statoil

WATER ANALYSIS 34/10-17

DST 1

STATOIL
EXPLORATION & PRODUCTION LABORATORY

by

Reidun Kleven

Oct-83 LAB 83.41

Prepared Approved

Den norske stats oljeselskap a.s

statoil
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Classification

Requested by

Jon Hanstveit

Subtitle

Co-workers

Helga Bårdsen

Title

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18.10.83 Reidun Kleven

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18.10.83 D.Malthe-Sørenssen

9.03.21 A

1. INTRODUCTION

Statoil Production Laboratory (PROLAB) was asked to analyse formation water from well 34/10-17. The interval tested was 2880-2890 meters. Prolab received twelve plastic bottles with water sampled within short time intervals.

After flowing the well for 8 hr the fluid produced was assumed to be formation water. These water samples were stored in 2 x 25 l plastic bottle and called number twelve in this report. One of these samples (25 l) were acidified offshore with HCl.

Prolab has analysed four of the water samples from the flowing well, time interval for the samples was 2 hr. West Lab has performed the water analysis of sample number twelve and compositional analysis of the suspended solids in these sample.

2. SAMPLE DESCRIPTION

The sample description is to be found in table 1 and Appendix 1.

3. METHODS OF ANALYSIS USED BY PROLAB

The samples were filtrated through 0.45 µm millipore filters and stabilized by adding concentrated nitric acid (1:1000) prior to the ionic analysis.Most of the analysis were carried out according to ASTM methods, using atomic absorbtion spectroscopy.

The following ions were determined by wet chemistry techniques.

Ions	Methods
Cl^- (including Br^- and I^-)	ASTM D512
HCO_3-, $CO_3$2-, OH^-	ASTM D513 C
$SO_4$2-	ASTM D516

Total dissolved solids (TDS) were determined by summation of the ions or drying the residue at 120°C over night. This value was compared with the TDS-values correlated from density. Density was measured by PAAR 401 densiometer. Conductivity was determined by using a Phillips conductivity meter PW 9501/01. These measurements were done at carefully controlled temperatures. The measured conductivity value was compared with the conductivity calculated from "the equivalent NaCl-concentration" (table 4) found by using the variable multipliers method from Schlumberger Gen 8 Log Interpretation Charts (1978 ed). Relative standard deviation, RSD, was determined on every measured value

$$RSD = s/\bar{x} \cdot 100\% \quad \text{where} \quad \bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}, \; x_i \; (i=1 \ldots n)$$

is measured values in n independent measurements

$$\text{and, } s = \left[\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1} \right]^{1/2}$$

4. RESULTS

Table 1 gives a sample description and table 2 gives the results of the water analysis. In table 3 the concentration of the ion is given in epm. Table 4 gives the estimated ion strength in "equivalent NaCl-concentration" used in the calculated value of the conductivity. The ion analysis of the most representative formations water sample is to be found in table 5.

Appendix 1 shows the sample details from the testoperator. Appendix 2 is the wellsite water analysis from Core Lab. Appendix 3 is the analysis of the formation water (sample no. 12) and compositional analysis of suspended solid performed by West Lab.

5. DISCUSSION

Ion analysis indicated that after a short period of production time, the fluid produced was pure formation water. Ion analysis of the produced water showed increasing salinity in the water from 0510 to 1310hrs. The absence of SO_4^{2-} in the sample produced 1040hrs indicated no invasion of mudfiltrate in the produced water at that time.

A good correlation between the calculated and measured total dissolved solids and the conductivity in the formation water was obtained as can be seen from table 2, indicating a complete ion analysis. The method used for measuring total dissolved solids was summation of the analysed ions. Drying the residue at $120^{o}C$ over night caused problem with uncontrolled boiling in the solutions. In addition the temperature was not high enough to remove the water from ($CaCl_2 + 2H_2O$.) These results are therefore not presented in this report. The ion analysis of formation water performed by Prolab was in good agreement with the water analysis performed by West Lab.

6. CONCLUSION

The most representative formation water sample is sample no 12. This sample was acidified offshore to prevent precipitation of salt.

