5.2 MUD

5.2.1. Mud Properties, Daily Report

Well no: 6507/11-1

Saga Petroleum a.s.

DATE	HOLE SIZE IN	DEPTH M	MUD WEIGHT PPG	P.V.	Y.P.	GEL STRENGTH	n	k	WATER LOSS	PH	ALKAL. PI/MF	CA PPM	CI PPM	SAND %	SOLIDS %	REMARKS
13.09	17 1/2		8,7													
14.09	17 1/2		8,7													
15.09	17 1/2	456	8,7													
16.09	30	456	8,7													
17.09	30	456	8,7	6	34	10/11				10,0		800		0	0	
18.09	17 1/2	735	9,4	7	46	4/5				10,0	0,2/0,4	1000	3000	tr	5	
19.09	26	815	9,4	9	48	5/6				10,1	0,2 1/0,4	1000	3200	tr	5	
20.09	26	600	9,4	8	32	5/6				10,1	0,21/0,41	1000	3400	tr	5	
20.09	26	815	9,4	7	27	5/6				10,0	0,2/0,39	980	3600	tr	5	
21.09	26	815	11,4	7	20	4/5				9,8	0,18/0,38	920	4200	tr	6	
22.09	20	815	9,2	10	18	3/4			12	10,0	0,12/0,36	1600	5800	0	0	
23.09	20	815	9,2	10	18	3/4			12	10,0	0,12/0,36	1600	5800	C	0	
24.09	20	815	9,2	10	18	3/4			12	10,0	0,12/0,36	1600	5800	0	0	
25.09	20	815	9,2	10	18	3/4			12	10,0	0,12/0,36	1600	5800	0	0	
26.09	17 1/2	816	9,2	10	19	3/4			8,8	9,8	0,12/0,35	1650	6400	0	tr	
26.09	17 1/2	906	9,2	11	18	3/4			12	9,9	0,18/0,38	1700	6200	0	1	
26.09	17 1/2	1108	9,6	11	18	3/4			14	9,8	0,2/0,4	1800	6000	tr	2	
27.09	17 1/2	1200	9,8	11	19	3/4			14	9,9	0,2/0,4	1800	6100	tr	4	
27.09	17 1/2	1328	9,7	14	21	4/5			12,8	9,7	0,18/0,39	2000	6200	tr	4	
27.09	17 1/2	1405	9,6	16	26	4/5			9,2	9,7	0,18/0,39	2300	6200	tr	4	
28.09	17 1/2	1455	9,7	15	25	4/5			9,6	10,0	0,2/0,4	2100	6200	tr	4	
29.09	17 1/2	1461	9,7	15	25	4/5			9,6	10,1	0,2/0,4	2100	6200	tr	4	
29.09	17 1/2	1461	9,8	16	25	5/10			10,1	9,9	0,14/0,31	2100	10000	0,1	5	
29.09	17 1/2	1548	9,8	17	25	6/14			12,4	9,8	0,13/0,30	2150	14000	C,2	5	
30.09	17 1/2	1615	9,8	18	25	7/18			11,6	9,7	0,14/0,30	2100	18000	0,25	5	
1.10	13 3/8	1615	9,8	18	25	7/18			11,6	9,6	0,14/0,30	2100	21000	0,25	5	
2.10	13 3/8	1615	9,8	18	25	7/18			11,6	9,6	0,14/0,30	2100	21000	0,25	5	
2.10	13 3/8	1615	10,2	20	32	10/30			20,0	12,5	1,1/1,3	3600	21000	0,25	5	
3.10	13 3/8	1615	9,7	10	17	5/8			18,0	9,5	0,1/0,3	2200	21000	0,25	4	
3.10	12 1/4	1618	9,8	15	15	3/5			24,0	10,2	0,15/0,30	1120	20000	0,25	4	
3.10	12 1/4	1760	9,7	14	16	4/5			10,2	10,1	0,14/0,30	1600	20000	0,25	4	
4.10	12 1/4	1802	9,7	14	17	4/5			9,6	10,0	0,14/0,30	1650	21000	0,25	4	

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Saga Petroleum a.s.

