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FMT REPORT

WELL 34/10-17

OCTOBER 1983

ENGINEER: P.SEIM

Den norske stats oljeselskap a.s

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1. GENERAL

34/10-17 was the first well to be drilled on the Beta structure in block 34/10. The well reached its total depth at 3466 m RKB in rocks of Triassic age.

Hydrocarbons were encountered in the Brent sands (2685 - 2993 m) of middle Jurassic age.

After setting the 9 5/8" casing at 2580 m RKB, the well was drilled with an 8.5" bit to 3015 m RKB. An intermediate logging run was performed, including the FMT. The objective was to define pressure gradients, fluid contacts and obtain formation fluid samples.

A 7" liner was then run to 3015 m RKB, the well drilled with a 6" bit to TD, and the FMT run again in order to get pore pressure information.

The CDL/CNLog/GR has been used for depth correlation.

2. RESULTS

Two FMT-runs were completed in 34/10-17. During the first run two sets of segregated samples were taken.

The maximum pore pressure in the Brent formation was estimated to 1.519 g/cm^3 EMW at 2685 m RKB by extrapolating the gas gradient from run no. 1.

Due to the uncertainty of the correct oil gradient, the contacts are not clearly defined, but the following values are suggested.

GOC : 2862 ± 12 (m RKB)
OWC : 2914 ± 4 (m RKB)

As to the gradients themselves, both the gas and water gradients are rather well defined, while the oil gradient is more uncertain. The following values are suggested in the Brent sands:

Gas gradient: 0.0410 bar/m (0.419 g/cm^3)
Oil gradient: 0 0480-0.0600 bar/m (0.49-0 61 g/cm^3)
Water gradient: 0 1006 bar/m (1 026 g/cm^3)

One segregated sample was taken in the oil zone, and one segregated sample in the gas zone. Both sets of samples were good, and preliminary results are presented in table 4 and 5.

In the Brent section all pretests indicated very good to excellent permeability with little or no drawdown, while pretests in the deeper sections of the well, (run no.2), indicated lower permeabilities.

3. RUN NO. 1 (Brent sands)

Run no. 1 was made in the Brent sands of middle Jurassic age. The members penetrated were Tarbert, Ness, Etive and Rannoch. The resistivity and porosity logs indicated the presence of gas, oil and water with the contacts partly masked by shale beds and porosity contrasts.

3.1 Pretests

3.1.1. The Gas Zone

The gradient in the gas zone is well defined and yields a gradient of 0 0410 bar/m corresponding to a fluid density in this part of the reservoir of 0.419 g/cm^3 (figure 3). All pretests in this zone (test no. 1 through 11) showed excellent permeability with very consistent readings for both hydrostatic and formation pressures.

3.1.2. The Oil Zone

The available data in this interval are not consistent. This is partly due to the operational procedure during the FMT-run. The initial program called for 22 pressure points with only three points in what was assumed to be the oil zone. During the recording these three points did not define a good gradient. A decision was made to complete the program, pull back to 2869 m RKB, and try to establish a better gradient through the oil zone by adding more points in the interval. The result was a better definition of the gradient, but due to a hysteresis effect on the gauge, the absolute pressure values did not correspond to the values obtained in the gas and water zones. Hence, the fluid contacts could not be taken directly from a plot of the temperature corrected data.

The gradient itself also appears to be wrong. The computed value of 0.0484 bar/m corresponding to a fluid density of 0.494 g/cm^3 is probably too low (figure 4). This might be due to the hysteresis effect again, but temperature variations could

also be influencing the results. A look at the hydrostatic pressures expressed as equivalent mud weight (EMW) suggests, that pretests 25,26 and 27 give too high pressures.

This leaves pretests 28 and 29, giving a gradient of 0.0582 bar/m (fluid density of 0 594 g/cm^3). Although it compares well with the preliminary laboratory results giving a fluid density at reservoir conditions in the range of 0.60 - 0.61 g/cm^3, it should be used with care, as only two points have been used for determination.

3.1.3 The Water Zone

During the first series of pretests a well defined gradient was obtained (figure 6). A value of 0.1006 bar/m corresponding to a fluid density of 1.026 g/cm^3 seems reasonable. During the second series of pretests three points in the assumed water zone were recorded, of which two were recorded at the same depth.

As in the oil zone the gradient given appears to be too steep, 0.0962 bar/m or a water density of 0.982 g/cm^3 (figure 7) and due to the limited number of points recorded during the second series, the results obtained during the first series of pretests are thought to be representative for this zone.

3.2 Sampling

Two sets of segregated samples were attempted in this well; one in the assumed oil zone and one in the gas zone. From an operational point of view the sampling was successful. For both samples the 2 3/4 gallon chamber was bled off on the rig floor, while the one gallon chambers were checked for pressure and then sealed for shipment to the Statoil laboratory. The results from the sampling are shown in tables 4 and 5. The results from the laboratory analysis will be presented in a separate report.

3.3 Fluid Contacts

As mentioned in section 3.1.2. the problems involved in defining the oil gradient makes it difficult to establish accurate fluid contacts. Small variations in the oil gradients can cause large shifts in the fluid contacts. This is especially true for the gas-oil contact.

