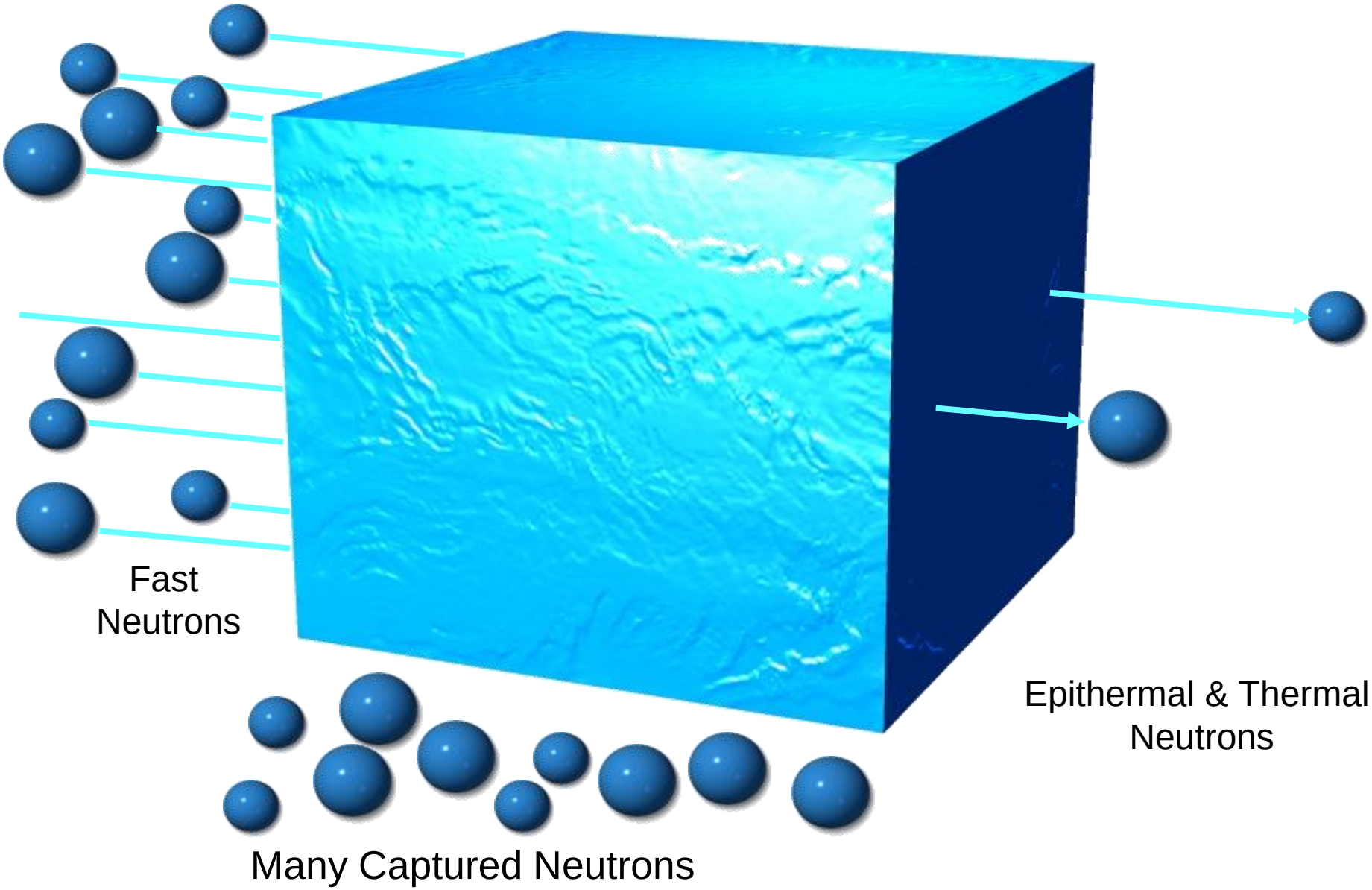
- Hydrogen Index is
  the quantity of hydrogen per unit volume
- Fresh water is defined as having a Hydrogen Index of 1
- Oil has a Hydrogen Index which is slightly less than that of water.
- The Hydrogen Index of gas is a *much* smaller than that of water.
- In a formation, it is generally the fluids that contain hydrogen (but not always!)