DATE	HOLE SIZE IN	DEPTH M	MUD WEIGHT PPG	P.V.	Y.P.	GEL STRENGTH	n	k	WATER LOSS	PH	ALKAL. PI/MF	CA PPM	CI PPM	SAND %	SOLIDS %	REMARKS
23/10	8 1/2	2330	12,2	20	15	5/8			6,7	11,8	2,35/3,35	200	13000	0,5	15	
24/10	8 1/2	2364	12,0	18	10	5/10			6,4	12,0	2,15/2,9	150	11000	0,5	14	
24/10	8 1/2	2393	12,3	17	13	6/13			6,7	12,0	1,5/2,3	60	12000	0,4	15	
25/10	8 1/2	2423	12,3	15	15	6/11			6,6	11,7	2,2/3,6	45	14500	0,4	15	
25/10	8 1/2	2440	12,3	11	18	6/11			7,0	12,0	1,35/2,25	40	11000	0,4	15	
26/10	8 1/2	2495	12,2	10	16	6/14			7,0	12,0	1,6/2,8	40	10000	0,4	15	
26/10	8 1/2	2506	12,2	16	13	7/20			6,4	12,0	1,6/2,1	40	11000	0,4	15	
27/10	8 1/2	2509	12,2	17	12	7/19			6,0	12,0	1,2/2,6	40	11000	0,4	15	
27/10	8 1/2	2511	12,2	14	14	6/20			6,1	11,8	0,9/1,7	tr	12000	0,3	15	
28/10	8 1/2	2527	12,3	12	15	6/20			6,0	11,5	0,5/1,6	40	11000	0,4	16	
29/10	8 1/2	2544	12,2	24	14	5/17			6,0	10,6	0,6/1,5	240	12000	0,5	19	
30/10	8 1/2	2627	12,2	19	13	8/26			7,0	11,0	0,5/1,2	100	12500	0,5	20	
31/10	8 1/2	2728	12,2	19	13	6/18			6,0	11,0	11,4	100	10000	0,5	16	
1/11	8 1/2	2728	12,2	17	13	5/15			6,2	11,0	0,6/1,9	100	10000	0,5	18	
2/11	8 1/2	2728	12,2	21	12	5/17			5,8	11,0		120	10000	0,5	18	
3/11	8 1/2	2785	12,2	23	16	7/24			6,5	10,5	1,0/1,6	40	11500	0,5	19	
4/11	8 1/2	2923	12,2	21	11	6/17			5,4	10,5		tr	12000	0,5	19	
5/11	8 1/2	2933	12,2	23	13	5/17			6,0	10,5	1,1/2,6	40	11000	0,5	19	
6/11	8 1/2	2964	12,2	24	11	4/15			5,5	10,5	2/2,75	100	13000	0,5	20	
6/11	8 1/2	2971	12,2	24	10	4/15			5,5	10,5	1,2/1,7	tr	13000	0,5	20	
6/11	8 1/2	2985	12,2	23	15	7/16			5,8	10,5	1,1/1,65	40	13000	0,5	20	
7/11	8 1/2	2988	12,2	27	12	6/12			6,3	10,5	1,2/1,95	tr	13000	0,5	20	
7/11	8 1/2	2998	12,2	27	13	7/13			6,0	10,5	1,0/2,0	100	13000	0,5	20	
7/11	8 1/2	3030	12,2	23	13	5/15			6,0	10,5	0,9/1,7	60	13000	0,5	20	
8/11	8 1/2	3043	12,2	25	14	7/13			6,0	10,5	1,2/1,95	100	12000	0,25	20	
9/11	8 1/2	3057	12,2	21	13	7/15			5,8	19,5	0,95/1,45	tr	11000	0,25	20	
9/11	8 1/2	3086	12,2	25	15	7/16			6,0	10,5	1,1/1,6	60	11000	0,25	20	
10/11	8 1/2	3100	12,2	28	15	6/13			5,6	11,5	1,0/1,5	100	11000	0,25	20	
10/11	8 1/2	3115	12,2	26	12	7/15			5,6	11,0	0,96/1,6	60	11000	0,25	20	
10/11	8 1/2	3139	12,2	23	15	7/15			5,6	11,0	1,0/1,7	60	11000	0,25	20	
11/11	8 1/2	3139	12,2	24	15	7/15			5,6	11,0	1,0/1,7	60	11000	0,25	20	
12/11	8 1/2	3139	12,2	22	12	6/14			5,9	10,9	0,9/1,6	60	11000	0,25	20	

