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TECHNICAL NOTE

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A GEOCHEMICAL STUDY OF NOCS WELL 7/12-3A

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by

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SUMMARY

A geochemical study of 9 sidewall core samples from NOCS Well 7/12-3A was undertaken by Geochemistry Branch, BP Research Centre, Sunbury.

Similar problems with poor specificity maturity indicators were encountered in this well as had been previously observed in Wells 7/12-3 and 7/12-4. However, the data suggested that the oil generation threshold was at about 3500m TVD. Basic soluble extract parameters indicated that the sediments contained accumulations of migrated hydrocarbons in the Upper Jurassic and Triassic sandstones. The only good oil source rock in the samples examined was at 3638.4m brt (3506.7m TVD) in the "Kimmeridge Clay Formation".

A. INTRODUCTION

NOCS Well 7/12-3A was deviated upflank from 7/12-3 to try to establish an oil-water contact in the Upper Jurassic sandstone reservoir. Deviation from 7/12-3 commenced at 1720 mbt, below the 13 3/8" casing shoe. Samples were designated throughout the study by their depth below rotary table (mbrt), but Table 1 shows a conversion of these depths to True Vertical Depth (TVD).

Initially there was confusion over the numbering of the geochemical samples, but this confusion was apparently resolved by BP Norway. However, sidewall core 44 from 3992.7 mbrt was described as a Triassic limestone in the geological completion report (1), but the sample received and labelled from that depth was a sandstone with only 11.6% wt of 'carbonate'. The kerogen concentrate from this sample was examined for diagnostic fossils but was found to be barren. This could be consistent with a Triassic age for this particular sample.

ineteen sidewall core samples were examined in detail for maturity and source rock richness.

B. ANALYSIS PERFORMED BY GEOCHEMISTRY BRANCH, SUNBURY

The Degree of Organic Diagenesis (DOD) of the samples was determined by vitrinite reflectance measurements on small pieces of sidewall cores. Samples were mounted in resin, polished, and the reflectance of dispersed vitrinite determined by standard oil immersion techniques. Spore fluorescence colours in UV light were useful in characterising the autochthonous vitrinite reflectance distributions.

Spore colours in transmitted white light, and kerogen type analyses were determined by microscopic examination of specially prepared organic concentrates.

Ground samples were extracted with dichloromethane to obtain Total Soluble Extracts (TSE). These extracts were separated into a saturate alkane concentrate (SAC) and aromatic and resin fractions by Low Pressure Liquid Chromatography (LPLC). The SAC fractions were analysed by capillary column gas/liquid chromatography to determine normal alkane distributions and Carbon Preference Indices (CPI). A portion of the SAC fraction was, in some instances, also analysed by C-GC-MS to determine sterane and pentacyclene distributions.

The solvent extracted, ground samples were acid treated to remove inorganic carbonates and Total Organic Carbon (TOC) contents and Stable Carbon Isotope Ratios ($\delta^{13}C_{PDB-1}$) determined on the residues.

C. RESULTS

(i) Vitrinite Reflectance Measurements

Results of these determinations are summarised in Table 3. Very poor data were obtained for this suite of samples and was described as a "meaningless jumble of results". Most of the results quoted are averages of a wide range of values. No trends with depth could be distinguished from the results. However, spore fluorescence colours in UV light were described as good, and consistent both within and between samples. These also showed no trend with depth, but the colours (yellow orange to orange) were considered to be approximately equivalent to a vitrinite reflectivity of about 0.6%. It is possible that proximity to the salt dome and its associated heat flow anomalies may have affected these results. Many anomalously low reflectivities were recorded which were mainly attributed to bitumen staining of the vitrinite.

(ii) Visual Kerogen Descriptions

These results are summarised in Table 4. A fairly good trend with depth was noted in the spore colour results, which appeared to conflict with observations of spore fluorescence variations in UV light. However, it was noted during vitrinite reflectance determinations that spores were abundant, and slight colour changes in white light may be more obvious than in UV light.

On the basis of spore colouration measurements, the oil generation threshold would be approximately 3650 mbrt, 3500 m TVD. Gas generation threshold and peak oil generation depths would occur at approximately 3750 mTVD in the Triassic.

