General information

Wellbore name	6406/11-1 S
Type	EXPLORATION
Purpose	WILDCAT
Status	P&A
Factmaps in new window	link to map
Main area	NORWEGIAN SEA
Discovery	6406/11-1 S
Well name	6406/11-1
Seismic location	DG M2-3D-90: ROW 243 & COL. 920
Production licence	156
Drilling operator	Saga Petroleum ASA
Drill permit	651-L
Drilling facility	TREASURE SAGA
Drilling days	123
Entered date	19.10.1990
Completed date	18.02.1991
Release date	18.02.1993
Publication date	30.06.2005
Purpose - planned	WILDCAT
Reentry	NO
Content	OIL
Discovery wellbore	YES
1st level with HC, age	MIDDLE JURASSIC
1st level with HC, formation	ILE FM
Kelly bushing elevation [m]	26.0
Water depth [m]	315.0
Total depth (MD) [m RKB]	4185.0
Final vertical depth (TVD) [m RKB]	4131.0
Maximum inclination [°]	28.8
Bottom hole temperature [°C]	150
Oldest penetrated age	LATE TRIASSIC
Oldest penetrated formation	RED BEDS (INFORMAL)
Geodetic datum	ED50
NS degrees	64° 2' 45.9'' N
EW degrees	6° 36' 14.16'' E
NS UTM [m]	7104524.70
EW UTM [m]	383011.32
UTM zone	32
NPDID wellbore	1539

Wellbore history

General

The well 6406/11-IS was drilled on a truncational/fault seal trap structure on the western slope of the Frøya High near the southern end of the Halten Terrace. The main objective of the well was to test the hydrocarbon potential in the Early to Middle Jurassic Fangst Group. Secondary objectives were to test the reservoir properties the underlying Tilje Formation, as well as possible sand development in the Tertiary. The well should also evaluate the source rock properties in the Early Jurassic Åre Formation. Planned total depth was 4526 m RKB TVD beneath a seismic marker interpreted as Triassic Evaporite. The well was the first well on a new block and the pressure prognosis was uncertain. Formation pressures were to be watched closely while drilling.

Operations and results

Wildcat well 6406/11-1 S was spudded with the semi-submersible installation Treasure Saga on 19 October 1990 and drilled to TD at 4185 m in the Late Triassic Red Beds. To avoid shallow gas the well was spudded and drilled deviated from a location 260 m NNW of the planned target location. During drilling the Nordland Group, two shallow gas intervals were penetrated at 893 - 897.5 m and 1148 - 1150 m. To get back to vertical drilling the well was deviated from 1235 m to 2165 m MD. Only minor problems occurred while drilling down to the 12 1/4" section. After drilling the 12 1/4" hole down to 3395 m, the VSP tool become stuck at 3383 m. A total of 5 days were spent recovering the wire line and miring the fish down. Only minor problems with tight spots occurred while drilling to TD.

Formation pressure was hydrostatic down to ca 1520 m, from where a gradual pressure build up was indicated in the Hordaland Group down through the Rogaland Group, estimated to a maximum of 1.60 g/cc EMW at 2400 m in the upper part of the Shetland Group. From here a slight pressure depletion down to approximately 3000 m was indicated. From 3000 m down to the Jurassic sandstones of the Fangst Group, increasing gas levels and decreasing sonic velocity indicated a new pressure build up. The pressure build up continues down to 3630.8 m in the Ile Formation where a maximum pressure gradient of 1.71 g/cc EMW was estimated on the basis of FMT recordings. High gas levels in the Åre Formation of the Båt Group indicate a possible new pressure build up towards the bottom of the well.

No significant sand development was seen in the Tertiary. The Fangst Group comprised shales of the Not Formation before penetrating the reservoir sands of the Ile Formation at 3599 m. The well drilled further through the Early Jurassic Båt Group comprising the Ror, Tilje and Åre Formations before penetrating the Triassic Grey Beds at 4134 m and Red Beds at 4149 m.

