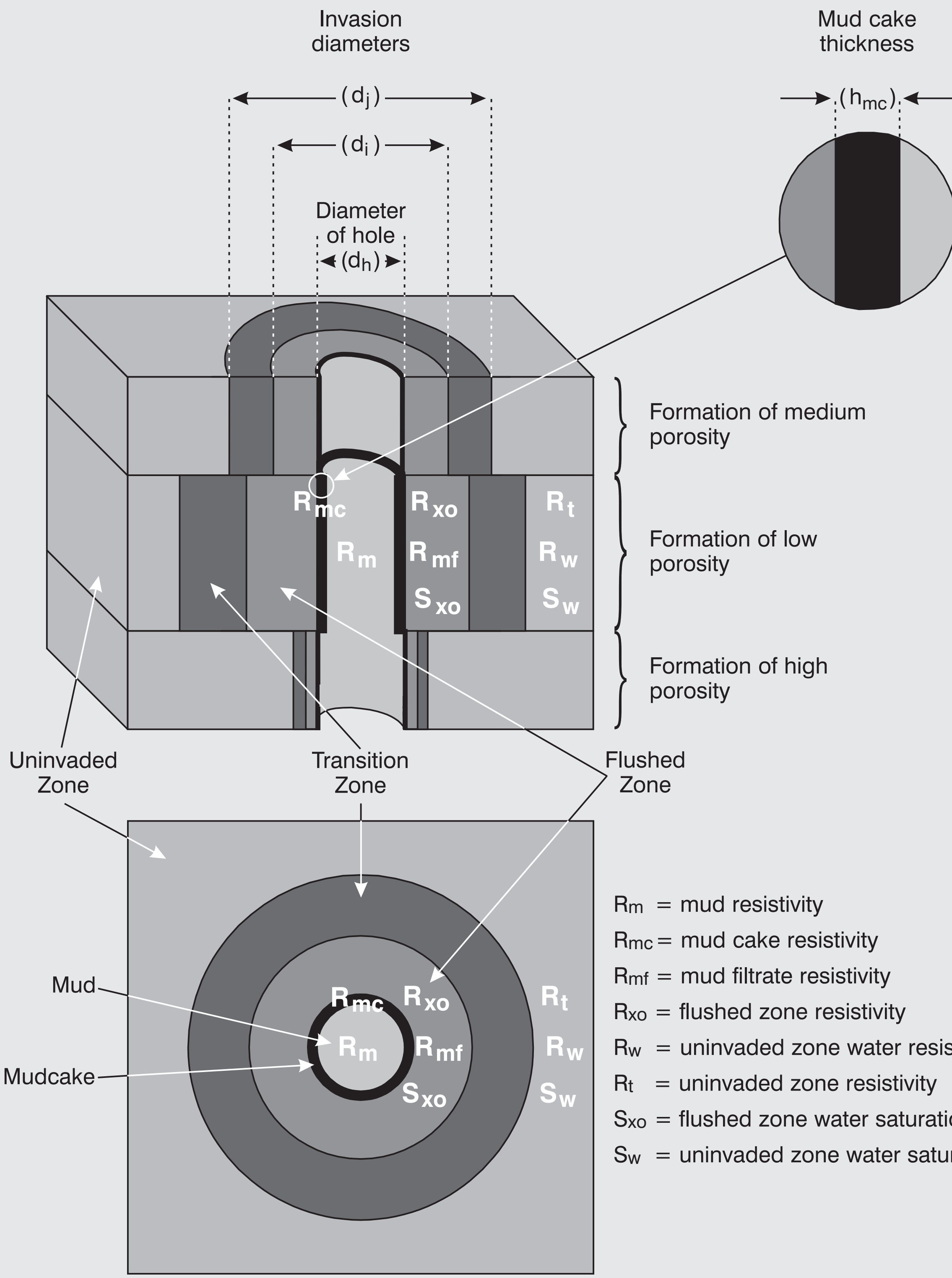
Definition of Parameters



R_m = mud resistivity

R_{mc} = mud cake resistivity

R_{mf} = mud filtrate resistivity

R_{xo} = flushed zone resistivity

R_w = uninvaded zone water resistivity

R_t = uninvaded zone resistivity

S_{xo} = flushed zone water saturation

S_w = uninvaded zone water saturation

Gen - 1

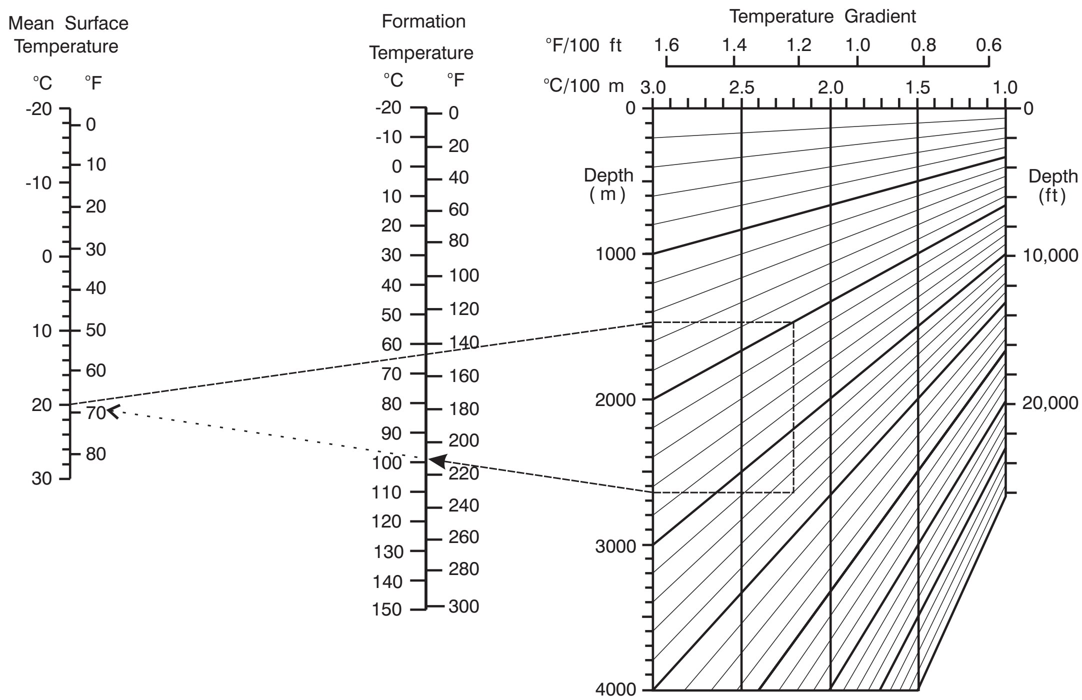


Chart **Gen-2** is used to derive formation temperatures by extrapolation from a known depth and temperature, assuming constant geothermal gradient. It is based on the equation:

$$T_f = T_{ms} + G \times D/100$$

where: $$G = \frac{T_f - T_{ms}}{D} \times 100$$

and D is depth, G the geothermal gradient, T_{ms} the mean surface temperature, and T_f the formation temperature.

Example: Depth = 2000 m T_{ms} = 20°C T_f = 64°C

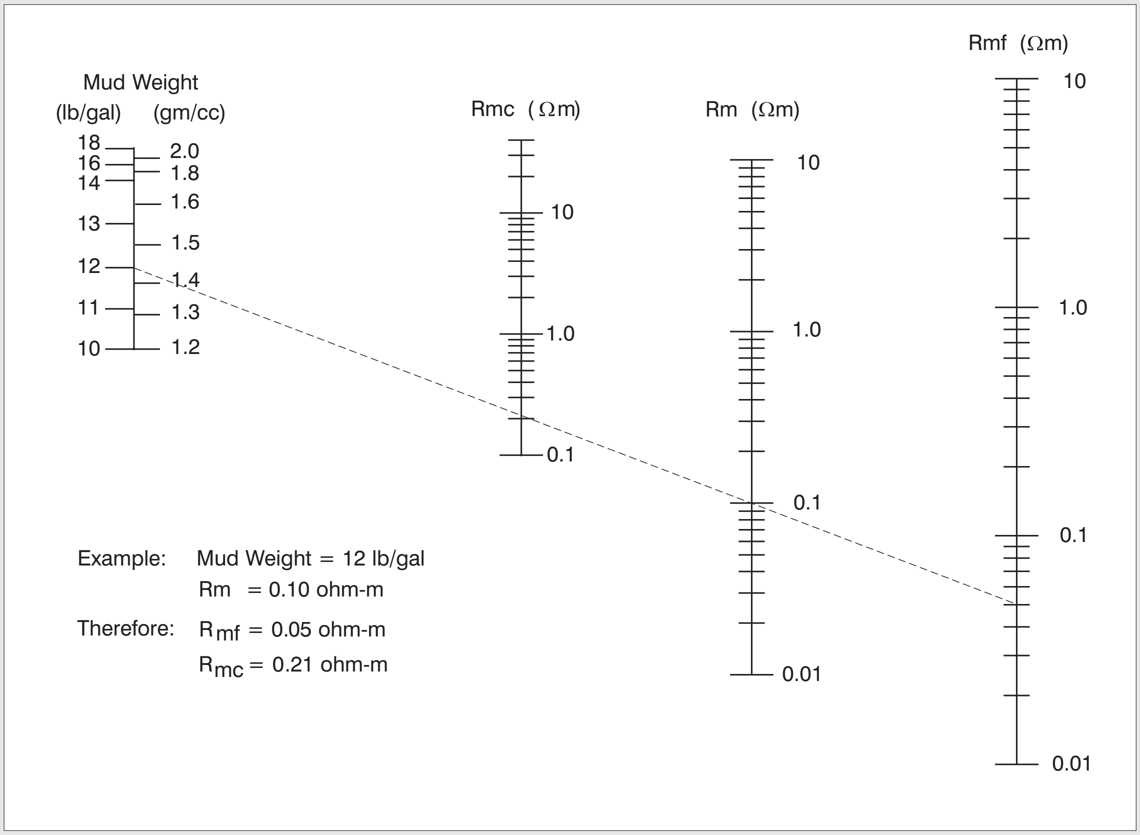
From the chart, G = 2.2 °C /100 m. Formation temperature at 3600 m is 99°C.

Temperature gradient conversions: 1°F/100 ft = 1.823°C/100 m
1°C/100 m = 0.549°F/100 ft

Gen - 2

Estimation of Rmf and Rmc

Applicability: Water based muds. Rm in the range 0.1 to 10 ohm-m at 24℃ (75℉).
Not applicable to lignosulphate muds.



Mud filtrate resistivity Rmf and mud cake resistivity Rmc may be predicted from the mud resistivity R_m using the following functions:

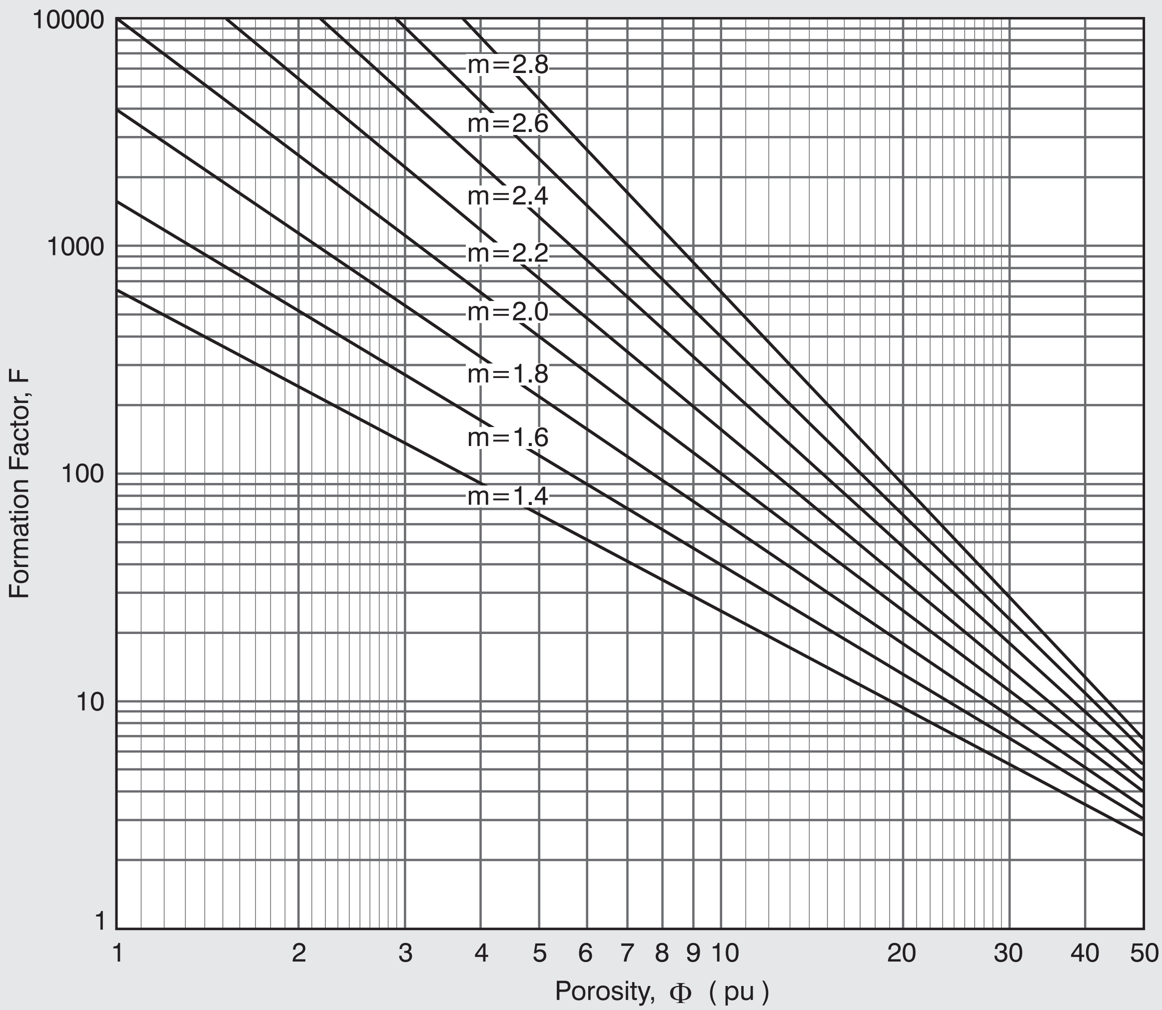
$$R_{mf} = K_m \, (R_m)^{1.07}$$

$$R_{mc} = 0.69 \, R_{mf} \, (R_m / R_{mf})^{2.65}$$

The value of the constant K_m depends on mud weight:

Mud Weight		K_m
lb/gal	gm/cc	
10	1.20	0.847
11	1.32	0.708
12	1.44	0.584
13	1.56	0.488
14	1.68	0.412
16	1.92	0.380
18	2.16	0.350

Gen - 3



Formation factor, F, is defined as R_o/R_w, where R_o is the resistivity of a formation fully saturated with water of resistivity Rw. It is related to formation porosity Φ via a number of empirical relationships of the form

$$F = \frac{a}{\Phi^m}$$

where m is the cementation exponent and **a** is sometimes called the Archie constant. F is used to compute water saturation in the Archie equation: $S_w^n = FR_w/R_t$

The chart allows F to be generated from porosity for values of m between 1.4 and 2.8 assuming **a** to be 1.0. For soft formations, the Humble formula is sometimes used in which **a** is 0.62 and m is 2.15.

Chart Gen - 7 is used to estimate the resistivity of NaCl equivalent solutions when the solids concentration is known, and also to convert resistivity from one temperature to another.

It is based on the Hilchie equation:

$$R(T) = R(1)\ [T(1) + x] / (T+x)$$

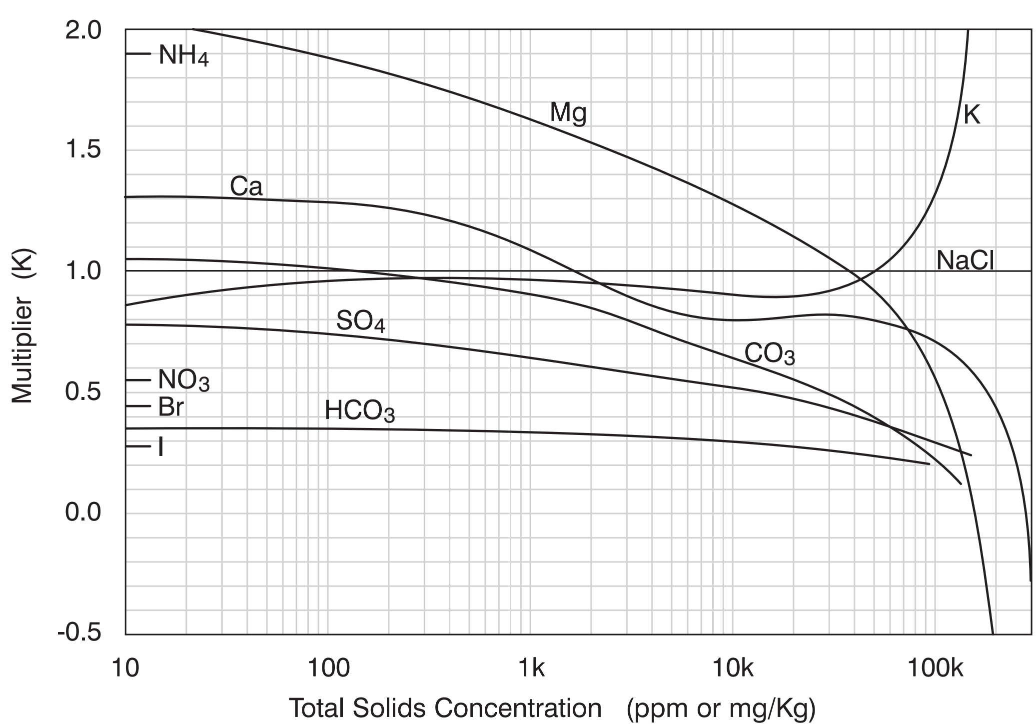
where $$x = 10^{-(0.340396 \log_{10} R(1) - 0.641427)}$$

and R(T) is the water resistivity at temperature T in degrees F and R(1) is the initial water resistivity at initial temperature T(1) degrees F.

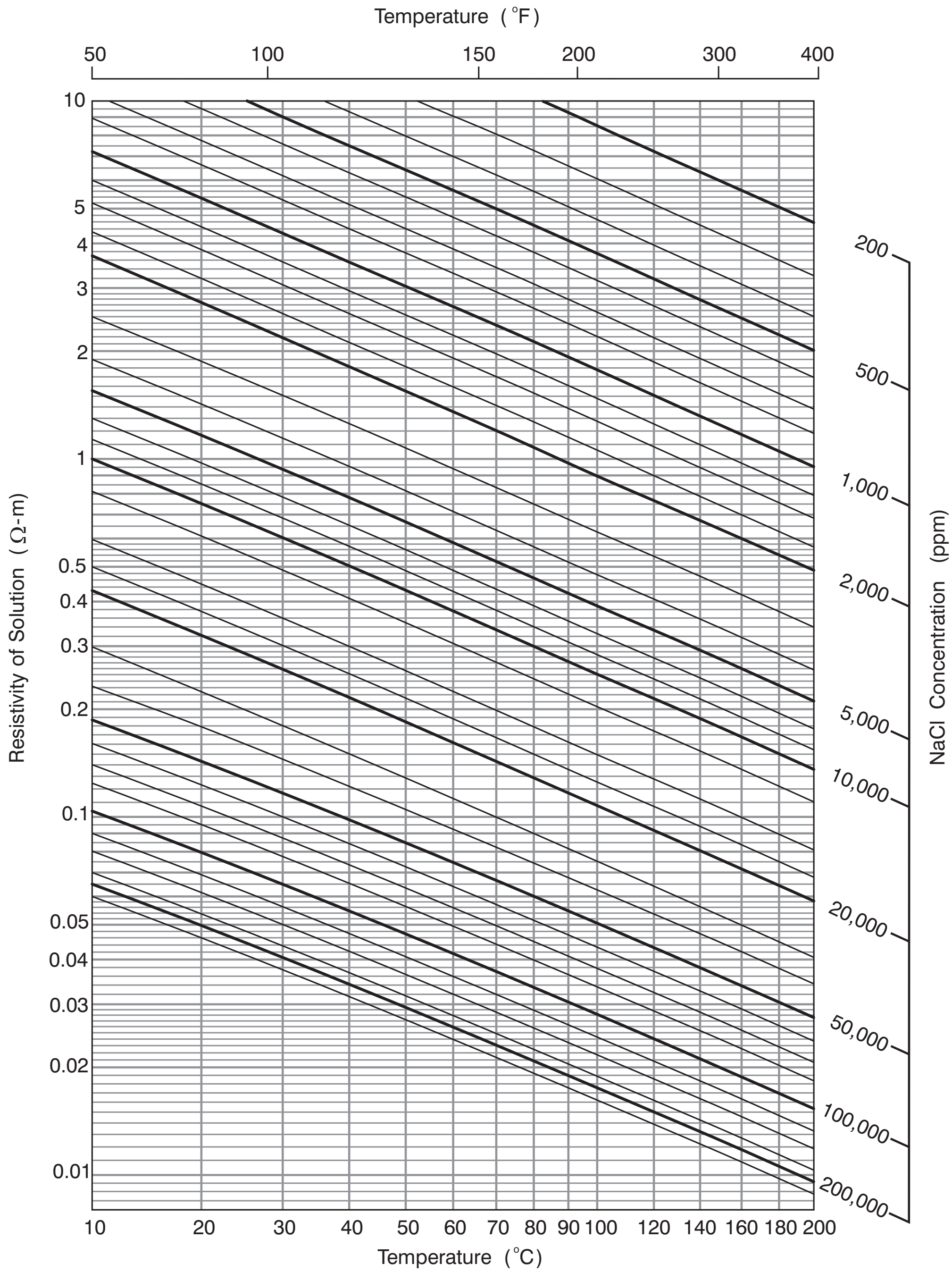
For solutions other than NaCl use the multipliers in **Gen - 6** to obtain equivalent concentrations. Then:

$$\text{Total NaCl equivalent} = \sum_{i=n}^{i=1} K_i \text{(solids concentration)}$$

where n is the number of components. The multiplier for NaCl is 1.0

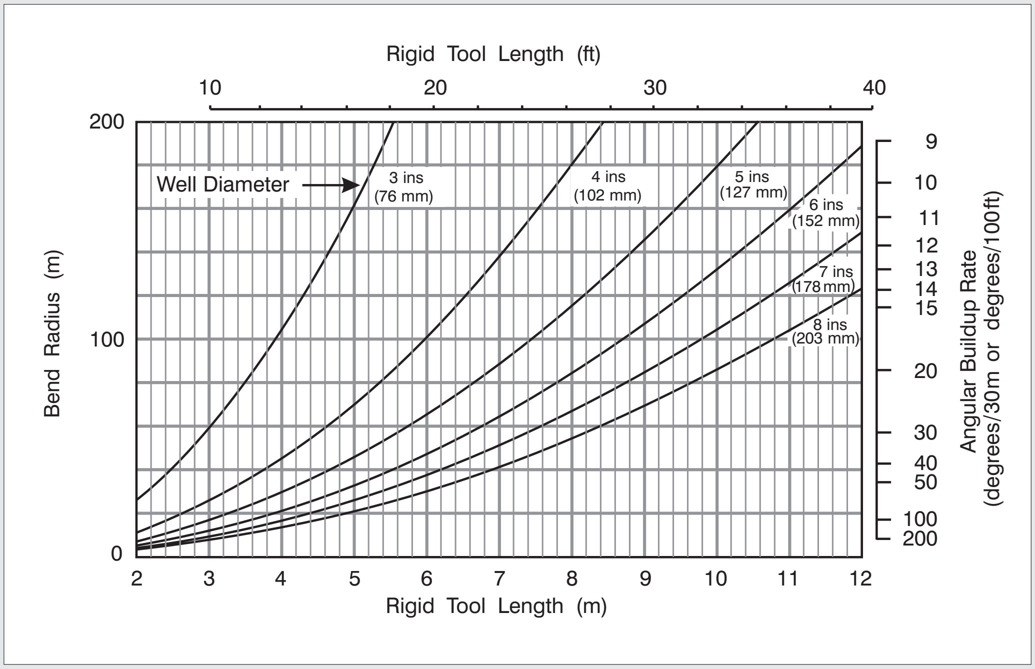


Gen - 6

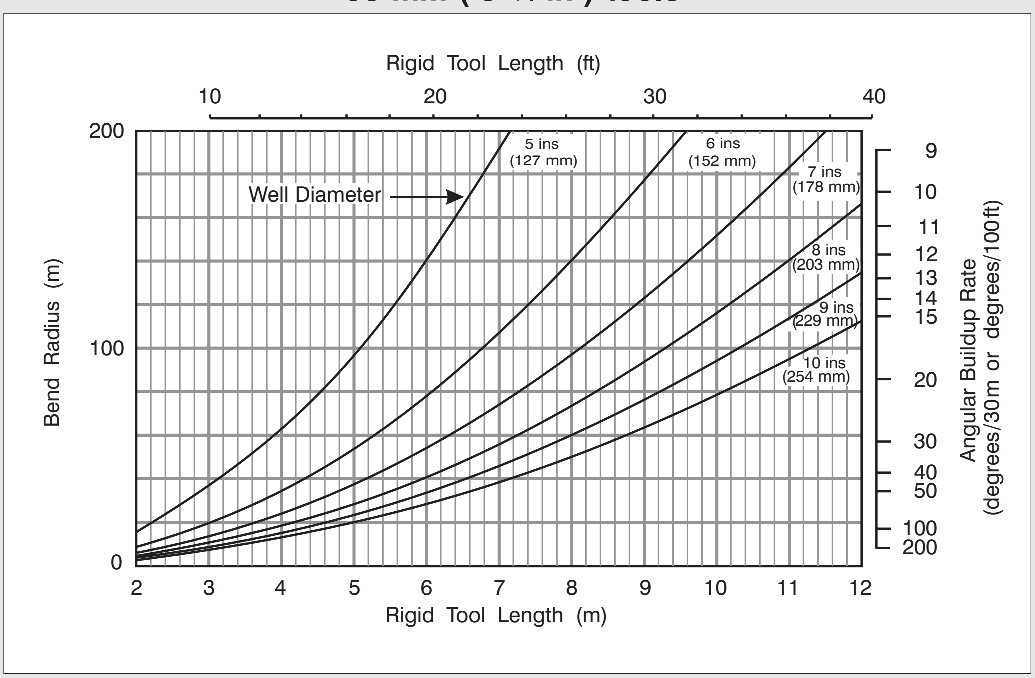

Temperature (°F)
50
100
150
200
300
400
10
5
4
3
2
1
0.5
0.4
0.3
0.2
0.1
0.05
0.04
0.03
0.02
0.01
Resistivity of Solution (Ω-m)
10
20
30
40
50
60
70
80
90
100
120
140
160
180
200
Temperature (°C)
200
500
1,000
2,000
5,000
10,000
20,000
50,000
100,000
200,000
NaCl Concentration (ppm)

Gen - 7

57 mm (2 1/4 in) tools



95 mm (3 3/4 in) tools



For a given tool diameter t, the maximum rigid tool length L that will traverse a well of diameter d and bend radius R is given by:

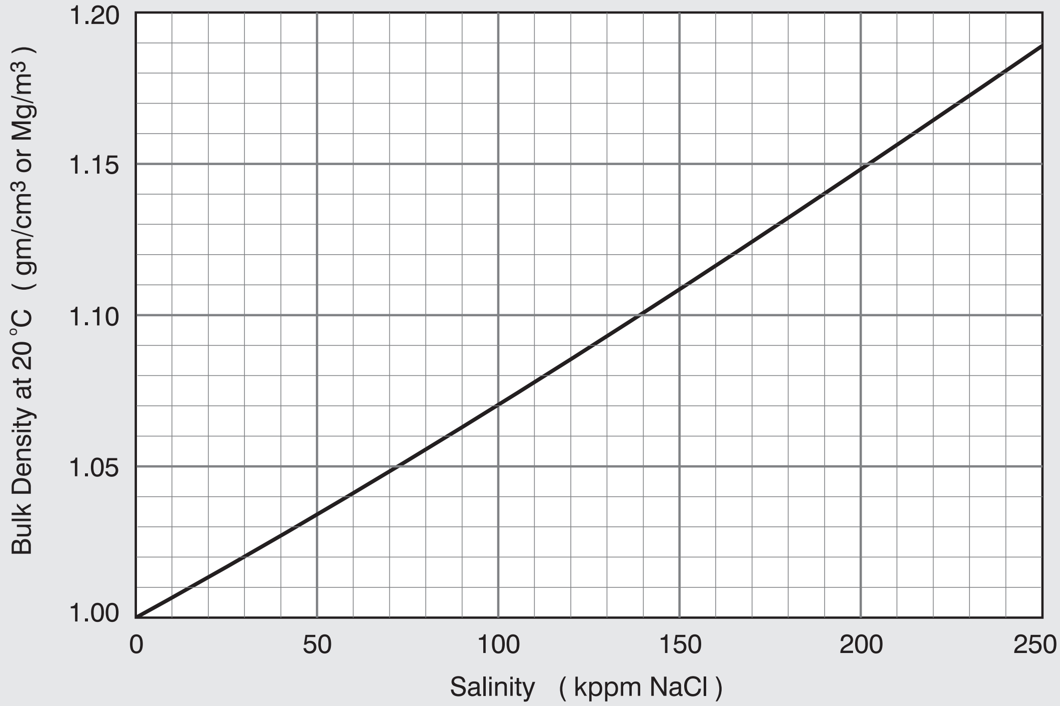
$$L = 2\{(R+d)^2 - (R+t)^2\}^{1/2}$$

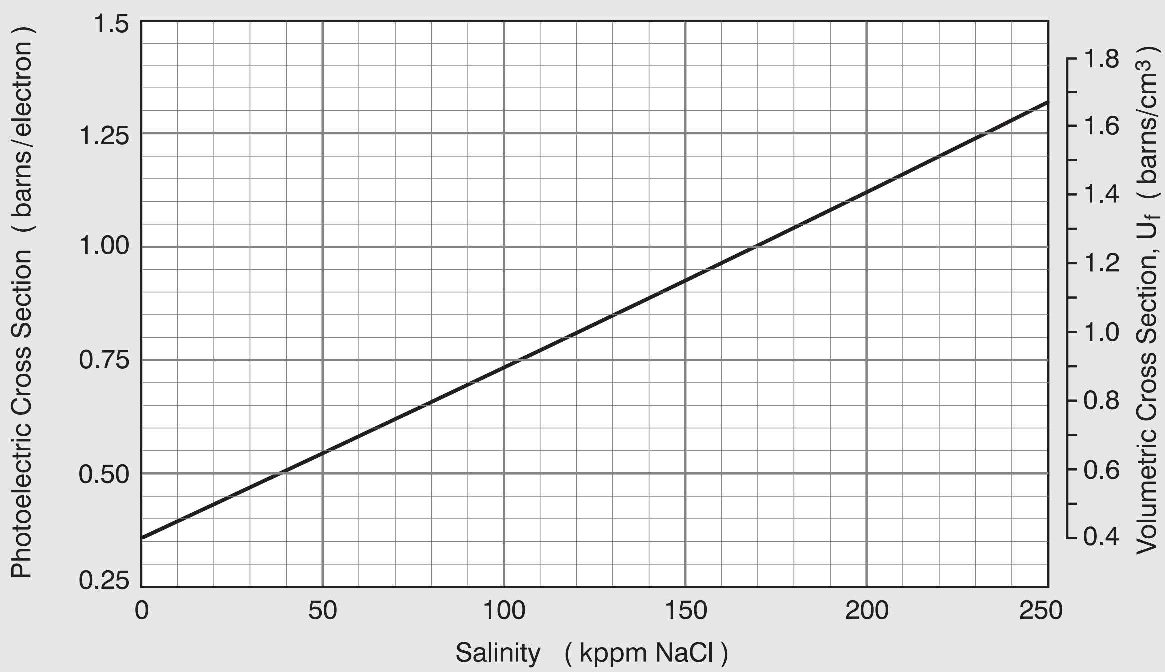
Angular build rate (degrees / 30 m) = 1718/R (R in m)

Gen - 8

Density and Pe Values of Salt Water Solutions

Applicability: NaCl solutions at 20°C.