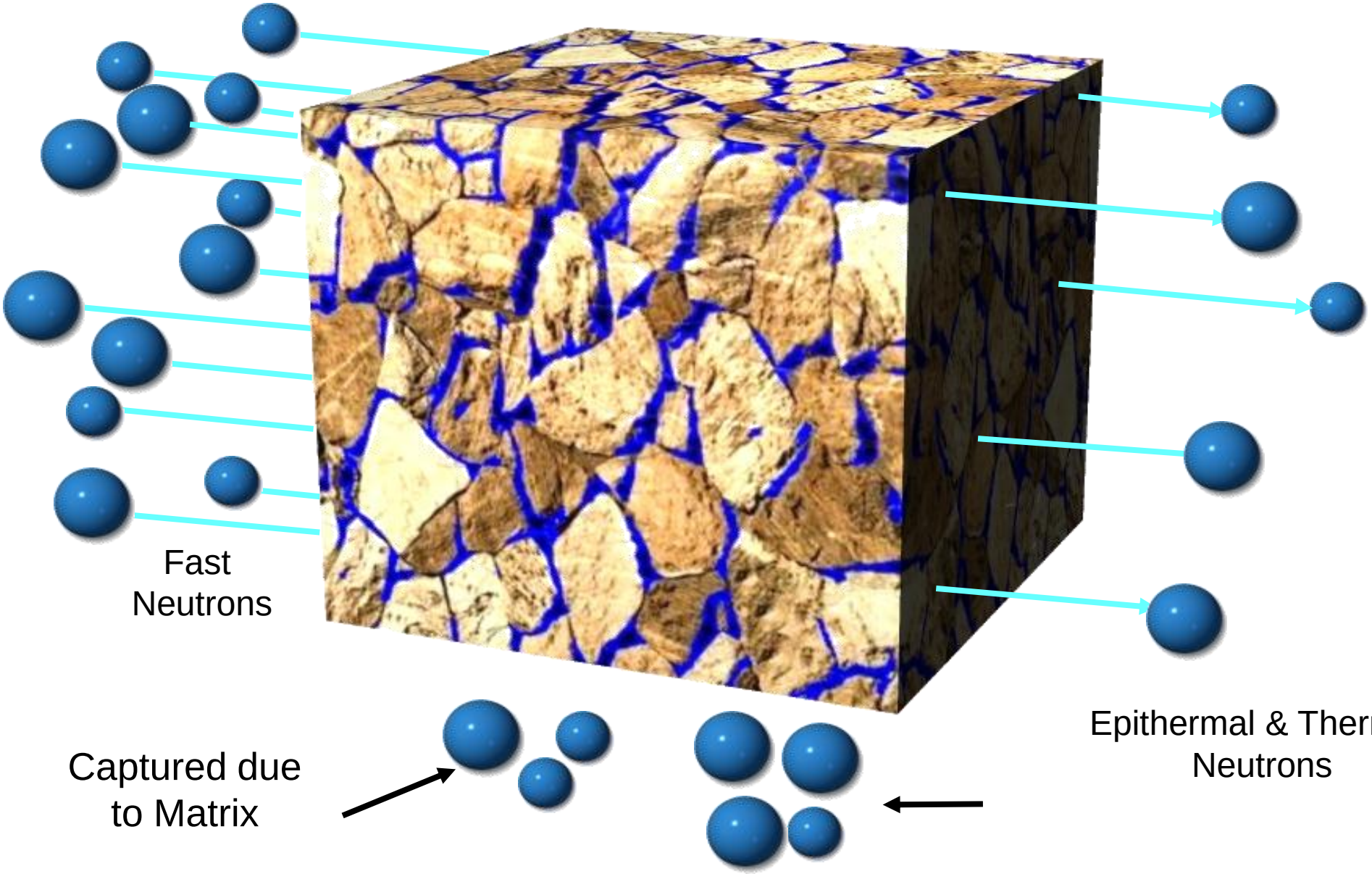
0% Porosity


Fast
Neutrons
Some Captured Neutrons
Epithermal & Thermal
Neutrons

100% Porosity

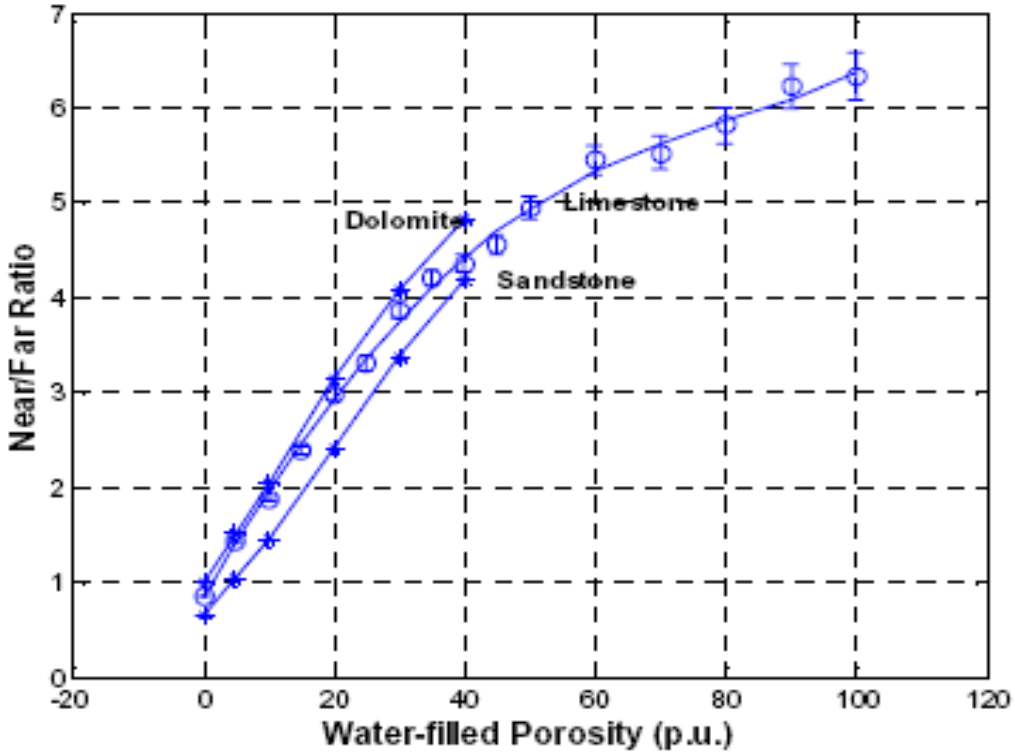


Fluid filled Pore-Space



Ratio to Porosity Transform

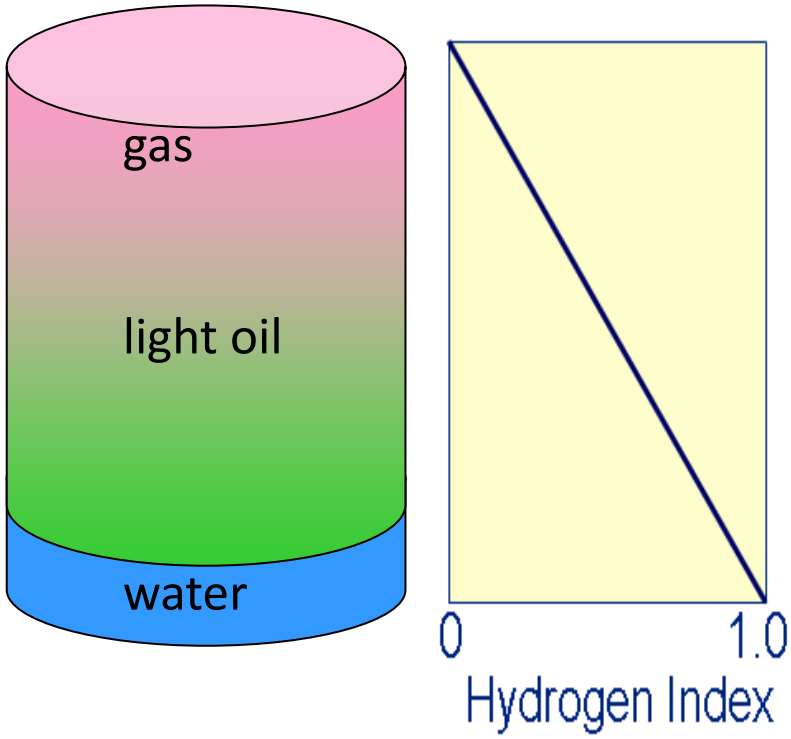
- Count rates are measured in the **N**ear and **F**ar detectors
- A ratio of these is then taken
- The ratio is translated into porosity using a **transform** (This is a combination of theoretical and experimental work).
- The output for the thermal neutron porosity is called **TNPH**

