1. TEST INTERPRETATION

1.1 RFT TESTING

In the interval from 4053 to 4158 mrkb, 8 runs were performed. The main objective of the RFT program was to obtain a representative hydrocarbon sample. The results are outlined in detail in table 1.1.

During run No 3, a number of ordinary pressure tests were made in addition to sampling. The results of these are given in table 1.2, and are also plotted in fig. 1.1.

1.1.1 RFT Sampling Operations

All the samples were taken as segregated samples, and when successful, the sample chambers were pressurized to 200 bars (prior to transferring), since this is the maximum pressure the equipment tolerates.

In all the recovered samples no pressure was detected in the chambers at surface conditions. This is an indication of water.

During transfer it was possible to observe through the cell window, whether any hydrocarbones were recovered. All the samples turned out to be mud filtrate, and thus transferred into plastic bottles. The salinity of each sample was checked for comparison with the mud salinity which was approximately 5000 ppm. The results are given in table 1.1.

1.1.2 Discussion of obtained results.

From run 2 the formation temperature was examined, and gave 240° F at 4148,5 m.

The pressure gradient was studied from data of run No 3 which later were plotted in fig. 1.1. Unfortunately it is not possible to make any conclusion concerning the internal pressure gradients in any of the two hydrocarbon zones, but it is quite clear that there is a water gradient below the Triassic hydrocarbon zone. Furthermore it appears that the two zones do not belong to the same pressure regime since the internal gradient, (if communication should exist), cannot be higher than a water gradient. The gradient between the two zones being approximately .8 psi/ft makes it possible to conclude that the two zones are not in communication.

1.2 FIT-TESTING

Since the RFT-sampling was not successful in determining the nature of the hydrocarbons in the Triassic interval 4141 - 4158 m RKB, it was decided to run an FIT-sampler with a 6 gallon chamber prior to the production test.

Two runs were made at a depth of 4150 m RKB, but both were unsuccessful due to malfunction of the charges (which did not explode). Experience from RFT-sampling said that the chances to recover hydrocarbons were not high enough to justify any further attempts, and thus any further attempt abandoned.

1.3 PRODUCTION TESTING*

In order to get information about the fluids present in the Triassic formation and its productivity; a production test was run over the perforated intervals 4142 - 4146 and 4148 - 4152 m RKB.

* If final pvt analysis, which has not yet been received will make any substantial changes to this interpretaton; an updated report will be issued.

The test produced gas and liquid to surface at a GOR of approximately 95.000 SCF/STB. (Ref. 2).

1.3.1 Validity of data

Due to technical problems the first flow period was reduced to approximately 2.3 hrs. Even though stabilization of flow rates within this short time span are not expected, the flow rate and pressure behaviour from the second flow period (2.5 hrs.) indicate that relatively stable conditions were achieved already during the last 30 minutes of the first flow period.

This early flowing stabilization can be attributed to the use of the bottomhole choke which might have helped to achieve a stabilizing effect of the flow of fluids through the tubing.

Thus the conditions under which the samples were taken during the second flow period has been accepted as representative enough to satisfy the main objective of the test.

The basic information about the flow and shut-in periods during the testing, including choke size, flow rates, bottom-hole (below and above choke) and wellhead pressures are shown in Fig. 1.2. Table 1.3 shows the basic test results.

The only pressure gauges working were the Halliburton gauge No 5635 (Ref. 3) above the choke and the Amerada gauge No 33616. (Ref. 4) below the APR-N valve.

1.3.2 Static reservoir pressure. x)

RFT-measurements indicated that the static reservoir pressure was 10450 psi at 4150 m RKB.

The initial build-up (Fig. 1.3) confirmed this order of magnitude being approximately 10425 psi.

x) All bottom hole pressures used in the analysis are at 4101 m RKB

The first build-up (Fig. 1.3) does, however, indicate a lower static pressure, in the range of 10260 psi. As the pressure behaviour during this build-up is typical of a two-layer response on the similog plot and as such can not be extrapolated; static pressure has been evaluated by means of Muskat method (Fig. 1.4) to be 10240 psi.

The higher pressure from RFT and initial build-up is thought to be due to overpressured formation caused by the hydrostatic head rather than a limited size of the reservoir. This because the first build-up did not reflect any reservoir limitation out to the radius of investigation of approximately 180 m. This implies a reservoir at least in the range of 100 times the size required to give a 200 psi drop in reservoir pressure only as a result of the initial flow.

Thus static reservoir pressure is 10240 psi.

1.3.3 Fluid properties.

The fluid produced during the test was gas condensate with a GOR in the range of 95000 SCF/STB. The GOR value remains uncertain however since the liquid rate was too low to be measured by the flow-meters.

A chromatographic analysis of the gas stream are shown in table 1.4 (Ref. 5).

