DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2004/119

Special core analysis for DONG E&P A/S
Well: Sofie-1

Overburden and electrical properties

Niels Springer

GEOLOGICAL SURVEY OF DENMARK AND GREENLAND
MINISTRY OF THE ENVIRONMENT

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Released 17.11.2008

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Enclosure: **- Data on CD-ROM**

Req. no.: 09251-514
File: Sofie_SCALrep.doc
Sofie-1_images.doc
Sofie-1_NOB.xls
Sofie-1_Co-Cw.xls
Sofie-1_RI.xls
Sofie-1_CEC.xls

1. Introduction

By request of DONG E&P A/S, GEUS Core Laboratory has performed special core analysis on the Sofie-1 well, Danish North Sea.

The experimental programme was specified in an e-mail attachment from Mr. Christian Høier, dated December 8, 2003 and a contract ref. R-055/04 was finally signed on January 26, 2004. The following analytical programme has been carried out:

- Screening of plugs for SCAL
- Porosity, permeability and formation resistivity factor at overburden conditions
- Resistivity index at overburden conditions
- Core conductivity at reservoir conditions
- Cation exchange capacity (CEC)
- Grain size distribution

Preliminary SCAL data have been reported in writing and at meetings during the period March to December 2004.

2 Sampling and analytical procedures

In collaboration with DONG E&P A/S and based on the conventional core analysis data [1] in total 31 plugs, covering both the upper and lower reservoir section in the Sofie-1 well, were selected for the special core analysis (SCAL) study, ref. table 2.1. Cleaned plugs as well as preserved plugs were included in the study. It was observed that the preserved plugs were kept in simulated formation water in glass bottles without any fixation. This sometimes caused peculiar plug shapes due to wear of the soft sandstone during handling and shipping of the storage boxes.

2.1 Plug quality screening

27 plugs were X-ray CT-screened at the scanning facility at Department of Chemical Engineering, the Technical University of Denmark. Two longitudinal cuts perpendicular to each other is recorded for each plug. Scanning images are attached chapter 7.

2.2 Overburden measurements

6 plug samples were measured, 4 existing CCAL plugs and 2 preserved plugs (postfix "P"). The "P" plugs were not analyzed for He-porosity and gas permeability before test, but were cold flush cleaned in a core holder and saturated with simulated formation brine directly while placed in the core holder. The former CCAL plugs were vacuum and pressure saturated with simulated formation brine (table 2.2), and all 6 plugs were then mounted in single electrical core holders at 10 bar hydrostatic confining pressure. The samples were flushed with 10 PV's of fresh brine and left to settle for 4-9 days before measurement started.

Each sample underwent a full measurement cycle during one working day. The computer controlled pump was set to step from one overburden pressure till the next during 30 minutes. The sample was then left to settle for 15 minutes before the compressibility was read from a graduated tube. The electrical impedance was recorded, and brine flow of 900 ml/h was started. During a period of 20 min the liquid permeability was recorded. The pump was then set to step till the next overburden pressure etc.

The client requested the overburden study be conducted at the following 5 hydrostatic confining stresses: 27, 80, 113, 140 and 177 bar. Overburden data are presented in section 5.2.

2.3 Resistivity index measurements

From inspection of the scanning images 6 very homogeneous plugs were selected for the electrical measurements, table 2.1. One preserved plug was cold flush cleaned as explained above, the remaining 5 cleaned plugs were vacuum and pressure saturated in simulated formation brine (table 2.2), and all plugs were then left to equilibrate in an anaerobic jar for several weeks.

Measurement of the resistivity index was performed in single resistivity cells with a 5 bar (nominel air-water BT specification) porous plate installed in the downstream end of the plug. Silver electrodes short circuited the porous plate to avoid series impedance effects. A hydrostatic confining pressure of 113 bar was applied, and during the following 9 weeks, 6 drainage steps was measured by gas displacement when drainage and resistivity equilibrium was observed at each step.

After completion of the measurements the plug samples were weighed and Dean Starked to obtain a proper determination of the end-point water saturation and check material balance. Finally plugs were remeasured for conventional core analysis data. Data for the resistivity index ‘RI’ and saturation exponent ‘n’ are contained in section 5.3.

2.4 Core conductivity measurements

The client requested that 4 samples be measured at 4 different brine concentrations derived from the Sofie formation brine composition. Brine conductivity was measured at 3 different frequencies 5, 10 and 20 kHz. A minor (but normal) increase in conductivity was observed, but data read at 10 kHz was preferred because of the low phase distortion (< -1 deg). For each brine 3 readings of consecutive conductivity and phase angle was recorded, but only the last 2 readings were used in the following calculations. This is due to a necessary chemical equilibrium time. Each reading was taken after a settling time of 3 hours. Pore volume compressibility was measured during a one hour stepwise pressure ramp from the initial 10 bar to 50, 70, 90 and 113 bar hydrostatic confining pressure; produced liquid downstream was read from a graduated glass tube at time = 20, 15, 15 and 10 minutes after pressure ramp start.

Brine data and C_o/C_w diagrams are contained in section 5.4

2.5 Cation Exchange Capacity measurement

Cation exchange capacity (CEC) was determined by exchange with sodium at pH 8.2, washing out of excess sodium chloride and exchange of sodium by ammonium. Exchanged sodium was determined by ICP-MS analysis.

The CEC measurements was performed on the same set of plugs used in the C_o/C_w study. CECdata are presented in section 5.5.

2.6 Grain size analysis

The analyses are carried out according to Danish Standard DS 405.9 extended by sieves to ½ phi scale. Grain size data are presented in section 5.6

Table 2.1. Sofie-1, list of samples and SCAL measurements carried out in the study.

SCAL plugs for overburden study :	Depth, m	Comment :
62	1875.20	
75	1878.47	
83	1880.47	
87	1881.46	
119P	1889.40	preserved plug
131P	1892.40	preserved plug
SCAL plugs for CoCw + CEC :		
67	1876.45	
88	1881.71	
127P	1891.40	preserved plug
139P	1894.40	preserved plug
SCAL plugs for resistivity study :		
64	1875.69	
76	1878.65	
84	1880.70	
101	1885.10	
131	1892.47	shrink tubing
143P	1895.40	OK, but trim
SCAL plugs for grain size :		
73V	1878.04	
89V	1882.03	
129V	1892.03	
145V	1896.03	
Additional plugs :		
63	1875.46	
63P	1875.40	preserved plug
67P	1876.40	preserved plug
68	1876.70	
71P	1877.40	
72	1877.71	
91	1882.48	pyrite
92	1882.68	-frc
132	1892.72	shrink tubing
147P	1896.40	-frc + pyrite ?
151P	1897.39	pyrite ?

Table 2.2. Sofie simulated formation water analysis supplied by DONG E&P. Measured physical properties appear below.

Core conductivity : Sofie simulated formation brine

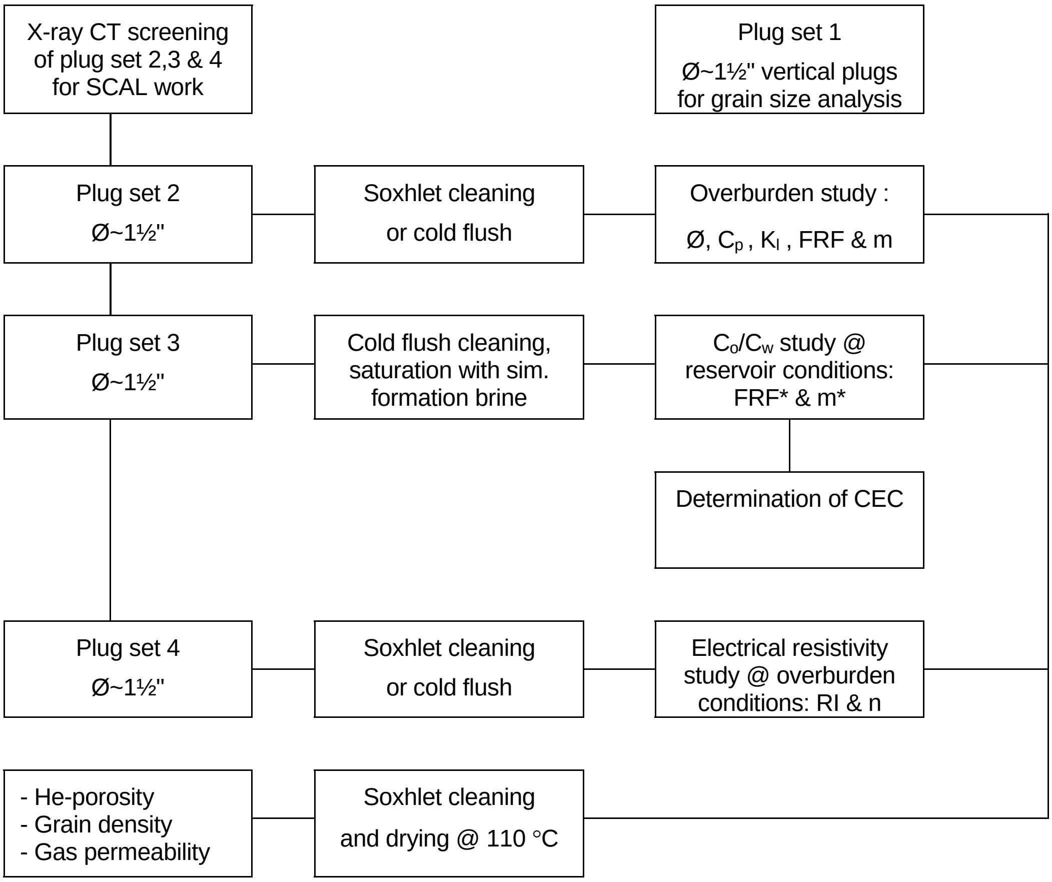
Element	Concentration	Compound	Gram compound per		
	mg/L		1 liter	3 liter	5 liter
Na total	28237.0				
Na^+	28194	NaCl	71.67	215.00	358.34
Na^+	43	$NaHCO_3$	0.16	0.48	0.79
K^+	242.5	KCl	0.46	1.39	2.31
Mg^{2+}	592.5	$MgCl_2, 6H_2O$	4.95	14.86	24.77
Ca^{2+}		$CaCl_2$	0.00	0.00	0.00
Ca^{2+}	4955.0	$CaCl_2, 2H_2O$	18.18	54.53	90.88
Sr^{2+}	637.5	$SrCl_2, 6H_2O$	1.94	5.82	9.70
Ba^{2+}		$BaCl_2, 2H_2O$	0.00	0.00	0.00
Cl^-	54707				
HCO_3^-	115.0				

TDS:	**89487**	**mg/L** ~	1.531	mol/L NaCl eqv.
pH:	**7.3**	@ **23 C**		

Comments: Used for Sofie-1 Co/Cw study

Physical data:			
	Resistivity R_w:	0.082	Ωm @ 25 °C
	Calculated R_w:	0.082	Ωm @ 25 °C
	Density d_w:	1.0595	g/cc @ 25 °C
	Calculated d_w:	1.057	g/cc @ 25 °C
	Viscosity μ_w:	1.165	cP @ 25 °C

3 Flow diagram of the analytical procedures



4 Analytical Methods

Electrical measurements are performed at 25 ± 1 ºC, and to the guidelines established by the Society of Core Analysts [2]. A temperature log may be provided on request.

4.1 Overburden measurements

Liquid permeability: The plug is mounted in a special Hassler core holder and a net confining pressure of 400 psi applied to the sleeve (or as specified by the client). The required fluid and fluid upstream pressure is delivered from a constant flow rate pump, and the back pressure is regulated within the range 30-75 psi to secure that residual gas is in solution. The flow rate is measured both gravimetrically and volumetrically, and the mean value used for calculation of the liquid permeability. Very low flow rates, e.g. when testing cap-rock seal capacity, is measured gravimetrically by continous reading from an electronic balance.

Porosity: The initial porosity is determined at room conditions. Archimedes test is applied to the fully saturated plug sample, and in combination with the sample grain density the porosity is calculated. During testing the sample pore volume decreases as overburden increases. This is observed as an amount of liquid expelled from the sample, constantly monitored using an electronic Mettler balance connected to a PC. The final reading is taken when a stable level has been reached on the balance. The porosity reduction is calculated as the relative decrease in the initial porosity:

$$Ø_i = \frac{V_{pi}}{V_{bi}}$$

$$Ø_{i+\Delta p} = \frac{V_{pi} - \Delta V_p}{V_{bi} - \Delta V_p}$$

The porosity reduction is then given as:

$$\frac{Ø_{i+\Delta p}}{Ø_i} \cdot 100\,\% = \frac{V_{pi} - \Delta V_p}{V_{bi} - \Delta V_p} \cdot \frac{V_{bi}}{V_{pi}} \cdot 100\,\%$$

Where $Ø_i$ = initial porosity
V_{pi} = initial pore volume
V_{bi} = initial bulk volume
$Ø_{i+\Delta P}$ = new porosity induced by a certain change Δp in confining stress.
ΔV_p = change in pore volume due to the change in confining stress.

The initial change in the pore volume that occurs from room conditions to the lowest confining stress applied in the study, is extrapolated from a liquid production curve (produced liquid vs effective confining stress).

In this study the produced liquid was measured at effective confining stresses of 10, 27, 80, 113, 140 and 177 bar. From these measurements the liquid production curve was fitted using a third degree polynomium.

Pore volume compressibility: The pore volume compressibility is calculated from the data recorded during the porosity reduction experiment as follows:

$$C_p = \frac{1}{V_p} \cdot \frac{dV_p}{dp_{eff}}$$

where:

C_p = Pore volume compressibility [vol/vol*bar]
V_p = Sample pore volume at a certain effective confining stress (ECS)
dV_p = Incremental change in pore volume resulting from an incremental change in ECS
dp_{eff} = Incremental change in ECS

The relationship dV_p/dp_{eff} is obtained by numerical (or graphical) differentiation of the liquid production curve.

4.2 Formation resistivity factor

In a "clean" formation (non-shaly) the formation factor F is described by Archie's equation:

$$F = \frac{R_0}{R_w} = \frac{a}{Ø^m}$$

Where

R_0 = resistivity of sample @ S_w = 100%
R_w = resistivity of formation brine
Ø = porosity
a = constant
m = cementation exponent

For a plug sample F is calculated from the following formula:

$$F = \frac{1}{R_w} \cdot \frac{z \cdot A}{L}$$

Where

R_w = resistivity of brine in ohm-m
z = impedance of plug sample in ohm @ S_w = 100%
A = area of the plug in m^2
L = length of plug in m

Rearranging Archie's equation for the formation factor:

log F = -m log Ø + log a

produces a straight-line relationship in a double logarithmic diagram where F is plotted as a function of Ø. The constant 'a' is then determined as the intercept and the cementation exponent 'm' as the slope of the best fit straight line. Values for 'm' are usually preferred for a = 1, which is expected from theoretical grounds. Therefore a set of regression constants are given for a regression line which has been biased through (1,1).

The measurement of F is performed with the plug mounted in a 2-electrode resistivity core holder at an overburden pressure >300 psi. The plug is allowed to settle for more that 3 hours. The porosity reduction/pore volume compressibility is recorded consecutively. The plug resistance is measured as the impedance to an AC signal of 5-20 kHz frequency depending on rock properties (minimum phase angle). Data logging is performed using the HP 4276A LCZ-meter controlled by a PC. The resistivity of the brine is measured in a specially designed standard cell. The standard cell is calibrated using a suitable conductivity standard solution delivered by a recognised chemical company. The measured formation brine resistivity is checked against a model calculated resistivity.

4.3 Resistivity index

In a “clean” formation (non-shaly) Archie determined experimentally that the water saturation could be expressed by the following equation:

$$S_w{}^n = \frac{FR_w}{R_t} = \frac{R_o}{R_t} = \frac{1}{RI}, \qquad RI = \frac{R_t}{R_o}$$

where
S_w = water saturation
n = saturation exponent
F = formation resistivity factor
RI = resistivity index
R_0 = resistivity of sample @ S_w = 100% in ohm-m
R_t = resistivity of sample @ S_w < 100% in ohm-m
R_w = resistivity of brine in ohm-m

Rearranging Archie’s equation for the water saturation :

$$RI = S_w{}^{-n}$$

and

$$\log(RI) = -n \ \log(S_w)$$

In a double logarithmic diagram consecutive values of S_w and RI should produce a straight line from which the saturation exponent 'n' can be determined as the slope.

The measurement of RI involves desaturation in a porous plate cell, therefore the measurement of RI is conveniently combined with air/brine or oil/brine capillary pressure experiments The measurement of RI is performed with the plug mounted in a resistivity core holder at an overburden pressure >300 psi. The plug is allowed to settle for more that 3 hours. The porosity reduction/pore volume compressibility can not normally be measured but is estimated from other sources, preferebly an overburden experiment. The two-electrode method is normally applied and the resistance measured as the impedance to an AC signal of 5-20 kHz frequency depending of the resistivity cell design and the type of rock (minimum phase angle). Data logging is performed using the HP 4276A LCZ-meter controlled by a PC.

When the desaturation (capillary pressure measurement) is conducted in single sample cells, the advantage is that the experiment does not need to be interrupted to determine the water saturation, which is necessary in the traditional multi sample pressure pot experiment. The disadvantage is that the water saturation is not precisely determined due to a difficult correction for dead volumes and surplus water that has to be drained from the cell before the sample starts draining. The effect of the porous plate, which can be significant, must be corrected for. This problem has been solved by a special electrode arrangement that electrically bypasses the porous plate. After completion of the RI measurement the porous plate is removed and the end point resistance checked to make sure that the porous plate measurement is not biased.

4.4 Core conductivity

Excess conductivity due to Cation Exchange Capacity (CEC) effects from conductive clay minerals can be corrected for by measuring the conductivity of shaly sand samples to a range of different brine salinities as described by Waxman & Smits[3] or the two-salinity method described by

Worthington[4]. The corrected Archie formation resistivity factor F* and the BQ_v factor in the Waxman-Smits equation is calculated from linear regression:

$$C_o = \frac{1}{F^*} \cdot (BQ_v + C_w)$$

where C_o = Conductivity of 100% saturated sample
C_w = Conductivity of brine

F* and BQ_v is determined from the slope and intercept of the regression line in a C_o vs C_w diagram.

Measurements of core conductivity are performed at overburden conditions at 25 ºC or at reservoir conditions in an owen as required. Samples are installed in single resistivity core holders and flushed with 20 PV's of a specified brine or NaCl solution. Overburden or reservoir pressure is applied and pore volume compressibility recorded as the samples are left overnight to equilibrate. The first conductivity reading is then taken. The samples are now flushed with 5 PV's of the same brine and left to stabilize for 3 hours before the second conductivity is recorded. Another 5 PV's of brine are flushed through the samples and after 3 hours stabilization time a final conductivity are recorded.

The procedure is repeated for each brine or NaCl solution. The two-electrode method is normally applied and the conductivity measured to an AC signal of 5-20 kHz frequency until minimum phase angle have been detected. Data logging is performed using the HP 4276A LCZ-meter controlled by a PC.

Samples passing a core conductivity analysis may later be used for wet chemical determination of CEC.

5 Results

Nomenclature

L	– sample length	[cm]	F or FRF	– formation resistivity factor	
D	– sample diameter	[cm]	F*	- intrinsic formation factor	
A	- sample area	[cm^2]	RI	– resistivity index	
BV	– bulk volume	[cc]	m	– cementation exponent	
PV	– pore volume	[cc]	m*	- intrinsic porosity exponent	
Δ PV	– pore volume change	[ml]	n	– saturation exponent	
GD	– grain density	[g/cc]	a	– Archie constant, or a dimensional correction factor in compressibility calculations	
V	– volume	[ml]	R_o	- resistivity of water saturated sample	[Ω m]
Δ V	– volume change	[ml]	R_w	- resistivity of formation water	[Ωm]
Ø	– porosity	[pct or frc]	C_o	- core conductivity	[S/m]
S_w	- water saturation	[pct or frc]	C_w	- formation water conductivity	[S/m]
S_{wf}	- final water saturation	[pct or frc]	Z_o	- impedance of water saturated sample	[Ω]
$_i$	- Subscript for "initial"		Z_t	- impedance of sample at $S_w < 1$	[Ω]
imp	- impedance	[ohm]			

5.1 Conventional core analysis data

Table 5.1 below lists the routine core analysis data measured before or after the SCAL tests as required. The He-porosity figure from table 5.1 is not always used directly in the following SCAL test; the initial porosity figure may be a mean value between the He-porosity and an Archimedes porosity that is routinely measured on saturated plugs before the SCAL test is initiated.

Table 5.1. CCAL data measured for the plugs used in the Sofie-1 SCAL study.

Sample ID	Depth meters	Gas Perm mD	Porosity %	Grain Dens g/cc	Type of SCAL test
62	1875.20	228	29.80	2.734	Net Overburden Study
75	1878.47	378	34.12	2.749	
83	1880.47	371	34.24	2.775	
87	1881.46	404	34.53	2.734	
119P	1889.40	311	32.75	2.742	
131P	1892.40	344	35.46	2.758	
67	1876.45	317	31.76	2.777	C_o/C_w and CEC Study
88	1881.71	375	33.99	2.733	
127P	1891.47	363	35.52	2.755	
139P	1894.49	393	35.12	2.742	
64	1875.69	264	31.39	2.783	Resistivity Study
76	1878.65	346	34.23	2.774	
84	1880.70	410	34.03	2.764	
101	1885.10	329	33.95	2.726	
131	1892.47	398	34.87	2.742	
143P	1895.45	410	35.31	2.744	

5.2 Overburden data

The electrical behaviour of the glauconitic sandstone @ Sw = 100% was much in line with a "clean" sandstone in the sense of Archie. The measured impedance vs. frequency decreased slightly as frequency rose and so did the phase angle that furthermore was close to zero or slightly negative in the 10-20 kHz frequency band. This behaviour is in line with a normal sedimentary rock.

Two samples showed a peculiar trend for the formation factor as confining pressure rose, plug no. 87 and 131P. There is no obvious explanation for this. Plug 131P furthermore showed an unstable permeability reading and a very high reduction in liquid permeability at the higher confining pressures. It was believed that this sample experienced pore collapse at pressures above 80 bar, but He-porosity measured after test could not confirm this. There is no significant difference between the He-porosity and the Archimedes porosity measured before test for plug 131P.

Table 5.2 below show the measured cementation exponents as a function of net confining stress; diagrams are given in the following.

Table 5.2. Sofie-1, calculated cementation exponent 'm' data obtained during the overburden study. No significant difference between the two formations (Frigg U1 and U2) could be observed with the modest number of samples analyzed.

<table>
<tr><th>Plug no. :</th><th>Depth</th><th>Formation</th><th colspan="5">'m' values @ hydrostatic overburden stress :</th></tr>
<tr><th></th><th>m</th><th></th><th>27 bar</th><th>80 bar</th><th>113 bar</th><th>140 bar</th><th>177 bar</th></tr>
<tr><td>64</td><td>1875.69</td><td rowspan="4">Frigg U2</td><td rowspan="6">2.03</td><td rowspan="6">2.04</td><td rowspan="6">2.03</td><td rowspan="6">2.02</td><td rowspan="6">2.02</td></tr>
<tr><td>76</td><td>1878.65</td></tr>
<tr><td>84</td><td>1880.70</td></tr>
<tr><td>101</td><td>1885.10</td></tr>
<tr><td>131</td><td>1892.47</td><td rowspan="2">Frigg U1</td></tr>
<tr><td>143P</td><td>1895.45</td></tr>
</table>

For an explanation to abbreviations used in the tables below, please refer to the nomenclature list at the top of section 5.

Subject: Overburden measurements
C_p, K_l and FRF properties

Room condition data: @ 25 °C

Plug no.	Depth	CCAL data @ room cond.				
	m	$L_{caliper}$ [cm]	A_{calc} [cm^2]	BV_i [cc]	PV_i [cc]	$Ø_i$ [%]
62	1875.20	4.601	11.00	50.60	15.10	29.85
75	1878.47	4.725	10.97	51.81	17.60	33.97
83	1880.47	4.781	10.95	52.36	17.90	34.18
87	1881.46	4.740	10.95	51.92	17.90	34.47
119P	1889.40	4.466	10.83	48.38	15.86	32.79
131P	1892.40	4.222	10.76	45.43	16.05	35.32

Formation brine data:	
Brine R_w :	0.082 ohmm
Viscosity :	1.165 cP

Net overburden data: @ 25 °C

27 bar hydrostatic confining pressure :

Plug no.	Depth	Plug porosity data @ 27 bar			Plug permeability data @ 27 bar			Plug resistivity data @ 27 bar		
	m	Δ PV [cc]	PV [cc]	Ø [%]	L [cm]	A [cm^2]	K_l [mD]	$\lvert Z_0 \rvert$ [ohm]	Phase [deg]	FRF
62	1875.20	0.46	14.64	29.21	4.587	10.93	225	40.67	-0.21	11.82
75	1878.47	0.43	17.17	33.42	4.712	10.90	152	32.05	-0.27	9.05
83	1880.47	0.46	17.44	33.60	4.767	10.89	323	32.50	-0.19	9.05
87	1881.46	0.44	17.46	33.91	4.727	10.89	272	32.18	0.04	9.04
119P	1889.40	0.45	15.41	32.16	4.452	10.77	260	32.87	-0.24	9.69
131P	1892.40	0.43	15.62	34.70	4.209	10.69	151	30.30	-0.39	9.39

80 bar hydrostatic confining pressure :

Plug no.	Depth	Plug porosity data @ 80 bar			Plug permeability data @ 80 bar			Plug resistivity data @ 80 bar		
	m	Δ PV [cc]	PV [cc]	Ø [%]	L [cm]	A [cm^2]	K_l [mD]	$\lvert Z_0 \rvert$ [ohm]	Phase [deg]	FRF
62	1875.20	0.81	14.29	28.71	4.576	10.88	191	42.12	-0.18	12.21
75	1878.47	0.67	16.93	33.10	4.705	10.87	99	33.07	-0.25	9.32
83	1880.47	0.68	17.22	33.31	4.760	10.86	244	33.41	-0.19	9.29
87	1881.46	0.84	17.06	33.39	4.714	10.83	233	34.38	-0.01	9.64
119P	1889.40	0.82	15.04	31.63	4.441	10.71	197	34.51	-0.26	10.15
131P	1892.40	0.80	15.25	34.16	4.197	10.63	111	31.13	-0.15	9.62

113 bar hydrostatic confining pressure :

Plug no.	Depth	Plug porosity data @ 113 bar			Plug permeability data @ 113 bar			Plug resistivity data @ 113 bar		
	m	Δ PV [cc]	PV [cc]	Ø [%]	L [cm]	A [cm^2]	K_l [mD]	$\lvert Z_0 \rvert$ [ohm]	Phase [deg]	FRF
62	1875.20	0.91	14.19	28.57	4.573	10.86	175	42.87	-0.18	12.42
75	1878.47	0.75	16.85	33.00	4.702	10.86	74	33.47	-0.30	9.42
83	1880.47	0.83	17.07	33.12	4.756	10.84	196	33.64	-0.21	9.35
87	1881.46	0.96	16.94	33.24	4.711	10.82	192	33.73	-0.01	9.44
119P	1889.40	0.95	14.91	31.44	4.437	10.69	157	35.14	-0.26	10.33
131P	1892.40	0.95	15.10	33.94	4.193	10.61	64	29.57	-0.02	9.12

140 bar hydrostatic confining pressure :

Plug no.	Depth	Plug porosity data @ 140 bar			Plug permeability data @ 140 bar			Plug resistivity data @ 140 bar		
	m	Δ PV [cc]	PV [cc]	Ø [%]	L [cm]	A [cm^2]	K_l [mD]	$\lvert Z_0 \rvert$ [ohm]	Phase [deg]	FRF
62	1875.20	1.01	14.09	28.42	4.570	10.85	139.6	43.42	-0.17	12.57
75	1878.47	0.83	16.77	32.89	4.700	10.85	55.6	33.76	-0.25	9.50
83	1880.47	0.93	16.97	32.99	4.753	10.82	136.4	33.85	-0.19	9.40
87	1881.46	1.06	16.84	33.10	4.708	10.80	135.3	33.46	-0.02	9.36
119P	1889.40	1.05	14.81	31.30	4.434	10.68	117.8	35.56	-0.28	10.44
131P	1892.40	1.08	14.97	33.74	4.189	10.59	38.8	28.90	0.00	8.91

177 bar hydrostatic confining pressure :

Plug no.	Depth	Plug porosity data @ 177 bar			Plug permeability data @ 177 bar			Plug resistivity data @ 177 bar		
	m	Δ PV [cc]	PV [cc]	Ø [%]	L [cm]	A [cm^2]	K_l [mD]	$\lvert Z_0 \rvert$ [ohm]	Phase [deg]	FRF
62	1875.20	1.13	13.97	28.25	4.567	10.83	115.2	44.12	-0.21	12.76
75	1878.47	0.94	16.66	32.75	4.696	10.83	48.8	34.10	-0.24	9.59
83	1880.47	1.03	16.87	32.86	4.750	10.81	92.0	34.19	-0.21	9.49
87	1881.46	1.16	16.74	32.97	4.705	10.79	93.9	33.51	-0.03	9.37
119P	1889.40	1.15	14.71	31.15	4.431	10.66	92.2	35.92	-0.27	10.54
131P	1892.40	1.23	14.82	33.52	4.184	10.56	27.4	28.96	-0.05	8.92

Recording data for resistivity cells:

Plug and cell impedance measured @ 5, 10 & 20 kHz
(only 10 kHz data is given in the tables below)