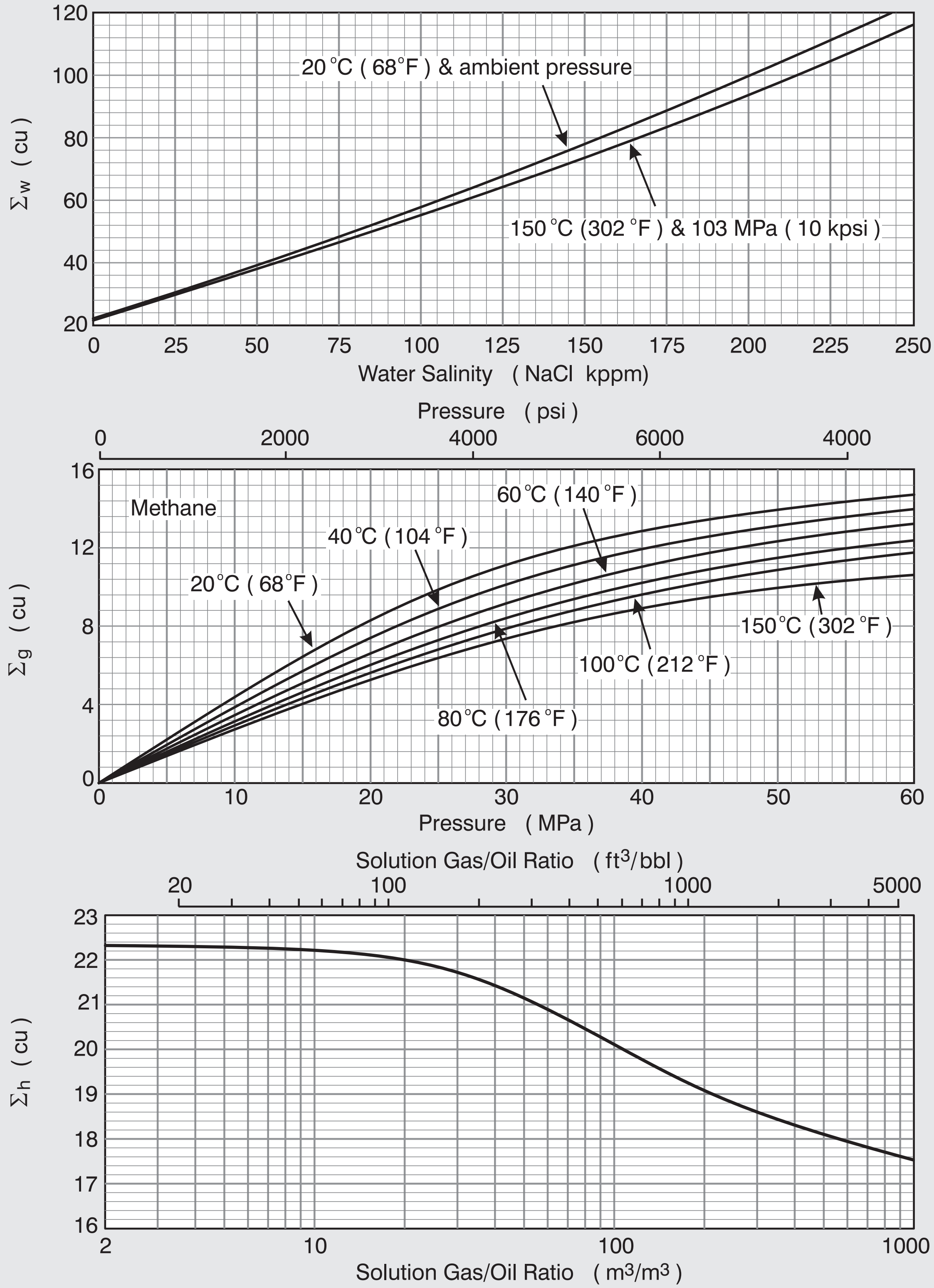




Gen - 9

Capture Cross Sections for Water & Hydrocarbons

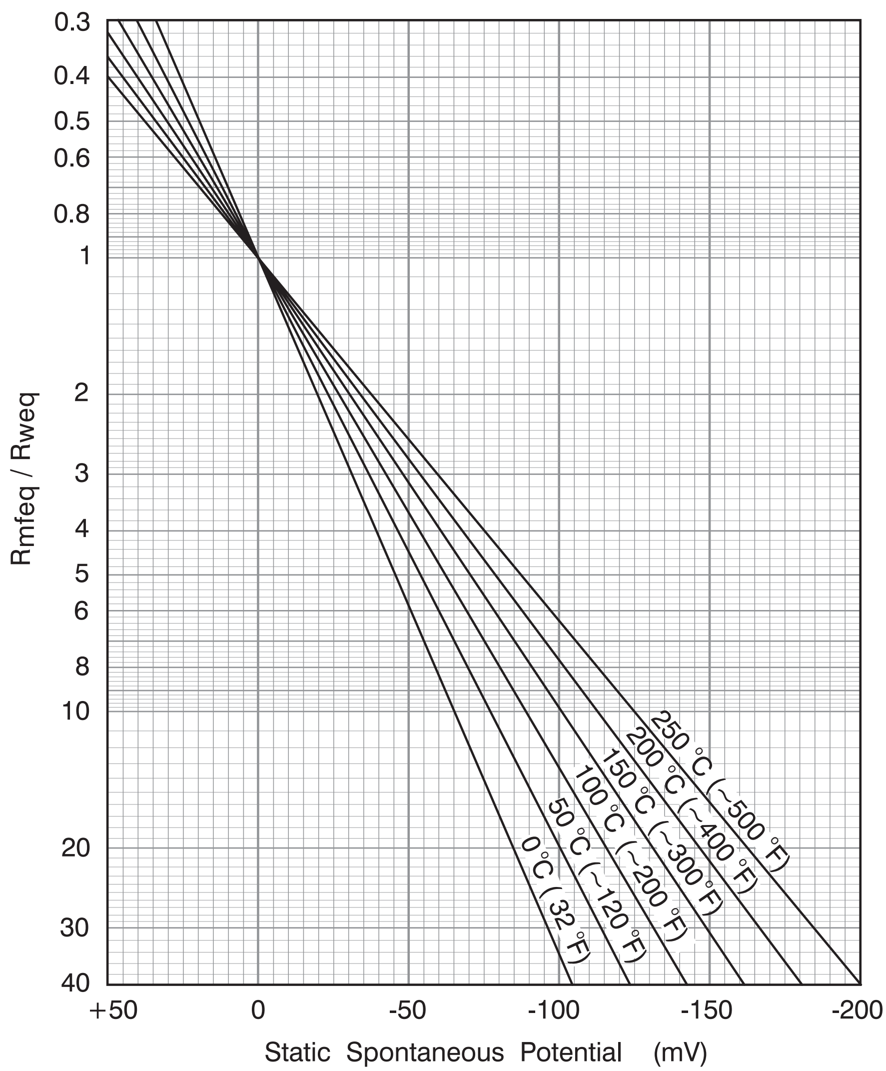
Applicability: For saturation calculations from Thermal Decay Sonde (TDS) logs.



Gen - 10

R_{weq} from the SSP

Applicability: Clean formations. Predominantly NaCl muds and formation waters.



Use charts SP-1 and SP-2 to compute R_w from the Static Spontaneous Potential (SSP).

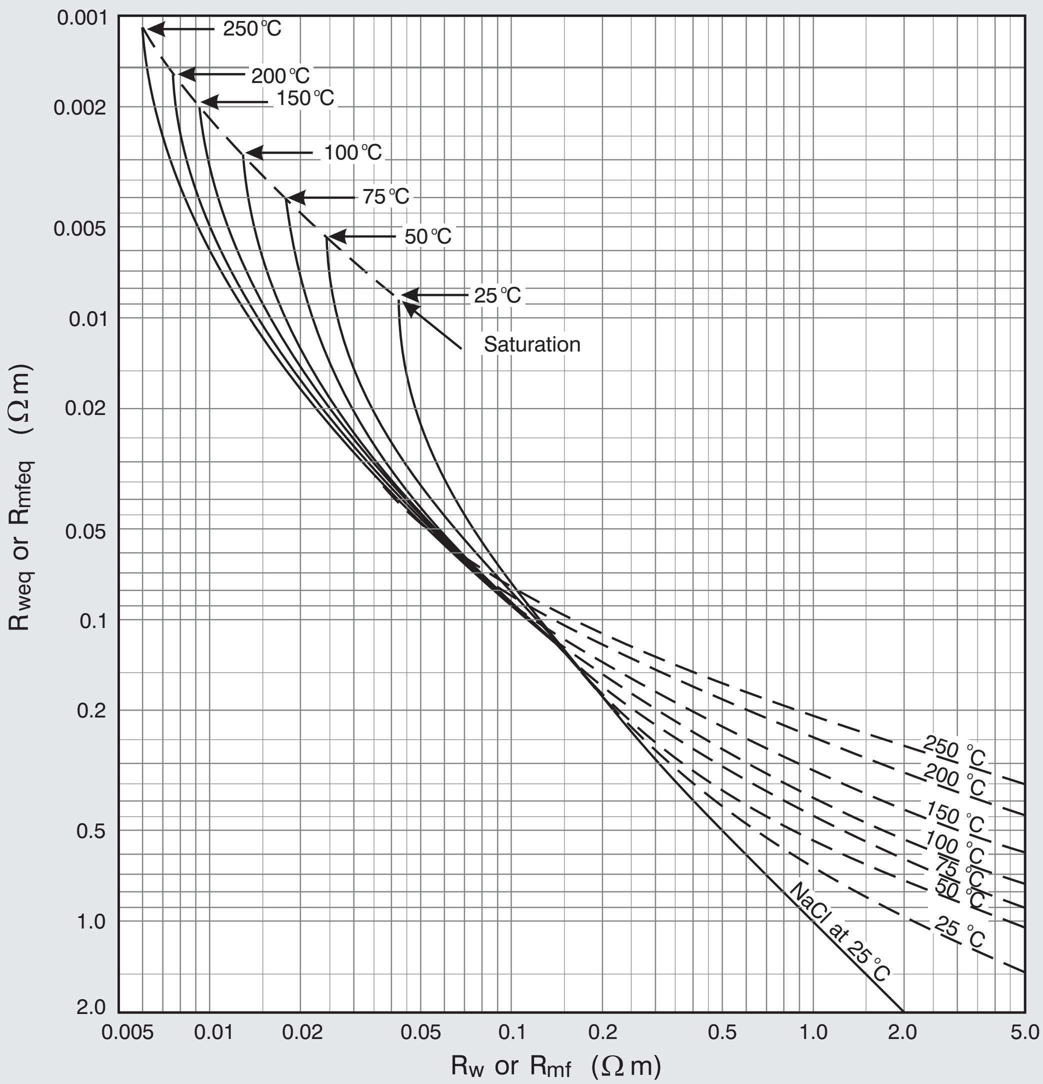
Enter chart SP-1 with the SSP value. The intersection with the appropriate temperature line gives R_{mfeq} / R_{weq} at formation temperature. R_{mfeq} is assumed to equal R_{mf} after correction to formation temperature using chart Gen-7. If, however, R_{mf} at 24°C (75°F) exceeds 0.1 ohm-m, use chart Gen-7 to correct the value to formation temperature, and use R_{mfeq} = 0.85 R_{mf}.

Having established R_{mfeq} and hence R_{we}, use chart SP-2 to find the actual value of R_w.

The chart is described by the equation: SSP = -K log(R_{mfeq}/R_{we}) where K = 65+0.24T (temperature in °C) or K = 61+0.133T (temperature in °F).

SP - 1

R_W from R_{weq} and Formation Temperature



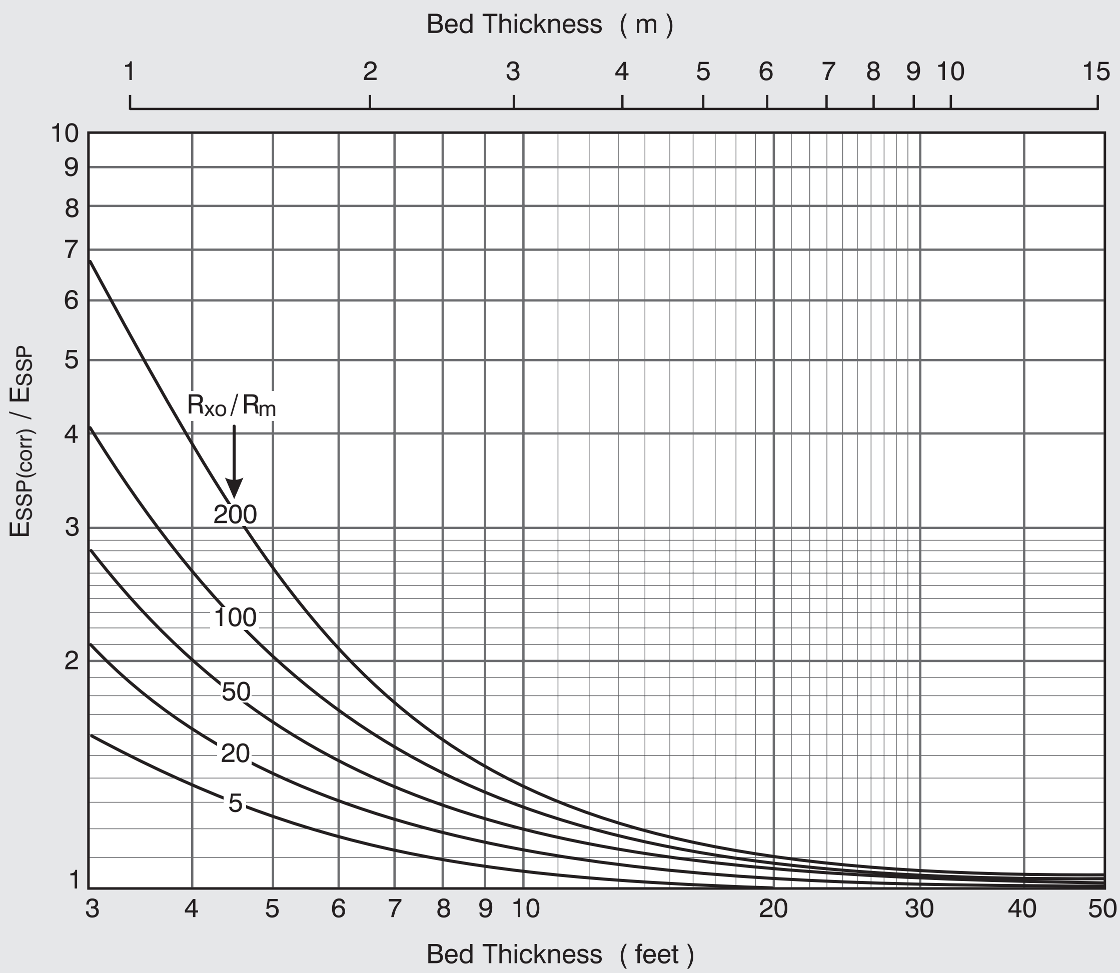
This chart converts R_{weq} (determined from chart SP-1) to actual water resistivity, R_w.

The solid lines represent predominantly NaCl waters. In the case of fresh waters, the effects of other salts can become significant. An approximate conversion for these cases is provided by the dashed lines.

The chart may also be used to convert R_{mf} to R_{mfeq}. Use the solid lines for NaCl muds and the dashed lines for gyp muds.

SP - 2

Applicability: 8 inch (203 mm) diameter holes.



These are empirical corrections based on observations in 8 inch (203 mm) diameter wells covering a range of R_{xo}/R_m conditions. They represent average corrections for a range of invasion depths, and should be increased by 10% for deeply invaded formations, or decreased by 10% for shallow invasion.

Example: bed thickness = 10 feet

E_{SSP} = -60 mV

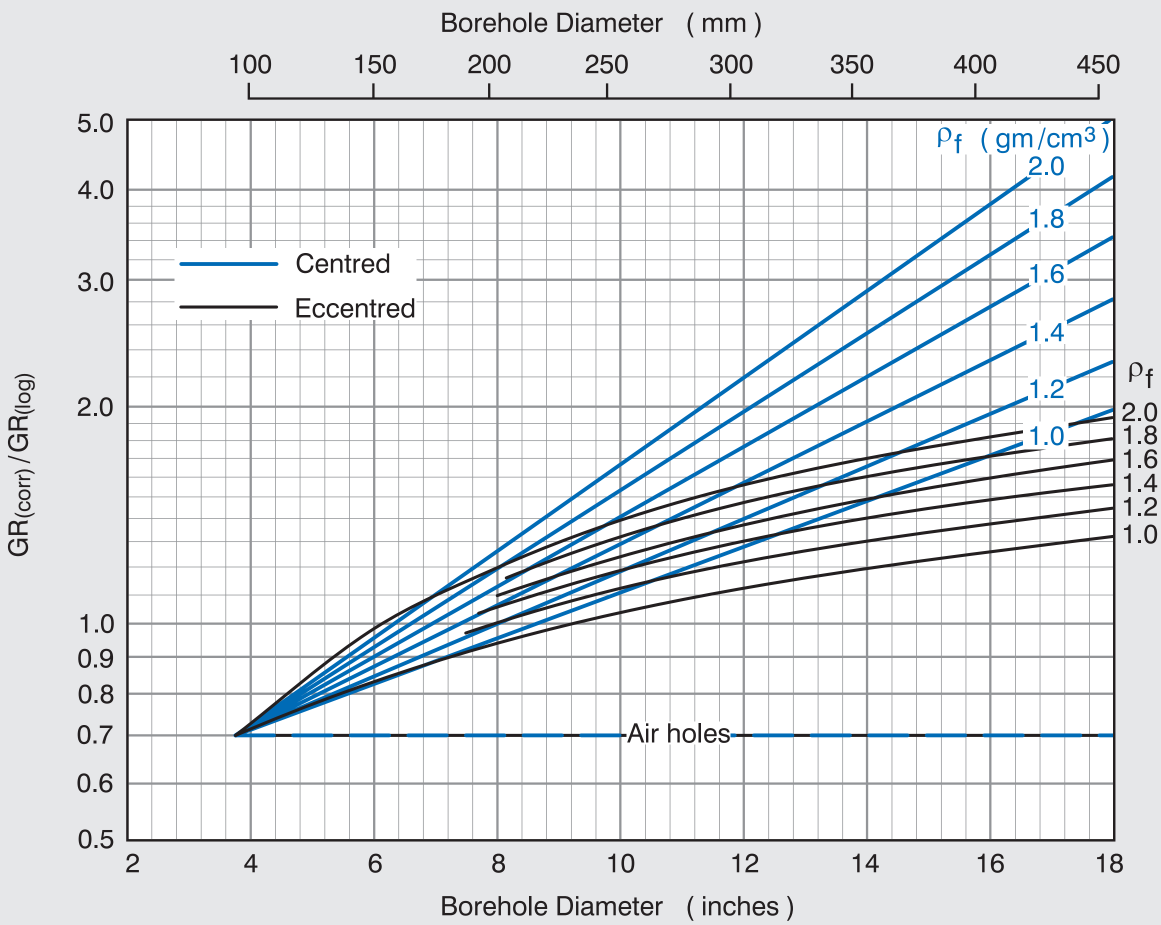
R_{xo} = 2.5 ohm-m

R_m = 0.05 ohm-m

Using the curve for R_{xo}/R_m = 50, $E_{SSP(corr)}/E_{SSP}$ = 1.2, therefore $E_{SSP(corr)}$ = -72 mV

SP - 3

Applicability: 95 mm (3¾ inch) diameter tools.
KCl free muds.



Use this chart to correct the Gamma Ray response from 95 mm (3¾ inch) tools for the effects of borehole size and mud weight.

Standard conditions are for eccentred tools in 203 mm (8 inch) diameter wells with KCl free mud of density 1.2 gm/cm³. Corrections for non-standard conditions are approximated by:

$$GR_{(corr)} / GR_{(log)} = 0.7\, e^{0.06978\, d\, \rho_f} \qquad \text{for centred tools}$$

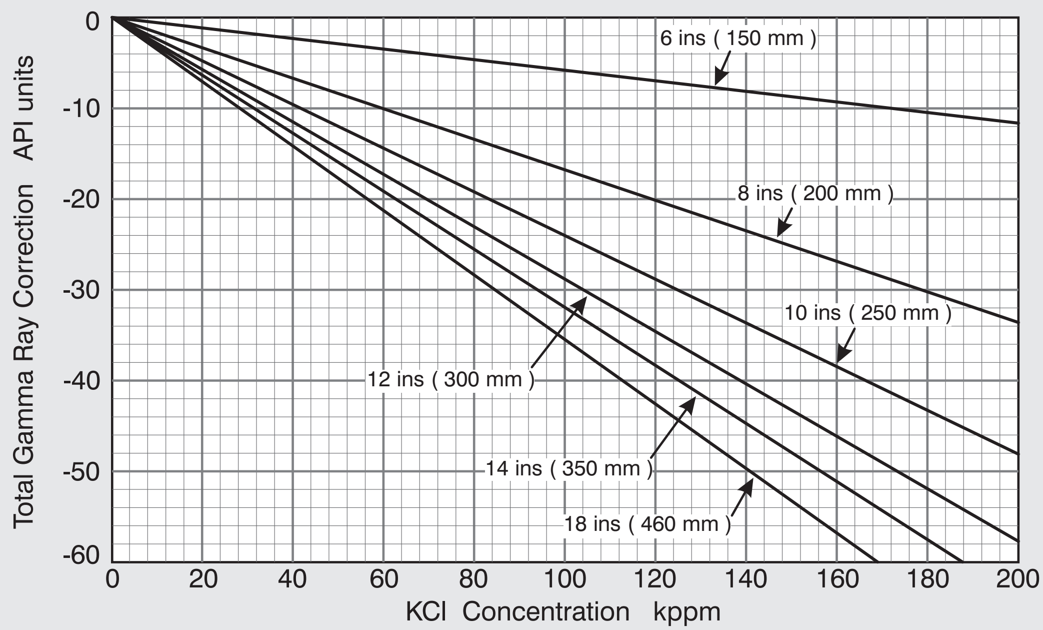
$$GR_{(corr)} / GR_{(log)} = \rho_f\,(1 - e^{-0.06753\, d}) + 0.7 \qquad \text{for eccentred tools}$$

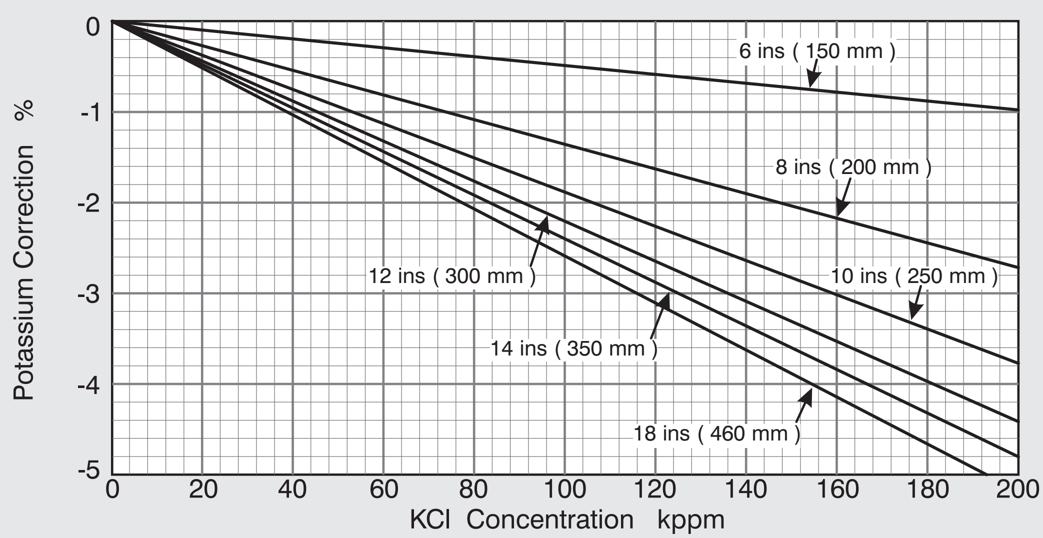
where: d = caliper in inches - 3.74
ρ_f = mud density in gm/cm³

Gam - 1

Spectral Gamma Ray KCl Mud Correction

Applicability: SGS series tools run eccentralised.





Use this chart to correct Spectral Gamma Ray logs for the effects of KCl drilling muds.

KCl increases the measured Total Gamma Ray and Potassium concentration curves. The corrections are given by:

$$GR_{corr} = GR_{log} - 0.382K\left(1 - e^{-0.207d}\right)$$

and $$K\%_{corr} = K\%_{log} - 0.027K\left(1 - e^{-0.25d}\right)$$

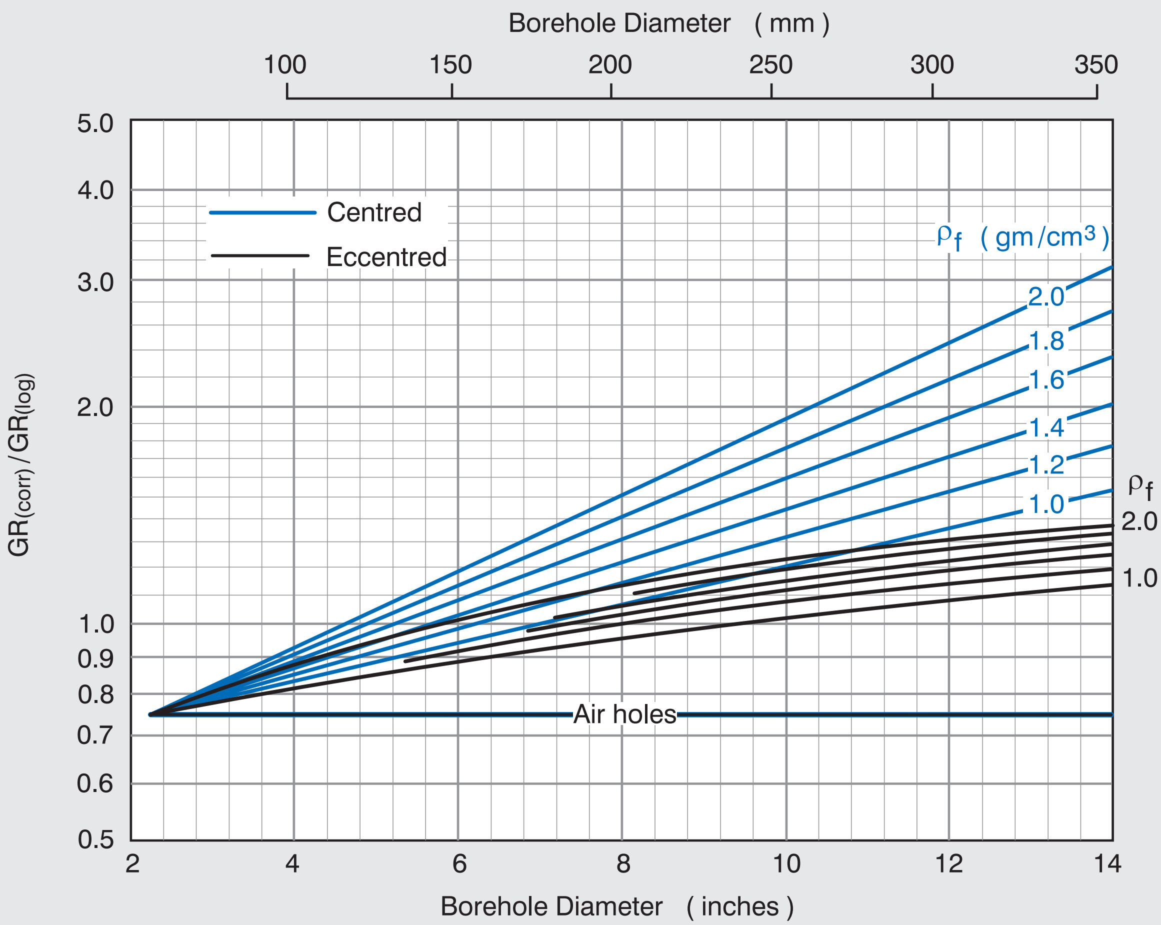
where K is the KCl concentration in kppm, and d = (caliper in inches - 5.2)

Gam - 2a

Gamma Ray Borehole Correction

Compact Systems

Applicability: Compact Series (MCG & MGS) tools.
KCl free muds.



Use this chart to correct Gamma Ray logs from Compact series tools for the effects of borehole size and mud weight.

