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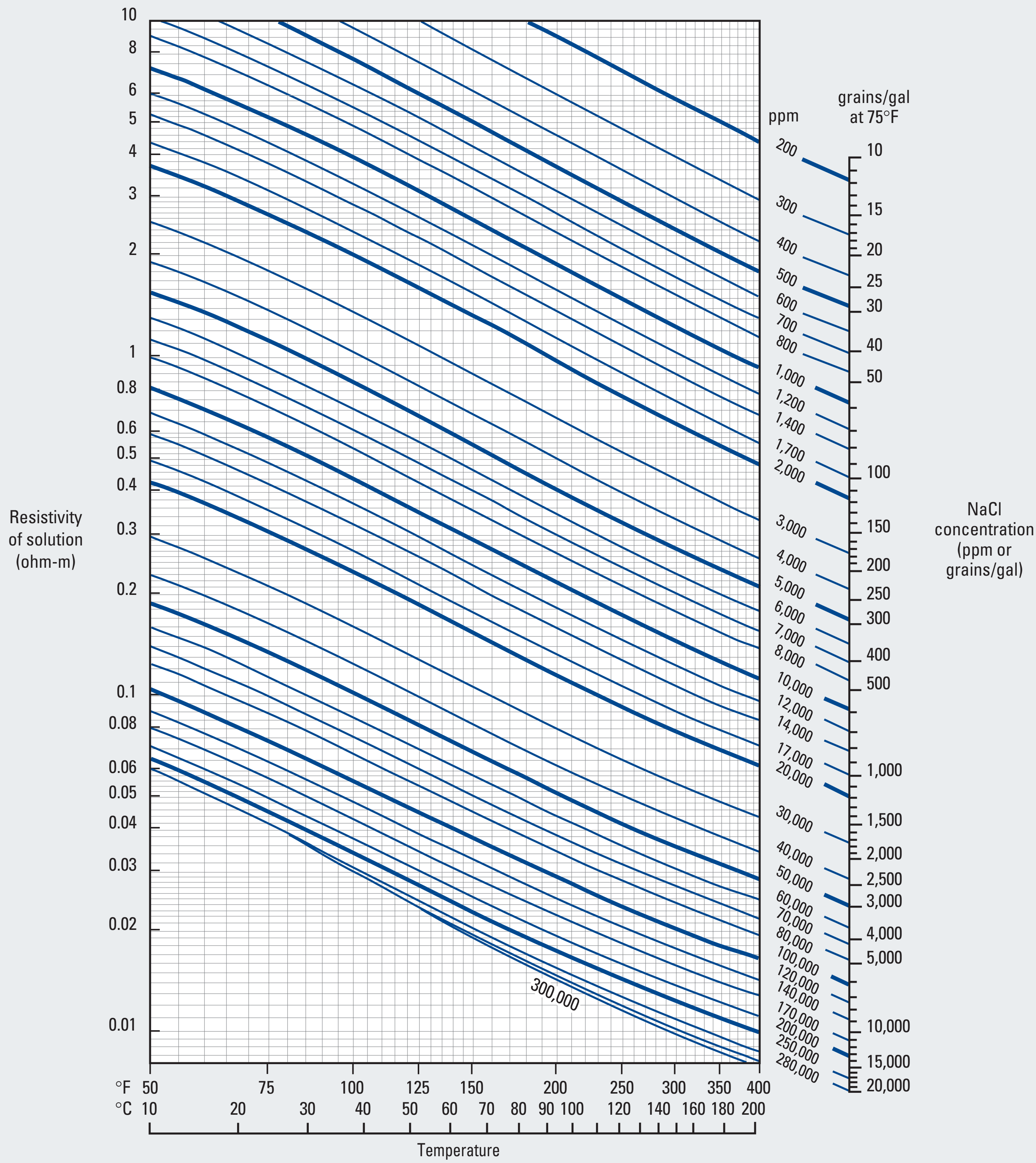
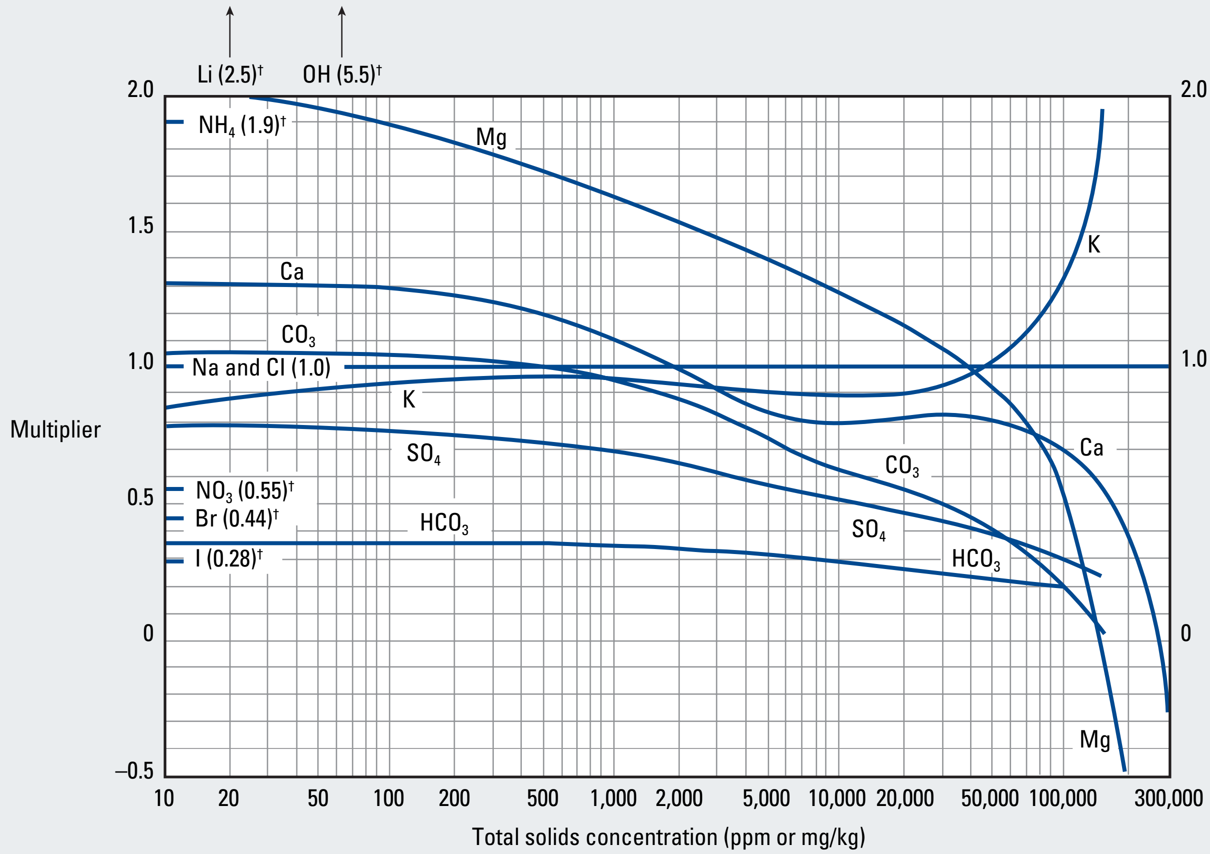
Resistivity of NaCl Water Solutions

