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2 / 6 - 2 WELL (NORWAY)

GEOCHEMICAL AND OPTICAL STUDIES OF THE ORGANIC MATTER (JURASSIC INTERVAL)

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LISTE DE DIFFUSION

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A B S T R A C T

Geochemical and optical studies carried out on the organic matter from the Cretaceous - Jurassic interval (4040 - 4760 m) of the 2/6-2 well show mainly that :

- The degree of catagenesis is high (0.8 % Ro at 4000 m to 1.2 at 4750 m).

- The two jurassic intervals - Kimmeridgian with sapropelic O. M and Dogger with ligneous-humic O. M have been source-rock for hydrocarbons before reaching this maturation and their residual potentials are low.

C O N T E N T S

L I S T O F P L A T E S

C H R O M A T O G R A M S

This report presents the geochemical and optical (reflected light and fluorescence) analyses carried out on the organic matter from Well 2/6-2 (location map on plate 1) mainly in the jurassic interval. It takes into account the optical observations in transmitted light on palynological slides *.
The main results are summarized on plate 5.

1 - CATAGENESIS DATA

1. 1 - TRANSMITTED LIGHT STUDY

In the lower Cretaceous the thermal alteration index (TAI) increases from 2.5 at 3836 m to 3/3 + at 4100 m.
In the Portlandian - Kimmeridgian the TAI is estimated at around 3.
No available data in the (probably) Bajocian. Below 4720 m the upper Permian microflora has a TAI estimated at 3 + / 3.5.

1. 2 - RELECTANCE AND FLUORESCENCE STUDY (PLATE 2)

The well has been studied from 3680 to 4760 m - Middle Cretaceous to Permian - on 17 samples, 3 cores and 14 drill cuttings.
The section is highly polluted by mud products which provide the main reflective population with a very constant Vitrinite reflectance, 0.25 - 0.30 %, all along the vertical range (studied).
The first reliable result, in the downward progression is the (0.8 %) Vitrinite Reflectance in the Valanginian - Furtherdown this result is supported by the fluorescence of the algae in 2 cores and 1 drill cutting in the middle Kimmeridgian, assuming a Vitrinite equivalent to not less than 1%. As one moves downwards, the fact that results in reflectance are grouped together to a certain extent accounts for a slow rank increase down to the upper Permian.
Therefore the overall increase with depth appears as follows :

VALANGINIAN	3980	0,80 % Ro
KIMMERIDGIAN	4221,75 4230	$\geqslant$ 1 Ro eq.
AALENIAN	4632	$\geqslant$ 1.1 % Ro
U. PERMIAN	4760	1.2

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* P. de RENEVILLE - J.L VOLAT - E. GROSDIDIER n° 0/1987 RP
2/6-2 Biostratigraphical study from 3700 to 4760 m.

The gradient of this vertical progression is not very steep, but the high value reached at 4000 m - 0,8 % - accounts for a steeper curve above, in the upper Cretaceous section (or in the Tertiary ?) :

It would be very useful to know at approximately what period the reflectance curve is at its steepest, to enable us to explain the thermal history of the basin.

1. 3 - GEOCHEMICAL DATA

The temperatures of Rock-Eval Pyrolysis (Tm in table 1 and on plate 5) increase from 445/447° C in the Kimmeridgian (4227.85 m) to 457° C in the upper Permian (4750 m). The temperatures in the Portlandian are not reliable because of the too low S2 amount.

1. 4 - CATAGENESIS CONCLUSION

The 3980 - 4760 m interval (lowermost Cretaceous, Malm - Dogger and upper Permian) is located at theend of the main oil generation zone(around 1 % eq. Ro) The some TAI values in the Cretaceous indicate that the threshold of the oil zone could be located in the Albian around 3830 m.

2 - ORGANIC MATTER CHARACTERISTICS - OIL POTENTIAL

2. 1 - ORGANIC MATTER CONTENT

Because of the great amount of polluting products below 4250 m, the samples had to be washed with chloroform and so only the insoluble organic carbon (IOC) is given :

- Lower Cretaceous (down to 4120 m) TOC $\ll$ 0.3 %
- Portlandian - late Kimmeridgian (4150 - 4220 m) TOC $\ll$ 0.45 %
- Kimmeridgian (4420 - 4352 m) 1.1 $<$ IOC $<$ 3 %
- Dogger - Permian (4352 - TD) 1 $<$ IOC $<$ 5 %

2. 2 - PALYNOFACIES (transmitted light)

The studied section (3807 - 4760 m) must be divided into several units in terms of kerogen characterization :

- 3807 to 3950 m (base of upper cretaceous to base of Barremian) : mixed elements of terrestrial origin (coal debris, vegetal and ligneous fragments) and amorphous O. M. (sometimes sapropelic).

- 3970 to 4160 m (Valanginian and early Portlandian) : mainly coal and ligneous elements.

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- 4170 to 4350 m (Kimmeridgian) : predominance of the algae sapropelic

- 4375 to 4585 m (supposed Bajocian) : mainly coal and black ligneous debris.

- 4590 to 4760 m (Bajocian and Permian) : mixed elements vegetal, ligneous, coal and amorphous.