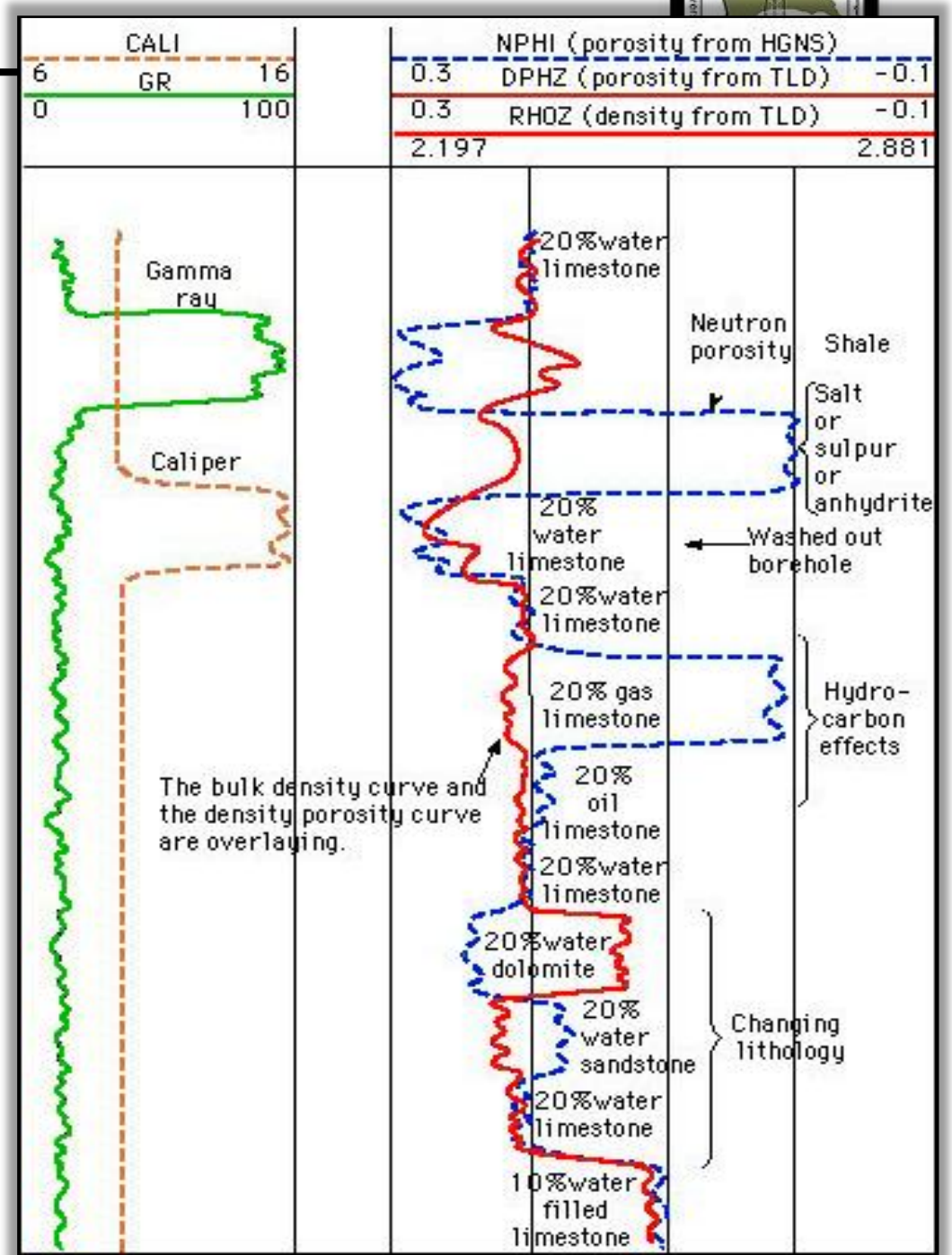


- **The choice of which transform is given by the parameter MATR**

Fluid Effects

