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REPORT TITLE/ TITTEL

Source Rock Analysis of Well 6609/7-1.

CLIENT/ OPPDRAGSGIVER

Phillips Petroleum

RESPONSIBLE SCIENTIST/ PROSJEKTANSVARLIG

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SUMMARY/ SAMMENDRAG

The interval 1500-1969m of well 6609/7-1 has been analysed by a number of screening methods. Mainly based on lithology the well can be divided into four zones. The claystones occurring in zones A, B and C have a poor to fair potential as source rocks for gas. The dolomites in zone D have no source rock potential. The entire section has a low maturity.

A sandstone interval in zone C (1830-1880m) contains high amounts of hydrocarbon gases, probably of petrogenic origin.

KEY WORDS/ STIKKORD

Source Rock Analysis

6609/7-1

Trænabanken

088/1/ah/1

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INTRODUCTION

47 samples from well 6609/7-1, depth interval 1500-1969m, were received for analysis. They were subjected to several screening analyses: headspace gas analysis, occluded gas analysis, lithological description, total organic carbon measurement and Rock-Eval pyrolysis. In addition the vitrinite reflectance of a few samples was measured. As agreed we present in this report the results of the screening analysis so that they can be used to decide upon the type and number of follow-up analyses. Suggestions for further analyses are discussed in the conclusion.

EXPERIMENTAL AND DESCRIPTION OF INTERPRETATION LEVELS

Headspace Gas Analysis

One ml. of the headspace gas from each of the cans was analysed gas chromatographically for light hydrocarbons. The results are shown in Table 1a. The canned samples were washed with temperated water on 4, 2, 1 and 0.125 mm sieves to remove drilling mud and thereafter dried at 35°C.

Occluded Gas

An aliquot of the 1-2 mm fraction of each sample before drying was crushed in water using an airtight ball mill, and one ml. of the headspace analysed chromatographically. The results are shown in Table 1b.

The composite gas data are also plotted and shown in figure 1.

Total Organic Carbon (TOC)

Picked cuttings of the various lithologies in each sample was crushed in a centrifugal mill. Aliquots of the samples were then weighed into Leco crucibles and treated with hot 2N HCl to remove carbonate and washed twice with distilled water to remove traces of HCl. The crucibles were then placed in a vacuum oven at 50°C and evacuated to 20 mm Hg for 12 hrs. The samples were then analysed on a Leco E C 12 carbon analyser, to determine the total organic carbon (TOC).

The results are shown in table 2 with the lithological description, also in figure 2.

Vitrinite Reflectance

Vitrinite reflectance measurements of the samples, taken at various intervals, were done at IKU. The samples were mounted in Bakelite resin blocks; care being taken during the setting of the plastic to avoid temperatures in excess of 100°C. The samples were then ground, initially on a diamond lap followed by two grades of corundum paper. All grinding and subsequent polishing stages in the preparation were carried out using isopropyl alcohol as lubricant, since water leads to the swelling and disintegration of the clay fraction of the samples.

Polishing of the samples was performed on Selvyt cloths using three grades of alumina, 5/20, 3/50 and Gamma, followed by careful cleaning of the surface.

Reflectance determinations were carried out on a Leitz M.P.V. microphotometer under oil immersion, R.I. 1.518 at a wavelength of 546 nm. The surface of the polished block was searched by the operator for suitable areas of vitrinitic material in the sediment. The reflectance of the organic particle was determined relative to optical glass standards of known reflectance.

Rock-Eval Pyrolysis

100 mg crushed sample was put into a platinum crucible whose bottom and cover are made of sintered steel and analysed on a Rock-Eval pyrolyser. The results are shown in Table 3 and are plotted in figure 3.

RESULTS AND DISCUSSION

Lithology and Total Organic Carbon (TOC)

Based on the variation in lithology (fig. 4) and TOC values the well section (1500-1969m) can be divided into 4 zones:

Zone A : 1500 - 1580m
Zone B : 1580 - 1630m
Zone C : 1630 - 1880m
Zone D : 1880 - 1969m

Zone A 1500-1580m: This zone consists predominantly of light grey and brownish-grey to dark grey claystones. Siderite is present in various amounts (up to 55% in A-6806, 1540-1550m). The light grey claystones have TOC values of 0.67-1.17%, i.e. fair to good abundances. The brownish-grey to dark grey claystones have 0.19-1.10% TOC (generally fair abundance).

Zone B 1580-1630m: The samples from this zone consist mainly of tuff with smaller amounts of olive-grey to grey claystones and some dolomite. The claystones have a fair to good abundance of TOC, i.e. 0.74-1.14%.

Zone C 1630-1880m: This zone consists mainly of olive-grey to grey and light green claystones together with lower amounts of limestone and tuff. The interval 1820-1840m contains up to 80% sandstones. The top of this zone (down to 1700m) is characterized by the olive-grey to grey claystones with 0.61-1.79% TOC (fair to good abundance). Below 1700m these claystones have a fair TOC abundance (0.32-0.49%). The main components in this part of the zone are light green claystones with 0.58-2.01% TOC (generally good abundance). The bottom part of the zone (below 1800m) again contains the olive-grey to grey claystones with fair to good TOC values (0.67-1.72%).

Zone D 1880-1969m: Dolomite is the dominant material in this zone together with sandstones in the deeper part (below 1930m). The TOC values are poor (0.06-0.19%).

Gas Analysis

Zones A and B 2500-1630m: These zones contain fair to good amounts of C_1-C_4 gases. Methane is the dominant component (wetness <4%), suggesting a biogenic origin.

Zone C 1630-1880m: The top part of this zone (1630-1830m) has a fair to rich abundance of C_1-C_4 gas with methane being the dominant component and a slowly increasing wetness. The bottom part of the zone with the sandstone interval (1830-1880) has a rich to very rich abundance of C_1-C_4 gas. In this area the C_2-C_4 gases are also significantly present resulting in wetness values of 10-54%. The iC_4/C_4 ratio is rather high indicating a low maturity.

Zone D 1880-1969m: The C_1-C_4 gases have a poor to fair abundance in this zone. Wetness decreases with increasing depth.

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Rock-Eval Pyrolysis

Rock-Eval Pyrolysis was preformed on 32 claystone samples with more than 0.7% TOC. All samples contain type III or type IV kerogen as indicated by the hydrogen and oxygen indices. The petroleum potential is poor. T_{max} values do not exhibit a clear increase downhole, and indicate immature sediments. The production indices are higher than expected for immature samples and suggest the presence of migrated hydrocarbons, especially in samples A-6807 (1560m), A-6818 (1670m), A-6822 (1710m), A-6824 (1730m) and A-6833 (1870m). Based on Rock-Eval data the sediments have a poor to fair potential as source rocks for gas.

