

6.1 Mud report

36" hole section

This section was drilled with seawater and high viscosity pills and returns to the seabed.

At TD the hole was displaced with a 1.20 SG mud prior to running casing.

The 30" casing was run and cemented without problems.

24" hole section

As for the previous hole section this section was drilled with seawater and high viscosity pills and returns to the seabed.

At TD the hole was displaced with 1.20 SG prior to running casing.

The 18 5/8" casing was run and cemented without problems.

17 1/2" hole section

This section was drilled with a KCl/polymer mud with a starting weight of 1.20 SG. The previous seawater was displaced while drilling the casing shoe and cement. The hole was drilled to 1710 m and the mud weight increased to a final weight of 1.30 SG. The mud weight was further increased to 1.32 SG due to heavy cleaning pills.

The 13 3/8" casing got differentially stuck at 1450 m and 1558 m while running in. The casing got loose after reducing the mud weight to 1.20 SG and 1.18 SG respectively and spotting pipe freeing chemicals.

12 1/4" hole section

This hole interval was drilled to TD at 3117 m. The hole was washed out to a maximum diameter of 20" from the 13 3/8" casing shoe down to 2500 m where the mud weight was increased from 1.27 SG to 1.30 SG after evidence of cavings. The rest of the well was drilled without further problems and the hole was in gauge.

It is recommended to drill this section in future wells with a mud weight of 1.10 SG (less intrusive), a low water loss, and the addition of asphaltic material to reduce erosion of the formation aggravated by filtrate invasion. This approach would be based on the possibility that erosion happens because of the unconsolidated nature of the claystones rather than because of overpressures.

The well was permanently abandoned.

((( (ooo)	Daily mud properties										Date														
Norsk Hydro	Well: 16/4-2 Mud Contractor: NL-BAROID Data: "Mid depth" from table 3, otherwise from table 14.										28/11-1990														
	System : BORE																								
Date	Mid. depth m, MD	Mud Dens. (SG)	PV cp	YP Pa	GEL 0 Pa	GEL 10 Pa	pH	100 psi (cc)	HP/HT (cc)	Cl- inn/out mg/l	Alkalinity			Ca++ inn/out mg/l	Oil %	Sol %	H2O %	V.G 600 rpm	meter 300 rpm	at 1 200 rpm	5 gr. 100 rpm	gr. 6 rpm	F 3 rpm	Mud Type	
900629	191	1.20	0	0																					SPUD
900630	206	1.20	0	0																					SPUD
900701	485	1.20	0	0																					SPUD
900702	485	1.20	0	0																					SPUD
900703	485	1.20	0	0																					KILLMUD
900704	514	1.24	13	6	2	2	12.2	4.0		47000/47000	0.80	1.10	1.70	136/136	0	8	92	38	25	18	11	3	3	3	KCL
900705	914	1.22	11	10	3	3	10.3	6.0		50000/50000	0.10	1.30	0.20	140/140	0	10	90	41	30	25	17	6	5	5	KCL
900706	1286	1.21	15	12	4	7	8.6	3.6		56000/56000	0.01	0.10	0.90	200/200	0	13	87	55	40	32	24	9	7	7	KCL
900707	1446	1.20	15	9	4	7	8.3	3.6		54000/54000		0.30	0.60	280/280	0	14	86	48	33	27	20	7	6	6	KCL
900708	1583	1.23	17	10	3	8	8.5	4.6		52000/52000	0.30	0.40	0.80	180/180	0	14	86	54	37	25	22	8	7	7	KCL
900709	1710	1.25	19	9	3	7	8.3	4.6		52000/52000		0.20	0.80	200/200	0			56	37	25	19	6	5	5	KCL
900710	1710	1.33	18	10	3	10	8.1	5.2		52000/52000		0.30	0.70	210/210	0	16	84	55	37	30	22	7	6	6	KCL
900711	1710	1.31	14	6	2	7	8.4	5.2		46000/46000			0.60	340/340		13		39	25	20	14	9	3	3	KCL
900712	1710	1.18	5	5	1	2	8.2	6.0	20.0	50000/50000	0.20		0.70	280/280	3	7	90	20	15	10	7	2	1	1	KCL
900713	1710	1.18	6	5	1	2	8.4	6.1	22.0	50000/50000	0.03	0.10	0.70	280/280	7	6	87	22	16	11	7	2	1	1	KCL
900715	1927	1.27	17	8	2	4	10.3	2.9	10.0	51000/51000	0.10	1.10	0.60	300/300	4	14	82	50	39	25	17	4	3	3	KCL
900716	2234	1.27	15	10	2	6	9.5	2.8	10.0	56000/56000	0.50	0.30	0.40	300/300	4	8	88	50	35	28	19	5	4	4	KCL
900717	2445	1.28	18	9	2	5	9.5	2.5	10.0	61000/61000	0.50	0.20	0.40	100/100	3	12	85	54	36	32	14	3	2	2	KCL
900718	2600	1.28	17	8	2	6	9.8	2.6	8.4	64000/64000	0.10	0.10	0.40	240/240	2	11	87	50	33	26	17	4	3	3	KCL
900719	2826	1.31	14	8	2	6	9.5	2.8	8.6	63000/63000	0.10	0.40	0.40	100/100	1	12	87	44	30	23	15	3	2	2	KCL
900720	3015	1.30	16	8	3	7	9.2	2.8	8.6	58000/58000	0.10	0.40	0.40	100/100	1	11	88	48	32	24	15	3	2	2	KCL
900721	3073	1.31	20	10	3	11	9.7	3.0	8.8	58000/58000	0.10	0.40	0.60		1	11	88	60	40	32	22	6	5	5	KCL
900722	3117	1.31	16	10	7	9	9.5	2.8	9.0	60000/60000	0.10	0.40	0.40	80/80	1	12	87	51	35	27	18	5	4	4	KCL
900723	3117	1.31	16	10	2	9	9.5	2.8	9.0	60000/60000	0.10	0.40	0.40	80/80	1	12	87	51	35	27	18	5	4	4	KCL
900724	1800	1.31	0	0																					KCL
900725	1557	1.30	0	0																					KCL
900726	1557	1.30	0	0																					KCL
900727	160	1.00	1	1																					KCL

