1323

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# IKU

Continental Shelf Institute

Institutt for kontinentalsokkelundersøkelser

| REPORT TITLE | |
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| Source Rock Evaluation of Well 30/7 - 6. | |
| CONTRACTOR | |
| Norsk Hydro A/S | |
| CONTRACTORS REF.: Asbjørn Sæbøe | JOB. NO.: 0 - 65/1 |

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SUMMARY

KEY WORDS

Source Rock

# INDEX

Summary:

The well can be divided into seven zones on the backpround of the light hydrocarbon analyses. A: 1510 - 2550 m, B: 2550 - 2825 m, C: 2825 - 3325 m, D: 3325 - 3500 m, E: 3500 - 3625 m, F: 3625 - 3725 m and G: 3725 - 3775 m.

Zone A has a fair potential as a source rock for oil and gas. Non to moderate mature for the upper 500 m, the rest is mature. Zone B has a fair to good potential as a source rock. The EOM is chemically mature while spore coloration shows moderate maturity. Probably migrated oil in the shale and siltstone in the zone. Significant show at 2675 m. Zone C has a good potential as a source for oil and gas, otherwise as for zone B.

Zone D has a fair potential as a source rock and is chemically mature, but fairly low spore coloration (2.2 - 2.3). Zone E has a good potential as a source rock for oil and gas. Again we find the EOM to be chemically mature, while spore coloration shows moderate maturity.

Zone F has a large abundance of dry gas. The zone has a good/rich potential as a source and is mature. Possibly migrated oil in the shales at 3600 m. Zone G has a rich potential as a source rock and is mature.

The differences in maturity by optical and chemical analyses indicate contamination from hydrocarbons migrated into the shales.

The oilwindow starts at approx. 3000 m, and the vitrinite reflectance shows a good gradient for the well with a maximum of 0.85 at 3725 m.

## EXPERIMENTAL

The samples were washed with temperated water on a 0,125 mm sieve to remove drilling mud and thereafter dried at 35 $^{o}$C. The samples from 2325 - 2550 had a distinct smell of diesel, and these samples were also washed in benzene and methanol to remove the diesel.

## LIGHT HYDROCARBONS

Aliquotes of the samples were dried at room temperature after washing, and sieved. The cuttings with grain size between 1 and 2 mm were used for light hydrocarbon determination. The cuttings were treated with 6N HCl in a closed evacuated system, thereafter flushed with water and the released gas analysed by gaschromatography. The results are shown in Table I.

## TOTAL ORGANIC CARBON (TOC)

The samples which had variation in lithology were sorted, and aliquotes of the different lithologies were crushed to a grainsize of 0,063 - 0,125 mm. The crushed samples were then treated with 6N HCl and analysed on a Leco WR 12 carbon analysator. (Table II).

## EXTRACTABLE ORGANIC MATTER (EOM)

From the light hydrocarbon and TOC results, samples for extraction were chosen, and extracted with dichloromethane (DCM) on soxhlets for 48 h. (Table III).

## CHROMATOGRAPHIC SEPARATION

The EOM were separated on columns packed with 2/3 siliza and 1/3 alumina, by eluting with hexane, benzene and methanol. (Table III). The saturated fractions were analysed gaschromatographic on a 25 m glas capillary column, using a Carlo Erba FV 2150 chromatograph. The different measurements from the gaschromatograms are shown in Table VII.

VITRINITE REFLECTANCE

Upon receipt, the cutting samples were soaked in warm water and sieved through 72 mesh to remove drilling mud. After oven drying at 40 $^{o}$C, the cuttings were mounted in Bakelite resin blocks; care being taken during the setting in the plastic to avoid temperatures in excess of 100 $^{o}$C. The samples were then ground, initially on a diamond lap followed by two grades of corundum paper. All grinding ond subsequent polishing stages in the preparation were carried out using isopopyl alcohol as lubricant since water leads to the swelling and disintegration of the clay fraction of the samples.

Polishing of the samples was performed on Selvyt cloths using three grades of alumina, 5/20, 3/50 and Gamma, followed by careful cleaning of the surface.

Reflectance determinations were carried out on a Leitz M.P.V. microphotometer under oil immersion, R.I. 1,516, at a wave-length of 546 nm. The field measured was varied to suit the size of the organic particle but was usually of the order of 2 micron diameter.

The surface of the polished block was searched by the operator for suitable areas of vitrinitic material in the sediment. The reflectance of the organic particle was determined relative to optical glass standards of known reflectance. Where possible, a minimum of twenty individual particles of vitrinite was measured although in many cases this number could not be achieved. The search for vitrinitic material was maintained for approximately 45 minutes on each sample before termination if the operator considered that no more vitrinitic particles were likely to be located.

## SPORE COLORATION

Samples for spore coloration were chosen amongst those used for biostratigraphic analyses (palynology) at IKU. Samples are from 2600 m, and especially from around 3300 m.

Maturity of the individual samples was determined by visual estimation of the colours of pollen, spores, cuticles, wood remains, and finely dispersed organic matters.

The colour tones are given according to Staplin's index (Staplin, F.L. 1969: Sedimentary organic matter, organic metamorphism, and oil and gas occurence. Bull. Canad. Petr. Geol. 17(1), 47-66).

The thermal alteration index indicates by 1(fresh yellow) - no alteration, 2(brownish yellow) - slight alteration, 3 (brown) - moderate alteration, 4 and 5(black) - strong to severe alteration.

## RESULTS AND DISCUSSION

### LIGHT HYDROCARBONS

From the light hydrocarbon data we can pick out seven zones, A: 1510-2550 m, B: 2550-2825 m, C: 2825-3325 m, D: 3325-2500 m, E: 3500-3625 m, F: 3625-3725 m and G: 3725-3775 m.

A: 1510-2550 m. The top 400 m, down to 1900 m, the $C_1$-$C_4$ hydrocarbons fall around 200 $\mu$l gas/kg rock, and it is a dry gas. From 1900 m the $C_1$-$C_4$ hydrocarbon abundance increases and has a maximum of approx. 2000 $\mu$l gas/kg rock at the base of the zone. From 1900 m down to the base of the zone the wetness increases.

B: 2550-2825 m. The $C_1$-$C_4$ hydrocarbon abundance in this zone is higher than in zone A, with 2575-2650 m as the richest part, approx. 4000 $\mu$l gas/kg rock. The gas here is wetter than zone A, with 22.5% wetness at 2625 m as the wettest.

C: 2875-3325 m. The $C_1$-$C_4$ hydrocarbon abundance vary a lot in this zone (Fig. 1). In this zone we have a mixed lithology of shale and siltstone, and the variation in gas abundance in the samples may come from different relative amount of the two lithologies in the samples. On the whole, $C_1$-$C_4$ hydrocarbons in zone C are less abundant than in zone B, and it is a drier gas.

D: 3325-3500 m. This zone has a larger abundance of $C_1$-$C_4$ hydrocarbons than zone C, and the gas is wetter. With exceptance of 3400 m, the samples are quite rich in $C_1$-$C_4$ hydrocarbons, 4400-6400 $\mu$l gas/kg rock.

E: 3500-3625 m. In this zone we again find a poor amount of $C_1$-$C_4$ hydrocarbons, mostly less than 1000 $\mu$l gas/kg rock. The gas is wetter than in zone D, with a maximum wetness of 22.2% at 3525 m.

is dry. We find a peak at 3700 m where we have a shale and limestone lithology.

G: Fair content of wet gas. We understand from the bio-stratographic group that we are in the Jurassic in this zone.

TOTAL ORGANIC CARBON

Total organic carbon analysis were done on all samples, and where there were significant amounts of different lithologies, TOC was measured on the different lithologies (Table II).

A: 1510-2550 m. The TOC for the shale in the upper 150 m is quite high (2-3%), but it decreases towards the bottom of the zone, to 1-1.5%. The sandstone stringers at 1800-1925 m have a TOC value of 0.1-0.25%, and a TOC value of 0.2% is quite high for quartz sand. This could indicate a possible oilshow. The limestone at 2400 m has a TOC of 0.9%. Again this is quite high for limestones at such a level.

B: 2550-2825 m. This zone contains mainly siltstone and shale, and for most of the samples it was very difficult to pick the different lithologies, and a mixture of shale and siltstone has been analysed. The samples from 2750-2850 m could be separated into two lithologies by using larger than 2 mm cuttings, care being taken that cavings were avoided. The siltstone samples have a TOC value of approx. 0.6% which is fairly high, and the shale samples are very rich, 2.0-4.2%. These results indicate that we here will have a very rich source rock or that hydrocarbons have migrated into the shale/siltstone sequence.

C: 2825-3325 m. This zone is very similar to zone B, with mainly shale/siltstone lithology. The shale and siltstone are analysed together since it was not possible to separate them. The TOC values at the top of the zone is approx. 2%, but decreases all the way towards the bottom of the zone with an average value of approx. 0.6%. The sample at 3325 m is again very rich, but we suspect this is from drilling mud additives as lignosulphonate. Generally there were a lot of coaly particles in some of the samples, and we have assumed that these are drilling additives.

Zone D: 3325-2500m, E: 3500-3625 m and F: 3625-2725 m all have a low TOC value of approx. 0.5%. There are relatively small variations between the different samples in these zones.

Zone G: 3725-3775 m. In this zone we again get a sharp rise in the TOC value with 3775 m at 2.06%.

EXTRACTABLE ORGANIC MATTER AND CHROMATOGRAPHIC FRACTIONS

From the TOC and light hydrocarbon analysis samples for extraction were picked. Generally there was a bad recovery of cuttings from 2700 m to the base of the well, and from 2900 m the samples had to be divided between organic geochemical analysis and biostratographic analysis. Because of these factors, some of the samples which gave high TOC values could not be analysed since there was no material left. Examples of this is 3425, 3525 and 3675 m. Samples from nearby levels were analysed instead.

Zone A has a fair potential as a source for oil and gas, 1510-2000 m is non to moderate mature while 2000-2550 m is mature.

Zone B has a good potential as a source for oil and gas. Traces of oil might have invaded the shales and siltstones in this interval. Significant show at 2625 m. The whole sequence consists of shale and siltstones which were difficult to pick out from each other. Because of this the most of the samples analysed were a mixture of shale and siltstone.

In the samples from 2750 m, 2775 m, 2800 m, 2825 m and

2850 m in zone B the different lithologies could be picked with using 2-4mm cuttings. In this sequence pure shale samples are extracted. For comparison the siltstone from 2825 m was also extracted. The saturated fraction from this sample correlates quite well with the shale samples from 2750-2850 m and also with the oilshow at 2625 m.

The $C_{15}+$ abundance is higher than would be expected in view of the amount and type of organic matter which these sediments contain. HC constitutes a high proportion of EOM for sediments of these levels of thermal maturation. All of this indicates non source hydrocarbons. Together with the knowledge that diesel was not added to the mud at these levels we assume that crude oil has migrated into the shale and siltstone at these levels. The saturated extract both from the shales and siltstone contains mainly heavy end n-alkanes which indicate a waxy oil.

Zone C has a good potential as a source rock, and it is mature. For the interval 2825-3025 m goes very much the same as for zone B, with migrated oil in the shale and siltstone. Some of the samples in this zone and in the underlying zones contained significant amounts of a coal-like material. This was put down as a drilling mud additive and care was taken to remove this from the samples. But some of this additive might have been left in the sample, and in that way contaminated it, and this will then affect the results. On the whole we do not think the contamination contribute with a large factor to the results.

Zone D. This zone has a fair potential as a source, and it is mature. Very small variations over the zone.

Zone E and F have a good and a good to rich potential as a source respectively, and are well matured. Traces of oil may have migrated into the shales at 3600 m.

Zone G has a rich potential as a source and is well matured.

F: 3625-3725 m. This zone has got the largest abundance of $C_1$-$C_4$ hydrocarbons with a peak of 31000 $\mu$l gas/kg rock at 3700 m. The gas in this zone is drier than in zone E, with 8.8% wetness at 3700 m.

G: 3725-3775 m. In this zone we again find a lower abundance of $C_1$-$C_4$ hydrocarbons than zone F, and again the wetness of the gas increases to approx. 20% wetness.

SUMMARY FROM $C_1$-$C_4$ HYDROCARBON ANALYSIS

A: Insignificant amounts of gas from 1510-1900 m. From 1900 m the $C_1$-$C_4$ hydrocarbon abundance is larger than 200 $\mu$l/kg rock and will in this sequence be classified as poor and poor/fair. (K. Le Tran, 1975). The gas wetness also improves in this sequence.

