LOG INTERPRETATION CHARTS
FOR
WESTERN CANADA RESERVOIRS

PROFESSIONAL LOG EVALUATION LTD
2009

LOG INTERPRETATION CHARTS FOR WESTERN CANADA RESERVOIRS

FORMATION TEMP. VS DEPTH 3,4

SP BED THICKNESS CORRECTION 5

Rw ESTIMATION FROM SP 6

Rw-TEMPERATURE CONVERSION 7

POROSITY VS FORMATION FACTOR 8

NØLst VS SONIC X-PLOT Metric 9
NØLst VS SONIC X-PLOT Imperial 10
ΔT VS DENSITY X-PLOT Metric 11
ΔT VS DENSITY X-PLOT Imperial 12
NØLst VS DØLst X-PLOT 13
NØSs VS DØSs X-PLOT 14

RWA FROM RT AND POROSITY 15
SW FROM RWA 16

SONIC TRAVEL TIME VS POROSITY
SANDSTONES
- Belly River - Keystone 17,18
- Cardium - Ferrier 19,20
  - Ricinus
- Viking - Giroux Lake 21,22
  -Empress
- Blairmore Consolidated 23,24
  -Jenner
  -Empress
  -Buick Creek
  -Peace River
  -Niton
  -Bantry
  -Chauvin
  -Taber
- Blairmore Unconsolidated 25,26
  -Swift Current
  -Lac La Biche
  -Peace River
  -Lloydminster
  -Chauvin
  -Martin Hills
  -Keg River

- Pre Cretaceous Sands 27,28
  -Elmworth - Nikinassin, Halfway, Belloy
  -Stoddart - Belloy
  -Nancy Peejay - Halfway
  -Inga - Charlie Lake
  -Mitsue - Gilwood

SONIC TRAVEL TIME VS POROSITY
LIMESTONES 29,30
- Innes- Marly
- Innes-Frobisher
- Gull Lake-Shaunovan
- Harmattan-Elkton
- Boundary Lake-Jurassic
- NE Alberta-Wabamun
- Twining-Pekisko
- Snipe Lake-Beaverhill Lake

SONIC TRAVEL TIME VS POROSITY
DOLOSTONES 31,32
- Clark Lake BC-Keg River
- Clive-Nisku
- Gold Creek-Leduc
- Harmattan-Elkton
- NE Alberta-Wabamun
- Meekwap-Nisku
- NEBC-Baldonnel
- Senex Creek-Keg River
- Virgo-Keg River

DØSs VS CORE Ø 33
- Countess-Glauconite
- Ferrier-Cardium
- Hamilton Lake-Viking
- Keg River-Bluesky
- Peace River-Gething
- Ricinus-Cardium
- Taber-Basal Quartz (Sunburst)

DØSs VS CORE ØLst 34

- Crossfield-Wabamun Dolostone
- Dunvegan-Debolt Calcareous Dolostone
- Rainbow-Keg RiverDolostone
- Senex Creek-Keg River Dolomitic Lst.
- Virgo-Keg River Dolostone
- Zama-Sulphur PointLimestone

SHALINESS CORRECTION TO ΔT DERIVED SAND POROSITY 35

RESISTIVITY Ø PLOTS IN WESTERN CANADA SANDSTONE RESERVOIRS 36

RESISTIVITYØ PLOTS IN WESTERN CANADA CARBONATE RESERVOIRS 37

OLD E-LOG DEPARTURE CURVES 38,39

GUIDELINES FOR USING DENSITY-NEUTRON LOGS FOR POROSITY 40

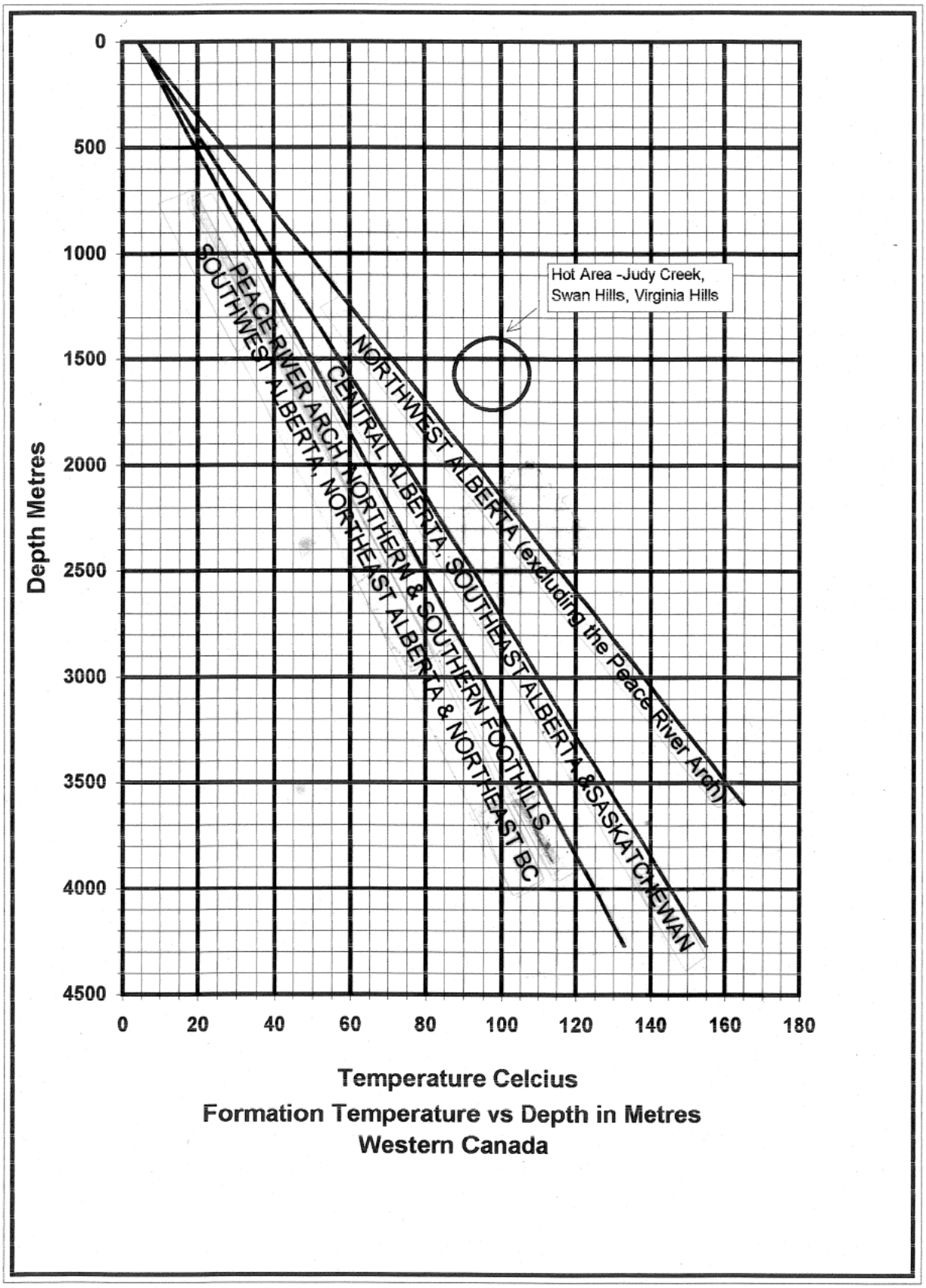
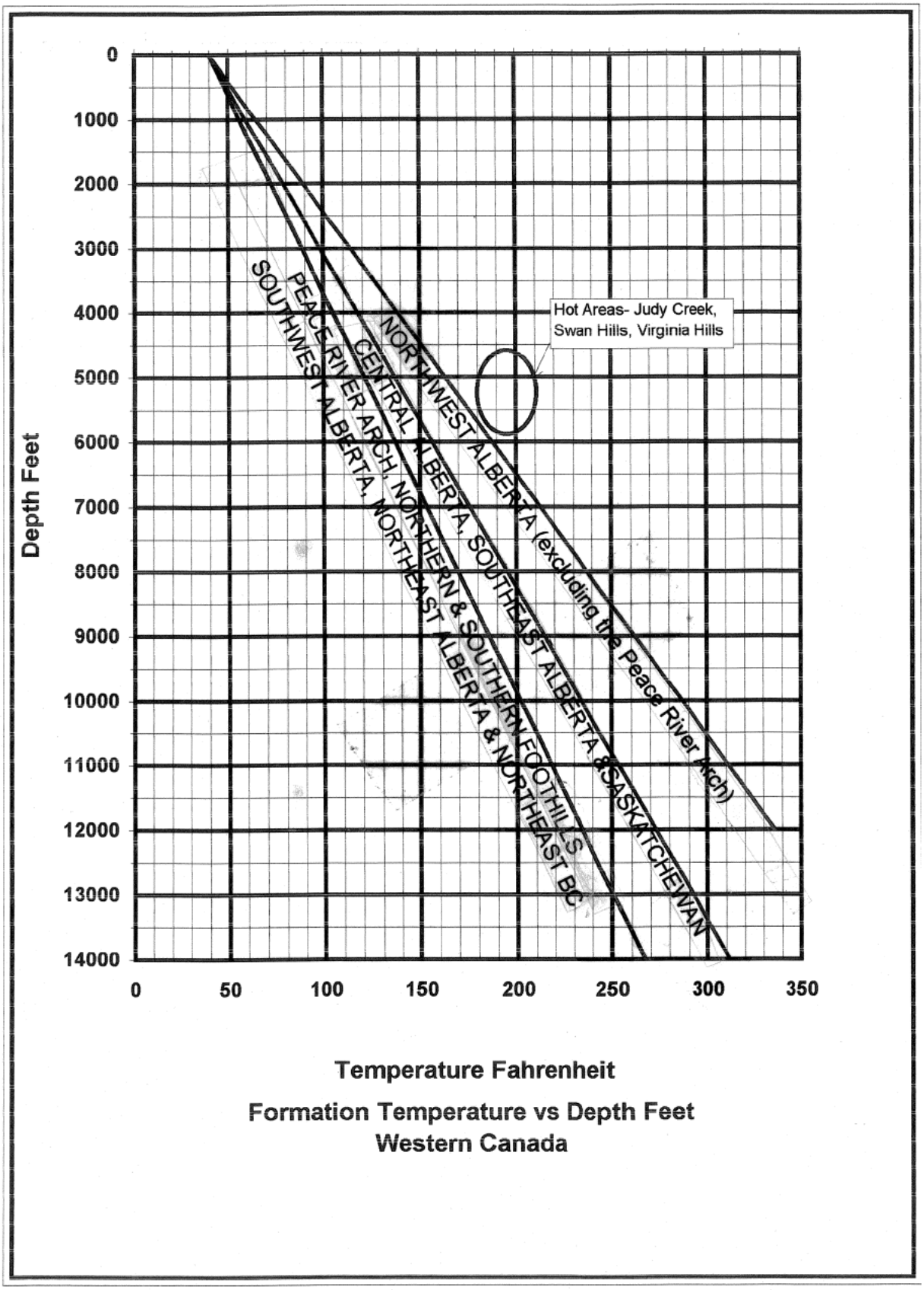

Depth Metres
0
500
1000
1500
2000
2500
3000
3500
4000
4500
0
20
40
60
80
100
120
140
160
180
Hot Area -Judy Creek, Swan Hills, Virginia Hills
NORTHWEST ALBERTA (excluding the Peace River Arch)
CENTRAL ALBERTA, SOUTHEAST ALBERTA & SASKATCHEWAN
PEACE RIVER ARCH, NORTHERN & SOUTHERN FOOTHILLS
SOUTHWEST ALBERTA, NORTHEAST ALBERTA & NORTHEAST BC
Temperature Celcius
Formation Temperature vs Depth in Metres
Western Canada