Intrinsic cell impedance: 0.32 ohm

Plug no.	Imp data @ 27 bar				Perm data @ 27 bar		Compressibility data @ 27 bar		
	Imp1 [ohm]	Imp2 [ohm]	Phase1 [deg]	Phase2 [deg]	Flow rate [ml/h]	Δ P [bar]	BV [cc]	Δ BV [%]	a
62	40.99	40.99	-0.21	-0.21	900	0.55	50.14	0.91	0.0030
75	32.56	32.18	-0.29	-0.24	900	0.84	51.38	0.83	0.0028
83	33.35	32.29	-0.20	-0.18	900	0.4	51.90	0.88	0.0029
87	31.16	33.83	0.06	0.02	900	0.47	51.48	0.85	0.0028
119P	33.19	33.19	-0.27	-0.21	900	0.47	47.93	0.93	0.0031
131P	28.95	32.29	-0.40	-0.37	900	0.77	45.00	0.95	0.0032

Plug no.	Imp data @ 80 bar				Perm data @ 80 bar		Compressibility data @ 80 bar		
	Imp1 [ohm]	Imp2 [ohm]	Phase1 [deg]	Phase2 [deg]	Flow rate [ml/h]	Δ P [bar]	BV [cc]	Δ BV [%]	a
62	42.55	42.32	-0.19	-0.17	900	0.65	49.79	1.60	0.0053
75	33.52	33.26	-0.26	-0.24	900	1.29	51.14	1.29	0.0043
83	33.97	33.49	-0.20	-0.17	900	0.53	51.68	1.30	0.0043
87	35.60	33.80	-0.01	-0.01	900	0.55	51.08	1.62	0.0054
119P	34.90	34.76	-0.26	-0.25	900	0.62	47.56	1.69	0.0056
131P	32.76	30.13	-0.29	0	900	1.05	44.63	1.76	0.0059

Plug no.	Imp data @ 113 bar				Perm data @ 113 bar		Compressibility data @ 113 bar		
	Imp1 [ohm]	Imp2 [ohm]	Phase1 [deg]	Phase2 [deg]	Flow rate [ml/h]	Δ P [bar]	BV [cc]	Δ BV [%]	a
62	43.28	43.10	-0.18	-0.17	900	0.71	49.69	1.80	0.0060
75	33.84	33.73	-0.28	-0.32	900	1.72	51.06	1.45	0.0048
83	34.11	33.80	-0.23	-0.19	900	0.66	51.53	1.59	0.0053
87	34.54	33.55	-0.01	-0.01	900	0.67	50.96	1.85	0.0062
119P	35.45	35.47	-0.25	-0.26	900	0.78	47.43	1.96	0.0065
131P	30.65	29.12	-0.04	0	900	1.81	44.48	2.09	0.0070

Notice: Unstable permeability reading for plug 131P @ 140 bar conf. P

Plug no.	Imp data @ 140 bar				Perm data @ 140 bar		Compressibility data @ 140 bar		
	Imp1 [ohm]	Imp2 [ohm]	Phase1 [deg]	Phase2 [deg]	Flow rate [ml/h]	Δ P [bar]	BV [cc]	Δ BV [%]	a
62	43.80	43.67	-0.17	-0.17	900	0.89	49.59	2.00	0.0067
75	34.15	34.00	-0.26	-0.24	900	2.3	50.98	1.60	0.0053
83	34.25	34.09	-0.19	-0.19	900	0.95	51.43	1.78	0.0059
87	34.04	33.52	-0.01	-0.02	900	0.95	50.86	2.04	0.0068
119P	35.98	35.77	-0.28	-0.27	900	1.04	47.33	2.17	0.0072
131P	29.48	28.96	0.00	0.00	900	3.01	44.35	2.38	0.0079

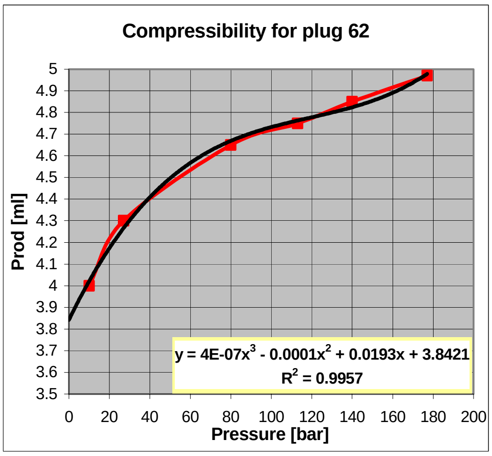
Notice: Unstable permeability reading for plug 131P @ 177 bar conf. P

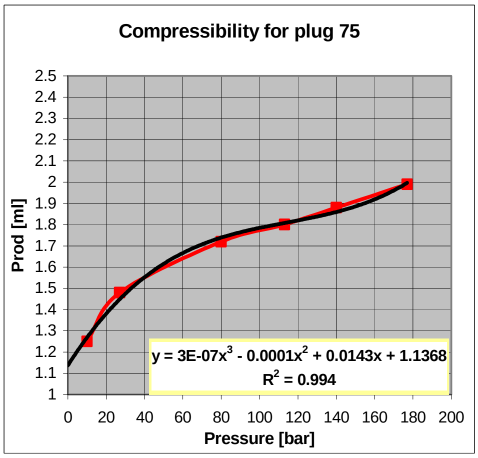
Plug no.	Imp data @ 177 bar				Perm data @ 177 bar		Compressibility data @ 177 bar		
	Imp1 [ohm]	Imp2 [ohm]	Phase1 [deg]	Phase2 [deg]	Flow [ml]	Δ P [bar]	BV [cc]	Δ BV [%]	a
62	44.50	44.38	-0.20	-0.21	900	1.08	49.47	2.23	0.0074
75	34.51	34.33	-0.23	-0.25	900	2.62	50.87	1.81	0.0060
83	34.58	34.44	-0.21	-0.20	900	1.41	51.33	1.97	0.0066
87	34.00	33.65	-0.03	-0.03	900	1.37	50.76	2.23	0.0074
119P	36.33	36.15	-0.26	-0.27	900	1.33	47.23	2.38	0.0079
131P	29.40	29.16	-0.10	0	900	4.26	44.20	2.71	0.0090

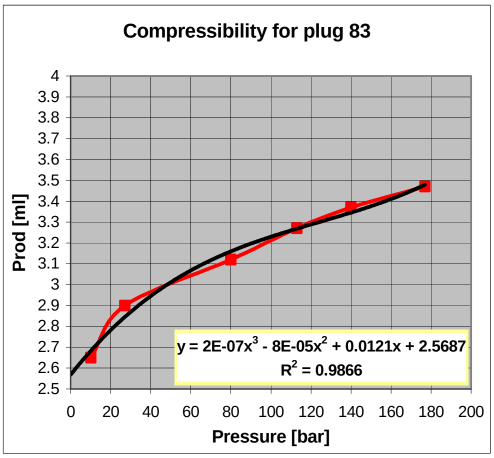
Subject: Overburden measurements	Company: DONG E&P A/S
Compressibility data	Well: Sofie-1
	GEUS Core Lab, 25.05.2004

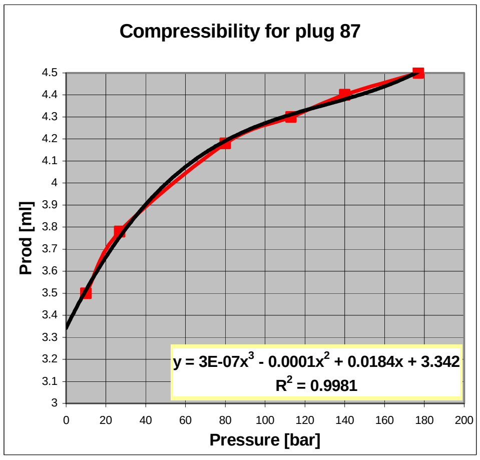
Initial confining pressure:	10 bar	hydrostatic
Final confining pressure:	177 bar	hydrostatic

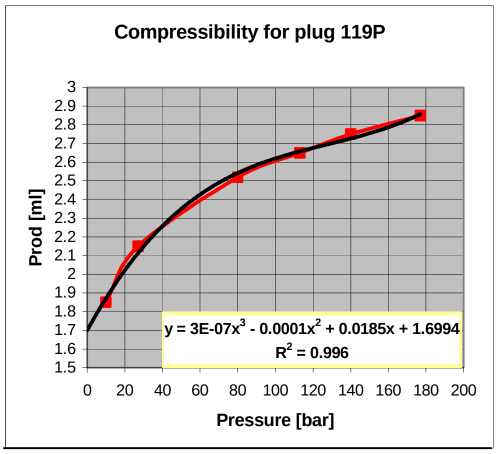
Plug no.	Depth	CCAL data @ room cond.			[ml] read from graduated glass tube @ given pressure						PV$_0$ from plot	Δ PV$_{177bar}$
	m	BV, cc	PV1, cc	Ø , %	10	27	80	113	140	177	[ml]	[ml]
62	1875.20	50.60	15.10	29.85	4.00	4.30	4.65	4.75	4.85	4.97	3.84	1.13
75	1878.47	51.81	17.60	33.97	1.25	1.48	1.72	1.80	1.88	1.99	1.05	0.94
83	1880.47	52.36	17.90	34.18	2.65	2.90	3.12	3.27	3.37	3.47	2.44	1.03
87	1881.46	51.92	17.90	34.47	3.50	3.78	4.18	4.30	4.40	4.50	3.34	1.16
119P	1889.40	48.38	15.86	32.79	1.85	2.15	2.52	2.65	2.75	2.85	1.70	1.15
131P	1892.40	45.43	16.05	35.32	6.81	7.10	7.47	7.62	7.75	7.90	6.67	1.23

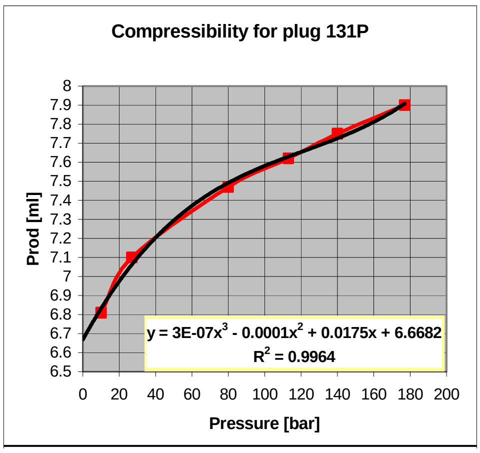




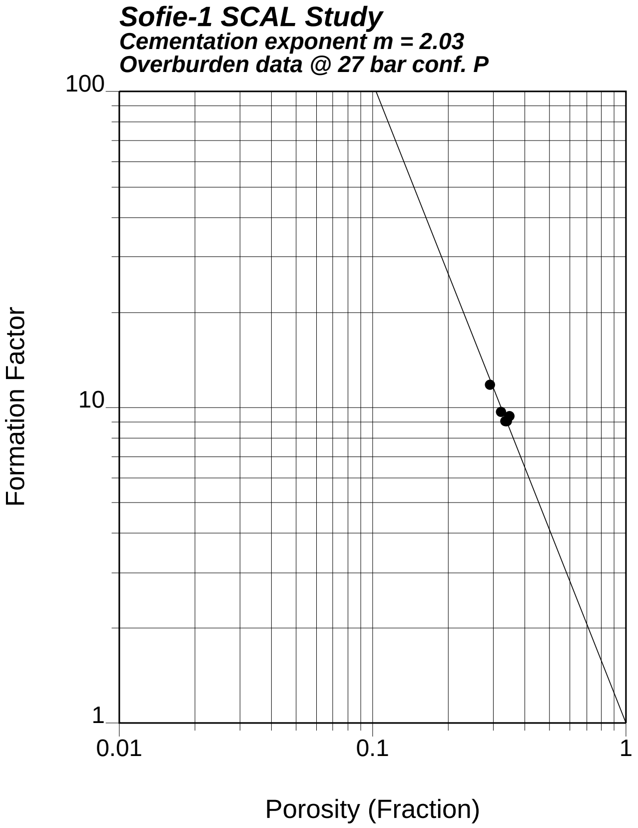




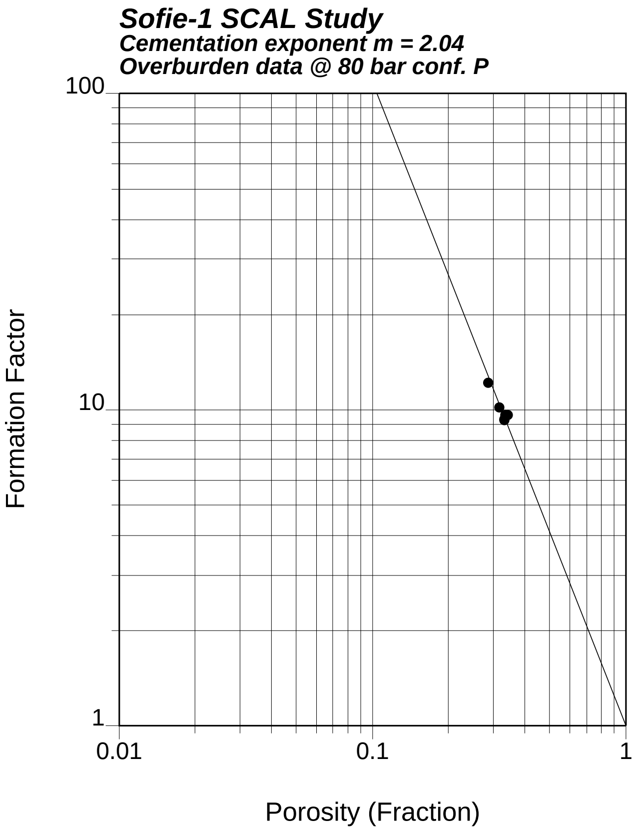




Sofie-1, Formation Resistivity Factor (FRF) data were measured at five increasing net confining stresses as shown in the diagrams below.

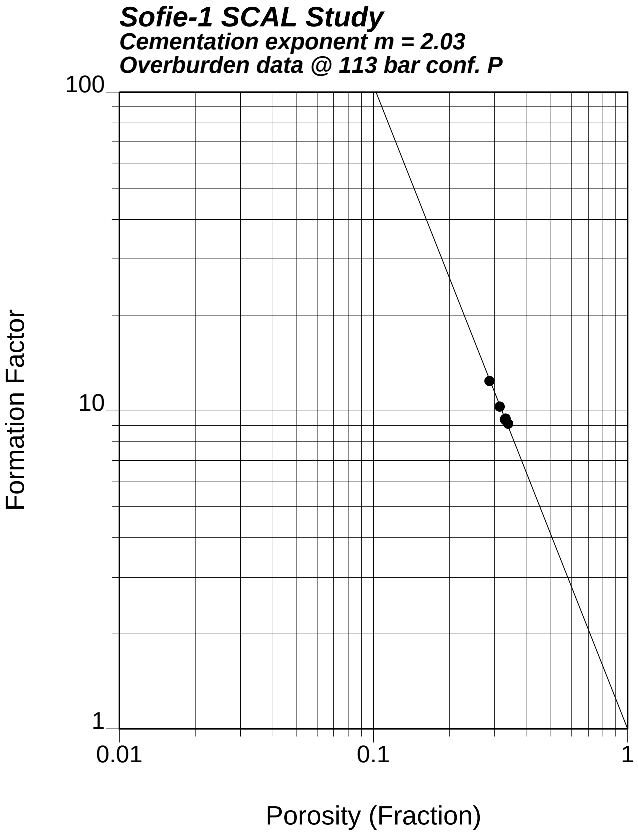


Number of data	6
Number plotted	6
X Variable:	
geom. mean	0.328
std. dev.	1.058
Y Variable:	
geom. mean	9.627
std. dev.	1.100
Correlation	-0.934
Rank correlation	-0.600
Regression:	
intercept	1.00
slope	-2.03

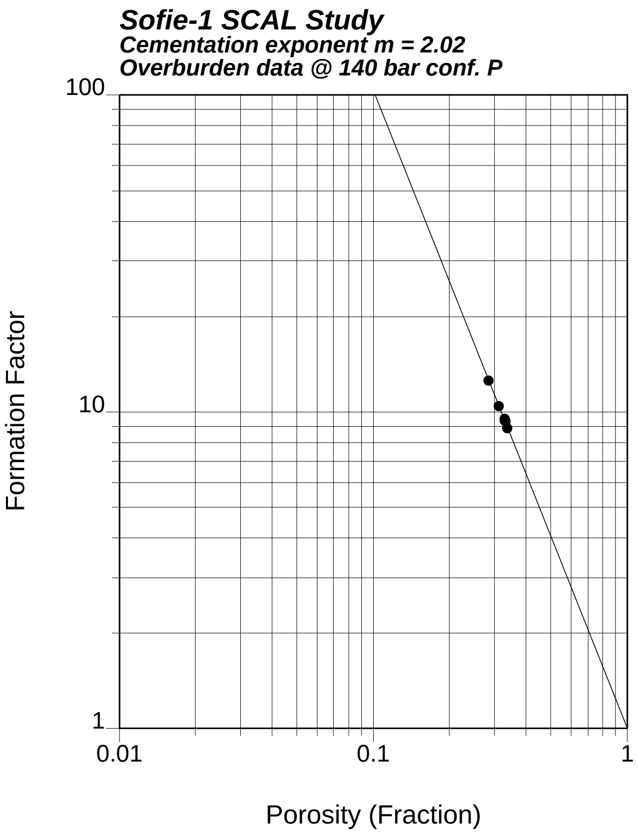


Number of data	6
Number plotted	6
X Variable:	
geom. mean	0.323
std. dev.	1.060
Y Variable:	
geom. mean	9.992
std. dev.	1.099
Correlation	-0.953
Rank correlation	-0.543
Regression:	
intercept	1.00
slope	-2.04

FRF diagrams continued 2,

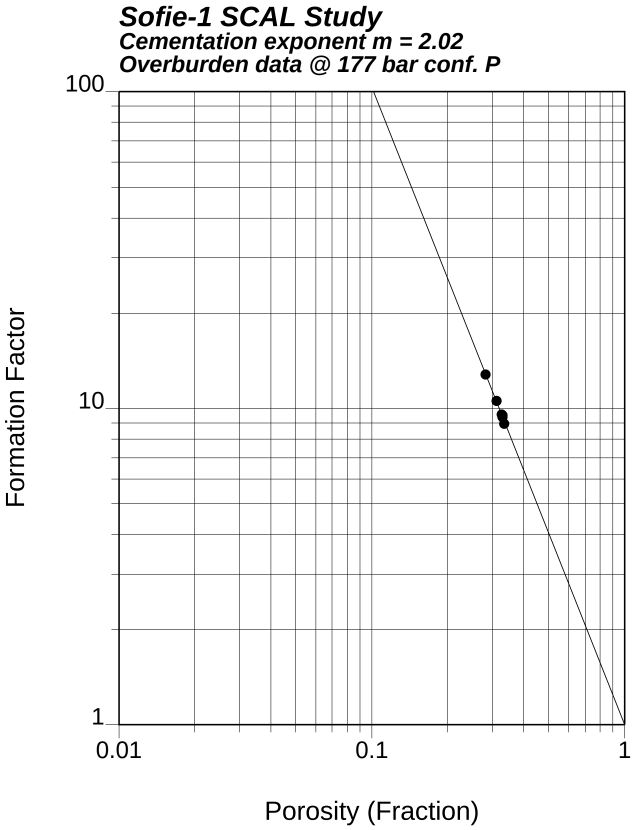


Number of data	6
Number plotted	6
X Variable:	
geom. mean	0.322
std. dev.	1.060
Y Variable:	
geom. mean	9.954
std. dev.	1.112
Correlation	-0.997
Rank correlation	-0.829
Regression:	
intercept	1.00
slope	-2.03



Number of data	6
Number plotted	6
X Variable:	
geom. mean	0.320
std. dev.	1.060
Y Variable:	
geom. mean	9.962
std. dev.	1.121
Correlation	-0.999
Rank correlation	-1.000
Regression:	
intercept	1.00
slope	-2.02

FRF diagrams continued 3.



Number of data	6
Number plotted	6
X Variable:	
geom. mean	0.319
std. dev.	1.060
Y Variable:	
geom. mean	10.038
std. dev.	1.126
Correlation	-0.998
Rank correlation	-1.000
Regression:	
intercept	1.00
slope	-2.02

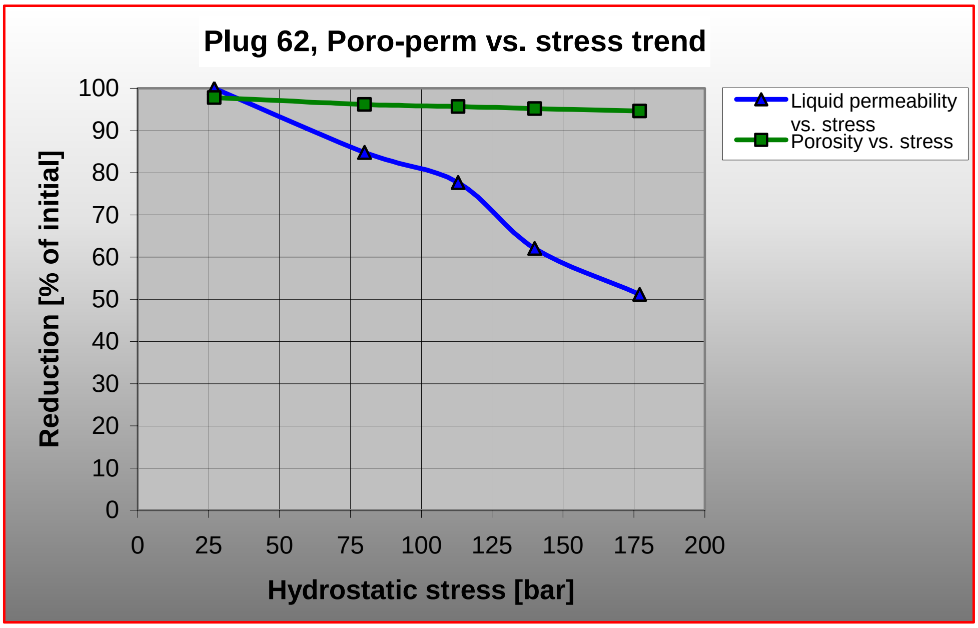
Subject: Overburden measurements | **Company: DONG E&P A/S**
Plug data at @ 25 °C | **Well: Sofie-1**

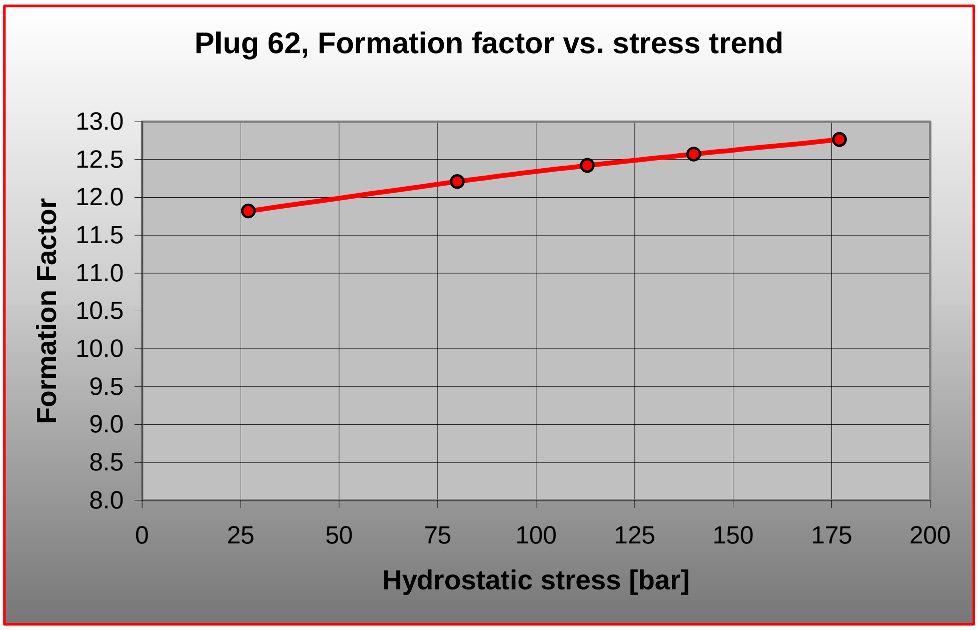
Plug no : 62
Depth [m] : 1875.20
Formation : Frigg U2

Conventional
Kg [mD] : 228
He-∅ [%] : 29.9

Confining pressure [bar]		Reduction in				C_p	F
hydrostatic	uniaxial *	K_l [mD]	% of initial	He-∅ [%]	% of initial	[bar^{-1}]	
27	43.5	225	100	29.21	97.8	8.43E-04	11.82
80	129.0	191	85	28.71	96.2	2.75E-04	12.21
113	182.3	175	78	28.57	95.7	1.45E-04	12.42
140	225.8	140	62	28.42	95.2	1.76E-04	12.57
177	285.5	115	51	28.25	94.6	4.22E-04	12.76

* corrected according to Teeuw (1971)





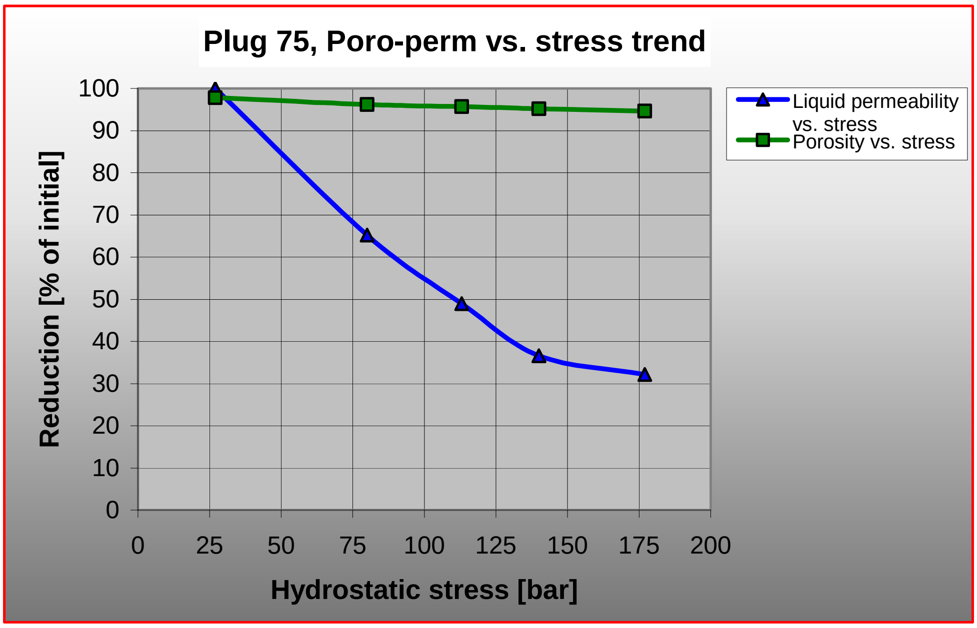
Subject: Overburden measurements | **Company: DONG E&P A/S**
Plug data at @ 25 °C | **Well: Sofie-1**

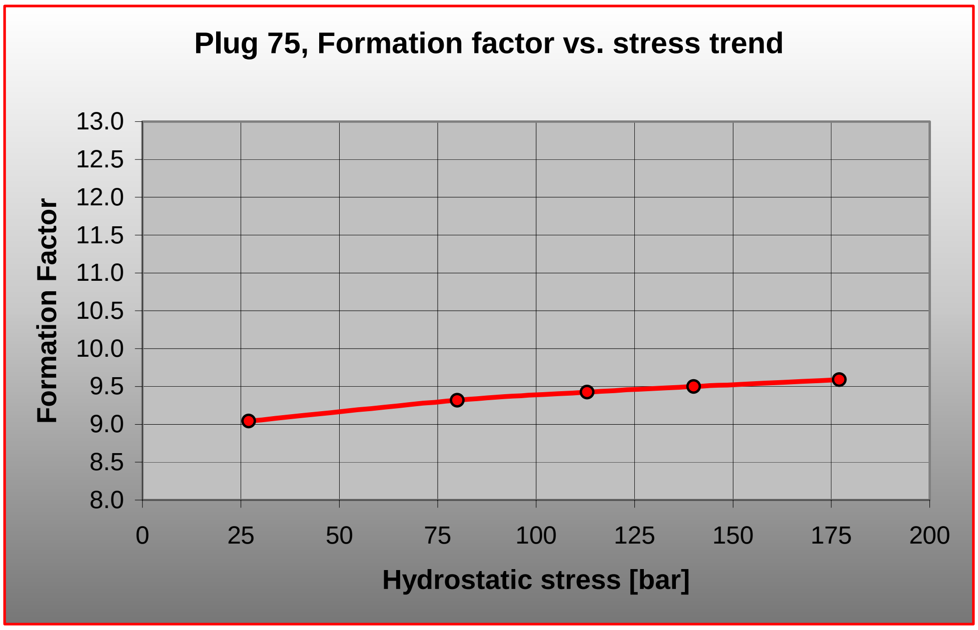
Plug no : 75
Depth [m] : 1878.47
Formation : Frigg U2

Conventional
Kg [mD] : 378
He-∅ [%] : 34.0

Confining pressure [bar]		Reduction in				C_p	F
hydrostatic	uniaxial *	K_l [mD]	% of initial	He-∅ [%]	% of initial	[bar^{-1}]	
27	43.5	152	100	33.42	98.4	7.16E-04	9.05
80	129.0	99	65	33.10	97.5	2.31E-04	9.32
113	182.3	74	49	33.00	97.1	1.22E-04	9.42
140	225.8	56	37	32.89	96.8	1.47E-04	9.50
177	285.5	49	32	32.75	96.4	3.52E-04	9.59

