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> SOURCE ROCK AND DOM EVALUATION WELL 9/12-1, NORWAY

by K. Reiman & J.E.A.M. Dielwart



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KONINKLIJKE/SHELL EXPLORATIE EN PRODUKTIE LABORATORIUM RIJSWIJK, THE NETHERLANDS

EP-45033

Technical Service Report

September 1973

RKTR 0273.73

SOURCE ROCK AND DOM EVALUATION

WELL 9/12-1, NORWAY

by

K. Reiman & J.E.A.M. Dielwart

Sponsor: SIPM-EP/Norske Shell

In co-operation with:

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Investigation

912.895

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KONINKLIJKE/SHELL EXPLORATIE EN PRODUKTIE LABORATORIUM RIJSWIJK, THE NETHERLANDS

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KEYWORDS

Source rock, Carbonization, DOM, well 9/12-1, Norway

- II -

I. INTRODUCTION

Geochemical investigations have been carried out on a suite of samples from the well as mentioned on the title page.

These investigations have been carried out to evaluate the presence and quality of source-rock layers, to establish the DOM trend and indicate the zone of possible oil and/or gas generation at the location of the well.

II. EVALUATION OF SOURCE-ROCK PROPERTIES

a. Source-rock indications

These indications have been determined by pyrolysis-sniffing¹ of the original samples. Moderate to high indications may indicate genuine source-rock properties or migrated oil or may be due to the presence of contaminants such as diesel oil used in the drilling fluid. To distinguish between the first possibility and the latter two, original samples with strong indications are remeasured after extraction with chloroform. Intervals or samples with high indications after extraction are investigated microscopically to ensure that the high values indicate genuine source-rock properties and are not due to contaminants insoluble in chloroform (such as walnut shells or other lost circulation material of an organic nature).

The results are given in the geochemical log (enclosure 1). For the location of the well see figure 1.

b. Type of organic matter

The type of organic matter present in the samples was determined by pyrolysis/gas solid chromatography^{2,3}. This is an empirical method in which the organic matter is ranked on the basis of its hydrogen content. The hydrogen content is lowest for organic matter of humic type and increases in order of the types: mainly humic, mixture, mainly kerogenous and kerogenous. Organic matter of humic type is a precursor of gas. Organic matter of mainly humic

type is also a precursor of gas; if sufficient quantities are present it may also yield oil. Organic matter of mixed type is a precursor of light oil (usually of a paraffinic nature) and gas. Organic matter of mainly kerogenous and kerogenous types are precursors of oil and gas.

The results have been included in the geochemical log.

III. DEGREE OF ORGANIC METAMORPHISM

a. <u>Results</u>

DOM values have been determined by measurement of vitrinite relfectance 4 .

The results are plotted as a function of depth in figure 2 in the form of DOM histograms. Any histogram that could not be accommodated on figure 2 is given in subsequent figures.

In general, the mode value of the histogram may or may not represent the true DOM of the stratum from which the sample is taken. The DOM obtained from cuttings may have been influenced by vitrite from cavings. Alternatively, the DOM may refer to reworked, resedimented or allochthonous vitrinite. However, it is probable that the DOM obtained for samples with histograms that have a rather sharp mode value does represent the truelayer DOM.

b. Compatible DOM

The compatible DOM is that which is in accordance with the present subsurface temperature and age of the formation in question. Knowledge of the compatible DOM is required to indicate the zone of possible oil generation (so-called cooking pot).

The dashed line in figure 2 indicates the compatible DOM trend based on $^{5-6}$ the present subsurface temperature gradient as indicated in the last figure. The temperature gradient is based on BHTs measured during logging after applying the so-called Middle East correction ⁷. If only a solid line is given in figure 2, the compatible DOM coincides with the true-layer DOM trend.

- 2 -

Rapidly buried Mesozoic sediments (generally those overlain by 5000 ft or more of Tertiary sediments) follow the DOM/subsurface temperature established for these sediments⁸. Other Mesozoic sediments⁹ and Palaeozoic sediments have been assumed to reach a given DOM earlier than Tertiary sediments. For a difference in age of 100 million years between the mid-age of the Tertiary and the mid-age of the sediments in question, the latter have been assumed to reach a given DOM 10^{0} F sooner than Tertiary sediments.

The compatible DOM values 60 and 75 indicate the limits of the zone in which oil generation may take place. Source rocks for oil located within these limits are expected to generate oil. The major gas generation takes place below the level indicated by the compatible DOM 75.

In those cases where it can be assumed that the strata are presently at their maximum depth of burial, the compatible DOM also indicates the predicted true-layer DOM.

c. True-layer DOM

The true-layer DOM is the DOM that a humic coal would have when subjected to the same burial/temperature history as the formation in question.