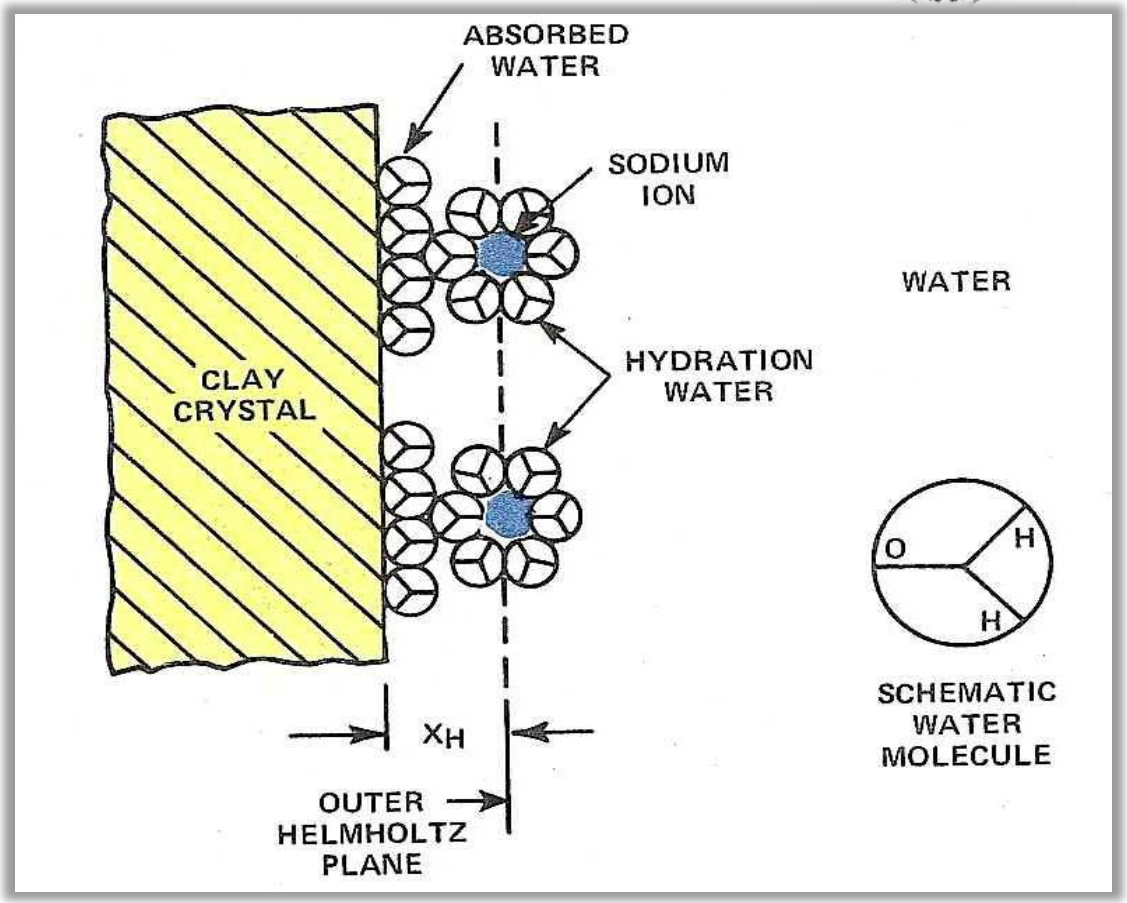
It will read less in oil and even less in gas for the same porosity zone.