((( (ooo) ----- Norsk Hydro	M u d c o n s u m p t i o n ----- System : BORE	Date 28/11-1990
	Well: 16/4-2 Mud company: NL-BAROID	13

	Actual used
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Drilling of 36 " hole

BARITE	Kg	60000
BENTONITE	Kg	22000
CAUSTIC	Kg	350
SODA ASH	Kg	350

Drilling of 24 " hole

BARITE	Kg	10000
BENTONITE	Kg	6000
CAUSTIC	Kg	250
SODA ASH	Kg	125

Drilling of 17 1/2" hole

BARITE	Kg	163000
BENTONITE	Kg	5000
CAUSTIC	Kg	100
DEXTRID	Kg	11005
EZ-MUD	Kg	2520
KCL	Kg	24515
PAC-L	Kg	2639
PAC-R	Kg	2110
SODA ASH	Kg	950
SODIUM BICARB	Kg	675
XCD-POLYMER	Kg	2850
EZ SPOT	l	57
KCL-BRINE	l	473000

Drilling of 12 1/4" hole

BARITE	Kg	179000
CAUSTIC	Kg	525
DEXTRID	Kg	8195
EZ-MUD	Kg	1430
KCL	Kg	12000
PAC-L	Kg	1835
PAC-R	Kg	850
POT HYDROXIDE	Kg	1050
SODA ASH	Kg	675
SODIUM BICARB	Kg	1750
XCD-POLYMER	Kg	2025
KCL-BRINE	l	163000

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25 JAN. 1991

**REGISTRERT**

OLJEDIREKTORATET

PETROLEUM GEOCHEMISTRY

WELL 16/4-2

PL 087

Norsk Hydro a.s.  
20.12.1990

## 1. INTRODUCTION

Well 16/4-2 was spudded on June 29th 1990 and reached total depth at 3117 m on July 22nd 1990 in siltstones of Upper Jurassic age.

