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SOURCE ROCK AND DOM EVALUATION

WELL 1/3-1, NORWAY

by

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

Sponsor: SIPM-EP/ Norske Shell

In co-operation with:

J. Alblas

J.H.H. Gales-Maas

M.C.M. v.d. Knaap-Holierhoek

Investigation

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EXPLORATIE EN PRODUKTIE LABORATORIUM

RIJSWIJK, THE NETHERLANDS

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KEYWORDS

Source rock, Carbonization, DOM, well 1/3-1, Norway

## 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-sniffing<sup>1</sup> 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<sup>2,3</sup>. 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. Results

DOM values have been determined by measurement of vitrinite reflectance<sup>4</sup>.

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 true-layer 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<sup>5-6</sup> 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<sup>7</sup>. If only a solid line is given in figure 2, the compatible DOM coincides with the true-layer DOM trend.

Rapidly buried Mesozoic sediments (generally those overlain by 5000 ft or more of Tertiary sediments) follow the DOM/subsurface temperature established for these sediments<sup>8</sup>. Other Mesozoic sediments<sup>9</sup> 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<sup>0</sup>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 true-layer DOM. It is based on those DOM values that are believed to be reliable. In this connection it can be remarked<sup>10</sup> 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

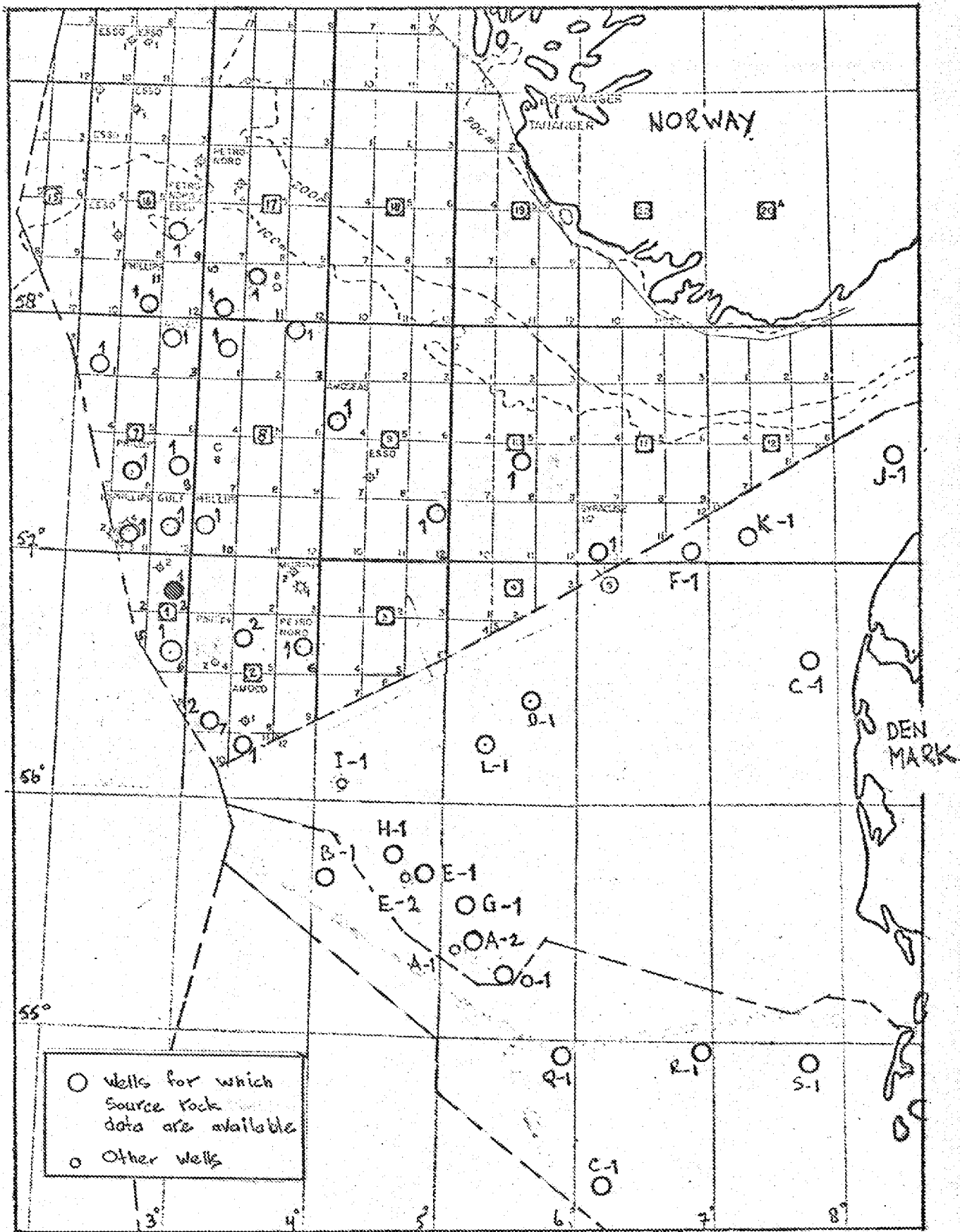
Interval 5900 - 10158 ft (Miocene to Paleocene) contains source rocks for oil. The base of this interval has been picked on the evidence of gamma ray intensity. The relatively high source rock indications for the cuttings from just below this interval have been assumed to refer to caved source rock matter.