Neutron Shale Effect

- The neutron tool detects:
  - Water bound to the surface area of the clay particles
  - OH- ions within the clay lattice



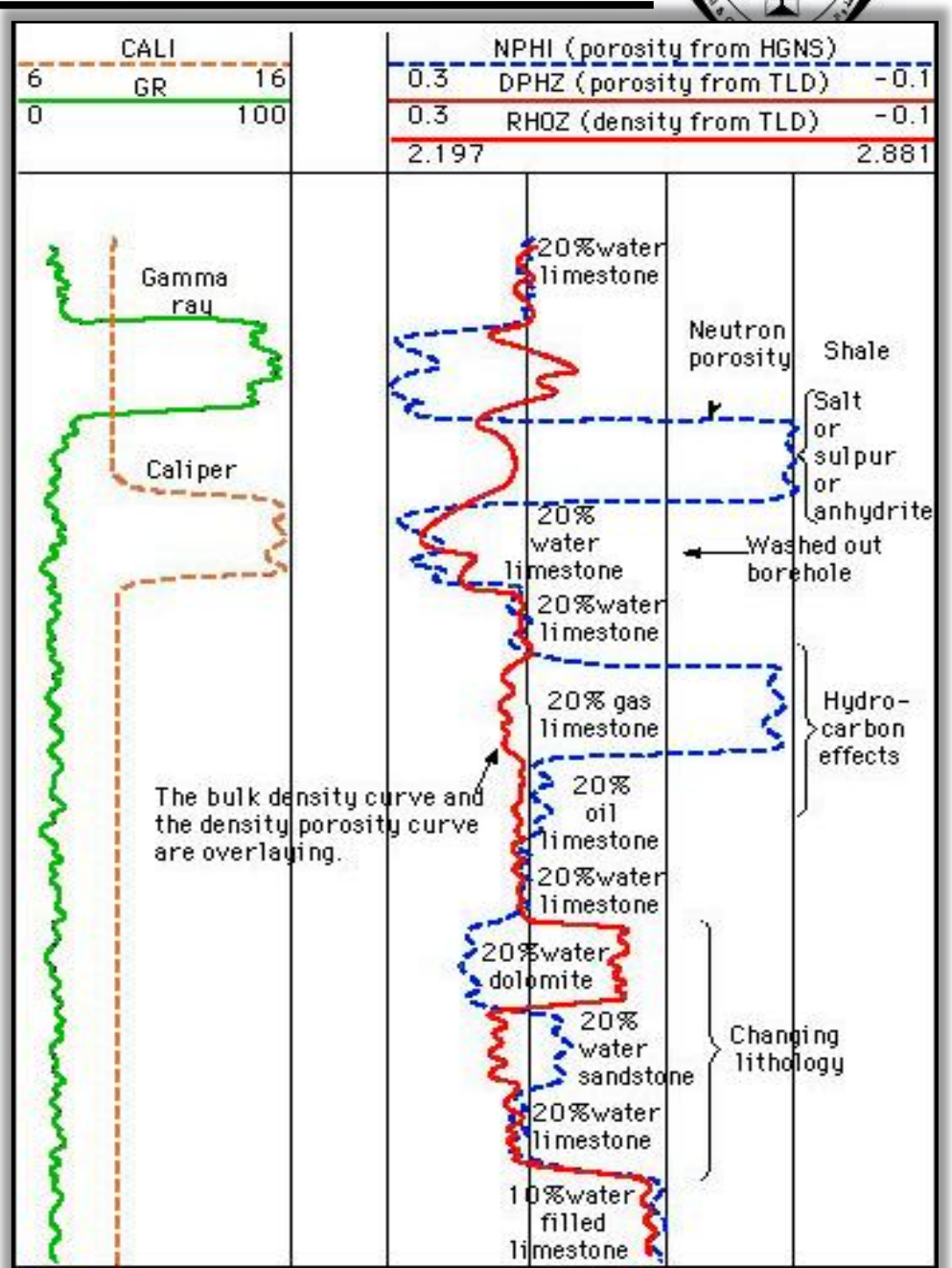
- Net Effect: The neutron porosity to reads too high in shales

