2. Chemical Consumption and Costs

a) Chemical Consumption by Hole Size

Interval / Chemicals	Bentonite/Seawater spud mud		Lime/Drispac/Seawater mud		
	36"(367-650ft)	26"(650-1430ft)	$17\frac{1}{2}$"(1430-4338 ft)	12 1/4" (4338-8675ft)	Total
Barytes (MT)	-	18.2	144.4	93.2	255.8
Magcogel (100 lb)	496	818	30	240	1584
Spersene (50 lb)		6	340	426	772
Soda Ash (50 kg)	8	6	41		55
Lime (40 kg)	5	11	684	511	1211
Caustic (25 kg)	18	30	388	508	944
Soltex (50 lb)			97		97
D.D. (55 gall)			11	10	21
Drispac Reg (50 lbs)	8		194	240	442
Drispac S.L. (50 lbs)			58	43	101

b) Mud Cost by Hole Size (US $)

	Bentonite/seawater		Lime/drispac/seawater mud		
Interval	36"	26"	17-1/2"	12-1/4"	TOTAL
Interval cost	4,889	8,348	74,369	70,302	157,907
Interval cost/day	2,444	1,391	10,624	3,906	4,785
Interval cost/foot	17.3	10.70	25.57	16.20	19.01
Interval cost excl. baryte	4,889	6,298	58,104	59,807	129,097
Interval cost/day excl. baryte	2,444	1,050	8,301	3,322	3,912
Interval cost/ft excl. baryte	17.3	8.07	19.98	13.79	15.54
Interval cost excl. kill mud	4,889	5,368+	69,172	65,105	144,534
Interval cost/day excl. kill mud	2,444	895	9,881	3,617	4,380
Interval cost/ft. excl. kill mud	17.3	6.88	23.78	16.20	17.40

The total mud cost for well 17/11-2 was $ 157.907 of which $ 28.810 (18.25%) was the cost of barytes and $ 13.373 (8.47%) was the cost of kill mud. It was company policy to keep a 500 bbls stock of kill mud, 100 psi/1000 ft heavier than the active system available at all times.

\+ Cost of kill mud made during 36/26" intervals has been allocated to 26" interval.

c) Mud Type and Performance

The mud used to drill 17/11-2 was again the DRISPAC/LIME system as used on well 1/6-4 with engineering service provided by Dresser Magcobar. Again the mud performance and engineering service proved more than satisfactory, although better control of pump rates, nozzle sizes etc. would have been of benefit since some overgauge hole was noted on the caliper logs.

Technical Service Report March 1977

RKTR 0068.77

SOURCE ROCK AND CARBONISATION EVALUATION WELL 17/11 - 2, NORWAY

by

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

Sponsor: **Norske Shell**

KONINKLIJKE/SHELL
EXPLORATIE EN PRODUKTIE LABORATORIUM
RIJSWIJK, THE NETHERLANDS

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Investigation

95.13.23

KONINKLIJKE/SHELL

EXPLORATIE EN PRODUKTIE LABORATORIUM

RIJSWIJK, THE NETHERLANDS

CONTENTS

I INTRODUCTION

A source rock evaluation has been carried out on a suite of samples from the well as mentioned on the title page. The location of the well is shown in figure 1.

The purpose of the investigation was: 1. To establish the presence (or absence) of source rocks in the penetrated series of sediments. 2. To determine the quality of any source rock present, that is whether it is a source rock for oil (and gas) or gas only. 3. To establish the zone of possible oil and/or gas generation at the location of the well.

A source rock is characterised by the concentration of live organic matter present, that is the amount of organic matter which is at a relatively low degree of carbonisation. This concentration excludes the amount of dead organic matter (highly carbonised matter) such as fusinite. Source rocks contain generally several tenths and up to one per cent of dead organic matter in addition to a certain concentration of live organic matter. Nevertheless, the concentration of dead organic matter may occasionally be very high in certain strata. If live organic matter is not present in such a case, the relevant stratum is either not a source rock (and never has been one) or may be a postmature source rock; this would depend on the quality of the organic matter present.

