PROMUD A/S

TOTAL MUD MATERIALS USED FOR WELL

COMPANY NORSK HYDRO A/S WELL NO. 7120/9-1 PAGE 1 of 1

Quantity	Material	Unit/Weight	Unit Cost	Total Cost
350.5	Barite	MT	148.60	52,084.30
70.5	Wyoming Bentonite	MT	391.00	27,565.50
303	Caustic Soda	25 kg	21.40	6,484.20
27	Soda Ash	50 kg	21.70	585.90
336	Gypsum	40 kg	10.30	3,460.80
404	Milpolymer 302	25 kg	240.68	97,234.72
200	Drispac Superlo	50 lb	208.00	41,600.00
32	Drispac Regular	50 lb	199.00	6,368.00
2	DM Detergent	55 gal	570.00	1,140.00
1	Alum. Stearate	25 kg	99.82	99.82
20	Lime	40 kg	10.30	206.00
30	Lime	20 kg	5.15	154.50
16	W.O. 21	25 kg	260.25	4,164.00

TOTAL COST FOR WELL $ 241,147.74

DEPTH AT T.D. 2300 m

AVERAGE COST per METER for WELL $ 104.85

PROMUD A/S

DAILY DRILLING MUD ADDITIONS

Contractor: WILHELMSEN
OPERATOR: NORSK HYDRO A/S
LEGAL DESCRIPTION:

Rig No.: TREASURE SCOUT
Well Name And No.: 7120/9-1
Field: TROMSØ
COUNTRY: NORWAY

Promud a/s Warehouse: HAMMERFEST
Spud Date: 25/7/82
No. Drilling Days To T.D.:
DATE T.D. REACHED: 2/9/82
TOTAL DEPTH: 2300 m
TOTAL COST $: 241,147.74

DATE (1982)	DEPTH meters	Barite (Unit: MT; Cost: 148.60)	Wyoming Bentonite (Unit: MT; Cost: 391.00)	Caustic Soda (Unit: 25 kg; Cost: 21.40)	Soda Ash (Unit: 50 kg; Cost: 21.70)	Lime (Unit: 40 kg; Cost: 10.30)	Lime (Unit: 20 kg; Cost: 5.15)	W.O. 21 (Unit: 25 kg; Cost: 260.25)	DAILY COST	CUMULATIVE COST
24/7						20	30	1	620.75	620.75
25/7								1	260.25	881.00
26/7									NIL	881.00
27/7		7	20	2	2			14	12,589.90	13,470.90
28/7	405	9	10						5,247.40	18,718.30
29/7	405	46	7	6	7				9,852.90	28,571.20
30/7	405								NIL	28,571.20
31/7	405								NIL	28,571.20
Totals:		62	37	8	9	20	30	16	28,571.20	
							30" casing set at 404 m.			
1/8	510		5	12	1				2,233.50	30,804.70
2/8	640	5	10	8	1				4,845.90	35,650.60
3/8	760		4	8	1				1,756.90	37,407.50
4/8	525		2	1					803.40	38,210.90
5/8	700		1	10					605.00	38,210.90
6/8	760	7	6						3,386.20	42,202.10
7/8	760								NIL	42,202.10
									13,630.90	
							20" casing set at 744 m.			
Page Total:		74	65	47	12	20	30	16	42,202.10	
Cumulative:		74	65	47	12	20	30	16		42,202.10

Date 7/8/82 Promud a/s Technical Representative Hutchings/Pawson. District Norway. North Sea. 1 of 4

PROMUD A/S

DAILY DRILLING MUD ADDITIONS

Contractor: WILHELMSEN
OPERATOR: NORSK HYDRO A/S
LEGAL DESCRIPTION:

Rig No.: TREASURE SCOUT
Well Name And No.: 7120/9-1
Field: TROMSØ
COUNTRY: NORWAY

Promud a/s Warehouse: HAMMERFEST
Spud Date: 25/7/82
No. Drilling Days To T.D.:
DATE T.D. REACHED: 2/9/82
TOTAL DEPTH: 2300 m
TOTAL COST $: 241,147.74

DATE (1982)	DEPTH meters	Barite	Wyoming Bentonite	Caustic Soda	Soda Ash	Gypsum	Milpolymer 302	Drispac Superlo	Drispac Regular	DM Detergent	Alum. Stearate	Lime	Lime	W.O. 21							DAILY COST	CUMULATIVE COST
Unit		MT	MT	25 kg	50 kg	40 kg	25 kg	50 lb	50 lb	55 gal	25 kg	40 kg	20 kg	25 kg								
Cost		148.60	391.00	21.40	21.70	10.30	240.68	208.00	199.00	570.00	99.82	10.30	5.15	260.29								
8/8	760			4	2	48	12				1										3,611.38	45,813.48
9/8	765	6	4	5		48	3														3,779.04	49,592.52
10/8	861	24		5	2	48	45	17													18,577.80	68,170.32
11/8	973	46		12			47														18,404.36	86,574.68
12/8	1213	29		25	1	24	51	12													19,883.98	106,458.66
13/8	1342	4		10			29														7,788.12	114,246.78
14/8	1505			34	5	120	25	21		2											13,597.10	127,843.88
15/8	1588			35	2	48	37	19													14,143.96	141,987.84
16/8	1665	2		24			62	22													20,308.96	162,296.80
17/8	1665	14																			2,080.40	164,377.20
18/8	1665																				NIL	164,377.20
19/8	1650			6			4														1,091.12	165,468.32
20/8	1651																				NIL	165,468.32
Totals:		125	4	160	12	336	315	91		2	1										123,266.22	165,468.32
								13 3/8" casing set at 1650 m.														
21/8	1681	20		13			5	5													5,493.60	170,961.92
22/8	1752	10					22	10													8,860.96	179,822.88
23/8	1782	24		10				10	10												7,850.40	187,673.28
24/8	1861	10		15				5	10												4,837.00	192,510.28
25/8	1911	10						7													2,942.00	195,452.28
Page Total:		199	4	198	12	336	342	128	20	2	1										153,250.18	
Cumulative:		273	69	245	24	336	342	128	20	2	1	20	30	16								195,452.28

Promud a/s

DAILY DRILLING MUD ADDITIONS

PROMUD A/S

Contractor WILHELMSEN OPERATOR NORSK HYDRO A/S LEGAL DESCRIPTION

Rig No. TREASURE SCOUT Well Name And No. 7120/9-1 Field TROMSØ COUNTRY NORWAY

Promud a/s Warehouse HAMMERFEST Spud Date 25/7/82 No. Drilling Days To T.D. DATE T.D. REACHED 2/9/82 TOTAL DEPTH 2300 m TOTAL COST $ 241,147.74

DATE (1982)	DEPTH meters	Barite (Unit MT, Cost 148.60)	Wyoming Bentonite (Unit MT, Cost 391.00)	Caustic Soda (Unit 25 kg, Cost 21.40)	Soda Ash (Unit 50 kg, Cost 21.70)	Gypsum (Unit 40 kg, Cost 10.30)	Milpolymer 302 (Unit 25 kg, Cost 240.68)	Drispac Superlo (Unit 50 lb, Cost 208.00)	Drispac Regular (Unit 50 lb, Cost 199.00)	DM Detergent (Unit 55 gal, Cost 570.00)	Alum. Stearate (Unit 25 kg, Cost 99.82)	Lime (Unit 40 kg, Cost 10.30)	Lime (Unit 20 kg, Cost 5.15)	W.O. 21 (Unit 25 kg, Cost 260.25)							DAILY COST	CUMULATIVE COST
26/8	1947	5		10				10													3,037.00	198,489.28
27/8	1965	5	0.5	1				5													1,999.90	200,489.18
28/8	1965			4	1		6														1,551.38	202,040.56
29/8	2010	22					3	16													7,319.24	209,359.80
30/8	2059						7														1,684.76	211,044.56
31/8	2137	5		16			1	10													3,406.08	214,450.64
1/9	2290			4			5	10													3,369.00	217,819.64
2/9	2300	2						3													921.20	218,740.84
3/9	2300																				NIL	218,740.84
4/9	2300	14		12			25	5	4												10,190.20	228,931.04
5/9	2300																				NIL	228,931.04
Totals:		127	0.5	85	1		74	96	24												63,462.72	228,931.04
								9 5/8" Casing set at 2285 m.														
6/9	2285																				NIL	228,931.04
7/9	2285																				NIL	228,931.04
8/9	2285																				NIL	228,931.04
9/9	2285																				NIL	228,931.04
10/9	2285	3	1.0	3																	901.00	229,832.04
11/9	2285																				NIL	229,832.04
12/9	2285																					
13/9	2285																				NIL	229,832.04
																					NIL	229,832.04
Page totals:		56	1.5	50	1		47	59	4												34,379.76	
Cumulative:		329	70.5	295	25	336	389	187	24	2	1	20	30	16								229,832.04

Date 13/9/82 Promud a/s Technical Representative Hutchings/Pawson District Norway Region North Sea

PROMUD A/S

DAILY DRILLING MUD ADDITIONS

Contractor: WILHELMSEN | OPERATOR: NORSK HYDRO A/S | LEGAL DESCRIPTION:

Rig No.: TREASURE SCOUT | Well Name And No.: 7120/9-1 | Field: TROMSØ | COUNTRY: NORWAY

Promud a/s Warehouse: HAMMERFEST | Spud Date: 25/7/82 | No. Drilling Days To T.D.: | DATE T.D. REACHED: 2/9/82 | TOTAL DEPTH: 2300 m | TOTAL COST $: 241,147.74

