DANMARKS OG GRØNLANDS GEOLOGISKE UNDERSØGELSE RAPPORT 2003/93

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Summary

The deep Hejre-1 and Svane-1/1A wells were drilled in the Gertrud and Tail End grabens in the Danish Central Trough to depths of 5294 m TVMDRT (true vertical mean depth below rotary table) and 5903 m TVMDRT. The Hejre-1 well had TD in pre-Jurassic rocks of unknown age, whereas the Svane-1/1A well had TD in Upper Jurassic rocks. A net oil column of 20.5 m with 19 m with a hydrocarbon saturation of 93% was encountered in the Hejre-1 well in the Heno Sand Formation. Temperatures are high, about 169°C at TD, and pressures are c. 14550 psi. In Svane-1/1A a condensate interval of 110 m with a hydrocarbon saturation of 69% was encountered in the Heno Sand equivalent. The TD temperature is c. 190°C.

Both wells were drilled with oil-based mud (VersaVert), which despite thorough washing and rinsing made source rock screening analyses highly unreliable. Therefore, no source rock quality interpretations have been attempted.

Vitrinite reflectance (VR) trends of both the Hejre-1 and Svane-1/1A wells show an upper linear segment, a middle part with a rapid increase in VR, and a lower linear segment with a higher VR gradient than the upper linear part. The VR curve of Hejre-1 cuts the surface at c. 0.17%R_o, whereas the Svane-1/1A VR curve cuts the surface at c. 0.14%R_o. These features are typical for undisturbed sediment packages. Semilog plots of the VR curves yield well-defined straight lines with gradients of 0.17%R_o/km for Hejre-1 and 0.19%R_o/km for Svane-1/1A. Around TD the mean VR in Hejre-1 is 1.18%R_o and in Svane-1/1A 1.53%R_o, which compared to the high temperatures seem too low. Overpressure induced retardation of organic matter maturation may be a sound explanation for the relatively low maturities. In overpressured basins the oil window will be translated to greater burial depth, which is positive for the prospectivity of the deep prospects. In particular, coaly source rocks may still be in the oil window due to the special generation characteristics displayed by terrestrial organic matter. Both the Hejre-1 oil and Svane-1/1A condensate seem to have a terrestrial input. The Svane DST2 condensate shows a relative significantly higher gammacerane content than that found in usual North Sea oils derived from Upper Jurassic source rocks.

Content

1. Introduction

This report presents the results of a petrographic and geochemical study of cutting samples from the Hejre-1 and Svane-1/1A deep wells in the Danish Central Graben, North Sea. The wells are the deepest in the Danish part of the North Sea. The aims of the study were to identify and qualify potential source rock intervals and to assess the maturation trends of the wells. In addition, the result of a biomarker analysis of a condensate from Svane-1/1A is reported.

The Hejre-1 well was drilled in the Gertrud Graben on block 5603/28 in the northern part of the Danish Central Graben by Phillips Petroleum International Corporation-Denmark (PPIC-D) and DONG E&P A/S on behalf of PPIC-D, Norsk Hydro ASA, Veba Oil & Gas UK ltd, and DONG E&P, the partners in 5/98 Licence Group (Fig. 1). Water depth was c. 67 m and rotary table elevation above mean sea level was c. 37 m. The well was principally drilled in order to test the reservoir potential of Upper Jurassic Heno Formation sandstones. TD was reached at a depth of 5294 m TVMDRT (True Vertical Mean Depth below Rotary Table) after which the well was plugged and abandoned.

The Svane-1/1A well was drilled in the Tail End Graben on block 5604/26 in the northeastern part of the Danish Central Graben by PPICD and DONG E&P A/S on behalf of PPIC-D, Norsk Hydro ASA, Petro-Oil Denmark GmbH, and DONG E&P A/S (Fig. 1). Water depth at the drilling location was 60 m and the rotary table elevation was c. 38 m. The main objective of the well was to test the reservoir potential of the Upper Jurassic J62 sequence, which is a Heno Formation equivalent. The Svane-1 well was drilled to 4933 m and plugged, and subsequently sidetracked by Svane-1A to a total depth of 5903.5 m TVMDRT. At TD the maximum deviation of Svane-1A was 17.4°, corresponding to a maximum difference of 49 m between MDRT (Mean Depth below Rotary Table) and TVMDRT (Fig. 2). All sample depths used in this report refer to TVMDRT. In Svane-1A two DST's were carried out in Heno Formation equivalent sandstones after which the well was plugged and abandoned.

