Geochemistry Report – Oil and Gas from well 16/1-9

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Table 1. Number of analyses performed

Analysis	Fluid	Gas	Total
Gas composition		2	2
Stable isotopes of gas		2	2
Stable isotopes of fractions	1		1
Iatroscan	1		1
Asphaltenes	1		1
MPLC	1		1
Density/Topping	1		1
GC of Whole Oil	1		1
GC of Saturated hydrocarbons	1		1
GC-MS of Saturated hydrocarbons	1		1
GC-MS of Aromatic hydrocarbons	1		1

Table 2. GC of Whole Oil (parameters)

Well	Sample type	Lower Depth (m)	APT ID	A	B	X	W	C	I	F	H	U	R	S
16/1-9	Oil		50949	0.47	1.55	1.21	5.35	0.78	1.43	0.61	22.43	1.55	3.56	71.35

A: Benz/n-C_6
B: Tol/n-C_7
X: m+p-Xyl/n-C_8
W: Benz*10/CyC_6
C: (n-C_6+n-C_7)/(CyC_6+$MCyC_6$)
I: (2-MC_6+3-MC_6)/(c1,3-$DMCyC_5$+t1,3-$DMCyC_5$+t1,2-$DMCyC_5$)
F: n-C_7/$MCyC_6$
H: n-C_7*100/(CyC_6+2-MC_6+3-MC_6+c1,3-$DMCyC_5$+t1,3-$DMCyC_5$+t1,2-$DMCyC_5$+n-C_7+$MCyC_6$)
U: CyC_6/$MCyC_5$
R: n-C_7/2-MC_6
S: n-C_6/2,2-DMC_4

Table 3. GC of saturated compounds (parameters)

Well	Sample type	Lower Depth (m)	APT ID	CPI 1	Pr/n-C17	Ph/n-C18	(Pr/n-C17)/(Ph/n-C18))	Pr/Ph	n-C17/(n-C17+C27)
16/1-9	Oil		50949T	1.06	0.51	0.42	1.23	1.35	0.68

Table 4. GCMS SIR of saturated compounds (parameters)

Well	Sample type	Lower Depth (m)	APT ID	%23:3	%28αβ	%30D	%27Ts	%22S	%29Ts	%20S	%ββ	%27dβS	%C27	%C29	28/29	24:4/23:3
16/1-9	Oil		50949T	14.98	21.55	23.12	70.04	57.42	25.23	57.37	60.52	70.24	34.55	35.95	0.78	0.67

%23:3	23:3/(23:3+30αβ)*100
%28αβ	28αβ/(28αβ+30αβ)*100
%30D	30D/(30D+30αβ)*100
%27Ts	27Ts/(27Ts+27Tm)*100
%22S	(32αβS/(32αβS+32αβR)*100
%29Ts	(29Ts/29Ts+30αβ)*100
%20S	(29ααS/29ααS+29ααR)*100

%ββ	(29ββ(R+S)/(29ββ(R+S)+29αα(R+S)*100
%27dβS	27dβS/(27dβS+27αα(R+S))*100
%C27	(27ββ(R+S)/(27ββ(R+S)+28ββ(R+S)+29ββ(R+S))*100
%C29	(29ββ(R+S)/(27ββ(R+S)+28ββ(R+S)+29ββ(R+S))*100
28/29	(28αα(R+S)+28ββ(R+S))/(29αα(R+S)+29ββ(R+S))
24:4/23:3	24:4/23:3

Table 5. GCMS SIR of aromatic compounds (parameters)

Well	Sample type	Lower Depth (m)	APT ID	AROM2	Crack1	Crack2	MSAro1	MSAro2	MSAro3	MSAro4	MSAro5	MSAro6	MSAro7	MSAro8	MSAro9
16/1-9	Oil		50949T	0.70	0.75	0.53	0.45	5.11	0.46	1.78	6.81	2.65	0.09	8.49	0.64

AROM2: $(C_{20}TA+C_{21}TA+SC_{26}TA+RC_{26}TA+SC_{27}TA+SC_{28}TA+RC_{27}TA+RC_{28}TA/(C_{20}TA+C_{21}TA+SC_{26}TA+RC_{26}TA+SC_{27}TA+SC_{28}TA+RC_{27}TA+RC_{28}TA+C_{21}MA+C_{22}MA+\beta SC_{27}MA+\beta RC_{27}MA+\beta RC_{27}DMA+\alpha SC_{27}MA+\beta SC_{28}MA+\beta SC_{28}DMA+\alpha RC_{27}DMA+\alpha SC_{27}DMA+\alpha RC_{27}MA+\alpha SC_{28}MA+\alpha SC_{29}MA+\alpha RC_{29}MA)$

Crack1: $(C_{20}TA)/(C_{20}TA+RC_{28}TA)$

Crack2: $(C_{20}TA+C_{21}TA)/(C_{20}TA+C_{21}TA+SC_{26}TA+RC_{26}TA+SC_{27}TA+SC_{28}TA+RC_{27}TA+RC_{28}TA)$

MSAro1: $(C_{21}MA+C_{22}MA)/(C_{21}MA+C_{22}MA+\beta SC_{27}MA+\beta RC_{27}MA+\beta RC_{27}DMA+\alpha SC_{27}MA+\beta SC_{28}MA+\beta SC_{28}DMA+\alpha RC_{27}DMA+\alpha SC_{27}DMA+\alpha RC_{27}MA+\alpha SC_{28}MA+\alpha SC_{29}MA+\alpha RC_{29}MA)$

MSAro2: 4-MDBT/1-MDBT

MSAro3: (2-MP+3-MP)/(1-MP+2-MP+3-MP+9-MP)

MSAro4: 2-MN/1-MN

MSAro5: (2,6-DMN+2,7-DMN)/1,5-DMN

MSAro6: 4-MDBT/DBT

MSAro7: DBT/P

MSAro8: 3-MP/Retene

MSAro9: $RC_{28}TA/(RC_{28}TA+\alpha RC_{28}MA+\beta RC_{29}MA+\beta RC_{29}DMA)$

Table 6. Gas Composition (volume-%)