All samples of Upper Jurassic age were described as being derived from a marine source facies. Abundant sapropelised material was noted in samples used for both visual kerogen and palaeontological analysis (1). On this basis, these samples were described as having good oil potential. (?)Middle and Lower Jurassic and Triassic samples were described as having little or no hydrocarbon source potential.

(iii) Basic Source Rock Parameters

Results of the various determinations are summarised in Table 2.

Carbonate contents of the samples were moderate, ranging from 10.1 - 28.3% wt.

Total Organic Carbon contents were low to moderate (0.02 - 0.70% wt), except for sample 154 from 3638.4 mbrt in the Kimmeridge Clay Formation, which contained 1.42% wt organic carbon. The TOC content of SWC 39 was found to be erroneous due to poor decarbonation. No accurate TOC content was available for this sample but an approximate value of 0.02% wt was obtained during $\delta^{13}C_{PDB-1}$ measurements.

TSE/TOC and SAC/TOC ratios indicated that the Upper Jurassic and Triassic were impregnated with migrated hydrocarbons. SAC/TSE values implied that the migrated hydrocarbons were mature.

N-alkane CPI values indicated that the whole sequence examined was mature.

C-GC-MS fragmentograms of selected sterane and pentacyclane distributions indicated a pattern fairly typical of North Sea marginal marine facies (Figures 1 and 2).

(iv) Stable Carbon Isotope Ratios

Results of these determinations are summarised in Table 2 and indicate that the kerogen of the Kimmeridge Clay Formation is strongly influenced by a terrestrial input. The gradual change in values, i.e. increasingly heavy (isotopically) down the succession usually reflects on increasing marine influence. However, in this case, the heavier ratios (up to -24.0% in the Triassic) are considered to be due to the presence of increasing amounts of coaly kerogen.

All geochemical parameters are summarised in Figure 3.

D. CONCLUSIONS

1. DOD indications were of low specificity in this well with vitrinite reflectance measurements being of little use over the interval examined. Spore fluorescence and spore colouration measurements suggested that the sequence was mature at 3650 mbrt for oil generation (3500 m TVD).

2. Visual kerogen descriptions indicated that sample 154 from 3638.4 mbrt was a good oil-prone source rock. Other samples were considered to have little or no hydrocarbon source potential.

3. $\delta^{13}C_{PDB-1}$ ratios indicated that the Kimmeridge Clay formation was from a paralic facies. Increasing amounts of coaly material probably influenced ratios obtained from the Middle and Lower Jurassic and Triassic.

4. Basic source rock parameters indicated that some of the samples contained large amounts of migrated hydrocarbons. Only sample 154 from 3638.4 m mbrt had a good TOC content. CPI values suggested that the sediments were mature for liquid hydrocarbon generation.

REFERENCES

1) Geological Completion Report Well 7/12-3A
A.M. Grainge, Jan. 1978. OC 10 873 pt.VI.

TABLE 1

RELATIONSHIP BETWEEN DOWN-HOLE AND TRUE VERTICAL DEPTHS FOR SIDEWALL CORES FROM 3638.4 - 4047.4m IN NOCS WELL 7/12-3A

DOWNHOLE DEPTH m	TRUE VERTICAL DEPTH m
3638.4	3506.7
3696.9	3558
3746.9	3602
3794.4	3645
3845.9	3692.5
3902.4	3744.6
3949.1	3787.7
3992.7	3830.1
4047.4	3878.6

