General information

Wellbore name	31/2-3
Type	EXPLORATION
Purpose	APPRAISAL
Status	P&A
Factmaps in new window	link to map
Main area	NORTH SEA
Field	TROLL
Discovery	31/2-1 (Troll Vest)
Well name	31/2-3
Seismic location	62-4421 SP.175
Production licence	054
Drilling operator	A/S Norske Shell
Drill permit	247-L
Drilling facility	BORGNY DOLPHIN
Drilling days	115
Entered date	28.03.1980
Completed date	20.07.1980
Release date	20.07.1982
Publication date	15.02.2006
Purpose - planned	APPRAISAL
Reentry	NO
Content	OIL/GAS
Discovery wellbore	NO
1st level with HC, age	LATE JURASSIC
1st level with HC, formation	SOGNEFJORD FM
2nd level with HC, age	MIDDLE JURASSIC
2nd level with HC, formation	FENSFJORD FM
Kelly bushing elevation [m]	25.0
Water depth [m]	334.0
Total depth (MD) [m RKB]	2601.0
Final vertical depth (TVD) [m RKB]	2600.0
Maximum inclination [°]	2.65
Bottom hole temperature [°C]	73
Oldest penetrated age	LATE TRIASSIC
Oldest penetrated formation	HEGRE GP
Geodetic datum	ED50
NS degrees	60° 50' 27.84'' N
EW degrees	3° 35' 10.82'' E

NS UTM [m]	6745386.82
EW UTM [m]	531872.26
UTM zone	31
NPDID wellbore	236

Wellbore history

General

Well 31/2-3 was drilled in the Troll West area, approximately 8 km NNE of the Troll Discovery well 31/2-1. The well was drilled to appraise the Troll Discovery. It should evaluate reservoir parameters along the axis of maximum gross hydrocarbon column; prove maximum hydrocarbon reserves in the major northern fault block; confirm the significance of the seismic flatspot as a direct hydrocarbon indicator; further assess the significance of the oil shows found in 31/2-1; and evaluate the influence of earlier Kimmerian fault movements on reservoir characteristics.

Operations and results

Appraisal well 31/2-3 was spudded with the semi-submersible installation Borgny Dolphin on 28 March and drilled to TD at 2601 m in Late Triassic sediments in the Statfjord Formation. Drilling took 115 days. The reason for the long drilling period was safety inspection of the rig as a result of the "Alexander Kielland" accident and a strike amongst the Norwegian rig crew. The well was drilled with bentonite and seawater down to 816 m and with a gypsum/lignosulphonate mud from 816 m to TD.

No potential reservoir zones were encountered above top Jurassic. The well confirmed that the Late Jurassic sandstone reservoir encountered in wells 31/2-1 and 2 was well developed also in this more northerly part of the structure. A gross gas column of 189 m was penetrated with top at 1384 m. The uppermost 120 m was in a good clean sand (Sognefjord Formation) while the lower part of the gas column was in a micaceous and poor reservoir sand (Heather and Fensfjord Formations). Below the gas a 12 m thick oil zone was encountered, the same thickness and at the same level as in well 31/2-2. In this well however, the oil was in a very micaceous and poorly developed reservoir. The reservoir was uncomformably overlain by Palaeocene claystones, which thus act as an effective seal for the reservoir. Below the OWC at 1585 no moveable hydrocarbons were seen in the well, but shows continued down to 1612 m and isolated shows were seen at 1630 m and at 1638 m.

The seismic Flatspot did coincide with the base of the gas column in well 31/2-3, supporting that the Flatspot indeed is a direct hydrocarbon indicator over the entire prospect.

Coring was performed in the Middle to Late Jurassic interval from 1412 m to 1645.5 m. Twenty-one cores with a total recovery of 194.4 m (84%) were cut. Coring started approximately 28 m below the top reservoir and continued well below the hydrocarbon/water contact. Prior to the full scale production test programme, a series of runs were made with the Schlumberger Repeat Formation Tester (RFT). A total of 10 RFT runs were made. The first run indicated pressure gradients very similar to those obtained in Wells 31/2-1 and 31/2-2. It was, however, impossible to confirm the 12-meter oil gradient indicated by RFT's in well 31/2-2. Sampling attempts in the water zone failed as only mud filtrate was recovered. In the suspected oil zone, no samples were obtained in spite of numerous attempts as the tool probe always plugged in the relatively tight and poorly consolidated formation. Only two gas samples were obtained, at 1458 m and 1568.5 m.

The well was permanently abandoned on 20 July 1980 as a gas and oil appraisal well.