3.3.1 The Oil-Water Contact

A straight-forward plotting of pretests 25 through 32, including all points, yields an oil-water contact (OWC) at approximately 2910 m RKB. As indicated in sections 3.1.2 and 3.1.3, both the oil and the gas gradients are too steep. Gradients corresponding to denser fluids would give an intersection of the gradients at a deeper level, and 2910 m RKB will be considered as the upper limit for the OWC. However, combining the oil gradient defined by pretests 28 and 29 with a water gradient of 0.1006 bar/m through pretest 30 as a pressure reference point, the resulting OWC will be at approximately 2914 m RKB.

Several other combinations of gradients and pressure reference points have been plotted giving contacts ranging from 2910 to 2918 m RKB.

They all require more adjustments on the original data than the two methods described above, but will have to be considered due to the uncertainty of the correct gradient and absolute pressure in this zone.

As a conclusion, the oil-water contact is suggested to be between 2910 and 2918 m RKB.

3.3.2 The Gas-Oil Contact

In order to define the gas-oil contact (GOC) from the available data, several assumptions have to be made. The resulting GOC must be viewed with extreme caution, as it will not be a result of direct measurements. Information from other sources such as

cores and log interpretation should be known before a decision as to the GOC is made.

Assuming that the oil gradient is 0.0582 bar/m (0.594 g/cm^3) and that the OWC is in the range suggested in section 3.3.1, a range for the GOC can be found by superimposing this oil gradient on a plot of the gas and water gradients obtained during the first 22 pretests. The result is a GOC at 2850 m RKB using an OWC at 2918 m RKB, and a GOC at 2870 m RKB using an OWC at 2910 m RKB. Using a steeper gradient in the oil zone and the same range for the OWC will push the GOC upwards into the interval for drillstem test no. 3 (2835 - 2845 m RKB), which produced gas and condensate. A gradient corresponding to a denser fluid in the oil zone would push the GOC downwards, but as the gradient used is alreadey towards the dense end of the range given in section 3.1.2, the lowest GOC using a reservoir fluid density of 0.61 g/cm^3 will be at 2874 m RKB, using 2910 m RKB as the OWC.

The resulting range for the gas-oil contact is therefore taken as 2850 to 2874 m RKB.

Combined with the range for the OWC, the height of the oil column in this well will be between 36 and 68 m.

A plot with the suggested gradients and fluid contacts is presented in figure 2.

4. RUN NO. 2

During run no. 2 of the FMT 5 pretests were attempted. Pretest no. 3 was taken in a tightish formation, which probably was supercharged leaving two good pretests in the Cook formation and two in Statfjord. Plotting a gradient through the Brent water zone and Statfjord, gives a gradient of 0.100 bar/m, or a water density of 1.021 g/cm^3 indicating that these zones could belong to the same pressure regime (figure 1). The pressure regime in the Cook sand seems to be slightly lower, with the Cook pressure points falling below the Brent - Statfjord line. The difference between the hydrostatic pressure in the Cook and Statfjord formations (EMW = 1.456 g/cm^3 vs. 1.452 g/cm^3) should indicate that the pressures in Cook is too high or Statfjord too low, strengthening the assumption of a different pressure regime in the Cook formation.

Well 34/10-17	FMT DATA	Run no. 1
Formation BRENT		

Test no	Depth mRKB	Cor.hydr.pr. before test bar	Cor.hydr.pr. before test (g/cc)	Cor.formation pres. bar	Cor.formation pres. (g/cc)	Cor.hydr.pr. after test bar	Cor.hydr.pr. after test (g/cc)	Remarks
1	2688	426.08	1.614	400.56	1.518	426.01	1.614	
2	2697	427.59	1.615	400.98	1.514	427.45	1.614	
3	2707	429.25	1.615	401.32	1.510	428.97	1.614	
4	2755.5	436.69	1.614	403.39	1.491	436.56	1.614	
5	2764	438.00	1.614	403.67	1.487	437.87	1.614	
6	2775	439.66	1.614	404.01	1.483	439.59	1.614	
7	2789	442.14	1.615	404.63	1.478	441.86	1.614	
8	2808	444.90	1.614	405.46	1.471	444.90	1.614	
9	2820	447.10	1.615	405.94	1.466	446.83	1.614	
10	2836	449.31	1.614	406.63	1.460	449.31	1.614	
11	2844	450.69	1.614	407.05	1.458	450.76	1.615	
12	2869	454.83	1.615	408.49	1.450	454.83	1.615	
13	2883	456.96	1.615	408.98	1.445	456.55	1.613	
14	2889	457.31	1.613	409.11	1.442	457.31	1.613	
15	2924	462.76	1.612	411.73	1.434	462.82	0.612	
16	2935	464.55	1.612	412.84	1.433	464.62	1.613	
17	2940	465.38	1.613	413.87	1.434	465.51	1.613	
18	2945	466.20	1.613	414.08	1.432	466.69	1.614	
19	2945	466.20	1.613	414.01	1.432	466.55	1.614	Repeat of test no. 18
20	2940	465.51	1.613	413.46	1.432	465.51	1.613	Repeat of test no. 17

