4.2.3 OTHER DATA

4.2.3.1 Mud characteristics

After the 9 5/8" casing had been set in the Upper Jurassic shales, the mud was changed to a BSX type mud. The mud is based on seawater with added NaCl and polymers. The NaCl salinity varied from 167 g/l at top reservoir, to 134 g/l when logging. The API water loss was 5.6 cc. Even though no major mud losses were reported during coring/drilling of the reservoir, the filtrate invasion is expected to be significant due to the high water loss value.

At the same time as the mud system was changed, radioactive tracers were added to the mud. This was done in order to "trace" the mud filtrate in an RFT sample / water DST. The tracer used was tritiated water (HTO) with a mean concentration in the mud of 329 Bq/ml. The HTO level in the mud was constantly monitored and adjusted by qualified personnel until the liner had been set. This method of labelling the mud proved very successful. Ref IFE (Institutt for Energiteknikk) report no. IFE/KR/F-89/117.

Summary of mud characteristics:

R_m	=	0.070 ohm-m @ 22 °C
R_{mf}	=	0.069 ohm-m @ 20 °C
R_{mc}	=	0.090 ohm-m @ 16 °C
Density	=	1.13 g/cc
Viscosity	=	56 s
pH	=	10.3
Fluid loss	=	5.6 cm^3
Salinity	=	134 g/l
Barite content	<	1%
Potassium	=	0%

4.3 RFT measurements

An RFT tool equipped with Strain gauge, HP crystal gauge and 2 3/4 + 1 gal sample chambers was run in the well. A total of 24 measurements were attempted, out of which only nine pressure points are considered valid formation pressures. A table listing all key information is given below:

Depth (mRKB)	Depth (mMSL)	HP gauge pressures Hydrostatic (BARA)	HP gauge pressures Formation (BARA)	Strain gauge pressures Hydrostatic (BARA)	Strain gauge pressures Formation (BARA)	Mobility ratio (mD/cP)	Comments
3188.6	3164.5	357.33	320.38	357.0	320.3	25	Good
3188.6	3164.5	357.27	320.34	356.2	319.4	~25	2 3/4 & 1 gal samples
3190.3	3166.2	357.42	320.80	357.0	320.5	~12	Supercharged
3190.4	3166.3	357.43	320.87	357.0	320.6	12	Supercharged
3191.7	3167.6	357.61	321.45	357.1	321.1	1.2	Supercharged
3193.2	3169.1	357.75	321.38	357.2	321.1	1.7	Supercharged
3196.0	3171.9	358.09	-	357.6	-	-	Dry test
3196.4	3172.3	358.14	320.88	357.6	320.6	61	Good
3197.3	3173.2	358.19	320.92	357.7	320.7	171	Good
3199.0	3174.9	358.38	321.08	357.8	320.8	263	Good
3200.1	3176.0	358.54	321.13	357.9	320.8	~150	Good
3204.2	3180.1	359.00	321.86	358.3	321.2	4.3	Supercharged
3205.0	3180.9	359.05	321.96	358.5	321.5	2.9	Supercharged
3207.8	3183.7	359.30	322.29	358.9	321.7	~3	Supercharged
3208.0	3183.9	359.37	322.39	359.4	322.2	2.1	Supercharged
3208.2	3184.1	359.45	322.31	359.0	322.0	~3	Supercharged
3208.4	3184.3	359.48	322.37	359.0	322.0	~5	Supercharged
3208.6	3184.5	359.48	322.45	359.1	322.1	~2	Supercharged
3213.5	3189.4	360.02	323.12	359.1	322.5	1.8	Supercharged
3214.0	3189.9	360.01	323.15	360.3	323.2	1.8	Supercharged
3218.5	3194.4	360.53	323.22	359.7	322.7	2.3	Supercharged
3220.0	3195.9	360.66	323.0	360.4	323.4	~6	Good ?
3223.0	3198.9	361.00	323.41	360.6	323.1	20	Good
3226.0	3201.9	361.38	323.7	360.9	323.3	~250	Good

A large amount of the points seem to be supercharged. This is clearly linked to the drawdown pressure and the mobility ratio (permeability/viscosity ratio).

Some of the formation pressures oscillate between two values on the HP gauge. The variation in pressure is as high as 0.17 bar in the worst case (3220 mRKB). These oscillations were only seen on good points, none of the supercharged points exhibited this behaviour. This introduces some additional uncertainty to these points.

The strain gauge showed some strange responses on the second half of the survey. This gauge has not been used for interpretation.

A segregated sample was taken in the top good sand at 3188.6 mRKB. Both chambers were filled. The 2 3/4 gallon chamber was opened at surface. This chamber contained water and traces of oil. Analysis performed by IFE showed that the recovered water contained 94% mud filtrate. The 1 gallon chamber was sent to Geco lab for analysis. This sample contained only water and some gas (GWR = 1.7 Sm^3/m^3). IFE analysis proved a filtrate content of 89 - 98.6%. It is not possible to conclude whether a small amount of formation water was recovered or not during the RFT sampling, as there is an uncertainty range as regards the level of radioactive tracers in the mud.

4.4 Drillstem testing

4.4.1 DST 1A

4.4.1.1 Introduction, summary

The perforated interval was 3222.0 - 3228.0 mRKB, in the good sand in the water zone. The objectives with the test were:

- obtain representative water samples
- productivity / permeability
- reservoir boundaries / heterogeneities

The well was successfully cleaned up, but due to compatibility problems between sea water and formation water, scaling appeared on the jet pump. This blocked the pump completely, and the test string had to be pulled. The scaling increased gradually, which slowly choked down the flow until it stopped. Hence, no interpretation is possible.

