

SIMPLE

Exercise simple: How to square log readings and determination of net thickness.

Objectives:

- Getting acquainted with the relations between FDC-CNL logs, porosity and shaliness of sandstone and shales.
- In this case porosity determination is an important objective. A comparable evaluation can be made for:
 - . water-influx tests from roof rock of coal seams and ore bodies.
 - . determination of the vertical lithology in fresh water reservoirs.

Well SIMPLE-6

Reservoir characteristics:

- The formation is an unconsolidated sandstone.
- Matrix densities measured on the core: approximately 2.65 g/cc.
- Formation temperature: 58°C.
- Qv-values measured on the core are approx. 0.04 meq/ml PV.
- Formation water salinity = 85000 ppm NaCl.
- $m = 1.6$

Mud characteristics

- $R_{mf} = 0.055 \text{ Ohm.m}$ at 58°C , thus 73000 ppm
- The RLLd does not have to be corrected for borehole and invasion effects.

SIMPLE Questions:

- Finish table 1 down to 1265 m (square Density and Neutron only).
- Plot the layers in a Density-Neutron cross plot.
- Determine fluid in the pores (Gas/Oil/Water).
- Calculate for the gas cap:
 - Net sand thickness,
 - Mean porosity,
 - Mean Sh,
 - Sh-column.
- Determine for each layer in interval 1250 -1265, using FDC-CNL plot:
 - Shaliness,
 - Total and effective porosity (using wet shale density = 2.55 gr/cc, shale Neutron por = 36 p.u. (porosity units), dry shale density = 2.65 gr/cc.)

Table 1: Squared and multiplexed log-values

Top Layer	Depth (m)	Density (g/cc)	Neutron (p.u.)	Rlld (ohm.m)	θ total (%)	Sw	Fluid type
1*	1240.2		27	6			
2	1240.9		24	6			
3	1241.4		24	6			
4	1242		7	90			
5	1242.5		7	140			
6	1243.3		6	55			
7	1244		8	200			
8	1244.4		6	60			
9	1245.1		29	60			
10	1245.9 1247.5		29	270			

* Layer 1 refers to the interval from 1240.2 - 1240.9 m. The depth in this column indicates the top of the layer.

Table 2: Gas net count results

Interval	thickness "h"	ρ	$h * \rho$	Shc	$h * \rho * Shc$
(m)	(m)		(m)		(m)