B: Fair and fair/good content of wet gas. Here we have stringers of siltstones which might contain migrated hydrocarbons. The best gas values are at the top of the zone, 2575-2650 m.

C: Zone C has very much the same lithology as zone B. The $C_1$-$C_4$ hydrocarbon abundance vary a lot in this zone, which might be because of variation in lithology in the analysed samples. On average the zone must be classified as poor/fair.

D: Good content of gas. The sample at 3425 m has a poor quantity of $C_1$-$C_4$ hydrocarbons, but this might be because of the same reasons as the large variation in zone C.

E: Poor content of wet gas. The lithology here changes into mainly shale, and this gives a sharp change in the $C_1$-$C_4$ hydrocarbon abundance. This again should indicate that the siltstone in the overlying zones contains migrated hydrocarbons.

F: Good content of dry gas. This zone has the largest abundance of $C_1$-$C_4$ hydrocarbons in the whole well. The gas

## VITRINITE REFLECTANCE

Samples taken over the whole well (1510 - 3775 m) were sent to Geoconsultants, Newcastle for vitrinite reflectance measurements. Generally it was a very difficult well to analyse, and the additive made things rather awkward since it seemed to be very variable in reflectance with some, possibly heat-affected or chemically altered material. Most of the organic material present was reworked with a very low indigenous content. Together with the actual vitrinite reflectance measurements we also get some other information, and in the following we will discuss each sample.

1510 m: Shale and carbonate, Ro = 0,43.
The sample has a low organic content with a few particles and wisps of vitrinite and inertinite. It was rather corroded. UV light shows a yellow fluorescence from spores and a low to moderate exinite content.

1800 m: Mixed shale plus limestone, Ro = 0,31 and Ro = 0,51.
The sample has a low organic content with a few low reflectance vitrinite wisps and particles. A lot of small wisps which are unmeasureable. No inertinite recorded. UV light shows a yellow and orange fluorescence from spores. A lot of dull reworked spores and a low exinite content.

2000 m: Pyritic mixed shale, Ro = 0,33 and Ro = 0,74.
The sample has a low organic content with a few particles of bitumen and vitrinite and a little inertinite. A good deal of bitumen staining and wisps. UV light shows a green/yellow fluorescence from spores, and a moderate exinite content.

2200 m: Shale and limestone, Ro = 0,35.
The sample has a low to moderate organic content. The limestone is barren and the shale has small particles and wisps, mostly of reworked material. UV light shows a yellow and orange fluorescence from spores, and a low exinite content.

2400 m: Mixed shale lithologies plus limestone. Ro = 0,47 and Ro = 0,76.
The sample has a low to moderate organic content. The limestone is barren and the shale has small gnarled particles and wisps of vitrinite plus reworked material. UV light shows a yellow/orange fluorescence from spores and fragments, and a low exinite content.

2500 m: Shale and limestone, Ro = 0,49.
The sample has a moderate organic content with small particles and wisps of vitrinite and reworked material. Some good wisps. UV light shows a yellow and orange fluorescence from spores plus possible hydrocarbon traces. A trace of exinite.

2600 m: Shale, Ro = 0,45, Ro = 0,59 and Ro = 1,45.
The sample is very low in organic content with a few wisps, plus particles, of vitrinite and reworked material. The high Ro is from reworked material. UV light shows an orange fluorescence from spores and a trace of exinite.

2700 m: Mixed shale lithologies and carbonate, Ro = 0,21 and Ro = 0,71.
The sample has a low to moderate organic content. The additive has two reflectance levels, Ro = 0,30 and Ro = 1,38. Small gnarled high relief particles of vitrinite and inertinite. UV light shows an orange fluorescence form spores and a trace of exinite. No true material is considered to be present.

2900 m: Shale, coal, limestone and cement, Ro = 1,14 and Ro = 3,12.
The limestone is barren while the shale has a low to moderate content of small, gnarled particles of reworked material. The measurements are wholly on reworked material. The coal is an additive with Ro = 0,36. UV light shows orange fluorescence from spore fragments and a trace of exinite.

3000 m: Limestone, Calcareous Shale and Coal. Ro = 0,51,

Ro = 0,93 and Ro = 1,43.
The limestone is barren while the shale has a low to moderate organic content with small particles of reworked material. The coal is an additive with large variation in reflectance, Ro = 0,35, Ro = 0,63 and Ro = 0,89. UV light shows a dull orange fluorescence from spores and a trace of exinite.

3100 m: Mixed shale lithologies and limestone, Ro = 0,49 and Ro = 0,87.
The sample has a low organic content with a few particles of coal (additive). A few gnarled particles of inertinite and vitrinite, some reworked. UV light shows a rather dull orange fluorescence from spores with a low exinite content.

3175 m: Shale, coal and limestone, Ro = 1,09.
The limestone is barren while the shale has a low to moderate organic content with a few small particles of reworked material. The coal is additive with Ro = 0,37 and Ro = 0,91. UV light shows no definite organic fluorescence, and no exinite content, but possible hydrocarbon traces.

3300 m: Chert and shale, Ro = 0,85.
The sample shows only a trace of organic material and is virtually barren with a few gnarled particles. No organic fluorescence in UV light.

3400 m: Mixed shale, chert and limestone, Ro = 0,71 and Ro = 0,98.
The sample has a low organic content with a few isolated corroded particles in shale. No good wisps. The organic could be reworked. UV light shows three orange fluorescing spores located in one cutting, possibly cavings. Only a trace of exinite.

3500 m: Shale & chert, Ro = 0,65.
The sample has a low organic content with small gnarled particles of intertinite plus reworked material.

Only a trace of true material. UV light shows a dull orange fluorescence from spores and a low exinite content.

3575 m: Mixed shale lithologies plus coal. Ro = 0,45 (cavings), Ro = 0,77 and Ro = 1,16.
The sample has a low to moderate organic content with a few small gnarled particles of vitrinite. The coal is additive with two reflectance levels, Ro = 0,36 and Ro = 1,32. UV light shows a deep orange fluorescence from spores and a low exinite content.

3650 m: Chert and shale, Ro = 0,30, Ro = 0,75 and RO = 1,11.
The sample has a low organic content and it is restricted to the shale. A few small gnarled particles, nearly all inertinite plus reworked. No definite organic fluorescence.

3725 m: Shale and chert, Ro = 0,85.
The sample has a low to moderate organic content with gnarled particles of reworked material and inertinite. Some possibly true material. UV light shows an orange fluorescence from spores and a trace of exinite.

3775 m: Mixed shale lithologies plus coal, Ro = 0,78 and Ro = 1,15.
The sample has a low organic content except for the additive.
Coal: two rank levels, Ro = 0,39 and Ro = 1,02. The upper level is slightly vesiculated (heat affected).
Shale: Virtually barren, slight bitumen staining plus a few gnarled particles. UV light shows a deep orange fluorescence from spores and a low exinite content.

Altogether the top and the bottom of the series analysed are reasonable, but the middle is very poor. There seems to be a good gradient from appr. 0,3 at 1800 m to appr. 0,8 at the bottom. The fluorescence from the spores agree with the vitrinite reflectance gradient.

## SPORE COLORATION

No samples were treated and analysed for palynofossils in zone A.

In zone B, samples from 2600 to 2805 m show indexes of 2.1 - 2.3.

In zone C, samples from 2925 - 3300 m show indexes of 2.1 -2.2.

Zone D gives and index of 2.2 - 2.3 while zone E has an index of 2.2. The index increases slightly in zone F, with 3625 m at 2.3 and 3700 m 2.3 -2.4. The lowermost sample analysed, 3775 m, has an index of 2.3 - 2.4.

All the samples contains marine organic remains.

From the spore coloration data, we see only very small changes in the analysed sequences, and the readings of 2.1 - 2.4 indidate moderate maturity and a possibility of wet or dry gas facies.

## CONCLUSION

The well from 1510 - 3775 m can be divided into seven different zones based on light hydrocarbon analyses. A: 1510 - 2550 m, B: 2550 - 2825 m, C: 2825 - 3325 m, D: 3325 - 3500 m, E: 3500 - 3625 m, F: 3625 - 3725 m and G: 3725 - 3775 m.

1510-2550m Tert

Zone A has a fair potential as a source for oil and gas. The upper 500 m are non- to moderate mature while the rest is mature. The $C_1$-$C_4$ hydrocarbon abundance is very low for the upper 400 m and it is a dry gas. From 1900 m the gas abundance increases to fair.

2550 - 2825m Cret

Zone B has a fair to good abundance of $C_1$-$C_4$ hydrocarbons and the other analyses give this zone a good potential as a source for oil and gas. Traces of oil might have invaded the shales and siltstones in this zone. The $C_{15}$+ analyses indicate waxy hydrocarbons for the whole zone. A significant show at 2625 m. The chemical analyses show that the zone is mature. On the other hand, spore coloration shows low readings, 2.1 - 2.3 which would indicate a moderate mature source rock. This together with the $C_{15}$+ hydrocarbon results indicate a contamination of migrated hydrocarbons.

2825 - 3325m

Zone C gives a large variation in $C_1$-$C_4$ hydrocarbon abundance, probably because of the lithological consistence of the samples. The zone has a good potential as a source rock, and the chemical analyses show it to be mature. On the other hand spore coloration shows only moderate maturity. As for zone B, we probably have contamination from migrated hydrocarbons in the shale and siltstones in this zone.

3325 - 3500m

Zone D has a good abundance of $C_1$-$C_4$ hydrocarbons, and it is a wetter gas than in zone C. The zone has a fair potential as a source for oil and gas and is chemically mature. Again the spore coloration gives an index of 2.2 - 2.3 which indicates moderate maturity.

3500 - 3625m

Zone E has a poor abundance of $C_1$-$C_4$ hydrocarbons, but the gas is wetter than in zone D, and could be classified as a wet gas. $C_{15}$+ analyses show that the zone has a good potential as a source rock and is chemically mature. There is very small variation in the $C_{15}$+ abundance for the different samples from this zone. Again the spore coloration is low and indicates moderate maturity.

3625 - 3725 m

Zone F has a large abundance of dry gas. The zone has a good/rich potential as a source rock and is mature. In this zone the spore coloration index increases to 2.3 - 2.4. There is possibly migrated oil in the shales at 3600 m.

3725- 3775m

Zone G has a fair to good abundance of $C_1$-$C_4$ hydrocarbons, and it is a wet gas. The zone has a rich potential as a source rock, and is mature.

Vitrinite reflectance gives a good gradient for the well, even if it was difficult to get any meaningful results in the middle of the well. The oilwindow (0.5 - 1.3) starts at approx. 3000 m, and we find the highest reading of 0.85 for true vitrinite at 3725 m.