The standard condition is an eccentred tool in a 203 mm (8 inch) diameter well with KCl free mud of density 1.2gm/cm³. Corrections for non-standard conditions are approximated by:

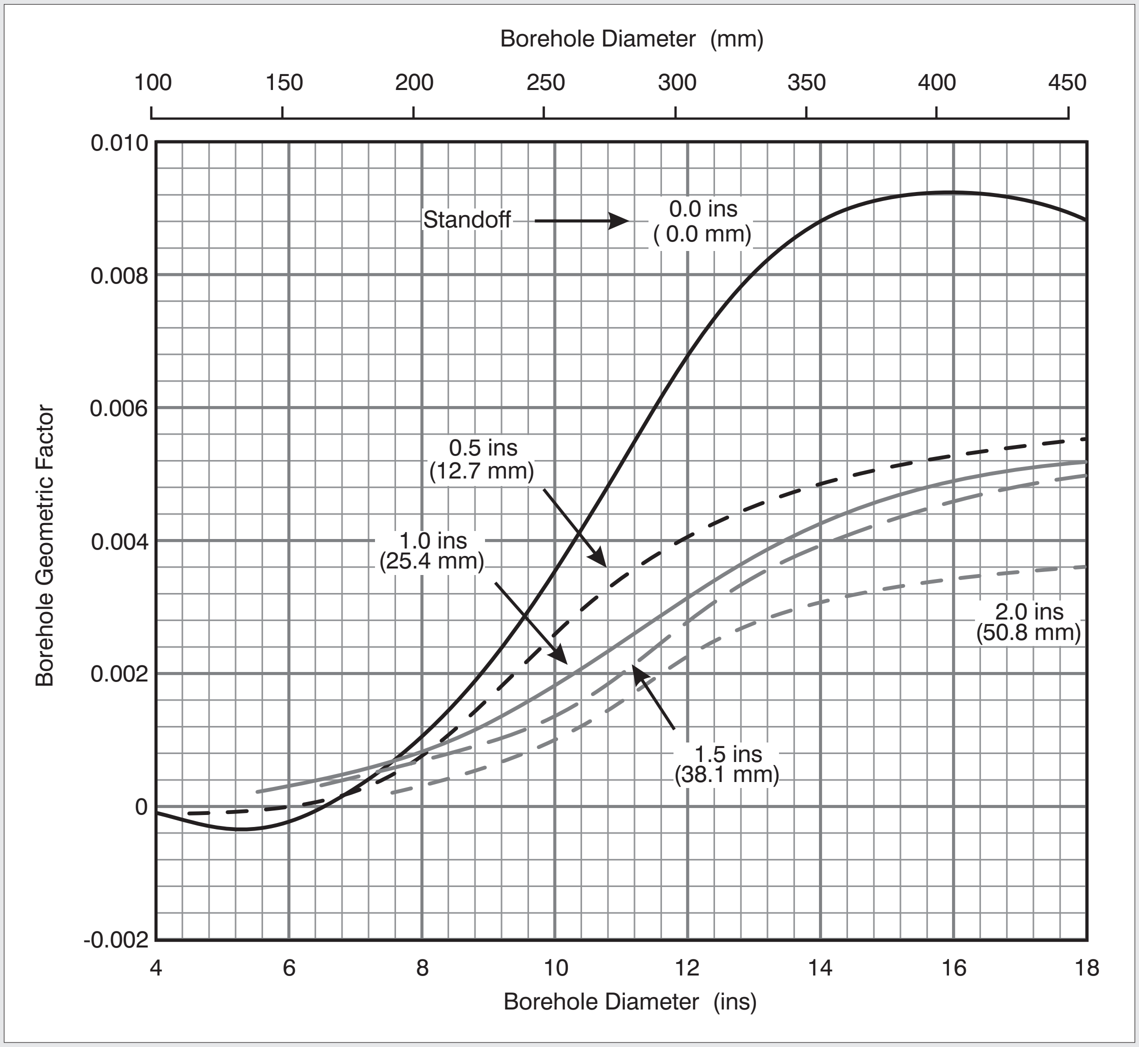
$$GR_{(corr)} / GR_{(log)} = 0.75 \exp\left[0.35\,\rho_f\left(\frac{d - 2.25}{5.75}\right)\right] \quad \text{for centred tools}$$

$$GR_{(corr)} / GR_{(log)} = 1.75 - \exp\left[-0.24\,\rho_f\left(\frac{d - 2.25}{5.75}\right)\right] \quad \text{for eccentred tools}$$

where d = caliper in inches
ρ_f = mud density in gm/cm³

Applicability: AIS series tools. Processing models 1, 2 and 4.
Field logs are normally corrected for standoff, bit size and nominal R_m.

Deep Induction



Borehole corrected conductivty = $(\sigma_{app} - \sigma_m G_b)/(1-G_b)$
where the borehole geometric factors, G_b, are approximated by $a_0 + a_1 d + a_2 d^2 + \ldots$,
d is borehole diameter in inches and σ_m is mud conductivity. In the table, standoff is in inches.

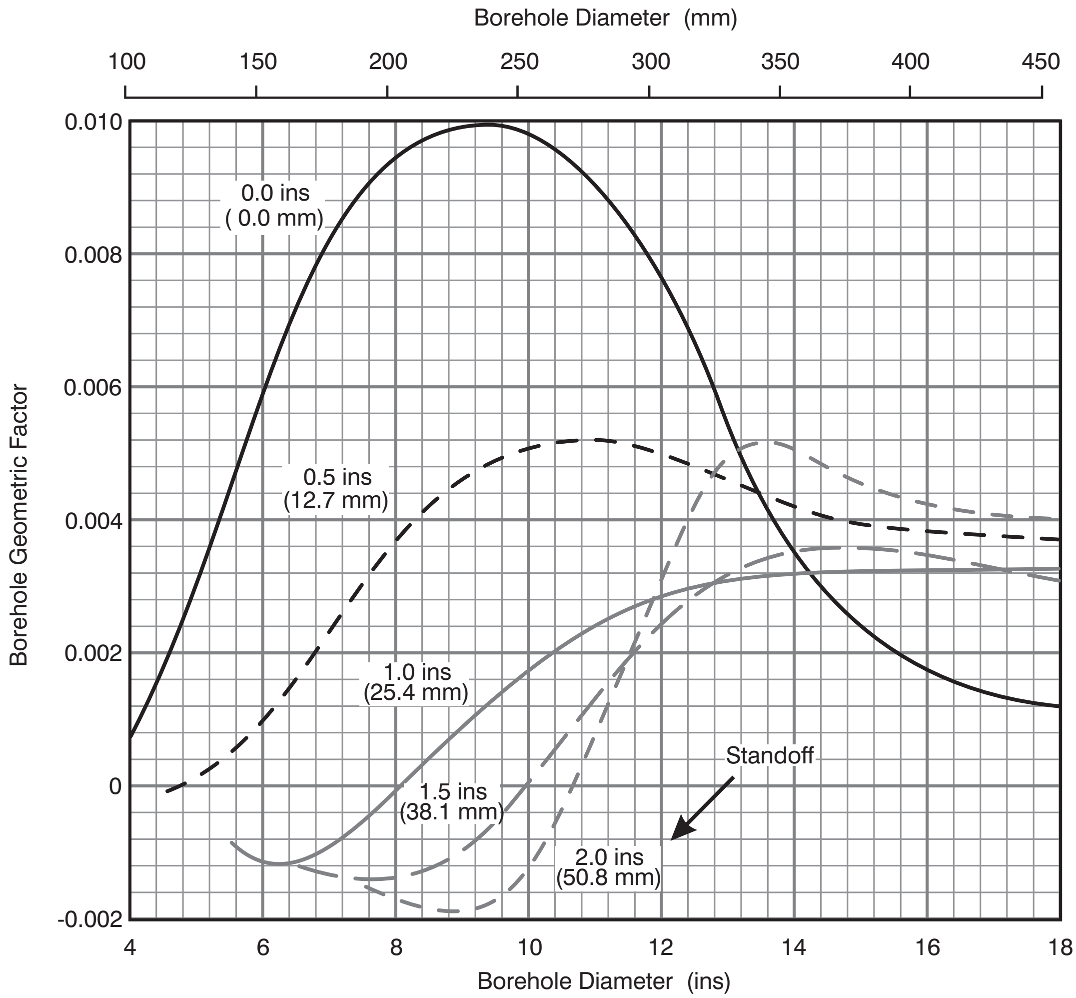
	Standoff = 0.0	Standoff = 0.5	Standoff = 1.0	Standoff = 1.5	Standoff = 2.0
a_0	-8.122239 e-3	1.068128 e-2	-2.980951 e-3	7.151788 e-3	8.553908 e-2
a_1	6.646812 e-3	-5.124065 e-3	2.428573 e-3	-1.747084 e-3	-3.460649 e-2
a_2	-1.960433 e-3	7.897578 e-4	-6.661266 e-4	3.536023 e-6	5.345326 e-3
a_3	2.489865 e-4	-4.427118 e-5	8.126969 e-5	2.692620 e-5	-3.953811 e-4
a_4	-1.327424 e-5	8.508113 e-7	-4.169532 e-6	-1.957996 e-6	1.427728 e-5
a_5	2.507541 e-7	0.000000 e-1	7.623346 e-8	4.053539 e-8	-2.031486 e-7

Ind - 1a

Array Induction Borehole Correction

Applicability: AIS series tools. Processing models 1, 2 and 4.
Field logs are normally corrected for standoff, bit size and nominal R_m.

Medium Induction



Borehole corrected conductivty = (σ_{app} - σ_m G_b)/(1-G_b)
where the borehole geometric factors, G_b, are approximated by $a_0 + a_1 d + a_2 d^2 + ...$,
d is borehole diameter in inches and σ_m is mud conductivity. In the table, standoff is in inches.

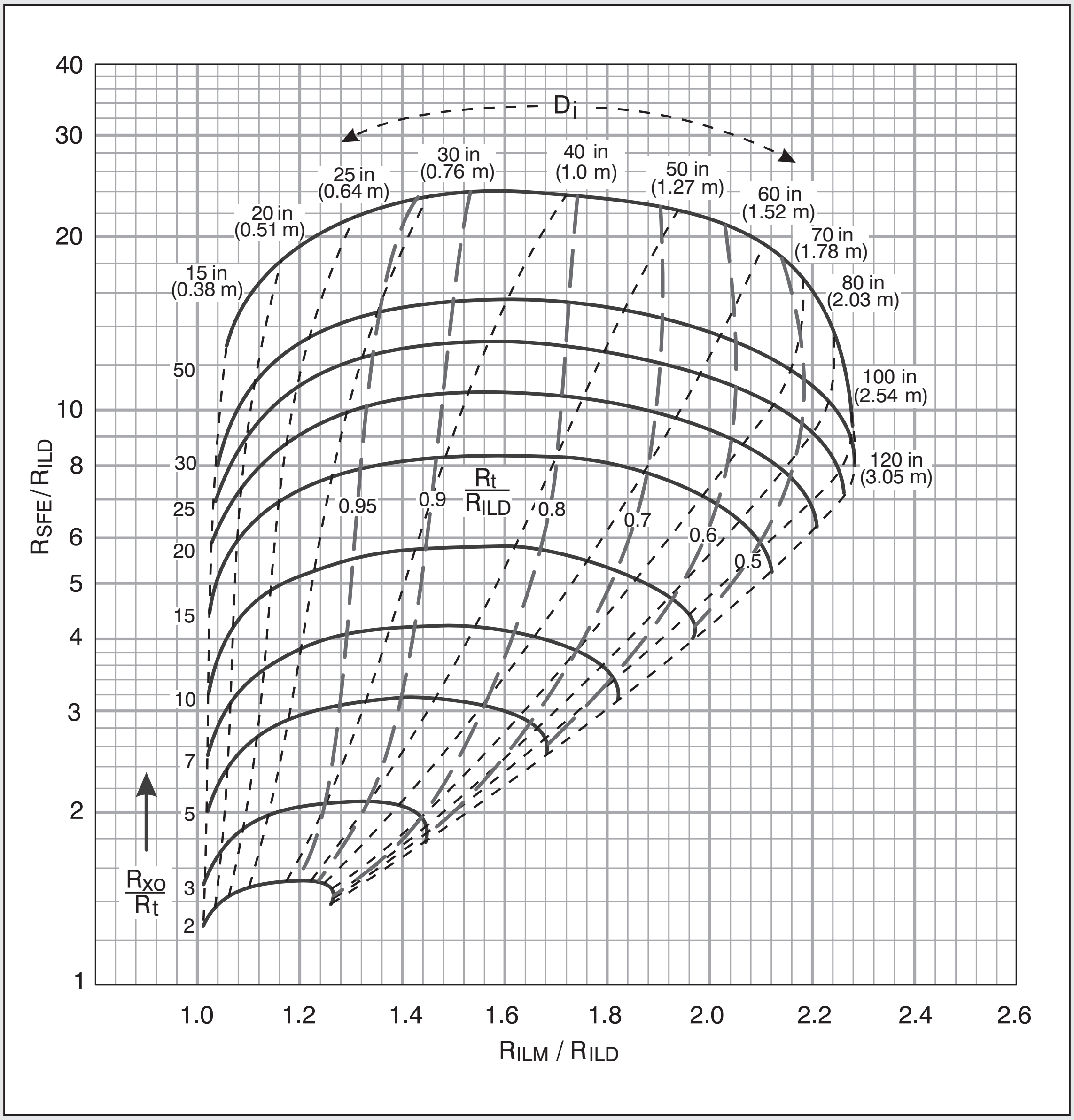
	Standoff = 0.0	Standoff = 0.5	Standoff = 1.0	Standoff = 1.5	Standoff = 2.0
a_0	2.127359 e-2	3.107716 e-2	5.813350 e-2	-1.568206 e-1	-9.880957 e-1
a_1	-1.772771 e-2	-1.923237 e-2	-2.835889 e-2	9.581317 e-2	5.345942 e-1
a_2	4.871560 e-3	4.194177 e-3	5.014313 e-3	-2.321462 e-2	-1.166158 e-1
a_3	-5.203529 e-4	-3.966286 e-4	-4.092995 e-4	2.827306 e-3	1.308967 e-2
a_4	2.390712 e-5	1.713986 e-5	1.589421 e-5	-1.829085 e-4	-7.978232 e-4
a_5	-3.991332 e-7	-2.784722 e-7	-2.383256 e-7	6.011542 e-6	2.511633 e-5
a_6	0.000000 e-1	0.000000 e-1	0.000000 e-1	-7.909357 e-8	-3.202614 e-7

Ind - 2a

Array Induction Tornado Chart

Applicability: All 95 mm (3¾ inch) AIS tools.
Thick beds. Use borehole corrected data.

R_{xo} = 10 Ω m

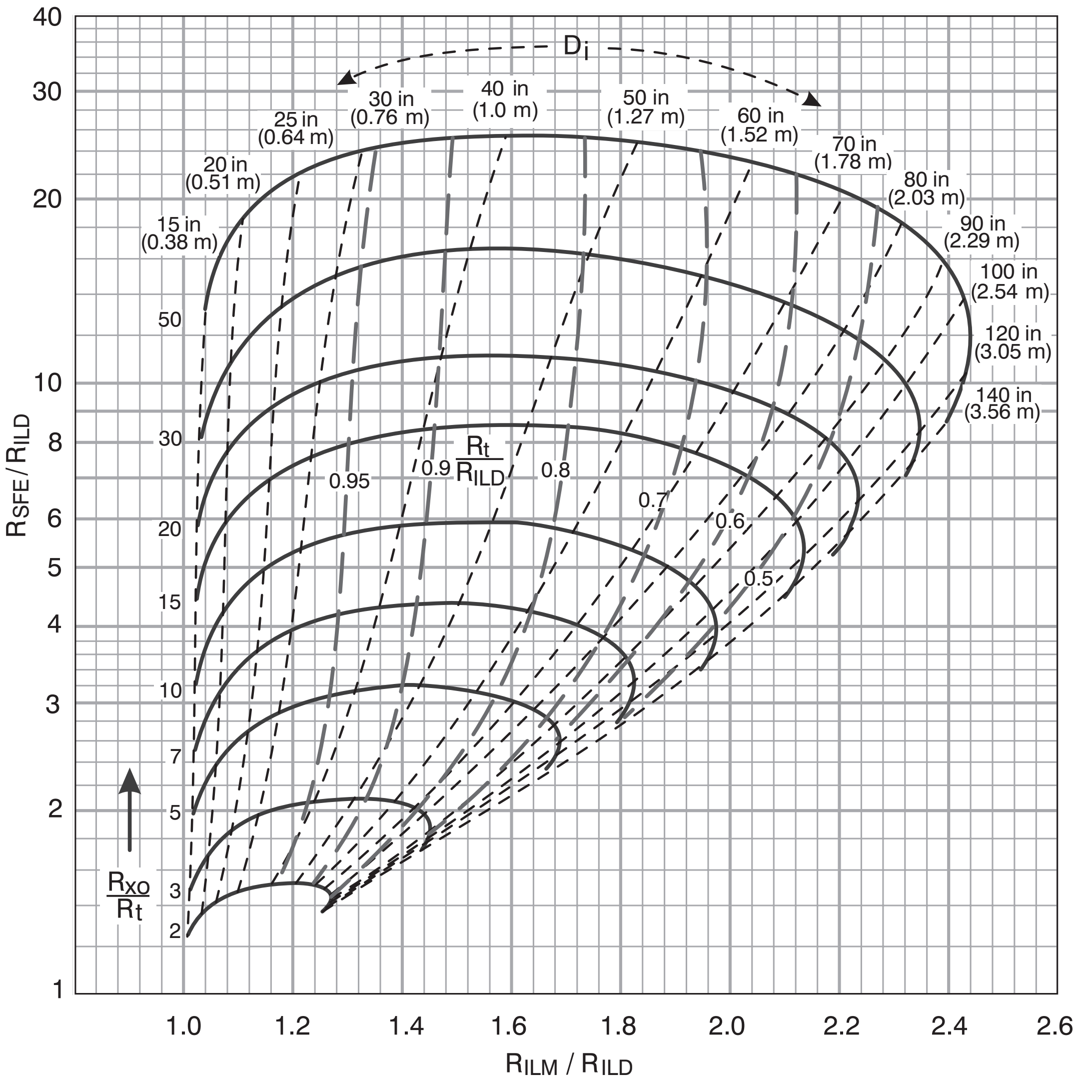


Ind - 5

Array Induction Tornado Chart

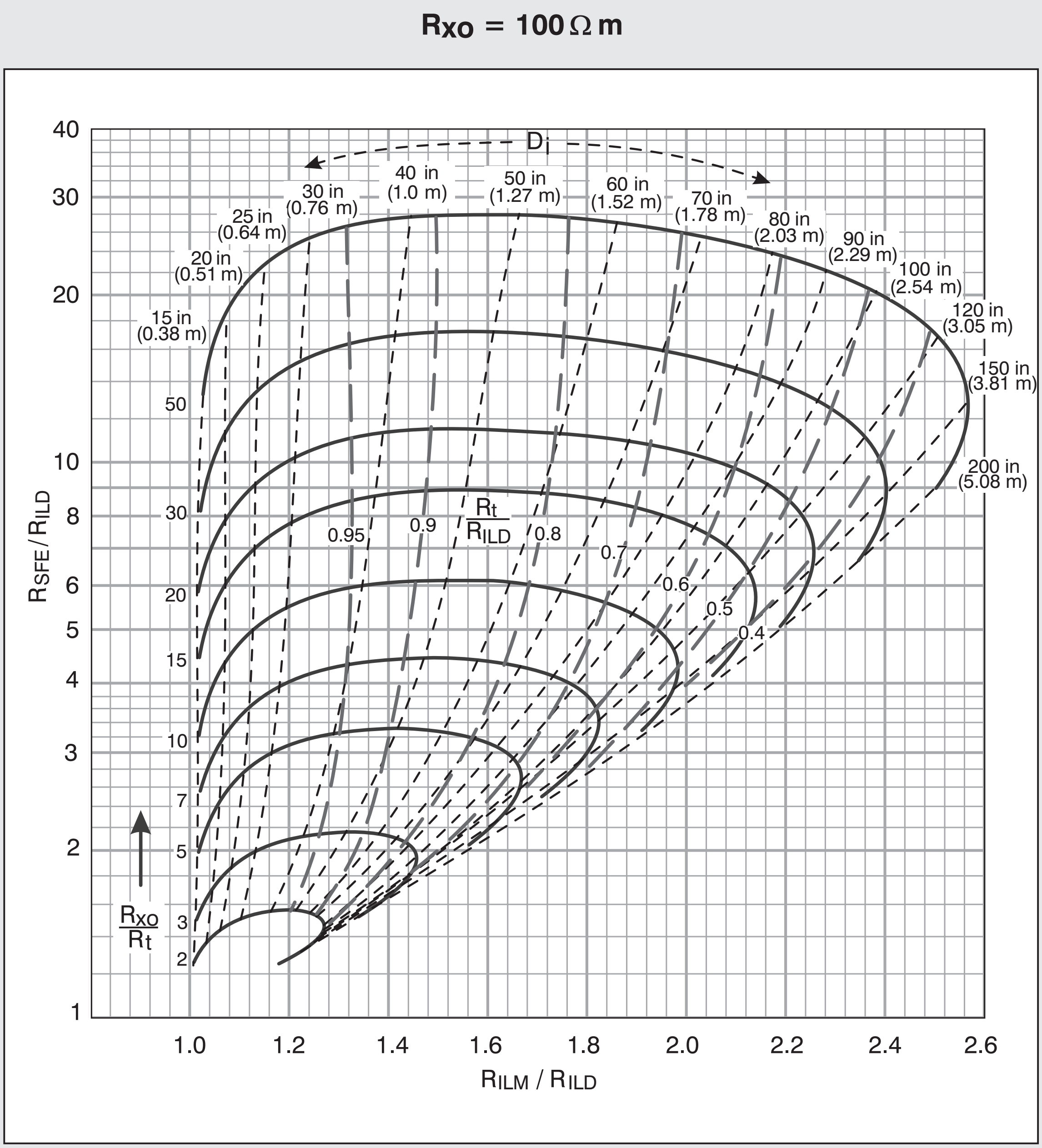
Applicability: All 95 mm (3¾ inch) AIS tools.
Thick beds. Use borehole corrected data.

R_{xo} = 20 Ω m



Ind - 6

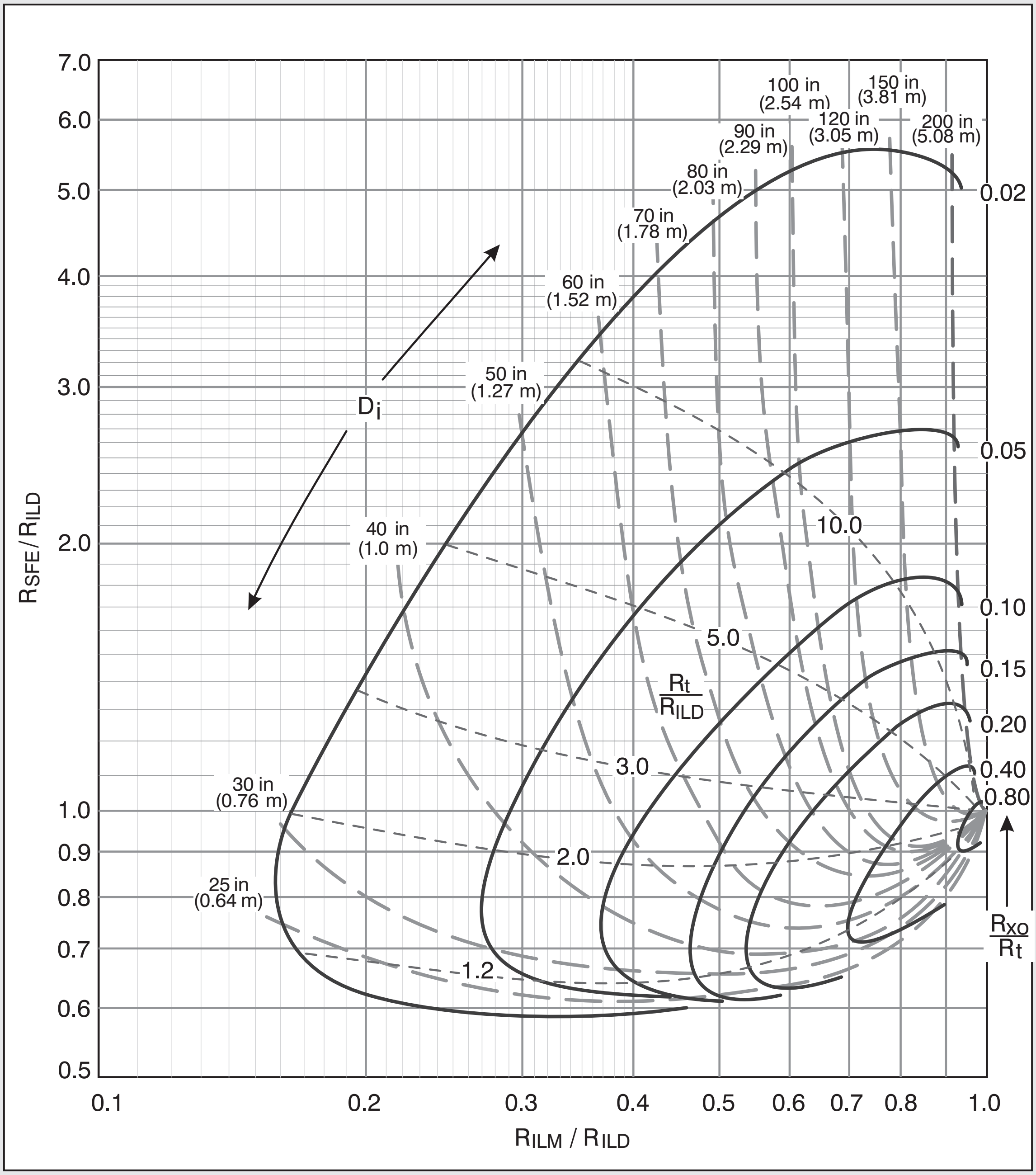
Applicability: All 95 mm (3¾ inch) AIS tools.
Thick beds. Use borehole corrected data.



Ind - 7

Applicability: All 95 mm (3¾ inch) AIS tools.
Thick beds. Use borehole corrected data.

$R_{xo} < R_t$

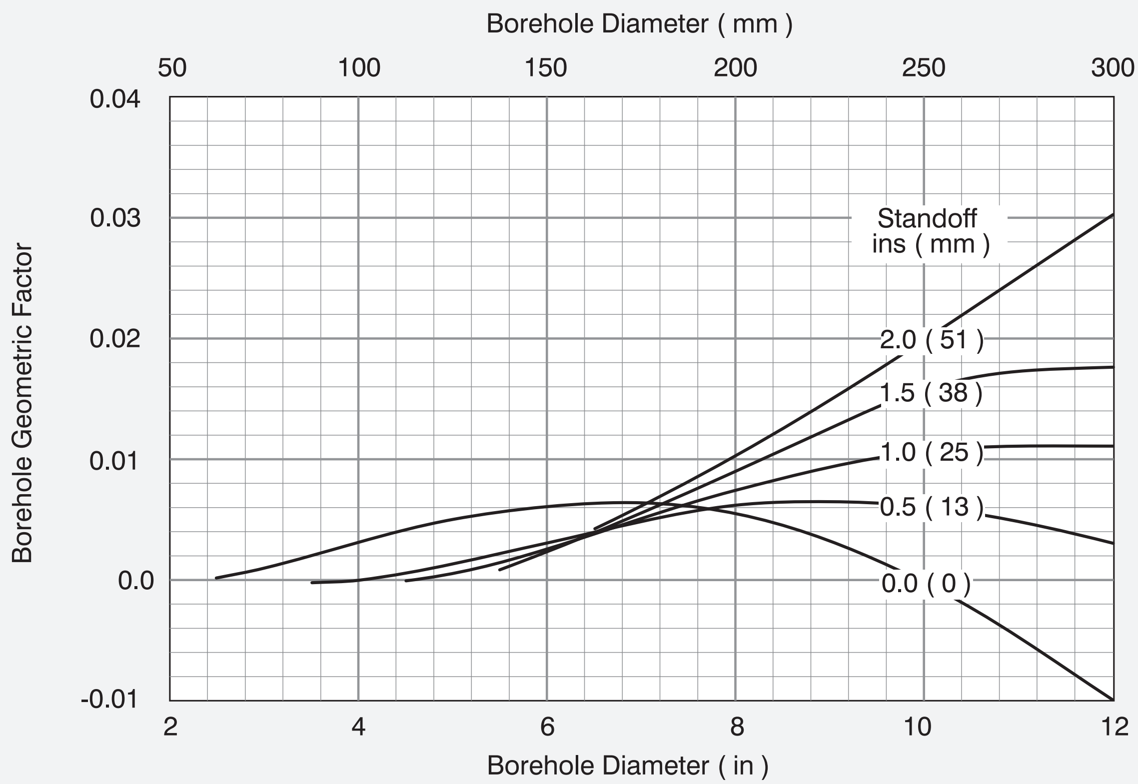


Ind - 8

Array Induction Borehole Correction - Shallow

Compact Systems

Applicability: Compact Series (MAI) tools.



Field logs are corrected for bit size, nominal standoff and borehole fluid salinity.

Corrections are applied to each sub-array. The chart shows the composite correction after construction of the Shallow output curve.

If borehole conditions depart significantly from nominal, new borehole corrections may be computed and applied to the processed logs after first removing the field corrections.

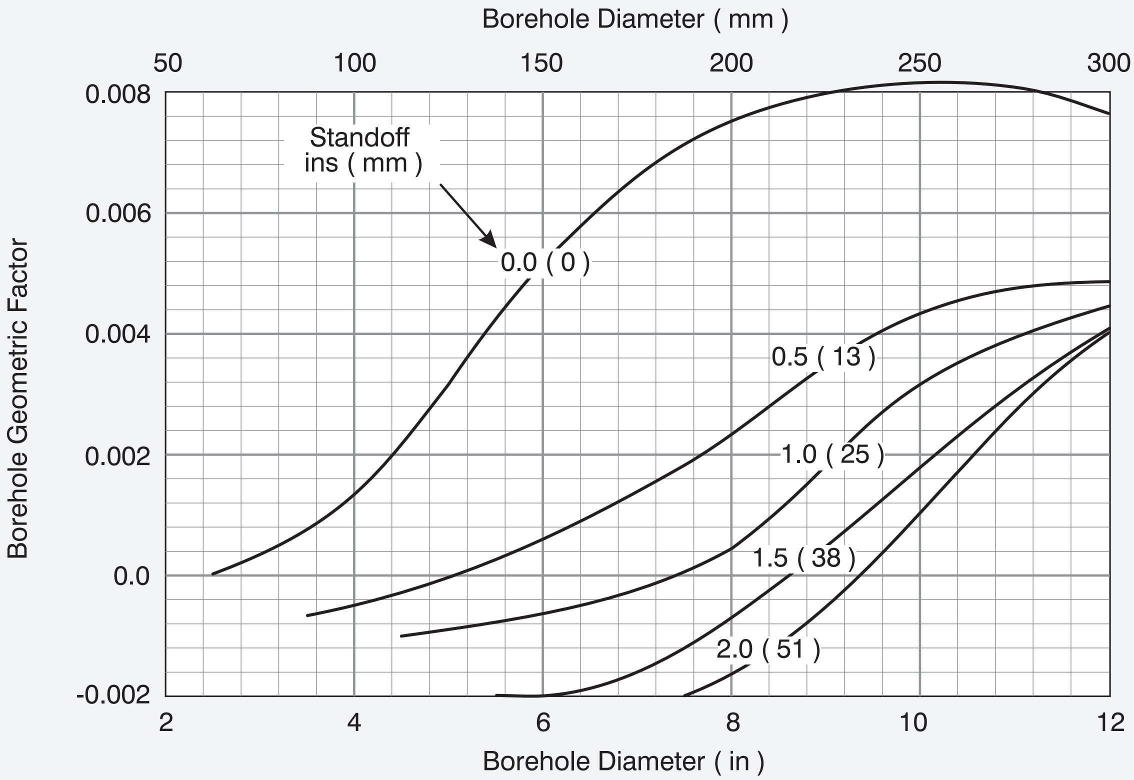
Borehole corrected conductivities are given by:

$$\sigma_{corr} = \frac{\sigma_{app} - g_b \sigma_m}{1 - g_b}$$

Where σ_{app} is the apparent conductivity, σ_m the borehole fluid conductivity, and g_b the borehole geometric factor.

Compact Systems

Applicability: Compact Series (MAI) tools.



Field logs are corrected for bit size, nominal standoff and borehole fluid salinity.

Corrections are applied to each sub-array. The chart shows the composite correction after construction of the Medium output curve.

If borehole conditions depart significantly from nominal, new borehole corrections may be computed and applied to the processed logs after first removing the field corrections.