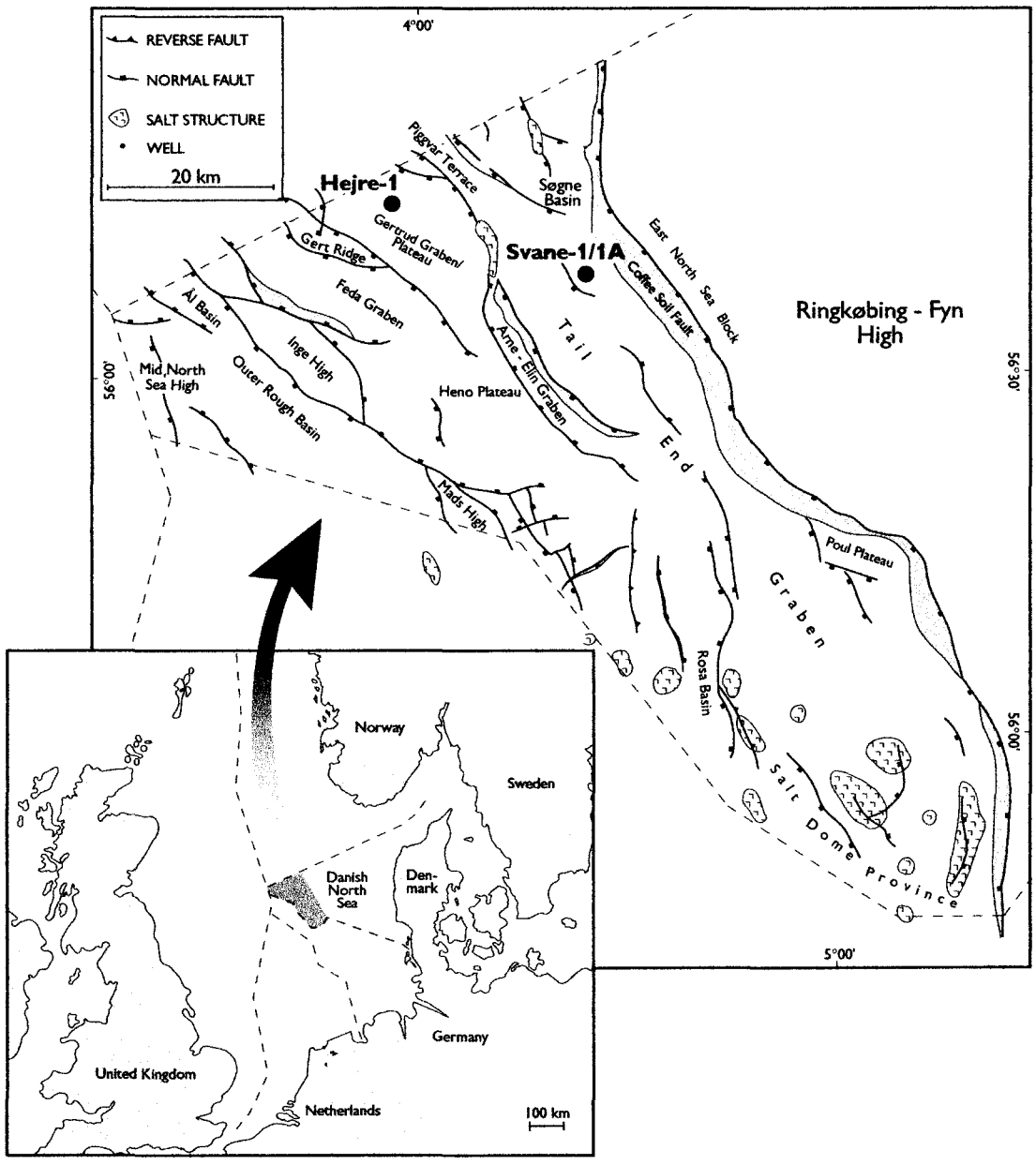

Figure 1. Location map of the Hejre-1 and Svane-1/1A wells in the Danish Central Graben.