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DATE	HOLE SIZE IN	DEPTH M	MUD WEIGHT PPG	P.V.	Y.P.	GEL STRENGTH	n	k	WATER LOSS	PH	ALKAL. PI/MF	CA PPM	CI PPM	SAND %	SOLIDS %	REMARKS
13/11	8 1/2	3139	12,2	22	12	6/14			5,8	10,9	1,0/1,6	60	11000	0,25	20	
14/11	8 1/2	3139	12,2	25	15	7/15			5,6	11,0	1,0/1,7	70	11000	0,25	20	
15/11	8 1/2	3139	12,2	26	15	6/15			5,4	11,0	0,9/1,55	60	11000	0,25	20	
16/11	8 1/2	3139	12,2	26	16	7/16			5,5	11,0	0,9/1,5	60	11000	0,25	20	
17/11	7	2650	12,2	24	14	5/14			5,5	11,0	0,9/1,5	60	11000	0,25	20	
17/11	7	2650	12,2	25	14	5/14			5,5	11,0	0,9/1,5	60	11000	0,25	20	
19/11	7	2650	9,5	3	3	0/1			30	10,0	0,2/0,6	60	12000	0,1	4	
20/11	7	2650	9,5	3	3	0/1			30	10,0	0,2/0,6	60	12000	0,1	4	
21/11	7	2650	9,5	4	3	0/1			30	10,0	0,2/0,6	60	12000	0,1	4	
22/11	7	2650	9,5	4	4	1/2			30	10,0	0,2/0,6	60	12000	0,1	4	
23/11	7	2650	9,5	4	4	1/2			30	10,0	0,2/0,6	60	12000	0,1	4	
24/11	7	2650	9,5	4	4	1/2			30	10,0	0,2/0,6	60	12000	0,1	4	
25/11	7	2650	9,5	4	4	1/2			30	10,0	0,2/0,6	60	12000	0,1	4	
26/11	7	2650	9,5	4	4	1/2			30	10,0	0,2/0,6	60	12000	0,1	4	
27/11	7	2650	9,5	4	4	1/2			30	10,0	0.2/0.6	60	12000	0,1	4	
28/11	7	2650	9,5	4	4	1/2			30	9,5	0,2/0,6	80	12000	0,1	4	
29/11	7	2650	9,5	4	4	1/2			30	9,5	0,2/0,6	60	12000	0,1	4	
30/11	7	2352	9,5	4	4	1/2			30	9,5		60	12000	0,1	4	
1/12	7	1492	9,5	4	4	1/2			30	9,5		60	12000	0,1	4	
2/12	7	1492	9,5	4	4	1/2			30	9,5		60	12000	0,1	4	

5.2.1. Mud Properties, Daily Report

Well no: 6507/11-1

Saga Petroleum a.s.