Gen-6
(former Gen-9)

Conversion approximated by $R_2 = R_1 [(T_1 + 6.77)/(T_2 + 6.77)]°F$ or $R_2 = R_1 [(T_1 + 21.5)/(T_2 + 21.5)]°C$



Equivalent NaCl Salinity of Salts



† Multipliers that do not vary appreciably for low concentrations (less than about 10,000 ppm) are shown at the left margin of the chart

Purpose

This chart is used to approximate the parts-per-million (ppm) concentration of a sodium chloride (NaCl) solution for which the total solids concentration of the solution is known. Once the equivalent concentration of the solution is known, the resistivity of the solution for a given temperature can be estimated with Chart Gen-6.

Description

The x-axis of the semilog chart is scaled in total solids concentration and the y-axis is the weighting multiplier. The curve set represents the various multipliers for the solids typically in formation water.

Example

Given: Formation water sample with solids concentrations of calcium (Ca) = 460 ppm, sulfate (SO_4) = 1,400 ppm, and Na plus Cl = 19,000 ppm. Total solids concentration = 460 + 1,400 + 19,000 = 20,860 ppm.

Find: Equivalent NaCl solution in ppm.

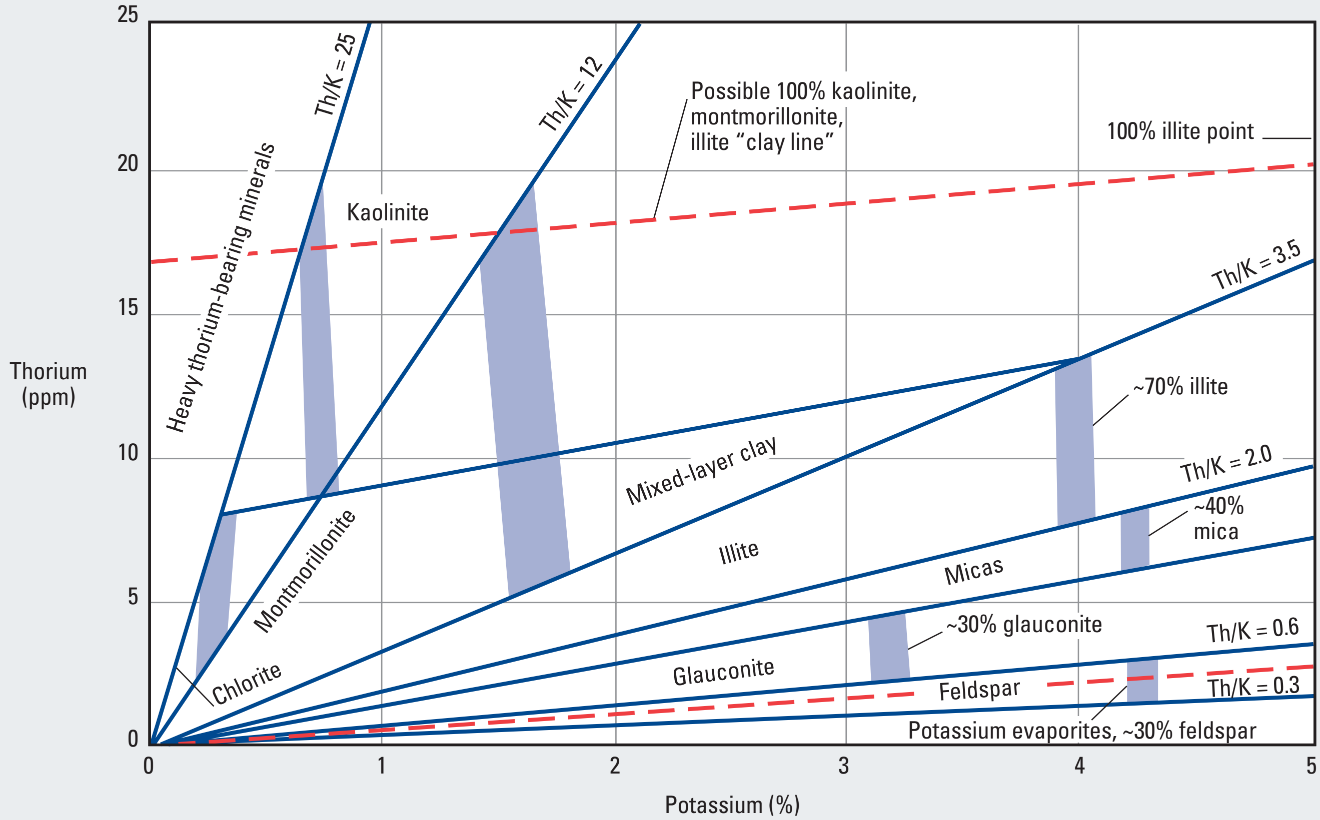
Answer: Enter the x-axis at 20,860 ppm and read the multiplier value for each of the solids curves from the y-axis: Ca = 0.81, SO_4 = 0.45, and NaCl = 1.0. Multiply each concentration by its multiplier:

$(460 \times 0.81) + (1{,}400 \times 0.45) + (19{,}000 \times 1.0) = 20{,}000$ ppm.

NGS* Natural Gamma Ray Spectrometry Tool

Mineral Identification—Open Hole

Lith-2
(former CP-19)



*Mark of Schlumberger

Purpose

This chart is used to determine the type of minerals in a shale formation from concentrations measured by the NGS Natural Gamma Ray Spectrometry tool.

Description

Entering the chart with the values of thorium and potassium locates the intersection point used to determine the type of radioactive minerals that compose the majority of the clay in the formation.

A sandstone reservoir with varying amounts of shaliness and illite as the principal clay mineral usually plots in the illite segment of the chart with Th/K between 2.0 and 3.5. Less shaly parts of the reservoir plot closer to the origin, and shaly parts plot closer to the 70% illite area.

