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SUMMARY

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1. INTRODUCTION

The optical reflectance of vitrinite in coals and finely dispersed in clastic sediments is a well established indicator of thermal maturity of sedimentary organic matter. Vitrinite reflectance is a standard method to assess the rank of coal, and it is widely used in petroleum exploration in geochemical studies as a reference indicator of organic maturity (Tissot and Welte, 1984) and in mathematical basin modeling as a calibration or check parameter for paleotemperature reconstruction (Lerche et al., 1984; Tissot and Welte, 1984; Yukler and Kokesh, 1984; Welte and Yalcin, 1986).

In the present study vitrinite reflectance analyses are performed in order to establish a vitrinite reflectance versus depth profile in well 6507/11-4 offshore Mid-Norway.

2. MATERIAL

The vitrinite reflectance data being used in this study are obtained from analyses of 9 samples.

The samples subjected for analyses are conventional cores and sidewall cores. Most of the samples are claystones with a moderate to rich content of organic material, and the maceral composition is generally highly dominated by inertinitic material over vitrinite and exinite. One coal sample is also analysed. It was dominated by vitrinite over inertinite and exinite.

3. ANALYTICAL TECHNIQUES

In this report the term ´vitrinite reflectance´ is used throughout although strictly vitrinite is defined only for the bituminous coal range for reflectance values above approximately Rm=0.50. The vitrinite precursor in the lower reflecting brown coal range is called ´humunite´.

All the samples being analysed in this study are treated with hydrofluoric acid prior to further preparation. The resulting material is embedded in a cold setting epoxy resin to make briquettes. These are subsequently ground flat and polished using 0.25 µm diamond paste and magnesium oxide as the two final steps.

The analytical equipment being used is a Zeiss MPM 03 photometer-microscope. Viewing and measurements are made through a Zeiss Epiplan Neofluoar 40/0.90 oil objective using immersion oil with refractive index n=1.518. The measurements are made through a green filter with peak transmission at 546 nm, and with a photometer sensitive field of about 2.5 µm in diameter. For photometer calibration a Schott sapphire glass standard is used with a reflectance in oil of Rm=0.588. The readings are performed without a polarizer and using a stationary stage. This has become more or less standard in vitrinite reflectance studies where clastic samples are to be analysed. This procedure is called measurement of random reflectance (Rm). This technique permits smaller particles to be measured which is important for clastic samples, and the results do not deviate significantly in precision from those obtained using a rotating stage technique. The reader is referred to Davis (1978), Ting (1978), Stach et al. (1982) and Bustin et al. (1985) for further information on these topics, and to Bostick (1971) and Bostick and Alpern (1977) for topics related to measurements on clastic samples. On each sample normally as many particles as possible up to 25 are measured. For coal samples the measurements are carried out on banded vitrinite or telocollinite, and an arithmetic mean value is calculated from all the readings. For clastic samples a representative population is selected among the readings based on observations made during measuring, and an arithmetic mean is calculated for this population. The principles for constituent selection in clastic samples follow that of Bostick (1971, 1979) and Bostick and Alpern (1977).

4. RESULTS

All the sample results and interpretations are given in Tables 1-2, whereas all the raw data are given in Appendix. Only a short comment is given here.

The results and interpretations are given in Table 1 (analytical data) and Table 2 (vitrinite reflectance versus depth trend).

The sample results are generally very good, but the distribution of samples cover only a narrow interval from 2533.4 mrkb to 2881.5 mrkb. This makes it impossible to establish a vitrinite reflectance versus depth trend for the entire well section. The interpreted trend is, however, considered to be very reliable.

5. CONCLUSION

The results from this study show that it has been possible to establish highly reliable vitrinite reflectance data from a narrow interval in well 6507/11-4.

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7. LIST OF TABLES

8. APPENDIX

Raw data and histograms

Table 1. Vitrinite reflectance data well 6507/11-4

WELL: 6507/11-4

sample code IFE	sample depth mrkb	sample type	lithology	vitrinite reflectance Rm (N)	sample quality
SA 249	2533.4	swc	clst	0.40 (22)+	oo-oo
SA 250	2536.7	swc	clst	0.43 (22)	oo+oo
SA 251	2541.0	swc	clst	0.49 (22)	oo+oo
SA 252	2562.0	swc	clst	0.35 (6)-	oo---
SA 253	2571.00	core	clst	0.40 (6)-	oo---
SA 254	2581.00	core	clst	0.40 (9)-	oo---
SA 255	2612.5	swc	clst	0.46 (26)+	ooooo
SA 256	2687.00	core	coal	0.45 (25)+	ooooo
SA 257	2881.5	swc	clst	0.59 (21)	o++--

LEGEND

Rm : mean random reflectance in oil
N : number of readings
+ : very good sample
- : difficult sample
-- : not vitrinite, wrong value
Cv : cavings
Ma : mud additive

CODE FOR DATA QUALITY

The sample quality is characterised by five items as follows:

```
+++++
|||||
||||└─ particle surface quality
|||└── particle size
||└─── type of vitrinite
|└──── identification of vitrinite
└───── abundance of vitrinite
```