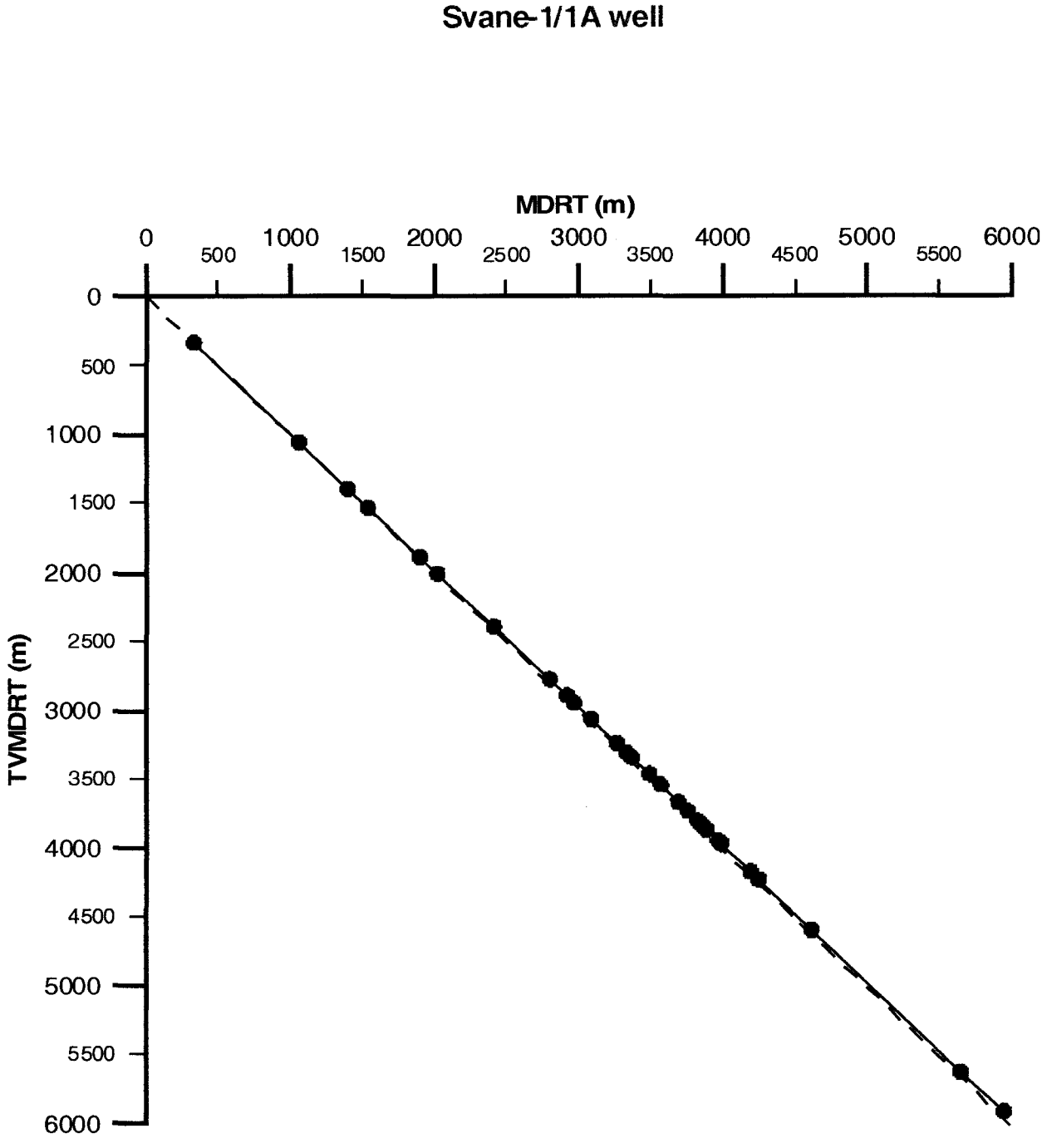

Figure 2. Correlation between measured depth (MDRT) and true vertical mean depth below rotary table (TVMDRT) for Svane-1/1A well. The stippled line indicates a 1:1 correlation.

2. Well results: synopsis

This section provides a brief overview of the stratigraphic and other results obtained by the Hejre-1 and Svane-1/1A wells as described in the final well reports for Hejre-1 and Svane-1/1A (PPIC-D and DONG E&P, 2002a, 2002b). The applied stratigraphy is similar to the one used in the final well reports. It should be noted that the Mandal Formation in the Norwegian North Sea area corresponds to the uppermost part of the Farsund Formation, including the Bo Member (previously called the "Hot Unit"), in the Danish Central Graben (Dybkjær, 1998; Michelsen et al., 2003).

2.1. The Hejre-1 well

The well was drilled to a TD of 5303 m into pre-Jurassic rocks of unknown age. Down to 1586 m Hejre-1 penetrated Quaternary loose quartz sand, and Pliocene and Upper–Middle Miocene deposits of the Nordland Group, which mainly are composed of claystones with frequent loose sand beds in the Pliocene (Table 1). The interval from 1586–2993 m is principally composed of Middle Miocene to Lower Eocene claystones with some intervals containing numerous thin limestone and dolomitic limestone beds; the deposits belong to the Hordaland Group. The Lower Eocene to upper Lower Paleocene section between 2993 m and 3098 m consists of claystones assigned to the Balder, Sele, Lista, and Våle formations of the Rogaland Group (Table 1).

The Lower Paleocene to Lower Cenomanian Chalk Group was penetrated between 3098 m and 3701 m, and consist of chalk, sometimes argillaceous in part, belonging to the Ekofisk, Tor, Hod, and Hidra formations. Very weak hydrocarbon shows were detected in the Ekofisk and Tor formations. The shows in the Ekofisk Formation may represent the remnants of migrated hydrocarbons, whereas the shows in the Tor Formation are oil-based mud (OBM) filtrate contamination. From 3701–4309 m the Rødby, Sola, Tuxen, and Valhall formations of the Upper Albian to Upper Ryazanian Cromer Knoll Group were drilled. The Rødby and Sola formations consist mainly of calcareous claystones, whereas the Tuxen Formation and the upper part of the Valhall Formation primarily consists of limestones and marl. The remaining part of the Valhall Formation contains variably calcareous claystones and thin limestone beds. Some very weak shows were seen in the Tuxen and Valhall formations.

The section between 4309 m and 5150 m consists of Upper Ryazanian to Lower Volgian and indeterminate Upper Jurassic sediments belonging to the Mandal, Farsund, and Heno formations of the Tyne Group (Table 1). Black claystones with occasional

Table 1: Lithostratigraphy, Hejre-1 well

Units	TVMDRT (m)	Thickness (m)
Nordland Group	*104*	*1482*
Base Quaternary	442	338
Hordaland Group	*1586*	*1407*
Rogaland Group	*2993*	*105*
Balder Fm.	2993	12
Sele Fm.	3005	43
Lista Fm.	3048	36
Våle Fm.	3084	14
Chalk Group	*3098*	*603*
Ekofisk Fm.	3098	119
Tor Fm.	3217	346
Hod Fm.	3563	132
Hidra Fm.	3695	6
Cromer Knoll Group	*3701*	*608*
Rødby Fm.	3701	28
Sola Fm.	3729	125
Tuxen Fm.	3854	91
Valhall Fm.	3945	364
Tyne Group	*4309*	*841*
Mandal Fm.	4309	150
Farsund Fm.	4459	633
Heno Sand Fm.	5092	58
Basal Sand Member	5125	25
Pre-Jurassic	5150	>153
TD	5303	-

TVMDRT: True vertical mean depth below rotary table

sandstone and siltstone beds characterise the Mandal Formation, whereas blackish claystones with very thin beds of limestone and dolomite are the typical lithology of the

Farsund Formation. Both the Mandal and Farsund formations had weak hydrocarbon shows.