DATE (1982)	DEPTH meters	Barite (Unit: MT, Cost: 148.60)	Wyoming Bentonite (Unit: MT, Cost: 391.00)	Caustic Soda (Unit: 25 kg, Cost: 21.40)	Soda Ash (Unit: 25 kg, Cost: 21.70)	Gypsum (Unit: 40 kg, Cost: 10.30)	Milpolymer 302 (Unit: 25 kg, Cost: 240.68)	Drispac Superlo (Unit: 50 lb, Cost: 208.00)	Drispac Regular (Unit: 50 lb, Cost: 199.00)	DM Detergent (Unit: 55 gal, Cost: 570.00)	Alum. Stearate (Unit: 25 kg, Cost: 99.82)	Lime (Unit: 40 kg, Cost: 10.30)	Lime (Unit: 20 kg, Cost: 5.15)	W.O. 21 (Unit: 25 kg, Cost: 260.25)	(Unit/Cost)	(Unit/Cost)	(Unit/Cost)	(Unit/Cost)	(Unit/Cost)	(Unit/Cost)	DAILY COST	CUMULATIVE COST
14/9	2285	1					1	2													805.28	230,637.32
15/9	2285																				NIL	230,637.32
16/9	2285	15		4	2		12	6	6												7,688.16	238,325.48
17/9	2285																				NIL	238,325.48
18/9	2285																				NIL	238,325.48
19/9	2285																				NIL	238,325.48
20/9	2285	5.5		4				5	2												2,340.90	240,666.38
21/9	2285						2														481.36	241,147.74
Totals:		24.5	1	11	2		15	13	8												12,216.70	241,147.74
Cumulative:		350.5	70.5	303	27	336	404	200	32	2	1	20	30	16								241,147.74

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Promud a/s

DRILLING MUD RECAP

PROMUD A/S

Contractor: WILHELMSEN | OPERATOR: NORSK HYDRO A/S | LEGAL DESCRIPTION:

Rig No.: TREASURE SCOUT | Well Name And No.: 7120/9-1 | Field: TROMSØ | COUNTRY: NORWAY

Promud a/s Warehouse: HAMMERFEST | Spud Date: 25/7/82 | No. Drilling Days To T.D.: | DATE T.D. REACHED: 2/9/82 | TOTAL DEPTH: 2300 m | TOTAL COST $ 241,147.74

DATE (1982)	TIME	DEPTH meters	WT (ppg)	FV API@	PV cp @	YIELD POINT pascal	GELS 0/10 pascal	pH	FILTRATE (ml/30 min) API	HT-HP	°F	Cake (32nd in)	Alkalinity P_m	P_f/M_f	Chloride (ppm)	Calcium (ppm)	Sand (% by Vol.)	Solids (% by Vol.)	Oil (% by Vol.)	Water (% by Vol.)	Methy. Blue (me/ml mud)		Circ. Volume (bbl)	REMARKS
25/7	0600		1.31	80			SPUD		MUD														780	Make spud mud of old mud.
25/7	2400		1.31	100+			SPUD		MUD														780	Spud in.
26/7	2400	405	1.20	100+			SPUD		MUD														530	POOH ot run casing.
27/7	2400	405	1.20	100+				10.5							40	10							250	Run csg. POOH w/csg. Ream to
28/7	2400	405	1.21	100+				10.5							40	10							1100	Run csg. POOH w/casing. TD.
29/7	2400	405	1.05	60				10.5							80	TR							900	Ream to TD. Run casing.
30/7	2400	405	1.05	60				10.5							80	TR								Problems with riser.
31/7	2400	405	1.05	60				10.5							80	TR								Run riser.
1/8	2400	510	1.06	38	5	13.5	3/12	10	N/C					.2/.5	11000	150	TR	5		95			1400	Drill with seawater+gel.
2/8	2400	640	1.05	36	4	12.5	7/9	9.6	N/C					.1/.3	11500	450	TR	5		95			1500	Roundtrip,Hole good, No fill.
3/8	2400	760	1.04	39	5	12.0	6/11	9.6	N/C					.2/.3	11600	150	TR	5		95			1400	Drilled to TD.Raised YP pr. to log
4/8	2400	525	1.06	33	4	7.0	4/6	9.3	N/C					.1/.2	14700	250	TR	5		95			1225	Ran schlumb.logs.RIH w/26".
5/8	2400	700	1.06	32	4	6.5	4/6.5	9.4	N/C					.15/.3	15100	220	TR	5		95			1610	Drill, roundtrip, drill.
6/8	2400	760	1.06	32	4	6.5	4/6	9.4	N/C					.15/.3	14900	200	TR	5		95			1644	POOH w/26"h.reamer/RIH 26"bit
7/8	2400			Building	volume	for 17	1/2"	hole section.																Run and cement casing.
8/8	2400			Building	volume	for 17	1/2"	hole section.																Run BOP and riser.
9/8	2400	765	1.06	32	5	5.0	1/2	10.2	33	N/C			0.19	.05/.15	20000	2200	TR						1678	Drill cmt.Displ.w/Gyp-polymer.
10/8	2400	861	1.10	38	8	4.5	2/3	9.7	12	N/C		1	0.10	.03/.10	23000	1500	TR	2		98	2.5		1547	Fish w/junkbasket.RIH.Drill.
11/8	2400	973	1.10	42	11	7.5	4/8	9.6	10	N/C		1	0.13	.07/.18	20000	1550	TR	2		98	2.5		1844	Changed bit. Drill ahead.
12/8	2400	1118	1.15	40	11	9.0	2.5/4.5	9.5	9.5			1	0.04	.07/.2	20000	2200	TR	6		94	8.0		2153	Drill ahead raise wt. to 1.15
13/8	2400	1342	1.15	41	10	8.0	3/4.5	9.4	11.5			1	0.05	.05/.2	20000	2200	TR	7		93	8.0		2266	POOH to change bit.
14/8	2400	1505	1.15	40	13	7.0	2.5/6	9.5	12.0			1	0.06	.04/.19	20000	2200	TR	8		92	13.0		389	Drilling ahead.
15/8	2400	1588	1.15	40	11	7.5	2.5/5	9.6	11.0			1	0.07	.05/.19	20000	1900	TR	10		90	16.0		415	POOH for bit. Hole tight.
16/8	2400	1665	1.15	45	15	9.5	4/11	9.6	10.0			1	0.07	.03/.04	19500	1400	TR	10		90	17.0		400	POOH to log.
17/8	2400	1665	1.20	48	16	10.5	4/10	9.0	9.6			1	0.04	.01/.01	20000	2800	TR	13		87	17.0		355	Logs bridged a 1507 raise.
18/8	2400	1665	1.20	48	17	11.5	4/10.5	9.3	9.0			1	0.05	.02/.03	20500	1700	TR	15		85	17.0		382.6	Mud weight.
19/8	2400	1650	1.20	50	18	11.5	5/12	9.0	9.0			1	0.08	.03/.05	19500	1400	TR	10		90	18.0		386	Running casing.
20/8	2400	1650	1.20	48	16	12.0	4/10	9.0	9.0			1	0.08	.03/.05	20000	1400	TR	10		90	18.0		267	Test stack.

DRILLING MUD RECAP

PROMUD a/s

Contractor WILHELMSEN OPERATOR NORSK HYDRO A/S LEGAL DESCRIPTION

Rig No. TREASURE SCOUT Well Name And No. 7120/9-1 Field TROMSØ COUNTRY NORWAY

Promud a/s Warehouse TANANGER/HAMMERFEST Spud Date 25/7/82 No. Drilling Days To T.D. DATE T.D. REACHED 2/9/82 TOTAL DEPTH 2300 m TOTAL COST $ 241,147.74