Well 34/10-17	FMT DATA	Run no. 1
Formation BRENT		

Test no	Depth mRKB	Cor.hydr.pr. before test bar	Cor.hydr.pr. before test (g/cc)	Cor.formation pres. bar	Cor.formation pres. (g/cc)	Cor.hydr.pr. after test bar	Cor.hydr.pr. after test (g/cc)	Remarks
21	2953	467.79	1.614	414.77	1.430	467.58	1.613	
22	2959	468.55	1.613	415.32	1.430	468.48	1.613	
23	2971	470.62	1.614	416.49	1.428	470.41	1.613	
24	2980	471.93	1.613	417.39	1.427	471.86	1.613	
25	2869	455.65	1.618	409.04	1.452	455.52	1.617	New series through oil zone.
26	2883	457.65	1.617	409.73	1.447	457.72	1.617	
27	2889	458.27	1.616	409.94	1.445	458.20	1.616	
28	2900	460.07	1.616	410.49	1.442	459.86	1.615	
29	2906	460.82	1.615	410.84	1.440	460.76	1.615	
30	2921.5	463.44	1.616	412.15	1.437	463.10	1.615	
31	2921.5	463.10	1.615	412.15	1.437	463.10	1.615	Repeat of test no.30.
32	2935	465.65	1.616	413.46	1.435	465.31	1.615	
33	2889	458.27	1.616	409.94	1.445	458.89	1.618	Sample no.1.
34	2697	427.94	1.616	401.32	1.515	428.21	1.617	Sample no.2.

Well 34/10-17	FMT DATA	Run no. 2
Formation COOK/ STATFJ.		

Test no	Depth mRKB	Cor.hydr.pr. before test bar	Cor.hydr.pr. before test (g/cc)	Cor.formation pres. bar	Cor.formation pres. (g/cc)	Cor.hydr.pr. after test bar	Cor.hydr.pr. after test (g/cc)	Remarks
1	3110	444.55	1.456	428.49	1.403	444.62	1.456	
2	3116	445.45	1.456	429.45	1.404	445.45	1.456	
3	3422.5	487.16	1.450	465.24	1.385	487.92	1.452	Tight, tool unstable
4	3431	488.96	1.452	462.55	1.373	488.96	1.452	
5	3442	490.33	1.451	463.58	1.372	490.27	1.451	Tool drifting.

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FMT SAMPLING DATA

Run no.: 1
Type of sample: segregated
Sample no.: 1 Choke size: 1 x 0 020"
Depth: 2889 m RKB

Chamber size (gallons)		2 3/4	1
Pretest corr. hydrostatic pressure (bar)		458.27	-
Pretest corr. formation pressure (bar)		409.94	-
Flowing time (sec.)		204	80
Minimum flowing pressure (bar)		253	-
Flowing pressure		408	409
Surface opening pressure (bar)		185	160
Recovery.	oil/condensate (cm^3)	6100	-
	oil/cond. density (g/cm^3)	0.87	-
	water (cm^3)	0	-
	gas (cm^3)	965600	-
Concentration.	H_2S (%)	0	-
	CO_2 (%)	0.75	-

Comments: One gallon chamber opening pressure in lab.: 190 bar. Laboratory results from the one gallon chamber will be presented in a special report.

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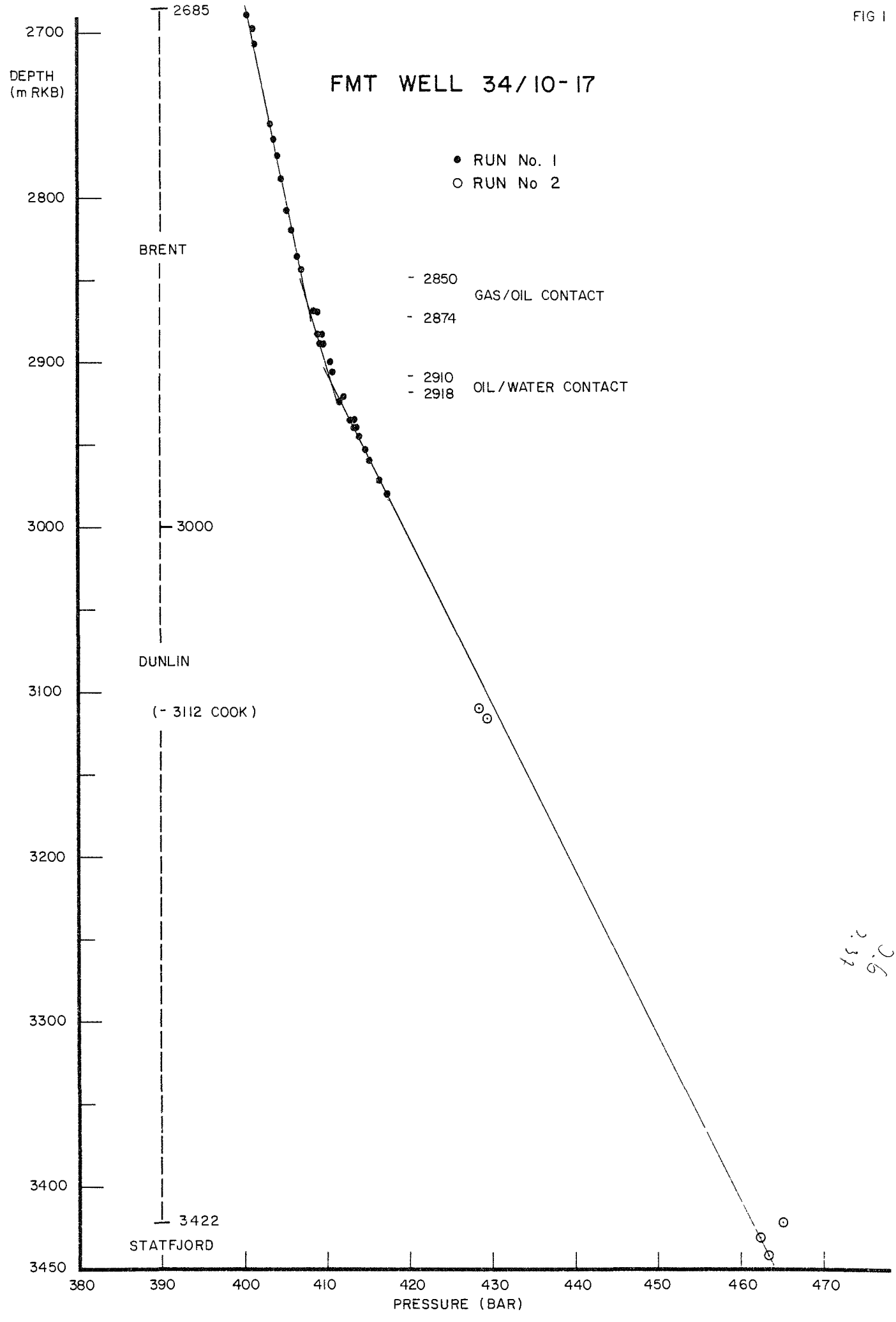
FMT SAMPLING DATA