FMT pressure measurements showed a possible gas/condensate gradient over the Ile Formation. The first appearance of C2+ components in the mud gas readings came at 3599 m in the Ile Formation. Sands of the Ile Formation contained moderate to good oil shows. Sands of the Tilje Formations also had weak oil shows, and weak, intermittent oil shows were recorded from 4025 m to 4100 m in the Åre Formation. Organic geochemical analyses showed that mainly gas-prone source rocks were penetrated in the well. These are the Upper Jurassic Melke Formation shales, which have a fair gas potential (and some condensate), and coals and shales within the Ile, Ror, and Åre Formation. Coal in the Ile Formation may have some minor potential for waxy oil. The well is immature (Ro < 0.5 %) down to about 2500 m, moderately mature (Ro 0.5 - 0.6 %) down to 3600 m and peak oil mature (~ 0.8 %) at about 4100 m, remaining within the oil window to TD at 4188 m. The analyses further confirmed oil stain from migrant hydrocarbons in the interval 3600 m to 4100 m. Extracts, FMT oil, and DST3A oil from the Ile Formation all showed a very waxy composition. PVT analyses of the FMT oil

showed a pour point of 34 °C, bubble point pressure of 275 bar at 80 °C, and stock tank oil density of 0.8754 g/cm3. The GOR from single stage flash was 126.5 Sm3/Sm3.

Three segregated FMT fluid samples were taken in the Ile Formation, and the sample from 3694.3 m contained 1.5 litres of oil and 7 litres of water. In the Tilje and Åre Formations no reliable pressure measurements were obtained due to tight formation and hole conditions. As the planned DST of the Tilje Formation was cancelled a cased hole RFT-tool was run here, with the objective to obtain fluid samples. This sampling was not conclusive as the chambers contained mainly filtrate water. A total of 11 conventional cores were cut in the Ile and Ror Formations, recovering a total of 109.7 m core. A total of 113 sidewall cores were attempted and 73 were recovered.

The well was permanently abandoned on 18 February 1991 as a minor oil discovery.

Testing

3 DST tests were performed. Test 1 in the intervals 4027 - 4049 m and 4053 - 4060 m (Åre Formation) yielded 2 Sm3/d of water. Test 3A within the Ile Formation yielded 19 Sm3/d of waxy oil with formation water in the interval 3709 - 3723 m. Test 3B perforated the interval 3692 - 3705 m in addition to 3709 - 3723 m, and an immediate pressure increase followed. This test produced 610 Sm3/d water and no oil.

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Cuttings at the Norwegian Offshore Directorate

Cutting sample, top depth [m]	Cutting samples, bottom depth [m]
440.00	4184.00

Cuttings available for sampling?	YES

Cores at the Norwegian Offshore Directorate

Core sample number	Core sample - top depth	Core sample - bottom depth	Core sample depth - uom
1	3604.0	3605.5	[m]
2	3615.0	3623.8	[m]
3	3625.0	3637.7	[m]
4	3642.0	3649.2	[m]
5	3653.0	3664.0	[m]
6	3665.0	3683.8	[m]
7	3684.0	3692.2	[m]
8	3694.0	3712.0	[m]
9	3712.0	3721.0	[m]
10	3725.0	3728.5	[m]
11	3733.0	3747.0	[m]

Total core sample length [m]	112.7

Cores available for sampling?	YES

Core photos


3604-3618m


3618-3623m


3623-3629m


3629-3634m


3634-3646m


3646-3654m


3654-3659m


3659-3664m


3665-3670m


3670-3675m


3675-3680m


3680-3685m


3685-3690m


3690-3696m


3696-3701m


3701-3706m


3706-3711m


3711-3716m


3716-3721m


3725-3734m


3734-3739m


3739-3744m


3744-3747m

Palynological slides at the Norwegian Offshore Directorate

Sample depth	Depth unit	Sample type	Laboratory
607.5	[m]	SWC	STRAT
620.0	[m]	DC	STRAT
630.0	[m]	DC	STRAT
640.0	[m]	DC	STRAT
650.0	[m]	DC	STRAT
660.0	[m]	DC	STRAT
670.0	[m]	DC	STRAT
680.0	[m]	DC	STRAT
694.0	[m]	SWC	STRAT
700.0	[m]	DC	STRAT
710.0	[m]	DC	STRAT
720.0	[m]	DC	STRAT
730.0	[m]	DC	STRAT
740.0	[m]	DC	STRAT
750.0	[m]	DC	STRAT
760.0	[m]	DC	STRAT
770.0	[m]	DC	STRAT
780.0	[m]	DC	STRAT
790.0	[m]	DC	STRAT
800.0	[m]	DC	STRAT
810.0	[m]	DC	STRAT
820.0	[m]	DC	STRAT
830.0	[m]	DC	STRAT
842.0	[m]	SWC	STRAT
850.0	[m]	DC	STRAT
860.0	[m]	DC	STRAT
870.0	[m]	DC	STRAT
880.0	[m]	DC	STRAT
890.0	[m]	DC	STRAT
900.0	[m]	DC	STRAT
910.0	[m]	DC	STRAT
920.0	[m]	DC	STRAT
930.0	[m]	DC	STRAT
940.0	[m]	DC	STRAT
950.0	[m]	DC	STRAT
965.0	[m]	SWC	STRAT
980.0	[m]	DC	STRAT
990.0	[m]	DC	STRAT