DATE (1982)	TIME	DEPTH meters	WT (ppg)	FV API@	PV cp @	YIELD POINT (lb/100ft²)	GELS (lb/100ft²) 0/10	pH	FILTRATE (ml/30 min) API	HT-HP	°F	Cake (32nd in)	Alkalinity P_m	P_f/M_f	Chloride (ppm)	Calcium (ppm)	Sand (% by Vol.)	Solids (% by Vol.)	Oil (% by Vol.)	Water (% by Vol.)	Methy. Blue (me/ml mud)		Circ Volume (bbl)	REMARKS
21/8	2400	1681	1.20	40	10	7.5	2/4.5	11	12.0			1	.2	09/.4	19500	1650	TR	11		89	10		392	Drill cement + shoe.
22/8	2400	1752	1.20	42	12	8.5	2/4.5	10	9.0	25	200	1	.2	02/.6	19500	1460	TR	12		88	10		390	Drill ahead.
23/8	2400	1850	1.22	41	12	8.5	3/4	10	8.5	25	200	1	.09	02/.4	19500	1200	TR	13		87	13		278	Raise mud wt. to 1.22.
24/8	2400	1860	1.22	42	14	8.0	3/4	10	7.0	19	200	1	.25	05/.12	20000	1150	TR	13		87	15		270	Core.
25/8	2400	1884	1.22	42	14	9.0	3/4	10.4	6.5	18	200	1	.15	05/07	22000	1150	TR	13		87	10		288	Core.
26/8	2400	1947	1.22	44	14	9.0	3/4	10.5	6.5	18	200	1	.15	06/07	20000	1150	TR	13		87	5		291	Core.
27/8	2400	1965	1.22	46	17	9.0	3/4	10.5	6.5	18	200	1	.3	03/06	20000	880	TR	13		87	5		298	Core No. 7 - logging.
28/8	2400	1965	1.22	46	17	9.0	3/4	10.5	6.5	18	200	1	.3	03/06	20000	880	TR	12		88	5		298	RIH.
29/8	2400	2010	1.22	45	16	9.0	3/4	10.0	6.0	18	200	1	.15	03/06	20000	880	TR	12		88	5		304	Logging.
30/8	2400	2059	1.22	46	16	10.0	3/4	10.0	5.5	18	200	1	.15	03/06	19000	880	TR	12		88	5		309	Logging. Drilling ahead.
31/8	2400	2137	1.22	46	18	10.0	3/4	10.5	5.5	18	200	1	.2	06/.1	20000	720	TR	12		88	10		314	Drilling ahead.
1/9	2400	2290	1.22	47	19	10.5	3/4	10	5.5	18	200	1	.1	03/06	20000	720	TR	12		88	10		314	Drilling.
2/9	2400	2300	1.22	47	19	10.5	3/4	10	5.5	18	200	1	.1	03/06	20000	720	TR	12		88	10		314	Drilling/logging.
3/9	2400	2300	1.22	47	19	10.5	3/4	10	5.5	18	200	1	.1	03/06	20000	720	TR	12		88	10		314	Logging.
4/9	2400	2300	1.25	47	19	11.0	3/4	10	5.8	16	200	1	.1	03/06	21000	600	TR	12		88	12.5		318	Logging. Rig up for 9 5/8"csg
5/9	2400	2300	1.25	50	20	11.5	3/4	10	5.8	16	200	1	.1	03/06	21000	600	TR	12		88	12.5		265	Casing. Shoe at 2285 meters.
6/9	2400	2285	1.25	50	20	11.5	3/4	10	5.8	16	200	1	.1	03/06	21000	600	TR	12		88	12.5		265	Making up test tubing.
7/9	2400	2285	1.25	48	21	10.5	3/4	10	5.9	16	200	1	.1	03/06	21000	600	TR	12		88	12.5			Pulled riser & BOP for repai
8/9	2400	2285	1.25	48	21	10.5	3/4	10	5.9	16	200	1	.1	03/06	21000	600	TR	12		88	12.5		270	Ran riser & BOP.RIH.Clean seal
9/9	2400	2285	1.25	48	21	10.5	3/4	10	6.0	16	200	1	.1	03/06	21000	600	TR	12		88	12.5		270	RIH w/csg scraper.
10/9	2400	2285	1.25	47	21	10.5	3/4	10	6.0	16	200	1	.1	03/06	21000	600	TR	12		88	12.5		260	Cement squeeze. Dummy run SST
11/9	2400	2285	1.25	48	21	10.5	3/4	10	6.0	16	200	1	.1	03/06	20000	600	TR	12		88	12.5		260	RIH with SST for tesing DST No.1.
12/9	2400	2285	1.25	48	21	10.5	3/4	10	6.0	16	200	1	.1	03/06	20000	600	TR	12		88	12.5		225	DST No.1 finished.RIH w/ cement stinger.
13/9	2400	2285	1.25	48	21	10.5	3/4	10	6.0	16	200	1	.1	03/06	20000	600	TR	12		88	12.5		203	Set cement retainer.
14/9	2400	2285	1.25	48	20	10.0	3/4	10	6.0	16	200	1	.1	03/06	20000	600	TR	12		88	12.5		195	RIH w/test string for DST No2
15/9	2400	2285	1.25	48	20	10.0	3/4	10	6.0	16	200	1	.1	03/06	20000	600	TR	12		88	12.5		195	DST No.2. Difficulty in flowing. Rev. circ
16/9	2400	2285	1.25	48	20	10.0	3/4	10	6.0	16	200	1	.1	03/06	20000	600	TR	12		88	12.5		235	Out gas and water. RIH with test string - DST No. 3.
17/9	2400	2285	1.25	48	21	12.5	3/4	9.5	5.5	16	200	1	.1	03/06	19500	400	TR	12		88	12.5		235	Test with DST No. 3.

17/9/82 Promud a/s

DRILLING MUD RECAP

PROMUD a/s

Contractor WILHELMSEN OPERATOR NORSK HYDRO A/S LEGAL DESCRIPTION

Rig No. TREASURE SCOUT Well Name And No. 7120/9-1 Field TROMSØ COUNTRY NORWAY

Promud a/s Warehouse TANANGER/HAMMERFEST Spud Date 25/7/82 No. Drilling Days To T.D. DATE T.D. REACHED 2/9/82 TOTAL DEPTH 2300 m TOTAL COST $ 241,147.74

DATE (1982)	TIME	DEPTH meters	WT (ppg)	FV API@	PV cp @	YIELD POINT (lb/100ft²)	GELS (lb/100ft²) 0/10	pH	FILTRATE (ml/30 min) API	HT-HP	°F	Cake (32nd in)	Alkalinity P_m	P_f / M_f	Chloride (ppm)	Calcium (ppm)	Sand (% by Vol.)	Solids (% by Vol.)	Oil (% by Vol.)	Water (% by Vol.)	Methy. Blue (me/ml mud)		Circ. Volume BBL 14.3	REMARKS
18/9	2400	2285	1.25	48	21	12.5	3/4	9.5	5.5	16	200	1	0.1	.03/.06	19500	400	TR	12		88	12.5		235	Test with DST No. 3.
19/9	2400	2285	1.25	48	21	12.5	3/4	9.5	5.5	16	200	1	0.1	.03/.06	19500	400	TR	12		88	12.5		235	Test with DST No. 3.
20/9	2400	2285	1.25	48	21	10.0	3/4	9.5	5.0	18	200	1	0.1	.03/.06	19000	440	TR	12		88	12.5		210	Complete DST No. 3. Rev.
																								cir. out gas.
21/9	2400	2400	1.25	48	21	10.0	3/4	9.5	5.0	18	200	1	0.1	.03/.06	19000	440	TR	12		88	12.5		210	Cement plug. POOH. Laying
																								downing DP. Plug and
22/9																								abandon.

2 REPEAT FORMATION TESTING

2.1 Summary of events

Run no. 1, 29/8-82, 12 1/4" hole. 32 tool settings/pressure tests performed, from 1840.5 to 1944 m, plus segregated sampling at 1842.5 m and 1900 m, 2 3/4 and 1 gal chamber.

Run no. 2, 3/9-82, 12 1/4" hole. 9 tool settings/pressure tests performed, from 1919 to 2270.4 m, plus segregated sampling at 1900.5 m, 2 3/4 and 1 gal chamber.

The pressure recordings are tabulated in Table 2.2.b 1 for runs 1 and 2.

Plot of formation pressure vs. depth Fig. 1, Fig. 2 and Fig. 3.

The reservoir fluid compositions of the samples taken at 1842.5 m and 1900.5 m are tabulated in Table 2.2.b 2.

2.2 Comments on pressure surveys

The RFT-pressure plotted vs. depth indicate a gas gradient of 0.084 psi/ft (0.195 g/cc) above 1904 m. Below 1904 m the plotted pressures indicate a water gradient of 0.48 psi/ft (1.1 g/cc), corresponding to a water salinity of 158 000 ppm. The water salinity found from the logs was 160 000 ppm.

WELL 7120/9-1,RFT RUN 1 tab 2.1

test no	depth m RKB	PHI psi	PF psi	PHA psi	Remarks
1	1840.5	3221	2993	3218	good permeability
2	1842.5	3222	2993	3222	good permeability
3	1844.5	3226	2996	3227	v.gd permeability
4	1848.3	3233	2999	3236	med.permeability
5	1851.5	3240	2998	3240	low permeability
6	1853.3	3243	2999	3243	poor permeability
7	1857.5	3247	3001	3249	low permeability
8	1860.0	3253	3001	3253	low permeability
9	1862.5	3257	3004	3258	poor permeability
10	1865.0	3261	3001	3261	med.permeability
11	1870.0	3271	3004	3272	poor permeability
12	1872.0	3274	3004	3275	low permeability
13	1874.0	3278	3006	3279	good permeability
14	1876.0	3281	3005	3282	low permeability
15	1878.0	3286	3006	3285	low permeability
16	1882.0	3292	3007	3293	low permeability
17	1884.0	3296	3008	3293	poor permeability
18	1892.5	3308	3010	3310	poor permeability
19	1893.5	3310	3008	3310	med.permeability
20	1894.5	3312	3010	3314	med.permeability
21	1899.5	3321	3011	3321	low permeability
22	1901.0	3323	3013	3324	low permeability
23	1902.5	3326		3327	seal failure
24	1904.0	3330	3026	3331	med.permeability
25	1905.5	3332	3021	3334	low permeability
26	1910.5	3341	3025	3341	poor permeability
27	1912.0	3342	3028	3343	med.permeability
28	1920.0	3356	3037	3358	good permeability
29	1927.8	3370	3051	3370	low permeability
30	1934.5	3383		3384	tight
31	1937.5	3388	3066	3388	poor permeability
32	1943.5	3398	3074	3399	good permeability
sample #1	1842.5	3215	2991	3218	segregated sample
sample #2	1900.0	3318	3001	3313	no recovery

Well 7120/9-1,RFT Run 2 tab 2.2

test no	depth m RKB	PHI psi	PF psi	PHA psi	Remarks
1	1935.5	3404	3073	3401	poor permeability
2	1989.0	3501	3157	3502	exel.permeability
3	2017.5	3551	3200	3553	exel.permeability
4	2072.0	3646	3284	3648	v.gd.permeability
5	2176.0	3829	3446	3828	low permeability
6	2270.4	3996	3595	3996	med.permeability
7	2143.5	3762	3385	3762	v.gd.permeability
8	2225.0	3903	3505	3901	low permeability
9	1919.7	3384	3062	3388	med.permeability
sample #1	1900.5	3338	3022	3330	segregated sample

WELL 7120/9-1,RFT SAMPLING tab 2.3

reservoir fluid composition

	RFS 1842.4m	RFS 1900.5m
N2	2.39	2.46
H2S	-	-
CO2	6.61	3.05
C1	81.77	84.84
C2	4.47	4.65
C3	2.10	2.16
IC4	.33	.33
NC4	.70	.70
IC5	.26	.26
NC5	.31	.30
C6	.39	.40
C7	.35	.38
C8	.18	.24
C9	.05	.07
C10+	.09	.16
	100.00	100.00

D. W E L L T E S T I N C

3. DST NO. 2A

Due to the very poor flow, test no. 2 was abandoned, the zone reperforated and the test string run a second time, filled with diesel cushion. This second run is named DST no. 2A.