The indeterminate Heno Formation comprise clay-, silt-, and sandstones. The formation can be divided into an upper more clayey unit and a sandy lower unit (Heno Basal Sand). In the upper unit a 5 m thick oil-bearing sandstone section occurs with an average porosity of 12.2%, and the net oil pay is 1.5 m with 60% hydrocarbon saturation (PPIC-D, 2002). The 25 m thick Basal Sand has a net oil pay of 19 m, an average porosity of 18.9%, and an average hydrocarbon saturation of 93%. The oil is estimated to have an API of 39.5°.

The pre-Jurassic section from 5150 to TD is composed of volcaniclastics and weathered volcanics.

Cutting samples were collected from 176 m depth to TD. Due to hole instability no conventional cores were taken and a sidewall core run was prevented by difficult hole conditions during logging at TD. It is noticeable that from 1785 m drilling was conducted with added Versa Vert oil-based mud.

Pressure measurements between 5126 m and 5144 m indicate a pressure between 1003.20 bar and 1004.32 bar (= 14550.4–14566.7 psi). Temperature measurements yield an estimated temperature at TD of 169°C, and by using a temperature of 8°C at the seabed a temperature gradient of 31°C/km can be calculated.

2.2. The Svane-1/1A well

The Svane-1/1A well was terminated at 5903 m depth in Upper Jurassic sandstones equivalent to the Heno Formation (Table 2). Down to 1403 m the well penetrated mainly loose, Quaternary quartz sand, Pliocene loose quartz sand and claystones, and Upper Miocene claystones of the Nordland Group. Claystones, in part with levels with limestone and dolomitic limestone beds, of the Middle Miocene to Lower Eocene Hordaland Group occur from 1403–2864 m. The Lower Eocene to upper Lower Paleocene Rogaland Group between 2864 m and 2950 m is only 86 m thick (Table 2). It consists principally of non-calcareous claystones of the Balder, Sele and Lista formations, and marls and very calcareous claystones of the Våle Formation.

The Lower Paleocene to Middle Cenomanian Chalk Group was penetrated from 2950–3797 m. The Ekofisk, Tor, Hod, and Hidra formations are present and consist of chalk which in the Hod and Hidra formations is more argillaceous. Although no shows were observed in the Ekofisk and Tor formations during drilling, petrophysical data suggests the occurrence of a 15–20% residual hydrocarbon saturation in parts of these

Table 2: Lithostratigraphy, Svane-1/1A well

Units	TVMDRT (m)	Thickness (m)
Nordland Group	*98*	*1305*
Base Quaternary	332	234
Hordaland Group	*1403*	*1461*
Rogaland Group	*2864*	*86*
Balder Fm.	2864	12
Sele Fm.	2876	20
Lista Fm.	2896	34
Våle Fm.	2930	20
Chalk Group	*2950*	*847*
Ekofisk Fm.	2950	110
Tor Fm.	3060	299
Hod Fm.	3359	370
Hidra Fm.	3729	68
Cromer Knoll Group	*3797*	*363*
Rødby Fm.	3797	15
Sola Fm.	3812	63
Tuxen Fm.	3875	62
Valhall Fm.	3937	223
Tyne Group	*4160*	*>1743*
Mandal Fm.	4160	120
Farsund Fm.	4280	996
Heno Sand equivalent	5276	>627
TD	5903	-

TVMDRT: True vertical mean depth below rotary table

formations. Very weak hydrocarbon shows were recorded in the lower part of the Hod Formation and in the Hidra Formation, but they may be related to oilbased mud contamination. The Cromer Knoll Group of Late Albian to Late Ryazanian age occurred from 3797–4160 m. The section comprises calcareous claystones, marl, and

argillaceous limestones of the Rødby and Sola formations, and interbedded more massive limestones and marl, on occasion with calcareous claystones, of the Tuxen Formation (Table 2). Very poor shows were observed in the Sola and Tuxen formations. The lower Valhall Formation consists primarily of calcareous claystones. The Upper Ryazanian Leek Member is present which, based on petrophysical data, in a limestone interval is considered to be hydrocarbon-bearing.

The Mandal, Farsund, and Heno formations of the Upper Ryazanian-Lower Volgian to Kimmeridgian-indeterminate Upper Jurassic Tyne Group occur from 4160 m down to TD. The Mandal Formation consists of carbonaceous, blackish claystones with occasional thin dolomites and limestones. Weak shows were recorded. Dark grey to dark brown and blackish carbonaceous claystones with very thin limestone, dolomitic limestone and dolomite beds characterise the Farsund Formation. Towards the base of the formation rare sand- and siltstone beds occur. The Svane-1A drilled 634 m of the Heno Formation equivalent sandstones, but did not penetrate the formation before TD was reached. The section can be divided into a sandy upper and lower part, and a middle part composed of claystones with dolomite and limestone stringers. Fair to good shows were observed. A net gas condensate bearing interval of 110 m with an average porosity of 12.0% and an average water saturation of 31.0%. DST1 tested the interval 5792–5910 m and DST2 tested the interval 5412–5602 m in the Heno J62 sands.