* corrected according to Teeuw (1971)





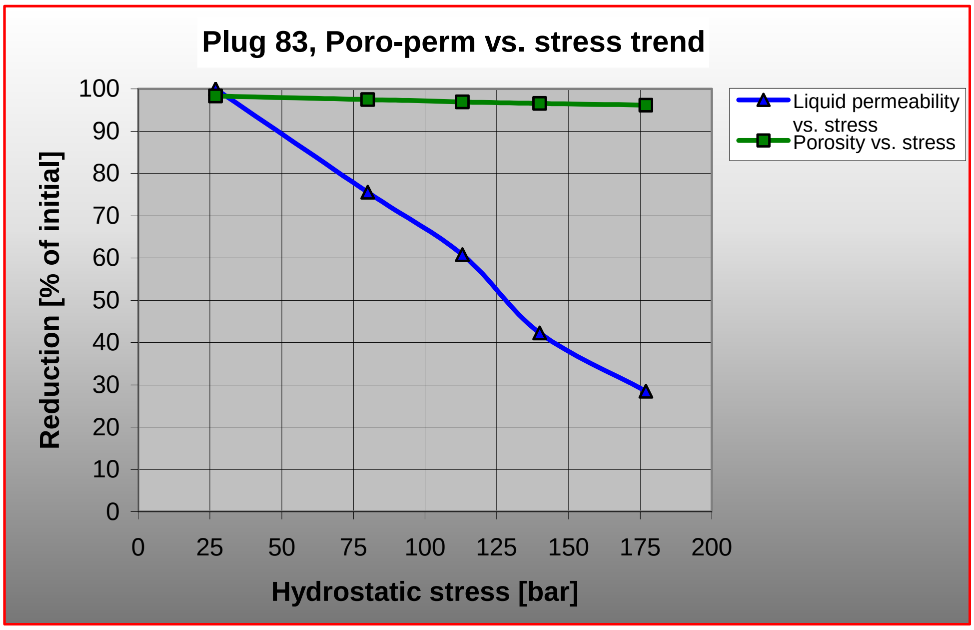
Subject: Overburden measurements **Company: DONG E&P A/S**
Plug data at @ 25 °C **Well: Sofie-1**

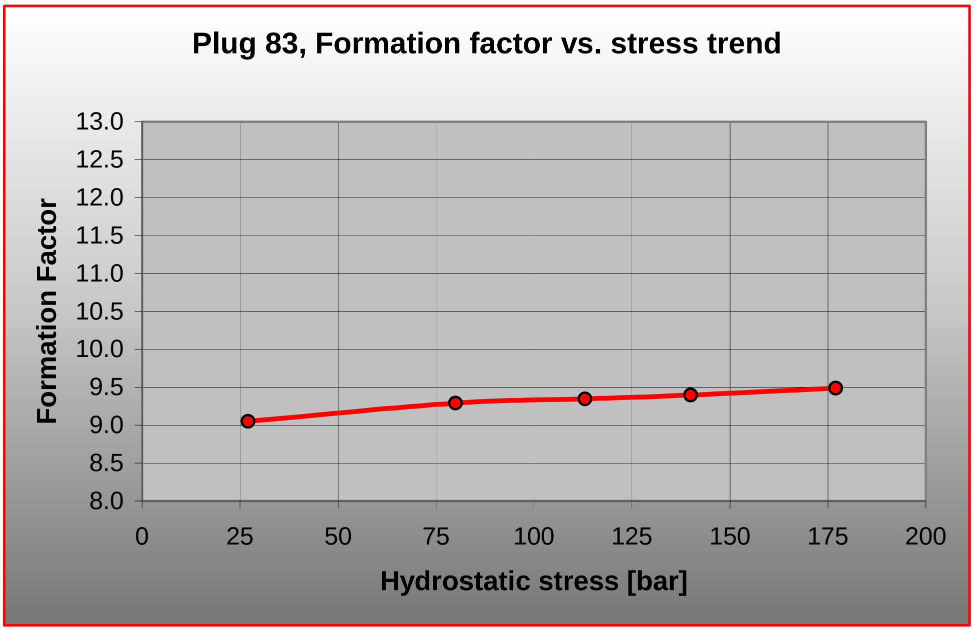
Plug no : **83**
Depth [m] : **1880.47**
Formation : **Frigg U2**

Conventional
Kg [mD] : **371**
He-∅ [%] : **34.2**

Confining pressure [bar]		Reduction in				C_p	F
hydrostatic	uniaxial *	K_l [mD]	% of initial	He-∅ [%]	% of initial	[bar^{-1}]	
27	43.5	323	100	33.60	98.3	4.83E-04	9.05
80	129.0	244	76	33.31	97.5	2.29E-04	9.29
113	182.3	196	61	33.12	96.9	1.65E-04	9.35
140	225.8	136	42	32.99	96.5	1.68E-04	9.40
177	285.5	92	28	32.86	96.1	2.57E-04	9.49

* corrected according to Teeuw (1971)





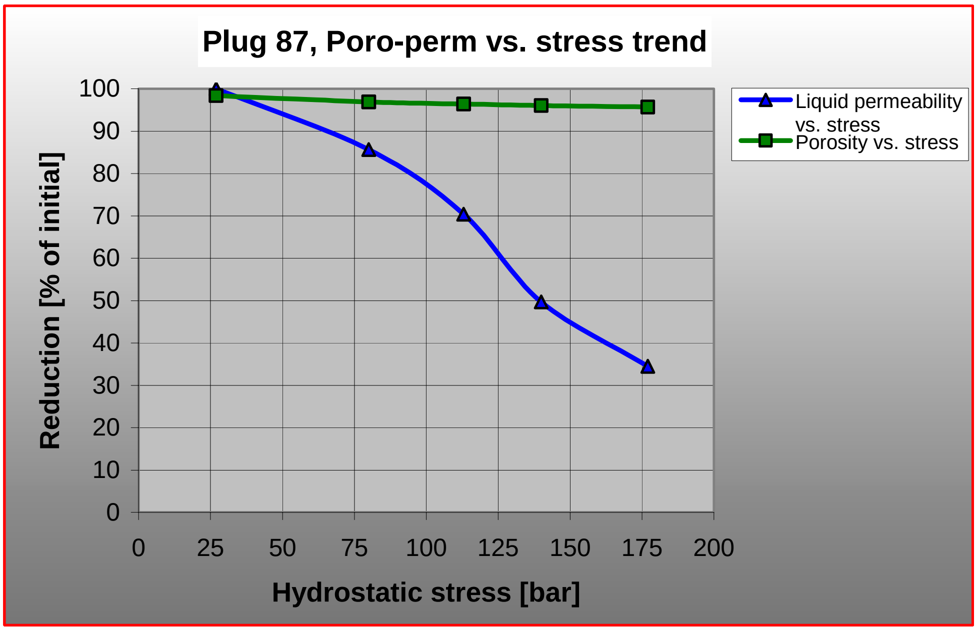
Subject: Overburden measurements | **Company: DONG E&P A/S**
Plug data at @ 25 °C | **Well: Sofie-1**

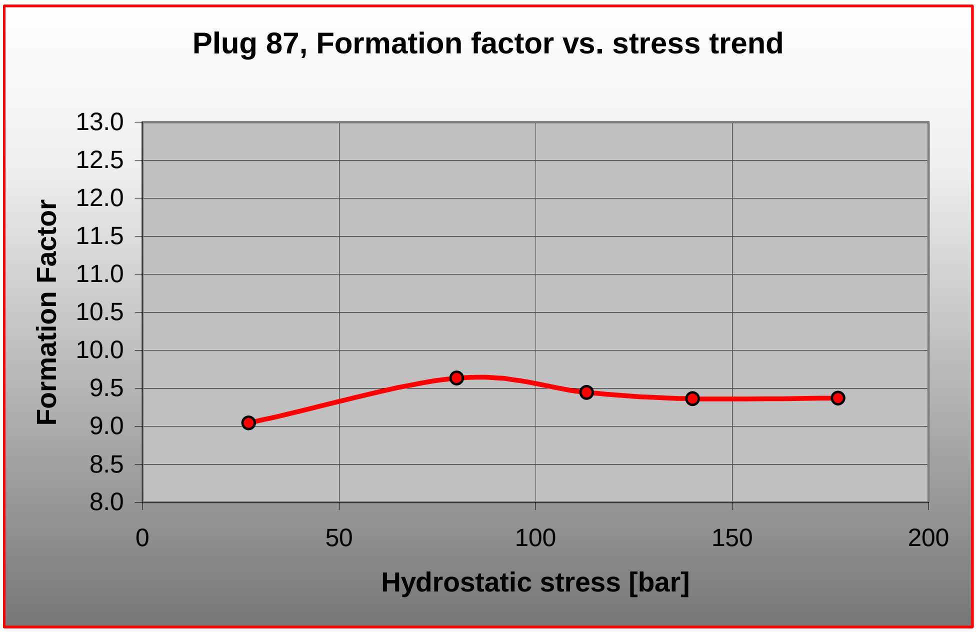
Plug no : 87
Depth [m] : 1881.46
Formation : Frigg U2

Conventional
Kg [mD] : 404
He-∅ [%] : 34.5

Confining pressure [bar]		Reduction in				C_p	F
hydrostatic	uniaxial *	K_l [mD]	% of initial	He-∅ [%]	% of initial	[bar^{-1}]	
27	43.5	272	100	33.91	98.4	7.12E-04	9.04
80	129.0	233	86	33.39	96.9	2.64E-04	9.64
113	182.3	192	70	33.24	96.4	1.25E-04	9.44
140	225.8	135	50	33.10	96.0	9.64E-05	9.36
177	285.5	94	34	32.97	95.7	1.83E-04	9.37

* corrected according to Teeuw (1971)





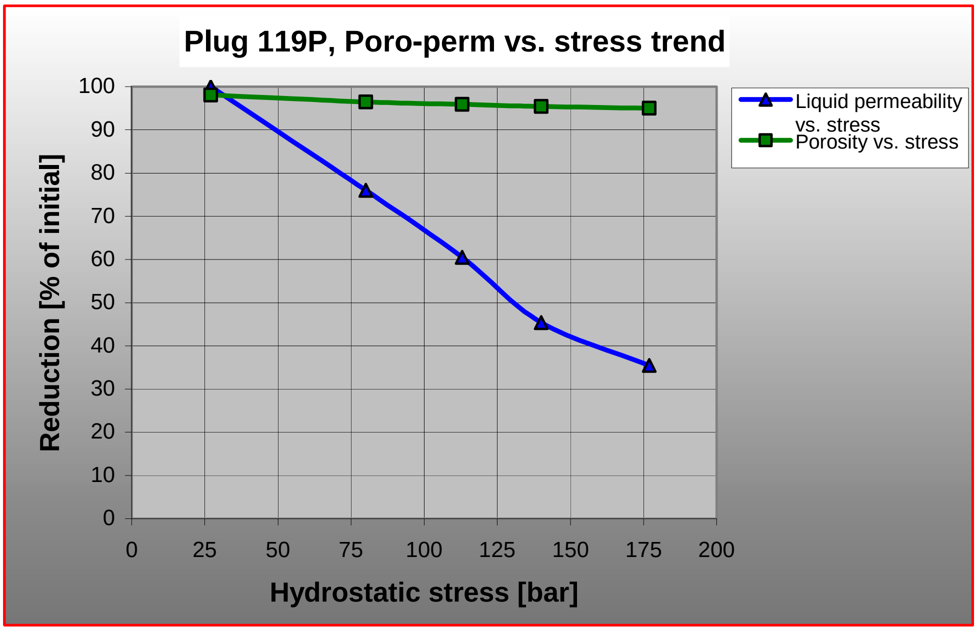
Subject: Overburden measurements **Company: DONG E&P A/S**
Plug data at @ 25 °C **Well: Sofie-1**

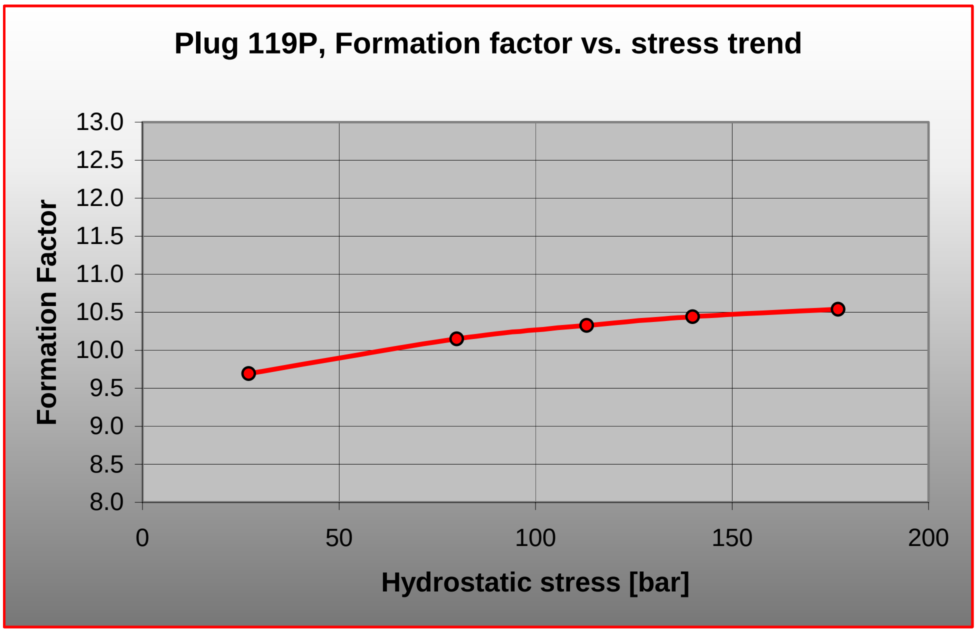
Plug no : **119P**
Depth [m] : **1889.40**
Formation : **Frigg U1**

Conventional
Kg [mD] : **311**
He-∅ [%] : **32.8**

Confining pressure [bar]		Reduction in				Cp	F
hydrostatic	uniaxial *	Kl [mD]	% of initial	He-∅ [%]	% of initial	[bar^{-1}]	
27	43.5	260	100	32.16	98.1	7.98E-04	9.69
80	129.0	197	76	31.63	96.5	2.71E-04	10.15
113	182.3	157	60	31.44	95.9	1.00E-04	10.33
140	225.8	118	45	31.30	95.5	5.63E-05	10.44
177	285.5	92	36	31.15	95.0	1.39E-04	10.54

* corrected according to Teeuw (1971)





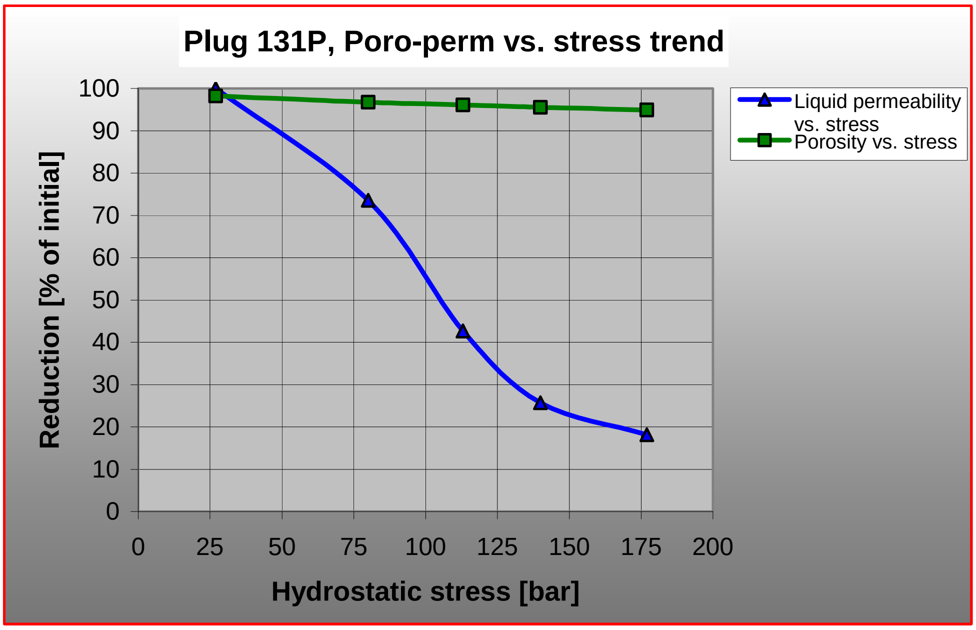
Subject: Overburden measurements | **Company: DONG E&P A/S**
Plug data at @ 25 °C | **Well: Sofie-1**

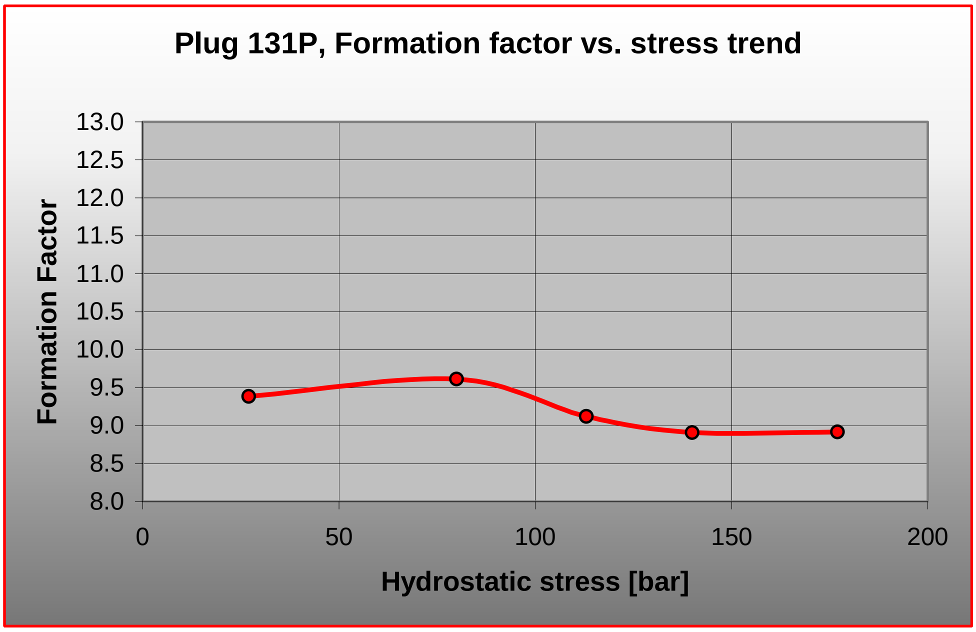
Plug no : 131P
Depth [m] : 1892.40
Formation : Frigg U1

Conventional
Kg [mD] : 344
He-∅ [%] : 35.3

Confining pressure [bar]		Reduction in				C_p	F
hydrostatic	uniaxial *	K_l [mD]	% of initial	He-∅ [%]	% of initial	[bar^{-1}]	
27	43.5	151	100	34.70	98.3	7.61E-04	9.39
80	129.0	111	74	34.16	96.7	3.10E-04	9.62
113	182.3	64	43	33.94	96.1	1.85E-04	9.12
140	225.8	39	26	33.74	95.5	1.78E-04	8.91
177	285.5	27	18	33.52	94.9	3.12E-04	8.92

* corrected according to Teeuw (1971)





5.3 Resistivity index data

Measurement of sample resistivity was uncomplicated, and there is no reason to suspect that a fixed regression through (1,1) in a double logaritmic plot is not valid for these samples. A formation factor cannot be determined from these measurements because the small area of the silver electrodes affect the measured impedance. This bias is the same for all drainage measurements and is therefore eliminated when RI is calculated. Sample pore volume reduction cannot be measured either because of surplus water in the porous plate and core holder during mounting of the plug, and gas in the inlet tubing. A pore volume reduction figure has been estimated from the net overburden study instead.

Experimental data are contained in the tables below and RI data presented in the diagrams. It was observed that the final data point measured at Sw ~ 45% falls systematically above the regression line for the first 5 drainage points in all samples. Therefore it was decided to present two regressions and diagrams for each sample. The corresponding 'n' values are shown in table 5.3 below.

Table 5.3. Calculated 'n' values for Sofie-1 samples. Data for 5 and 6 data point regressions are given as explained above. No significant difference in 'n' value is observed between the two formations.

Plug no. :	Depth	Regression data for the saturation exponent		
	m	Formation	'n' (5 point)	'n' (6 point)
64	1875.69	Frigg U2	1.90	2.02
76	1878.65		1.93	2.03
84	1880.70		1.85	1.97
101	1885.10		1.82	1.98
131	1892.47	Frigg U1	1.93	2.07
143P	1895.45		1.80	1.97

For an explanation to abbreviations used in the tables below, please refer to the nomenclature list at the top of section 5.

In the tables below, the green column S_w designates the water saturation read from a graduated glass during the drainage experiment. After experiment a Dean Stark extraction supplied the yellow S_{wf} water saturation. An overall evaluation of data finally resulted in the blue column S_w' figures that have been used in the regression analysis to obtain the saturation exponent data.

Subject: Resistivity Index measurements
Electrical measurements at overburden conditions

Room condition data: @ 25 °C

Plug no.	Depth	CCAL data @ room cond.								
	m	$L_{caliper}$ [cm]	$D_{caliper}$ [cm]	Wet wt [g]	Dry wt [g]	$BV_{caliper}$ [cc]	$BV_{i(Hg)}$ [cc]	PV_i [cc]	**$Ø_i$ [%]**	GD [g/cc]
64	1875.69	4.752	3.767	117.70	nd	52.96	52.68	16.66	31.62	2.783
76	1878.65	4.776	3.754	114.15	nd	52.86	52.33	18.00	34.40	2.774
84	1880.70	4.782	3.767	115.18	nd	53.30	52.78	17.99	34.09	2.764
101	1885.10	4.351	3.735	101.53	nd	47.67	47.07	16.03	34.05	2.726
131	1892.47	4.478	3.707	102.35	nd	48.33	47.58	16.60	34.88	2.742
143P	1895.45	3.680	3.719	84.41	nd	39.98	39.25	13.82	35.26	2.744

Net overburden data @ 113 bar: @ 25 °C

Plug no.	Depth	Plug porosity data			Plug resistivity data @ Sw = 100 %				
	m	Δ PV [cc]*	PV [cc]	**Ø [%]**	L [cm]	A [cm^2]		$\|Z_0\|$ [ohm]	Phase [deg]
64	1875.69	0.99	15.67	30.31	4.722	10.95		52.49	-0.72
76	1878.65	0.90	17.10	33.25	4.749	10.83		42.44	-0.76
84	1880.70	0.80	17.19	33.08	4.758	10.93		42.25	-1.17
101	1885.10	0.71	15.32	33.04	4.329	10.71		41.89	-1.45
131	1892.47	0.88	15.72	33.66	4.450	10.49		38.16	-2.36
143P	1895.45	0.74	13.08	33.97	3.657	10.53		31.19	-0.81

* estm. from the NOB study

Drainage data @ Pc = 0.08 bar (air-brine system)

Plug no.	Depth	Data read from graduated tube			Plug resistivity data @ Sw given in column below					
	m	V_w (0) [cc]	V_w (t) [cc]	Δ V_w [cc]	**Sw [%]**	**Sw' [%]**		$\|Z_t\|$ [ohm]	Phase [deg]	**RI**
64	1875.69	2.85	5.80	2.95	81.2	80.8		76.09	-0.97	1.45
76	1878.65	3.25	7.18	3.93	77.0	76.1		71.00	-0.80	1.67
84	1880.70	2.82	7.45	4.63	73.1	71.7		76.28	-1.00	1.81
101	1885.10	3.30	7.05	3.75	75.5	72.5		73.39	-1.24	1.75
131	1892.47	3.70	8.00	4.30	72.6	73.2		69.66	-1.98	1.83
143P	1895.45	2.15	5.80	3.65	72.1	72.1		56.58	-0.80	1.81

Drainage data @ Pc = 0.10 bar (air-brine system)

Plug no.	Depth	Data read from graduated tube			Plug resistivity data @ Sw given in column below					
	m	V_w (0) [cc]	V_w (t) [cc]	Δ V_w [cc]	**Sw [%]**	**Sw' [%]**		$\|Z_t\|$ [ohm]	Phase [deg]	**RI**
64	1875.69	2.85	6.00	3.15	79.9	79.5		79.53	-0.78	1.52
76	1878.65	3.25	7.20	3.95	76.9	76.0		71.93	-0.66	1.69
84	1880.70	2.82	8.05	5.23	69.6	68.2		84.90	-0.68	2.01
101	1885.10	3.30	7.18	3.88	74.7	71.7		75.80	-0.99	1.81
131	1892.47	3.70	8.38	4.68	70.2	70.8		73.05	-1.48	1.91
143P	1895.45	2.15	6.75	4.60	64.8	69.8		59.23	-0.49	1.90

Drainage data @ P_c = 0.11 bar (air-brine system)

Plug no.	Depth	Data read from graduated tube			Plug resistivity data @ Sw given in column below					
	m	V_w (0) [cc]	V_w (t) [cc]	Δ V_w [cc]	Sw [%]	Sw' [%]		|Zt| [ohm]	Phase [deg]	RI
64	1875.69	2.85	7.25	4.40	71.9	71.5		99.18	-0.97	1.89
76	1878.65	3.25	8.40	5.15	69.9	69.0		87.07	-0.75	2.05
84	1880.70	2.82	9.08	6.26	63.6	62.2		101.56	-0.64	2.40
101	1885.10	3.30	8.00	4.70	69.3	66.3		88.11	-0.99	2.10
131	1892.47	3.70	8.95	5.25	66.6	67.2		82.41	-1.30	2.16
143P	1895.45	2.15	7.67	5.52	57.8	62.8		71.97	-0.46	2.31

Drainage data @ P_c = 0.13 bar (air-brine system)

Plug no.	Depth	Data read from graduated tube			Plug resistivity data @ Sw given in column below					
	m	V_w (0) [cc]	V_w (t) [cc]	Δ V_w [cc]	Sw [%]	Sw' [%]		|Zt| [ohm]	Phase [deg]	RI
64	1875.69	2.85	7.90	5.05	67.8	67.4		113.41	-0.82	2.16
76	1878.65	3.25	8.92	5.67	66.8	65.9		96.02	-0.84	2.26
84	1880.70	2.82	9.50	6.68	61.1	59.7		111.60	-0.62	2.64
101	1885.10	3.30	8.50	5.20	66.1	63.1		98.12	-1.01	2.34
131	1892.47	3.70	9.30	5.60	64.4	65.0		89.27	-1.00	2.34
143P	1895.45	2.15	8.03	5.88	55.0	60.0		78.76	-0.41	2.53

Drainage data @ P_c = 0.17 bar (air-brine system)

Plug no.	Depth	Data read from graduated tube			Plug resistivity data @ Sw given in column below					
	m	V_w (0) [cc]	V_w (t) [cc]	Δ V_w [cc]	Sw [%]	Sw' [%]		|Zt| [ohm]	Phase [deg]	RI
64	1875.69	2.85	8.90	6.05	61.4	61.0		135.51	-0.83	2.58
76	1878.65	3.25	9.88	6.63	61.2	60.3		112.10	-0.81	2.64
84	1880.70	2.82	10.25	7.43	56.8	55.4		128.18	-0.63	3.03
101	1885.10	3.30	9.25	5.95	61.2	58.2		114.15	-0.99	2.73
131	1892.47	3.70	10.00	6.30	59.9	60.5		100.67	-0.89	2.64
143P	1895.45	2.15	8.55	6.40	51.1	56.1		88.22	-0.45	2.83

Drainage data @ P_c = 0.90 bar (air-brine system)

Plug no.	Depth	Data read from graduated tube			Plug resistivity data @ Sw given in column below					
	m	V_w (0) [cc]	V_w (t) [cc]	Δ V_w [cc]	Sw [%]	Sw' [%]	Swf [%]	|Zt| [ohm]	Phase [deg]	RI
64	1875.69	2.85	11.15	8.30	47.0	46.6	46.6	270.83	-0.77	5.16
76	1878.65	3.25	12.30	9.05	47.1	46.2	46.2	223.44	-0.58	5.27
84	1880.70	2.82	12.28	9.46	45.0	43.6	43.6	254.73	-0.60	6.03
101	1885.10	3.30	11.35	8.05	47.4	44.4	44.4	249.23	-0.79	5.95
131	1892.47	3.70	12.02	8.32	47.1	47.7	47.7	206.91	-0.61	5.42
143P	1895.45	2.15	9.95	7.80	40.4	45.4	44.3	183.03	-0.55	5.87

Recording data for resistivity cells:

Plug and cell impedance measured @ 5, 10 & 20 kHz
(the avg. of 10+20 kHz data is given in the tables below)

Intrinsic cell impedance: 0.32 ohm

Formation brine data:

Brine R_w :	0.082	ohmm
Density d_w :	1.059	g/cc

Plug no.	Imp data @ 113 bar				Compressibility data @ 113 bar		
	Imp1 [ohm]	Imp2 [ohm]	Phase1 [deg]	Phase2 [deg]	BV [cc]	Δ BV [%]	a
64	52.63	52.98	-0.35	-1.09	51.69	1.88	0.0063
76	42.89	42.62	-1.22	-0.30	51.43	1.72	0.0057
84	42.24	42.89	-1.72	-0.61	51.98	1.52	0.0051
101	42.40	42.01	-2.01	-0.88	46.36	1.51	0.0050
131	38.76	38.2	-3.17	-1.55	46.70	1.85	0.0062
143P	31.63	31.39	-1.32	-0.29	38.51	1.89	0.0063

