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WELL 25/2-5 (NORWAY)

GEOCHEMICAL STUDY OF A FEW JURASSIC
ROCK SAMPLES AND OF THE OILS

WELLFILE

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Boussens - April 1977

Reference : Order n° 033126

- R. CUSSEY - Report n° 7/1449 RS -
"25/2-5 well (Norway) - Sedimentological study of Jurassic deposits".

LISTE DE DIFFUSION

DESTINATAIRES :

DISTRICT 2	1
DISTRICT 2 - NORVEGE	45 10
DIRECTION EXPLORATION puis DIVISION OPERATIONS PARIS	1
DIVISION OPERATIONS PAU	1
D.R.A. BOUSSENS	1

The aim of this study was to complete the knowledge about the Upper and Middle Jurassic source-rocks in this area and to analyse and compare the 25/2-5 and the 25/2-4 crude products, oils and condensates respectively.

According to the palynological report* the cutting samples contain numerous cavings. So, this study was limited to sidewall core and core samples, between 3308 and 3480 m : 6 shaly and 5 sandstony samples were analysed.

This report takes into account the palynofacies data and thermal alteration indices*.

The petrological study in reflectance and fluorescence of the organic matter from this well will be carried out later.

1 - ORGANIC MATTER CHARACTERIZATION OF THE SHALY SAMPLES

1.1 - KIMMERIDGIAN

The palynofacies is primarily made up of amorphous matter.

The thermal alteration indices are 3 to 3.5.

The contents of insoluble organic carbon (weight % of the rock) are 5.9 and 4.7, respectively at 3308 and 3314.50 m ; these 2 sidewall core samples are, according to the lithology, representatives of the 3302 - 3318 shale interval.

They contain abundant light hydrocarbons (about 1700 ppm in the range C5 - C14) and saturated hydrocarbons (about 200 ppm of n-alkanes) ; these hydrocarbons are characterized by a moderated pristane/phytane ratio (between 1.40 and 1.65), a relatively low proportion of heavy n-alkanes and a distinctly even n-alkane predominance in the range between C 20 and C 24.

According to the whole of the analytical data available, the Kimmeridgian shale interval (about between 3302 and 3318 m) is a present oil source-rock ; its geochemical characteristics are relatively close to those previously recognized from the same formation (euxinic marine deposits) in this area.

1.2 - MIDDLE TO LOWER CALLOVIAN

The palynofacies is of mixed type : ligneous - coaly matter and amorphous matter.

The thermal alteration indices are 3 to 3.5.

The content of insoluble organic carbon is about 3 % at 3326 m ; this sidewall core sample is, according to the lithology, representative of the 3318 - 3338 shale interval.

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* J.F. RAYNAUD in report n° 6/1413 R - November 1976 - "Well 25/2-5 - Biostratigraphical study of the Cretaceous and the Jurassic".

It contains relatively abundant light hydrocarbons (about 700 ppm) and saturated hydrocarbons (about 100 ppm of n-alkanes) ; these hydrocarbons are characterized by a high pristane/phytane ratio (about 3.5), a relatively high proportion of heavy n-alkanes and a distinctly odd n-alkane predominance in the range C 22 - C 29.

The Callovian shale interval (between 3318 and 3338 m approximately) is a present oil source-rock ; its geochemical characteristics are relatively close to those previously recognized from the source-rocks of the Dogger to Liassic open marine shales (prodeltaic deposits) in this area.

1.3 - DOGGER

The palynofacies are very heterogeneous ; they are, for instance, mixed facies at 3441 m or very fine woody-ligneous facies in the core n° 4 (3476 - 3484 m).

The thermal alteration indices are 3 to 3.5.

Only 3 selected silty-shaly core samples were partially analysed for geochemical purposes. The contents of insoluble organic carbon are 4.3 % and 6 % in core 4 (respectively at 3368.80 and 3369.90 m) and 1 % in core 5 at 3477.80 m. These samples are less rich in hydrocarbons than the upper Jurassic samples probably due to a lower average initial petroleum quality (light HC in C 5 - C 14 range : about 450 and 100 ppm respectively in core 4 and 5 ; extract variables : 650 and 1950 ppm in core 4, lower than 200 ppm in core 5). No characterization of the saturates was carried out.