Analysis in Reflected Light

Five samples from well 6609/7-1 were chosen for examination in reflected light. The samples were claystones and had good TOC values apart from A-7174 which had a fair TOC. This was not observed in reflected light examination. Indeed all of the samples except A-7174 had very low phytoclast contents. Very little vitrinite was observed although some samples contained variable amounts of bitumen wisps/spore fragments. Sample A-7174 had a moderate phytoclast content but this was observed only as inertinite/reworked vitrinite. Examination under ultra-violet excitation gave fluorescence colours which implied a lower maturity than the reflectance might indicate which could imply that the few vitrinite fragments that were observed had been reworked.

The samples are described below:

Sample A-6803 (light grey claystone), 1510-1520m: Ro = 0.42(1) and 0.60(5) (overall = 0.57)
There is a very low phytoclast content. It is difficult to distinguish primary and reworked vitrinite. Some clasts are moderately rich in bitumen wisps or fragments. The lithology appears flaky and looks immature. A moderate content of spores fluorescee green/yellow.

Sample A-6803 (dark grey claystone), 1510-1520m: Ro = 0.41(1) and 0.84(3)
This is a poor sample with a very low phytoclast content. Some clasts have higher contents of bitumen wisps but this could never be classified as rich. All possible vitrinite located was measured. The lowest result agrees very well with the lowest result from the light grey claystone of the same depth. Green/yellow fluorescence is observed from a moderate number of spores whilst a trace of spores show mid-orange fluorescence.

Sample A-6820, 1680-1690m: Claystone and Limestone, Ro = 0.55(1)/N.D.P.
This is a very poor sample. It is almost barren of phytoclasts and has only a few bitumen wisps and/or spore fragments. Only one fragment of possible primary vitrinite was located. Green/yellow fluorescence is observed from a trace of spores.

Sample A-6828, 1760-1770m: Claystone, Ro = 0.55(3)
There is a very low phytoclast content (the sample is almost barren). There is a trace of bitumen wisps and some very thin possible vitrinite material but this cannot be measured. Only three possible primary vitrinite fragments were measurable. Fluorescence is seen from a low content of green/yellow spores (possibly caved?) and a trace of yellow/orange and light orange unidentified fragments.

Sample A-7174, 1860-1870m: Claystone, No Determination Possible
There is a moderate phytoclast content but this is totally inertinite or reworked vitrinite as poor small rounded fragments. No primary vitrinite was located. There is a trace of fluorescence from green/yellow spores and yellow/orange fragments.

CONCLUSION AND SUGGESTION FOR FURTHER ANALYSES

The division of the well section analysed (1500-1969m) into 4 zones is based mainly on variations in the lithology. The claystones occurring in zones A, B and C have a fair to good abundance of TOC (0.6-2.0%). Rock-Eval data indicate small variations in organic matter type. All samples analysed have poor type III or type IV kerogen with a low potential for oil or gas production. Rock-Eval T_{max} and observations in reflected light show the sediments to have a low maturity.

The amount of C_1-C_4 gases is fair to rich in zones A, B and C. Zone D has a poor to fair amount of C_1-C_4 gases. In most samples methane is the dominant compound, suggesting a biogenic origin for the gas. The interval in zone C containing sandstones (1830-1880m) has a rich to very rich abundance of C_1-C_4 gases, with a substantial amount of C_2-C_4 compounds, suggesting a petrogenic origin.

In general the interval analysed has a poor to fair potential as source rock for gas only. The sandstone interval (1830-1880m) has a high abundance of migrated hydrocarbon gases, probably of petrogenic origin.

Based on the observed homogenous nature of the organic matter we suggest to analyse a limited number of samples in more detail, i.e. extraction, MPLC fractionation of the extracts into saturates, aromatics, NSO-compounds and asphaltenes, and gas chromatograms of the saturates and aromatic hydrocarbons. Thermal evaporation/pyrolysis-GC can be used to obtain more information on the insoluble organic material.

We suggest the following samples to be selected for detailed analyses:

Zone A: 2-3 claystones, e.g. A-6803, A-6805 and A-6808
Zone C: 3-5 claystones, e.g. A-6810, A-6821, A-6825, A-6827 and A-7174
Zone D: 1-2 dolomites, e.g. A-7177 and A-7181

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TABLE I a.

CONCENTRATION (ml Gas / kg Rock) OF C1 - C7 HYDROCARBONS IN HEADSPACE.

	IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4/nC4
A	6802	1510	1111	33	5				1149	38	3.30	
A	6803	1520	5472	21	3				5496	24	0.43	
A	6804	1530	6037	17	1				6056	19	0.31	
A	6805	1540	4718	20	2				4739	21	0.45	
A	6806	1550	6841	16	20				6896	35	0.51	
A	6807	1560	10836	25	2				10863	27	0.25	
A	6808	1570	3658	10	1				3670	12	0.32	
A	6809	1580	19898	60	7				19965	67	0.34	
A	6810	1590	4896	24	5				4924	28	0.57	
A	6811	1600	3182	14					3196	14	0.43	
A	6812	1610	6900	31					6931	31	0.43	
A	6813	1620	3559	23					3582	23	0.64	
A	6814	1630	2517	13					2530	13	0.50	
A	6815	1640	6395	106	4				6505	109	1.68	
A	6816	1650	1184						1184		0.00	
A	6817	1660	4595	24					4619	24	0.53	
A	6818	1670	5085	48					5133	48	0.94	
A	6819	1680	4051	32					4083	32	0.79	
A	6820	1690	3874	28					3903	28	0.73	
A	6821	1700	5246	46					5292	46	0.87	
A	6822	1710	5950	54					6004	54	0.90	
A	6823	1720	10877	115					10991	115	1.04	
A	6824	1730	OPEN LID									

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TABLE I a.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS IN HEADSPACE.

	IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4/nC4
A	6825	1740	6611	86	6				6702	91	1.36	
A	6826	1750	18024	224	15	16			18280	256	1.40	
A	6827	1760	10474	173	16				10662	189	1.77	
A	6828	1770	9118	159	19				9296	178	1.92	
A	6829	1780	4475	87	14	5		15	4581	106	2.32	
A	6830	1790	8547	201	40				8788	242	2.75	
A	6831	1800	5505	124	26				5654	149	2.64	
A	6832	1810	7848	131	39				8017	169	2.11	
A	6833	1820	807	123	46				975	169	17.29	
A	7170	1830	136550	12671	13390	1307			163918	27368	16.70	
A	7171	1840	9647	438	313	50	49		10497	850	8.10	1.04
A	7172	1850	3127	306	345	75	87	79	3941	814	20.66	0.85
A	7173	1860	16939	1910	2364	585	698	452	22497	5558	24.71	0.84
A	7174	1870	3463	747	1734	540	764	929	7247	3785	52.22	0.71
A	7175	1880	2087	229	327	88	112	76	2843	756	26.60	0.79
A	7176	1890	906	106	198	65	88	98	1362	456	33.47	0.74
A	7177	1900	418	18	34	14	20	26	504	86	17.07	0.69
A	7178	1910	461	12	14	5	8		501	40	7.89	0.65
A	7179	1920	244	8	10	4	6		272	28	10.40	0.70
A	7180	1930	370	44	84	26	30		554	184	33.27	0.85
A	7181	1940	75	6	12	5	8		106	30	28.77	0.61
A	7870	1950	101	4	8				113	12	10.78	
A	7871	1960	78	3	4				86	7	8.63	

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TABLE I a.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS IN HEADSPACE.

IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4/nC4
A 7872	1960.70	60	2	4				66	6	9.17	

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TABLE I b.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS IN CUTTINGS .

IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4/nC4
A 6802	1510	342	7					349	7	1.97	
A 6803	1520	70957		3121				74078	3121	4.21	
A 6804	1530	126						126		0.00	
A 6805	1540	229	5	3				238	9	3.60	
A 6806	1550	154						154		0.00	
A 6807	1560	428						428		0.00	
A 6808	1570	284						284		0.00	
A 6809	1580	170						170		0.00	
A 6810	1590	193						193		0.00	
A 6811	1600	227	5	5				237	9	3.99	
A 6812	1610	141	6				19	147	6	3.91	
A 6813	1620	158	6	4			21	169	10	6.02	
A 6814	1630	74	5	2			22	81	7	9.11	
A 6815	1640	89					5	89		0.00	
A 6816	1650	190		5			39	195	5	2.82	
A 6817	1660	176	8				28	185	8	4.44	
A 6818	1670	174	4		2		19	180	6	3.34	
A 6819	1680	167	4	4	3		25	178	11	6.19	
A 6820	1690	195			5		33	201	5	2.67	
A 6821	1700	149	5	4	2		26	159	10	6.54	
A 6822	1710										
A 6823	1720	112					30	112		0.00	
A 6824	1730	OPEN LID									

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TABLE I b.

CONCENTRATION (ml Gas / kg Rock) OF C1 - C7 HYDROCARBONS IN CUTTINGS .

	IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4/nC4
A	6825	1740	215	8				42	223	8	3.75	
A	6826	1750	139	7	6				152	13	8.54	
A	6827	1760	168	7				22	175	7	3.74	
A	6828	1770	158	9				24	166	9	5.33	
A	6829	1780	171	9				19	179	9	4.79	
A	6830	1790	191	11	9			30	211	20	9.29	
A	6831	1800	222	12	9			15	243	21	8.57	
A	6832	1810	166	11	12			24	189	22	11.83	
A	6833	1820	258	13	12			26	283	25	8.89	
A	7170	1830	470	24	54	15		22	564	93	16.52	
A	7171	1840	429	46	73	20	23	95	590	161	27.33	0.86
A	7172	1850	150	25	91	50	93	235	409	259	63.25	0.53
A	7173	1860	260	80	311	160	320	560	1132	872	77.00	0.50
A	7174	1870	143	14	94	96	232	684	580	437	75.26	0.41
A	7175	1880	300	45	222	129	277	572	973	673	69.18	0.47
A	7176	1890	815	25	82	51	117	345	1090	275	25.26	0.43
A	7177	1900	1361	23	18	6	16	8	1423	62	4.33	0.36
A	7178	1910	1327	21	14			33	1362	35	2.57	
A	7179	1920	1372	16	11				1399	27	1.94	
A	7180	1930	1085	14	11			30	1110	25	2.23	
A	7181	1940	582	9	6				596	14	2.43	
A	7870	1950	530	1	6				537	7	1.30	
A	7871	1960	647	11					657	11	1.64	

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TABLE I b.

CONCENTRATION (µl Gas / kg Rock) OF C1 - C7 HYDROCARBONS IN CUTTINGS .

IKU no.	DEPTH m/Ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4/nC4
A 7872	1968.70	376	6					382	6	1.69	

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TABLE I c.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS (Ia + Ib).

IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4/nC4
A 6802	1510	1453	40	5				1497	45	2.99	
A 6803	1520	76429	21	3124				79574	3145	3.95	
A 6804	1530	6163	17	1				6182	19	0.30	
A 6805	1540	4947	25	5				4977	30	0.60	
A 6806	1550	7015	16	20				7050	35	0.50	
A 6807	1560	11263	25	2				11290	27	0.24	
A 6808	1570	3943	10	1				3954	12	0.30	
A 6809	1580	20068	60	7				20135	67	0.33	
A 6810	1590	5089	24	5				5118	28	0.55	
A 6811	1600	3409	19	5				3433	23	0.68	
A 6812	1610	7040	37				19	7078	37	0.52	
A 6813	1620	3717	29	4			21	3750	33	0.88	
A 6814	1630	2591	18	2			22	2611	20	0.77	
A 6815	1640	6484	106	4			5	6594	109	1.66	
A 6816	1650	1374		5			39	1379	5	0.33	
A 6817	1660	4771	32				28	4804	32	0.68	
A 6818	1670	5259	53		2		19	5313	54	1.02	
A 6819	1680	4217	37	4	3		25	4261	43	1.02	
A 6820	1690	4070	26		5		33	4104	34	0.82	
A 6821	1700	5395	51	4	2		26	5452	56	1.04	
A 6822	1710	5950	54					6004	54	0.90	
A 6823	1720	10988	115				30	11103	115	1.03	
A 6824	1730	OPEN LID									

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TABLE I c.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS (Ia + Ib) .

	IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4 / nC4
A	6825	1740	6826	94	6			42	6925	100	1.44	
A	6826	1750	18163	232	21	14			18432	269	1.46	
A	6827	1760	10642	179	16			22	10837	195	1.80	
A	6828	1770	9275	168	19			24	9462	187	1.98	
A	6829	1780	4645	96	14	5		34	4760	115	2.42	
A	6830	1790	8738	212	49			30	8999	261	2.90	
A	6831	1800	5727	136	34			15	5897	170	2.89	
A	6832	1810	8014	141	50			24	8206	192	2.34	
A	6833	1820	1065	136	58			26	1259	194	15.40	
A	7170	1830	137020	12695	13444	1322		22	164482	27461	16.70	
A	7171	1840	10075	484	386	70	71	95	11087	1011	9.12	0.98
A	7172	1850	3277	330	436	125	182	315	4350	1073	24.67	0.68
A	7173	1860	17200	1990	2676	745	1018	1011	23629	6430	27.21	0.73
A	7174	1870	3606	762	1028	636	996	1618	7828	4221	53.93	0.64
A	7175	1880	2387	275	548	218	388	648	3816	1429	37.46	0.56
A	7176	1890	1721	130	280	116	205	438	2452	731	29.82	0.56
A	7177	1900	1779	41	52	19	36	34	1927	148	7.66	0.54
A	7178	1910	1788	33	28	5	8	33	1863	75	4.00	0.65
A	7179	1920	1616	24	21	4	6		1672	55	3.32	0.70
A	7180	1930	1455	58	95	26	30	30	1664	209	12.56	0.85
A	7181	1940	657	14	18	5	8		702	45	6.40	0.61
A	7870	1950	631	5	15				650	20	3.02	
A	7871	1960	725	14	4				743	18	2.45	

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TABLE I c.