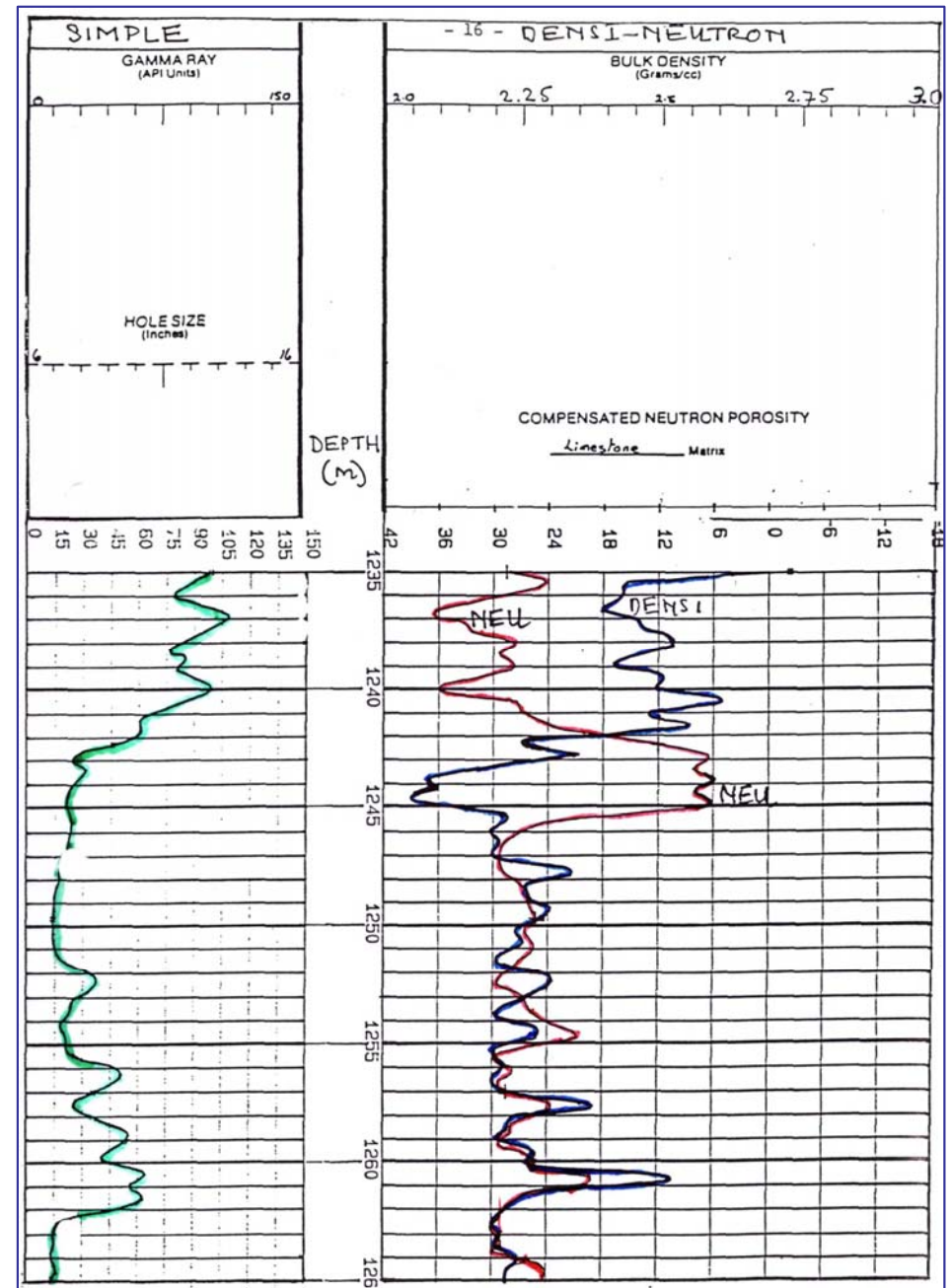
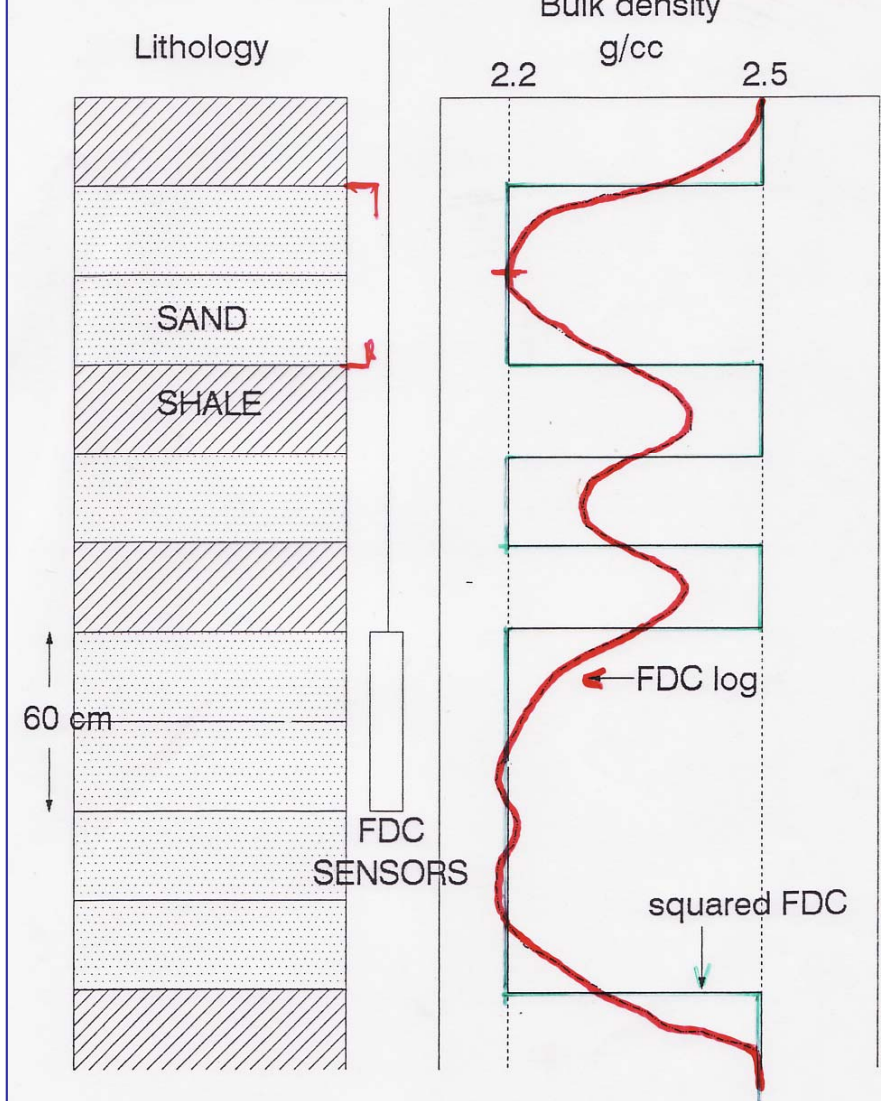
Mean porosity :
Porosity column :
Mean Shc :
h.c. column :

Table 3: FDC-CNL porosity and Vsh

Layer	Depth	Density	Neutron	Vsh	ϕ total	ϕ eff
	(m)	(g/cc)	(p.u.)			
11	1247.5					
12						
13						
14						
15						
16						
17						
18						
19						
20						

EFFECT OF SQUARING is a function of:

- * thickness of the layer
- * vertical resolution of the tool
- * physical response formation $\pm 0.02 \text{ g/cc}$
Bulk density