Run no.: 1
Type of sample: segregated
Sample no.: 2 Choke size: 1 x 0.02"
Depth: 2697 m RKB

Chamber size (gallons)		2 3/4	1
Pretest corr. hydrostatic pressure (bar)		427.94	-
Pretest corr. formation pressure (bar)		401.32	-
Flowing time (sec.)		200	80
Minimum flowing pressure (bar)		290	367
Flowing pressure (bar)		400	401
Surface opening pressure (bar)		190	150
Recovery	oil/condensate (cm^3)	1600	-
	oil/cond. density (g/cm^3)	0.78	-
	water (cm^3)	0	-
	gas (cm^3)	1308240	-
Concentration	H_2S (%)	0	-
	CO_2 (%)	0.75	-

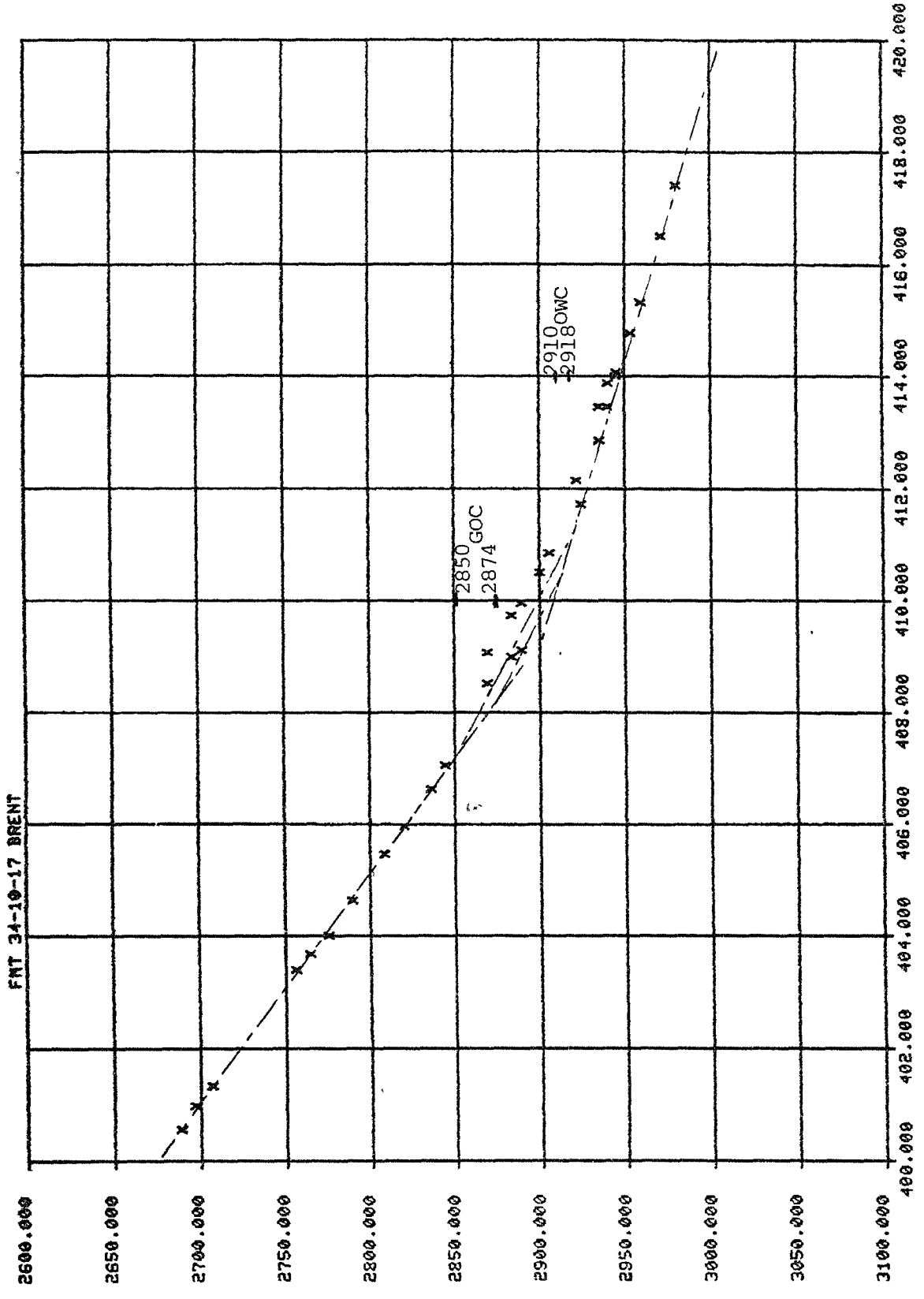
Comments: One gallon chamber opening pressure in lab.: 205 bar
Laboratory results from the one gallon chamber will be presented in a special report.