The interval from about 1400 ft to 5900 ft (Pleistocene to Miocene) probably also contains source rocks (for gas). This is likely in view of the high gamma ray intensity of this interval and is evidenced by the high source rock indications obtained for a few samples from this interval.

The zone of possible oil generation or cooking pot at the location of well 1/3-1, based on the levels of compatible DOM 60 and 75, is between 10500 ft and about 14000 ft.

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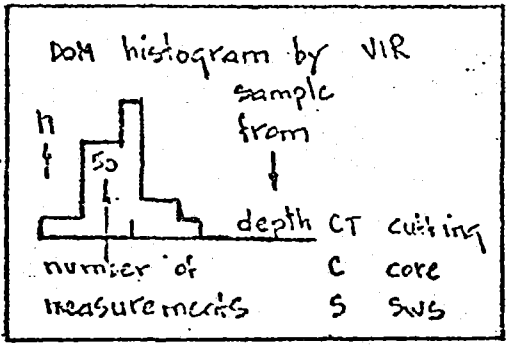
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LOCATION MAP

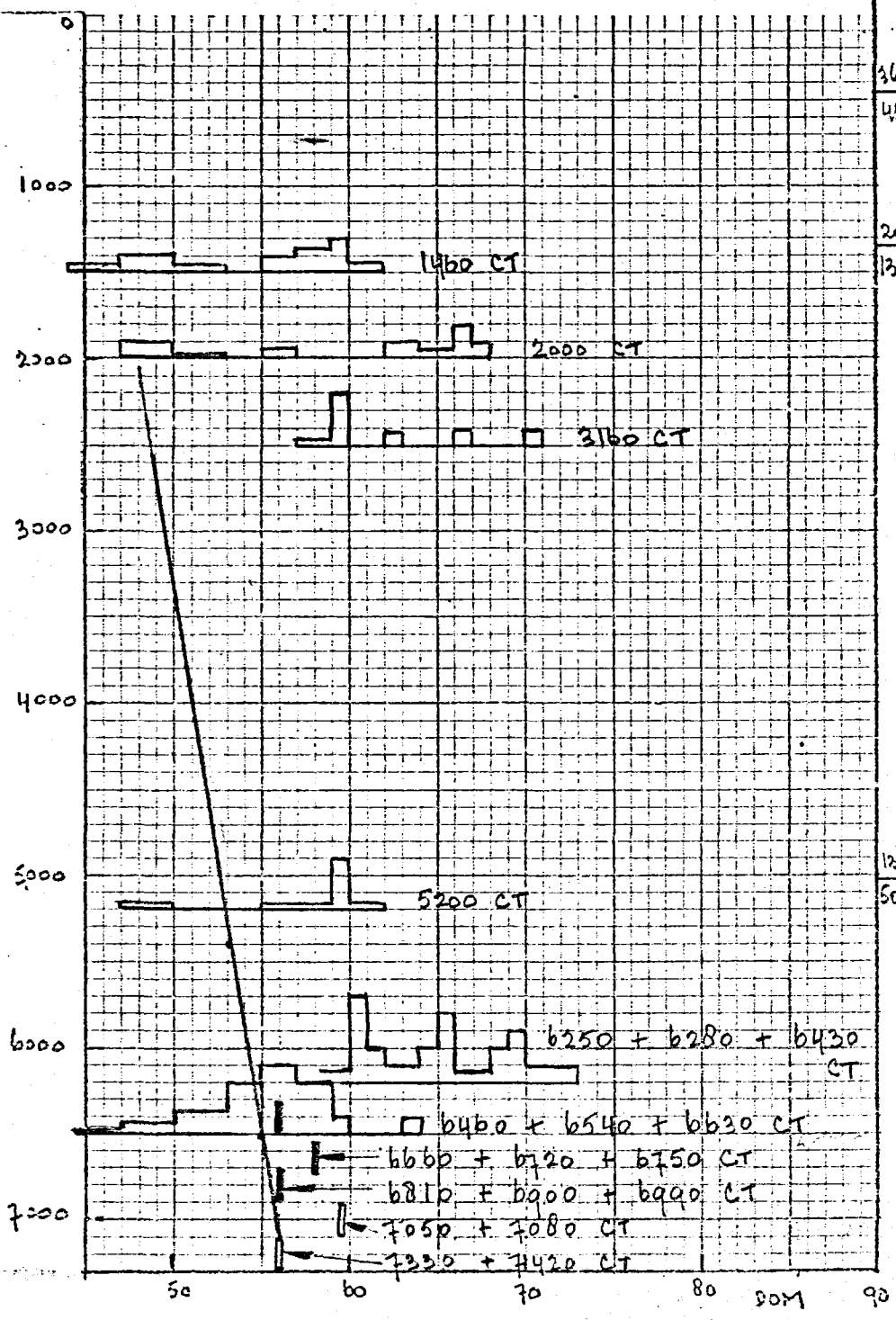


Age	Formation Grp. Mbr.	Depth, 'ft bdf
		At 2070, 4150, 4450 and 4930 vitrinite is not present.
	sea bottom	
Q P5		
P1		
T		
M1		



Casing shoe

317



36"

4.8

20"

1338

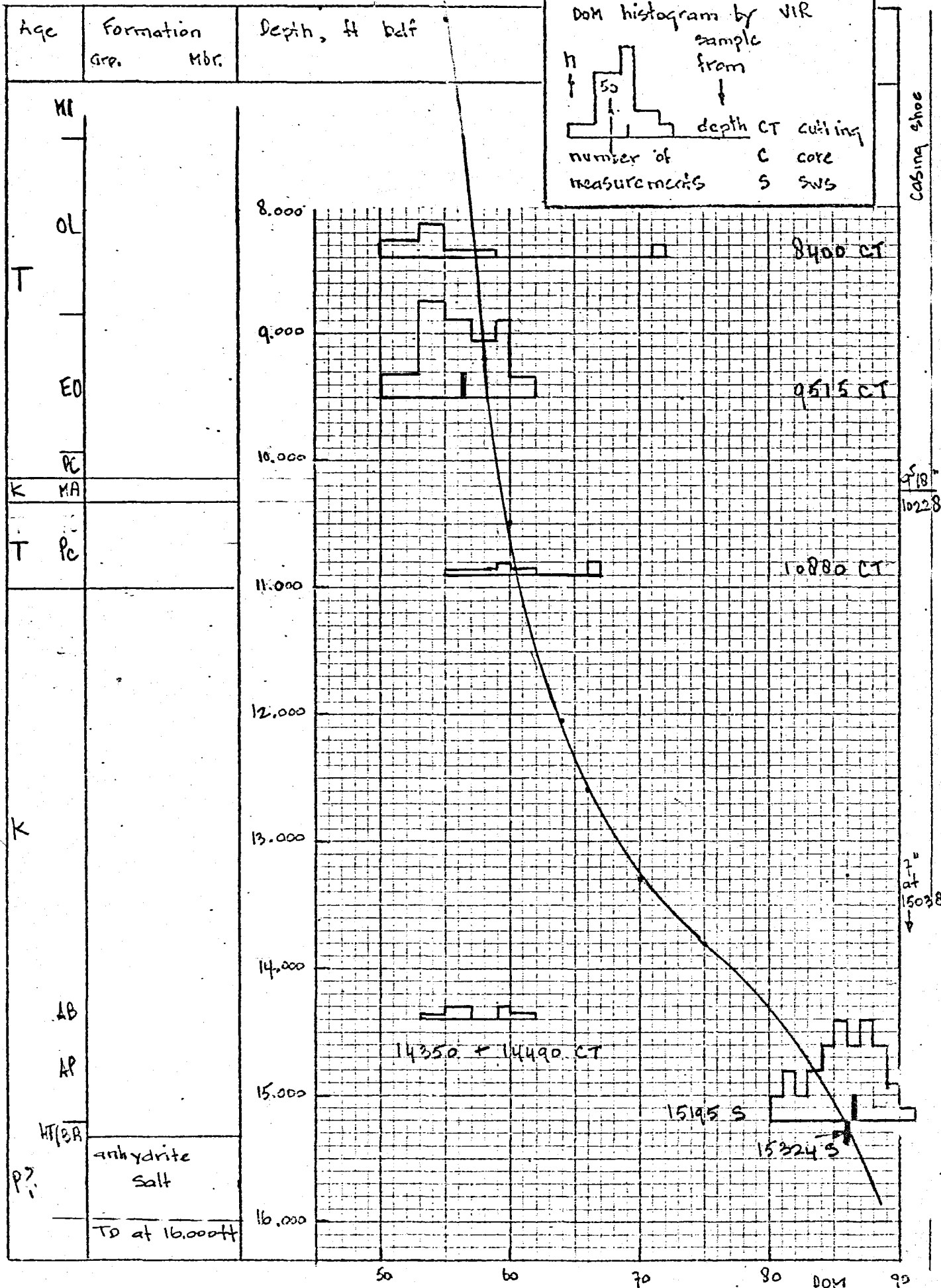
1878"