Well	Sample type	Lower Depth (m)	APT ID	C1%	C2%	C3%	iC4%	nC4%	iC5%	nC5%	C6+%	CO2%	Sum C1-C5	Wetness	iC4/nC4	ppm
16/1-9	Gas	2405	50950	83.4	8.6	4.4	0.58	1.4	0.39	0.48	0.20	0.55	99.3	15.2	0.43	1048738
16/1-9	Gas		50951	69.9	13.1	9.0	1.4	3.4	0.93	1.2	0.57	0.61	98.8	27.8	0.40	1039964

Table 7. Gas Isotopes (δ13C (‰ PDB) & δD (‰ SMOW))

Well	Sample type	Lower Depth (m)	APT ID	C1 δ13C	C2 δ13C	C3 δ13C	i-C4 δ13C	n-C4 δ13C	i-C5 δ13C	n-C5 d13C	CO2 d13C	C1 δD	
16/1-9	Gas	2405	50950	-40.6	-30.4	-27.8	-28.0	-28.3				-195.0	
16/1-9	Gas		50951	-40.6	-30.5	-28.3	-28.2	-28.3				-211.0	

Table 8. Isotopes of fractions, δ13C (‰ PDB)

Well	Sample type	Lower Depth (m)	APT ID	δ13C-Oil/EOM	δ13C-Sat	δ13C-Aro	δ13C-Pol	δ13C-Asp	δ13C-Ker
16/1-9	Oil		50949	-28.3	-29.3	-27.7			

Table 9. Extraction, Asphaltene precipitation and Iatroscan data

Well	Sample type	Lower Depth (m)	APT ID	Rock weight (g)	EOM (mg)	EOM (mg/kg Rock)	SAT (wt% of EOM/Oil)	ARO (wt% of EOM/Oil)	POL (wt% of EOM/Oil)	ASP (wt% of EOM/Oil)	HC (wt% of EOM/Oil)
16/1-9	Oil		50949				69.7	26.3	2.7	1.3	96.0

Table 10. Density and topping

Well	Sample type	Lower Depth (m)	APT ID	Density (g/cm3)	°API	Topped oil
16/1-9	Oil		50949	0.843	36.3	78.7

Table 11. GC of Whole Oil (peak area)

Well	Sample type	Lower Depth (m)	APT ID	IS 2,2,4-TMC5	n-C3	i-C4	n-C4	i-C5	n-C5	2,2-DMC4	CyC5	2,3-DMC4	2-MC5	3-MC5	n-C6	2,2-DMC5	MCyC5	2,4-DMC5	2,2,3-TMC4	Benz
16/1-9	Oil		50949	1.41e5	2.08e4	1.32e4	5.62e4	5.93e4	1.06e5	2.34e3	1.93e4	1.06e4	7.40e4	4.67e4	1.67e5	2.59e3	9.57e4	7.00e3	7.41e2	7.91e4

Table 11. continued, GC of Whole Oil (peak area)

Well	Sample type	Lower Depth (m)	APT ID	3,3-DMC5	CyC6	2-MC6	2,3-DMC5	1,1-DMCyC5	3-MC6	c-1,3-DMCyC5	t-1,3-DMCyC5	3-EC5	t-1,2-DMCyC5	n-C7	c-1,2-DMCyC5	MCyC6	1,1,3-TMCyC5	ECyC5	2,5-DMC6	2,2,3-TMC5/ 2,4-DMC6
16/1-9	Oil		50949	1.77e3	1.48e5	5.08e4	1.56e4	1.14e4	5.52e4	2.06e4	1.95e4	3.50e3	3.40e4	1.81e5	0.00e0	2.97e5	1.17e4	1.41e4	7.45e3	9.61e3

Table 11. continued, GC of Whole Oil (peak area)

Well	Sample type	Lower Depth (m)	APT ID	c,t-1,2,4-TMCyC5	3,3-DMC6	t,c-1,2,3-TMCyC5	2,3,4-TMC5	Tol	2,3-DMC6	2-MC7	4-MC7	3-MC7	c-1,3-DMCyC6	t-1,4-DMCyC6	1,1-DMCyC6	t-1,2-DMCyC6	n-C8	E-CyC6	i-C9	E-Benz
16/1-9	Oil		50949	1.11e4	2.41e3	1.00e4	2.03e3	2.80e5	1.21e4	6.27e4	1.89e4	4.52e4	6.55e4	2.61e4	9.66e3	2.88e4	2.02e5	8.15e4	2.14e4	5.08e4

Table 11. continued, GC of Whole Oil (peak area)

Well	Sample type	Lower Depth (m)	APT ID	m-Xyl	p-Xyl	4-MC8	2-MC8	3-MC8	o-Xyl	n-C9	i-C10	n-C10	i-C11	n-C11	n-C12	i-C13	i-C14	n-C13	i-C15	n-C14
16/1-9	Oil		50949	1.87e5	5.72e4	2.29e4	3.03e4	7.85e3	8.67e4	1.86e5	3.15e4	1.80e5	3.37e4	1.72e5	1.70e5	2.99e4	1.08e5	1.68e5	3.65e4	1.60e5

Table 11. continued, GC of Whole Oil (peak area)

Well	Sample type	Lower Depth (m)	APT ID	i-C16	n-C15	n-C16	i-C18	n-C17	i-C19	n-C18	i-C20	n-C19	n-C20	n-C21	n-C22	n-C23	n-C24	n-C25	n-C26	n-C27
16/1-9	Oil		50949	7.19e4	1.69e5	1.49e5	3.89e4	1.39e5	7.08e4	1.25e5	5.07e4	1.21e5	1.14e5	1.01e5	9.56e4	8.93e4	8.25e4	7.40e4	6.97e4	5.88e4

Table 11. continued, GC of Whole Oil (peak area)

Well	Sample type	Lower Depth (m)	APT ID	n-C28	n-C29	n-C30	n-C31	n-C32	n-C33	n-C34	n-C35	n-C36
16/1-9	Oil		50949	4.73e4	4.42e4	3.59e4	3.19e4	2.50e4	1.79e4	1.50e4	1.35e4	1.23e4

Table 12. GC of Whole Oil (amounts in ng/g)

Well	Sample type	Lower Depth (m)	APT ID	IS 2,2,4-TMC5	n-C3	i-C4	n-C4	i-C5	n-C5	2,2-DMC4	CyC5	2,3-DMC4	2-MC5	3-MC5	n-C6	2,2-DMC5	MCyC5	2,4-DMC5	2,2,3-TMC4	Benz
16/1-9	Oil		50949	7.34e6	1.12e6	7.01e5	2.98e6	3.12e6	5.55e6	1.22e5	9.89e5	5.53e5	3.88e6	2.45e6	8.73e6	1.35e5	4.90e6	3.65e5	3.87e4	3.76e6