A map over Block 16/4 indicating the position of well 16/4-2 is given in Figure 1.1.

98 samples (71 DCs and 27 SWCs) covering the interval from 1100 m to 3113 m were selected for organic geochemical analysis. Vitrinite reflectance was measured by Geo-Optics, Newcastle, U.K. All other geochemical analyses together with the compilation and interpretation presented in this report was undertaken by Norsk Hydro Research Centre, Bergen.

All reported depths are in meters relative to RKB.

## 2. DETECTION AND CHARACTERIZATION OF FREE HYDROCARBONS

Well 16/4-2 was drilled with diesel oil in the mud from 1715 m to 3117 m (TD). Hydrocarbons added to the mud may stain cuttings and cores collected for geochemical analysis. The extent of contamination depends on the quantity and type of oil additive used. Contamination of geochemical samples affects the amount as well as the composition of extractable hydrocarbons, rendering subsequent analysis difficult.

Four composite geochemical samples (CGS), caught at 1000 m, 1500 m, 2000 m and 2500 m, were available for analysis. CGSs are samples of water, drilling mud and rock fragments, stored in tin cans. Free hydrocarbons are normally not flushed from the cuttings into the mud except in sandstone lithologies. Consequently, hydrocarbons extracted from the water phase when penetrating tight formations originate from the drilling mud.

