u-619

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GEOCHEMICAL EVALUATION AND HYDROCARBON CHARACTERISATION STUDY 6406/8-2 WELL

EXECUTIVE SUMMARY

The section between 600 metres and 4520 metres has been evaluated.

Apart from minor good and rich interbeds at 1800-2150± metres in the Narvik Formation the Tertiary and Cretaceous claystones are poor source rocks for gas or gas and associated light liquids. Minor hydrocarbon generation commences below 3075± metres.

Within the Nesna Formation are rich interbeds of oil prone shale which, on structure, are at the threshold of peak hydrocarbon generation. The remaining Nesna shales and those from the Englevaer are poor, mainly gas prone and, due to their kerogen type effectively mature; significant hydrocarbon generation.

Scattered shales within the Tomma sands and those from the Leka and Aldra formations, are generally poor source rocks for gas. Exceptional are the basal Leka and Aldra shales which at 4170-4500± metres are variously a fair-good or rich source for gas-condensate.

Strong shows of a light to medium gravity crude oil resembling the DST-2 sample were detected in the Nesna shales at 3840-3860± metres and further traces occur in the Englevaer.

Further strong shows of the DST-2 type oil are present in the Tomma sandstones at 3930-4000± metres, 4067± metres and at 4078-4121± metres. The same type of oil has migrated into the Aldra sands at 4300-4369± metres. Although these oils all belong to one family they exhibit minor compositional changes which suggests slight differences in the inferred source facies.

Carbon isotope ratios correlate the shows and tested crude oil with selected shales in the Nesna.

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CONCLUSIONS

The section between 600 metres and 4520 metres has been, for the purposes of this study, divided into six zones.

Zone A (600-2437 metres) is composed of medium olive grey and medium brownish grey claystones, with interbedded sands above 1800 metres, from the Sula, Sklinna and Skomvaer groups. The claystones generally have poor to fair (0.29-0.70% organic carbon) contents of mainly woody and inertinitic kerogen, and are poor source rocks. Within the Narvik Formation (1970-2309 metres) are better claystones (2.06-4.64% organic carbon) which contain a greater proportion of herbaceous kerogen and have a good to rich potential for gas-condensate. The sediments are immature on structure and have not started to generate hydrocarbons.

Zone B^1 (2437-3119 metres) is .equivalent to the Flatoey Group - which is dominated by medium grey to medium olive grey claystones and shaly claystones Organic carbon contents are commonly below average at (0.30) 0.48-1.12% and this leanness is aggravated by the poor quality (inertinite and wood) of the principal kerogen types. These claystones yielded less than 1.83 mg/g pyrolysate and are rated as a poor gas source. Minor oil generation could be expected at this depth but the analysed sediments are gas prone and, hence, are effectively immature.

Zone B^2 covers the 3119-3841 metre interval, which corresponds to the Finavaer Group. The top 100 metres is composed of medium dark grey to brownish grey claystones which overlie light olive grey shaly claystones and, below 3390 metres, brownish grey silty mudstones. Scattered sands occur at 3250-3320 metre, beds of shale at 3380-3430± metres and traces of lignite from the mud system generally. Above average (1.06-1.31%) organic carbon values apply at 3140-3240± metres and intermittently elsewhere but the organic matter consisting of inertinite and wood with minor herbaceous and algal kerogen, generated less than 1.37mg/g pyrolysate - resulting in a 'poor' rating. Minor gas generation has commenced on structure because the sediments are, effectively, marginally mature.

Zone C (3841-3930± metres) includes the Nesna and, below 3867 metres Engelvaer formations. The brownish grey shales within the Nesna are

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a potentially rich (13.1-19.2 mg/g pyrolysate) oil and gas source but are interbedded with poor dark grey shales. On structure the, dominantly algal and amorphous kerogen in the richer shales has just reached the peak hydrocarbon generation stage. The Engelvaer shales, however have poor to fair organic carbon contents, are effectively marginally mature and have a negligible potential for gas and minor liquids.

Zone D, 3930 metres down to 4128.5 metres, includes the Tomma I to III formations. Sandstones predominate within this interval although silts (at 4033-4056 metres) and medium dark grey shales are also present. The latter have good (1.03-1.52%) organic carbon contents but only yielded 0.68-1.52mg/g pyrolysate and are therefore poor source rocks. Migrated hydrocarbons from this interval are discussed below.

Zone E extends from 4128.5 metres down to the deepest sample at 4520 metres (TD at 4523 metres). This interval is apparently (poor sample quality), a sequence of sands and medium dark grey shales - from the Leka, Aldra and Hitra formations. Herbaceous and atypical amorphous organic matter is present in the richest Aldra shales at 4480-4500 metres. Per unit volume they have an excellent (4.27-54.75 mg/g pyrolysate) potential for gas and associated liquids. With these exceptions the section below 4128.5 metres has a fair, with good interbeds, potential for gas-condensate and (at 4285-4350 metres) oil and gas. Significant hydrocarbon generation, from the mainly woody kerogen, is occurring in the Leka whereas the Aldra shales, with the progressive increase in maturation levels and improvement in organic matter quality, are at the peak hydrocarbon generation phase.

The light (39.1° API) crude oil tested during DST-2 (3937-3995 metres) is derived from mature but not highly mature source rocks containing mainly, but not totally, marine organic matter. This oil is present in the Nesna shales (at 3840-3860± metres) and down to 4000± metres in the Tomma sandstones. The shows in the Lower sands at 4067± metres and at 4078-4121± metres, plus those in the Aldra at 4300-4369± metres, are of a similar but not identical oil, recognised by a greater pristane and phytane content and slightly heavier (more positive) carbon isotope ratios.

Attempts to correlate (by means of bio-markers) the Nesna shales, shows of migrated hydrocarbons and the DST-2 crude oil were complicated by migrated hydrocarbons in the potential source rocks. Kerogen carbon isotope ratios vary between $-27.61^{o}/oo$ and $-29.07^{o}/oo$ suggesting appreciable variations in organic facies within this narrow interval. The lighter (more negative) value at 3840-3850± metres does correlate closely with the total extract delta values of the oils and shows of migrated hydrocarbons in the Tomma and Aldra sandstones. On this basis selected shale horizons within the Nesna are believed to be the source of the crude oil.

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ORGANIC FACIES AND SOURCE RICHNESS

The amount of organic matter within a sediment is measured by its organic carbon content. Average shales contain approximately one percent organic carbon.

Organic matter type influences not only source richness but also the character of the hydrocarbon product (oil, gas) and the response of the organic matter to thermal maturation. Richness and oiliness decrease in the order: amorphous-algal-herbaceous-woody. Wood has a primary (but not exclusive) potential for gas whilst inertinitic (oxidised, mineral charcoal) material has only a limited hydrocarbon potential. Pyrolysis-derived hydrogen indices increase with organic matter quality.

Hydrocarbon source richness has been evaluated from the yields of extractable C_{15+} hydrocarbons (C_{15+} HC) and of pyrolysate (S2) in association with the total organic carbon (TOC) contents. The following rating scheme has been employed:

	S2 ppm (mg/g)	C_{15+} HC (ppm)	TOC (%)
POOR SOURCE	below 2000 (2 mg/g)	below 100	below 0.5
FAIR SOURCE	2000-3000 (2-3 mg/g)	100-250	0.5-1.0
GOOD SOURCE	3000-5000 (3-5 mg/g)	250-500	1 - 3
VERY GOOD	5000-10,000 (5-10 mg/g)	500-1000	3 - 5
RICH SOURCE	over 10,000 (10 mg/g)	over 1000	over 5

The type of product (oil, gas) has been determined from the gas chromatograms of the pyrolysate (S2) fractions for which the gas-oil indices have also been calculated. Oil-prone sediments have indices of less than 20%, 20-35% indicates a mixed potential for oil and gas, 35-50% for condensate and values in excess of 50% are indicative of dry gas.

The solvent extractable C_{15+} hydrocarbons are commonly enhanced by non-indigenous species (see below) and hence are of limited value in evaluating source richness in this well.

Claystones from the Korgen Formation (600-1970 metres) generally have below average (0.29-0.70%) organic carbon contents although interbeds with values of 1.44-2.17% are present. Similar values (0.45) 1.07-1.38% apply within the Narvik (1970-2309 metres) but the medium brownish grey interbeds are signifiantly richer as 2.06-4.64%. Land plant debris - woody, inertinitic and herbaceous - is present in the Zone A claystones generally. Those in the

Narvik, however, contain a greater proportion of herbaceous kerogen and the richest of these (at 1800-2150 metres) interbeds yielded 3.39-10.40mg/g pyrolysate. Apart from the latter, which have a good - rich potential for gas-condensate, the Zone A claystones are poor (less than 2.0mg/g pyrolysate) gas prone source rocks.

With very few exceptions the Flatoey Group claystones (at 2437-3199 metres) have below average (0.30-1.12% organic carbon) contents of inertinitic and woody organic matter. As a consequence of the poor kerogen quality these sediments yielded less than 1.83mg/g pyrolysate and have, therefore, a poor potential for gas.

The Finnvaer Group claystones (3119-3841 metres) have organic carbon contents of 1.06-1.31% at 3140-3240± metres but, apart from scattered interbeds, lower values prevail elsewhere in this unit. Organic matter consisting mainly of wood and inertinite, with minor herbaceous and algal kerogen, generated less than 1.37mg/g pyrolysate and these claystones have, thus, a negligble potential - for gas.

Analyses show that the Nesna (3841-3867 metres) shales are not uniformly rich; thus the brownish grey shales have organic carbon contents of 4.15 to 6.36% - whilst the dark grey shales are leaner at 0.71-0.87%. The algal and amorphous organic matter in the richer shales is difficult to differentiate, appears to be degraded and not obviously oil prone. Chromatograms of the pyrolysis products from the brownish grey shales display gas and gasoline range hydrocarbons in addition to an extended range of alkene-alkane doublets; which indicate a potential for oil and gas. They are interbedded with lean and gas prone dark grey shales.

Shales from the Engelvaer Formation have poor to fair 0.29-1.17% contents of inertinite and wood; and a poor potential for gas.

Core samples of shales at 4033-4056 metres in the Tomma Formation contain 1.03-1.52% organic carbon and generated 0.68-1.52mg/g pyrolysate. They are poor gas source rocks for gas and condensate.

Interbeds of shale have good (1.24-2.24%) organic carbon contents in the Leka (4128.5-4285 metres) and similarly (1.03-2.94% organic carbon) in the Aldra (4285-4496 metres) reaching 3.23 and 11.2% at 4480-4500± metres. Their organic matter mainly consists of wood and inertinite but herbaceous and amorphous (atypical) kerogen becomes significant in the Aldra shales. The latter are good source rocks, improving to rich at 4490-4500 metres, and have a potential for oil and gas above 4350± metres or gas-condensate below this depth. Shales from Leka are, generally fair (1.56-4.18 mg/g pyrolysate) and have a potential for gas condensate improving to oil and gas at 4230-4270± metres.

To summarise:-

LITHOLOGY	ORGANIC CARBON	PYROLYSATE	RATING
Sklinna and Skomvaer groups			
medium olive grey claystones	less than 1.38%		poor gas source
1800-2150 metres	2.06-4.64%	3.39-10.4 mg/g	good to rich gas-condensate
Flatoey Group			
medium grey to light olive grey claystones	less than 1.12%	less than 1.83 mg/g	poor gas source
Finvaer Group			
medium dark grey to brownish grey claystones and silty claystones	1.06-1.31%	less than 1.37 mg/g	poor gas source

LITHOLOGY	ORGANIC CARBON	PYROLYSATE	RATING
Nesna			
dark grey and dark brownish grey shales	0.71-6.61%	0.11-19.2 mg/g	rich gas-oil source with poor interbeds
Engelvaer			
medium dark grey to medium grey shales	0.29-1.17%	less than 1.26 mg/g	poor gas source
Tomma			
scattered shales	1.03-1.52%	less than 1.52 mg/g	poor gas-condensate source
Leka			
interbeds of shale	1.24-2.24%	up to 4.18 mg/g	fair to good for oil/gas or gas-condensate
Aldra			
interbeds of shale	1.03-2.94%	0.44-5.75mg/g	generally fair or good potential for gas-condensate
4480-4496 metres	3.23, 11.2	4.27, 54.75 mg/g	good oil and gas source with gas-condensate in basal 20± metres.