Testing

Four Production Tests were conducted in the Middle to Late Jurassic. PT1 tested the interval 1600.5 m to 1605.5 m in the water zone, PT2 tested the interval 1577.5 m to 1582.5 m in the oil zone, PT3 tested the interval 1520 m to 1535 m in the micaceous part of the gas bearing section, and PT4 tested 1435 m to 1460 m in the top clean sand of the gas section.

After the bottom hole test valve was opened for the test in the water zone, the well flowed for 17 minutes until it died. Some 87.5 litres of formation water (70.000 ppm NaCl equivalent) were recovered.

In the oil zone test (PT2) the well came in at a low rate and flowed at about 4.5 - 6.6 Sm3/day for four days. The oil was about 24 deg API and the GOR around 36 Sm3/Sm3. The micaceous gas zone test (PT3) stabilized at a rate of about 142000 Sm3/day on 28/64" choke during the clean up period. The produced fluids were gas of gravity 0.617 (air = 1) and condensate of 50.3 API, with some water (mostly brine) and traces of sediment. The gas contained no detectable H2S and approximately 0.4% C02. Sequential rate tests followed where the rates continuously improved up to 923000 Sm3/day. The test was terminated while production rates were still increasing. The reason for the increasing rates was assumed to be development of a channel behind the casing creating communication with the better sand some 10 meters above the top of the perforations. The clean sand gas test was performed with a gravel pack completion. Severe turbulence effects dominated it. After the initial clean up at 368000 - 481000 Sm3/day flow rate, the well produced at maximum rate of about 1133000 Sm3/day. The fluids had similar composition as in PT3.

Temperatures measured during the test gave a formation temperature of 60 - 62 deg C in the gas-bearing section of the reservoir. This corresponds to a linear temperature gradient from seafloor to top reservoir of ca 50 deg C, which is very high for the area.

Cuttings at the Norwegian Offshore Directorate

Cutting sample, top depth [m]	Cutting samples, bottom depth [m]
460.00	2599.00

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	1412.0	1415.5	[m]
2	1421.0	1425.0	[m]
3	1425.0	1441.0	[m]
4	1443.0	1449.3	[m]
5	1450.0	1461.2	[m]
6	1462.4	1467.8	[m]
8	1469.2	1473.0	[m]
9	1473.0	1475.0	[m]

10	1484.5	1496.4	[m]
11	1496.4	1514.5	[m]
12	1514.5	1529.6	[m]
13	1533.0	1540.9	[m]
14	1551.0	1564.5	[m]
15	1564.5	1566.5	[m]
16	1566.6	1584.3	[m]
17	1584.0	1599.7	[m]
18	1601.0	1619.3	[m]
19	1619.0	1623.9	[m]
20	1624.0	1627.7	[m]
21	1628.0	1645.4	[m]
22	2116.0	2133.9	[m]