Borehole corrected conductivities are given by:

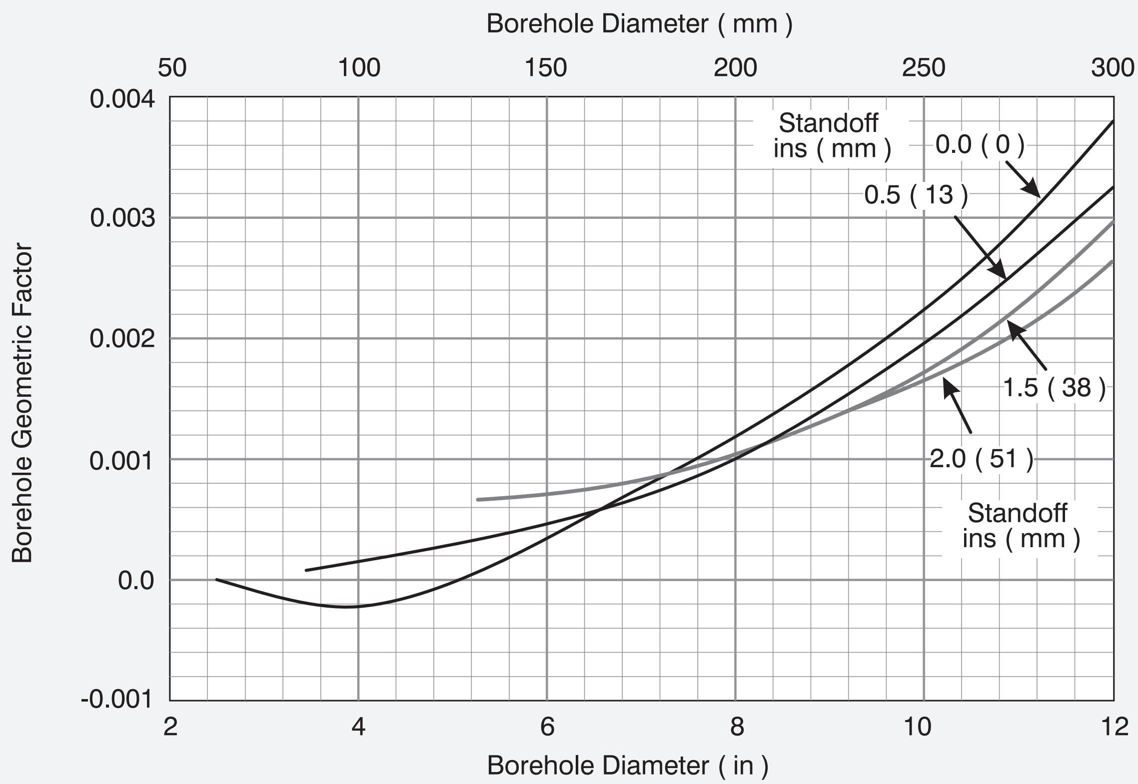
$$\sigma_{corr} = \frac{\sigma_{app} - g_b \sigma_m}{1 - g_b}$$

Where σ_{app} is the apparent conductivity, σ_m the borehole fluid conductivity, and g_b the borehole geometric factor.

Array Induction Borehole Correction - Deep

Compact Systems

Applicability: Compact Series (MAI) tools.



Field logs are corrected for bit size, nominal standoff and borehole fluid salinity.

Corrections are applied to each sub-array. The chart shows the composite correction after construction of the Deep output curve.

If borehole conditions depart significantly from nominal, new borehole corrections may be computed and applied to the processed logs after first removing the field corrections.

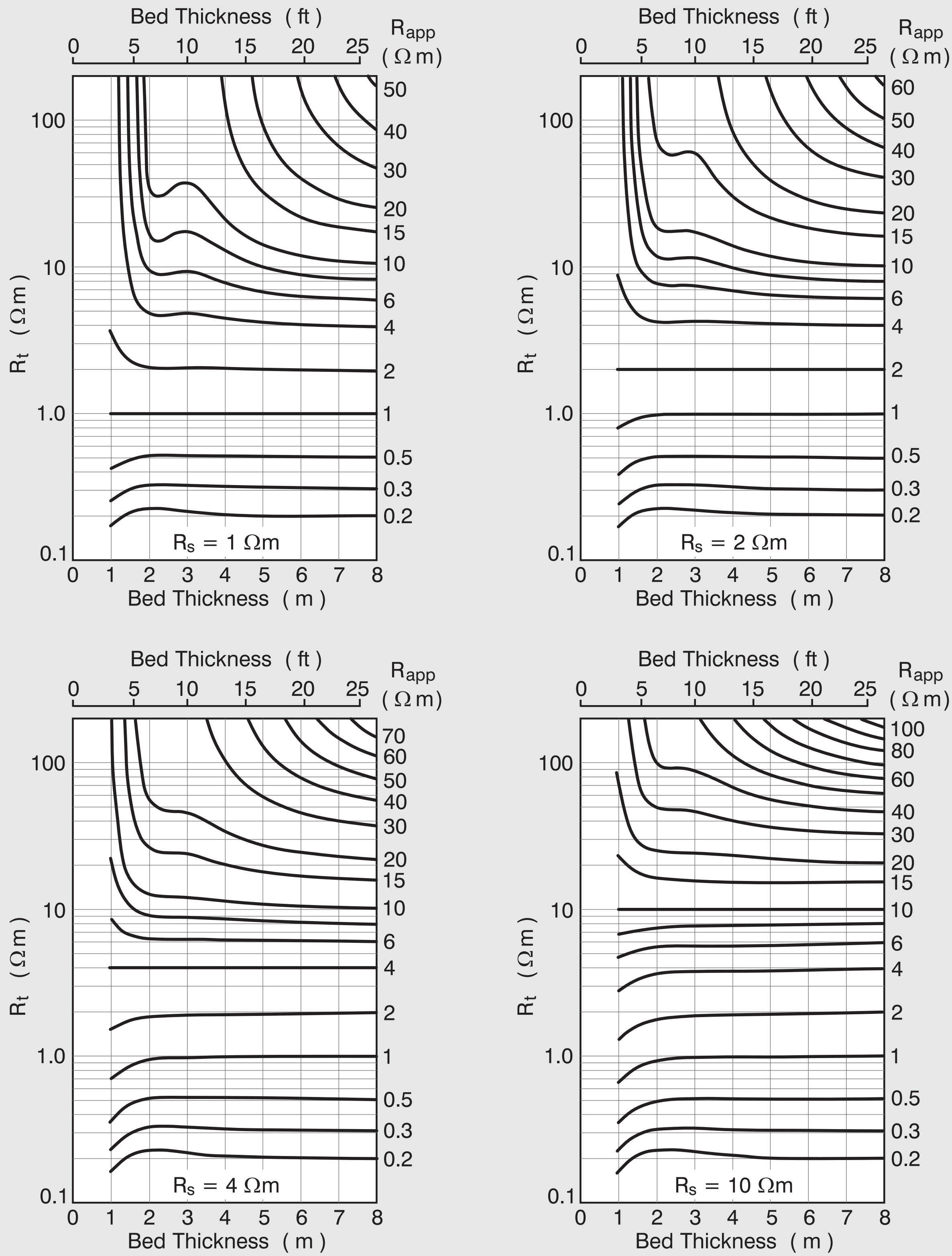
Borehole corrected conductivities are given by:

$$\sigma_{corr} = \frac{\sigma_{app} - g_b \sigma_m}{1 - g_b}$$

Where σ_{app} is the apparent conductivity, σ_m the borehole fluid conductivity, and g_b the borehole geometric factor.

Array Induction Bed Thickness Correction (Deep)

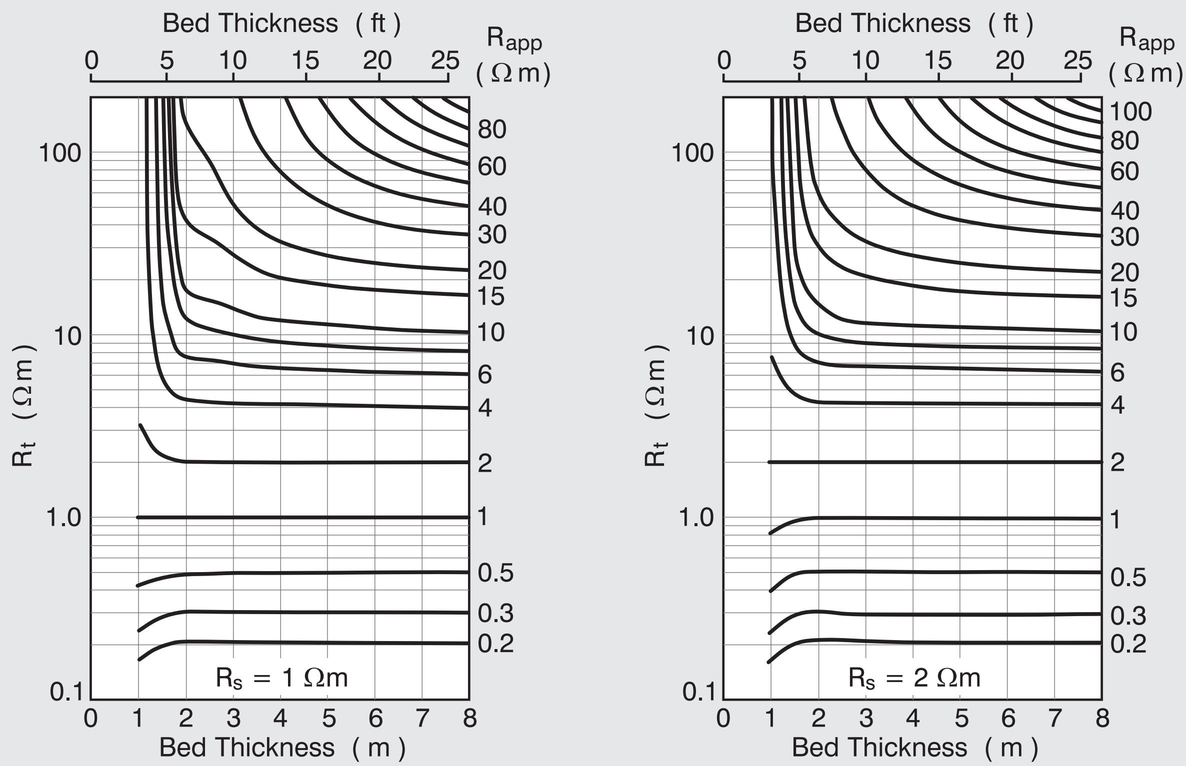
Applicability: All 95 mm (3¾ inch) diameter AIS tools.
Use VECTAR processed data.



Ind - 20

Array Induction Bed Thickness Correction (Medium)

Applicability: All 95 mm (3¾ inch) diameter AIS tools.
Use VECTAR processed data.

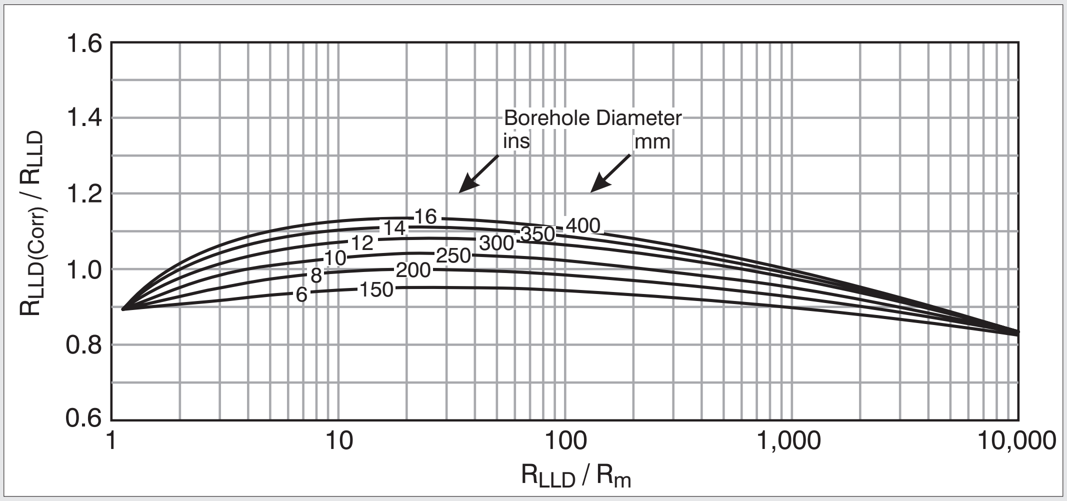


Ind - 21

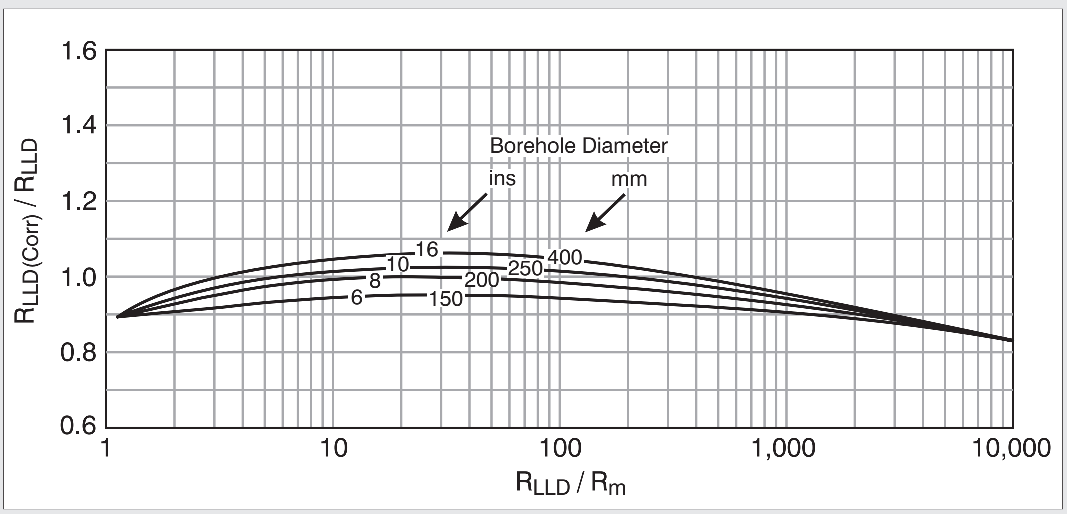
Deep Laterolog Borehole Correction

Applicability: DLS series tools. Thick beds.

Centred



Standoff = 1.5 ins. (38 mm)



Curves are normalized at $R_t / R_m = 20$ and borehole diameter of 8 inches (203 mm).
Corrections are approximated by:

$R_{LLD(Corr)} / R_{LLD} = (A + Bx) e^{-kx}$ where $x = \ln(R_{LLD}/R_m)$. For the centred case:

$A = 0.9012 - 0.00176\ cal$
$B = -0.07164 + 0.03947\ cal - 0.000871\ cal^2$
$k = 0.01625 + 0.01722\ cal - 0.000478\ cal^2$

For the case of 1.5 inch (38 mm) standoff :

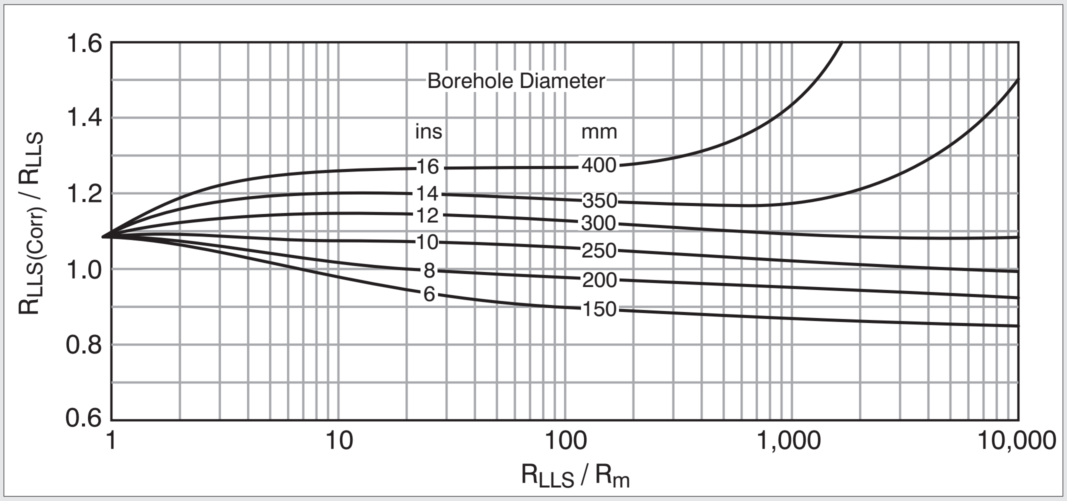
$A = 0.9012 - 0.00227\ cal + 0.000064\ cal^2$
$B = -0.0754 + 0.043176\ cal - 0.001411\ cal^2$
$k = 0.01893 + 0.017372\ cal - 0.000589\ cal^2$ where cal = caliper in inches.

Lat - 1

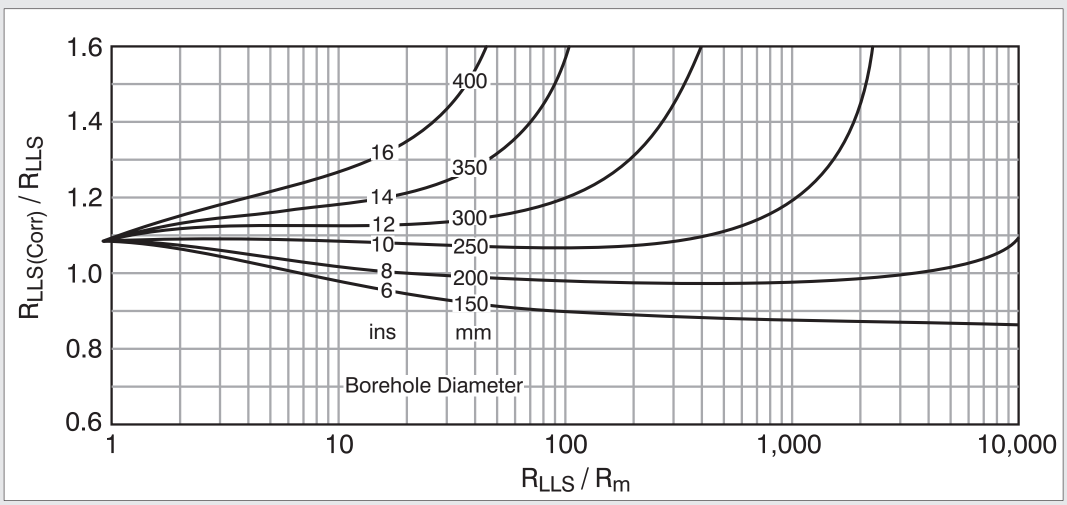
Shallow Laterolog Borehole Correction

Applicability: DLS series tools. Thick beds.

Centred



Standoff = 1.5 ins. (38 mm)



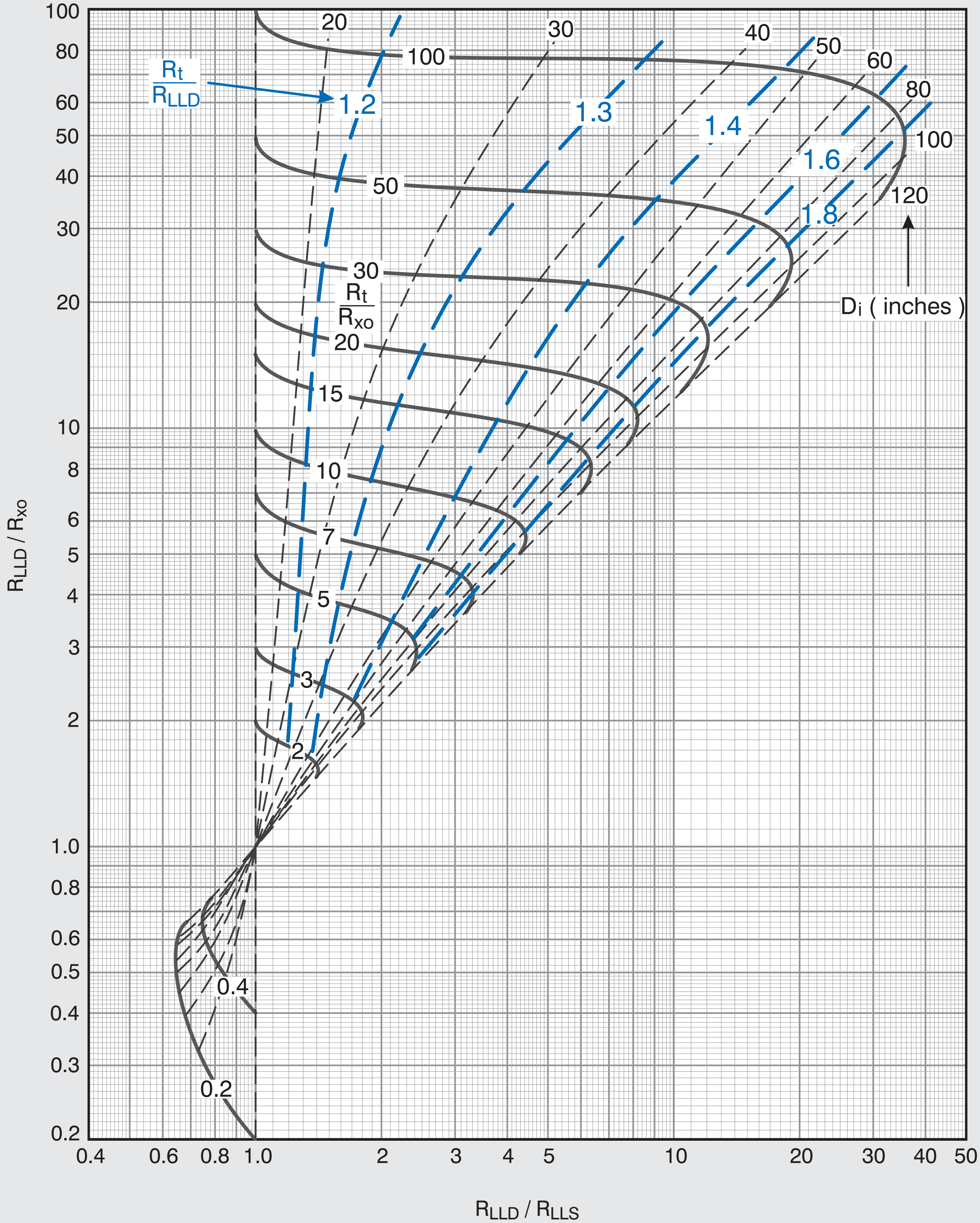
Corrections are approximated by: $R_{LLS(Corr)} / R_{LLS} = a_0 + a_1x + a_2x^2 + a_3x^3 + ...$
where $x = \ln(R_{LLS}/R_m)$. Coefficients for 6,8,10,12,14 and 16 inch wells are (left to right):

Centred	a_0	1.0841000	1.0852000	1.0881000	1.0918000	1.0955800	1.0998000
	a_1	-0.0239700	-0.0146900	0.0186100	0.0614050	0.1228130	0.1673600
	a_2	-0.0220100	-0.0137230	-0.0177400	-0.0288660	-0.0629900	-0.0814110
	a_3	0.0067500	0.0044270	0.0042460	0.0058089	0.0163960	0.0229840
	a_4	-0.0007230	-0.0005120	-0.0004580	-0.0005945	-0.0021660	-0.0035963
	a_5	0.0000270	0.0000200	0.0000180	0.0000243	0.0001118	0.0002338
1.5 ins Standoff	a_0	1.0853000	1.0861000	1.0840000	1.0900000	1.0932000	1.0969000
	a_1	-0.0113010	0.0035330	0.0253970	0.0432500	0.0894800	0.1239400
	a_2	-0.0317160	-0.0331050	-0.0551100	-0.0261400	-0.0601000	-0.1043500
	a_3	0.0093580	0.0112530	0.0272190	0.0094620	0.0311930	0.0751500
	a_4	-0.0010130	-0.0015000	-0.0052920	-0.0022470	-0.0086380	-0.0246500
	a_5	0.0000384	0.0000721	0.0003602	0.0002670	0.0010720	0.0032370

Lat - 2

Dual Laterolog Tornado Chart for Invasion Correction

Applicability: DLS series tools.
Thick beds, 8 inch (203 mm) hole, step invasion profile.
Use borehole corrected data.



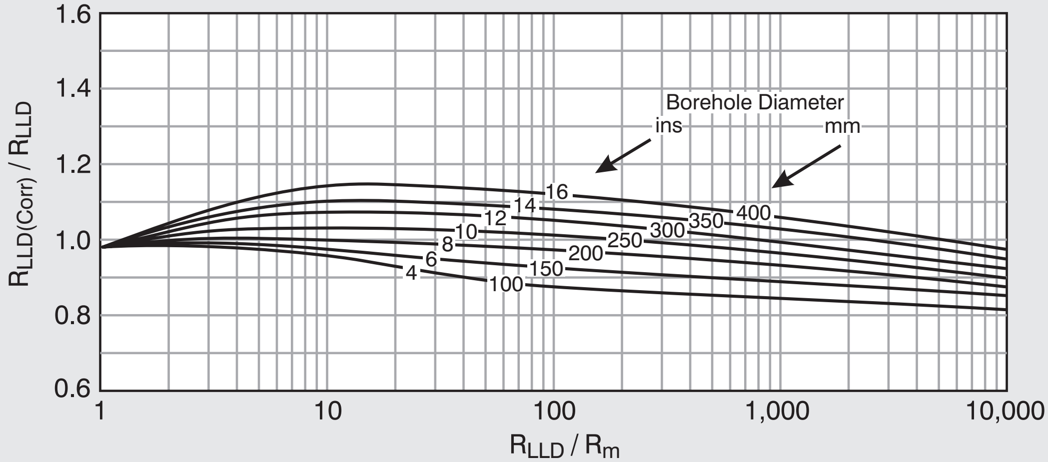
Lat - 3

Compact Deep Laterolog Borehole Correction

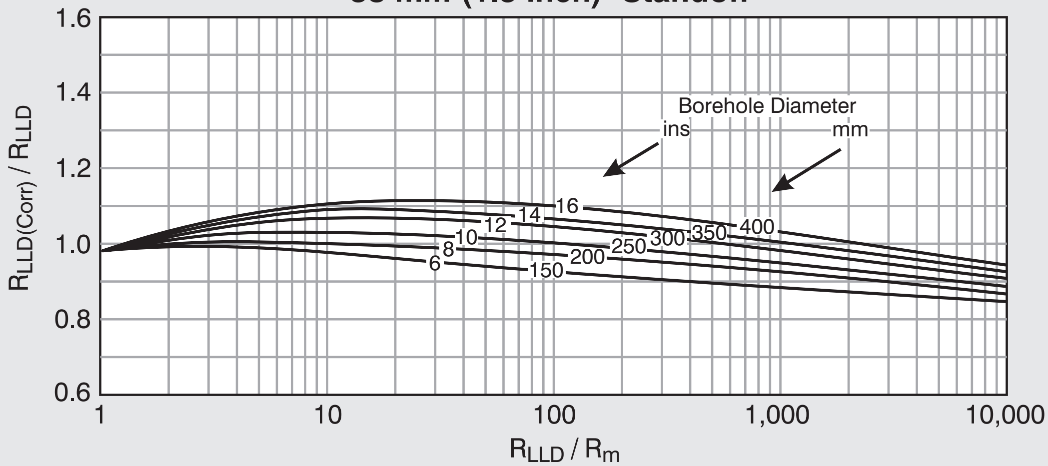
Compact Systems

Applicability: Compact Series (MDL) tools, Operating Mode A.
Standard condition is 13 mm (0.5 inch) standoff in a 200 mm (8 inch) well, Ra/Rm = 20.

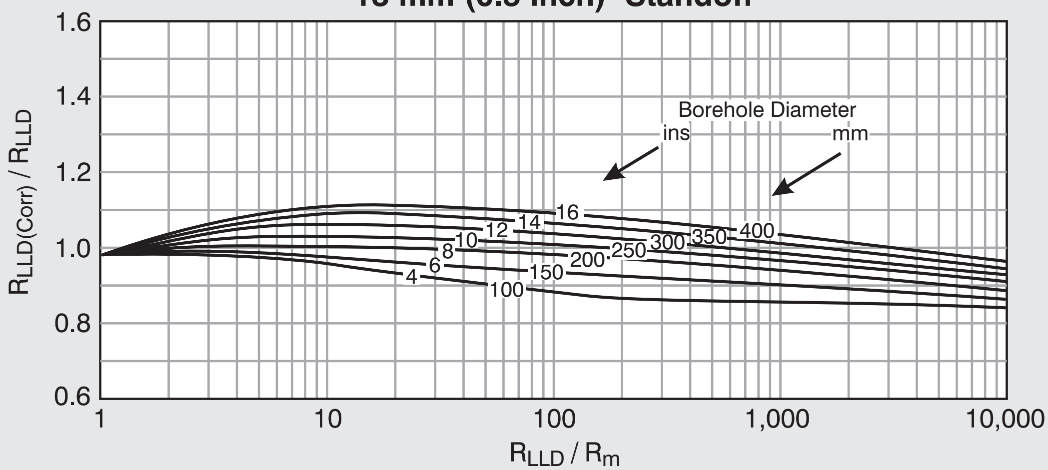
Centred



38 mm (1.5 inch) Standoff



13 mm (0.5 inch) Standoff



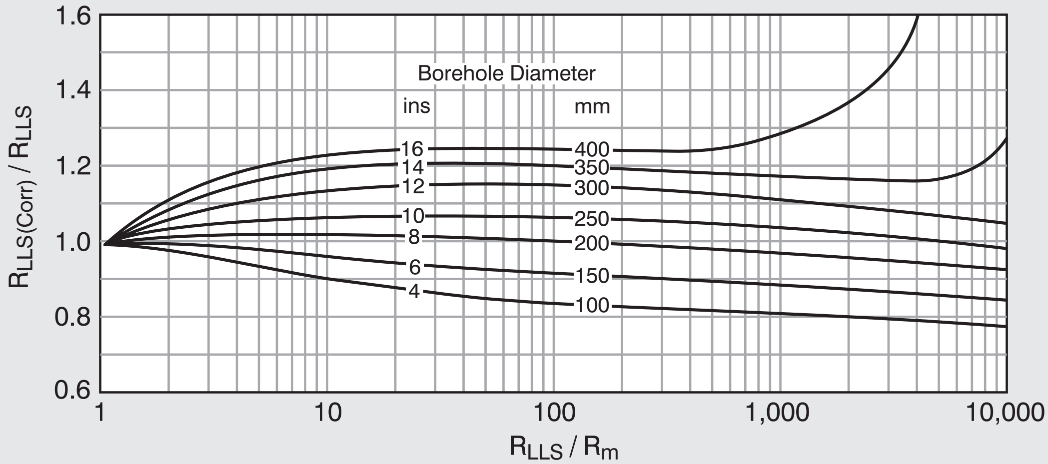
Lat - 4

Compact Shallow Laterolog Borehole Correction

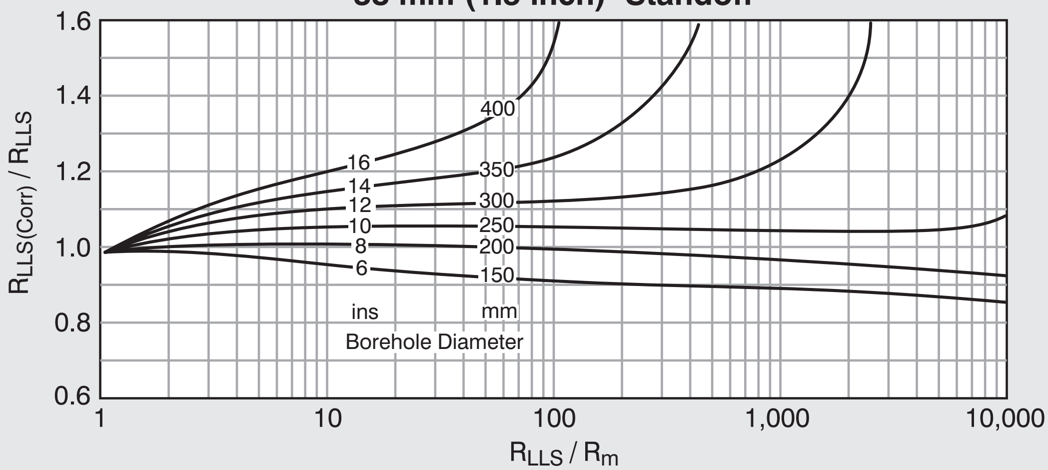
Compact Systems

Applicability: Compact Series (MDL) tools, Operating Mode A.
Standard condition is 13 mm (0.5 inch) standoff in a 200 mm (8 inch) well, Ra/Rm = 20.