4.4.1.2 Programme

Due to the low formation pressure (equivalent gradient to surface = 1.02 g/cc), a jet pump was to be set in the string to lift the water to surface. The pump is set and retrieved by wireline. Fluid is pumped into the test string annulus at surface, and is ejected through a nozzle inside the pump pointing upwards. A mixture of power fluid and pumped fluid is then produced through the tubing.

The initial programme was:

- pumping flow; monitor level of radioactive tracers on surface until readings are low and stable, indicating that only formation water and power fluid is flowing.
- close LPR and perform build-up
- pull jet pump
- displace tubing volume with diesel
- open LPR, allowing clean formation water to flow into the tubing
- when flow has stopped, RIH with bottomhole samplers
- reverse circulate tubing volume while taking water samples

The programme had to be aborted when the jet pump plugged. As the pump could not be pulled by wireline, the testing string was pulled, and the remainder of the programme was transferred to DST 1B.

4.4.1.3 Sequence of main events

15/06/89	13:45	Start pumping in the annulus (approx. 180 litres/min)
	21:45	Production rate starts dropping as the first sea water reaches the pump.
	22:45	Production rate equals pumping rate. Stop pumping.
	23:02	Restart pumping.
	23:35	Stop pumping due to low flowrate returns.
	23:37	Close LPR-NR
16/06/89	00:47	Attempted to pull pump, no success.
	02:30	2. attempt to pull pump, no success.
	08:12	4. attempt unsuccessful
	08:35	Open LPR-NR
17/07/89	00:00	Numerous attempts to pull pump, no success. Will attempt bottomhole sampling.
	13:10	Displace tubing with diesel.
	15:35	Open well.
	18:22	RIH with bottomhole samplers.
	23:20	BH samples at surface, contained only brine. LPR had been closed by a mistake, so the flow was just a U-tubing from the annulus.
18/07/89	00:00	Pull testing string

4.4.1.4 Radioactive tracer level

The level of radioactive tracers was monitored continuously at surface. Some samples were analyzed on site (with a time lag of around 1 hour), and several samples were analyzed onshore at a later stage. A plot of radioactivity level vs. time is given in fig. 4.6.

This plot shows that the well was probably cleaned up after a cumulative production of 60 m^3 formation water (i.e. 10 m^3 / m perforations)

4.4.1.5 Equipment

Two Geoservices (Terratek) and two Flopetrol (FHPR-A) gauges were set in bundle carriers in the string. Both Flopetrol gauges and one Geoservices gauge read tubing pressure, one Geoservices gauge read annulus pressure. All four gauges performed well.

4.4.2 DST 1B

4.4.2.1 Introduction, summary

DST 1B was planned as a production test for sampling purposes, followed by an injection test, over the same perforated interval as DST 1A (3222.0 - 3228.0 mRKB). The objectives with the test were:

- obtain representative water samples
- water zone injectivity
- secure productivity / permeability data (from fall-off data) due to problems with DST 1A

Good representative water samples were obtained, both bottomhole and at surface when reverse circulating. Filtered sea water was injected at several increasing rates in three different flow periods. Data from three fall-off periods are available for interpretation. Throughout the test, a decrease in pressure (increase in injectivity) was seen with time, probably due to microfracturing in the reservoir. Injectivity index from the last flow period (400 m^3/d) was 2.0 $m^3/d/bar$.

4.4.2.2 Programme

Since DST 1A was aborted without obtaining formation water samples, this part of the programme for DST 1A was added to the beginning of DST 1B.
The programme was:

- displace tubing with diesel
- flow formation water into tubing
- sample bottomhole
- reverse out tubing volume
- inject seawater filtered to $2*10^{-6}$ m at 4 rates: 75, 150, 250 and 400 m^3/d, each for 3 hrs
- perform a fall-off of 5 hrs

This programme was slightly changed as the test progressed, due to the special problems of microfracturing. These changes are described in the next chapter.

4.4.2.3 Sequence of main events

19/06/89	22:05	Pump diesel into tubing
	23:15	Open well
20/06/89	01:40	Recovered 11.5 m^3, close well
	03:20	Pump diesel into tubing
	04:48	Open well
	07:45	Recovered 12.7 m^3, close well
	09:25	RIH with 4 bottom hole samplers
	15:35	RIH with 4 more bottomhole samplers due to failure of two samplers on previous run.
	22:51	Reverse out tubing contents
21/06/89	00:51	Start to inject treated seawater at a rate of 70 m^3/d
	02:30	Increase rate to 75 m^3/d
	03:50	Increase rate to 135 m^3/d
	06:55	Increase rate to 200 m^3/d
	15:40	Close well for 1. fall-off
	18:04	Inject treated seawater at a rate of 300 m^3/d
	20:00	Close well for 2. fall-off
	22:04	Inject treated seawater at a rate of 400 m^3/d
22/06/89	00:05	Close well for 3. and final fall-off

4.4.2.4 Equipment

Two Geoservices (Terratek) and two Flopetrol (FHPR-A) gauges were set in bundle carriers in the string. Both Flopetrol gauges and one Geoservices gauge read tubing pressures. One Geoservices read annulus pressure. All four gauges performed well.

4.4.2.5 Injection rates and pressures

Flow no:	1	2	3	4	5
Injection rate, m^3/d:	75	135	200	300	400
WHP (end of flow), bara:	233	239	189	203	201
BHP (end of flow), bara:	556	565	512	524	518
BHP - WHP (end of flow), bar:	323	326	323	321	317
Injectivity index, $m^3/d/bar$:	0.3	0.6	1.1	1.5	2.1

4.4.2.6 Sampling

A total of 8 bottomhole samples (Flopetrol PSTE-C / PSTE-T) on two runs were attempted. On the first run, two of the sample chambers had not fired. One of them was opened to confirm that the content was clean formation water. On the second run, all four samplers contained formation water. Again, one sample was opened to confirm the contents. IFE analysis on radioactivity proved that the samples contained 100% clean formation water.

