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## CONTINENTAL SHELF INSTITUTE

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REPORT TITLE/ TITTEL			
Headspace Isotope Analyses of well 6507/11-2.			
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### SUMMARY/ SAMMENDRAG

On the basis of isotope compositions ( $\delta^{13}\text{C}$  values), gas from mature sources is found in well 6507/11-2.

Other maturity parameters reveal that the well does not reach maturities high enough for such gas to be produced in situ and a migration of gases produced from a mature zone elsewhere is most likely.

### KEY WORDS/ STIKKORD

Mature Gas

Migration

Secondary Effects

6507/11-2

These isotope analyses are part of Source Rock Analysis on well 6507/11-2 (IKU report 0-470). The work was subcontracted to

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The report is authored by Dr. Schoell with minor technical changes and brief summary by IKU (see title page).

## 1. INTRODUCTION

Isotope analyses on head space methane allows one to estimate the maturity regime of a drilled section (Schoell 1981). This report compiles  $^{13}\text{C}/^{12}\text{C}$  isotope analyses on methane from well 6507/11-2 in the Haltenbanken area.

## 2. SAMPLES

Eleven canned cuttings were submitted for analysis. The cans were partly very corroded (rusty) and had little or no head space gas remaining. Some of the cans contained too much water. The status of the cans is noted in the tables.

## 3. ANALYTICAL TECHNIQUE

The cans are homogenized by rolling them for one hour. Head space gas was extracted by expanding the gas to a vacuum which is the inlet volume of the GC. Methane was separated from air by gas-chromatography and was oxidized to  $\text{CO}_2$  at the outlet of the GC by passing it over  $\text{CuO}$  at  $850^\circ\text{C}$ .  $^{13}\text{C}$  was determined by mass-spectrometry;  $\delta$ -values are reported against PDB standard.

$$\delta = \left( \frac{R_{\text{sample}}}{R_{\text{standard}}} - 1 \right) \times 1000 (\text{‰})$$

## 4. RESULTS

The results are listed in Table 1 and are graphically displayed in Fig. 2. Unreliable results due to quality of cans have been omitted.

## 5. INTERPRETATION OF RESULTS

### 5.1 General background

The genetic interpretation of the results follows the general genetic characterization of natural gases (1) which is reproduced in Fig. 1 for easier reference. The various genetic types of natural gases are often distributed in the sedimentary sequences in a characteristic zoning, which results from increasing maturity of organic matter. The following zones can be distinguished in an undisturbed sequence of increasingly mature sediments (see Figure 1 and 2).

Biogenic Zone ("B"): Immature, often unconsolidated sediments, dry gases of bacteriogenic origin,  $\delta^{13}\text{C}$  values of methane range from -80 to -60 ‰. Maturity of OM  $R_o \sim 0.5\%$ .

Mixing Zone ("M"): Transition zone between biogenic and mature zone. Here, often, mixing of biogenic and thermogenic gases is observed. Typical  $\delta^{13}\text{C}$  values of methane range from -60 to -50. Maturity of OM  $R_o \sim 0.5$  to 0.6%.

Thermogenic Zone ("T"): Principal zone of oil formation. Maturity of organic matter  $R_o \sim 0.7$  to 1.2%. Formation of oil and associated gas.

Overmature Zone ("TT(m)"): Principal zone of dry gas formation. Organic matter is overmature ( $R_o > 1.2$ ). Source rocks contain organic matter of Type II.

Coal Gas Zone ("TT(h)"): Mature to overmature zone. Typical isotope values of gases formed from coal of the mature to overmature stage are more positive than -30 ‰. Also high rank organic matter ( $R_o \sim 2.5\%$ ) of any type may form gases of this isotopic composition.