TABLE I

Concentration (μl gas/kg rock) of $C_1$-$C_4$ hydrocarbon in cuttings.

| Depth (m) | $C_1$ | $C_2$ | $C_3$ | $iC_4$ | $nC_4$ | Tot $C_1$-$C_4$ | Tot $C_2$-$C_4$ | % Gas wetness | $iC_4/nC_4$ |
|---|---|---|---|---|---|---|---|---|---|
| 1510 | 87 | 2 | < 1 | < 1 | < 1 | 92 | 5 | 5.4 | |
| 1550 | 131 | 3 | < 1 | < 1 | < 1 | 137 | 6 | 4.4 | |
| 1600 | 75 | 2 | 1 | < 1 | < 1 | 80 | 5 | 6.3 | |
| 1650 | 126 | 3 | < 1 | < 1 | < 1 | 132 | 6 | 4.5 | |
| 1700 | 131 | 1 | < 1 | < 1 | < 1 | 135 | 4 | 3.0 | |
| 1750 | 157 | 3 | 1 | < 1 | < 1 | 163 | 6 | 3.7 | |
| 1775 | 174 | 5 | < 1 | < 1 | < 1 | 182 | 8 | 4.4 | |
| 1800 | 241 | 6 | 2 | < 1 | < 1 | 251 | 10 | 4.0 | |
| 1825 | 184 | 7 | 2 | < 1 | < 1 | 195 | 11 | 5.6 | |
| 1850 | 180 | 7 | 2 | < 1 | < 1 | 191 | 11 | 5.8 | |
| 1875 | 148 | 2 | 1 | < 1 | < 1 | 193 | 5 | 2.6 | |
| 1900 | 143 | 4 | 1 | < 1 | < 1 | 150 | 7 | 4.7 | |
| 1925 | 621 | 154 | 41 | 1 | 7 | 824 | 203 | 24.6 | 0.14 |
| 1950 | 470 | 14 | 4 | < 1 | < 1 | 490 | 20 | 4.1 | |
| 1975 | 765 | 93 | 30 | 8 | 11 | 907 | 142 | 15.7 | 0.73 |
| 2000 | 443 | 34 | 11 | 3 | 4 | 495 | 52 | 10.5 | 0.75 |
| 2025 | 330 | 21 | 4 | < 1 | 1 | 357 | 27 | 7.6 | |
| 2050 | 388 | 44 | 14 | 4 | 6 | 456 | 68 | 14.9 | 0.67 |
| 2075 | 277 | 22 | 8 | 2 | 3 | 312 | 35 | 11.2 | 0.67 |
| 2100 | 267 | 12 | 3 | 2 | 3 | 287 | 20 | 7.0 | 0.67 |

TABLE I - p.2

| Depth (m) | $C_1$ | $C_2$ | $C_3$ | $iC_4$ | $nC_4$ | Tot $C_1$-$C_4$ | Tot $C_2$-$C_4$ | % Gas wetness | $iC_4/nC_4$ |
|---|---|---|---|---|---|---|---|---|---|
| 2125 | 316 | 16 | 6 | 3 | 3 | 344 | 28 | 8.1 | 1 |
| 2150 | 520 | 27 | 14 | 9 | 8 | 578 | 58 | 10.0 | 1.13 |
| 2175 | 581 | 30 | 13 | 7 | 7 | 638 | 57 | 8.9 | 1 |
| 2200 | 861 | 89 | 48 | 4 | 17 | 1019 | 158 | 15.5 | 0.24 |
| 2225 | 672 | 30 | 9 | 4 | 5 | 720 | 48 | 6.7 | 0.80 |
| 2250 | 699 | 35 | 12 | 4 | 5 | 755 | 56 | 7.4 | 0.80 |
| 2275 | 663 | 34 | 12 | 4 | 5 | 718 | 55 | 7.7 | 0.80 |
| 2300 | 507 | 24 | 5 | 2 | 2 | 540 | 33 | 6.1 | 1 |
| 2325 | 450 | 23 | 9 | 3 | 4 | 479 | 39 | 8.1 | 0.75 |
| 2350 | 752 | 41 | 17 | 5 | 7 | 822 | 70 | 8.5 | 0.71 |
| 2375 | 672 | 53 | 24 | 8 | 12 | 769 | 97 | 12.6 | 0.67 |
| 2400 | 1969 | 141 | 56 | 23 | 26 | 2215 | 246 | 11.1 | 0.88 |
| 2425 | 1664 | 126 | 51 | 18 | 22 | 1881 | 217 | 11.5 | 0.82 |
| 2450 | 519 | 49 | 22 | 8 | 10 | 608 | 89 | 14.6 | 0.80 |
| 2475 | 702 | 70 | 31 | 10 | 13 | 826 | 124 | 15.0 | 0.77 |
| 2500 | 191 | 19 | 9 | 4 | 5 | 228 | 37 | 16.2 | 0.80 |
| 2525 | 596 | 118 | 59 | 20 | 28 | 821 | 225 | 27.4 | 0.71 |
| 2550 | 49 | 5 | 3 | $<1$ | $<1$ | 59 | 10 | 16.9 | |
| 2575 | 3192 | 471 | 253 | 19 | 90 | 4025 | 833 | 20.7 | 0.21 |
| 2600 | 2920 | 427 | 252 | 27 | 96 | 3722 | 802 | 21.5 | 0.28 |
| 2625 | 3484 | 563 | 314 | 24 | 112 | 4497 | 1013 | 22.5 | 0.21 |
| 2650 | 2759 | 404 | 214 | 27 | 83 | 3487 | 728 | 20.9 | 0.33 |

TABLE I - p.3

| Depth (m) | $C_1$ | $C_2$ | $C_3$ | $iC_4$ | $nC_4$ | Tot $C_1$-$C_4$ | Tot $C_2$-$C_4$ | % Gas wetness | $iC_4/nC_4$ |
|---|---|---|---|---|---|---|---|---|---|
| 2675 | 543 | 59 | 27 | 8 | 12 | 649 | 106 | 16.3 | 0.67 |
| 2700 | 995 | 70 | 37 | 17 | 25 | 1144 | 149 | 13.0 | 0.68 |
| 2725 | 1030 | 97 | 50 | 19 | 30 | 1226 | 196 | 16.0 | 0.63 |
| 2750 | 2039 | 227 | 101 | 19 | 40 | 2426 | 387 | 16.0 | 0.48 |
| 2775 | 1620 | 163 | 73 | 15 | 30 | 1901 | 281 | 14.8 | 0.50 |
| 2800 | 832 | 64 | 35 | 16 | 24 | 971 | 139 | 14.3 | 0.67 |
| 2825 | 29 | 2 | $<1$ | $<1$ | $<1$ | 34 | 5 | 14.7 | |
| 2850 | 179 | 13 | 7 | 5 | 7 | 211 | 32 | 15.2 | 0.71 |
| 2875 | 1067 | 60 | 33 | 25 | 27 | 1212 | 145 | 12.0 | 0.93 |
| 2900 | 194 | 14 | 7 | 5 | 5 | 225 | 31 | 13.8 | 1 |
| 2925 | 134 | 10 | 5 | 2 | 3 | 154 | 20 | 13.0 | 0.67 |
| 2950 | 996 | 85 | 47 | 24 | 34 | 1186 | 190 | 16.0 | 0.71 |
| 2975 | 744 | 47 | 26 | 19 | 20 | 856 | 112 | 13.1 | 0.95 |
| 3000 | 1549 | 133 | 60 | 26 | 34 | 1802 | 253 | 14.0 | 0.76 |
| 3025 | 2663 | 273 | 147 | 37 | 67 | 3187 | 524 | 16.4 | 0.55 |
| 3050 | No recovery of gas. | | | | | | | | |
| 3075 | 189 | 7 | 4 | 3 | 3 | 206 | 17 | 8.3 | 1 |
| 3100 | 746 | 67 | 31 | 12 | 17 | 873 | 127 | 14.5 | 0.71 |
| 3125 | 555 | 41 | 20 | 10 | 13 | 639 | 84 | 13.1 | 0.77 |
| 3150 | 207 | 12 | 6 | 1 | 1 | 227 | 20 | 8.8 | 1 |
| 3175 | 896 | 61 | 32 | 18 | 25 | 1032 | 136 | 13.2 | 0.72 |
| 3200 | 2889 | 356 | 178 | 25 | 72 | 3520 | 631 | 17.9 | 0.35 |

## T A B L E  I - p.4

| Depth (m) | $C_1$ | $C_2$ | $C_3$ | $iC_4$ | $nC_4$ | Tot $C_1$-$C_4$ | Tot $C_2$-$C_4$ | % Gas wetness | $iC_4/nC_4$ |
|---|---|---|---|---|---|---|---|---|---|
| 3250 | 72 | 9 | 3 | $<1$ | $<1$ | 86 | 14 | 16.3 | |
| 3275 | 562 | 35 | 11 | 2 | 3 | 613 | 51 | 8.3 | 0.67 |
| 3300 | 1370 | 95 | 34 | 10 | 15 | 1524 | 154 | 10.1 | 0.67 |
| 3325 | 620 | 39 | 14 | 4 | 6 | 683 | 63 | 9.2 | 0.67 |
| 3350 | 3957 | 286 | 100 | 32 | 54 | 4429 | 472 | 10.7 | 0.59 |
| 3375 | 4965 | 707 | 393 | 50 | 161 | 6276 | 1311 | 20.9 | 0.31 |
| 3400 | 700 | 49 | 20 | 5 | 9 | 783 | 83 | 10.6 | 0.56 |
| 3425 | 5708 | 410 | 161 | 52 | 82 | 6413 | 705 | 11.0 | 0.63 |
| 3450 | 1114 | 96 | 45 | 27 | 33 | 1315 | 201 | 15.3 | 0.82 |
| 3475 | 1056 | 91 | 58 | 48 | 67 | 1320 | 264 | 20.0 | 0.72 |
| 3500 | 610 | 41 | 14 | 4 | 5 | 674 | 64 | 9.5 | 0.80 |
| 3525 | 643 | 52 | 42 | 36 | 54 | 827 | 184 | 22.2 | 0.67 |
| 3550 | 288 | 18 | 10 | 4 | 7 | 327 | 39 | 11.9 | 0.57 |
| 3575 | 646 | 75 | 52 | 42 | 62 | 877 | 231 | 26.3 | 0.68 |
| 3600 | 1731 | 131 | 63 | 21 | 36 | 1982 | 251 | 12.7 | 0.58 |
| 3625 | 1433 | 109 | 80 | 46 | 72 | 1740 | 307 | 17.6 | 0.64 |
| 3650 | 2120 | 139 | 66 | 29 | 42 | 2396 | 276 | 11.5 | 0.69 |
| 3675 | 7113 | 529 | 225 | 46 | 93 | 8006 | 893 | 11.2 | 0.49 |
| 3700 | 27994 | 1969 | 506 | 79 | 135 | 30683 | 2689 | 8.8 | 0.59 |
| 3725 | 4232 | 398 | 251 | 95 | 167 | 5143 | 911 | 17.7 | 0.57 |
| 3750 | 1411 | 162 | 93 | 71 | 100 | 1873 | 426 | 22.7 | 0.71 |
| 3775 | 3410 | 305 | 225 | 97 | 159 | 4196 | 786 | 18.7 | 0.61 |

# T A B L E II

Lithology and TOC measurements.

| Sample depth(m) | TOC (%) | Lithology |
|---|---|---|
| 1510 | 0.89 | App. 95% Shale, grey to light green.<br>< 3% Limestone and quartz, white to to brown; Mica; Glauconite.<br>Max. 2% Siltstone, coarse, with glauconite. |
| 1550 | 2.28 | App. 95% Shale, grey to light green<br>< 3% Limestone and quartz, white to brown; Mica; Glauconite.<br>Max. 2% Siltstone, coarse, with glauconite. |
| 1600 | 1.29 | App. 95% Shale, grey to light green.<br>< 3% Limestone and quartz, white to brown; Mica; Glauconite.<br>Max. 2% Siltstone, coarse, with glauconite. |
| 1650 | 2.13 | Min. 97% Shale, grey to light green.<br>< 3% Limestone, white to brown. |
| 1700 | 2.17 | Min. 97% Shale, grey to light green.<br>< 3% Limestone, light brown; Siltstone, coarse, with glauconite. |
| 1750 | 2.19 | Min. 97% Shale, grey to green.<br>< 3% Limestone, light brown; Quartz grains, clear. |
| 1775 | 2.19 | App. 80% Shale, grey to green.<br>15 - 20% Quartz sand, fine to medium, well-rounded, well-sorted, with glauconite. |

TABLE II - p.2

| Sample depth(m) | TOC | Lithology |
|---|---|---|
| 1800 | 0.24 | 60-70% Quartz sand, fine to medium, well-sorted, well-rounded. |
| | 2.72 | 30-40% Shale, grey to green. Small amounts quartz and Limestone, white to brown. |
| 1825 | 0.25 | 65-70% Quartz sand, fine to medium, well-sorted, well-rounded. |
| | 2.56 | App. 30% Shale, grey to green. < 3% Limestone and quartz; Mica. |
| 1850 | 0.19 | 65-70% Quartz sand, fine to medium, well-sorted, well-rounded. |
| | 2.32 | App. 30% Shale, grey to green. < 3% Limestone and quartz, white to brown; Mica. |
| 1875 | 0.11 | App. 70% Quartz sand, fine to medium, well-sorted, well-rounded. |
| | 2.43 | App. 30% Shale, grey to green. < 3% Limestone and quartz, white to brown; Mica. |
| 1900 | 0.21 | App. 70% Quartz sand, fine to medium, well-sorted, well-rounded. |
| | 2.23 | App. 30% Shale, grey to green. < 3% Limestone and quartz, light brown; Mica. |
| 1925 | 0.22 | App. 50% Quartz sand, fine to medium, well-sorted, well-rounded. |
| | 2.45 | App. 50% Shale, grey to green. < 3% Limestone and quartz, light to brown; Mica; Glauconite. |

