

JULY 1983

RKER 83.101

SOURCE ROCK ANALYSIS OF CORES FROM INTERVALS
3947-3950.5, 4086-4090.4 AND 4145-4149.4 M
OF THE KIMMERIDGE CLAY FM. FROM WELL 15/3-1,
NORWAY

Scough Elf

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BA 83-6319-1

1 2 DEC 1983

REGISTRERT
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Investigation

9.5.3263

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1.0 INTRODUCTION

A source rock evaluation has been carried out on cores from well 15/3-1, NORWAY. The approximate location is shown in Figure 1.

The samples are taken from the intervals 3947-3950.5, 4086-4090.4 and 4145-4149.4 m of the Kimmeridge Clay Fm, i.e. Portlandian, Upper Jurassic.

Total depth was reached at 5132.0 m.b.d.f..

The purpose of the investigation was:

1. to detect the presence (or absence) of source rocks in the samples
2. to determine the quality of the organic matter, as well as its distribution.
3. to establish the degree of organic metamorphism (level of maturity).

A source rock is identified by measuring the amount of temperature reactive ("live") organic matter present, i.e. the amount of organic matter that yields hydrocarbons upon pyrolysis. The method excludes any ("dead") organic matter such as inertinites.

In addition, the total organic carbon content can be determined which gives the sum of "live" and "dead" organic carbon. Rocks containing less than 0.5%wt organic carbon are not considered to have a potential for commercial oil accumulations.

The source rock indications (SRI), which are a measure of the amount of pyrolysable organic matter, are determined on the original samples and in certain cases also after extraction with organic solvents. A systematically lower value after extraction is due to the presence of extractable hydrocarbons. These may consist of trapped oil, oil generated in situ by a source rock, or e.g. gasoil used in the drilling fluid.

In general, samples with source rock indications of 30 or less do not represent (immature or mature) source rocks. Values between 30 and 100 generally indicate marginal source rocks, while values above 100 commonly indicate good source rocks.

Intervals or samples with high source rock indications are investigated under a microscope to ensure that the high values indicate genuine source rock properties and are not due to contaminants of an organic nature such as lost circulation material.

The quality of a source rock for oil/gas generation depends on the type of organic matter present. Five categories of organic matter can be distinguished, viz.: humic, mainly humic, mixed, mainly kerogenous, kerogenous. This classification is based on the hydrogen content of the organic matter.

Source rocks with organic matter of kerogenous, mainly kerogenous and/or mixed type generate predominantly oil. Organic matter of humic type generates gas only. Strata with organic matter of mainly humic quality generate either gas, or gas and oil.

In addition to the type and the concentration of the organic matter, the source rock quality is also characterised by the distribution of the typical organic constituents, or macerals(1), in the sediments. The maceral distribution can be used to further qualify the source rock, especially when mainly humic quality is found. For this purpose a microscopic investigation on polished rock fragments is carried out.

The "maturity" of source rocks is expressed in terms of degree of organic metamorphism. With increasing degree of organic metamorphism the organic matter is gradually carbonised while generating hydrocarbons. With increasing carbonification the light reflectance of vitrinite, one of the coal macerals, increases. The degree of organic metamorphism can be assessed by measuring this reflectance.

1) maceral: an organic constituent which can be recognised with the microscope (with objectives 25x to 50x)

2.0 RESULTS

The results are listed in Table I (source rock indication values, total organic carbon content, type of organic matter) and Table II (maceral description, comment lines). All chemically obtained results are summarised in Enclosure 1 (Geochemical log).

3.0 DISCUSSION

3.1 Interval 3947.0-3950.5 m

All samples from this interval show good to excellent source rock indication (SRI) values, together with high amounts of organic carbon in the range 6.0-10.3 %wt.

In their maceral composition all samples show as main constituent "common" sapropelic organic matter (SOM) in a distribution, favourable for oil expulsion. In addition to the SOM, varying amounts of liptinites, some microplankton, fusinite, micrinite and very small amounts of detrital desmocollinite (vitrinite-2) are present.