When reversing out the tubing volume, 5 litre samples were taken every 1 m^3. Most of these samples (the ones in the middle) are also non-contaminated by filtrate.

The results from the extensive analysis programme performed on these water samples are presented in chapter 4.6.

4.4.3 DST 2

4.4.3.1 Introduction, summary

DST 2 was perforated in the interval 3196.0 - 3201.0 mRKB. The objectives with the test were:

- determine mobile phases in this interval
- acquire valid oil samples
- determine productivity / permeability and possible boundaries

Both oil and water flowed in the test. The surface watercut (q_w / [q_w + q_o]) during the initial flow was 0.22. Representative oil samples were taken from the separator. The effective oil permeability is 5-600 mD.

4.4.3.2 Programme

- clean-up flow at high rate (6 hours)
- sampling flow at low rate (8 hours) while sampling from separator
- main flow at intermediate rate (10 hours)
- build-up (30 hours)
- bottomhole oil sampling

This programme was changed as the test progressed, mainly due to the high watercut. These changes are described in the next chapter.

4.4.3.3 Sequence of main events

27/06/89	00:08	Displace tubing with diesel cushion in order to have a differential pressure of 50 bar when opening
	02:00	Open well on 16/64" choke
	02:10	Increase choke to 22/64"
	05:38	First PVT sample set (safety set): 1 oil, 2 gas
	08:16	Decrease choke to 16/64"
	12:20	Second PVT sample set: 1 oil, 2 gas
	14:05	Third PVT sample set: 1 oil, 2 gas
	17:00	Shut in well downhole
28/06/89	08:40	Finish build-up

Due to the high watercut, the main flow, half of the build-up and the bottomhole sampling were removed from the testing programme.

4.4.3.4 Equipment

Two Geoservices (Terratek) and one Flopetrol (FHPR-A) gauges were set in bundle carriers in the string. All gauges read tubing pressures. One of the Geoservices gauges failed and produced unusable data.

4.4.3.5 Flow and pressure data

Flow:	Clean-up	Sampling
Choke, in	22/64	16/64
Oil rate, Sm^3/d:	202	74
Water rate, m^3/d:	56	16
Surface water cut ($q_w / [q_o + q_w]$):	0.22	0.17
Downhole water cut ($q_w / [B_o \times q_o + q_w]$):	0.14	0.11
GOR, Sm^3/Sm^3:	168	174
Flowing pressure (P_{wf}), bara:	306.6	314.9
Wellhead pressure, bara:	83.3	88.2
Wellhead temperature, °C:	24.7	19.7
Separator pressure, bara:	19.4	12.9
Separator temperature, °C:	49.8	44.8

During the first flow period, the separator was not able to handle all the water, so some of the water was carried on through the oil line. The water rate computations are uncertain due to this problem and other measurement problems.

4.4.3.6 Sampling

A total of three PVT sample sets were taken from the separator, each consisting of one oil bottle (600 cc) and two gas bottles (20000 cc each). The sampling was done by qualified personnel from Petrotech. The first set is not completely representative due to the unstable separator and flow conditions. The other two sets are sampled under stable conditions and should both be representative. All three PVT sets have been analyzed at PVT labs, and the results are presented in chapter 4.6.

Three 200 litre drums were filled with dead oil.

No bottomhole sampling was done due to the presence of water.

Water samples were taken from separator, and have been analyzed.

4.6 Fluids

4.6.1 OIL

Three PVT sample sets were taken from the separator during DST 2. The first set was analyzed at Geco in Stavanger, and the second and third set were analyzed at the Elf PVT lab in Boussens, France. The first sample is considered less representative than the two last sets, due to the uncertain GOR (unstable separator conditions). The results presented here are those from the Elf PVT lab on the two last sets.

Flash conditions: 321 bar, 109.9 °C to 13 bar, 44 °C to 1 bar, 15 °C

Bubble point pressure at 110 °C:	237 bara
Compressibility at bubble point:	365 x 10^{-6} $m^3/m^3/bar$
Compressibility at BHP (321 bara):	261 x 10^{-6} $m^3/m^3/bar$
Gas/oil ratio:	193.9 Sm^3/Sm^3
B_o at BHP (321 bara), single flash:	1.6167 m^3/Sm^3
Density at BHP (321 bara):	0.6382 g/cm^3
Density at 15 °C:	0.8265 g/cm^3
Viscosity at BHP (321 bara):	0.275 g/cm^3

A reservoir engineering summary of the PVT results is added in appendix 6.

4.6.2 WATER

Water samples have been taken

- Downhole (DST 1)
- At surface (DST 1) when reversing out
- At separator (DST 2)

All types of samples have been analyzed by Petrotech or Elf (France). The analysis results are fairly consistent with each other. Water from DST 1 seems to be identical to water from DST 2. The retained analysis results are taken from the analysis performed by Petrotech on two bottomhole samples:

CATIONS	
Barium (Ba)	235 mg/l
Calcium (Ca)	637
Iron (Fe)	14.4
Potassium (K)	248
Magnesium (Mg)	137
Sodium (Na)	16900
Strontium (Sr)	159
ANIONS	
Chloride (Cl)	26800
Sulphate (SO_4)	5
Bicarbonate (HCO_3)	936
Total dissolved solids (calc.)	46100
OTHER PROPERTIES	
pH (20 °C)	6.2
Density (60 °F)	1.033 g/cm^3
Resistivity (25 °C)	0.145 ohm-m
Suspended solids	187 mg/l

The conductivity was measured on all Petrotech samples as a function of temperature. This function is a linear relationship, i.e. a straight line may be extrapolated beyond 100 °C to obtain resistivity at the reservoir temperature. A plot of conductivity vs. temperature of the bottomhole samples analyzed at Petrotech is given in fig. 4.18. An extrapolation gives:

R_w = 0.053 ohm-m @ 106.1 °C

société nationale elf aquitaine (production)

EP/S/EXP/Lab.n° 91/17RP Pau, January, 1991

WELL 25/5-2

(NORWAY)

GEOCHEMICAL FOLLOW-UP STUDY OF JURASSIC ROCK EXTRACTS AND DST OIL AND GAS.