FDC-CNL Cross Plot

POROSITY AND LITHOLOGY DETERMINATION FROM
FORMATION DENSITY LOG AND
COMPENSATED NEUTRON LOG (CNL*)
SALT WATER, LIQUID-FILLED HOLES

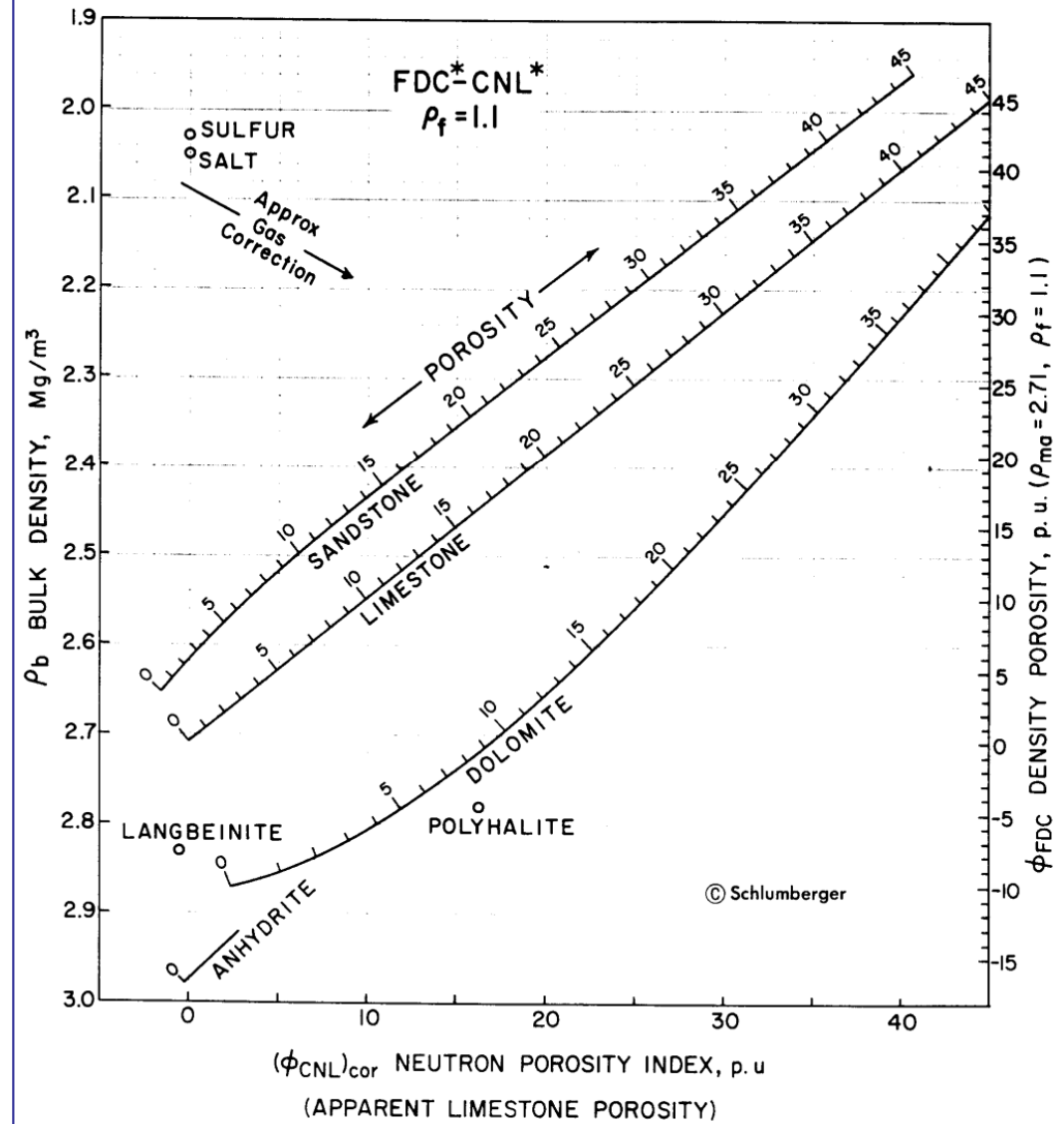