Chart 3

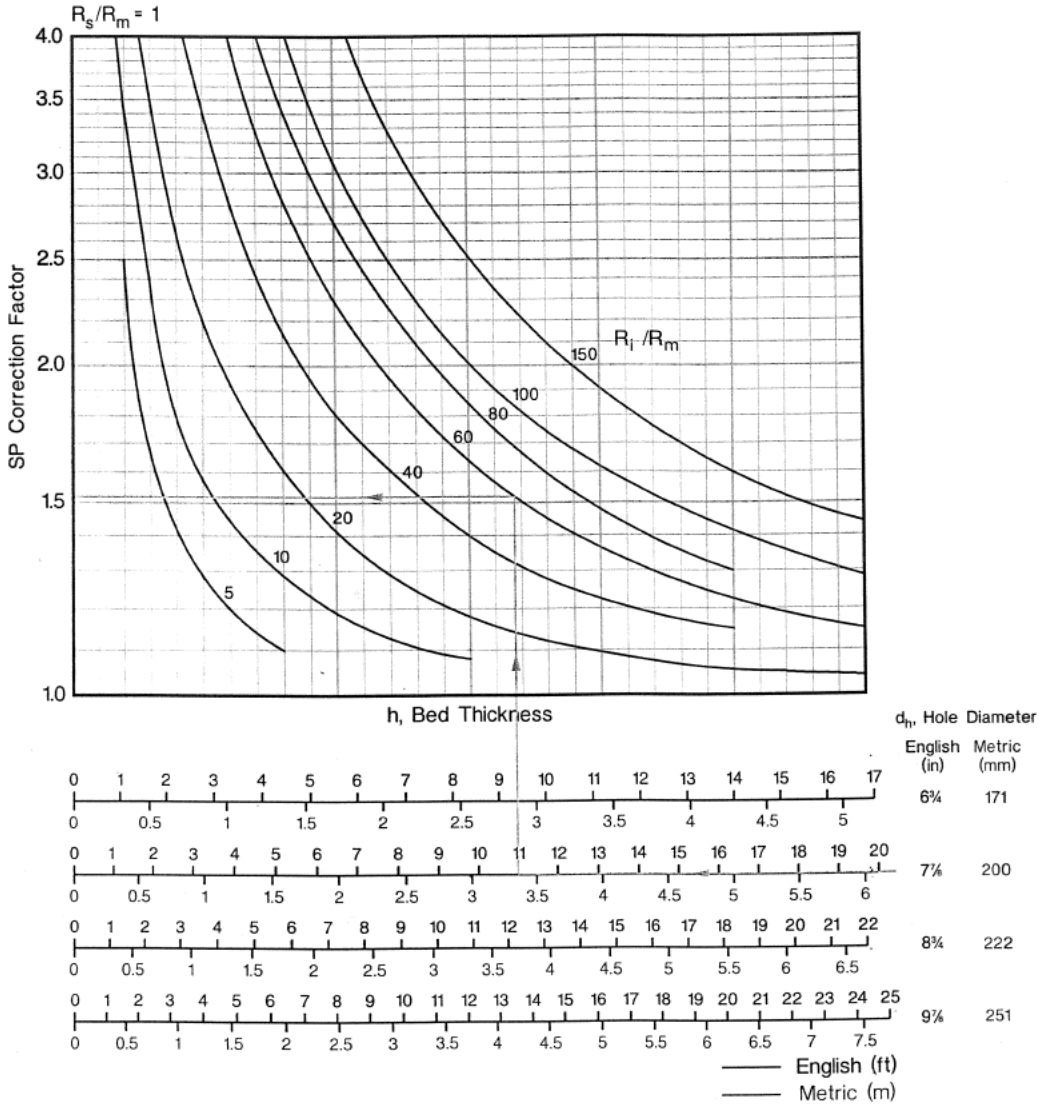


Formation Temperature vs Depth Feet
Western Canada

Chart 4

Spontaneous Potential Bed Thickness Corrections

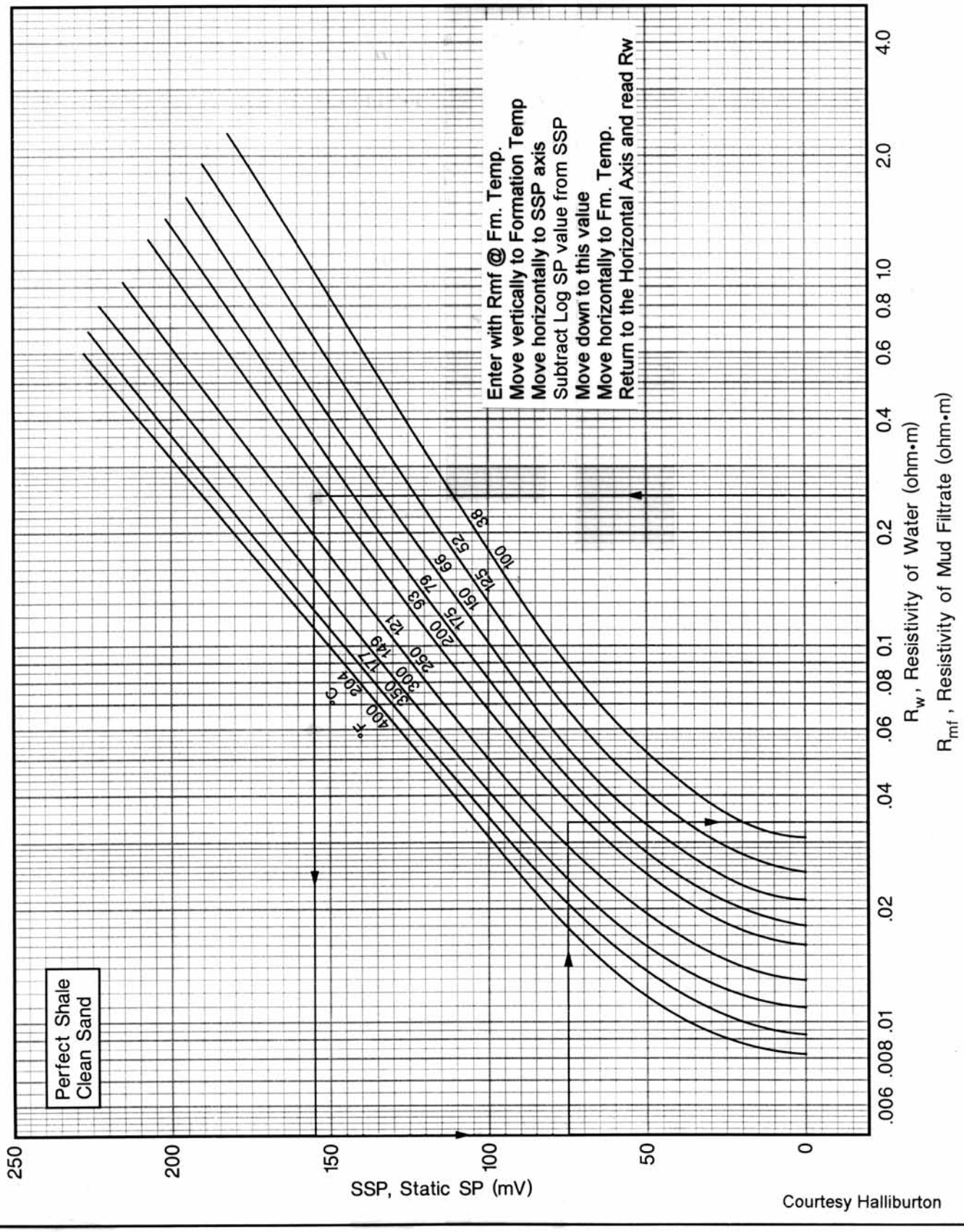
Diameter of Invasion = $2d_h$



courtesy Halliburton

SP Bed Thickness Correction

R_w Estimation from SSP



Courtesy Halliburton

Chart 6

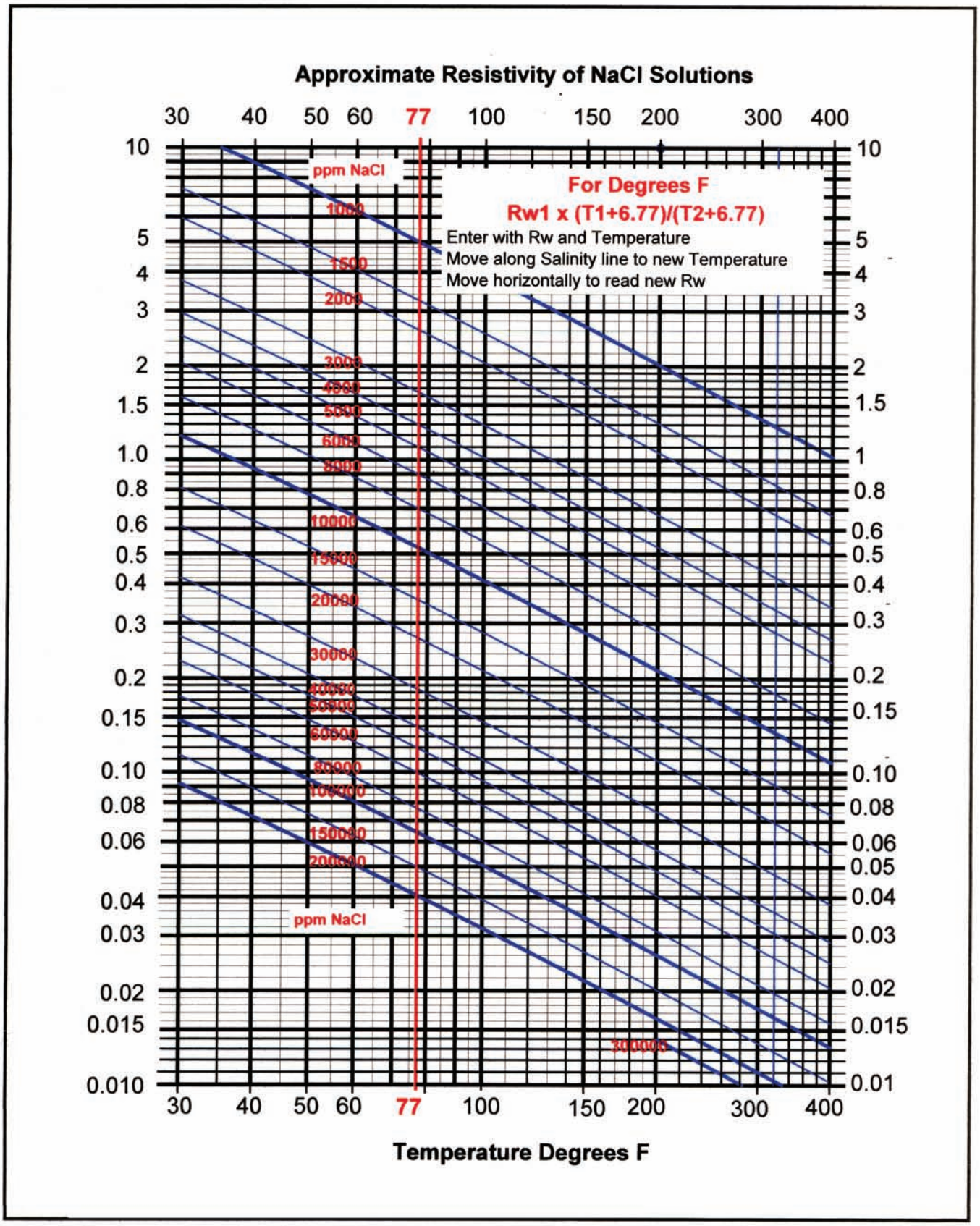

Approximate Resistivity of NaCl Solutions
30 40 50 60 77 100 150 200 300 400
10 5 4 3 2 1.5 1.0 0.8 0.6 0.5 0.4 0.3 0.2 0.15 0.10 0.08 0.06 0.04 0.03 0.02 0.015 0.010
ppm NaCl
1000
1500
2000
3000
4000
5000
6000
8000
10000
15000
20000
30000
40000
50000
60000
80000
100000
150000
200000
300000
ppm NaCl
For Degrees F
Rw1 x (T1+6.77)/(T2+6.77)
Enter with Rw and Temperature
Move along Salinity line to new Temperature
Move horizontally to read new Rw
Temperature Degrees F

Chart 7

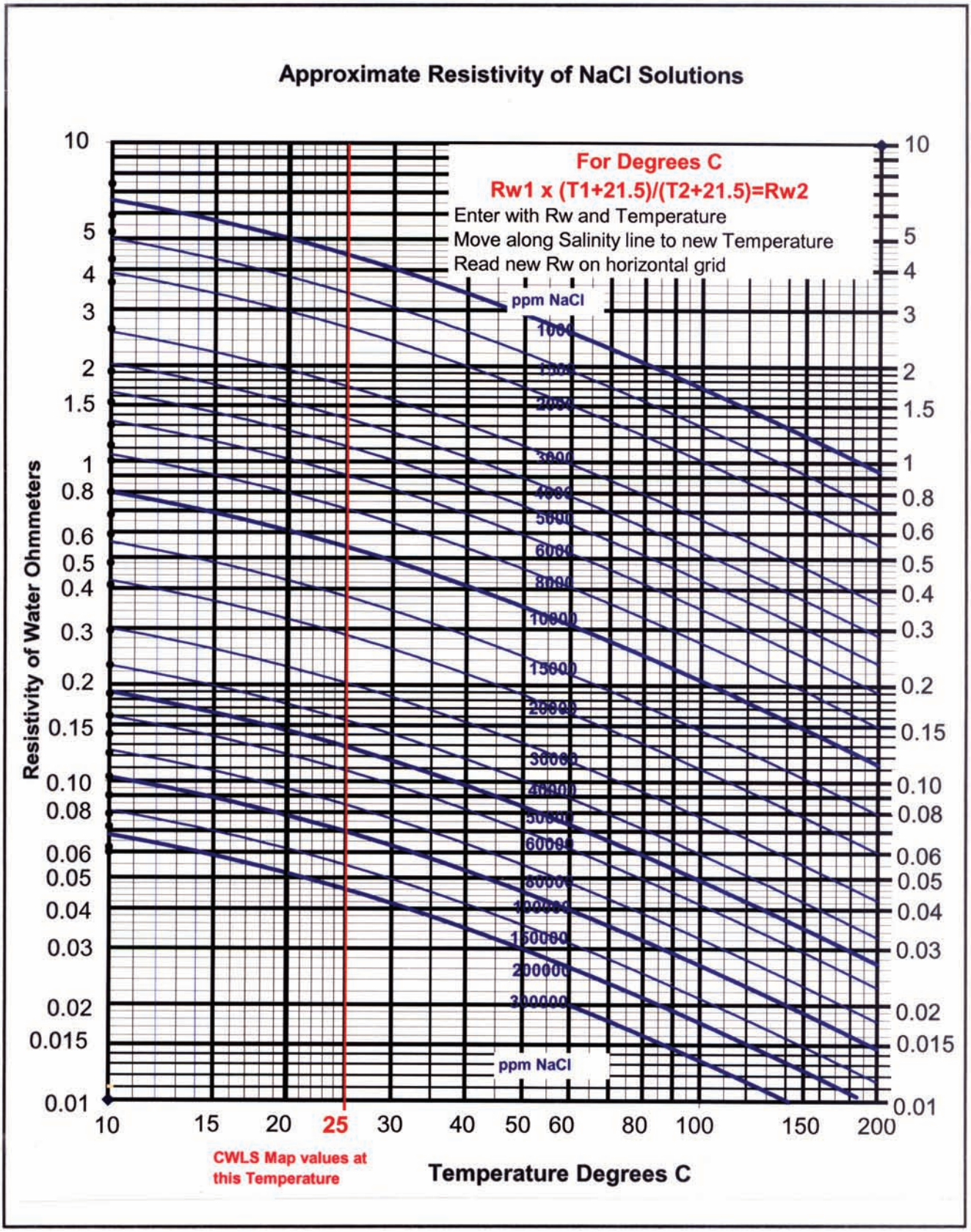
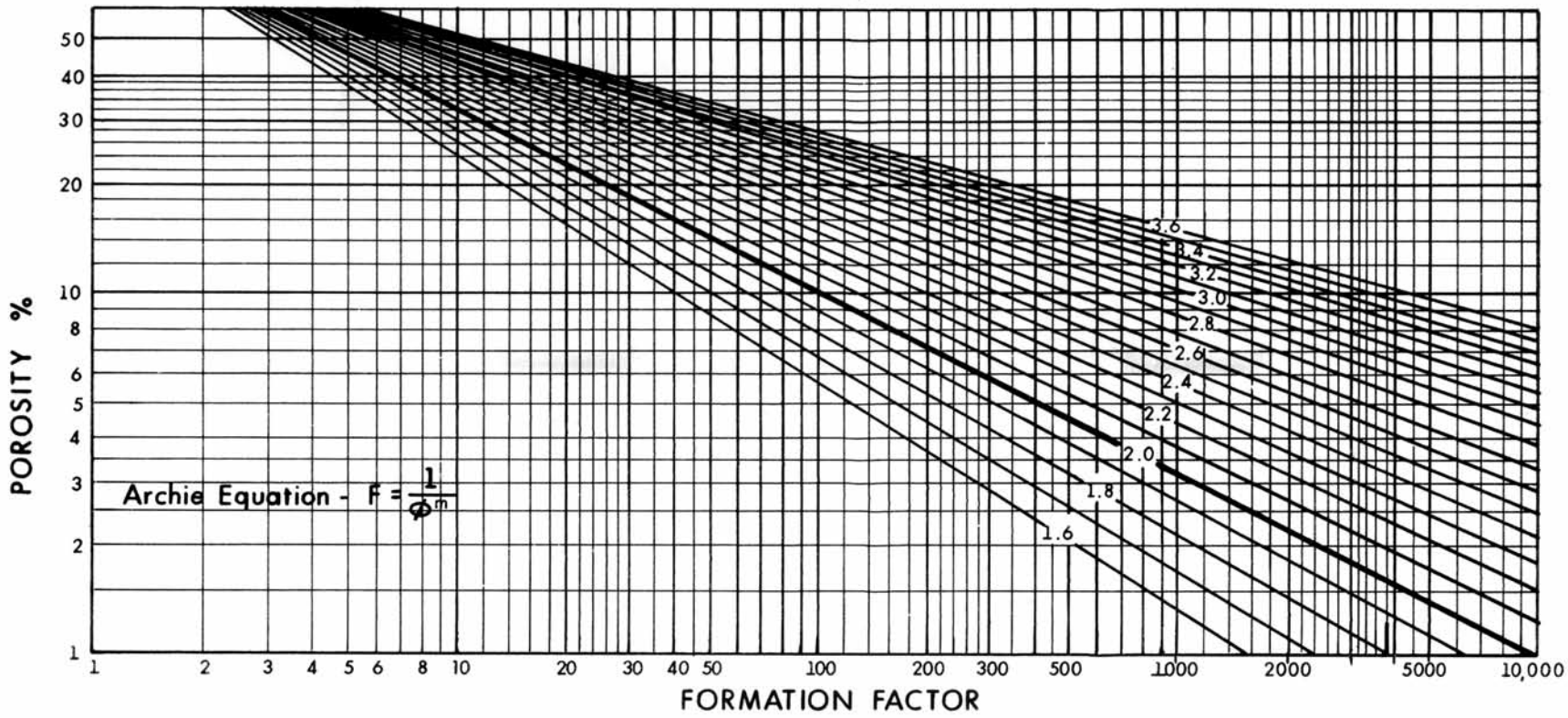

Approximate Resistivity of NaCl Solutions
For Degrees C
Rw1 x (T1+21.5)/(T2+21.5)=Rw2
Enter with Rw and Temperature
Move along Salinity line to new Temperature
Read new Rw on horizontal grid
ppm NaCl
ppm NaCl
Resistivity of Water Ohmmeters
10
5
4
3
2
1.5
1
0.8
0.6
0.5
0.4
0.3
0.2
0.15
0.10
0.08
0.06
0.05
0.04
0.03
0.02
0.015
0.01
10
15
20
25
30
40
50
60
80
100
150
200
CWLS Map values at this Temperature
Temperature Degrees C

Chart 7A

Chart 8



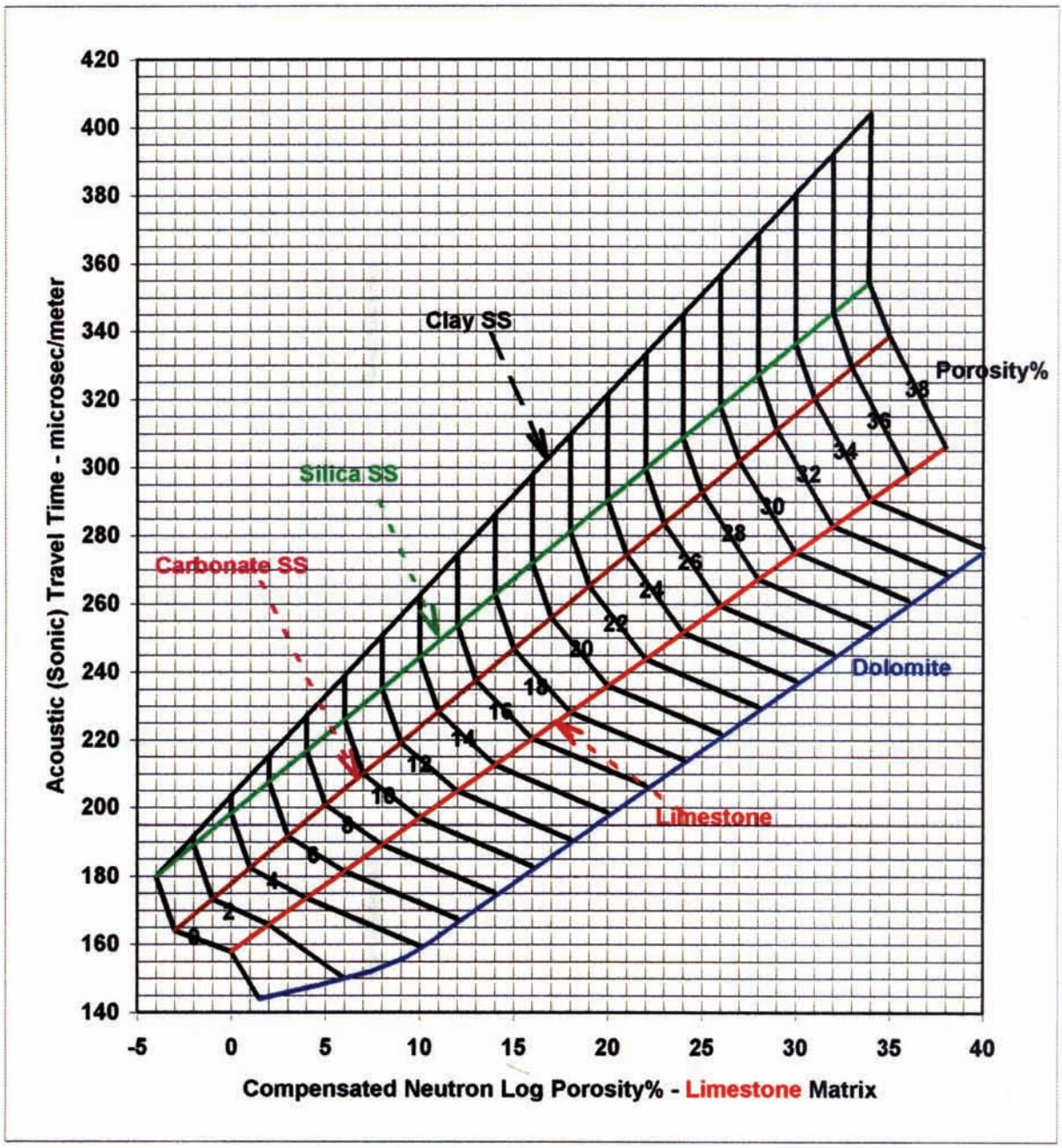
Recommended Values of "m" For Western Canada Reservoirs

Sandstones —	consolidated	2.0
	unconsolidated	1.8
Limestones —	at 5000'	2.0
	6000'	2.1
	>8000'	2.2
Dolomites —	at 5000'	2.0
	7000'	2.2
	9000'	2.4
	11,000'	2.8
	13,000'	3.0