DATE	HOLE SIZE IN	DEPTH M	MUD WEIGHT PPG	P.V.	Y.P.	GEL STRENGTH	n	k	WATER LOSS	PH	ALKAL. PI/MF	CA PPM	CI PPM	SAND %	SOLIDS %	REMARKS
4.10	12 1/4	1904	9,7	18	19	2/8			9,5	10,0	0,2/0,6	2920	23000	0,25	6	
4.10	12 1/4	2042	9,7	18	19	3/10			9,8	9,8	0,16/0,3	2600	23000	0,25	8	
5.10	12 1/4	2116	9,7	17	19	3/14			9,6	9,5	0,1/0,3	2350	23000	0,25	9	
5.10	12 1/4	2125	11,3	17	17	4/20			10,1	10,0	0,15/0,45	3000	26000	0,25	17	
5.10	12 1/4	2125	11,3	18	18	4/21			9,8	9,9	0,15/0,45	2950	26000	0,25	17	
6.10	12 1/4	2125	11,5	20	22	11/30			10,0	9,8	0,15/0,45	3000	26000	0,25	18	
6.10	12 1/4	2137	11,8	24	26	12/18			16,0	9,7	0,15/0,45	3000	24000	0,25	20	
6.10	12 1/4	2137	12,4	20	18	10/20			14,6	9,6	0,15/0,45	29000	25000	0,50	20	
7.10	12 1/4	2137	12,4	22	18	9/20			14,4	9,6	0,15/0,45	2900	21000	0,50	20	
7.10	12 1/4	2137	12,9	26	14	4/10			10,2	9,8	0,2/0,4	2000	21000	0,50	20	
7.10	12 1/4	2137	12,9	24	16	5/10			10,2	9,7	0,2/0,4	2600	22000	0,50	21	
8.10	12 1/4	2137	13,2	24	16	5/10			10,2	9,7	0,2/0,4	2500	22000	0,50	21	
8.10	12 1/4	2137	13,2	28	25	8/18			10,0	9,6	0,2/0,4	2600	21000	0,50	21	
8.10	12 1/4	2195	13,2	26	26	14/29			10,6	9,8	0,2/0,45	2600	20000	0,50	22	
9.10	12 1/4	2225	13,2	26	26	14/29			9,6	9,9	0,18/0,45	2400	20000	0,50	22	
9.10	12 1/4	2300	13,2	23	24	12/35			10,2	9,8	0,2/0,3	2200	21000	0,50	22	
9.10	12 1/4	2300	13,2	24	24	12/32			10,0	9,6	0,2/0,4	2200	23000	0,50	22	
10.10	12 1/4	2300	13,2	22	22	14/30			10,6	9,5	0,2/0,4	1800	20000	0,50	22	
11.10	12 1/4	2300	13,2	24	21	14/30			11,0	10,5	0,35/0,80	1100	21000	0,50	23	
12.10	12 1/4	2300	13,2	27	17	5/20			9,6	9,5	0,15/0,60	1360	20000	0,50	23	
13.10	12 1/4	2300	13,2	25	15	6/20			9,2	10,0	0,15/0,55	1720	20000	0,75	23	
13.10	12 1/4	2300	13,2	20	20	5/15			9,1	10,0	0,26/0,59	1700	20000	0,75	23	
14.10	9 5/8	2287	13,2	26	13	4/11			9,6	9,5	0,20/0,70	1440	20000	0,75	22	
14.10	9 5/8	2287	13,1	11	38	3/21			8,0	9,3	0,15/0,70	1400	15500	0,50	22	
15.10	9 5/8	2286	13,1	10	15	2/6			9,6	10,0	2,6/4,5	1700	21000	0,50	22	
16.10	9 5/8	2286	12,6	9	12	4/6			15	11,5	2,65/3,05	1020	19000	0,50	18	
17.10	9 5/8	574	13,1	10	15	8/12			16	12,0	2,5/3,1	400	20000	0,50	21	
18.10	9 5/8	2125	13,2	9	10	7/10			15	11,7	2,25/2,6	80	20000	0,50	22	
19.10	9 5/8	2183	13,4	11	8	4/5			15	11,8	2,25/2,45	100	19000	0,50	23	
20.10	9 5/8	PIT	13,5	28	13	3/7			6,0	11,5	1,2/2,5	80	19000	0,50	23	
21.10	9 5/8	PIT	13,5	28	13	3/7			6,0	11,5	1,2/2,5	80	19000	0,50	23	
22.10	8 1/2	228	12,0	15	13	6/15			10,1	11,9	2,7/3,5	200	13000	0,50	14	

5.2.2. Mud Materials used

Well no: 3507/11-1

Saga Petroleum a.s.