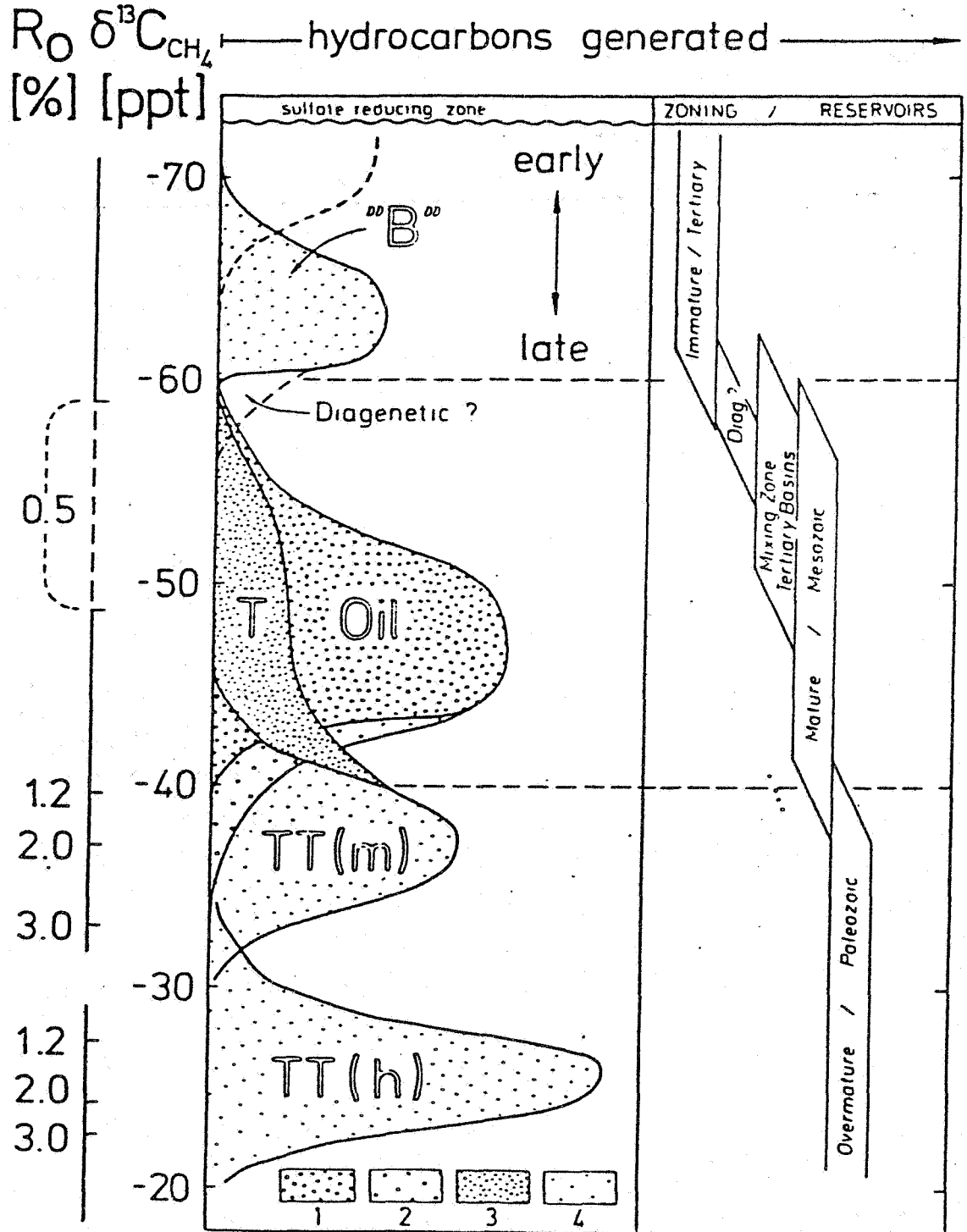
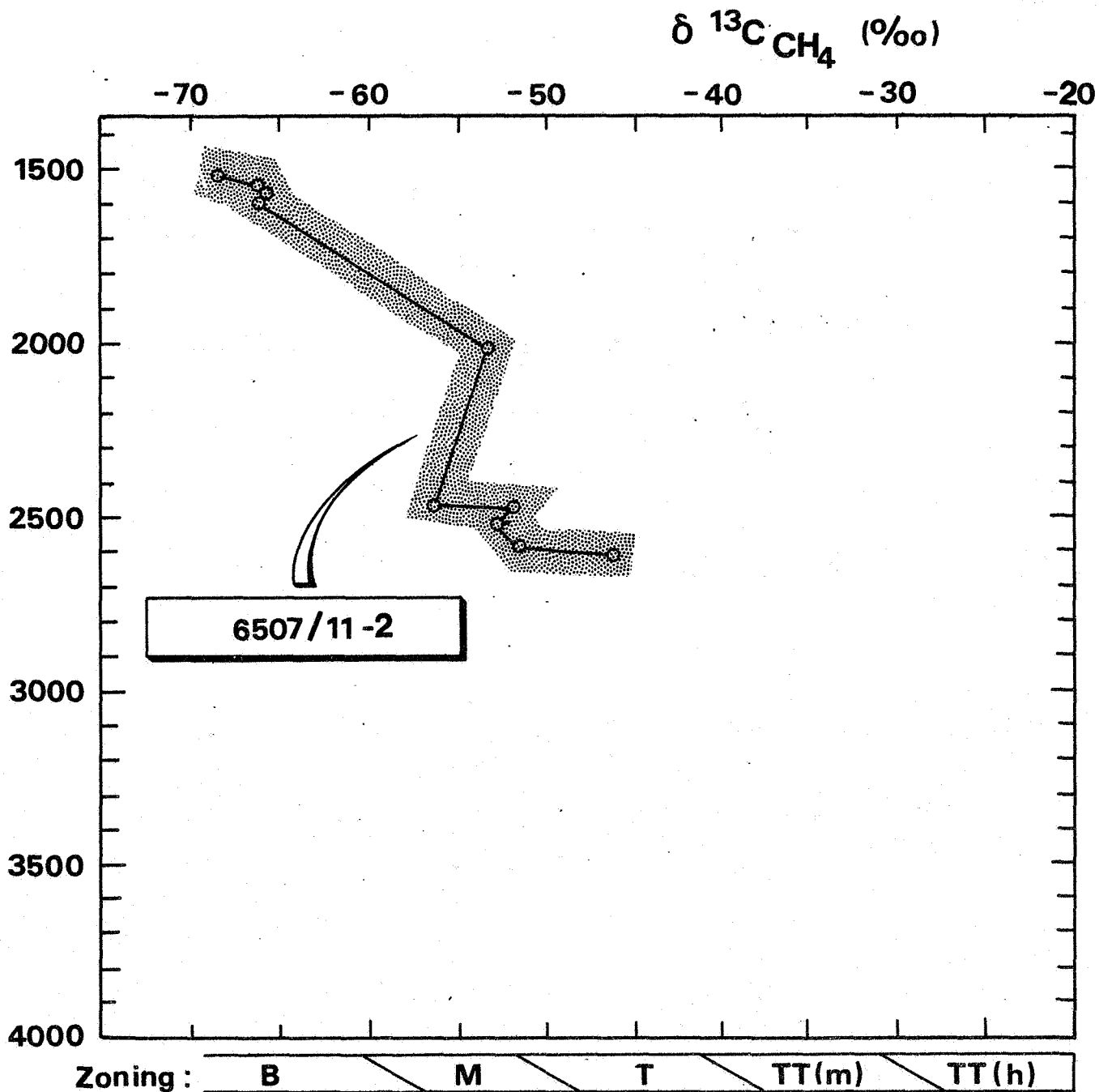