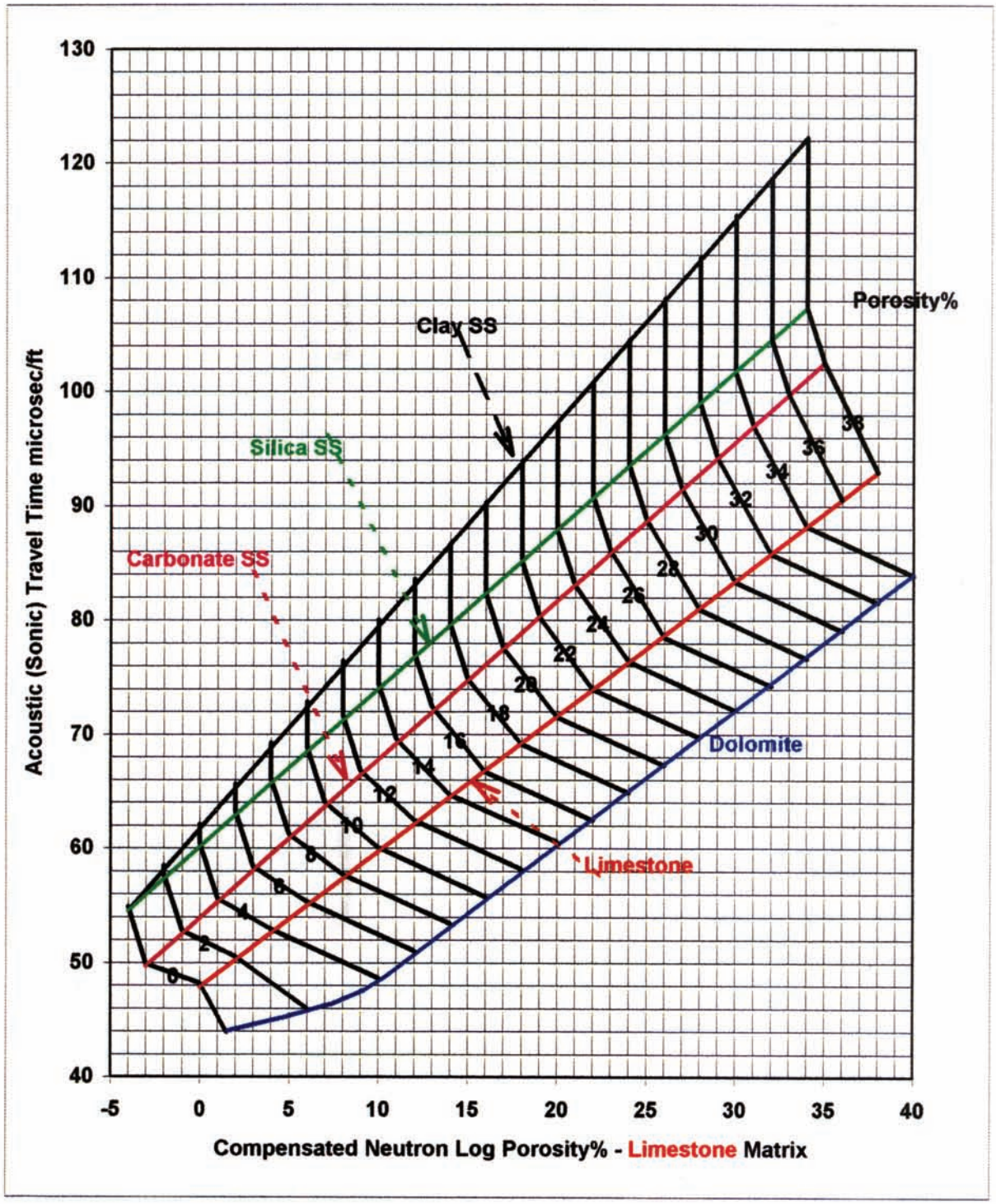
Increasing vug porosity

Increasing fractures

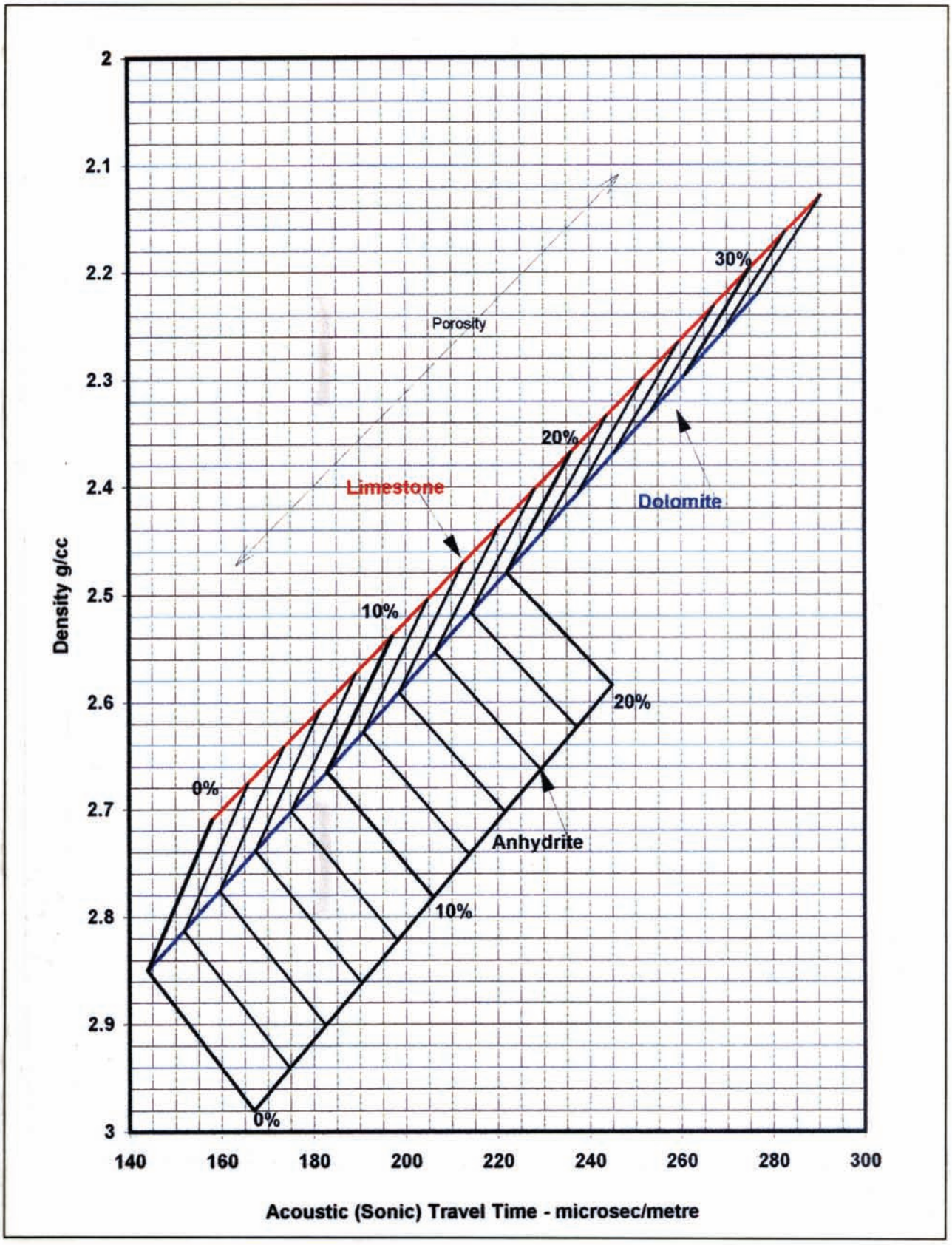
POROSITY versus FORMATION FACTOR



Neutron Log Porosity vs Acoustic (Sonic) Log Travel Time
Limestone Matrix - Metric Units

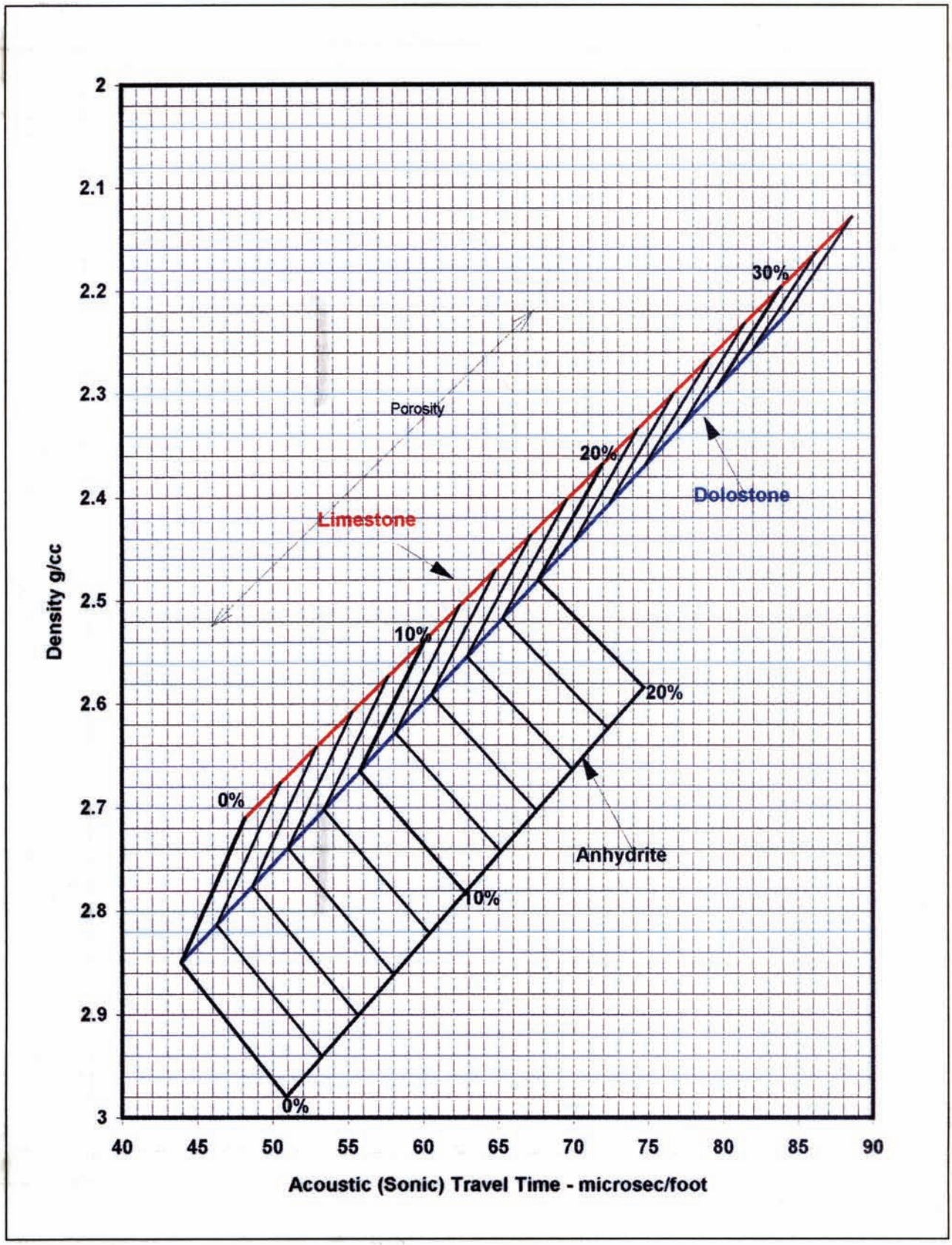


Neutron Log Porosity vs Acoustic (Sonic) Travel Time
Limestone Matrix - Imperial Units



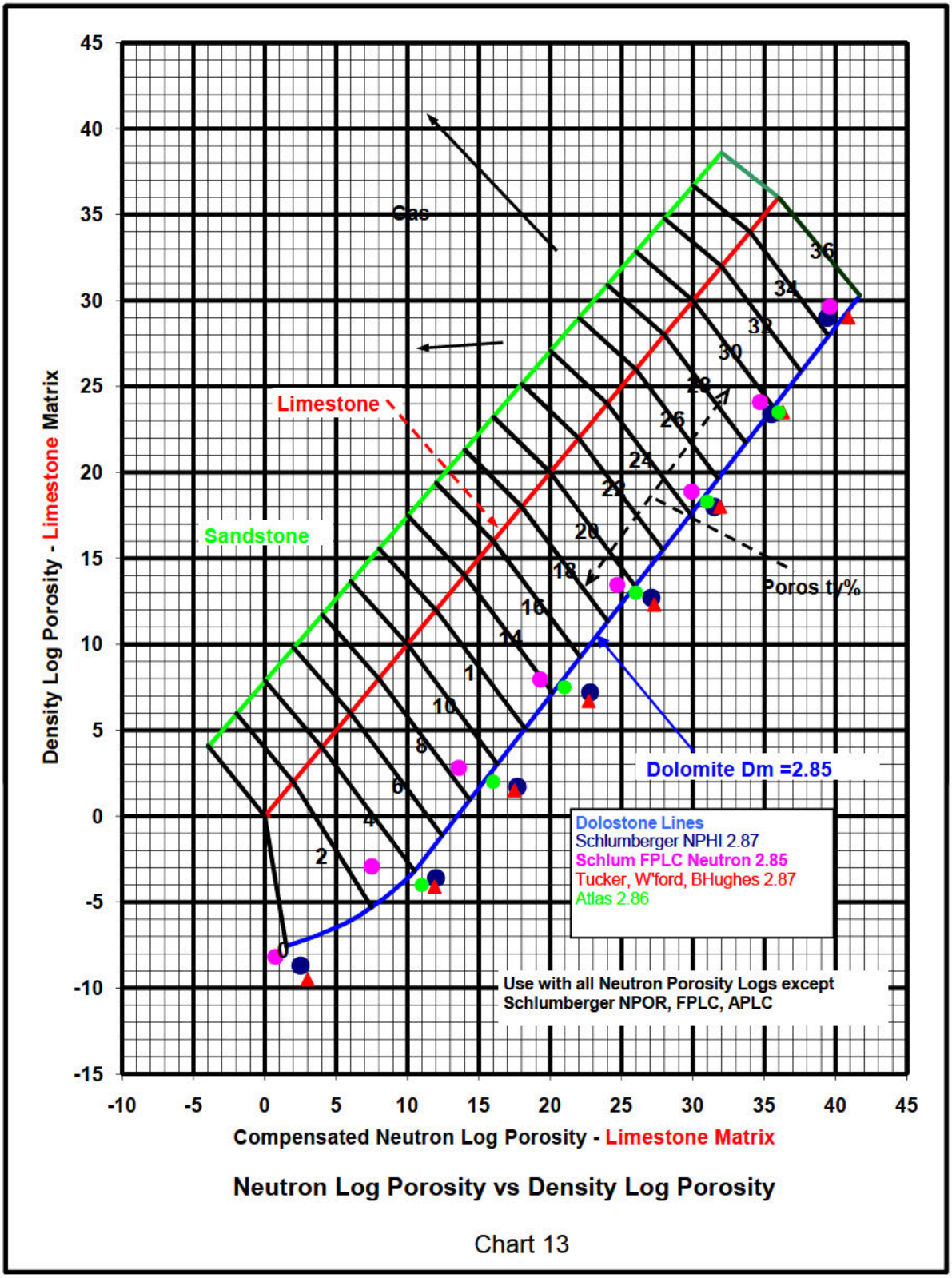
Acoustic (Sonic) Travel Time vs Density
Metric Units

Chart 11



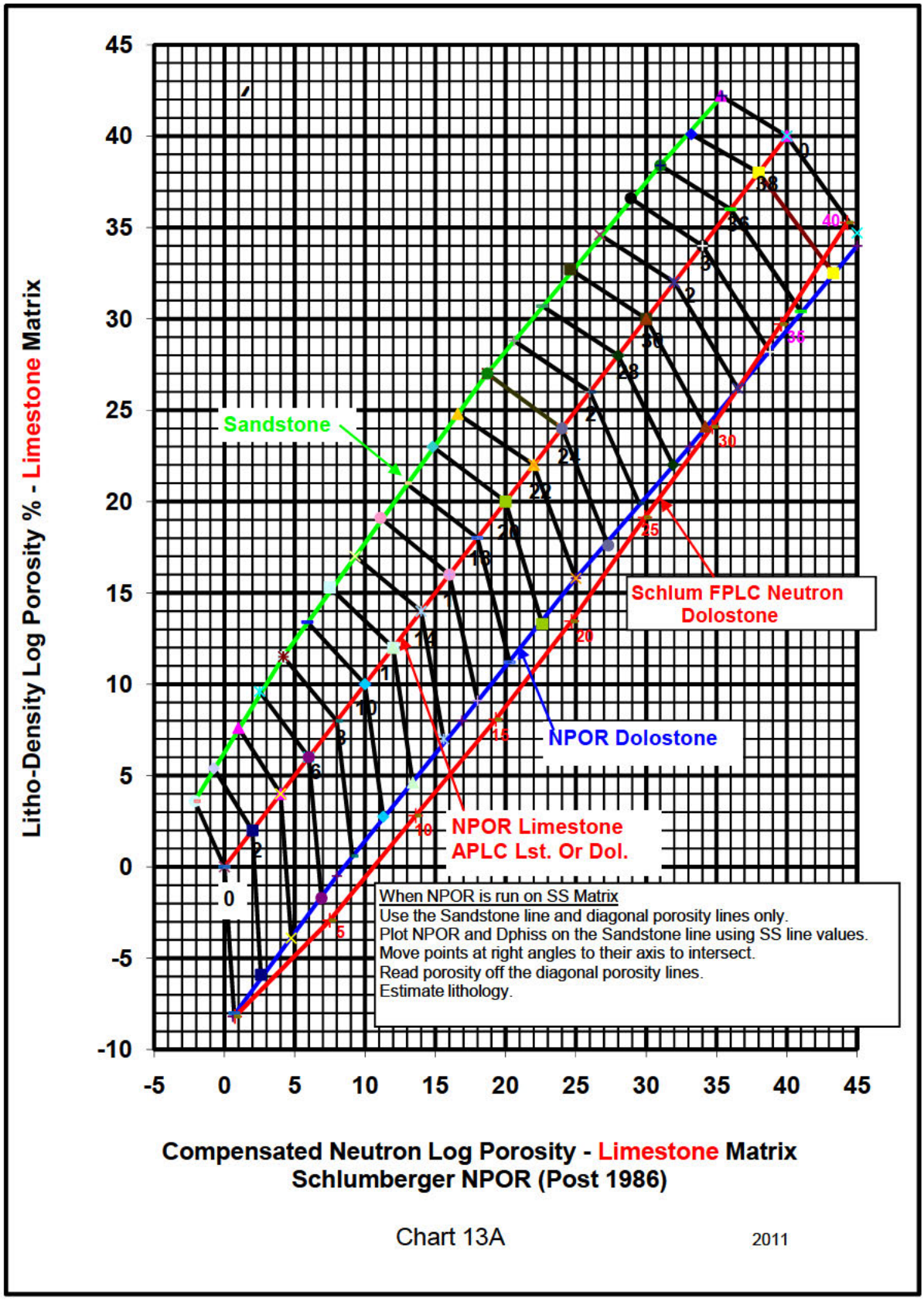
Acoustic (Sonic) Travel Time vs Density
Imperial Units

Chart 12



Neutron Log Porosity vs Density Log Porosity

Chart 13


Litho-Density Log Porosity % - Limestone Matrix
Compensated Neutron Log Porosity - Limestone Matrix
Schlumberger NPOR (Post 1986)
Sandstone
Schlum FPLC Neutron
Dolostone
NPOR Dolostone
NPOR Limestone
APLC Lst. Or Dol.
When NPOR is run on SS Matrix
Use the Sandstone line and diagonal porosity lines only.
Plot NPOR and Dphiss on the Sandstone line using SS line values.
Move points at right angles to their axis to intersect.
Read porosity off the diagonal porosity lines.
Estimate lithology.
Chart 13A
2011