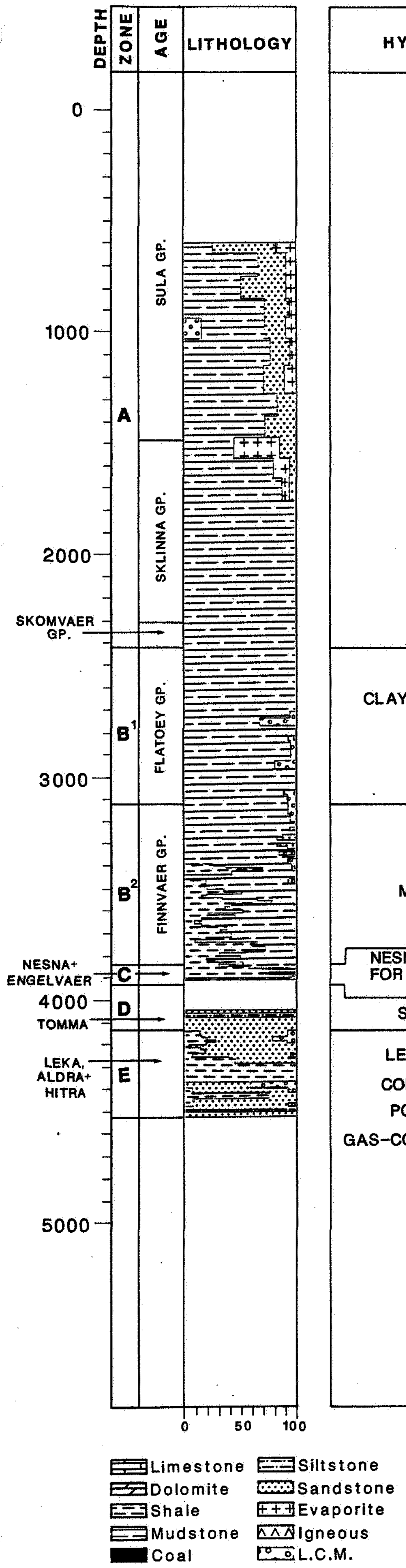
TABLE 4
GAS – OIL INDEX

GEOCHEM SAMPLE NUMBER	DEPTH	DRY GAS	WET GAS	GASOLINES KEROSENES	GAS OIL DISTILLATE	GAS-OIL INDEX
		% C_1	% $C_2 - C_5$	% $C_6 - C_{14}$	% C_{15+}	% $\frac{C_1 - C_5}{TOTAL}$
1506-032A	1900-1950	5.16	41.06	49.89	3.89	46.22
1506-036B	2100-2150	12.58	61.17	26.25	0.00	73.75
1506-096A	2940-2950	5.44	52.10	42.47	0.00	57.53
1506-190B	3840-3850	9.26	31.01	52.35	7.38	40.27
1506-191A	3848.50	4.67	43.62	51.71	0.00	48.29
1506-192A	3850-3860	8.16	36.96	43.93	10.96	45.11
1506-193A	3857.50	7.76	37.12	49.03	6.09	44.87
1506-195A	3860-3870	10.01	46.99	41.48	1.52	57.00
1506-204A	4056-.02	16.77	43.92	36.16	3.15	60.69
1506-205B	4150-4160	10.63	50.55	37.92	0.90	61.18
1506-207A	4170-4180	10.54	35.28	50.35	3.82	45.82
1506-212B	4230-4240	9.17	39.84	40.22	10.77	49.01
1506-215B	4260-4270	12.77	38.97	45.22	3.04	51.74
1506-217A	4282.88-.	11.26	41.29	45.93	1.52	52.55
1506-219A	4299.45-.	10.93	36.44	46.33	6.29	47.37
1506-222A	4348.45-.	15.53	41.15	38.36	4.96	56.68
1506-224B	4420-4430	8.24	47.55	42.58	1.62	55.80
1506-226B	4430-4440	13.39	41.14	43.12	2.35	54.53
1506-233B	4480-4490	21.86	45.33	31.05	1.75	67.19
1506-234B	4490-4500	18.36	30.37	41.15	10.12	48.73

FIGURE 1

WELL 6406/3-2

SUMMARY CHART



ZONE	HYDROCARBON SOURCE POTENTIAL	SHOW EVALUATION
A	GENERALLY POOR GAS PRONE CLAYSTONES MINOR GOOD-RICH CLAYSTONES FOR GAS - CONDENSATE AT 1800-2150 METRES IMMATURE	TRACES OF WET GAS-CONDENSATE AT 2490-2620± METRES GAS KICK AT 3250-3320± METRES
B1	CLAYSTONES HAVE POOR POTENTIAL FOR GAS AND ARE EFFECTIVELY IMMATURE	
B2	POOR GAS SOURCE MINOR HYDROCARBON GENERATION	
C	NESNA SHALES RICH WITH POOR INTERBEDS FOR GAS AND OIL, AT TOP OF OIL WINDOW ENGELVAER-POOR SOURCE	STRONG OIL SHOWS IN NESNA SHALES AND TOMMA SANDS
D	SCATTERED POOR SHALES AND SILTS	
E	LEKA SHALES FAIR - GOOD FOR GAS AND CONDENSATE, ALDRA SHALES HAVE GOOD POTENTIAL FOR OIL AND GAS WITH RICH GAS-CONDENSATE SOURCE IN BASAL 20± METRES	STRONG SHOWS OF OIL IN ALDRA SANDS.

