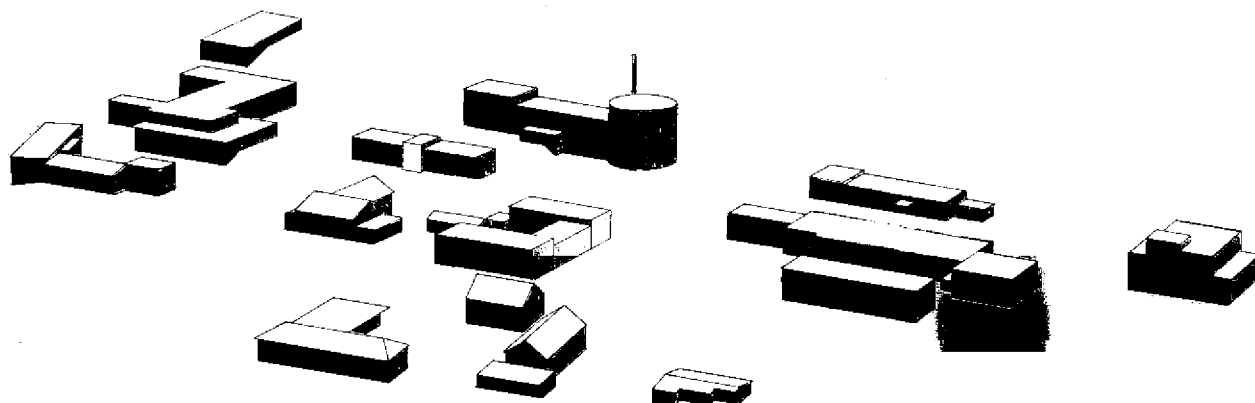REPORT NO.
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REPORT ON MUD AND RESERVOIRED GAS STABLE ISOTOPE
GEOCHEMISTRY FROM WELL 6407/1-3

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SUMMARY

The gas components CH_4, C_2H_6, C_3H_8, $i-C_4H_{10}$, $n-C_4H_{10}$ and CO_2 have been separated from the reservoired gas of well 6407/1-3. CH_4 have been separated from the mud gas samples which were received in vacutainers. The $\delta^{13}C$ values of the separated hydrocarbon gas components have been measured.

A high maturity source (source LOM of about 13) is clearly indicated for all the reservoired gas samples.

The $\delta^{13}C$ methane values of most of the mud gas samples range from -40.5 to -46.5, indicating that the well from the 2400 m level and downwards are completely dominated by thermogenically formed gas. Only the methane of the highest gas sample (2300 m) may have a component of bio-genically formed methane, but thermogenically formed methane is also in this case dominating.

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REPORT ON MUD AND RESERVOIRED GAS STABLE ISOTOPE GEOCHEMISTRY FROM
WELL 6407/1-3

ANALYTICAL PROCEDURE

The natural gas has been separated into the different gas components
by a Carlo-Erba 4200 instrument. The hydrocarbon gas components were
oxydized in separate CuO-ovens, which enables us to collect several
times when the concentration of a gas component is low. The
combustion products CO_2 and H_2O were frozen into collection vessles
and separated. The isotopic measurements were performed on a Finnigan
Mat 251 mass spectrometer. Our $\delta^{13}C$-value on NBS-22 is -29.77
+/- .06 $^0/oo$.

RESULTS

The results are given in tables 1 and 2.

INTERPRETATION

a) reservoired gas

The $\delta^{13}C$ values of methane, ethane, propane and n-butane for the reser-
voired gas samples are plotted on the maturity diagram by James (1983)*
Fig. 1.

A high maturity source (source LOM of about 13) is clearly indidcated for
all the samples. Only sample Ex 6 Gać RFT 3695 has different (heavier)
$\delta^{13}C$ values than the other samples. The reason for this is not at present
undersstood.**

The $\delta^{13}C$-methane values falls above the methane line in the diagram. This
is often the case for LOMs from 12 to 14, the range of maturities where
condensates are common.

b) mud gas

$\delta^{13}C$-methane values have been determined from the 2300 m level to the
6002 m level. Only the sample from the 2300 m level (and possibly the
sample from the 2399 m level) indicate a mixture between biogenic and
thermogenic methane. Early diagenetic isotopically light methane is also
a possibility in the case of these samples. The $\delta^{13}C$ values for the other
samples range from -40.5 to - 46.5, indicating that the gas samples from
the 2400 m level and downwards are completely dominated by
thermogenically formed gas.