The solid line in figure 2 is considered to indicate the trend of the truelayer DOM. It is based on those DOM values that are believed to be reliable. In this connection it can be remarked¹⁰ that the standard deviation in the DOM measurement, including the variability occurring in nature, is 4 DOM units. The shape of the line, that is the rate of DOM increase as a function of DOM, is based on accumulated experience.

If the area has been uplifted, in the sense that the strata were once at greater depth, or if they have been at higher temperature, the true-layer DOM is higher than the compatible DOM. Source rocks with a true-layer DOM between 60 and 75 are mature for oil. If these source rocks have been uplifted, the true-layer DOM is incompatible.

Mature source rocks for oil have generated oil when the relevant strata have dropped below the level of the compatible DOM 60. Mature source rocks for oil lying outside the interval between the compatible DOM 60 and 75 levels are not expected to generate oil at present. IV. DISCUSSION AND CONCLUSIONS

Interval 6600 - 6690 ft (Kimmeridgian - Oxfordian) contains source rocks for oil.

Interval 6690 - 6910 ft (Middle Jurassic) contains source rocks for gas.

The zone of possible oil generation or cooking pot at the location of the well, as indicated by the levels of compatible DOM 60 and 75, is between 9000 ft and about 15500 ft. - 4 -

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- 5 -



LOCATION MAP

Fig: 1



KSEPL

F16: 2

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Well	:_	9/12-1	· .		· .	
depth	:_	5840	ft	DOM:	~ 56	

Type of sample: cuttings/SWS/core/surface/coal

The DOM of the sample is based on the mode value of the DOM histogram. It is [only] the DOM of the vitrinite mostly present in the sample. It may or may not coincide with the true layer DOM.

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Fig.

2

Countr	y: Norway		
Well	: 9/12-1		
depth	: 6210 ft	DOM:	~ 56

Type of sample: cuttings/SWS/core/surface/coal-

The DOM of the sample is based on the mode value of the DOM histogram. It is [only] the DOM of the vitrinite mostly present in the sample. It may or may not coincide with the true layer DOM.

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Fig.

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DOM: 56

Type of sample:-outtings/SWS/core/surface/coal-

The DOM of the sample is based on the mode value of the DOM histogram. It is [only] the DOM of the vitrinite mostly present in the sample. It may or may not coincide with the true layer DOM.

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Fig.

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Country: Morw	<u>ay</u>					
Well : $9/12-$	•		• .		•	•
depth : <u>6740</u>	ft	 DOM: _		\sim	56	

Type of sample: cuttings/SWS/core/surface/coal

The DOM of the sample is based on the mode value of the DOM histogram. It is [only] the DOM of the vitrinite mostly present in the sample. It may or may not coincide with the true layer DOM.

Number of	5	10	15	20	25	30	35	40	45	50
measurements	PREMIN	MALL	MMA	MAN	VAM.	1111	ΠΠΠ		ПП	Π
Analist	Abs	· .				•	• ·			

Relative reflectance [diamond = 100]

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Fig.

Countr	y: Morway			
Well	: 9/12-1		• •	
depth	: 6840 ft	DOM:	51	

Type of sample: cuttings/SWS/core/surface/coal

The DOM of the sample is based on the mode value of the DOM histogram. It is [only] the DOM of the vitrinite mostly present in the sample. It may or may not coincide with the true layer DOM.

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Relative reflectance [diamond = 100]

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Fig.

Countr	y: Morway	·		
Well	: 9/12-1		•	
depth	: 6900 H	DOM:	~ 56	

Type of sample: cuttings/SWS/core/surface/coal-

DOM:

The DOM of the sample is based on the mode value of the DOM histogram. It is [only] the DOM of the vitrinite mostly present in the sample. It may or may not coincide with the true layer DOM.

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Fig.

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GEOCHEMICAL LOG

WELL 9/12_1

SCALE 1:5000

AGE	FORMATION	DEPTH IN FT	ГІТНОГОGY	WOQ	100 1	PYR0 200	OLYSIS SNIF OF ORIGINAL 300	FING VA SAMPLE 400	500	600 I	SAMPL 100	PYROI E AFTER 200	LYSIS SN O EXTRAC 300	IFFING N F TION WIT 400	/ALUE TH CHLOR 500	0F0RM 600	DEPTH IN FT	% ORGANIC * CARBON	TYPE OF ORGANIC MATTER
	Sea floor	0 - -									VA	LUES SMA NOT	LLER TH	AN 30 AF DF SIGNIF	E CONSID	ERED	o —		
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