FIG 1



30 09 83 PS

Figure 2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2700.000
2750.000
2800.000
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2900.000
2950.000
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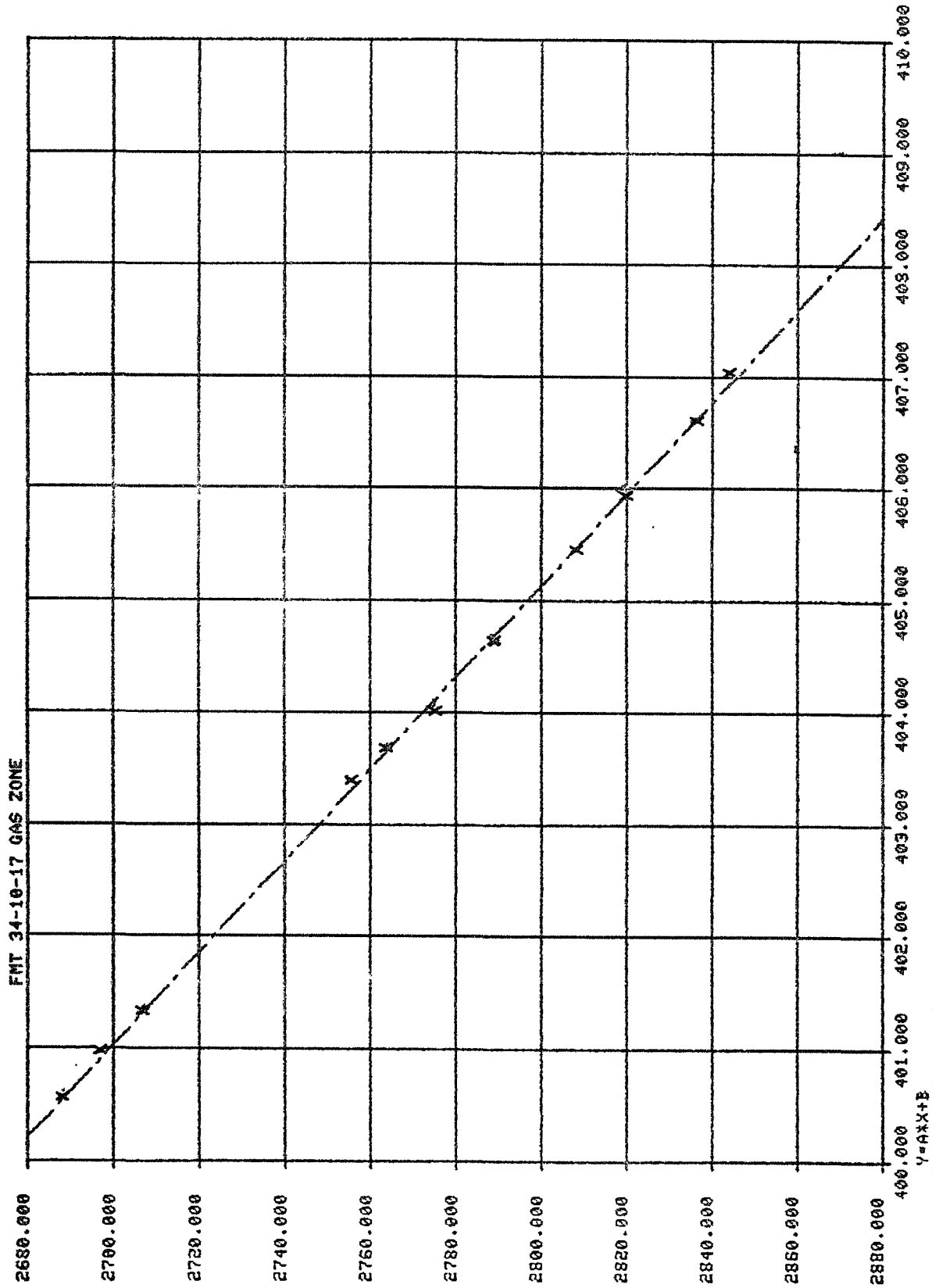
3050.000
3100.000
400.000
402.000
404.000
406.000
408.000
410.000
412.000
414.000
416.000
418.000
420.000
2850
2874
GOC
2910
2918
OWC