MATERIAL	UNIT	36" HOLE	26" HOLE	17½" HOLE	12 1/4" HOLE	8½" HOLE	5 7/8" HOLE	TOTAL
Barite	MT		129	39	700	134.	63	1065
	50 kg		60					60
Wyoming Bentonite	MT	25	17					42
	50 kg		292		270			562
Milgel	50 kg				15	200	13	228
Caustic	50 kg	6			15			21
Soda	25 kg	2	35	75	66	41	42	261
Gysum	40 kg		117	181	7			305
Soda Ash	50 kg	2			7	4		13
Bicarbonate of Soda	50 kg			4	62	20		86
Milpolymer 302	25 kg			178	35			213
Drispac Reg.	50 lbs			22	13			35
Drispac SL	50 lbs				40			40
CMC LoVis	25 kg			44	95	21	47	207
CMC HiVis	25 kg				21	29		50
Milspot	25 kg				125			125
	25 kg				6	20	25	51
Drillaid	20 kg				135			135
Kwickseal	40 lbs				4			4
Unical	25 kg				63			63
Ligcon	50 lbs				170	100	50	320
LD-8	56 al			1	5			6
Carbo Mud					1			1
MD					2			1

x) MT: Metric Tons

6.5.3 RFT Measurements

The formation pressures of the Jurassic sandstones were measured using the Schlumberger RFT tool. The results are listed in table 6.10. In figure 6.9 the pressures are plotted versus depth.

The plot shows a distinct GWC at 2526m RKB, which corresponds to the result of the log evaluation. Above this depth a uniform gas gradient of 0.10 psi/ft (0.23 g/cc) has been estimated. The two gas bearing sands therefore probably belong to the same pressure system. Below the GWC a water gradient of 0.44 psi/ft (1.00 g/cc) was found.

A number of reservoir fluid samples were taken by means of the RFT tool. The results are listed in table 6.11. As can be seen from the table, 12 attempts at sampling failed due to poor seal and tight formation. The results of 4 samples were false because of leaks in the sampling chambers.

Only the samples from the depths 2401.5m RKB and 2526.0m RKB are nearly representative. They contained gas and condensate at a GCR of 95950 SCF/BBl and 83300 SCF/BBL respectively. The sample at 2532 m RKB, which was taken just below the estimated GWC, consisted of water with only traces of gas as expected.

Table 6.10 Results of the RFT pressure measurements

Depth m, RKB	Hydrostatic pressure, psi	Drawdown pressure, psi	Formation pressure, psi	Remarks
2364.5 x	4953	4	3579	
2364.5	5012	3	3579	
2369.5	5024	5	3581	
2377.5	5037	9	3581	
2386.0	5053	46	3583	
2399.0	5079	15	3586	
2399.0 x	5021	15	3585	
2401.5 x	5030	75	3589	
2409.7 x	5045	45	3592	
2416.0	5116	24	3593	
2418.0 x	5064			No seal
2421.7 x	5069	2673	3596	
2433.0	5154	3325	3609	Supercharge?
2435.3 x	5101	2688	3601	
2436.0	5158	--	--	Tight
2448.0 x	5121	--	--	Tight
2500.5	5293	38	3622	
2504.0	5300	218	3623	
2514.0	5321	2	3627	
2519.0	5331	6	3628	
2519.7 x	5275	9	3627	
2520.0 x	5272	3	3627	
2524.5	5339	12	3629	
2525.5 x	5285	398	3630	
2533.5	5358	477	3639	
2531.1 x	5301	142	3637	
2543.3 x	5321	--	--	Tight
2569.0 x	5373	16	3687	
2578.0	5447	85	3696	
2626.8 x	5500	20	3769	
2653.0	5604	28	3802	
2713.0	5725	84	3889	

x The measurement is from the second run, which took place 10 days after the first one.

All pressures are temperature corrected.