Drainage data @ P_c = 0.08 bar (air-brine system)

Plug no.	Imp data @ given S_w			
	Imp1 [ohm]	Imp2 [ohm]	Phase1 [deg]	Phase2 [deg]
64	76.15	76.67	-0.95	-0.98
76	71.37	71.27	-0.79	-0.80
84	76.27	76.92	-1.01	-0.98
101	73.75	73.66	-1.20	-1.27
131	69.93	70.03	-1.96	-1.99
143P	56.88	56.91	-0.8	-0.8

Drainage data @ P_c = 0.10 bar (air-brine system)

Plug no.	Imp data @ given S_w			
	Imp1 [ohm]	Imp2 [ohm]	Phase1 [deg]	Phase2 [deg]
64	80.06	79.64	-1.03	-0.52
76	72.42	72.07	-0.93	-0.39
84	85.43	85.01	-0.91	-0.45
101	76.38	75.85	-1.25	-0.72
131	73.70	73.03	-1.90	-1.06
143P	59.67	59.42	-0.72	-0.25

Drainage data @ P_c = 0.11 bar (air-brine system)

Plug no.	Imp data @ given Sw			
	Imp1 [ohm]	Imp2 [ohm]	Phase1 [deg]	Phase2 [deg]
64	99.50	99.50	-0.97	-0.97
76	87.62	87.15	-0.99	-0.51
84	102.11	101.65	-0.82	-0.46
101	88.74	88.12	-1.22	-0.76
131	83.06	82.40	-1.65	-0.95
143P	72.42	72.15	-0.63	-0.29

Drainage data @ P_c = 0.13 bar (air-brine system)

Plug no.	Imp data @ given Sw			
	Imp1 [ohm]	Imp2 [ohm]	Phase1 [deg]	Phase2 [deg]
64	114.04	113.41	-1.00	-0.63
76	96.64	96.04	-1.07	-0.61
84	112.17	111.67	-0.79	-0.45
101	98.78	98.09	-1.23	-0.78
131	89.87	89.30	-1.26	-0.73
143P	79.22	78.93	-0.56	-0.26

Drainage data @ P_c = 0.17 bar (air-brine system)

Plug no.	Imp data @ given Sw			
	Imp1 [ohm]	Imp2 [ohm]	Phase1 [deg]	Phase2 [deg]
64	136.21	135.45	-0.98	-0.68
76	112.76	112.08	-0.99	-0.62
84	128.78	128.22	-0.76	-0.49
101	114.87	114.07	-1.18	-0.80
131	101.27	100.70	-1.10	-0.67
143P	88.70	88.37	-0.56	-0.33

Drainage data @ P_c = 0.90 bar (air-brine system)

Plug no.	Imp data @ given Sw			
	Imp1 [ohm]	Imp2 [ohm]	Phase1 [deg]	Phase2 [deg]
64	271.80	270.50	-0.78	-0.76
76	224.20	223.32	-0.61	-0.54
84	255.50	254.60	-0.62	-0.58
101	250.20	248.90	-0.82	-0.76
131	207.60	206.86	-0.65	-0.57
143P	183.70	183.00	-0.56	-0.53

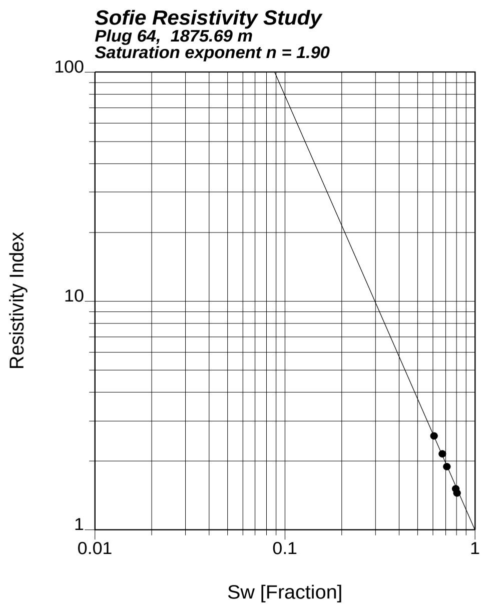
Subject: Resistivity Index measurements	Company: DONG E&P A/S
Plug data at @ 25 °C and overburden conditions	Well: Sofie-1

Plug no : 64
Depth [m] : 1875.69
Formation : Frigg U2

Conventional
Kg : 264 [mD]
He-∅ : 31.4 [%]

Sw [%]	|Zt| [ohm]	Phase [deg.]	RI
80.8	76.1	-0.97	1.45
79.5	79.5	-0.78	1.52
71.5	99.2	-0.97	1.89
67.4	113.4	-0.82	2.16
61.0	135.5	-0.83	2.58
46.6	270.8	-0.77	5.16

|Z0|: 52.49 [ohm]



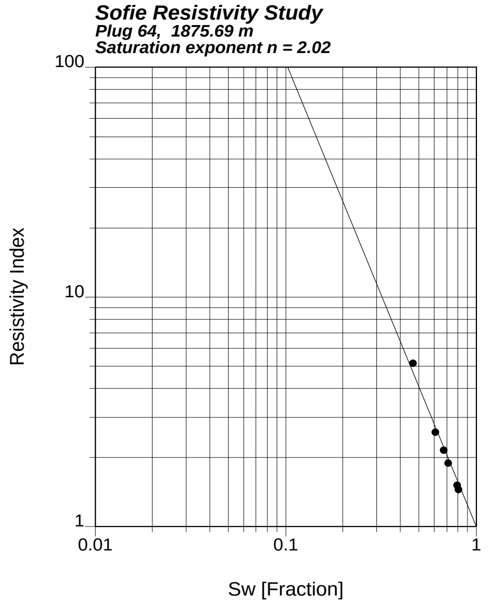
Number of data 5
Number plotted 5

X Variable:
geom. mean 0.716
std. dev. 1.110

Y Variable:
geom. mean 1.876
std. dev. 1.240

Correlation -0.999
Rank correlation -1.000

Regression:
intercept 1.00
slope -1.90



Number of data 6
Number plotted 6

X Variable:
geom. mean 0.667
std. dev. 1.205

Y Variable:
geom. mean 2.220
std. dev. 1.530

Correlation -0.998
Rank correlation -1.000

Regression:
intercept 1.00
slope -2.02

Subject: Resistivity Index measurements	Company: DONG E&P A/S
Plug data at @ 25 °C and overburden conditions	Well: Sofie-1

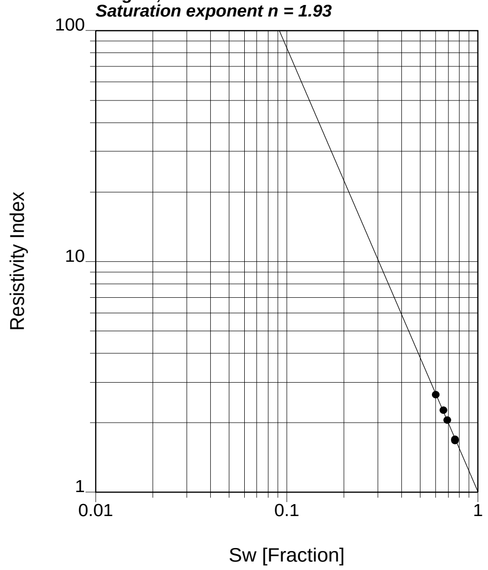
Plug no : 76
Depth [m] : 1878.65
Formation : Frigg U2

Conventional
Kg : 346 [mD]
He-∅ : 34.2 [%]

Sw	|Zt|	Phase	RI
[%]	[ohm]	[deg.]	
76.1	71.0	-0.80	1.67
76.0	71.9	-0.66	1.69
69.0	87.1	-0.75	2.05
65.9	96.0	-0.84	2.26
60.3	112.1	-0.81	2.64
46.2	223.4	-0.58	5.27

|Z0|: 42.44 [ohm]

Sofie Resistivity Study
Plug 76, 1878.65 m
Saturation exponent n = 1.93



Number of data 5
Number plotted 5

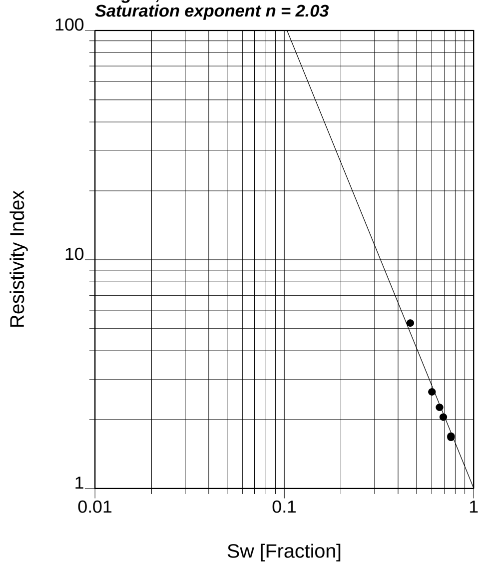
X Variable:
geom. mean 0.692
std. dev. 1.093

Y Variable:
geom. mean 2.031
std. dev. 1.191

Correlation -0.999
Rank correlation -1.000

Regression:
intercept 1.00
slope -1.93

Sofie Resistivity Study
Plug 76, 1878.65 m
Saturation exponent n = 2.03



Number of data 6
Number plotted 6

X Variable:
geom. mean 0.647
std. dev. 1.186

Y Variable:
geom. mean 2.380
std. dev. 1.476

Correlation -0.997
Rank correlation -1.000

Regression:
intercept 1.00
slope -2.03

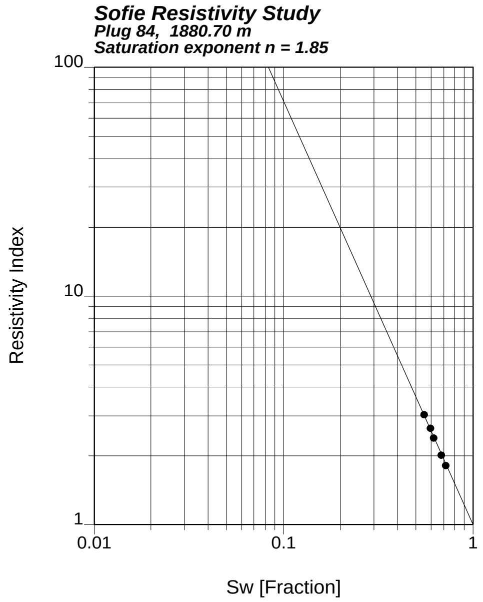
Subject: Resistivity Index measurements	Company: DONG E&P A/S
Plug data at @ 25 °C and overburden conditions	Well: Sofie-1

Plug no : **84**
Depth [m] : **1880.70**
Formation : **Frigg U2**

Conventional
Kg : **410 [mD]**
He-∅ : **34.0 [%]**

Sw [%]	|Zt| [ohm]	Phase [deg.]	RI
71.7	76.3	-1.00	1.81
68.2	84.9	-0.68	2.01
62.2	101.6	-0.64	2.40
59.7	111.6	-0.62	2.64
55.4	128.2	-0.63	3.03
43.6	254.7	-0.60	6.03

|Z0|: 42.25 [ohm]



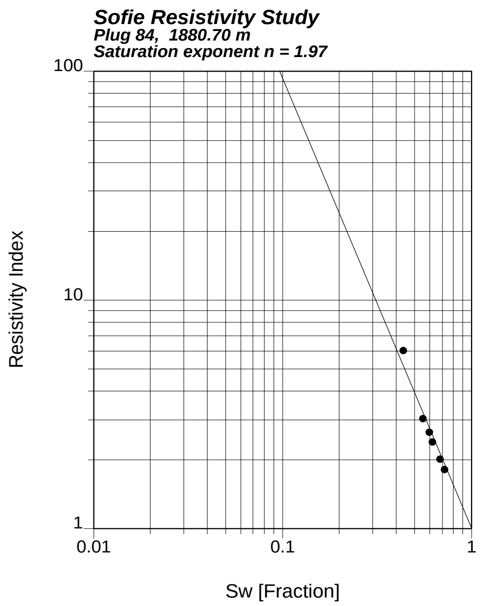
Number of data 5
Number plotted 5

X Variable:
geom. mean 0.632
std. dev. 1.097

Y Variable:
geom. mean 2.338
std. dev. 1.203

Correlation -1.000
Rank correlation -1.000

Regression:
intercept 1.00
slope -1.85



Number of data 6
Number plotted 6

X Variable:
geom. mean 0.594
std. dev. 1.176

Y Variable:
geom. mean 2.738
std. dev. 1.479

Correlation -0.995
Rank correlation -1.000

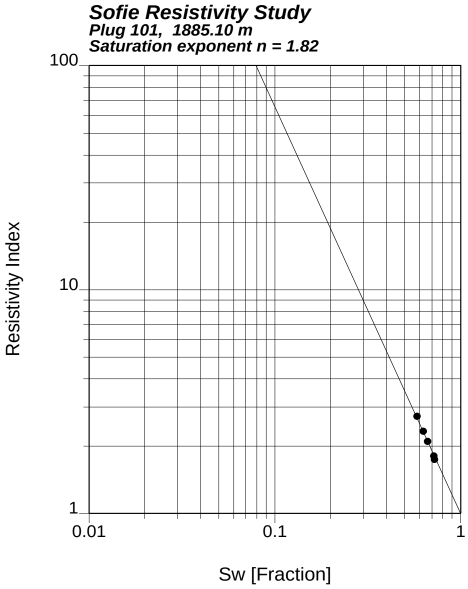
Regression:
intercept 1.00
slope -1.97

Subject: Resistivity Index measurements	**Company: DONG E&P A/S**
Plug data at @ 25 °C and overburden conditions	**Well: Sofie-1**

Plug no :	**101**	**Conventional**			
Depth [m] :	**1885.10**	**K_g :**	**329**	**[mD]**	
Formation :	**Frigg U2**	**He-∅ :**	**33.9**	**[%]**	

Sw [%]	|Zt| [ohm]	Phase [deg.]	RI
72.5	73.4	-1.24	1.75
71.7	75.8	-0.99	1.81
66.3	88.1	-0.99	2.10
63.1	98.1	-1.01	2.34
58.2	114.2	-0.99	2.73
44.4	249.2	-0.79	5.95

$|Z_0|$: 41.89 [ohm]



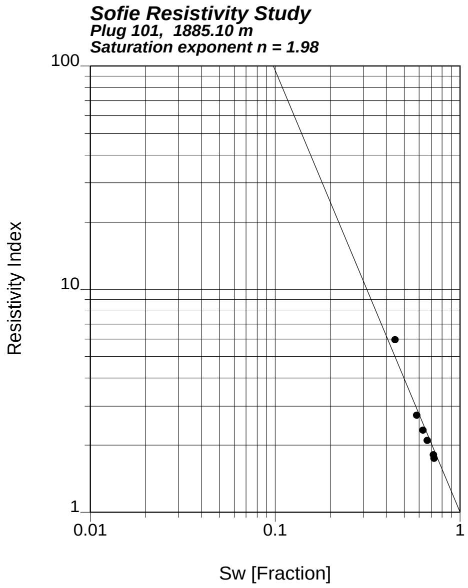
Number of data 5
Number plotted 5

X Variable:
geom. mean 0.661
std. dev. 1.085

Y Variable:
geom. mean 2.117
std. dev. 1.179

Correlation -1.000
Rank correlation -1.000

Regression:
intercept 1.00
slope -1.82



Number of data 6
Number plotted 6

X Variable:
geom. mean 0.619
std. dev. 1.181

Y Variable:
geom. mean 2.515
std. dev. 1.512

Correlation -0.996
Rank correlation -1.000

Regression:
intercept 1.00
slope -1.98

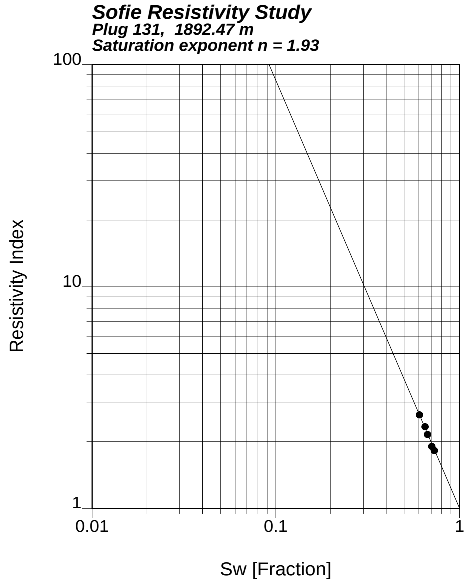
Subject: Resistivity Index measurements **Company: DONG E&P A/S**
Plug data at @ 25 °C and overburden conditions **Well: Sofie-1**

Plug no : **131**
Depth [m] : **1892.47**
Formation : **Frigg U1**

Conventional
Kg : **398 [mD]**
He-∅ : **34.9 [%]**

Sw	|Zt|	Phase	RI
[%]	[ohm]	[deg.]	
73.2	69.7	-1.98	1.83
70.8	73.0	-1.48	1.91
67.2	82.4	-1.30	2.16
65.0	89.3	-1.00	2.34
60.5	100.7	-0.89	2.64
47.7	206.9	-0.61	5.42

|Zo|: 38.16 [ohm]



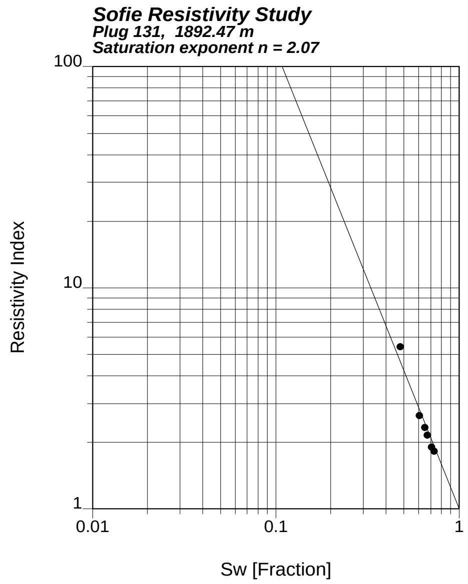
Number of data 5
Number plotted 5

X Variable:
geom. mean 0.672
std. dev. 1.069

Y Variable:
geom. mean 2.157
std. dev. 1.143

Correlation -0.996
Rank correlation -1.000

Regression:
intercept 1.00
slope -1.93



Number of data 6
Number plotted 6

X Variable:
geom. mean 0.635
std. dev. 1.152

Y Variable:
geom. mean 2.515
std. dev. 1.440

Correlation -0.994
Rank correlation -1.000

Regression:
intercept 1.00
slope -2.07

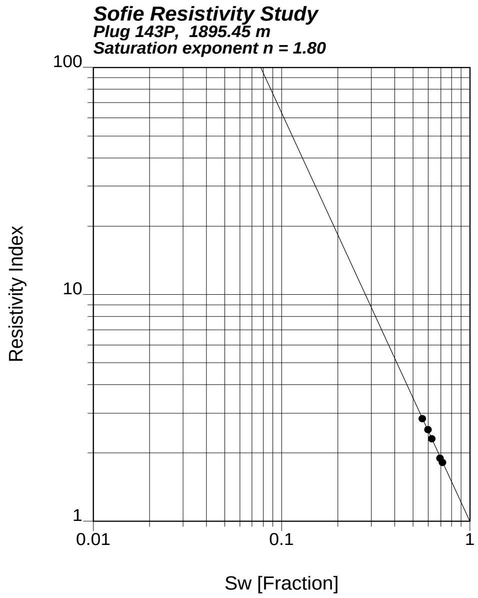
Subject: Resistivity Index measurements **Company: DONG E&P A/S**
Plug data at @ 25 °C and overburden conditions **Well: Sofie-1**

Plug no : 143P
Depth [m] : 1895.45
Formation : Frigg U1

Conventional
Kg : 410 [mD]
He-∅ : 35.3 [%]

Sw	|Zt|	Phase	RI
[%]	[ohm]	[deg.]	
72.1	56.6	-0.80	1.81
69.8	59.2	-0.49	1.90
62.8	72.0	-0.46	2.31
60.0	78.8	-0.41	2.53
56.1	88.2	-0.45	2.83
45.4	183.0	-0.55	5.87

|Z0|: 31.19 [ohm]



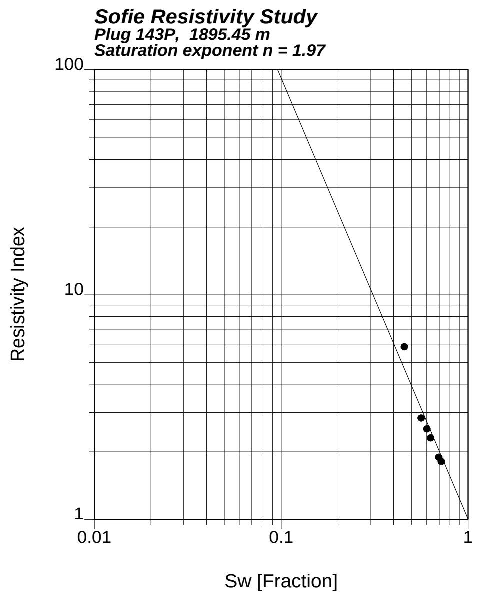
Number of data 5
Number plotted 5

X Variable:
geom. mean 0.639
std. dev. 1.098

Y Variable:
geom. mean 2.244
std. dev. 1.184

Correlation -1.000
Rank correlation -1.000

Regression:
intercept 1.00
slope -1.80



Number of data 6
Number plotted 6

X Variable:
geom. mean 0.603
std. dev. 1.166

Y Variable:
geom. mean 2.634
std. dev. 1.477

Correlation -0.983
Rank correlation -1.000

Regression:
intercept 1.00
slope -1.97

5.4 Core conductivity

Table 5.4.1 is a listing of calculated conductivity values for the complete set of samples; single sample diagrams are presented below.

Measurements were carried out at reservoir temperature 65 °C and hydrostatic overburden pressure 113 bar. Brine conductivity was measured in a calibrated glass conductivity cell at 25 °C and then converted to 65 °C using Arp's equation. The four different brine formulations and measured and calculated physical properties are given in table 5.4.2 below. If the calculated and measured conductivity differs, the calculated value is preferred in calculations and diagrams.

Please observe that only the last 2 core conductivity measurements, called imp 2 and imp 3 in the tables below, have been used in the final calculation of core conductivity.

Table 5.4.1.

Plug	**Depth**	**$Ø_{113\ bar}$**	**F***	**m***	**BQ_v**
no.	**m**	**%**			
67	1876.45	30.6	13.35	2.19	0.921
88	1881.71	32.8	11.20	2.17	2.184
127P	1891.40	34.4	10.21	2.18	3.261
139P	1894.40	33.7	9.78	2.10	0.550

For an explanation to abbreviations used in the tables below, please refer to the nomenclature list at the top of section 5.

Table 5.4.2. Brine concentrations of approx. 40.000, 90.000, 150.000 and 180.000 mg/L were used in the Sofie core conductivity study.

Brine data: **Core conductivity : 40.000 mg/L brine**

Element	Concentration mg/L	Compound	Gram compound per 1 liter	3 liter	5 liter
Na total	12620.0				
Na+	12600	NaCl	32.03	96.09	160.15
Na+	20	NaHCO3	0.07	0.21	0.36
K+	109.0	KCl	0.21	0.62	1.04
Mg2+	265.0	MgCl2, 6H2O	2.22	6.65	11.08
Ca2+		CaCl2	0.00	0.00	0.00
Ca2+	2215.0	CaCl2, 2H2O	8.12	24.37	40.62
Sr2+	285.0	SrCl2, 6H2O	0.87	2.60	4.34
Ba2+		BaCl2, 2H2O	0.00	0.00	0.00
Cl-	24452				
HCO3-	52.0				

TDS: **39998 mg/L** ~ 0.684 mol/L NaCl eqv.

pH: **7.55 @ 23 C**

Comments: Used for Sofie-1 Co/Cw study

Physical data:

Resistivity $R_{w:}$	0.160	Ωm @ 25 °C
Calculated $R_{w:}$	0.162	Ωm @ 25 °C
Density $d_{w:}$	1.025	g/cc @ 25 °C
Calculated $d_{w:}$	1.025	g/cc @ 25 °C
Viscosity $\mu_{w:}$		cP @ 25 °C

Calculated brine conductivity @ 65 °C : 11.483 S/m

Table 5.4.2 continued

Brine data:	Core conductivity : 90.000 mg/L brine

Element	Concentration mg/L	Compound	Gram compound per 1 liter	3 liter	5 liter
Na total	28237.0				
Na+	28194	NaCl	71.67	215.00	358.34
Na+	43	NaHCO3	0.16	0.48	0.79
K+	242.5	KCl	0.46	1.39	2.31
Mg2+	592.5	MgCl2, 6H2O	4.95	14.86	24.77
Ca2+		CaCl2	0.00	0.00	0.00
Ca2+	4955.0	CaCl2, 2H2O	18.18	54.53	90.88
Sr2+	637.5	SrCl2, 6H2O	1.94	5.82	9.70
Ba2+		BaCl2, 2H2O	0.00	0.00	0.00
Cl-	54707				
HCO3-	115.0				

TDS:	**89487**	**mg/L**	~	1.531 mol/L NaCl eqv.
pH:	**7.3**	**@ 23 C**		

Comments: Used for Sofie-1 Co/Cw study

Physical data:			
	Resistivity R_w:	0.082	Ωm @ 25 ^oC
	Calculated R_w:	0.082	Ωm @ 25 ^oC
	Density d_w:	1.0595	g/cc @ 25 ^oC
	Calculated d_w:	1.057	g/cc @ 25 ^oC
	Viscosity μ_w:	1.165	cP @ 25 ^oC

Calculated brine conductivity @ 65 ^oC 22.686 S/m

Table 5.4.2 continued

Brine data: | **Core conductivity : 150.000 mg/L brine**

Element	Concentration mg/L	Compound	Gram compound per 1 liter	3 liter	5 liter
Na total	47330.0				
Na+	47257	NaCl	120.13	360.38	600.64
Na+	73	NaHCO3	0.27	0.80	1.33
K+	406.5	KCl	0.78	2.33	3.88
Mg2+	993.2	MgCl2, 6H2O	8.31	24.92	41.53
Ca2+		CaCl2	0.00	0.00	0.00
Ca2+	8305.6	CaCl2, 2H2O	30.47	91.40	152.33
Sr2+	1068.6	SrCl2, 6H2O	3.25	9.75	16.26
Ba2+		BaCl2, 2H2O	0.00	0.00	0.00
Cl-	91699				
HCO3-	192.8				

TDS: **149996 mg/L** ~ 2.567 mol/L NaCl eqv.

pH: **6.63 @ 23 C**

Comments: Used for Sofie-1 Co/Cw study

Physical data:			
	Resistivity $R_{w:}$	0.056	Ωm @ 25 ^oC
	Calculated $R_{w:}$	0.056	Ωm @ 25 ^oC
	Density $d_{w:}$	1.0995	g/cc @ 25 ^oC
	Calculated $d_{w:}$	1.096	g/cc @ 25 ^oC
	Viscosity $\mu_{w:}$		cP @ 25 ^oC

Calculated brine conductivity @ 65 ^oC **33.218 S/m**

Table 5.4.2 continued

Brine data: | **Core conductivity : 180.000 mg/L brine**

Element	Concentration	Compound	Gram compound per		
	mg/L		1 liter	3 liter	5 liter
Na total	56799.0				
Na+	56712	NaCl	144.16	432.48	720.80
Na+	87	NaHCO3	0.32	0.96	1.59
K+	487.8	KCl	0.93	2.79	4.65
Mg2+	1191.6	MgCl2, 6H2O	9.96	29.89	49.82
Ca2+		CaCl2	0.00	0.00	0.00
Ca2+	9966.6	CaCl2, 2H2O	36.56	109.68	182.80
Sr2+	1282.5	SrCl2, 6H2O	3.90	11.71	19.51
Ba2+		BaCl2, 2H2O	0.00	0.00	0.00
Cl-	110043				
HCO3-	231.3				

TDS: **180002 mg/L** ~ 3.080 mol/L NaCl eqv.

pH: **6.74 @ 23 C**

Comments: Used for Sofie-1 Co/Cw study

Physical data:

Resistivity R_{w} :	0.051	Ωm @ 25 ^{o}C
Calculated R_{w} :	0.050	Ωm @ 25 ^{o}C
Density d_{w} :	1.118	g/cc @ 25 ^{o}C
Calculated d_{w} :	1.115	g/cc @ 25 ^{o}C
Viscosity μ_{w} :		cP @ 25 ^{o}C

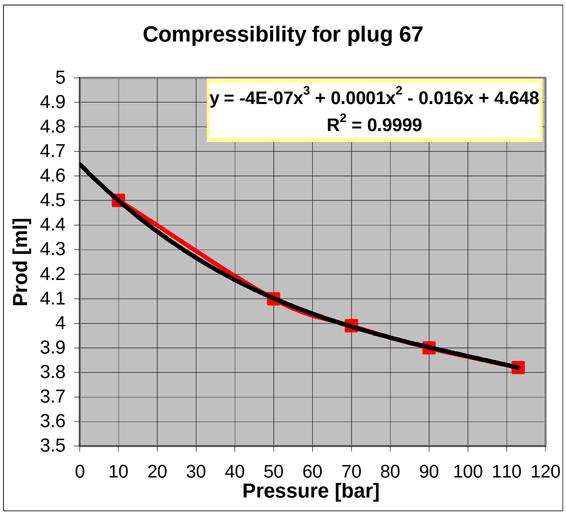
Calculated brine conductivity @ 65 ^{o}C **37.204 S/m**