+ : may give a too high vitrinite reflectance value
o : have no effect on the resulting vitrinite reflectance value
- : may give a too low vitrinite reflectance value

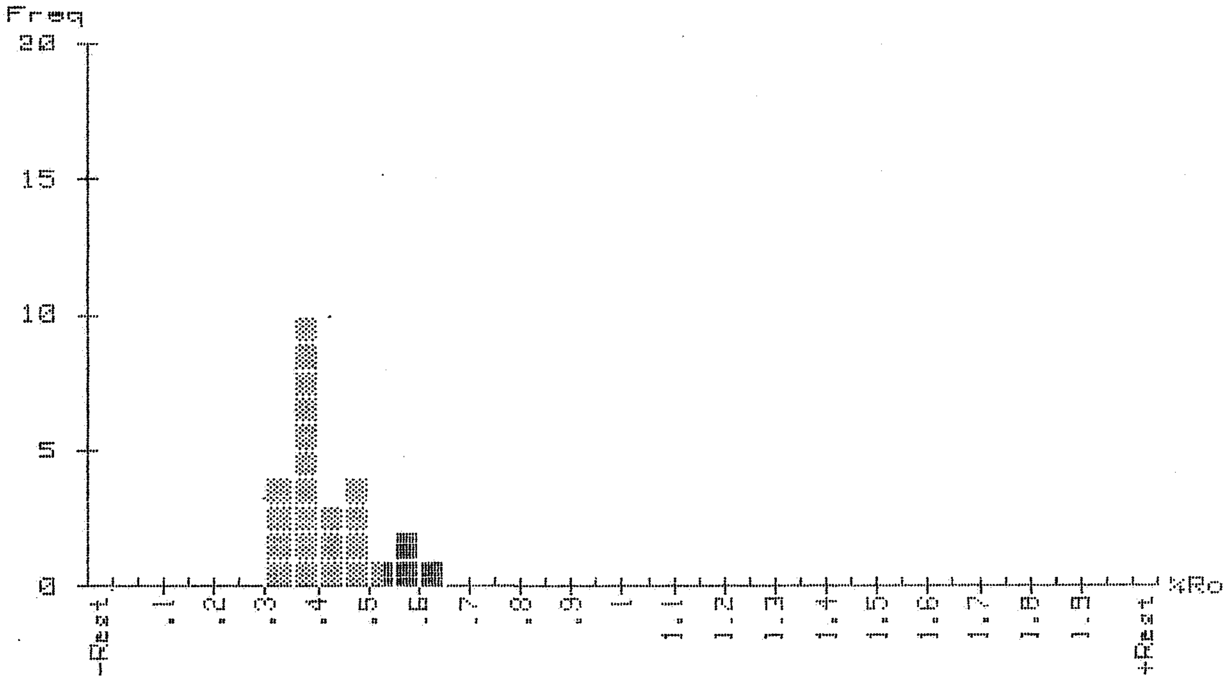
An ideal sample is characterised as follows: ooooo

Table 2. Vitrinite reflectance trend well 6507/11-4

WELL: 6507/11-4

depth mrk	vitrinite reflectance trend
100	
200	
400	
600	
800	
1000	
1200	
1400	
1600	
1800	
2000	
2200	
2400	0.40
2600	0.43
2800	0.47
3000	0.52
3200	
3400	
3600	
3800	
4000	
4200	
4400	
4600	
4800	

Sample No.: |249 | |A|
Well Name: |6507/11-4 |
Depth: |2533.4 m, SWC |
Analyst: |T.THRONDSEN |
Date: |09.11.1987 |



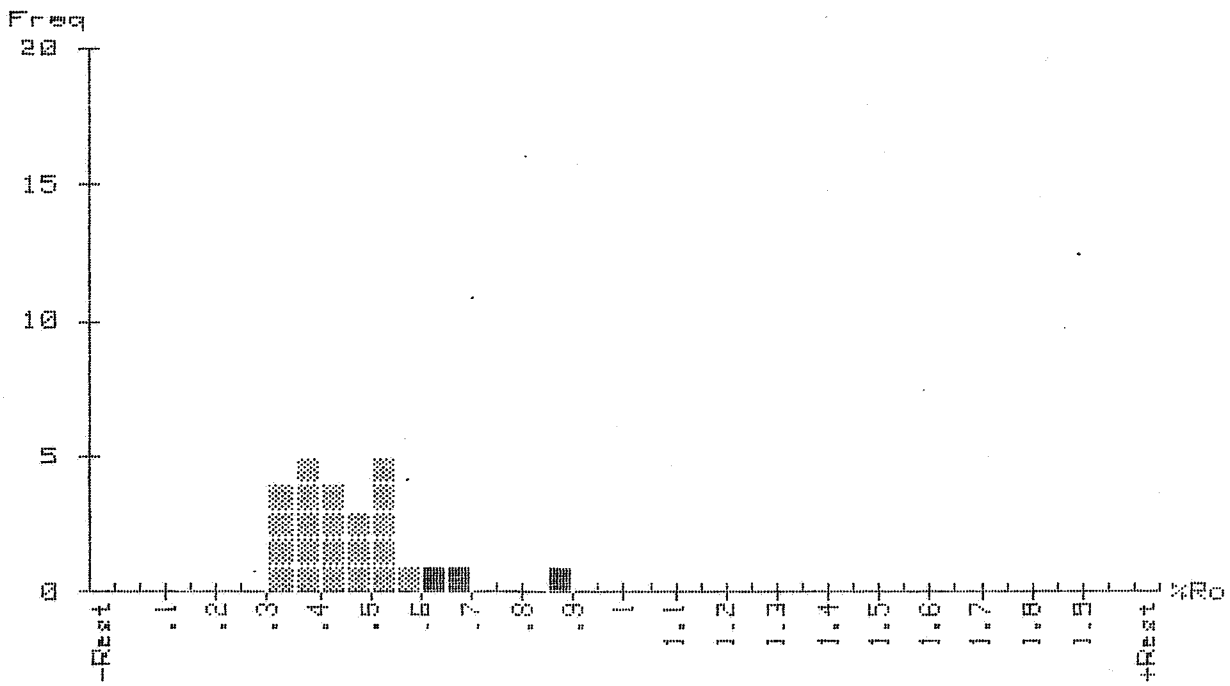
* Pop. 1 From .30 to .53 Mean= .40 St.D= .06 Total= 22
· Pop. 2 From .53 to .65 Mean= .58 St.D= .04 Total= 3