Total core sample length [m]	216.4
Cores available for sampling?	YES

Core photos


1412-1414m


1414-1416m

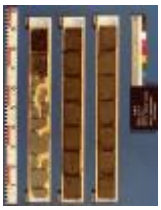

1421-1423m


1423-1425m


1425-1427m


1427-1430m


1430-1433m


1433-1435m

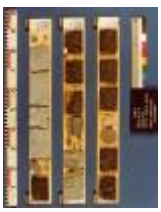

1435-1438m


1438-1441m


1443-1445m


1445-1448m


1448-1449m


1450-1452m


1452-1455m


1455-1458m


1458-1460m


1460-1461m


1462-1463m


1469-1471m

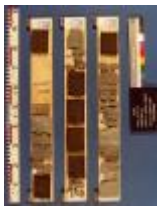

1471-1473m


1473-1475m


1484-1487m

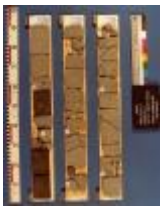

1487-1489m


1489-1492m


1492-1495m


1495-1496m


1496-1499m


1499-1501m


1501-1504m


1504-1507m


1507-1509m


1509-1512m


1512-1514m


1514-1517m


1517-1519m


1519-1522m


1522-1525m


1525-1528m


1528-1529m


1533-1535m


1535-1538m


1538-1540m


1551-1553m

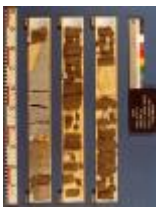

1553-1556m


1556-1559m


1559-1561m


1561-1564m


1564-1566m


1566-1569m


1569-1572m


1572-1574m


1574-1577m


1577-1580m


1580-1582m


1582-1584m


1584-1586m


1586-1589m


1589-1592m


1592-1594m


1594-1597m


1601-1603m


1603-1606m


1606-1609m


1609-1611m


1611-1614m


1614-1617m


1617-1619m


1619-1621m


1621-1623m


1624-1626m


1626-1627m


1628-1630m


1730-1633m

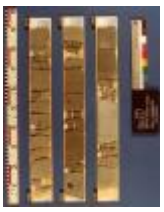

1633-1636m


1636-1638m


1638-1641m


1641-1644m


1644-1645m


2116-2118m


2118-2121m


2121-2124m


2126-2129m


2129-2132m


2132-2133m

Oil samples at the Norwegian Offshore Directorate

Test type	Bottle number	Top depth MD [m]	Bottom depth MD [m]	Fluid type	Test time	Samples available
DST	DST1	1577.00	1582.00	WATER	06.06.1980 - 20:00	YES

Lithostratigraphy

Top depth [mMD RKB]	Lithostrat. unit
359	NORDLAND GP
643	HORDALAND GP
1145	ROGALAND GP
1145	BALDER FM
1200	SELE FM
1242	LISTA FM
1374	VÅLE FM
1384	VIKING GP
1384	SOGNEFJORD FM
1508	HEATHER FM
1561	FENSFJORD FM
1677	KROSSFJORD FM
1755	HEATHER FM

1812	BRENT GP
1902	DUNLIN GP
1902	DRAKE FM
2010	COOK FM
2055	AMUNDSEN FM
2097	JOHANSEN FM
2176	AMUNDSEN FM
2236	STATFJORD GP
2358	HEGRE GP

Composite logs

Document name	Document format	Document size [MB]
236	pdf	0.45

Geochemical information

Document name	Document format	Document size [MB]
236_1	pdf	1.29
236_2	pdf	0.51

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

Document name	Document format	Document size [MB]
236_01_WDSS_General_Information	pdf	0.15
236_02_WDSS_completion_log	pdf	0.18

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

Document name	Document format	Document size [MB]
236_01_31_2_3_Completion_Report	pdf	35.06
236_02_31_2_3_Completion_log	pdf	1.29
236_31_2_3_Biostratigraphy_appendix	pdf	2.43
236_31_2_3_Bottom_hole_press.calc	pdf	0.44

236_31_2_3_Core_description_core_1-21	pdf	10.79
236_31_2_3_Core_report_core_1-22_final_report	pdf	10.10
236_31_2_3_Form.testing_services_report_DST1	pdf	0.36
236_31_2_3_Formation_survey_analysis	pdf	0.06
236_31_2_3_Geochem_eval_of_source_rock	pdf	0.44
236_31_2_3_Geochem_eval_of_source_rock_encl_1	pdf	0.12
236_31_2_3_Geological_investigation_cores_vol_3	pdf	139.86
236_31_2_3_Geological_investigation_cores_vol_1	pdf	17.61
236_31_2_3_Geological_Investigation_cores_vol_2	pdf	20.73
236_31_2_3_Palynofacies_invest_on_the_Jurassic	pdf	6.05
236_31_2_3_Press.surv.rep_test1_run3	pdf	1.25
236_31_2_3_Press.surv.rep_test2_run1	pdf	0.77
236_31_2_3_Press.surv.rep_test2_run2	pdf	1.51
236_31_2_3_Press.surv.rep_test3_run1	pdf	1.22
236_31_2_3_Press.surv.rep_test3_run2	pdf	1.66
236_31_2_3_Press.surv.rep_test3_run3	pdf	1.43
236_31_2_3_Press.surv.test1_run1	pdf	0.60
236_31_2_3_Press.surv.test_clean_sand	pdf	0.84
236_31_2_3_Prod.test sampling	pdf	0.54
236_31_2_3_Production_test	pdf	1.97
236_31_2_3_Production_test_programme	pdf	2.69
236_31_2_3_PVT_study_on_b.h.sample	pdf	0.50
236_31_2_3_Rapport_fra_prod.test	pdf	1.12
236_31_2_3_Res.fliud_study	pdf	0.32
236_31_2_3_Res.fliud_study_2	pdf	0.71
236_31_2_3_Res.fluid_analysis_80167	pdf	0.35
236_31_2_3_Res.fluid_analysis_80167B	pdf	0.34
236_31_2_3_Res.fluid_analysis_80168	pdf	0.33
236_31_2_3_Res.fluid_analysis_80169	pdf	0.34
236_31_2_3_Res.fluid_analysis_81.12	pdf	0.56
236_31_2_3_Res.fluid_analysis_91.13	pdf	0.28
236_31_2_3_Res.fluid_study_80090	pdf	0.20
236_31_2_3_Res.fluid_study_80091	pdf	0.23
236_31_2_3_Res.fluid_study_by_Sintef	pdf	0.38
236_31_2_3_Rock_mineral_analysis	pdf	0.14