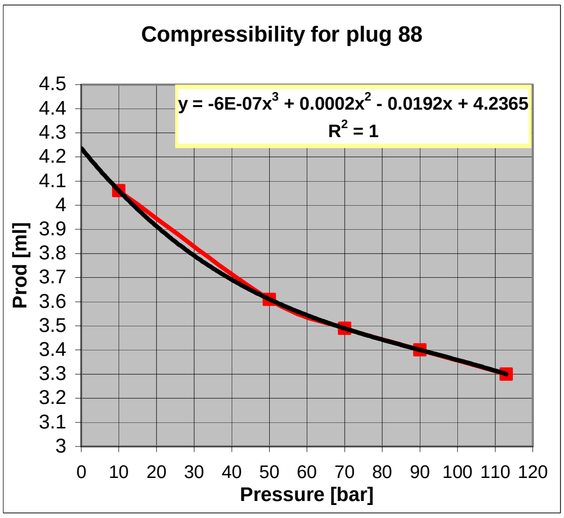
Subject: Electrical properties	:ompany: DONG E&P A/S
Core conductivity measurements	Well: Sofie-1
@ reservoir conditions	GEUS Core Lab, 25.04.2004

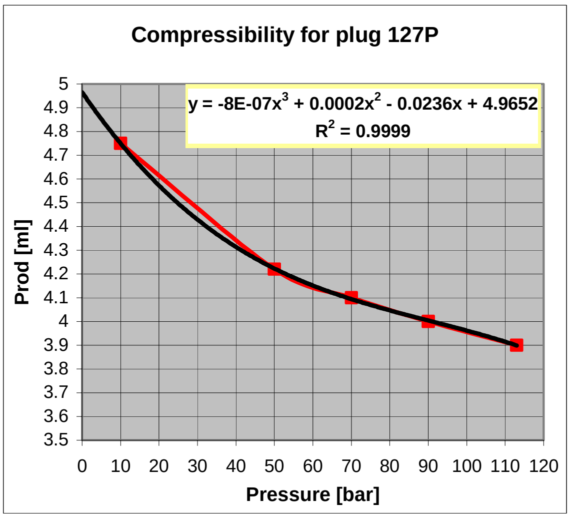
Compressibility data:

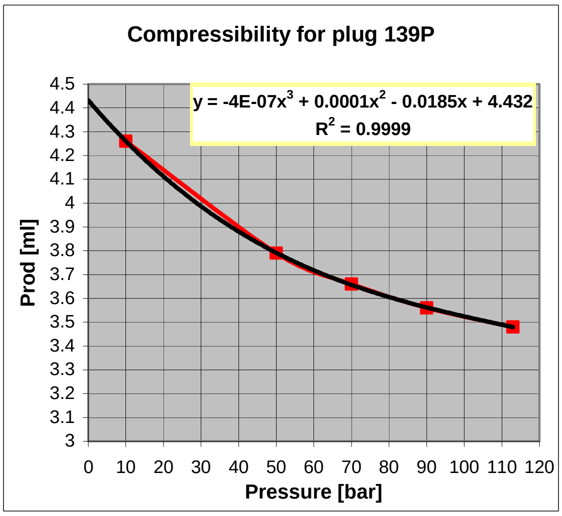
Initial confining pressure:	10	bar	hydrostatic
Final confining pressure:	113	bar	hydrostatic

Plug no	Depth	CCAL data @ room cond.			ml] read from graduated glass tube @ given pressur					PV_0 from plot	delta $PV_{113\ bar}$
	m	BV, cc	PV1, cc	Ø , %	10	50	70	90	113	[ml]	[ml]
67	1876.45	53.36	16.90	31.68	4.50	4.10	3.99	3.90	3.82	4.65	0.83
88	1881.71	52.18	17.76	34.03	4.06	3.61	3.49	3.40	3.30	4.24	0.94
127P	1891.40	46.05	16.56	35.97	4.75	4.22	4.10	4.00	3.90	4.97	1.07
139P	1894.40	47.25	16.57	35.06	4.26	3.79	3.66	3.56	3.48	4.43	0.95









Subject: Electrical properties
Core conductivity measurements
@ reservoir conditions

Company: DONG E&P A/S
Well: Sofie-1
GEUS Core Lab, 25.04.2004

Room condition data: @ 25 °C

Formation brine resistivity, R_w: 0.082 ohmm @ 25 °C
Confining pressure: 10 bar hydrostatic

Plug and cell impedance measured @ 10 kHz
Intrinsic cell impedance: 0.3 ohm

Plug no.	Depth	CCAL data @ room cond.			Plug resistivity data @ room cond.			
	m	BV, cc	PV1, cc	**Ø , %**	$\lvert Z_0 \rvert$, ohm	Phase, deg.	**FRF**	τ
67	1876.45	53.36	16.90	31.68	43.81	-0.60	12.22	3.87
88	1881.71	52.18	17.76	34.03	40.67	-1.12	11.38	3.87
127P	1891.40	46.05	16.56	35.97	32.92	-0.48	9.81	3.53
139P	1894.40	47.25	16.57	35.06	33.25	-0.69	9.87	3.46

Imp data					
Imp1, ohm	Imp2, ohm	Imp3, ohm	Phase1, deg.	Phase2, deg.	Phase3, deg.
44.11	44.11	44.11	-0.60	-0.60	-0.60
40.97	40.97	40.97	-1.12	-1.12	-1.12
33.22	33.22	33.22	-0.48	-0.48	-0.48
33.55	33.55	33.55	-0.69	-0.69	-0.69

Reservoir condition data: @ 65 °C

Formation brine resistivity, R_w: 0.044 ohmm @ 65 °C
Confining pressure: 113 bar hydrostatic

Plug no.	Depth	Plug data @ reservoir cond.				
	m	Δ $PV_{113\ bar}$, cc	$PV_{113\ bar}$, cc	**$Ø_{113\ bar}$, %**	$L_{113\ bar}$, cm	$A_{113\ bar}$, cm2
67	1876.45	0.83	16.07	30.60	4.805	10.93
88	1881.71	0.94	16.82	32.82	4.740	10.81
127P	1891.40	1.07	15.49	34.45	4.308	10.44
139P	1894.40	0.95	15.62	33.73	4.375	10.58

Plug compressibility data @ 113 bar				
$L_{caliper}$, cm	A_{calc}, cm2	$BV_{113\ bar}$, cc	Δ $BV_{113\ bar}$, %	a
4.830	11.05	52.53	1.56	0.0052
4.769	10.94	51.24	1.80	0.0060
4.342	10.61	44.98	2.32	0.0077
4.405	10.73	46.30	2.01	0.0067

Core conductivity data: @ 65 °C

40.000 mg/L brine conductivity, C_{w1} : 11.626 S/m @ 65 °C

Plug no.	Depth	Plug data @ reservoir cond.			
	m	$\|Z_0\|$, ohm	Phase, deg.	R_0, ohmm	C_{o1}, S/m
67	1876.45	45.74	-0.40	1.041	0.961
88	1881.71	35.27	-0.32	0.804	1.243
127P	1891.40	28.54	-0.41	0.692	1.446
139P	1894.40	31.42	-0.56	0.760	1.316

Imp data, 40.000 mg/L					
Imp1, ohm	Imp2, ohm	Imp3, ohm	Phase1, deg.	Phase2, deg.	Phase3, deg.
40.01	46.16	45.91	-0.3	-0.38	-0.41
34.83	36.07	35.07	-0.31	-0.30	-0.34
28.07	28.93	28.75	-0.40	-0.42	-0.40
34.48	32.63	30.81	-0.59	-0.53	-0.55

89.487 mg/L brine conductivity, C_{w2} : 22.686 S/m @ 65 °C

Plug no.	Depth	Plug data @ reservoir cond.			
	m	$\|Z_0\|$, ohm	Phase, deg.	R_0, ohmm	C_{o2}, S/m
67	1876.45	25.59	-0.30	0.582	1.718
88	1881.71	20.20	-0.10	0.461	2.171
127P	1891.40	16.35	-0.20	0.396	2.525
139P	1894.40	18.54	-0.57	0.448	2.231

Imp data, 89.487 mg/L					
Imp1, ohm	Imp2, ohm	Imp3, ohm	Phase1, deg.	Phase2, deg.	Phase3, deg.
26.27	26.08	25.69	-0.4	-0.30	-0.30
20.84	20.72	20.28	-0.10	-0.10	-0.10
17.61	16.75	16.54	-0.20	-0.20	-0.20
20.27	18.65	19.02	-0.70	-0.50	-0.50

150.000 mg/L brine conductivity, C_{w3} : 33.218 S/m @ 65 °C

Plug no.	Depth	Plug data @ reservoir cond.			
	m	$\|Z_0\|$, ohm	Phase, deg.	R_0, ohmm	C_{o3}, S/m
67	1876.45	17.37	-0.20	0.395	2.531
88	1881.71	13.76	0.11	0.314	3.187
127P	1891.40	11.44	0.01	0.277	3.607
139P	1894.40	12.00	-0.30	0.290	3.446

Imp data, 150.000 mg/L					
Imp1, ohm	Imp2, ohm	Imp3, ohm	Phase1, deg.	Phase2, deg.	Phase3, deg.
18.15	17.72	17.61	-0.20	-0.20	-0.20
14.18	14.10	14.02	0.10	0.13	0.11
11.72	11.73	11.75	-0.01	0.03	0.01
13.03	12.38	12.22	-0.38	-0.27	-0.26

180.000 mg/L brine conductivity, C_{w4} : 36.475 S/m @ 65 °C

Plug no.	Depth	Plug data @ reservoir cond.			
	m	$\|Z_0\|$, ohm	Phase, deg.	R_0, ohmm	C_{o4}, S/m
67	1876.45	15.17	-0.06	0.345	2.898
88	1881.71	12.48	0.22	0.285	3.514
127P	1891.40	10.30	0.17	0.250	4.007
139P	1894.40	10.51	-0.17	0.254	3.936

Imp data, 180.000 mg/L					
Imp1, ohm	Imp2, ohm	Imp3, ohm	Phase1, deg.	Phase2, deg.	Phase3, deg.
15.84	15.48	15.45	-0.05	-0.03	-0.10
12.88	12.81	12.75	0.22	0.24	0.20
10.85	10.63	10.57	0.20	0.17	0.14
11.17	10.82	10.79	-0.22	-0.12	-0.16

Subject: Electrical properties	Company: DONG E&P A/S
Core conductivity measurements at reservoir conditions,	Well: Sofie-1
113 bar hydrostatic loading, 65 °C reservoir temperature	GEUS Core Lab, 25.04.2004

Plug no : 67
Depth, m : 1876.45
Formation : Frigg U2

Conventional
Kg [mD] : 317
He-∅ [%] : 31.8

Brine concentration K [mg/L]	Brine conductivity Cw [S/m]	Core conductivity Co [S/m]
40,000	11.483	0.96
89,487	22.686	1.72
150,000	33.218	2.53
180,000	37.204	2.90

∅113 bar :	0.306
1/F* :	0.0749
BQv :	0.921
F* :	13.35

m* :	**2.19**

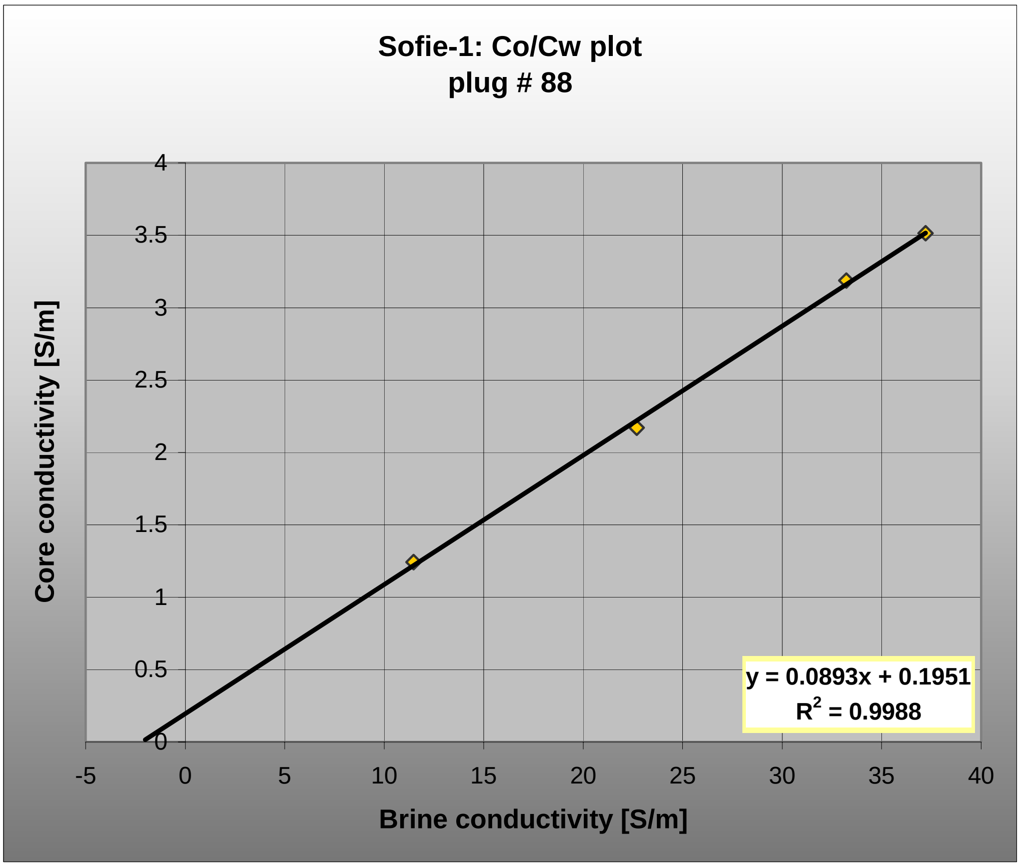
Subject: Electrical properties	Company: DONG E&P A/S
Core conductivity measurements at reservoir conditions,	Well: Sofie-1
113 bar hydrostatic loading, 65 °C reservoir temperature	GEUS Core Lab, 25.04.2004

Plug no : 88
Depth, m : 1881.71
Formation : Frigg U2

Conventional
Kg [mD] : 375
He-∅ [%] 34.0

Brine concentration K [mg/L]	Brine conductivity Cw [S/m]	Core conductivity Co [S/m]
40,000	11.483	1.24
89,487	22.686	2.17
150,000	33.218	3.19
180,000	37.204	3.51

∅113 bar :	0.328
1/F* :	0.0893
BQv :	2.184
F* :	11.20
m* :	**2.17**



Subject: Electrical properties	Company: DONG E&P A/S
Core conductivity measurements at reservoir conditions,	Well: Sofie-1
113 bar hydrostatic loading, 65 °C reservoir temperature	GEUS Core Lab, 25.04.2004

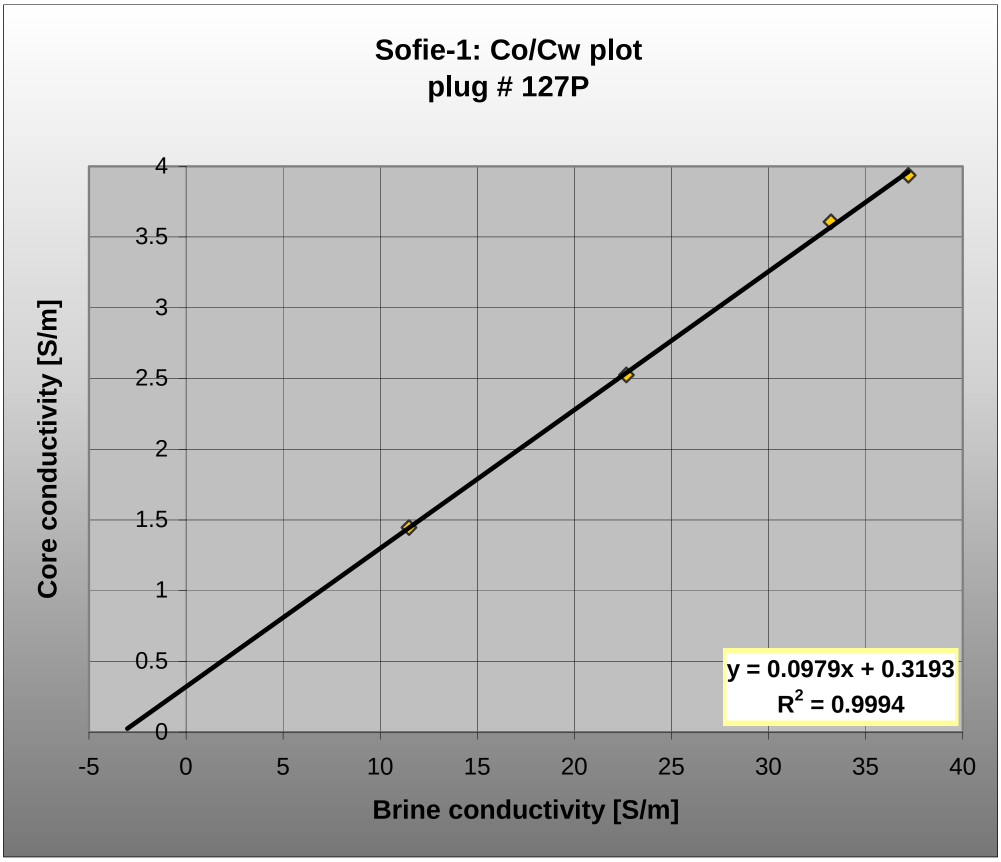
Plug no : 127P
Depth, m : 1891.40
Formation Frigg U1

Conventional
Kg [mD] : 363
He-∅ [%] 35.5

Brine concentration K [mg/L]	Brine conductivity C_w [S/m]	Core conductivity C_o [S/m]
40,000	11.483	1.45
89,487	22.686	2.52
150,000	33.218	3.61
180,000	37.204	3.94

∅113 bar :	0.344
1/F* :	0.0979
BQv :	3.261
F* :	10.21

m* : 2.18



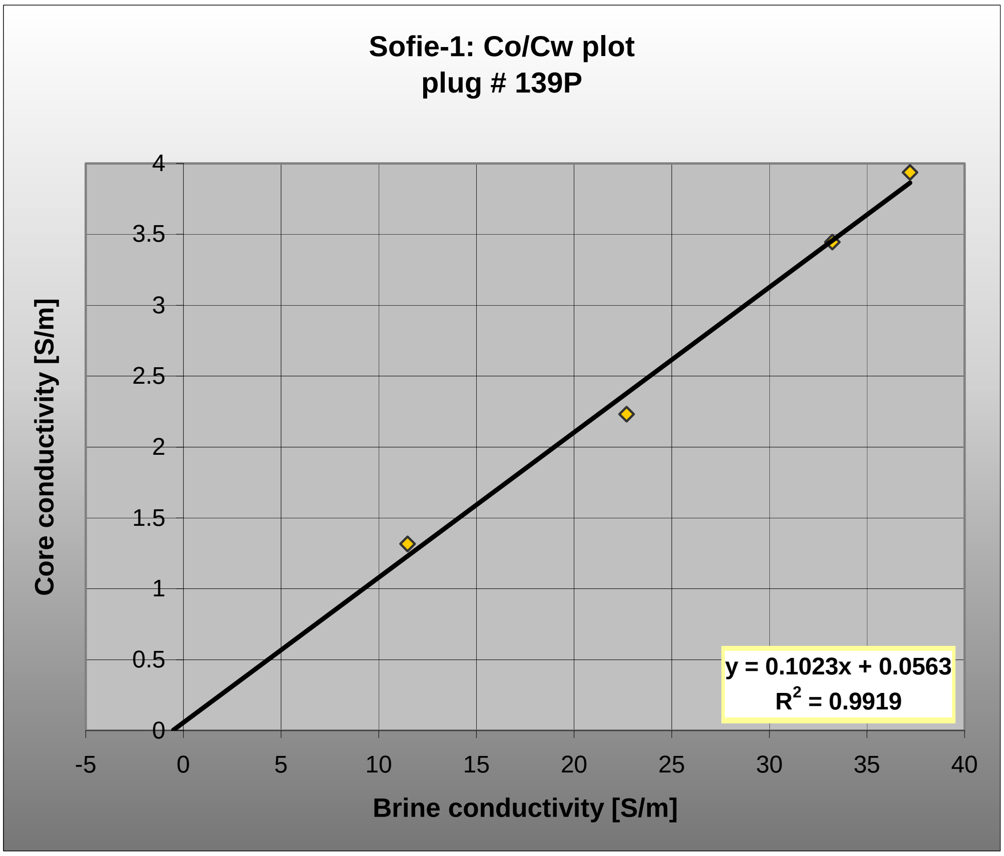
Subject: Electrical properties	Company: DONG E&P A/S
Core conductivity measurements at reservoir conditions,	Well: Sofie-1
113 bar hydrostatic loading, 65 °C reservoir temperature	GEUS Core Lab, 25.04.2004

Plug no : **139P**
Depth, m : **1894.40**
Formation : **Frigg U1**

Conventional
Kg [mD] : **393**
He-∅ [%] **35.1**

Brine concentration K [mg/L]	Brine conductivity Cw [S/m]	Core conductivity Co [S/m]
40,000	11.483	1.32
89,487	22.686	2.23
150,000	33.218	3.45
180,000	37.204	3.94

∅113 bar :	0.337
1/F* :	0.1023
BQv :	0.550
F* :	9.78
m* :	**2.10**



5.5 Cation Exchange Capacity

Plugs used in the core conductivity study were cleaned in methanol, dried and forwarded for CEC measurement.

Sample ID	Depth, m	CEC	Adsorped	Adsorped	Adsorped	Adsorped
		Na	Na	K	Mg	Ca
		meq Na/100g	meq Na/100g	meq K/100g	meq Mg/100g	meq Ca/100g
67	1876,45	12	7.4	0.5	0.6	3.2
88	1881,71	17	6.9	0.5	0.8	3.4
127P	1891,47	12	5.0	0.4	0.8	3.5
139P	1894,49	15	6.8	0.5	0.3	2.5

5.6 Grain size

Four vertical routine plugs were cleaned and dried and used for grain size analysis; data are shown in the diagrams below.

Grain Size Distribution

Geological

Sample Id: 73 V
Lab. Id: 04008
Submitter: DONG
Subject: SOFIE-1
Date: januar 2004
Executed: I. Nørgaard.
Remarks:

GEUS
Øster Voldgade 10
DK-1350 Copenhagen K
Phone: +45 38 14 20 00
Fax: +45 38 14 20 50
Email: GEUS@geus.dk
www.geus.dk

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Fractions

Sieve Analysis

		Size	Size	Weight	Weight	Cumulated amount in sieve
		mm	Φ	g	%	%
Gravel		16.00	-4.00	0.00	0.00	0.00
Gravel		8.00	-3.00	0.00	0.00	0.00
Gravel		4.00	-2.00	0.00	0.00	0.00
Gravel		2.80	-1.49	0.00	0.00	0.00
Gravel		2.00	-1.00	0.00	0.00	0.00
Sand		1.40	-0.49	0.00	0.00	0.00
Sand		1.00	0.00	0.00	0.00	0.00
Sand		0.710	0.49	0.00	0.00	0.00
Sand		0.500	1.00	0.00	0.00	0.00
Sand		0.355	1.49	0.00	0.00	0.00
Sand		0.250	2.00	0.02	0.02	0.02
Sand		0.180	2.47	4.55	4.56	4.58
Sand		0.125	3.00	42.66	42.78	47.36
Sand		0.090	3.47	26.98	27.05	74.41
Sand		0.075	3.74	5.48	5.49	79.91
Sand		0.063	3.99	2.69	2.70	82.60
		< 0,063	> 3,99	17.35	17.40	100.00

Total Weight 99.73

Size Classes (DGF-Bulletin 1 1988)

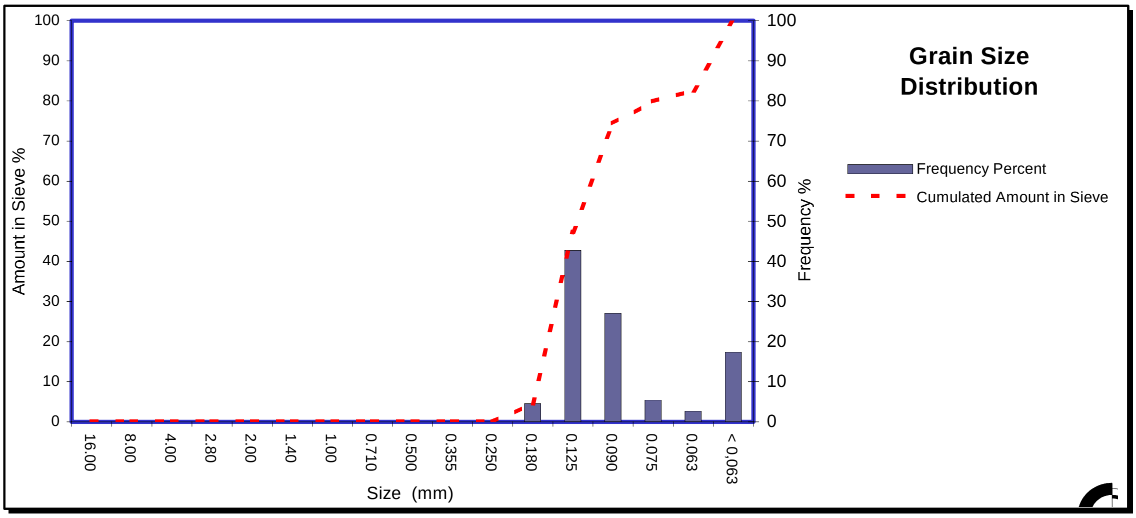
		Weight %
Silt and clay	(< 0,063 mm):	17.40
Sand, fine	(0,063 mm - 0,200 mm):	79.32
Sand, medium	(0,2 mm - 0,6 mm):	3.28
Sand, coarse	(0,6 mm - 2 mm):	0.00
Gravel	(> 2 mm):	0.00
Sum:		100.00

Moments Measures

Percentile Amount in sieve	Percentile Amount passing	d(mm)	Φ
5%	95%	0.18	2.48
16%	84%	0.17	2.60
25%	75%	0.15	2.70
40%	60%	0.13	2.89
Median 50%	50%	0.12	3.04
75%	25%	0.09	3.50
84%	16%	-------	-------
90%	10%	-------	-------
95%	5%	-------	-------

Moments Statistics

Mean	2.82
Sorting	-------
Skewness	-------
Kurtosis	-------
Uniformity Coefficient	-------



Formulas and notes

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)
Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%–ϕ5%) / 6,6 (Folk and Ward 1957)
Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)
Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)
Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve".
Uniformity coefficient is based on "Amount passing".
Size Classes and Percentiles are found by linear interpolation

Grain Size Distribution

Geological

Sample Id: 89 V
Lab. Id: 04009
Submitter: DONG
Subject: SOFIE-1
Date: januar 2004
Executed: I. Nørgaard.
Remarks:

GEUS
Øster Voldgade 10
DK-1350 Copenhagen K
Phone: +45 38 14 20 00
Fax: +45 38 14 20 50
Email: GEUS@geus.dk
www.geus.dk

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount in sieve
	mm	Φ	g	%	%
Gravel	16.00	-4.00	0.00	0.00	0.00
Gravel	8.00	-3.00	0.00	0.00	0.00
Gravel	4.00	-2.00	0.00	0.00	0.00
Gravel	2.80	-1.49	0.00	0.00	0.00
Gravel	2.00	-1.00	0.00	0.00	0.00
Sand	1.40	-0.49	0.00	0.00	0.00
Sand	1.00	0.00	0.00	0.00	0.00
Sand	0.710	0.49	0.00	0.00	0.00
Sand	0.500	1.00	0.00	0.00	0.00
Sand	0.355	1.49	0.00	0.00	0.00
Sand	0.250	2.00	0.08	0.08	0.08
Sand	0.180	2.47	5.44	5.60	5.68
Sand	0.125	3.00	43.97	45.23	50.91
Sand	0.090	3.47	23.15	23.81	74.72
Sand	0.075	3.74	5.20	5.35	80.07
Sand	0.063	3.99	2.12	2.18	82.25
	< 0,063	> 3,99	17.26	17.75	100.00

Total Weight 97.22

Size Classes (DGF-Bulletin 1 1988)

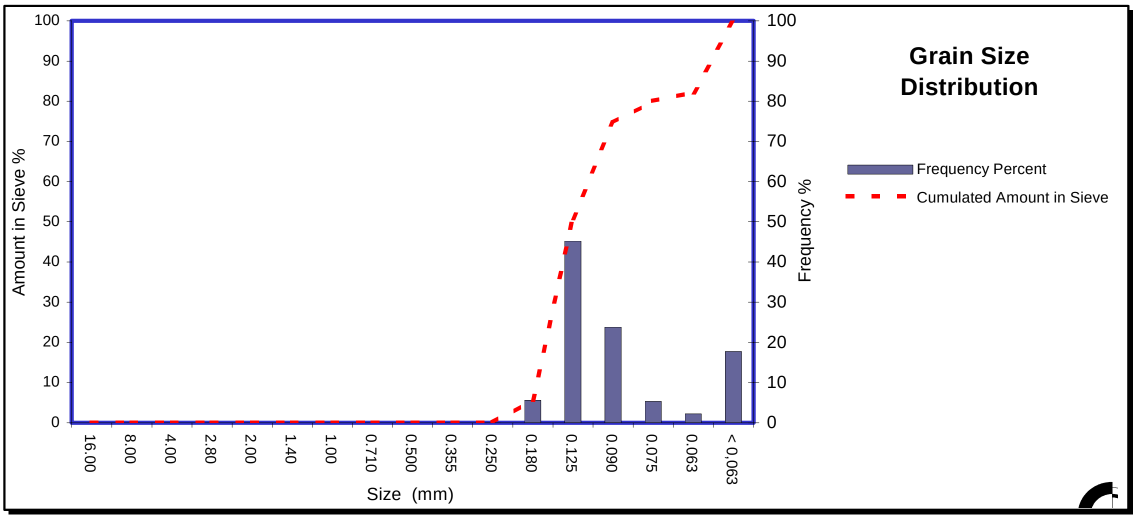
		Weight %
Silt and clay	(< 0,063 mm):	17.75
Sand, fine	(0,063 mm - 0,200 mm):	78.17
Sand, medium	(0,2 mm - 0,6 mm):	4.08
Sand, coarse	(0,6 mm - 2 mm):	0.00
Gravel	(> 2 mm):	0.00
Sum:		100.00