CONCENTRATION (ul Gas / kg Rock) OF C1 - C7 HYDROCARBONS (Ia + Ib) .

IKU no.	DEPTH m/ft	C1	C2	C3	iC4	nC4	C5+	SUM C1-C4	SUM C2-C4	WET-NESS (%)	iC4 / nC4
A 7872	1968.70	436	9	4				449	13	2.80	

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Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology	
A-6802	1500-1510	1.05	70%	Claystone, light grey, none to poor fissility, occasionally micaceous, pyritic, occasionally with organic material
		0.19	15%	Claystone, olive grey, brownish grey, slightly fissile
			5%	Claystone, light green, fissile
			10%	Siderite, dark grey, grey with organic material?, very fine grained
			Trace	Limestone, grey
			Sm.am.	Sand; Shell fragments
A-6803	1510-1520	1.17	65%	Claystone, light grey, as above
		1.10	15%	Claystone, dark grey, brownish grey, slightly fissile
			Sm.am.	Claystone, light green
			20%	Siderite, dark grey, dark brownish grey, grey, very fine grained
			Sm.am.	Tuff; Sand
			Trace	Limestone, white, yellowish; Shell fragments
A-6804	1520-1530	0.73	60%	Claystone, light grey, as above
			5%	Claystone, brownish grey to dark grey as above
			5%	Siderite, dark grey, as above
			30%	Siderite, light grey , grey, very fine grained, occasionally pyritic
			Sm.am.	Claystone, light green; Stained, light brown, Claystone; Sandstone

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC		Lithology
A-6805	1530-1540	0.44	20%	Claystone, siltstone, black, occasionally fissile, occasionally with secondary yellow sulphates on the surface
		0.83	15%	Claystone, light grey, as above
		0.76	30%	Claystone, different shades of grey; light brownish and brownish grey, olive grey, grey, occasionally sandy, occasionally silty
			2%	Dolomite, light brown due to staining by weathered pyrite (?), fine grained, very fine grained
			5%	Siderite, dark grey, as above
			28%	Siderite, light grey, grey, as above
A-6806	1540-1550	0.71	20%	Claystone, light grey, as above
			5%	Claystone, siltstone, black, as above
			10%	Claystone, brownish grey, grey, olive-grey, as above
			55%	Siderite, light grey, clayey, to sideritic claystone
			Sm.am.	Siderite, dark grey, as above
			10%	Dolomite, as above

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology
A-6807	1550-1560		30% Siderite, light grey, light olive-grey, very fine grained
			20% Siderite, dark grey, black, very fine grained
		0.67	40% Claystone, light grey, olive-grey, light olive-brown, occasionally sandy
		0.79	10% Claystone, dark grey, black, occasionally sandy
			Sm.am. Dolomite, light brown, medium grained, fine grained, clayey
			Trace Claystone, light green, slightly fissile
A-6808	1560-1570	1.02	40% Claystone, light grey, olive-grey, light olive-brown, occasionally sandy
			5% Claystone, dark grey, as above
			5% Claystone, light green, as above
			28% Siderite, light grey, as above
			2% Siderite, dark grey, as above
			20% Dolomite, as above, pyritic
			Sm.am. Tuff, grey, laminated
			Sm.am. Pyrite; Limestone
A-6809	1570-1580	0.95	58% Claystone, light grey, as above, sandy
			2% Claystone, dark grey, as above
			Sm.am. Claystone, light green
			30% Dolomite, as above, pyritic
			10% Siderite, light grey, as above
			Sm.am. Tuff; Sand
			Sm.am. Fossils

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology	
A-6810	1580-1590	1.14	15%	Claystone, olive grey, grey, slightly fissile to non-fissile, occasionally micaceous, sandy
			5%	Dolomite, light brown (stained), fine grained, very fine grained
			Sm.am.	Limestone, brown, recrystallized
			80%	Tuff, different shades of grey and brown, laminated, occasionally blue laminae
			Sm.am.	Fossils; Claystone, light green
A-6811	1590-1600		5%	Claystone, as above
			5%	Dolomite, light brown, yellow-brown (stained)
			90%	Tuff, as above
			Sm.am.	Claystone, light green; Pyrite; Glauconite
A-6812	1600-1610		5%	Claystone, as above
			5%	Dolomite, as above
			90%	Tuff, as above
			Sm.am.	Claystone, light green; Pyrite; Glauconite; Fossils
A-6813	1610-1620	0.74	10%	Claystone, as above
			5%	Dolomite, as above
			85%	Tuff, as above
			Sm.am.	Siderite, clayey siderite; Pyrite; Quartz/gravel

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology
A-6814	1620-1630		10% Claystone, grey, olive grey, as above 8% Dolomite, pale brown, greyish brown, pyritic, fine grained 80% Tuff, as above Sm.am. Limestone; Claystone, light green; Quartz and gravel; Pyrite; Fossils 2% Claystone, light grey, occasionally white, non-fissile
A-6815	1630-1640	0.77	77% Claystone, grey, olive-grey, slightly fissile Sm.am. Claystone, brownish grey, light green 20% Tuff, as above 3% Dolomite, as above Sm.am. Limestone, white; Pyrite; Fossils; Gravel and Quartz
A-6816	1640-1650	0.74	77% Claystone, grey, olive-grey, light olive-grey, as above, occasionally sandy 3% Claystone, dark grey, black, silty 5% Dolomite, as above 10% Limestone, grey, fine grained, impure (contains clay) 5% Tuff

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology
A-6817	1650-1660	1.10	70% Claystone, grey, olive-grey, light olive-grey, as above 1% Claystone, dark grey, black, as above 10% Limestone, grey, as above 4% Limestone, yellow, yellow-brown 5% Dolomite, as above 1% Tuff, as above Sm.am. Limestone, white, very fine grained; Pyrite; Quartz; Gravel; Siderite
A-6818	1660-1670	0.83	50% Claystone, grey, olive-grey, light olive-grey, as above 30% Limestone, grey, dark grey, as above 5% Dolomite, as above 2% Tuff, as above 10% Pyrite 3% Sandstone, calcite cemented Sm.am. Quartz; Gravel; Limestone, white, as above; Limestone, brown, as above; Claystone, light green; Siderite
A-6819	1670-1680	0.61	50% Claystone, grey, olive-grey, light olive-grey, as above 40% Limestone, grey, as above 8% Dolomite, as above 2% Claystone, light green Sm.am. Pyrite; Quartz; Gravel; Siderite; Tuff