**FIGURE 2.1**  
**GAS CHROMATOGRAM,**  
**DRILLING MUD EXTRACT**  
**2000 M**



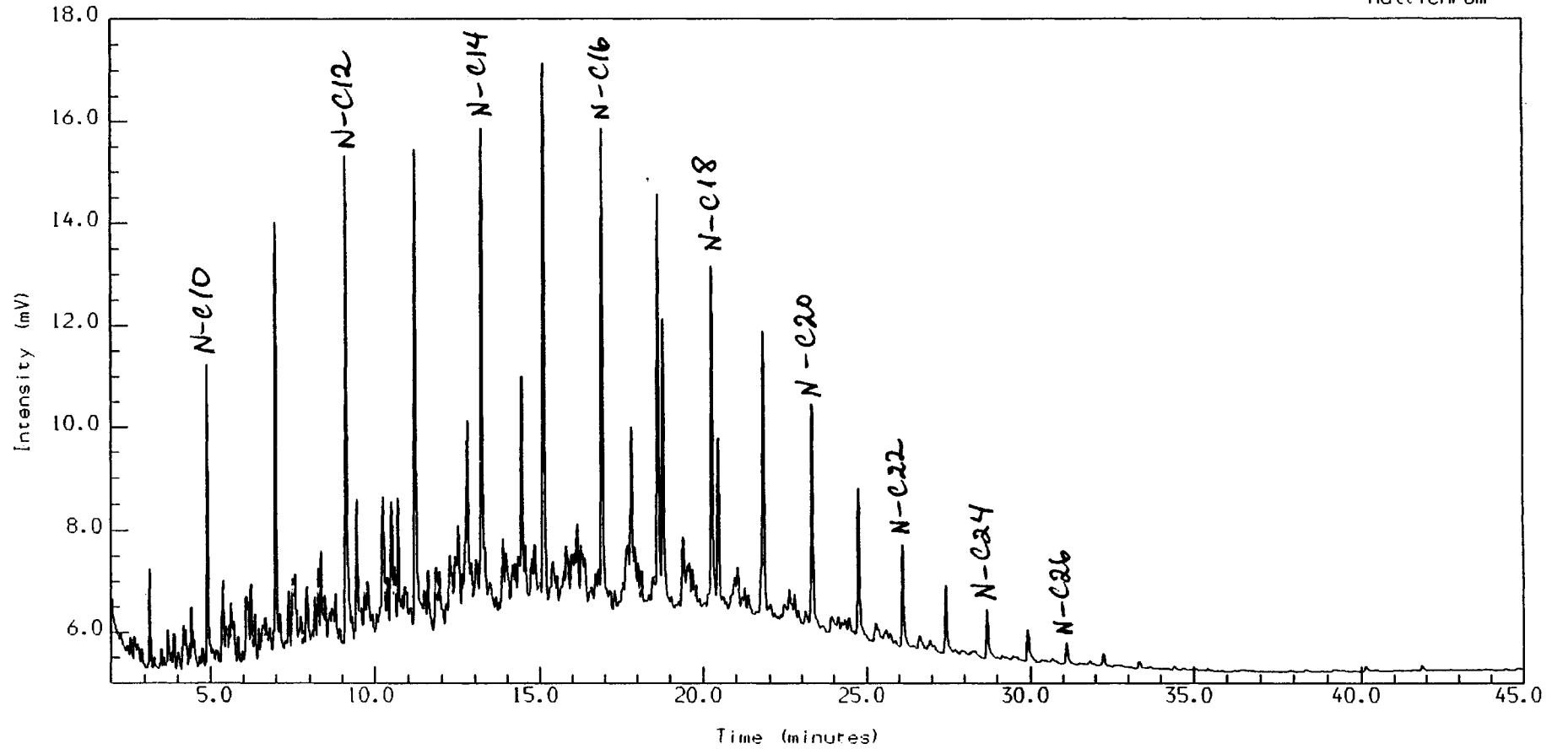
NORSK HYDRO RESEARCH CENTRE

Analysis Name : [PETRO] 11 A160402\_MUD.1.1.

16/4-2 MUD 2000 M. EXTR. M/DCM

HIGH TEMPERATURE GC-ANALYSIS

Multichrom



Instrument : HP605300

Channel Title : WAX ANALYSIS

Lims ID :

Acquired on 25-OCT-1990 at 17:47

Reported on 19-NOV-1990 at 13:45

Method : WAX

Calibration : WAX

Run Sequence : WAX

**TABLE 3.1**  
**ROCKEVAL/TOC RESULTS**

Table 3.1 SOURCE ROCK SCREENING DATA WELL 16/4-2



Depth (m)	% Lithology	Sample	S1 Kg/t	S2 Kg/t	S3 Kg/t	TOC %	HI	OI	PI	Tmax Deg.c	Company
2955.00	0 CLYST	DC	0.1	0.2		0.4	35		0.40	424	F-BERGEN
2957.00	0 CLYST	DC	0.9	16.9		4.3	396		0.05	427	F-BERGEN
2960.00	0 CLYST	DC	1.2	23.1		5.2	450		0.05	426	F-BERGEN
2960.00	100 CLYST/LST	SWC	0.6	0.1		0.3	38		0.86		F-BERGEN
2962.00	CLYST	DC	2.0	35.6		7.3	491		0.05	425	F-BERGEN
2965.00	CLYST	DC	1.9	29.5		6.3	467		0.06	423	F-BERGEN
2965.00	CLYST	SWC	2.0	23.3		5.7	409		0.08	420	F-BERGEN
2967.00	CLYST	DC	2.0	30.6		6.3	485		0.06	422	F-BERGEN
2970.00	CLYST	DC	1.6	34.6		7.8	444		0.04	419	F-BERGEN
2972.00	CLYST	DC	1.7	40.2		8.5	475		0.04	423	F-BERGEN
2975.00	CLYST	DC	1.9	41.4		8.7	476		0.04	419	F-BERGEN
2975.00	CLYST	SWC	6.2	40.2		8.4	476		0.13	423	F-BERGEN
2980.00	CLYST	DC	0.9	28.1		7.9	357		0.03	422	F-BERGEN
2982.00	CLYST	DC	0.8	23.2		7.7	303		0.03	423	F-BERGEN
2985.00	CLYST	DC	4.0	39.7		7.3	546		0.09	424	F-BERGEN
2987.00	CLYST	DC	4.0	39.0		7.2	544		0.09	425	F-BERGEN
2990.00	CLYST	DC	3.3	36.0		6.8	529		0.08	424	F-BERGEN
2990.00	CLYST	SWC	3.8	39.1		7.8	501		0.09	421	F-BERGEN