Sample No.: |249 | |A|
Well Name: |6507/11-4 |
Depth: |2533.4 m, SWC |
Analyst: |T.THRONDSEN |
Date: |09.11.1987 |

Channel: R1 6507/11-4,2533.4m,SWC
No. of Measurements: 25
Mean: .419
Standard Deviation: .082
Coeff. of Variation: .1964

	1	2	3	4	5	6	7	8	9	10
0	.327	.329	.332	.332	.355	.356	.359	.364	.368	.371
10	.378	.380	.383	.386	.421	.424	.425	.469	.478	.490
20	.496	.501	.555	.557	.630					

Sample No.: |250 | |A|
Well Name: |6507/11-4 |
Depth: |2536.4 m, SWC |
Analyst: |T.THRONDSEN |
Date: |09.11.1987 |



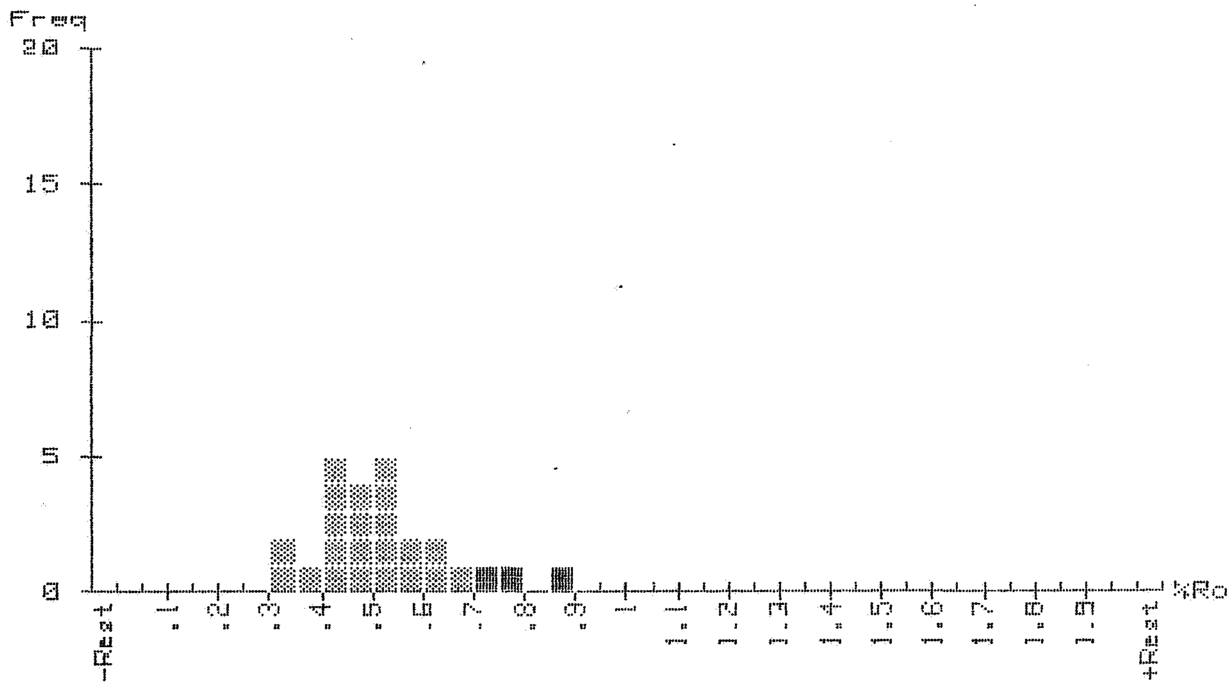
*	Pop.	1	From	.30	to	.60	Mean=	.43	St.D=	.08	Total=	22
	Pop.	2	From	.60	to	.70	Mean=	.65	St.D=	.04	Total=	2
	Pop.	3	From	.85	to	.90					Total=	0