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology
A-6820	1680-1690	1.79	40% Claystone, grey, olive-grey, calcareous, slightly fissile, non-fissile, occasionally sandy, silty 2% Claystone, light green, fissile, glauconitic, occasionally micaceous 3% Claystone, sandy Claystone, light grey, calcareous, non-fissile 40% Limestone, light grey - grey 10% Dolomite, as above, fossiliferous Sm.am. Siderite, dark grey Sm.am. Tuff; Pyrite; Fossils 5% Rock-fragments (gravel) and quartz
A-6821	1690-1700	0.76 1.22	40% Claystone, grey, olive grey, as above 40% Claystone, light green, slightly fissile, occasionally sandy, occasionally pyritic, occasionally calcareous Sm.am. Limestone, grey, as above 5% Dolomite, as above 10% Tuff, grey, brownish grey, laminated Sm.am. Siderite, grey, brown 3% Sandstone, grey, calcite cemented 2% Rock fragments, sand Sm.am. Pyrite; Fossils

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology
A-6822	1700-1710	1.45 0.32	50% Claystone, light green, as above 30% Claystone, olive-grey, light olive-grey, grey as above, occasionally very calcareous lamelae 5% Limestone, as above 15% Tuff Sm.am. Dolomite, as above, Pyrite; Sand/Gravel
A-6823	1710-1720	1.78 0.39	45% Claystone, light green, as above 40% Claystone, olive grey, light olive-grey, grey, as above 5% Limestone, grey, as above 10% Tuff, as above Sm.am. Marl, very calcareous claystone, grey; Dolomite, as above; Limestone, yellow/yellow-brown coarse grained; Sand/Gravel; Glauconitic Sandstone; Fossils
A-6824	1720-1730	1.94 0.41	30% Claystone, light green, as above 50% Claystone, olive-grey, light olive-grey, grey, as above 2% Dolomite, as above, occasionally with organic material 8% Tuff, as above 10% Limestone, as above Sm.am. Limestone, yellow, coarse; Fossils; Pyrite; Glauconite; Gravel/Sand

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology
A-6825	1730-1740	1.93	50% Claystone, light green, as above
		0.34	15% Claystone, olive-grey etc., as above
			25% Limestone, as above, silty, occasionally sandy
			6% Tuff, as above
			2% Siderite, dark grey, very fine grained
			2% Dolomite, as above
			Sm.am. Fossils; Limestone, white, very fine grained; Limestone, coarse, yellow to brown; Pyrite; Glauconite; Sand and gravel
A-6826	1740-1750	0.58	50% Claystone, light green, as above
			10% Claystone, olive-grey etc., as above
			25% Limestone, as above
			3% Dolomite, as above
			12% Tuff, as above
			Sm.am. Marl; Claystone, brown; Sandstone, brown; Limestone, white, yellow; Pyrite; Sand (quartz)
A-6827	1750-1760	1.99	50% Claystone, light green, greyish green, slightly fissile, occasionally pyritic, occasionally micaceous, occasionally silty
		0.37	15% Claystone, olive grey, light grey, grey, non-fissile to slightly fissile, occasionally micaceous, silty/sandy
			15% Limestone, grey, white, as above
			15% Tuff, as above
			3% Dolomite, as above
			2% Siderite?, grey

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology	
A-6828	1760-1770	2.01	35%	Claystone, light green etc., as above
		0.37	30%	Claystone, olive grey, dark olive-grey, slightly fissile, occasionally silty/sandy
			8%	Claystone, light grey, non-fissile, occasionally pyritic
			5%	Limestone, grey, as above
			20%	Tuff, as above
			2%	Marl/very calcareous Claystone, greyish white
			Sm.am.	Dolomite, as above; Siderite, as above; Pyrite; Glauconite; Sand (quartz) and gravel
A-6829	1770-1780	1.67	20%	Claystone, light green, as above
		0.36	20%	Claystone, olive-grey, dark olive-grey, as above
			10%	Claystone, light grey, as above
			Sm.am.	Sandstone, grey, brownish grey, light grey, pyritic, occasionally glauconitic
			40%	Tuff, as above
			10%	Limestone, light grey, grey, as above
			Sm.am.	Limestone, yellow, white; Fossils; Pyrite; Glauconite; Quartz; Siderite?
			Trace	Coal (brown) with fossiliferous limestonlayer (mollusca)

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology	
A-6830	1780-1790	1.56	30%	Claystone, light green, as above
		0.39	15%	Claystone, olive-grey, brownish grey, dark olive-grey, slightly fissile
			5%	Claystone, dark brownish grey to nearly black
			2%	Claystone, light grey, as above
			35%	Tuff, as above
			3%	Sandstone, as above, calcareous
			8%	Limestone, as above
			2%	Marl, as above
			Sm.am.	Dolomite; Siderite; Fossils; Quartz
A-6831	1790-1800	1.56	20%	Claystone, light green, as above
		0.49	15%	Claystone, grey, olive-grey, brown-olive-grey, as above
		0.60	13%	Claystone, light grey, as above
			15%	Limestone, grey, light grey, as above, occasionally, white, bluish grey
			7%	Claystone, dark grey, fissile, sideritic?, occasionally sandy
			30%	Tuff, as above
			Sm.am.	Dolomite, as above; Siderite; Pyrite; Quartz; Fossils

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology
A-6832	1800-1810		10% Claystone, light green, as above
		1.72	30% Claystone, olive-grey, grey, brownish grey, light olive-grey
			5% Claystone, dark grey, dark olive-grey
			10% Limestone, as above
			12% Sandstone, grey, fine-grained, calcareous, glauconitic
			20% Tuff, as above
			Sm.am. Marl; Pyrite; Glauconite; Quartz; Siderite
			8% Dolomite, light brown, as above
A-6833	1810-1820		5% Claystone, light green, as above
		0.97	15% Claystone, olive-grey, grey, light olive grey
			8% Claystone, dark olive grey
			27% Sandstone, grey, brownish grey, fine grained, calcareous, glauconitic
			10% Limestone, as above
			30% Tuff, as above
			5% Dolomite, light brown, as above
			Sm.am. Marl; Pyrite; Glauconite; Quartz; Siderite?

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology
A-7170	1820-1830		10% Claystone, grey, olive grey, fissile, slightly calcareous 5% Claystone, light grey, non-fissile, slightly calcareous Sm.am. Claystone, light green, occasionally pyritic Sm.am. Glauconite; Pyrite 75% Sandstone, fine grained, very fine grained, glauconitic, calcareous 10% Tuff, grey, brownish grey, laminated, often with light blue minerals Sm.am. Siderite, brown, very fine grained
A-7171	1830-1840		8% Claystone, olive-grey, dark olive-grey 5% Tuff, as above 80% Sand, Sandstone, as above, pyritic Sm.am. Fossils; Glauconite; Claystone, light green 5% Siderite, brown, grey, very fine grained 1% Pyrite
A-7172	1840-1850		10% Claystone, olive-grey, grey, non-fissile 90% Cement Sm.am. Limestone; Tuff; Siderite; Sand; Fossils; Pyrite
A-7173	1850-1860	0.67	50% Claystone, grey, non-fissile, calcareous 45% Cement 5% Siderite, brown, dolomitic, fine grained to very fine grained Sm.am. Limestone; Fossils; Glauconite; Pyrite