The type of organic matter as observed, "kerogenous", is in agreement with the maceral description.

This interval can be regarded as good to excellent source rock for oil.

3.2 Interval 4086.0-4090.4 m

The core samples of this interval show fairly good to good source rock indication (SRI) values. The organic carbon contents range from 4.2-7.3 %wt.

In their maceral composition all samples, except for the top sample (4086.0 m) of the interval, show as main constituent "common" SOM in a distribution favourable for oil expulsion; sample 4086.0 m contains only "few" SOM. The SOM is found to be partly micrinitised and shows dark fluorescence.

Compared to the upper interval, considerably smaller amounts of liptodetrinites and tasmanites are observed,

while microplankton is absent. Exsudatinite is present now. The type of organic matter ranges from "mainly kerogenous" to "kerogenous".

Based on the differences between the upper and middle interval as observed in the maceral descriptions, hydrocarbon yields and type of organic matter, it is suggested that these are not only a consequence of increasing maturity, but may point to a poorer source rock quality of the middle interval (turbiditic sequence?) with respect to the upper.

It is concluded that interval 4086.0-4090.4 m can be regarded as a fairly good to good source rock for (predominantly) oil.

3.3 Interval 4145.0-4149.4 m

Except for the top sample of this interval, all samples show good to excellent SRI-values, in combination with high organic carbon contents (generally between 6 and 10 %wt).

In their maceral composition the samples of this interval are comparable with those of the upper interval, with the exception that the SOM shows a more dense distribution now. Moreover exsudatinite is present.

The type of organic matter is "mainly kerogenous" to "kerogenous".

Comparison of this source rock type with that of the upper interval suggests a somewhat increased stage of maturity of the lower interval with respect to the upper.

Interval 4145.0-4149.4 m can be regarded as a good to excellent source rock for oil.

4.0 CONCLUSION

Interval 3947.0-3950.5 m can be regarded as a good to excellent source rock for oil.

Interval 4086.0-4090.4 m can be regarded as a fairly good to good source rock for (predominantly) oil.

Interval 4145.0-4149.4 m can be regarded as a good to excellent source rock for oil.