Sample No.: ¦250 ¦ ¦A¦
Well Name: ¦6507/11-4 ¦
Depth: ¦2536.4 m. SWC ¦
Analyst: ¦T.THRONDSEN ¦
Date: ¦09.11.1987 ¦

Channel: R2 6507/11-4,2536.7m,SWC
No. of Measurements: 25
Mean: .466
Standard Deviation: .124
Coeff. of Variation: .2659

	1	2	3	4	5	6	7	8	9	10
0	.326	.327	.328	.329	.359	.381	.386	.386	.393	.409
10	.413	.420	.440	.466	.477	.499	.507	.508	.525	.525
20	.529	.552	.621	.681	.857					

Sample No.: ¦251 ¦ ¦A¦
Well Name: ¦6507/11-4 ¦
Depth: ¦2541.0 m, SWC ¦
Analyst: ¦T.THRONDSEN ¦
Date: ¦10.11.1987 ¦



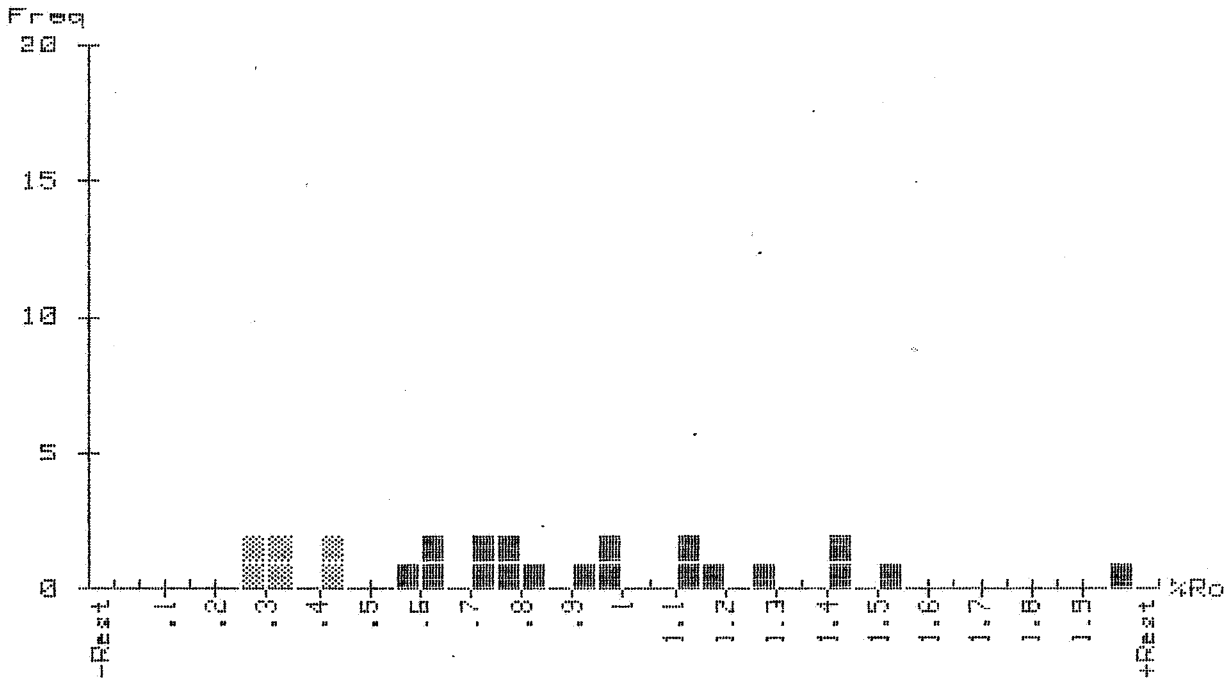
*	Pop.	1	From	.30	to	.70	Mean=	.49	St.D=	.10	Total=	22
	Pop.	2	From	.70	to	.90	Mean=	.78	St.D=	.08	Total=	3

```
Sample No.: |251   |   |A|
Well Name:  |6507/11-4          |
Depth:      |2541.0 m, SWC      |
Analyst:    |T.THRONDSEN        |
Date:       |10.11.1987         |
```

```
            Channel: R1 6507/11-4,2541.0m,SWC
No. of Measurements:      25
                Mean:        .525
  Standard Deviation:        .135
 Coeff. of Variation:        .2560
```

	1	2	3	4	5	6	7	8	9	10
0	.314	.324	.398	.402	.413	.428	.433	.442	.454	.464
10	.469	.471	.513	.521	.532	.546	.549	.565	.591	.643
20	.648	.679	.701	.773	.862					

Sample No.: |252 | |A|
Well Name: |6507/11-4 |
Depth: |2562.0 m, SWC |
Analyst: |T.THRONDSEN |
Date: |10.11.1987 |