504

FIG: 2 . a

(continued)





DOM AS A FUNCTION OF DEPTH, WELL 1/3-1

FIG: 2 b

DOM BY MEASUREMENT OF VITRINITE REFLECTANCE

Country: NORWAY

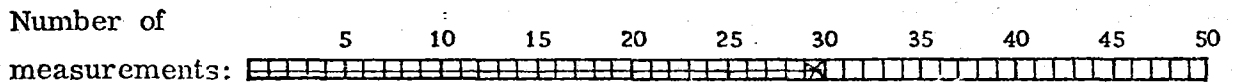
Well : 1/3-1

depth : b660 + b720 + b750

DOM: 58

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.



Analist : FHS

Relative reflectance [diamond = 100]

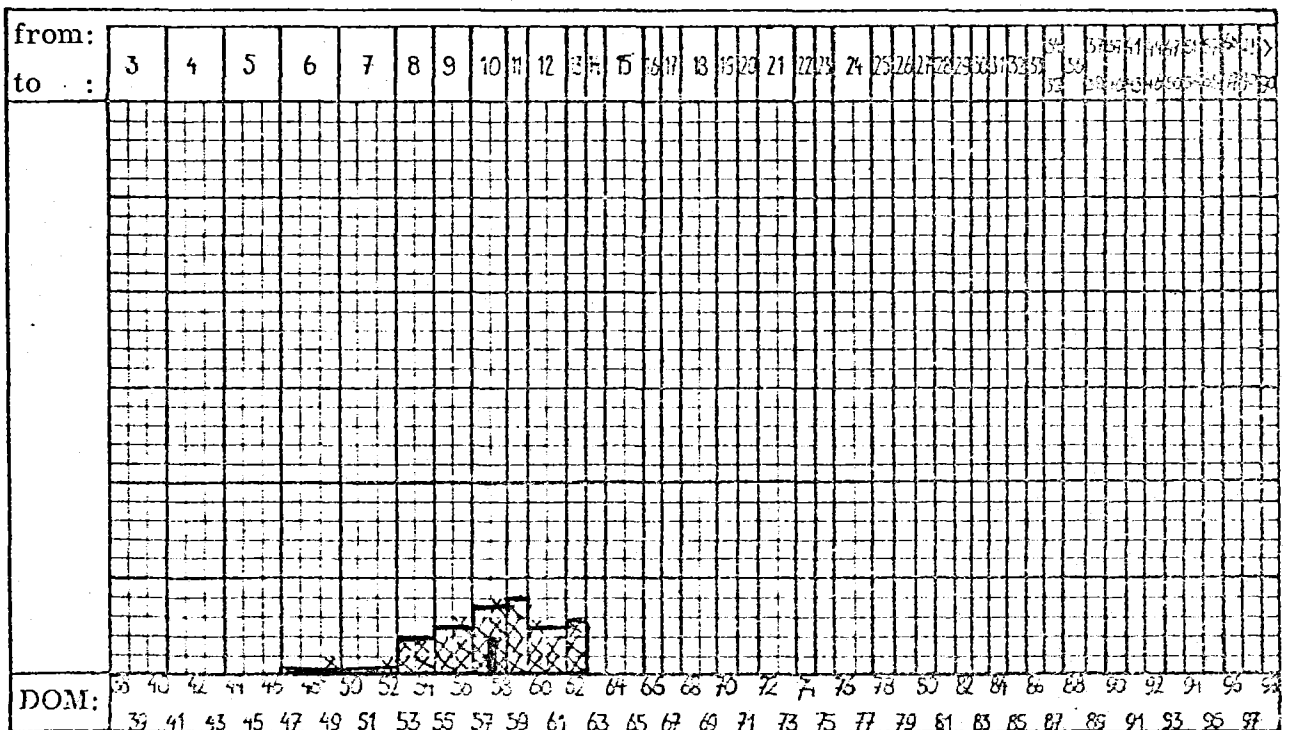


Fig. 3

DOM BY MEASUREMENT OF VITRINITE REFLECTANCE

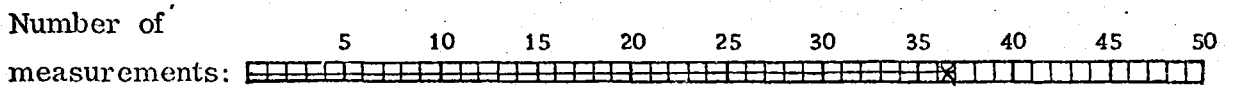
Country: Norway

Well : 1/3-1

depth : b810 + b900 + b990 (2x) 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.