FIGURE 2 **RATING DIAGRAM**

WELL 6406/3-2

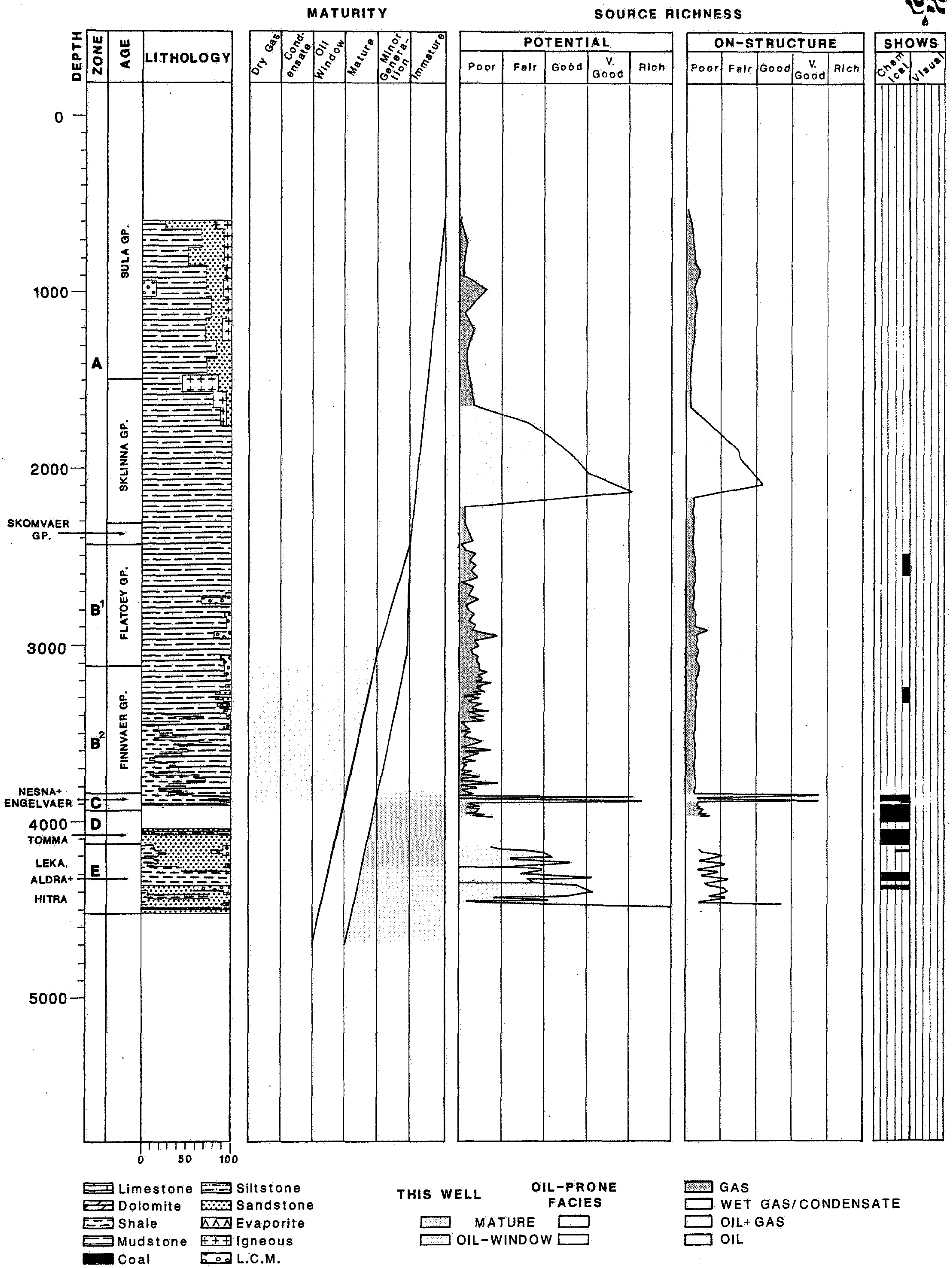


FIGURE 3
WELL 6406/3-2

SOURCE FACIES

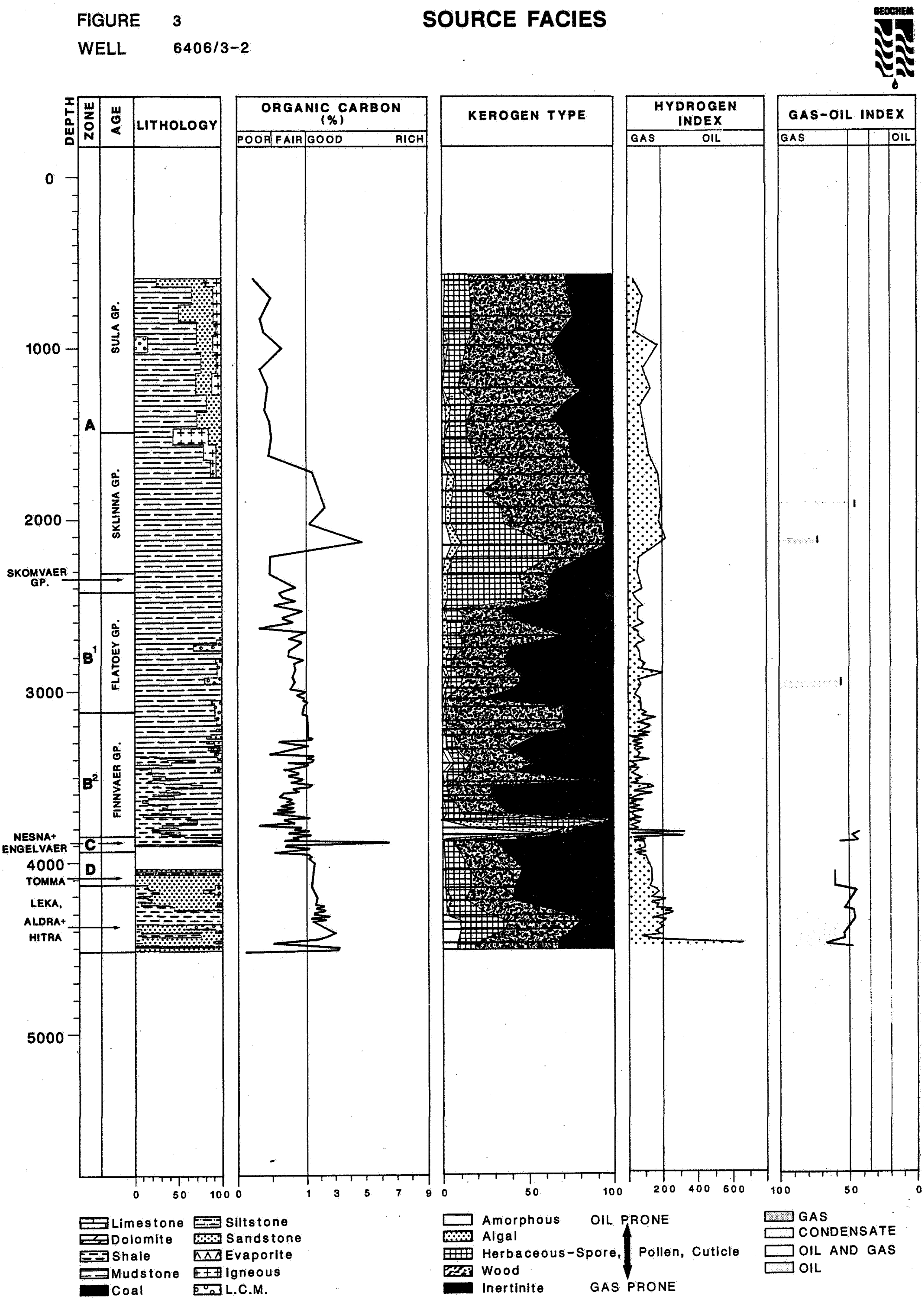
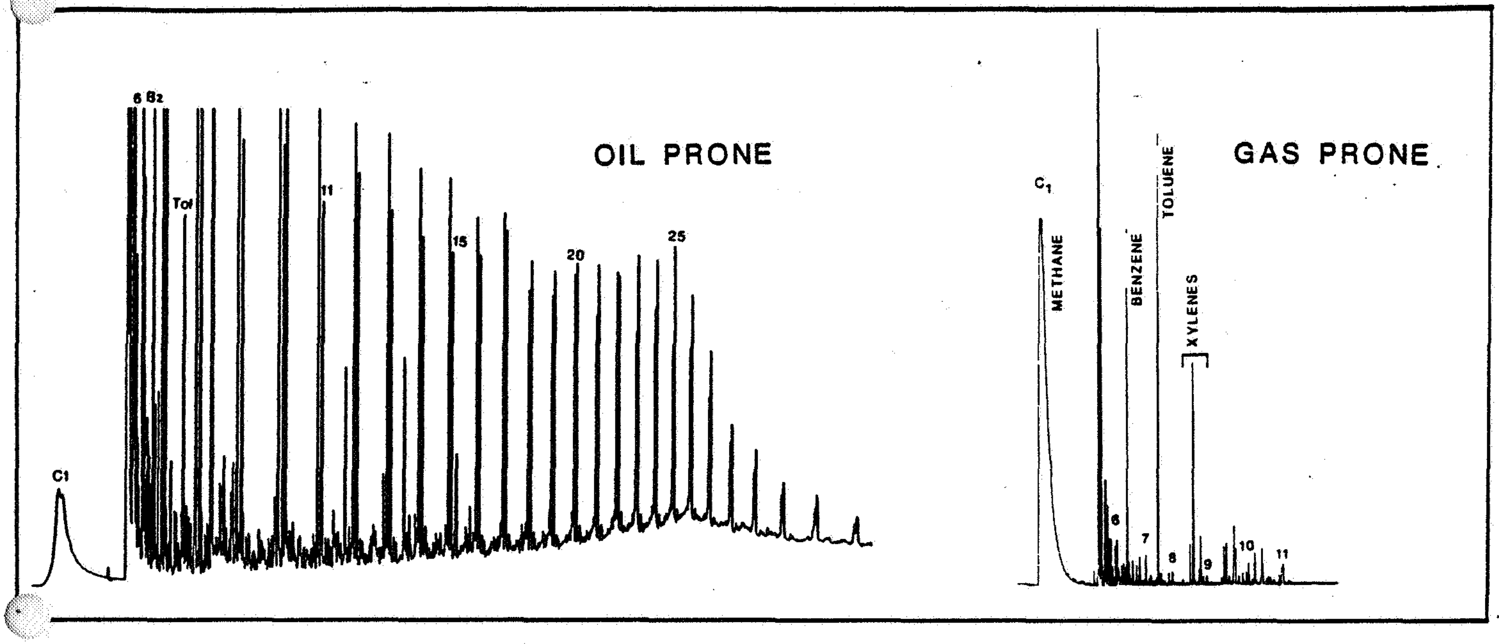


FIGURE 11a

WELL 6406/3-2

PYROLYSIS GC



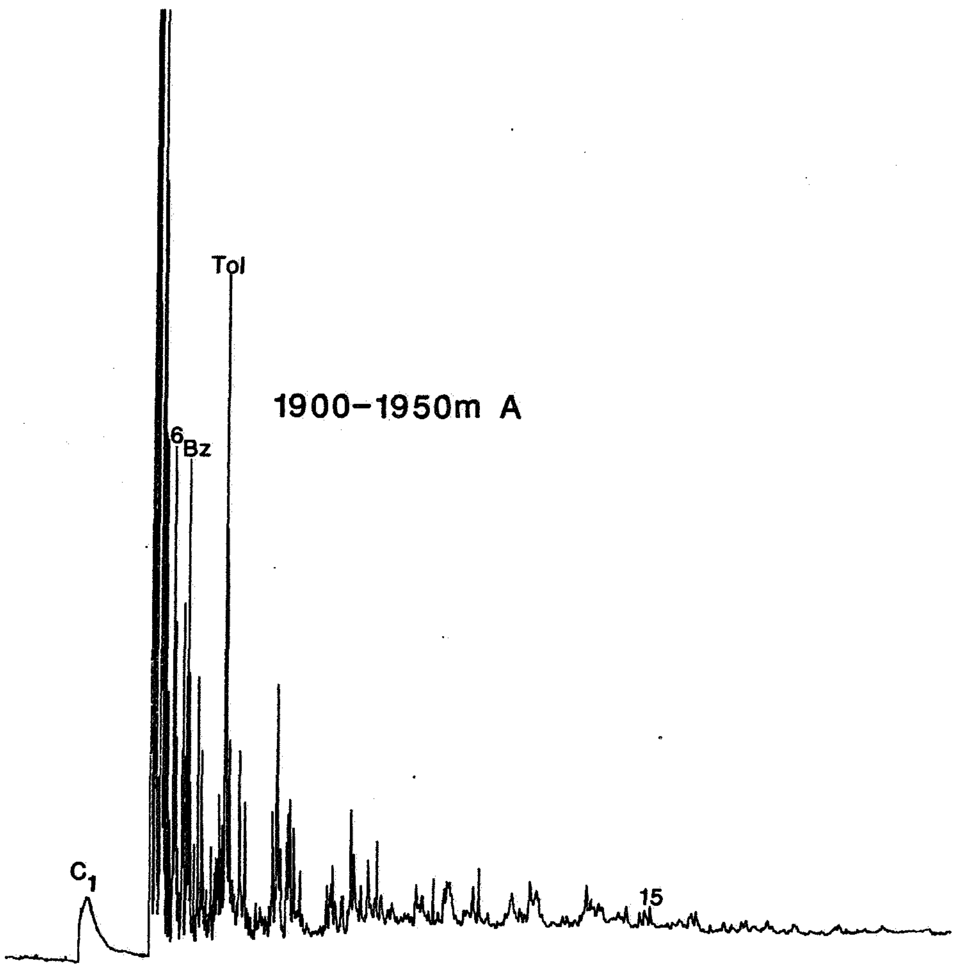
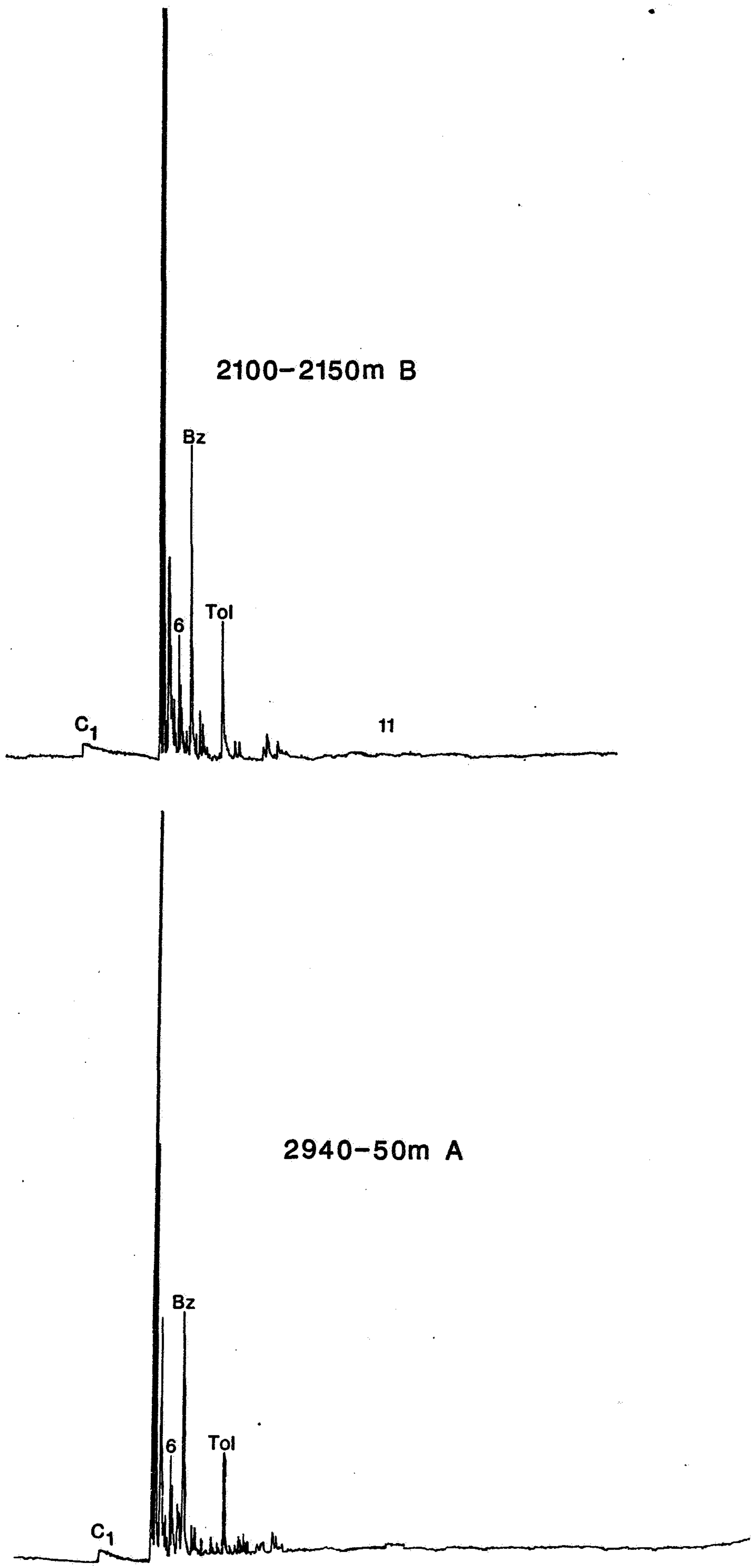