In view of the organic inventory results and the thermovaporizations in core 4 there are some silty - shaly samples which are source-rocks, but their initial potential was probably lower than that of the Kimmeridgian shales. Furthermore, these samples are not representative of the whole of the core (9 m) ; indeed, in this core, the silty - shaly beds are thin and the sandstones or siltstones predominate.

The shale sample from core 5 is not source-rock, it may be considered in view of its lithology, as representative of the 2 shale beds (3477.40 to 3477.90 and 3481 to 3482.20 m) of core 5 (9 m).

According to the sedimentological study*, the total thickness of the possible source-rock silty - shaly beds, in the Dogger, is probably lower than 20 m.

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* R. CUSSEY - Report n° 7/1449 R - March 1977 - "25/2-5 well (Norway) - Sedimentological study of Jurassic deposits".

2 - ORGANIC MATTER CHARACTERIZATION
OF THE SANDSTONY SAMPLES

2.1 - CORE 1, in Lower to Middle Callovian

The contents of chloroform extractable organic matter are lower than 200 ppm at 3339.50 and 3339.70 m. The analyses of the desorbed gases show a relatively high content of C 1 to C 5 (average 30000 μ l per Kg of rock) by comparison to the C6⁺ contents (average 6500 μ l per Kg of rock).

The absence of liquid hydrocarbons in this core can be explained by the very low permeabilities* ; only a small quantity of gas has penetrated.

2.2 - CORE 2, in Lower to Middle Callovian

The contents of chloroform extractable organic matter are 6500 ppm at 3353 m, 3500 ppm at 3353.6 m and 10000 ppm at 3354 m.

The analysis of the desorbed gases at 3353.6 shows a low content of C 1 to C 5 (about 30000 μ l/Kg) in comparison to the C6⁺ content (about 78500 μ l/Kg).

These results show an enrichment of liquid hydrocarbons in agreement with the occurrence of permeability* ; the low C 1 to C 5 content may be explained by evaporation.

The geochemical analyses carried out on these samples (thermovaporization at 3353 m, minianalyses of the saturates at 3353 and 3354 m) show identical geochemical characteristics to those of the crude oil from test n° 3 (3337 - 3362 m).

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* See petrophysical measurements in note 2035 n° 6/39 N -

"Sondage 25/2-5 - Etude rapide de quelques échantillons entre 3307 et 3353,6 m".

3 - CHARACTERIZATION OF THE OILS FROM 25/2-5 AND COMPARISON
WITH THE CONDENSATES FROM 25/2-4

Sampling : 25/2-5 : test n° 3 at 3337 - 3362 m in Lower to Middle Callovian
test n° 2 at 3652 - 3695 m in Liassic
* 25/2-4 : FIT n° 12 at 3640 m in Callovian(?)
FIT n° 13 at 3650.6 m in Callovian(?)

The chromatograms of the 25/2-5 oils are given on Plate 1 and 2. The chromatograms of the vapours in the range C 5 - C 14 and of the saturates in the C 14⁺ range correlate very well, suggesting that they were generated by the same source-rock.

The main geochemical characteristics are the high predominance of pristane over phytane (Pr/Ph is about 2.7) and the relatively high development of the heavy n-alkanes ; they show, that the source-rock is composed of a mixed organic facies.

These characteristics are very close to those of the hydrocarbons from the Dogger to Lias source-rock intervals previously studied in this area and from the Middle to Lower Callovian shale interval in this well.

However, the oil from test n° 3 seems slightly less matured than the oil from test n° 2 :

- pristane/n C 17 and phytane/n C 18 about 0.65 and 0.30 for test n° 3, 0.45 and 0.20 for test n° 2 ;
- n C 6/Methylcyclopentane (X 1) and n C 7/Dimethylcyclopentane (X 2) about 1.70 and 4.8 for test n° 3, 1.85 and 6.70 for test n° 2.

The main geochemical characteristics of the 25/2-5 oils are fairly close to those of the 25/2-4 condensates, though there are fewer aromatics in the vapour range at 25/2-5 than at 25/2-4 (no explanation of this difference at present time), suggesting that their source-rock is the same.

In view of all the data available, the 25/2-4 crude products seem slightly more matured than those from 25/2-5 : indeed, the Saturate/Aromatic, X 1 and X 2 ratios are higher for the 25/2-4 condensate (Fit 12 : S/A = 3.4 ; X 1 = 1.90 ; X 2 = 7.20) than for the deeper 25/2-5 oil (Test n° 2 : S/A = 2.65 ; X 1 = 1.85 ; X 2 = 6.70).