The result of the ion analysis of the formation water is to be found in table 5.

REFERENCES

1) CRC Handbook of chemistry and Physics 60th edition page D-261.

2) Schlumberger Log inter pretation chart 1978 edition.

Table 1. Sample description of the formation water 34/10-17 DST no 1.

Sample no.	Time	Depth (m)	Colour
2	05.40		Brown, containing particles.
6	07.10	2934 to 2944	Yellow, small amount of particles.
10	1040		lean yellow
12	1310		lean yellow, no particles

Table 2. Results of ion analysis of water samples from well 34/10-17

No sample	2	6	10	12[a]	
time hrs.	05.40	07.40	10.40	13.10	RSD %
Density (20°C)	1.021	1.022	1.021	1.021	0.1
PH (20°C)	7.78	7.92	7.95	8.13	1
Conductivity mmho/cm (20°C)	45.77	45.82	46.03	46.16	1
Conductivity correlated from equivalent NaCl conc[b]	45.5	44.5	46.5	46.0	
ION	concentration mg/l				
Na^+	11580	10850	12250	11900	4
K^+	95	110	75	270	2
Mg^{2+}	98	95	98	96	1
Ca^{2+}	679	705	701	701	1.5
Ba^{2+}	<2	68	36	72	6
Mn^{n+}	0	0	0	0	4
Si^{n+}	32	34	35	29	2
Sr^{2+}	53	55	56	55	1.5
Cr^{n+}	0	0	0	0	
Fe^{n+}	42	29	29	26	2
Zn^{2+}	2	2	1	1	4
Cl^-	19039	18799	19142	18902	1
SO_4^{2-}	7	2	0	0	1
HCO_3^-	1098	1220	976	1098	1
CO_3^{2-}	0	0	0	0	1
OH^-	0	0	0	0	1
Sum ions	32725	31969	33399	33150	
TDS.correlated from density v/20°C	32700	32800	32700	32700	

a) Sample no.12 is later refered to as the formation water.

b) Cfr. table 4.

Table 3 **Data from table 2 given in epm.**

Element	Sample 2	Sample 6	Sample 10	Sample 12
Na^+	503.7	472	532.9	517.7
K^+	2.4	2.8	1.9	6.9
Mg^{2+}	8.1	7.8	8.1	7.9
Ca^{2+}	33.9	35	35	35
Ba^{2+}	0	1.0	0.5	1.0
Fe^{n+}	1.5	1.0	1.0	0.9
Mn^+	0	0	0	0
Si^{n+}	4.9	5.0	4.2	4.6
Sr^{2+}	0.6	0.6	0.6	0.6
Cr^{n+}	0	0	0	0
Zn^{2+}	0	0	0	0
Cl^-	537.1	530.3	540	533.2
SO_4^{2-}	0.2	0	0	0
HCO_3^-	18	20	16	18
CO_3^{2-}	0	0	0	0
OH^-	0	0	0	0
Sum anion/cation	555.3/555.1	550.3/525.2	556/584.2	551/574.4

Table 4. **A transformation of ionic concentrations from table 2 into "equivalent NaCl"-concentration (mg/ℓ).**

No sample		2	6	10	12
ion	factor		eqvivalent NaCl		
Cl^-	1	19039	18900	19142	18902
HCO_3^-	0.25	275	305	244	275
Na^+	1	11580	10850	12250	11900
K^+	0.92	88	101	69	248
Mg^{2+}	1.4	137	133	137	134
Ca^{2+}	0.8	543	564	501	561
Si^{n+}	1	32	34	35	29
Sr^{2+}	0.4	21	22	22	22
Fe^{n+}	1[a)]	42	29	29	26
Ba^{2+}	0.3	0	20	11	22
SUM		31757	30958	32500	32119

a) The factor is not to be found in ref 1 and approximately set equal 1.

Table 5. Results of ion analysis of formation water from well 34/10-17.