Moments Measures

Percentile Amount in sieve	Percentile Amount passing	d(mm)	Φ
5%	95%	0.19	2.41
16%	84%	0.17	2.58
25%	75%	0.16	2.68
40%	60%	0.14	2.85
Median 50%	50%	0.13	2.99
75%	25%	0.09	3.49
84%	16%	-------	-------
90%	10%	-------	-------
95%	5%	-------	-------

Moments Statistics

Mean	2.78
Sorting	-------
Skewness	-------
Kurtosis	-------
Uniformity Coefficient	-------



Formulas and notes

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)
Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%–ϕ5%) / 6,6 (Folk and Ward 1957)
Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)
Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)
Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve".
Uniformity coefficient is based on "Amount passing".
Size Classes and Percentiles are found by linear interpolation

Grain Size Distribution
Geological

Sample Id: 129 V
Lab. Id: 04010
Submitter: DONG
Subject: SOFIE-1
Date: januar 2004
Executed: I. Nørgaard.
Remarks:

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Øster Voldgade 10
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Fax: +45 38 14 20 50
Email: GEUS@geus.dk
www.geus.dk

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount in sieve
	mm	Φ	g	%	%
Gravel	16.00	-4.00	0.00	0.00	0.00
	8.00	-3.00	0.00	0.00	0.00
	4.00	-2.00	0.00	0.00	0.00
	2.80	-1.49	0.00	0.00	0.00
	2.00	-1.00	0.00	0.00	0.00
Sand	1.40	-0.49	0.00	0.00	0.00
	1.00	0.00	0.00	0.00	0.00
	0.710	0.49	0.00	0.00	0.00
	0.500	1.00	0.00	0.00	0.00
	0.355	1.49	0.00	0.00	0.00
	0.250	2.00	1.54	1.40	1.40
	0.180	2.47	13.12	11.93	13.33
	0.125	3.00	38.22	34.76	48.10
	0.090	3.47	18.66	16.97	65.07
	0.075	3.74	4.71	4.28	69.36
	0.063	3.99	2.50	2.27	71.63
	< 0,063	> 3,99	31.19	28.37	100.00

Total Weight 109.94

Size Classes (DGF-Bulletin 1 1988)

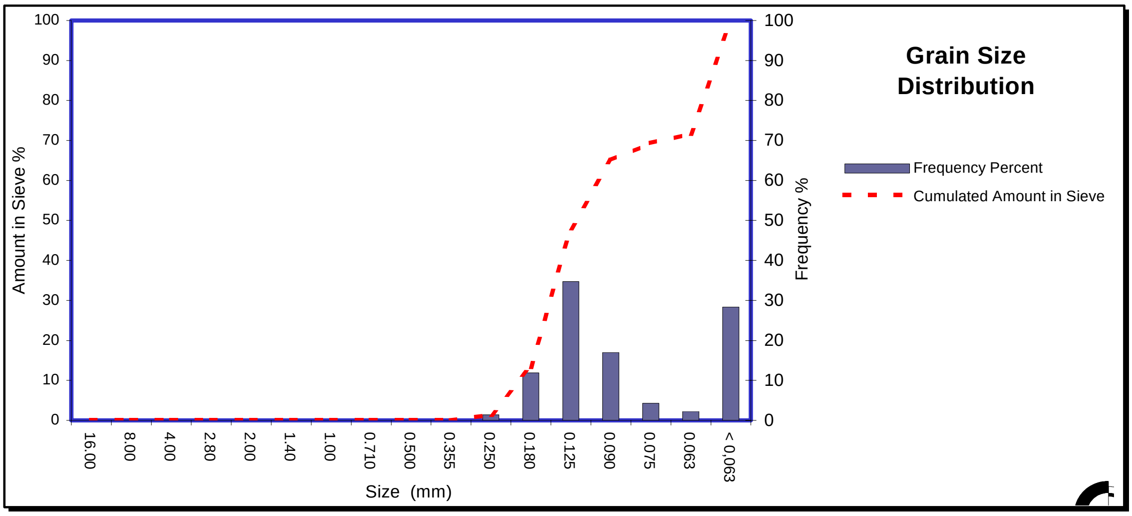
		Weight %
Silt and clay	(< 0,063 mm):	28.37
Sand, fine	(0,063 mm - 0,200 mm):	61.71
Sand, medium	(0,2 mm - 0,6 mm):	9.92
Sand, coarse	(0,6 mm - 2 mm):	0.00
Gravel	(> 2 mm):	0.00
Sum:		100.00

Moments Measures

Percentile Amount in sieve	Percentile Amount passing	d(mm)	Φ
5%	95%	0.23	2.13
16%	84%	0.18	2.51
25%	75%	0.16	2.63
40%	60%	0.14	2.86
Median 50%	50%	0.12	3.05
75%	25%	-------	-------
84%	16%	-------	-------
90%	10%	-------	-------
95%	5%	-------	-------

Moments Statistics

Mean	2.78
Sorting	-------
Skewness	-------
Kurtosis	-------
Uniformity Coefficient	-------



Formulas and notes

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)
Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%–ϕ5%) / 6,6 (Folk and Ward 1957)
Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)
Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)
Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve".
Uniformity coefficient is based on "Amount passing".
Size Classes and Percentiles are found by linear interpolation

Grain Size Distribution

Geological

Sample Id: 145 V
Lab. Id: 04011
Submitter: DONG
Subject: SOFIE-1
Date: januar 2004
Executed: I. Nørgaard.
Remarks:

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DK-1350 Copenhagen K
Phone: +45 38 14 20 00
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www.geus.dk

The analysis is executed according to DS 405.9 extended by sieves to the ½ phi scale

Size Fractions

Sieve Analysis

	Size	Size	Weight	Weight	Cumulated amount in sieve
	mm	Φ	g	%	%
Gravel	16.00	-4.00	0.00	0.00	0.00
	8.00	-3.00	0.00	0.00	0.00
	4.00	-2.00	0.00	0.00	0.00
	2.80	-1.49	0.00	0.00	0.00
	2.00	-1.00	0.00	0.00	0.00
Sand	1.40	-0.49	0.00	0.00	0.00
	1.00	0.00	0.00	0.00	0.00
	0.710	0.49	0.00	0.00	0.00
	0.500	1.00	0.00	0.00	0.00
	0.355	1.49	0.01	0.01	0.01
	0.250	2.00	0.50	0.50	0.51
	0.180	2.47	9.61	9.67	10.18
	0.125	3.00	42.75	43.00	53.17
	0.090	3.47	20.92	21.04	74.21
	0.075	3.74	5.17	5.20	79.41
	0.063	3.99	2.61	2.62	82.04
	< 0,063	> 3,99	17.86	17.96	100.00

Total Weight 99.43

Size Classes (DGF-Bulletin 1 1988)

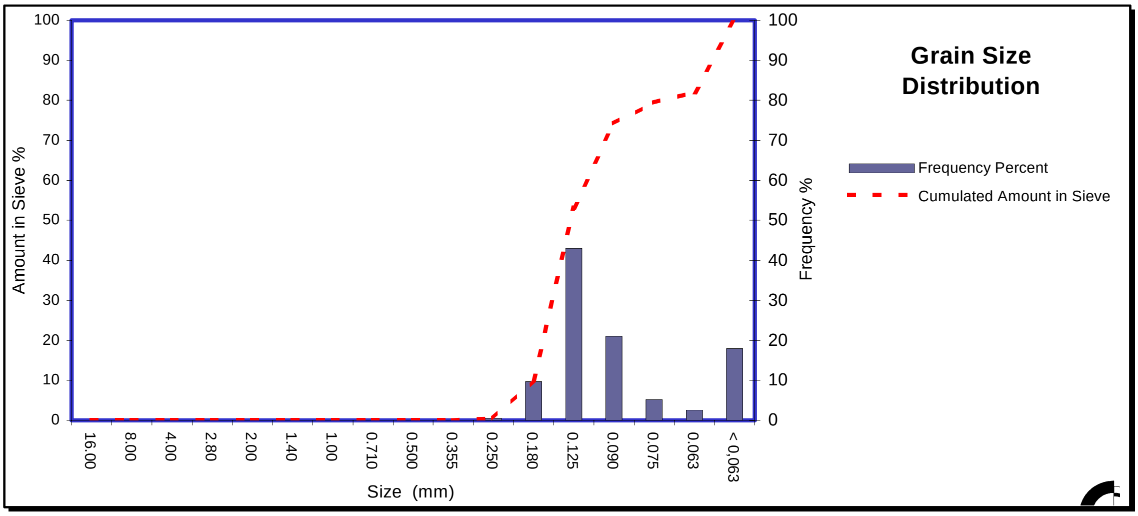
		Weight %
Silt and clay	(< 0,063 mm):	17.96
Sand, fine	(0,063 mm - 0,200 mm):	74.62
Sand, medium	(0,2 mm - 0,6 mm):	7.42
Sand, coarse	(0,6 mm - 2 mm):	0.00
Gravel	(> 2 mm):	0.00
Sum:		100.00

Moments Measures

Percentile Amount in sieve	Percentile Amount passing	d(mm)	Φ
5%	95%	0.22	2.20
16%	84%	0.17	2.53
25%	75%	0.16	2.63
40%	60%	0.14	2.82
Median 50%	50%	0.13	2.95
75%	25%	0.09	3.51
84%	16%	-------	-------
90%	10%	-------	-------
95%	5%	-------	-------

Moments Statistics

Mean	2.74
Sorting	-------
Skewness	-------
Kurtosis	-------
Uniformity Coefficient	-------



Formulas and notes

Mean (ϕ16%+ϕ84%+ϕ50%) / 3 (Folk and Ward 1957)
Sorting (ϕ84%-ϕ16%) / 4 + (ϕ95%–ϕ5%) / 6,6 (Folk and Ward 1957)
Kurtosis (ϕ95% - ϕ5%) / (2,44 * (ϕ75% - ϕ25%)) (Folk and Ward 1957)
Uniformity Coefficient (d60% / d10%) (dgf-Bulletin 1988)
Skewness (ϕ16%+ϕ84% - 2*ϕ50%) / (2*(ϕ84%-ϕ16%)) + (ϕ5%+ϕ95% - 2*ϕ50%) / (2*(ϕ95%-ϕ5%)) (Folk and Ward 1957)

Mean, sorting, skewness and kurtosis are based on "Amount in sieve".
Uniformity coefficient is based on "Amount passing".
Size Classes and Percentiles are found by linear interpolation

6 References

1. Conventional core analysis report, Sofie-1, 5605/13-3. Report no. AF805.
Robertson Research International Ltd., 2003

2. SCA Guidelines for sample preparation and porosity measurement of electrical resistivity samples, part I-IV.
The Log Analyst, **31**, 1 & 2, 1990.

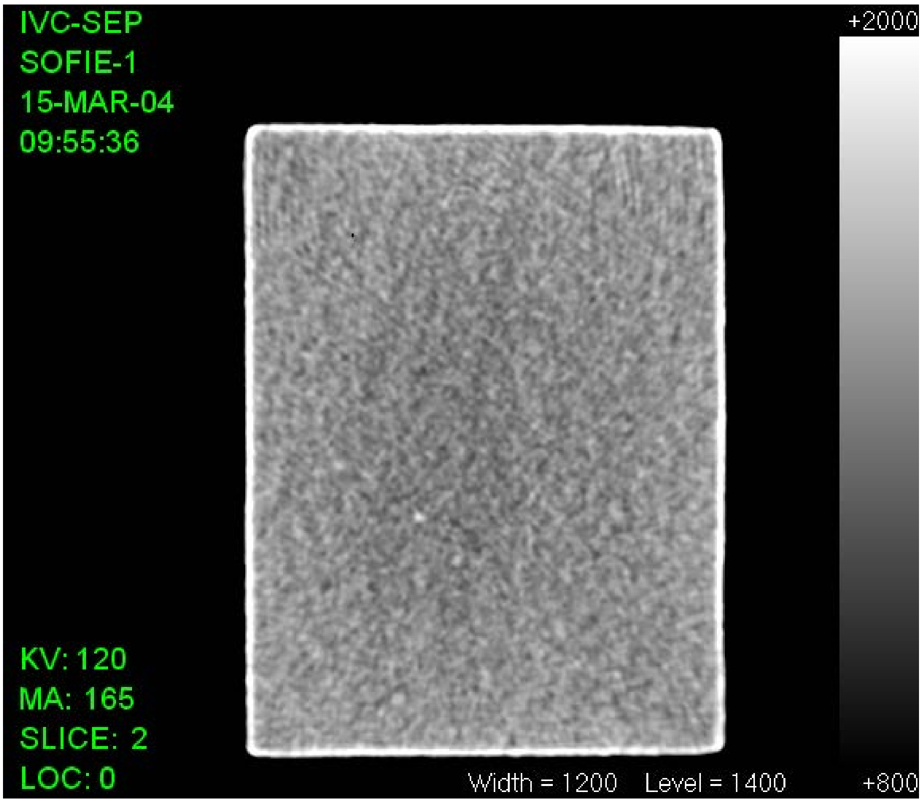
3. Waxman, M.H. & Smits, L.J.M.: "Electrical conductivities in oil-bearing shaly sands". SPEJ, **8**, 1968, p. 107-122.

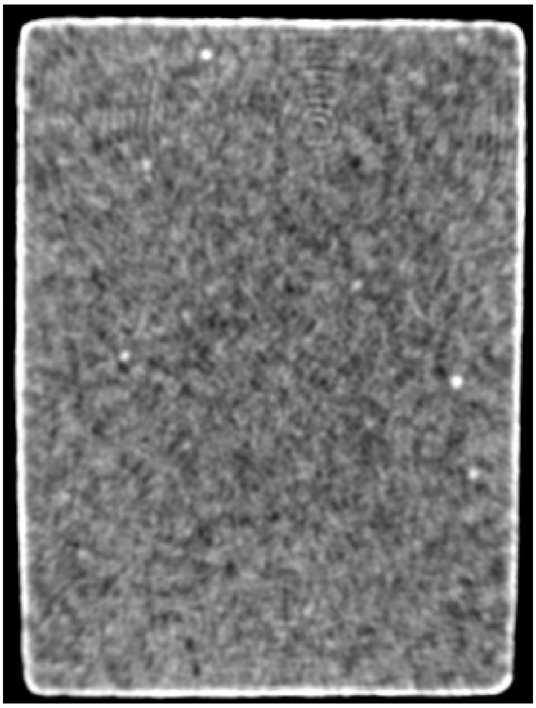
4. Worthington, P.F.: "Characterization of the intrinsic porosity exponent through dual salinity measurements of electrical conductivity". *Intl SCA Symp., Pau*, (September 2003), paper SCA-2003-30.

7 Plug quality screening

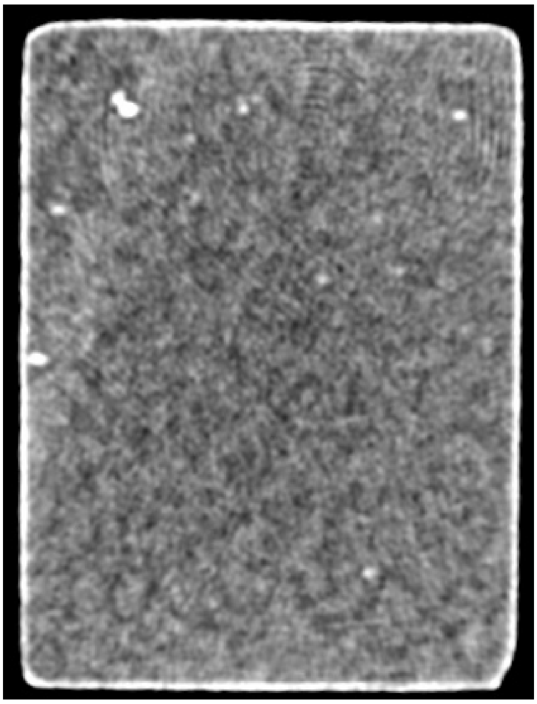
Scanning parameters:

Sellar-ear	Ultra High
120 kV	330 mAs
Time=	2 s.
Slice=	2 mm
Zoom=	8.0
Threshold:	**JPG-files**
Window:	1200
Center:	1600

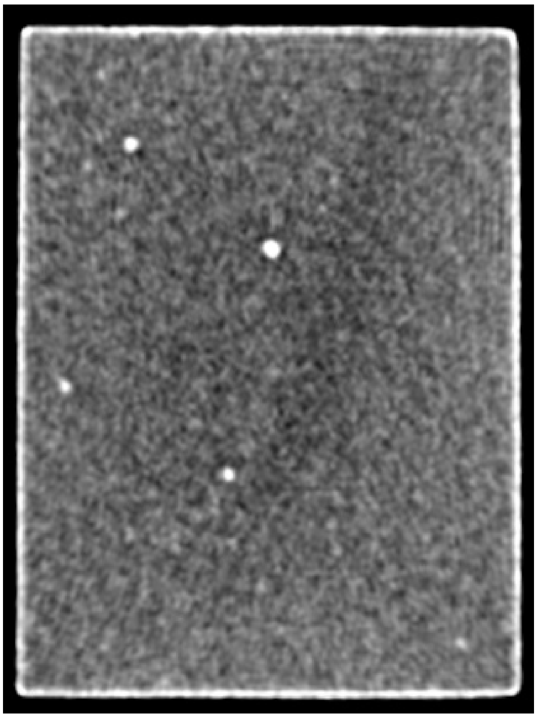




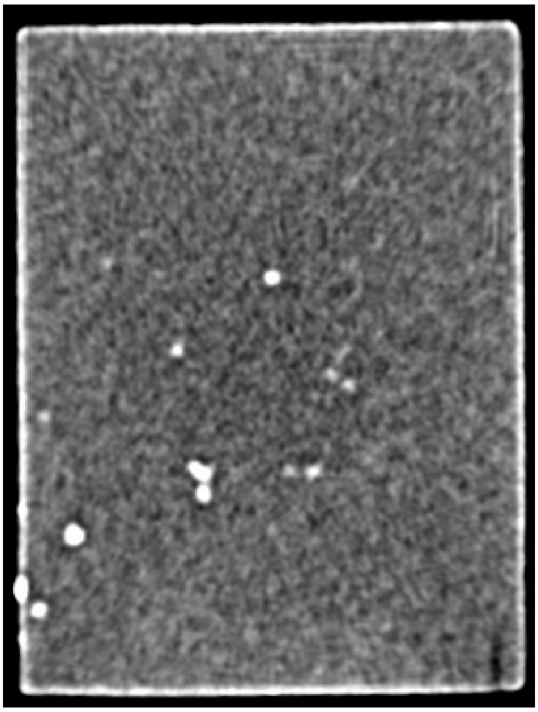
Plug 62 cleaned	Rotated 0 deg.
Depth:	1875.20 [m]
Selected for:	overburden exp.



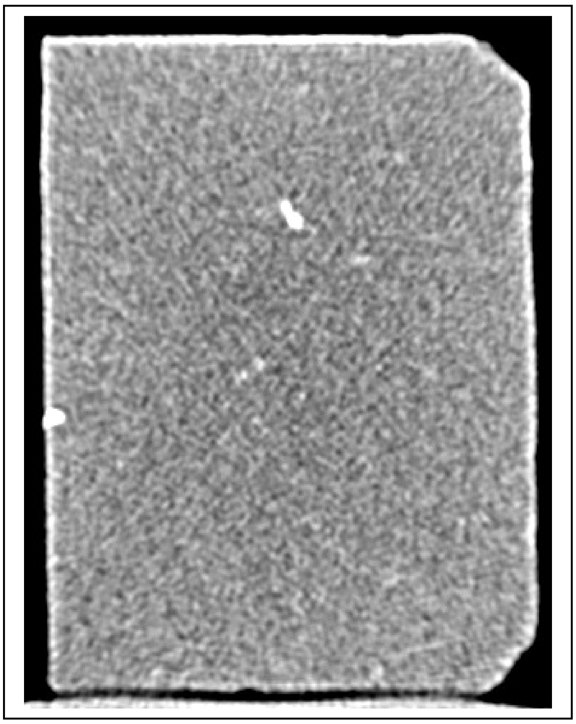
Plug 62 cleaned	Rotated 90 deg.
Depth:	1875.20 [m]
Selected for:	overburden exp.



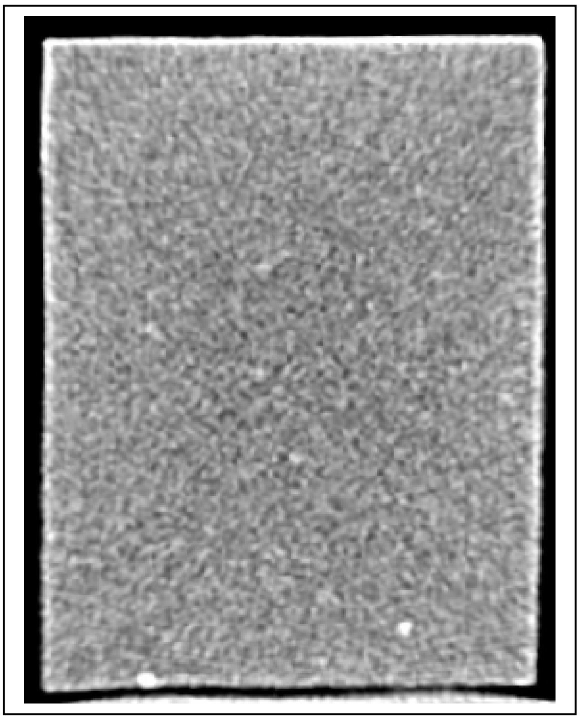
Plug 63 cleaned	Rotated 0 deg.
Depth:	1875.46 [m]
Selected for:	additional



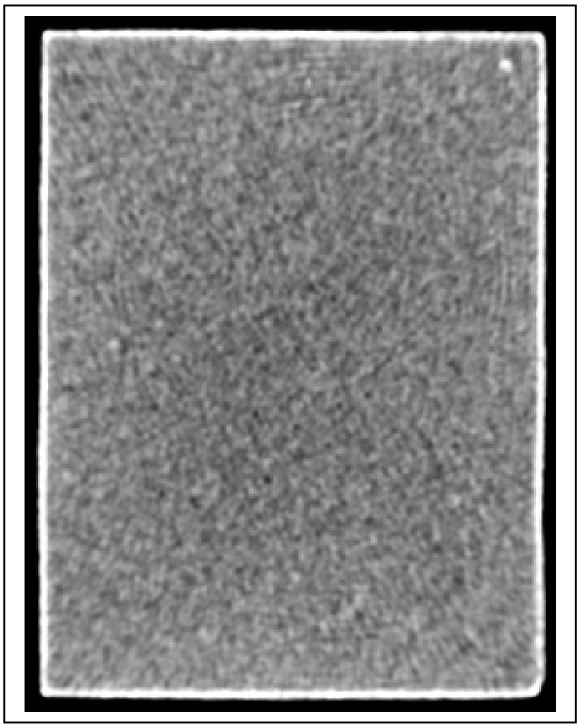
Plug 63 cleaned	Rotated 90 deg.
Depth:	1875.46 [m]
Selected for:	additional



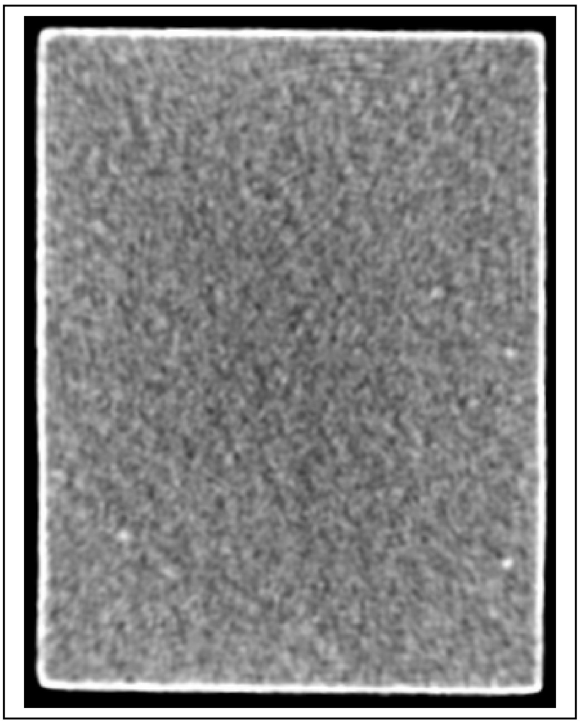
Plug 63P preserved	Rotated 0 deg.
Depth:	1875.40 [m]
Selected for:	additional



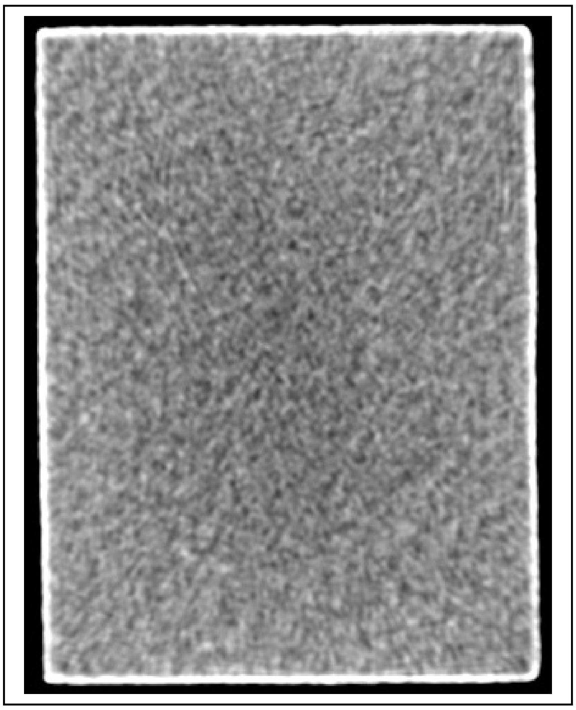
Plug 63P preserved	Rotated 90 deg.
Depth:	1875.40 [m]
Selected for:	additional



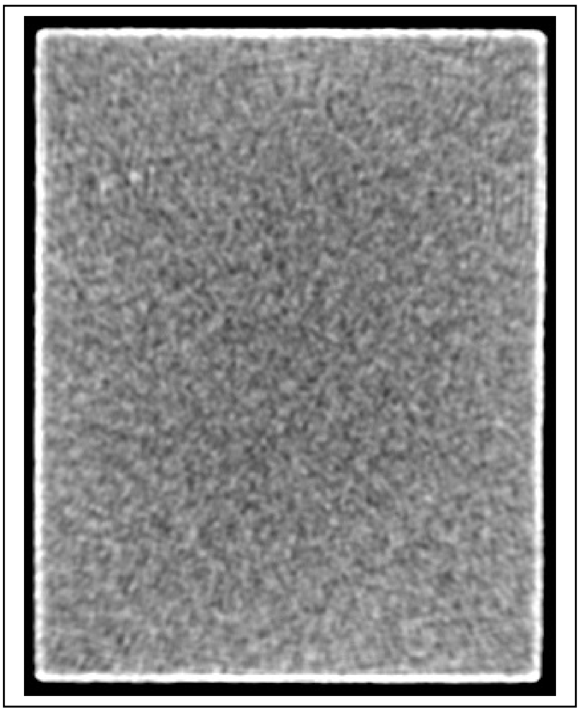
Plug 64 cleaned	Rotated 0 deg.
Depth:	1875.69 [m]
Selected for:	resistivity exp.



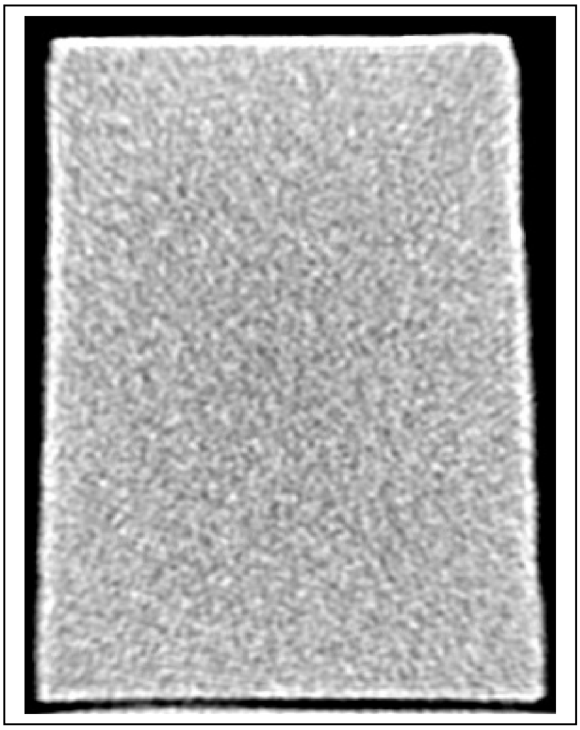
Plug 64 cleaned	Rotated 90 deg.
Depth:	1875.69 [m]
Selected for:	resistivity exp.