Objectives:

As for DST no. 2.
Due to solids settling out on top of the bottom squeeze packer, the lower perforation interval was elevated one meter. Thus the perforation intervals, DST no. 2A were as follows:

1958 - 64 and 1968 - 74 m RKB (Ref. LDL/CNL).

Test string

As for DST no. 2, except for the following:

- Bottom hole pressure/temperature gauges:
  - 1 x Sperry Sun MK-3
  - 1 x Sperry Sun MK-1
  - 1 x Lynes DMR-314
  - 1 x Flopetrol Amerada

- The test string was filled with a diesel cushion.

For test string tally list, refer to appendix 2.1.

Surface test equipment

As for DST no. 2.

Test operation:

For sequence of events, refer to appendix 2a.2.

The test sequences/durations were as follows:

- Initial flow	10 min
- Initial build up	102 min
- Main flow	20 hrs 39 min
- Main build up	37 hrs 05 min

During the main flow, 3 sets of separator recombination samples were taken (see Fluid sampling). Glycol injecting (below the SSTT) was stopped in good time prior to sampling.

At the end of the main flow period, signs of freezing/hydrate formation were recognized. After the main build up period, the well was opened for a modified isochronal test. Glycol was injected to prevent further hydrate formation. This was not successful and the well was shut in to restore to initial conditions.

Prior to opening the well again, methanol was injected below the SSTT, and methanol injection continued after the well was opened. However, after a few minutes, methanol injection was made impossible due to plugging in the injection line or in the SSTT, and the well was shut in. Hydrate plugs formed above the SSTT would prevent killing operations, and in addition the mechanical condition of the SSTT was uncertain. This situation was considered to be unsafe and it was decided to abort the test at this point. When killing the well it was found that hydrates had formed a solid plug from the SSTT and approximately 200 m up in the test string. This plug was removed by circulating heated mud in the riser and pumping a heated glycol/methanol mixture into the test string.

Fluid sampling

During the main flow period, 3 sets of recombination samples were taken from the operator. Each set consisted of

2 x 600 cc condensate bottles
4 x 20 l gas bottles

The samples were taken as follows:

1st set: from 00:40 - 03:30 hrs, 18/9-82
2nd set: from 02:45 - 06:47 hrs, 18/9-82
3rd set: from 04:15 - 08:45 hrs, 18/9-82

In addition, 10 x 25 l cans were filled with condensate from the separator.

Fluid production

Below is listed the test results from the main flow period:

	DST no. 2A
Gas rate (MMSCF/D)	10.3
Condensate rate, BBL/D	68.7*
COR avg. (SCF/BBL)	149927
WHP (psia)	1305**
Choke size (1/64")	52***
Condensate gravity (^{o}API)	53.5
Gas gravity (Air = 1)	0.72
B.S.W (%)	Trace
CO-2 (%)	6.5
H2S (%)	NIL
Sep. press. (psig)	390
Sep. temp. ^{o} F	101

* Measured in the stock tank
** Measured when having stable flow prior to start of hydrate formation
*** Adjustable heater choke

NOTE: During the initial flow period (10 min) the well flowed 1.8 BBL to the stock tank

Test results

DST no. 2

Choke: Final flow	44/64"
With stabilized flow:	
Oil rate:	59,5 B/D
Gas rate:	10,6 MM SCF/D
Oil gravity:	54,7 deg. API
Gas gravity:	0,72
CO_2:	7%
Separator pressure:	26,2 bar
Separator pressure:	75 deg. C

U-338

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Prepared for

NORSK HYDRO

DATA REPORT
WELL 7120/9-1

April 1986

GEOCHEM

Petroleum Geochemistry Division

3/

GEOCHEM

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1307-026	1848.5m	A 98% Sandstone, massive, fine grained, subangular, well sorted, dark, silty? laminae, v. pale milky cut, pale yellowish brown	10YR6/2	
1307-027	1851.0m	A 98% Sandstone, as 1307-026A, v. pale milky cut	10YR6/2	
1307-028	1854.5m	A 98% Silty sandstone, massive, v. fine grained, well sorted, non-calc., v. pale milky cut, light brownish grey to medium light grey	5YR6/1-N6	
1307-029	1861.8m	A 98% Sandstone, massive, v. fine grained, well sorted, silty laminae, v. pale milky cut, v. pale yellowish brown to medium grey	10YR7/2-N5	
1307-030	1872.4m	A 98% Sandstone, massive, v. fine grained, well sorted, non-calc., pale milky cut, v. pale yellowish brown	10YR7/2	
1307-031	1877.5m	A 98% Sandstone, as 1307-030A, pale milky cut	10YR7/2	
1307-032	1882.0m	A 98% Sandstone, as 1307-030A, pale milky cut	10YR7/2	
1307-033	1888.0m	A 98% Sandstone, massive, fine grained, well sorted, minor dark silty layers, pale milky cut, v. pale yellowish brown to medium light grey	10YR7/2-N6	
1307-034	1891.0m	A 98% Sandstone, massive, fine to medium grained, subangular, well sorted, non-calc., pale milky cut, v. pale yellowish brown	10YR7/2	
1307-035	1894.0m	A 98% Sandstone, as 1307-034A, pale milky cut	10YR7/2	
1307-036	1895.0m	A 60% Sandstone, massive, medium grained, subangular, fairly well sorted, sl. calc., v. pale yellowish brown	10YR7/2	
		B 40% Silty shale/siltstone, blocky to subfissile, mod. hard, non-calc., medium dark grey to medium grey	N4-5	
1307-037	1897.0m	A 98% Sandstone, massive, fine to medium grained, well sorted, silty laminae, pale milky cut, v. pale yellowish grey to medium light grey	10YR7/2-N6	
1307-038	1898.0m	A 98% Sandstone, as 1307-037A, pale milky cut	10YR7/2-N6	

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	GSA Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1307-039	1898.5m	A 98% Sandstone, massive, fine to medium grained, subangular, well sorted, silty layer, milky cut, v. pale yellowish brown to medium light grey	10YR7/2-N6	
1307-040	1900.4m	A 98% Sandstone, massive, medium grained, subangular, well sorted, non-calc., milky cut, v. pale yellowish brown	10YR7/2	
1307-041	1901.0m	A 98% Sandstone, massive, fine grained, well sorted, non-calc., milky cut, v. pale yellowish brown	10YR7/2	
1307-042	1903.0m	A 98% Sandstone, as 1307-041A, milky cut	10YR7/2	
1307-043	1905.0m	A 98% Sandstone, massive, fine grained, well sorted, grain supported, milky cut, pale yellowish brown	10YR6/2	
1307-044	1907.0m	A 98% Sandstone, as 1307-043A, milky cut	10YR6/2	
1307-045	1909.1m	A 98% Sandstone, massive, fine to medium grained, well sorted, non-calc., grain supported, milky cut, v. pale yellowish brown	10YR7/2	
1307-046	1910.5m	A 98% Sandstone, massive, fine to medium grained, subangular, well sorted, grain supported, milky cut, pale yellowish brown	10YR6/2	
1307-047	1911.0m	A 98% Sandstone, massive, fine grained, well sorted, grain supported, milky cut, v. pale yellowish brown to pale yellowish brown	10YR7/2-10YR6/2	
1307-048	1913.5m	A 98% Sandstone, as 1307-047A, milky cut	10YR7/2-10YR6/2	
1307-049	1914.5m	A 98% Sandstone, as 1307-047A, milky cut	10YR7/2-10YR6/2	
1307-050	1916.5m	A 98% Sandstone, massive, fine to medium grained, subangular, well sorted, grain supported, pale milky cut, v. pale yellowish brown	10YR7/2	
1307-051	1918.0m	A 98% Sandstone, massive, medium grained, well sorted, grain supported, creamy F., milky cut, medium yellowish brown	10YR5/2	
1307-052	1920.0m	A 98% Sandstone, massive, medium grained, subangular, well sorted, grain supported, carbonaceous plant remains, v. pale milky cut, pale yellowish brown	10YR6/2	

Abbreviations = arenaceous, argillaceous, calcareous, Cut, dolomitic, Fluorescence, foraminifera, fossiliferous
Lost Circulation Material, moderately, occasionally, slightly, very

TABLE 1
ORGANIC CARBON RESULTS AND GROSS LITHOLOGIC DESCRIPTIONS

GEOCHEM SAMPLE NUMBER	DEPTH	GROSS LITHOLOGIC DESCRIPTION	G S A Colour Code	TOTAL ORGANIC CARBON (Wt. % of Rock)
1307-053	1923.0m	A 98% Sandstone, massive, fine to medium grained, well sorted, grain supported, v. pale milky cut, pale yellowish brown to v. pale yellowish brown	10YR6/2-10YR7/2	
1307-054	1928.1m	A 98% Sandstone, massive, fine to medium grained, well sorted, v. pale milky cut, pale yellowish brown	10YR6/2	

Abbreviations = **are**naceous, **arg**illaceous, **calc**areous, **Cut**, **dol**omitic, **Fluor**escence, **foram**inifera, **foss**iliferous
Lost **C**irculation **M**aterial, **mod**erately, **occ**asionally, **sl**ightly, **v**ery