Table 12. continued, GC of Whole Oil (amounts in ng/g)

Well	Sample type	Lower Depth (m)	APT ID	3,3-DMC5	CyC6	2-MC6	2,3-DMC5	1,1-DMCyC5	3-MC6	c-1,3-DMCyC5	t-1,3-DMCyC5	3-EC5	t-1,2-DMCyC5	n-C7	c-1,2-DMCyC5	MCyC6	1,1,3-TMCyC5	ECyC5	2,5-DMC6	2,2,3-TMC5/ 2,4-DMC6
16/1-9	Oil		50949	9.25e4	7.57e6	2.65e6	8.12e5	5.82e5	2.88e6	1.05e6	9.95e5	1.83e5	1.74e6	9.44e6	0.00e0	1.52e7	5.98e5	7.20e5	3.88e5	5.00e5

Table 12. continued, GC of Whole Oil (amounts in ng/g)

Well	Sample type	Lower Depth (m)	APT ID	c,t-1,2,4-TMCyC5	3,3-DMC6	t,c-1,2,3-TMCyC5	2,3,4-TMC5	Tol	2,3-DMC6	2-MC7	4-MC7	3-MC7	c-1,3-DMCyC6	t-1,4-DMCyC6	1,1-DMCyC6	t-1,2-DMCyC6	n-C8	E-CyC6	i-C9	E-Benz
16/1-9	Oil		50949	5.68e5	1.26e5	5.13e5	1.06e5	1.35e7	6.29e5	3.26e6	9.86e5	2.35e6	3.35e6	1.33e6	4.94e5	1.48e6	1.05e7	4.17e6	1.11e6	2.46e6

Table 12. continued, GC of Whole Oil (amounts in ng/g)

Well	Sample type	Lower Depth (m)	APT ID	m-Xyl	p-Xyl	4-MC8	2-MC8	3-MC8	o-Xyl	n-C9	i-C10	n-C10	i-C11	n-C11	n-C12	i-C13	i-C14	n-C13	i-C15	n-C14
16/1-9	Oil		50949	9.08e6	2.77e6	1.19e6	1.58e6	4.08e5	4.20e6	9.65e6	1.64e6	9.33e6	1.75e6	8.92e6	8.78e6	1.55e6	5.60e6	8.68e6	1.89e6	8.28e6

Table 12. continued, GC of Whole Oil (amounts in ng/g)

Well	Sample type	Lower Depth (m)	APT ID	i-C16	n-C15	n-C16	i-C18	n-C17	i-C19	n-C18	i-C20	n-C19	n-C20	n-C21	n-C22	n-C23	n-C24	n-C25	n-C26	n-C27
16/1-9	Oil		50949	3.71e6	8.73e6	7.68e6	2.00e6	7.18e6	3.65e6	6.42e6	2.61e6	6.26e6	5.87e6	5.18e6	4.92e6	4.59e6	4.25e6	3.81e6	3.59e6	3.02e6

Table 12. continued, GC of Whole Oil (amounts in ng/g)

Well	Sample type	Lower Depth (m)	APT ID	n-C28	n-C29	n-C30	n-C31	n-C32	n-C33	n-C34	n-C35	n-C36
16/1-9	Oil		50949	2.43e6	2.27e6	1.84e6	1.64e6	1.28e6	9.19e5	7.71e5	6.95e5	6.34e5

Table 13. GC of saturated compounds (peak area)

Well	Sample type	Lower Depth (m)	APT ID	n-C10	n-C11	n-C12	i-C13	i-C14	n-C13	i-C15	n-C14	i-C16	n-C15	n-C16	i-C18	n-C17	Pr	n-C18	Ph	n-C19
16/1-9	Oil		50949T	7.72e6	1.12e7	1.25e7	2.14e6	2.24e6	1.36e7	2.64e6	1.45e7	4.56e6	1.50e7	1.54e7	4.22e6	1.58e7	8.09e6	1.44e7	5.98e6	1.36e7

Table 13. continued, GC of saturated compounds (peak area)

Well	Sample type	Lower Depth (m)	APT ID	n-C20	n-C21	n-C22	n-C23	n-C24	n-C25	n-C26	n-C27	n-C28	n-C29	n-C30	n-C31	n-C32	n-C33	n-C34	n-C35	n-C36
16/1-9	Oil		50949T	1.34e7	1.21e7	1.17e7	1.10e7	1.02e7	9.52e6	8.62e6	7.56e6	6.05e6	5.76e6	4.60e6	4.10e6	3.15e6	2.67e6	2.84e6	1.74e6	1.28e6

Table 14. GC of saturated compounds (amounts in ng/g)

Well	Sample type	Lower Depth (m)	APT ID	n-C10	n-C11	n-C12	i-C13	i-C14	n-C13	i-C15	n-C14	i-C16	n-C15	n-C16	i-C18	n-C17	Pr	n-C18	Ph	n-C19
16/1-9	Oil		50949T	4.72e6	6.87e6	7.66e6	1.31e6	1.37e6	8.30e6	1.61e6	8.85e6	2.78e6	9.18e6	9.41e6	2.58e6	9.67e6	4.94e6	8.80e6	3.65e6	8.33e6

Table 14. continued, GC of saturated compounds (amounts in ng/g)

Well	Sample type	Lower Depth (m)	APT ID	n-C20	n-C21	n-C22	n-C23	n-C24	n-C25	n-C26	n-C27	n-C28	n-C29	n-C30	n-C31	n-C32	n-C33	n-C34	n-C35	n-C36
16/1-9	Oil		50949T	8.16e6	7.41e6	7.13e6	6.73e6	6.25e6	5.82e6	5.27e6	4.62e6	3.70e6	3.52e6	2.81e6	2.51e6	1.93e6	1.63e6	1.73e6	1.07e6	7.82e5