Figure 2: FDC-CNL plot, limestone compensated

ANSWERS

Squaring logging curves

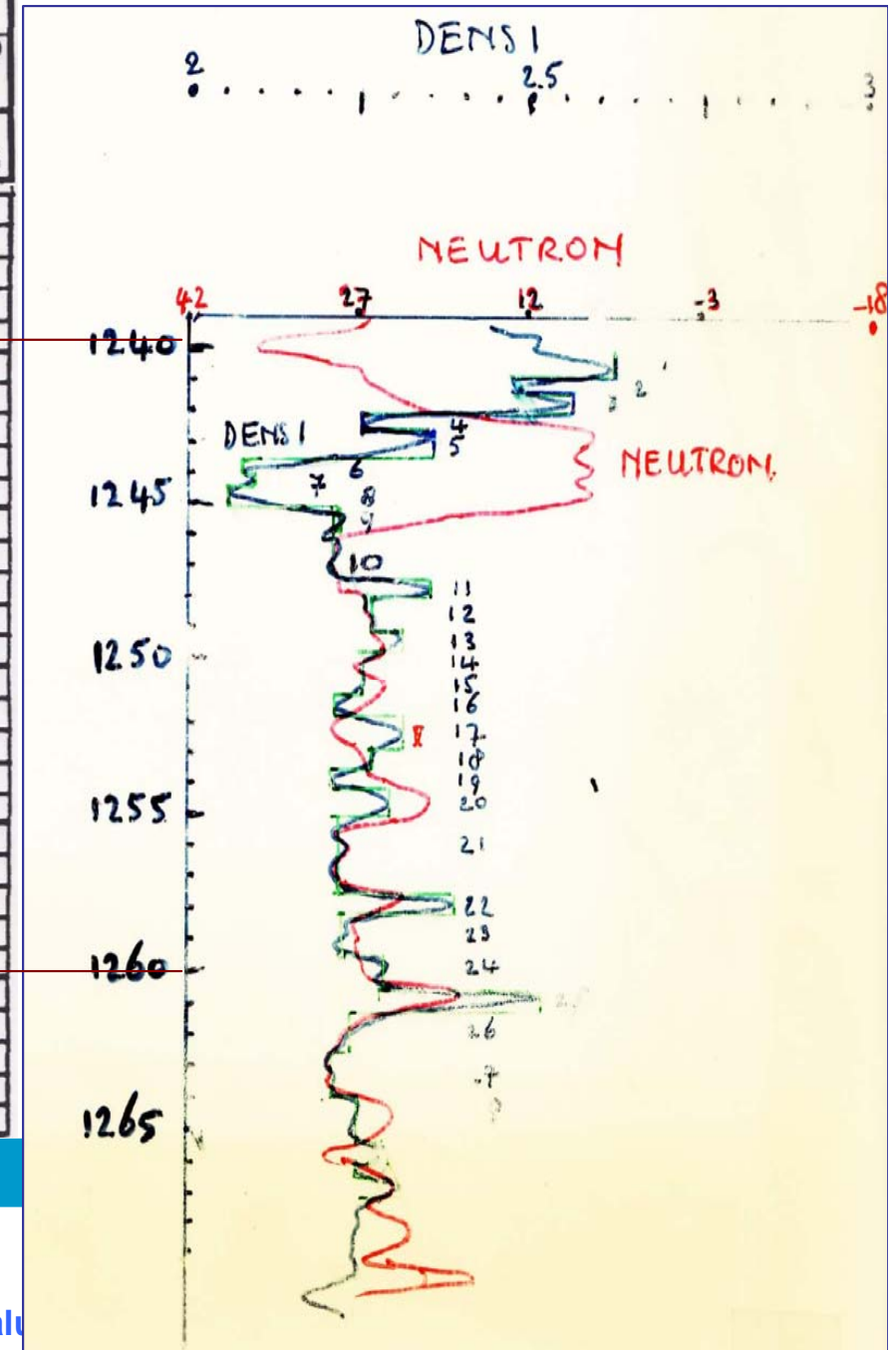
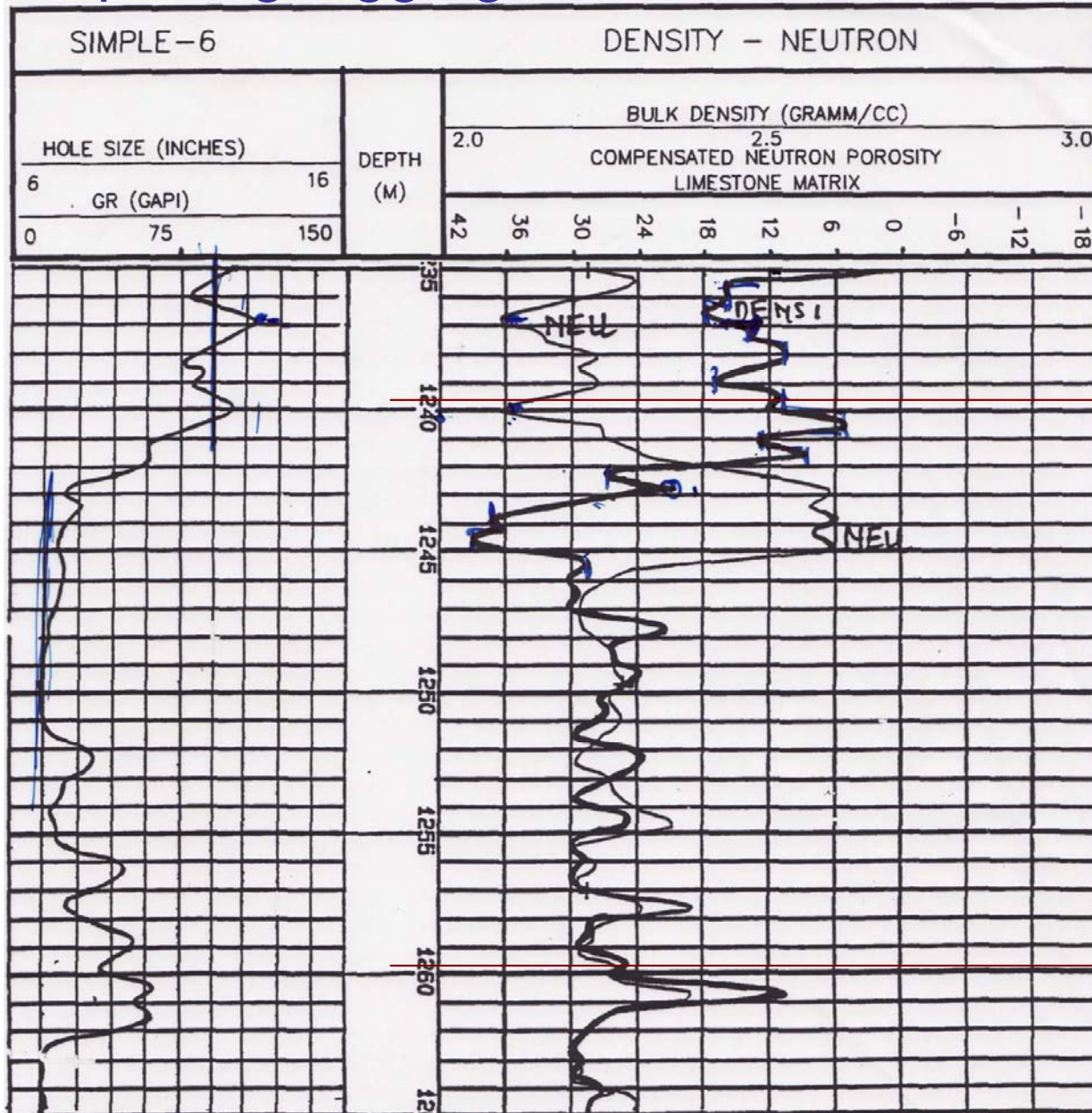