Other fluid properties from PVT-analysis are not yet available, and the values applied are based only on standard tables (Standing), through which all proporties have been estimated.

1.3.4 Rock properties.

For the analysis of rock properties from pressure vs. time data the Horner method has been applied for two semilog straight lines, see Fig. 1.5.

Slope m_1 = 520 psi/cycle gives a permeability of 2.4 md, but a negative skin (s = - 0.14), which means that the well must have been stimulated in one or another way. This did not take place and it was not possible to match the test results to a negative skin on the type curve.

The build-up behaviour may be explained more successfully as a two layer response, where the two sands separated by a shale stringer, have different properties. In this case slope m_2 = 340 psi/cycle would represent the formation properties, but the line can not be extrapolated to give static reservoir pressure. Permeability was calculated to be 3.7 md and skin s = 2.5

Type curve analysis has been done by matching test results with the analytical solution given in Ref. 6, see Fig. 1.6. From match 2 permeability is 3,7 md, skin s - 2.5 and porosity is 14.3%.

The Muskat method was used to evaluate static reservoir pressure. Assuming circular and square drainage area a permeability of 4.2 md and 3.4 md was obtained respectively. This confirms the Horner and type curve analysis.

Table 1.5 presents the conclusion as to formation properties, given the calculated fluid properties.

TABLE 1.1: SAMPLING DATA

Depth. (m)	Hydrost. press(psi)	Formation press(psi)	Salinity cl⁻ ppm	Chamber size, gals		Comments
				Lower	Upper	
				(2 3/4)	(1)	Tool malfunctioned
4148.5	11238	10560				Pretest before sampling
		(10545)		2 3/4		Seal lower chamber
		(10558)	5200		1	Seal upper chamber
						Results from ordinary pressure tests given in table 2
4145	11147	10450				Pretest before sampling
		(10428)		2 3/4		Seal lower chamber
		(10437)	4800		1	Seal upper chamber
4053	10889	10230		(2 3/4)	(1)	Pretest before sampling. Sampling failed due to blocked flowline
4053	10885	10229				Pretest before sampling.
		(10221)		2 3/4		Seal lower chamber.
		(10229)	5200		1	Seal upper chamber.
4157.5	11175	10516				Pretest before sampling.
		(10450)	4900	6	(2 3/4)	Seal lower chamber. Could not open upper chamber due to burned electrical wire in the RFT-tool.
4157.5	11148	10471				Pretest before sampling. When trying to sample, tool did not seal properly. Tool was set again.
4157.5	11115	10482	5200	(6)	2 3/4	Pretest before sampling. When trying to sample, lower chamber would not open. Opened upper chamber briefly to check for blocked flowline. Turned out that Schlumberger had forgotten to unlock the water cushion on lower chamber.
4157.5	11115	10456				Pretest before sampling. Had to use rig power as the Schlumberger power supply broke down when initiating pretest.
		(10436)		6+2 3/4		Seal lower chamber.
		(10446)	8000		1	Seal upper chamber.

TABLE 1.2: PRESSURE RECORDINGS IN RUN NO. 3

Depth, mRKB	Hydrostatic pressure, psig	Formation pressure, psig	Comments
4294	11548	10682	
4271.5	11479		Tight
4259	11435	10610	
4227	11335	10562	
4210	11276	10538	3 attempts (2 seal failures)
4195.5	11225	10528	
4186	11193		2 seal failures
4157	11128	10456	
4155.5	11124	10457	Very low perm.
4151.5	11109		Tight
4150	11106	10455	
4148.5	11101	10455	
4145	11089	10460	
4143.5	11085	10460	
4055	10857	10231	
4053	10845	10227	
4051.5	10834	10227	
4049	10823	10226	
4045.2	10811		2 seal failures
4045.5	10815		2 seal failures
4046	10817		seal failure
3991	10679		2 seal failures
3990.5	10680		seal failure

Table 1.3

TEST SUMMARY

EVENT	TIME (MIN)	CHOKE SIZE (1/64")	BOTTOM HOLE PRESSURE (PSIG)	FLOWING WELLHEAD PRESSURE (PSIG)	FLOWING WELLHEAD TEMP (^{O}F)	GAS FLOW RATE (MMSCF/D)	OIL FLOW RATE (BBL/D)	GAS/OIL RATIO (SCF/BBL)	GAS GRAVITY (AIR 1.0)	OIL GRAVITY (^{O}API)
INITIAL FLOW	4	8	9320	3000						
INITIAL BUILD-UP	67		10390							
FIRST FLOW	132	48	7516	902	72	10.73				
FIRST BUILD-UP	995		10233							
SECOND FLOW	168	48	7520	910	64	10.74	110.8	96931	.622	49

RESERVOIR TEMPERATURE AT 4150 M RKB IS ESTIMATED TO: 267^{O}F