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1040.0	[m]	DC	STRAT
1050.0	[m]	DC	STRAT
1060.0	[m]	DC	STRAT
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3999.0	[m]	DC	STRAT
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4035.0	[m]	DC	STRAT

4044.0	[m]	DC	STRAT
4053.0	[m]	DC	STRAT
4062.0	[m]	DC	STRAT
4071.0	[m]	DC	STRAT
4080.0	[m]	DC	STRAT
4089.0	[m]	DC	STRAT
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4152.0	[m]	DC	STRAT
4161.0	[m]	DC	STRAT
4170.0	[m]	DC	STRAT
4179.0	[m]	DC	STRAT
4179.0	[m]	DC	OD
4184.0	[m]	DC	STRAT
4185.0	[m]	DC	OD

Lithostratigraphy

Top depth [mMD RKB]	Lithostrat. unit
341	NORDLAND GP
341	NAUST FM
1191	KAI FM
1397	HORDALAND GP
1397	BRYGGE FM
2143	ROGALAND GP
2143	TARE FM
2190	TANG FM
2335	SHETLAND GP
2335	SPRINGAR FM
2371	NISE FM
2770	KVITNOS FM
3205	CROMER KNOLL GP
3205	LANGE FM
3370	LYR FM

3419	VIKING GP
3419	MELKE FM
3522	FANGST GP
3522	NOT FM
3599	ILE FM
3722	BÅT GP
3722	ROR FM
3787	TOFTE FM
3822	ROR FM
3871	TILJE FM
3985	ÅRE FM
4134	GREY BEDS (INFORMAL)
4149	RED BEDS (INFORMAL)

Composite logs

Document name	Document format	Document size [MB]
1539	pdf	0.54

Geochemical information

Document name	Document format	Document size [MB]
1539_1	pdf	3.60

Documents - older Norwegian Offshore Directorate WDSS reports and other related documents

Document name	Document format	Document size [MB]
1539_01_WDSS_General_Information	pdf	0.57
1539_02_WDSS_completion_log	pdf	0.22

Documents - reported by the production licence (period for duty of secrecy expired)

Document name	Document format	Document size [MB]
1539_6406_11_1_S_COMPLETION_LOG	pdf	2.56

1539_6406_11_1_S_COMPLETION_REPORT	pdf	15.41

Drill stem tests (DST)

Test number	From depth MD [m]	To depth MD [m]	Choke size [mm]
1.0	4027	4060	6.4
2.0	3709	3723	31.8
3.0	3692	3723	16.7

Test number	Final shut-in pressure [MPa]	Final flow pressure [MPa]	Bottom hole pressure [MPa]	Downhole temperature [°C]
1.0	1.000		51.000	141
2.0	2.000		35.000	134
3.0	2.300		37.000	139

Test number	Oil [Sm3/day]	Gas [Sm3/day]	Oil density [g/cm3]	Gas grav. rel.air	GOR [m3/m3]
1.0					
2.0	19				
3.0					

Logs

Log type	Log top depth [m]	Log bottom depth [m]
CDL CNL GR	3269	4183
CDL CNL GR	3408	3923
CDL CNL GR	3550	4125
COREGUN	495	1203
COREGUN	1560	2161
COREGUN	2453	3355
DIFL ACL CDL GR	448	1208
DIFL ACL CDL GR	1202	2164
DIFL ACL CDL GR	2148	3394
DIFL ACL GR	3269	4183
DIPLOG	3266	4173
DLL MLL GR	3562	3923
FMT	3599	3909

FMT	3650	3978
MWD RWD - GR RES DIR	341	4185
VSP	472	4160

Casing and leak-off tests

Casing type	Casing diam. [inch]	Casing depth [m]	Hole diam. [inch]	Hole depth [m]	LOT/FIT mud eqv. [g/cm3]	Formation test type
CONDUCTOR	30	449.0	36	454.0	0.00	LOT
INTERM.	20	1202.0	26	1218.0	0.00	LOT
INTERM.	13 3/8	2151.0	17 1/2	2165.0	1.72	LOT
INTERM.	9 5/8	3275.0	12 1/4	3395.0	1.92	LOT
OPEN HOLE		4185.0	8 1/2	4185.0	1.98	LOT

