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TECHNICAL NOTE

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GEOCHEMICAL STUDY OF NOCS WELL 7/12-4. W25 , Copy no, 1

by

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SUMMARY

A geochemical study was undertaken on 39 sidewall cores and 4 wet cuttings samples from this well. Conventional maturity indicators were of poor specificity, but suggested that the oil generation threshold was at a depth of approximately 3400m. Rocks of Portlandian age had the highest Total Organic Carbon (TOC) contents, but rocks of Eocene age were also considered to be of good quality.

Good oil prone source rocks were identified at 2675m in the Palaeocene and at 3350m, 3380m, and 3440m in the "Kimmeridge Clay Formation" of the Portlandian. A good gas source was evident in a sample from 2640m in the Eocene.

A) INTRODUCTION

NOCS Well 7/12-4 was the third appraisal well of the 7/12-2 oil find. Significant quantities of gas, and traces of fluorescence were noted from 3312m downwards in the well, but the reservoir proper was encountered at 3445m in Jurassic sandstones. Traces of hydrocarbons were recorded in sidewall cores (swc) down to TD at 3623m. A geochemical study of 39 swc and 4 canned wet cuttings samples of Eocene to Triassic (?) age was undertaken, and the results summarised in an abbreviated format in April 1978 (1).

B. ANALYSES PERFORMED BY GEOCHEMISTRY BRANCH, BP SUNBURY.

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

Spore colour in transmitted white light and kerogen type analysis were determined by microscope examination of specially prepared organic concentrates. Samples were examined by two separate laboratories undertaking this type of work.

Ground core samples were extracted with dichloromethane to obtain Total Soluble Extracts (TSE). These extracts were then separated into an alkane fraction (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 the normal alkane distributions and their Carbon Preference Indices together with the acyclic hydrocarbon distribution patterns. The solvent extracted, ground samples were then decarbonated to remove inorganic carbonates and Total Organic Carbon (TOC) contents determined on the residues.

C) RESULTS

(i) Vitrinite Reflectance Results

Vitrinite reflectance values are summarised in Table 3. The results were considered to be of very poor specificity and no extrapolations with depth were attempted. The main reason for the lack of usable results was the virtual absence of indigenous (autochthonous) vitrinite in the samples examined. Most of the vitrinite present appeared to be reworked i.e. allochthonous. Spore fluorescence in UV light indicated a maturity level equivalent to a reflectance of about 0.5%. No changes in fluorescence colours were noted over the interval examined i.e. 2580 - 3620m. Some sections contained bitumen and hydrocarbons which could have lowered the reflectance of the vitrinite. These intervals were mainly associated with the reservoir section of the well. An oil generation threshold of approximately 3400m was suggested from the results.

(ii) Visual Kerogen Descriptions

The results from these analyses are summarised in Table 4. Kerogen typing was undertaken in two separate laboratories so it was possible that slight differences between the two sets of results existed. The first set of samples from 3350m, 3380m, 3440m in the Kimmeridge Clay Formation were all described as having good oil potential, although no TOC results were available to check the organic carbon contents. Spore colours recorded for this set of results were given scale values of 3, but it was suggested that this might be a little low and that the sample DOD could even be approaching that equivalent to peak oil generation levels.

The second set of results from 2580 to 3275m indicated only the sample from 2675m as having any good oil potential, and that from 2640m as having possible good gas potential.

Unfortunately duplicate samples for comparative purposes were not sent to the two laboratories which undertook these visual kerogen studies.

(iii) Basic Source Rock Parameters

Carbonate and organic carbon contents of the swc samples are summarised in Tables 1 and 2. The highest carbonate contents were found in rocks of Valanginian age in the Valhal Formation (3312 - 3347m), where acid soluble material ranged from 19.7 to 39.5% wt. Other carbonate contents were rather lower and ranged from 4.3 to 15.6% wt.

39 samples were analysed for TOC contents. The values obtained were in the range 0.05 - 9.50% wt., with the richest source rocks being in the "Kimmeridge Clay Formation" of the Portlandian. Good TOC contents were also observed in the Eocene from 2610 to 2640m.