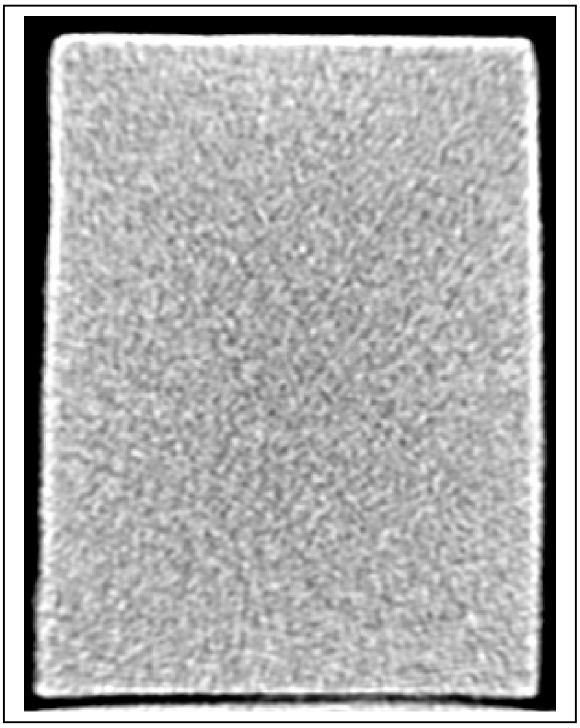
Plug 67 cleaned	Rotated 0 deg.
Depth:	1876.45 [m]
Selected for:	C_o / C_w + CEC



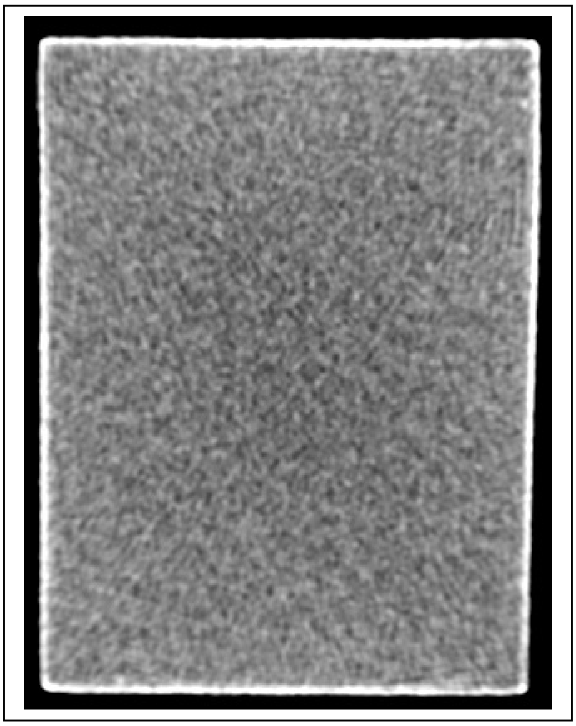
Plug 67 cleaned	Rotated 90 deg.
Depth:	1876.45 [m]
Selected for:	C_o / C_w + CEC



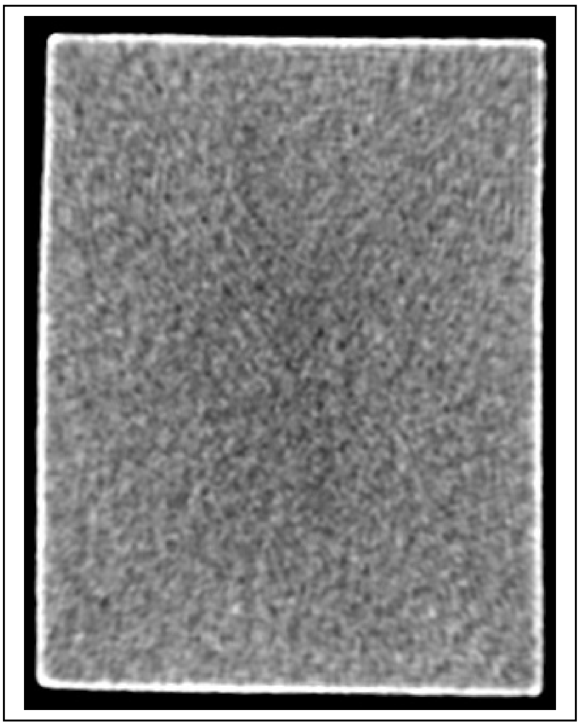
Plug 67P preserved	Rotated 0 deg.
Depth:	1876.40 [m]
Selected for:	additional



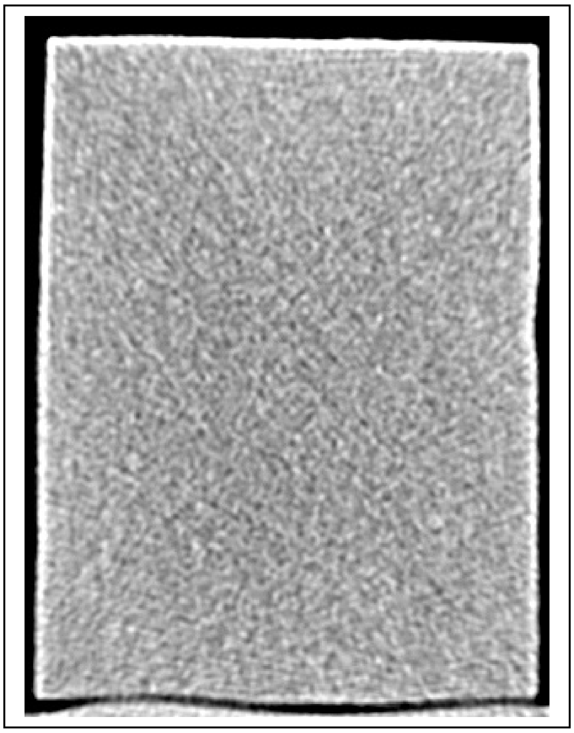
Plug 67P preserved	Rotated 90 deg.
Depth:	1876.40 [m]
Selected for:	additional



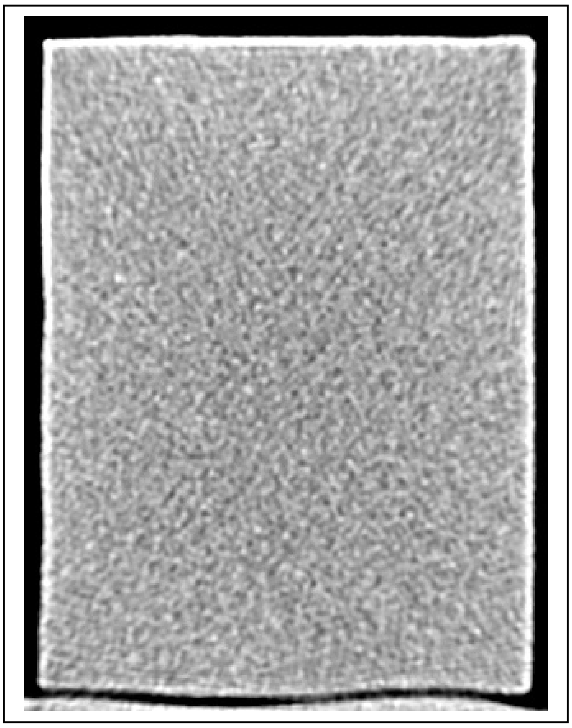
Plug 68 cleaned	Rotated 0 deg.
Depth:	1876.70 [m]
Selected for:	additional



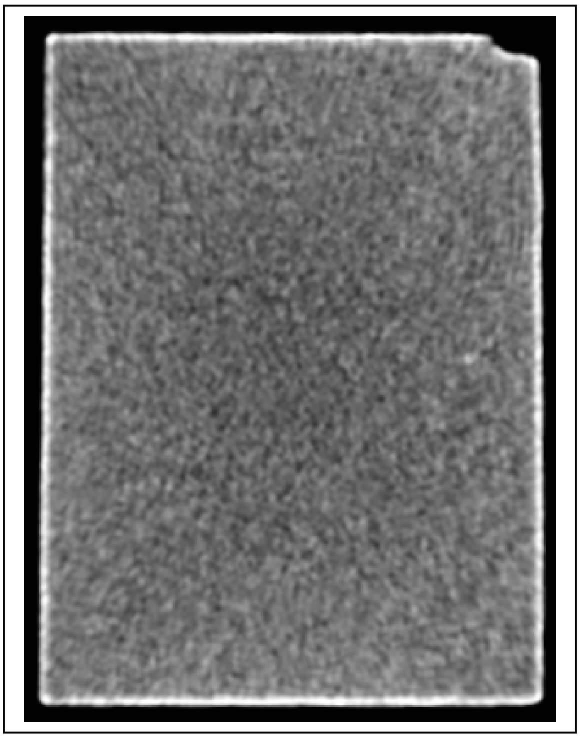
Plug 68 cleaned	Rotated 90 deg.
Depth:	1876.70 [m]
Selected for:	additional



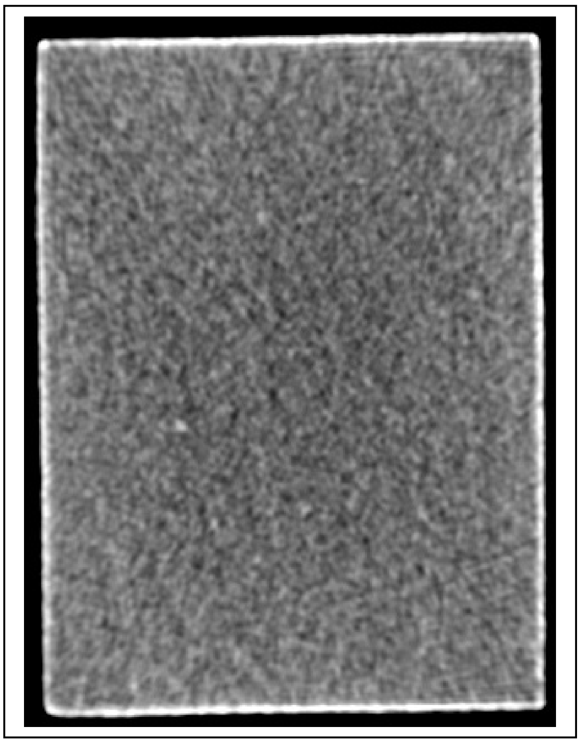
Plug 71P preserved	Rotated 0 deg.
Depth:	1877.40 [m]
Selected for:	additional



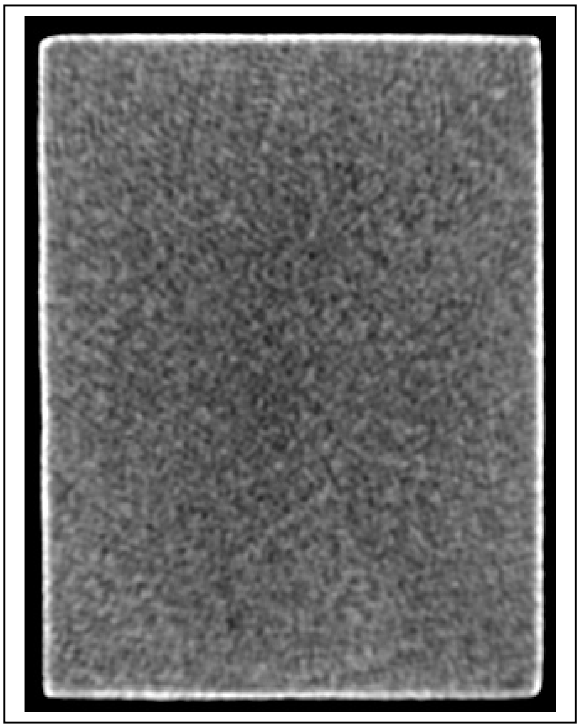
Plug 71P preserved	Rotated 90 deg.
Depth:	1877.40 [m]
Selected for:	additional



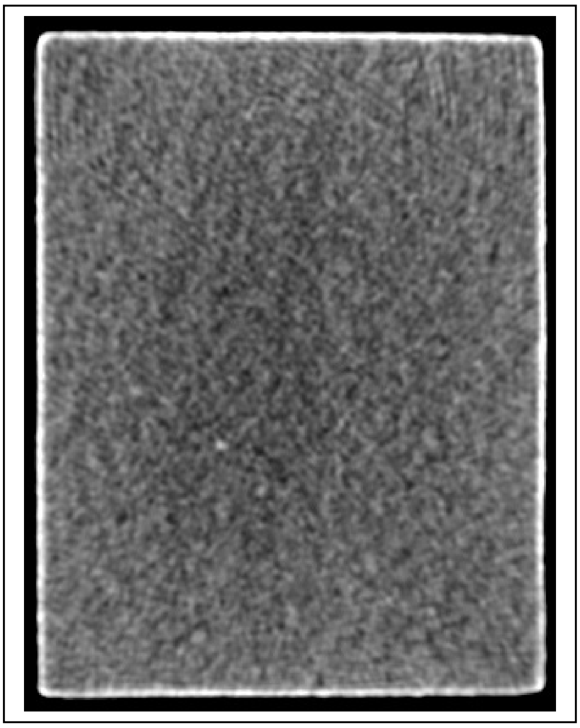
Plug 72 cleaned Rotated 0 deg.
Depth: 1877.71 [m]
Selected for: additional



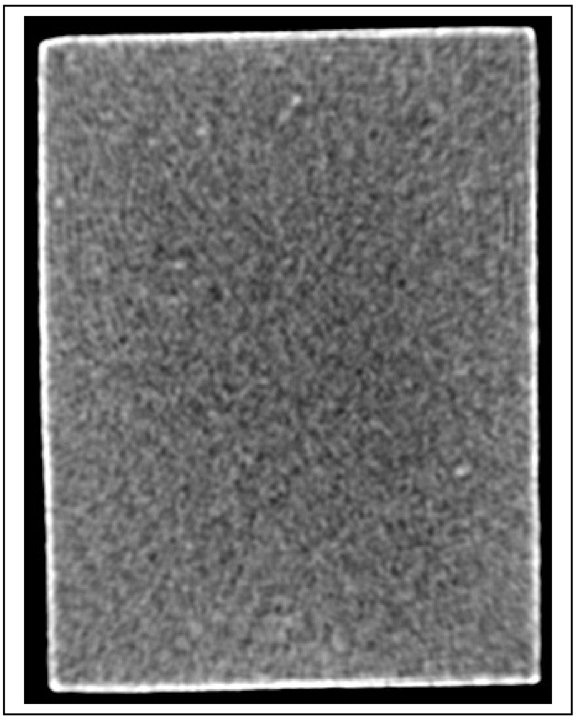
Plug 72 cleaned Rotated 90 deg.
Depth: 1877.71 [m]
Selected for: additional



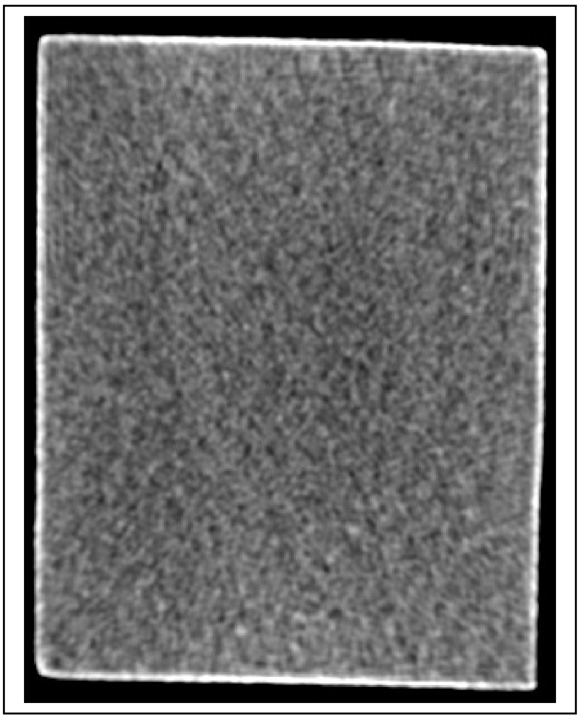
Plug 75 cleaned Rotated 0 deg.
Depth: 1878.47 [m]
Selected for: overburden exp.



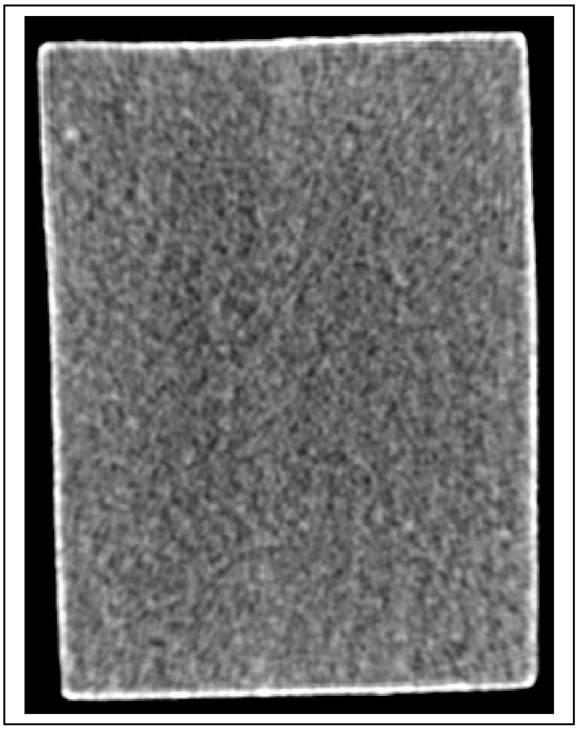
Plug 75 cleaned Rotated 90 deg.
Depth: 1878.47 [m]
Selected for: overburden exp.



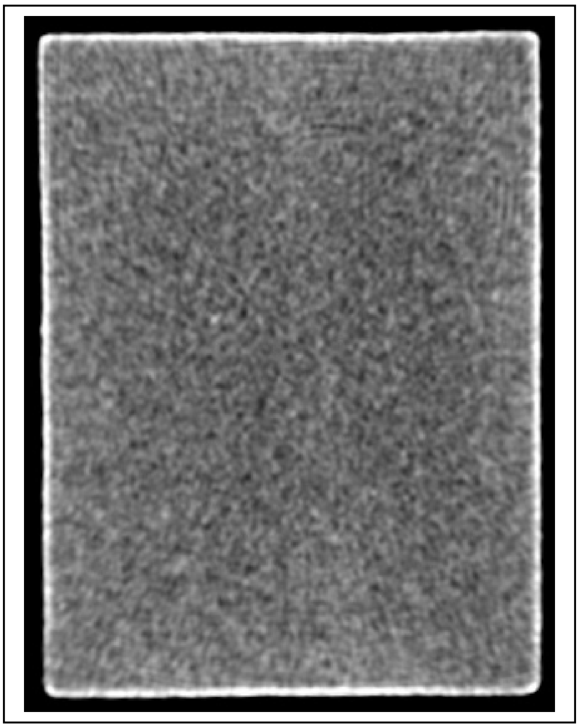
Plug 76 cleaned	Rotated 0 deg.
Depth:	1878.65 [m]
Selected for:	overburden exp.



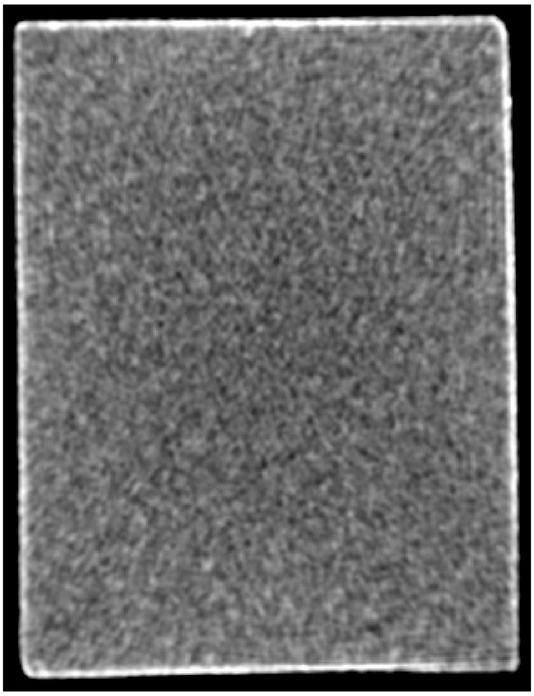
Plug 76 cleaned	Rotated 90 deg.
Depth:	1878.65 [m]
Selected for:	overburden exp.



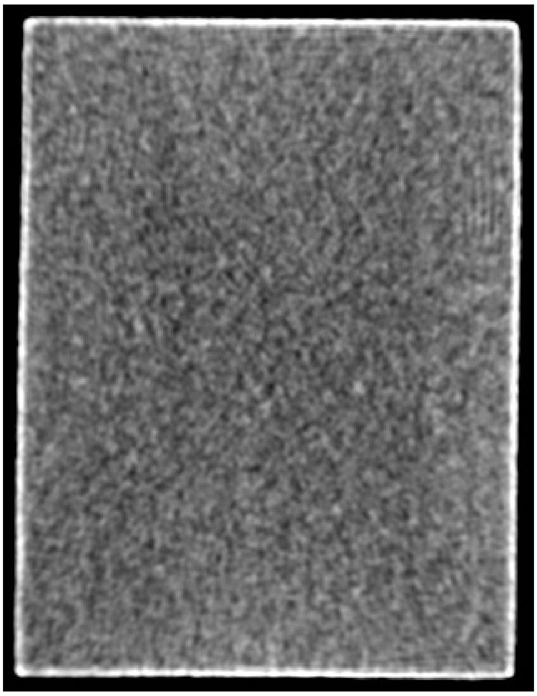
Plug 83 cleaned	Rotated 0 deg.
Depth:	1880.47 [m]
Selected for:	overburden exp.



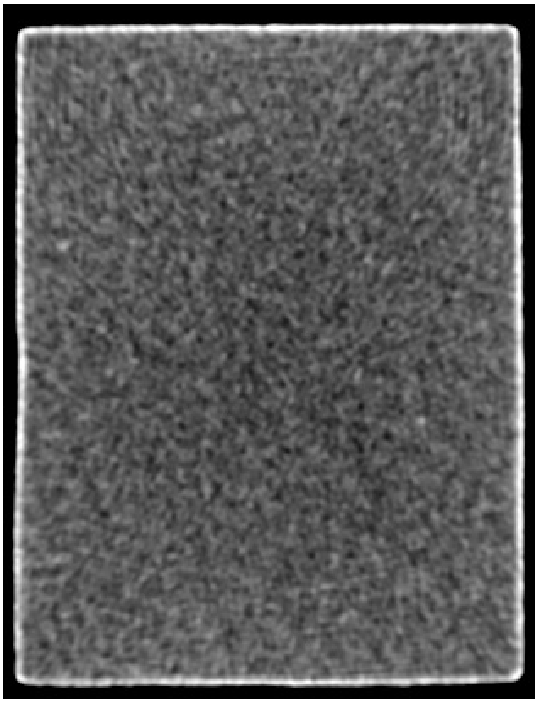
Plug 83 cleaned	Rotated 90 deg.
Depth:	1880.47 [m]
Selected for:	overburden exp.



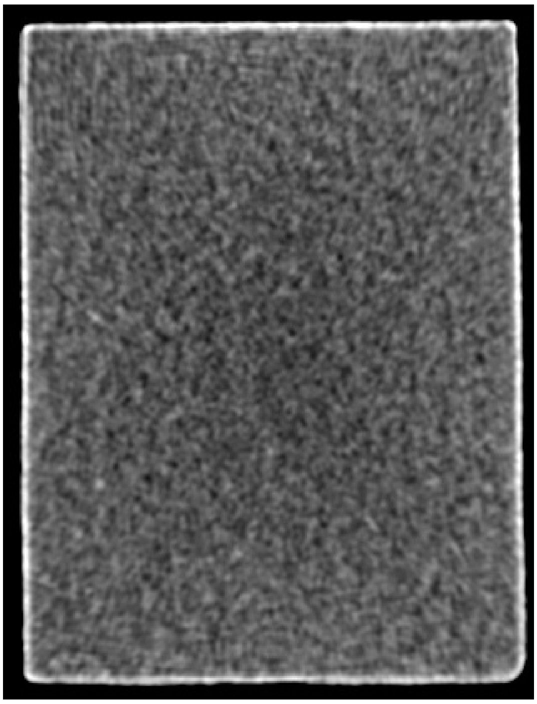
Plug 84 cleaned	Rotated 0 deg.
Depth:	1880.70 [m]
Selected for:	resistivity exp.



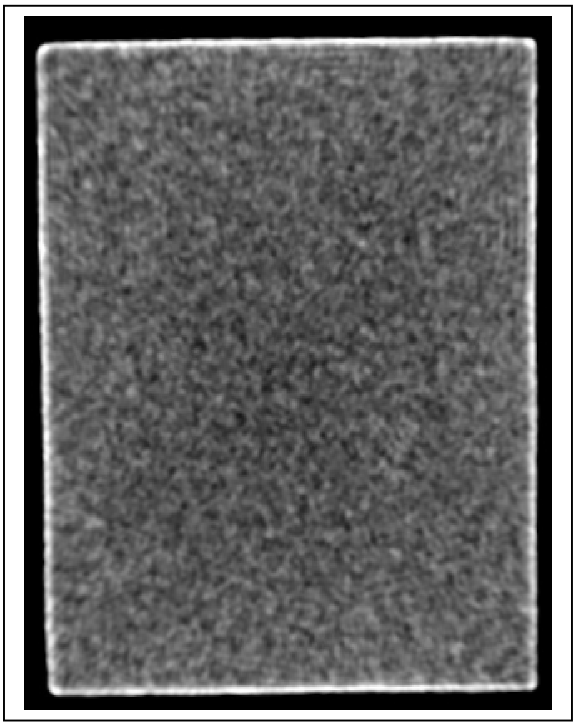
Plug 84 cleaned	Rotated 90 deg.
Depth:	1880.70 [m]
Selected for:	resistivity exp.



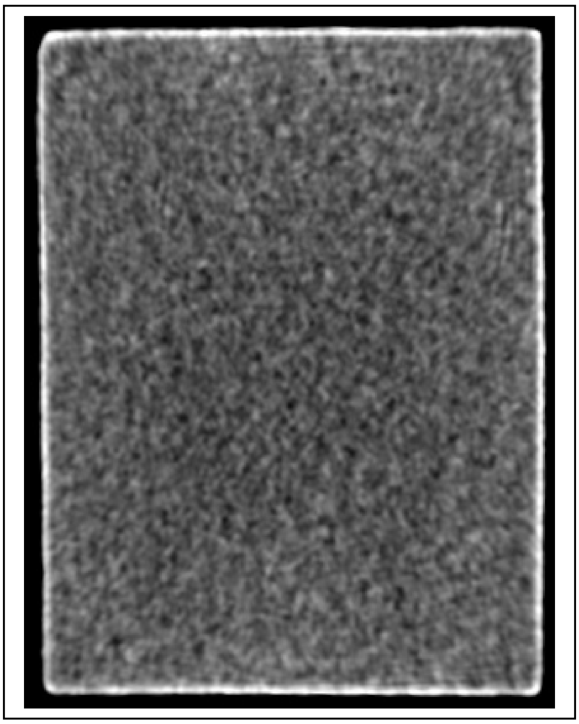
Plug 87 cleaned	Rotated 0 deg.
Depth:	1881.46 [m]
Selected for:	overburden exp.



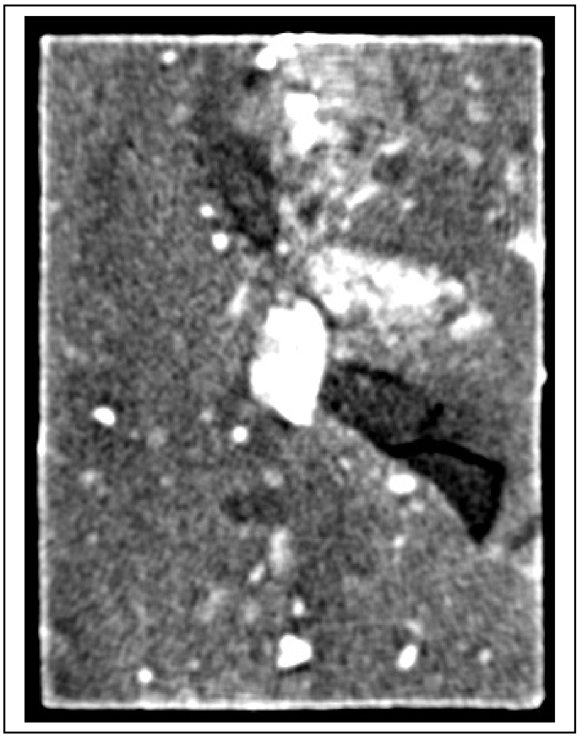
Plug 87 cleaned	Rotated 90 deg.
Depth:	1881.46 [m]
Selected for:	overburden exp.