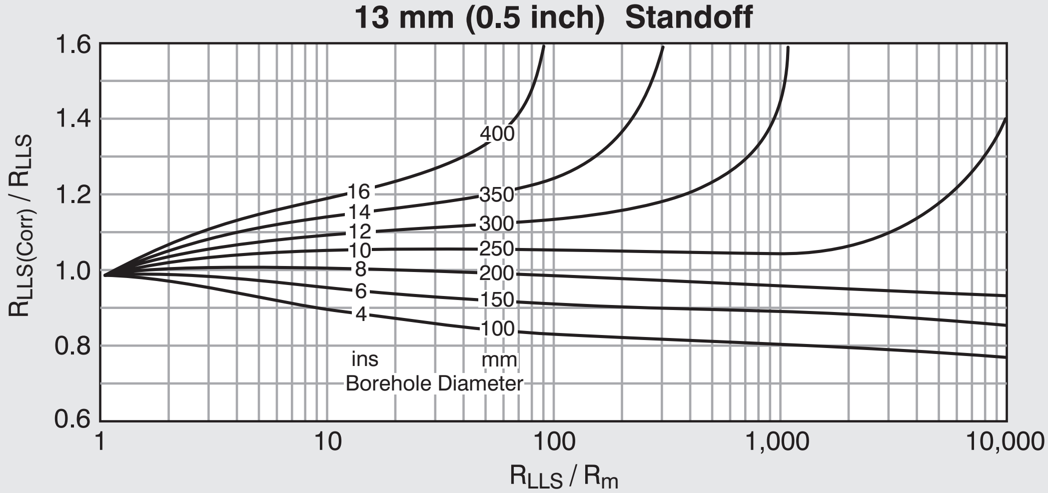
Centred



38 mm (1.5 inch) Standoff



13 mm (0.5 inch) Standoff

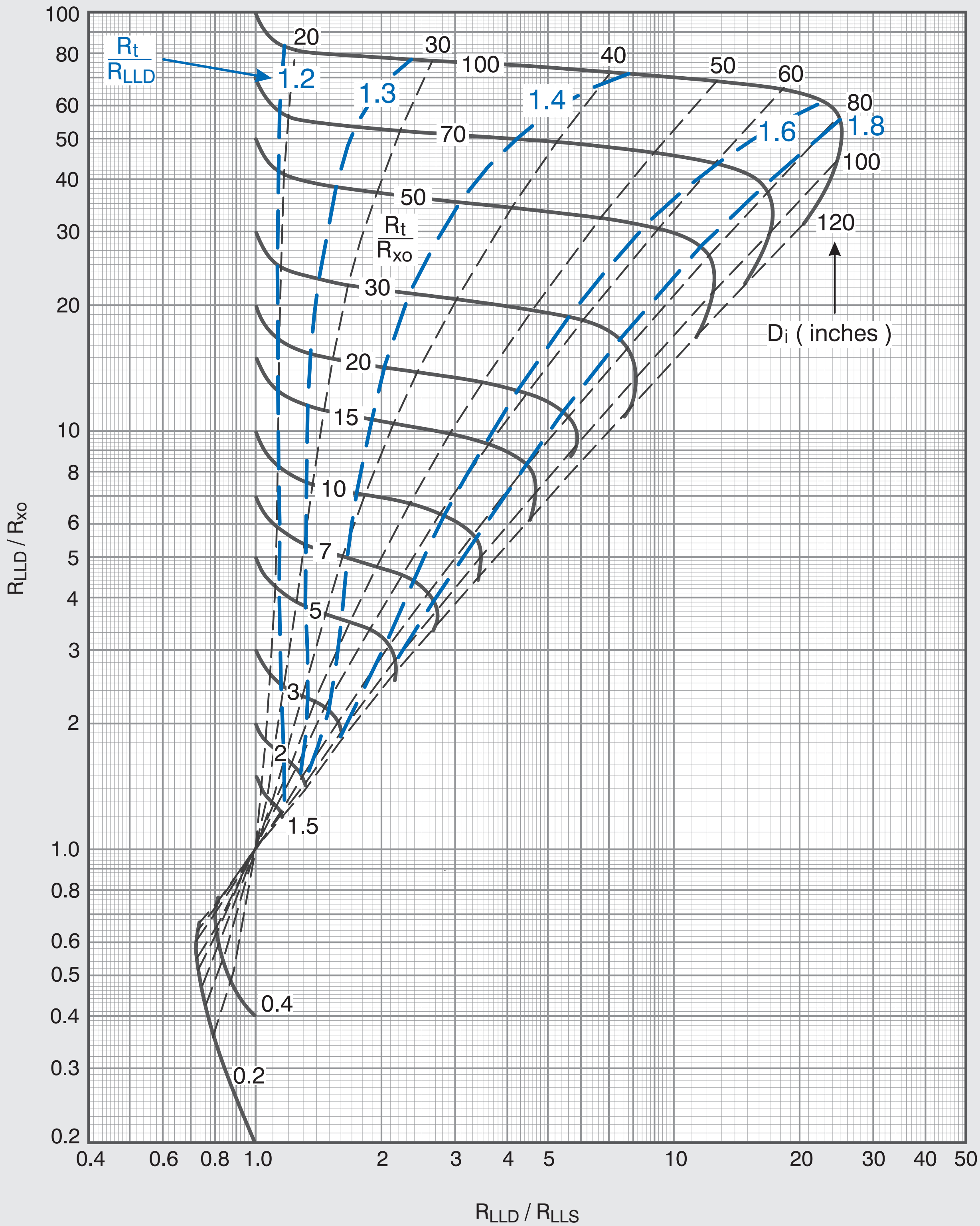


Lat - 5

Compact Dual Laterolog Tornado Chart

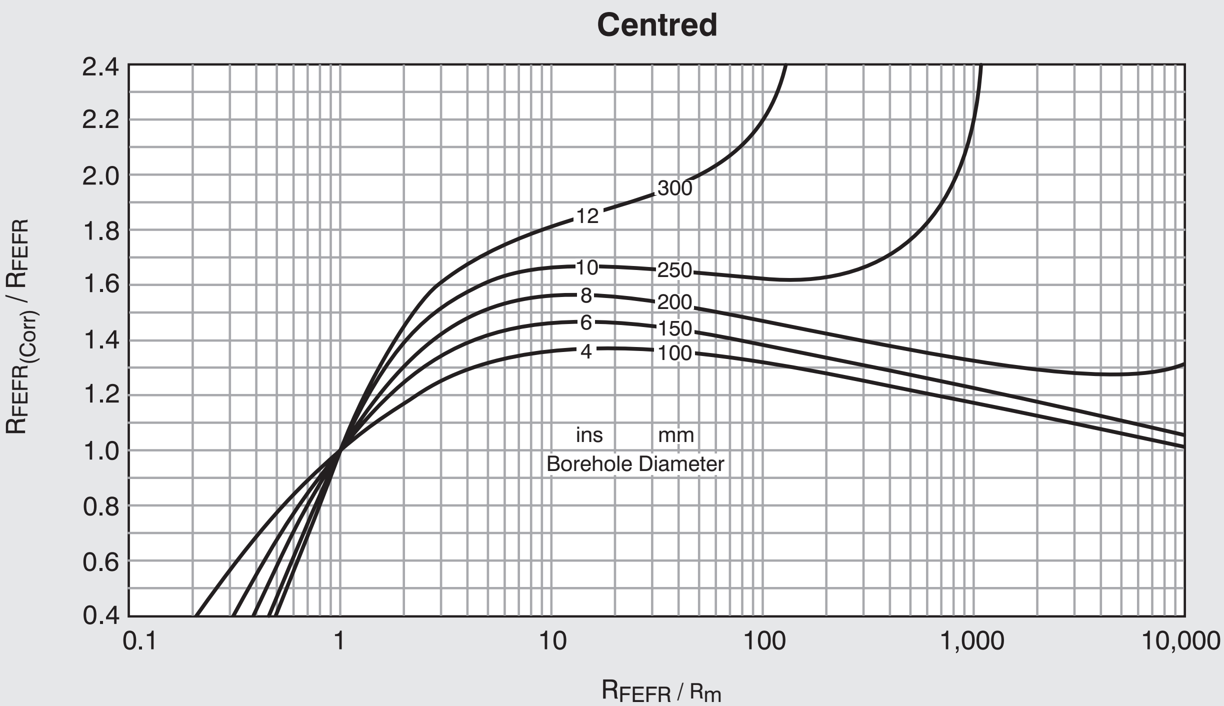
Compact Systems

Applicability: Compact Series (MDL) tools. Operating Mode A.
Thick beds, 8 inch (203 mm) hole, step invasion profile, Rxo/Rm = 50.
Use Borehole corrected data.



Lat - 6

Applicability: Compact Series (MFE) tools.



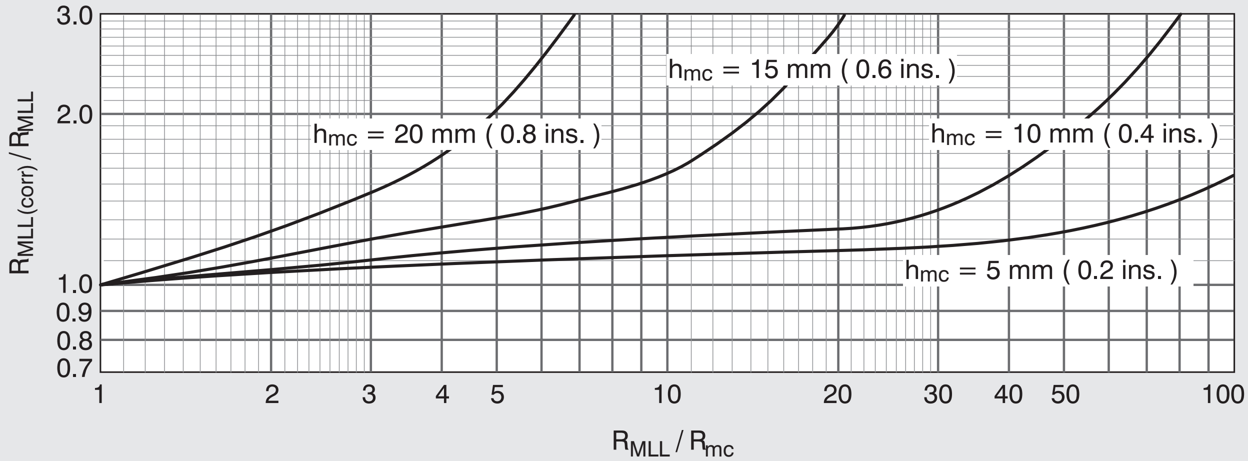
The Corrected Shallow Resistivity curve FEFE has been corrected for bit size and Rm. To apply an alternative correction, enter the chart using the Raw Shallow Resistivity curve FEFR.

Corrections are approximated by: $R_{FEFR(Corr)} / R_{FEFR} = a_0 + a_1x + a_2x^2 + a_3x^3 + ...$
where $x = \ln(R_{FEFR}/R_m)$. Coefficients for 4,6,8,10 and 12 inch wells are (left to right):

Centred					
a_0	1.0000000	1.0000000	1.0000000	1.0000000	1.0000000
a_1	0.3515411	0.5245657	0.6591658	0.7950933	0.9368961
a_2	-0.1259589	-0.2158732	-0.2848466	-0.4006034	-0.4659671
a_3	0.0209587	0.0404045	0.0570030	0.1119412	0.1453734
a_4	-0.0018341	-0.0037254	-0.0056788	-0.0172275	-0.0286625
a_5	0.0000652	0.0001324	0.0002223	0.0010960	0.0026412

SFE - 2

Applicability: MRS series tools with 8 inch (203 mm) pad profile.



MRS mudcake corrections are approximated by: $\ln(R_{MLL(corr)}/R_{MLL}) = a_1 x + a_2 x^2 + ...$

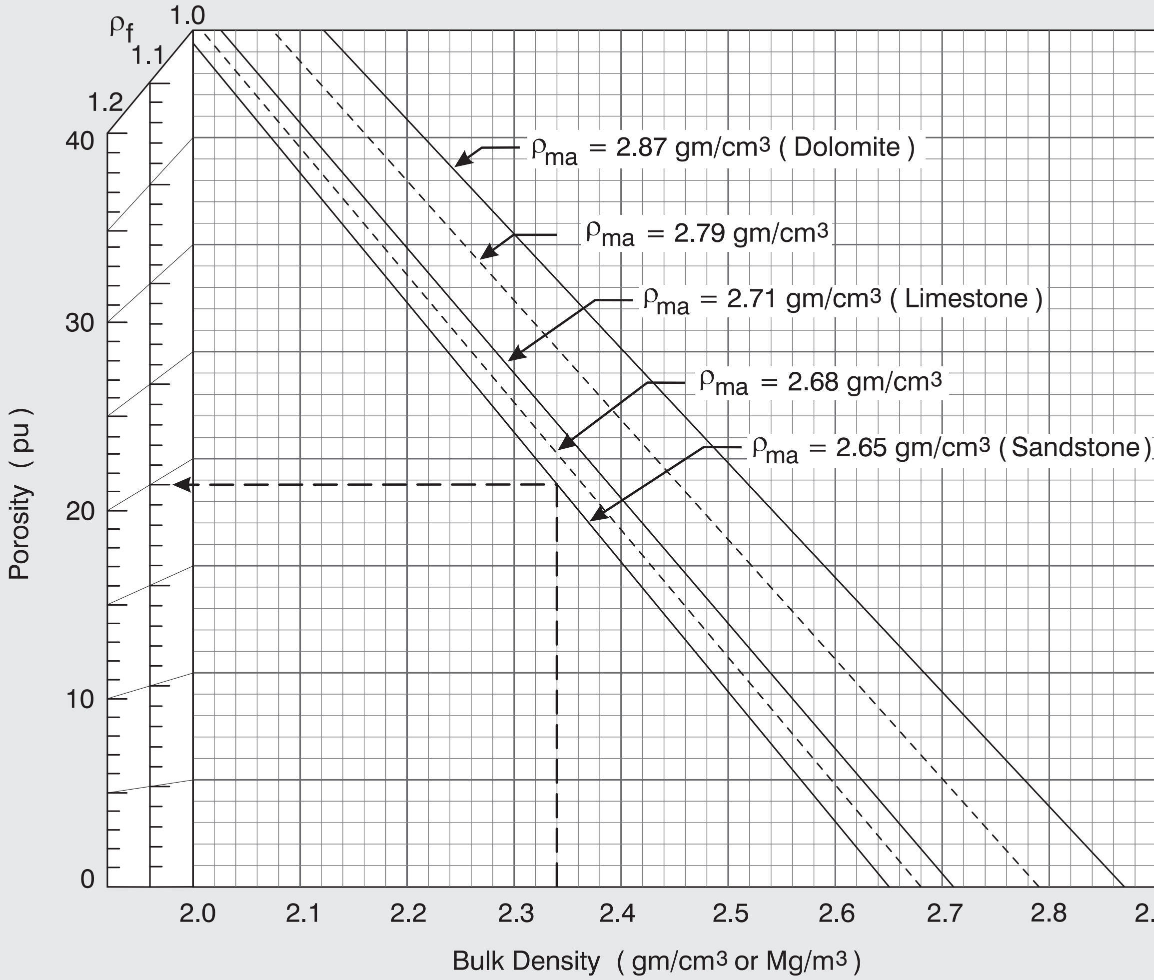
where $x = \ln(R_{MLL}/R_{mc})$

and R_{mc} = mud cake resistivity.

The coefficients are:

h_{mc} = 5 mm		h_{mc} = 10 mm		h_{mc} = 15 mm		h_{mc} = 20 mm	
$1 \leqslant R_{MLL}/R_{mc} \leqslant 120$		$1 \leqslant R_{MLL}/R_{mc} \leqslant 80$		$1 \leqslant R_{MLL}/R_{mc} \leqslant 22$		$1 \leqslant R_{MLL}/R_{mc} \leqslant 8$	
a_1	0.06592	a_1	-0.00289	a_1	0.09843	a_1	0.27612
a_2	0.02160	a_2	0.17825	a_2	0.18271	a_2	0.28891
a_3	-0.02080	a_3	-0.10172	a_3	-0.15378	a_3	-0.36847
a_4	0.00382	a_4	0.01693	a_4	0.03990	a_4	0.15526

Micro - 2



Use the chart to compute porosity from the Compensated Density log (or any other measure of formation density). It is based on the equation:

$$\Phi = \frac{\rho_{ma} - \rho_b}{\rho_{ma} - \rho_f}$$

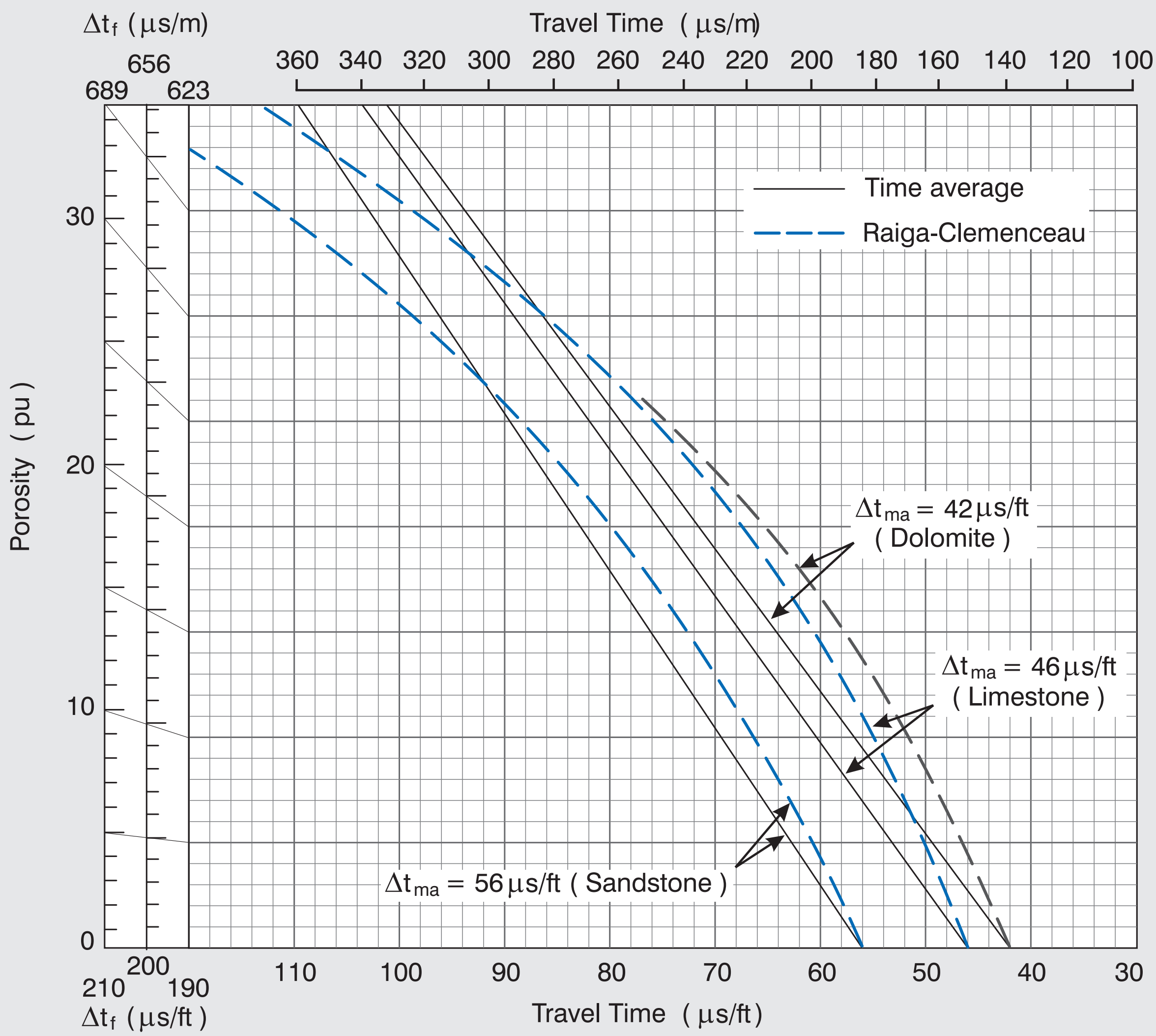
Enter the chart with a bulk density (ρ_b) value and move vertically to the appropriate matrix density (ρ_{ma}). Now move horizontally to intersect the porosity scale at the appropriate formation fluid density (ρ_f).

For example: ρ_b = 2.34 gm/cm^3
ρ_{ma} = 2.65 gm/cm^3 (Sandstone)
ρ_f = 1.10 gm/cm^3 (Salt mud)
Therefore porosity Φ = 20 %

Por - 1

Porosity from Acoustic Travel Time

Applicability: Compressional travel time in clean gas-free formations.



Use the chart to compute porosity from the Compensated Sonic Interval Transit Time log, or any compressional wave slowness measurement. Two transforms are presented. The linear transform is the Time Average equation given by:

$$\Phi = \frac{\Delta t - \Delta t_{ma}}{\Delta t_f - \Delta t_{ma}}$$

In many cases, better agreement with core data is achieved using a non-linear transform. The one used here is due to Raiga-Clemenceau and is given by:

$$\Phi = 1 - \left(\frac{\Delta t_{ma}}{\Delta t}\right)^{1/x}$$

where x = 1.60 for Sandstones, 1.76 for Limestones, and 2.00 for Dolomites.

Enter the chart with a Travel Time (Δt) value and move vertically to the appropriate characteristic line. Now move horizontally to intersect the Porosity scale at the appropriate Fluid Travel Time value (Δt_f). For Raiga-Clemenceau lines, use the Δt_f = 190 scale.

Por - 2

Applicability: CNS and MDN series tools.

Neutron porosity logs are recorded in Limestone units (curve mnemonic NPRL) and may also be displayed in Sandstone (mnemonic NPRS) or Dolomite units (mnemonic NPRD). Charts Npor-1a and Npor-5 show the magnitude of these transforms.

Use charts Npor-2a to Npor-4, and Npor-5 to Npor-8 to determine the magnitude of environmental corrections. Compact tool field logs may be corrected automatically for any of the environmental perturbations - refer to the correction parameter values listed in the log tail to determine whether a particular correction has been applied (indicated by departure from standard conditions).

CNS series tools are normally corrected for hole size, borehole fluid salinity and formation matrix cross section. Hole size correction uses caliper or bit size logs (if bit size has been used, an asterisk appears next to the BIT parameter in the Logging Constants part of the log tail). The borehole fluid salinity correction is controlled by the MDNACL parameter (NaCl concentration in kppm), also listed in Logging Constants.

Standard conditions are:

Limestone matix:	$CaCO_3$ with 7.10 cu capture cross section
Borehole size:	8.0 inches (203 mm)
Borehole fluid:	fresh water
Tool standoff:	0.0 inches (0 .0 mm)
Mud weight:	8.345 lb/US gallon (1000 Kg/m^3)
Borehole temperature:	68°F (20°C)
Formation pressure:	0 kpsi (0 Mpa)
Formation fluid:	fresh water with 22.2 cu capture cross section

Standard Sandstone matrix is SiO_2 with 4.26 cu capture cross section. Standard Dolomite matrix is $CaMg(CO_3)$ with 4.70 cu capture cross section.

If a correction was not applied during acquisition, or if alternative parameter values are established, the charts allow a new nett correction to be computed. The raw Apparent Limestone porosity curve NPOR is provided for this purpose.

Corrections are applied in a specific order. Using chart Npor-6 for illustration, begin with NPOR, and draw a line vertically from the uppermost porosity entry point through to the second porosity scale. A correction is computed from each nomogram by following the correction curves from the actual condition to the standard condition. A multiplier is applied to the corrections for borehole fluid salinity and standoff if the hole size is not 8 inches. The total correction is the arithmetic sum of the individual corrections. Next, transform the resulting porosity into the appropriate matrix units using Chart Npor - 5, before applying Σ_{ma} and formation fluid salinity corrections in charts Npor - 7 and Npor - 8. Finally, return to chart Npor - 6 to perform formation temperature and pressure corrections.

Applicability: CNS tools with Type 5 processing. Σ_{fl} value: 22.2 cu.
Σ_{ma} values: Silica 4.26 cu Limestone 7.10 cu Dolomite 4.70 cu

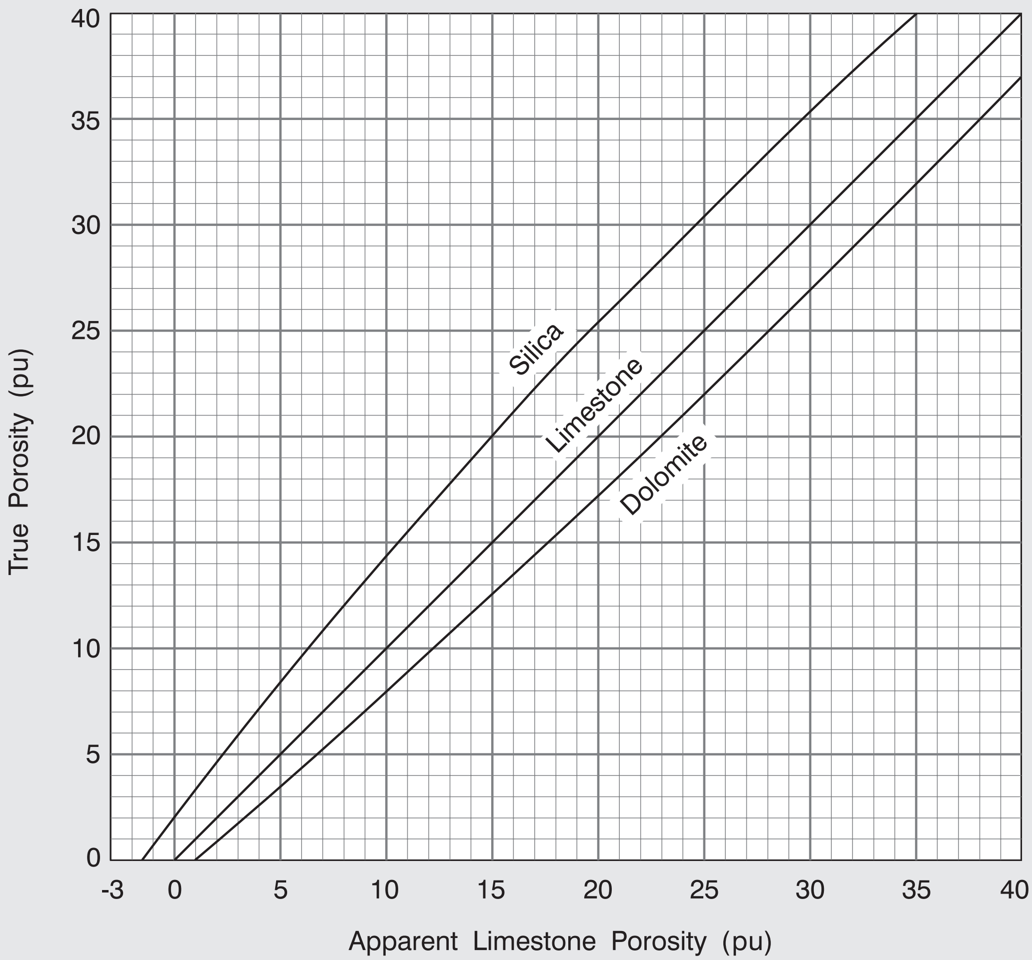


Chart Npor-1a provides true porosities for silica sandstones and dolomites from CNS logs recorded in apparent limestone units.

Enter the apparent limestone porosity and move vertically to the appropriate matrix line. Read the true porosity from the vertical axis.

The transforms are approximated by the following equations:

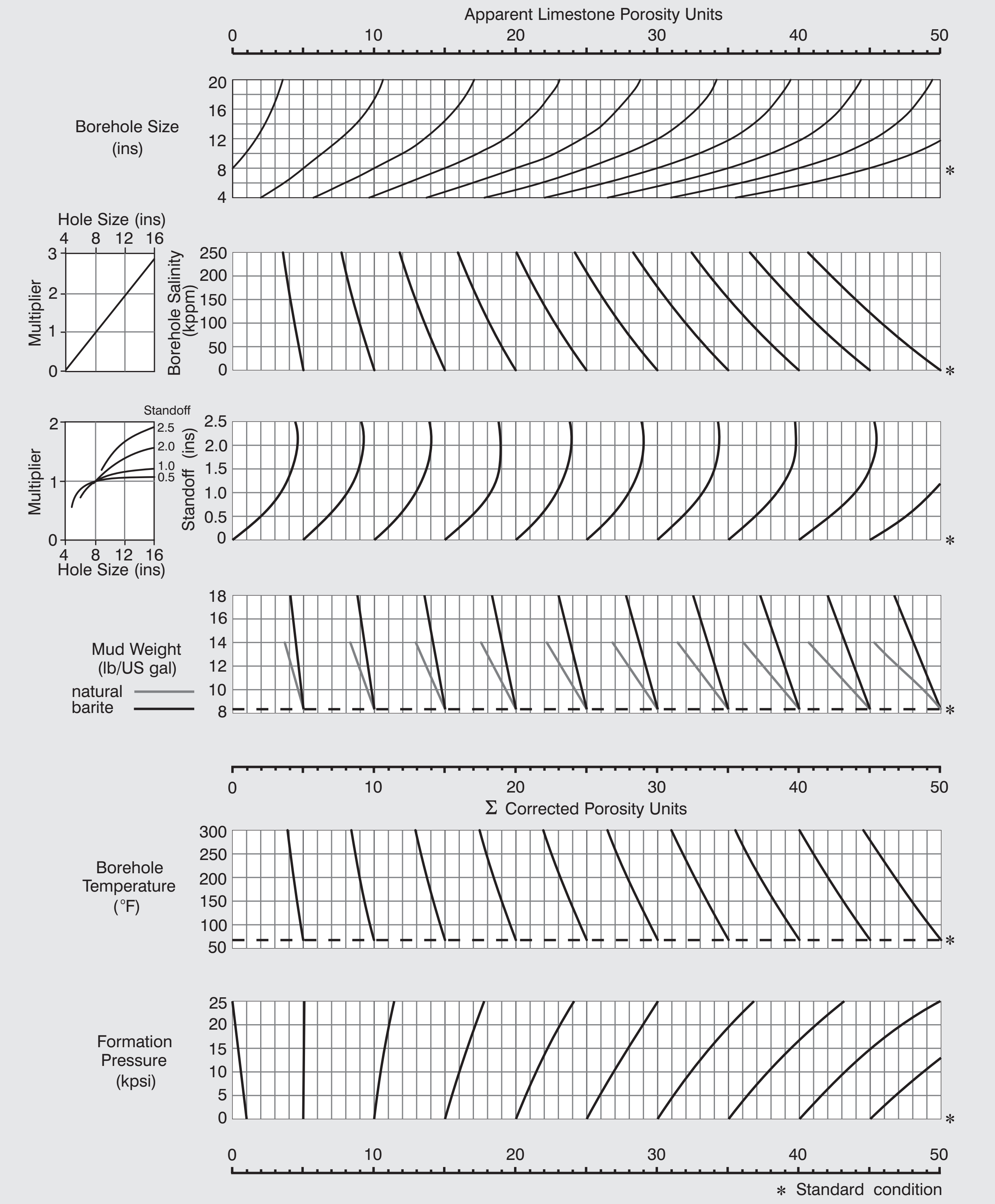
$$\Phi_{sand} = 0.000052\,\Phi_{lim}^{3} - 0.0085\,\Phi_{lim}^{2} + 1.32\,\Phi_{lim} + 2.0$$

$$\Phi_{dol} = -0.000015\,\Phi_{lim}^{3} + 0.003\,\Phi_{lim}^{2} + 0.85\,\Phi_{lim} - 0.87$$

When formation Σ_{ma} values depart significantly from standard conditions, use chart Npor-3a to make additional corrections.