		RSD %
Density (20°C)	1.021	0.1
pH (20°C) (measured)	8.13	1
pH measured offshore	7.0	1
Conductivity (mmho/cm)	46.16	
Conductivity (mmho/cm) correlated from equivalent NaCl conc.	46.0	

ION	Concentration mg/l	
Na^+	11900	4
K^+	270	2
Mg^{2+}	96	1
Ca^{2+}	701	1.5
Ba^{2+}	72	6
Mn^{n+}	0	4
Si^{n+}	29	2
Sr^{2+}	55	1.5
Cr^{n+}	0	
Fe^{n+}	26	2
Zn^{2+}	1	4
Cl^-	18902	1
SO_4^{2-}	0	1
HCO_3^-	1098	1
Co_3^{2-}	0	
OH^-	0	

Appendix 1

CORE LABORATORIES UK LTD.
Petroleum Reservoir Engineering
ABERDEEN, SCOTLAND

SAMPLE DETAILS:

WELLSITE WATER ANALYSIS

COMPANY: Statoil A/S LOCATION: Offshore Deep Sea Bergen

WELL NO: 34/10-17 STATE: Norway

FIELD: WILDCAT FILE NUMBER: SCL 152/11

SAMPLE NO:	DST	DATE:	TIME:	SAMPLED FROM:	REMARKS.
A1 A11	1	31.5.83	1300	ACTIVE PIT	FILTRATE TESTED
B	1	31.5.83	1800	DRILL FLOOR	CUSHION
1	1	2.6.83	0509	CHOKE MANIFOLD	PRODUCED FLUIDS (GEL CONTAMINATED
2	1	2.6.83	0540	CHOKE MANIFOLD	CONTAMINATED FORMATION WATER
3	1	2.6.83	0613	CHOKE MANIFOLD	"
4	1	2.6.83	0640	CHOKE MANIFOLD	"
5	1	2.6.83	0710	CHOKE MANIFOLD	"
6	1	2.6.83	0740	CHOKE MANIFOLD	"
7	1	2.6.83	0810	CHOKE MANIFOLD	"
8	1	2.6.83	0840	CHOKE MANIFOLD	CONTAMINATED FORMATION WATER
9	1	2.6.83	0940	CHOKE MANIFOLD	FORMATION WATER
10	1	2.6.83	1040	CHOKE MANIFOLD	FORMATION WATER
11	1	2.6.83	1140	CHOKE MANIFOLD	FORMATION WATER
12	1	2.6.83	1310	CHOKE MANIFOLD	FORMATION WATER
			1310	"	3 x 1l acidified
			[illegible]	"	1 x 0.5l acidified
			1245-57	"	1 x 2.5l acidified
			1300-15	"	1 x 2.5l

UPSTREAM PRESSURE 42 Bar (APPROX)
TEMPERATURE 75°C (APPROX)

Appendix 2

CORE LABORATORIES UK LTD.
Petroleum Reservoir Engineering
ABERDEEN, SCOTLAND

WELLSITE WATER ANALYSIS

COMPANY: Statoil A/S LOCATION: Deep Sea Bergen

WELL NO: 34/10-17 STATE: Norway

FIELD: WILDCAT FILE NUMBER: SCL 152/11

Drill Stem Test No: 1

Interval Tested: 2934 2944 meters.

Sample No:	6	7	8	9	10
Sample From:	CHOKE MANIFOLD				
Time, hrs:	0740	0810	0840	0940	1040
Date:	2/6/83	2/6/83	2/6/83	2/6/83	2/6/83
~~Barrels~~/ Strokes					
Specific Gravity @ 60/60°F.	1025	1025	1025	1025	1026
Resistivity, ohm-metres @ 60°F	0 242	0 251	0 251	0 241	0 252
NaCl Equivalent, mg/l:	33000	32000	32000	33000	32000
Chloride, mg/l	18550	19250	17400	1·50.	18800
Chloride as NaCl, mg/l:	30570	31720	28670	32120	30980
pH:	7·0	7 1	7 0	7·0	7·0
Bicarbonate mg/l:	1030	1060	1090	1000	1060
Carbonate mg/l:	NIL	NIL	NIL	NIL	NIL
Hydroxide mg/l:	NIL	NIL	NIL	NIL	NIL
Sulphate mg/l:	15	17	17	NIL	NIL
Barium mg/l:	85	85	95	80	82
Iron mg/l:	14	12	13	25	11