FIGURE 1b

WELL 6406/3-2

PYROLYSIS GC



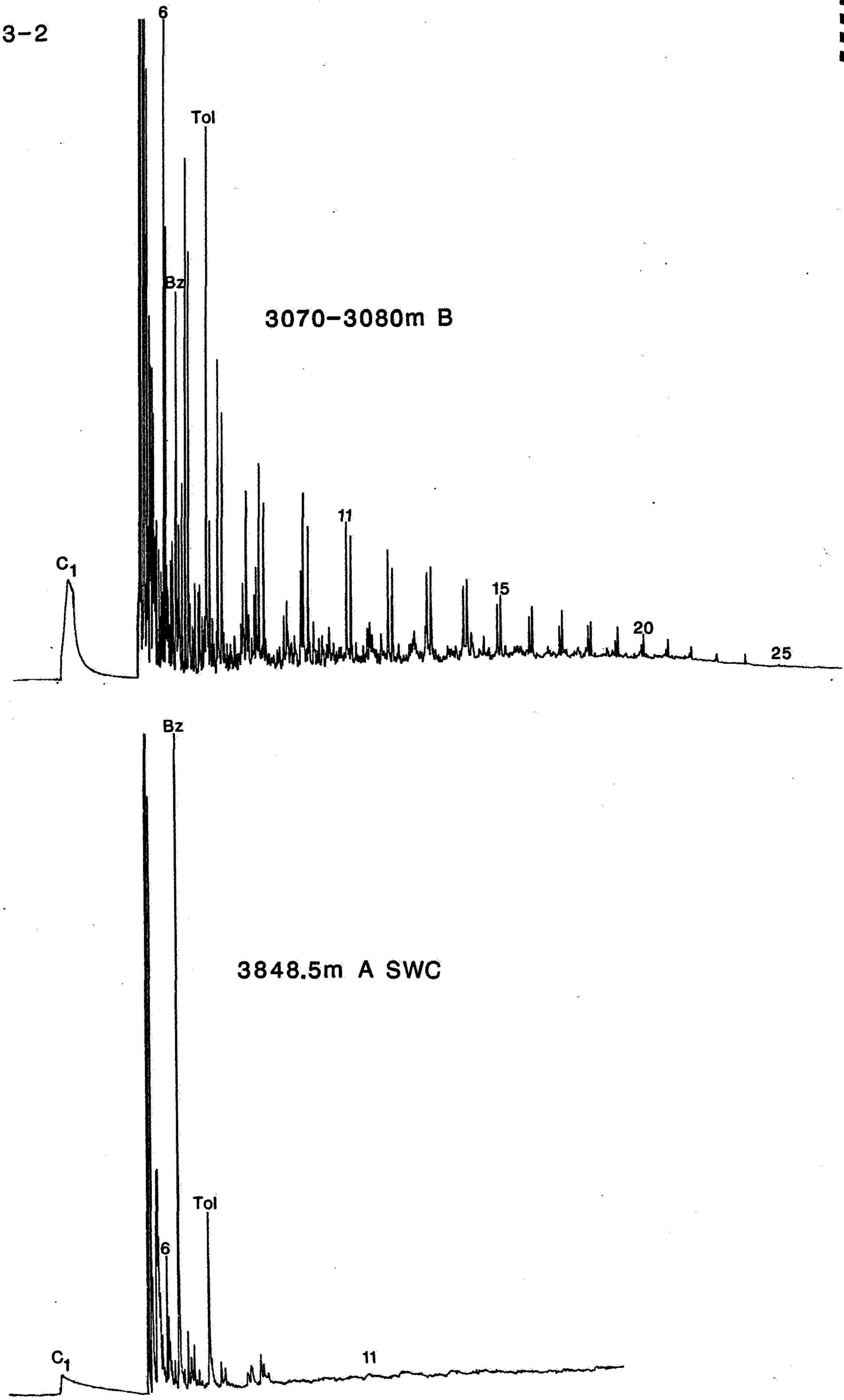
STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

Bz - Benzene
To - Toluene

FIGURE 11c

WELL 6406/3-2

PYROLYSIS GC



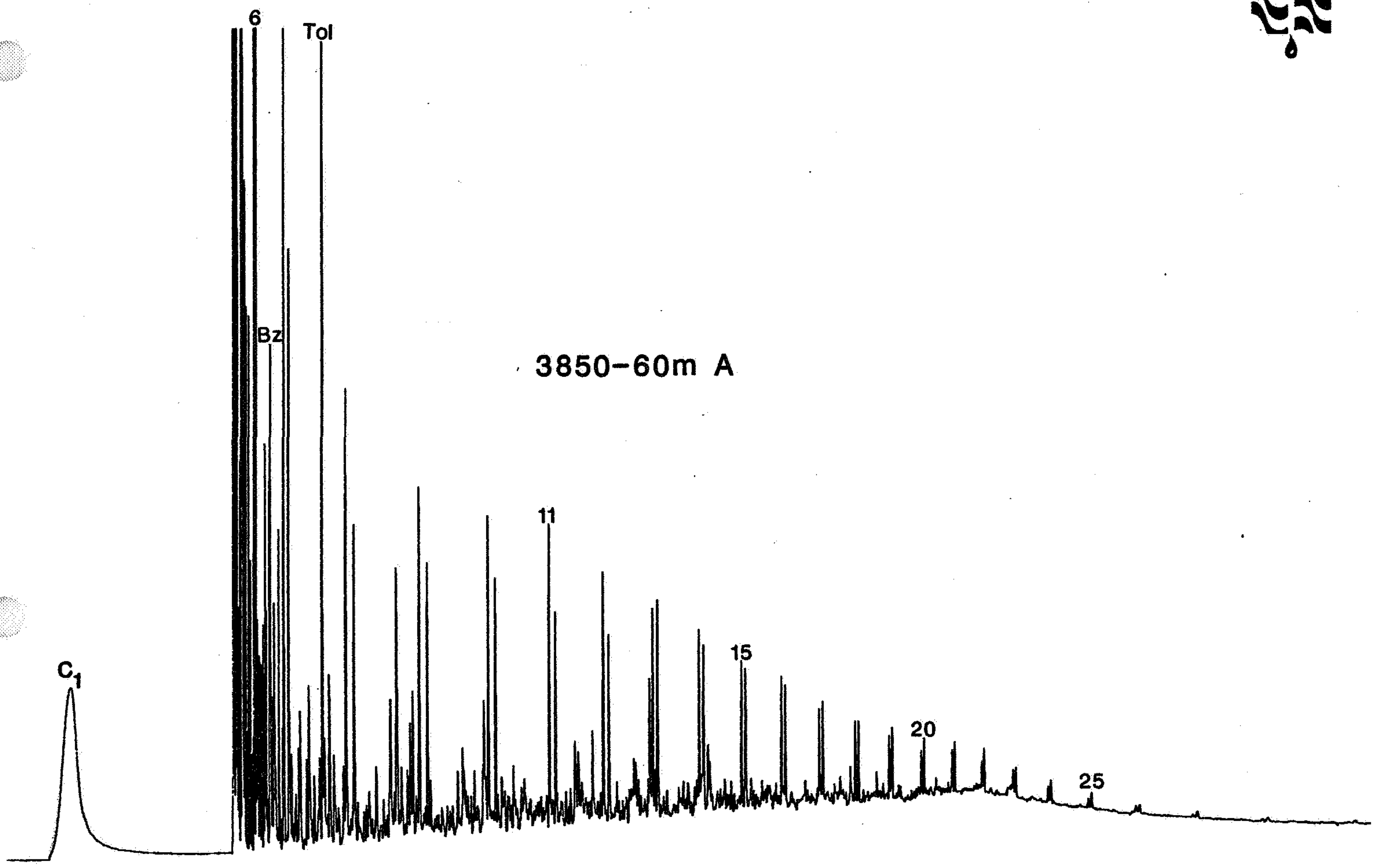
STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