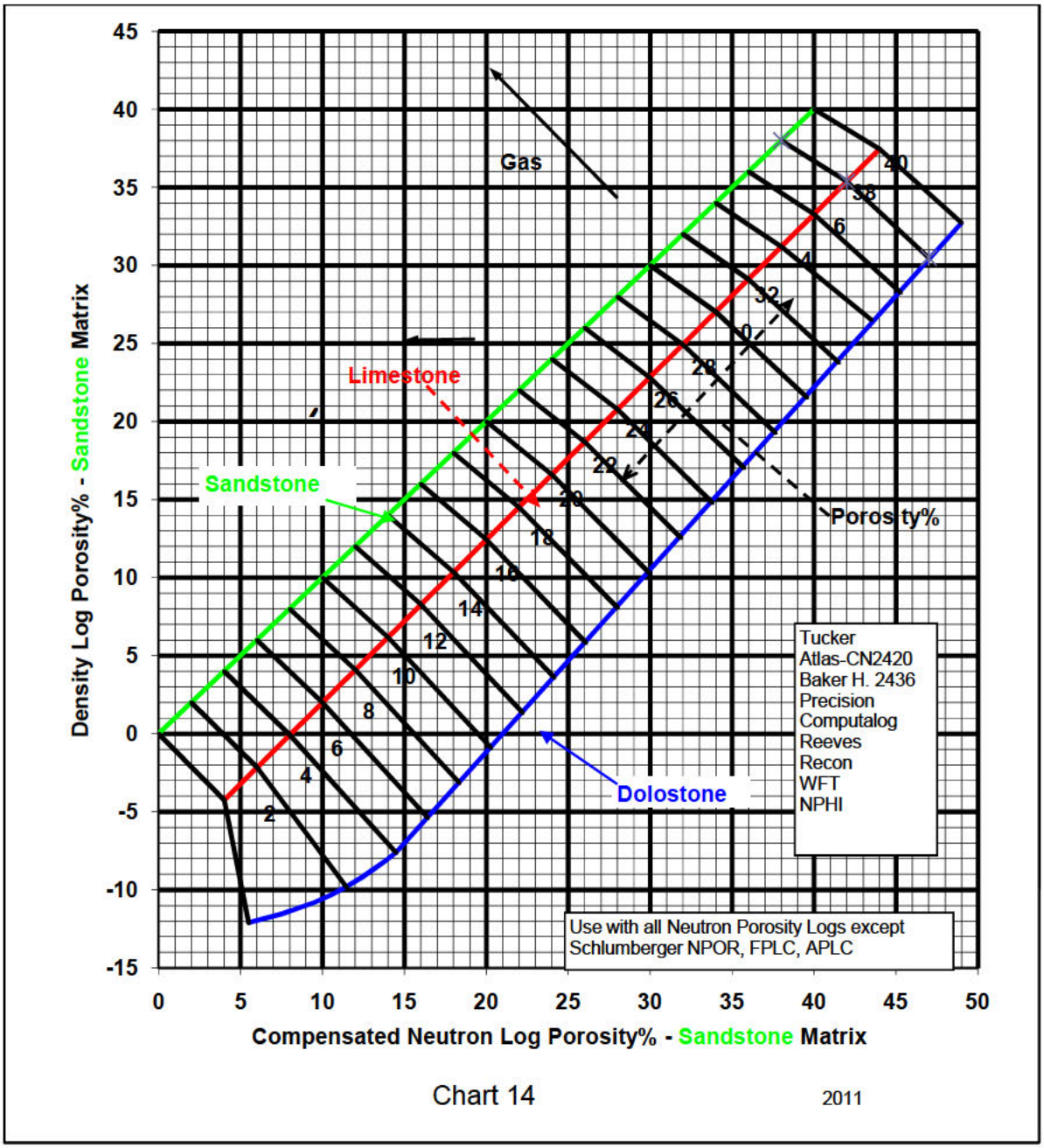


Chart 14 2011

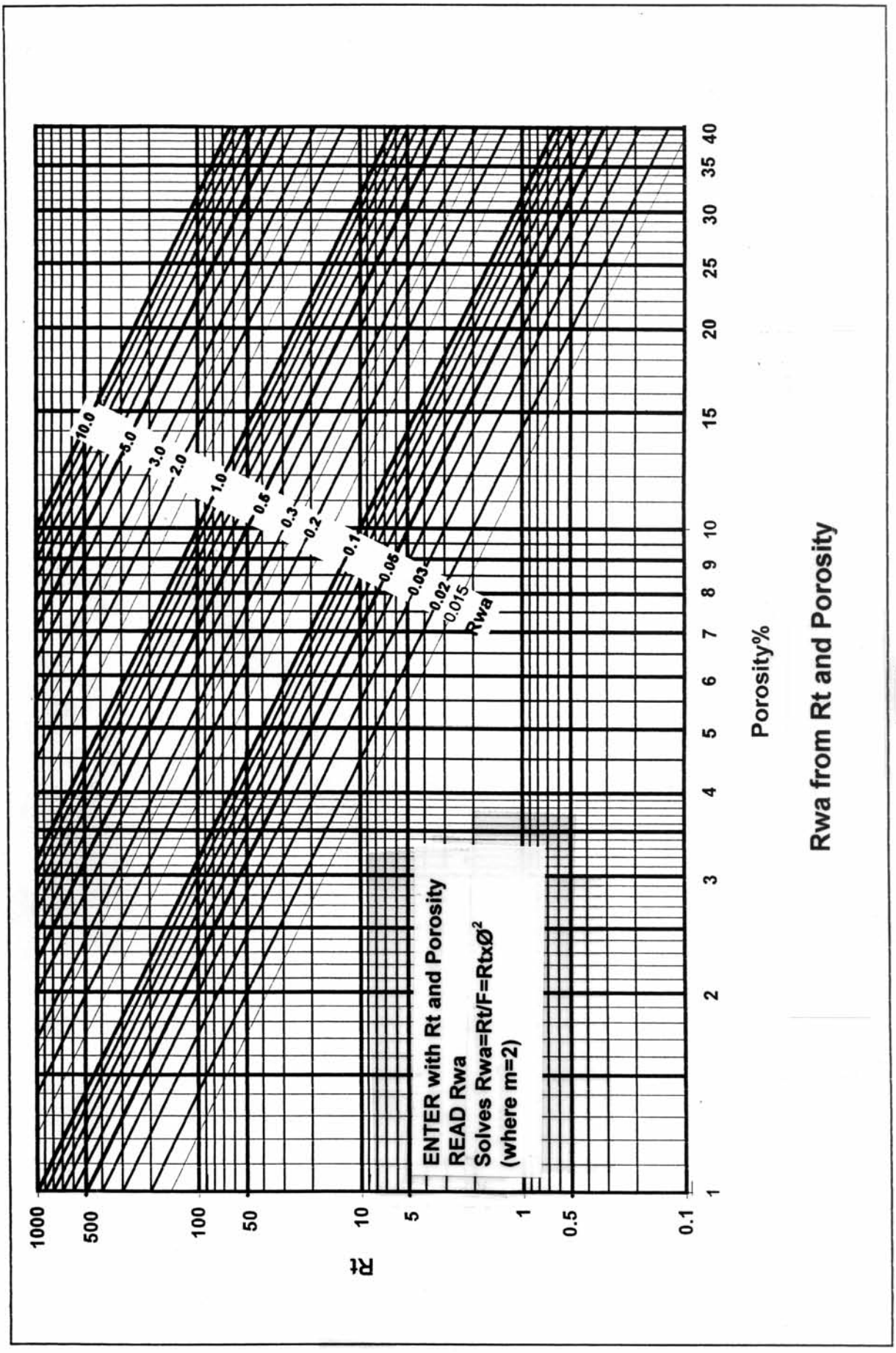

Rwa from Rt and Porosity
Porosity%
Rt
Rwa
10.0
5.0
3.0
2.0
1.0
0.5
0.3
0.2
0.1
0.06
0.03
0.02
0.015
ENTER with Rt and Porosity
READ Rwa
Solves Rwa=Rt/F=RtxØ²
(where m=2)
1000
500
100
50
10
5
1
0.5
0.1
1
2
3
4
5
6
7
8
9
10
15
20
25
30
35
40

Chart 15

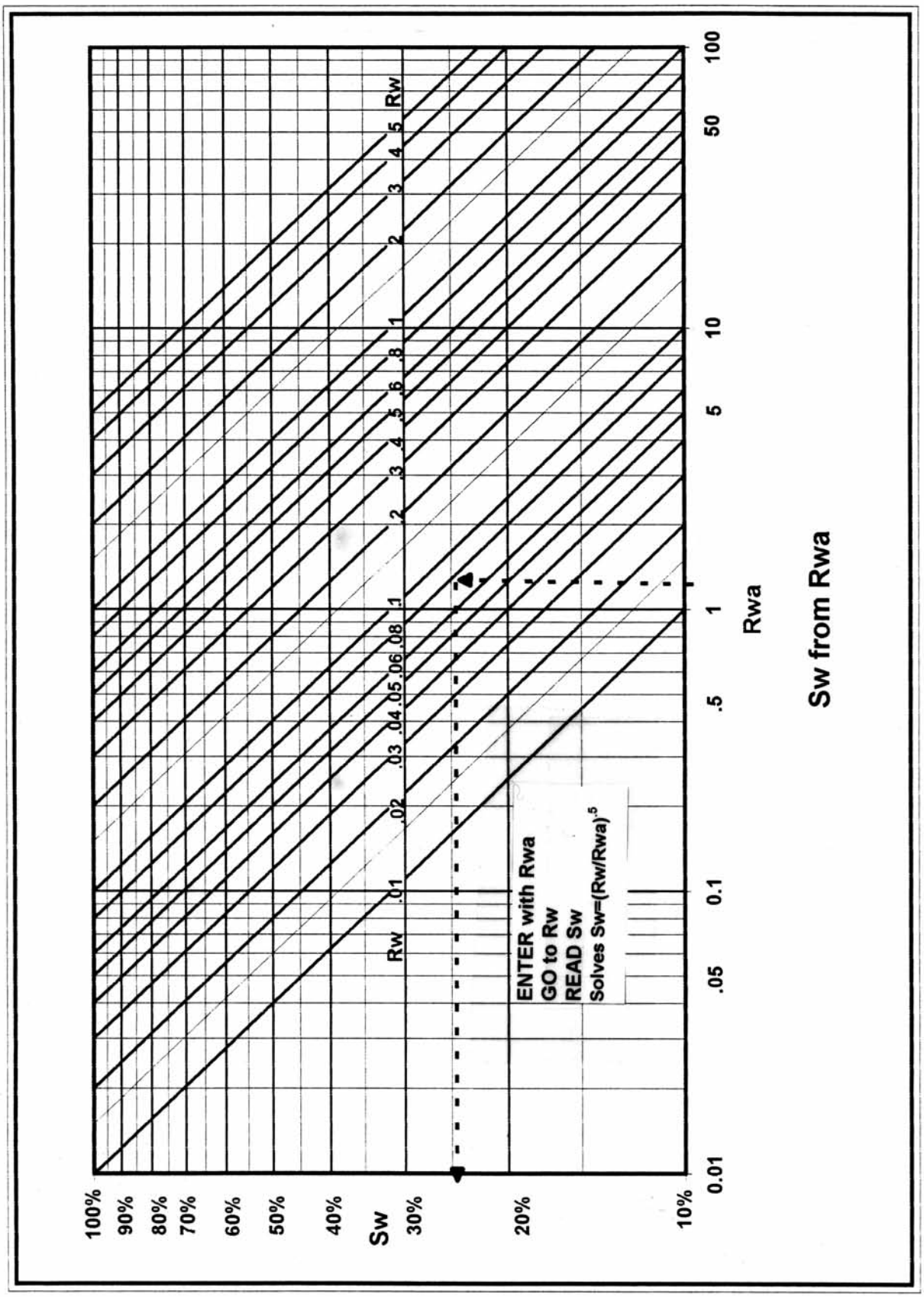
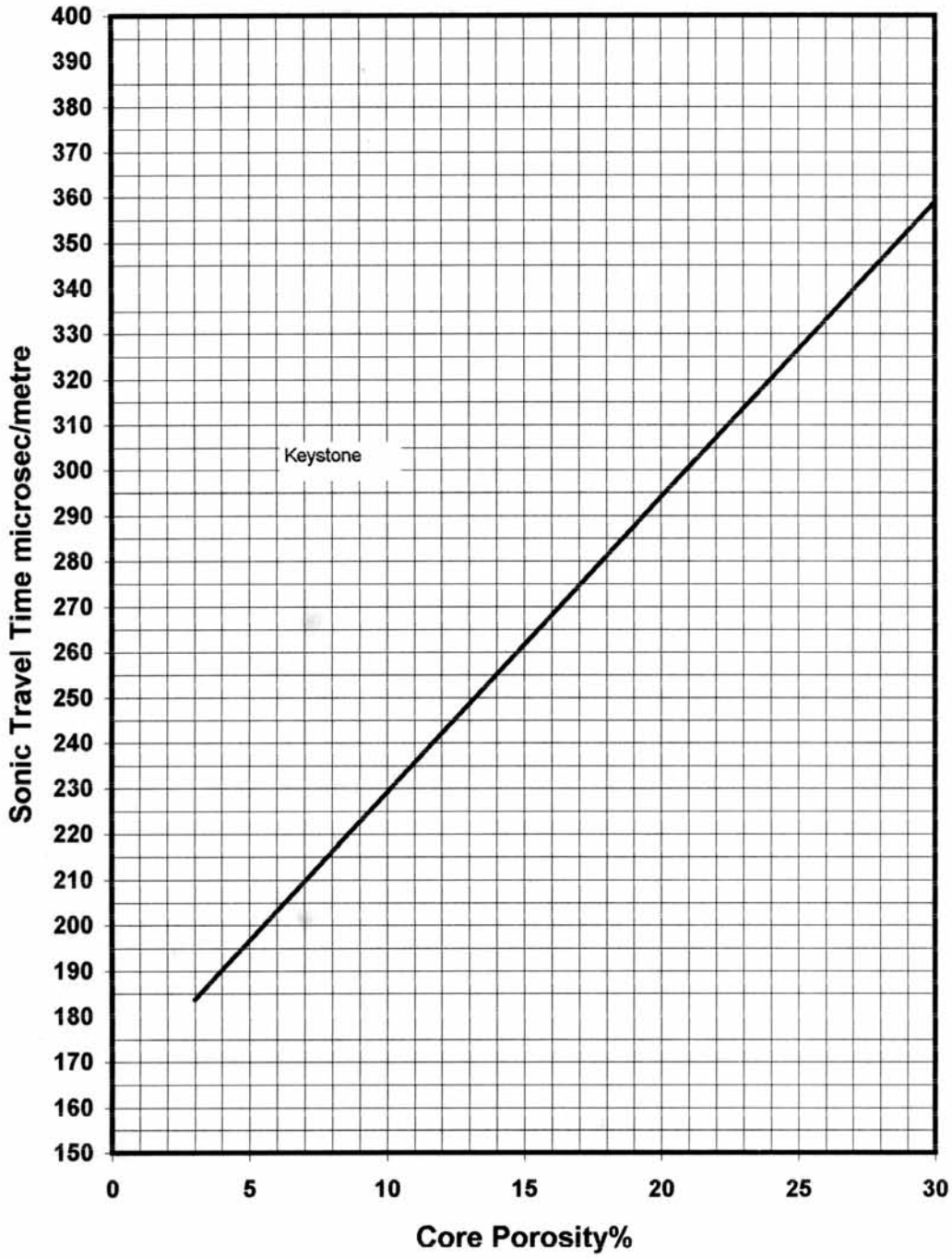
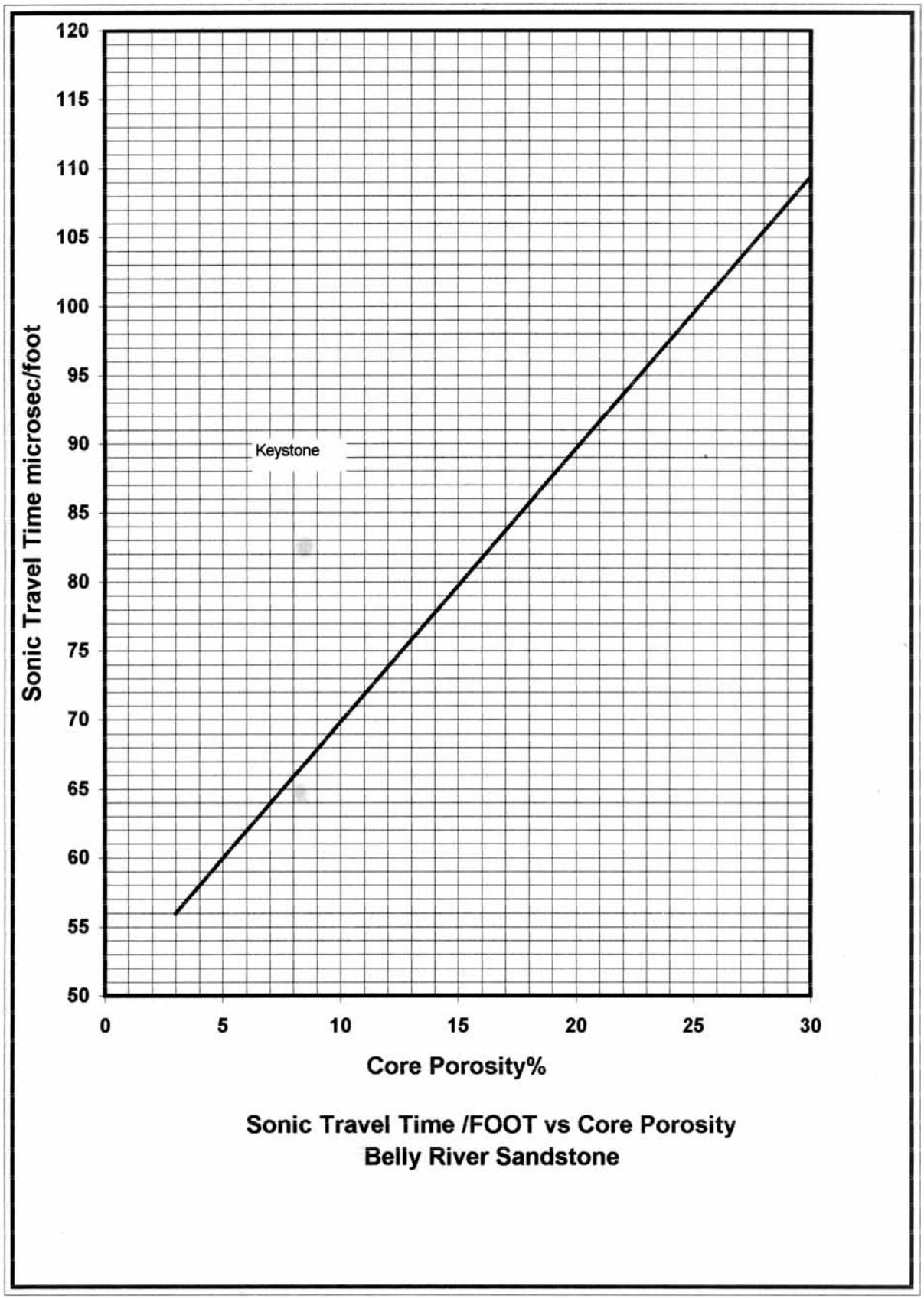

Sw from Rwa
Sw
Rwa
Rw
ENTER with Rwa
GO to Rw
READ Sw
Solves Sw=(Rw/Rwa)^.5
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0.01
.05
0.1
.5
1
5
10
50
100