TABLE 2a
CONCENTRATION (PPM) OF EXTRACTED C_{15+} MATERIAL IN ROCK

GEOCHEM SAMPLE NUMBER	DEPTH	TOTAL EXTRACT	HYDROCARBONS			NON HYDROCARBONS			
			Paraffin - Naphthenes	Aromatics	TOTAL	Preciptd. Asphaltenes	Eluted NSO's	Non-eluted NSO's	Sulphur
1307-026A	1848.5	317	162	42	204	68	45	1	0
1307-027A	1851.0	373	212	42	254	74	39	6	0
1307-028A	1854.5	641	409	69	478	109	48	6	0
1307-029A	1861.8	678	346	106	452	146	80	1	0
1307-030A	1872.4	180	100	23	123	38	18	0	0
1307-031A	1877.5	599	347	78	426	109	56	9	0
1307-032A	1882.0	527	315	50	366	107	46	9	0
1307-033A	1888.0	1156	718	149	868	158	119	11	0
1307-034A	1891.0	347	186	33	219	92	33	3	0
1307-035A	1894.0	134	68	11	79	43	12	0	0
1307-036A	1895.0	324	197	26	222	70	28	4	0
1307-037A	1897.0	373	179	53	233	105	32	3	0
1307-038A	1898.0	292	158	27	185	81	23	3	0
1307-039A	1898.5	1926	1214	229	1443	286	180	17	0
1307-040A	1900.4	223	149	18	167	39	16	1	0
1307-041A	1901.0	426	294	36	330	67	25	4	0
1307-042A	1903.0	5098	3912	453	4365	326	328	79	0
1307-043A	1905.0	6441	4888	545	5433	386	605	17	0
1307-044A	1907.0	7730	5673	949	6622	430	657	21	0
1307-045A	1909.1	2601	1849	217	2066	187	313	34	0
1307-046A	1910.5	1093	807	90	897	109	79	8	0
1307-047A	1911.0	2889	2158	218	2375	167	326	20	0
1307-048A	1913.5	4126	2964	413	3377	373	337	38	0
1307-049A	1914.5	4032	2976	372	3347	315	335	36	0
1307-050A	1916.5	793	438	87	526	166	94	7	0
1307-051A	1918.0	11631	9699	950	10649	221	699	62	0
1307-052A	1920.0	2403	1511	272	1783	306	293	20	0
1307-053A	1923.0	3393	2565	268	2833	208	300	53	0
1307-054A	1928.1	4588	3535	336	3871	380	294	42	0

TABLE 2b

COMPOSITION (NORMALISED %) OF C_{15+} MATERIAL EXTRACTED FROM ROCK

GEOCHEM SAMPLE NUMBER	DEPTH	HYDROCARBONS		NON HYDROCARBONS			
		Paraffin – Naphthenes	Aromatics	Preciptd. Asphaltenes	Eluted NSO's	Non eluted NSO's	Sulphur
1307-026A	1848.5	51.03	13.24	21.46	14.04	0.23	0.00
1307-027A	1851.0	56.94	11.21	19.76	10.40	1.69	0.00
1307-028A	1854.5	63.90	10.74	16.98	7.42	0.95	0.00
1307-029A	1861.8	50.97	15.65	21.50	11.75	0.12	0.00
1307-030A	1872.4	55.94	12.59	21.15	10.14	0.17	0.00
1307-031A	1877.5	58.02	13.07	18.21	9.28	1.42	0.00
1307-032A	1882.0	59.83	9.58	20.23	8.71	1.66	0.00
1307-033A	1888.0	62.12	12.93	13.69	10.32	0.94	0.00
1307-034A	1891.0	53.65	9.54	26.37	9.54	0.90	0.00
1307-035A	1894.0	50.70	8.12	32.21	8.68	0.28	0.00
1307-036A	1895.0	60.68	7.89	21.60	8.62	1.21	0.00
1307-037A	1897.0	48.10	14.27	28.19	8.63	0.81	0.00
1307-038A	1898.0	54.12	9.41	27.79	7.81	0.87	0.00
1307-039A	1898.5	63.02	11.90	14.83	9.37	0.88	0.00
1307-040A	1900.4	66.73	8.07	17.52	7.28	0.39	0.00
1307-041A	1901.0	69.11	8.40	15.64	5.89	0.97	0.00
1307-042A	1903.0	76.74	8.89	6.40	6.43	1.55	0.00
1307-043A	1905.0	75.90	8.46	5.99	9.40	0.26	0.00
1307-044A	1907.0	73.40	12.27	5.56	8.50	0.28	0.00
1307-045A	1909.1	71.10	8.34	7.21	12.05	1.30	0.00
1307-046A	1910.5	73.81	8.26	9.96	7.19	0.77	0.00
1307-047A	1911.0	74.70	7.53	5.78	11.30	0.70	0.00
1307-048A	1913.5	71.85	10.00	9.04	8.18	0.93	0.00
1307-049A	1914.5	73.80	9.22	7.80	8.30	0.88	0.00
1307-050A	1916.5	55.28	11.03	20.98	11.83	0.89	0.00
1307-051A	1918.0	83.39	8.17	1.90	6.01	0.54	0.00
1307-052A	1920.0	62.88	11.34	12.73	12.21	0.84	0.00
1307-053A	1923.0	75.59	7.89	6.12	8.84	1.56	0.00
1307-054A	1928.1	77.04	7.33	8.28	6.42	0.93	0.00

TABLE 3

SIGNIFICANT RATIOS (%) OF C_{15+} FRACTIONS AND ORGANIC CARBON

GEOCHEM SAMPLE NUMBER	DEPTH	ORGANIC CARBON (wt. %)	HYDROCARBONS / TOTAL EXTRACT	HYDROCARBONS / ORG. CARBON	TOTAL EXTRACT / ORG. CARBON	P-NAPHTHENES / AROMATICS
1307-026A	1848.5	0.40	64.27	5.09	7.92	3.85
1307-027A	1851.0	0.19	68.15	13.36	19.61	5.08
1307-028A	1854.5	0.67	74.64	7.14	9.56	5.95
1307-029A	1861.8	0.36	66.63	12.55	18.83	3.26
1307-030A	1872.4	0.12	68.53	10.25	14.96	4.44
1307-031A	1877.5	0.19	71.09	22.40	31.51	4.44
1307-032A	1882.0	0.16	69.40	22.87	32.96	6.25
1307-033A	1888.0	0.31	75.04	27.99	37.30	4.81
1307-034A	1891.0	0.31	63.19	7.07	11.20	5.62
1307-035A	1894.0	0.15	58.82	5.24	8.91	6.24
1307-036A	1895.0	0.14	68.57	15.88	23.16	7.69
1307-037A	1897.0	0.23	62.37	10.11	16.21	3.37
1307-038A	1898.0	0.30	63.53	6.18	9.73	5.75
1307-039A	1898.5	0.08	74.93	180.36	240.73	5.29
1307-040A	1900.4	0.32	74.80	5.21	6.97	8.27
1307-041A	1901.0	0.12	77.51	27.52	35.50	8.23
1307-042A	1903.0	0.35	85.62	124.71	145.65	8.64
1307-043A	1905.0	0.65	84.35	83.59	99.09	8.97
1307-044A	1907.0	0.35	85.67	189.20	220.84	5.98
1307-045A	1909.1	0.62	79.44	33.32	41.95	8.52
1307-046A	1910.5	0.29	82.07	30.92	37.68	8.93
1307-047A	1911.0	0.35	82.23	67.87	82.54	9.92
1307-048A	1913.5	0.24	81.85	140.71	171.90	7.18
1307-049A	1914.5	0.29	83.02	115.43	139.04	8.01
1307-050A	1916.5	0.23	66.31	22.86	34.48	5.01
1307-051A	1918.0	0.11	91.55	968.08	1057.36	10.21
1307-052A	1920.0	0.80	74.21	22.29	30.03	5.55
1307-053A	1923.0	0.30	83.48	94.43	113.11	9.58
1307-054A	1928.1	0.38	84.37	101.87	120.73	10.51

TABLE 4

COMPOSITION (NORMALISED %) OF C_{15+} SATURATE (PARAFFIN – NAPHTHENE) HYDROCARBONS

GEOCHEM SAMPLE NUMBER	-026A	-027A	-028A	-029A	-030A	-031A	-032A	-033A
DEPTH	1848.5	1851.0	1854.5	1861.8	1872.4	1877.5	1882.0	1888.0
SAMPLE TYPE								
nC_{15}	5.81	4.64	8.29	6.60	5.78	6.07	6.88	6.15
nC_{16}	7.62	6.64	8.77	8.71	8.79	7.77	8.69	8.50
nC_{17}	8.78	8.17	8.98	9.43	10.49	8.49	9.40	8.85
nC_{18}	8.85	8.58	8.29	9.29	9.71	8.23	8.91	8.78
nC_{19}	9.65	8.93	8.70	8.85	8.94	8.16	8.91	8.71
nC_{20}	8.20	8.51	7.94	8.42	8.87	7.71	8.33	8.29
nC_{21}	7.91	7.89	6.91	7.11	8.64	6.99	7.97	7.26
nC_{22}	7.76	7.20	6.91	6.89	7.40	6.73	7.10	6.36
nC_{23}	6.17	6.85	5.73	6.53	6.63	6.66	6.73	6.15
nC_{24}	5.73	6.16	5.59	5.73	5.78	5.49	5.29	5.25
nC_{25}	4.79	6.02	4.77	4.50	5.01	5.09	5.14	4.77
nC_{26}	4.50	4.22	3.87	4.14	3.70	4.18	3.62	4.08
nC_{27}	3.48	4.29	3.52	3.48	3.16	3.92	3.19	3.25
nC_{28}	2.69	3.11	2.69	2.76	2.31	3.00	2.39	2.83
nC_{29}	2.39	2.77	2.76	2.25	1.70	2.94	2.39	2.70
nC_{30}	1.74	1.80	1.93	1.45	1.08	1.96	1.30	1.94
nC_{31}	1.38	1.38	1.45	1.16	0.77	1.70	1.23	1.73
nC_{32}	1.02	1.11	0.90	0.87	0.46	1.31	0.80	1.17
nC_{33}	0.87	0.83	1.10	0.87	0.46	1.57	0.87	1.52
nC_{34}	0.58	0.62	0.69	0.65	0.23	1.44	0.58	1.24
nC_{35}	0.07	0.28	0.21	0.29	0.08	0.59	0.22	0.48
PARAFFIN	65.71	51.19	51.68	48.93	61.35	44.21	53.24	42.65
ISOPRENOID	4.72	4.53	5.14	4.55	6.48	3.81	5.90	4.30
NAPHTHENE	29.57	44.28	43.18	46.52	32.17	51.98	40.86	53.05
CPI INDEX 1	0.97	1.09	0.98	0.98	1.07	1.05	1.10	1.03
CPI INDEX 2	1.02	1.18	1.11	1.02	1.12	1.12	1.21	1.06
CPI INDEX 3	0.97	1.17	1.07	1.01	1.05	1.09	1.06	0.94
PRISTANE/PHYTANE	1.41	1.51	1.44	1.67	1.49	1.69	1.55	1.75
PRISTANE/nC_{17}	0.48	0.65	0.65	0.62	0.60	0.64	0.71	0.73