Cutting samples were collected from 161 m and down to TD. From 1013 m VersaVert oil-based mud was used during drilling. No conventional cores were taken due to unstable hole conditions and no sidewall cores were collected due to hole problems during logging at TD.

Temperature measurements yield an estimated TD temperature of 190°C, and by using a seabed temperature of 8°C and average temperature gradient of 31.3°C/km is obtained.

3. Samples and methods

A total of 164 cutting samples were collected from the Hejre-1 well. In Svane-1 a total of 98 cuttings were sampled, whereas a total of 141 were collected from Svane-1A. Table 3 shows the sampling intervals for screening analyses in the various stratigraphic levels for Hejre-1 and Svane-1/1A.

The samples were extremely dirty and contaminated. Initially they were washed with detergent in tepid water in a 355 μm sieve in order to rinse the samples and remove drilling mud. Sometimes the samples were put to soak in detergent for one day before they were washed. The samples from Svane-1/1A were more difficult to rinse. The washed samples were sieved between 1–4 mm sieves in order to obtain the analysis fraction (standard analysis range). Finally recognisable contaminants were removed manually from the analysis fraction; these may include metal and nylon threads, painting flakes, mica, magnetic metal pieces from the drill head, and small pellets of unknown origin (Teflon?). From the petrographic analyses it was also evident that graphite has been added. Much of this was removed during sifting. In some samples the cutting sample material was so limited that cutting particles were hand-picked from the sample.

The samples were crushed to a grain size <250 μm for total organic carbon (TOC), total carbon (TC) and total sulphur (TS) determinations, and Rock-Eval pyrolysis. Between 48–52 mg material is used for each analysis. The samples were decarbonated by HCl before TOC determination. Normally 300–500 mg sample material is used for TOC determination, but amounts down to 100 mg were also accepted. If less than 100 mg sample material was available only the TC and TS contents could be determined. TOC, TC and TS were measured on a LECO CS-200 instrument; the instrument was calibrated with an internal standard and checked for each 10. analysis. Rock-Eval pyrolysis was performed on a Rock-Eval 6 instrument. The instrument was calibrated with an external standard (IFP-55000 standard), and the analyses were additionally checked with an in-house standard which is run together with the samples. For further

Table 3: Sampling intervals and number (n) of samples for screening analyses

Well	MDRT interval (m)	Stratigraphy	Series	Sampling interval (m)	n
Hejre-1	1000-1540	Nordland Group	Pleistocene - U. Miocene	60	10
	1600-3000	Hordaland Group	M. Miocene - L. Eocene	60	22
	3100-3700	Chalk Group	L. Paleocene - E. Cenomanian	100	7
	3730-4300	Cromer Knoll Group	L.-?M. Albian - U. Ryazanian	30	20
	4305-4460	Mandal Formation	U. Ryazanian - M. Volgian	5	30
	4465-4500	Farsund Formation	M. Volgian	5	8
	4510-5000	Farsund Formation	M. Volgian - Jurassic unspecified	10	50
	5009-5090	Farsund Formation	Jurassic unspecified	9	10
	5099-5190	Heno Sand Formation	Jurassic unspecified	9	7
Svane-1	170-3420	Nordland, Hordaland, Rogaland & Chalk groups	Pleistocene - L. Campanian	100	30
	3750-4100	Chalk & Cromer Knoll groups	L. Coniacian - U. Ryazanian	varying, between 20-30	14
	4115-4310	(Cromer Knoll Group) & Mandal Formation	U. Ryazanian - M. Volgian	15	14
	4325-4930	Farsund Formation	M. Volgian - E. Volgian-?U. Kimmeridgian	15	40
Svane-1A	4055-4188	Cromer Knoll Group	L. Valanginian - U. Ryazanian	15	10
	4206-4310	Mandal Formation	U. Volgian - M. Volgian	15	8
	4325-5055	Farsund Formation	M. Volgian - E. Volgian-?U. Kimmeridgian	15	49
	5070-5310	Farsund Formation	E. Volgian - ?U. Kimmeridgian	10	25
	5320-5500	Heno Sand equivalent	E. Volgian - ?U. Kimmeridgian	10	18
	5514-5952	Heno Sand equivalent	Kimmeridgian - Jurassic unspecified	15	31

information on the Rock-Eval pyrolysis see e.g. Peters (1986), Bordenave et al. (1994) and Lafargue et al. (1998).

Pellets of whole rock samples suited for reflected light microscopy were prepared from part of the analysis fractions (1–4 mm) from 39 samples from Hejre-1, 27 samples from Svane-1, and 44 samples from Svane-1A. The samples were embedded in epoxy, ground, and polished to obtain a smooth analysis surface. Vitrinite reflectance (VR; $\%R_o$) measurements were conducted by a Leitz reflected light microscope with a 50x objective and oil immersion at 546 nm (monochromatic light). The VR measurements were "random", i.e. the samples were not oriented before measurements as is the case for maximum VR measurements ($\%R_{max}$). For further information on the methodology etc. of VR measurements see e.g. Taylor et al. (1998).