This seems to be in agreement with the thermal alteration indices, which indicate a slightly stronger catagenesis of the series at 25/2-4 than at 25/2-5 (in the Liassic shales the TAI = 4 at 25/2-4 and 3.5 at 25/2-5).

However, this difference in maturation between 25/2-4 and 25/2-5 is perhaps not sufficient to explain the presence of condensates and of oils respectively ; it is probably also more or less linked to a better lateral and vertical sealing of the reservoirs in 25/2-4 area, so that there is so no substantial escape of gas.

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* See Report Bss n° 6/1405 R - December 1976 -
"25/2-4 - Organic matter study of the Cretaceous and the Jurassic".

The main source-rock of the crude products from 25/2-4 and 25/2-5 is probably the Liassic shale interval (between 3500 and 3650 m at 25/2-5 approximately*); indeed, according to the sedimentological study, this interval corresponds to the same deposit environment (prodeltaic open marine) as 25/4-1 where it was pointed out that it is a source-rock with hydrocarbons correlating with the 25/2-4 and 25/2-5 crude products.

4 - CONCLUSIONS

- Source-rocks

The Liassic shale interval between 3500 and 3650 m, which is probably the main source-rock, in view of previous studies, has not been analysed*. Only the series between 3302 and 3490 m were studied.

• Kimmeridgian

The homogeneous Kimmeridgian shale interval, between 3302 and 3318 m approximately, is a present oil source-rock; its geochemical characteristics are relatively close to those of the same formation previously studied in other parts of this area.

• Middle to Lower Callovian

The fairly homogeneous middle to lower Callovian shale interval, between 3318 and 3338 m approximately, is a present oil source-rock, whose the initial oil potential was probably lower than that of the Kimmeridgian, due to a lower kerogen content. The geochemical characteristics of this Callovian interval are relatively close to those of the Dogger and Liassic shale source-rock intervals previously studied in this area.

• Dogger

The heterogeneous Dogger series contains some thin silty - shaly beds which are present source-rocks; their total thickness is probably lower than 20 m.

It can be noticed that the thicknesses of these three source-rock intervals are, here, low.

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* Some analyses of this Liassic interval will be carried out to attempt its characterization.

- Oils

Correlations can be made between the oils from the Callovian and the Liassic, and the condensates from 25/2-4 ; the first seems slightly less matured than the second, itself less matured than the condensates. Their geochemical characteristics show that their source-rock is composed of a mixed organic facies.

The main source-rock is probably the Liassic shale interval which lies between the two reservoir members, at 25/2-5.