Lithology Effects

- Shale – Neutron reads too high
- Lithology

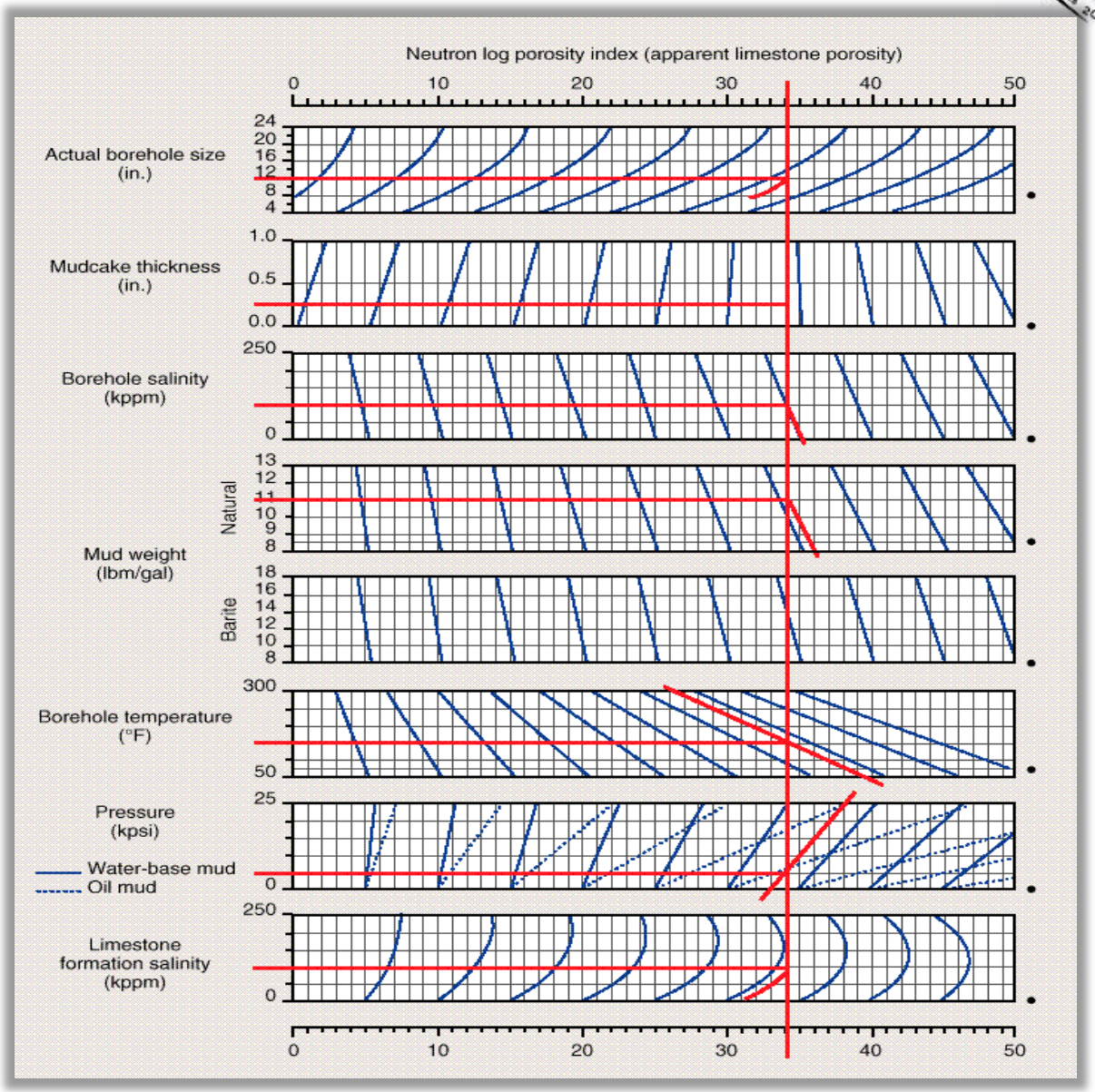
1) Limestone
2) Sandstone
3) Dolomite

- Parameter MATR (OP & GeoFrame) must be set to 'Limestone' to get and accurate porosity in a limestone formation, etc…



Neutron: Environmental Corrections

- Stand-off
- **Borehole size**
- Mud cake
- Borehole salinity
- Mud weight
- **Temperature**
- Pressure
- Formation salinity



Neutron Porosity: LQC

- Washouts – *neutron reads too high*
- Air Drilled Holes – *measurement won't work*
- Strong Neutron Absorbers
- Shales - *neutron porosity to reads too high*
  - Bound Water
  - OH- ions in clay lattice
- Matrix Transform (Parameter = MATR)
  - Limestone, Dolomite, Sandstone

- 1- Define reservoir zones
- 2- calculate porosity at one point or more for each reservoir zone
- 3- compare with the neutron apparent porosity. And tell what do you notice.