T A B L E  II - p. 3

| Sample depth(m) | TOC | Lithology |
|---|---|---|
| 1950 | 3.04 | Min. 90% Shale, grey to green.<br>< 10% Limestone and quartz, white to light brown; Mica. |
| 1975 | 2.63 | Min. 90% Shale, grey to green.<br>< 10% Quartz sand, fine; Quartz and Limestone, white to light brown; Mica. |
| 2000 | 3.23 | Min.90% Shale, grey to green.<br>< 10% Quartz sand, fine; Quartz and Limestone, white to light brown. |
| 2025 | 3.00 | Min. 92% Shale, grey to green.<br>Max. 7-8% Quartz; Siltstone, coarse; Limestone; Mica; Glauconite. |
| 2050 | 2.91 | Min. 90% Shale, grey to green.<br>< 10% Quartz, partly siltstone, coarse, with glauconite; Limestone. |
| 2075 | 2.20 | Min. 80% Shale, grey to green.<br>Max. 20% Quartz; Siltstone, coarse, with glauconite; Limestone. |
| 2100 | 2.88 | Min. 85% Shale.<br>< 15% Siltstone, coarse; Quartz; Glauconite, sporadic. |
| 2125 | 3.12 | Min. 85% Shale, grey to green.<br>< 15% Siltstone, coarse, with glauconite; Quartz; Limestone, sporadic. |
| 2150 | 2.29 | Min. 90% Shale, grey to green.<br>< 10% Siltstone, coarse; Quartz; Limestone, sporadic. |

TABLE II - p.4

| Sample depth(m) | TOC | Lithology |
|---|---|---|
| 2175 | 2.66 | App. 95% Shale.<br>App. 5% Quartz; Limestone.<br>Glauconite and Pyrite, sporadic. |
| 2200 | 2.45 | App. 92% Shale, grey to green.<br>App. 7-8% Quartz; Siltstone, coarse; some Limestone.<br>Pyrite observed. |
| 2225 | 2.62 | Min. 90% Shale.<br>Max. 10% Quartz; Siltstone, coarse; some Limestone.<br>Pyrite - marcasite, sporadic. |
| 2250 | 1.69 | App. 60-70% Shale, grey to green.<br>App. 30-40% Quartz sand.<br>< 2% Limestone; Pyrite. |
| 2275 | 2.59 | App. 80-85% Shale, grey to green.<br>Max. 15-20% Quartz sand. |
| 2300 | 1.76 | 85-90% Shale, grey to green.<br>10-15% Quartz sand.<br>Pyrite-marcasite, sporadic. |
| 2325 | 1.70 | 85-90% Shale, grey to green.<br>Max. 10-15% Quartz sand.<br>Pyrite, sporadic. |
| 2350 | 1.95 | App. 90% Shale, grey to green.<br>Max. 10% Quartz sand.<br>< 2% Limestone; Pyrite. |
| 2375 | 1.42 | App. 85-90% Shale, grey to green.<br>Max. 10-15% Quartz sand.<br>< 3% Limestone; Pyrite. |

T A B L E II - p.5

| Sample depth(m) | TOC | Lithology |
|---|---|---|
| 2400 | 1.56<br>0.91 | App. 70-75% Shale.<br>Max. 25-30% Limestone; Quartz; Siltstone.<br>Pyrite, observed. |
| 2425 | 1.01 | App. 80% Shale, light grey to grey, partly light green.<br>App. 10% Limestone.<br>App. 10% Quartz. |
| 2450 | 1.18 | App. 92% Siltstone, shaly Siltstone, Shale, light to light grey.<br>Max. 10% Limestone.<br>App. 2-3% Quartz sand. |
| 2475 | 1.26 | App. 92% Siltstone-Shale, light to grey.<br>Max. 5% Limestone.<br>2-3% Quartz. |
| 2500 | 0.86 | App. 85% Siltstone-Shale.<br>App. 10-12% Limestone.<br>App. 2% Quartz. |
| 2525 | 1.37 | App. 97% Shale-Siltstone, grey.<br>App. 3% Limestone. |
| 2550 | 1.61 | App.100% Shale and some Siltstone, grey Siltstone partly light brown.<br>App. 1% Limestone and quartz. |
| 2575 | 1.01 | 100% Shale and some Siltstone, grey, Siltstone partly light brown. |
| 2600 | 1.01 | App. 97% Shale-Siltstone, grey, Siltstone partly light brown.<br>Max. 3% Limestone. |

TABLE II - p.6.

| Sample depth(m) | TOC | Lithology |
|---|---|---|
| 2625 | 1.18 | 98-99% Shale and some Siltstone, light to grey.<br>1- 2% Limestone. |
| 2650 | 1.24 | App.100% Shale, and some Siltstone, light grey, Shale partly reddish and greenish.<br>App. 1% Limestone. |
| 2675 | 2.05 | App. 98% Shale - Siltstone, light and light grey.<br>App. 2% Limestone.<br>Glauconite, quartz, pyrite observed. |
| 2700 | 1.40 | 100% Siltstone - Shale, light to light grey. |
| 2725 | 2.83 | 100% Shale - Siltstone, light grey. |
| 2750 | 0.66<br>4.16 | App. 65% Siltstone, light grey.<br>App. 35% Shale, light grey. |
| 2775 | 0.60<br>3.16 | App. 65% Siltstone. light grey.<br>App. 35% Shale, light grey.<br>App. 2% Coal-like material (drilling mud). |
| 2800 | 0.50<br>1.97 | App. 65% Siltstone, light grey.<br>App. 35% Shale, light grey. |
| 2825 | 0.56<br>2.04 | App. 65% Siltstone, light grey.<br>App. 35% Shale, light grey, partly greenish. |
| 2850 | 0.75<br>2.18 | App. 65% Siltstone, grey.<br>App. 35% Shale, grey. |

T A B L E II - p.7.

| Sample depth(m) | TOC | Lithology |
|---|---|---|
| 2875 | 1.17 | App.100% Siltstone - Shale, light grey to grey.<br>Pyrite observed. |
| 2900 | 1.23 | 100% Siltstone - Shale. |
| 2925 | 1.22 | App.100% Siltstone - Shale, grey.<br>App.1-2% Coal-like material (drilling mud). |
| 2950 | 1.17 | 100% Siltstone and Shale, grey, partly greenish grey and brownish. |
| 2975 | 0.56 | App.100% Siltstone - Shale, grey, partly brownish.<br>App.1-2% Coal-like material (drilling mud).<br>Pyrite observed. |
| 3000 | 0.68 | App.100% Siltstone and Shale.<br>App. 1% Coal-like material (drilling mud). |
| 3025 | 1.47 | 100% Siltstone - Shale, grey. |
| 3050 | 1.22 | 100% Siltstone - Shale, grey. |
| 3075 | 1.17 | 100% Siltstone - Shale, grey. |
| 3100 | 0.61 | App.100% Siltstone and some Shale, light to light grey, partly greenish and brownish.<br>Max. 1% Coal-like material (drilling mud).<br>Limestone observed. |

TABLE II - p.8.

| Sample depth(m) | TOC | Lithology |
|---|---|---|
| 3125 | 0.82 | 100% Siltstone and Shale, grey, some greenish fragments.<br>Pyrite, observed. |
| 3150 | 0.71 | App. 95% Siltstone and som Shale, grey and partly greenish grey.<br>App. 5% Coal-like material (drilling mud). |
| 3175 | 0.67 | App.100% Siltstone and some Shale, grey, partly greenish. |
| 3200 | 0.69 | 100% Siltstone/Shale, grey, partly greyish green. |
| 3250 | 0.63 | App. 98% Siltstone and Shale, grey, partly greenish.<br>2-3% Coal-like material (drilling mud).<br>Pyrite observed. |
| 3275 | 0.65 | 100% Siltstone and some Shale, grey, partly greenish.<br>Pyrite, observed. |
| 3300 | 1.51 | 100% Siltstone - Shale, light to grey, partly greenish grey. |
| 3325 | 0.59 | 100% Siltstone - Shale, grey. |
| 3350 | 0.40 | App. 99% Siltstone/Shale, grey.<br>1-2% Coal-like material (drilling mud). |
| 3375 | 0.57 | App. 99% Siltstone and some Shale, grey and greenish grey.<br>1-2% Coal-like material (drilling mud). |

T A B L E II - p.9.

| Sample depth(m) | TOC | Lithology |
|---|---|---|
| 3400 | 0.52 | 100% Siltstone and some Shale, grey and greenish grey. |
| 3425 | 0.70 | 100% Siltstone and Shale, grey. |
| 3450 | 0.48 | 80-90% Shale, grey.<br>10-20% Siltstone, coarse.<br>< 2% Coal-like material (drilling mud).<br>Limestone, small amounts. |
| 3475 | 0.50 | App. 70% Shale, grey.<br>Max. 10% Siltstone, coarse.<br>Max. 15% Limestone.<br>< 3% Coal-like material (drilling mud).<br>Quartz grains, observed. |
| 3500 | 0.55 | 90-95% Shale, grey.<br>Max.5% Limestone.<br>Max. 3-5% Siltstone, coarse. |
| 3525 | 0.54 | Min. 90% Shale, grey, partly greenish.<br>Max. 5% Siltstone, coarse.<br>Max. 3% Limestone.<br>< 1% Coal-like material (drilling mud). |
| 3550 | 0.47 | Min. 92% Shale, grey, partly greenish grey.<br>Max. 3-5% Siltstone, coarse.<br>Max. 3% Limestone.<br>Glauconite, pyrite, observed. |
| 3575 | 0.59 | Min. 85% Shale, grey.<br>App. 10% Siltstone, coarse.<br>Max. 3% Limestone.<br>Max. 2% Coal-like material (drilling mud). |

TABLE II - p. 10.

| Sample depth(m) | TOC | Lithology |
|---|---|---|
| 3600 | 0.48 | Min. 88% Shale, grey.<br>Max. 5-7% Limestone; Siltstone, coarse; Quartz, sporadic.<br>< 5% Coal-like material (drilling mud). |
| 3625 | 0.59 | App. 70% Shale, light to dark grey.<br>App. 20-25% Coal-like material (drilling mud).<br>App. 5-10% Limestone; Some quartz; Siltstone.<br>Pyrite, observed. |
| 3650 | 0.53 | Min. 90% Shale, light to dark grey.<br><10% Siltstone, coarse; Limestone. |
| 3675 | 0.74 | Min. 90% Shale, light to dark grey.<br><10% Siltstone, coarse; Limestone. |
| 3700 | 0.45 | App. 75% Shale.<br>Max. 25% Limestone, light brown.<br>< 5% Siltstone, coarse. |
| 3725 | 0.61 | App. 90-95% Shale.<br>App. 5-10% Siltstone, coarse; Quartz; Limestone; Pyrite. |
| 3750 | 0.86 | Min. 90% Shale, greenish grey and grey.<br>Max. 5% Siltstone, coarse; Limestone.<br>Max. 5% Coal-like material (drilling mud).<br>Pyrite, observed. |
| 3775 | 2.06 | Min. 90% Shale, light to dark grey.<br>Max. 5-10% Siltstone, coarse; Limestone; Pyrite, sporadic. |

# TABLE III

Weight (mg) of EOM chromatographic fractions.