CONCLUSION

A high maturity source (source LOM of about 13) is clearly indicated for all the reservoired gas samples. The $\delta^{13}C$ methane values of most of the mud gas samples range from-40.5 to -46.5, indicating that the well from the 2400 m level and downwards are completely dominated by thermogenically formed gas. Only the methane of the highest gas sample (2300 m) may have a component of biogenically formed methane, but thermogenically formed methane is also in this case dominating.

* James, Alan T. (1983) : Correlation of Natural Gas by Use of Carbon Isotopic Distribution Between Hydrocarbon Components, A.A.P.G. Vol. 67, No. 7, July, 1983.

** The gas volume of this sample container(aluminium bag) has, however. decreased considerably since the isotope analyses were done. A very early stage of bacterial degradation in the sample container could therefore be the reason for the different values in the case of sample Ex 6 Gac RFT 3695.

TABELL 1.

ISOTOPIC COMPOSITION OF MUD AND RESERVOIRED GAS FROM WELL 6407/1-3

IFE No.	Sample depth m	$\partial^{13}C_1$	δD	C_2	C_3	iC_4	nC_4	Co_2
1334	Trip gas after core # 2	-41.7						
1335	2300	-49.4						
1336	2399	-47.4						
1337	TD3160 ≈ 2400	-43.2						
1338	2453	-45.9						
1339	2455	-45.4						
1340	2455.8	-42.7						
1341	2464	-45.0						
1342	2484.8	-45.4						
1343	2523	-44.0						
1344	2560	-45.3						
1346	TD-Ditch sample while reaming 3136	-42.7						
1347	TD-chokeline sample whilst circ thru choke 3136	-43.9						
1348	3222	-46.5						
1350	wtg from 3364	-44.3						
1351	3426	-42.4						
1352	3437.8	-42.3						
1353	3463	-41.1						
1354	3463.6	-42.2						
1355	3465.9	-40.5						
1356	3473.9	-44.3						
1359	wtg from 3545 T.D.3388	-44.6						
1360	3609	-42.5						

IFE No.	Sample depth m	$\delta^{13}C_1$ δD	C_2	C_3	iC_4	nC_4	Co_2
1361	3639	-41.3					
1328	RFT 3676	-43.5	-30.9	-29.7		-29.5	-13.8
1329	RFT 3692	-43.5	-30.4	-30.5	-29.3	-29.8	-13.2
1330	A-14768	-43.7	-31.0	-30.7	-28.5	-30.6	-14.9
1331	A-14749	-44.1˙	-30.3	-30.1	-29.1	-29.9	-14.9
1332	Ex 6 GAC RFT 3695	-43.8	-27.4	-26.7	-27.6	-27.5	
1363	3766	-44.7					
1364	Trip gas 4274	-44.7					
1365	Trip gas 4274	-43.9					
1366	4292	-42.8					
1367	STG 4310	-42.6					
1368	4361.5	-41.8					
1369	4363	-44.6					
1370	4393	-43.7					
1371	4417.5	-40.9					
1372	4429/CXN	-42.8					
1373	4440	-42.0					
1374	4458	-42.3					
1375	4460	-41.9					
1376A	T.D. 4469	-42.5					
1376B	T.D. 4469	-41.8					
1376C	T.D. 4469	-41.6					
1377A	T.G. 4469	-42.4					
1378	6002	-43.1					

Our uncertainty on the $\delta^{13}C$-value is estimated to be +/- .3 ^{0}/oo, and includes all the different analyses steps.

TABELL 2.