TABLE 2

BASIC SOURCE ROCK DATA FOR SIDEWALL CORES FROM NOCS WELL 7/12-3A

SAMPLE	AGE	DEPTH (DOWN HOLE) m/ft	SAMPLE* TYPE/ MAIN LITHOLOGY	CARBONATE HCl SOLUBLES %wt	TOTAL ORGANIC CARBON (TOC) %wt	TOTAL SOLUBLE EXTRACT (TSE) %wt	TSE/TOC INDEX ‰	SAC/TOC INDEX ‰	TSE			
									SATURATE ALKANE CONTENT (SAC) %wt	CARBON PREFERENCE INDEX (CPI)	PRISTANE PHYTANE RATIO pr/ph	ASPHALTENE CONTENT %wt
154	E.PORT/KIMM	3638.4	SILTST	24.4	1.42	0.402	283	175	62	1.05	1.4	
120	KIMM	3696.9	SST	10.1	<0.18	0.024	132	45	34	1.07	1.3	
111	E. KIMM OXFORD	3746.9	SST	12.2	0.33	0.043	131	55	42	1.04	1.8	
90	"	3794.4	SST?	24.8	0.54	0.043	80	33	41	1.06	1.6	
137	M.JUR?	3845.9	MUDST	11.5	0.36	0.009	26	6	26	1.08	0.6	
✓ 67	SINE/HETT	3902.4	MUDST	18.1	0.70	0.012	17	3	15	1.07	0.7	
57	TR	3949.1	SILTST	18.6	0.25	0.010	39	12	30	1.05	0.6	
44	TR	3992.7	LMST) SST)	11.6	0.02	0.004	205	45	22	1.04	0.4	
39	TR	4047.4	MUDST	28.3	0.02	1.014	705	479	68	1.08	0.5	

TABLE 3

NOCS WELL 7/12-3A

VITRINITE REFLECTANCE MEASUREMENTS ON SWC SAMPLES

DOWN HOLE DEPTH m	MEAN VITRINITE REFLECTANCE			
	AUTOCHTHONOUS	ALLOCHTHONOUS		
3516.5	$0.45_{(3)}$			$1.57_{(1)}$
3530.5	$0.45_{(2)}$			$1.19_{(2)}$
3550.5	$0.46_{(3)}$	$0.68_{(3)}$		$1.31_{(3)}$
3564.5	$0.42_{(11)}$	$0.81_{(3)}$		$1.51_{(3)}$
3580.5	$0.50_{(12)}$	$0.72_{(1)}$		$1.17_{(2)}$
3638.4	$0.42_{(2)}$	$0.74_{(1)}$		$1.46_{(10)}$
3696.9	$0.47_{(10)}$	$0.60_{(1)}$		
3746.9	$0.42_{(14)}$	$0.82_{(2)}$		
3794.4	$0.52_{(16)}$			
3845.9	$0.43_{(12)}$	$0.91_{(1)}$	$1.02_{(1)}$	$1.91_{(1)}$
3902.4	$0.50_{(12)}$			
3949.1	$0.42_{(5)}$?			
3992.7	-			
4047.4	$0.56_{(5)}$			

Figures in parenthesis are the number of separate determinations.

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TABLE 4 NOCS WELL 7/12-3A

VISUAL KEROGEN DESCRIPTIONS.

SAMPLES														VASCULAR PLANT DEBRIS																						COLOUR/ MATURATION							SOURCE POTENTIAL	DEPOSITIONAL ENVIRONMENT					
Depth in metres	Type	MIOSPORES				PHYTO-PLANKTON EXCLUDING TASMANITIDS				TASMAN-ITIDS			Reworking	CUTICLES			BROWN "WOOD" (LIGNITE)			BLACK "WOOD" (VITRAIN FUSAIN)			FINELY DISSEM-INATED			SAPRO-PELISED			AMORPHOUS (ALGAL)				PRESER-VATION					Threshold ?						Marine undifferentiated	Open marine	Near-shore marine	Restricted marine	Non-marine	Unknown
		Trace 1-2	Common 3	Frequent 4	Abundant 5	1-2	3	4	5	1	2	3		1-2	3	4-5	1-2	3	4-5	1-2	3	4-5	1-2	3	4-5	1-2	3	4-5	1-2	3	4	5	good	fair	poor	1	2	3	4	5	6	7							
3638.4	swc	●					●										●			●								●							●			●					Oil				●		
3696.9	"	●				●											●				●						●								●			●					? Oil			●			
3746.9	"					●											●				●						●								●				●				? Oil	●					
3794.4	"	●				●											●				●						●								●				●				? Oil			●			
3845.9	"	●												●			●			●						●									●				●				–					●	
3902.4	"		●			●								●			●				●					●									●					●			–			●			
3949.1	"	●												●				●				●													●					●			–					●	
3992.7	"																●				●														●								–						
4047.4	"	ONLY REWORKED MATERIAL																																									–						

TABLE 5

KEROGEN STABLE CARBON ISOTOPE RATIOS

FOR NOCS WELL 7/12-3A.