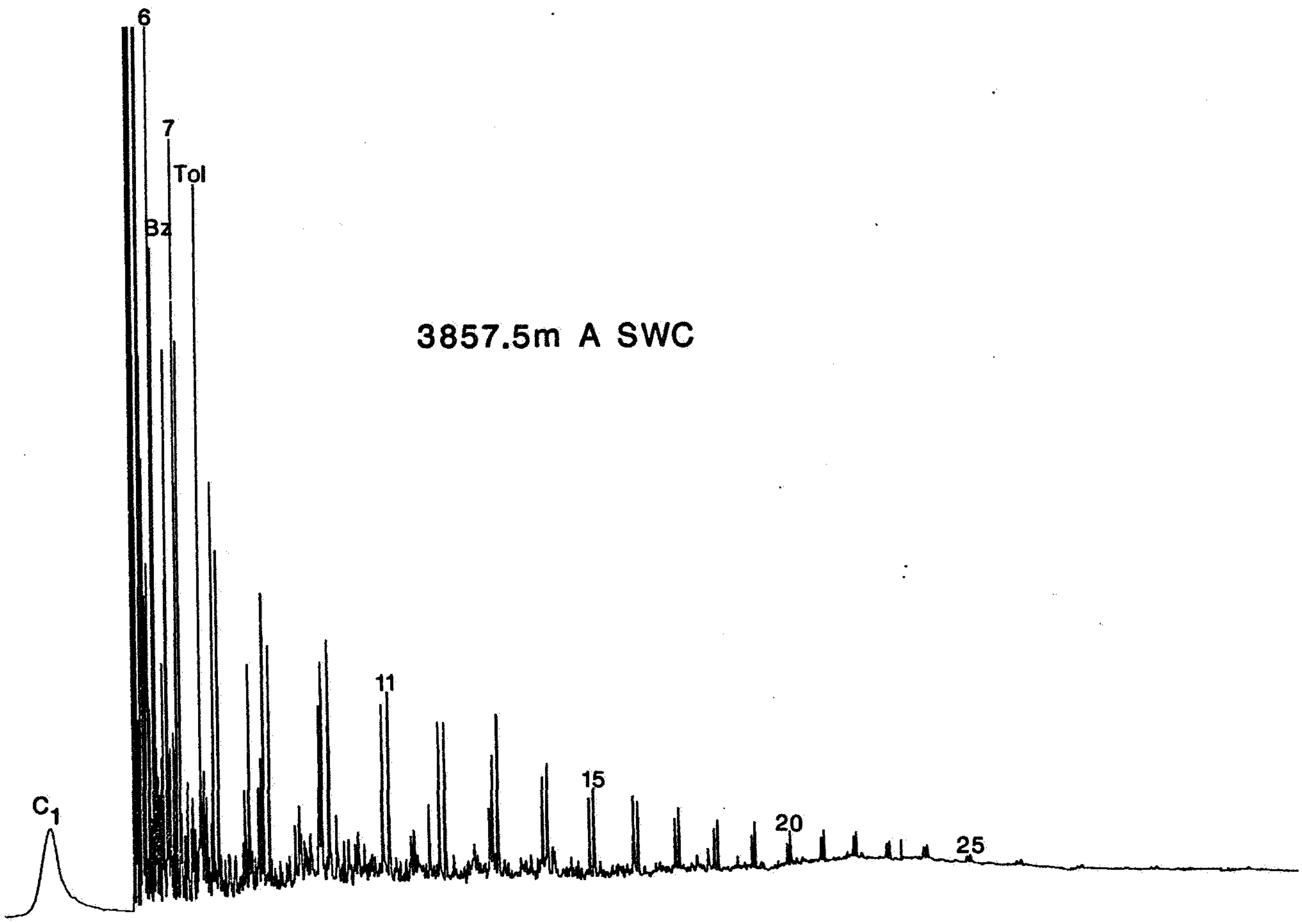
Bz - Benzene
To - Toluene

FIGURE 11d

PYROLYSIS GC

WELL 6406/3-2





Bz - Benzene
To - Toluene

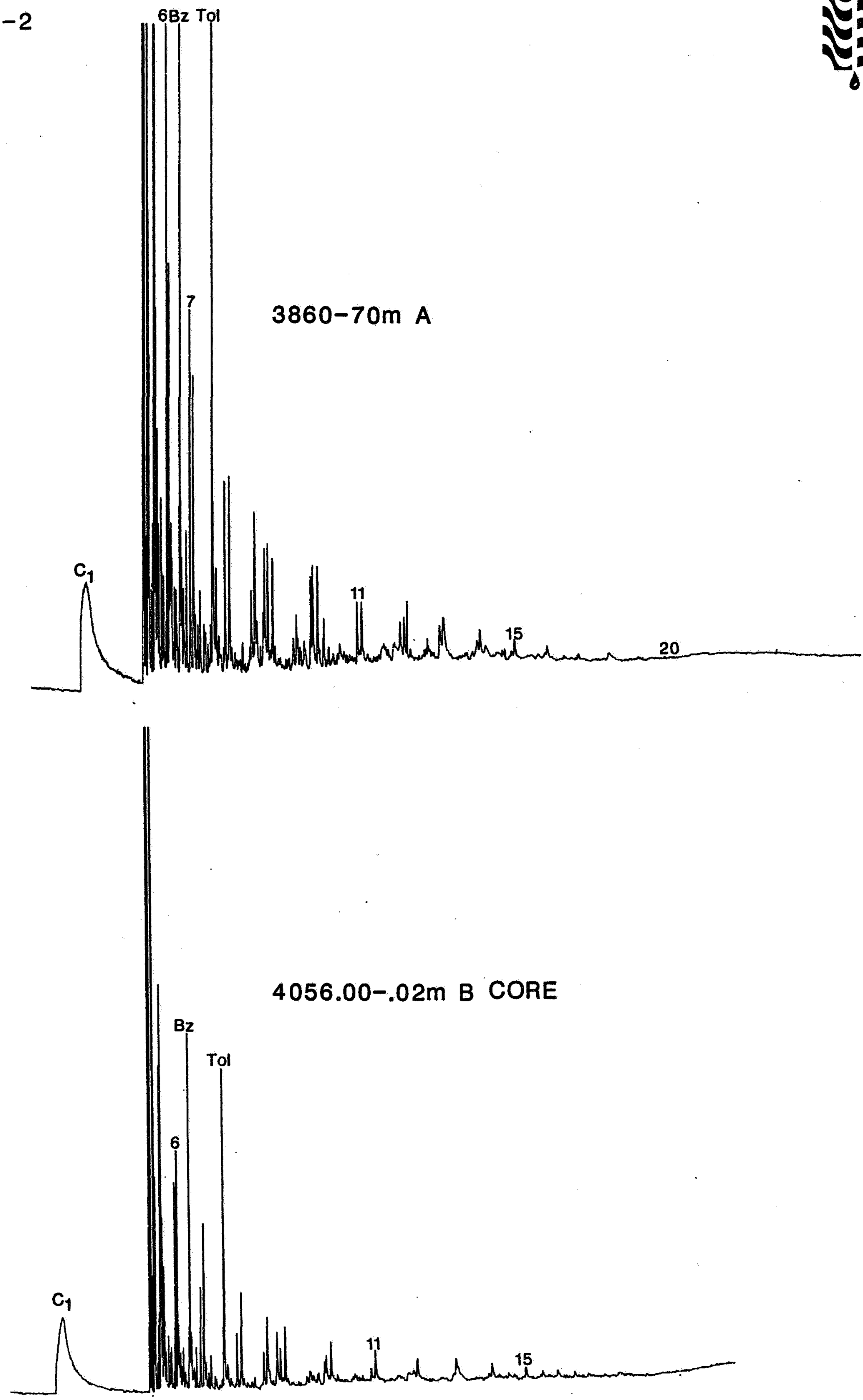
STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

FIGURE 11e

PYROLYSIS GC

GEOCHEM

WELL 6406/3-2



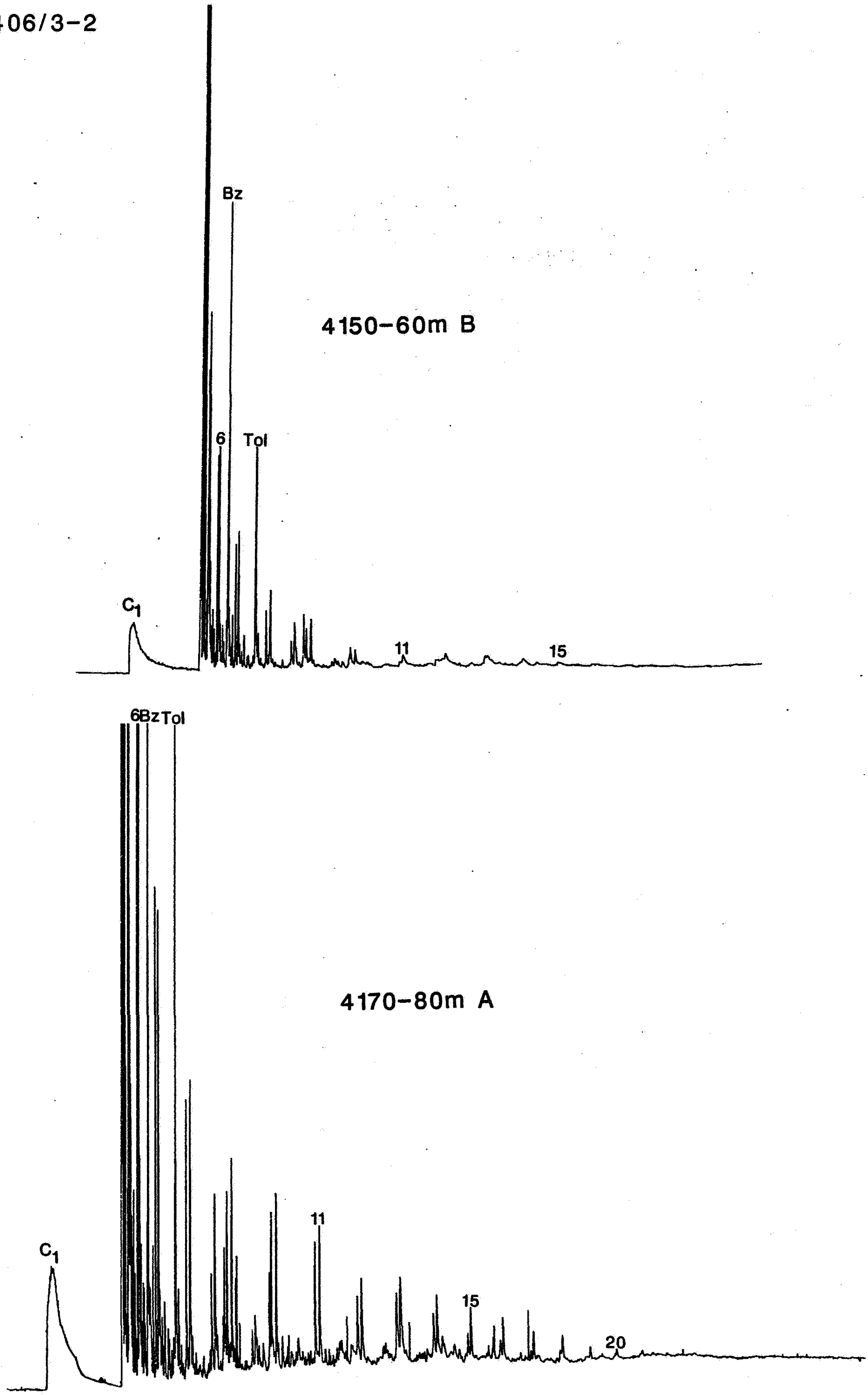
STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