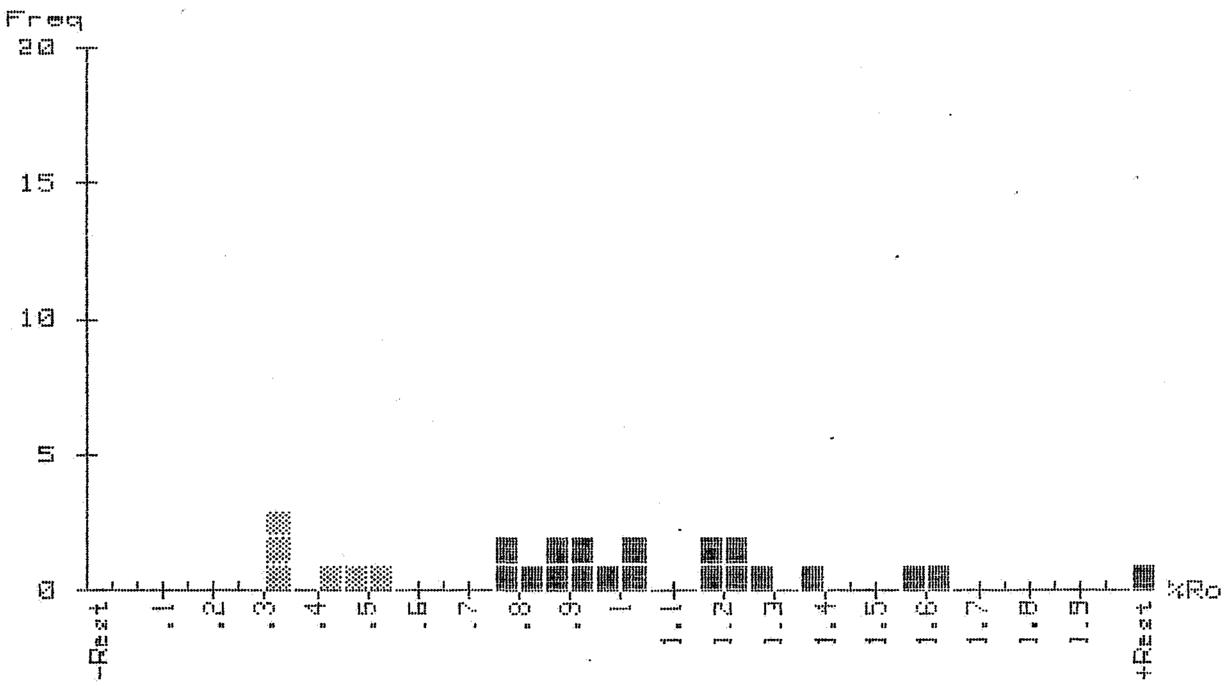
* Pop.	1	From	.25 to	.45	Mean= .35	St.D= .06	Total=	6
Pop.	2	From	.55 to	.65	Mean= .60	St.D= .04	Total=	3
Pop.	3	From	.70 to	.85	Mean= .76	St.D= .04	Total=	5
Pop.	4	From	.90 to	1.00	Mean= .98	St.D= .03	Total=	3
Pop.	5	From	1.10 to	2.00	Mean= 1.37	St.D= .28	Total=	8

```
Sample No.: |252  |  |A|
Well Name:  |6507/11-4             |
Depth:      |2562.0 m. SWC         |
Analyst:    |T.THRONDSEN           |
Date:       |10.11.1987            |


            Channel: R2 6507/11-4,2562.0m,SWC
No. of Measurements:        25
               Mean:          .863
 Standard Deviation:          .435
Coeff. of Variation:          .5044
```

	1	2	3	4	5	6	7	8	9	10
0	.284	.292	.319	.339	.402	.441	.557	.615	.631	.716
10	.718	.761	.779	.819	.946	.997	.998	1.112	1.118	1.167
20	1.257	1.406	1.425	1.528	1.951					

Sample No.: |253 | |A|
Well Name: |6507/11-4 |
Depth: |2571.00 m, CORE |
Analyst: |T.THRONDSEN |
Date: |10.11.1987 |