Analyst : FVS

Relative reflectance [diamond = 100]

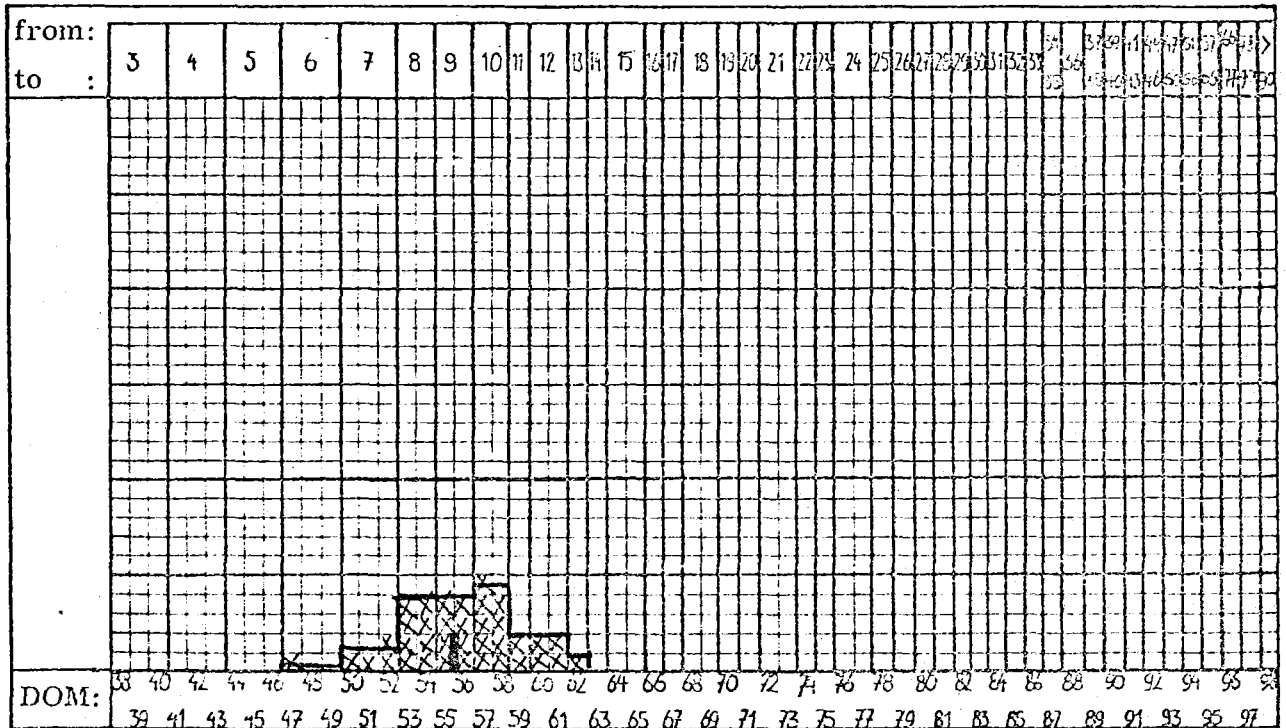


Fig. 4

DOM BY MEASUREMENT OF VITRINITE REFLECTANCE

Country: Norway

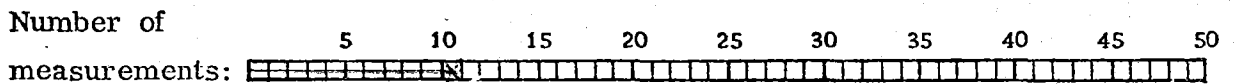
Well : 1/3-1

depth : 7050 + 7080 ft

DOM: 59 ?

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.