TSE/TOC and SAC/TOC indices supported observations that the rocks were either gas prone or immature down to 3275m, but showed that contamination of the sediments by migrated hydrocarbons had probably occurred below this depth. The SAC/TSE indices supported the view that this contamination was probably crude oil.

The Carbon Preference Index (CPI) suggested that rocks below 2785m were marginally mature, but this was considered to be more related to the kerogen being of marine origin.

A summary of all the geochemical results is shown in Figure 1.

D. CONCLUSIONS

(1) Conventional maturity indicators were of poor specificity, vitrinite reflectance measurements being complicated by large amounts of reworked material. An oil generation threshold of approximately 3400m was suggested by the results obtained.

(2) Visual kerogen descriptions indicated that good oil prone kerogen could be recognised at 2675m, 3350m, 3380m and 3440m. A good gas prone source rock was recognised at 2640m. Spore colour measurements indicated that the section examined approached the oil generation threshold at about 3200m but could be slightly more mature, possibly reaching peak oil generation at 3350 to 3440m.

(3) Basic source rock parameters supported vitrinite reflectance and spore colour maturity indications. This data also suggested that contamination by migrated hydrocarbons had occurred below 3275m, which corresponded to the known reservoir interval.

E. REFERENCES

Sedimentary Petroleum Geochemistry Report No. 13

"The Geochemistry of Sidewall Cores and Cuttings Samples from 7/12-4" by S.P. Lowe and L.A. Perry.

TABLE 1

BASIC SOURCE ROCK DATA NOCS WELL 7/12-4

SAMPLE	AGE	DEPTH m	SAMPLE* TYPE/ MAIN LITHOLOGY * All swc	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	TSE: CARBON PREFERENCE INDEX (CPI)	TSE: PRISTANE PHYTANE RATIO pr/ph	TSE: ASPHALTENE CONTENT %wt
60	Eocene	2580	Calc. Mudst.	20.2	0.1	0.004	39	7.7	19.7	-	-	
58	Eocene	2630	Silt. St.	-	1.3 ?	0.043	33	5.5	16.7	1.14	3.3	
51	Palaeocene	2710	Mudst/Siltst	8.7	0.71	0.018	26	4.4	16.8	1.24	0.6	
46	Palaeocene	2785	Limestone	-	-	0.010	-	-	2.2	1.06	-	
42	Palaeocene	2845	Limestone	-	-	0.004	-	-	34.7	1.02	-	
30	Valanginian	3192	Mudstone	7.6	0.26	0.013	51	8.3	16.2	-	0.8	
25	Valanginian	3215	Mudstone	11.8	0.22	0.005	23	7.9	34.4	1.05	0.8	
18	Valanginian	3275	SH/Mudstone	12.1	0.40	0.014	34	3.4	9.9	1.02	1.7	
12	Valanginian	3335	SH/Mudstone	21.5	0.55	0.177	324	173	53.5	1.07	1.8	
3	Portlandian	3357	Carbonaceous Mudstone	9.3	4.57	0.884	193	73	37.8	1.09	1.6	
62	Jurassic/ Triassic	3615	Mudstone	7.2	0.15	0.013	89	28	31.0	-	-	

TABLE 2

TOTAL ORGANIC CARBON AND CARBONATE CONTENTS

NOCS WELL 7/12-4

SAMPLE DEPTH (m)	TOTAL ORGANIC CARBON CONTENT %	CARBONATE "HC1 SOLUBLE" CONTENT %
2610	2.06	11.9
2640	1.92	6.7
2675	1.07	8.2
2680	0.84	5.5
2685	0.69	13.9
2690	0.64	7.5
3197	0.26	11.2
3302	0.27	15.6
3210	0.18	10.1
3220	0.25	10.7
3225	0.16	7.6
3245	0.31	13.9
3255	0.29	12.5
3288	0.28	11.9
3312	0.21	39.5
3327	0.35	19.7
3339	0.89	32.9 ?
3345	3.45	23.1
3347	0.71	25.9
3349	2.53	12.0
3351	9.50	7.4
3583	-	-
3595	0.05	< 51
3610	2.50	11.7
3620	0.08	4.3

