pickett crossplot method

The pickett crossplot (pickett, 1972) is one of the simplest and the most effective crossplot methods in use, This technique not only gives estimates of water saturation, but can also help determine:

1. formation water resistively (R_w).
2. cementation factor (m).
3. matrix parameters for porosity logs (Δt_{ma} and ρ_{ma}).

The pickett methods is based on the observation that true resistivity (R_1) is a function of porosity ϕ, water saturation (S_w), and cementation factor (m).

A Pickett crossplot is developed by plottin porosity values with deep resistivity (R_{IL4} or R_{LL4}) values on two-by-three cycle log-log paper ($F_{1g,}$ 40).

On the plot, a zone with constant R_w ,m, and S_w equal to 100% will have data points plotted along a single.

Straight-line-trend (fig.40) This straight-line trend represents the R_0 (wey resistivity) line.

The slope of the R_0 line represent water saturation values less than 100%.

The geologist must remember that data points plotted above the R_0 line only represent water saturation less than 100% when R_0 and m are both constant.

A value for R_0 can be obtained from a pickett Crossplot (see Figure 40 for the procedure).

Water saturation (S_w can be quantified from the pickett crossplot method by remembering that S_w that $S_w = R_0 / R_1)^{v2}$.

A porosity value of 10% (0.10) will have a wet resistivity (R_0) value of 5.6 ohms (Fig.40).

The values of various water saturation lines (Fig.40), Parallel to the R_0 line, are determined as follows:

porosity	R_0	R_1	$S_w = \sqrt{(R_0 / R_t)}$
0.10	5.6	2× R_0=11.2	71%
0.10	5.6	4× R_0=22.4	50%
0.10	5.6	6× R_0=33.6	41%
0.10	5.6	8× R_0=44.8	35%
0.10	5.6	14× R_0=78.4	27%
0.10	5.6	20× R_0=112.0	22%

After you determine the R_0 line (S_w = 100%), you can plot the lower water saturation values (see above listing) parallel to the R_0 line.

Your next step is plotting on the crossplot actual values from the zone you are interested in.

This will give you a "quick look" assessment of a zone's water saturation.

As an example, given: $\phi = 0.21, R_0 = 1.5, R_t = 40$.

By the formula:

$$S_w = \sqrt{R_0 / R_t}$$

Then a value for $S_w = 19.4\%$ is calculated.

This is already plotted of figure 40. As other points are added, you will have a better picture of the range of water saturations for the well. In addition to plotting true porosity versus deep resistivity (R_{ILd} or R_{LLd}) on a Pickett crossplot, the following can also be plotted on the vertical (or y) axis:

$$\Delta t - \Delta t_{ma}$$

Where:

$\Delta t =$ interval transit time of formation.

$\Delta t_{ma} =$ interval transit time of matrix.

$$\rho_{ma} - \rho_b$$

Where:

$\rho_{ma} =$ density of matrix.

$\rho_b =$ bulk density of information.

$$\phi_{snp} \text{ or } \phi_{cnl}$$

Where:

$\phi_{snp} =$ side wall neutron porosity, lime stone ϕ units.

$\phi_{cnl} =$ compensated neutron porosity, limestone ϕ units.

When $\Delta t - \Delta t_{ma}$ or $\rho_{ma} - \rho_b$ plotted versus R_t (R_{ILd} or R_{LLd}), a value for information matrix (Δt_{ma} or ρ_{ma}) must be used. Pickett (1972) suggests that whenever Δt_{ma} or ρ_{ma}, selected foe the log-log crossplot, is incorrect, the R_0 line for $\Delta t - \Delta t_{ma}$ or $\rho_{ma} - \rho_b$ versus R_t plot will not plot as a straight line (Fig.40), but will curve. A geologist should try several matrix values (Δt_{ma} or ρ_{ma}) until the R_0 line is straight. By such trial and error, a correct matrix parameter (Δt_{ma} or ρ_{ma}) for a formation is determined.

Determining matrix parameters (Δt_{ma} or ρ_{ma}) is an additional benefit of the pickett crossplot technique.

Example of a resistivity porosity (pickett) crossplot, Example taken from the Morrow sand storms, Cimarron County, Oklahoma.

Use the chart to find wet resistivity (R_0) which can be used to compute $R_{w.}$

Given:

Porosity (ϕ) equals 10%; cementation factor (m) is determined by the slope of the R_0 line (see chart) and is equal to 2; formation factor (F) is equal to $0.81/\phi^m$ (SEE TABLE 1).

Procedure:

1. Find the porosity value (10%) on the left-hand scale.
2. Follow the value horizontally until it intersects the sloping R_0 line.
3. Follow the value vertically down from the intersection to the R_{ILd} scale at the bottom, and read the value of R_0 in this case, R_0 equals 5.5 ohms.

In computing R_w from R_0, remember that:

$R_w = R_0 / F$ (see text under heading R_{wa} curve)

$R_w = 5.6/81$

$R_w = 0.069$ at formation tempreture.