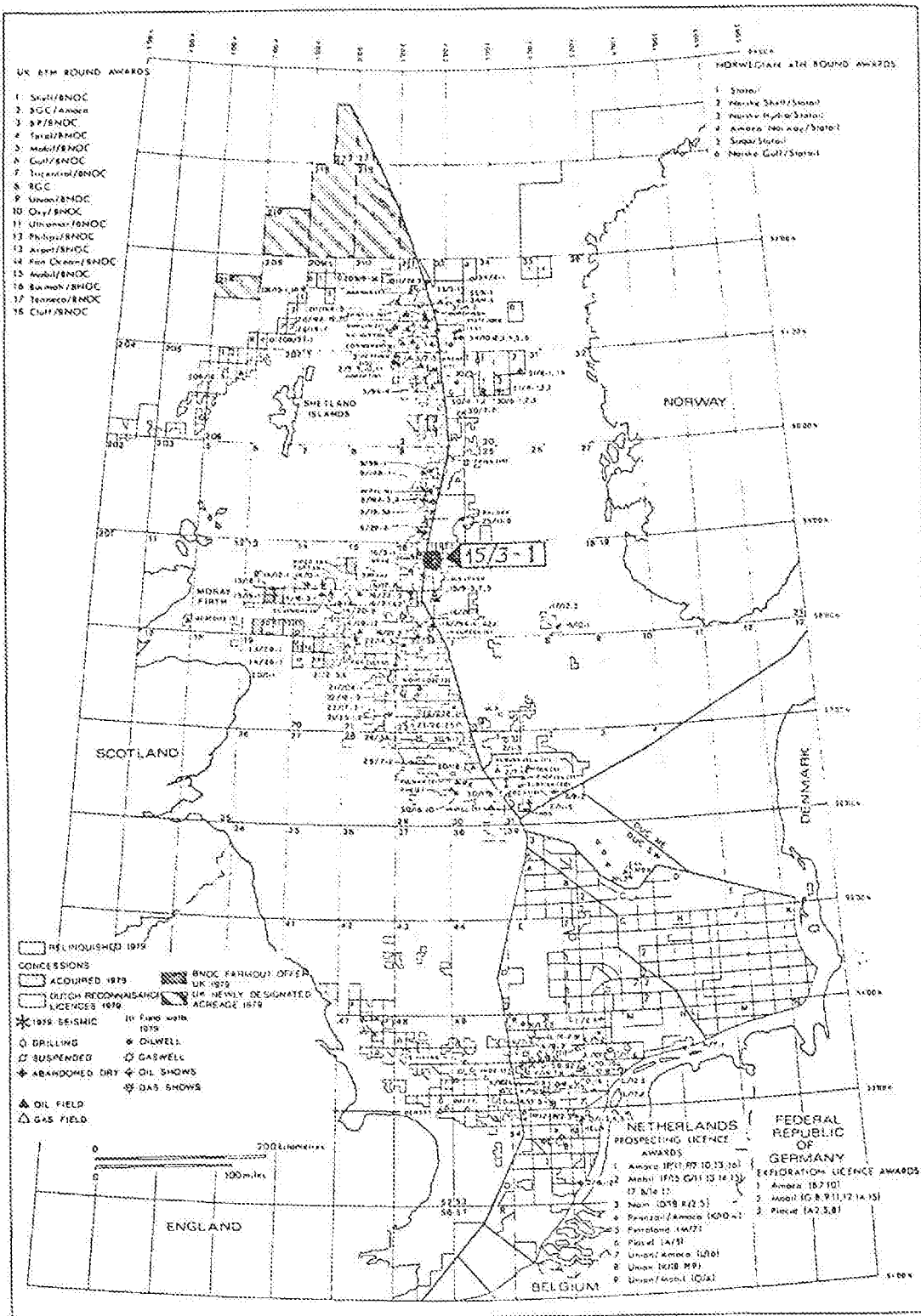


FIGURE 1: LOCATION MAP

GEOCHEMICAL SOURCE ROCK DATA

TABLE I

WELL: 15/3-1

DEPTH	TYPE OF SAMPLE	SOURCE ROCK INDICATION BEFORE EXTR.*	SOURCE ROCK INDICATION AFTER EXTR.*	TYPE OF ORGANIC MATTER	ORGANIC CARBON CONTENT %W
3947	R	740	725	K	8.1
3948	R	650	625	K	6.3
3949	R	900	835	K	10.3
3949	R	900	835	K	10.2
3950	R	525	500	K	6.0
3950.50	R	410	390	K	7.0
4086	R	140	120	MK	4.2
4087.20	R	260	245	MK /K	5.8
4088	R	375	365	K	7.9
4089	R	170	135	MK	4.8
4089.50	R	305	295	K	7.8
4090	R	325	315	K	6.5
4090.40	R	445	440	K	7.8
4145	R	140	115	MK	3.5
4146	R	425	425	K	9.0
4146.50	R	335	320	MK /K	6.8
4146.80	R	535	530	K	8.8
4147	R	670	560	K	10.0
4147.30	R	315	295	K /MK	8.1
4149.20	R	210	195	K	6.0
4149.40	R	570	470	MK	10.4

TYPE OF SAMPLE C = CUTTINGS, R = CORE, S = SIDEWALL SAMPLE

CONTAMINATION : W = WALNUT FRAGMENTS OR SOME SIMILAR PRODUCT, E = CELLOPHANE SHREDS, F = FIBRES, P = PLASTIC OR PAINT AND C = CONTAMINATED BUT KIND NOT SPECIFIED

A DASH (-) INDICATES TEST NOT MADE, ASTERISKS INDICATE THE ORGANIC CARBON CONTENT IS THE AVERAGE FOR THE SAMPLES CONCERNED