Fig. 1: Genetic characterization of natural gases

Fig.2



## 5.2 Secondary isotope effects in head space gases

Head space gases generally resemble reservoir gases in their isotopic composition (2,3). However, systematic isotope fractionations in different lithologies have been observed (3). Usually, pure sandy cuttings reveal a shift to positive  $\delta^{13}\text{C}$  values. Drilling additives may also influence the results. If cans are stored for lengthy periods after sampling, any methane present may become oxidized, or conversely methane may be bacterially formed. Because information on lithology and sampling is not available the following interpretation may have to be reviewed to account for these effects. Moreover all cans were more or less corroded. This could lead to gas loss and would cause unpredictable changes in the isotope values.

## 5.3 Evaluation of isotope measurements

There is a pronounced trend of the methane isotope values with increasing depth.

Between 1500m and 1600m depth the isotope values indicate biogenic gas formation. The isotope values indicate a mixed origin of the gases between 2000 and 2600m. One value at 2600m suggests a mature source. A concluding interpretation would require information on the maturity of the drilled section. The data from 6507/11-2 indicates the top of mature sediments at around 2500m. Similar changes have been encountered at Tertiary/Mesozoic boundaries in subalpine basins and in the North Sea. If secondary effects such as discussed above can be ruled out the deepest value would indicate thermogenic gas from a mature source. This gas could have migrated from below as it is often observed in the mesozoic of the North Sea.

## 6. CONCLUSIONS

The analyses reveal a pronounced increase of  $\delta^{13}\text{C}$  values in the head space methane. This indicates that gases from mature sources are either formed in situ or are migrated to the area. The results show a smooth change of isotope values with depth.

## 7. SUGGESTION

The canned cutting head space technique has some disadvantages regarding sample preservation. Corrosion of the cans may cause severe changes in the isotopic composition. This cannot be ruled out for the cans in this study. Further sampling should be performed with vacutainers which allow easy sampling and shipping and storage of samples without secondary changes.



Table 1: Results of isotope analyses on head space methane well 6507/11-2:

IKU No.	Depth m	$\delta^{13}\text{C}$ (‰)	Remarks <sup>1)</sup> on can	
1	M-5100	1520 - 1530	-68.1	1
2	M-5102	1540 - 1550	-66.4	1
3	M-5104	1560 - 1570	-65.9	1
4	M-5106	1580 - 1590	-66.4	1
5	M-5152	2012 - 2021	-53.2	7
6	M-5154	2030 - 2039	(-34.6)	7
7	M-5202	2462 - 2471	-56.1	1
8	M-5204	2480 - 2489	-51.7 <sup>2)</sup>	1
9	M-5208	2516 - 2525	-52.8	7
10	M-5216	2588 - 2597	-51.1	1
11	M-5218	2606 - 2615	-45.9	1

1) Quality of can:

1 good can, 2 leakage, 3 filled with water, 4 no head space gas,  
5 small head space gas, 6 open can, 7 corroded can.

2) Two cans A + B have been delivered and were analysed with  $\delta^{13}\text{C}$   
values for A = - 52,8 and B = -50,6 ‰ respectively. Value in  
the table is the mean.

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