Npor - 1a

Applicability: Open hole logs from CNS series tools with Type 5 processing.



Npor - 2a

Applicability: CNS tools with Type 5 processing.
Porosity (Φ) in pu. Range: as Chart Npor - 2a.

Borehole Size

Field logs are corrected automatically using a caliper or bit size log. To compute a correction based on an alternative measure of hole size, use the following equations applied to the raw Apparent Limestone Porosity curve (mnemonic NPOR):

$$\Delta\Phi = f(\Phi) \cdot f(c)$$

where

$c = (\text{caliper} - 8.0)$ inches

$f(\Phi) = 0.000009\,\Phi^3 - 0.00037165\Phi^2 + 0.26433\Phi + 1.7216$

$f(c) = -0.00055c^3 + 0.01865c^2 - 0.25813c$

Borehole Fluid Salinity

Field logs are corrected automatically for borehole fluid salinity. To compute a correction for an alternative value of salinity, use the following equation applied to the raw Apparent Limestone Porosity curve (mnemonic NPOR):

$$\Delta\Phi = k\cdot(0.2\Phi + 0.64)\text{MDNACL}/250$$

where:

$k = (\text{caliper} - 3.75)/4.25$ inches

MDNACL = NaCl equivalent salinity in kppm

Standoff

$$\Delta\Phi = k\cdot f(\text{standoff})\cdot f(\Phi)$$

where:

$k = (\text{caliper} - 3.75)/4.25$ inches

$f(\text{standoff}) = 1.113\,s^2 - 4.719\,s$

$f(\Phi) = 0.000515\Phi^2 - 0.021\Phi + 1.0$

$s = \text{standoff}/k$ inches

Mud Weight

Natural Muds

$$\Delta\Phi = (0.0143\Phi + 0.1786)\cdot(w - 8.345)$$

Barite Muds

$$\Delta\Phi = (0.0057\Phi + 0.0714)\cdot(w - 8.345)$$

where:

w = mud weight in lbs/US gallon

Borehole Temperature

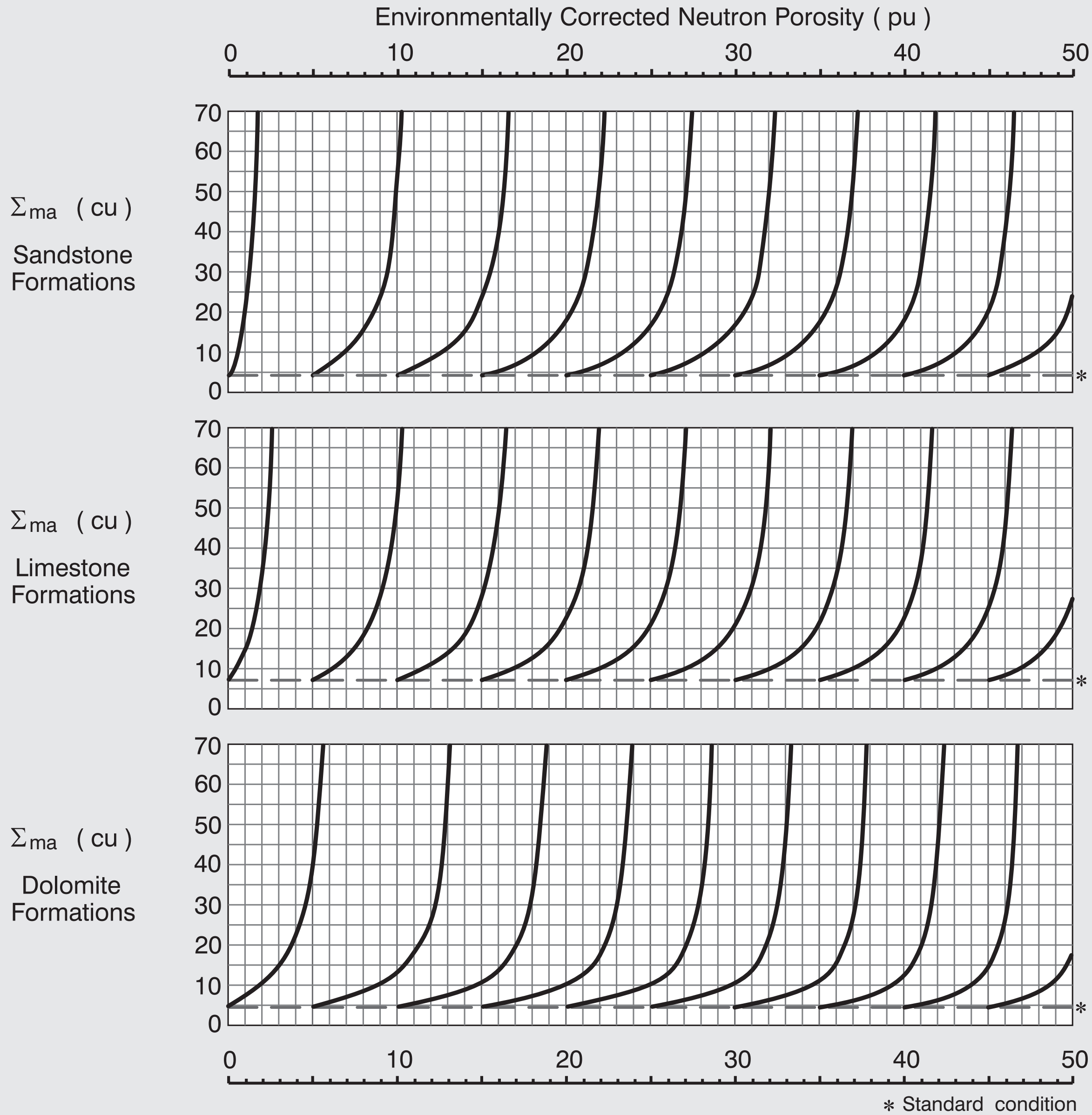
$$\Delta\Phi = (0.000464\Phi + 0.002982)\cdot({}^\circ F - 68)$$

Formation Pressure

$$\Delta\Phi = (0.04 - 0.0085\Phi)\ \text{kpsi}$$

Neutron Porosity Matrix Cross Section Correction

Applicability: Open hole logs from 95 mm (3 3/4 inch) diameter CNS series tools.



Use the appropriate nomogram to deduce corrections for variations in matrix sigma values. Formation fluid sigma corrections associated with salinity changes are approximated by the formation salinity nomogram in Chart Npor-2a. Matrix sigma corrections are given by:

sand $\Delta\Phi = (-7.56a^2 + 18.52a - 10.96)\cdot(0.065\Phi \exp(-0.035\Phi) + 0.07)$

lime $\Delta\Phi = (-1.37a^2 + 8.78a - 7.41)\cdot(0.085\Phi \exp(-0.035\Phi) + 0.20)$

dolomite $\Delta\Phi = (-0.75a^2 + 14.04a - 13.29)\cdot(0.07\Phi \exp(-0.045\Phi) + 0.15)$

where: Φ = borehole corrected neutron porosity in appropriate matrix units

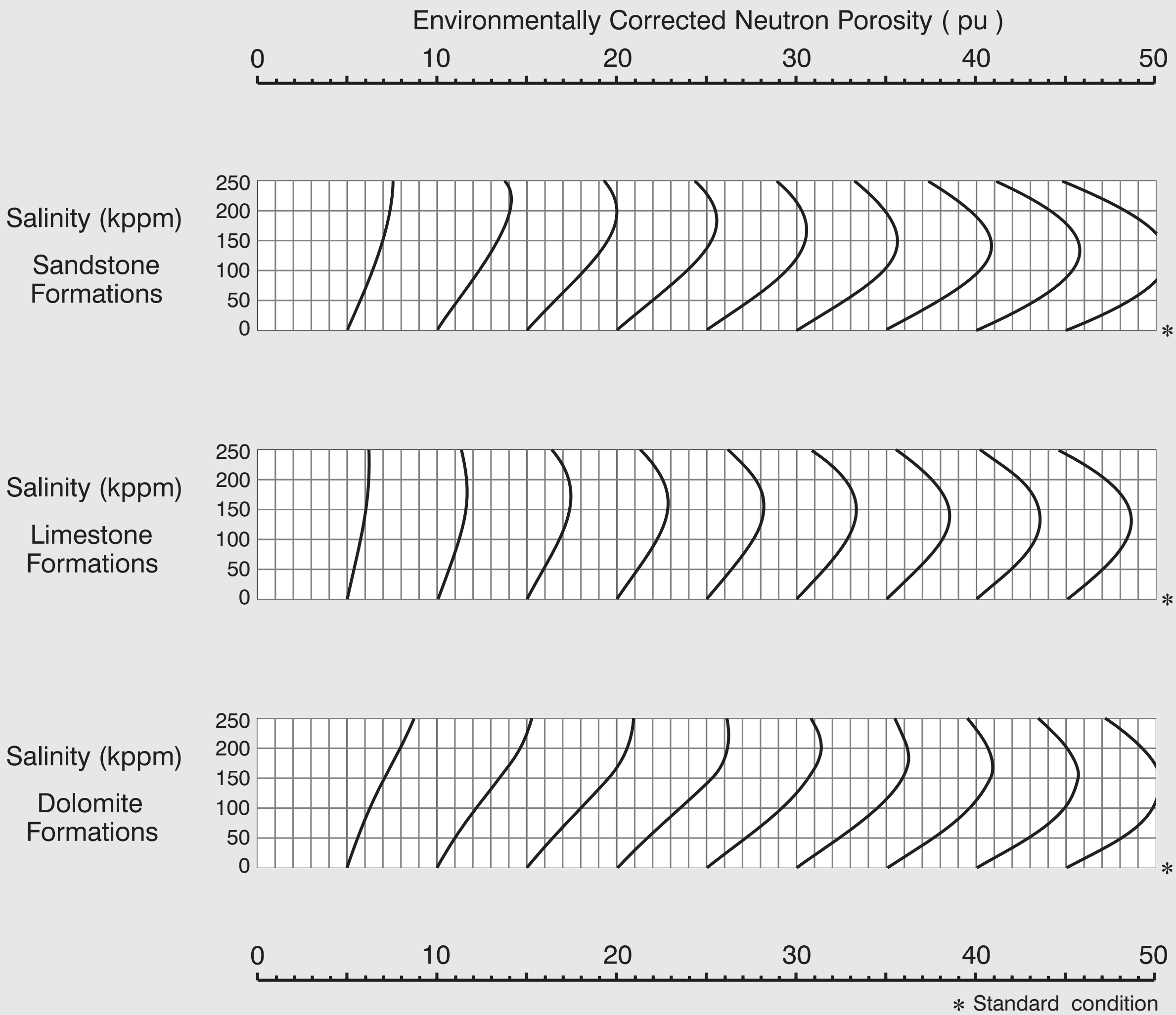
and $a = \Sigma_{ma(std)} / \Sigma_{ma}$

and $\Sigma_{ma(std)}$ = 4.26, 7.10 and 4.70 cu respectively for standard sand, lime and dolomite.

Npor - 3a

Neutron Porosity Formation Salinity Correction

Applicability: Open hole logs from CNS Series tools.



Use the appropriate nomogram to deduce corrections for variations in formation salinity. If the matrix cross section is known, a correction should first be made using Chart Npor-3a. Salinity corrections are approximated by:

sand $\Delta\Phi = (-0.045\,\Phi^2 + 3.2\Phi - 8.0)\cdot kppm^3\cdot 10^{-8} + (0.025\,\Phi^2 - 0.7\,\Phi + 2.0)\cdot kppm^2\cdot 10^{-5} - (1.75\,\Phi + 1.0)\cdot kppm\cdot 10^{-3}$

lime $\Delta\Phi = (-0.055\,\Phi^2 + 3.6\,\Phi - 12.0)\cdot kppm^3\cdot 10^{-8} + (0.017\,\Phi^2 - 0.6\Phi + 2.0)\cdot kppm^2\cdot 10^{-5} - (\Phi + 1.0)\cdot kppm\cdot 10^{-3}$

dolomite $\Delta\Phi = (-0.045\,\Phi^2 + 2.8\Phi - 10.0)\cdot kppm^3\cdot 10^{-8} + (0.025\Phi^2 - 0.8\,\Phi + 2.0)\cdot kppm^2\cdot 10^{-5} - (1.5\,\Phi + 1.0)\cdot kppm\cdot 10^{-3}$

where: Φ = borehole corrected neutron porosity in appropriate matrix units

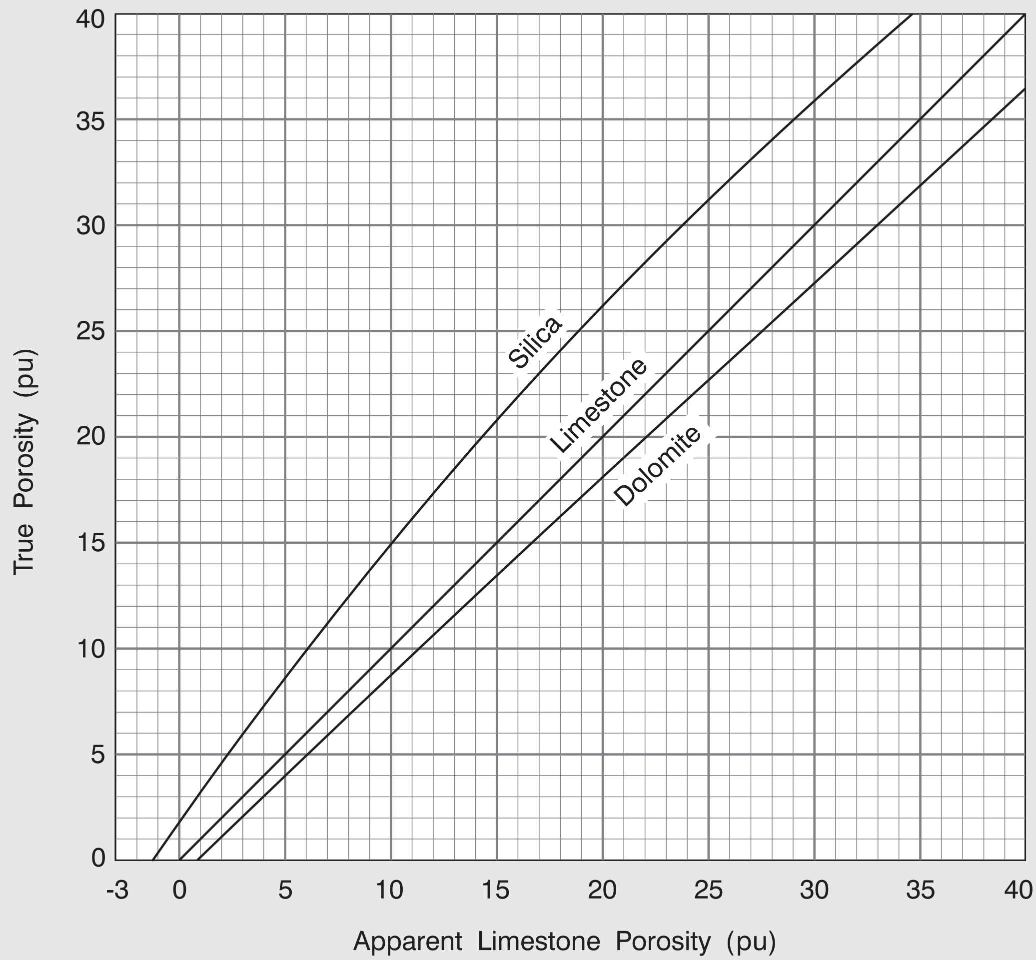
Npor - 4

Neutron Porosity Matrix Transforms

Compact Systems

Applicability: Compact Series (MDN) tools. Σ_{fl} value: 22.2 cu.

Σ_{ma} values: Silica 4.26 cu Limestone 7.10 cu Dolomite 4.70 cu



Use Chart Npor - 5 to transform Compact Series neutron porosity logs recorded in apparent limestone units into true sandstone and dolomite porosities.

Enter the apparent limestone porosity and move vertically to the appropriate matrix line. Read the true porosity from the vertical axis.

The transforms are described by the following equations:

$$\Phi_{sand} = 0.000075\,\Phi_{lim}^{3} - 0.012\,\Phi_{lim}^{2} + 1.43\,\Phi_{lim} + 1.76$$

$$\Phi_{dol} = 0.000025\,\Phi_{lim}^{3} - 0.0022\,\Phi_{lim}^{2} + 0.982\,\Phi_{lim} - 0.88$$

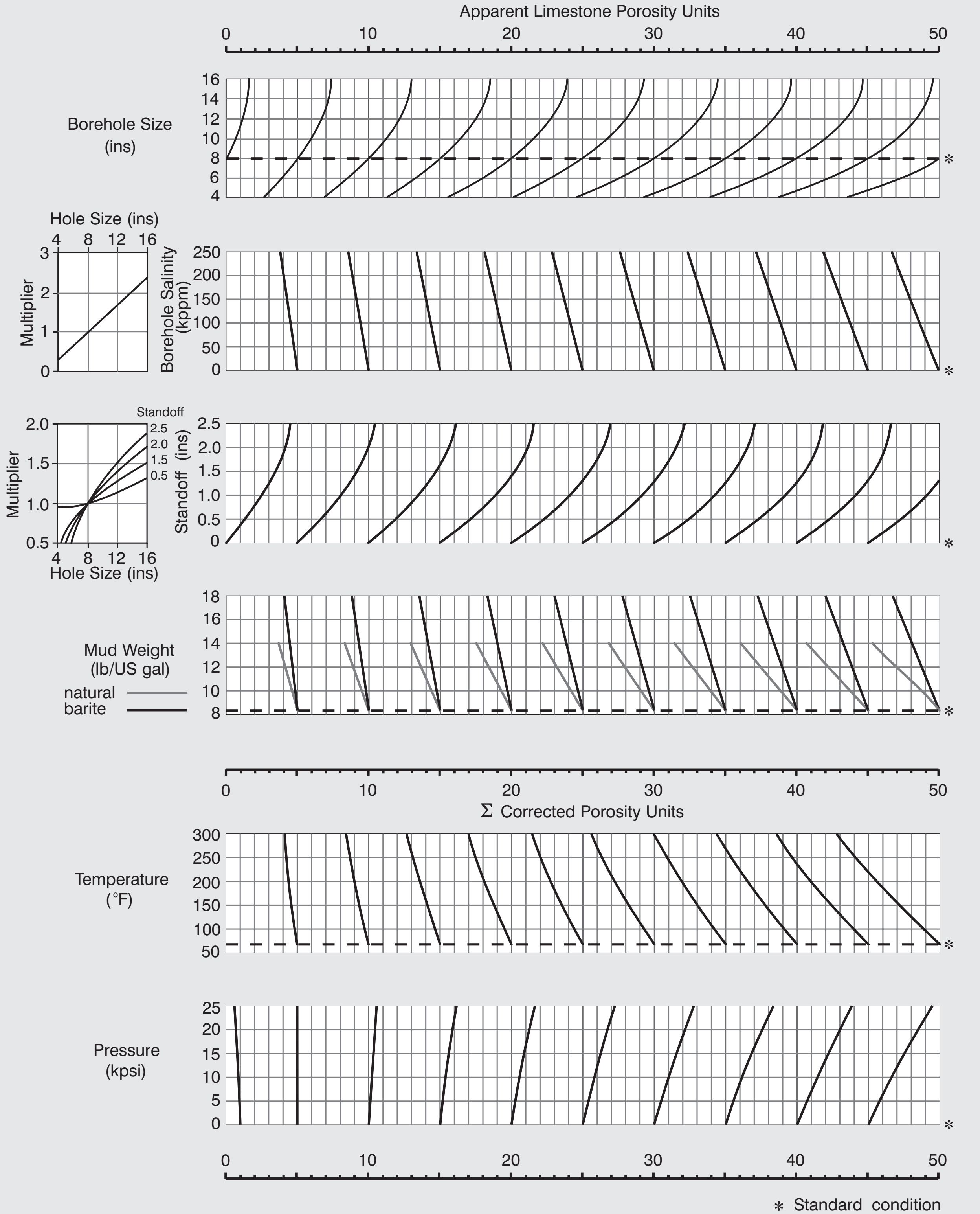
When formation Σ_{ma} values depart significantly from standard conditions, use chart Npor - 7 to make additional corrections.

Npor - 5

Neutron Porosity Environmental Correction

Compact Systems

Applicability: Open hole logs from Compact Series (MDN) tools.



Npor - 6

Applicability: Compact Series (MDN) tools.

Porosity (Φ) in pu. Range: as Chart Npor - 6.

General

To determine whether a particular environmental correction was applied during acquisition, refer to the correction parameter value recorded on the log tail; if it is equal to the standard condition value, then no correction was applied. Corrections are additive.

To compute corrections for borehole size, borehole fluid salinity, standoff and mud weight based on alternative parameter values, use the relevant equations applied to the raw Apparent Limestone Porosity curve (mnemonic NPOR). Temperature and pressure corrections should be applied after matrix and formation fluid salinity corrections have been made.

Borehole Size

$$\Delta\Phi = f(\Phi) \cdot f(c)$$

where:

$c = (\text{caliper} - 8.0)$ inches

$f(\Phi) = -0.00231\Phi^2 + 0.214\,\Phi + 2.1$

$f(c) = -0.00034c^3 + 0.01313c^2 - 0.167c$

Borehole Fluid Salinity

$$\Delta\Phi = k \cdot (0.05\Phi + 1.0)\,\text{MDNACL} / 250$$

where:

$k = (\text{caliper} - 2.25)/5.75$ inches

MDNACL = NaCl equivalent salinity in kppm

Standoff

$$\Delta\Phi = f(\text{standoff}) \cdot f(\Phi) \cdot (\text{caliper}^2/128 + \text{caliper}/16)$$

where:

$f(\text{standoff}) = 0.8s^2 - 4.4\,s$

$f(\Phi) = -0.0005\,\Phi^2 + 0.034\,\Phi + 0.6$

$s = \text{standoff} / k$ inches

$k = (\text{caliper} - 2.25)/5.75$ inches

Mud Weight

Natural Muds

$$\Delta\Phi = (0.0143\Phi + 0.1786) \cdot (w - 8.345)$$

Barite Muds

$$\Delta\Phi = (0.0057\Phi + 0.0714) \cdot (w - 8.345)$$

where:

w = mud weight in lbs/US gallon

Borehole Temperature

$$\Delta\Phi = (0.0007\Phi + 0.001) \cdot (^\circ F - 68)$$

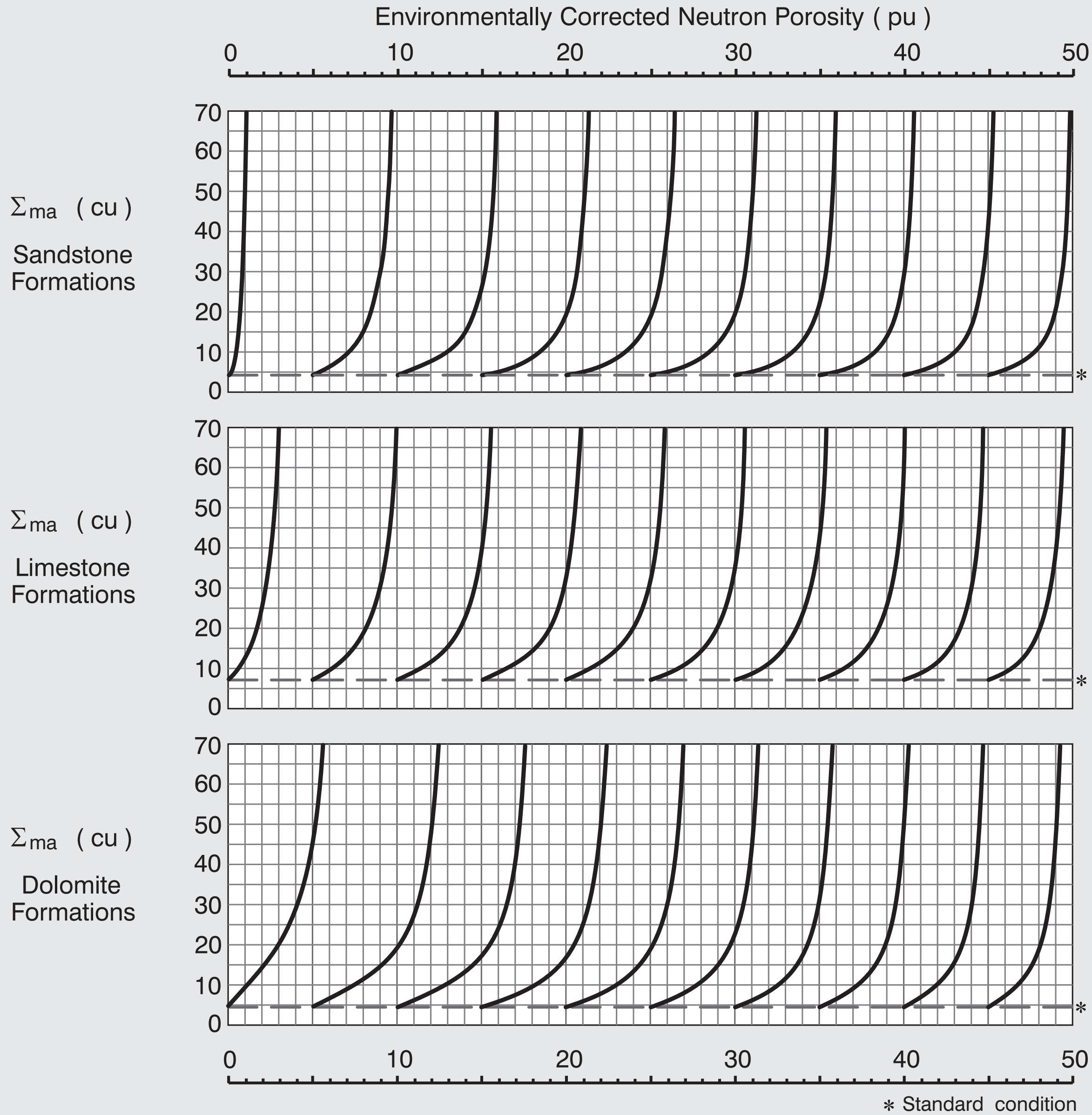
Pressure

$$\Delta\Phi = (0.02 - 0.004\,\Phi) \cdot \text{kpsi}$$

Neutron Porosity Matrix Cross Section Correction

Compact Systems

Applicability: Open hole logs from Compact Series (MDN) tools.



Use the appropriate nomogram to deduce corrections for variations in matrix sigma values. Sigma corrections associated with variations in formation fluid salinity are specified in Chart Npor - 8. Matrix sigma corrections are given by:

sand $\Delta\Phi = (-2.51a^2 + 11.34a - 8.83)\cdot(0.08\,\Phi\exp(-0.04\,\Phi) + 0.05)$

lime $\Delta\Phi = (-1.37a^2 + 8.78a - 7.41)\cdot(0.08\Phi\exp(-0.045\,\Phi) + 0.25)$

dolomite $\Delta\Phi = (-7.09a^2 + 16.98a - 9.89)\cdot(0.11\,\Phi\exp(-0.06\,\Phi) + 0.20)$

where: Φ = borehole corrected neutron porosity in appropriate matrix units

and $a = \Sigma_{ma(std)} / \Sigma_{ma}$

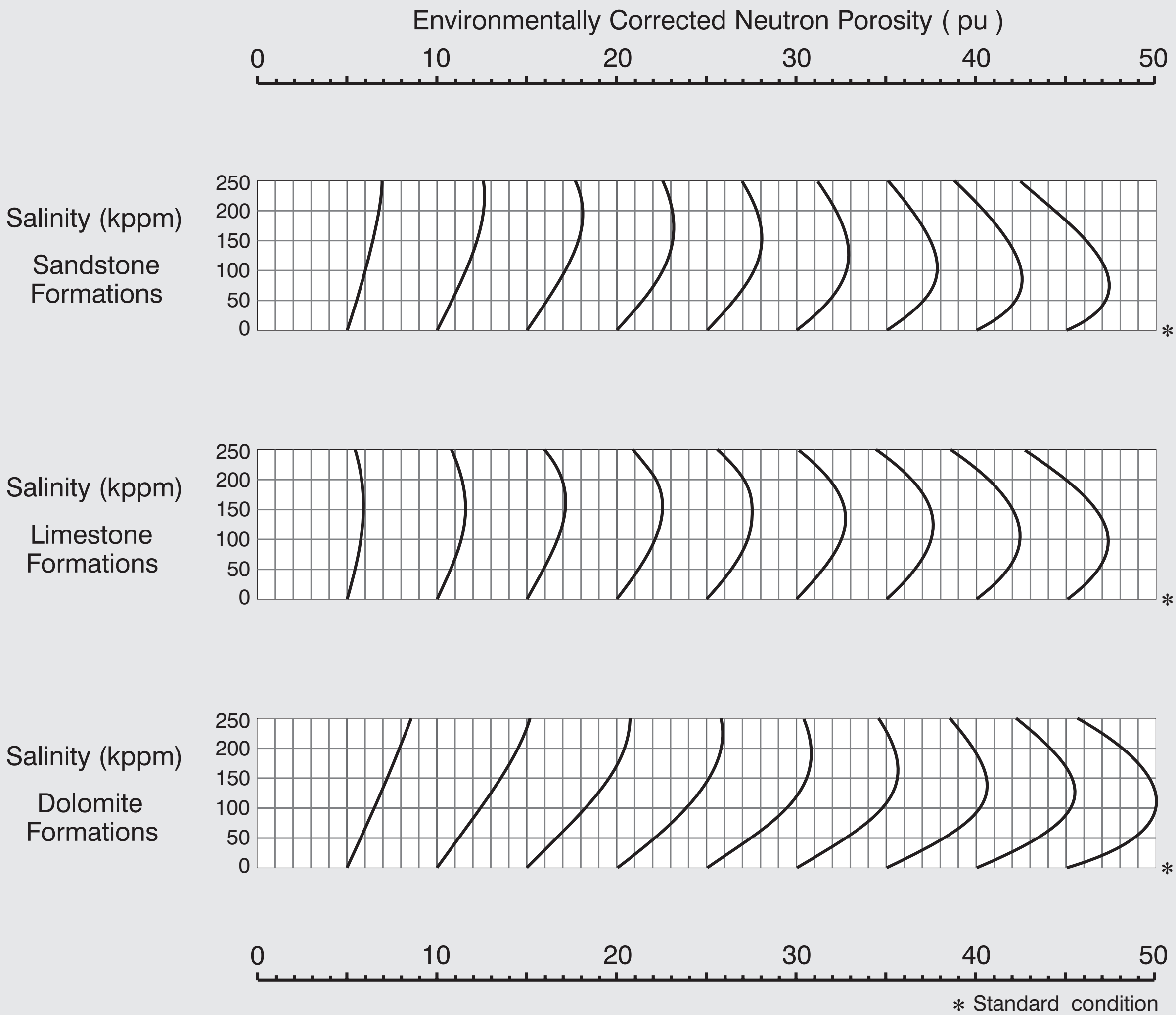
and $\Sigma_{ma(std)}$ = 4.26, 7.10 and 4.70 cu respectively for standard sand, lime and dolomite.