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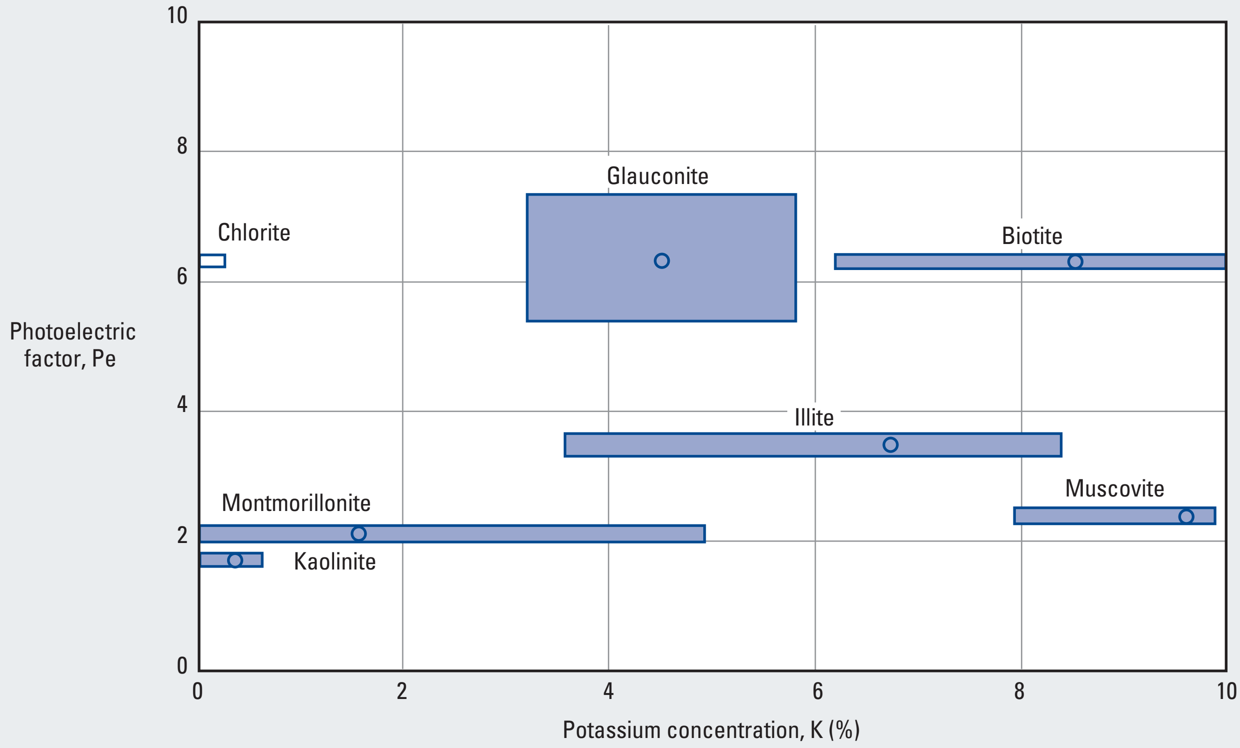
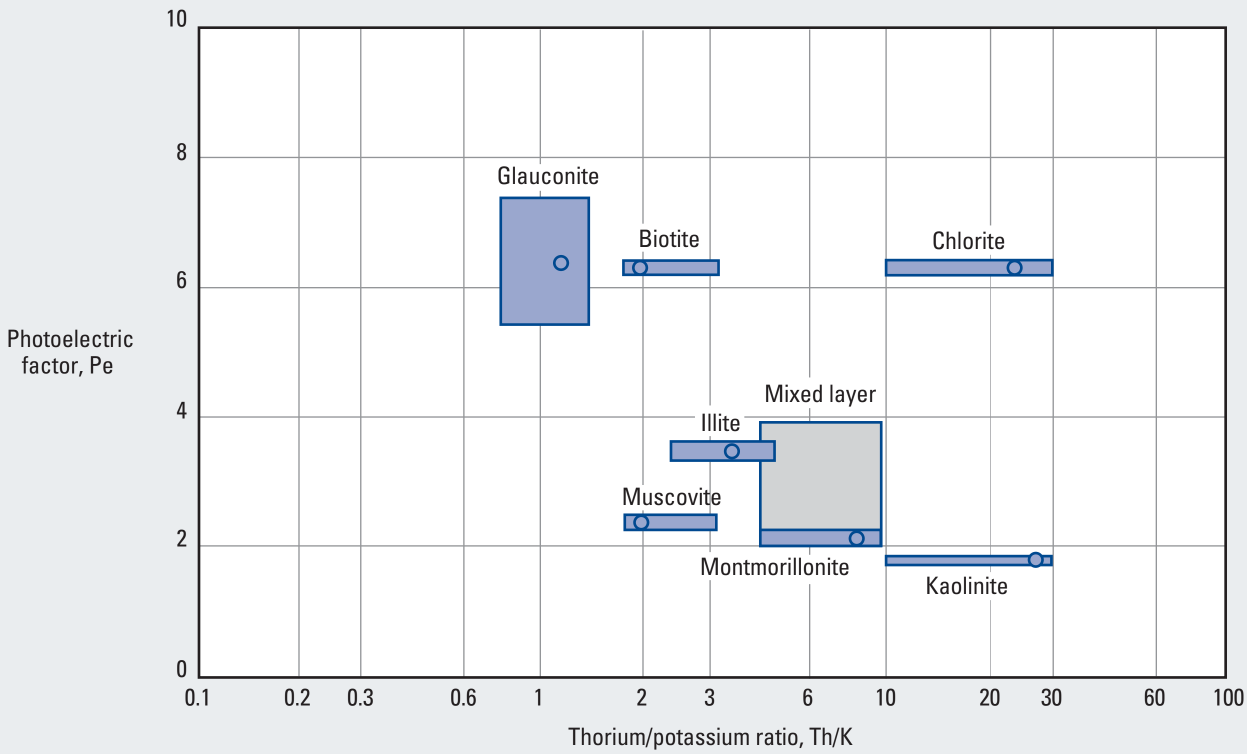
Density and NGS* Natural Gamma Ray Spectrometry Tool

Mineral Identification—Open Hole

Lith-1
(former CP-18)