Drilling mud

Depth MD [m]	Mud weight [g/cm3]	Visc. [mPa.s]	Yield point [Pa]	Mud type	Date measured
934	1.13	5.0	20.0	WATER BASED	22.10.1990
1215	1.15	5.0	19.0	WATER BASED	24.10.1990
1215	1.16	6.0	21.0	WATER BASED	25.10.1990
1215	1.18	6.0	22.0	WATER BASED	26.10.1990
1215	1.15	5.0	20.0	WATER BASED	24.10.1990
1218	1.18	7.0	25.0	WATER BASED	29.10.1990
1218	1.18	7.0	25.0	WATER BASED	29.10.1990
1235	1.30	23.0	34.0	WATER BASED	29.10.1990
1920	1.52	28.0	40.0	WATER BASED	31.10.1990
2125	1.59	37.0	23.0	WATER BASED	01.11.1990
2165	1.61	36.0	13.0	WATER BASED	05.11.1990
2165	1.61	35.0	15.0	WATER BASED	05.11.1990
2165	1.61	34.0	18.0	WATER BASED	05.11.1990
2165	1.61	35.0	15.0	WATER BASED	06.11.1990
2297	1.66	30.0	13.0	WATER BASED	08.11.1990
2450	1.71	37.0	21.0	WATER BASED	09.11.1990
2636	1.71	30.0	21.0	WATER BASED	13.11.1990
2721	1.71	31.0	15.0	WATER BASED	13.11.1990
2827	1.71	31.0	17.0	WATER BASED	13.11.1990
2898	1.71	35.0	20.0	WATER BASED	14.11.1990
2992	1.71	37.0	19.0	WATER BASED	15.11.1990

3104	1.71	33.0	23.0	WATER BASED	15.11.1990
3159	1.71	34.0	22.0	WATER BASED	16.11.1990
3195	1.71	32.0	20.0	WATER BASED	20.11.1990
3244	1.71	28.0	17.0	WATER BASED	20.11.1990
3244	1.71	28.0	17.0	WATER BASED	20.11.1990
3295	1.71	29.0	21.0	WATER BASED	20.11.1990
3319	1.72	30.0	11.0	WATER BASED	10.12.1990
3319	1.72	30.0	11.0	WATER BASED	10.12.1990
3319	1.72	26.0	10.0	WATER BASED	10.12.1990
3319	1.72	30.0	10.0	WATER BASED	10.12.1990
3319	1.72	28.0	21.0	WATER BASED	12.12.1990
3319	1.72	32.0	18.0	WATER BASED	13.12.1990
3320	1.72	30.0	15.0	WATER BASED	14.12.1990
3324	1.72	30.0	18.0	WATER BASED	14.12.1990
3324	1.72	32.0	12.0	WATER BASED	18.12.1990
3324	1.72	30.0	18.0	WATER BASED	18.12.1990
3348	1.71	38.0	25.0	WATER BASED	22.11.1990
3389	1.71	32.0	19.0	WATER BASED	22.11.1990
3390	1.72	27.0	12.0	WATER BASED	18.12.1990
3395	1.71	34.0	19.0	WATER BASED	26.11.1990
3395	1.71	33.0	22.0	WATER BASED	26.11.1990
3395	1.71	31.0	18.0	WATER BASED	27.11.1990
3395	1.71	30.0	18.0	WATER BASED	28.11.1990
3395	1.72	36.0	21.0	WATER BASED	30.11.1990
3395	1.72	35.0	13.0	WATER BASED	05.12.1990
3395	1.72	36.0	16.0	WATER BASED	05.12.1990
3395	1.72	34.0	17.0	WATER BASED	05.12.1990
3395	1.72	35.0	19.0	WATER BASED	05.12.1990
3395	1.72	34.0	17.0	WATER BASED	10.12.1990
3395	1.71	33.0	21.0	WATER BASED	23.11.1990
3395	1.71	35.0	19.0	WATER BASED	26.11.1990
3395	1.72	35.0	12.0	WATER BASED	05.12.1990
3405	1.72	25.0	12.0	WATER BASED	19.12.1990
3455	1.72	26.0	10.0	WATER BASED	19.12.1990
3488	1.72	29.0	15.0	WATER BASED	21.12.1990
3532	1.72	30.0	14.0	WATER BASED	21.12.1990
3532	1.72	31.0	16.0	WATER BASED	02.01.1991
3532	1.72	32.0	16.0	WATER BASED	02.01.1991
3532	1.72	34.0	17.0	WATER BASED	02.01.1991
3532	1.72	36.0	18.0	WATER BASED	02.01.1991