Bz - Benzene
To - Toluene

FIGURE 11f

WELL 6406/3-2

PYROLYSIS GC



Bz - Benzene

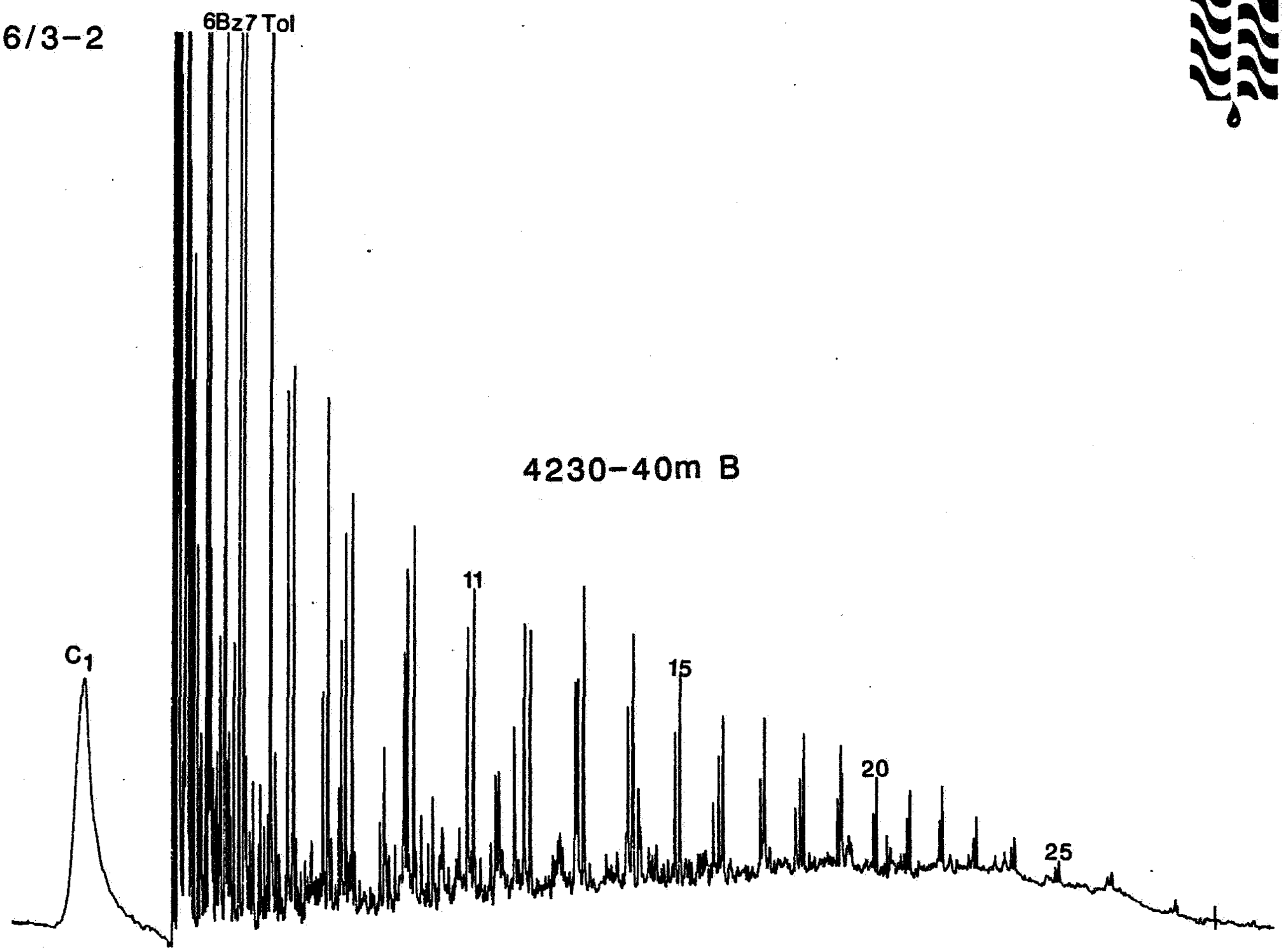
To - Toluene

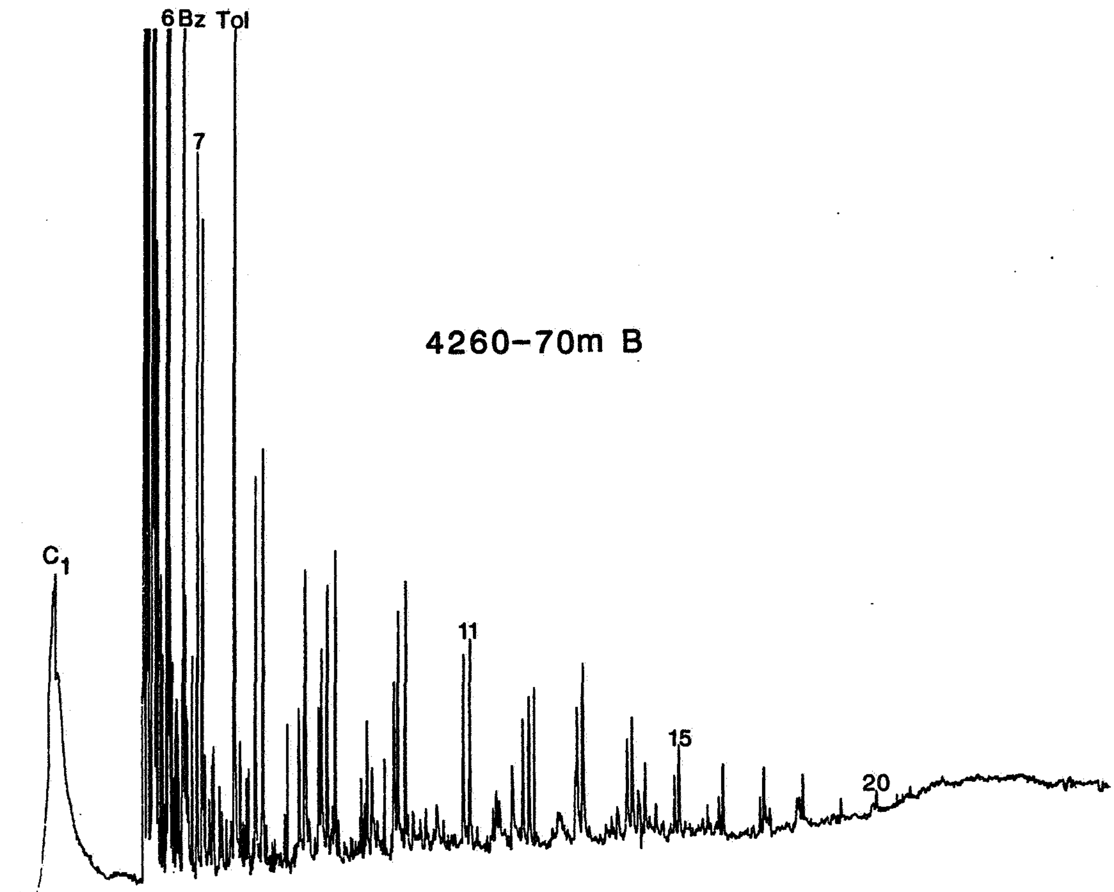
STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