*Mark of Schlumberger

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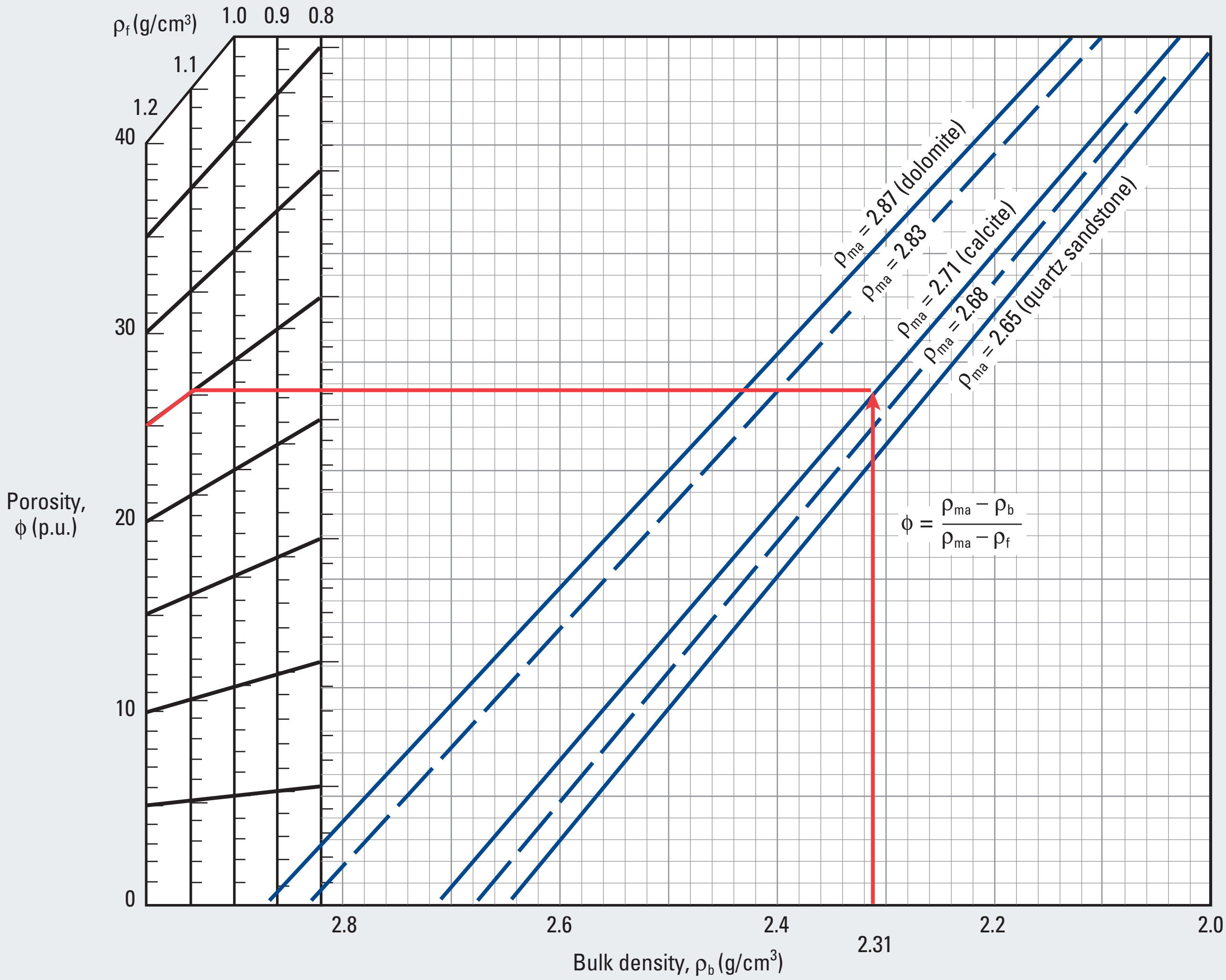
Density Tool

Porosity Determination—Open Hole

Por-3
(former Por-5)



*Mark of Schlumberger

Por

Purpose

This chart is used to convert grain density (g/cm³) to density porosity.

Description

Values of log-derived bulk density (ρ_b) corrected for borehole size, matrix density of the formation (ρ_{ma}), and fluid density (ρ_f) are used to determine the density porosity (ϕ_D) of the logged formation. The ρ_f is the density of the fluid saturating the rock immediately surrounding the borehole—usually mud filtrate.

Enter the borehole-corrected value of ρ_b on the x-axis and move vertically to intersect the appropriate matrix density curve. From the intersection point move horizontally to the fluid density line. Follow the porosity trend line to the porosity scale to read the formation porosity as determined by the density tool. This porosity in combination with CNL* Compensated Neutron Log, sonic, or both values of porosity can help determine the rock type of the formation.

Example

Given: ρ_b = 2.31 g/cm³ (log reading corrected for borehole effect), ρ_{ma} = 2.71 g/cm³ (calcite mineral), and ρ_f = 1.1 g/cm³ (salt mud).

Find: Density porosity.

Answer: ϕ_D = 25 p.u.

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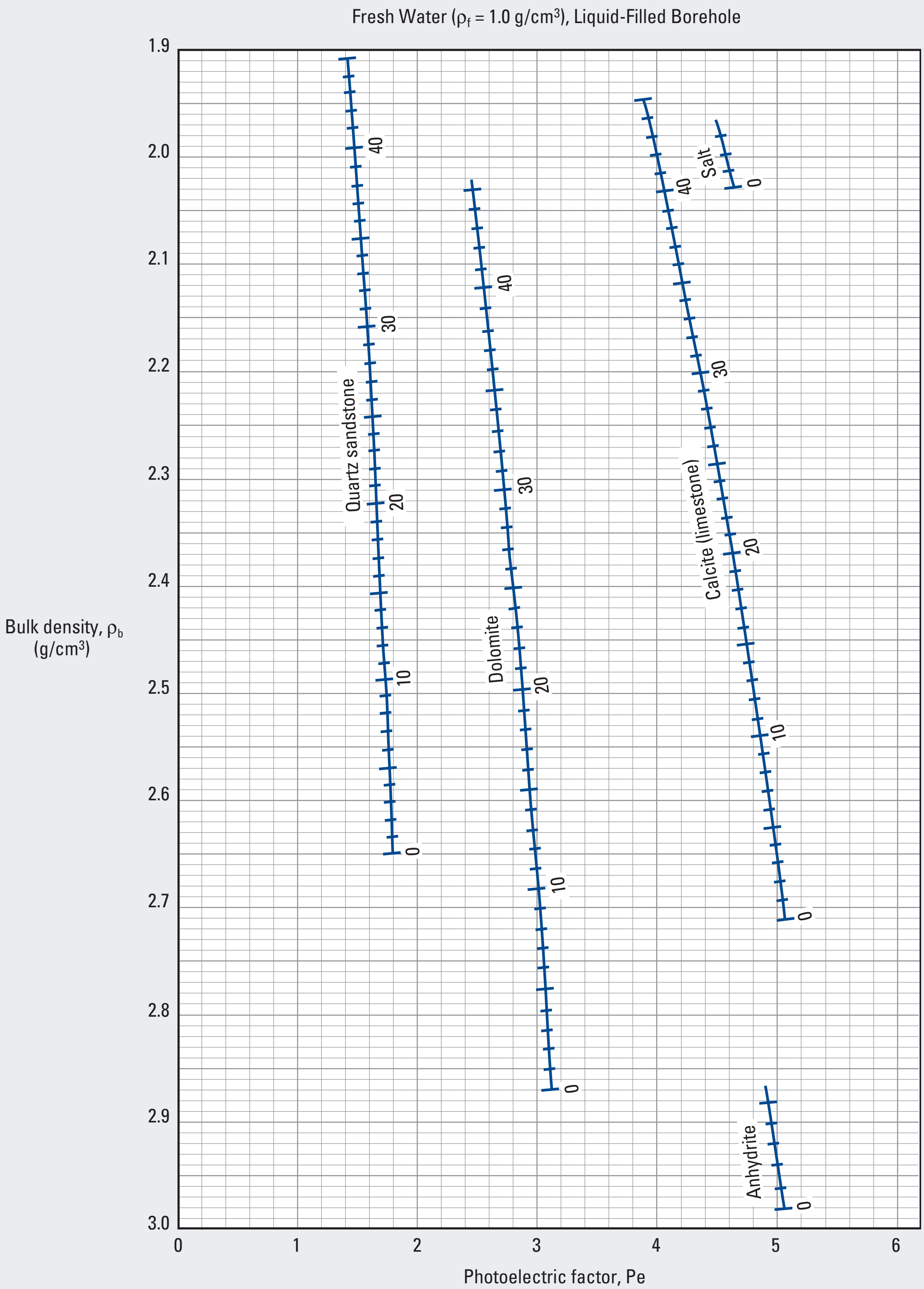
Platform Express* Three-Detector Lithology Density Tool

