What is Porosity & How Do We Measure It?

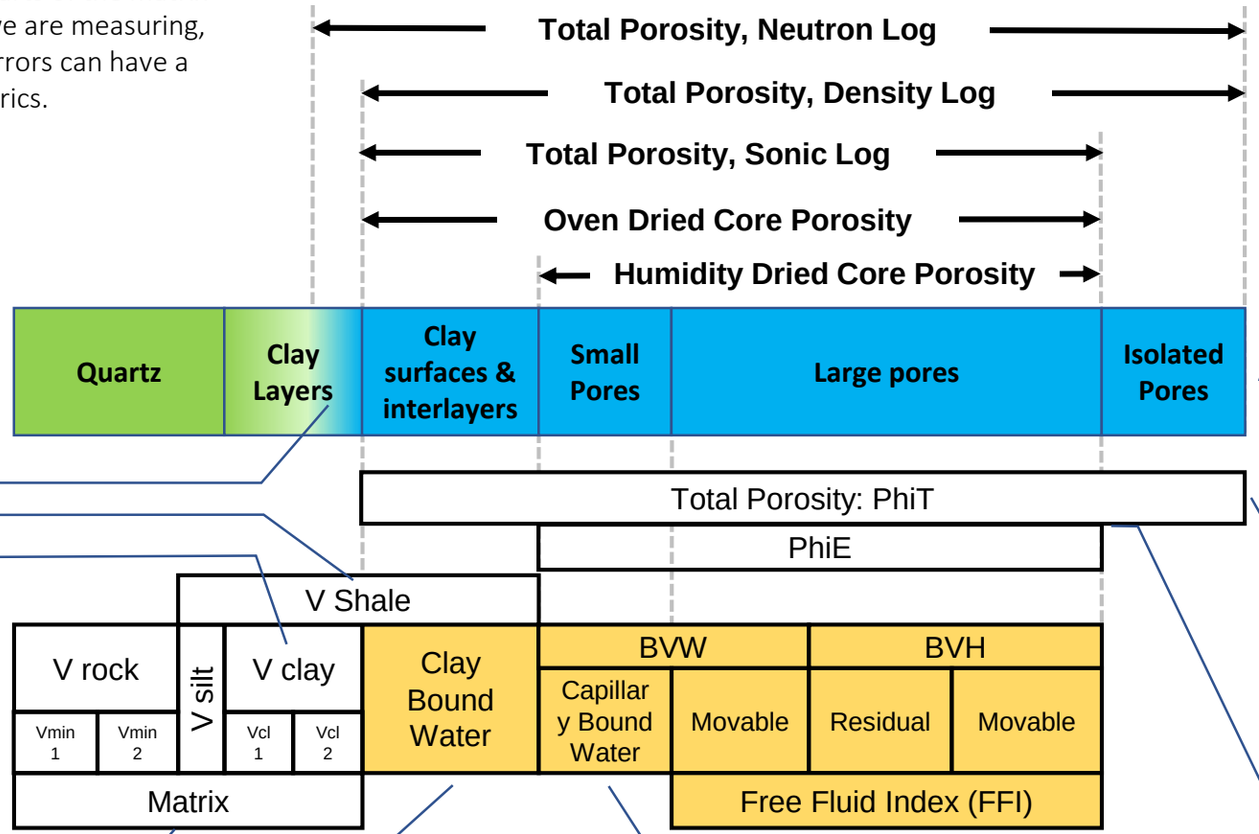
Porosity is not so straight forward. The many different core and log-based methods that we employ all measure slightly different parts of the matrix-porosity system. It is critical that we understand what we are measuring, especially in low porosity systems, where the smallest errors can have a big impact on reservoir property modelling and volumetrics.

Structurally Bound Water. Water molecules that are actually part of the clay crystal structure. These are "seen" by the neutron log, but no other logs

V Shale: Shale is a rock. It is made up of silt, clays, organics, heavy minerals and more. V-shale is typically estimated by measuring the gamma-ray response, which will include an indication of clay, organic and silt-grade K=feldspar abundance (Spooner, 2014).

V Clay: Clay is a mineral. It is not the same as Vshale, although some text books and software seem to use them synonymously. Vclay can be estimated using log techniques, or by analysis of core samples (e.g. X-Ray Diffraction – XRD, SEM)

Matrix: Be careful with Matrix. To a petrophysicist, matrix is everything that is not fluid. To a geologist, the matrix is the fine-grained material between the framework grains!



Isolated Pores: Negligible in most rocks, but important in some carbonates. Can be estimated by taking the difference between Total Porosity from Neutron or Density and the Total Porosity from Sonic (but pay attention to the impact of structurally bound water).

Total Porosity – PhiT: But which log do we use? They measure different things. In a simple rock with no clay or isolated pores, they should all give the same result. Otherwise, be careful.

Effective Porosity - PhiE: This is the part that we believe will contribute to flow. Typically determined by subtracting V-Shale from PhiT. Clearly with abundant capillary-bound water associated with clays and small pores, and / or isolated pores, this does not always work.

Clay Bound Water: The volume of CBW is dependent on the Qv of the rock (Cation Exchange per Unit Volume i.e. the type of clays) and the salinity of the water.

Capillary Bound Water: Relative volumes of capillary bound water and hydrocarbons depend on the height above Free Water Level (FWL).

NMR Terms: NMR differentiates Bulk Volume Water (BVW) and Bulk Volume Hydrocarbon (BVH). NMR can also differentiate the movable fluids (Free Fluid Index).

Reference

Spooner, P. (2014, September 16). Lifting the Fog of Confusion Surrounding Clay and Shale in Petrophysics. Society of Petrophysicists and Well-Log Analysts.