The microscope was calibrated against three standards: the 0.515$\%R_o$ standard was used up to measured VR values of c. 0.75$\%R_o$; the 0.893$\%R_o$ standard was used in the VR range of approximately 0.75– 1.2$\%R_o$; and the 1.677$\%R_o$ standard was used above 1.2$\%R_o$. Several samples did not contain measurable organic matter and VR values were not determined. As many measurements as possible were carried out in each sample, and afterwards the mean VR value was calculated from a selected population from the total amount of measurements. The selected VR population was considered to represent the true degree of maturation at the actual depth.

The Svane DST2 stock tank condensate (perforation: 5412–5602 m) has been analysed. The condensate was fractionated into saturated, aromatic and polar compounds (NSO) by MPLC (Radke et al., 1980). A biomarker concentrate was prepared from the saturated fraction following the procedure in Nytoft and Bojesen-Koefoed (2001).

Gas chromatography-mass spectrometry (GC-MS) was carried out using a Hewlett-Packard 6890N gas chromatograph connected to a Waters (Micromass) Quattro Micro GC tandem quadropole mass spectrometer. The GC was fitted with an HP-5MS column (30 m x 0.25 mm i.d., film thickness 0.10 µm). The temperature program was 30°C/min from 70 to 100°C and 4°C/min from 100 to 308°C followed by 8 min at 308°C. The samples were dissolved in isooctane, and the concentration was about 3 mg/100µl. The

MS was operated in electron impact (EI) mode with an electron energy of 70 eV. Analysis was done in the selected ion monitoring (SIM) detection mode. GC-MS-MS analysis was carried out using the same instrument and identical GC-conditions. Argon was used as collision gas.

4. Results and discussion

4.1. Source rock evaluation

The hydrocarbon generation potential of the penetrated strata has been evaluated by analysing 164 samples in the Hejre-1 well and a total of 239 samples in the Svane-1/1A well by Rock-Eval pyrolysis (Tables 4, 5 and 6). Sampling intervals were most dense in the normal source rock units, i.e. the Upper Jurassic Mandal and Farsund formations (Table 3).

The obtained results are not reliable and cannot be used for determining the source rock quality. Despite the careful and thorough rinsing with detergent in tepid water and removal of physical contaminants before the screening analyses, the use of oil-based drilling mud has obscured the analysis results and prevented meaningful interpretation. The addition of oil base mud obscures the measurements of S_1 and S_2 by the Rock-Eval instrument. The remnant oil base mud in the samples after rinsing interferes with the potential true free hydrocarbons, and will in addition in part also be represented in the S_2 peak thereby hindering estimation of the true remaining source potential.

The inability to define the S_1 and S_2 peaks by the Rock-Eval instrument will often result in wrong estimates of T_{max}. This is illustrated by the T_{max} *vs* depth plots for the Hejre-1 and Svane1/1A wells (Figs. 3 and 4). The expected increase in T_{max} with increasing depth (maturity) is not present. In contrast Hejre-1 shows three tentative trends of which the middle trend actually is decreasing whereas the lowest trend only shows a very minor increase in T_{max}. The Svane-1/1A well shows no meaningful T_{max} trend through the drilled section. At TD around 6 km's depth, where the temperature is estimated to be about 190°C, the T_{max} values are generally <430°C. This indicates immaturity (approximately equivalent to a VR of less than 0.55%R_o; Hunt, 1996, p. 389), which of course is highly unlikely.