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology	
A-7174	1860-1870	0.87	90%	claystone, grey, as above, occasionally sandy, clauconitic
			5%	Cement
			5%	Reconsolidated sandstone
			Sm.am.	Claystone, light grey, yellowish
			Sm.am.	Claystone, light green
A-7175	1870-1880	0.86	50%	Claystone, grey, as above, occasionally with layers of calcite
			45%	Dolomite, yellow, brown, white, very fine grained with medium grained euhedral crystals on cracks and in cavities
			5%	Sandstone, white, light grey, calcite cemented quartz, glauconitic, very fine to fine grained
			Sm.am.	Pyrite; Glauconite; Fossils; Additives; Cement
A-7176	1880-1890		5%	Claystone, grey, as above
			95%	Dolomite, as above, occasionally grey
			Sm.am.	Limestone, white, very fine grained, occasionally sandy
A-7177	1890-1900		100%	Dolomite, as above
			Sm.am.	Coarse grained Limestone, white; Quartz; Pyrite
			Sm.am.	Claystone, olive brown
A-7178	1900-1910		100%	Dolomite, as above
			Sm.am.	Quartz; Pyrite

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology
A-7179	1910-1920	0.06	85% Dolomite, as above, also grey like the limestone, Fossiliferous (Bryozoa) 15% Limestone, very calcareous Sandstone, grey Sm.am. Pyrite; Cement
A-7180	1920-1930		68% Dolomite, as above 20% Limestone, grey, occasionally white, occasionally sandy 10% Sandstone, red due to iron oxide 2% Muscovite and biotite Sm.am. Pyrite
A-7181	1930-1940	0.19	50% Dolomite, as above 10% Limestone, as above 40% Sandstone, as above Sm.am. Muscovite; Biotite; Pyrite; Fossils (pyritized)
A-7870	1946-1950		30% Dolomite, as above 50% Sandstone, as above 20% Quartz - Muscovite - Feldspar - setnest, white, grey, red Sm.am. Limestone; Pyrite; Cement; Muscovite
A-7871	1950-1960		20% Dolomite, as above 60% Sandstone, as above 20% Schist, as above Sm.am. Muscovite; Biotite; Cement; Wood (additives)

IKU

Lithology and Total Organic Carbon measurements

TABLE NO.: 2.
WELL NO.: 6609/7-1

Sample	Depth (m)	TOC	Lithology
A-7872	1960-1968.7	0.16	20% Dolomite, as above 60% Sandstone, as above 20% Schist, as above Sm.am. Muscovite; Biotite; Cement; Wood (additives)

TABLE 3.

R O C K E V A L P Y R O L Y S E S

IKU No.	DEPTH m/ft	S1	S2	S3	TOC (%)	HYDR. INDEX	OXYGEN INDEX	OIL OF GAS CONTENT S1+S2	PROD. INDEX S1/(S1+S2)	TEMP. MAX (C)
A 6802	1510	0.39	1.02	0.56	1.05	97	53	1.41	0.28	414
A 6803	1520	0.17	0.97	0.53	1.17	83	45	1.14	0.15	412
		Clst	lt - sy							
A 6803	1520	0.11	0.67	0.61	1.10	61	55	0.78	0.14	425
A 6804	1530	0.11	0.52	0.49	0.73	71	67	0.63	0.17	405
A 6805	1540	0.10	0.57	0.45	0.76	75	59	0.67	0.15	413
		Clst	lt -brn - sy							
A 6805	1540	0.21	0.47	0.52	0.83	57	63	0.68	0.31	415
A 6806	1550	0.13	0.38	0.42	0.71	54	59	0.51	0.25	412
A 6807	1560	0.96	0.47	0.66	0.79	59	84	1.43	0.67	406
A 6808	1570	0.48	0.62	0.74	1.02	61	73	1.10	0.44	426
A 6809	1580	0.12	0.65	0.56	0.95	68	59	0.77	0.16	420
A 6810	1590	0.18	0.98	0.70	1.14	86	61	1.16	0.16	420
A 6813	1620	0.12	0.29	0.77	0.74	39	104	0.41	0.29	409
A 6815	1640	0.15	0.43	0.84	0.77	56	109	0.58	0.26	414
A 6816	1650	0.13	0.45	0.51	0.74	61	69	0.58	0.22	410
A 6817	1660	0.19	0.79	0.66	1.10	72	60	0.98	0.19	414
A 6818	1670	1.01	0.36	1.00	0.83	43	120	1.37	0.74	408
A 6820	1690	0.18	0.60	0.67	1.79	34	37	0.78	0.23	413
A 6821	1700	0.29	0.11	0.79	0.76	14	104	0.40	0.72	339
		Clst	sy -olv - sy							
A 6821	1700	0.28	0.35	0.84	1.22	29	69	0.63	0.44	405
A 6822	1710	1.39	0.52	0.70	1.45	36	48	1.91	0.73	414
A 6823	1720	0.36	0.78	1.21	1.78	44	68	1.14	0.32	420
A 6824	1730	0.43	0.00	0.63	1.94	0	32	0.43	1.00	323
A 6825	1740	0.38	1.32	0.84	1.93	68	44	1.70	0.22	419

TABLE 3.

R O C K E V A L P Y R O L Y S E S

IKU No.	DEPTH m/ft	S1	S2	S3	TOC (%)	HYDR. INDEX	OXYGEN INDEX	OIL OF GAS CONTENT S1+S2	PROD. INDEX S1/S1+S2	TEMP. MAX (C)
A 6827	1760	0.25	0.77	0.98	1.99	39	49	1.02	0.25	421
A 6828	1770	0.35	0.97	0.90	2.01	48	45	1.32	0.27	420
A 6829	1780	0.20	0.83	0.82	1.67	50	49	1.03	0.19	417
A 6830	1790	0.31	0.67	0.83	1.56	43	53	0.98	0.32	415
A 6831	1800	0.22	0.68	0.94	1.56	44	60	0.90	0.24	414
A 6832	1810	0.37	0.71	0.87	1.72	41	51	1.08	0.34	423
A 6833	1820	1.12	0.22	0.72	0.97	23	74	1.34	0.84	404
A 7174	1870	0.09	0.17	0.25	0.87	20	29	0.26	0.35	422
A 7175	1880	0.11	0.16	0.40	0.86	19	47	0.27	0.41	420