The quality of a given source rock depends on the type of organic matter present. Five categories of organic matter are recognised, that is: humic, mainly-humic, mixture, mainly-kerogenous and kerogenous. In the first instance this is a chemical classification based on the hydrogen concentration of the organic matter, Nevertheless, this classification parallels the composition of the organic matter as observed microscopically. Organic matter of the types humic to mixture is usually land plant derived and generally indicates organic matter with increasing quantities of pollen, spores, cuticles and resins.

Source rocks with organic matter of mixture, mainly-kerogenous or kerogenous type generate predominantly oil at a relatively low level of carbonisation. Organic matter of humic type generates gas only. Strata with organic matter of mainly-humic type generate mainly gas. However, if the concentration of the organic matter is high and the source rock interval thick, such strata can generate (and expel) oil in commercial quantities.

II EVALUATION OF SOURCE ROCK PROPERTIES

The source rock indications, which are a measure of the amount of live organic matter, are given in the geochemical log (enclosure 1). For a number of the samples the log also gives the total concentration of organic matter.

The source rock indications have been determined on the original samples and in certain cases also after extraction with chloroform. Any systematic difference between the two is due to the presence of extractable hydrocarbons. These may consist of trapped oil, migrating oil, oil generated in situ by a source rock or gasoil used in the drilling fluid.

In general, samples with source rock indications of 30 or less do not represent source rocks. Values between 30 and 100 indicate marginal source rocks; this depends also on the thickness of the interval. Marginal source rocks may develop downdip into a genuine source rock. Strata with source rock indications of 100 or more qualify as genuine source rocks.

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

The type of organic matter present in the source rock interval has been determined by gaschromatography. The results are included in the geochemical log.

III CARBONISATION OF STRATA

a. General

It is recognised that source rocks generate oil and/or gas in substantial quantities when subsiding into a certain critical zone. This zone is characterised by the carbonisation of the strata. A yardstick for this carbonisation is given by the carbonisation of vitrinite, one of the coal macerals. There is a certain parallel between the carbonisation (conversion) of the organic matter in source rocks, which usually does not consist of vitrinite, and that of vitrinite.

The carbonisation of vitrinite is expressed in terms of DOM (degree of organic metamorphism) or FCC (fixed-carbon content). The DOM/FCC is determined by measurement of the reflectance of polished vitrinite particles. For the relation between DOM and reflectance see one of the sheets showing a DOM/FCC histogram at the end of the report.

It has been found that the main zone of oil generation is limited by the DOM/FCC 60 and 75 levels, while the main gas generation takes place below the DOM/FCC 75 level. This empirical relation between the zones of oil and gas generation and the carbonisation yardstick is based on Tertiary and Mesozoic sediments; it does not necessarily hold for Paleozoic sediments. Depending on the maceral composition of the organic matter in source rocks for oil, the peak of the oil generation may vary within the DOM/FCC 60 to 75 range.

b. <u>Results</u>

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

The modal value of the histogram indicates the level of the carbonisation of the sample only, as it is the carbonisation of the vitrinite mostly present in the sample. It may or may not represent the carbonisation of the stratum from which the sample is taken. The DOM/FCC obtained from cuttings may have been influenced by caved vitrinite. Alternatively, the DOM/FCC may refer to reworked or allochthonous vitrinite.

The carbonisation at a given horizon can only be obtained by measuring a number of samples spaced over a suitable interval. If the measured carbonisation values increase as a function of depth in an expected manner, it can be concluded that the measured vitrinite is autochthonous. The true carbonisation at a given horizon is then given by the mean relation between the individual measurements as the standard deviation of the measurements is about 4 DOM/FCC units. This standard deviation includes the variability as it occurs in nature.