TABLE 3

NOCS WELL 7/12-4

VITRINITE REFLECTANCE MEASUREMENTS

DEPTH m	MEAN VITRINITE REFLECTANCE					
	AUTOCHTHONOUS	ALLOCHTHONOUS				
2580	0.42 (2)					1.01 (4)
2640	0.41 (16)	0.57 (2)				
2675	0.43 (10)	0.54 (9)	0.68 (1)			
2680	-	0.53 (20)				
2685	0.44 (8)					
2690	0.38 (4)	0.53 (16)				
2710	0.34 (5)	0.51 (9)				
3202	0.40 (1)					1.80 (15)
3210	0.41 (1)				0.89 (1)	1.17 (1)
3215	0.44 (1)					
3245	0.4 to 0.64 (5)					
3275	0.38 (4)	0.51 (2)	0.61 -	1.0 (9)		
3312	0.47 (1)		0.73 (2)	1.18 (4)		
3339	-	0.65 (2)			0.81 (1)	
3345	0.43 (11)					
3347	0.51 (6)		0.73 (1)			
3349	0.50 (3)	0.63 (2)				
3350	0.52 (4)					
3351	0.51 (19)		0.75 (1)			
3357	0.42 (19)					
3380	0.55 (11)					
3610	0.65 (15)					
3620	0.67 (7)				0.84 (14)	

Figures in parenthesis are the number of separate determinations.

VISUAL KEROGEN DESCRIPTIONS.

TABLE 4 NOCS WELL 7/12-4

SAMPLES: Depth in metres	Type	MIOSPORES: Trace 1-2	Common 3	Frequent 4	Abundant 5	PHYTOPLANKTON EXCLUDING TASMANITIDS 1-2	3	4	5	TASMANITIDS 1	2	3	Reworking
2580	swc	●					●						
2630	"			●					●				
2640	"			●		●							
2675	"			●				●					
2710	"		●				●						
3192	"		●						●				
3210	"		●					●					
3275	"		●						●				
3350	cttg	●						●					
3380	"		●					●				●	
3440	"	●						●				●	

Depth in metres	Type	VASCULAR PLANT DEBRIS: CUTICLES 1-2	3	4-5	BROWN "WOOD" (LIGNITE) 1-2	3	4-5	BLACK "WOOD" (VITRAIN FUSAIN) 1-2	3	4-5	FINELY DISSEMINATED 1-2	3	4-5	SAPROPELISED 1-2	3	4-5	AMORPHOUS (ALGAL) 1-2	3	4	5
2580	swc				●			●									●			
2630	"	●				●			●								●			
2640	"							●												
2675	"						●	●									●			
2710	"					●			●								●			
3192	"				●				●											
3210	"				●				●											
3275	"			●	●				●											
3350	cttg				●				●						●			●		
3380	"								●						●			●		
3440	"								●						●				●	

Depth in metres	Type	PRESERVATION: good	fair	poor	COLOUR/MATURATION (Threshold ? between 3 and 4): 1	2	3	4	5	6	7	SOURCE POTENTIAL	DEPOSITIONAL ENVIRONMENT: Marine undifferentiated	Open marine	Near-shore marine	Restricted marine	Non-marine	Unknown
2580	swc	●					●					–		●				
2630	"	●				●						–	●					
2640	"		●			●						–				●		
2675	"		●			●						–			●			
2710	"		● (on line fair/poor)			● (on line 2/3)						–	●					
3192	"		●					●				–	●					
3210	"		●				●					–	●					
3275	"		●					●				–	●					
3350	cttg	● (on line good/fair)					●					Oil						
3380	"		● (on line fair/poor)				●					Oil						
3440	"		● (on line fair/poor)				●					Oil						