MACERAL DESCRIPTION OF 20 SAMPLES FROM WELL 15/3-1, NORWAY

DEPTH IN M	SAMPLE TYPE
---------------	----------------

	ORGANIC											INORG.								
	VITR.		LIPIDINITE					INERT.												
					ALORE															
SAPROPELIC ORG. MATTER	TELLOLLINITE	TELINITE	DESMOCELLINITE	SPOANITE	CUTINITE	RESINITE	LIPIDOLIPINITE	BOTRYOCOCCUS	TASMANITES	OTHER ALORE	MICROPLANKTON	EXSUDINITE	SCLEROTINITE	FUSINITE	MAGRINITE	MICRINITE	UNDEFINED MINERALS	FAMBOURAL PYRITE	AGGREGATES OF PYRITE	CRYSTALS OF PYRITE

3947.0	CORE	+		-	-			+	+	/				-	+	*	+	/	-
3948.0	CORE	+		-	-			+	/	/				/	+	*	+	/	/
3949.0	CORE	+		-	-			+	/	/				-	+	*	+	/	-
3950.0	CORE	/		-	-			+	/	/				/	+	*	+	/	-
3950.5	CORE	+		-	-			+	/	/				/	+	*	+	+	/
4086.0	CORE	+		-	-			-	-		+			/	+	*	+	-	/
4087.2	CORE	+		-	-			-	-		/			/	+	*	+	/	-
4088.0	CORE	+		-	-			/			/			/	+	*	+	/	-
4089.0	CORE	+		-	-			-			/			/	+	*	+	/	-
4089.5	CORE	+		-	-			/	-		/			/	+	*	+	+	-
4090.0	CORE	+		-	-			/	-		-			/	+	*	+	/	-
4090.4	CORE	+		-	-			/	-		/			/	+	*	+	/	-
4145.0	CORE	/		-	-			-			+			-	+	*	+	/	/
4146.0	CORE	+		-	-			+	/		/			/	+	*	+	+	/
4146.5	CORE	+		-	-			+	/		/			/	+	*	+	/	-
4146.8	CORE	+		-	-			+	/		/			/	+	*	+	+	-
4147.0	CORE	+		-	-			+	/		/			/	+	*	+	/	-

L E G E N D	
*	ABUNDANT
+	COMMON
/	FEW
-	RARE

DEPTH IN M	SAMPLE TYPE
---------------	----------------

4147.3	CORE
4149.2	CORE
4149.4	CORE

	ORGANIC													INORG.			
	VITR.		LIPIDINITE						INERT.								
			ALGAE														
SARAPCELIC ORG. MATTER																	
TELLOLLINITE																	
TELINITE																	
OFSMOLLINITE																	
SPAINITE																	
CUTINITE																	
RESINITE																	
LIPIDETRAINITE																	
BOTRYOCOCCUS																	
TASMANITES																	
OTHER ALGAE																	
MICROPLANKTON																	
EXUDATINITE																	
SCLEROTINITE																	
FUSINITE																	
MAGRINITE																	
MICRINITE																	
UNDEFINED MINERALS																	
FERRUGINOUS PYRITE																	
AGGREGATES OF PYRITE																	
CRYSTALS OF PYRITE																	

+		-				+	/		/	/		+	*	+	+	/
+		-				/	-		/		+	+	*	+	/	/
+		-				+	/		/	/		+	*	+	/	/