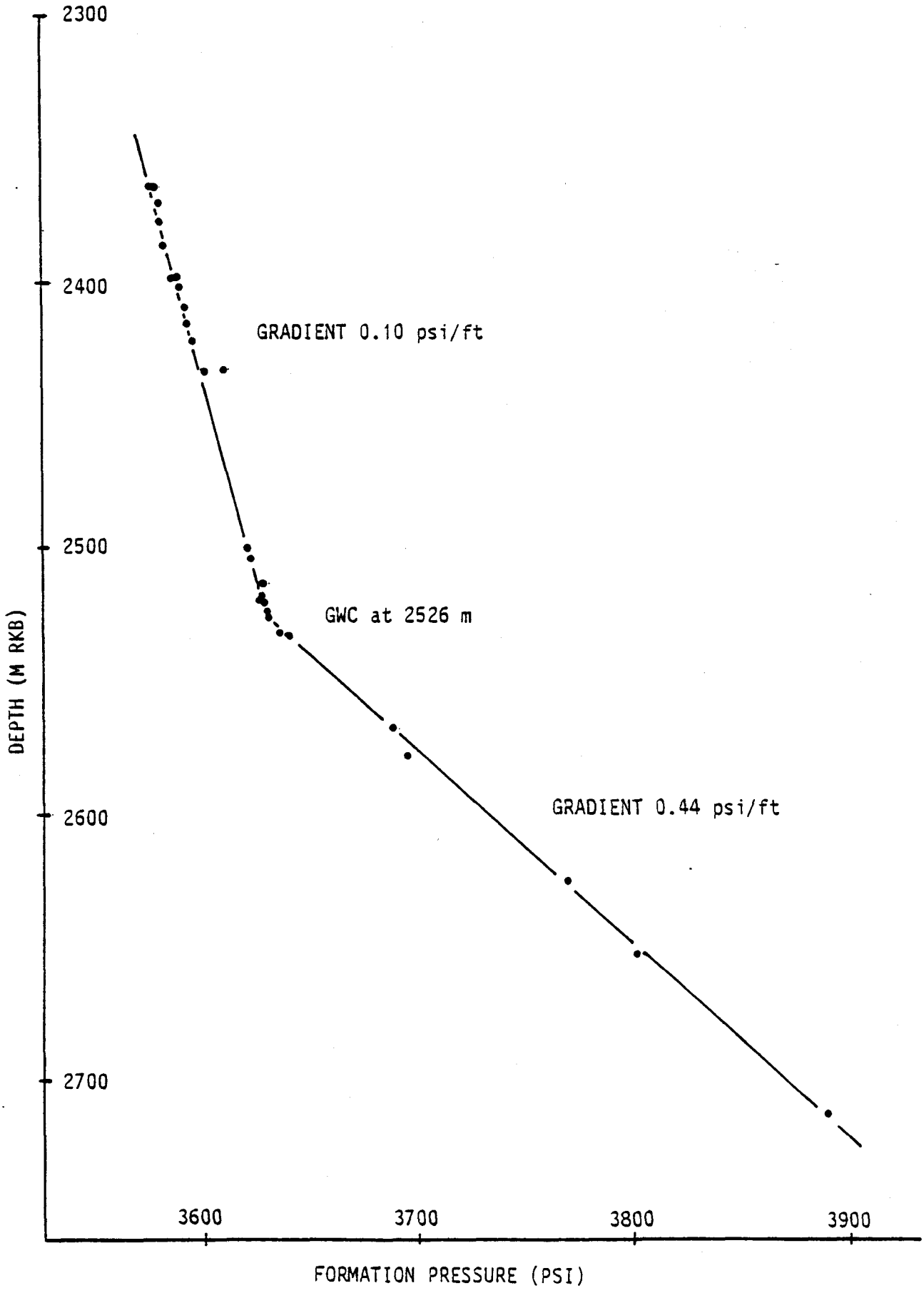

Fig. 6.9 Formation pressure vs depth, RFT results.

Table 6.11 Summary of RFT sampling results.