Porosity and Lithology—Open Hole

Lith-3
(former CP-16)



*Mark of Schlumberger

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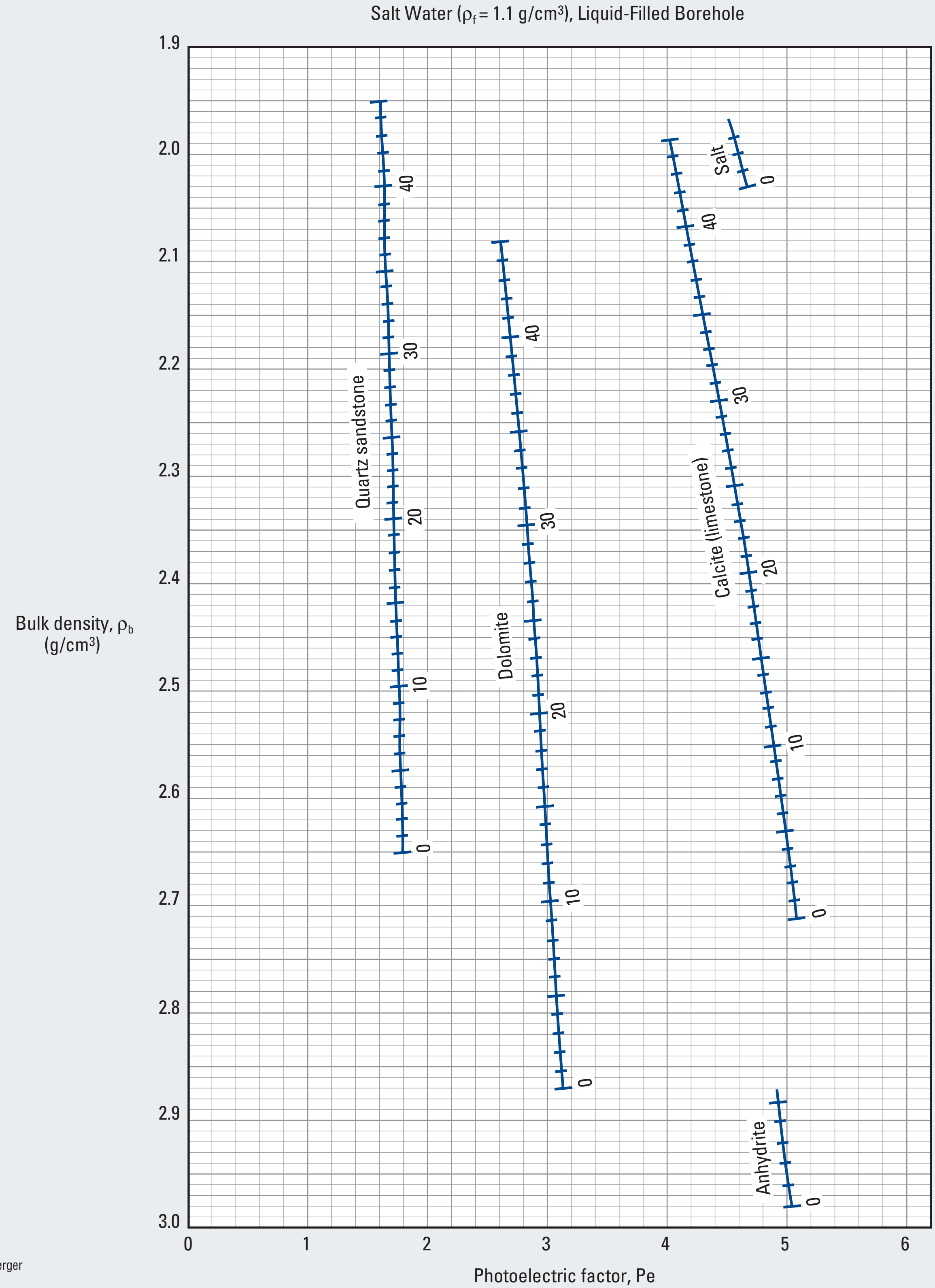
Platform Express* Three-Detector Lithology Density Tool

Porosity and Lithology—Open Hole

Lith-4
(former CP-17)



*Mark of Schlumberger

This chart is used similarly to Chart Lith-3 for lithology and porosity determination with values of photoelectric factor (Pe) and bulk density (ρ_b) from the Platform Express TLD tool in saltwater borehole fluid.