Analist : Fhs

Relative reflectance [diamond = 100]

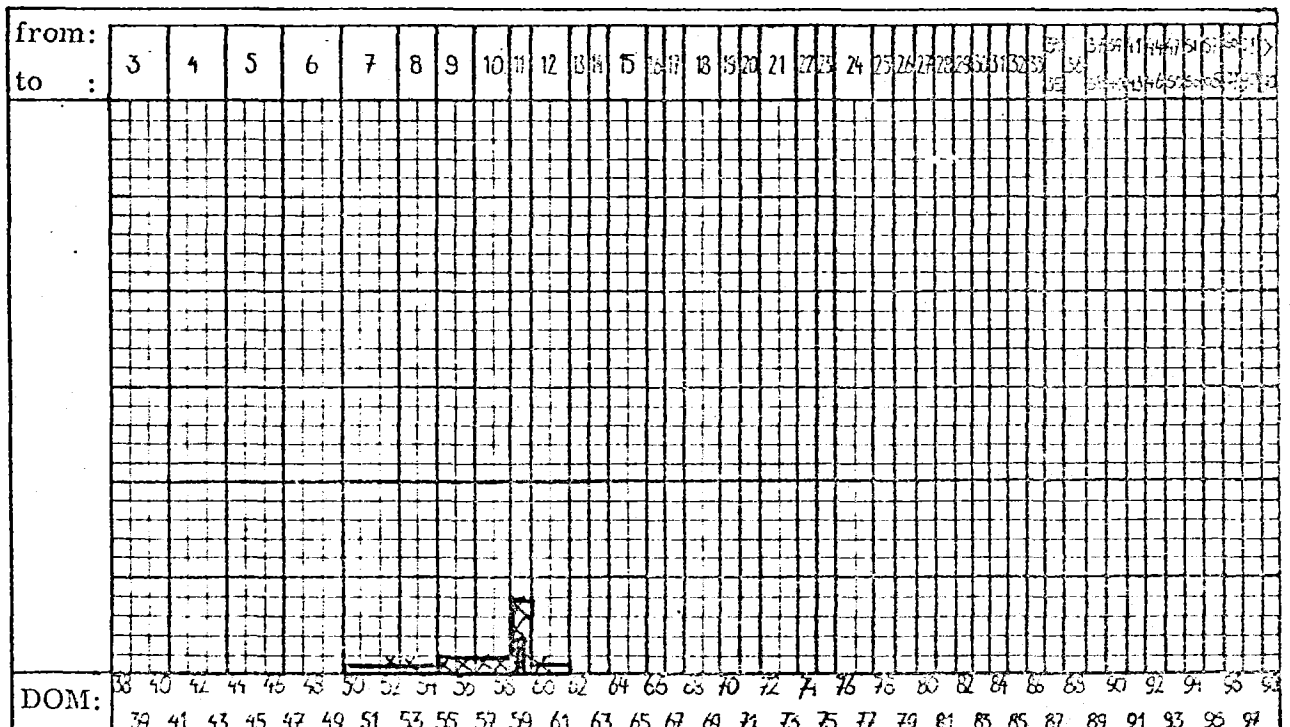


Fig. 5

DOM BY MEASUREMENT OF VITRINITE REFLECTANCE

Country: Norway

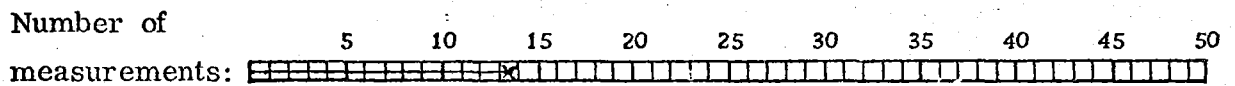
Well : 1/3-1

depth : 7330 + 7420

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.



Analist : Fhs

Relative reflectance [diamond = 100]