Table 4: Screening data, Hejre-1 well

GEUS Labno.	MDRT (m)	TOC (wt.%)	TC (wt.%)	TS (wt.%)	Tmax (°C)	S_1 (mg HC/g rock)	S_2 (mg HC/g rock)	HI	PI	PC
9161	1000		4.86	15.74	420	18.95	8.43		0.69	2.27
9162	1060				366	0.18	0.62		0.23	0.07
9163	1120		3.94	27.60	364	0.27	0.27		0.50	0.04
9164	1180				389	0.15	0.20		0.43	0.03
9165	1240	0.57	5.95	11.97	389	0.13	0.59	104	0.18	0.06
9166	1300	0.42	8.65	3.59	406	0.04	0.30	72	0.12	0.03
9167	1360				404	0.24	0.59		0.29	0.07
9168	1420		6.32	3.34	398	0.18	0.65		0.22	0.07
9169	1480	1.24	1.47	0.88	342	0.54	4.30	347	0.11	0.40
9170	1540	0.82	5.73	0.57	339	0.40	2.56	311	0.14	0.25
9171	1600	2.07	3.47	1.23	418	0.68	8.96	433	0.07	0.80
9172	1660	2.47	3.35	1.32	331	1.11	11.66	473	0.09	1.06
9173	1720	2.73	3.77	1.54	338	0.90	12.00	440	0.07	1.07
9174	1780	2.39	3.90	1.45	339	1.09	11.93	499	0.08	1.08
9175	1840	3.65	7.20	2.72	430	25.20	7.60	208	0.77	2.72
9176	1900	5.95	6.22	1.64	421	30.66	11.53	194	0.73	3.50
9178	2020		7.26	0.82	437	13.24	5.89		0.69	1.59
9179	2080				404	5.67	2.79		0.67	0.70
9180	2140		9.49	0.82	410	5.43	1.67		0.76	0.59
9181	2200				423	11.71	6.31		0.65	1.50
8218	2320	1.02	5.82	24.57	405	1.93	0.62	61	0.76	0.21
8219	2380				401	4.40	1.61		0.73	0.50
8220	2440	1.34	9.63	0.59	405	21.68	1.17	88	0.95	1.90
8221	2500	1.24	8.69	1.67	418	15.09	1.32	106	0.92	1.36
8222	2560	0.94	8.83	4.15	423	8.19	1.05	111	0.89	0.77
8223	2620	1.84	10.28	0.75	413	32.06	2.14	116	0.94	2.84
8224	2680	1.48	9.53	0.82	403	20.62	1.52	103	0.93	1.84
8225	2740	0.94	10.24	0.70	406	11.17	1.32	141	0.89	1.04
8226	2820	1.26	8.48	0.44	399	12.73	1.87	148	0.87	1.21
8228	2920	1.14	5.34	0.61	305	6.53	1.96	172	0.77	0.70
8229	2980				386	3.25	2.37		0.58	0.47
8230	3000	1.61	5.69	1.43	415	10.19	2.57	160	0.80	1.06
8231	3100	1.37	11.40	0.25	433	29.01	3.23	235	0.90	2.68
8232	3200	1.17	10.45	0.33	430	22.77	3.93	336	0.85	2.22
8233	3300	0.96	14.06	0.25	438	48.86	2.38	247	0.95	4.25
8234	3400	1.18	12.84	0.77	435	36.39	2.67	227	0.93	3.24
8235	3500	0.94	11.94	0.18	436	34.34	2.77	294	0.93	3.08
8236	3600	1.46	10.86	0.50	434	35.93	4.12	283	0.90	3.32
8237	3700	1.48	10.95	0.48	439	27.24	5.84	396	0.82	2.75
8249	3730	1.11	7.18	0.30	420	10.53	2.93	263	0.78	1.12
8250	3760	1.11	8.07	0.54	437	12.63	2.10	190	0.86	1.22

Table 4 continued										
8251	3790	1.48	10.28	0.15	446	21.89	2.94	199	0.88	2.06
8252	3820	1.34	9.70	0.49	407	18.28	2.46	184	0.88	1.72
8253	3850	1.27	11.81	0.32	444	27.73	2.81	221	0.91	2.53
8254	3880	1.16	12.08	0.53	444	31.79	3.07	265	0.91	2.89
8255	3910	1.36	10.94	0.33	437	23.93	2.79	205	0.90	2.22
8256	3940	1.96	10.61	0.77	432	38.13	3.66	187	0.91	3.47
8257	3965	1.75	10.87	0.40	440	31.28	3.30	189	0.90	2.87
8258	4000	1.49	8.86	0.48	440	15.18	2.74	184	0.85	1.49
8259	4030	1.25	6.29	0.76	408	11.50	1.44	115	0.89	1.07
8260	4060	1.35	9.45	0.33	431	19.43	3.24	241	0.86	1.88
8261	4090	4.05	9.25	0.65	401	20.31	1.26	31	0.94	1.79
8262	4120	1.48	8.40	0.39	406	21.11	1.76	119	0.92	1.90
8263	4150	1.05	7.65	0.87	405	11.75	1.20	114	0.91	1.07
8264	4180	1.00	7.28	0.90	406	8.94	0.97	97	0.90	0.82
8265	4210	1.22	8.66	0.73	401	15.06	1.17	96	0.93	1.35
8266	4235	1.23	8.84	0.54	401	21.49	1.31	107	0.94	1.89
8267	4270	1.46	8.18	0.52	405	24.86	1.55	106	0.94	2.19
8268	4300	1.14	10.13	0.72	439	22.22	3.94	347	0.85	2.17
8330	4305	2.04	12.37	0.67	436	48.83	8.61	421	0.85	4.77
8331	4310	5.85	9.38	2.03	445	44.28	39.22	670	0.53	6.93
8332	4315	7.12	9.88	1.97	439	54.95	38.45	540	0.59	7.75
8333	4320	7.15	9.48	1.85	439	66.73	34.33	480	0.66	8.39
8334	4325	7.31	9.40	1.86	438	60.39	37.61	514	0.62	8.13
8335	4330	8.04	11.43	1.85	438	58.83	42.18	525	0.58	8.38
8336	4335	7.48	10.19	1.92	436	38.82	33.33	445	0.54	5.99
8337	4340	6.18	9.32	1.62	436	35.74	24.87	402	0.59	5.03
8338	4345	3.96	6.34	1.16	436	20.67	13.24	334	0.61	2.81
8339	4350	3.50	4.78	0.92	433	12.38	11.10	317	0.53	1.95
8340	4355	8.43	11.47	2.85	568	3.29	0.17	2	0.95	0.29
8341	4360	7.99	10.60	2.48	437	41.58	36.94	462	0.53	6.52
8342	4365	7.50	10.37	2.80	433	46.82	28.77	383	0.62	6.27
8343	4370	5.81	10.54	1.84	439	36.50	25.68	442	0.59	5.16
8344	4375	7.58	10.17	2.30	435	38.00	30.62	404	0.55	5.70
8345	4380	5.39	8.11	1.52	437	28.29	21.36	396	0.57	4.12
8346	4385	8.16	11.16	1.96	441	57.07	34.95	428	0.62	7.64
8347	4390	7.74	11.03	2.02	439	56.23	33.03	427	0.63	7.41
8348	4395	7.98	10.84	2.09	437	56.40	33.33	418	0.63	7.45
8349	4400	8.30	10.80	1.94	442	63.86	32.90	396	0.66	8.03
8350	4410	7.97	10.48	1.95	437	63.20	31.89	400	0.66	7.89
8351	4415	7.83	10.72	2.14	439	65.99	28.80	368	0.70	7.87
8352	4420	6.19	8.82	1.81	441	56.21	20.03	324	0.74	6.33
8353	4425	4.85	6.97	1.65	439	37.40	15.19	313	0.71	4.36
8354	4430	3.81	8.56	1.99	437	36.06	10.61	278	0.77	3.87
8355	4435	4.22	5.95	2.23	435	33.49	7.33	174	0.82	3.39
8356	4440	2.84	4.44	2.03	433	18.06	3.42	121	0.84	1.78