SONDAGE : 25/2 - 5
NORVÈGE

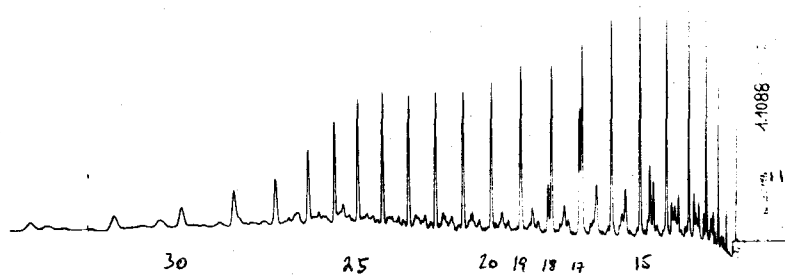
Echantillon huile - test n°3

Cote = 3337 - 3362 m
Age : Callovien inférieur à moyen
Lithologie = Grès

non effectué

CHROMATOGRAPHIE DES AROMATIQUES

Bimodal



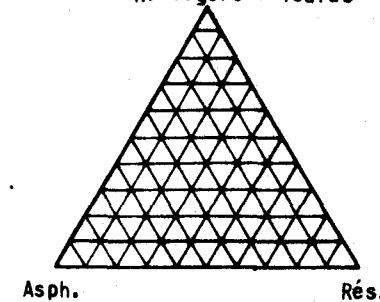
CHROMATOGRAPHIE DES SATURES

Composition du produit total

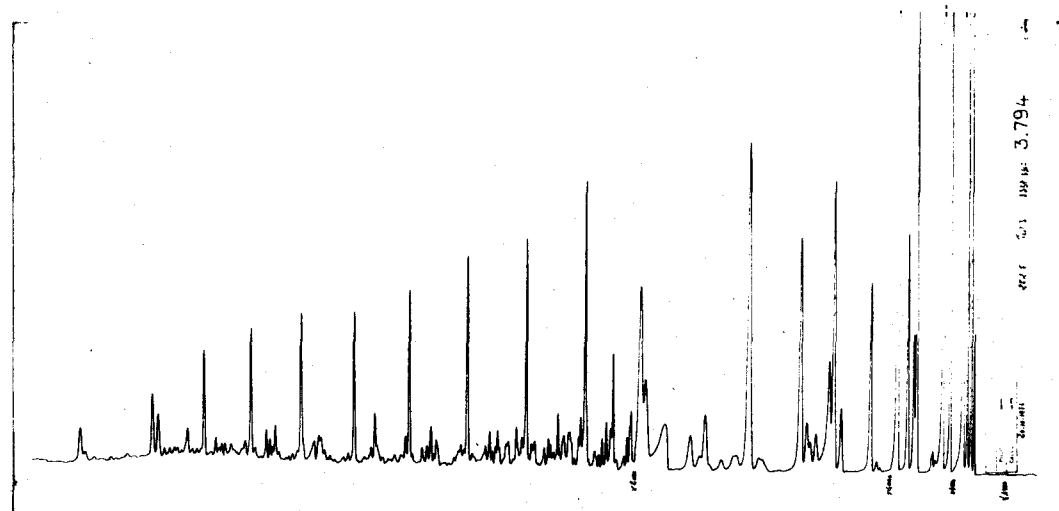
Asphalènes :	3.86	%
Résines :	78.97	%
H. saturés	17.17	%
H. aromatiques :		

Plate 1

H. légers + lourds



Interprétation :



PRODUITS THERMOVAPORISES

SONDAGE : 25/2-5
NORVÈGE

Echantillon huile - Test n°2

Cote = 3652 - 3695 m
Age : Lias
Lithologie = Grès

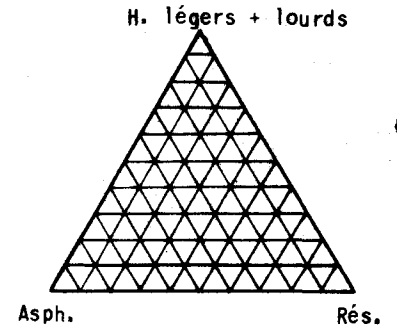
Composition du produit total

Asphal tènes :		
Résines :	3,29	%
H. saturés	80,47	%
H. aromatiques :	15,33	%
Pertes	0,91	%
	100	