2. 3 - ORGANIC FACIES (Reflectance and fluorescence)

. Cretaceous - Early Portlandian - Late Kimmeridgian :

Due to the abundance of mud products (and scarcity of autochthonous O.M.), the (studied) section of Cretaceous and upper most Jurassic) does not provide any reliable results. Only 1 sample from the Valanginian shows a good coal population at 3980 m, rich in Vitrinite (Collinite, Télinite).

The middle Kimmeridgian is characterized by a typical sapropelic O.M., very rich in algae tasmanaceae, low in fluorescence because of their high thermal evolution (not less than 1 % Vitrinite - reflectance equivalent), always reflective, together with (low in fluorescence) solid bitumens. These bitumens give 2 reflectance populations (0,6 - 0,85 %) in the Kimmeridgian and only a medium value (0,7 %) in the (probably) Bajocian. Fluorescent groundmasses are not rare but their low-dark fluorescence has disappeared almost completely, due to the high rank. Therefore, the main components to be taken into account in the global fluorescence index which reaches as high as 1,5 in Core 2, are the numerous algae.

The lowest part of Jurassic has a mixed O.M. composed of bitumens, Vitrinite and rare dark groundmasses. A lignite mud material also forms part of these cuttings.

2. 4 - GEOCHEMICAL DATA

Geochemical analyses were carried out on 24 samples (3 SWC, 3 core , 18 cutting samples) from 4040 m in lower cretaceous to 4750 m in the upper Permian.

2. 4 - 1 - HYDROCARBONS

- A first series of Rock Eval analyses on raw samples, just cleared of mud, showed that the samples were devoid of free hydrocarbons down to 4200 m and that the amount of free HC was high to very high below this depth (S1 up to 4000 ppm i-e. 40 to 65 % of S1 + S2). More over the temperature of pyrolysis showed variations without meaning. Hence a second series of Rock Eval analyses had to be carried out on sampled washed with $CHCl_3$ to eliminate free hydrocarbons.

- At 4227.85 m, 4326 m and 4565 m the hydrocarbons present the genetic characteristics of the upper Jurassic hydrocarbons : (Pristane/nC 17) / (Phytane/nC 18) $<$ 1.5 and aromatic distribution.

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ABBREVIATIONS AND UNITS USED IN TABLES 1 AND 2

TOC	Total organic carbon (% of rock)	
IOC	Organic carbon insoluble in chloroform	
S1	Hydrocarbons present in the rock	mg HC/g of rock
S2	Hydrocarbons produced by pyrolysis	mg HC/g of rock
HI	Hydrogen index (mg HC/g TOC)	
OI	Oxygen index (mg CO2/g TOC)	
Tm	Temperature at the top of peak S2	
nC 7/DMCP	Normal heptane / dimethylcyclopentane	
Pr, Ph	Pristane, Phytane	
A/B	(Pr/nC 17) / (Ph/nC 18)	
EOM	Extract by chloroform	
D	Cutting sample	
K	Core sample	
SWC	Side wall core sample.	

TABLE 1 - 2/6-2 GEOCHEMICAL RESULTS

	N°	DEPTH	TOC	IOC	S1	S2	HI	OI	Tm *
EARLY PORTLANDIAN - LATE KIMMERIDGIAN (VALANGINIAN)	1	4040	0.25		-	-	-	180	-
	2	4100/4120	0.30		-	0.12	40	160	(438)
	3	4150	0.20		0.02	-	-	175	-
	4	4170	0.30		-	0.08	25	140	(437)
	5	4180	0.45		-	0.16	35	180	(436)
	6	4200	0.40		-	0.15	40	130	(451)
KIMMERIDGIAN	7	4227,85	3.0		3.91	6.56	220	15	447
	8	4250		1.10		1.02	95	70	447
	9	4300		1.65		1.41	85	45	446
	10	4352		1.35		0.84	60	100	445
ALLENIAN - BAJOCIAN	11	4404		2.55		1.40	55	120	445
	12	4468		4.20		1.67	40	25	447
	13	4506		5.05		3.91	75	20	451
	14	4544		2.80		0.62	20	55	453
	15	4598		1.0		0.54	55	75	453
	16	4650		1.35		0.59	45	175	453
	17	4696		2.85		1.90	65	55	454
UPPER PERMIAN	18	4750		1.10		0.55	50	35	457

* Tm values in brackets are unreliable.

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	DEPTH (m)	Pr / nC 17	Ph / nC 18	A / B	Asphalt. %	Resins %	Saturated HC %	Aromatic HC %	SAT / Aro	EOM (ppm)
K2	4222 • 7	0.66	0.59	1.12						
K2	4227 • 85	0.65	0.56	1.15						
D	4326	0.70	0.70	1.0	6.2	15.9	51.6	26.3	1.96	10400
SWC	4565	0.43	0.32	1.32	- 10.3 -		74.3	15.4	4.8	1370
SWC	4568				- 19.9 -		62.2	17.8	3.5	530
SWC	4585				- 36.2 -		11.3	52.6	0.2	330

TABLE 2 - 2/6-2 GEOCHEMICAL RESULTS

CHROMATOGRAPHY AND EXTRACT COMPOSITIONS