Figure 3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2740.000
2760.000
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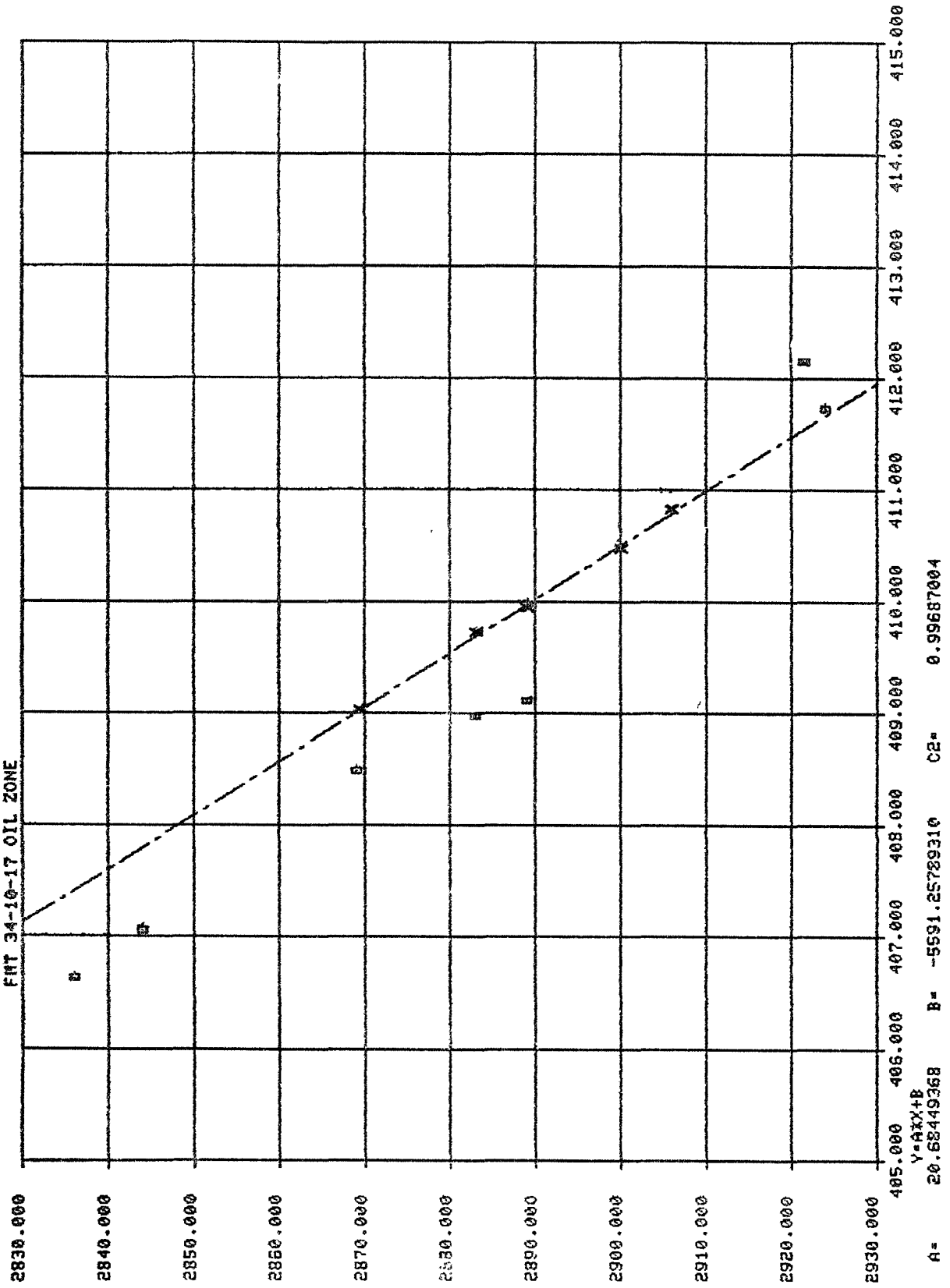
2880.000
400.000
401.000
402.000
403.000
404.000
405.000
406.000
407.000
408.000
409.000
410.000
Y=AX+B
A= 24.39149366
B= -7082.13788792
C2= 0.99926469

Figure 4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2830.000
2840.000
2850.000
2860.000
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2890.000
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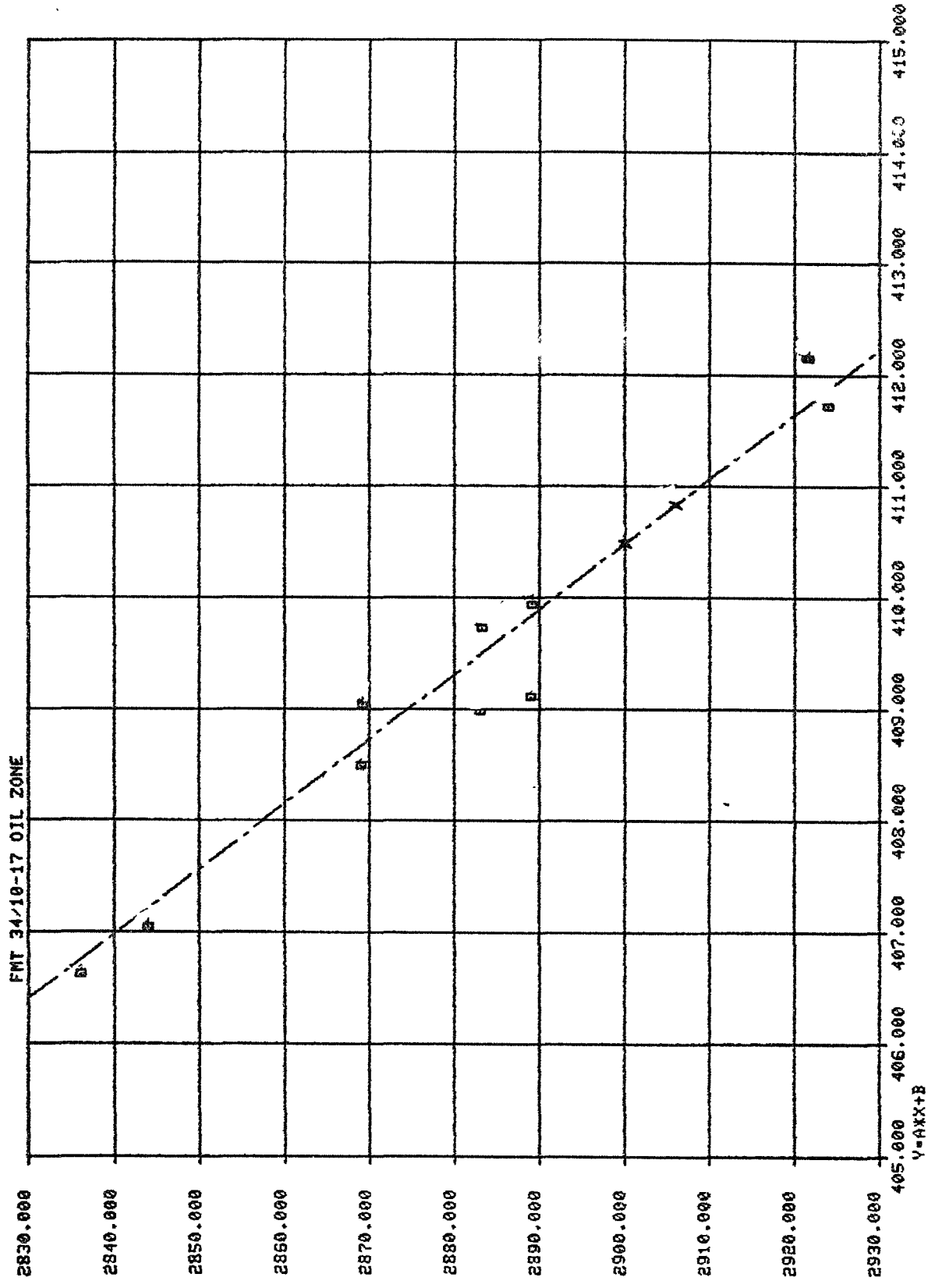
2920.000
2930.000
405.000
406.000
407.000
408.000
409.000
410.000
411.000
412.000
413.000
414.000
415.000
Y=AXX+B
A= 20.68449368
B= -5591.25789310
C2= 0.99687004