Chart 16



Sonic Travel Time/METRE vs Core Porosity
Belly River Sandstone



Sonic Travel Time /FOOT vs Core Porosity
Belly River Sandstone

Chart 18

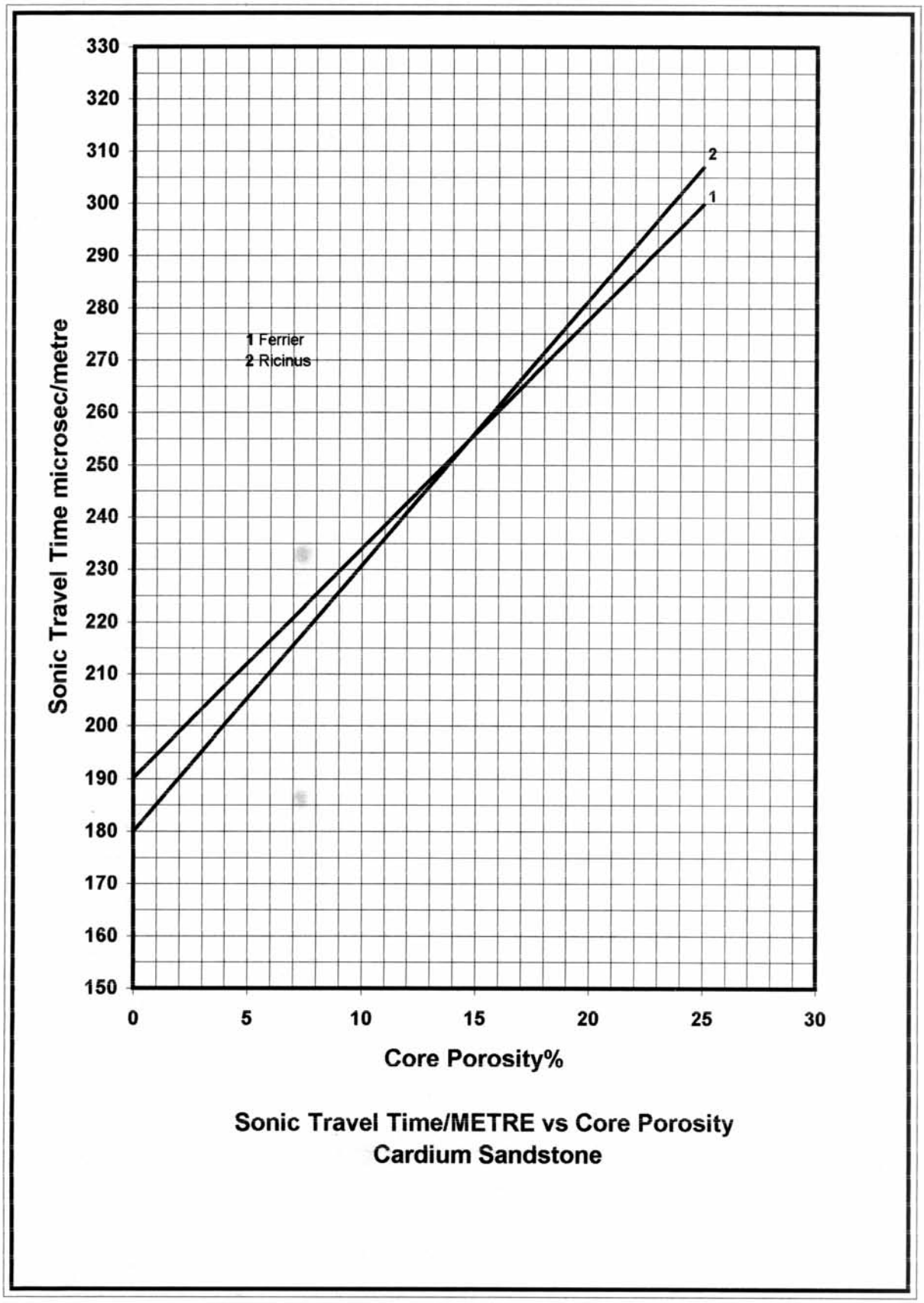
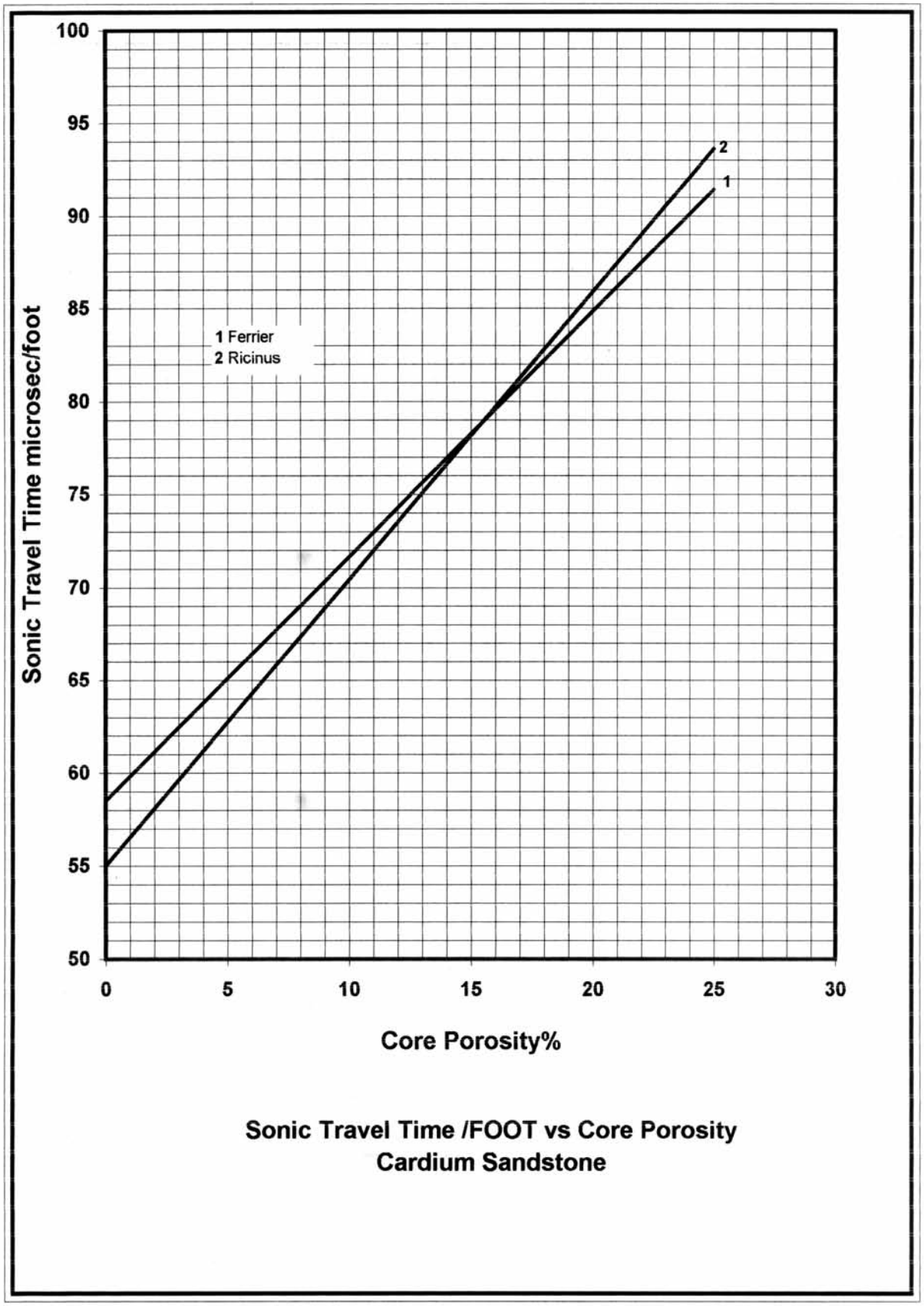
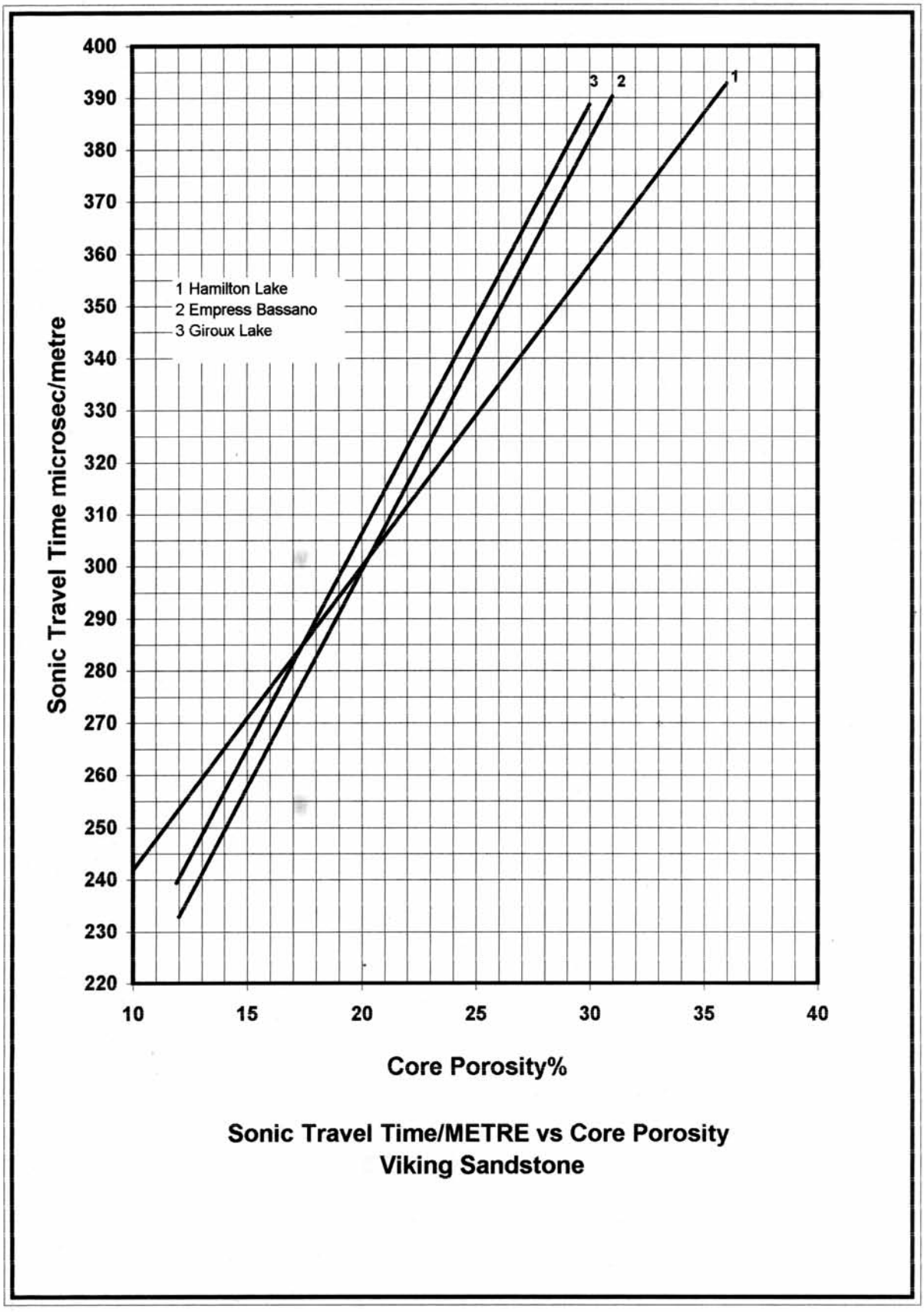

330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
Sonic Travel Time microsec/metre
1 Ferrier
2 Ricinus
2
1
0
5
10
15
20
25
30
Core Porosity%
Sonic Travel Time/METRE vs Core Porosity
Cardium Sandstone

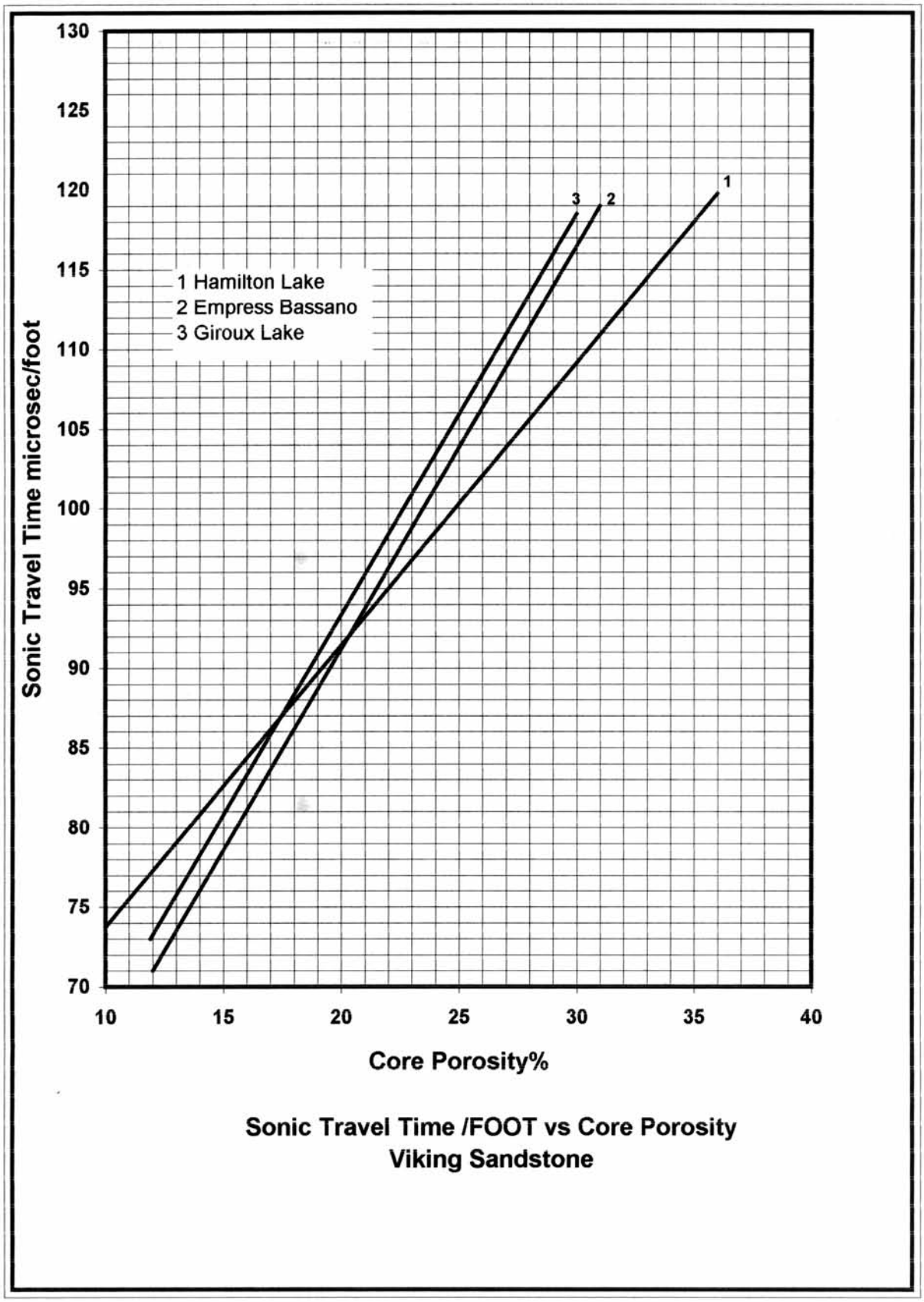
Chart 19



Sonic Travel Time /FOOT vs Core Porosity
Cardium Sandstone



Sonic Travel Time/METRE vs Core Porosity
Viking Sandstone



Sonic Travel Time /FOOT vs Core Porosity
Viking Sandstone

Chart 22

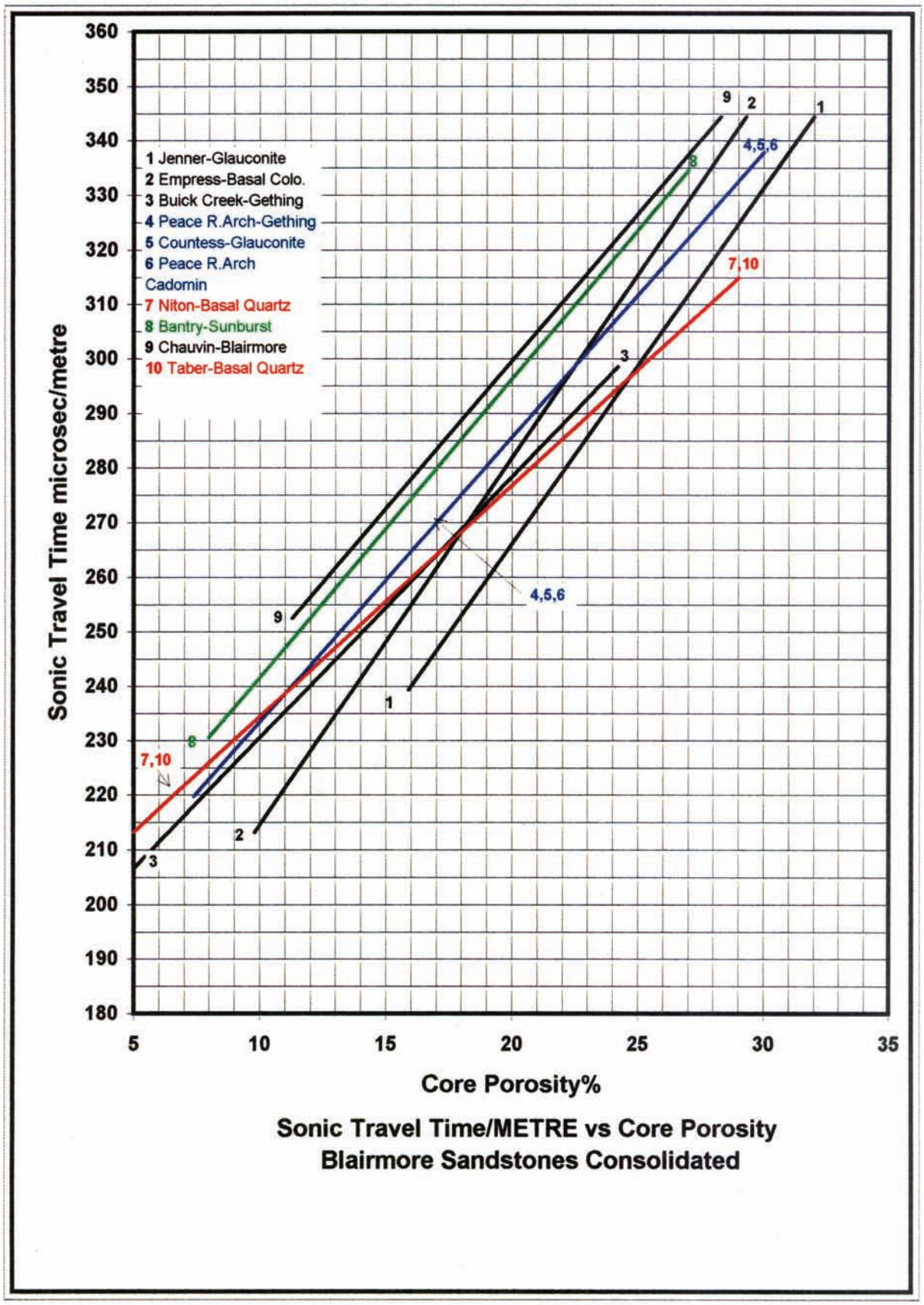

Sonic Travel Time microsec/metre
360
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
5
10
15
20
25
30
35
Core Porosity%
1 Jenner-Glauconite
2 Empress-Basal Colo.
3 Buick Creek-Gething
4 Peace R.Arch-Gething
5 Countess-Glauconite
6 Peace R.Arch
Cadomin
7 Niton-Basal Quartz
8 Bantry-Sunburst
9 Chauvin-Blairmore
10 Taber-Basal Quartz
9
2
1
4,5,6
8
7,10
3
4,5,6
9
1
8
7,10
2
3
Sonic Travel Time/METRE vs Core Porosity
Blairmore Sandstones Consolidated