3532	1.72	33.0	16.0	WATER BASED	07.01.1991
3532	1.72	27.0	12.0	WATER BASED	02.01.1991
3532	1.72	34.0	17.0	WATER BASED	04.01.1991
3576	1.72	29.0	12.0	WATER BASED	31.12.1990
3600	1.72	34.0	11.0	WATER BASED	07.01.1991
3600	1.76	40.0	12.0	WATER BASED	07.01.1991
3600	1.72	34.0	16.0	WATER BASED	07.01.1991
3615	1.72	28.0	11.0	WATER BASED	31.12.1990
3625	1.72	29.0	11.0	WATER BASED	31.12.1990
3653	1.72	29.0	10.0	WATER BASED	31.12.1990
3665	1.72	29.0	10.0	WATER BASED	31.12.1990
3684	1.72	29.0	11.0	WATER BASED	31.12.1990
3713	1.72	28.0	11.0	WATER BASED	31.12.1990
3875	1.81	28.0	17.0	WATER BASED	19.02.1991
3875	1.85	22.0	9.0	WATER BASED	19.02.1991
3945	1.78	26.0	10.0	WATER BASED	11.01.1991
3945	1.78	28.0	11.0	WATER BASED	11.01.1991
3945	1.78	29.0	14.0	WATER BASED	11.01.1991
3975	1.83	22.0	8.0	WATER BASED	08.02.1991
3975	1.83	23.0	8.0	WATER BASED	08.02.1991
3975	1.83	22.0	8.0	WATER BASED	08.02.1991
3975	1.83	23.0	8.0	WATER BASED	08.02.1991
3975	1.83	21.0	4.0	WATER BASED	11.02.1991
3975	1.83	22.0	9.0	WATER BASED	11.02.1991
3975	1.83	22.0	9.0	WATER BASED	11.02.1991
3975	1.83	22.0	8.0	WATER BASED	12.02.1991
3975	1.83	22.0	8.0	WATER BASED	14.02.1991
3975	1.84	22.0	10.0	WATER BASED	14.02.1991
4091	1.87	36.0	18.0	WATER BASED	15.01.1991
4091	1.81	36.0	18.0	WATER BASED	16.01.1991
4185	1.83	32.0	14.0	WATER BASED	17.01.1991
4185	1.83	28.0	10.0	WATER BASED	18.01.1991
4185	1.83	26.0	10.0	WATER BASED	18.01.1991
4185	1.83	25.0	8.0	WATER BASED	21.01.1991
4185	1.83	28.0	9.0	WATER BASED	21.01.1991
4185	1.83	24.0	10.0	WATER BASED	21.01.1991
4185	1.83	26.0	14.0	WATER BASED	24.01.1991
4185	1.83	22.0	8.0	WATER BASED	25.01.1991
4185	1.83	26.0	8.0	WATER BASED	28.01.1991
4185	1.83	25.0	8.0	WATER BASED	29.01.1991

4185	1.83	28.0	9.0	WATER BASED	29.01.1991
4185	1.83	28.0	9.0	WATER BASED	30.01.1991
4185	1.83	23.0	8.0	WATER BASED	01.02.1991
4185	1.83	23.0	8.0	WATER BASED	04.02.1991
4185	1.83	22.0	10.0	WATER BASED	04.02.1991
4185	1.83	22.0	10.0	WATER BASED	04.02.1991
4185	1.83	23.0	8.0	WATER BASED	06.02.1991
4185	1.83	22.0	10.0	WATER BASED	07.02.1991
4185	1.83	33.0	13.0	WATER BASED	16.01.1991
4185	1.83	22.0	8.0	WATER BASED	24.01.1991
4185	1.83	26.0	8.0	WATER BASED	29.01.1991
4185	1.83	22.0	9.0	WATER BASED	30.01.1991
4185	1.83	22.0	10.0	WATER BASED	04.02.1991

Pressure plots

The pore pressure data is sourced from well logs if no other source is specified. In some wells where pore pressure logs do not exist, information from Drill stem tests and kicks have been used. The data has been reported to the NPD, and further processed and quality controlled by IHS Markit.

Document name	Document format	Document size [MB]
1539_Formation_pressure_(Formasjonstrykk)	pdf	0.28