EP/S/EXP/Lab.n° 91/17RP

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LEGENDS OF TABLES AND FIGURES OF ORGANIC INVENTORY ANALYSES : ABBREVIATIONS, UNITS AND CUT OFFS

SAMPLE TYPE : ND=unwashed cuttings; DE=cuttings washed on site.......... [the ND are washed and the DE are washed anew in the laboratory]
CA=core; CL=sidewall core; TE=outcrop; BO=mud; XX=other or undetermined
IR : Insoluble residue after HCl attack (% weight of rock)

TOC : Total organic carbon (% weight of rock) .... [measured with Rock Eval+TOC analyser or LECO]
IOC : Insoluble organic carbon in chloroform (% weight of rock) Id.
OC : Organic carbon (total or insoluble)

X-RAY DIFF. : ALBite ; ORThoclase ; ANHydrite (or chlorite/kaolinite) ; QuaRtZ ; CALcite ; DOLomite ; SIDerite ; uNDosed (% weight of rock)

ROCK EVAL ANALYSIS

Carried out on : .... [generally not performed if OC< .3%]
RT : Total rock
RI_RT : Insoluble residue after HCl attack
RE : Rock extracted with chloroform
RI_RE : Rock extracted with chloroform, and after HCl attack

Measured parameters : .... [# : result not given because meaningless; <S : lower than the detection threshold]
Tmax : Temperature of S2 peak (°C) .... [meaningless if S2 small]
S1 : Free hydrocarbons in the rock (mgHC/g of rock) ...... [meaningless if the analysis is performed on the extracted rock]
S2 : Hydrocarbons yielded by pyrolysis (mgHC/g of rock)
S3 : CO2 yielded by pyrolysis (mg CO2/g of rock)

Calculated parameters :
PI : Production Index= S1/(S1+S2) .... [# : meaningless if S1 and S2 < .2]
HI : Hydrogen Index = (S2/OC)x100 (mg HC/g OC)
OI : Oxygen Index = (S3/OC)x100 (mg CO2/g OC) .. [to be used with caution for analyses carried out on RT or RE if OC < 2%;
IO>170 : mineral contribution to S3 peak]

EXTRACT ANALYSIS

EOM: extractable organic matter with chloroform (% per weight of rock) .... [<S if lower than .01 %]
Normalized composition of the extract (% EOM) ....[generally not performed if EOM < .03 %]
SAT: Saturated hydrocarbons
ARO: Aromatic hydrocarbons
POL: Polar compounds (Resins+Asphaltenes)
HC: SAT+ARO (mg HC/g of rock)

Q1: Contaminations or cavings, affecting the Rock Eval and TOC analyses | I=high; M=medium; F=low;
Q2: Contaminations or cavings, affecting the organic extract | N=null or not detected; U=unknown

Follow-up

TABLE: 1 25/5-2

DESCRIPTION OF ANALYSED SAMPLES AND ORGANIC CARBON CONTENT

LAB. REF.	SAMPLE TYPE	DEPTHS Metres	IR %	TOC %	IOC %	LITHOLOGY
B22535	CL	2080.00 2090.00	87.3	.42		SHALE GREY
B22536	CL	2192.00 2200.00	62.0	.17		SHALE GREY, CALCAREOUS, INT. ANHYDRITE
B22537	CL	2300.01	90.7	.39		SHALE GREY
B22538	CL	2431.01	85.8	.62		SHALE GREY
B22539	CL	2455.01	86.9	.90		SHALE GREY
B22498	ND	2780.00	20.5	.14		LIMESTONE GREY
B22540	CL	2785.01	83.5	.48		SHALE GREY, SILTY CALCAREOUS
B22500	ND	2860.00	32.8	.20		LIMESTONE GREY
B22541	CL	2906.01	81.7	.23		SHALE GREY, SILTY, CALCAREOUS
B22502	ND	2940.00	48.2	.28		MARL GREY
B22505	ND	2970.00	71.0	.41		SHALE GREY, SILTY, CALCAREOUS
B22506	ND	3010.00	82.6	4.63		SHALE DARK GREY-BLACK
B22542	CL	3010.01	90.0	7.00		SHALE DARK GREY-BLACK
B22507	ND	3020.00	91.7	7.44		SHALE DARK GREY-BLACK
B22543	CL	3020.01	86.2	8.02		SHALE DARK GREY-BLACK
B22508	ND	3030.00	90.6	7.62		SHALE DARK GREY-BLACK
B22509	ND	3040.00	91.5	6.16		SHALE DARK GREY-BLACK
B22544	CL	3040.01	88.3	3.22		SHALE DARK GREY-BLACK
B22510	ND	3050.00	92.9	9.89		SHALE DARK GREY-BLACK
B22545	CL	3055.01	87.3	1.01		SHALE DARK GREY-BLACK
B22511	ND	3060.00	92.8	9.47		SHALE DARK GREY-BLACK
B22512	ND	3070.00	91.8	9.09		SHALE DARK GREY-BLACK
B22546	CL	3075.00	83.2	7.66		SHALE DARK GREY-BLACK
B22513	ND	3080.00	77.8	4.85		SHALE DARK GREY-BLACK
B22514	ND	3090.00	78.1	4.71		SHALE DARK GREY-BLACK
B22515	ND	3100.00	83.9	5.16		SHALE DARK GREY-BLACK
B22516	ND	3110.00	89.7	6.51		SHALE DARK GREY-BLACK
B22517	ND	3120.00	90.6	6.48		SHALE DARK GREY-BLACK
B22547	CL	3125.00	90.4	7.64		SHALE DARK GREY-BLACK
B22518	ND	3130.00	87.9	6.70		SHALE DARK GREY-BLACK
B22519	ND	3140.00	66.3	4.00		SHALE DARK GREY-BLACK
B22520	ND	3150.00	60.6	3.40		SHALE DARK GREY-BLACK
B22521	ND	3160.00	76.0	4.86		SHALE DARK GREY-BLACK
B22522	ND	3170.00	82.4	5.35		SHALE DARK GREY-BLACK
B22531	CA01	3180.40	93.2	2.04		SHALE DARK GREY-BLACK, SILTY, MICACEOUS
B24959	CA01	3185.00	98.1	.24		IMPREGNATED SANDSTONE
B24960	CA01	3193.00	98.1	.24		IMPREGNATED SANDSTONE
B22532	CA02	3195.40	94.2	8.43		SHALE DARK GREY-BLACK, SILTY, MICACEOUS
B22533	CA03	3203.15	96.9	12.52		SHALE BLACK
B22534	CA03	3210.35	99.0	57.71		COAL
B22523	ND	3240.00	71.2	1.12		SHALE GREY, SILTY, CALCAREOUS
B22548	CL	3240.00	89.2	1.70		SHALE GREY, SILTY
B22524	ND	3250.00	84.2	1.71		SHALE GREY, SILTY
B22525	ND	3260.00	75.0	1.75		SHALE GREY, SILTY, CALCAREOUS
B22526	ND	3270.00	75.1	1.10		SHALE GREY, SILTY, CALCAREOUS