Chart 23

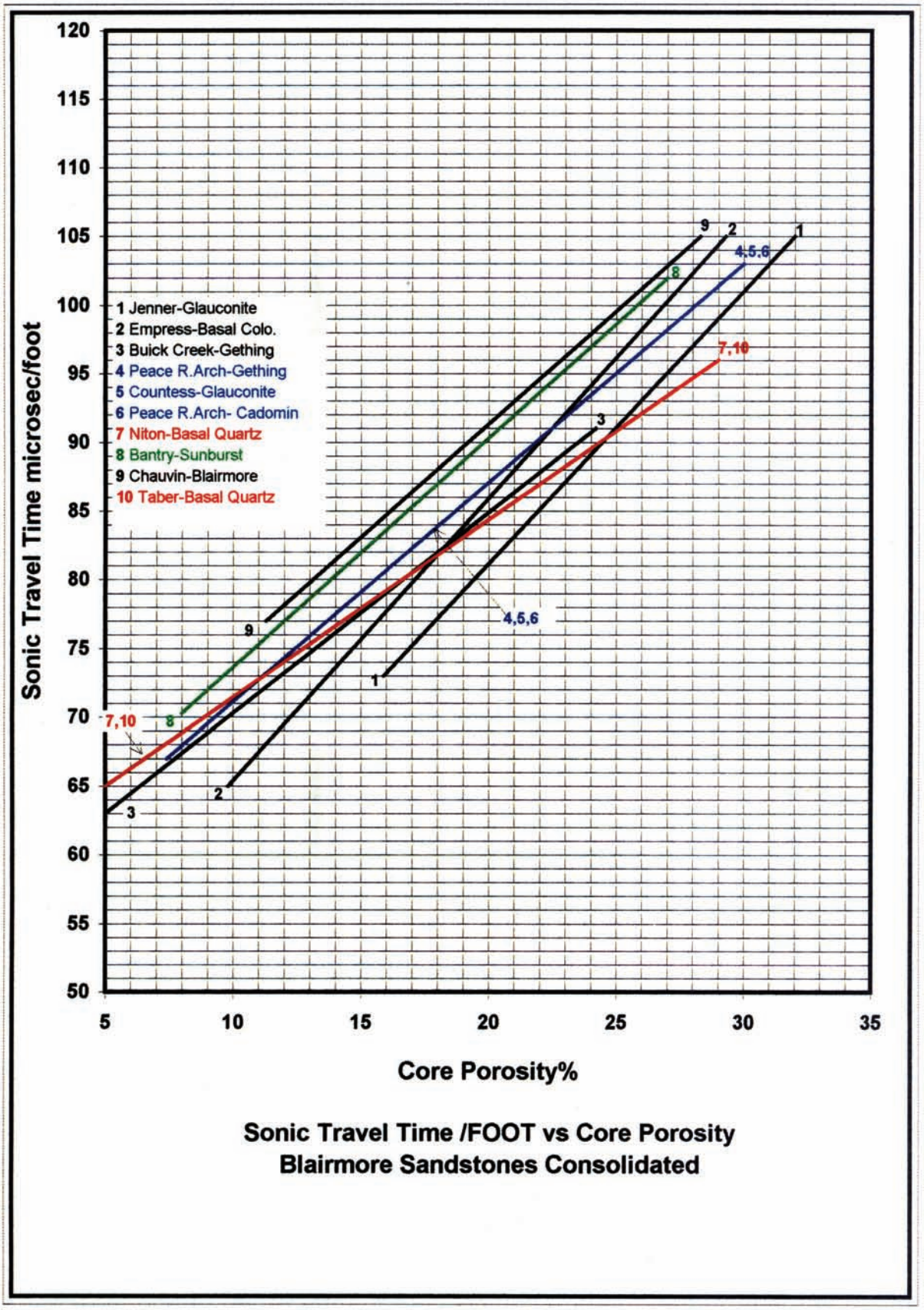
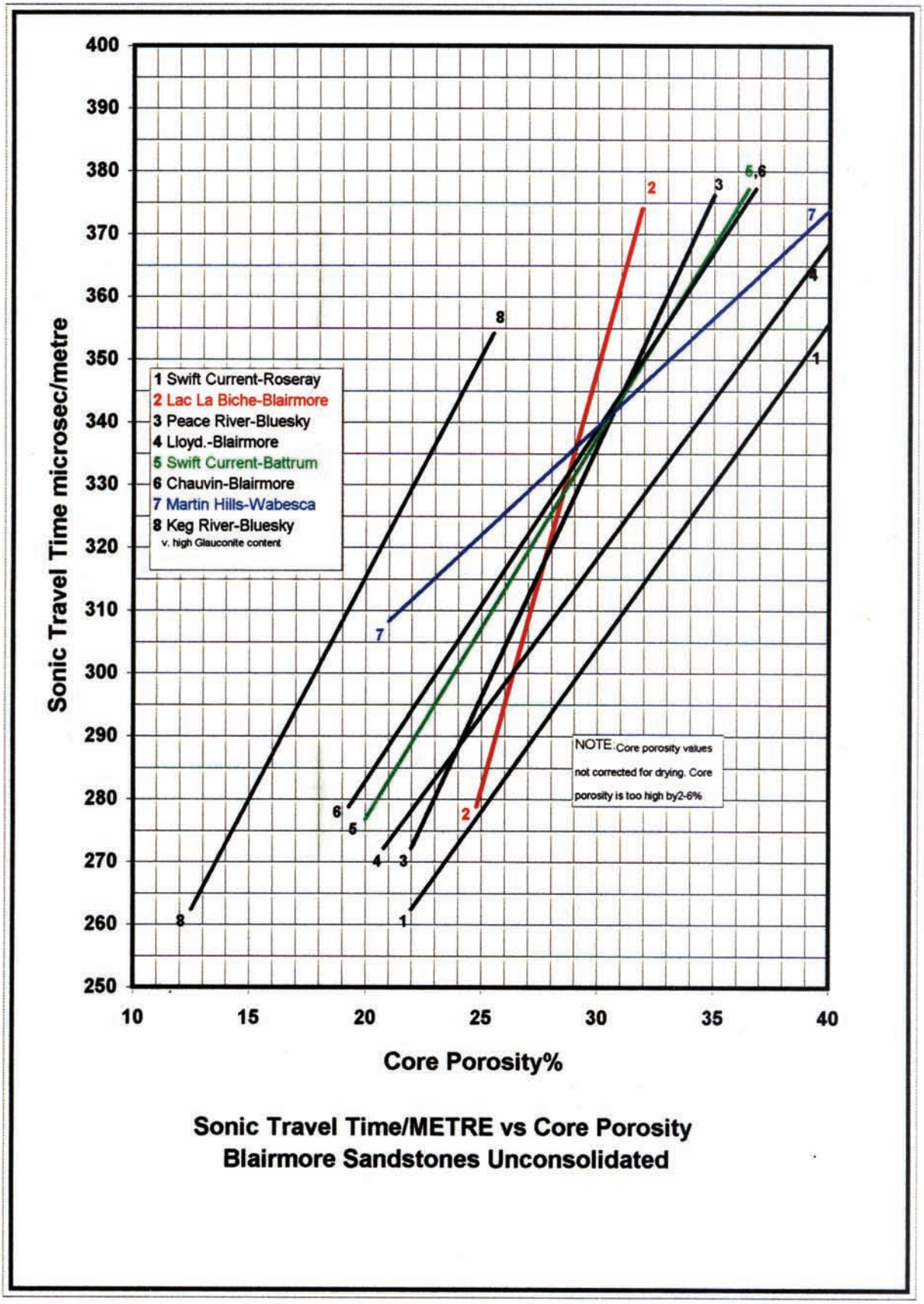
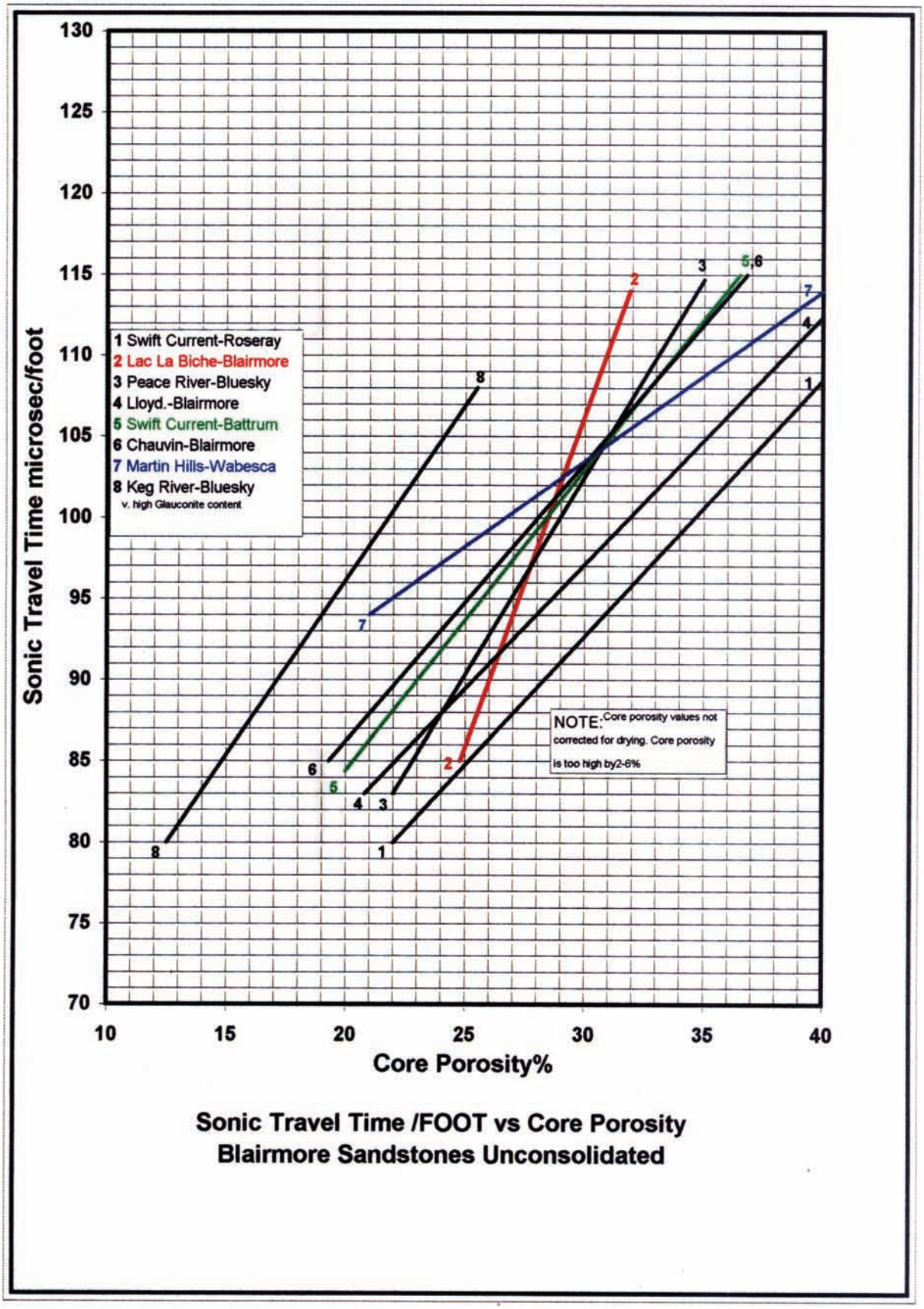

Sonic Travel Time microsec/foot
120
115
110
105
100
95
90
85
80
75
70
65
60
55
50
5
10
15
20
25
30
35
Core Porosity%
1 Jenner-Glauconite
2 Empress-Basal Colo.
3 Buick Creek-Gething
4 Peace R.Arch-Gething
5 Countess-Glauconite
6 Peace R.Arch- Cadomin
7 Niton-Basal Quartz
8 Bantry-Sunburst
9 Chauvin-Blairmore
10 Taber-Basal Quartz
4,5,6
7,10
Sonic Travel Time /FOOT vs Core Porosity
Blairmore Sandstones Consolidated

Chart 24



Sonic Travel Time/METRE vs Core Porosity
Blairmore Sandstones Unconsolidated

Chart 25



Sonic Travel Time /FOOT vs Core Porosity
Blairmore Sandstones Unconsolidated

Chart 26

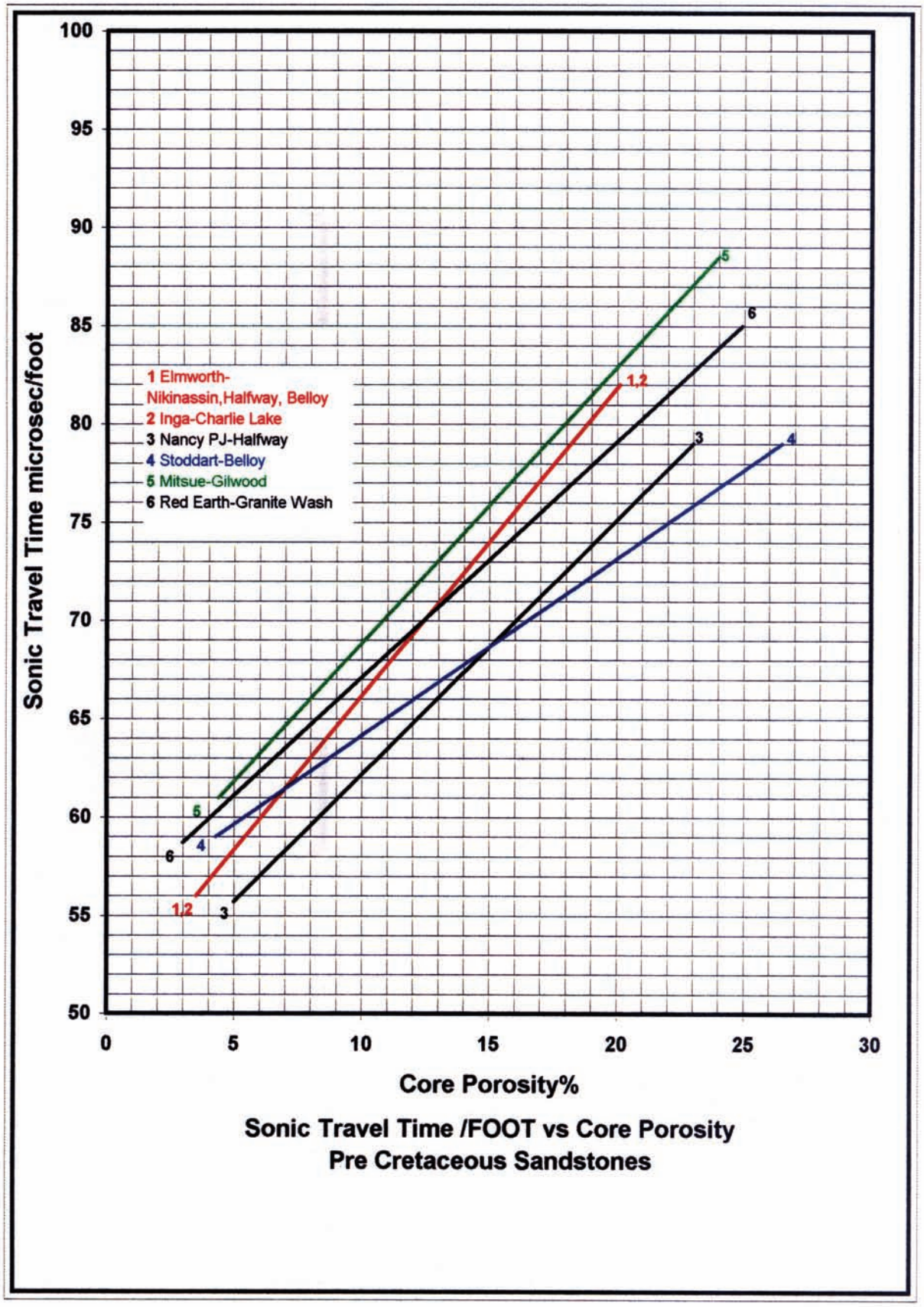

Sonic Travel Time microsec/foot
100
95
90
85
80
75
70
65
60
55
50
0
5
10
15
20
25
30
Core Porosity%
1 Elmworth-
Nikinassin,Halfway, Belloy
2 Inga-Charlie Lake
3 Nancy PJ-Halfway
4 Stoddart-Belloy
5 Mitsue-Gilwood
6 Red Earth-Granite Wash
1,2
3
4
5
6
Sonic Travel Time /FOOT vs Core Porosity
Pre Cretaceous Sandstones

Chart 27

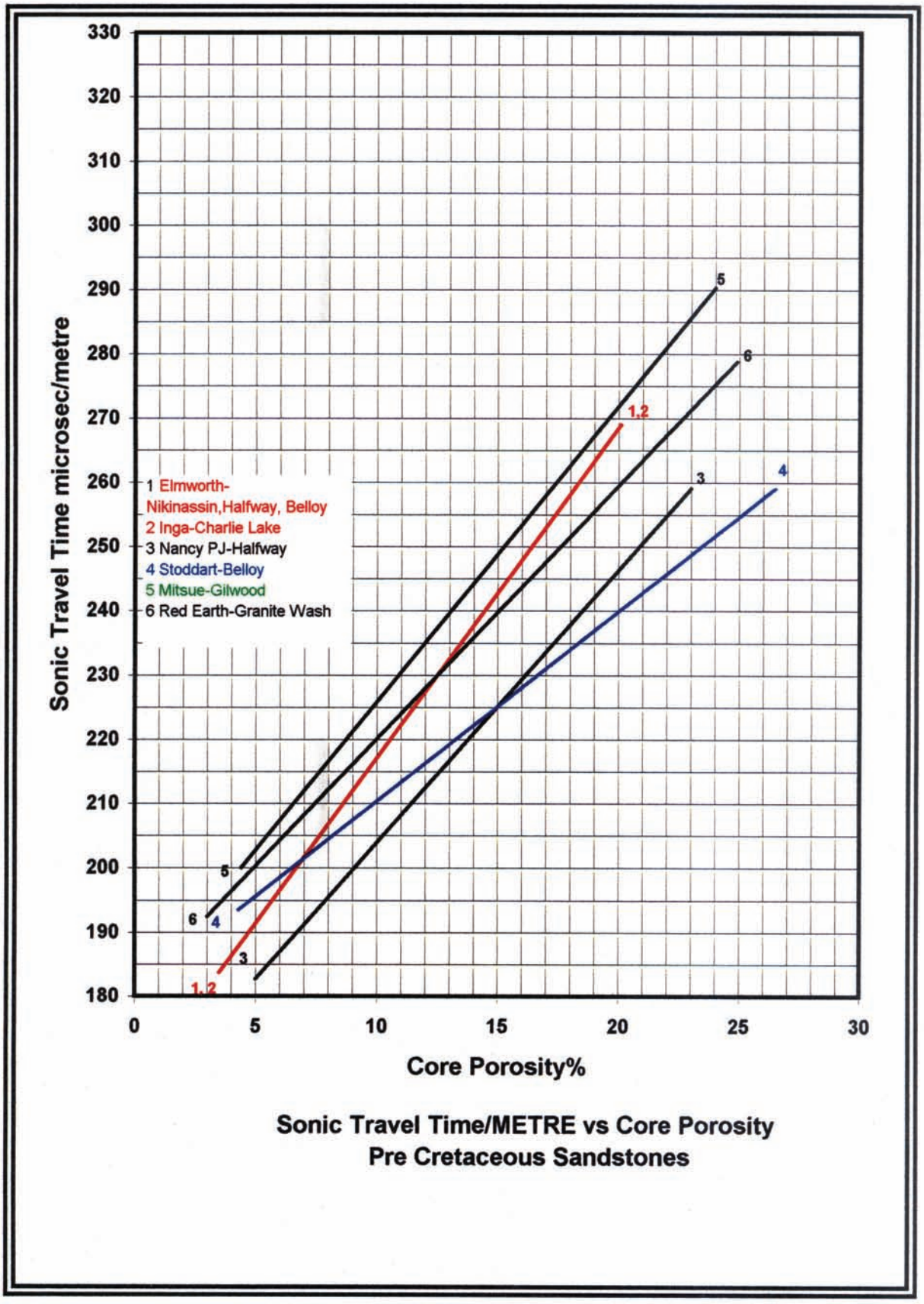
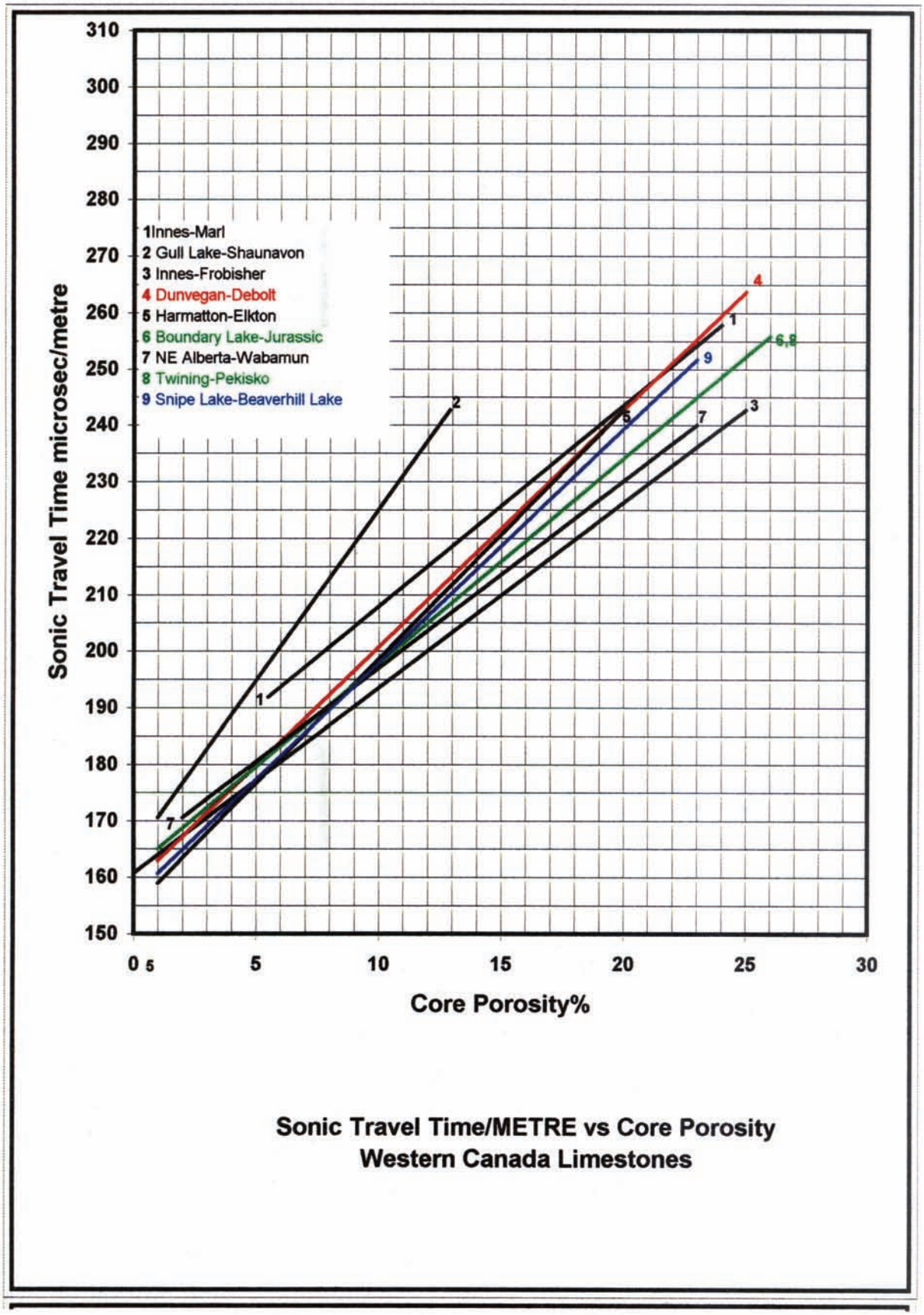
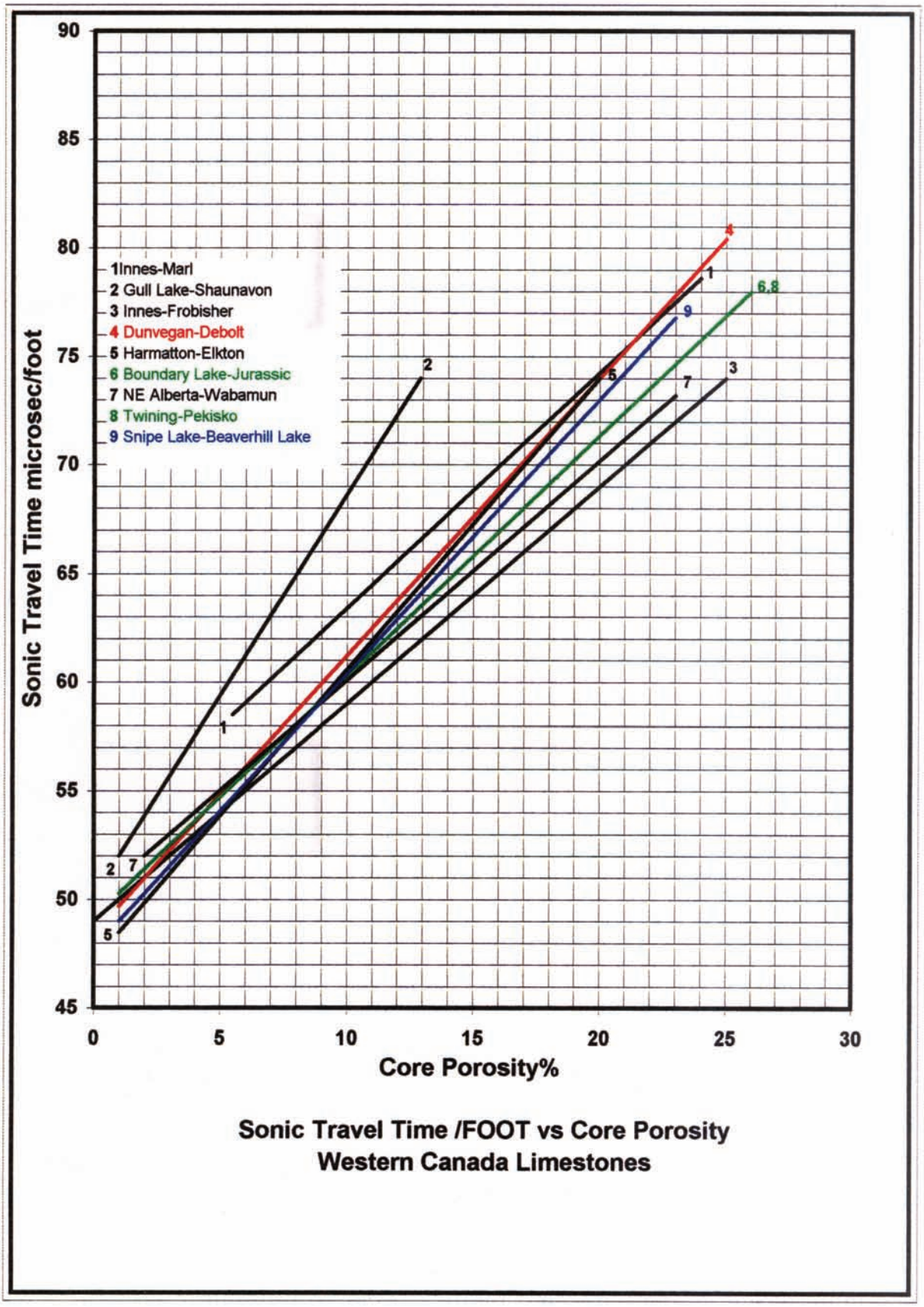