Npor - 7

Neutron Porosity Formation Salinity Corrections

Compact Systems

Applicability: Open hole logs from Compact Series (MDN) tools.



Use the appropriate nomogram to deduce corrections for variations in formation salinity. If the matrix cross section is known, a correction should first be made using Chart Npor-7. Salinity corrections are approximated by:

sand $\Delta\Phi = (-0.07\,\Phi^2 + 2.0\,\Phi - 3.0)\cdot kppm^3\cdot 10^{-8} + (0.031\Phi^2 - 0.4\Phi + 1.0)\cdot kppm^2\cdot 10^{-5} - (1.4\,\Phi + 2.0)\cdot kppm\cdot 10^{-3}$

lime $\Delta\Phi = (-0.066\,\Phi^2 + 3.0\,\Phi - 1.0)\cdot kppm^3\cdot 10^{-8} + (0.024\,\Phi^2 - 0.6\,\Phi + 1.2)\cdot kppm^2\cdot 10^{-5} - (\Phi + 1.0)\cdot kppm\cdot 10^{-3}$

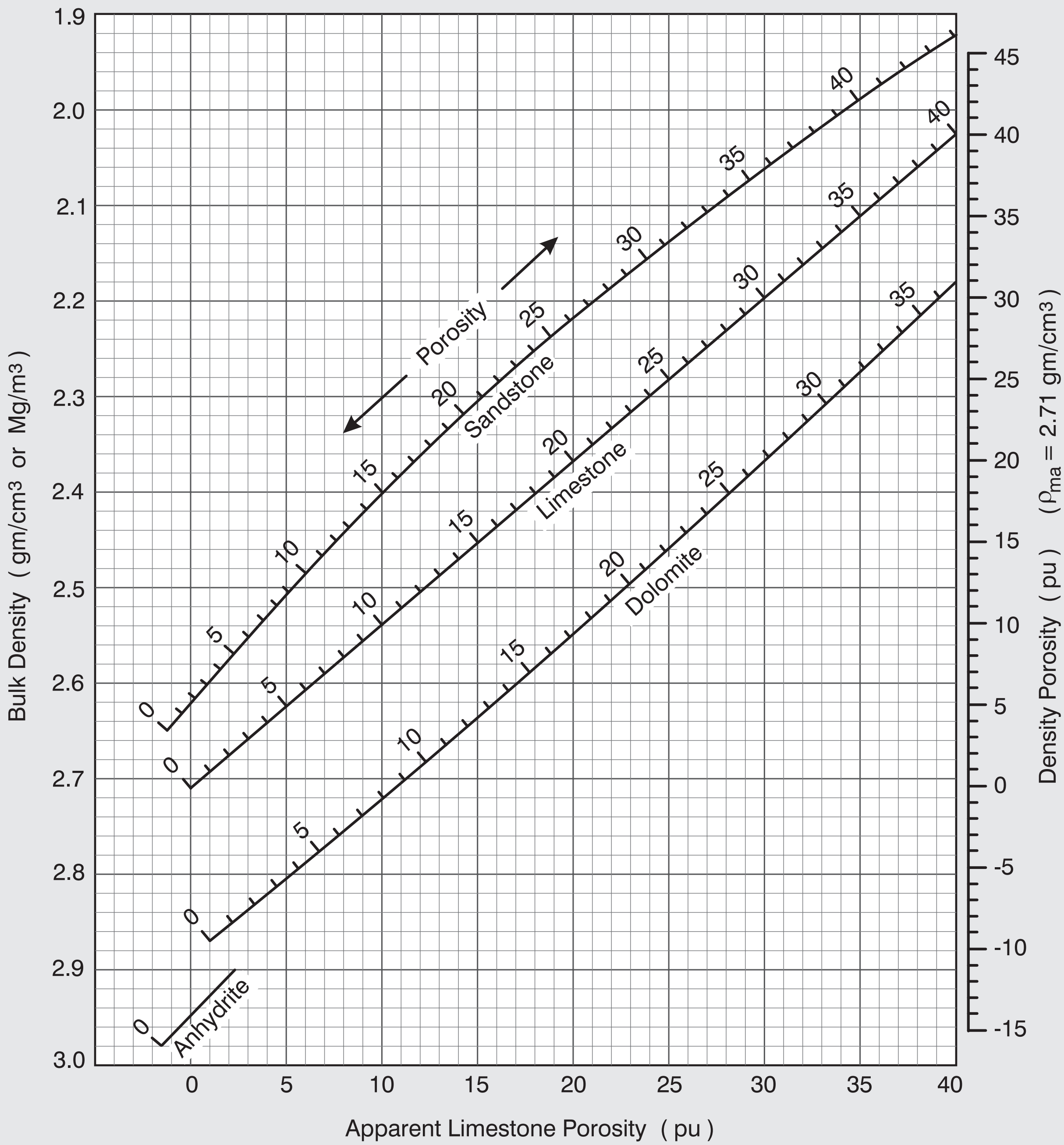
dolomite $\Delta\Phi = (-0.02\,\Phi^2 + 0.4\Phi - 1.0)\cdot kppm^3\cdot 10^{-8} + (0.022\,\Phi^2 - 0.1\Phi + 1.0)\cdot kppm^2\cdot 10^{-5} - (2.0\,\Phi + 2.0)\cdot kppm\cdot 10^{-3}$

where: Φ = borehole corrected neutron porosity in appropriate matrix units

Npor - 8

Lithology-Porosity from Density-Neutron Crossplot

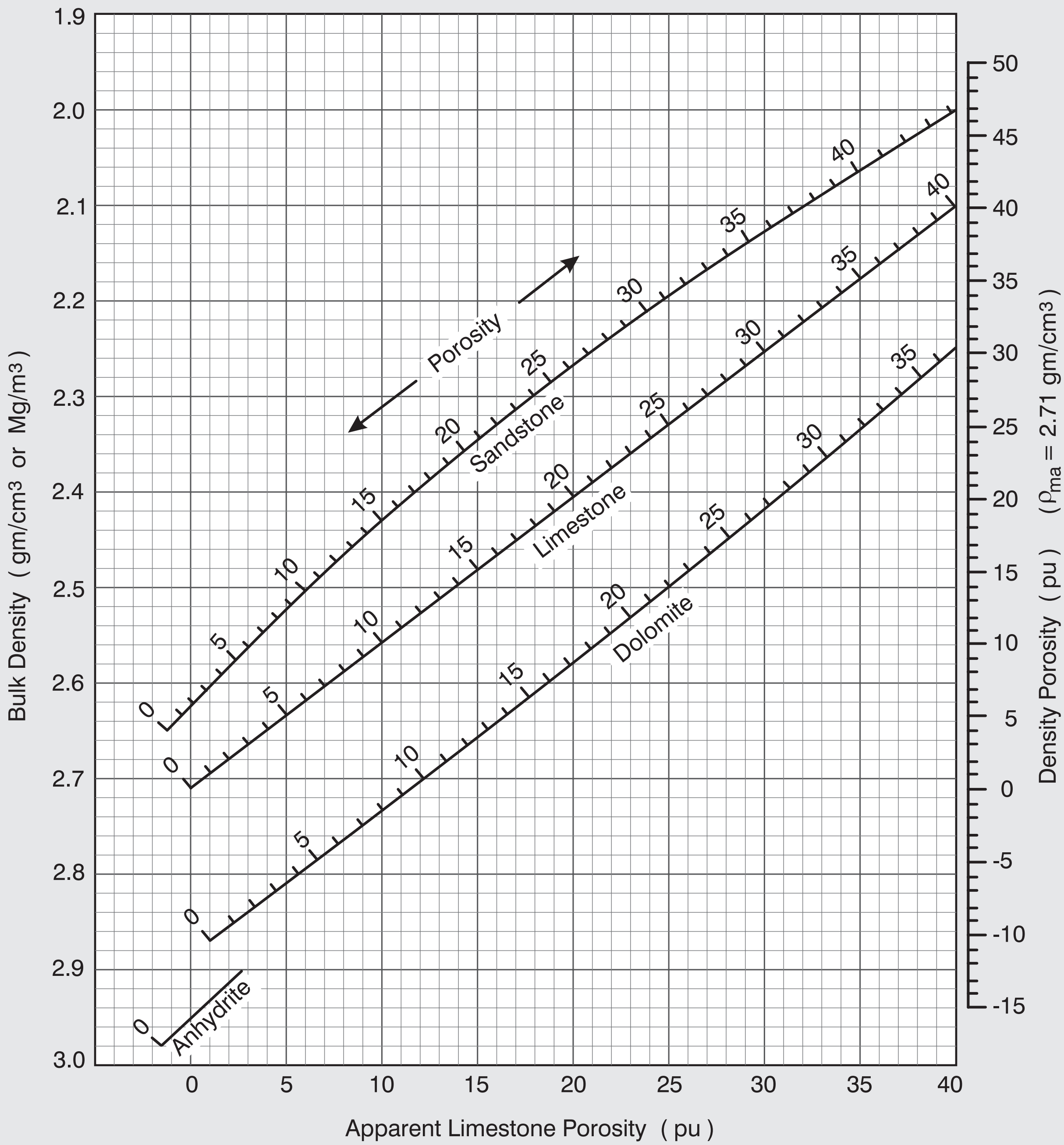
Applicability: CNS tools with Type 5 processing, environmentally corrected.
Formation fluid density = 1.0 gm/cm3 (Mg/m3).



LP - 1

Lithology-Porosity from Density-Neutron Crossplot

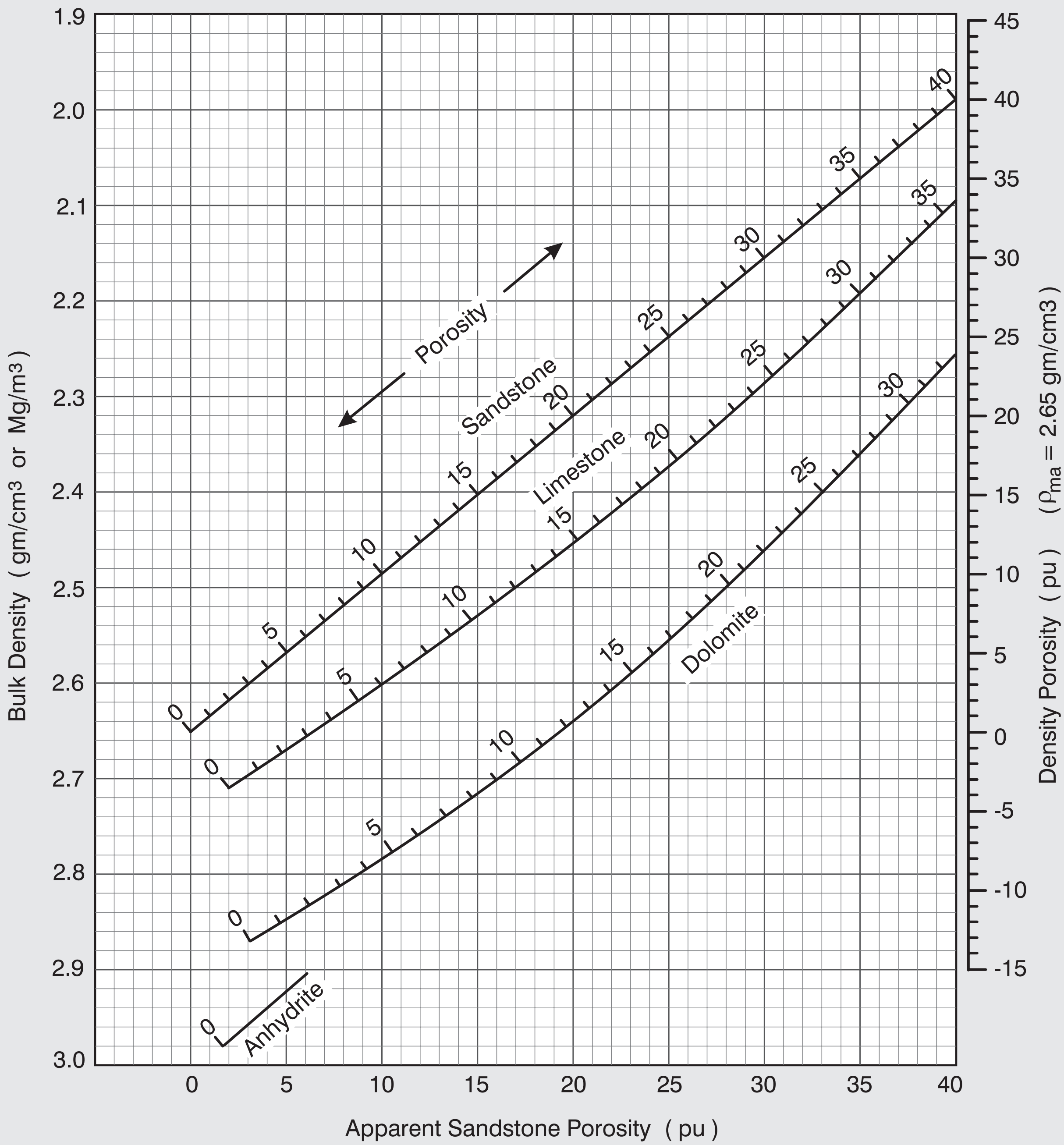
Applicability: CNS tools with Type 5 processing, environmentally corrected.
Formation fluid density = 1.19 gm/cm^3 (Mg/m^3).



LP - 2

Lithology-Porosity from Density-Neutron Crossplot

Applicability: CNS tools with Type 5 processing, environmentally corrected.
Formation fluid density = 1.0 gm/cm3 (Mg/m3).

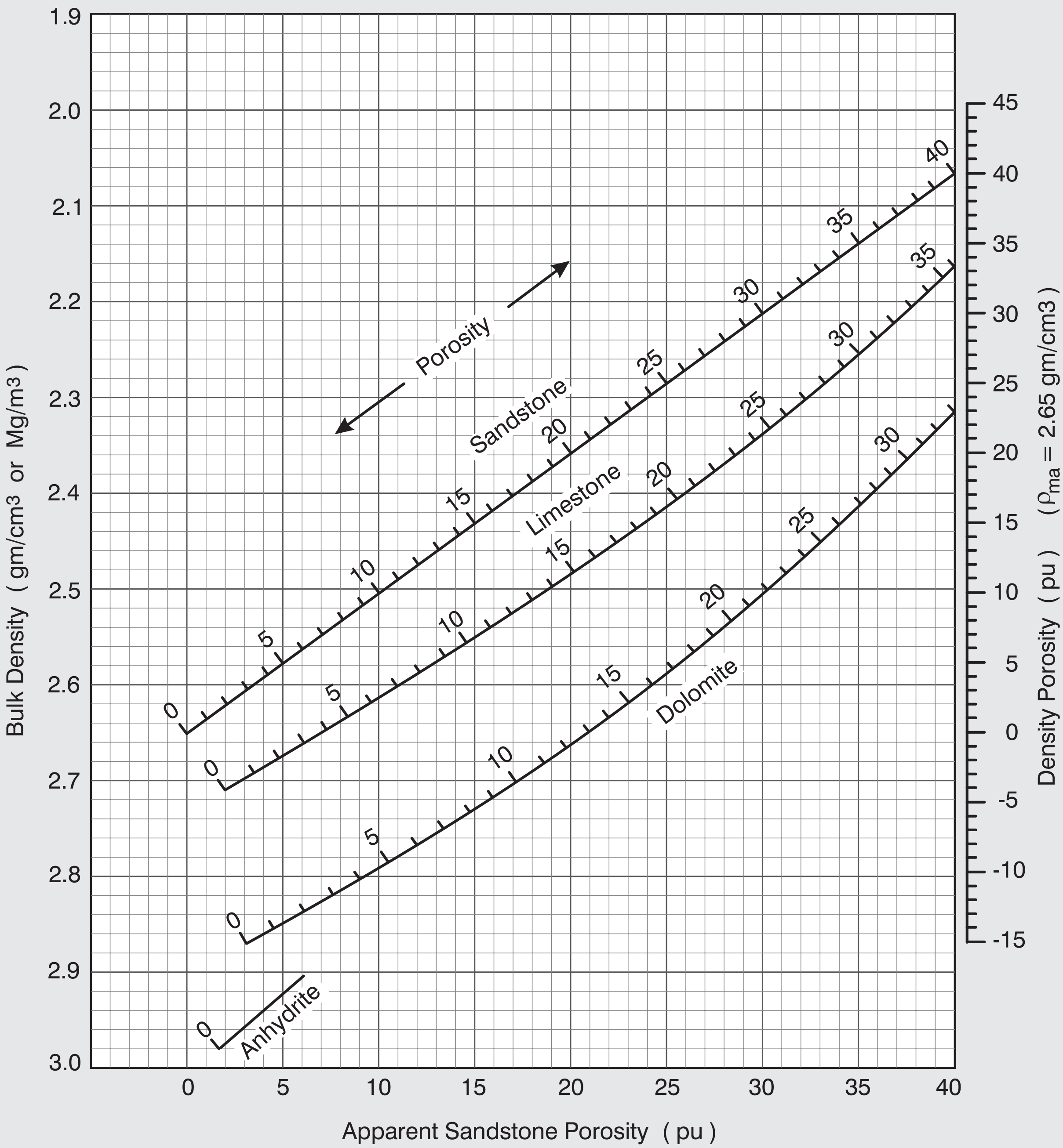


LP - 3

Reeves

Lithology-Porosity from Density-Neutron Crossplot

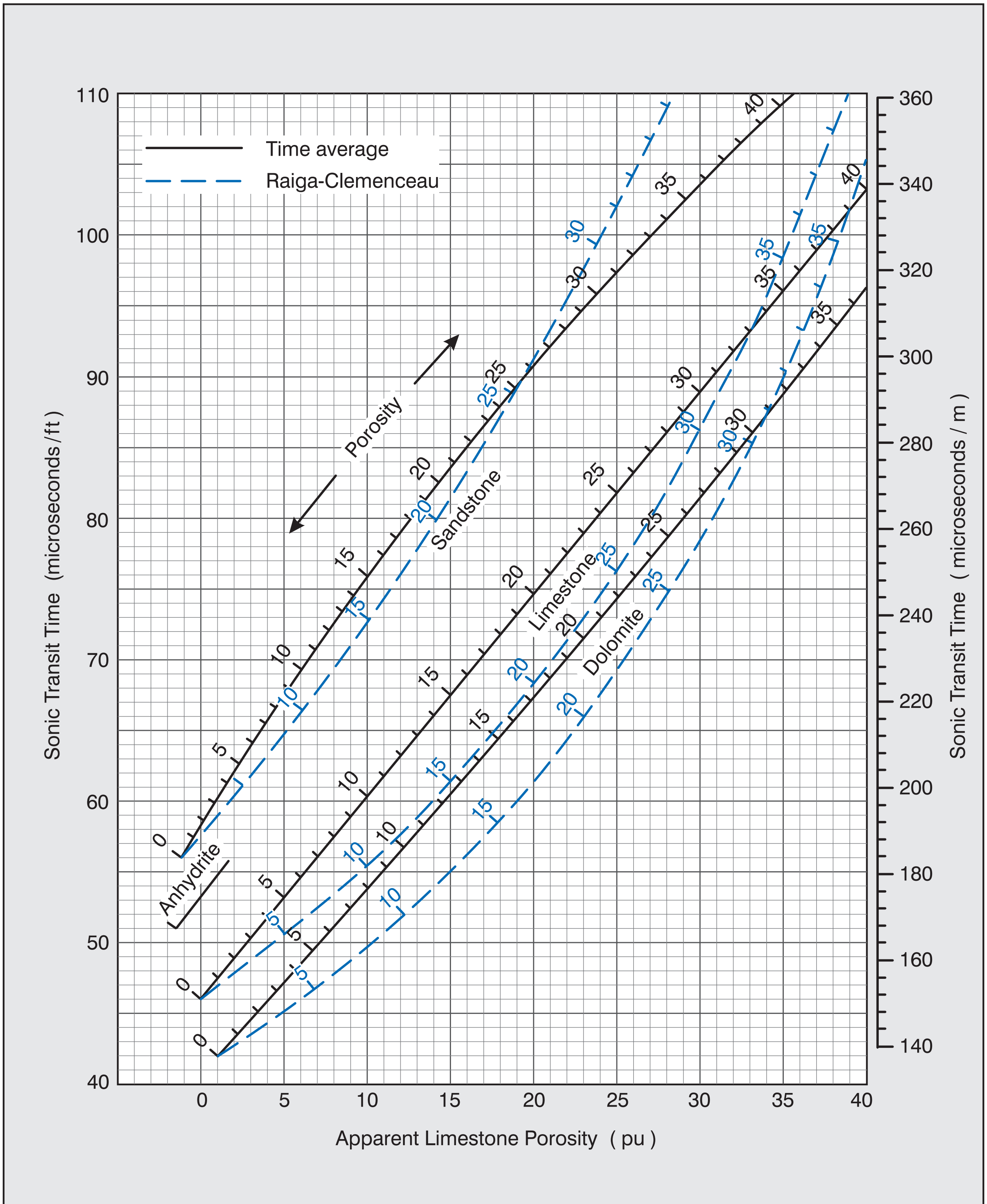
Applicability: CNS tools with Type 5 processing, environmentally corrected.
Formation fluid density = 1.19 gm/cm3 (Mg/m3).



LP - 4

Lithology-Porosity from Sonic-Neutron Crossplot

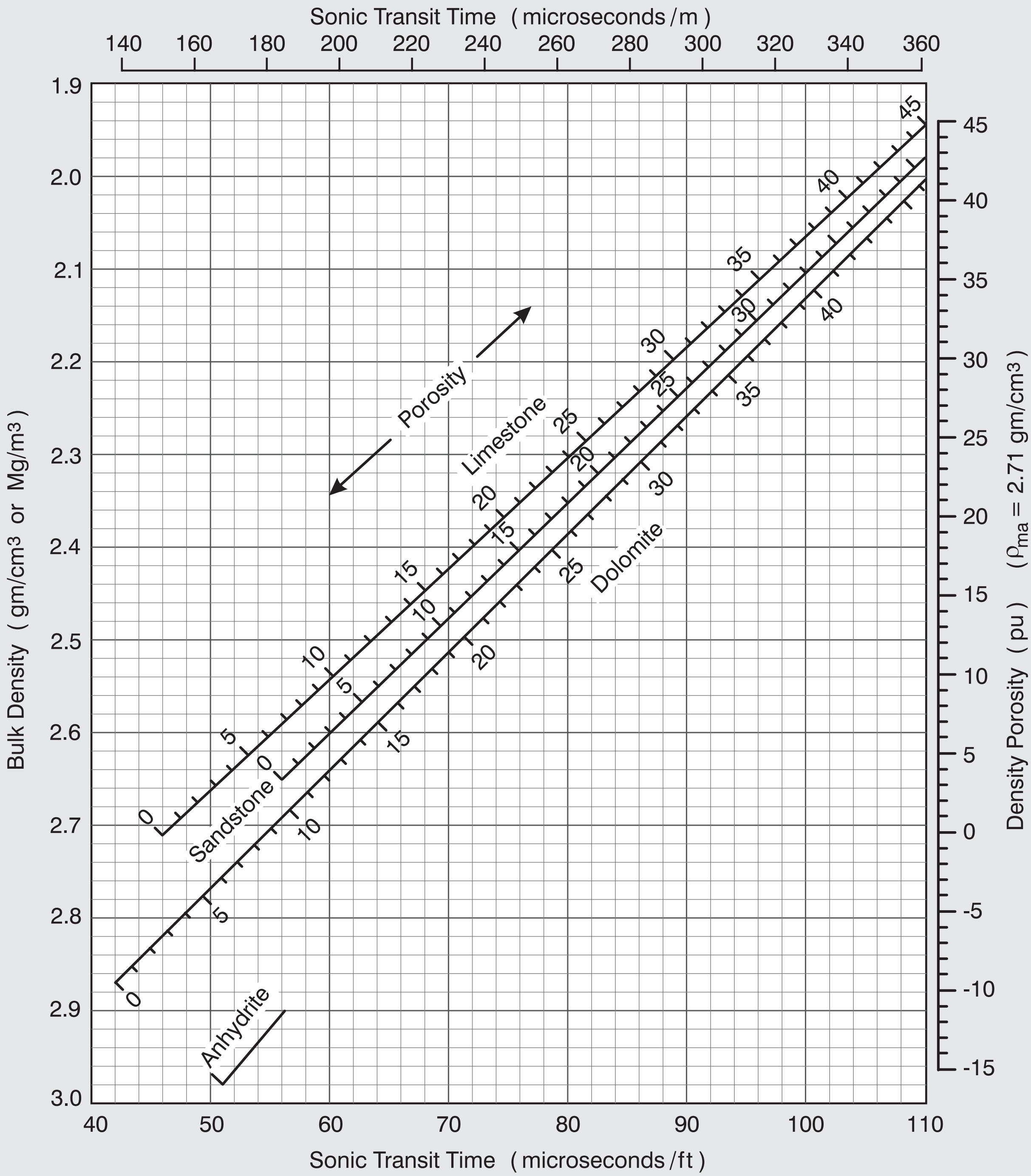
Applicability: CNS tools with Type 5 processing, environmentally corrected.
Formation fluid slowness = 189 microseconds/ft (620 microseconds/m).
Formation fluid salinity = 0 kppm.



LP - 5

Lithology-Porosity from Density-Sonic Crossplot

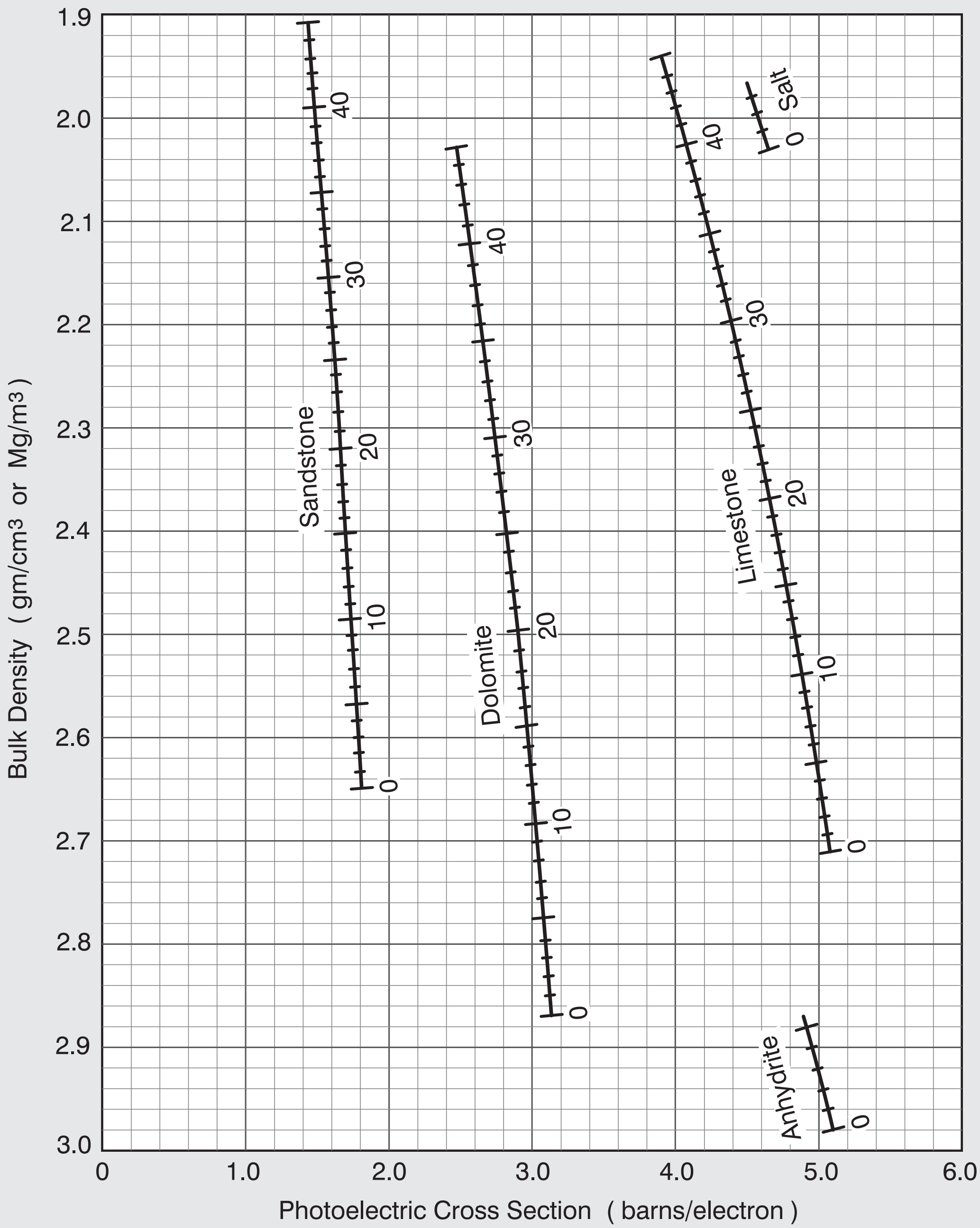
Applicability: Formation fluid density = 1.0 gm/cm^3 (Mg/m^3).
Formation fluid slowness = 189 microseconds/ft (620 microseconds/m).
Sonic porosity from time average equation.



LP - 7

Lithology-Porosity from Density-Pe Crossplot

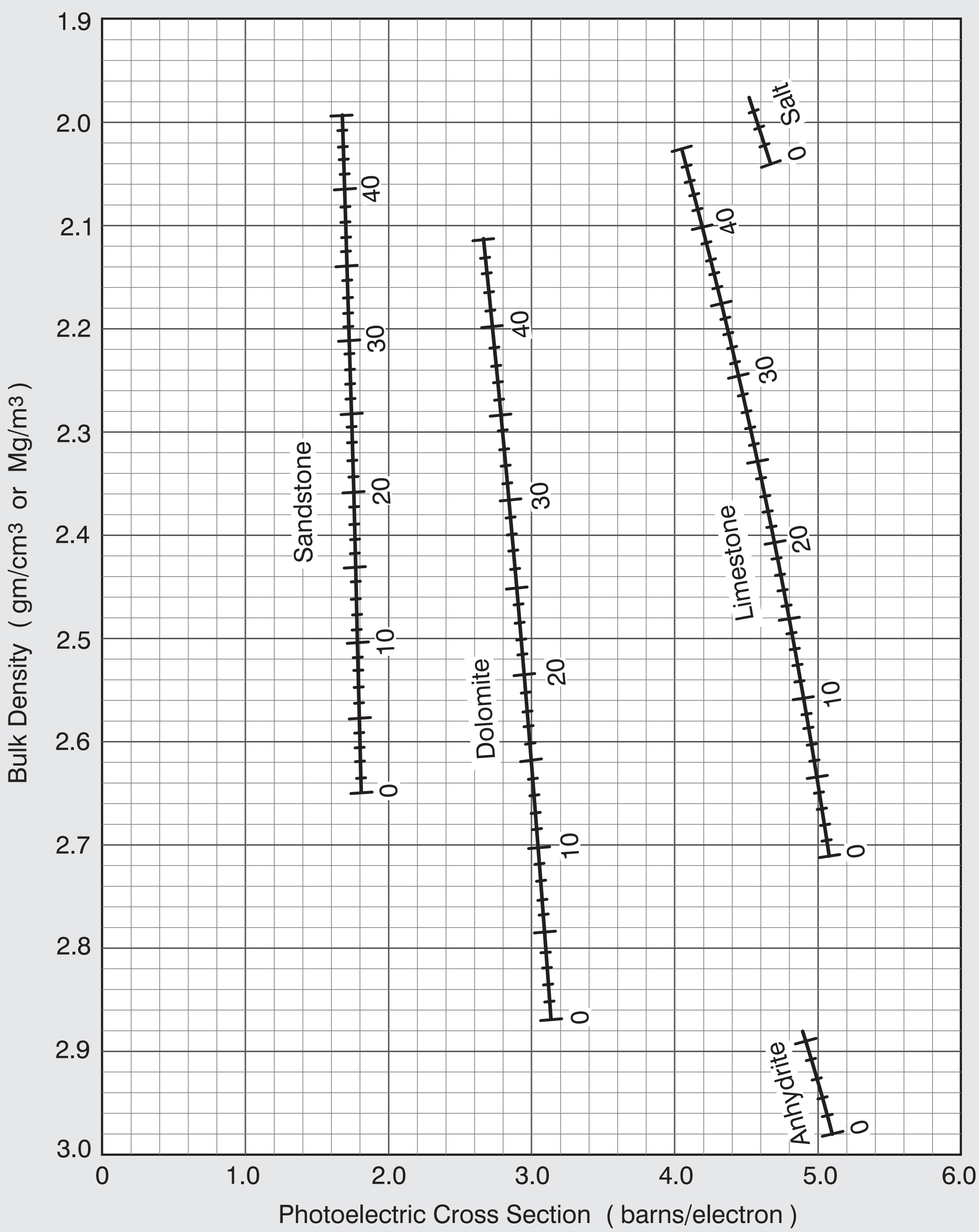
Applicability: PDS and MPD series tools.
Fresh water filled formations, fluid density = 1.0 gm/cm3 (Mg/m3).