| Depth (m) | Rock extracted(g) | EOM | Sat. | Aro | Total hydrocarbons (HC) | Non hydrocarbons |
|---|---|---|---|---|---|---|
| 1510 | 100.0 | 30.0 | 3.5 | 2.1 | 5.6 | 22.2 |
| 1560 | 100.0 | 24.8 | 0.2 | 1.9 | 2.1 | 19.5 |
| 1800 | 44.2 | 13.4 | 1.6 | 2.3 | 3.9 | 8.5 |
| 1950 | 100.0 | 35.3 | 4.4 | 4.2 | 8.6 | 26.4 |
| 2100 | 100.0 | 42.4 | 3.2 | 11.4 | 14.6 | 23.5 |
| 2200 | 100.1 | 107.0 | 7.7 | 27.5 | 35.2 | 67.9 |
| 2350 | 100.0 | 33.9 | 1.8 | 4.7 | 6.5 | 25.4 |
| 2425 | 30.0 | 38.8 | 4.8 | 8.8 | 13.6 | 17.6 |
| 2575 | 100.0 | 92.3 | 12.6 | 22.7 | 35.3 | 54.5 |
| 2650 | 25.0 | 80.6 | 11.2 | 6.8 | 18.0 | 57.1 |
| 2675 | 60.0 | 395.7 | 180.4 | 190.3 | 370.7 | 24.2 |
| 2725 | 80.0 | 84.6 | 22.0 | 22.5 | 44.5 | 32.5 |
| 2750 | 45.0 | 65.0 | 9.3 | 17.6 | 26.9 | 32.5 |
| 2775 | 34.0 | 31.9 | 5.0 | 6.9 | 11.9 | 17.5 |
| 2800 | 15.0 | 31.1 | 4.4 | 9.4 | 13.8 | 15.3 |
| 2825 | 25.0 | 76.4 | 20.9 | 23.0 | 43.9 | 29.7 |
| 2850 | 50.0 | 76.0 | 17.7 | 19.8 | 37.5 | 28.9 |
| 2950 | 25.0 | 83.9 | 11.4 | 18.5 | 29.9 | 38.0 |
| 3025 | 50.0 | 66.9 | 26.3 | 16.0 | 42.3 | 16.1 |
| 3075 | 30.0 | 24.7 | 4.8 | 7.7 | 12.5 | 12.0 |
| 3125 | 40.0 | 25.7 | 5.4 | 12.1 | 17.5 | 7.8 |
| 3200 | 40.0 | 17.5 | 4.1 | 6.3 | 10.4 | 7.0 |
| 3350 | 40.0 | 26.3 | 6.9 | 6.0 | 12.9 | 11.8 |
| 3450 | 53.6 | 44.0 | 11.4 | 7.1 | 18.5 | 23.5 |
| 3550 | 40.0 | 28.8 | 9.8 | 6.4 | 16.2 | 9.2 |
| 3600 | 30.0 | 35.5 | 15.5 | 3.7 | 19.2 | 14.9 |
| 3650 | 40.0 | 36.8 | 9.2 | 4.6 | 13.8 | 21.9 |
| 3750 | 35.0 | 41.7 | 7.3 | 8.7 | 16.0 | 24.1 |
| 3775 | 35.0 | 73.0 | 7.6 | 20.1 | 27.7 | 40.9 |
| 2825 Siltstone | 15.0 | 29.3 | 5.2 | 6.7 | 11.9 | 14.2 |

TABLE IV

Concentration of EOM and chromatographic fractions (Weight ppm of rock).

| Depth (m) | EOM | Sat | Aro | HC | Non hydrocarbons |
|---|---|---|---|---|---|
| 1510 | 300 | 35 | 21 | 56 | 222 |
| 1560 | 250 | 2 | 19 | 21 | 195 |
| 1800 | 300 | 36 | 52 | 88 | 192 |
| 1950 | 350 | 44 | 42 | 86 | 204 |
| 2100 | 420 | 32 | 114 | 146 | 235 |
| 2200 | 1070 | 77 | 275 | 352 | 679 |
| 2350 | 340 | 18 | 47 | 65 | 254 |
| 2425 | 1290 | 160 | 296 | 456 | 587 |
| 2575 | 920 | 126 | 227 | 353 | 545 |
| 2650 | 3220 | 448 | 272 | 720 | 2284 |
| 2675 | 6595 | 3007 | 3172 | 6179 | 403 |
| 2725 | 1060 | 275 | 281 | 556 | 406 |
| 2750 | 1440 | 207 | 391 | 598 | 722 |
| 2775 | 940 | 147 | 203 | 350 | 515 |
| 2800 | 2070 | 293 | 627 | 920 | 1020 |
| 2825 | 3060 | 836 | 920 | 1756 | 1188 |
| 2850 | 1520 | 354 | 396 | 750 | 578 |
| 2950 | 3360 | 456 | 740 | 1196 | 1520 |
| 3025 | 1340 | 526 | 320 | 846 | 322 |
| 3075 | 820 | 160 | 257 | 417 | 400 |
| 3125 | 640 | 135 | 303 | 438 | 196 |
| 3200 | 440 | 103 | 158 | 261 | 175 |
| 3350 | 660 | 173 | 150 | 323 | 295 |
| 3450 | 820 | 213 | 132 | 245 | 438 |
| 3550 | 720 | 245 | 160 | 405 | 230 |
| 3600 | 1180 | 517 | 123 | 640 | 497 |
| 3650 | 920 | 230 | 115 | 345 | 548 |
| 3750 | 1180 | 209 | 249 | 458 | 689 |
| 3775 | 2090 | 217 | 574 | 791 | 1168 |
| 2825 Siltstone | 1950 | 347 | 447 | 794 | 947 |

TABLE V

Concentration of EOM and chromatographic fractions (mg/gTOC).

| Depth (m) | EOM | Sat | Aro | HC | Non hydrocarbons |
|---|---|---|---|---|---|
| 1510 | 33.7 | 3.9 | 2.4 | 6.3 | 24.9 |
| 1560 | 11.2 | 0.1 | 0.9 | 1.0 | 8.8 |
| 1800 | 11.1 | 1.3 | 1.9 | 3.2 | 7.1 |
| 1950 | 11.6 | 1.4 | 1.4 | 2.8 | 8.7 |
| 2100 | 14.7 | 1.1 | 4.0 | 5.1 | 8.2 |
| 2200 | 43.7 | 3.1 | 11.2 | 14.3 | 27.7 |
| 2350 | 17.4 | 0.9 | 2.4 | 3.3 | 13.0 |
| 2425 | 128.1 | 15.8 | 29.0 | 44.8 | 58.1 |
| 2575 | 92.3 | 12.6 | 22.7 | 35.3 | 54.5 |
| 2650 | 260.0 | 36.1 | 21.9 | 58.0 | 184.2 |
| 2675 | 321.7 | 146.7 | 154.7 | 301.4 | 19.7 |
| 2725 | 37.3 | 9.7 | 9.9 | 19.6 | 14.4 |
| 2750 | 34.7 | 5.0 | 9.4 | 14.4 | 17.4 |
| 2775 | 29.7 | 4.7 | 6.4 | 11.1 | 16.3 |
| 2800 | 105.2 | 14.9 | 31.8 | 46.7 | 51.8 |
| 2825 | 149.8 | 41.0 | 45.1 | 86.1 | 58.2 |
| 2850 | 69.7 | 16.2 | 18.2 | 34.4 | 26.5 |
| 2950 | 286.8 | 39.0 | 63.2 | 102.2 | 129.9 |
| 3025 | 91.0 | 35.8 | 21.8 | 57.6 | 21.9 |
| 3075 | 70.4 | 13.7 | 21.9 | 35.6 | 34.2 |
| 3125 | 78.3 | 16.5 | 36.9 | 53.4 | 23.8 |
| 3200 | 63.4 | 14.9 | 22.8 | 47.7 | 25.4 |
| 3350 | 164.4 | 43.1 | 37.5 | 80.6 | 73.8 |
| 3450 | 171.0 | 43.4 | 27.6 | 71.0 | 91.3 |
| 3550 | 153.2 | 52.1 | 34.0 | 86.1 | 48.9 |
| 3600 | 246.5 | 107.6 | 25.7 | 133.3 | 103.5 |
| 3650 | 173.6 | 43.4 | 21.7 | 65.1 | 103.3 |
| 3750 | 137.5 | 24.3 | 28.9 | 53.2 | 80.1 |
| 3775 | 101.2 | 10.5 | 27.9 | 38.4 | 56.7 |
| 2825 Siltstone | 348.8 | 61.9 | 79.8 | 141.7 | 169.1 |

# T A B L E  VI

Composition in % of the organic material extracted from the rock.

| Depth (m) | Sat / Eom | Aro / Eom | HC / EOM | Sat / Aro | Non HC / EOM | HC / Non HC |
|---|---|---|---|---|---|---|
| 1510 | 11.7 | 7.5 | 18.7 | 166.7 | 74.0 | 25.2 |
| 1560 | 0.8 | 7.7 | 8.5 | 10.5 | 78.6 | 10.8 |
| 1800 | 11.9 | 17.2 | 29.1 | 69.6 | 63.4 | 45.9 |
| 1950 | 12.5 | 11.8 | 24.4 | 104.7 | 74.8 | 32.6 |
| 2100 | 7.5 | 26.9 | 34.4 | 28.1 | 55.4 | 62.1 |
| 2200 | 7.2 | 25.7 | 32.9 | 28.0 | 63.5 | 47.9 |
| 2350 | 5.3 | 13.9 | 19.2 | 38.3 | 74.9 | 25.6 |
| 2425 | 12.4 | 22.7 | 35.1 | 54.5 | 45.4 | 77.2 |
| 2575 | 13.7 | 24.6 | 38.3 | 55.5 | 59.1 | 64.8 |
| 2650 | 13.9 | 8.4 | 22.3 | 164.7 | 70.8 | 31.5 |
| 2675 | 45.6 | 48.1 | 93.7 | 94.8 | 6.1 | 1531.8 |
| 2725 | 26.0 | 26.6 | 52.6 | 97.8 | 38.4 | 115.9 |
| 2750 | 14.3 | 27.1 | 41.4 | 52.8 | 50.0 | 82.8 |
| 2775 | 15.7 | 21.6 | 37.3 | 72.5 | 54.9 | 68.0 |
| 2800 | 14.1 | 30.2 | 44.3 | 46.8 | 49.2 | 90.2 |
| 2825 | 27.4 | 29.6 | 57.0 | 90.9 | 33.9 | 147.8 |
| 2850 | 23.3 | 26.1 | 49.4 | 89.4 | 33.0 | 129.8 |
| 2950 | 13.6 | 22.1 | 35.7 | 61.6 | 45.3 | 78.7 |
| 3025 | 39.3 | 23.9 | 63.2 | 166.4 | 24.1 | 262.7 |
| 3075 | 19.4 | 31.2 | 50.6 | 62.3 | 45.3 | 104.2 |
| 3125 | 21.0 | 47.1 | 68.1 | 44.6 | 34.6 | 224.0 |
| 3200 | 23.4 | 36.0 | 59.4 | 65.1 | 40.0 | 148.6 |
| 3350 | 26.2 | 22.8 | 49.0 | 115.0 | 44.9 | 109.3 |
| 3450 | 25.9 | 17.5 | 43.4 | 160.6 | 53.4 | 58.2 |
| 3550 | 34.0 | 23.1 | 57.1 | 152.2 | 31.9 | 165.3 |
| 3600 | 43.6 | 10.4 | 54.0 | 418.9 | 42.0 | 128.9 |
| 3650 | 25.0 | 12.5 | 37.5 | 200.0 | 59.5 | 63.0 |
| 3750 | 17.6 | 21.0 | 38.6 | 83.9 | 58.2 | 66.4 |
| 3775 | 10.4 | 27.5 | 37.9 | 37.8 | 56.0 | 67.7 |
| 2825 Siltstone | 17.7 | 22.9 | 40.6 | 77.6 | 48.5 | 83.8 |

## T A B L E VII

Tabulation of datas from the gaschromatograms.

| Depth (m) | Pristane/$nC_{17}$ | Pristane/Phytane | CPI |
|---|---|---|---|
| 1560 | 0.52 | 1.62 | 1.41 |
| 1800 | 0.86 | 1.90 | 1.08 |
| 1950 | 0.78 | 1.60 | 1.33 |
| 2100 | 1.08 | 1.12 | 1.10 |
| 2200 | 0.74 | 1.54 | 1.02 |
| 2350 | 0.56 | 1.97 | 0.92 |
| 2425 | 0.80 | 1.59 | 0.96 |
| 2575 | 0.63 | 1.58 | 0.94 |
| 2675 | 0.42 | 1.56 | 0.91 |
| 2750 | 0.36 | 1.66 | 1.01 |
| 2775 | 0.50 | 1.49 | 0.99 |
| 2800 | 0.45 | 1.45 | 0.97 |
| 2825 | 0.39 | 1.54 | 0.94 |
| 2850 | 0.40 | 1.60 | 1.01 |
| 2950 | 0.45 | 1.60 | 0.97 |
| 3025 | 0.41 | 1.50 | 1.00 |
| 3125 | 0.49 | 1.36 | 0.98 |
| 3200 | 0.37 | 1.40 | 1.00 |
| 3350 | 0.42 | 1.66 | 1.02 |
| 3450 | 0.39 | 1.41 | 0.97 |
| 3550 | 0.43 | 1.56 | 1.01 |
| 3650 | 0.53 | 1.61 | 0.99 |
| 3700 | 0.35 | 1.90 | 0.90 |
| 3750 | 0.51 | 1.66 | 0.97 |
| 3775 | 0.38 | 1.60 | 0.98 |
| | | | |
| 2825 Siltstone | 0.39 | 1.50 | 0.95 |

# T A B L E VIII

Vitrinite reflectance and spore coloration.
(Number of particles measured for vitrinite reflectance in brackets.)