Table 15. GCMS SIR of saturated compounds (peak height)

m/e				177				191											
Well	Sample type	Lower Depth (m)	APT ID	25nor28αβ	25nor29αβ	25nor30αβ	25nor31αβ	19/3	20/3	21/3	23/3	24/3	25/3R	25/3S	24/4	26/3R	26/3S	28/3R	28/3S	29/3R
16/1-9	Oil		50949T	0.00e0	0.00e0	0.00e0	7.13e5	9.47e5	9.04e5	1.24e6	1.73e6	1.57e6	7.54e5	7.59e5	1.16e6	7.20e5	6.36e5	6.64e5	7.40e5	9.68e5

Table 15. continued, GCMS SIR of saturated compounds (peak height)

m/e				191															
Well	Sample type	Lower Depth (m)	APT ID	29/3S	27Ts	27Tm	30/3R	30/3S	28αβ	25nor30αβ	29αβ	29Ts	30ξ	29βα	30O	30αβ	30βα	31αβS	31αβR	30G
16/1-9	Oil		50949T	1.03e6	4.19e6	1.79e6	9.36e5	7.44e5	2.70e6	0.00e0	4.15e6	3.31e6	2.95e6	5.20e5	0.00e0	9.81e6	1.05e6	4.88e6	3.50e6	7.18e5

Table 15. continued, GCMS SIR of saturated compounds (peak height)

m/e				191									217							
Well	Sample type	Lower Depth (m)	APT ID	31βα	32αβS	32αβR	33αβS	33αβR	34αβS	34αβR	35αβS	35αβR	21αα	21ββ	22αα	22ββ	27dβS	27dβR	27dαR	27dαS
16/1-9	Oil		50949T	9.81e5	3.44e6	2.55e6	2.50e6	1.58e6	1.62e6	1.05e6	1.52e6	9.93e5	2.34e6	2.37e6	1.82e6	1.12e6	7.23e6	4.34e6	1.74e6	2.19e6

Table 15. continued, GCMS SIR of saturated compounds (peak height)

m/e			217																	
Well	Sample type	Lower Depth (m)	APT ID	28dβS#1	28dβS#2	28dβR#1	28dβR#2	28dαR	27ααS	27ββR+29dβS	27ββS	28dαS	27ααR	29dβR	29dαR	28ααS	29dαS	28βββR	28βββS	28ααR
16/1-9	Oil		50949T	3.15e6	3.22e6	1.82e6	2.26e6	1.38e6	1.67e6	4.71e6	2.24e6	9.77e5	1.39e6	3.35e6	1.82e6	6.69e5	1.72e6	1.99e6	2.97e6	9.50e5

Table 15. continued, GCMS SIR of saturated compounds (peak height)

m/e			217								218								
Well	Sample type	Lower Depth (m)	APT ID	29ααS	29ββR	29ββS	29ααR	30ααS	30ββR	30βββS	30ααR	27ββR	27ββS	28ββR	28ββS	29ββR	29ββS	30ββR	30βββS
16/1-9	Oil		50949T	1.92e6	2.69e6	2.43e6	1.42e6	7.74e5	9.53e5	6.02e5	4.75e5	4.57e6	3.83e6	3.17e6	4.01e6	4.54e6	4.21e6	1.21e6	1.08e6

Abbreviations of saturated biomarkers

17α(H), 21β(H)-25,28,30-trisnorhopane	25nor28αβ
17α, 21β-25,30-bisnorhopane	25nor29αβ
17α(H), 21β(H)-25-norhopane	25nor30αβ
17α, 21β, 22(R/S)-25-norhomohopane	25nor31αβ
$C_{19}H_{34}$ tricyclic terpane	19/3
$C_{20}H_{36}$ tricyclic terpane	20/3
$C_{21}H_{38}$ tricyclic terpane	21/3
$C_{23}H_{42}$ tricyclic terpane	23/3
$C_{24}H_{44}$ tricyclic terpane	24/3
$C_{25}H_{46}$ tricyclic terpane	25/3R
$C_{25}H_{46}$ tricyclic terpane	25/3S
$C_{24}H_{42}$ tetracyclic terpane	24/4
$C_{26}H_{48}$ tricyclic terpane	26/3R
$C_{26}H_{48}$ tricyclic terpane	26/3S
$C_{28}H_{52}$ tricyclic terpane	28/3R
$C_{28}H_{52}$ tricyclic terpane	28/3S
$C_{29}H_{54}$ tricyclic terpane	29/3R
$C_{29}H_{54}$ tricyclic terpane	29/3S
18α(H)-22,29,30-trisnorneohopane	27Ts
17α(H)-22,29,30-trisnorhopane	27Tm
$C_{30}H_{56}$ tricyclic terpane	30/3R
$C_{30}H_{56}$ tricyclic terpane	30/3S
17α(H), 21β(H)-28,30-bisnorhopane	28αβ
17α(H), 21β(H)-30-norhopane	29αβ
18α(H)-30-norneohopane	29Ts
15α-methyl-17α(H)-27-norhopane (diahopane)	30d
17β(H), 21α(H)-30-norhopane (normoretane)	29βα
18α(H)-oleanane	30O
17α(H), 21β(H)-hopane	30αβ
17β(H), 21α(H)-hopane (moretane)	30βα
17α(H), 21β(H), 22(S)-homohopane	31αβS
17α(H), 21β(H), 22(R)-homohopane	31αβR
Gammacerane	30G
17β(H), 21α(H)-homohopane	31βα
17α(H), 21β(H), 22(S)-bishomohopane	32αβS
17α(H), 21β(H), 22(R)-bishomohopane	32αβR
17α(H), 21β(H), 22(S)-trishomohopane	33αβS