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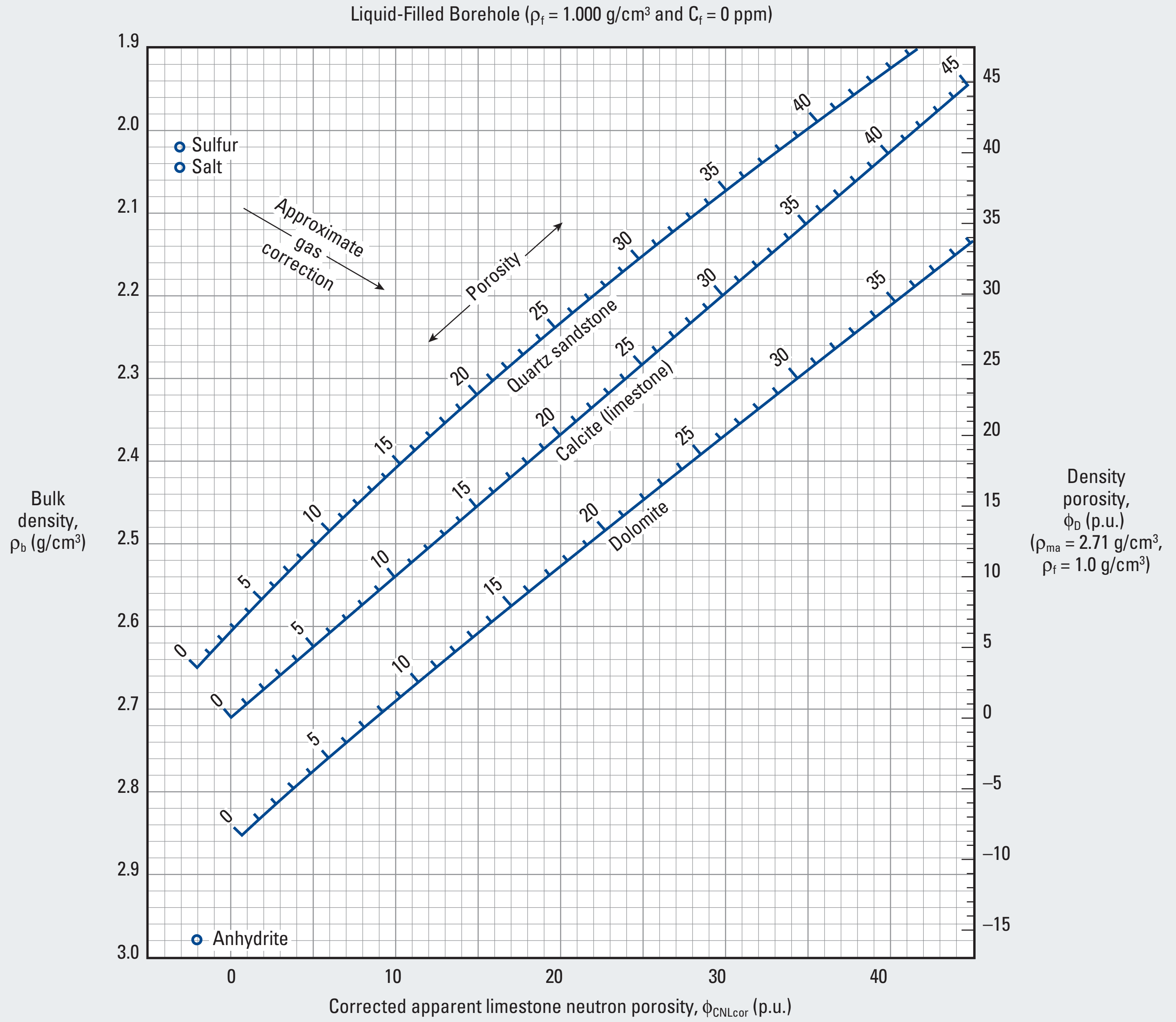
CNL* Compensated Neutron Log and Litho-Density* Tool (fresh water in invaded zone)

Porosity and Lithology—Open Hole

Por-11
(former CP-1e)

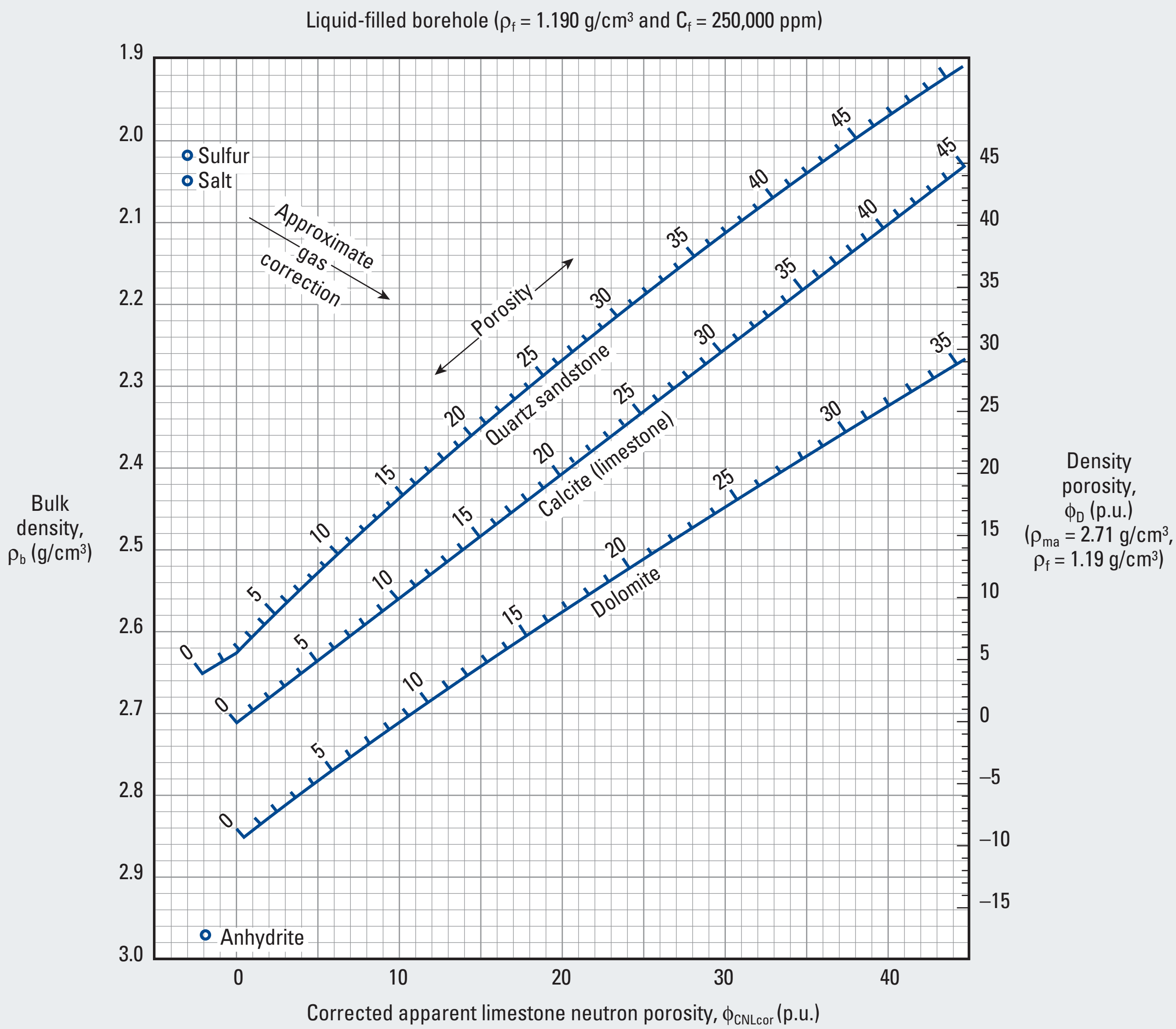


*Mark of Schlumberger

CNL* Compensated Neutron Log and Litho-Density* Tool (salt water in invaded zone)

Por-12
(former CP-11)

Porosity and Lithology—Open Hole



Purpose

This chart is used similarly to Chart Por-11 with CNL Compensated Neutron Log and Litho-Density values to approximate the lithology and determine the crossplot porosity in the saltwater-invaded zone.