| Depth (m) | Spore col. | Vitrinite refl. |
|---|---|---|
| 1510 | | 0.43(20) |
| 1800 | | 0.31(17) 0.51(1) |
| 2000 | | 0.33(6) 0.74(3) |
| 2200 | | 0.35(18) |
| 2400 | | 0.47(17) 0.76(4) |
| 2500 | | 0.49(21) |
| 2600 | 2.0-2.2 | 0.45(8)0.59(8) 1.45(9) |
| 2700 | 2.0 | 0.43(5) 1.30(5) |
| 2765 | 2.1 | |
| 2800 | | 0.71(8) |
| 2805 | 2.0-2.1 | |
| 2825 | 2.1 | |
| 2900 | | 1.14(8) 3.12 |
| 2925 | 2.1 | |
| 3000 | | 0.51(5) 0.93(1) 1.43(2) |
| 3025 | 2.1-2.2 | |
| 3100 | | 0.49(8) 0.87(1) |
| 3125 | 2.1-2.2 | |
| 3175 | 2.1 | 1.09(5) |
| 3250 | 2.1-2.2 | |
| 3275 | 2.2 | |
| 3300 | 2.1-2.2 | 0.35(2) |
| 3350 | 2.2 | |
| 3400 | 2.2-2.3 | 0.71(11) 0.98(10) |
| 3450 | 2.2-2.3 | |
| 3500 | | 0.26(1) 0.65(6) |
| 3550 | 2.2 | |
| 3575 | 2.2 | 0.45(2) 0.77(9) 1.16(3) |
| 3625 | 2.3 | |
| 3650 | | 0.75(4) 1.11(1) |
| 3700 | 2.3-2.4 | |
| 3725 | 2.2-2.3 | |
| 3750 | 2.3 | 0.85(9) |
| 3775 | 2.3 | 0.78(2) 1.15(7) |

## PRESENTATION OF ANALYTICAL DATA

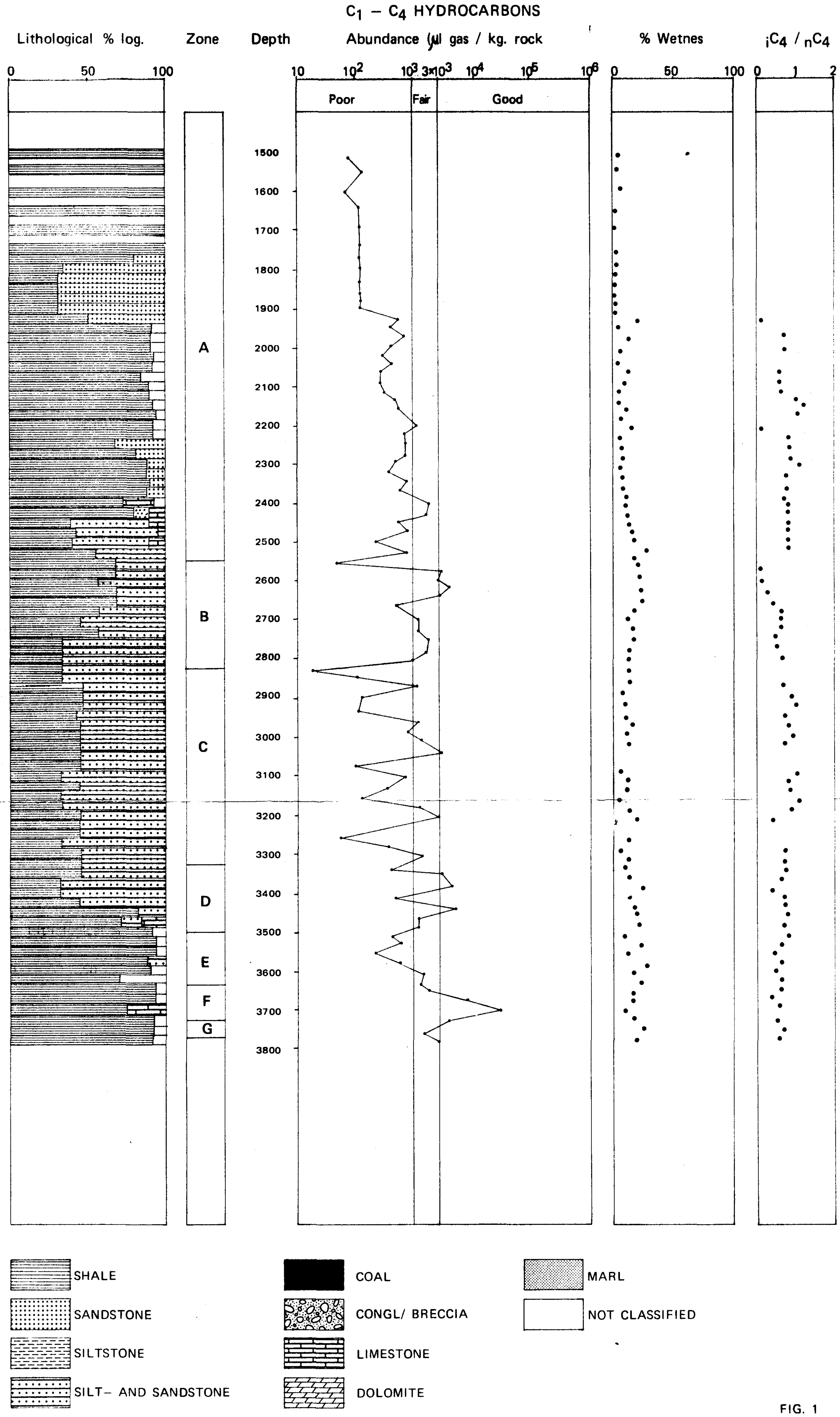
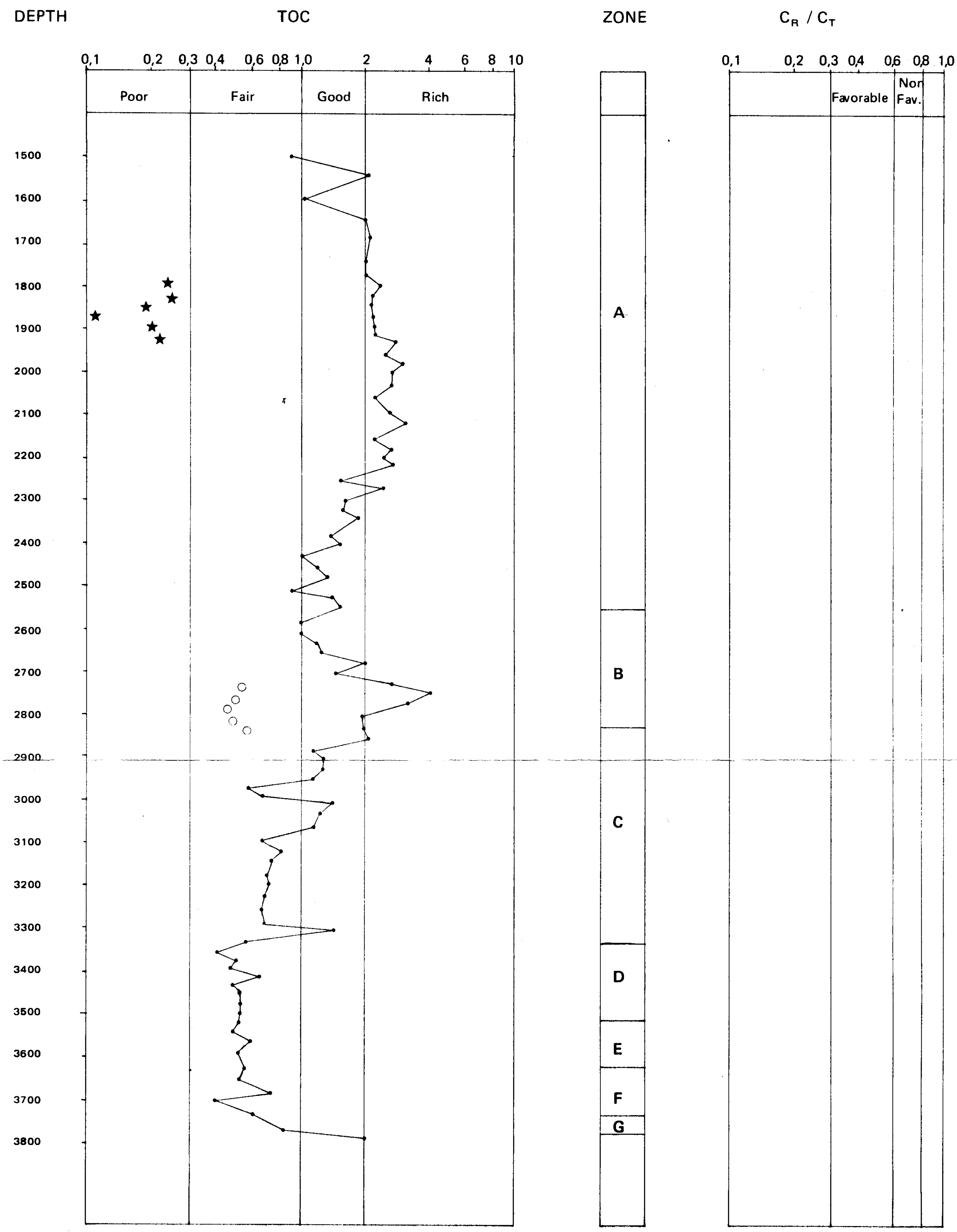