Table 1

Well Simple-6

Squared and multiplexed log values

Layer	Depth (m)	Densi g/cc	Neutron p.u.	Rl1d Ohmm	Sonic msec/ft	POrt	Sw	
1	1240.2	2.62	27	6	87	.02	2.05	shale
2	1240.9	2.48	24	6	87	.106	.54	shale
3	1241.4	2.56	24	6	87	.058	.87	shale
4	1242	2.25	7	90	92	.191	.087	gas
5	1242.5	2.36	7	140	58	.15	.084	gas
6	1243.3	2.08	6	55	101	.248	.09	gas
7	1244	2.1	8	200	101	.25	.047	gas
8	1244.4	2.05	6	60	101	.26	.083	gas
9	1245.1	2.23	29	60	94	.255	.084	oil
10	1245.9	2.21	29	270	97	.268	.038	oil

Gasgap: 1242-1245.1 m

POROSITY AND LITHOLOGY DETERMINATION FROM FORMATION DENSITY LOG AND COMPENSATED NEUTRON LOG (CNL*) SALT WATER, LIQUID-FILLED HOLES

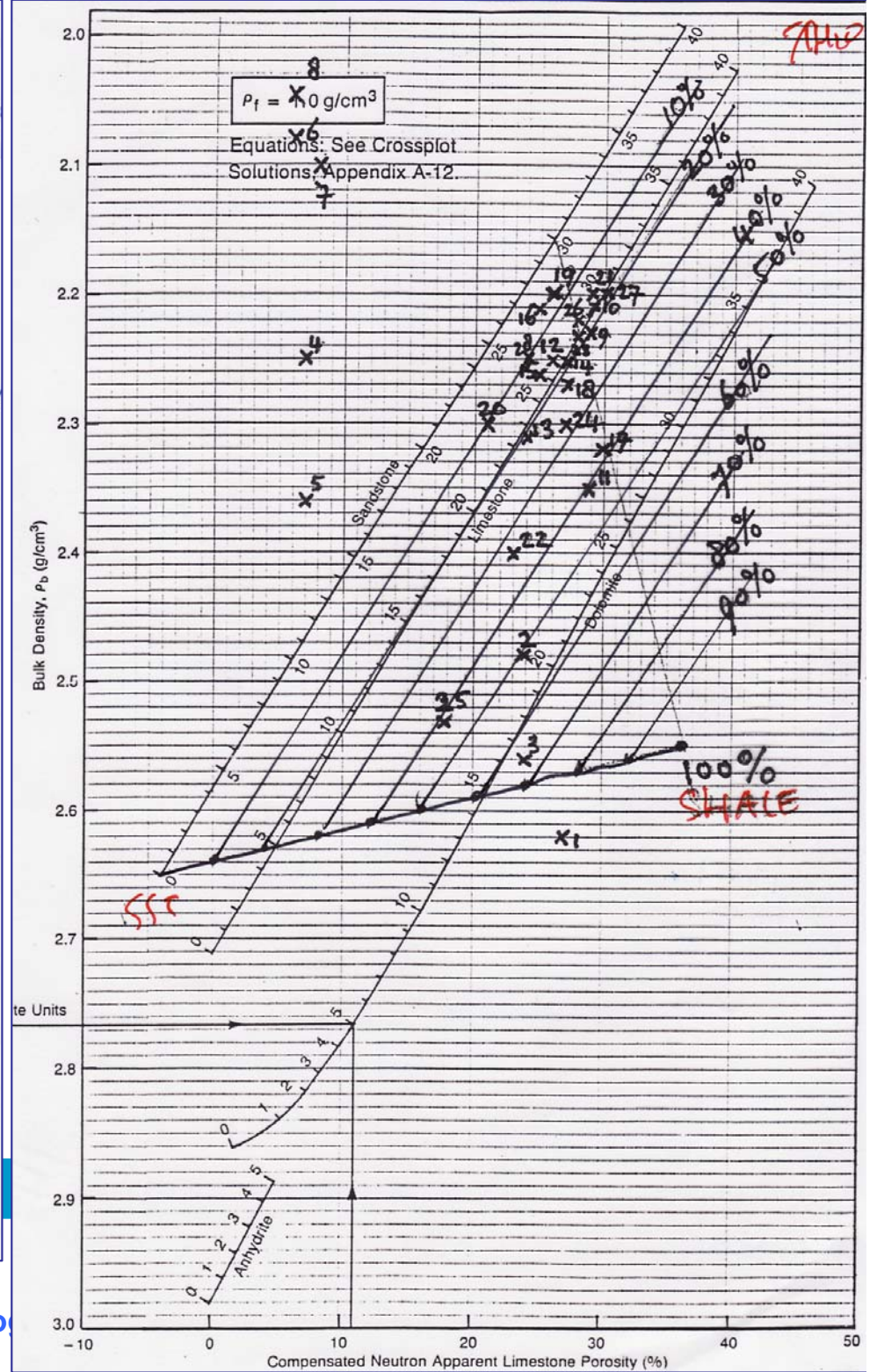
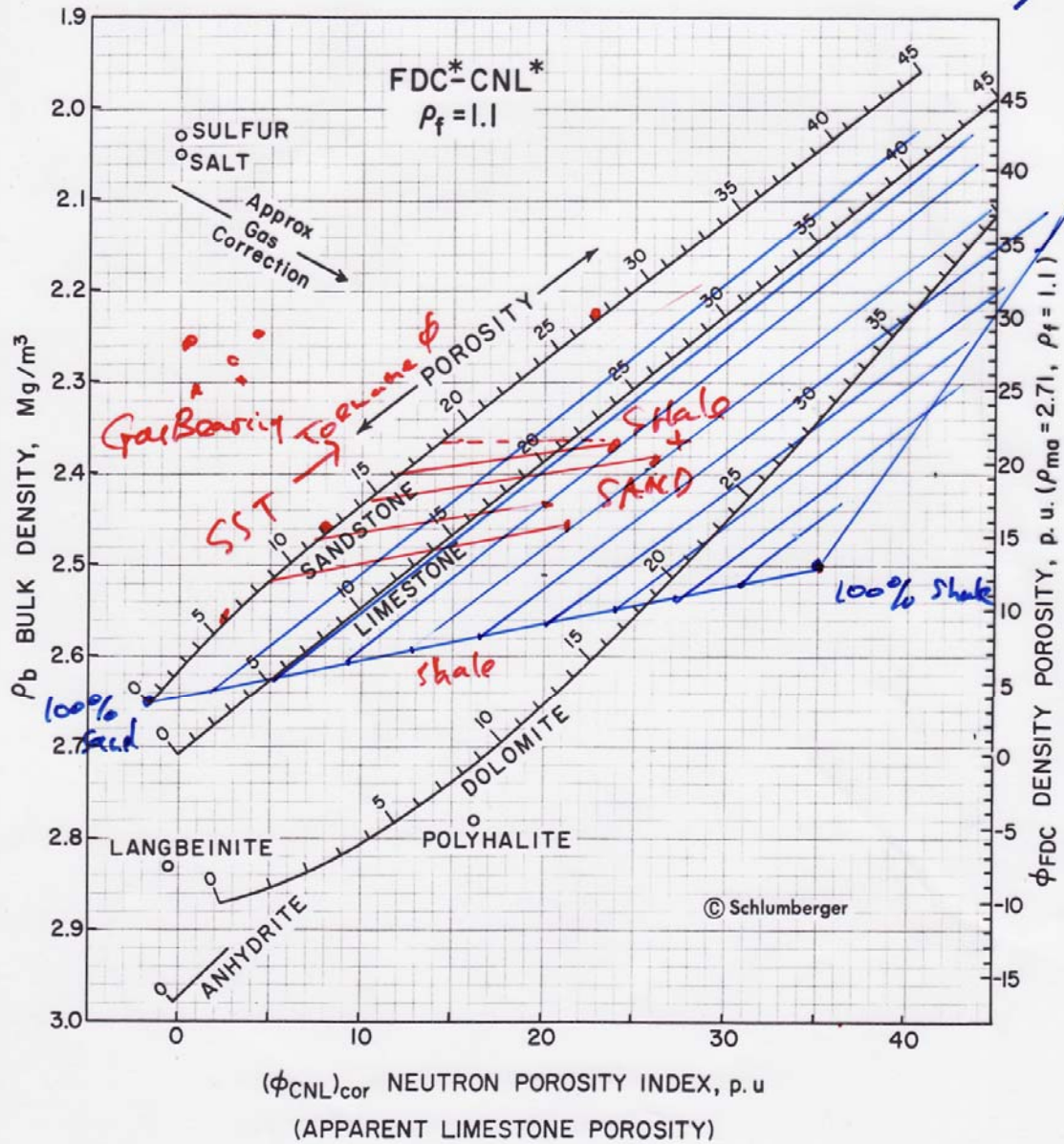