Example

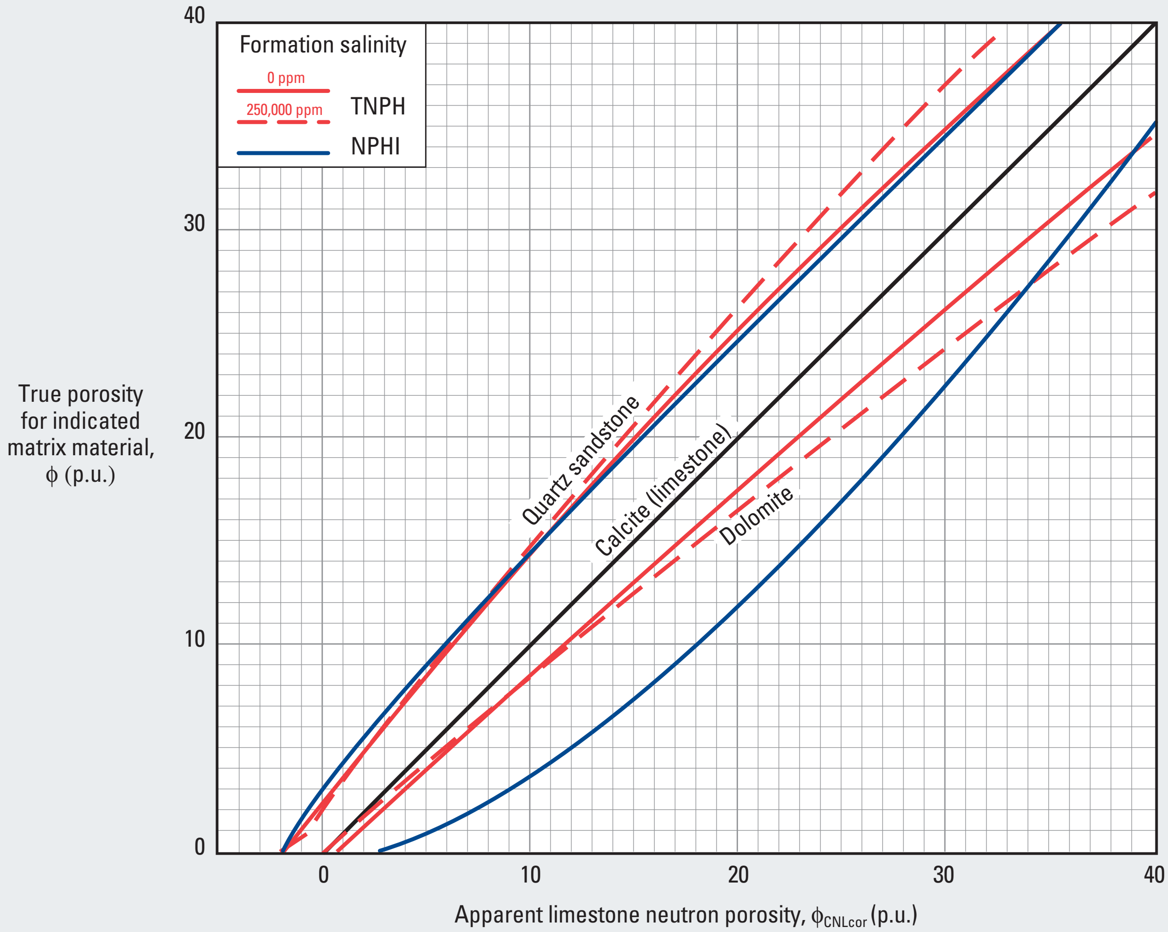
Given: Corrected apparent neutron limestone porosity = 16.5 p.u. and bulk density = 2.38 g/cm^3.

Find: Crossplot porosity and lithology.

Answer: Crossplot porosity = 20 p.u. The lithology is approximately 55% quartz and 45% limestone.

Thermal Neutron Tool

Porosity Equivalence—Open Hole



Purpose

This chart is used to convert CNL* Compensated Neutron Log porosity curves (TNPH or NPHI) from one lithology to another. It can also be used to obtain the apparent limestone porosity (used for the various crossplot porosity charts) from a log recorded in sandstone or dolomite porosity units.

Description

To determine the porosity of either quartz sandstone or dolomite enter the chart with the either the TNPH or NPHI corrected apparent limestone neutron porosity (ϕ_{CNLcor}) on the x-axis. Move vertically to intersect the appropriate curve and read the porosity for quartz sandstone or dolomite on the y-axis. The chart has a built-in salinity correction for TNPH values.

NPHI	Thermal neutron porosity (ratio method)
NPOR	Neutron porosity (environmentally corrected and enhanced vertical resolution processed)
TNPH	Thermal neutron porosity (environmentally corrected)

Example

Given: Quartz sandstone formation, TNPH = 18 p.u. (apparent limestone neutron porosity), and formation salinity = 250,000 ppm.

Find: Porosity in sandstone.

Answer: From the TNPH porosity reading of 18 p.u. on the x-axis, project a vertical line to intersect the quartz sandstone dashed red curve. From the y-axis, the porosity of the sandstone is 24 p.u.