Plug 88 cleaned	Rotated 0 deg.
Depth:	1881.71 [m]
Selected for:	C_o / C_w + CEC

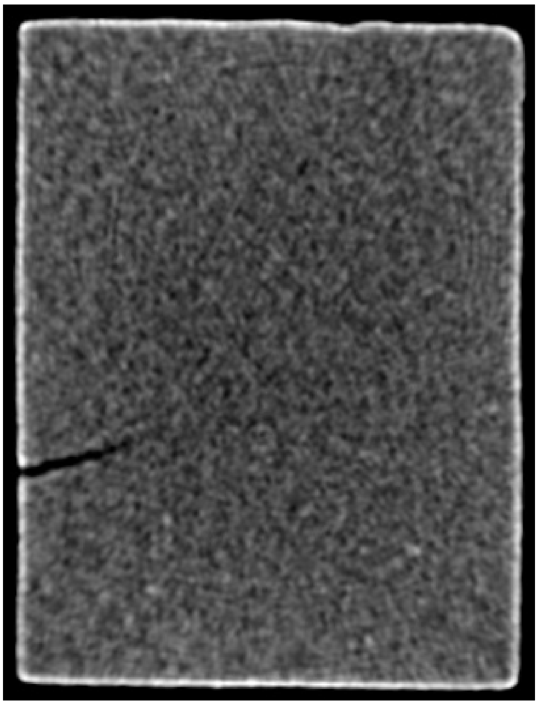


Plug 88 cleaned	Rotated 90 deg.
Depth:	1881.71 [m]
Selected for:	C_o / C_w + CEC

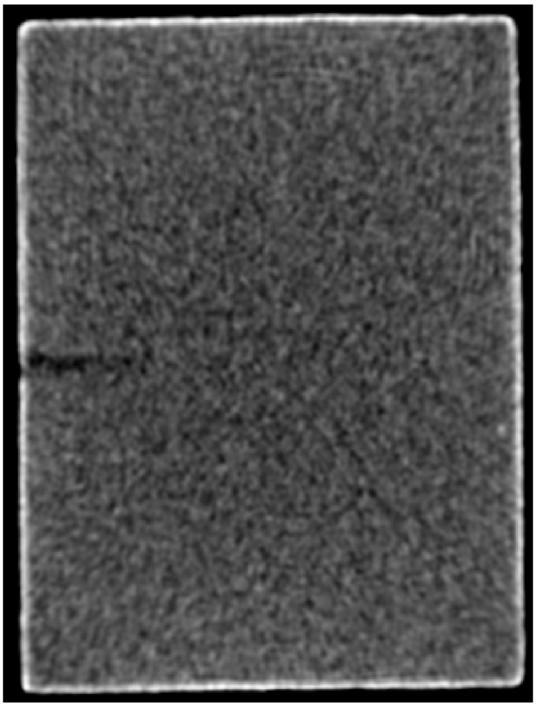


Plug 91 cleaned	Rotated 0 deg.
Depth:	1882.48 [m]
Selected for:	discarded

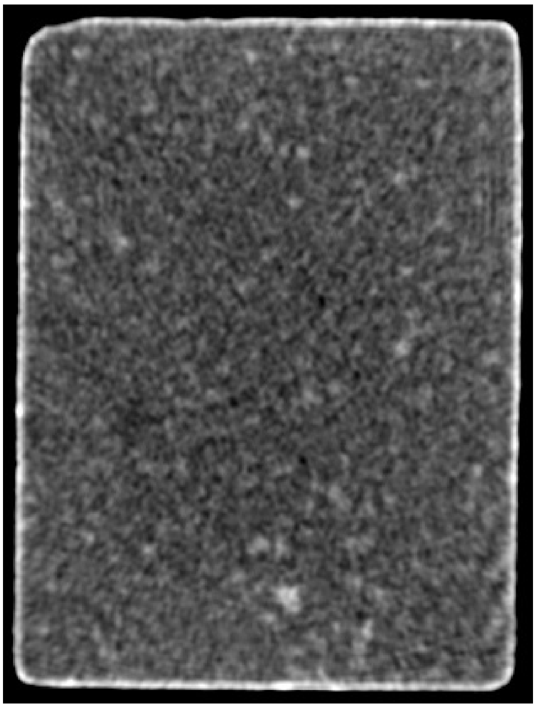
Plug 91 cleaned	Rotated 90 deg.
Depth:	1882.48 [m]
Selected for:	discarded



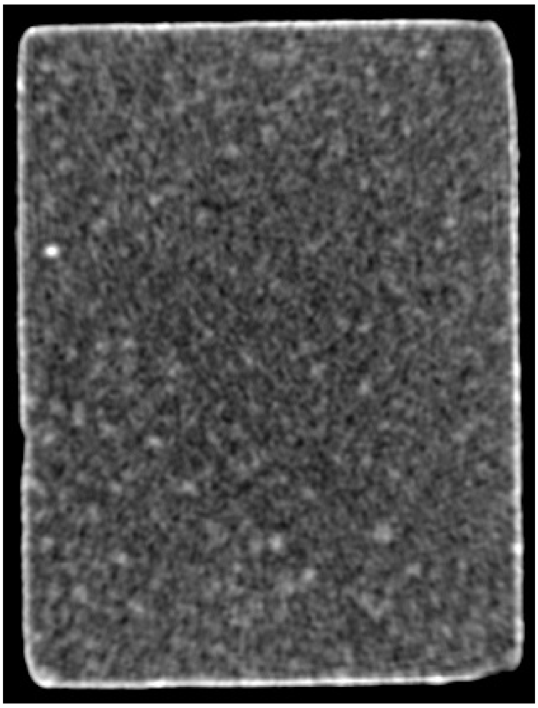
Plug 92 cleaned	Rotated 0 deg.
Depth:	1882.68 [m]
Selected for:	additional



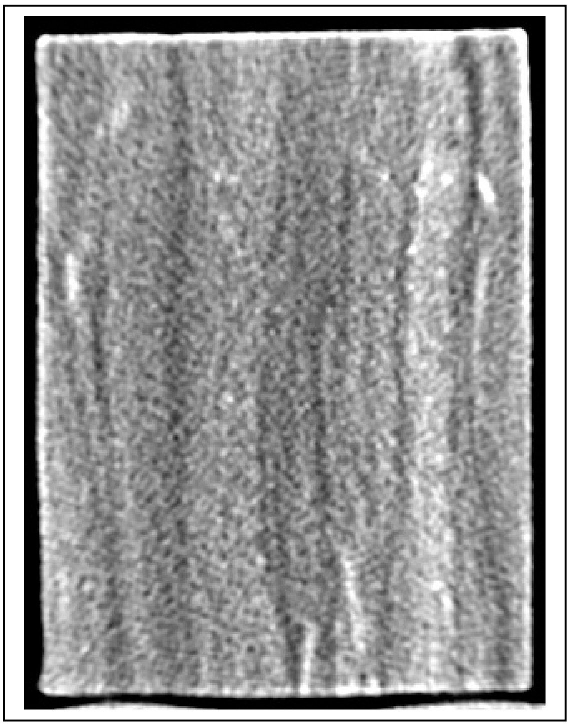
Plug 92 cleaned	Rotated 90 deg.
Depth:	1882.68 [m]
Selected for:	additional



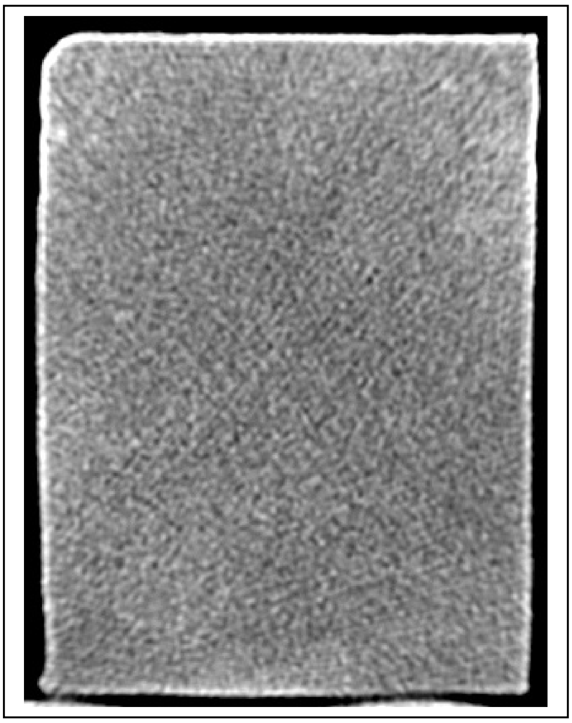
Plug 101 cleaned	Rotated 0 deg.
Depth:	1885.10 [m]
Selected for:	resistivity exp.



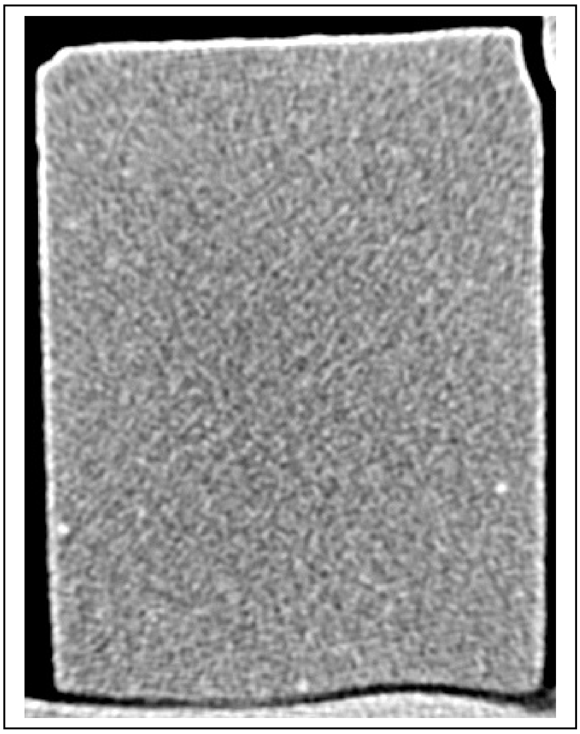
Plug 101 cleaned	Rotated 90 deg.
Depth:	1885.10 [m]
Selected for:	resistivity exp.



Plug 119P preserved	Rotated 0 deg.
Depth:	1889.40 [m]
Selected for:	overburden exp.

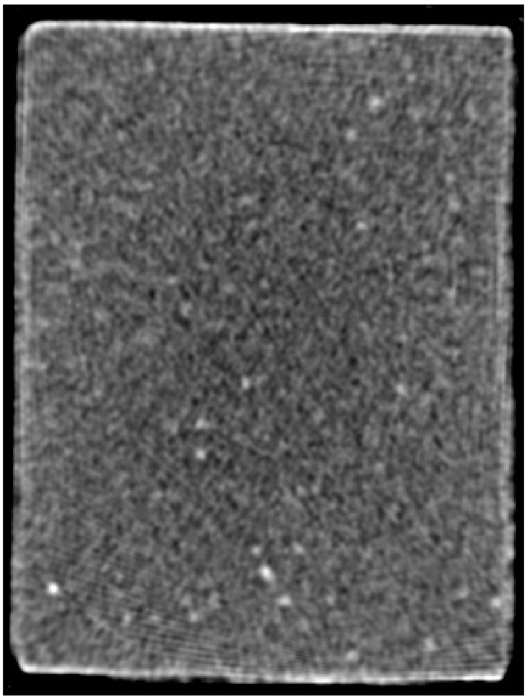


Plug 119P preserved	Rotated 90 deg.
Depth:	1889.40 [m]
Selected for:	overburden exp.

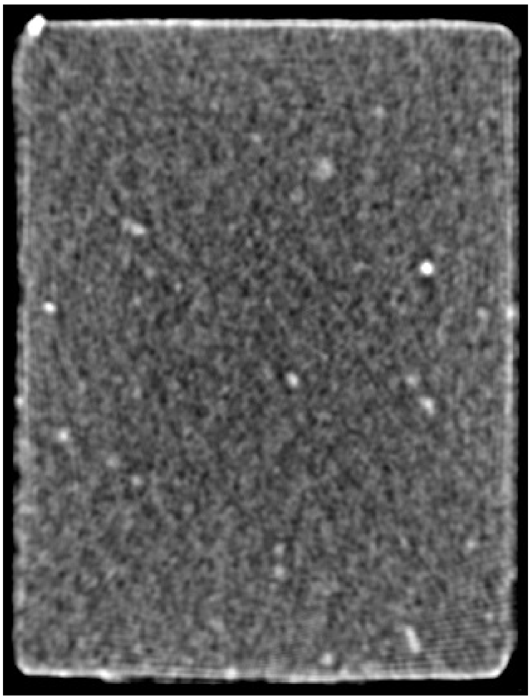


Plug 127P preserved	Rotated 0 deg.
Depth:	1891.40 [m]
Selected for:	C_o / C_w + CEC

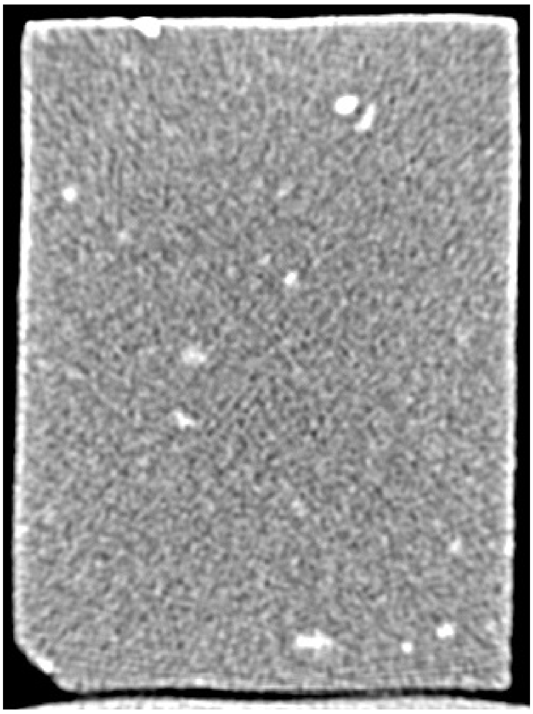
Plug 127P preserved	Rotated 90 deg.
Depth:	1891.40 [m]
Selected for:	C_o / C_w + CEC



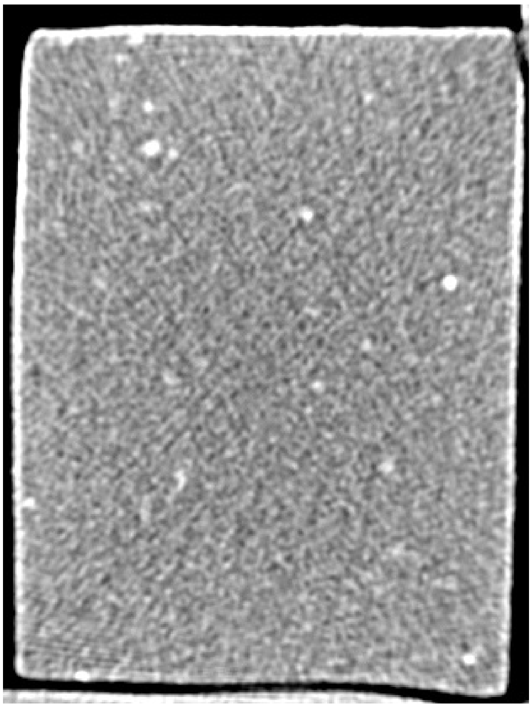
Plug 131 cleaned Rotated 0 deg.
Depth: 1892.47 [m]
Selected for: resistivity exp.



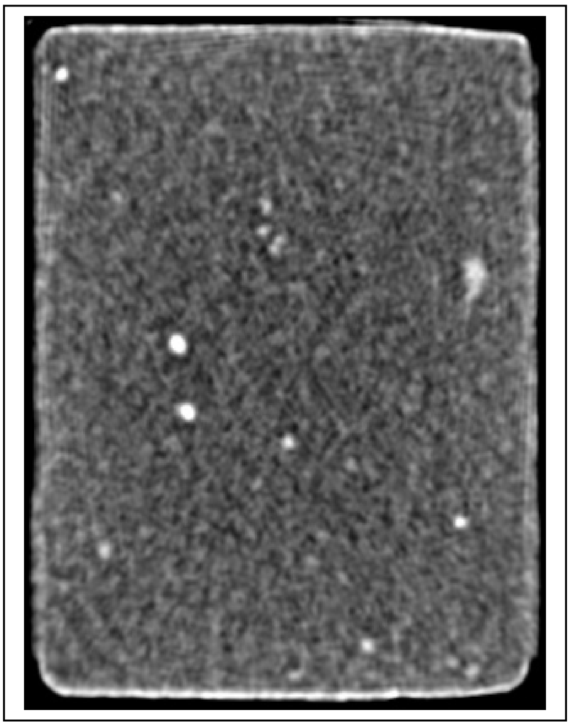
Plug 131 cleaned Rotated 90 deg.
Depth: 1892.47 [m]
Selected for: resistivity exp.



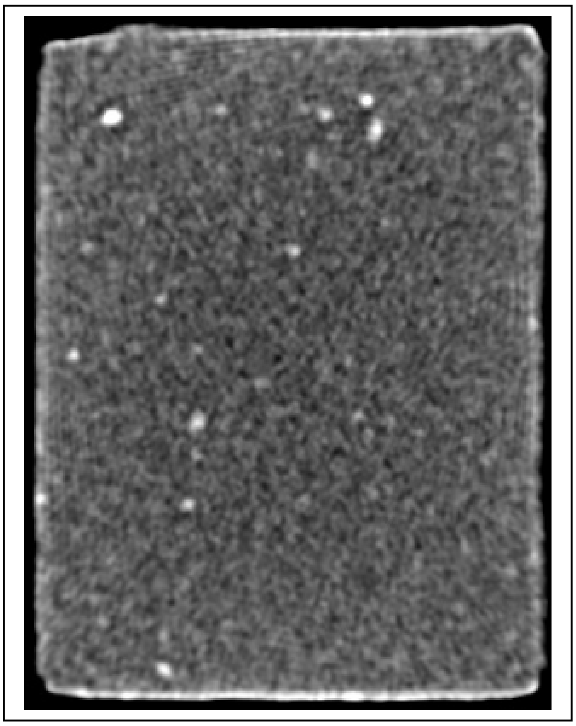
Plug 131P preserved Rotated 0 deg.
Depth: 1892.40 [m]
Selected for: overburden exp.



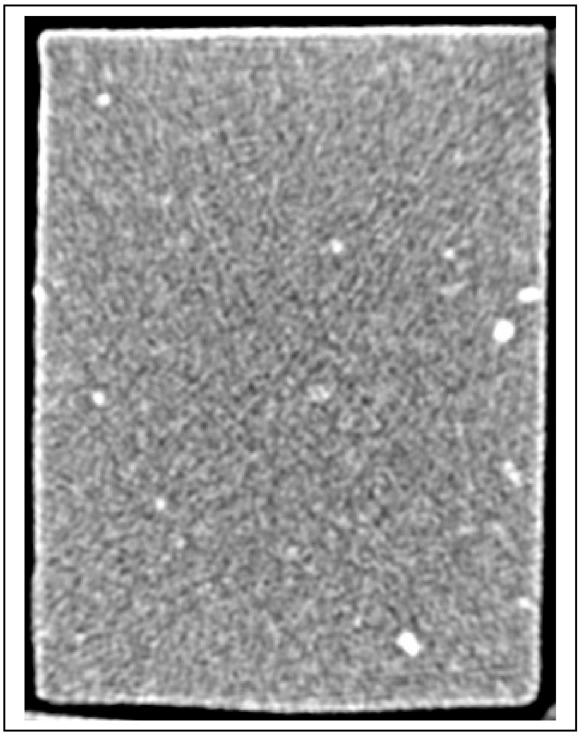
Plug 131P preserved Rotated 90 deg.
Depth: 1892.40 [m]
Selected for: overburden exp.



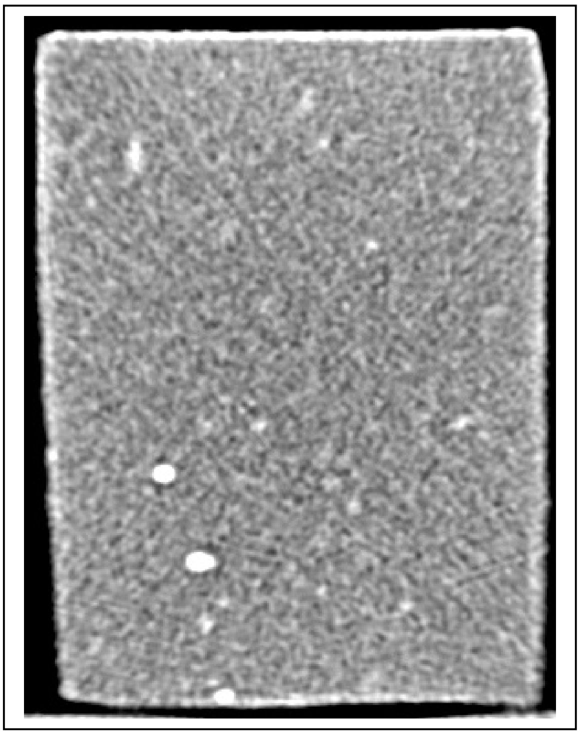
Plug 132 cleaned	Rotated 0 deg.
Depth:	1892.72 [m]
Selected for:	resistivity exp.



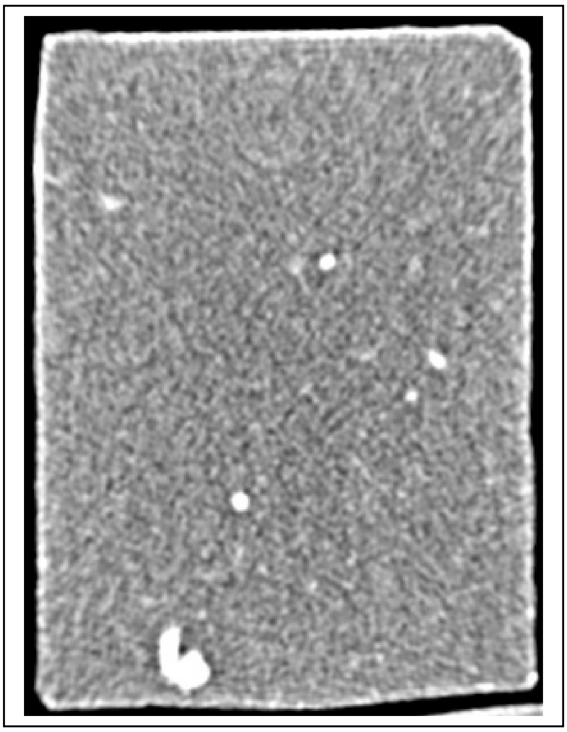
Plug 132 cleaned	Rotated 90 deg.
Depth:	1892.72 [m]
Selected for:	resistivity exp.



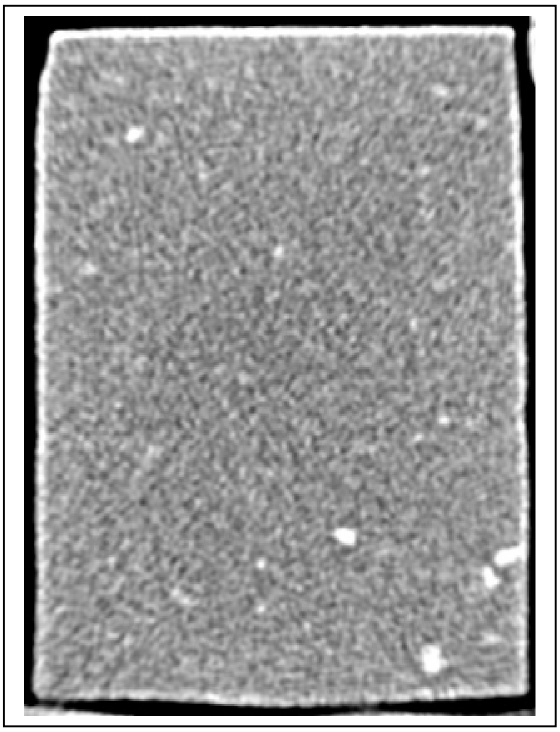
Plug 139P preserved	Rotated 0 deg.
Depth:	1894.40 [m]
Selected for:	C_o / C_w + CEC



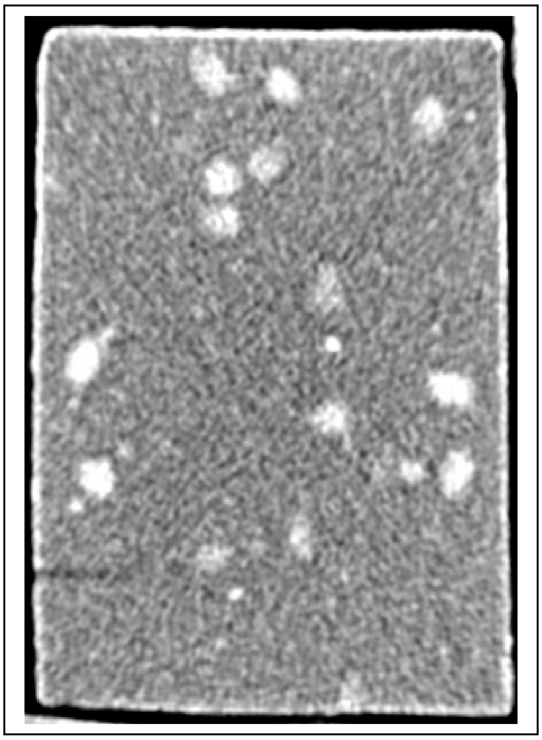
Plug 139P preserved	Rotated 90 deg.
Depth:	1894.40 [m]
Selected for:	C_o / C_w + CEC



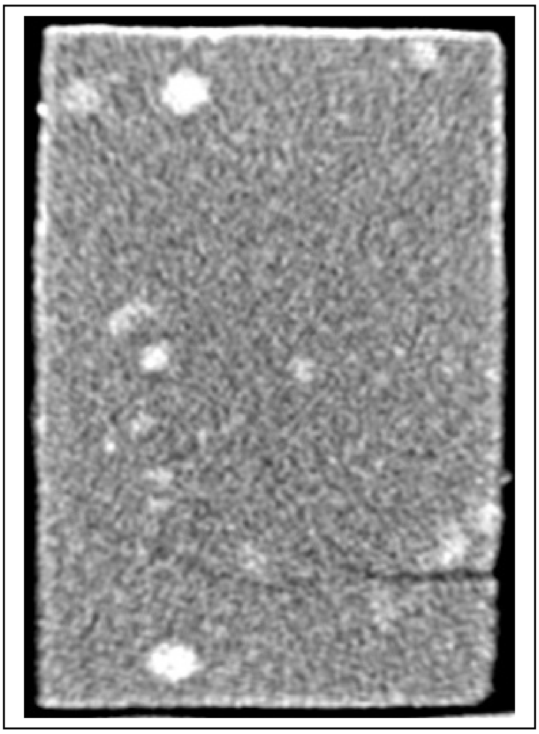
Plug 143P preserved	Rotated 0 deg.
Depth:	1895.40 [m]
Selected for:	resistivity exp.



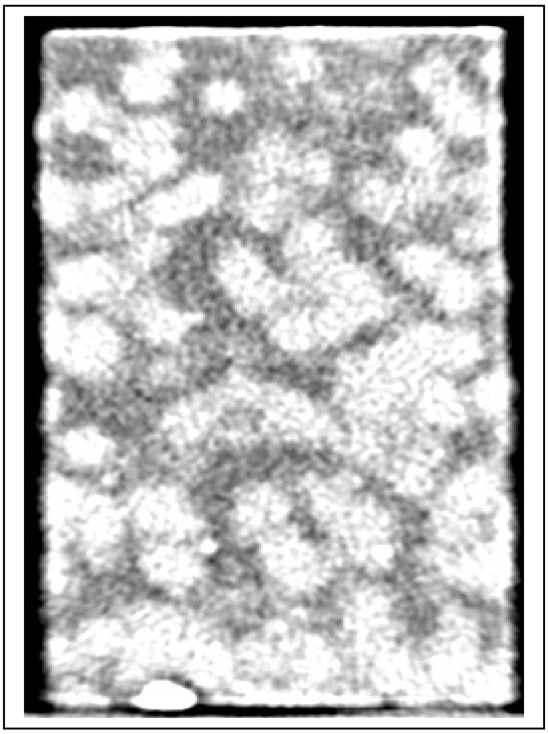
Plug 143P preserved	Rotated 90 deg.
Depth:	1895.40 [m]
Selected for:	resistivity exp.



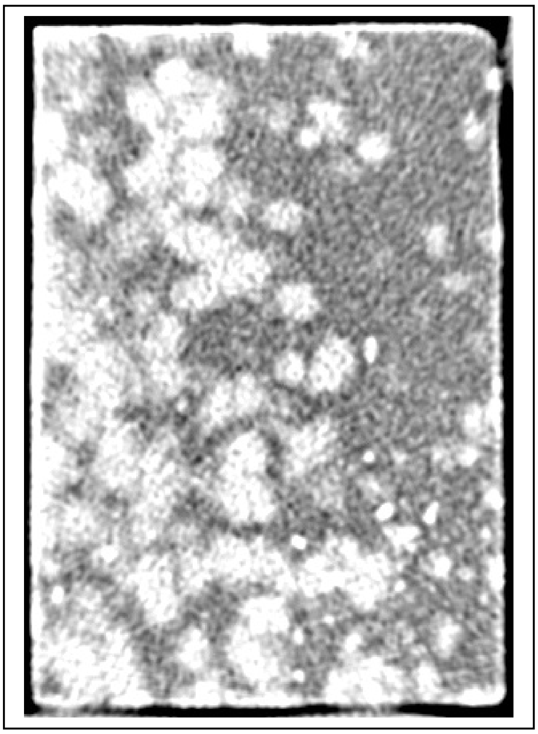
Plug 147P preserved	Rotated 0 deg.
Depth:	1896.40 [m]
Selected for:	additional



Plug 147P preserved	Rotated 90 deg.
Depth:	1896.40 [m]
Selected for:	additional



Plug 151P preserved	Rotated 0 deg.
Depth:	1897.39 [m]
Selected for:	additional



Plug 151P preserved	Rotated 90 deg.
Depth:	1897.39 [m]
Selected for:	additional