FIG. 1

**TOTAL ORGANIC CARBON (TOC) AND $C_R$ / $C_T$**

**Presentation of analytical Data**




TOC : Total Organic Carbon

$C_R$/ $C_T$ : Organic Carbon Residue / Total Organic Carbon

• : Shale

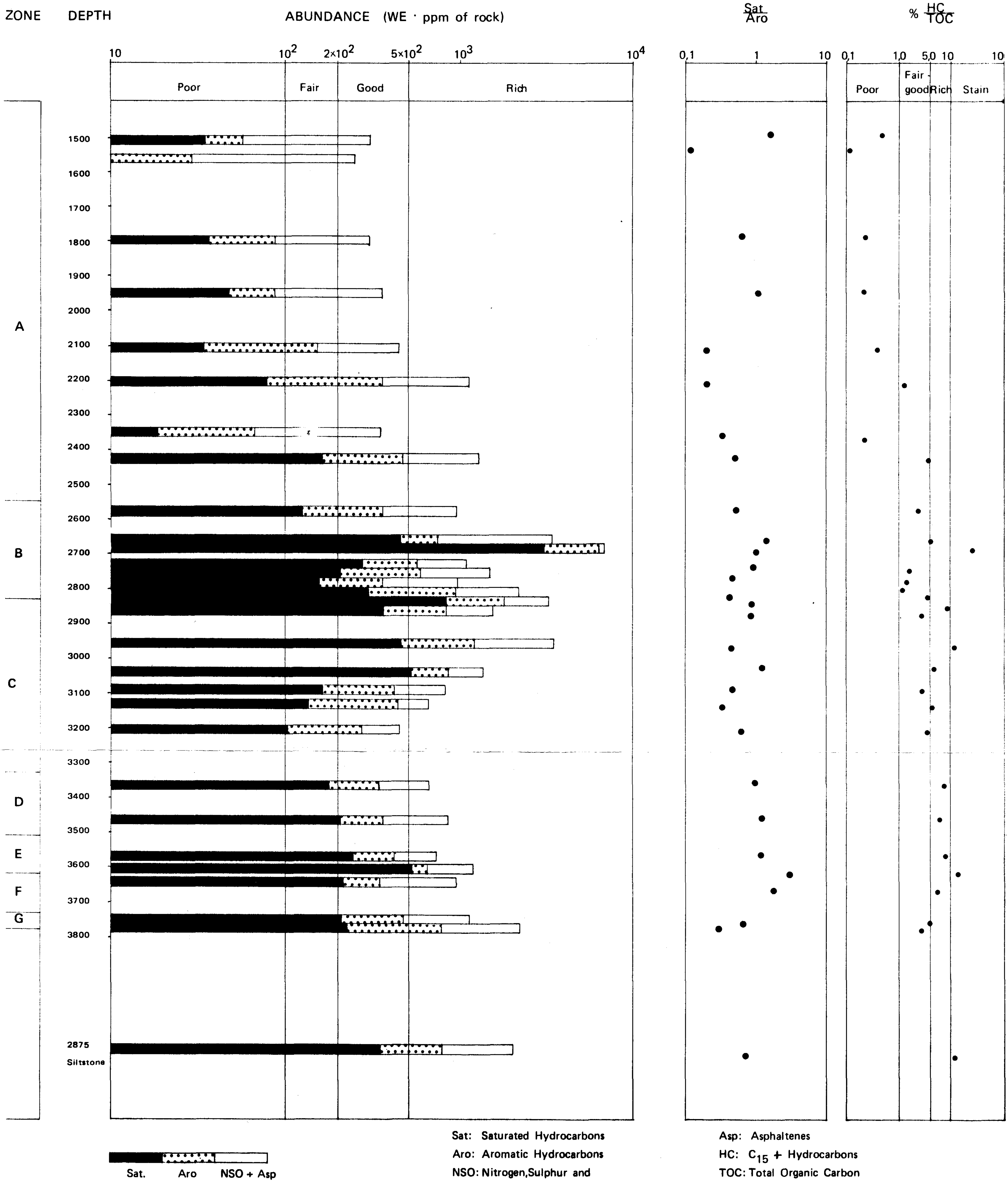
★ : Sandstone

○ : Siltstone

Fig.2

## $C_{15}^{+}$ HYDROCARBONS

**Presentation of Analytical Data**

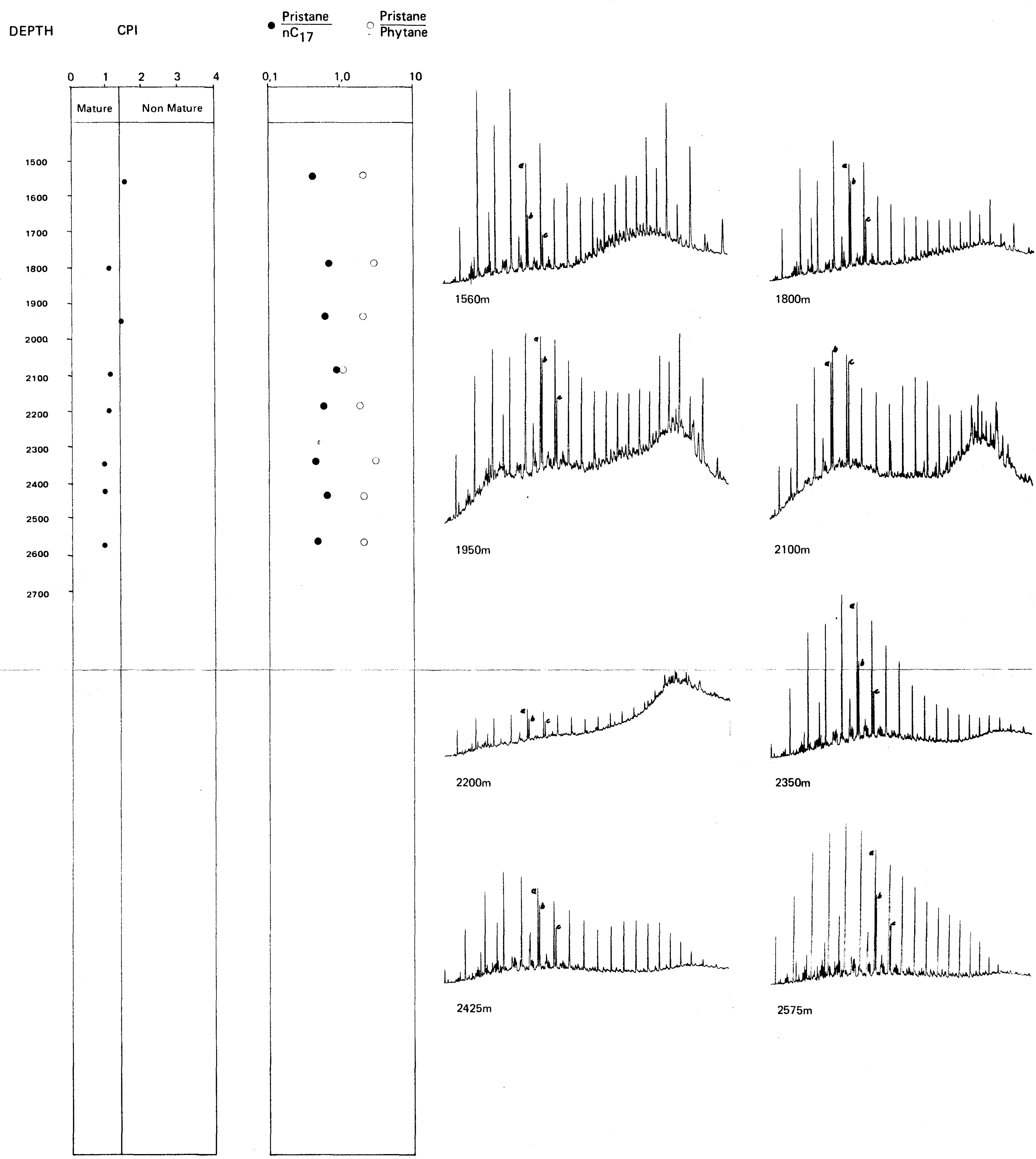



Sat: Saturated Hydrocarbons
Aro: Aromatic Hydrocarbons
NSO: Nitrogen,Sulphur and Oxygen containing compounds