$$C.P.I.\ 1 = \frac{1}{2}\left[\frac{C21+C23+C25+C27}{C20+C22+C24+C26} + \frac{C21+C23+C25+C27}{C22+C24+C26+C28}\right]$$

$$C.P.I.\ 2 = \frac{1}{2}\left[\frac{C25+C27+C29+C31}{C24+C26+C28+C30} + \frac{C25+C27+C29+C31}{C26+C28+C30+C32}\right]$$

$$C.P.I.\ 3 = \frac{2x\ (C27)}{C26+C28}$$

CT – ditch cuttings **CO** – core **SWC** – sidewall core

TABLE 4

COMPOSITION (NORMALISED %) OF C_{15+} SATURATE (PARAFFIN – NAPHTHENE) HYDROCARBONS

GEOCHEM SAMPLE NUMBER	-034A	-035A	-036A	-037A	-038A	-039A	-040A	-041A
DEPTH	1891.0	1894.0	1895.0	1897.0	1898.0	1898.5	1900.4	1901.0
SAMPLE TYPE								
nC_{15}	7.89	2.71	4.61	6.61	8.69	8.02	2.39	4.67
nC_{16}	7.75	5.20	7.69	8.78	8.25	9.81	5.73	7.00
nC_{17}	8.99	7.36	8.66	9.23	8.77	9.66	7.84	7.87
nC_{18}	9.21	8.33	10.36	9.61	8.62	8.84	7.98	8.27
nC_{19}	9.36	9.02	9.63	9.16	9.58	8.40	9.58	8.47
nC_{20}	8.63	8.81	9.55	8.56	7.36	7.88	9.43	7.93
nC_{21}	7.38	8.47	8.74	7.96	7.58	6.69	7.62	7.53
nC_{22}	6.94	8.33	8.01	7.13	7.13	6.76	8.06	7.07
nC_{23}	7.09	7.70	6.55	6.08	6.32	5.72	7.47	6.27
nC_{24}	5.12	6.59	5.91	5.26	5.94	4.98	6.89	5.53
nC_{25}	4.61	5.69	5.18	4.80	4.98	4.83	6.24	5.20
nC_{26}	3.65	4.79	4.13	3.60	3.86	3.71	5.22	4.40
nC_{27}	3.22	4.58	3.07	3.38	3.42	3.42	4.28	4.20
nC_{28}	2.41	3.19	2.67	2.40	2.75	2.60	2.90	3.40
nC_{29}	1.97	2.78	2.18	2.25	2.23	2.38	2.76	3.27
nC_{30}	1.68	2.01	1.05	1.35	1.41	1.71	1.60	2.27
nC_{31}	1.24	1.73	0.81	1.20	1.19	1.41	1.52	2.00
nC_{32}	0.73	1.04	0.49	0.98	0.74	1.11	0.87	1.53
nC_{33}	0.95	0.90	0.40	0.83	0.67	0.97	0.94	1.60
nC_{34}	0.73	0.56	0.24	0.60	0.37	0.74	0.44	1.00
nC_{35}	0.44	0.21	0.08	0.23	0.15	0.37	0.22	0.53
PARAFFIN	49.85	55.06	63.35	46.14	53.58	44.00	61.05	48.97
ISOPRENOID	5.69	4.05	5.89	4.33	5.41	4.02	4.39	4.34
NAPHTHENE	44.46	40.89	30.75	49.53	41.00	51.98	34.56	46.69
CPI INDEX 1	1.07	1.04	1.00	1.06	1.02	1.01	0.99	1.03
CPI INDEX 2	1.08	1.12	1.08	1.16	1.10	1.12	1.14	1.10
CPI INDEX 3	1.06	1.15	0.90	1.13	1.03	1.08	1.05	1.08
PRISTANE/PHYTANE	1.56	1.52	1.56	1.72	1.57	1.80	1.30	1.61
PRISTANE/nC_{17}	0.77	0.60	0.65	0.64	0.70	0.61	0.52	0.69

$$\text{C.P.I. } 1 = \frac{1}{2}\left(\frac{C21+C23+C25+C27}{C20+C22+C24+C26} + \frac{C21+C23+C25+C27}{C22+C24+C26+C28}\right)$$

$$\text{C.P.I. } 2 = \frac{1}{2}\left(\frac{C25+C27+C29+C31}{C24+C26+C28+C30} + \frac{C25+C27+C29+C31}{C26+C28+C30+C32}\right)$$

$$\text{C.P.I. } 3 = \frac{2x\ (C27)}{C26+C28}$$

CT – ditch cuttings CO – core SWC – sidewall core

TABLE 4
COMPOSITION (NORMALISED %) OF C_{15+} SATURATE (PARAFFIN – NAPHTHENE) HYDROCARBONS

GEOCHEM SAMPLE NUMBER	-042A	-043A	-044A	-045A	-046A	-047A	-048A	-049A
DEPTH	1903.0	1905.0	1907.0	1909.1	1910.5	1911.0	1913.5	1914.5
SAMPLE TYPE								
nC_{15}	2.84	5.58	5.16	3.05	3.10	2.55	4.19	2.84
nC_{16}	4.57	7.45	6.88	5.30	5.35	5.70	6.67	4.57
nC_{17}	8.03	7.88	9.35	6.99	7.46	7.84	8.00	6.31
nC_{18}	8.79	7.88	8.18	7.67	9.01	8.38	7.87	7.28
nC_{19}	8.30	7.76	8.18	8.42	9.30	8.58	8.13	7.67
nC_{20}	8.93	7.21	7.08	8.83	8.03	8.24	7.30	8.31
nC_{21}	8.03	7.09	6.60	7.60	7.96	8.71	8.00	8.05
nC_{22}	8.51	6.42	5.91	7.33	7.75	7.31	7.43	7.15
nC_{23}	7.27	5.76	5.91	7.26	6.69	7.17	6.60	7.86
nC_{24}	6.64	5.70	5.57	6.31	5.85	6.64	6.92	6.64
nC_{25}	5.67	5.15	5.43	5.84	5.07	6.03	5.71	6.64
nC_{26}	4.71	4.42	4.33	4.89	4.58	4.83	5.21	5.61
nC_{27}	4.15	4.42	4.54	4.34	4.15	4.49	4.83	5.15
nC_{28}	3.39	3.58	3.92	3.73	3.38	3.49	3.94	4.25
nC_{29}	3.39	3.76	3.65	3.46	3.31	3.02	3.11	3.80
nC_{30}	2.08	2.55	2.82	2.31	2.39	2.01	2.03	2.38
nC_{31}	1.52	2.24	2.06	2.04	2.04	1.68	1.40	1.87
nC_{32}	1.11	1.64	1.44	1.43	1.48	1.14	1.08	1.22
nC_{33}	1.04	1.70	1.51	1.49	1.55	1.01	0.83	1.16
nC_{34}	0.62	1.21	0.96	1.15	0.99	0.80	0.51	0.84
nC_{35}	0.42	0.61	0.48	0.54	0.56	0.40	0.25	0.39
PARAFFIN	55.41	45.67	58.37	48.95	53.81	44.51	52.91	45.63
ISOPRENOID	4.72	3.68	4.30	3.52	4.13	3.88	4.43	3.20
NAPHTHENE	39.88	50.65	37.33	47.52	42.06	51.61	42.66	51.16
CPI INDEX 1	0.98	1.03	1.06	1.02	1.01	1.08	1.00	1.09
CPI INDEX 2	1.09	1.12	1.10	1.09	1.07	1.11	1.03	1.11
CPI INDEX 3	1.03	1.11	1.10	1.01	1.04	1.08	1.06	1.05
PRISTANE/PHYTANE	1.32	1.77	1.74	1.52	1.27	1.60	1.36	1.48
PRISTANE/nC_{17}	0.60	0.65	0.50	0.62	0.58	0.68	0.60	0.66

$$\text{C.P.I. } 1 = \frac{1}{2}\left(\frac{C21+C23+C25+C27}{C20+C22+C24+C26} + \frac{C21+C23+C25+C27}{C22+C24+C26+C28}\right)$$

$$\text{C.P.I. } 2 = \frac{1}{2}\left(\frac{C25+C27+C29+C31}{C24+C26+C28+C30} + \frac{C25+C27+C29+C31}{C26+C28+C30+C32}\right)$$