Sonic Travel Time microsec/metre
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
0
5
10
15
20
25
30
Core Porosity%
1 Elmworth-
Nikinassin,Halfway, Belloy
2 Inga-Charlie Lake
3 Nancy PJ-Halfway
4 Stoddart-Belloy
5 Mitsue-Gilwood
6 Red Earth-Granite Wash
1,2
5
6
3
4
Sonic Travel Time/METRE vs Core Porosity
Pre Cretaceous Sandstones

Chart 28



Sonic Travel Time/METRE vs Core Porosity
Western Canada Limestones



Sonic Travel Time /FOOT vs Core Porosity
Western Canada Limestones

Chart 30

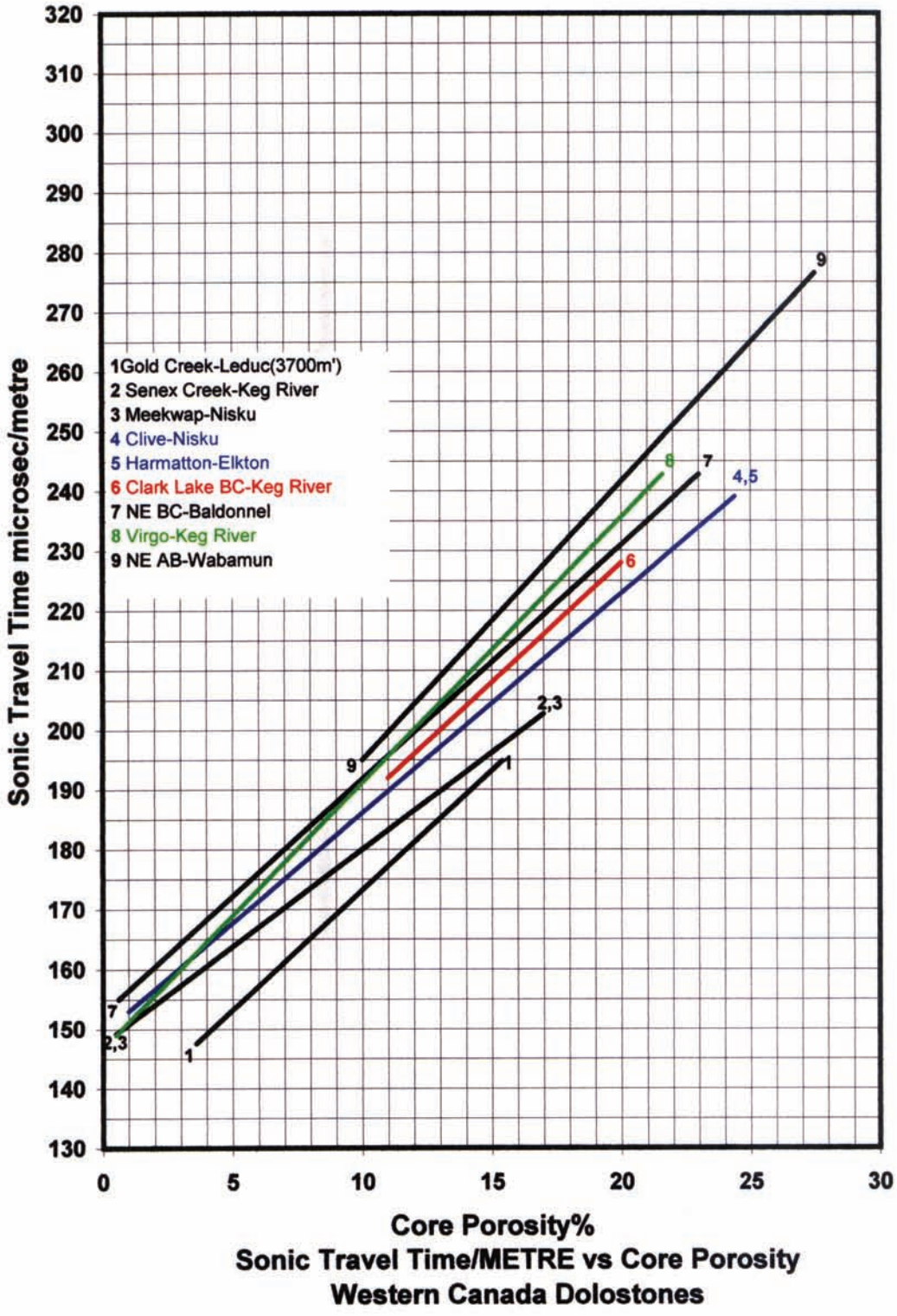
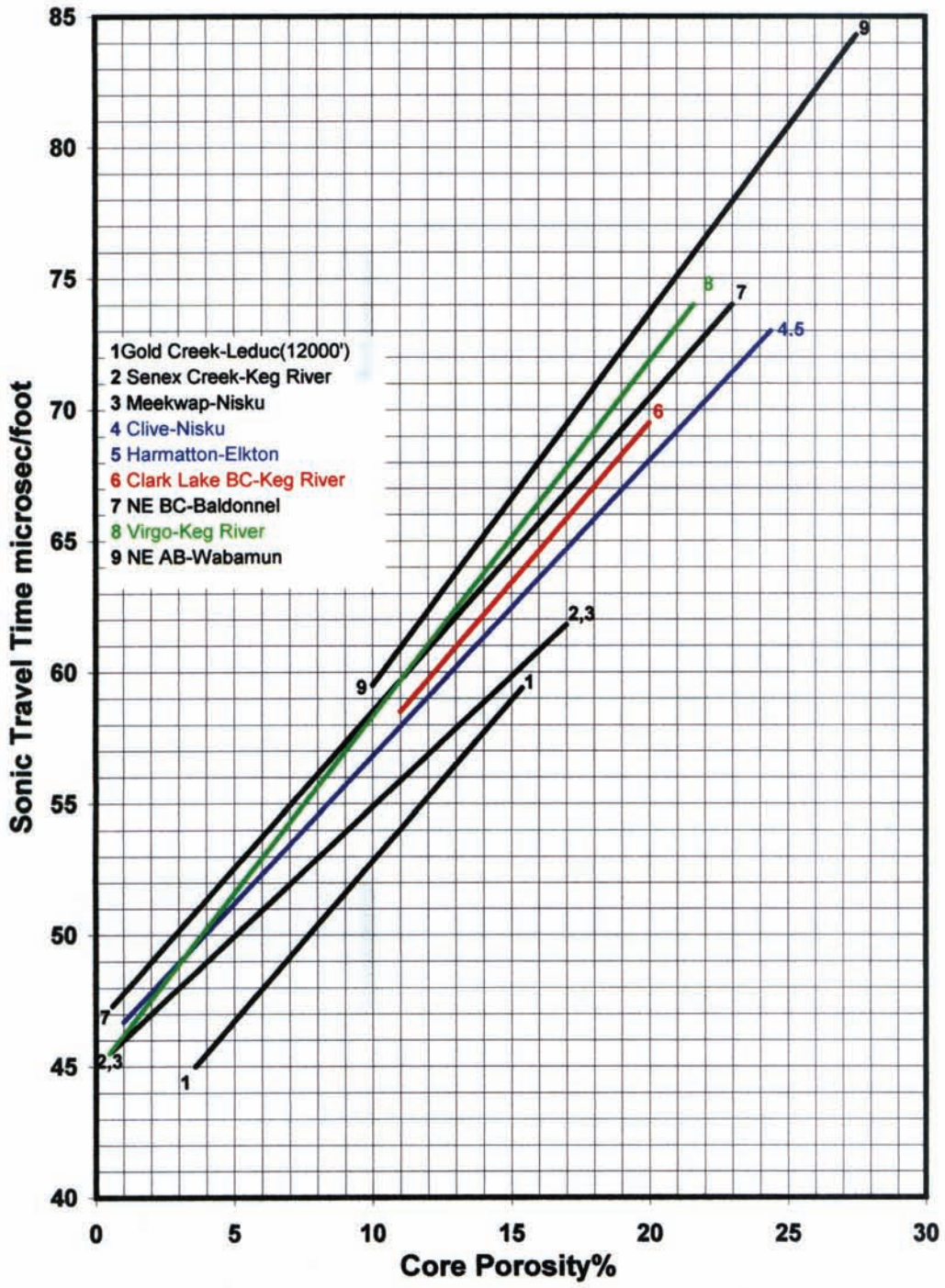

Sonic Travel Time microsec/metre
320
310
300
290
280
270
260
250
240
230
220
210
200
190
180
170
160
150
140
130
0
5
10
15
20
25
30
1Gold Creek-Leduc(3700m')
2 Senex Creek-Keg River
3 Meekwap-Nisku
4 Clive-Nisku
5 Harmatton-Elkton
6 Clark Lake BC-Keg River
7 NE BC-Baldonnel
8 Virgo-Keg River
9 NE AB-Wabamun
9
8
7
4,5
6
2,3
1
9
1
7
2,3
Core Porosity%
Sonic Travel Time/METRE vs Core Porosity
Western Canada Dolostones

Chart 31



Sonic Travel Time /FOOT vs Core Porosity
Western Canada Dolostones

Chart 32

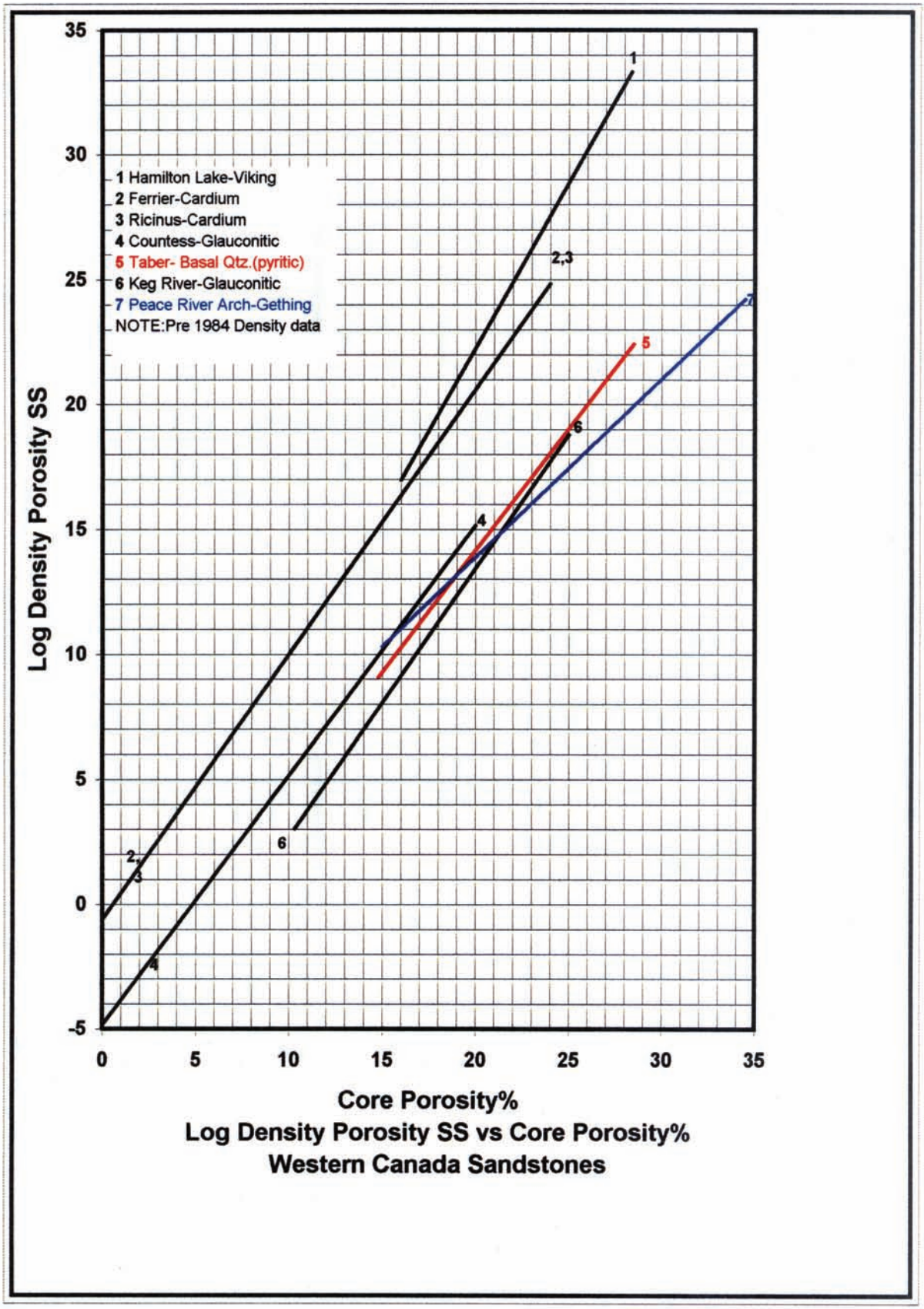

1 Hamilton Lake-Viking
2 Ferrier-Cardium
3 Ricinus-Cardium
4 Countess-Glauconitic
5 Taber- Basal Qtz.(pyritic)
6 Keg River-Glauconitic
7 Peace River Arch-Gething
NOTE:Pre 1984 Density data
Log Density Porosity SS
Core Porosity%
Log Density Porosity SS vs Core Porosity%
Western Canada Sandstones

Chart 33

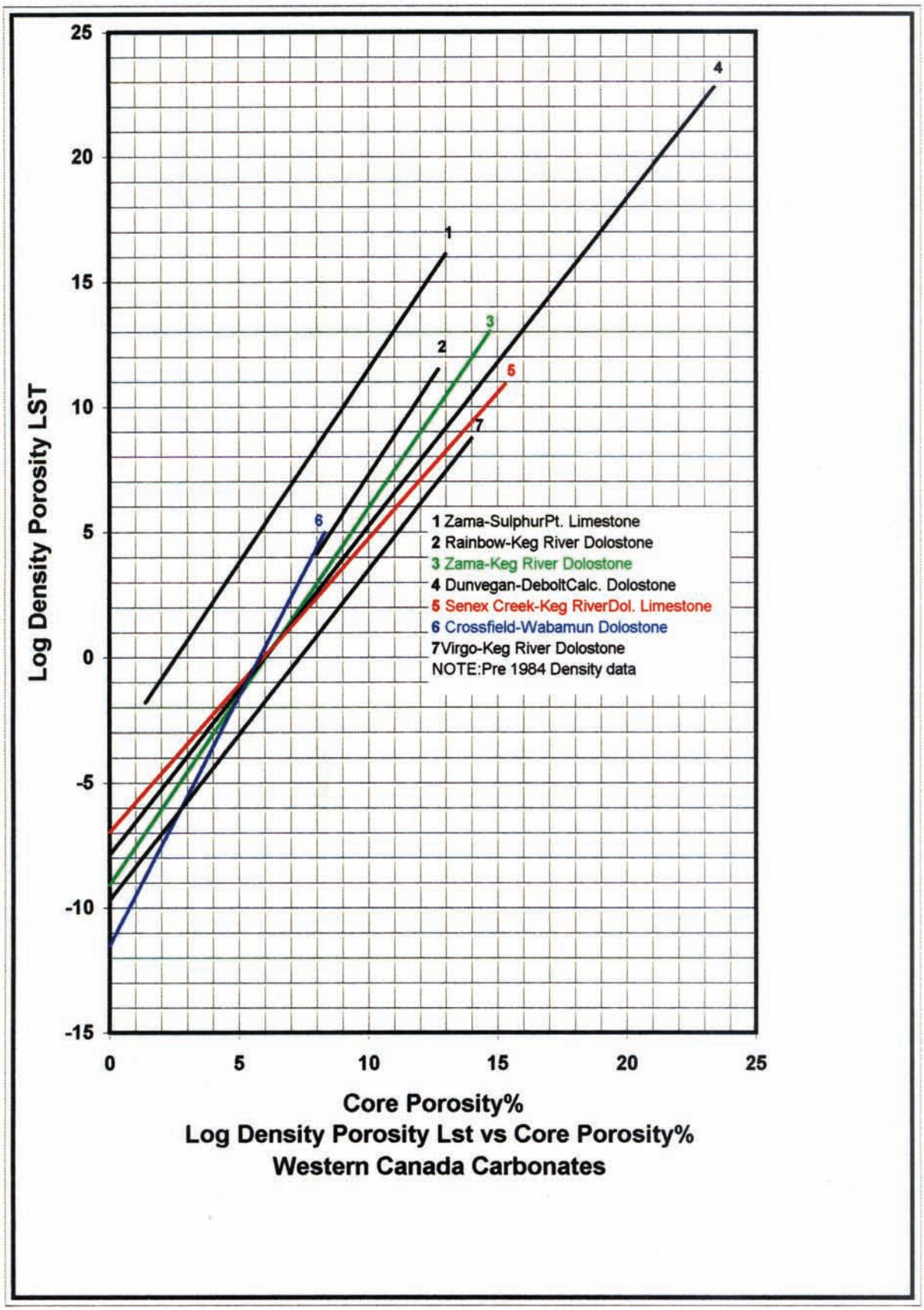

Log Density Porosity LST
25
20
15
10
5
0
-5
-10
-15
0
5
10
15
20
25
Core Porosity%
1 Zama-SulphurPt. Limestone
2 Rainbow-Keg River Dolostone
3 Zama-Keg River Dolostone
4 Dunvegan-DeboltCalc. Dolostone
5 Senex Creek-Keg RiverDol. Limestone
6 Crossfield-Wabamun Dolostone
7Virgo-Keg River Dolostone
NOTE:Pre 1984 Density data
Log Density Porosity Lst vs Core Porosity%
Western Canada Carbonates