CORE LABORATORIES UK LTD.
Petroleum Reservoir Engineering
ABERDEEN, SCOTLAND

WELLSITE WATER ANALYSIS

COMPANY: Statoil A/S LOCATION: Deep Sea Bergen

WELL NO: 34/10-17 STATE: Norway

FIELD: WILD CAT FILE NUMBER: SCL 152/11

Drill Stem Test No:			
Interval Tested:			
Sample No:	11	12	12
Sample From:	CHOKE MANIFOLD		Repeated @ 20°C
Time, hrs:	1160	1310	
Date:	2/6/83	2/6/83	
Barrels/ Strokes			
Specific Gravity @ 60/60°F.	1.025	1.024	1.025
Resistivity, ohm-metres @ 60°F	0.250	0.251	0.244
NaCl Equivalent, mg/l:	32000	32000	33000
Chloride, mg/l	18550	19020	19080
Chloride as NaCl, mg/l:	30570	31340	31440
pH:	6.9	7.0	7.0
Bicarbonate mg/l:	1010	940	950
Carbonate mg/l:	NIL	NIL	NIL
Hydroxide mg/l:	NIL	NIL	NIL
Sulphate mg/l:	NIL	NIL	2
Barium mg/l:	75	85	90
Iron mg/l:	9	2.5	10
		Tot Fe	12

Appendix 3

WEST·LAB AS
Analytical Services

Statoil.

Tananger 6/7-83.

Report : Statoil-02.

Analysis of formation
water. And compositional
analysis of suspended
solids.

Att : R. Kleven.

WEST·LAB AS
Analytical Services

Costomer: Statoil/P. Kleven.	Sample No: B	Date Sampled: 2/6-83, 12.57-13.10
Field:	Legal description:	Job no: Statoil-02

Lease or Unit:	Well:	Depth:	Formation:	Rate B/D:

Type of Water (Produced, supply, etc.) Formation.	Sampling Point	Sampled by

Remarks (Any other relevant information)

Sample labeled : 34/10-17. DST 1.

DISSOLVED SOLIDS:

CATIONS	mg/l	me/l
Sodium, Na (meas.)	10.800	470
Calcium, Ca	806	40
Magnesium, Mg	90	7
Barium, Ba	67	1
Iron, Fe	0,2	-
Strontium	52	1
Potassium	354	9
ANIONS		
Cloride, Cl	19.741	556
Sulfate, SO_4	2	-
Carbonate, CO_3	0	-
Bicarbonate HCO_3	826	14
Hydroxide	0	-
Total Dissolved Solids (calc.)	32.738	mg/l

OTHER PROPERTIES:

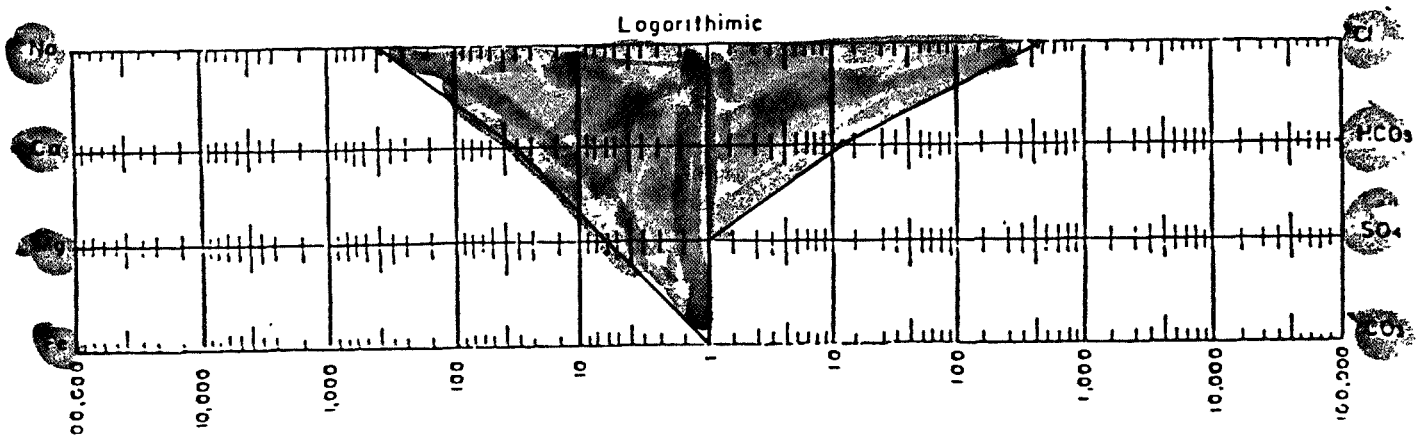
pH	7,41	20°C
Specific Gravity.	1,026	
Resistivity (ohm-meters)	0,214	20°C
Sulfide as H_2S mg/l		
Suspended solids mg/l	125,37	

REMARKS & RECOMMENDATIONS

PO_4 (ortho) : 1,0 mg/l

Analyses by: T.F. / B.E.B.

WATER PATTERNS _____ me/l



WEST·LAB AS
Analytical Services

Costomer: Statoil/P. Kleven.	Sample No: A	Date Sampled: 2/6-83, 12.45 hrs.
Field:	Legal description:	Job no: Statoil-02
Lease or Unit:	Well: / Depth: / Formation:	Rate B/D:
Type of Water (Produced,supply,etc.) Formation.	Sampling Point	Sampled by
Remarks (Any other relevant information) Sample labeled : 34/10-17. DST 1.		

DISSOLVED SOLIDS:

CATIONS	mg/l	me/l
Sodium,Na(meas.)	11.900	517
Calcium,Ca	764	38
Magnesium,Mg	110	9
Barium,Ba	64	1
Iron,Fe	21	1
Strontium	53	1
Potassium	346	9
ANIONS		
Cloride,Cl	20.798	586
Sulfate,SO_4	13	-
Carbonate,CO_3	0	-
*) Bicarbonate HCO_3		
Hydroxide	0	-
Total Dissolved Solids(calc.)	34.069	mg/l

OTHER PROPERTIES:

pH	2,34	20°C
Specific Gravity.	1,026	
Resistivity(ohm-meters)	0,206	20°C
Sulfide as H_2S mg/l		
Suspended solids mg/l	84,59	