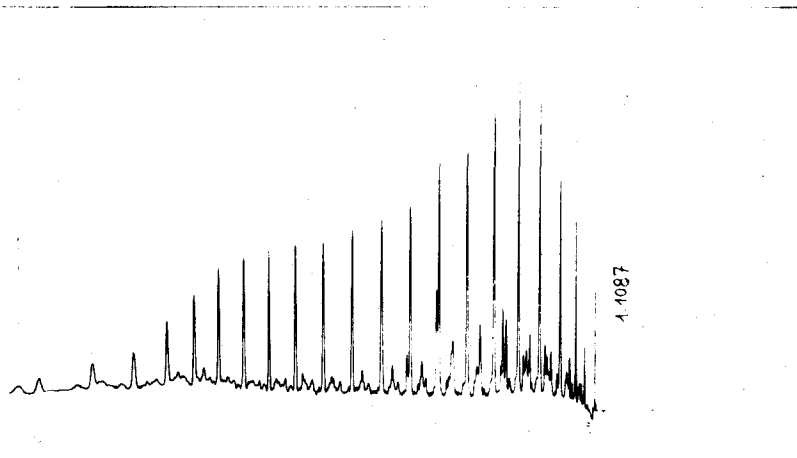
Plate 2

non effectuée

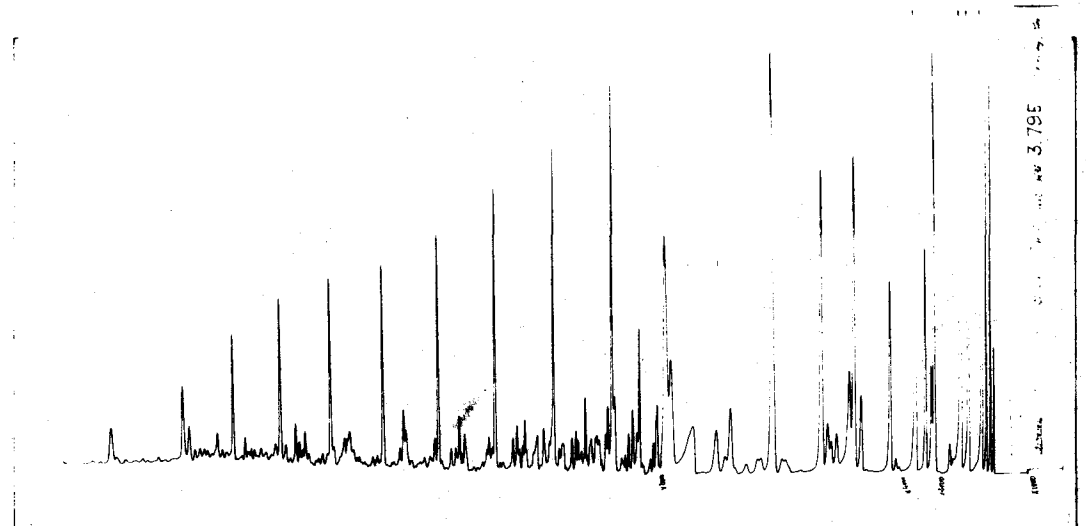
CHROMATOGRAPHIE DES AROMATIQUES



Interpretation :



CHROMATOGRAPHIE DES SATURES



PRODUITS THERMOVAPORISES



elf.r.e.

CENTRE DE RECHERCHES DE BOUSSENS

DEPARTEMENT GEOLOGIQUE CENTRAL LABORATOIRE

ORGANIC MATTER STUDY

Synthesis of results

Country NORWAY

Well 25/2-5

Section

Date January 1977

TECHNICAL SECTION DEPTH SCALE 1:20000	CORES	HC. SHOWS	LITHOLOGY	STRATIGRAPH		ANALYSIS RESULTS (organic inventory)	IOC			EOM		EOM							
				FORM			% rock	2	4	6%	2000	6000	%	2	4	6	8%		
30"																			
193					LIGNITIC SERIES	MIOCENE to PLEISTOCENE													
20"					BROWN CLAYS GROUPE	OLIGOCENE													
699							MIDDLE TO UPPER EOCENE												
1000																			
2000					LOW EOCENE														
					LOWER EOCENE GROUPE	PRLEOCENE													
							DANIAN SANDS												
13 ³ / ₈					CHALK	MAAST. CAMP.?													
2860						CAMPANIAN													
3000						Indet. CRETAC.													
9 ⁵ / ₈																			
3300						NOT SH. KIMM. CALLOVIAN													
7"						BRENT SDS DOGGER													
3597																			
4 ¹ / ₂						LIASSTIC													
3750						TRIAS.													
4000																			

Analyses on sidewall cores or cores

ORGANIC FACIES paly. processing	VITRINITE AND BITUMEN REFLECTANCE	THERMAL ALTERATION INDEX	ORGANIC GEOCH.	MAIN RESULTS
Amorphous (apropelit)	Dominant mode (from core)	Core samples	Extracts	<p><u>Source - rocks :</u></p> <p>The Liassic shale interval (about 150 m) has not been studied.</p> <p>Three source-rock intervals were revealed in the upper and middle Jurassic, but they are thin:</p> <ul style="list-style-type: none"> — Kimmeridgian: (about 15 m.); geochemical characteristics close to those of the same formation previously studied — Middle to lower Callovian: (about 20 m) geochemical characteristics close to those of the Dogger-Liassic shale source-rocks previously studied — Dogger: silty shaly beds (total thickness < 20 m.) <p><u>OILS :</u></p> <p>The oils from the Callovian and the Liassic have the same origin; the first seems slightly less matured than the second; Their main source-rock is probably the Liassic shale interval (here between 3500 and 3650 m.)</p>
Divided amorph mat.	(from cullings)	Cuttings samples	Crude Oils	
Black powdery mat.	Lack of coal or no representative population			
Coal	Spreading			
Fusinit	Bitumen			
Ligneous material				
Cuticles, epiderms				
20 40 60 80%	0% 0.5 1 2 4 6%	1 2 3 4 5		
Microf.				