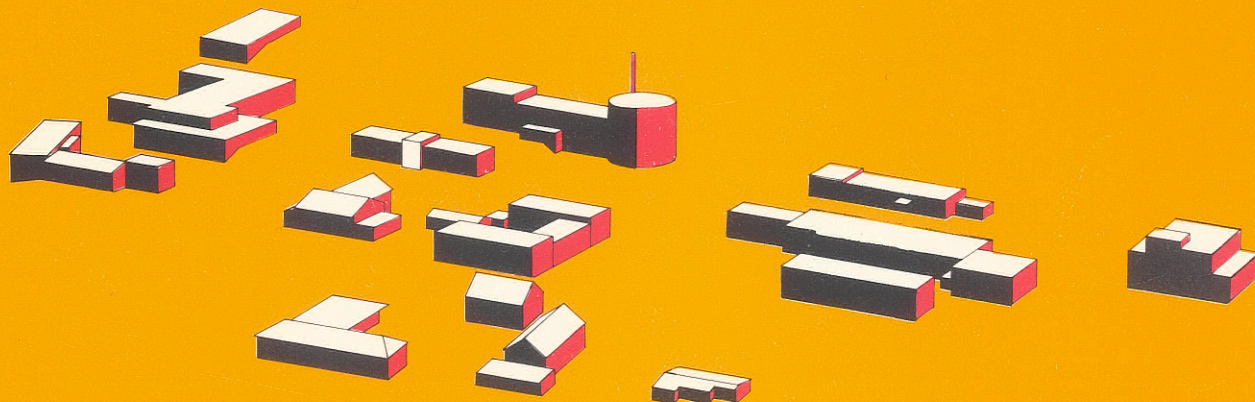


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REPORT TITLE
REPORT ON MUD AND RESERVOIRED GAS STABLE ISOTOPE
GEOCHEMISTRY FROM WELL 6407/1-3

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SUMMARY				DISTRIBUTION
<p>The gas components CH₄, C₂H₆, C₃H₈, i-C₄H₁₀, n-C₄H₁₀ and CO₂ have been separated from the reservoir gas of well 6407/1-3. CH₄ have been separated from the mud gas samples which were received in vacutainers. The δ¹³C values of the separated hydrocarbon gas components have been measured.</p> <p>A high maturity source (source LOM of about 13) is clearly indicated for all the reservoir gas samples.</p> <p>The δ¹³C 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.</p>				<p>Oppdragsgiver 10 Andresen, B. Berg, J.O. Brevik, E. Garder, K. Gaudernack, B. Råheim, A.</p>
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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 CO₂ and H₂O were frozen into collection vessles and separated. The isotopic measurements were performed on a Finnigan Mat 251 mass spectrometer. Our δ¹³C-value on NBS-22 is -29.77 +/- .06 /oo.

RESULTS

The results are given in tables 1 and 2.

INTERPRETATION

a) reservoird gas

The δ¹³C values of methane, ethane, propane and n-butane for the reservoird 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 Gač RFT 3695 has different (heavier) δ¹³C values than the other samples. The reason for this is not at present undersstood.**

The δ¹³C-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

δ¹³C-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 δ¹³C 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 reservoir gas samples. The $\delta^{13}\text{C}$ 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	$\delta^{13}\text{C}_1$ ‰	C_2	C_3	$i\text{C}_4$	$n\text{C}_4$	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	$\delta^{13}\text{C}_1$ ‰	C_2	C_3	$i\text{C}_4$	$n\text{C}_4$	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 $\delta^{13}\text{C}$ -value is estimated to be $\pm .3$ ‰, and includes all the different analyses steps.

TABELL 2.