236_31_2_3_Sidewall_sample_description	pdf	0.69
236_31_2_3_Sieve_analysis	pdf	2.60
236_31_2_3_Test_information_micace	pdf	0.75
236_31_2_3_Well_summary_by_Anchor	pdf	2.06
236_31_2_3_Well_testing_data_sheet	pdf	2.29
236_31_2_3_Well_test_interpretation	pdf	11.20
236_31_2_3_Well_test_report_DST1_DST2	pdf	6.07
236_31_2_3_Well_test_report_gas_no1	pdf	5.32
236_31_2_3_Well_test_report_gas_no1_micaceous	pdf	9.81
236_31_2_3_Well_test_report_gas_no2	pdf	3.63
236_31_2_3_Well_test_report_gas_no2_annexes	pdf	6.10
236_31_2_3_Facies_inndeling_basert_paa_logg	pdf	1.31

Drill stem tests (DST)

Test number	From depth MD [m]	To depth MD [m]	Choke size [mm]
1.0	1575	1580	0.0
2.0	1552	1557	6.4
3.0	1495	1510	50.8
4.0	1410	1435	38.1

Test number	Final shut-in pressure [MPa]	Final flow pressure [MPa]	Bottom hole pressure [MPa]	Downhole temperature [°C]
1.0				
2.0				
3.0				
4.0				

Test number	Oil [Sm3/day]	Gas [Sm3/day]	Oil density [g/cm3]	Gas grav. rel.air	GOR [m3/m3]
1.0					
2.0	14	560	0.910		40
3.0		914000			
4.0		1133000			

Logs

Log type	Log top depth [m]	Log bottom depth [m]
CBL	350	1816
CBL	630	1352
CST	1	0
CST	2	0
CST	3	0
DLL MSFL GR	1352	1824
FDC CNL GR CAL	445	818
FDC CNL GR CAL	803	1367
FDC CNL GR CAL	1352	1824
FDC CNL GR CAL	1817	2590
HDT	1352	1819
HDT	1817	2596
ISF BHC GR SP	445	814
ISF BHC GR SP	803	1368
ISF BHC GR SP	1352	1821
ISF BHC GR SP	1817	2593
LSS GR	445	816
LSS GR	803	1364
LSS GR	1352	1819
LSS GR	1817	2594
RFT	1387	1750

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	420.0	36	425.0	0.00	LOT
SURF.COND.	20	779.0	26	789.0	1.43	LOT
INTERM.	13 3/8	1328.0	17 1/2	1339.0	1.55	LOT
INTERM.	9 5/8	1791.0	12 1/4	1798.0	1.74	LOT
LINER	7	2576.0	8 1/2	2576.0	0.00	LOT

Drilling mud

Depth MD [m]	Mud weight [g/cm3]	Visc. [mPa.s]	Yield point [Pa]	Mud type	Date measured
789	1.31	54.0		seawater	
1338	1.32	60.0		seawater	
1433	1.28	52.0		seawater	
1941	1.18	52.0		seawater	
2267	1.19	48.0		seawater	

Thin sections at the Norwegian Offshore Directorate

Depth	Unit
1414.40	[m]
1432.80	[m]
1443.45	[m]
1450.20	[m]
1471.25	[m]
1486.90	[m]
1492.80	[m]
1505.10	[m]
1534.35	[m]
1540.40	[m]
1553.70	[m]
1558.45	[m]
1563.90	[m]
1565.65	[m]
1568.65	[m]
7574.45	[m]
1574.45	[m]
1579.86	[m]
1585.79	[m]
7586.92	[m]
1586.92	[m]
1590.54	[m]
1599.08	[m]
1609.86	[m]
1615.50	[m]
1623.24	[m]
1628.12	[m]
1414.00	[m]

1433.00	[m]
1443.00	[m]
1450.00	[m]
1471.00	[m]
1487.00	[m]
1493.00	[m]
1505.00	[m]
1513.00	[m]
1523.00	[m]
1534.00	[m]
1540.00	[m]
1554.00	[m]
1558.00	[m]
1564.00	[m]
1566.00	[m]
1569.00	[m]
1575.00	[m]
1580.00	[m]
1586.00	[m]
1587.00	[m]
1628.00	[m]

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]
236_Formation_pressure_(Formasjonstrykk)	pdf	0.22