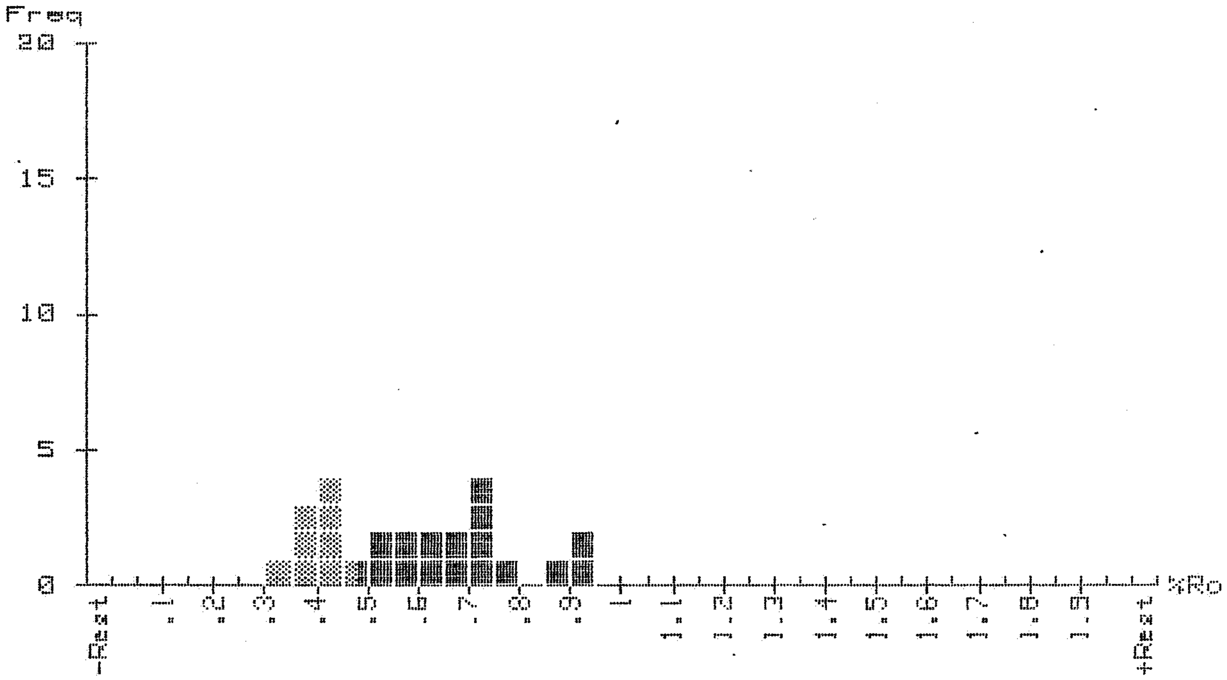
*	Pop.	1	From	.30	to	.55	Mean=	.40	St.D=	.09	Total=	6
	Pop.	2	From	.75	to	1.05	Mean=	.90	St.D=	.10	Total=	10
	Pop.	3	From	1.15	to	1.40	Mean=	1.24	St.D=	.07	Total=	6
	Pop.	4	From	1.55	to	1.65	Mean=	1.60	St.D=	.02	Total=	2

```
Sample No.: |253   |   |A|
Well Name:  |6507/11-4         |
Depth:      |2571.00 m, CORE   |
Analyst:    |T.THRONDSEN       |
Date:       |10.11.1987        |
```

```
            Channel: R3 6507/11-4,2571.00m,CO
No. of Measurements:       25
               Mean:        .961
 Standard Deviation:        .433
Coeff. of Variation:        .4502
```

	1	2	3	4	5	6	7	8	9	10
0	.315	.319	.336	.428	.453	.547	.755	.771	.809	.870
10	.898	.906	.917	.995	1.023	1.028	1.164	1.186	1.210	1.239
20	1.272	1.361	1.586	1.616	2.020					

Sample No.: |254 | |A|
Well Name: |6507/11-4 |
Depth: |2581.00 m, CORE |
Analyst: |T.THRONDSEN |
Date: |10.11.1987 |



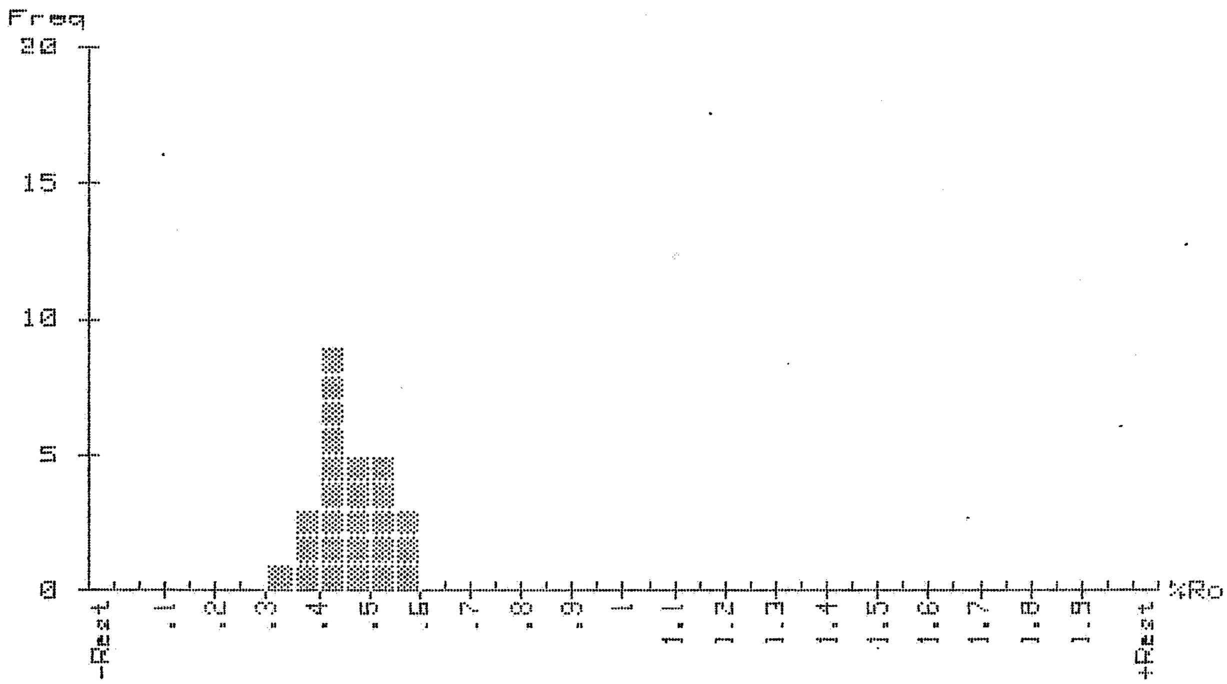
*	Pop.	1	From	.30	to	.48	Mean=	.40	St.D=	.05	Total=	9
	Pop.	2	From	.48	to	.83	Mean=	.65	St.D=	.09	Total=	13
	Pop.	3	From	.83	to	.95	Mean=	.91	St.D=	.03	Total=	3