Composition of mud and reservoired gas from well 6407/1-3
% of C₁-C₄

Sample depth m	C ₁	C ₂	C ₃	iC ₄	nC ₄	Co ₂	<u>C₂-C₄</u>	<u>iC₄</u>
	% of C ₁ -C ₄						C ₁ -C ₄	nC 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	$\frac{C_2 - C_4}{C_1 - C_4}$	$\frac{iC_4}{nC_4}$
	% 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

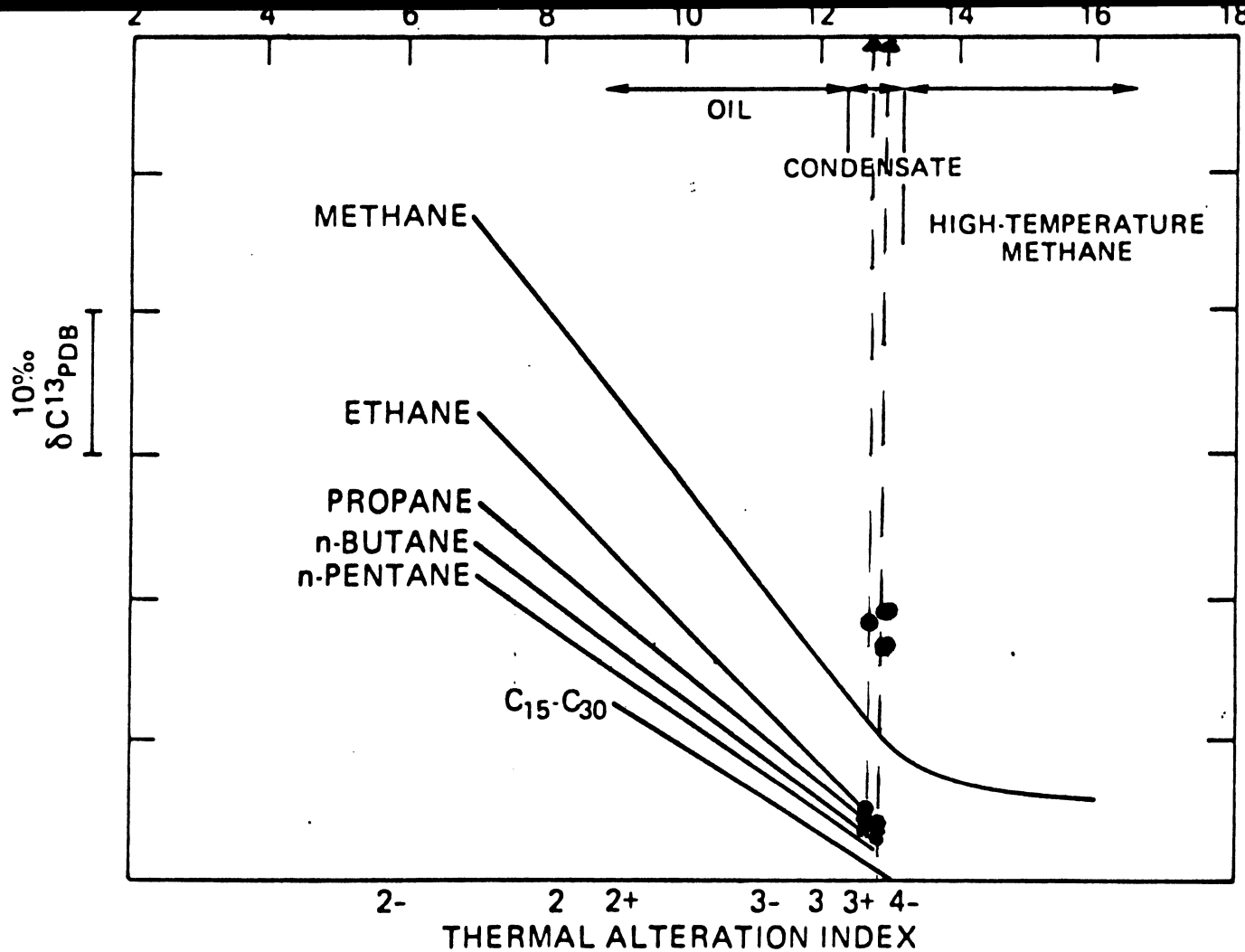


Figure 1. Carbon isotopic separations of natural gases from well 6407/1-3 plotted on the maturity diagram (after James, 1983). A source LOM of about 13 is indicated for the gases.

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 $\delta^{13}\text{C}$ 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.