17α(H), 21β(H), 22(R)-trishomohopane	33αβR
17α(H), 21β(H), 22(S)-tetrakishomohopane	34αβS
17α(H), 21β(H), 22(R)-tetrakishomohopane	34αβR
17α(H), 21β(H), 22(S)-pentakishomohopane	35αβS
17α(H), 21β(H), 22(R)-pentakishomohopane	35αβR
C21-5α(H), 14α(H), 17α(H)-pregnane	21αα
C21-5α(H), 14β(H), 17β(H)-pregnane	21ββ
C22-5α(H), 14α(H), 17α(H)-pregnane	22αα
C22-5α(H), 14β(H), 17β(H)-pregnane	22ββ
13β(H), 17α(H), 20(S)-cholestane (diasterane)	27dβS
13β(H), 17α(H), 20(R)-cholestane (diasterane)	27dβR
13α(H), 17β(H), 20(R)-cholestane (diasterane)	27dαR
13α(H), 17β(H), 20(S)-cholestane (diasterane)	27dαS
24-methyl-13β(H), 17α(H), 20(S)-cholestane (diasterane)	28dβS
24-methyl-13β(H), 17α(H), 20(R)-cholestane (diasterane)	28dβR
24-methyl-13α(H), 17β(H), 20(R)-cholestane (diasterane)	28dαR
5α(H), 14α(H), 17α(H), 20(S)-cholestane	27ααS
5α(H), 14β(H), 17β(H), 20(R)-cholestane	27ββR
24-ethyl-13β(H), 17α(H), 20(S)-cholestane (diasterane)	29dβS
5α(H), 14β(H), 17β(H), 20(S)-cholestane	27ββS
24-methyl-13α(H), 17β(H), 20(S)-cholestane (diasterane)	28dαS
5α(H), 14α(H), 17α(H), 20(R)-cholestane	27ααR
24-ethyl-13β(H), 17α(H), 20(R)-cholestane (diasterane)	29dβR
24-ethyl-13α(H), 17β(H), 20(R)-cholestane (diasterane)	29dαR
24-methyl-5α(H), 14α(H), 17α(H), 20(S)-cholestane	28ααS
24-ethyl-13α(H), 17β(H), 20(S)-cholestane (diasterane)	29dαS
24-methyl-5α(H), 14β(H), 17β(H), 20(R)-cholestane	28ββR
24-methyl-5α(H), 14β(H), 17β(H), 20(S)-cholestane	28ββS
24-methyl-5α(H), 14α(H), 17α(H), 20(R)-cholestane	28ααR
24-ethyl-5α(H), 14α(H), 17α(H), 20(S)-cholestane	29ααS
24-ethyl-5α(H), 14β(H), 17β(H), 20(R)-cholestane	29ββR
24-ethyl-5α(H), 14β(H), 17β(H), 20(S)-cholestane	29ββS
24-ethyl-5α(H), 14α(H), 17α(H), 20(R)-cholestane	29ααR
24-propyl-5α(H), 14α(H), 17α(H), 20(S)-cholestane	30ααS
24-propyl-5α(H), 14β(H), 17β(H), 20(R)-cholestane	30ββR
24-propyl-5α(H), 14β(H), 17β(H), 20(S)-cholestane	30ββS
24-propyl-5α(H), 14α(H), 17α(H), 20(R)-cholestane	30ααR

Table 16. GCMS SIR of saturated compounds (amounts in ng/g)

			m/e	177				191											
Well	Sample type	Lower Depth (m)	APT ID	25nor28αβ	25nor29αβ	25nor30αβ	25nor31αβ	19/3	20/3	21/3	23/3	24/3	25/3R	25/3S	24/4	26/3R	26/3S	28/3R	28/3S	29/3R
16/1-9	Oil		50949T	0.00e0	0.00e0	0.00e0	5.82e3	7.73e3	7.38e3	1.01e4	1.41e4	1.28e4	6.15e3	6.20e3	9.48e3	5.88e3	5.20e3	5.42e3	6.04e3	7.90e3

Table 16. continued, GCMS SIR of saturated compounds (amounts in ng/g)

			m/e	191															
Well	Sample type	Lower Depth (m)	APT ID	29/3S	27Ts	27Tm	30/3R	30/3S	28αβ	25nor30αβ	29αβ	29Ts	30ξ	29βα	30O	30αβ	30βα	31αβS	31αβR	30G
16/1-9	Oil		50949T	8.44e3	3.42e4	1.46e4	7.64e3	6.07e3	2.20e4	0.00e0	3.39e4	2.70e4	2.41e4	4.24e3	0.00e0	8.01e4	8.55e3	3.98e4	2.85e4	5.86e3

Table 16. continued, GCMS SIR of saturated compounds (amounts in ng/g)

			m/e	191									217							
Well	Sample type	Lower Depth (m)	APT ID	31βα	32αβS	32αβR	33αβS	33αβR	34αβS	34αβR	35αβS	35αβR	21αα	21ββ	22αα	22ββ	27dβS	27dβR	27dαR	27dαS
16/1-9	Oil		50949T	8.01e3	2.81e4	2.08e4	2.04e4	1.29e4	1.32e4	8.59e3	1.24e4	8.11e3	1.91e4	1.94e4	1.48e4	9.16e3	5.90e4	3.54e4	1.42e4	1.79e4

Table 16. continued, GCMS SIR of saturated compounds (amounts in ng/g)

m/e			217																	
Well	Sample type	Lower Depth (m)	APT ID	28dββS#1	28dββS#2	28dββR#1	28dββR#2	28dααR	27ααS	27ββR+29dββS	27ββS	28ααS	27ααR	29dββR	29ααR	28ααS	29ααS	28ββR	28ββS	28ααR
16/1-9	Oil		50949T	2.57e4	2.63e4	1.49e4	1.84e4	1.12e4	1.36e4	3.85e4	1.83e4	7.98e3	1.14e4	2.74e4	1.49e4	5.46e3	1.40e4	1.62e4	2.43e4	7.76e3

Table 16. continued, GCMS SIR of saturated compounds (amounts in ng/g)

m/e			217								218							
Well	Sample type	Lower Depth (m)	APT ID	29ααS	29ββR	29ββS	29ααR	30ααS	30ββR	30ββS	30ααR	27ββR	27ββS	28ββR	28ββS	29ββR	29ββS	30ββR	30ββS
16/1-9	Oil		50949T	1.56e4	2.20e4	1.98e4	1.16e4	6.32e3	7.78e3	4.92e3	3.88e3	3.73e4	3.13e4	2.58e4	3.27e4	3.70e4	3.44e4	9.91e3	8.84e3

Table 17. GCMS SIR of aromatic compounds (peak height)

m/e				142		156										170				
Well	Sample type	Lower Depth (m)	APT ID	2-MN	1-MN	2-EN	1-EN	2,6-DMN	2,7-DMN	1,3- + 1,7-DMN	1,6-DMN	2,3- + 1,4-DMN	1,5-DMN	1,2-DMN	1,8-DMN	1,3,7-TMN	1,3,6-TMN	1,3,5- + 1,4,6-TMN	2,3,6-TMN	1,2,7-TMN
16/1-9	Oil		50949T	7.40e8	4.16e8	3.95e7	1.27e7	1.57e8	1.56e8	2.83e8	2.28e8	7.77e7	4.60e7	2.33e7	3.77e5	7.70e7	1.01e8	7.45e7	6.14e7	1.30e7