Table 3.1 SOURCE ROCK SCREENING DATA WELL 16/4-2 (cont'd)

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HYDRO

Depth (m)	%	Lithology	Sample	S1 Kg/t	S2 Kg/t	S3 Kg/t	TOC %	HI	OI	PI	Tmax Deg.c	Company
2992.00		CLYST	DC	3.3	38.5		7.2	536		0.08	426	F-BERGEN
2995.00		CLYST	DC	3.7	41.5		7.9	526		0.08	426	F-BERGEN
2997.00		CLYST	DC	3.3	38.1		6.9	552		0.08	426	F-BERGEN
3000.00		CLYST	DC	3.5	38.3		7.5	512		0.08	425	F-BERGEN
3002.00		CLYST	DC	1.5	30.6		7.1	432		0.05	423	F-BERGEN
3005.00		CLYST	DC	1.5	33.3		7.5	446		0.04	423	F-BERGEN
3007.00		CLYST	DC	1.4	31.7		7.0	450		0.04	423	F-BERGEN
3010.00		CLYST	DC	0.7	20.9		6.7	312		0.03	424	F-BERGEN
3010.00		CLYST	SWC	3.9	42.3		7.4	570		0.08	425	F-BERGEN
3012.00		CLYST	DC	0.7	18.3		5.9	308		0.04	423	F-BERGEN
3015.00		CLYST	DC	2.7	30.4		6.1	499		0.08	426	F-BERGEN
3017.00		CLYST	DC	1.6	22.9		5.2	437		0.06	423	F-BERGEN
3020.00		CLYST	DC	1.9	26.2		5.6	468		0.07	426	F-BERGEN
3022.00		CLYST	DC	2.2	28.1		6.2	456		0.07	426	F-BERGEN
3025.00		CLYST	DC	2.1	28.2		6.1	464		0.07	422	F-BERGEN
3027.00		CLYST	DC	2.5	32.4		5.6	583		0.07	425	F-BERGEN
3030.00		CLYST	DC	1.1	24.1		6.0	402		0.04	426	F-BERGEN
3030.00	100	CLYST	SWC	2.6	23.0	0.0	5.6	411	0	0.10	428	F-BERGEN
3032.00		CLYST	DC	1.1	25.2		5.9	429		0.04	425	F-BERGEN

Table 3.1 SOURCE ROCK SCREENING DATA WELL 16/4-2 (cont'd)



Depth (m)	%	Lithology	Sample	S1 Kg/t	S2 Kg/t	S3 Kg/t	TOC %	HI	OI	PI	Tmax Deg.c	Company
3035.00		CLYST	DC	0.8	21.7		5.8	377		0.04	425	F-BERGEN
3037.00		CLYST	DC	1.4	31.8		6.5	487		0.04	425	F-BERGEN
3040.00		CLYST	DC	1.3	29.6		6.6	447		0.04	424	F-BERGEN
3040.00		CLYST	SWC	3.9	37.4		7.1	530		0.10	426	F-BERGEN
3042.00		CLYST	DC	2.3	26.6		5.5	485		0.08	424	F-BERGEN
3045.00		CLYST	DC	2.1	23.6		5.0	475		0.08	425	F-BERGEN
3047.00		CLYST	DC	1.9	21.2		4.8	444		0.08	427	F-BERGEN
3050.00		CLYST	DC	2.1	25.4		5.3	478		0.08	424	F-BERGEN
3050.00		CLYST	SWC	5.2	1.7		0.6	278		0.76	424	F-BERGEN
3052.00		CLYST	DC	1.7	24.1		5.0	481		0.07	424	F-BERGEN
3055.00		CLYST	DC	1.3	17.9		4.3	414		0.07	429	F-BERGEN
3057.00		CLYST	DC	1.4	17.8		4.4	405		0.07	428	F-BERGEN
3060.00		CLYST	DC	1.2	16.1		4.1	392		0.07	429	F-BERGEN
3060.00	100	CLYST	SWC	2.3	20.3	0.0	4.4	462	0	0.10	428	F-BERGEN
3062.00		CLYST	DC	0.9	12.5		3.3	373		0.07	430	F-BERGEN
3065.00		CLYST	DC	0.3	7.8		2.6	300		0.04	432	F-BERGEN
3067.00		CLYST	DC	0.2	5.6		2.3	244		0.04	433	F-BERGEN
3068.00	100	CLYST	SWC	0.7	3.6	0.0	1.6	228	0	0.17	433	F-BERGEN
3070.00		CLYST	DC	0.1	1.1		1.2	91		0.05	435	F-BERGEN