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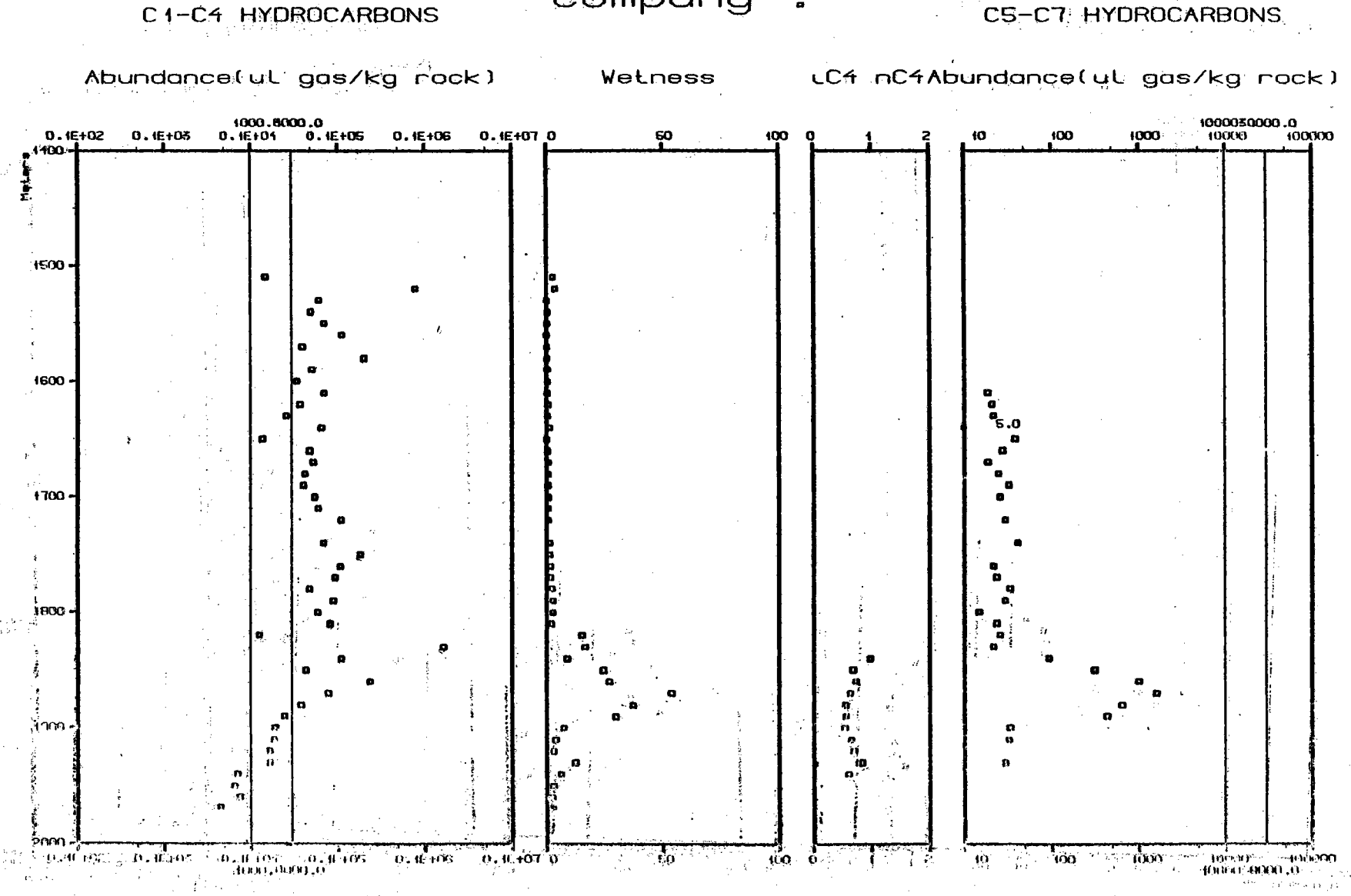

Figure 1. Composite gas results vs. depth.

WELL ID: 6609/7-1

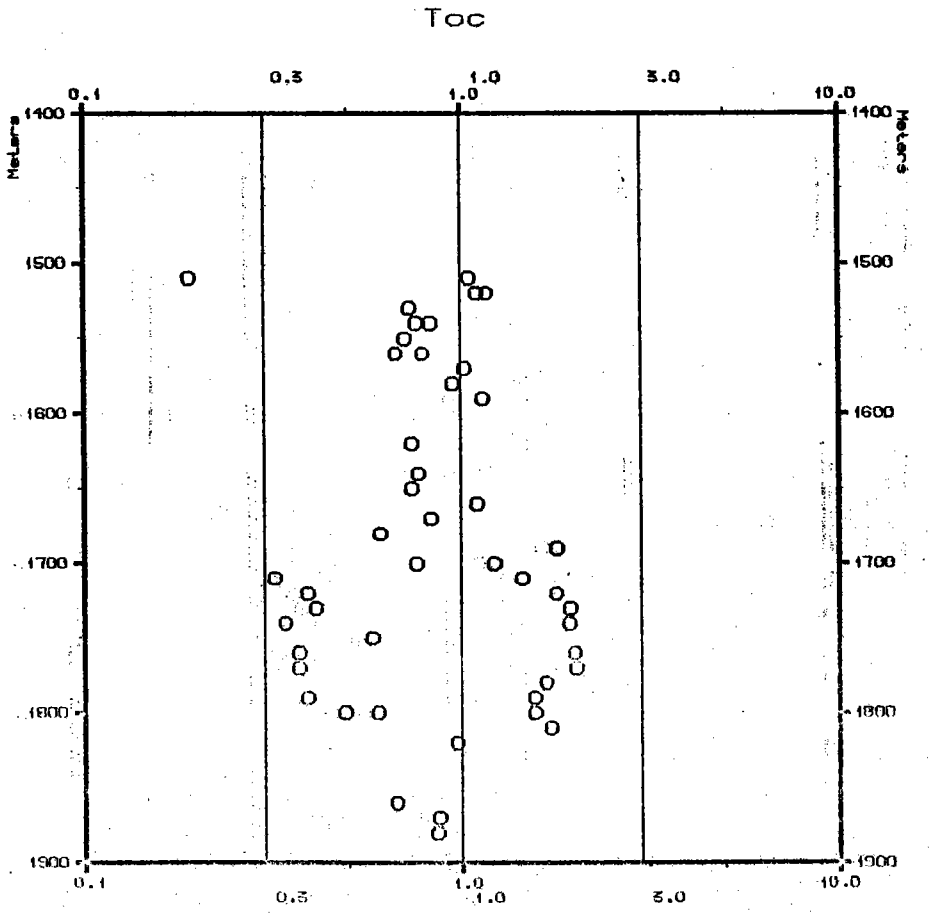

Figure 2. Total organic carbon vs. depth.