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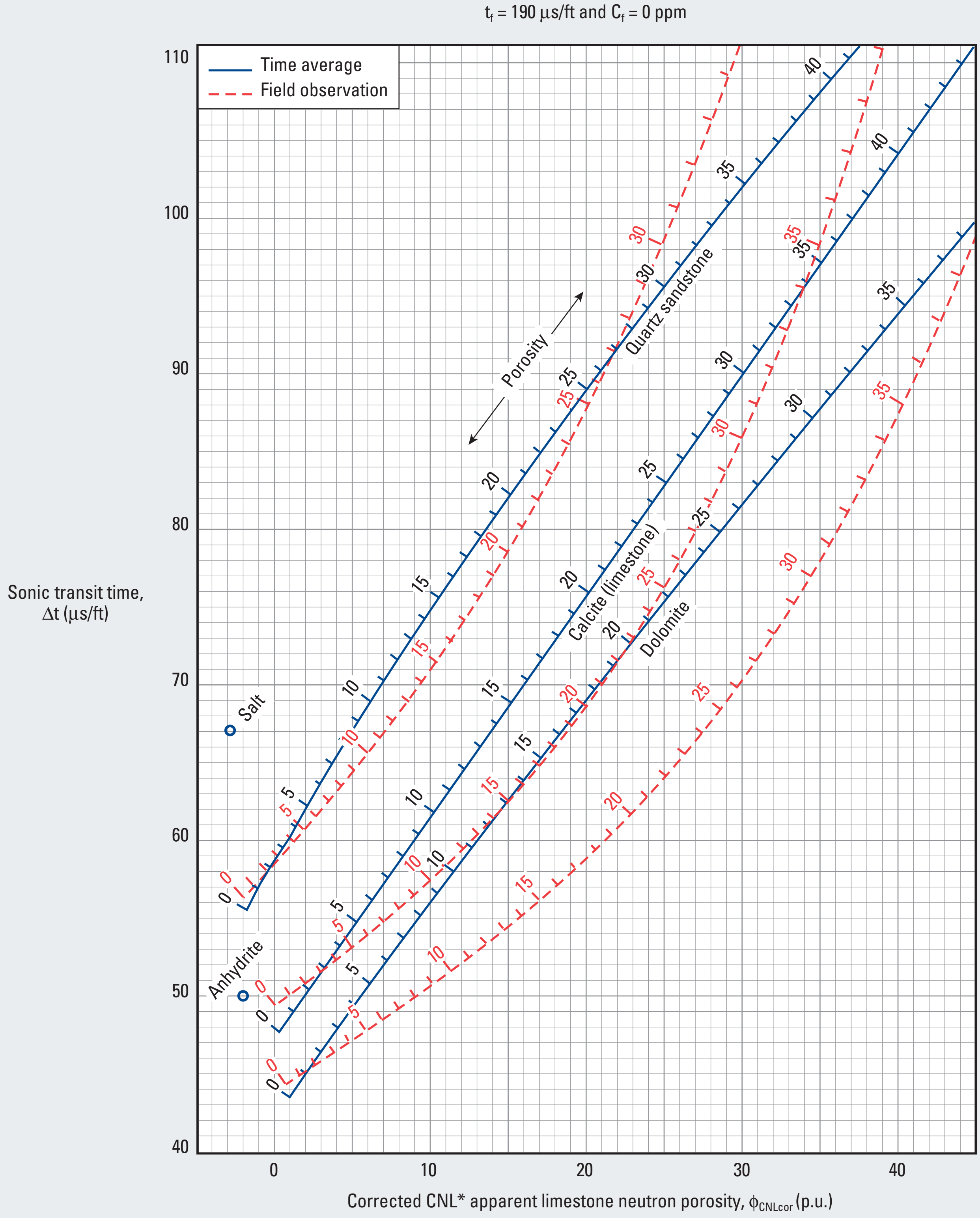
Sonic and Thermal Neutron Crossplot

Porosity and Lithology—Open Hole, Freshwater Invaded

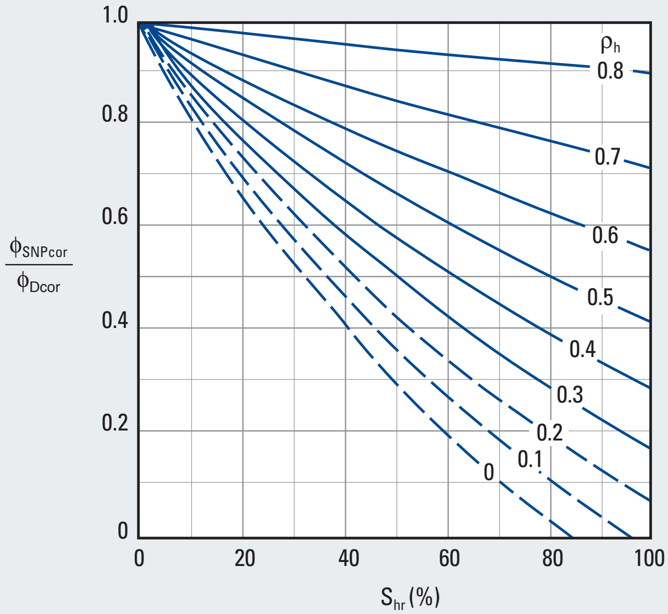
Por-20
(customary, former CP-2c)

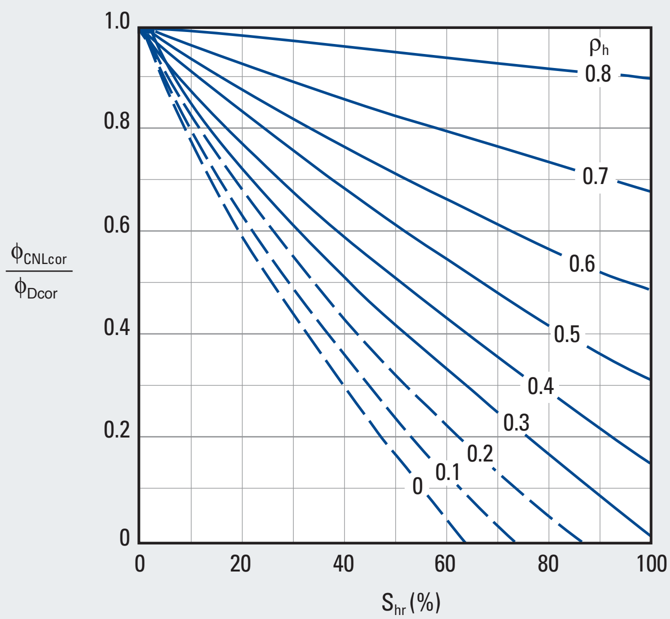


*Mark of Schlumberger

Por

Hydrocarbon Density Estimation





Purpose

This chart is used to estimate the hydrocarbon density (ρ_h) within a formation from corrected neutron and density porosity values.

Description

Enter the ratio of the sidewall neutron porosity (SNP) or CNL* Compensated Neutron Log neutron porosity and density porosity corrected for lithology and environmental effects (ϕ_{SNPcor} or ϕ_{CNLcor} /ϕ_{Dcor}, respectively) on the y-axis and the hydrocarbon saturation on the x-axis. The intersection point of the two values defines the density of the hydrocarbon.

Example

Given: Corrected CNL porosity = 15 p.u., corrected density porosity = 25 p.u., and S_{hr} = 30% (residual hydrocarbon).

Find: Hydrocarbon density.

Answer: Porosity ratio = 15/25 = 0.6. ρ_h = 0.29 g/cm^3.