NOCS 7/12-4 SUMMARY GEOCHEMICAL LOG

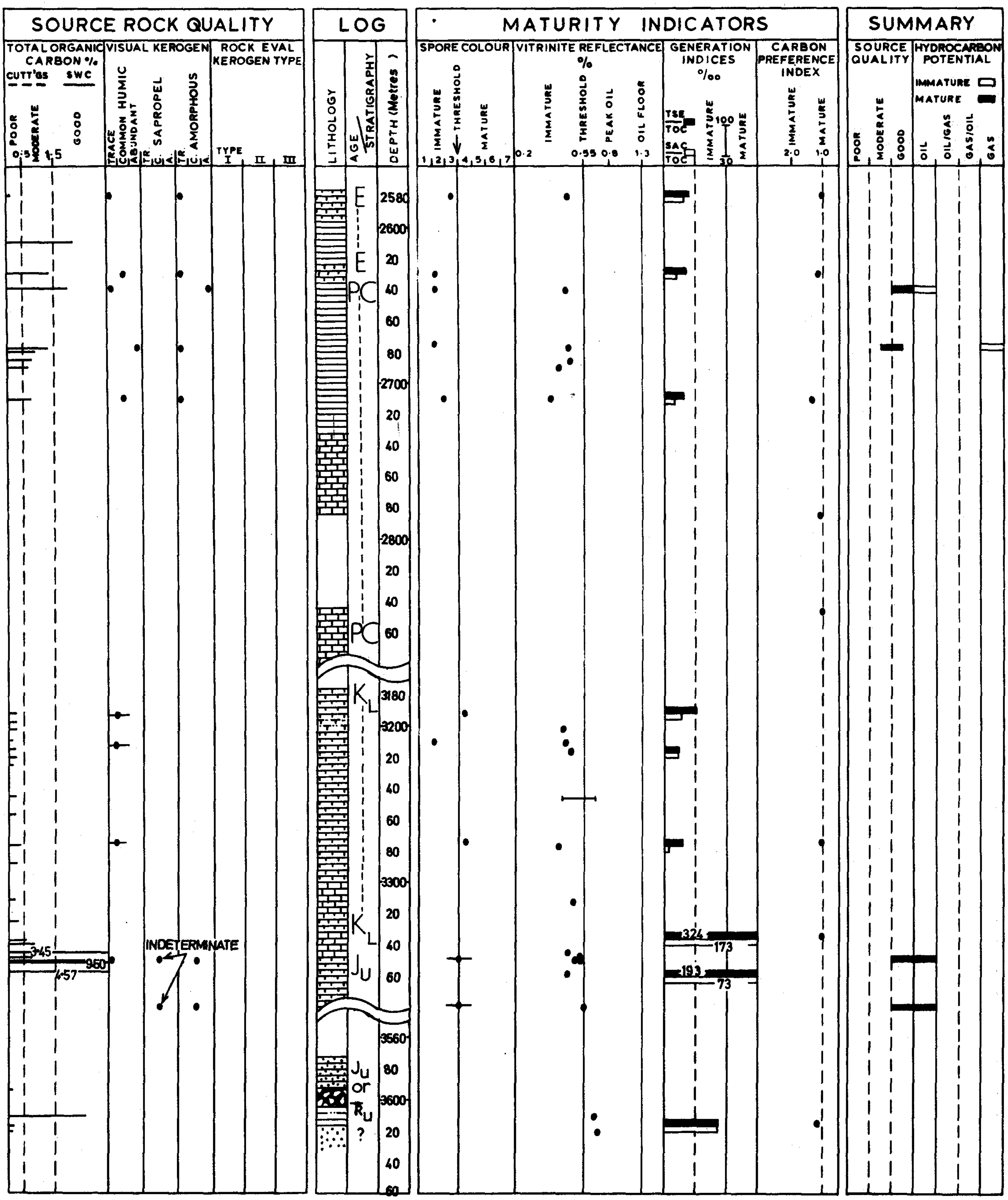

FIG. 1