Table 3.1 SOURCE ROCK SCREENING DATA WELL 16/4-2 (cont'd)



Depth (m)	% Lithology	Sample	S1 Kg/t	S2 Kg/t	S3 Kg/t	TOC %	HI	OI	PI	Tmax Deg.c	Company
3072.00	CLYST	DC	0.1	1.1		1.2	87		0.05	434	F-BERGEN
3075.00	CLYST	DC	0.1	0.8		0.9	83		0.07	428	F-BERGEN
3077.00	CLYST	DC	0.0	0.3		0.5	59		0.06	427	F-BERGEN
3080.00	CLYST	DC	0.0	0.4		0.7	63		0.08	430	F-BERGEN
3080.00	CLYST	SWC	0.7	4.5		1.9	238		0.13	435	F-BERGEN
3082.00	CLYST	DC	0.1	1.6		1.4	115		0.04	437	F-BERGEN
3085.00	CLYST	DC	0.1	2.2		1.6	134		0.05	437	F-BERGEN
3087.00	CLYST	DC	0.1	2.0		1.5	133		0.05	437	F-BERGEN
3090.00	CLYST	DC	0.2	3.7		2.0	186		0.05	437	F-BERGEN
3092.00	CLYST	DC	0.3	4.6		2.2	212		0.06	436	F-BERGEN
3095.00	CLYST	DC	0.3	6.2		2.3	272		0.05	435	F-BERGEN
3097.00	CLYST	DC	0.2	5.0		2.2	228		0.04	435	F-BERGEN
3100.00	CLYST	DC	0.1	4.5		2.0	219		0.03	435	F-BERGEN
3100.00	CLYST	SWC	0.9	8.4		2.8	298		0.10	432	F-BERGEN
3102.00	CLYST	DC	0.2	5.2		2.2	234		0.03	434	F-BERGEN
3105.00	CLYST	DC	0.2	5.1		2.2	234		0.04	435	F-BERGEN
3107.00	CLYST	DC	0.3	5.9		2.3	254		0.05	433	F-BERGEN
3110.00	CLYST	DC	0.5	9.1		2.6	347		0.05	433	F-BERGEN
3112.00	CLYST	DC	0.5	9.7		2.8	348		0.05	432	F-BERGEN

Table 3.1 SOURCE ROCK SCREENING DATA WELL 16/4-2 (cont'd)



Depth (m)	%	Lithology	Sample	S1 Kg/t	S2 Kg/t	S3 Kg/t	TOC %	HI	OI	PI	Tmax Deg.c	Company
3112.00		CLYST	SWC	1.6	12.4		3.0	409		0.12	429	F-BERGEN
3113.00		CLYST	SWC	4.9	4.1		2.1	197		0.55	432	F-BERGEN
3115.00		CLYST	DC	0.5	8.0		2.3	342		0.06	432	F-BERGEN
3117.00		CLYST	DC	0.5	8.3		2.4	352		0.06	432	F-BERGEN