Figure 5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2840.000
2850.000
2860.000
2870.000
2880.000
2890.000
2900.000
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2920.000
2930.000
405.000
406.000
407.000
408.000
409.000
410.000
411.000
412.000
413.000
414.000
415.000
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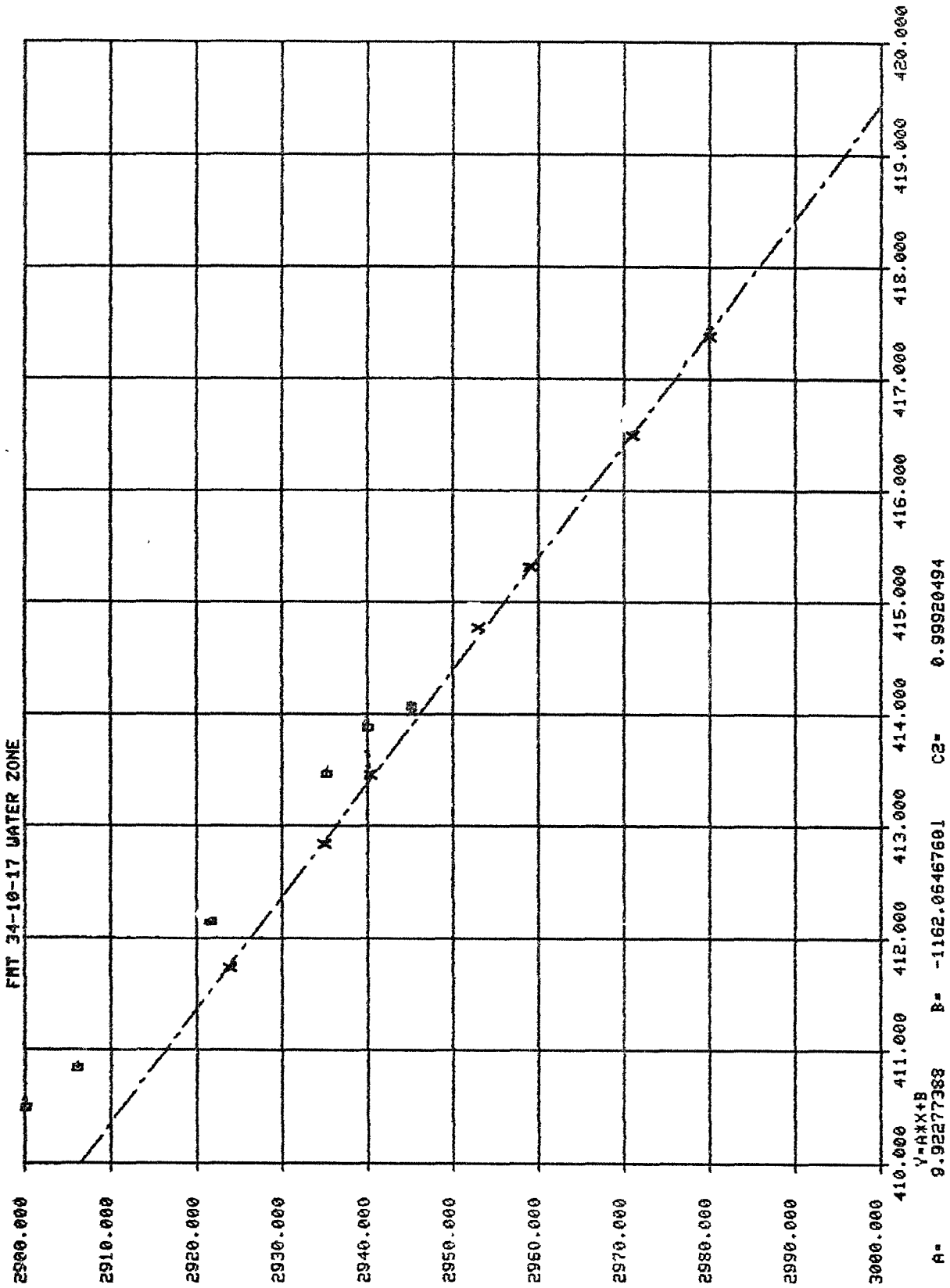
B= -4152.89684366