TABLE: 1 (Continued) 25/5-2

DESCRIPTION OF ANALYSED SAMPLES AND ORGANIC CARBON CONTENT

LAB. REF.	SAMPLE TYPE	DEPTHS Metres	IR %	TOC %	IOC %	L I T H O L O G Y
B22549	CL	3279.00	41.0	.75		SHALE LIGHT GREY, SILTY, CALCAREOUS
B22527	ND	3280.00	80.6	.70		SHALE LIGHT GREY, SILTY
B22528	ND	3290.00	77.6	.61		SHALE LIGHT GREY, SILTY, CALCAREOUS
B22529	ND	3300.00	82.2	.77		SHALE LIGHT GREY, SILTY
B22530	ND	3304.00	81.9	.52		SHALE LIGHT GREY, VERY SILTY

TABLE: 2 25/5-2

MINERALOGICAL COMPOSITION BY X-RAY DIFFRACTION

LAB. REF.	SAMPLE TYPE	DEPTHS Metres	IR %	TOC %	IOC %	ALB %	ORT %	ANH %	QRZ %	CAL %	DOL %	SID %	ND %
B22535	CL	2080.00 2090.00	87.3	.42		0	0	1	13	0	0	0	86
B22536	CL	2192.00 2200.00	62.0	.17		9	0	4	8	2	0	0	77
B22537	CL	2300.01	90.7	.39		0	0	1	27	0	0	0	72
B22538	CL	2431.01	85.8	.62		2	0	1	20	0	1	0	76
B22539	CL	2455.01	86.9	.90		6	2	2	30	0	0	0	60
B22498	ND	2780.00	20.5	.14		0	0	0	5	70	0	0	25
B22540	CL	2785.01	83.5	.48		4	0	1	21	12	0	0	62
B22500	ND	2860.00	32.8	.20		2	0	1	9	63	0	0	25
B22541	CL	2906.01	81.7	.23		2	0	1	18	12	0	0	67
B22502	ND	2940.00	48.2	.28		1	0	1	18	49	0	0	31
B22505	ND	2970.00	71.0	.41		2	0	1	21	25	0	0	51
B22506	ND	3010.00	82.6	4.63		1	0	0	21	14	1	0	63
B22542	CL	3010.01	90.0	7.00		1	0	0	23	3	1	0	72
B22507	ND	3020.00	91.7	7.44		1	0	0	29	1	2	0	67
B22543	CL	3020.01	86.2	8.02		2	0	0	30	1	2	0	65
B22508	ND	3030.00	90.6	7.62		1	0	0	28	1	2	0	68
B22509	ND	3040.00	91.5	6.16		2	0	1	27	1	2	0	67
B22544	CL	3040.01	88.3	3.22		0	0	0	19	0	0	0	81
B22510	ND	3050.00	92.9	9.89		1	0	0	31	0	2	0	66
B22545	CL	3055.01	87.3	1.01		0	0	0	18	5	0	0	77
B22511	ND	3060.00	92.8	9.47		1	0	0	32	0	1	1	65
B22512	ND	3070.00	91.8	9.09		1	0	0	27	1	1	0	70
B22546	CL	3075.00	83.2	7.66		0	0	0	25	2	2	1	70
B22513	ND	3080.00	77.8	4.85		1	0	0	21	5	2	2	69
B22514	ND	3090.00	78.1	4.71		0	0	1	23	6	2	2	66
B22515	ND	3100.00	83.9	5.16		0	0	0	24	4	3	0	69
B22516	ND	3110.00	89.7	6.51		0	0	0	28	1	2	0	69
B22517	ND	3120.00	90.6	6.48		0	0	1	27	1	3	0	68
B22547	CL	3125.00	90.4	7.64		0	0	0	29	0	1	1	69
B22518	ND	3130.00	87.9	6.70		0	0	0	26	5	2	0	67
B22519	ND	3140.00	66.3	4.00		0	0	0	18	17	4	3	58
B22520	ND	3150.00	60.6	3.40		0	0	0	15	18	3	4	60
B22521	ND	3160.00	76.0	4.86		0	0	0	17	13	2	2	66
B22522	ND	3170.00	82.4	5.35		1	0	0	18	10	1	1	69
B22531	CA01	3180.40	93.2	2.04		1	2	1	20	1	0	1	74
B24959	CA01	3185.00	98.1	.24		2	0	0	21	1	0	11	65
B24960	CA01	3193.00	98.1	.24		3	0	2	20	1	0	3	71
B22532	CA02	3195.40	94.2	8.43		2	2	2	20	0	1	1	72
B22533	CA03	3203.15	96.9	12.52		1	1	2	14	0	1	0	81
B22534	CA03	3210.35	99.0	57.71		0	0	0	1	0	0	0	99
B22523	ND	3240.00	71.2	1.12		1	1	1	26	10	2	10	49
B22548	CL	3240.00	89.2	1.70		1	1	0	26	0	0	8	64
B22524	ND	3250.00	84.2	1.71		2	0	2	25	1	0	6	64
B22525	ND	3260.00	75.0	1.75		2	1	0	23	2	0	10	62
B22526	ND	3270.00	75.1	1.10		2	1	0	25	8	0	9	55