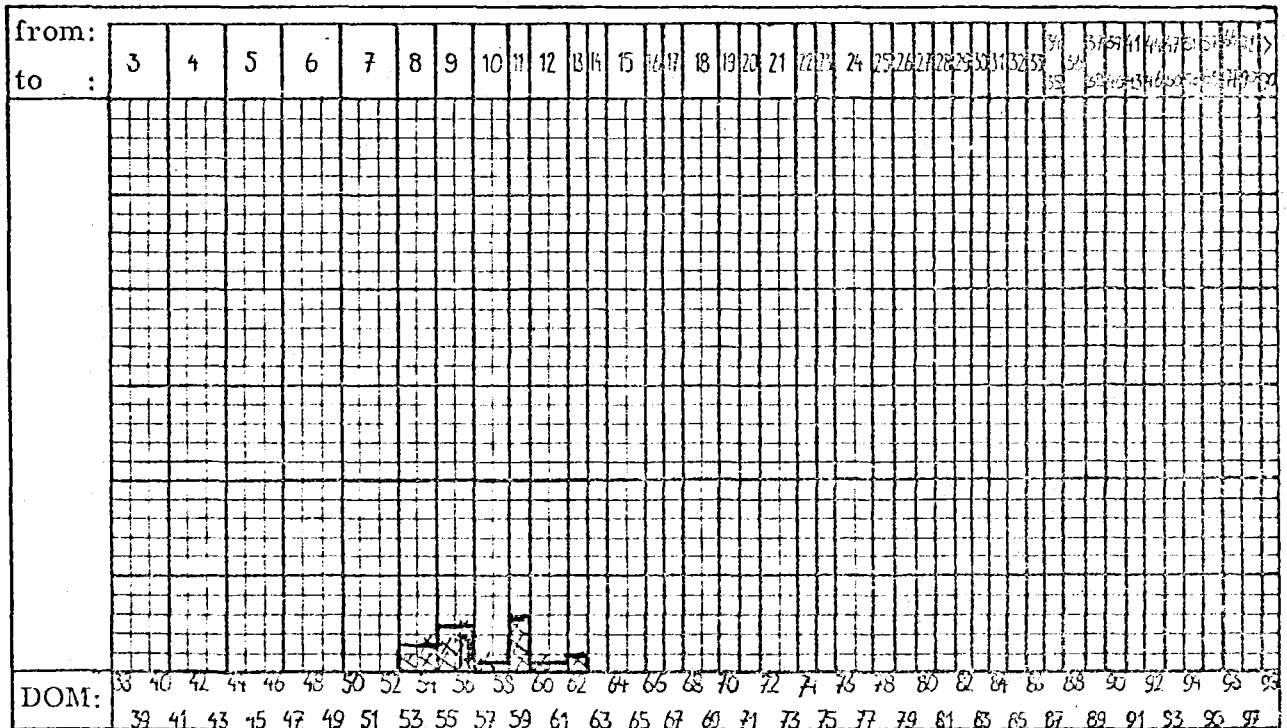


Fig. 6

DOM BY MEASUREMENT OF VITRINITE REFLECTANCE

Country: Norway

Well : 1/3-1

depth : 15324 Ft

DOM: 86

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 measurements: 50

Analist : abs

Relative reflectance [diamond = 100]