L E G E N D	
*	: ABUNDANT
+	: COMMON
/	: FEW
-	: RARE

- 3947.0 M : INITIAL MICRINISATION S.O.M.
- 3948.0 M : INITIAL MICRINISATION S.O.M.
FOSSIL REMAINS
- 3949.0 M : LAMINATED S.O.M. PROBABLY OF ALGAL ORIGIN
LAMINATED (ALGAL) S.O.M. PARTLY BACTERIALLY TRANSFORMED
INITIAL MICRINISATION S.O.M.
FOSSIL REMAINS
- 3950.0 M : INITIAL MICRINISATION S.O.M.
SECTION NOT PERPENDICULAR TO BEDDING PLANE
- 3950.5 M : OTHER ALGAE GRADING INTO LAMINATED S.O.M.
INITIAL MICRINISATION S.O.M.
- 4086.0 M : S.O.M. PARTLY MICRINISED
FEW SOLID HYDROCARBONS
DARK FLUORESCENT SOM + ALGAE
COARSE GRAINED FEW TO COMMON FUSINITE
- 4087.2 M : S.O.M. PARTLY MICRINISED
DARK FLUORESCENT SOM + ALGAE
FEW TO COMMON FUSINITE
- 4088.0 M : S.O.M. PARTLY MICRINISED
DARK FLUORESCENT SOM
FEW TO COMMON FUSINITE
- 4089.0 M : S.O.M. PARTLY MICRINISED
FEW SOLID HYDROCARBONS
DARK FLUORESCENT SOM
INHOMOGENEOUS SAMPLE; PARTLY COARSE GRAINED; SOL. HYDROCARBONS
- 4089.5 M : S.O.M. PARTLY MICRINISED
FEW SOLID HYDROCARBONS
DARK FLUORESCENT SOM+ALGAE + FEW TO COMMON FUSINITE
INHOMOGENEOUS SAMPLE; PARTLY COARSE GRAINED; SOL. HYDROCARBONS
- 4090.0 M : S.O.M. PARTLY MICRINISED
DARK FLUORESCENT SOM + ALGAE
FEW TO COMMON FUSINITE
- 4090.4 M : S.O.M. PARTLY MICRINISED
RARE SOLID HYDROCARBONS
DARK FLUORESCENT SOM+ALGAE + FEW TO COMMON FUSINITE
SOME COARSE GRAINED MATTER + SOLID HYDROCARBONS
- 4145.0 M : S.O.M. PARTLY MICRINISED
- 4146.0 M : LAMINATED (ALGAL) S.O.M. PARTLY BACTERIALLY TRANSFORMED
S.O.M. PARTLY MICRINISED
RARE SOLID HYDROCARBONS
DARK FLUORESCENT SOM+ALGAE + FEW TO COMMON FUSINITE
SOME COARSE GRAINED MATTER + SOLID HYDROCARBONS
- 4146.5 M : LAMINATED (ALGAL) S.O.M. PARTLY BACTERIALLY TRANSFORMED
S.O.M. PARTLY MICRINISED
RARE SOLID HYDROCARBONS
DARK FLUORESCENT SOM+ALGAE; FEW TO COMMON SOLID HYDROCARBONS

TABLE 2d

	SOME COARSE GRAINED MATTER + SOLID HYDROCARBONS
4145.8 M :	LAMINATED (ALGAL) S.O.M. PARTLY BACTERIALLY TRANSFORMED S.O.M. PARTLY MICRINISED FEW SOLID HYDROCARBONS DARK FLUORESCENT SOM + ALGAE SOME COARSE GRAINED MATERIAL + SOLID HYDROCARBONS
4147.0 M :	LAMINATED (ALGAL) S.O.M. PARTLY BACTERIALLY TRANSFORMED S.O.M. PARTLY MICRINISED RARE SOLID HYDROCARBONS DARK FLUORESCENT SOM + ALGAE
4147.3 M :	LAMINATED (ALGAL) S.O.M. PARTLY BACTERIALLY TRANSFORMED S.O.M. PARTLY MICRINISED FEW SOLID HYDROCARBONS DARK FLUORESCENT SOM + ALGAE SOME COARSE GRAINED MATTER + SOLID HYDROCARBONS
4149.2 M :	S.O.M. PARTLY MICRINISED FEW TO COMMON EXSUDATINITE DARK FLUORESCENT ALGAE; FEW TO COMMON FUSINITE
4149.4 M :	LAMINATED (ALGAL) S.O.M. PARTLY BACTERIALLY TRANSFORMED S.O.M. PARTLY MICRINISED FEW SOLID HYDROCARBONS DARK FLUORESCENT SOM + ALGAE