TABLE: 2 (Continued) 25/5-2

MINERALOGICAL COMPOSITION BY X-RAY DIFFRACTION

LAB. REF.	SAMPLE TYPE	DEPTHS Metres	IR %	TOC %	IOC %	ALB %	ORT %	ANH %	QRZ %	CAL %	DOL %	SID %	ND %
B22549	CL	3279.00	41.0	.75		2	0	0	12	0	0	49	37
B22527	ND	3280.00	80.6	.70		2	2	0	38	4	0	8	46
B22528	ND	3290.00	77.6	.61		3	0	0	33	11	0	6	47
B22529	ND	3300.00	82.2	.77		2	0	1	32	6	0	5	54
B22530	ND	3304.00	81.9	.52		3	3	0	39	1	0	9	45

TABLE: 3 25/5-2

RESULTS OF ORGANIC INVENTORY ANALYSIS

LAB. REF.	SAMPLE TYPE	DEPTHS Metres		ROCK-EVAL Q1	on	Tmax	S1	S2	S3	PI	HI	OI	TOC	Follow up	IATROSCAN Q2	EOM	100(EOM/TOC)	SAT	ARO	POL	SAT/ARO	HC
B22535	CL	2080.00	2090.00	N	RI_RT	#	.01	.06	.09	#	15	21	.42		N	.011	2.6					
B22536	CL	2192.00	2200.00	N	RI_RT					#			.17		N	<S						
B22537	CL	2300.01		N	RI_RT	#	.05	.01	.05	#	2	14	.39		N	<S						
B22538	CL	2431.01		N	RI_RT	#	.03	.09	.06	#	14	10	.62		N	.010	1.6					
B22539	CL	2455.01		N	RI_RT	#	.03	.15	.24	#	16	27	.90		N	.013	1.4					
B22498	ND	2780.00		N	RI_RT	#	.01	.04	.15	#	29	107	.14		N	<S						
B22540	CL	2785.01		N	RI_RT	#	.03	.06	.02	#	12	4	.48		N	.011	2.4					
B22500	ND	2860.00		N	RI_RT	#	.03	.04	.17	#	22	87	.20		N	<S						
B22541	CL	2906.01		N	RI_RT					#			.23		N	<S						
B22502	ND	2940.00		N	RI_RT	#	.04	.06	.16	#	21	57	.28		N	<S						
B22505	ND	2970.00		N	RI_RT	#	.07	.08	.21	#	19	52	.41		N	<S						
B22506	ND	3010.00		N	RI_RT	429	1.63	23.00	.45	.07	497	10	4.63		N	.428	9.2	23.7	26.1	50.2	.91	2.13
B22542	CL	3010.01		N	RI_RT	427	2.51	37.84	.35	.06	541	5	7.00	x	N	.643	9.2	26.3	33.4	40.3	.79	3.84
B22507	ND	3020.00		N	RI_RT	430	2.87	38.23	.56	.07	514	8	7.44		N	.719	9.7	23.8	26.3	49.9	.90	3.60
B22543	CL	3020.01		N	RI_RT	427	3.81	42.56	.46	.08	530	6	8.02	x	N	1.011	12.6	26.9	38.8	34.3	.69	6.64
B22508	ND	3030.00		N	RI_RT	432	2.84	38.38	.54	.07	503	7	7.62		N	.709	9.3	23.0	27.7	49.3	.83	3.59
B22509	ND	3040.00		N	RI_RT	428	3.44	26.79	.44	.11	435	7	6.16		N	.779	12.7	26.6	31.9	41.6	.83	4.55
B22544	CL	3040.01		N	RI_RT	422	.57	9.60	.36	.06	298	11	3.22		N	.365	11.3	31.9	45.7	22.4	.70	2.83
B22510	ND	3050.00		N	RI_RT	432	5.91	42.63	.46	.12	431	5	9.89	x	N	1.563	15.8	21.7	33.9	44.4	.64	8.69
B22545	CL	3055.01		N	RI_RT	#	.10	.53	.68	.15	53	67	1.01		N	.023	2.3					
B22511	ND	3060.00		N	RI_RT	432	5.66	38.98	.43	.13	412	5	9.47		N	1.462	15.4	21.5	30.2	48.3	.71	7.55