Table 17. continued, GCMS SIR of aromatic compounds (peak height)

m/e				170			178	192				206								
Well	Sample type	Lower Depth (m)	APT ID	1,6,7+1,2,6-TMN	1,2,4-TMN	1,2,5-TMN	P	3-MP	2-MP	9-MP	1-MP	2-EP+9-EP+ 3,6-DMP	1-EP	2,6- + 2,7- + 3,5-DMP	1,3- + 2,10- + 3,9- + 3,10-DMP	1,6- + 2,5- + 2,9-DMP	1,7-DMP	2,3-DMP	1,9- + 4,9- + 4,10-DMP	1,8-DMP
16/1-9	Oil		50949T	5.02e7	5.15e6	2.01e7	1.07e8	5.28e7	6.35e7	7.67e7	6.25e7	7.51e6	1.48e7	9.21e6	6.54e7	3.06e7	3.34e7	8.64e6	1.69e7	6.71e6

Table 17. continued, GCMS SIR of aromatic compounds (peak height)

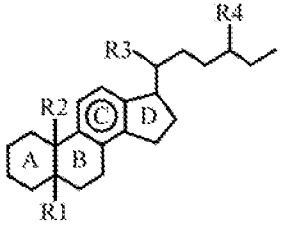
m/e				206	219	184	198			253										
Well	Sample type	Lower Depth (m)	APT ID	1,2-DMP	Retene	DBT	4-MDBT	(3+2)-MDBT	1-MDBT	C21MA	C22MA	βSC27MA	βSC27DMA	βRC27MA+ βRC27DMA	αSC27MA	βSC28MA+ βSC28DMA+ αRC27DMA	αSC27DMA	αRC27MA	αSC28MA	βRC28MA+ βRC28DMA
16/1-9	Oil		50949T	3.01e6	6.22e6	9.48e6	2.51e7	8.35e6	4.91e6	6.02e5	3.96e5	6.96e4	3.20e5	2.47e5	8.82e4	4.72e5	8.58e4	6.16e4	1.23e5	3.28e5

Table 17. continued, GCMS SIR of aromatic compounds (peak height)

m/e				253				231							
Well	Sample type	Lower Depth (m)	APT ID	βSC29MA+ βSC29DMA	αSC29MA	αRC28MA+ βRC29MA+ βRC29DMA	αRC29MA	C20TA	C21TA	SC26TA	RC26TA+ SC27TA	SC28TA	RC27TA	RC28TA	
16/1-9	Oil		50949T	3.64e5	6.97e4	2.67e5	2.41e4	1.38e6	1.34e6	2.26e5	8.10e5	4.64e5	4.16e5	4.64e5	

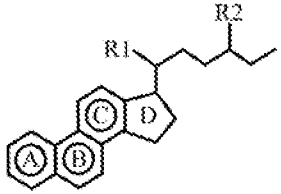
Abbreviation of aromatic biomarkers

C-ring monoaromatic steroid



Substituents				
R_1	R_2	R_3	R_4	Label
				$C_{21}MA$
				$C_{22}MA$
β(H)	CH_3	$S(CH_3)$	H	$\beta SC_{27}MA$
$\beta(CH_3)$	H	$S(CH_3)$	H	$\beta SC_{27}DMA$
$\beta(CH_3)$	H	$RCH_3)$	H	$\beta RC_{27}DMA+$
β(H)	CH_3	$R(CH_3)$	H	$\beta RC_{27}MA$
α(H)	CH_3	$S(CH_3)$	H	$\alpha SC_{27}MA$
β(H)	CH_3	$S(CH_3)$	CH_3	$\beta SC_{28}MA+$
$\alpha(CH_3)$	H	$R(CH_3)$	H	$\alpha RC_{27}DMA+$
$\beta(CH_3)$	H	$S(CH_3)$	CH_3	$\beta SC_{28}DMA$
$\alpha(CH_3)$	H	$S(CH_3)$	CH_3	$\alpha SC_{27}DMA$
α(H)	CH_3	$R(CH_3)$	H	$\alpha RC_{27}MA$
α(H)	CH_3	$S(CH_3)$	CH_3	$\alpha SC_{28}MA$
β(H)	CH_3	$R(CH_3)$	CH_3	$\beta RC_{28}MA+$
$\beta(CH_3)$	H	$R(CH_3)$	CH_3	$\beta RC_{28}DMA$
β(H)	CH_3	$S(CH_3)$	C_2H_5	$\beta SC_{29}MA+$
$\beta(CH_3)$	H	$S(CH_3)$	C_2H_5	$\beta SC_{29}DMA$
α(H)	CH_3	$S(CH_3)$	C_2H_5	$\alpha SC_{29}MA$
α(H)	CH_3	$R(CH_3)$	CH_3	$\alpha RC_{28}MA+$
β(H)	CH_3	$R(CH_3)$	C_2H_5	$\beta RC_{29}MA+$
$\beta(CH_3)$	H	$R(CH_3)$	C_2H_5	$\beta RC_{29}DMA$
α(H)	CH_3	$R(CH_3)$	C_2H_5	$\alpha RC_{29}MA$

ABC-ring triaromatic steroids



Substituents		
R_1	R_2	Label
CH_3	H	$C_{20}TA$
CH_3	CH_3	$C_{21}TA$
$S(CH_3)$	C_6H_{13}	$SC_{26}TA$
$R(CH_3)$	C_6H_{13}	$RC_{26}TA+$
S(CH3)	C_7H_{15}	$SC_{27}TA$
$S(CH_3)$	C_8H_{17}	$SC_{28}TA$
$R(CH_3)$	C_7H_{15}	$RC_{27}TA$
$R(CH_3)$	C_8H_{17}	$RC_{28}TA$

Polycyclic aromatic hydrocarbons and sulphur compounds

MN	Methylnaphthalene
EN	Ethylnaphthalene
DMN	Dimethylnaphthalene
TMN	Trimethylnaphthalene
P	Phenanthrene
MP	Methylphenanthrene
EP	Ethylphenanthrene
DMP	Dimethylphenanthrene
DBT	Dibenzothiophene
MDBT	Methyldibenzothiophene