FIGURE 11g

WELL 6406/3-2

PYROLYSIS GC





Bz - Benzene

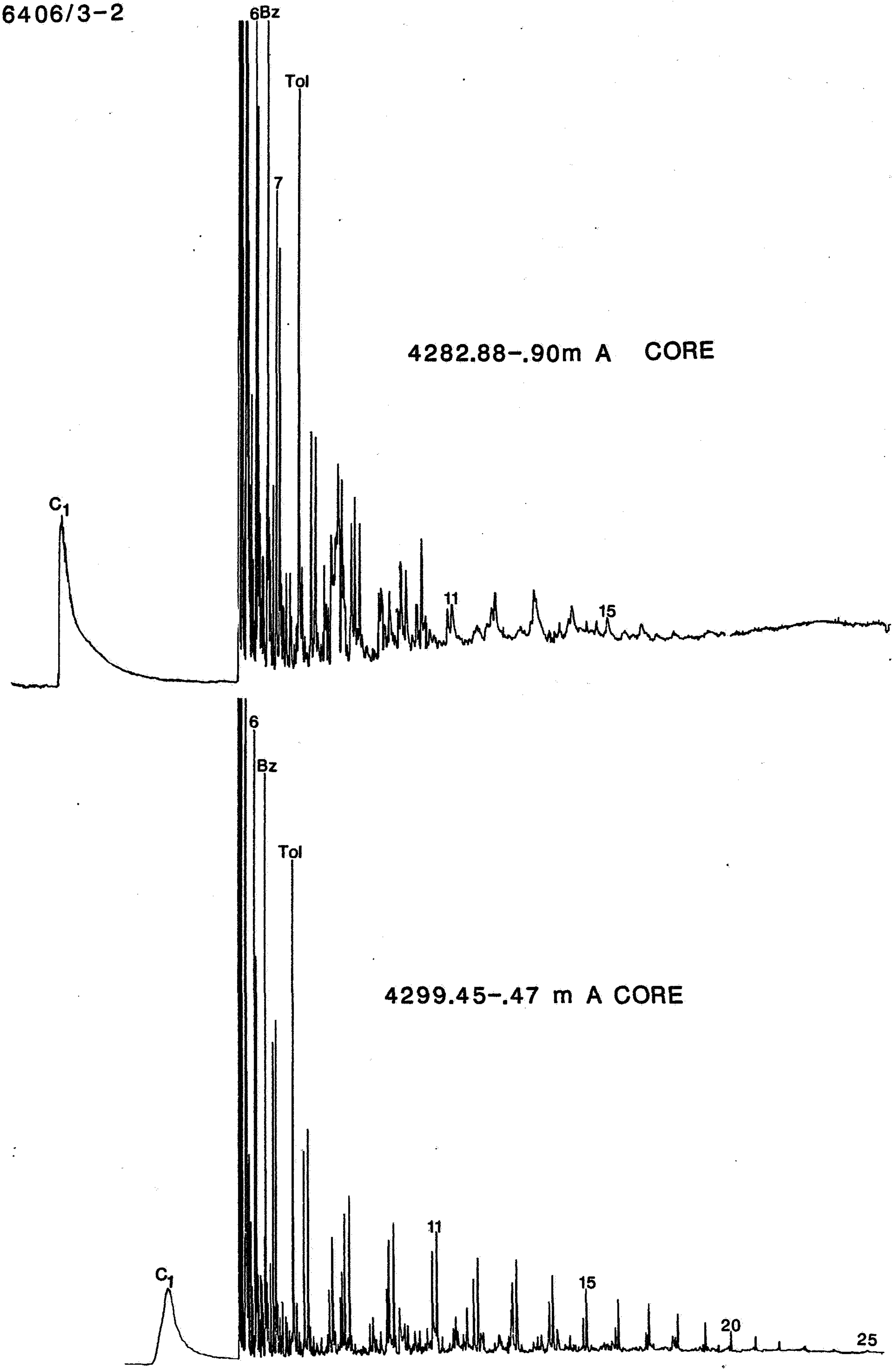
To - Toluene

STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

FIGURE 11h

PYROLYSIS GC

WELL 6406/3-2



Bz - Benzene

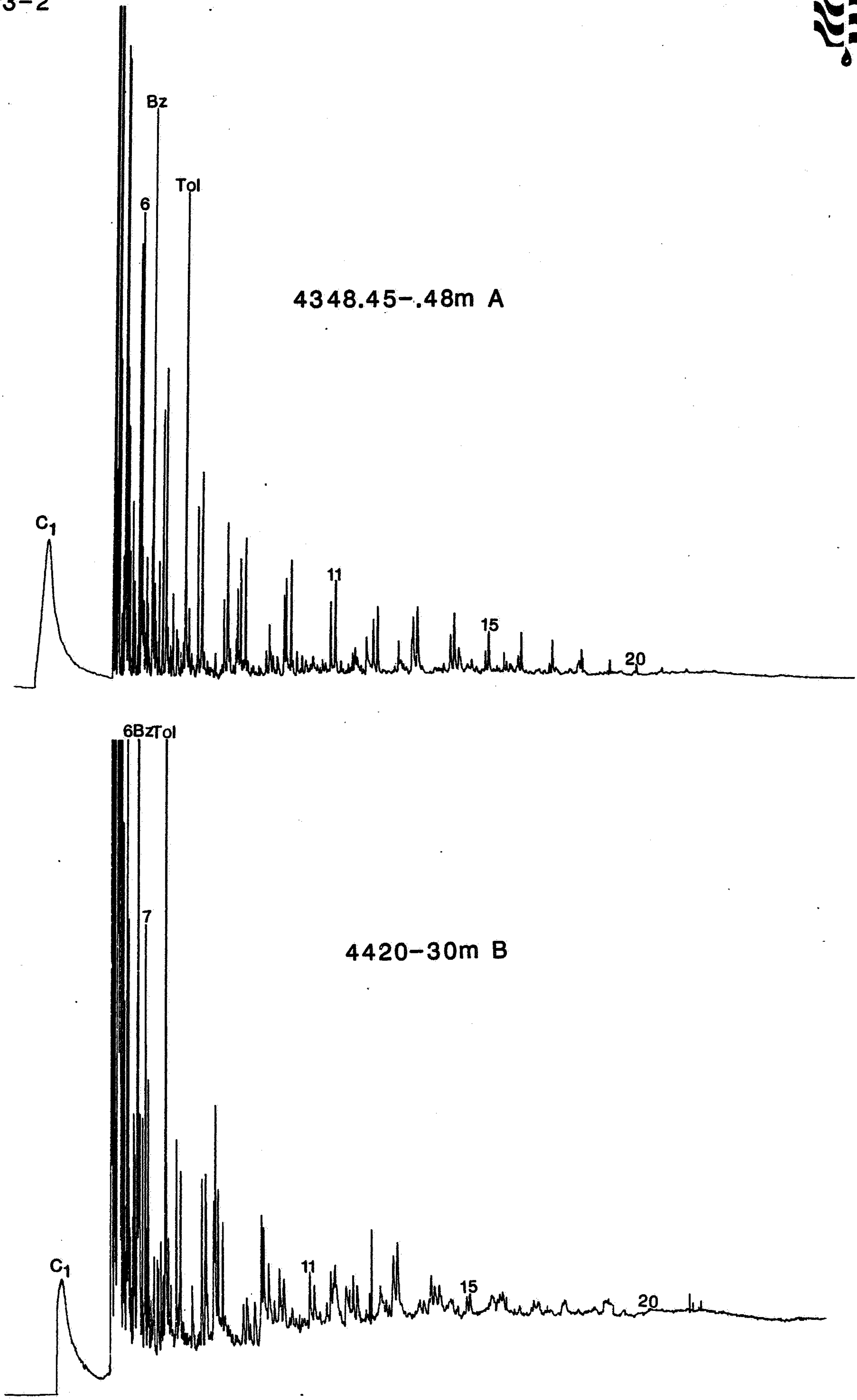
To - Toluene

STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

FIGURE 11i

WELL 6406/3-2

PYROLYSIS GC



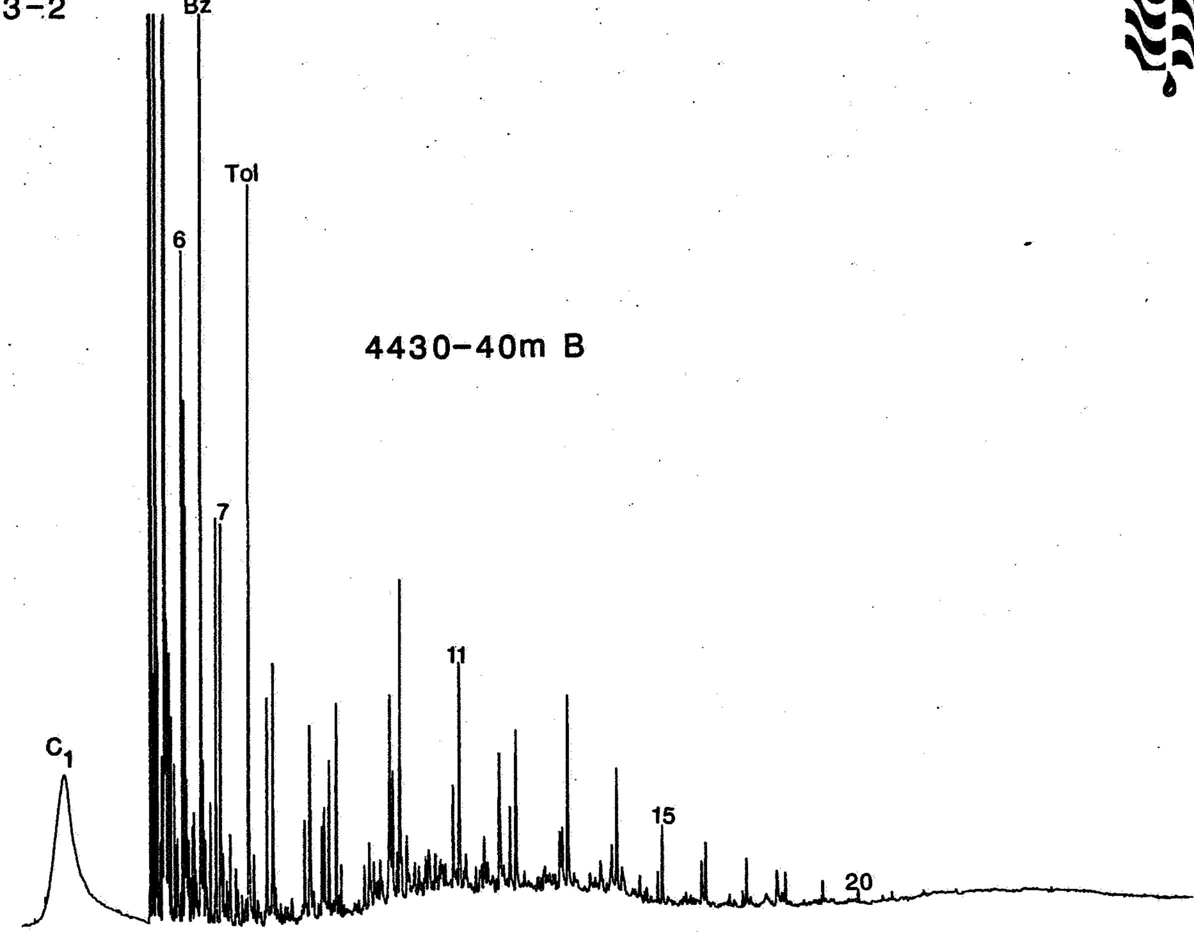
STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

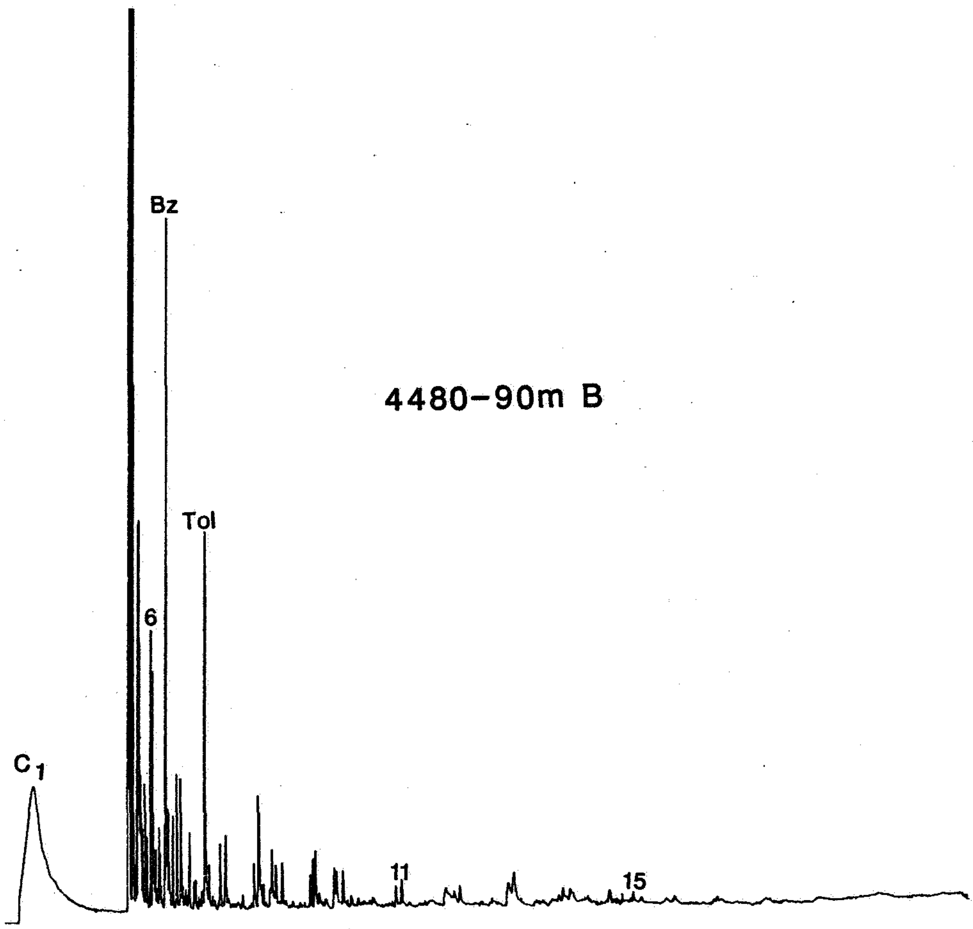
Bz - Benzene
To - Toluene

FIGURE 11j

PYROLYSIS GC

WELL 6406/3-2





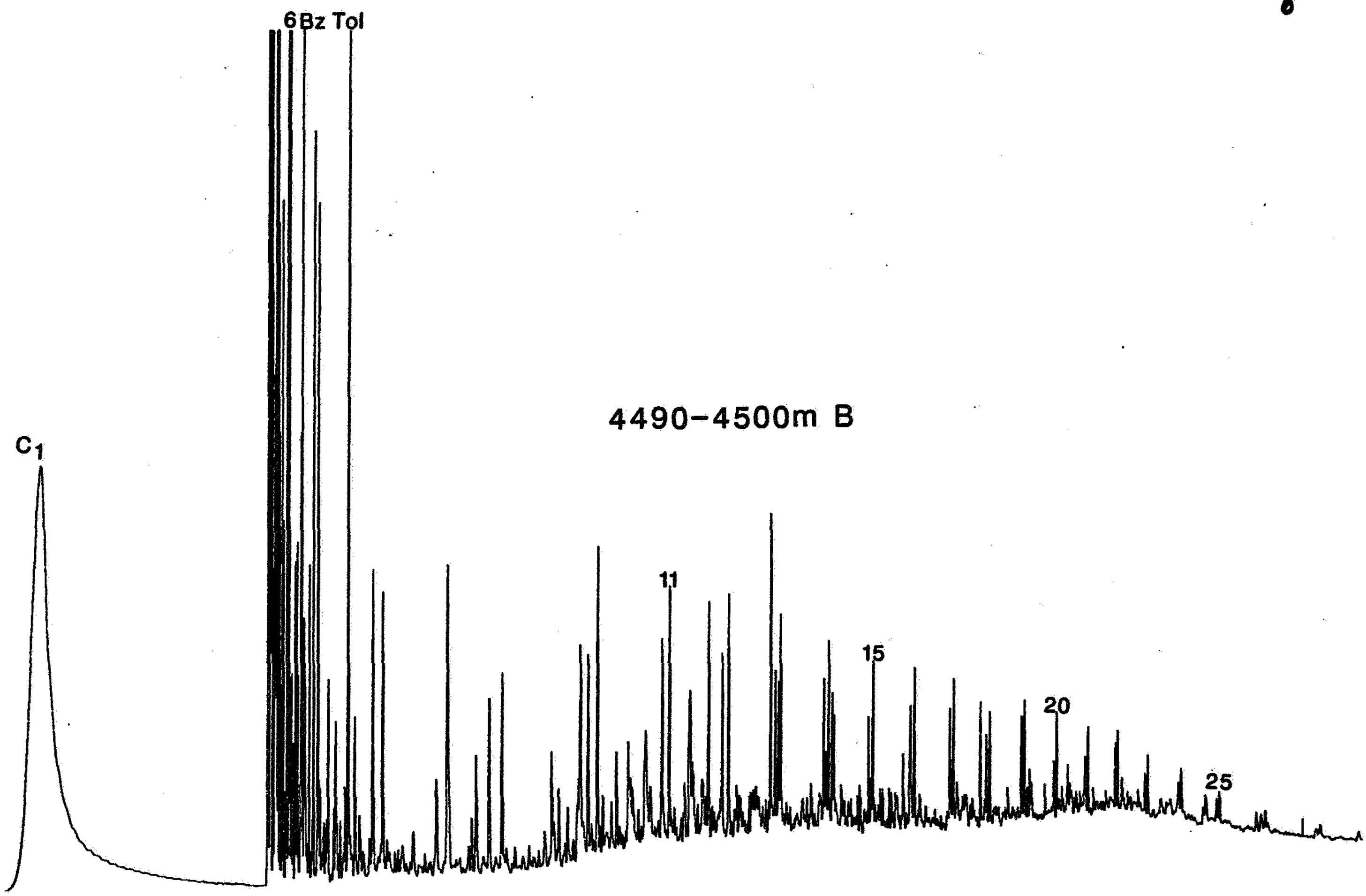
Bz - Benzene
To - Toluene

STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

FIGURE 11k

PYROLYSIS GC

WELL 6406/3-2



Bz - Benzene
To - Toluene

STANDARD TRACES ILLUSTRATED ON FIRST SHEET
NORMAL ALKENE/ALKANE DOUBLETS
IDENTIFIED BY CARBON NUMBERS

30.06.87. BA-87-775-1

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CONTENTS - Cont'd.

APPENDIX FIGURES

TABLE 14a
PEAK HEIGHT DATA

M/Z 217

SAMPLE NO (depth)	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1505-001 (3937-3995m)	112	81	52	47	61	42	32	89	35	23	60	30	12	28	10	10	15	28	20	15
1505-002 (3932.58-.68m)	113	70	29	55	62	43	25	113	42	26	65	38	27	47	13	12	25	28	34	25
1505-005 (3942.00-.10m)	114	69	38	50	63	46	29	110	45	28	65	31	23	41	11	17	27	28	26	22
1505-006 (3952.00-.10m)	95	68	52	45	57	45	48	106	49	28	66	33	20	37	10	13	27	42	30	22
1505-007 (3960.02-.09m)	102	72	47	45	55	46	27	101	42	34	69	35	23	42	10	21	29	40	37	29
1505-008 (3966.02-.09m)	98	63	24	46	59	43	22	104	45	51	63	30	21	39	10	24	31	28	33	40
1505-009 (3980.07-.17m)	97	71	20	41	57	46	25	110	47	31	70	34	22	45	11	17	28	33	31	26
1505-010 (3989.08-.15m)	110	74	27	46	65	39	24	112	49	28	62	27	26	45	12	19	26	30	31	29
1505-011 (4000.15-.21m)	102	70	25	44	59	40	23	106	43	27	63	28	23	43	10	16	24	29	28	27
1505-015 (4083.31-.38m)	114	77	25	52	69	50	23	111	50	28	70	33	23	49	11	20	32	36	34	21
1505-016 (4086.16-.22m)	107	72	20	46	62	48	24	117	45	25	70	28	25	47	12	20	24	33	34	32
1505-017 (4098.17-.25m)	106	73	21	46	65	43	25	115	46	27	71	31	28	49	12	21	28	37	35	32

TABLE 14a

PEAK HEIGHT DATA

M/Z 217

SAMPLE NO (depth)	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1505-019 (4121.24-.31m)	96	67	30	55	61	44	26	98	43	42	59	32	22	35	11	17	26	38	34	23
1505-024 (4309.00-.10m)	96	68	18	43	60	50	25	115	45	25	67	33	20	42	11	20	29	29	32	28
1505-028 (4364.17-.24m)	95	71	19	38	58	52	23	108	43	27	67	33	20	45	9	16	26	25	28	24
1505-029 (4369.30-.27m)	112	82	27	47	65	52	24	102	40	26	63	35	17	42	8	16	23	22	25	20