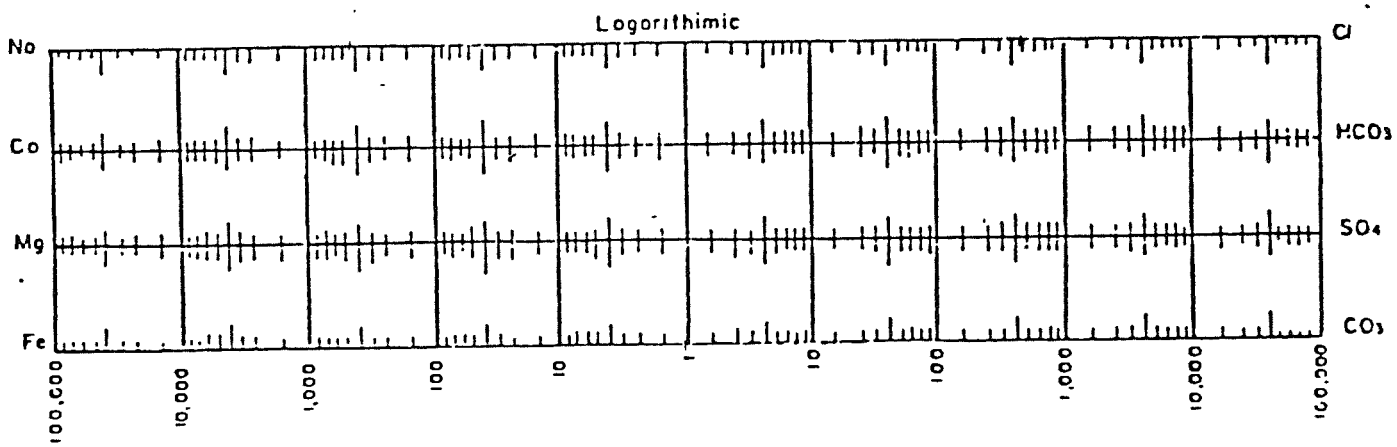
REMARKS & RECOMMENDATIONS

PO_4 (ortho) : 1,1 mg/l

*) Alkanity was not possible because of added acid.

Analyses by: T.F. / B.E.B.

WATER PATTERNS _____ me/l



WEST·LAB AS
Analytical Services

Report : Statoil-02.

ANALYSIS OF SUSPENDED SOLIDS.

Sample no.: A. Sample labeled : 34/10-17. DST 1. Taken 2/6-83, 12.45 hrs.

Element	Weight% of ash.	Most probable chem form	weight%
Inorganics. Sulphur,S.	6,64		
Zinc,Zn.	0,06	ZnO	0,08
Barium,Ba.	25,20	$BaSO_4$	42,90
Silicon,Si.	7,29	SiO_2	15,60
Iron,Fe.	1,09	Fe_2O_3	1,55
Magnesium,Mg.	0,19	$MgCO_3$	0,68
Aluminium,Al.	1,29	Al_2O_3	2,44
Calcium,Ca.	1,23	$CaCO_3$	3,07
Sodium,Na.	8,30	NaCl	21,10
Strontium,Sr.	0,42	$SrSO_4$	0,86
Potassium,K.	0,56	KCl	1,07
Phosphorus,P.	< 0,01		
Manganese,Mn.	< 0,01	MnO	
Lead,Pb.	< 0,01	PbO	
Boron,B.	< 0,01		
Tin,Sn.	< 0,01	SnO	
Titanium,Ti.	< 0,01	TiO_2	
Chromium,Cr.	< 0,01		
Organics: Wt. loss on ignition/500°C Organics by difference % weight	Weight % of tot. sample. 53,90		

Remarks:

Acid insolubles have been treated by carbonate fusion and analysed by plasma emission spectrometry.

100% sample = Ash + Organics.

Ash = element oxides.

WEST·LAB AS
Analytical Services

Report : Statoil-02.

ANALYSIS OF SUSPENDED SOLIDS.

Sample no.: F. Sample labeled : 34/10-17. DST 1. Taken 2/6-83, 12.57 - 13.10 hrs.

Element	Weight% of ash.	Most probable chem form,	weight%
Inorganics. Sulphur,S.	0,44		
Zinc,Zn.	0,28	ZnO	0,34
Barium,Ba.	2,09	$BaSO_4$	3,55
Silicon,Si.	6,71	SiO_2	14,40
Iron,Fe.	39,50	Fe_2O_3	56,50
Magnesium,Mg.	0,18	$MgCO_3$	0,63
Aluminium,Al.	0,31	Al_2O_3	0,59
Calcium,Ca.	2,50	$CaCO_3$	6,23
Sodium,Na.	6,30	NaCl	16,00
Strontium,Sr.	0,26	$SrSO_4$	0,54
Potassium,K.	0,34	KCl	0,65
Phosphorus,P.	< 0,01		
Manganese,Mn.	< 0,01	MnO	
Lead,Pb.	< 0,01	PbO	
Boron,B.	< 0,01		
Tin,Sn.	< 0,01	SnO	
Titanium,Ti.	< 0,01	TiO_2	
Chromium,Cr.	< 0,01		
Organics: Wt. loss on ignition/500°C Organics by difference % weight	Weight % of tot. sample. 59,10		

Remarks:

Acid insolubles have been treated by carbonate fusion and analysed by plasma emission spectrometry.

100% sample = Ash + Organics.

Ash = element oxides.