B22512	ND	3070.00		N	RI_RT	432	5.16	33.50	.40	.13	369	4	9.09	x	N	1.358	14.9	21.0	33.5	45.5	.63	7.40
B22546	CL	3075.00		N	RI_RT	426	4.76	27.43	.32	.15	358	4	7.66		N	1.332	17.4	23.3	44.4	32.3	.53	9.02
B22513	ND	3080.00		N	RI_RT	427	1.68	15.31	.34	.10	315	7	4.85		N	.525	10.8	22.4	32.6	45.0	.69	2.89
B22514	ND	3090.00		N	RI_RT	427	1.66	14.59	.37	.10	310	8	4.71	x	N	.477	10.1	21.5	31.7	46.8	.68	2.54
B22515	ND	3100.00		N	RI_RT	429	1.56	16.50	.38	.09	320	7	5.16		N	.415	8.0	20.2	32.7	47.1	.62	2.20
B22516	ND	3110.00		N	RI_RT	431	1.63	18.74	.48	.08	288	7	6.51		N	.386	5.9	15.0	30.5	54.5	.49	1.76
B22517	ND	3120.00		N	RI_RT	432	1.41	18.00	.50	.07	278	8	6.48	x	N	.312	4.8	14.2	29.4	56.4	.48	1.36
B22547	CL	3125.00		N	RI_RT	429	1.43	18.46	.42	.07	242	5	7.64		N	.401	5.3	18.0	35.0	47.0	.52	2.13
B22518	ND	3130.00		N	RI_RT	431	1.20	18.00	.49	.06	268	7	6.70		N	.319	4.8	14.6	24.3	61.1	.60	1.24
B22519	ND	3140.00		N	RI_RT	435	.34	5.99	.27	.05	150	7	4.00	x	N	.132	3.3	11.8	24.9	63.3	.47	.49
B22520	ND	3150.00		N	RI_RT	437	.31	3.14	.15	.09	92	4	3.40	x	N	.077	2.3	9.8	25.7	64.5	.38	.27
B22521	ND	3160.00		N	RI_RT	433	1.47	19.49	.36	.07	401	8	4.86	x	N	.405	8.3	25.9	33.4	40.7	.78	2.40
B22522	ND	3170.00		N	RI_RT	435	2.45	25.16	.30	.09	470	6	5.35	x	N	.530	9.9	30.2	37.4	32.4	.81	3.59
B22531	CA01	3180.40		N	RI_RT	433	.31	3.99	.19	.07	195	9	2.04	x	N	.141	6.9	15.5	35.6	48.9	.44	.72
B24959	CA01	3185.00		N	RI_RT								.24	x	N	.185	77.0	57.5	20.0	22.5	2.87	1.43
B24960	CA01	3193.00		N	RI_RT								.24	x	N	.206	85.6	59.7	25.0	15.3	2.39	1.74
B22532	CA02	3195.40		N	RI_RT	436	1.94	14.87	.38	.12	176	4	8.43		N	.378	4.5	10.2	39.3	50.5	.26	1.87
B22533	CA03	3203.15		N	RI_RT	430	3.50	39.26	.53	.08	313	4	12.52		N	.495	4.0	9.1	35.7	55.2	.25	2.22
B22534	CA03	3210.35		N	RI_RT	436	27.27	264.99	1.24	.09	459	2	57.71		N	1.878	3.3	8.9	30.7	60.4	.29	7.43
B22523	ND	3240.00		N	RI_RT	433	.11	2.28	.15	.04	203	13	1.12		N	.061	5.4	19.5	27.6	52.9	.71	.29
B22548	CL	3240.00		N	RI_RT	435	.12	3.73	.19	.03	219	11	1.70		N	.096	5.6	23.5	32.3	44.2	.73	.53
B22524	ND	3250.00		N	RI_RT	433	.16	3.74	.19	.04	219	11	1.71	x	N	.093	5.4	17.1	28.3	54.6	.60	.42
B22525	ND	3260.00		N	RI_RT	436	.25	4.38	.23	.05	251	13	1.75		N	.116	6.6	20.9	31.1	48.0	.67	.60
B22526	ND	3270.00		N	RI_RT	433	.11	1.98	.09	.05	179	8	1.10		N	.069	6.3	19.8	34.0	46.2	.58	.37