DOWNHOLE DEPTH (m)	$\delta^{13}C_{PDB-1}$ per mil.
3638.4	- 28.1
3696.9	- 28.1
3746.9	- 26.0
3794.4	- 26.7
3845.9	- 25.2
3902.4	- 25.0
3949.1	- 24.6
3992.7	- 24.8
4047.4	- 24.0

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FIGURE 1 PENTACYCLANE DISTRIBUTIONS

NOCS WELL 7-12/3A

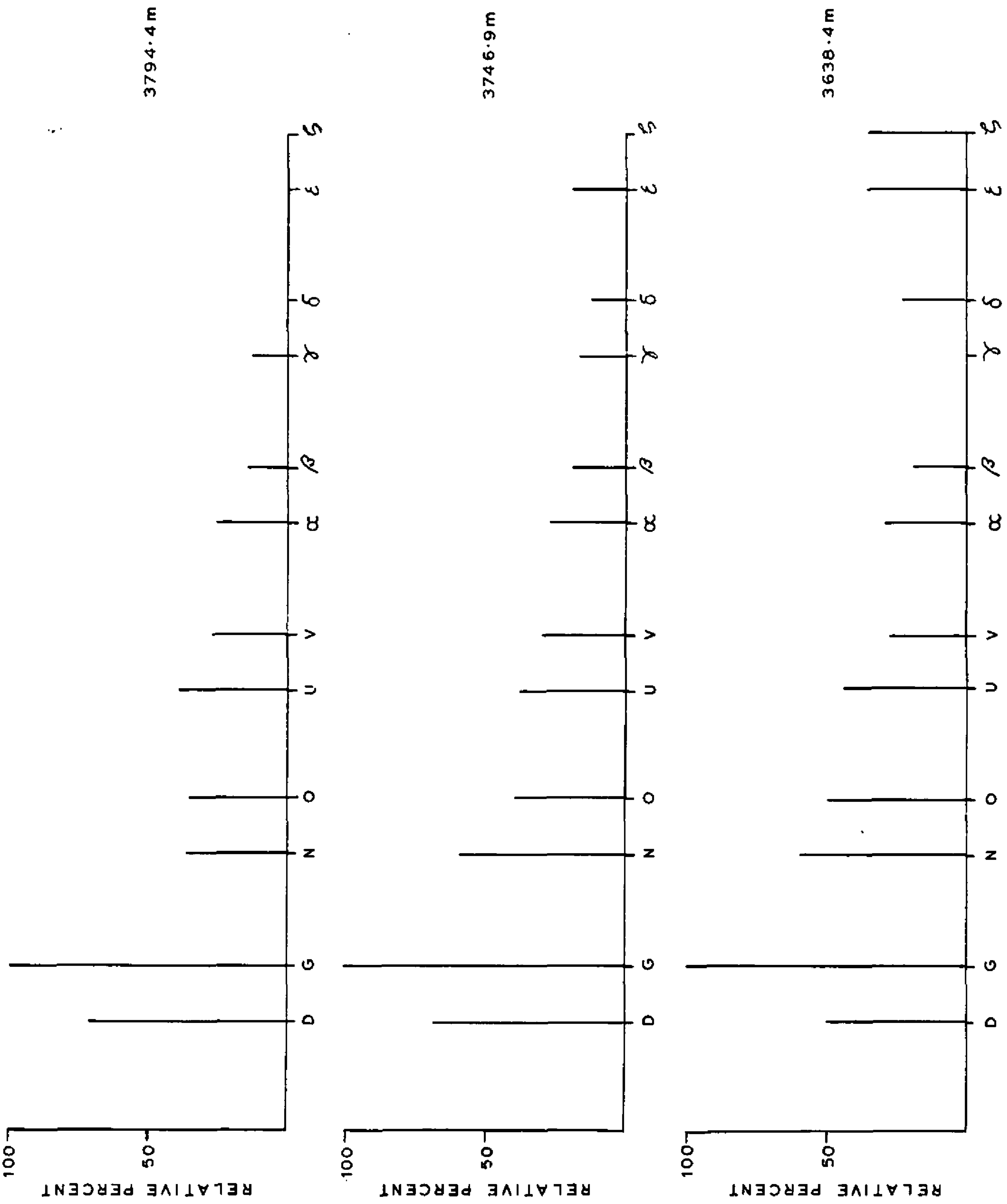

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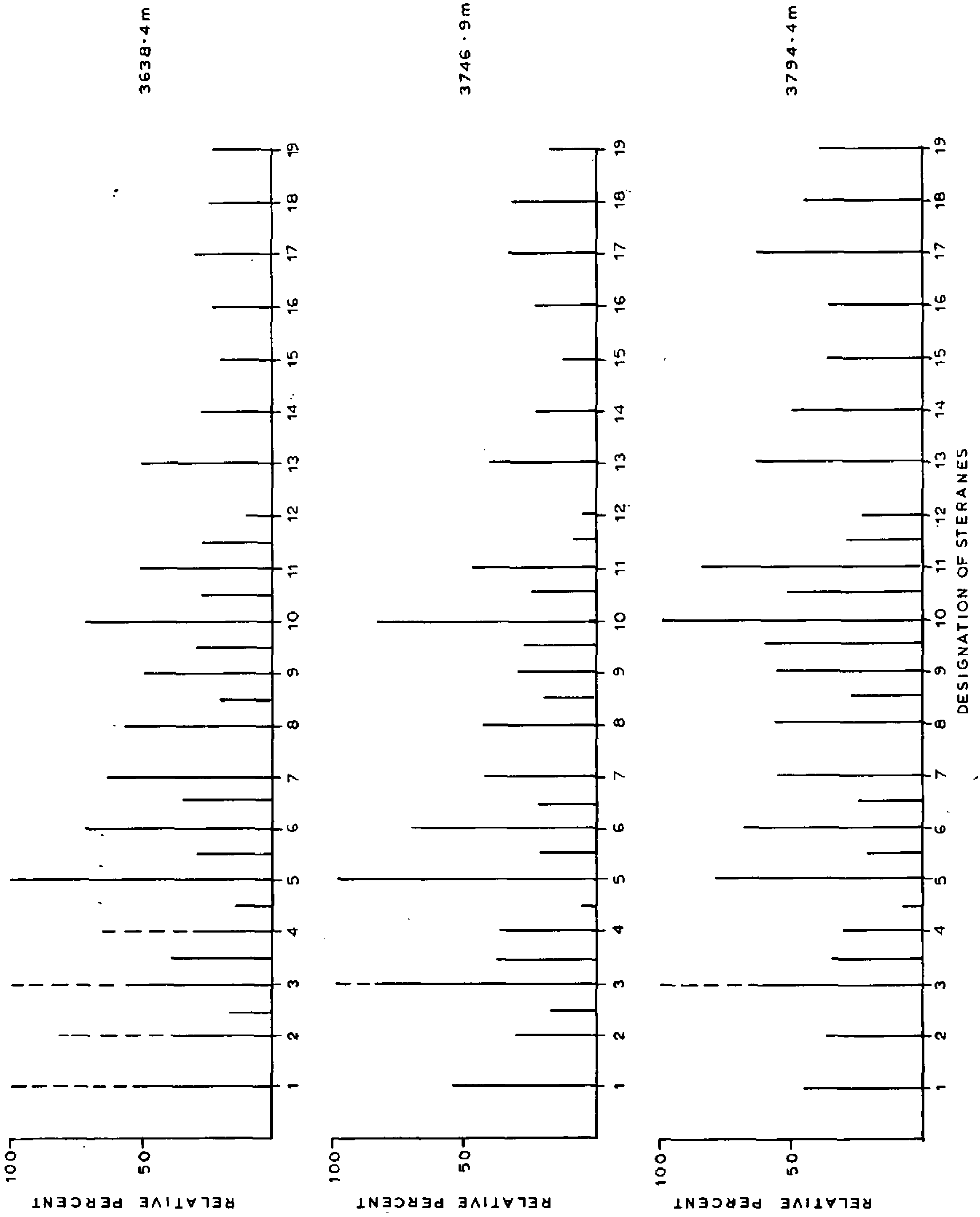
FIGURE 2 STERANE DISTRIBUTIONS

NOCS WELL 7/12-3A



NOCS 7/12-3A SUMMARY GEOCHEMICAL LOG

FIG.3