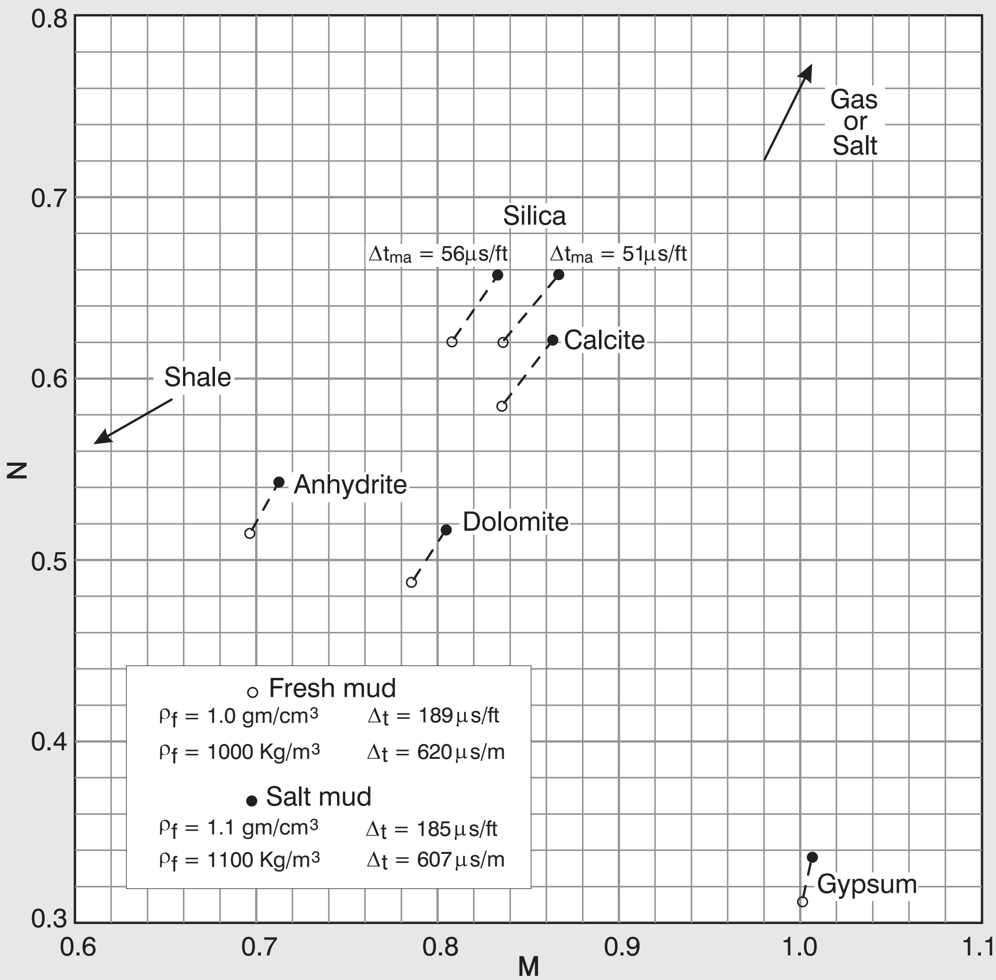
Lpor - 11

Lithology-Porosity from Density-Pe Crossplot

Applicability: PDS and MPD series tools.
Salt water filled formations, fluid density = 1.19 gm/cm3 (Mg/m3).



Lpor - 12



The M and N parameters are insensitive to variations in porosity, and are used in the crossplot to help identify mineral mixtures in clean gas-free formations. They are defined as:

$$M = \frac{\Delta t_f - \Delta t}{\rho_b - \rho_f} \times 0.01 \text{ (Imperial)} \qquad M = \frac{\Delta t_f - \Delta t}{\rho_b - \rho_f} \times 0.003 \text{ (Metric)} \qquad N = \frac{(\Phi_N)_f - \Phi_N}{\rho_b - \rho_f}$$

The silica points correspond to pure quartz (Δt_{ma} = 51μs/ft , 167μs/m) and to a typical zero porosity clean sandstone (Δt_{ma} = 56μs/ft , 184μs/m).

Lith - 1a

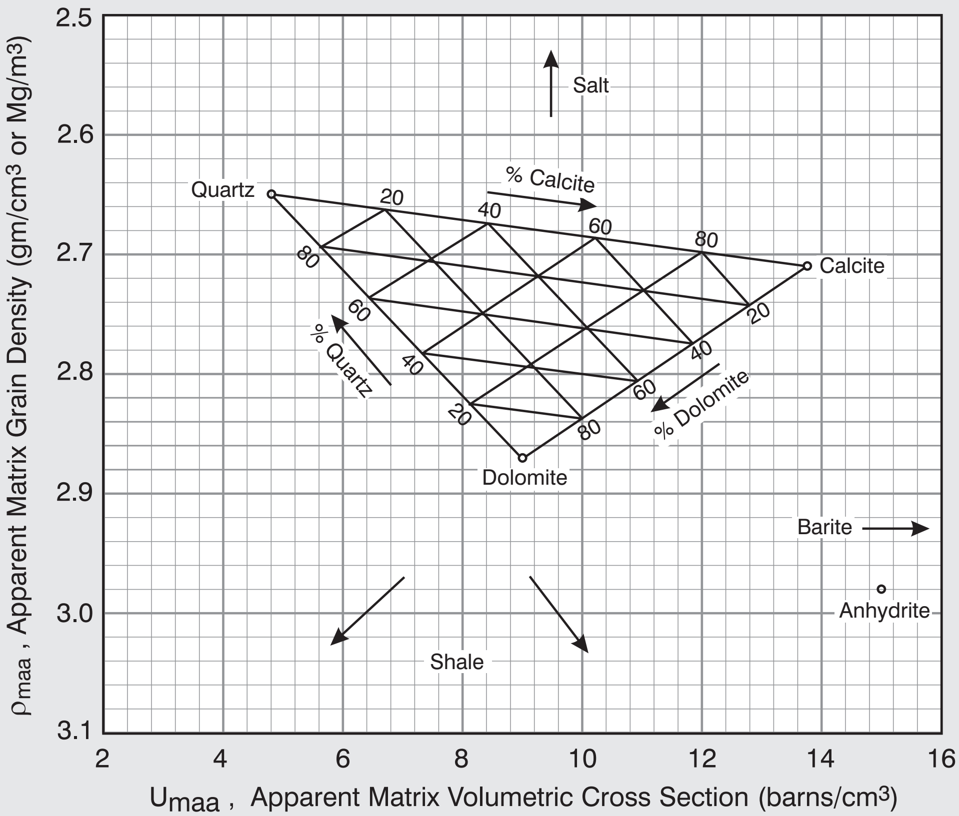


Chart Lith - 2 is used to identify matrix components in mixed lithology formations. Input data are density, Pe and total porosity computed, for example, from a density - neutron crossplot.

The apparent matrix grain density ρ_{maa} , and the apparent matrix volumetric cross section U_{maa} are computed as:

$$\rho_{maa} = \frac{\rho_{log} - \Phi_t \rho_f}{1 - \Phi_t} \quad \text{and} \quad U_{maa} = \frac{P_e \rho_e - \Phi_t U_f}{1 - \Phi_t}$$

where Φ_t is total porosity, ρ_f is formation fluid density, U_f is formation fluid volumetric cross section, and ρ_e is the formation electron density given by:

$\rho_e = \rho_{log}$ ($\rho_{log} > 2.71$ gm/cm^3)

$\rho_e = (\rho_{log} + 0.187797)/1.07009$ ($1.687 \leq \rho_{log} \leq 2.71$ gm/cm^3)

$\rho_e = \rho_{log} + 0.065$ ($\rho_{log} < 1.687$ gm/cm^3)

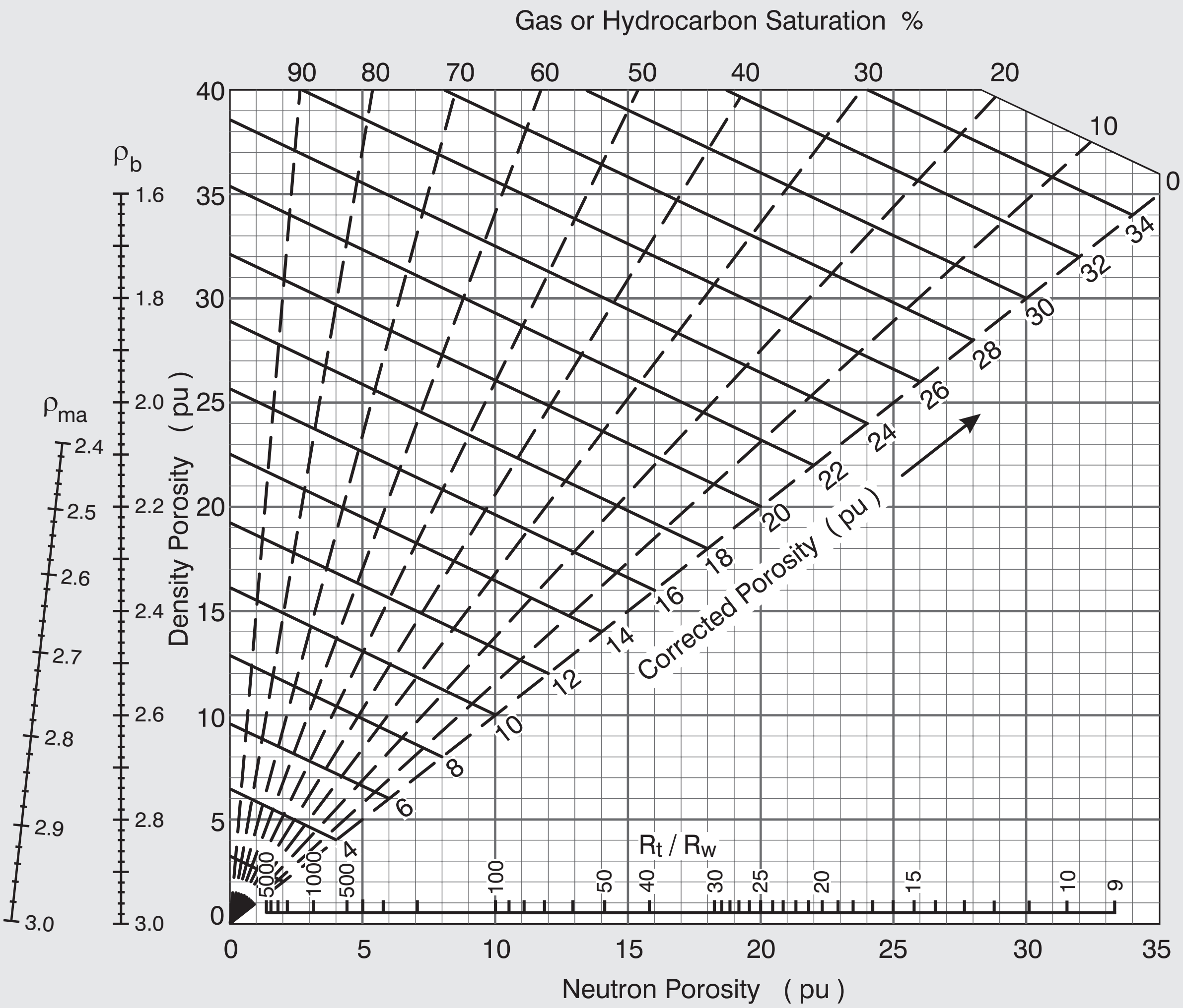
Typical values for the fluid parameters ρ_f and U_f are:

	ρ_f	U_f
Water (fresh)	1.00	0.40
Water (200kppm NaCl)	1.11	1.36
Oil	$1.22 \rho_{oil} - 0.19$	$0.14 \rho_{oil}$
Gas	$1.33 \rho_{gas} - 0.19$	$0.12 \rho_{gas}$

Lith - 2

Name	Chemical Formula	$\frac{\Sigma Z}{M}$	ρ_{log} (gm/cm^3)	P_e (barn/elct)	U (barn/cm^3)	Φ_N p.u.	Δt_c μs/ft	Δt_s μs/ft
Quartz	SiO_2	0.499	2.65	1.81	4.8	-1.4	56	88
Calcite	$CaCO_3$	0.500	2.71	5.08	13.8	0.0	46	89
Dolomite	$CaMg(CO_3)_2$	0.498	2.87	3.14	9.0	1.0	42	77
Anhydrite	$CaSO_4$	0.499	2.98	5.05	15.0	-1.5	51	98
Barite	$BaSO_4$	0.446	4.11	266.80	1096.1	-1.5	69	133
Gypsum	$CaSO_4.2H_2O$	0.511	2.35	3.99	9.4	58.0	52	
Halite	NaCl	0.479	2.03	4.65	9.4	-3.3	67	120
Sylvite	KCl	0.483	1.86	8.51	15.8	-2.5	74	140
Siderite	$FeCO_3$	0.483	3.89	14.69	57.1	12.0	44	85
Hematite	Fe_2O_3	0.476	5.18	21.48	111.3	11.0	44	74
Magnetite	Fe_3O_4	0.475	5.08	22.24	113.0	9.0	72	155
Goethite	FeO(OH)	0.484	4.30	19.02	81.8	60+		
Pyrite	FeS_2	0.483	5.00	16.97	84.5	-2.0	39	62
Orthoclase	$KAlSi_3O_8$	0.496	2.52	2.86	7.2	-2.0	69	
Anorthoclase	$(Na,K)AlSi_3O_8$	0.496	2.59	2.86	7.4	-1.0		
Albite	$NaAlSi_3O_8$	0.496	2.60	1.68	4.4	-1.0	47	98
Anorthite	$CaAl_2Si_2O_8$	0.496	2.74	3.13	8.6	-1.0	45	
Muscovite	$KAl_2(AlSi_3)O_{10}(OH)_2$	0.497	2.82	2.40	6.8	20.0	47	79
Biotite	$K(Mg,Fe)_3AlSi_3O_{10}(OH)_2$	0.493	3.00	6.27	18.8	21.0	49	82
Kaolinite	$Al_4Si_4O_{10}(OH)_8$	0.504	2.41	1.83	4.4	40.0	212	328
Montmorillonite	$Al_4(Si_4O_{10})_2.nH_2O$	0.502	2.10	2.04	4.3	47.0		
Illite	$K_yAl_4(Si_{8-y}Al_y)O_{20}(OH)_4$	0.499	2.52	3.45	8.7	35.0		
Bituminous Coal	$CH_nN_xO_y$	0.527	1.31	0.17	0.2	60+	120	
Anthracite	$CH_nN_xO_y$	0.513	1.54	0.16	0.3	40	105	
Lignite	$CH_nN_xO_y$	0.525	1.25	0.20	0.3	54	160	

Lith - 3a



Use this chart to compute porosity and gas saturation in gas-filled holes from a combination of density - neutron or density - resistivity logs. If all three logs are used, oil saturation may also be found. The chart assumes gas density and gas hydrogen index to be zero.

Enter the chart either with a neutron porosity value (corrected for shale and matrix effects) or an R_t/R_w ratio, and move vertically to intersect the density porosity. Move diagonally down to read the saturation corrected porosity, and diagonally up to read the gas saturation. Note that the density porosity may be computed by projecting a line from the matrix density graticule through the bulk density to the vertical axis.

To compute oil saturation as well, enter the chart with density and neutron porosity values, note the gas saturation, then move parallel to the corrected porosity lines to the intersection with the Rt/Rw ratio. This gives the total hydrocarbon saturation from which the oil saturation is computed as (hydrocarbon saturation - gas saturation).

Sw - 1

Chart CBL - 1 Explanatory Note

Use chart CBL -1 to determine the strength of the cement bond between casing and formation.

Begin by computing the CBL amplitude as a percentage of the free pipe signal. Enter the chart with this value on the left hand side and move parallel to the sloping lines to intersect the appropriate casing size. Now move horizontally to the attenuation axis, and project a line through the appropriate casing thickness to the strength axis and read the result.

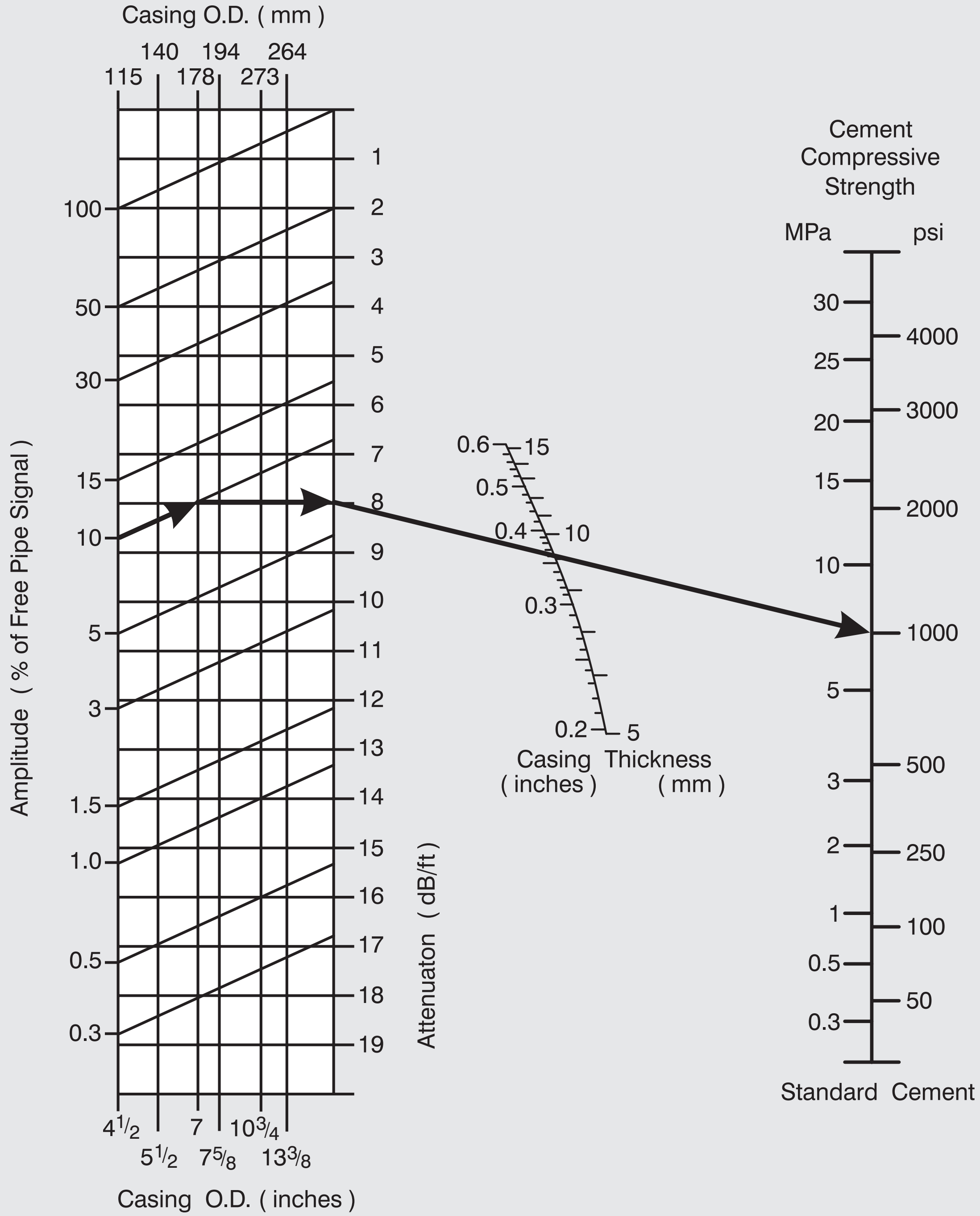
Note that casing thickness is a function of casing size and weight, and may be obtained from Chart Misc - 5 by computing the difference between the quoted inner and outer diameters.

Example: Amplitude is 6.5 millivolts in 7 inch, 26 lb/ft casing.
Free pipe amplitude is 65 millivolts.

From Chart Misc - 5, casing thickness is 0.362 inches. CBL Amplitude as a percentage of free pipe signal is 10%, and the cement compressive strength is therefore 1000 psi.

Attenuation Rate & Cement Strength from CBL Logs

Applicability: Centralised tools with 3 foot (0.91 m) transmitter - receiver spacing.



CBL - 1

Data for Threaded Non-Upset Casing (Metric)

O.D. mm	Weight* Kg/m	Nominal I.D.(mm)	Drift Diam**
101.6	17.26	87.1	83.9
114.3	14.14	103.9	100.7
	17.26	101.6	98.4
	20.09	99.6	96.4
120.7	23.81	103.7	100.5
127.0	17.11	115.8	112.6
	19.35	114.1	111.0
	22.32	112.0	108.8
	26.34	109.2	106.0
	26.79	108.6	105.4
	31.25	105.5	102.3
139.7	19.35	128.1	124.9
	20.83	127.3	124.1
	22.32	126.3	123.1
	23.07	125.7	122.6
	25.30	124.3	121.1
	29.76	121.4	118.2
	34.23	118.6	115.4
146.1	20.83	134.4	131.2
	25.30	131.8	128.7
	29.02	129.3	126.1
	33.48	126.7	123.8
152.4	22.32	140.3	137.1
	23.81	139.7	136.5
	26.79	137.8	134.6
	29.76	135.9	132.8
	34.23	133.1	129.9
168.3	25.30	155.8	152.7
	29.76	153.6	150.5
	32.74	152.1	148.9
	35.72	150.4	147.2
	38.69	148.7	145.5
	39.88	148.2	145.1
	41.67	147.1	143.9
	43.16	146.3	143.2
	47.62	144.1	141.0
177.8	25.30	166.1	162.9
	29.76	164.0	160.8
	32.74	162.5	159.3
	34.23	161.7	158.5
	35.72	160.9	157.8
	38.69	159.4	156.2
	41.67	157.8	154.7
	43.16	157.1	153.9
	44.65	156.3	153.1
	47.62	154.8	151.6
	52.09	152.5	149.3
	56.55	150.4	147.2
	59.53	148.2	145.1
193.7	29.76	181.0	177.8
	35.72	178.4	175.3
	39.29	177.0	173.8
	44.20	174.6	171.4
	50.15	171.8	168.7
	58.04	168.3	165.1
219.1	35.72	205.7	202.5
	41.67	203.6	200.5
	47.62	201.2	198.0
	53.58	198.8	195.6
	56.55	197.5	194.3
	59.53	196.2	193.0
	63.99	196.2	193.0
	65.48	193.7	190.5
	72.92	190.8	187.6
228.6	50.60	210.6	207.4
	56.55	208.2	205.0
	59.53	207.0	203.8
	66.97	204.0	200.8
	81.85	198.4	195.2
244.5	43.60	230.2	226.2
	48.07	228.6	224.7
	53.58	226.6	222.6
	59.53	219.3	220.4
	64.74	222.4	218.4
	69.95	220.5	216.5
	79.62	216.8	212.8
254.0	49.11	238.4	234.4
273.1	48.74	258.9	254.9
	59.53	255.4	251.4
	60.27	255.3	251.3
	66.97	253.0	249.0
	67.71	252.7	248.8
	71.43	251.5	247.5
	75.90	250.2	246.3
	80.36	248.5	244.6
	82.60	247.9	243.9
298.5	56.55	283.2	279.2
	62.50	281.5	277.6
	69.95	279.4	275.4
	80.36	276.4	272.4
	89.29	273.6	269.6
304.8	59.53	289.2	285.2
330.2	59.53	315.9	312.0
339.8	71.43	323.0	319.0
406.4	81.85	390.5	385.7
473.1	116.08	453.5	448.7
508.0	133.94	487.4	482.6
546.1	137.66	526.0	521.3
	153.28	523.5	518.7
	169.65	521.0	516.2
622.3	149.56	603.3	598.5
	168.17	600.7	595.9

* Weight is given for plain pipe (no threads or couplings).

** Drift diameter is the guaranteed minimum internal diameter of any part of the casing. Use drift diameter to determine the largest diameter equipment that can be safely run inside the casing. Use nominal diameter (I.D.) for volume capacity calculations.

O.D. inches	Weight* per ft	Nominal I.D.	Drift Diam**
4	11.60	3.428	3.303
4 1/2	9.5	4.090	3.965
	11.60	4.000	3.875
	13.5	3.920	3.795
4 3/4	16.00	4.082	3.957
5	11.50	4.560	4.435
	13.00	4.494	4.369
	15.00	4.408	4.283
	17.70	4.300	4.175
	18.00	4.276	4.151
	21.00	4.154	4.029
5 1/2	13.00	5.044	4.919
	14.00	5.012	4.887
	15.00	4.974	4.849
	15.50	4.950	4.825
	17.00	4.892	4.767
	20.00	4.778	4.653
	23.00	4.670	4.545
5 3/4	14.00	5.290	5.165
	17.00	5.190	5.065
	19.50	5.090	4.965
	22.50	4.990	4.875
6	15.00	5.524	5.399
	16.00	5.500	5.375
	18.00	5.424	5.299
	20.00	5.352	5.227
	23.00	5.240	5.115
6 5/8	17.00	6.135	6.010
	20.00	6.049	5.924
	22.00	5.989	5.864
	24.00	5.921	5.796
	26.00	5.855	5.730
	26.80	5.837	5.712
	28.00	5.791	5.666
	29.00	5.761	5.636
	32.00	5.675	5.550

O.D. inches	Weight* per ft	Nominal I.D.	Drift Diam**
7	17.00	6.538	6.413
	20.00	6.456	6.331
	22.00	6.398	6.273
	23.00	6.366	6.241
	24.00	6.336	6.211
	26.00	6.276	6.151
	28.00	6.214	6.089
	29.00	6.184	6.059
	30.00	6.154	6.029
	32.00	6.094	5.969
	35.00	6.004	5.879
	38.00	5.920	5.795
	40.00	5.836	5.711
7 5/8	20.00	7.125	7.000
	24.00	7.025	6.900
	26.40	6.969	6.844
	29.70	6.875	6.750
	33.70	6.765	6.640
	39.00	6.625	6.500
8 5/8	24.00	8.097	7.972
	28.00	8.017	7.892
	32.00	7.921	7.796
	36.00	7.825	7.700
	38.00	7.775	7.650
	40.00	7.725	7.600
	43.00	7.725	7.600
	44.00	7.625	7.500
	49.00	7.511	7.386
9	34.00	8.290	8.165
	38.00	8.196	8.071
	40.00	8.150	8.025
	45.00	8.032	7.907
	55.00	7.812	7.687
9 5/8	29.30	9.063	8.907
	32.30	9.001	8.845
	36.00	8.921	8.765
	40.00	8.635	8.679
	43.50	8.755	8.599
	47.00	8.681	8.525
	53.50	8.535	8.379

O.D. inches	Weight* per ft	Nominal I.D.	Drift Diam**
10	33.00	9.384	9.228
10 3/4	32.75	10.192	10.036
	40.00	10.054	9.898
	40.50	10.050	9.894
	45.00	9.960	9.804
	45.50	9.950	9.794
	48.00	9.902	9.746
	51.00	9.850	9.694
	54.00	9.784	9.628
	55.50	9.760	9.604
11 3/4	38.00	11.150	10.994
	42.00	11.084	10.928
	47.00	11.000	10.844
	54.00	10.880	10.724
	60.00	10.772	10.616
12	40.00	11.384	11.228
13	40.00	12.438	12.282
13 3/8	48.00	12.715	12.559
16	55.00	15.375	15.187
18 5/8	78.00	17.855	17.667
20	90.00	19.190	19.002
21 1/2	92.50	20.710	20.522
	103.00	20.610	20.422
	114.00	20.510	20.322
24 1/2	100.50	23.750	23.562
	113.00	23.650	23.462

* Weight per foot (in pounds) is given for plain pipe (no threads or couplings).

** Drift diameter is the guaranteed minimum internal diameter of any part of the casing. Use drift diameter to determine the largest diameter equipment that can be safely run inside the casing. Use nominal diameter (I.D.) for volume capacity calculations.

Tubing Sizes and Weights

Outside Diameter		Nominal Internal Diameter		Weight	
inches	mm	inches	mm	lb/ft	Kg/m
2 1/16	52.4	1.751	44.5	3.30	4.90
2 3/8	60.3	2.041	51.8	4.00	5.95
		1.995	50.7	4.60	6.85
		1.867	47.4	5.80	8.63
2 7/8	73.0	2.441	62.0	6.40	9.52
		2.259	57.4	8.60	12.80
3 1/2	88.9	3.068	77.9	7.70	11.46
		2.992	76.0	9.20	13.69
		2.922	74.2	10.20	15.18
		2.750	69.9	12.70	18.90
4	101.6	3.548	90.1	9.50	14.14
		3.476	88.3	11.00	16.37
4 1/2	114.3	3.958	100.5	12.60	18.75

Drill Pipe Sizes and Weights

Outside Diameter		Nominal Internal Diameter		Weight	
inches	mm	inches	mm	lb/ft	Kg/m
2 3/8	60.3	1.815	46.1	6.65	9.90
2 7/8	73.0	2.441	62.0	6.85	10.19
		2.151	54.6	10.40	15.48
3 1/2	88.9	2.992	76.0	9.50	14.14
		2.764	70.2	13.30	19.79
		2.602	66.1	15.50	23.07
4	101.6	3.476	88.3	11.85	17.63
		3.340	84.8	14.00	20.83
4 1/2	114.3	3.958	100.5	13.75	20.46
		3.826	97.2	16.60	24.70
		3.640	92.5	20.00	29.76
5	127.0	4.408	112.0	16.25	24.18
		4.276	108.6	19.50	29.02
		4.000	101.6	25.60	38.10
5 1/2	139.7	4.778	121.4	21.90	32.59
		4.670	118.6	24.70	36.75
6 5/8	168.3	5.965	151.5	25.20	37.50