Density Porosity

The density porosity is usually abbreviated **DPHI** or **PHID** on log panels and denoted as ϕ_d in equations.

The key measurement is the bulk rock density ρ_B (log name **RHOB**) from Litho-Density Tool.

The key model parameters are:

ρ_m	rock matrix density
ρ_{sh}	shale density
ρ_f	pore-saturating fluid density
ρ_{mf}	mud filtrate density
$\{\rho_w, \rho_o, \rho_g\}$	formation water, oil, gas density
s_{xo}	a fraction of pore volume invaded by mud filtrate
$\{s_w, s_o, s_g\}$	original water, oil, gas reservoir saturations $s_w + s_o + s_g = 1$

The values of ρ_m and ρ_{sh} are calibrated for each lithofacies individually and can be assessed as vertical axis cut-off on ρ_B cross-plot against the lab core porosity ϕ_{air} and shaliness V_{sh}.

The model also accounts for saturating rock fluids with fluid density ρ_f.

In overbalance drilling across permeable rocks the saturating fluid is usually mud filtrate.

In underbalance drilling the saturating fluid is identified from resistivity logs.

The **total density porosity** ϕ_d equation is:

(1) $$\phi_d = \frac{\rho_B - \rho_m}{\rho_{fl} - \rho_m}$$

The **effective density porosity** ϕ_{ed} equation is:

(2) $$\phi_{ed} = \phi_d - \frac{\rho_{sh} - \rho_m}{\rho_{fl} - \rho_m} \cdot V_{sh}$$

The fluid density ρ_f is calculated in-situ using the following equation:

(3) $$\rho_f = s_{xo}\rho_{mf} + (1 - s_{xo})(s_w\rho_w + s_o\rho_o + s_g\rho_g)$$

The matrix density is calculated from the following equation:

(4) $$\rho_m = \sum_i V_{m,i}\,\rho_{m,i}$$

where

$V_{m,i}$ – volume share of the *i*-th matrix component,

$\rho_{m,i}$ – density of the *i*-th matrix component,

$\sum_i V_{mi} = 1$.