Figure 6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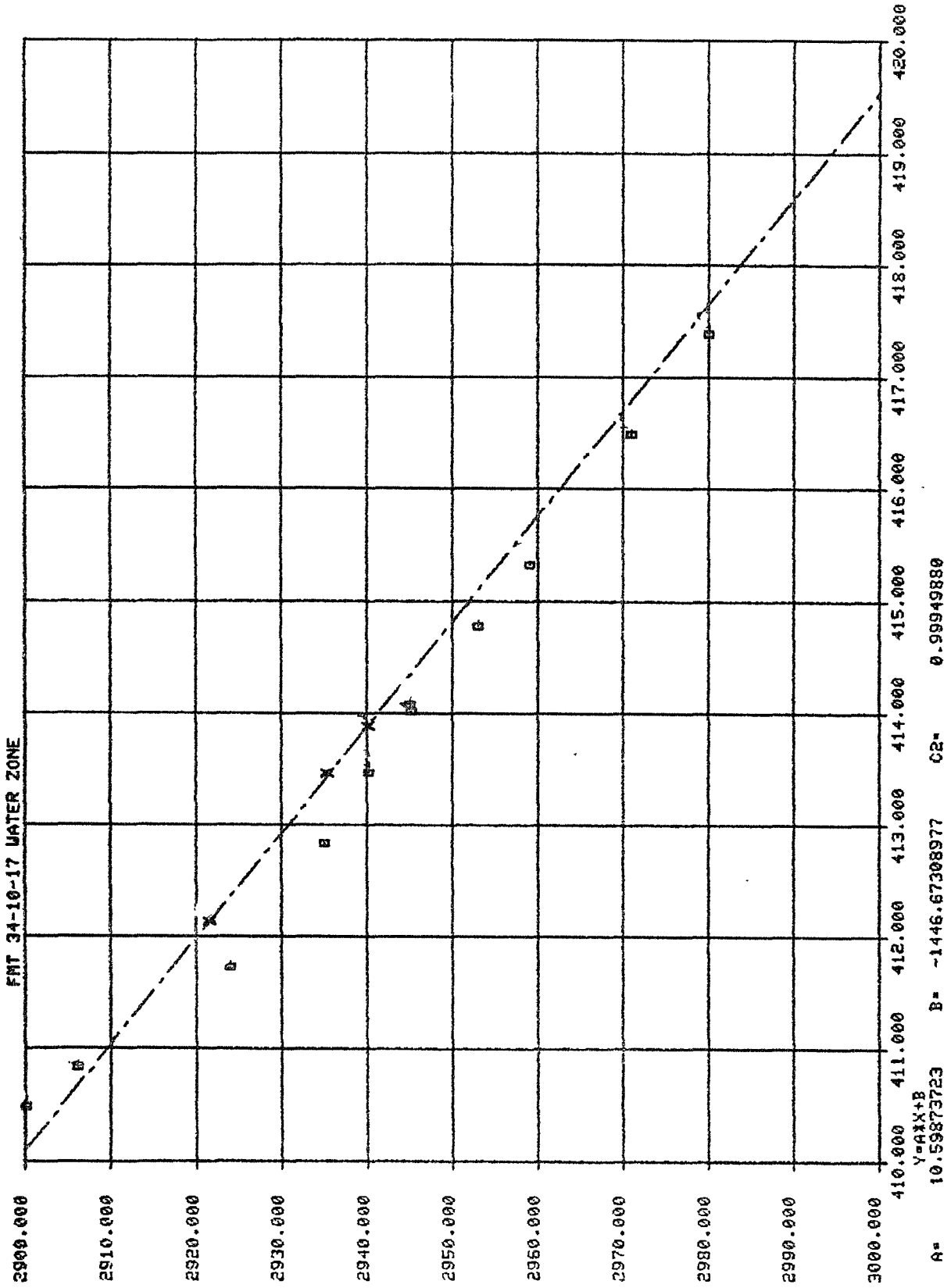
2910.000
2920.000
2930.000
2940.000
2950.000
2960.000
2970.000
2980.000
2990.000
3000.000
410.000
411.000
412.000
413.000
414.000
415.000
416.000
417.000
418.000
419.000
420.000
Y=A*X+B
A= 9.92277388
B= -1162.06467601
C2= 0.99920494

Figure 7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2920.000
2930.000
2940.000
2950.000
2960.000
2970.000
2980.000
2990.000
3000.000
410.000
411.000
412.000
413.000
414.000
415.000
416.000
417.000
418.000
419.000
420.000
Y=A*X+B
A= 10.59873723
B= -1446.67308977
C2= 0.99949880