Depth, m RKB	Sampl. press., psi	Content	Remarks
2364.5	3580	Gas+Condensate GOR=34545 SCF/BBL	Op. press. 800 psi
2401.5	3591	Gas+Condensate GOR=95950 SCF/BBL	
2408.7			Lost seal
2408.8			Lost seal
2409.3			Lost seal
2409.7			Lost seal
2435.0			Dry
2435.2			Dry
2435.3			Lost seal
2514.0	3625	Gas+Condensate GOR=34045 SCF/BBL	Op. press. 1400 psi
2514.0			Lost seal
2520.0	3629	Condensate + traces of water	Op. press. 0 psig
2525.5			Lost seal
2526.0	3630	Gas+Condensate GOR=83300 SCF/BBL	
2532.0	3636	Water+traces of Gas	Op. press. 25 psig
2533.5			Lost seal
2533.6			Lost seal
2535.4			Lost seal

All pressures are temperature corrected

6.5.4 Production Test

The Middle Jurassic Sandstone was perforated over the interval

2396.0 - 2402.0m RKB

with a 4" Hyper-Jet II Casing Gun. The perforation fluid was 9.5 pgg brine

The sequence of events during the test is given in table 6.12.

Table 6.12 Production test, sequence of events

Event	Time Period	Stab. Flow Rate, MMSCF/D	Choke Size inch	WHP, psi
1.Flow	22h 53m	10.2	24/64	2697
1.Shut-in	21h 17m			3000
2.Flow	6h 14m	12.2	24/64	2700
2.Shut-in	5h 37m			2875
3.Flow	7h 22m	22.7	40/64	2400
3.Shut-in	5h 10m			2900
4.Flow	8h 05m	27.0	51/64	2130
4.Shut-in	3h 20m			2872

After 11 hours of the initial flow period at approx. 10.2 MM SCF/D, the rate was slowly and stepwise increased. At 17-18 MM SCF/D the well had to be shut in, due to a build-up of hydrates in the surface test tree. Because of this problem it was decided to shut in the well after every stabilized flow rate for the rest of the test and inject glycol and methanol down hole during the shut-in periods to prevent the build-up of hydrates. Although this was done, the hydrate problem limited the highest flow rate to 27 MM SCF/D.

During the first flow period, the condensate gas ratio measured in the separator averaged ~~13 BBL/MMSCF~~. Later this value increased, probably as a result of the injection of huge amounts of glycol and methanol.

Fluid samples were regularly taken upstream of separator during the flow periods. No water was observed in these samples. After every flow period, fluid samples were taken at the bottom of the separator. These samples contained water, methanol and glycol. No sand production was observed at any stage of the test.

Six sets of gas and condensate samples for recombination were taken during the stabilized phase of the first flow period. For two examples, gas composition and some key parameters are listed in Table 6.13.

Table 6.13 Key parameters of the reservoir hydrocarbons

Gas composition. %	Set 4	Set 5
C1	84.75	85.21
C2	8.74	8.56
C3	3.39	3.23
iso-C4	0.51	0.47
n-C4	0.85	0.76
iso.C5	0.23	0.21
n-C5	0.22	0.19
C6	0.12	0.14
C7+	0.22	0.27
H2S	0	0
CO2	0.12	0.12
N2	0.01	0.01
Gas gravity (air=1.00)	0.673	0.669
Spec. gravity of condensate, g/cc:	0.794	0.794
GOR SCF/BBL approx.		78500

Due to the very rapid pressure stabilization after flow rate changes, no build-up or draw-down analyses can be done. The test was therefore analysed as a conventional deliverability test.

During the shut-in periods the bottom hole pressure averaged 3612 psi. In connection with the stabilized flow rates, the following flow pressures were measured:

Qg, MMscfd	pw, psi	ps2 - pw2
10.2	Fluctuating	
12.2	3609	21650
22.7	3605	51500
27.0	3603	64900

A graphical solution of the steady state radial gas flow, gives a permeability of

3.6 Darcies

using the data given above and the following constants:

h = 131 ft
= 0.018 cP) Standing
Zavg = 0.945) Standing
Tf = 648 R
re/rw = 10,000
S = 16) Completion skin, Brons & Maring.

From the same equation an open hole flow potential of 525 MM scfd was calculated. At this rate the pressure drop is mainly caused by the turbulence.