Sample No.: |254 | |A|
Well Name: |6507/11-4 |
Depth: |2581.00 m, CORE |
Analyst: |T.THRONDSEN |
Date: |10.11.1987 |

Channel: R4 6507/11-4,2581.00m,CO
No. of Measurements: 25
Mean: .591
Standard Deviation: .183
Coeff. of Variation: .3091

	1	2	3	4	5	6	7	8	9	10
0	.318	.353	.354	.398	.411	.419	.435	.443	.465	.502
10	.503	.553	.588	.637	.639	.656	.695	.704	.717	.732
20	.734	.764	.878	.927	.937					

Sample No.: |255 | |A|
Well Name: |6507/11-4 |
Depth: |2612.5 m, SWC |
Analyst: |T.THRONDSEN |
Date: |12.11.1987 |



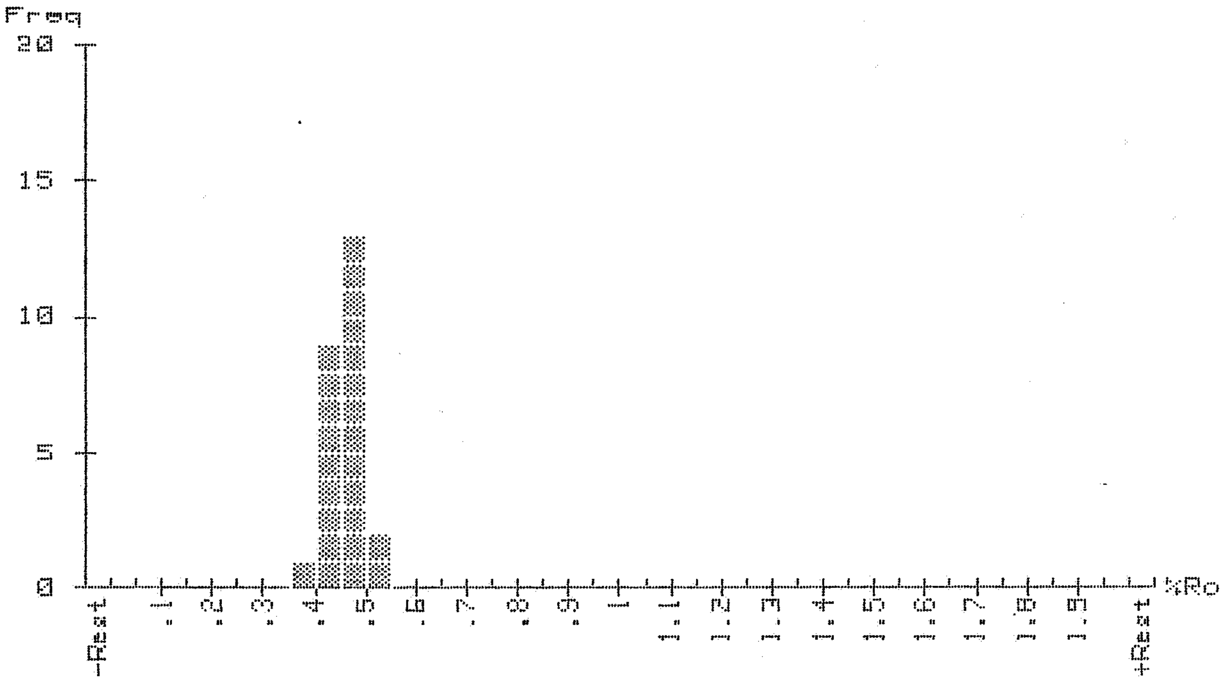
* Pop. 1 From .30 to .60 Mean= .46 St.D= .06 Total= 26

Sample No.: |255 | |A|
Well Name: |6507/11-4 |
Depth: |2612.5 m, SWC |
Analyst: |T.THRONDSEN |
Date: |12.11.1987 |

Channel: R1 6507/11-4,2612.50m,SW
No. of Measurements: 26
Mean: .460
Standard Deviation: .065
Coeff. of Variation: .1407