Table 18. GCMS SIR of aromatic compounds (amounts in ng/g)

m/e				142		156										170				
Well	Sample type	Lower Depth (m)	APT ID	2-MN	1-MN	2-EN	1-EN	2,6-DMN	2,7-DMN	1,3- + 1,7-DMN	1,6-DMN	2,3- + 1,4-DMN	1,5-DMN	1,2-DMN	1,8-DMN	1,3,7-TMN	1,3,6-TMN	1,3,5- + 1,4,6-TMN	2,3,6-TMN	1,2,7-TMN
16/1-9	Oil		50949T	3.35e6	1.88e6	1.79e5	5.78e4	7.12e5	7.07e5	1.28e6	1.03e6	3.52e5	2.08e5	1.06e5	1.71e3	3.49e5	4.58e5	3.37e5	2.78e5	5.89e4

Table 18. continued, GCMS SIR of aromatic compounds (amounts in ng/g)

m/e				170			178	192				206								
Well	Sample type	Lower Depth (m)	APT ID	1,6,7+1,2,6-TMN	1,2,4-TMN	1,2,5-TMN	P	3-MP	2-MP	9-MP	1-MP	2-EP+9-EP+3,6-DMP	1-EP	2,6- + 2,7- + 3,5-DMP	1,3- + 2,10- + 3,9- + 3,10-DMP	1,6- + 2,5- + 2,9-DMP	1,7-DMP	2,3-DMP	1,9- + 4,9- + 4,10-DMP	1,8-DMP
16/1-9	Oil		50949T	2.28e5	2.33e4	9.10e4	6.32e5	3.11e5	3.74e5	4.52e5	3.68e5	4.42e4	8.70e4	5.42e4	3.85e5	1.80e5	1.97e5	5.09e4	9.93e4	3.95e4

Table 18. continued, GCMS SIR of aromatic compounds (amounts in ng/g)

m/e				206	219	184	198			253										
Well	Sample type	Lower Depth (m)	APT ID	1,2-DMP	Retene	DBT	4-MDBT	(3+2)-MDBT	1-MDBT	C21MA	C22MA	βSC27MA	βSC27DMA	βRC27MA+βRC27DMA	αSC27MA	βSC28MA+βSC28DMA+αRC27DMA	αSC27DMA	αRC27MA	αSC28MA	βRC28MA+βRC28DMA
16/1-9	Oil		50949T	1.77e4	3.66e4	5.58e4	1.48e5	4.92e4	2.89e4	3.25e3	2.14e3	3.75e2	1.72e3	1.33e3	4.76e2	2.54e3	4.63e2	3.33e2	6.62e2	1.77e3

Table 18. continued, GCMS SIR of aromatic compounds (amounts in ng/g)

m/e				253				231							
Well	Sample type	Lower Depth (m)	APT ID	βSC29MA+ βSC29DMA	αSC29MA	αRC28MA+ βRC29MA+ βRC29DMA	αRC29MA	C20TA	C21TA	SC26TA	RC26TA+ SC27TA	SC28TA	RC27TA	RC28TA	
16/1-9	Oil		50949T	1.97e3	3.76e2	1.44e3	1.30e2	7.44e3	7.26e3	1.22e3	4.37e3	2.50e3	2.24e3	2.51e3	

Table 19. Reference data for GC Whole Oil measured on NSO-1

Variable	Permissible range	Most likely value	26.05.08	
Pristane/n-C17	0.55-0.64	0.60	0.61	
Benzene/Hexane	0.38-0.42	0.41	0.42	

Table 20. Reference data for GC of Saturated Compounds measured on NSO-1

Variable	Permissible range	Most likely value	04.06.08	04.06.08	
Pr/n-C17	0.55-0.66	0.60	0.63	0.63	
n-C15/n-C20	1.4-2.0	1.8	1.5	1.7	
n-C30/n-C20	0.20-0.32	0.29	0.30	0.30	
n-C17/(n-C17+n-C27)	0.75-0.82	0.79	0.75	0.75	

Table 21. Reference data for GC-MS of Saturated Compounds measured on NSO-1

Variable	Permissible range	Most likely value	08.06.08	08.06.08	08.06.08	08.06.08	
[23/3]/30ab	0.04-0.09	0.07	0.06	0.06	0.05	0.06	
35abR/30ab	0.06-0.13	0.08	0.08	0.08	0.09	0.09	
25nor30ab/25nor28ab	0.3-0.8	0.5	0.79	0.79	0.83	0.84	
29aaR/27dbS	0.2-0.6	0.3	0.29	0.28	0.33	0.29	
29bbS/27bbR	0.7-1.2	0.9	0.99	0.95	1.03	0.98	

Our column resolves the 25nor28αβ doublet, thus giving a value in the high-end region of the acceptable range specified by NIGOGA.

Table 22. Reference data for GC-MS of Aromatic Compounds measured on NSO-1

Variable	Permissible range	Most likely value	11.06.08	
1-MP/P	0.53-0.70	0.59	0.54	
A1/E1	0.3-0.7	0.5	0.51	
a1/d1	0.2-0.4	0.31	0.36	

Experimental Procedures

All procedures follow NIGOGA, 4th Edition. Below are brief descriptions of procedures/analytical conditions.

Deasphaltening
Pentane is added in access (40 times the volume of oil). The solution is stored for at least 12 hours in a dark place before the solution is filtered or centrifuged and the weight of the asphaltenes measured.

Iatroscan
An Iatroscan MK-5 (TLC/FID Analyser) instrument is used. 2 µl of extract or diluted oil is spotted on Chromarod S-III rods before elution in hexane (25 min), toluene (8 min) and dichloromethane with 7 % methanol (vol/vol). The solvent is allowed to evaporate before the rods are placed into the next eluation chamber. Before running the rods in the analyser, the rods are heated for 90 sec. in a heating chamber at 60 °C.

Density
An Anton Parr instrument is used. Air and distilled water is used to calibrate the instrument. All measurements are done at 15°C. NSO-1 is used as a reference sample, and is run in each series of density measurements. If the viscosity of the oil is very high at 15°C, a gravimetric method is used.
API gravity is calculated from the density.

