Pulse Neutron Neutron Thermal Decay Logging (PNN)

Neutron count in time interval $\tau = [\tau_1, \tau_2]$

Neutron Porosity

(1) $$N_{near}[\tau] = \int_{\tau_1}^{\tau_2} N_{near}(t)dt$$

(2) $$N_{far}[\tau] = \int_{\tau_1}^{\tau_2} N_{far}(t)dt$$

(3) $$N2F = \frac{N_{near}[\tau]}{N_{far}[\tau]}$$

Diffusion Correction

(4) $$\phi_T = N2F[\tau] + \Delta_\tau(\phi_N)$$

Neutron Sigma

(5) $$N_{near}(t) = N_{near}(0)\exp(-t\,\Sigma_{near})$$

(6) $$N_{far}(t) = N_{far}(0)\exp(-t\,\Sigma_{far})$$

Diffusion Correction

(7) $$\Sigma_{near} = \Sigma_{frm} + \Delta_{near}(\phi)$$

(8) $$\Sigma_{far} = \Sigma_{frm} + \Delta_{far}(\phi)$$

Neutron Saturation

(9) $$\Sigma_{frm} = (1-\phi)\,\Sigma_m + \phi\,(\Sigma_w\,s_w + \Sigma_o\,s_o + \Sigma_g\,s_g)$$

(10) $$\delta\Sigma_{frm} \approx +/- 1.5 c.u.$$

(11) $$\Sigma_m = \sum_k \Sigma_k$$

(12) $$\Sigma_o \approx 18 \quad 11 < \Sigma_o < 21$$

(13) $$\Sigma_w = 21 + 0.05 * Sal[\text{ppk}]$$

(14) $$\Sigma_g \approx 3$$

(15) $$\Sigma_{sh} \approx 40\,c.u.$$

(16) $$\Sigma_{ls} \approx 7\,c.u.$$

In case of two-component sandstone-shale model:

(17) $$\Sigma_m = (1 - V_{sh})\,\Sigma_{snd} + V_{sh}\,\Sigma_{sh}$$

In case of two-component limestone-shale model:

(18) $$\Sigma_m = (1 - V_{sh})\,\Sigma_{lms} + V_{sh}\,\Sigma_{sh}$$

TSCN, TSCF, NPHI, SIGMA

References

SPE162074 – Memory Pulsed Neutron-Neutron Logging