$$\text{C.P.I. } 3 = \frac{2x\ (C27)}{C26+C28}$$

CT – ditch cuttings CO – core SWC – sidewall core

TABLE 4

COMPOSITION (NORMALISED %) OF C_{15+} SATURATE (PARAFFIN – NAPHTHENE) HYDROCARBONS

GEOCHEM SAMPLE NUMBER	-050A	-051A	-052A	-053A	-054A
DEPTH	1916.5	1918.0	1920.0	1923.0	1928.1
SAMPLE TYPE					
nC_{15}	5.54	4.86	7.78	5.57	7.48
nC_{16}	7.03	7.04	8.55	7.95	9.41
nC_{17}	8.23	7.85	10.17	8.75	9.55
nC_{18}	9.16	8.03	9.24	8.55	8.70
nC_{19}	8.59	8.09	9.24	7.95	7.84
nC_{20}	8.37	7.60	7.70	8.02	6.99
nC_{21}	7.45	6.91	7.70	6.43	6.77
nC_{22}	7.95	6.91	5.70	6.30	5.63
nC_{23}	7.67	6.60	5.32	6.56	5.49
nC_{24}	6.10	6.04	5.24	5.90	5.06
nC_{25}	5.82	5.17	4.55	5.10	4.70
nC_{26}	5.04	4.92	4.16	4.51	3.71
nC_{27}	3.83	4.48	3.78	4.57	4.28
nC_{28}	2.91	3.49	2.62	3.31	3.49
nC_{29}	2.34	3.30	2.47	2.92	3.28
nC_{30}	1.49	2.30	1.93	2.19	2.14
nC_{31}	0.99	1.93	1.46	1.72	1.92
nC_{32}	0.57	1.37	0.85	1.33	1.14
nC_{33}	0.50	1.43	0.85	1.13	1.28
nC_{34}	0.28	1.12	0.54	0.86	0.78
nC_{35}	0.14	0.56	0.15	0.40	0.36
PARAFFIN	56.41	50.38	56.36	50.76	57.74
ISOPRENOID	4.76	4.14	4.56	4.51	4.40
NAPHTHENE	38.83	45.48	39.08	44.74	37.86
CPI INDEX 1	1.01	1.00	1.07	1.02	1.09
CPI INDEX 2	1.07	1.06	1.08	1.08	1.17
CPI INDEX 3	0.96	1.07	1.11	1.17	1.19
PRISTANE/PHYTANE	1.64	1.69	1.92	1.73	1.82
PRISTANE/nC_{17}	0.64	0.66	0.52	0.64	0.51

$$C.P.I.\ 1 = \frac{1}{2}\ \frac{C21+C23+C25+C27}{C20+C22+C24+C26} + \frac{C21+C23+C25+C27}{C22+C24+C26+C28}$$

$$C.P.I.\ 2 = \frac{1}{2}\ \frac{C25+C27+C29+C31}{C24+C26+C28+C30} + \frac{C25+C27+C29+C31}{C26+C28+C30+C32}$$

$$C.P.I.\ 3 = \frac{2x\ \ (C27)}{C26+C28}$$

CT – ditch cuttings **CO** – core **SWC** – sidewall core

BRIEF DESCRIPTION OF THE ANALYSES PERFORMED BY GEOCHEM

"Screen Analyses" are described in sections A, C and D, "Sample Preparation" in section B, "Follow-up Analyses" in sections E through K and "Correlation Studies" in section L. The analyses can be run on either core or cuttings material with the proviso that samples must be canned for the C_1-C_7 analysis and should be canned (or at least wet) for the C_4-C_7 analysis. The other analyses can be run on both canned and bagged samples.

A) C_1-C_7 LIGHT HYDROCARBON ANALYSIS

The abundance and composition of the C_1-C_7 hydrocarbons in sediments reflects their source richness, maturity and the character of the hydrocarbons they can yield. Most importantly, it is extremely sensitive to the presence of migrated hydrocarbons and is an excellent method for their detection. As it provides the information on most of the critical parameters and is also economical, this analysis is excellent for screening samples to decide which of them merit further analysis.

During the time which elapses between the collection of the sample at the wellsite and its analysis in the laboratory, a fraction of the total gas passes from the rock to the air space at the top of the can. For this reason, both the air space and the cuttings are analysed.

The analysis involves the gas chromatographic separation of the individual C_1-C_4 gaseous hydrocarbons (methane, ethane, propane, isobutane and normal butane) and a partial resolution of the C_5-C_7 gasoline-range hydrocarbons (for their complete resolution see Section E). The ppm abundance of the five gases and of the total C_5-C_7 hydrocarbons are calculated from their electronically integrated peak areas (not from peak height) by comparison with a standard.

In the report, the following data are tabulated: the abundance and composition of the air space gas, of the cuttings gas and of the combined air space and cuttings gases. The combined results are also presented graphically.

B) SAMPLE WASHING AND HAND PICKING

All of the analyses described in subsequent sections are run on washed and hand picked samples.

Cuttings are washed to remove the drilling mud, care being taken not to remove soft clays and fine sand during the washing procedure. Using the C_1-C_7 hydrocarbon data profile of the well, or the organic carbon profile (if this analysis is used for screening), electric logs (if supplied) and the appearance of the cuttings under the binocular microscope, samples are selected to represent the lithological and geochemical zones penetrated by the well. These samples are then carefully hand picked and the lithology of the uncaved material is described. It is these samples which are submitted for further analysis.

Sample material remaining after analysis is retained for six months. Unless instructions are received to the contrary, Geochem Laboratories may then destroy the samples.

Our reports incorporate a gross lithological description of all the samples which have been analysed and litho percentage logs. As screen analyses are recommended at narrow intervals, a complete lithological profile is obtained.

GEOCHEM

C) ORGANIC CARBON ANALYSIS

The organic carbon content of a rock is a measure of its total organic richness. Combined with the visual kerogen, C_1-C_7, C_4-C_7, pyrolysis and C_{15+} analyses, the organic carbon content is used to evaluate the potential (not necessarily actual) hydrocarbon source richness of the sediment. This analysis is an integral part of a total evaluation and it can also be used as an economical screen analysis for dry samples (when the C_1-C_7 analysis cannot be used).

Hand picked samples are dried, crushed and then acidised to remove the inorganic calcium and magnesium carbonates. The actual analysis involves combustion in a Leco carbon analyser. Blanks, standards and duplicates are run routinely for purposes of quality control at no extra cost to the client.

The data are tabulated and presented diagramatically in our reports in a manner which facilitates comparison with the gross lithology (see Section B) of the samples.

D) MINI-PYROLYSIS

An ideal screen analysis which provides a definitive measure of potential source richness upon those samples whose organic carbon contents suggest fair or good source potential. This is described in detail in section K.

E) DETAILED C_4-C_7 HYDROCARBON ANALYSIS

The abundance and composition of the C_4-C_7 gasoline-range hydrocarbons in sediments reflects their source quality, level of thermal maturation and organic facies. In addition, the data also reveal the present of migrated hydrocarbons and can be used for crude oil-parent source rock correlation studies.

This powerful analysis, performed upon hand picked lithologies, is employed as a follow-up to confirm the potential of samples which have been selected using the initial screen analysis. It is used in conjunction with the organic carbon, visual kerogen and C_{15+} analyses.

The individual normal paraffins, isoparaffins, naphthenes and aromatics with between four and seven carbon atoms in the molecule (but also including toluene) are resolved by capillary gas chromatography and their peak areas electronically integrated.

Normalised compositions, selected ratios and the ppm abundance of the total gasoline-range fraction are tabulated in the report and also presented graphically.

F) KEROGEN TYPE AND MATURATION

Kerogen is the insoluble organic matter in rocks. Visual examination of the kerogen gives a direct measure of thermal maturity and of the composition of the organic matter (organic facies) and indicates the source quality of the sediment - which is confirmed using the organic carbon, light hydrocarbon, pyrolysis and C_{15+} analyses.

The type of hydrocarbon (oil or gas) generated by a source rock is a function of the types and level of thermal maturation of the organic matter which are present. Both of these parameters are measured directly by this method.

Kerogen is separated from the inorganic rock matrix by acid digestion and flotation methods which avoid oxidation of the organic matter. It is then mounted on a glass slide and examined at high and low magnifications with a Leitz microscope. Chemical methods measure the total kerogen population but, with this technique, individual particles can be selected for examination and spurious material identified. This is particularly valuable in reworked, contaminated and turbodrilled sediments.

The following data are generated: the types of the organic matter present and their relative abundances, an estimate of the proportion of reworked material, preservation state, the thermal maturity of the non-reworked organic matter using the spore colouration technique.

Our maturation scale has been developed to digitise small but recognisable changes in organic matter colouration resulting from increasing maturity and to place particular emphasis upon the immature to mature transition. In the absence of a universal colouration scale, the most significant points on our scale have been calibrated against equivalent vitrinite reflectance values. The following maturation stages are recognised at the low end of the scale:-

a) immature; thermal index less than 2- (0.45% Ro)
b) marginally mature; indices between 2- and 2.
   Minor hydrocarbon generation from amorphous and herbaceous (± algal) organic matter
c) mature; indices between 2 (0.53% Ro) and 2 to 2+ (0.72% Ro), significant generation from amorphous, algal and herbaceous organic matter but wood only marginally mature
d) oil window; indices of 2 to 2+ (0.72% Ro) through to 3 (1.2% Ro). Peak hydrocarbon generation.

The condensate zone starts at a thermal index of 3 whilst indices of 3+ (2.0% Ro) and higher indicate the eometamorphic dry gas stage.

A total of fourteen types of organic matter are sought based upon the major categories of algal, amorphous, herbaceous (spore, pollen, cuticle), wood, inertinite and resin. This detail is essential for a proper understanding of hydrocarbon source potential as the different sub-groups within each category have different properties.

Upon completion of the study, the kerogen slides are sent to the client.

G) <u>VITRINITE REFLECTANCE</u>

Vitrinite reflectance is an alternative/confirmatory method for evaluating thermal maturation which is used in conjection with the <u>visual kerogen</u> analysis. The reflectivity of vitrinite macerals increases in response to thermal alteration and is used to define maturation levels and, by projection, to predict maturity at depth or the thicknesses of section removed by erosion.

Measurements are made upon kerogen separations in conjunction with polished whole rock samples. In general, this analysis is performed upon the same samples as the visual kerogen analysis, thus facilitating a direct comparison of the two sets of results.

If possible, forty to fifty measurements are taken per sample - unless the sediments are organically lean, vitrinite is sparse or only a single uniform population is present. The data are plotted in a histogram which distinguishes the indigenous vitrinite from possible reworked or caved material. Averages are calculated for each population. Comments upon exinite fluorescence and upon the character of the phytoclasts are noted on the histograms. The reports contain the tabulated data, histograms and the reflectivities plotted against depth.