Asp: Asphaltenes
HC: $C_{15}$ + Hydrocarbons
TOC: Total Organic Carbon

Fig. 3

## $C_{15}$+ SATURATED HYDROCARBONS



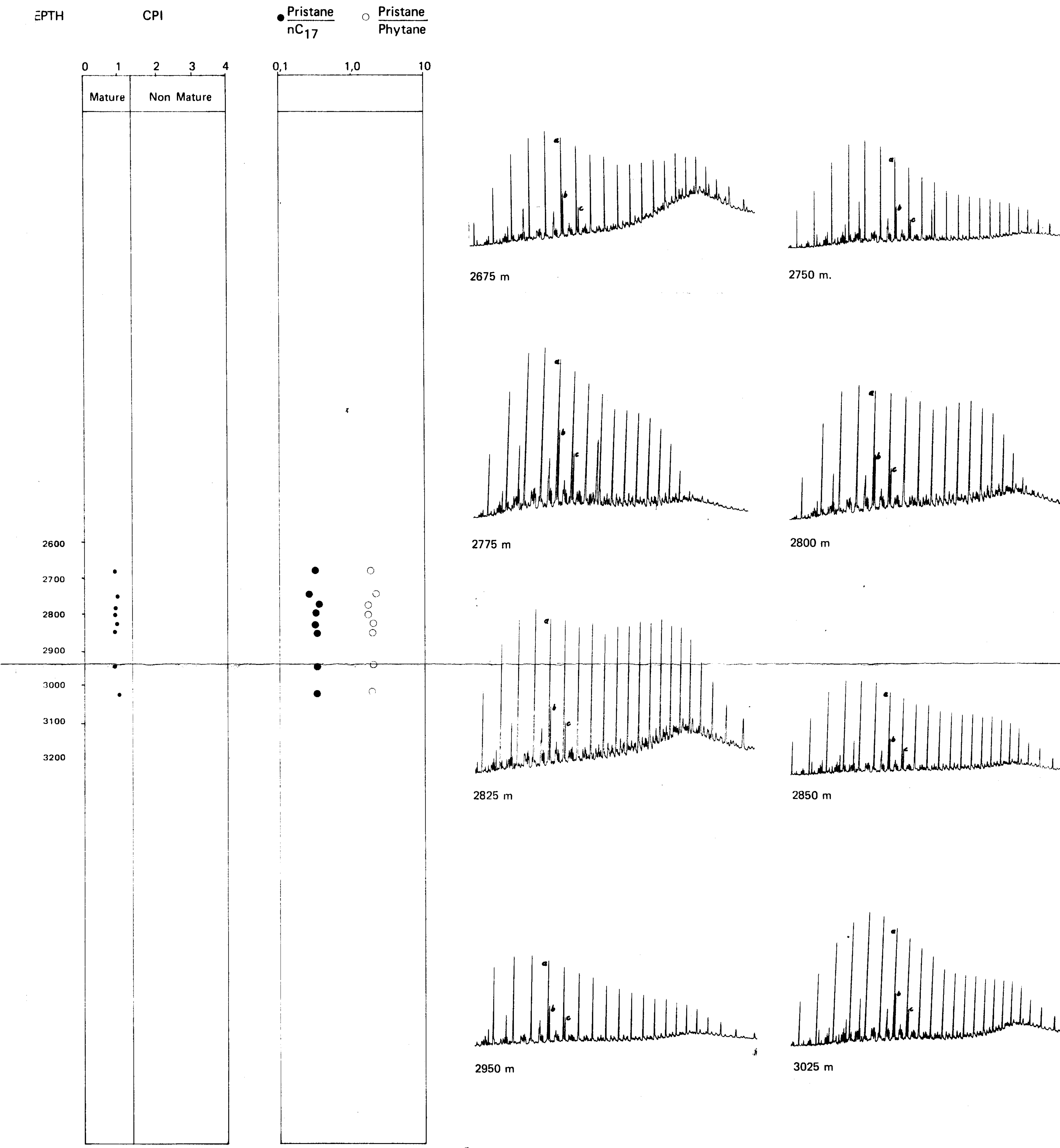

a: $nC_{17}$

b: Pristane

c: Phytane

**Fig. 4a**

# $C_{15}$+ SATURATED HYDROCARBONS




a: $nC_{17}$

b: Pristane

c: Phytane

Fig. 4b

## $C_{15}$+ SATURATED HYDROCARBONS

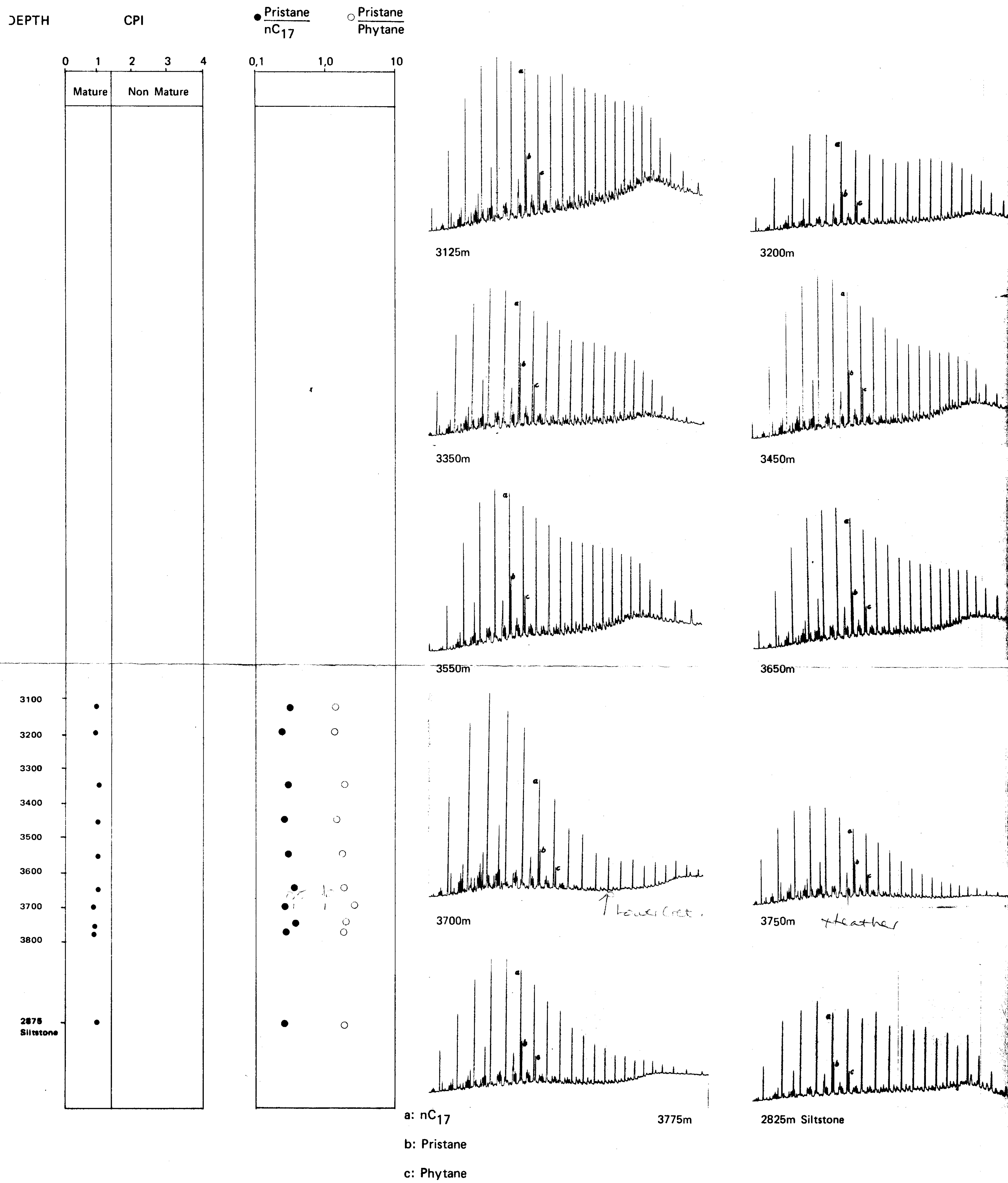



Fig. 4c

## MATURATION

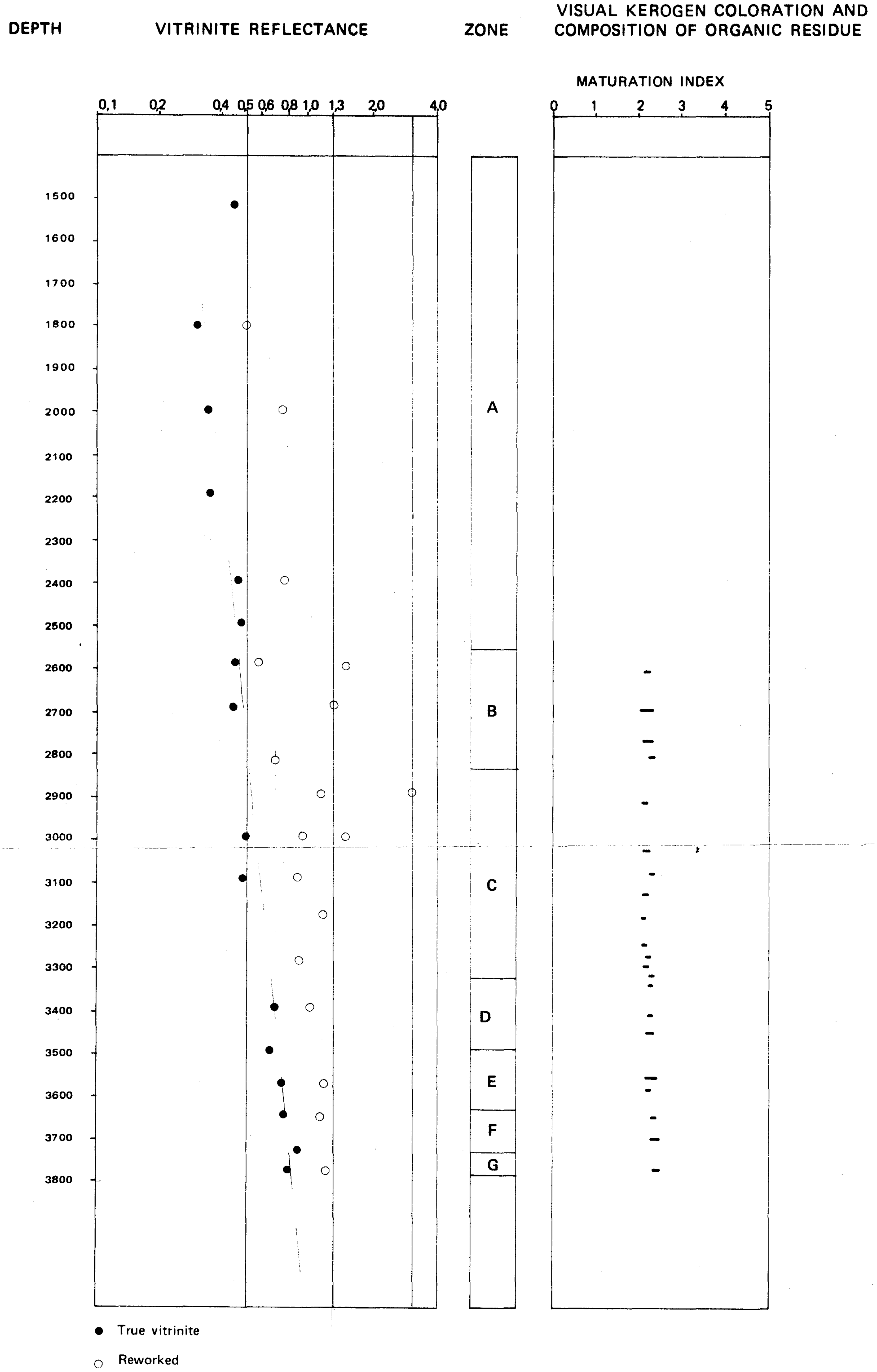
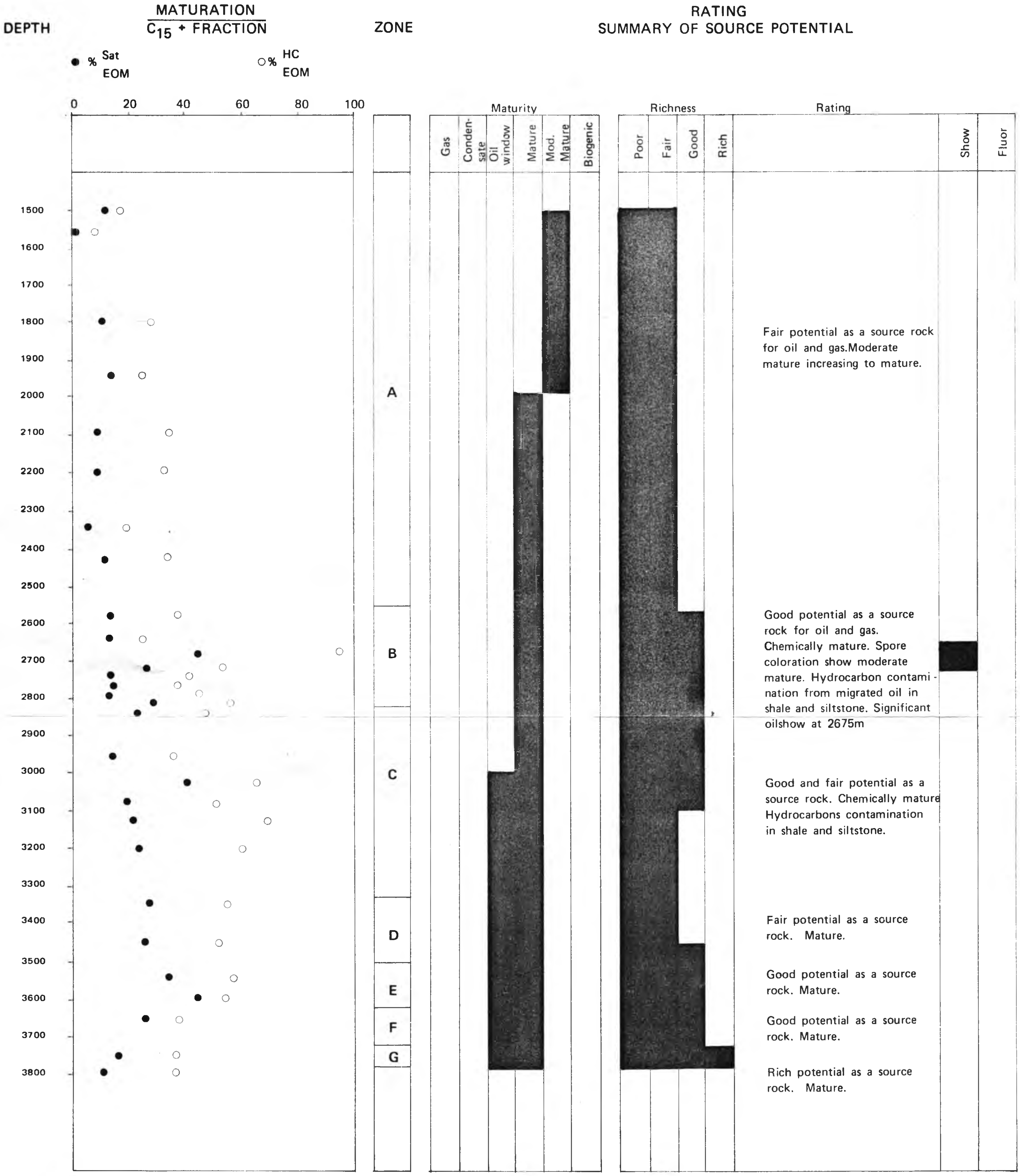



Fig. 5

## INTERPRETATION DIAGRAM



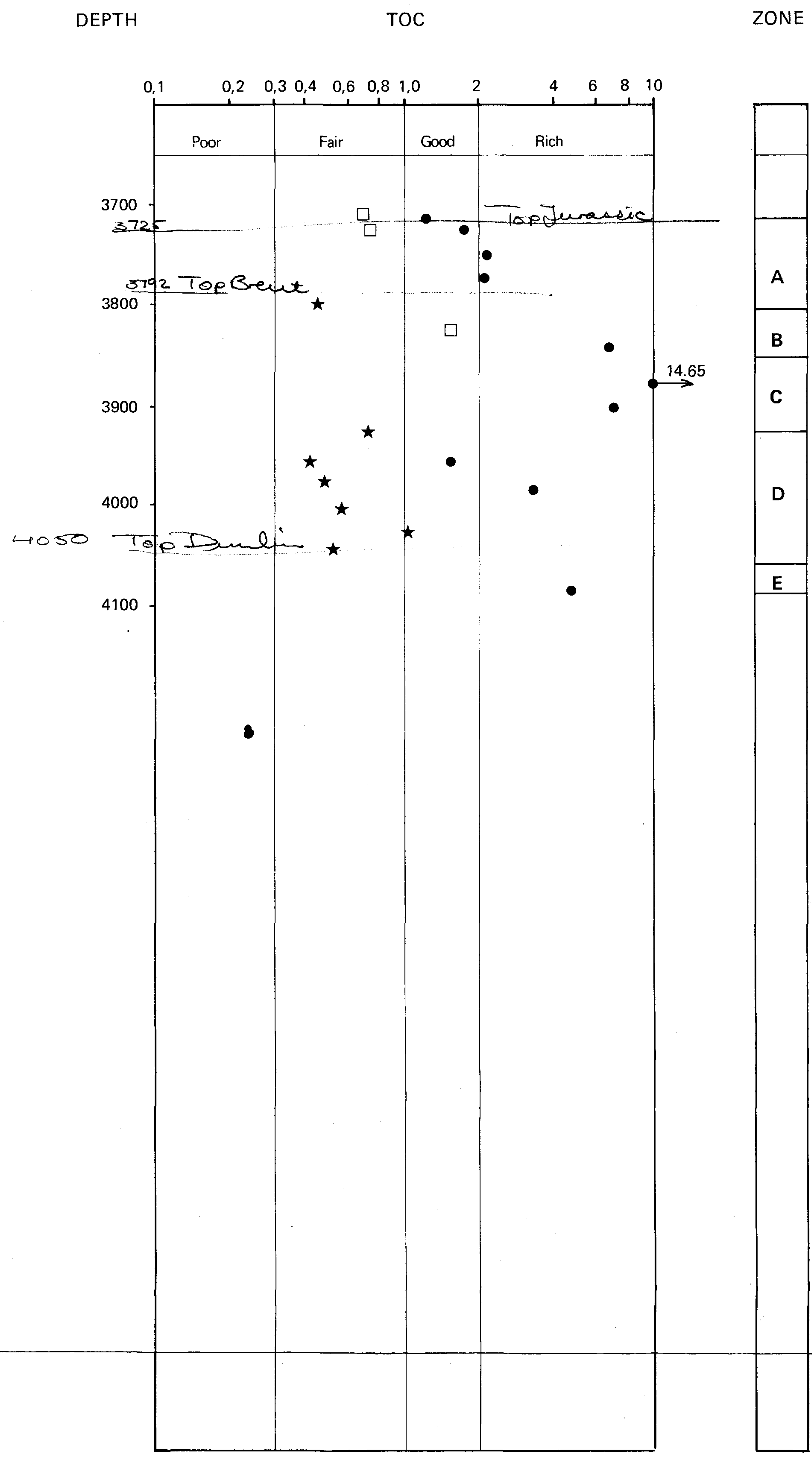

Sat: Saturated Hydrocarbons

HC: Hydrocarbons

EOM:Extractable Organic Matter

Fig. 6

## TOTAL ORGANIC CARBON (TOC)
Presentation of Analytical Data




TOC: Total Organic Carbon

- ● Claystone
- ★ Sandstone
- □ Siltstone