If one or a few measurements have been made and the results coincide with the carbonisation trend expected on the basis of the subsurface temperature gradient it is likely that the measured DOM/FCC value(s) indicate the true carbonisation.

We recognise two carbonisation levels, the compatible DOM/FCC and the true-layer DOM/FCC.

c. <u>Compatible carbonisation</u>

The compatible DOM/FCC is the carbonisation value which is in accordance with the present subsurface temperature and age of the formation in question. It is, among other things required to indicate the zone of possible oil and/or gas generation.

The dashed line in figure 2 indicates the compatible DOM/FCC trend based on the present subsurface temperature gradient. If only a solid line is given in figure 2, the compatible trend coincides with the true-layer trend.

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

d. True-layer carbonisation

The true-layer DOM/FCC of a stratum is the true-layer carbonisation value a humic coal would have when subjected to the same burial/temperature history as the stratum in question.

The solid line in figure 2 is considered to indicate the true-layer DOM/FCC. It is based on those values which are considered to be reliable. The shape of the line, that is the rate of DOM/FCC increase as a function of DOM/FCC, is based on accumulated experience.

If the area has been uplifted, in the sense that the strata were once at a greater depth, or if they have been at higher temperature, the true-layer carbonisation value is higher than the compatible value. Source rocks with a true-layer DOM/FCC between 60 and 75 are mature for oil. If these source rocks have been uplifted, these mature source rocks do now not generate oil.

IV Discussion and conclusions

A suite of cuttings from interval 2400 - 2595 m penetrated by well 17/11-2 has been investigated for source rock properties.

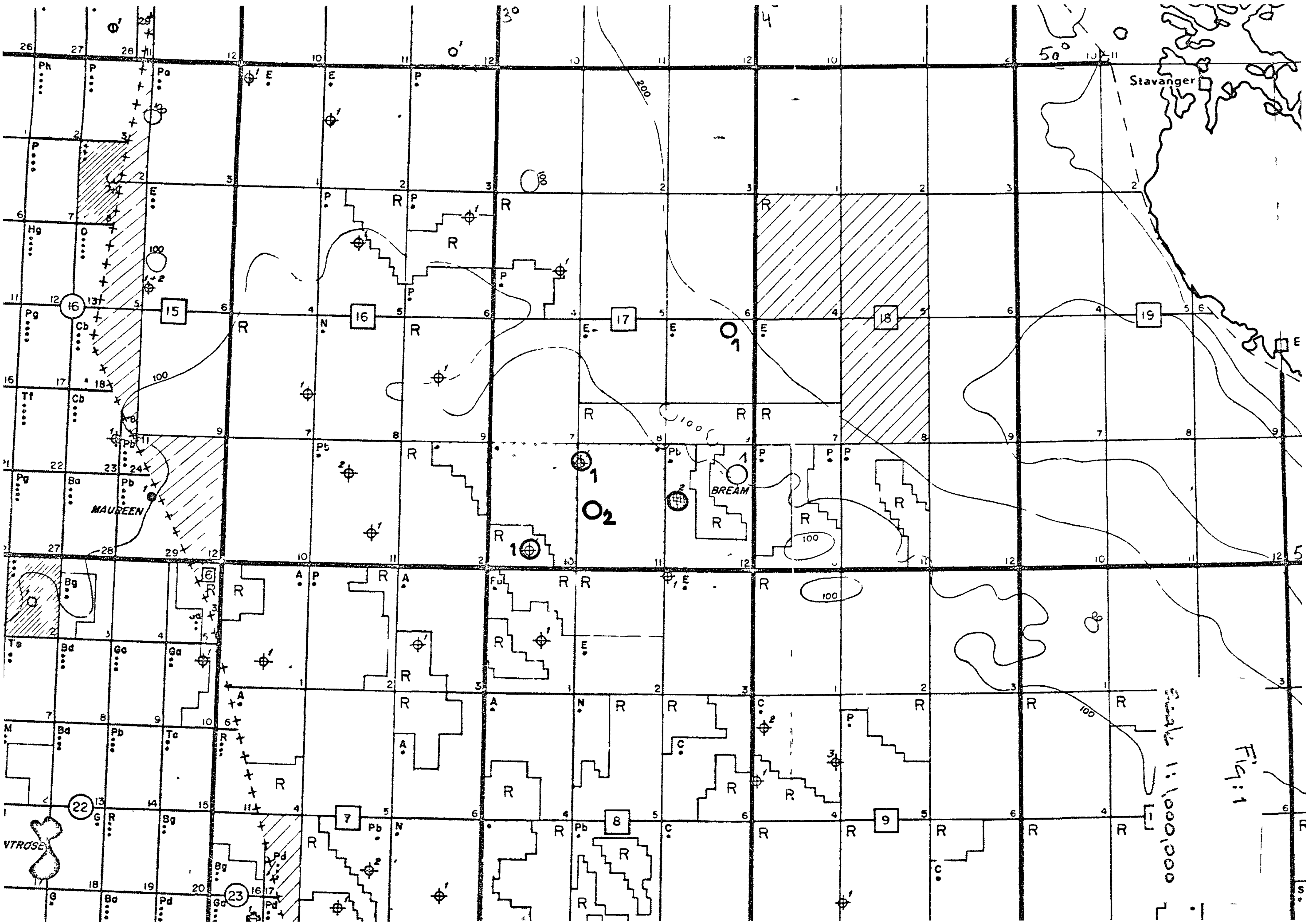
The results indicate that the samples from interval 2425 - 2585 m (Berresian/Portlandian/Kimmeridgian/Triassic ?) contain sufficient organic matter to qualify as source rock for oil. Most of the organic matter is concentrated in interval 2455 - 2525 m (mainly the Portlandian and Kimmeridgian).