Table 2

Net sand count example

Interval (m)	Thickness h (m)	POR fr.b.v.	POR.h (m)	Shc fr.p.v.	POR.h.Shc (m)
1242-1242.5	0.5	.191	.0955	.913	0.0872
1242.5-1243	0.5	.15	.075	.916	0.0687
1243 -1244	1	.248	.248	.91	0.2257
1244 -1244.4	0.4	.25	.1	.953	0.0953
1244.4-1245.1	0.7	.26	.182	.917	0.1669
	3.1		0.7005		0.6438

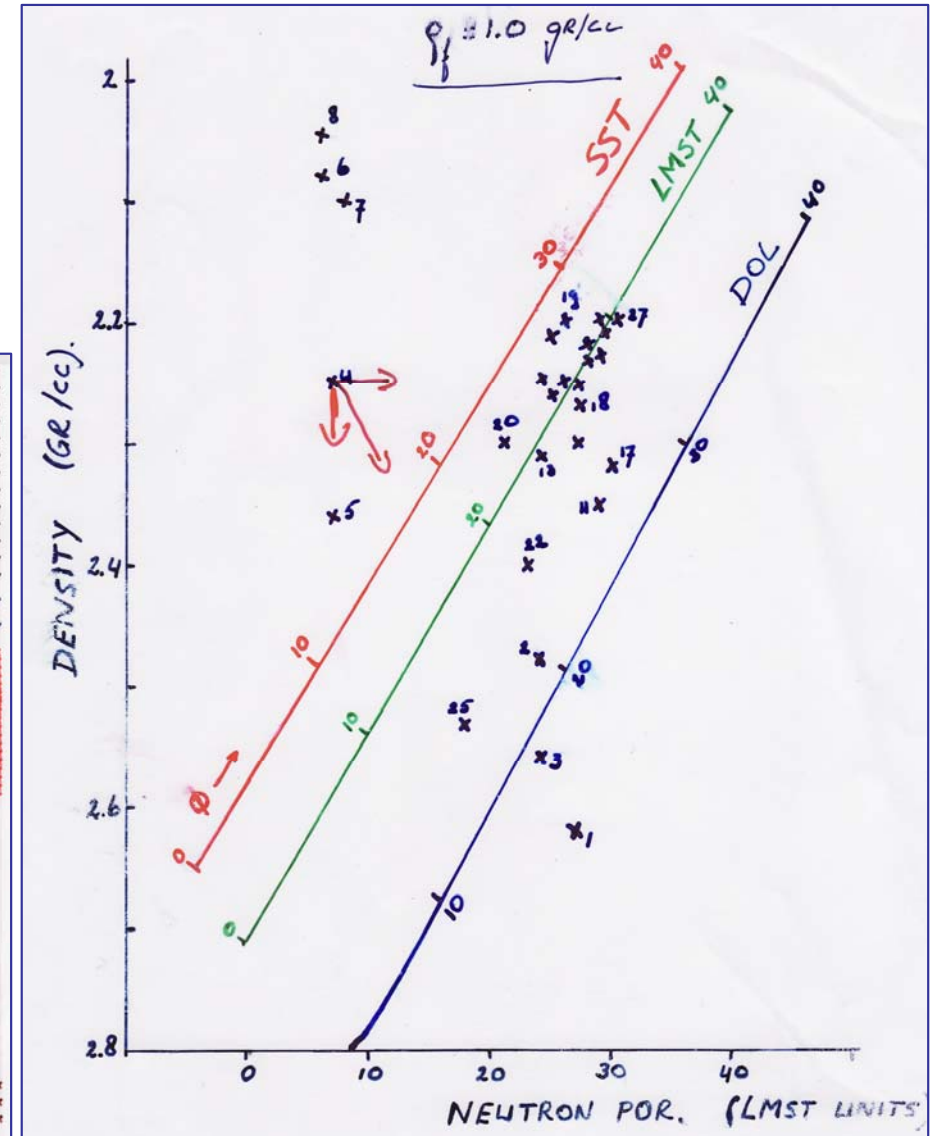
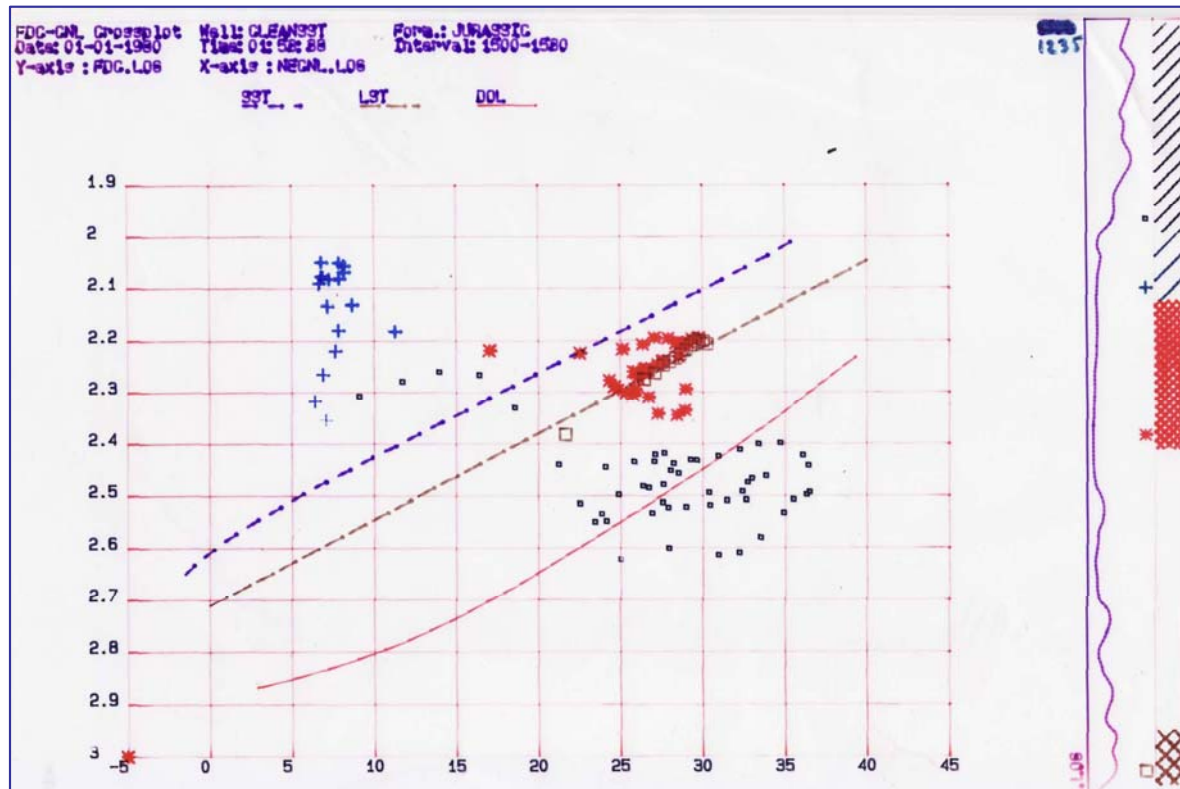
$$\text{Mean POR} = \text{Sum (POR.h)} / h = 0.7005 / 3.1 = 0.226$$

$$\text{Porosity column} = 0.70 \text{ m}$$

$$\text{Mean Shc} = \text{Sum (POR.h.Shc)} / \text{Sum (POR.h)} = 0.6438 / 0.7005 = 0.92$$

$$\text{H.C. column} = 0.64 \text{ m}$$

Simple: Example by computer (below) and by hand (right)



Shale volume, effective and total porosity from Densi-Neutron crossplot

Layer	Depth (m)	Densi g/cc	Neutron p.u.	Vsh fr.b.v.	PORtot fr.p.v.	POReff fr.p.v.
11	1247.5	2.35	29	.41	.18	.153
12	1248	2.26	26	.17	.243	.232
13	1249	2.31	24	.22	.205	.19
14	1250	2.25	27	.20	.243	.229
15	1250.5	2.26	25	.16	.238	.225
16	1251.5	2.21	25	.07	.269	.263
17	1252	2.32	30	.39	.20	.173
18	1252.8	2.27	27	.23	.23	.216
19	1253.5	2.2	26	.08	.275	.27
20	1254.2	2.3	21	.10	.21	.204
21	1255	2.2	29	.16	.275	.262
22	1257.5	2.4	23	.33	.151	.13
23	1258	2.23	28	.20	.257	.242
24	1259.5	2.3	27	.28	.21	.192
25	1260.5	2.53	18	.42	.073	.048
26	1261	2.22	28	.17	.262	.25
27	1262.5	2.2	30	.2	.275	.261
28	1264	2.25	24	.11	.243	.248