TABLE 14a

PEAK HEIGHTS DATA

M/Z 217

SAMPLE NO (depth)	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1506-051 (2490-2500m)	65	48	20	33	40	24	44	93	52	85	47	15	40	40	14	81	33	56	41	120
1506-060 (2580-2590m)	66	47	27	41	51	42	33	73	41	92	62	20	32	30	12	109	28	58	48	117
1506-075 (2730-2740m)	94	70	40	70	89	65	55	100	68	110	74		51	51	19	91	35	97	47	115
1506-109 (3070-3080m)	97	67	29	68	78	55	45	115	65	64	65		4	40	16	40	32	55	44	57
1506-126 (3240-3250m)	85	65	29	49	59	39	43	116	64	65	66		31	38	20	35	37	58	47	51
1506-129 (3274.5m)	77	48	21	34	41	28	37	121	60	75	56	16	28	36	14	31	39	67	45	58
1506-133 (3300-3310m)	76	47	21	45	50	39	58	106	70	75	55		50	58	29	49	49	77	60	64
1506-153 (3480-3490m)	82	53	21	37	40	32	41	101	53	56	57	20	30	40	20	36	40	52	46	48
1506-177 (3720-3730m)	50	24		28	22		65	126	86	63	21		46	44	16	28	49	85	72	57
1506-183 (3780-3790m)	110	67	26	48	48	30	50	113	60	50	51		29	44	22	20	23	45	38	25
1506-190 (3840-3850m)	107	65	32	49	57	38	32	108	55	63	60	22	41	52	21	29	45	69	61	54
1506-193 (3857.5m)	119	78	33	49	57	35		99	52	35	59	25	27	40	17	19	28	36	37	29

<u>TABLE 14a</u>

PEAK HEIGHTS DATA

M/Z 217

SAMPLE NO (depth)	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1506-198 (3890-3900m)	100	52	35	40	44	32	56	105	57	71	55		41	59	36	31	60	85	54	81
1506-204 (4056.00-.02m)	89	56	28	38	44			100	39	43	55		23	40	25	20	44	45	50	51
1506-207 (4170-4180m)	61	34	16	34	38	28	38	108	72	70	45		45	57	30	39	46	70	59	57
1506-211 (4220-4230m)	75	46	20	32	40	28	32	108	57	62	49	12	32	50	26	34	40	45	47	50
1506-215 (4260-4270m)	69	38	11	31	36	27	31	102	53	51	47		33	44	24	32	37	37	44	39
1506-221 (4338.91-.92m)	48	29	12	24	27	23	25	96	38	47	59	21	20	24	22	23	54	64	56	47
1506-226 (4430-4440m)	61	40	16	34	40	30	45	103	66	65	50		45	57	32	45	49	66	64	56
1506-233 (4480-4490m)	97	56	26	42	41	33	40	111	64	55	52		38	48	20	30	35	49	53	40

TABLE 14b

PEAK HEIGHT DATA

M/Z 191

SAMPLE NO (depth)	A	B	Z	C	C_1	X	E	F	G	H	I	J	J^1	K	K^1	L	L^1	M	M^1
1505-001 (3937-3995m)	58	29	28	41	57	45	96	13	43	35	8	38	20	25	13	13	6	8	6
1505-002 (3932.58-.68m)	44	20	9	52	42	26	118	9	53	41	6	45	24	27	19	17	10	11	6
1505-005 (3942.00-.10m)	49	23	15	54	45	24	119	10	56	39	10	41	23	21	15	14	7	9	5
1505-006 (3952.00-.10m)	44	22	20	50	47	22	119		59	41	6	42	23	24	15	14	9	11	6
1505-007 (3960.02-.09m)	42	22	22	50	44	25	119	11	54	41	4	43	23	25	16	15	9	11	6
1505-008 (3966.02-.09m)	38	23	15	52	37	20	119	8	51	39	3	35	22	21	13	14	9	10	6
1505-009 (3980.07-.17m)	43	22	12	50	39	24	116	10	52	42	5	40	21	25	15	15	10	11	6
1505-010 (3989.08-.15m)	43	21	10	59	44	28	117	9	52	41	6	43	27	29	18	17	10	12	8
1505-011 (4000.15-.21m)	40	25	10	52	45	24	118	10	50	41	6	39	24	27	15	15	9	11	7
1505-015 (4083.31-.38m)	46	38	10	52	42	30	118	9	49	40	7	40	21	23	17	15	10	11	6
1505-016 (4086.16-.22m)	45	26	9	59	48	30	118	9	50	38	7	41	21	26	15	15	10	11	7
1505-017 (4098.17-.25m)	40	24	17	56	42	23	120	11	52	41	6	40	23	25	16	17	10	12	7

TABLE 14b

PEAK HEIGHT DATA

M/Z 191

SAMPLE NO (depth)	A	B	Z	C	C_1	X	E	F	G	H	I	J	J^1	K	K^1	L	L^1	M	M^1
1505-019 (4121.24-.31m)	55	34	28	65	45	18	123	10	50	37	5	39	23	21	15	13	10	11	9
1505-024 (4309.00-.10m)	58	28	16	64	59	33	115	9	49	40	10	38	19	23	15	13	9	9	7
1505-028 (4364.17-.24m)	67	30	26	51	65	46	101	15	40	33	12	29	15	19	11	12	6	7	6
1505-029 (4369.30-.27m)	78	27	28	48	70	45	98	12	35	20	11	30	14	18	10	10	7	7	7

TABLE 14b

PEAK HEIGHT DATA

M/Z 191

SAMPLE NO (depth)	A	B	Z	C	C_1	X	D	E	F	G	H	I	J	J^1	K	K^1	L	L^1	M	M^1
1506-051 (2490-2500m)	19	33	10	83	91	5	31	128	32	37	90	34	15	24	13	7	5	3	3	2
1506-060 (2580-2590m)	20	27	32	51	74	7	33	125	25	31	61	22	14	16	9	6	4	3	2	2
1506-075 (2730-2740m)	14	24	124	65	22	5	35	116	24	32	97	22	12	18	14	8				
1506-109 (3070-3080m)	19	21	32	60	21	5	19	95	20	45	130	18	15	14	9	7	4	3	2	2
1506-126 (3240-3250m)	24	37	25	86	24	10	25	129	28	72	82	13	24	18	13	9	8	5	4	2
1506-129 (3274.5m)	19	27	10	74	19	10	15	125	18	62	56	10	28	21	20	11	10	6	8	5
1506-133 (3300-3310m)	25	36	18	89	28	6	19	120	19	54	48	10	29	22	18	11	11	6	7	4
1506-153 (3480-3490m)	23	64	12	111	22	6	35	126	40	65	57	16	25	17	12	8	6	3	3	1
1506-177 (3720-3730m)	14	40		88	14		18	125	16	40	30	13	24	22						
1506-183 (3780-3790m)	44	39	19	102	30	9	12	106	13	41	48		13	16						
1506-190 (3840-3850m)	33	21	8	70	34	14	8	124	12	51	49	5	38	26	27	18	16	9	10	7
1506-193 (3857.5m)	50	17	6	41	41	26	3	122	10	55	41	4	38	24	24	14	13	8	9	5
1506-198 (3890-3900m)	15	41	6	90	21	13	12	125	30	54	54	8	30	21	15	10				

TABLE 14b

PEAK HEIGHT DATA

M/Z 191

SAMPLE NO (depth)	A	B	Z	C	C_1	X	D	E	F	G	H	I	J	J^1	K	K^1	L	L^1	M	M^1
1506-204 (4056.00-.02m)	21	33	10	70	28	49		116	14	61	48	7	51	34	22	15	11	7	6	3
1506-207 (4170-4180m)	25	35	15	84	23	19	11	121	14	62	61	6	37	25	22	13	14	8	11	6
1506-211 (4220-4230m)	14	35	7	48	15	7	19	72	21	36	129	13	17	16	10	6	5	3	3	2
1506-215 (4260-4270m)	35	56		95	26	14	18	108	20	46	117	10	24	17						
1506-221 (4338.91-.92m)	45	22		44	54	68	11	114		47	31		34	21	16	11	11	6	14	4
1506-226 (4430-4440m)	31	40		91	31	9	14	117	15	53	41	5	29	19	17	10	8	5	6	3
1506-233 (4480-4490m)	40	45	20	109	36	13	13	120	14	54	49	5	30	20	17	11	9	5	7	4

TABLE 14c

PEAK HEIGHT DATA

M/Z 218

SAMPLE NO (depth)	A	B	C	D	E	F
1505-001 (3937-3995m)	81	50	38	45	50	45
1505-002 (3932.58-.68m)	120	80	69	75	65	74
1505-005 (3942.00-.10m)	120	83	55	68	58	67
1505-006 (3952.00-.10m)	114	85	55	64	95	75
1505-007 (3960.02-.09m)	113	79	60	67	80	74
1505-008 (3966.02-.09m)	115	82	52	63	79	75
1505-009 (3980.07-.17m)	113	84	60	74	69	65
1505-010 (3989.08-.15m)	120	78	62	74	66	72
1505-011 (4000.15-.21m)	118	87	62	74	65	65
1505-015 (4083.31-.38m)	122	89	69	88	79	78
1505-016 (4086.16-.22m)	122	90	69	85	75	81
1505-017 (4098.17-.25m)	122	88	70	78	78	75
1505-019 (4121.24-.31m)	106	76	55	60	69	67
1505-024 (4309.00-.10m)	119	90	65	78	68	75
1505-028 (4364.17-.24m)	114	85	65	79	63	70
1505-029 (4369.30-.27m)	109	78	55	73	54	60

TABLE 14c

PEAK HEIGHT DATA

M/Z 218

SAMPLE NO (depth)	A	B	C	D	E	F
1506-051 (2490-2500m)	123	95	83	87	91	81
1506-060 (2580-2590m)	105	79	77	72	97	79
1506-075 (2730-2740m)	119	86	81	90	91	73
1506-109 (3070-3080m)	88	66	52	51	64	56
1506-126 (3240-3250m)	125	87	57	61	90	78
1506-129 (3274.5m)	125	79	47	53	101	80
1506-133 (3300-3310m)	118	100	80	90	90	85
1506-153 (3480-3490m)	118	92	58	70	78	72
1506-177 (3720-3730m)	127	93	53	47	109	74
1506-183 (3780-3790m)	124	92	49	60	62	54
1506-190 (3840-3850m)	121	91	76	85	105	106
1506-193 (3857.5m)	85	62	46	51	50	54
1506-198 (3890-3900m)	118	77	52	82	88	57
1506-204 (4056.00-.02m)	110	74	46	61	90	92
1506-207 (4170-4180m)	121	105	70	86	86	89
1506-211 (4220-4230m)	114	86	54	74	65	
1506-215 (4260-4270m)	108	87	64	74	52	
1506-221 (4338.91-.92m)	91	78	40	39	116	
1506-226 (4430-4440m)	117	95	74	85	83	
1506-233 (4480-4490m)	120	90	65	73	71	

TABLE 15

DETAILED GASOLINE (C4-C7) ANALYSIS

GEOCHEM SAMPLE NUMBER	001
DEPTH	3937-3995
isobutane	0.07
n-butane	0.74
isopentane	2.14
n-pentane	5.13
2,2-dimethylB	0.01
cyclopentane(CP)	0.70
2,3-dimethylB	0.05
2-methylP	4.54
3-methylP	2.84
n-hexane	9.89
methylCP(MCP)	5.59
2,2-dimethylP	0.45
2,4-dimethylP	0.01
2,2,3-trimethylB	0.04
benzene	4.92
cyclohexane(CH)	10.01
3,3-dimethylP	0.00
1,1-dimethylCP	0.00
2-methylH	4.13
2,3-dimethylP	0.64
3-methylH	4.04
1,c,3-dimethylCP	1.16
1,t,3-dimethylCP	1.15
1,t,2-dimethylCP	2.59
3-ethylP	0.00
n-heptane	11.84
methylCH(MCH)	14.71
1,c,2-dimethylCP	0.00
toluene	12.58
ABUNDANCE	
nC7/C7nap x100	60.36
MCP/Bz	1.14
MH/DMCP	1.66
nC6/MCP	1.77
%n-PARAFFINS	27.60
%iso-PARAFFINS	18.97
% NAPHTHENES	35.93
% AROMATICS	17.50