Chart 34

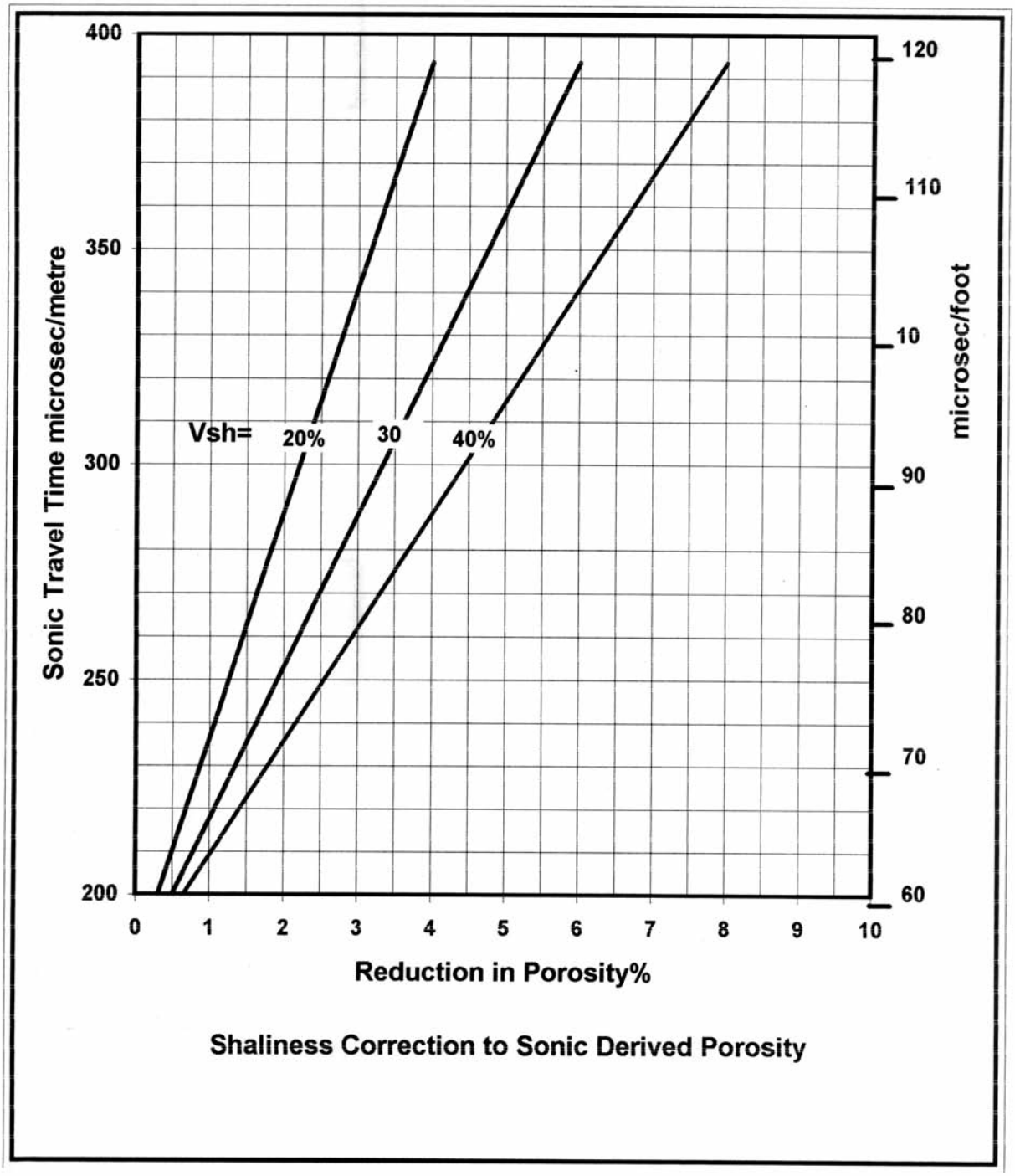

400
350
300
250
200
120
110
10
90
80
70
60
Sonic Travel Time microsec/metre
microsec/foot
Vsh=
20%
30
40%
0
1
2
3
4
5
6
7
8
9
10
Reduction in Porosity%
Shaliness Correction to Sonic Derived Porosity

Chart 35

Listing of Reservoir Log Studies on CD

FIELD	FORMATION	PROV.
Bantry	Sunburst Sandstone	AB
Battrum	Battrum and Roseray Sandstones	SK
Bellshell lake	Basal Quartz Sandstone	AB
Bigstone Waskahigan	Dunvegan Sandstone	AB
Boundary Lake	Charlie Lake Dolomite	BC
Buick Creek-Rigel	Cadomin Sandstone	BC
Chauvin South	Sparky, Lloyd Sandstones	AB
Clarke Lake-Kotcho	Slave Point Dolostone Reef	AB
Clive	Nisku Dolostone	AB
Countess	Glauconite Sandstone	AB
Crossfield	Wabamun Dolostone	AB
Dunvegan	Debolt Dolostone	AB
Elmworth	Fahler Sandstone	AB
Edson	Elkton Dolostone	AB
Empress-Bassano	Basal Colorado Sandstone	AB
Empress-Bassano	Viking Sandstone	AB
Ferrier	Cardium Sandstone	AB
Giroux Lake	Viking Sandstone	AB
Gold Creek	Wabamun Dolostone	AB
Gull Lake	U. Shaunovan Sandstone/Limestone	SK
Golden-Evi	Slave Point Dolostone	AB
Hamilton Lake	Viking Sandstone	AB
Harmattan	Elkton Dolostone	AB
Hummingbird	Nisku Dolostone	SK
Hoosier	Bakken Sandstone	SK
Innes	Frobisher Limestone	SK
Jenner	Glauconite Sandstone	AB
Judy Creek	Swan Hills Limestone Reef	AB
Kaybob	Gething Sandstone	AB
Kaybob South	Swan Hills Dolostone Reef	AB
Kaybob South	Montney Dolomitized Coquina	AB
Keg River	Bluesky Sandstone	AB
Keystone-Pembina	Belly River Sandstone	AB

FIELD	FORMATION	PROV.
Lac La Biche	Manville Sandstone	AB
Lloydminster-Wainwright	Sparky-Lloyd Sandstones	AB
Martin Hills	Wabasca Sandstone	AB
Meekwap	Nisku Dolostone	AB
Midale	Bakken Sandstone/Siltstone	SK
Mitsue	Gilwood Sandstone	AB
Morinville	Leduc Dolostone Reef	AB
Nancy-Peejay	Halfway Sandstone	BC
Niton	Basal Quartz Sandstone	AB
Northeast Alberta	Wabamun Limestone Subcrop	AB
Northeast BC	Baldonnel Dolostone	BC
Northeast BC	Charlie Lake Sandstone	BC
Paddle River-Whitecourt	Nordegg Sandstone	AB
Paddle River	Pekisko Liomestone	AB
Parkman	Tilston Limestone MC-1	SK
Peace River Arch	Paddy Sandstone	AB
Peace River Arch	Cadotte Sandstone	AB
Peace River Arch	Bluesky Sandstone	AB
Peace River Arch	Gething Sandstone	AB
Peace River Arch	Cadomin Sandstone	AB
Rainbow B Pool	Keg River Dolostone Reef	AB
Red Earth-Utikuma	Granite Wash Sandstone	AB
Ricinus-Strachan	Leduc Dolostone Reef	AB
Ricinus	Cardium Sandstone	AB
Riviere	Wabamun	AB
Senex Creek	Keg River Dolostone Reef	AB
Snipe Lake	Swan Hills Limestone Reef	AB
Stoddart	Belloy Sandstone	BC
Sturgeon Lake South	Montney Dolomitic Sandstone	AB
Taber	Sunburst Sandstone	AB
Twining	Pekisko Limestone	AB
Virgo	Keg River Dolostone Reef	AB
West Eagle	Belloy Sandstone	BC
Workman	Frobisher Alida Limestone MC-3	SK
Workman	Frobisher Limestone MC-5	SK
Workman	Midale Limestone MC-7	SK

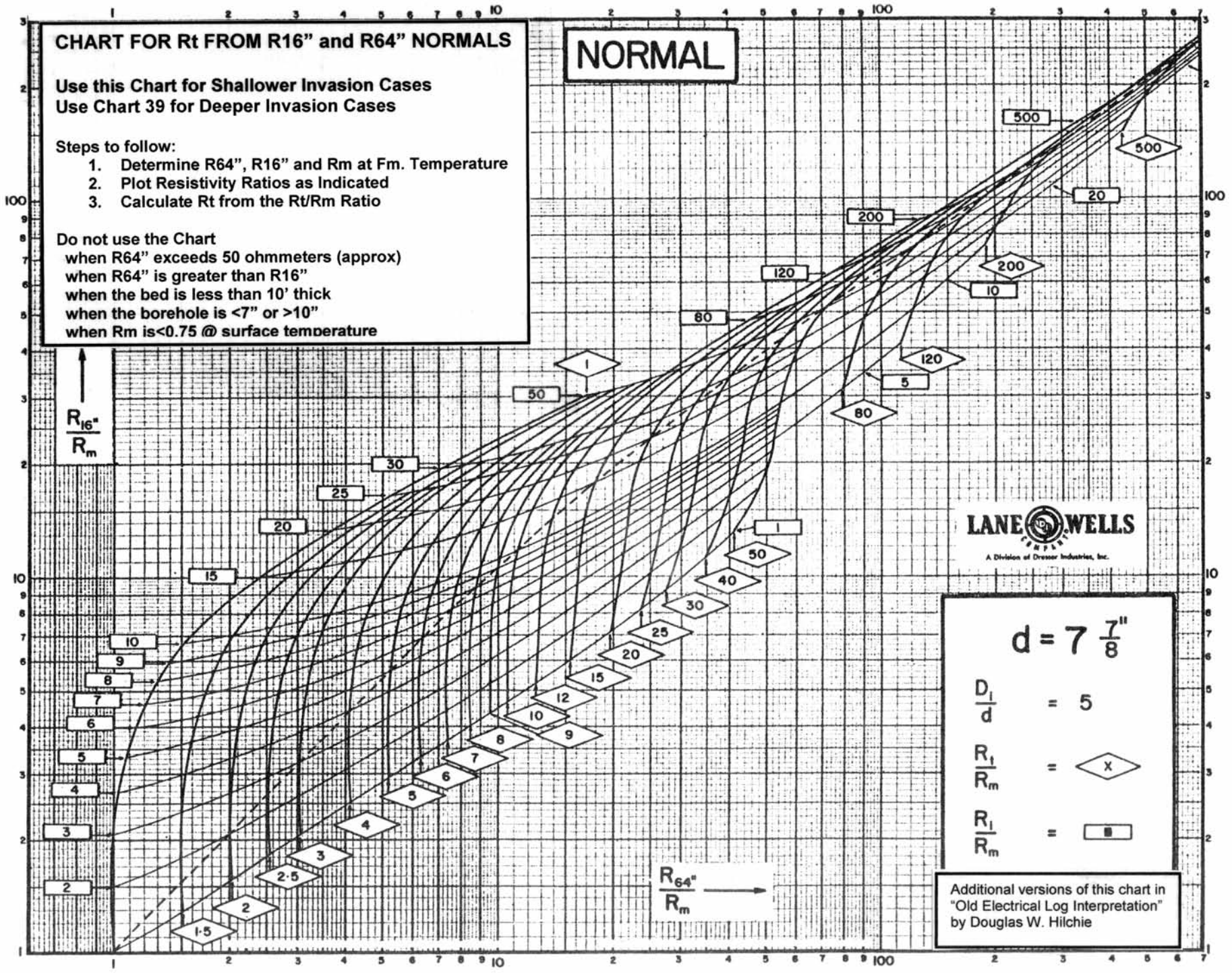


CHART FOR Rt FROM R16" and R64" NORMALS
Use this Chart for Shallower Invasion Cases
Use Chart 39 for Deeper Invasion Cases
Steps to follow:
1. Determine R64", R16" and Rm at Fm. Temperature
2. Plot Resistivity Ratios as Indicated
3. Calculate Rt from the Rt/Rm Ratio
Do not use the Chart
when R64" exceeds 50 ohmmeters (approx)
when R64" is greater than R16"
when the bed is less than 10' thick
when the borehole is <7" or >10"
when Rm is<0.75 @ surface temperature
NORMAL
R16"/Rm
R64"/Rm
LANE WELLS
A Division of Dresser Industries, Inc.
d = 7 7/8"
Di/d = 5
Rt/Rm = X
Ri/Rm = ■
Additional versions of this chart in "Old Electrical Log Interpretation" by Douglas W. Hilchie

Chart 38

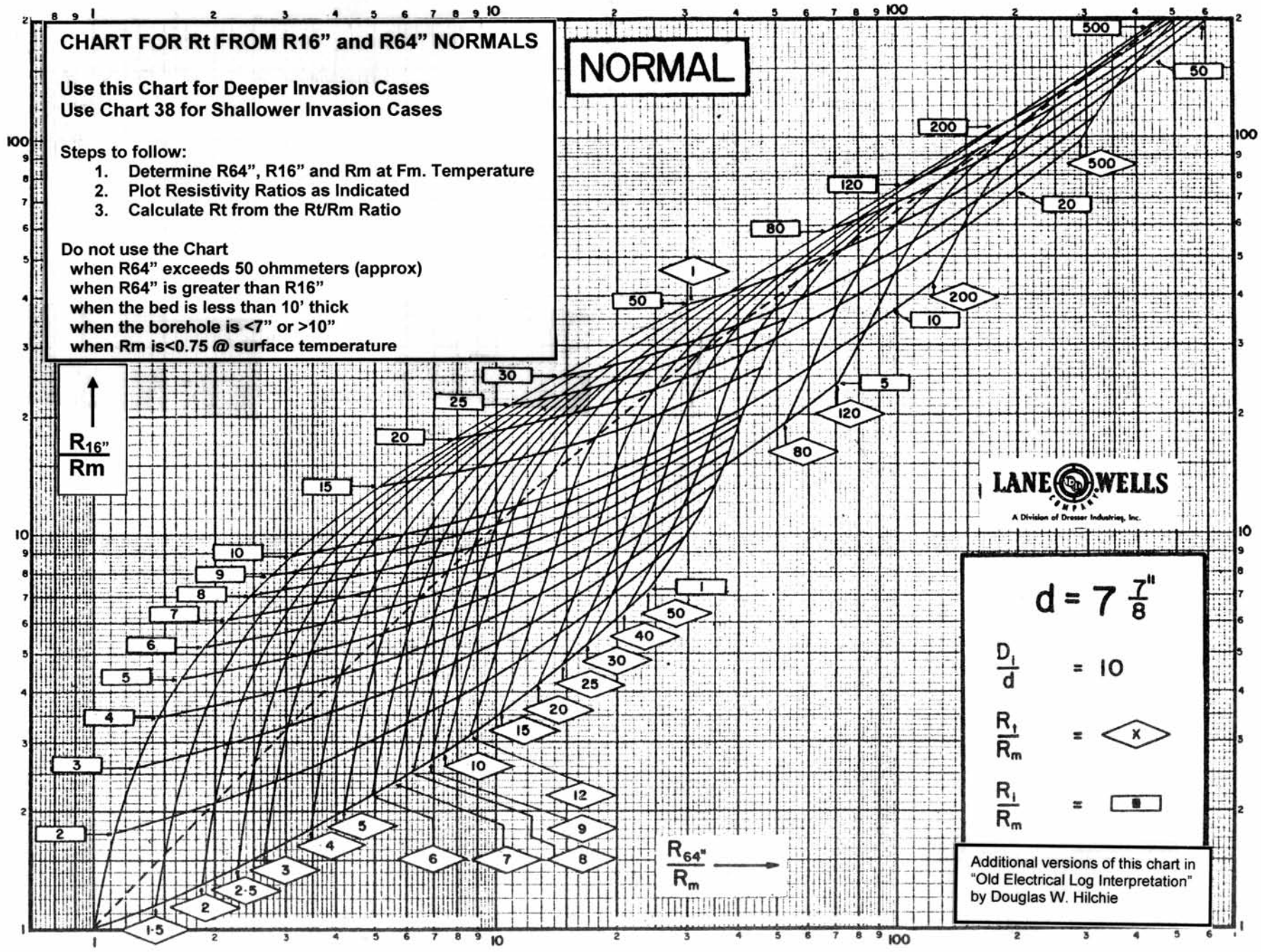


CHART FOR Rt FROM R16" and R64" NORMALS
Use this Chart for Deeper Invasion Cases
Use Chart 38 for Shallower Invasion Cases
Steps to follow:
1. Determine R64", R16" and Rm at Fm. Temperature
2. Plot Resistivity Ratios as Indicated
3. Calculate Rt from the Rt/Rm Ratio
Do not use the Chart
when R64" exceeds 50 ohmmeters (approx)
when R64" is greater than R16"
when the bed is less than 10' thick
when the borehole is <7" or >10"
when Rm is<0.75 @ surface temperature
NORMAL
R16"/Rm
R64"/Rm
LANE WELLS
A Division of Dresser Industries, Inc.
d = 7 7/8"
Di/d = 10
Rt/Rm = X
Ri/Rm = ■
Additional versions of this chart in "Old Electrical Log Interpretation" by Douglas W. Hilchie

Chart 39

Guidelines for using Density – Neutron Logs to Determine Porosity and Lithology

Three options exist for Density – Neutron porosity sensitivity, Limestone, Sandstone and less commonly, Dolostone. Curve separation will indicate the three specific lithologies depending on the amount and direction of curve separation. Note that it is possible to have false gas effect or, with a widened D-N separation with N on the left, to have gas effect masked. Pe values of 2 in sandstone, 3 in dolostone and 5 in limestone will provide an excellent guide to lithology.

For all Neutron Logs except Schlumberger's NPOR (post 1986)

*For logs run on SANDSTONE MATRIX

- In Sandstones N-D curves overlay Pe=2
- In Limestones N-D curves separate Pe=5
  4%Ø ← N D → 3.6%Ø
  or 2.5 Chart Divisions
- In Dolostones N-D curves separate Pe=3
  10% Ø ←——— N D ———→ 12%Ø
  or 71/3 Chart Div. **gas can be masked**
- In Anhydrite DØss goes to –20%Ø
  and NØss goes to 3%Ø Pe=5.1

*For logs run on DOLOSTONE MATRIX

- In Sandstones N-D **curves cross over** Pe=2
  12% Ø ←——— D N ———→ 10% Ø
  or 7 1/3 Chart Divisions
- In Limestones N-D **curves cross over** Pe=5
  7.5% Ø ←——— D N ———→ 6% Ø
  or 4 1/3 chart divisions
- In Dolostones curves overlay Pe=3
- In Anhydrite DØDol goes to –7%Ø
  and NØDol goes to 5.5%Ø

*For logs run on LIMESTONE MATRIX

- In Dolostones curves separate Pe=3
  6% Ø ←——— N D ———→ 7.5% Ø
  or 4 1/3 Chart Divisions **gas can be masked**
- In Limestones curves overlay Pe=5
- In Sandstones N-D **curves cross over** Pe=2
  3.6% Ø ←——— D N ———→ 4% Ø
  or 2.5 Chart Divisions
- In Anhydrite DØLst goes to –15%Ø
  and NØLst goes to –0.5%Ø Pe=

Note that mid point porosities are approximately correct if no gas is present except below 6%Ø where they will be too low in Dolostones

Use the appropriate service company chart whenever possible.

For Schlumberger Neutron Logs Designated NPOR (post 1986)

*For logs run on SANDSTONE MATRIX

- In Sandstones N-D curves overlay Pe=2
- In Limestones N-D curves separate Pe=5
  5%Ø ← N D → 3.6%Ø
  or 2.5 Chart Divisions
- In Dolostones N-D curves separate Pe=3
  6-10% Ø ←——— N D ———→ 12%Ø
  or 6-71/3 Chart Div. **gas can be masked**
  In Anhydrite DØss goes to –20%Ø
  and NØss goes to 3%Ø Pe=5.1

*For logs run on DOLOSTONE MATRIX

- In Sandstones N-D **curves cross over** Pe=2
  12% Ø ←——— D N ———→ 5-9% Ø
  or 5 2/3-7 Chart Divisions
- In Limestones N-D **curves cross over** Pe=5
  7.5% Ø ←——— D N ———→ 1-5% Ø
  or 3-4 chart divisions
- In Dolostones curves overlay Pe=3
- In Anhydrite DØDol goes to –7%Ø
  and NØDol goes to 5.5%Ø

*For logs run on LIMESTONE MATRIX

- In Dolostones curves separate Pe=3
  1-5% Ø ←——— N D ———→ 7.5% Ø
- or 3-4 Chart Divisions **gas can be masked**
- In Limestones curves overlay Pe=5
  In Sandstones N-D curves cross over Pe=2
  3.6% Ø ←——— D N ———→ 4% Ø
  or 2.5 Chart Divisions
- In Anhydrite DØLst goes to –15%Ø
  and NØLst goes to –0.5%Ø Pe=5.1

Note that mid point porosities are always too low by approx 2% Ø if no gas is present and cannot be used below 6% Ø.

Use the appropriate service company chart whenever possible.