	1	2	3	4	5	6	7	8	9	10
0	.313	.377	.395	.396	.403	.404	.420	.423	.424	.427
10	.444	.445	.448	.452	.456	.458	.471	.478	.503	.511
20	.533	.536	.540	.555	.565	.573				

```
Sample No.: |256   |   |A|
Well Name:  |6507/11-4            |
Depth:      |2687.00 m, CORE      |
Analyst:    |T.THRONDSEN          |
Date:       |12.11.1987           |
```



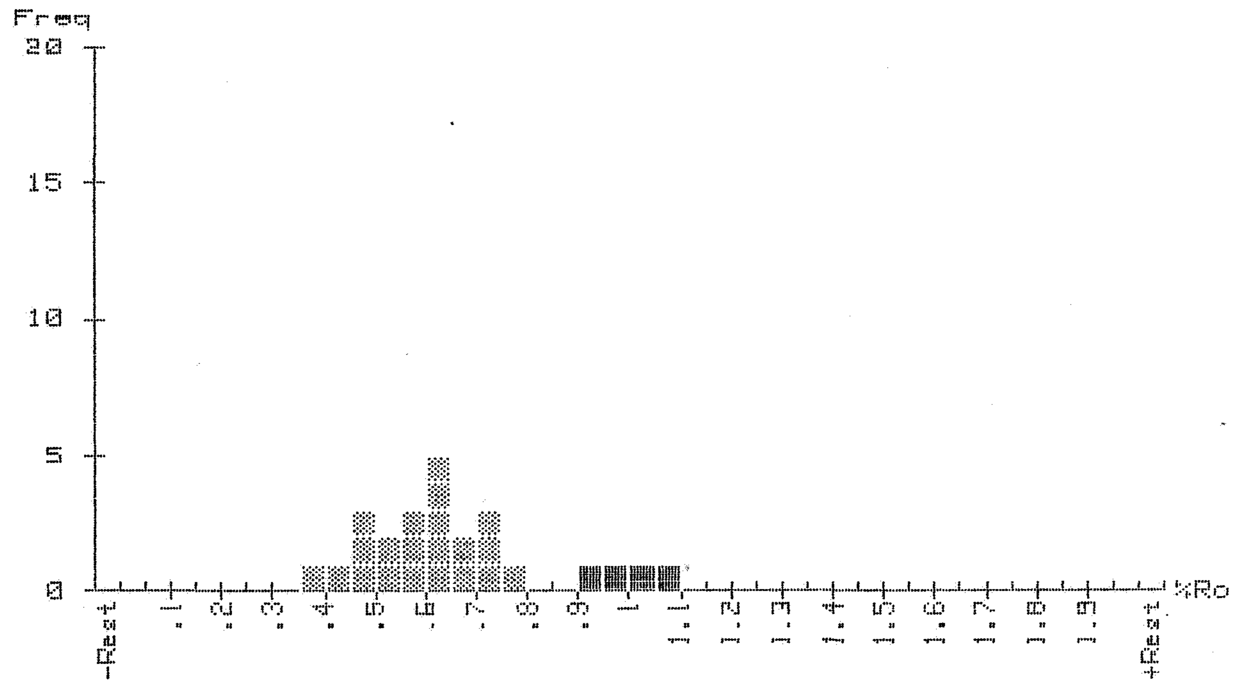
* Pop. 1 From .35 to .55 Mean= .45 St.D= .03 Total= 25

Sample No.: |256 | |A|
Well Name: |6507/11-4 |
Depth: |2687.00 m, CORE |
Analyst: |T.THRONDSEN |
Date: |12.11.1987 |

Channel: R2 6507/11-4,2687.00m,CO
No. of Measurements: 25
Mean: .453
Standard Deviation: .029
Coeff. of Variation: .0642

	1	2	3	4	5	6	7	8	9	10
0	.392	.415	.416	.418	.425	.427	.432	.437	.438	.439
10	.450	.455	.458	.460	.466	.467	.467	.468	.468	.471
20	.472	.492	.494	.500	.505					

Sample No.: |257 | |A|
Well Name: |6507/11-4 |
Depth: |2881.50 m, CORE |
Analyst: |T.THRONDSEN |
Date: |12.11.1987 |



*	Pop.	1	From	.35	to	.80	Mean=	.59	St.D=	.10	Total= 21
	Pop.	2	From	.90	to	1.10	Mean=	.99	St.D=	.07	Total= 4
	Pop.	3	From	1.10	to	1.13					Total= 0
	Pop.	4	From	1.13	to	1.15					Total= 0

Sample No.: |257 | |A|
Well Name: |6507/11-4 |
Depth: |2881.50 m, CORE |
Analyst: |T.THRONDSEN |
Date: |12.11.1987 |

Channel: R3 6507/11-4,2881.50m,CO
No. of Measurements: 25
Mean: .655
Standard Deviation: .179
Coeff. of Variation: .2727

	1	2	3	4	5	6	7	8	9	10
0	.391	.442	.463	.499	.499	.516	.528	.560	.565	.567
10	.604	.605	.616	.643	.643	.665	.690	.701	.704	.706
20	.796	.908	.970	1.006	1.082					