General information

Wellbore name	16/1-28 S
Type	EXPLORATION
Purpose	APPRAISAL
Status	RE-CLASS TO DEV
Press release	link to press release
Factmaps in new window	link to map
Main area	NORTH SEA
Discovery	16/1-12 Troldhaugen
Well name	16/1-28
Seismic location	LN12 M02 R16 /inline 3648. xline 3094
Production licence	338 C
Drilling operator	Lundin Norway AS
Drill permit	1687-L
Drilling facility	COSLInnovator
Drilling days	134
Entered date	03.04.2018
Completed date	23.08.2018
Plugged date	23.08.2018
Release date	23.08.2020
Publication date	23.08.2020
Purpose - planned	APPRAISAL
Reclassified to wellbore	16/1-CA-1 H
Reentry	NO
Content	OIL
Discovery wellbore	NO
1st level with HC, age	PRE-DEVONIAN
1st level with HC, formation	BASEMENT
Kelly bushing elevation [m]	25.0
Water depth [m]	108.0
Total depth (MD) [m RKB]	4880.0
Final vertical depth (TVD) [m RKB]	1918.0
Maximum inclination [°]	91.2
Bottom hole temperature [°C]	80
Oldest penetrated age	PRE-DEVONIAN
Oldest penetrated formation	BASEMENT
Geodetic datum	ED50
NS degrees	58° 48' 51.49'' N
EW degrees	2° 16' 14.28'' E

NS UTM [m]	6519754.15
EW UTM [m]	457869.23
UTM zone	31
NPDID wellbore	8357

Wellbore history

General

Well 16/1-28 S was drilled to appraise the 16/1-12 Rolvsnes Discovery on the Utsira High in the North Sea. The objective was to verify pressure communication within the reservoir and determine possible depletion resulting from production from the Edvard Grieg Field. Further objectives were to prove the drillability of a 2.5 km long horizontal well within granitic basement, and to perform a production test to better understand the reservoir performance.

Operations and results

Appraisal well 16/1-28 S was spudded with the semi-submersible installation COSL Innovator on 3 April and a 36 “x 42” was drilled to 200 m. A 9 7/8” pilot was drilled from 200 to 780 m due to shallow gas warnings. No shallow gas was observed. Hole instability problems were encountered in the 12 ¼” section, from 1742 to 2186 m, and this section was unintentionally side-tracked at 1978 m while reaming. The side-track, 16/1-28 ST2, was drilled to final TD at 4880 m (1919 m TVD) in granite basement rock. The well was drilled vertical down to 957 m, building angle from there to ca 2410 m, from where the well was drilled horizontally. A union strike delayed the DST operations with approximately 11 days. The well was drilled with seawater and hi-vis pills down to 957 m, with Aquadril mud from 957 m to 1734 m, with Delta TEQ oil-based mud from 1734 m to 2180 m, and with Performadril mud from 2180 m to TD.

Basement was encountered at 2335.5 m (1908.8 m TVD) and well TD was reached at 4880 m (1919.0 m TVD). A total horizontal section of 2500 m in basement was drilled with an average penetration rate of 9.9 m/h. 65 pressure measurements were attempted, the successful tests showed a depletion of about 10 bars, which can be the result of production from the Edvard Grieg Field. Good oil shows were recorded throughout the fractured granitic reservoir from 2336.5 to 4880 m, otherwise no shows were described in the well.

Due mainly to wellbore instability issues, no cores or sidewall cores were taken in wellbore 16/1-28 ST2. This restricted the amount of petrographic data acquired to evaluate the degree and type of alteration of the basement rock. Fluid samples were taken during the DST

The well was permanently abandoned on 23 August 2018 as an oil appraisal.

Testing

The well was formation-tested (DST) for ten days. The well was tested from intervals separated by swell packers over the whole reservoir section below 2417 m and production logging was carried out. The maximum production rate was 1100 Sm3 oil per flow day through a 52/64” nozzle opening. The main flow period of 5 days was held with a rate of 650 Sm3 oil per day through a 52/64” nozzle opening. The oil is undersaturated with a gas/oil ratio of 130 Sm3/Sm3. The DST temperature at Gauge depth 1852.4 m TVD was 77.6°C.