The vitrinite and visual kerogen techniques provide mutually complementary information upon maturity, organic matter type and diagenesis.

H) C_{15+} EXTRACTION, DEASPHALTENING AND CHROMATOGRAPHIC SEPARATION

Sections "A" and "E" dealt with analyses covering the light end of the hydrocarbon spectrum. This section is concerned with the solvent extractable oranic material in the rock with more than fourteen carbon atoms in the molecule (i.e. the heavy end). The amount and composition of this extract indicates source richness and type, the level of thermal maturation and the possible presence of migrated hydrocarbons.

These results are integrated with those derived from the pyrolysis, visual kerogen, organic carbon and light hydrocarbon analyses.

The techniques involved in this analysis employ pure solvents and have been designed to give reproducible results. Hand picked samples are ground and then solvent extracted in a soxhlet apparatus, or by blending, with dichloromethane (the solvent system can be adapted to client's specifications). After asphaltene precipitation, the total extract is separated by column chromatography or high pressure liquid chromatography into the following fractions: paraffin-naphthene hydrocarbons, aromatic hydrocarbons, eluted NSO's (nitrogen-, sulphur-, and oxygen- containing non-hydrocarbons) and non-eluted NSO's. Note that the non-hydrocarbons are split into three fractions and not reported as a gross value. These fractions can be submitted for further analyses (carbon isotopes, gas chromatography, mass spectroscopy) including correlation studies.

For convenience and thoroughness, the data are reported in three formats: the weights of the fractions, ppm abundances and normalised percentage compositions. The data are also presented diagramatically.

J) GC ANALYSIS OF C_{15+} PARAFFIN-NAPHTHENE HYDROCARBONS

The gas chromatographic configurations of the heavy C_{15+} paraffin-naphthene hydrocarbons reflect source type, the degree of thermal maturation and the presence and character of migrated hydrocarbons or contamination.

Not only is this analysis an integral part of any source rocks study but it also provides a fingerprint for correlation purposes and helps to define the geochemical/palynological environmental character of the source rocks from which crude oils were derived.

The paraffin-naphthene hydrocarbons obtained by column chromatography are separated by high resolution capillary chromatography. Excellent resolution of the individual normal paraffins, isoprenoids and significant individual isoparaffins and naphthenes is achieved. Runs are normally terminated at nC_{35}. A powerful in-house microprocessor system is being introduced to correct for the change in response factor with chain length.

The normal paraffin carbon preference indices (C.P.I.) indicate if odd (values in excess of 1) or even (values less than 1) normal paraffins are dominant.

Strong odd preferences (± strong pristane peaks) are characteristic of immature land plant organic matter whilst even preferences (± strong phytane peaks) suggest a reducing environment of deposition. With increasing maturity, values approach 1.0 and oils are typically close to 1.0. The indices are calculated using the following formulae:

$$C.P.I_A = \frac{\dfrac{C_{21} + C_{23} + C_{25} + C_{27}}{C_{20} + C_{22} + C_{24} + C_{26}} + \dfrac{C_{21} + C_{23} + C_{25} + C_{27}}{C_{22} + C_{24} + C_{26} + C_{28}}}{2}$$

$$C.P.I_B = \frac{\dfrac{C_{25} + C_{27} + C_{29} + C_{31}}{C_{24} + C_{26} + C_{28} + C_{30}} + \dfrac{C_{25} + C_{27} + C_{29} + C_{31}}{C_{26} + C_{28} + C_{30} + C_{32}}}{2}$$

Chromatograms are reproduced in the report for use as visual fingerprints and in addition, the following data are tabulated: normalised normal paraffin distributions; proportions of paraffins, isoprenoids and naphthenes in the total paraffin-naphthene fraction; $C.P.I_A$ and $C.P.I_B$; pristane to phytane ratio; pristane to nC_{17} ratio.

K) PYROLYSIS

The process of thermal maturation can be simulated in the laboratory by pyrolysis, which involves heating the sample under specified conditions and measuring the oil-like material which is freed/generated from the rock. With this analysis, the potential richness of immature sediments can be determined and, by coupling the pyrolysis unit to a gas chromatograph, the liberated material can be characterised. These results are correlated with those obtained from the organic carbon, kerogen and C_{15+} analyses.

Small amounts of powdered sample are heated in helium to release the thermal bitumen (up to 340°C) and pyrolysate (340-550°C). The thermal bitumen correlates with the solvent extractable material (see above) whilst the pyrolysate fraction does not exist in a "free" state but is generated from the kerogen, thus simulating maturation in the subsurface. Abundances (weight ppm of rock) are measured with a flame ionisation detector against a standard. Thermal bitumen includes source indigenous, contaminant and migrated hydrocarbons but the pyrolysate abundance is a measure of ultimate source richness. The capillary gas chromatogram of the pyrolysate is used to evaluate the character of the parent organic matter and whether it is oil or gas prone. Peak temperature(s) of pyrolysate evolution is recorded. Carbon dioxide can be measured if requested but is normally ignored as the separation of the organic and inorganic species has been found to be artificial and unreliable.

Pyrolysate yields provide a definitive measure of potential source richness which avoids the ambiguities of the organic carbon data and the problem of contamination. This analysis is also used to evaluate the quality and character of the organic matter and the degree to which it has realised its ultimate hydrocarbon potential. Geochem does not employ the pyrolysis technique to evaluate maturation, preferring the kerogen and vitrinite reflectance analyses which avoid the problem of reworking and hence, are more reliable.

Capillary chromatograms produced for the pyrolysate hydrocarbons range from C_1 (methane) out towards C_{35} but exhibit considerable variations. They are used to define whether a source rock will yield oil, condensate or gas. With this new technique, it is now possible to complete the evaluation of a source rock.

The data are tabulated and presented graphically. MINI-PYROLYSIS includes ppm thermal bitumen and ppm pyrolysate. PYROLYSIS also provides the above together with the temperature of peak pyrolysate evolution. The capillary chromatograms of the pyrolysate obtained by PYROLYSIS-GC are reproduced in the report. The Mini-Pyrolysis analysis is recommended as a screening technique.

L) <u>CORRELATION STUDY ANALYSES</u>

Oil to oil and oil to parent source rock correlation studies require high resolution analytical techniques. This requirement is satisfied by some of the analyses discussed above but others have been selected specifically for correlation work. Many of these analyses also provide information upon the character of the environment of deposition of the parent source rocks.

- detailed C_4-C_7 hydrocarbon (gasoline range) analysis. See Section E. Although these hydrocarbons can be affected by migrational/alteration processes, they commonly provide a very useful correlation parameter.

- capillary gas chromatography of the C_{15+} paraffin-naphthenes. See section J. The branched±normal paraffin distributions are used to "fingerprint" the samples.

- capillary chromatograms of whole oils and of the C_{4+} fraction of source rocks.

- capillary gas chromatography of C_{15+} aromatic hydrocarbons. Separate chromatograms of the hydrocarbons and of the sulphur-bearing species are reproduced.

- high pressure liquid chromatograms.

- mass spectrometric carbon isotope analyses of crude oil and rock extract fractions and of kerogen separations. A powerful tool for comparing hydrocarbons and correlating hydrocarbons to organic matter. With this technique the problem of source rock contamination can be avoided. The data are recorded on x-y or Galimov plots.

- mass fragmentograms (mass chromatograms) of fragment ions characteristic of selected hydrocarbon groups such as the steranes and terpanes. The fragmentograms provide a convenient and simple means of presenting detailed mass spectrometric data and are used as a sophisticated fingerprinting technique. This provides the ultimate resolution for correlating hydrocarbons and facilitates the examination of hydrocarbon classes.

- vanadium and nickel contents.

Suites of (rather than single) analyses are employed in correlation studies, the actual selection depending upon the complexity of the problem. See also section N.

M) ANALYSES FOR SPECIAL CASES

M-1) ELEMENTAL KEROGEN ANALYSIS

This analysis evaluates source quality, whether the sediments are oil or gas prone, the character of the organic matter and its level of thermal maturation. It is the chemical equivalent of the visual kerogen analysis. The pyrolysis analysis is generally preferred to this technique, both methods providing similar information.

M-2) SULPHUR ANALYSIS

The abundance of sulphur in source rocks and crude oils.

M-3) CARBONATE CONTENT

The mineral carbonate content of sediments is determined by acid treatment. These data are particularly useful when used in conjunction with organic carbon contents as a screening technique.

M-4) NORMAL PARAFFIN ANALYSIS

Following the removal of the branched paraffins and naphthenes from the total paraffin-naphthene fraction, a chromatogram of the normal paraffins is obtained. The resulting less complicated chromatogram facilitates the examination of normal paraffin distributions.

M-5 SOLID BITUMEN EVALUATION

Residual solid bitumen after crude oil is generated by three prime processes; the action of waters, gas deasphalting, thermal alteration. Thus it provides a means of determining the reservoir history of a crude and of evaluating whether adjacent traps will or will not be prospective for oil. In carbonate sections, where organic matter is sometimes sparse, this technique is also used to evaluate thermal maturation levels.

The analysis involves the determination of the solubility (in CS_2) of the solid bitumen and of the atomic hydrogen to carbon ratio of the insoluble fraction.

N) CRUDE OIL ANALYSIS

N-1) API GRAVITY

This can be performed upon large (hydrometer) and small (SG bottle, pycnometer) samples and even upon stains extracted from sediments (refractive index).

N-2) SULPHUR CONTENTS (ASTM E30-47)

N-3) POUR POINT (ASTM D97-66, IP15/67)

N-4) VISCOSITY (ASTM D445-72, IP71/75)

N-5) FRACTIONAL DISTILLATION

Graph of cumulative distillation yield against temperature. Five percent cuts taken for further analysis. Mass spectrometric studies of these fractions provide a detailed picture of the distribution of paraffins and of the various naphthene and aromatic groups within a crude, which is useful both for correlation and for refinery evaluation purposes.