Composition of mud and reservoired gas from well 6407/1-3
% of C_1-C_4

Sample depth m	C_1	C_2	C_3	iC_4	nC_4	Co_2	$\dfrac{C_2\text{-}C_4}{C_1\text{-}C_4}$	$\dfrac{iC_4}{nC_4}$
			% of C_1-C_4					
U/S	0.03	0.002				0.07	0.06	
Trip gas after core								
# 2	1.8	0.10	0.05	0.008	0.013	0.05	0.09	0.62
2300	1.4	0.03	0.003		0.002	0.04	0.03	
2399	0.3	0.01	0.003		<0.001	0.03	0.04	
T.D.3160								
* 2400	2.7	0.22	0.11	0.02	0.03	0.04	0.12	0.67
2453	5.0	0.71	0.40	0.06	0.11	0.05	0.20	0.55
2455	0.4	0.04	0.03	0.06	0.09	0.05	0.36	0.67
2455.8	7.7	1.0	0.60	0.10	0.17	0.05	0.20	0.59
2464	2.0	0.35	0.18	0.03	0.05	0.03	0.23	0.60
2484.8	8.2	0.93	0.49	0.08	0.15	0.04	0.17	0.53
2523	0.9	0.08	0.06	0.008	0.015	0.03	0.15	0.53
2560	1.2	0.14	0.09	0.014	0.029	0.04	0.19	0.48
3136 *	0.1	0.04	0.04	0.006	0.012	0.03	0.50	0.50
3136 **	1.0	0.09	0.05	0.007	0.017	0.03	0.14	0.41
3136 ***	0.7	0.26	0.35	0.10	0.18	0.03	0.56	0.56
3222	0.7	0.03	0.01		0.002	0.04	0.06	
Bkg 3338	0.4	0.01	0.003		<0.001	0.04	0.03	
WTG 3364	0.5	0.01	0.004		<0.001	0.05	0.03	
3426	0.5	0.02	0.008		<0.001	0.04	0.05	
3437.8	0.8	0.03	0.01		0.002	0.05	0.05	
3463	0.8	0.03	0.01		0.001	0.05	0.05	
3463.6	1.4	0.06	0.03	0.004	0.006	0.04	0.07	0.67
3465.9	2.3	0.11	0.06	0.008	0.016	0.04	0.08	0.50
3473.9	1.4	0.06	0.03	0.005	0.009	0.02	0.07	0.56
3525	0.1	0.007	0.006		0.001	0.02	0.12	
3543	0.2	0.009	0.004		0.001	0.03	0.07	
WTG 3545								
TD 3388	0.3	0.02	0.007		0.001	0.04	0.09	
3609	1.6	0.08	0.04	0.005	0.015	0.03	0.08	0.33
3639	0.7	0.03	0.01	0.002	0.003	0.02	0.06	0.67
RFT 3676	68	4.3	2.5	0.4	0.8	3.1	0.11	0.50
3684	0.03	0.009	0.02	0.004	0.01	0.06	0.59	0.40
RFT 3692	64	4.0	1.6	0.3	0.5	2.3	0.09	0.60
A 14768	76	5.0	2.8	0.35	0.76	3.5	0.11	0.46
A 14749	81	6.3	4.6	0.47	0.42	2.2	0.13	1.12
Ex 6 GAC								
RFT 3695	76	9.0	5.4	1.0	3.0	0.31	0.20	0.33
3766	0.5	0.01	0.004			0.03	0.03	
Trip gas								
4274	0.5	0.05	0.02		0.002	0.08	0.13	
Trip gas								
4274	5.3	0.8	0.7	0.11	0.15	0.03	0.25	0.73
4292	0.5	0.07	0.06	0.02	0.03	0.04	0.27	0.67
STG 4310	0.5	0.06	0.02		0.008	0.03	0.15	
4361.5	0.5	0.07	0.04		0.005	0.04	0.19	
4363	0.9	0.1	0.05		0.009	0.04	0.15	
4393	0.3	0.04	0.02		0.002	0.03	0.17	
4417.5	0.3	0.03	0.01		<0.001	0.04	0.12	

Sample depth m	C_1	C_2	C_3	iC_4	nC_4	CO_2	$\dfrac{C_2-C_4}{C_1-C_4}$	$\dfrac{iC_4}{nC_4}$
			% of C_1-C_4					
4429/CXN	0.8	0.08	0.03		0.004	0.03	0.13	
4440	0.7	0.08	0.03		0.004	0.04	0.14	
4458	0.8	0.08	0.03		0.005	0.03	0.13	
4460	1.2	0.2	0.06			0.04	0.18	
T.D.4469	0.7	0.1	0.04		0.006	0.03	0.17	
T.D.4469	0.7	0.1	0.04		0.006	0.04	0.17	
T.D.4469	0.7	0.1	0.04		0.006	0.04	0.17	
T.G. 4469	1.5	0.3	0.2	0.015	0.023	0.05	0.26	0.65
6002	0.4	0.02	0.007			0.03	0.06	