WELL ID: 6609/7-1

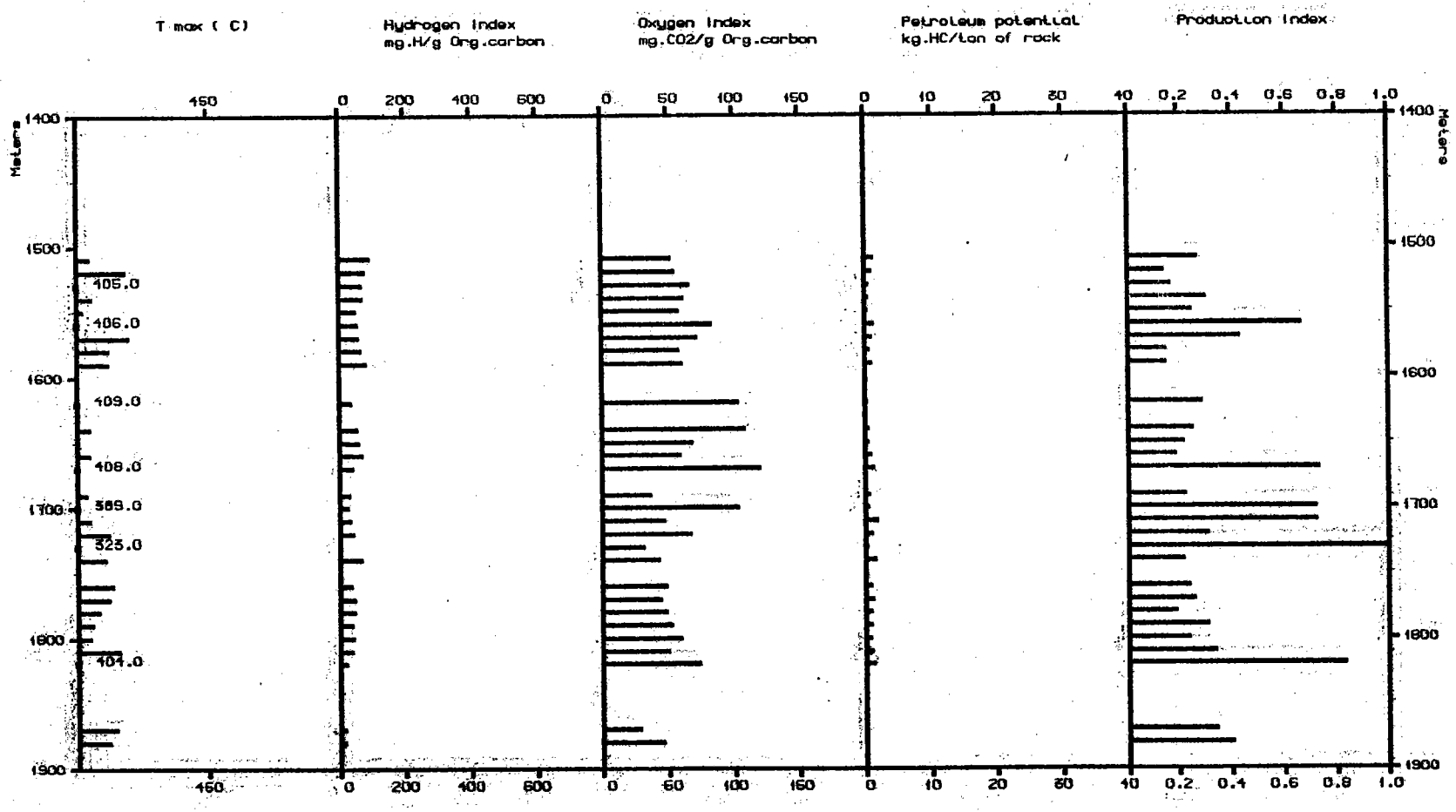

Figure 3. Rock-Eval data vs. depth.

6609/7 – 1 Phillips Petroleum

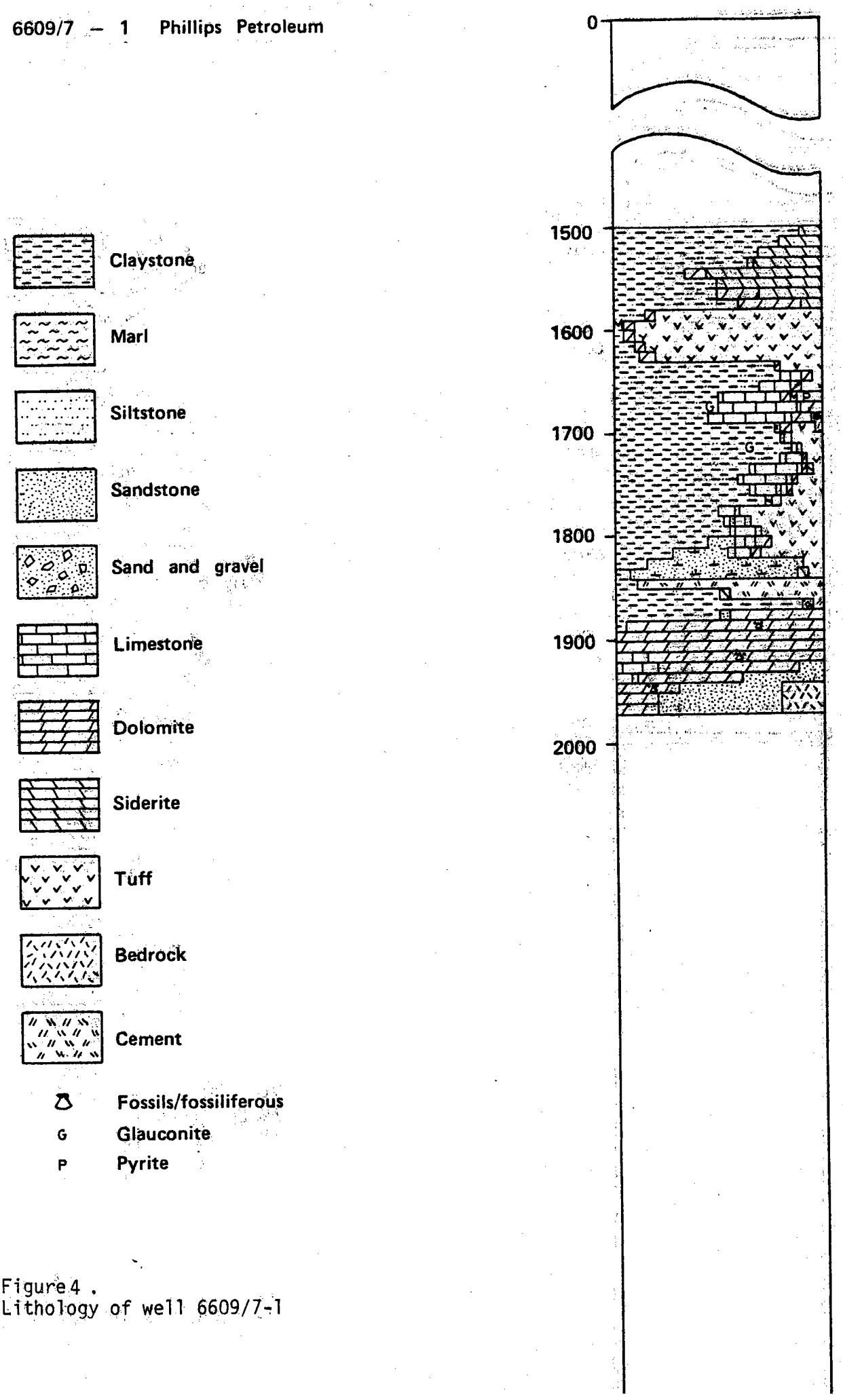

Figure 4 .
Lithology of well 6609/7-1