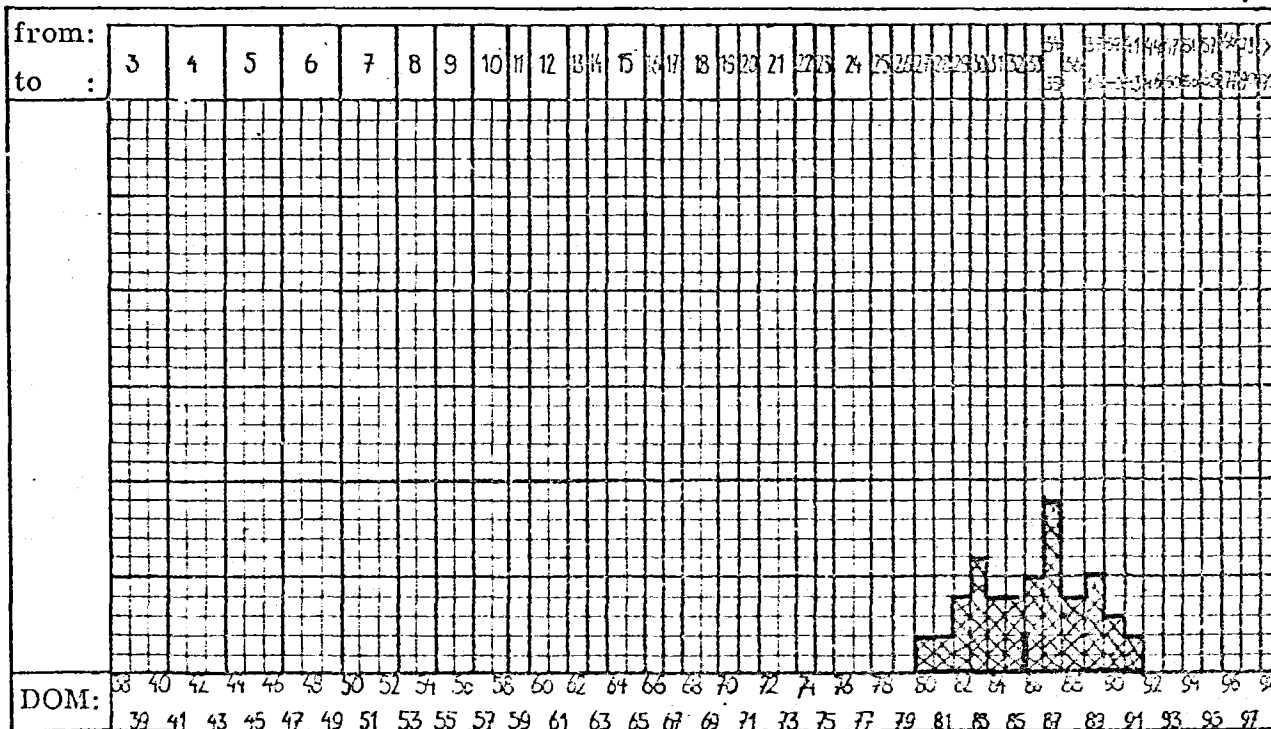
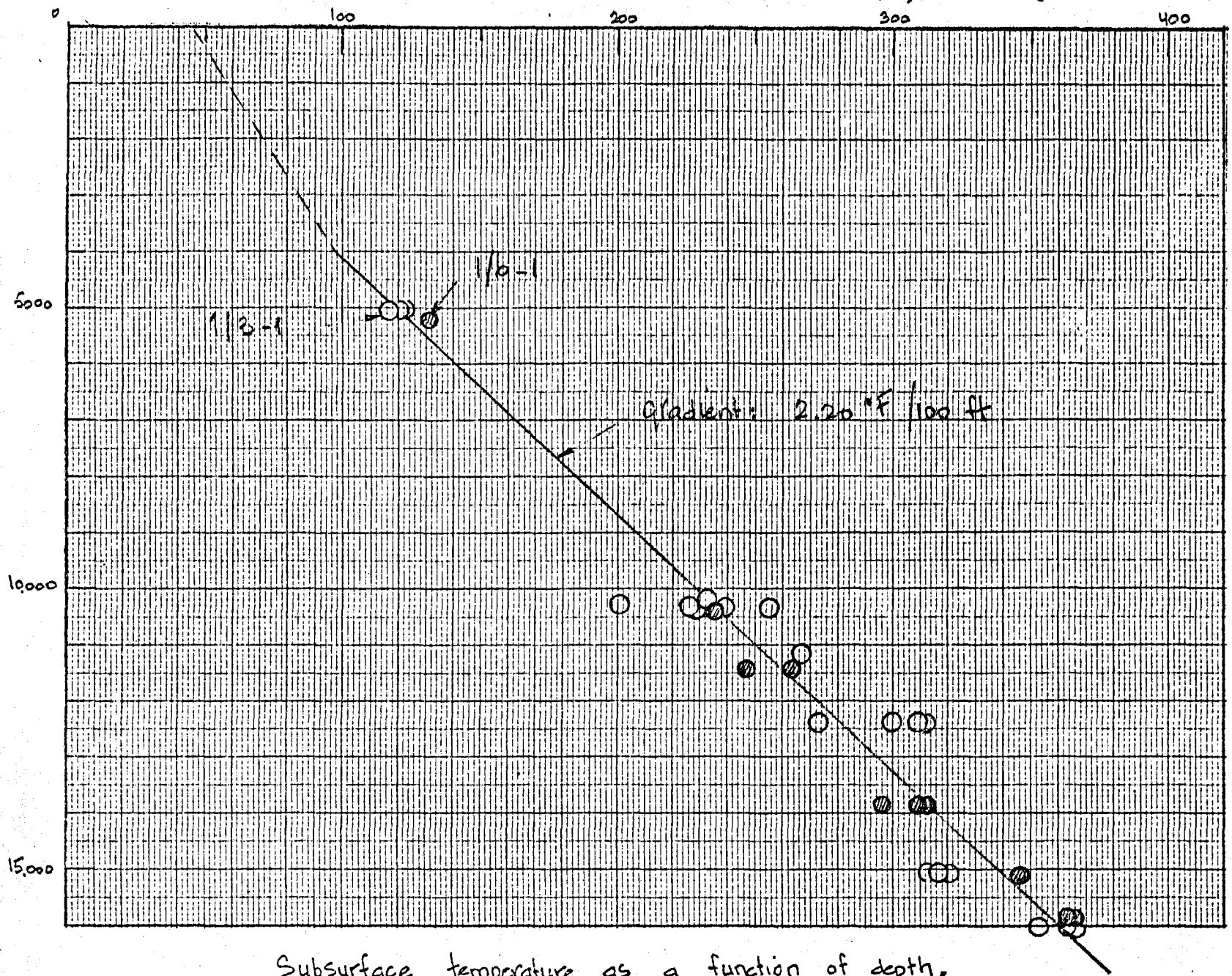


Fig. 7

Depth, ft

BHT OF, corrected (Middle East cor.)



Subsurface temperature as a function of depth.  
Wells 1/3-1, 1/6-1.

Fig: 8