*   Ditch gas after WOW prior to circulation

** TD. Ditch sample while reaming

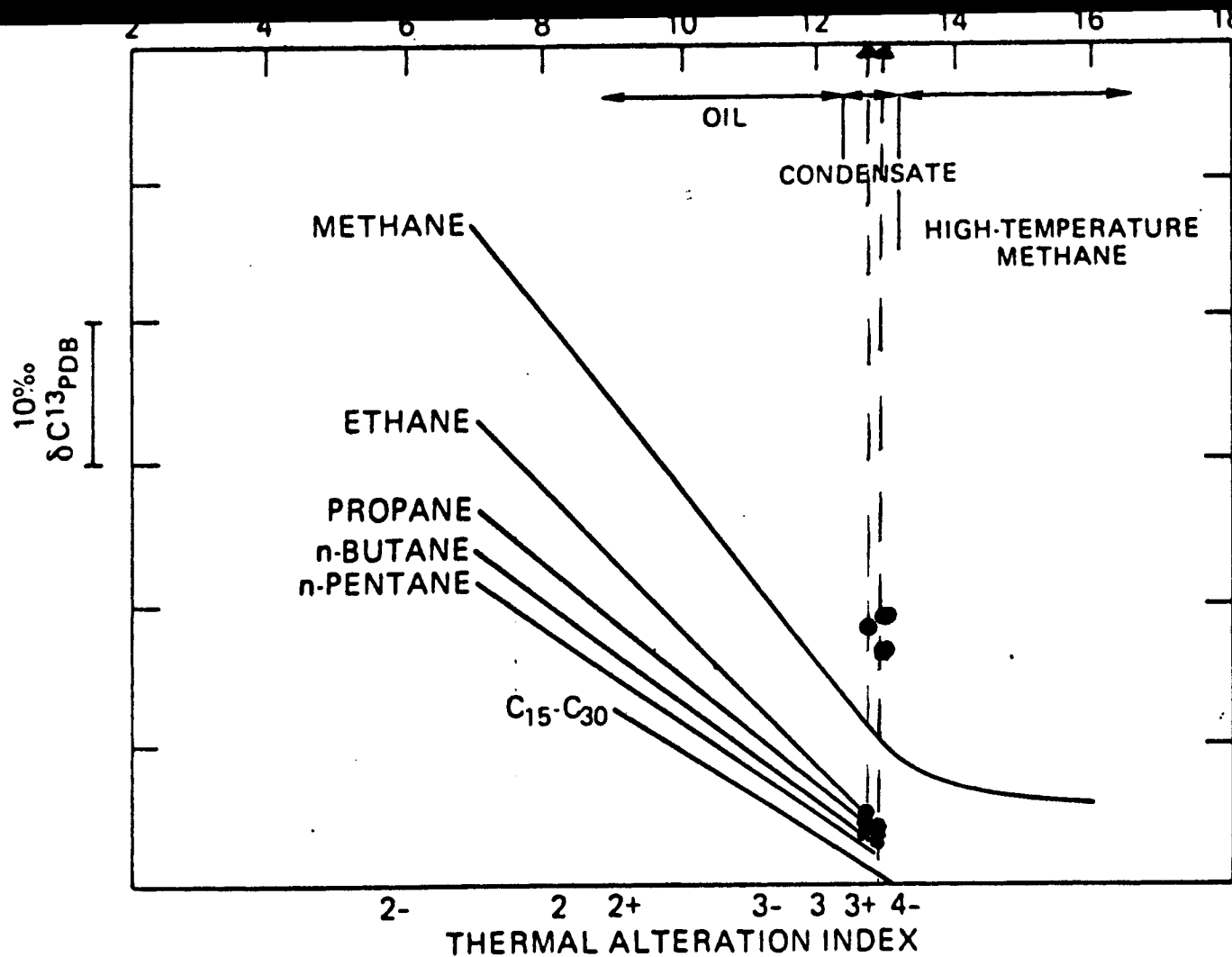*** TD. chokeline sample whilst circ. thru choke

Figure 1. Carbon isotopic separations of natural gases from well 6407/1-3 plotted on the maturity diagram (after James, 1983). A source LOM of about 13 is indicated for the gases.

The calculated carbon isotopic separations between gas component are plotted on the vertical axis using a sliding scale that is simply the algebraic difference, in parts per mil, between the isotopic compositions of the natural gas components. The scale does not possess a fixed origin, but is oriented with the more depleted $\delta^{13}C$ values at the upper end. Use of this sliding scale allows the maturity of a gas to be assessed without prior knowledge of the isotopic composition of the gas' source.