In first instance one would probably conclude that the lower concentrations of kerogenous and mainly-kerogenous organic matter present in the cuttings from below 2525 m in the mainly sandy Triassic ? is caved from the Portlandian/Kimmeridgian source rock interval above it. However, a gas analysator at the well site indicated gas to be present at a significant level in intervals 2425 - 2582 m. This gas might of course be present as such in the interval but more likely it has been made in situ while drilling through the source rock under the influence of the heat of friction. Gas is often observed when drilling through source rock. Redrilling of cavings can only occur by accumulation of cavings at the bottom of the hole during the period of a roundtrip to change the bit. On completion of coring at the depth of 2542 m no further bit change has been made until the TD at 2644 m was reached. This indicates that the gas readings over the interval 2542 - 2582 m cannot be due to redrilling of cavings.

The concurrence of the presence of organic matter in the suite of cuttings from interval 2425 - 2585 m and the increased gas level in interval 2425 - 2582 m is such that we tend to conclude that the lower concentration of the organic matter in the samples from below 2525 m is not or is not all due to caving but indicates the presence of source rocks, in presumably shale stringers, in the sand body of the Triassic (?). If you wish us to persue this matter further we could carry out a source rock investigation of core no 1 (interval 2533 - 2542 m).

No attempt was made to measure DOM/FCC values as it appeared that suitable organic matter is not present.

Compatible DOM/FCC trends for Jurassic and Triassic sediments, based on the present subsurface temperature gradient, are shown in figure 2. This indicates that the source rock as penetrated by well 17/11-2 is not yet mature for oil. The Jurassic source rock for oil should be burried to at least 3200 m before reaching maturity.