API Gravity (°) = 141.5/Density (g/cm^3) – 131.5

Topping
A rotavapor is used and ~ 1ml of oil is weighted accurately into a small round bottum flask. The oil is evaporated for 15 min at 90°C with the water pump turned to maximum. After the evaporation the oil is weighted again.
One aliquot of NSO-1 is run as a reference sample together with the topping series.

GC analysis of gas components
Aliquots of the samples were transferred to exetainers. 0.1-1ml were sampled using a Gerstel MPS2 autosampler and injected into a Hewlett Packard 5890 Series II GC equipped with Porabond Q column, a flame ionisation detector (FID), a thermal conductivity detector (TCD) and a methylization unit. Hydrocarbons were measured by FID, CO_2 by metylization (to CH_4) and then FID and N_2 and O_2 by TCD.

Carbon isotope analysis of hydrocarbon compounds and CO2
The carbon isotopic composition of the hydrocarbon gas components was determined by a GC-C-IRMS system. Aliquots were sampled with a syringe and analysed on a Trace GC2000, equipped with a Poraplot Q column, connected to a Delta plus XP IRMS. The components were burnt to CO_2 and water in a 1000 °C furnace over Cu/Ni/Pt. The water was removed by Nafion membrane separation. Repeated analyses of standards indicate that the reproducibility of $\delta^{13}C$ values is better than 1 ‰ PDB (2 sigma).

Carbon isotope analysis of low concentration methane using the Precon.
The carbon isotopic composition of methane was determined by a Precon-IRMS system. Aliquots were sampled with a GCPal autosampler. CO_2, CO and water were removed on

chemical traps. Other hydrocarbons than CH_4 and remaining traces of CO_2 were removed by cryotrapping. The methane was burnt to CO_2 and water in a 1000 °C furnace over Cu/Ni/Pt. The water was removed by Nafion membrane separation. The sample preparation system described (Precon) was connected to a Delta plus XP IRMS for $\delta^{13}C$ analysis. Repeated analyses of standards indicate that the reproducibility of $\delta^{13}C$ values is better than 1 ‰ PDB (2 sigma).

Hydrogen isotope analysis of methane

The hydrogen isotopic composition of methane was determined by a GC-C-IRMS system. Aliquots were sampled with a GCPal and analysed on a Trace GC2000, equipped with a Poraplot Q column, connected to a Delta plus XP IRMS. The components were decomposed to H_2 and coke in a 1400 °C furnace. The international standard NGS-2 and an in-house standard (Std A) were used for testing accuracy and precision. The "true" value of NGS-2 is given to –172.5 ‰ V-SMOW (http://deuterium.nist.gov/standards.html). Repeated analyses of standards indicate that the reproducibility of δD values is better than 10 ‰ PDB (2 sigma).

Stable carbon and hydrogen isotope analysis of fractions

The samples were dissolved in a known amount of dichloromethane, and 4-5 mg of the sample (or as much as possible) was transferred to a glass container. The solvent was evaporated in an oven at 50 °C. CuO and some silver wires were added to the containers, which were then sealed by melting in a vacuum. The samples were then combusted in an oven at 550 °C for 1 hour (Sofer, 1980). The combustion products CO_2 and H_2O were separated at –80°C.

Carbon isotopic composition of the CO_2 aliquot was determined on a Finnigan MAT 251 mass spectrometer. A standard (NGS NSO-1, topped oil) is analysed for each 10th sample. The $\delta^{13}C$ value obtained for this standard is –28.77 ‰ PDB. The variation in the isotopic values for the standard by repeated analysis over a period of five years is ± 0.13 ‰.

$H_2O_{(g)}$ aliquot was reduced with $Zn_{(s)}$ to $H_{2(g)}$ and $ZnO_{(s)}$ in sealed, evacuated quartz vessels at 900 °C. The δD composition was determined by a Finnigan MAT 251 mass spectrometer. Average analysed value for GISP from IAEA is δD_{VSMOW}= -189.71 ± 0.89 ‰ (one standard deviation). Given value from IAEA is -189.73 ± 0.9 ‰.

Stable carbon isotope analysis of kerogens

The samples were weighed and transferred to a 9x15 mm tin capsule. Approximately 3 mg of the samples were used. The combustion of the samples in the presence of O_2 and Cr_2O_3 at 1700 °C was done in a Carlo Erba NCS 2500 element analyser. Reduction of NO_x to N_2 was done in a Cu oven at 650 °C. H_2O was removed in a chemical trap of $KMnO_4$ before separation of N_2, CO_2 and SO_2 on a 2 m Poraplot Q GC column. CO_2 is flushed on-line in a He flow to a Micromass Optima, Isotope Ratio Mass Spectrometer for determination of $\delta^{13}C$. A standard (USGS-24) is analysed for each 10th sample. The $\delta^{13}C$ value obtained for this standard is -16.01 ± 0.06 ‰ PDB (one standard deviation). Given value from IAEA is -15.99 ± 0.11 ‰ PDB (one standard deviation).

GC of whole oil

A HP5890 II instrument is used. The column is a HP PONA, length 50 m, i.d. 0.2 mm, film thickness 0.5 μm. 2,2,4-tri-methyl-pentane is used as an internal standard.

Temperature programme

30 °C (10 min.) - 2 °C/min. - 60 °C (10 min.)- 2 °C/min - 130 °C (0 min.)-4 °C/min. - 320 °C (25 min.)

GC of saturated fraction

A HP5890 II instrument is used. The column is a CP-Sil-5 CB-MS, length 60 m, i.d. 0.25 mm, film thickness 0.25 μm. C20D42 is used as an internal standards.

Temperature programme
50 °C (1 min.) - 4 °C/min. - 320 °C (25 min.)

GCMS of saturated and aromatic fractions

A Micromass ProSpec high resolution instrument is used. The instrument is tuned to a resolution of 3000 and data is acquired in Selected Ion Recording (SIR) mode. The column used is a 60 m CP-Sil-5 CB-MS with an i.d. of 0.25 mm and a film thickness 0.25 μm. D_4-27ααR is used as internal standard when quantitative results are requested for the saturated compounds. D_8-naphthalene and D_{10}-phenanthrene are used as internal standards when quantitative results are required for the aromatic compounds. The aromatic and aliphatic fractions may be analysed together or separately.

Temperature programme
50 °C (1 min.) - 20 °C/min. - 120 °C - 2 °C/min - 320 °C (20 min.)