TABLE: 3 (Continued) 25/5-2

RESULTS OF ORGANIC INVENTORY ANALYSIS

LAB. REF.	SAMPLE TYPE	DEPTHS Metres	ROCK-EVAL Q1	on	Tmax	S1	S2	S3	PI	HI	OI	TOC		IATROSCAN Q2	EOM	100(EOM/TOC)	SAT	ARO	POL	SAT/ARO	HC
B22549	CL	3279.00	N	RI_RT	436	.04	.95	.06	.04	126	8	.75		N	.039	5.2	25.7	29.6	44.8	.87	.21
B22527	ND	3280.00	N	RI_RT	434	.06	.95	.04	.06	136	6	.70		N	.044	6.3	18.0	28.6	53.4	.63	.21
B22528	ND	3290.00	N	RI_RT	436	.04	.61	.04	.06	101	6	.61		N	.030	4.9	17.5	26.4	56.0	.66	.13
B22529	ND	3300.00	N	RI_RT	436	.05	.89	.06	.05	115	7	.77		N	.037	4.9	17.5	25.7	56.9	.68	.16
B22530	ND	3304.00	N	RI_RT	436	.02	.52	.02	.05	98	5	.52		N	.028	5.3	18.6	27.5	53.9	.68	.13

TABLE 4

GAS CHROMATOGRAPHY RATIOS OF ROCK EXTRACTS AND OIL

25/5-2

	SATURATED HYDROCARBONS				AROMATIC HYDROCARBONS			SULFUR COMPOUNDS			*
DEPTH (m)	PR/ nC17	PH/ nC18	PR/PH	A/B	MPI 1	MPI 3	MP/ P	MDBT 1	MDBT 3	MDBT 4/1	
3010.01	1.74	1.30	1.49	1.34	.86	1.00	2.68	.48	.50	.33	
3020.01	1.36	1.04	1.40	1.31	.87	.95	3.08	.46	.51	.35	
3050	1.01	1.29	.84	.79	1.04	1.02	4.29	.51	.63	.49	
3070	1.12	1.30	.84	.86	.90	.95	3.39	.52	.73	.61	*
3090	1.34	1.42	1.13	.95	.63	.72	2.41	.60	.82	.71	
3120	2.46	1.18	2.32	2.09	.46	.60	1.72	.57	.75	.59	
3140	2.29	1.00	2.51	2.29	.46	.64	1.53	.63	.78	.65	
3150	2.34	.88	2.96	2.65	.50	.67	1.64	~	~	~	*
3160	1.38	.76	2.22	1.83	.53	.68	1.80	.67	.79	.67	*
3170	1.18	.79	1.94	1.49	.54	.67	1.91	.66	.80	.69	*
3180.40	1.70	.47	4.10	3.63	.50	.75	1.37	.78	1.38	2.09	*
3185	.93	.47	1.71	1.99	.66	.71	2.75	~	~	~	*
3193	.95	.47	1.65	2.03	.71	.71	3.44	~	~	~	*
DST2	.79	.39	2.43	2.05	.60	.63	2.84	1.20	1.46	2.12	*
3250	2.25	.58	4.21	3.89	.46	.66	1.42	~	~	~	

SATURATED HYDROCARBON RATIOS :
PR = PRISTANE; PH = PHYTANE
A = PRISTANE/nC17 ; B = PHYTANE/nC18

AROMATIC HYDROCARBON RATIOS :
P = PHENANTHRENE; MP = METHYLPHENANTHRENE
MPI1 = 1.5(2MP+3MP)/(P+1MP+9MP)
MPI3= (2MP+3MP)/(1MP+9MP)
MP/P = SUM OF METHYLPHENANTHRENES/PHENANTHRENE

SULFUR COMPOUND RATIOS :
MDBT1 = 1.5(4MDBT+2,3MDBT)/(DBT+2,3MDBT+1MDBT)
MDBT3 = (4MDBT+2,3MDBT)/(2,3MDBT+1MDBT)
MDBT4/1 = 4MDBT/1MDBT

* SAMPLES SUBMITTED TO FURTHER CARBON ISOTOPE AND GC/MS ANALYSES

CARBON ISOTOPE RATIOS OF ROCK EXTRACTS AND OIL

25/5-2

	CARBON ISOTOPY per mil PDB					
SAMPLE DEPTH (m)	TOTAL OIL	RESID.	TOTAL EXTR.	SAT	ARO	RES
3070	~	~	-29.6	-30.5	-29.6	-29.2
3150	~	~	-25.3	-27.7	-25.3	-25.0
3160	~	~	-28.0	-29.6	-27.8	-27.4
3170	~	~	-28.8	-30.0	-28.4	-28.2
3180.40	~	~	-26.2	-28.2	-25.6	-25.9
3185	~	~	-28.2	-28.3	-27.6	-27.7
3193	~	~	-28.3	-28.9	-27.7	-27.8
DST2 OIL	-27.8	-28.2	~	-28.5	-27.1	-27.3

RESID = RESIDUE OF DISTILLATION
SAT = SATURATED HYDROCARBONS
ARO = AROMATIC HYDROCARBONS
RES = RESINS

TABLE 6

RESULTS OF OIL ANALYSIS

25/5-2

IDENTIFICATION	
SAMPLE	DST 2
LAB REFERENCE	B23290
RESERVOIR	
DEPTH (m)	3196-3201
LITHOLOGY	SANDSTONE
BULK PROPERTIES	
SPECIFIC GR.	.833
API GRAVITY	38.50
SULFUR %	.39
RESIDUE C14+ %	64.72
CARBON ISOTOPY (per mil PDB)	
TOTAL OIL	-27.8
RESIDUE	-28.2
SATURATES C14+	-28.5
AROMATICS C14+	-27.1
RESINS	-27.3
COMPOSITION OF RESIDUE C14+	
SATURATED HC	56.46
AROMATIC HC	34.90
RESINS	8.64
ASPHALTENES	.00
TOTAL HC	91.36
SAT/ARO	1.62
COMPOSITION OF WHOLE OIL	
DISTILLATE %	35.28
SAT. HC C14+	36.54
ARO. HC C14+	22.59
RESINS	5.59
ASPHALTENES	.00
GAS CHROMATOGRAPHY	
PR/PH	2.43
PR/nC17 = A	.79
PH/nC18 = B	.39
A/B	2.05
MPI-1	.60
MPI-3	.63
MP/P	2.84

PR = PRISTANE; PH = PHYTANE
MPI-1 = 1.5 (2MP+3MP)/(P+1MP+9MP)
MPI-3 = (2MP+3MP)/(1MP+9MP)
MP/P = SUM OF METHYL-PHENANTHRENES/PHENANTHRENE

TABLE 7

GAS COMPOSITION AND CARBON ISOTOPE RATIOS

25/5-2

IDENTIFICATION	
SAMPLE	DST 2
DEPTH	3196-3201 m
RESERVOIR	
COMPOSITION	
N2	2.424
CO2	3.633
C1	65.018
C2	12.048
C3	10.804
iC4	1.360
nC4	2.868
iC5	.587
nC5	.670
C6	.454
C7	.095
C8	.037
C9	.003
C10+	~
MOLECULAR RATIOS	
iC4/nC4	.474
iC5/nC5	.876
C1/C1-C4 (%)	70.596
C1/C2-C3	2.845
ISOTOPY	
d13C C1	-47.4
d13C C2	-31.5
d13C C3	-30.0
d13C C4	-29.4
d13C CO2	- 9.8
dD C1	-225
d18O CO2	+41

Composition analysis performed by PVT, composition in % molar
Carbon isotope ratios (d13C) in per mil PDB
Hydrogen isotopic ratio (dD) in per mil SMOW
Oxygen isotopic ratio (d18O) in per mil SMOW