Cuttings at the Norwegian Offshore Directorate

Cutting sample, top depth [m]	Cutting samples, bottom depth [m]
970.00	2186.00

Cuttings available for sampling?	YES

Lithostratigraphy

Top depth [mMD RKB]	Lithostrat. unit
133	NORDLAND GP
133	NO FORMAL NAME
730	UTSIRA FM
923	NO FORMAL NAME
992	HORDALAND GP
992	NO FORMAL NAME
1010	SKADE FM
1175	NO FORMAL NAME
1529	NO FORMAL NAME
1626	GRID FM
1704	NO FORMAL NAME
1809	ROGALAND GP
1809	BALDER FM
1820	SELE FM
1860	LISTA FM
1996	VÅLE FM
2036	SHETLAND GP
2036	EKOFISK FM
2110	TOR FM
2233	HOD FM
2283	CROMER KNOLL GP
2283	SOLA FM
2288	ÅSGARD FM
2336	BASEMENT
2336	SHETLAND GP
2336	EKOFISK FM
2768	UNDIFFERENTIATED
2807	BASEMENT
3030	UNDIFFERENTIATED

3050	BASEMENT
4050	UNDIFFERENTIATED
4060	BASEMENT
4267	UNDIFFERENTIATED
4295	BASEMENT

Drill stem tests (DST)

Test number	From depth MD [m]	To depth MD [m]	Choke size [mm]
0.0	2093	0	20.7

Test number	Final shut-in pressure [MPa]	Final flow pressure [MPa]	Bottom hole pressure [MPa]	Downhole temperature [°C]
0.0				77

Test number	Oil [Sm3/day]	Gas [Sm3/day]	Oil density [g/cm3]	Gas grav. rel.air	GOR [m3/m3]
0.0	600	77000			130

Logs

Log type	Log top depth [m]	Log bottom depth [m]
MWD LWD - GR PWD RES DIR AC	176	1734
MWD LWD - NBRES NBINC NBGR	1649	2186
MWD LWD - NBRES NBINC NBGR	1649	2186
MWD LWD - PWD RES GR DIR	131	957
MWD LWD - RES PWD GR DIR CAL DEN	1649	2186

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	199.3	36	200.0	0.00	
PILOT HOLE		780.0	9 7/8	780.0	0.00	
SURF.COND.	20	957.1	26	965.0	1.56	FIT
INTERM.	13 3/8	1733.6	17 1/2	1742.0	1.65	FIT

LINER	11 3/4	1836.0		0.0	0.00	
LINER	9 5/8	2162.7	12 1/4	2180.0	1.40	FIT
OPEN HOLE		4880.0	8 1/2	4880.0	0.00	

Drilling mud

Depth MD [m]	Mud weight [g/cm3]	Visc. [mPa.s]	Yield point [Pa]	Mud type	Date measured
199	1.39	23.0		AQUA-DRILL WBM	
200	1.03			Seawater	
200	1.25	16.0		AQUA-DRILL WBM	
200	1.50	19.0		AQUA-DRILL WBM	
469	1.03			Seawater	
469	1.25	16.0		AQUA-DRILL WBM	
560	1.03			Seawater	
560	1.50	16.0		AQUA-DRILL WBM	
560	1.25	16.0		AQUA-DRILL WBM	
727	1.03			Seawater	
727	1.25	16.0		AQUA-DRILL WBM	
965	1.41	27.0		AQUA-DRILL WBM	
965	1.25	16.0		AQUA-DRILL WBM	
965	1.03			Seawater	
1107	1.45	25.0		AQUA-DRILL WBM	
1742	1.03	24.0		AQUA-DRILL WBM	
1742	1.45	24.0		CARBO-SEA	
1757	1.42	27.0		CARBO-SEA	
2050	1.45	24.0		CARBO-SEA	
2090	1.48	29.0		DELTA-TEQ	
2100	1.11			Other	
2127	1.50	32.0		DELTA-TEQ	
2151	1.45	29.0		CARBO-SEA	
2156	1.11	1.0		PACKER-FLUID	
2156	1.11	1.0		Inhibited Brine	
2180	1.09	17.0		PERFLOW CM	
2180	1.03			Seawater	
2180	1.11			Inhibited KCL/NaCL	
2180	1.11			Other	
2180	1.50	31.0		DELTA-TEQ	
2186	1.48	29.0		DELTA-TEQ	

2186	1.45	30.0		Other	
2186	1.45	26.0		CARBO-SEA	
2195	1.10	14.0		PERFLOW CM	
2493	1.09	13.0		PERFLOW CM	
3002	1.09	13.0		PERFLOW CM	
4072	1.09	16.0		PERFLOW CM	
4471	1.09	20.0		PERFLOW CM	
4880	1.10			PACKER-FLUID	
4880	1.10	9.0		SFSCRF	
4880	1.09	20.0		PERFLOW CM	