**TABLE 3.4**  
**EXTRACTION DATA**

**GEOCHEMISTRY WELL 16/4-2**



Table 3.4 SOURCE ROCK EXTRACTION DATA I WELL 16/4-2

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Depth(m)	EOM(mg)	EOM(%)	Hydrocarbons			Non Hydrocarbons		
			SAT(%)	ARO(%)	TOTAL(%)	NSO(%)	ASPH(%)	TOTAL(%)
2960.00		0.36	15	6	21	2	77	79
2965.00		0.50	10	10	20	25	55	80
2975.00		1.31	12	15	27	29	44	73
2990.00		0.94	9	12	21	38	41	79
3010.00		0.98	9	12	21	42	37	79
3040.00		0.93	15	15	30	34	37	71
3050.00		2.50	40	23	63	4	33	37
3080.00		0.34	5	4	9	18	72	90
3100.00		0.64	16	13	29	27	45	72
3112.00		0.51	22	17	39	27	35	62

**TABLE 3.5**  
**EXTRACTION RATIOS**

Table 3.5 SOURCE ROCK EXTRACTION DATA II WELL 16/4-2



Depth(m)	TOC (%)	EOM(%) / TOC(%)	SAT(%) / TOC(%)	SAT(%) / ARO(%)	HC / non HC
2960.00	0.29	1.24	51.72	2.50	0.27
2965.00	5.69	0.09	1.76	1.00	0.25
2975.00	8.44	0.16	1.42	0.80	0.37
2990.00	7.80	0.12	1.15	0.75	0.27
3010.00	7.41	0.13	1.21	0.75	0.27
3040.00	7.05	0.13	2.13	1.00	0.42
3050.00	0.60	4.17	66.67	1.74	1.70
3080.00	1.90	0.18	2.63	1.25	0.10
3100.00	2.80	0.23	5.71	1.23	0.40
3112.00	3.03	0.17	7.26	1.29	0.63

**TABLE 3.6**  
**MOLECULAR RATIOS, SATURATED FRACTION**

TABLE 3.6 WELL 16/4-2  
MOLECULAR RATIOS, SATURATED FRACTION

DEPTH [M]	PRI/N-C17	PHY/N-C18	PRI/PHY	N-C17/N-C27	CPI I	CPI II
2960.00	0.77	0.56	1.54	23.06	1.10	0.88
2965.00	1.17	0.88	1.65	6.76	1.11	1.26
2975.00	0.93	0.82	1.29	12.36	0.99	0.92
2990.00	1.31	1.16	1.31	4.47	0.98	0.95
3010.00	1.07	0.89	1.41	4.37	0.87	0.76
3040.00	1.18	0.98	1.47	5.02	0.98	0.95
3050.00	0.77	0.58	1.61	29.50	1.09	0.86
3080.00	0.92	0.70	0.99	2.98	1.01	1.12
3100.00	0.87	0.70	1.48	10.74	1.08	1.08
3112.00	0.81	0.63	1.44	14.26	1.12	1.01
15/9-1 DST # 1	0.64	0.49	1.28	1.03	1.08	1.07
15/3-4 TEST	0.02	--	--	1.94	0.86	0.87

**TABLE 4.1**  
**VITRINITE REFLECTANCE DATA**

**GEOCHEMISTRY WELL 16/4-2**

TABLE 4.1 WELL 16/4-2  
VITRINITE REFLECTANCE DATA

depth [M]	Ro average	No. readings
1000	0.27	4
1100	0.30	23
1200	0.29	20
1300	0.28	20
1400	NDP	-
1500	0.33	23
1600	0.34	22
1700	0.36	8
1715	0.33	6
1814	NDP	-
1910	0.36	3
2005	0.43	5
2070	0.49	3
2190	NDP	-
2275	0.40	10
2403	NDP	-
2531	0.57	3
2633	0.50	1
2706	0.67	2
2804	NDP	-
2914	0.51	4
3010	0.47	9
3100	0.43	20