Stavanger
MAUREEN
BREAM
15
16
17
18
19
7
8
9
22
23
200
100
Fig: 1
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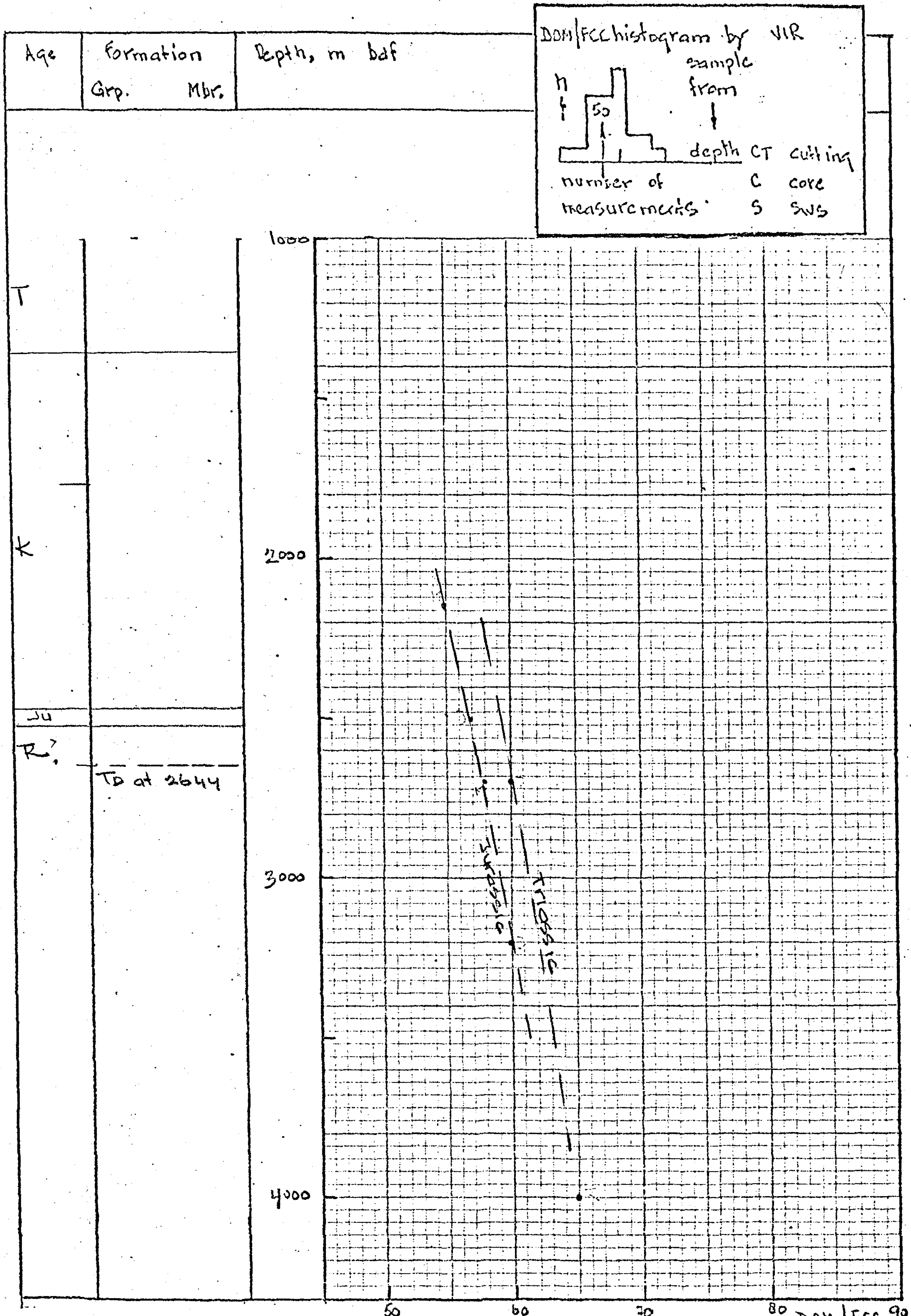

DOM|FCC AS A FUNCTION OF DEPTH, WELL 17/11-2

FIG. 5

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GEOCHEMICAL LOG

WELL 17/11-2

SCALE 1:5000