Table 4 continued										
8357	4450	3.55	4.19	2.10	435	16.30	3.68	104	0.82	1.66
8358	4455	3.62	8.53	1.51	434	32.49	5.61	155	0.85	3.16
8359	4460	3.05	9.12	1.32	436	31.72	4.69	154	0.87	3.02
8360	4465	4.33	7.15	1.52	438	49.91	6.88	159	0.88	4.71
8361	4470	3.46	4.87	1.76	431	24.50	3.79	109	0.87	2.35
8362	4475	3.16	5.69	1.35	435	23.86	4.36	138	0.85	2.34
8363	4480	3.04	11.13	0.09	436	41.62	5.67	186	0.88	3.93
8364	4485	3.54	6.64	1.40	435	33.26	4.89	138	0.87	3.17
8365	4490	3.98	9.48	1.40	432	52.32	5.42	136	0.91	4.79
8366	4495	4.49	6.62	1.63	432	52.47	4.62	103	0.92	4.74
8367	4500	5.24	7.94	1.71	436	65.59	6.85	131	0.91	6.01
8368	4510	5.07	7.83	1.81	438	68.19	5.82	115	0.92	6.14
8369	4520	2.92	10.97	1.07	438	42.89	5.19	178	0.89	3.99
8370	4530	4.67	7.89	1.65	436	62.58	6.27	134	0.91	5.71
8371	4540	2.53	4.89	2.12	431	12.32	4.06	161	0.75	1.36
8372	4550	2.72	3.79	1.70	427	15.82	3.81	140	0.81	1.63
8373	4560	2.83	4.29	1.79	423	21.49	3.47	123	0.86	2.07
8374	4570	2.75	6.12	1.64	436	23.88	3.82	139	0.86	2.30
8375	4580	3.25	9.28	1.33	435	39.64	5.25	161	0.88	3.73
8376	4590	2.78	4.85	1.90	424	19.64	3.99	143	0.83	1.96
8377	4600	2.84	5.04	1.60	425	17.36	3.77	133	0.82	1.75
8378	4610	2.82	4.54	1.68	431	21.50	3.92	139	0.85	2.11
8379	4620	3.71	5.66	1.95	428	32.12	3.96	107	0.89	2.99
8380	4630	3.14	5.24	2.07	428	28.50	3.36	107	0.89	2.64
8381	4640	2.94	4.55	2.16	425	16.05	3.72	126	0.81	1.64
8382	4650	3.88	5.38	2.42	429	37.54	3.81	98	0.91	3.43
8383	4660	3.28	6.04	2.02	429	33.55	4.23	129	0.89	3.14
8384	4670	3.43	6.41	1.96	434	34.70	4.92	143	0.88	3.29
8385	4680	3.75	8.83	1.59	434	51.14	4.71	126	0.92	4.64
8386	4690	4.04	10.18	1.51	435	66.30	7.84	194	0.89	6.15
8387	4700	4.07	8.28	1.14	446	49.92	10.34	254	0.83	5.00
8388	4710	5.72	12.58	1.39	427	116.96	18.42	322	0.86	11.24
8389	4720	5.73	12.91	1.16	437	100.84	9.38	164	0.91	9.15
8390	4730	5.01	12.66	1.07	433	84.09	8.46	169	0.91	7.68
8391	4740	4.73	9.64	1.17	430	60.79	8.31	176	0.88	5.74
8392	4750	5.42	9.92	1.17	434	84.99	9.13	168	0.90	7.81
8393	4760	4.97	13.90	0.84	431	93.93	7.49	151	0.93	8.42
8394	4770	4.81	12.68	0.69	427	89.81	6.82	142	0.93	8.02
8395	4780	5.34	12.15	0.92	424	87.24	7.81	146	0.92	7.89
8396	4790	4.31	11.54	1.08	427	65.32	6.96	162	0.90	6.00
8397	4800	5.49	9.33	1.50	428	74.89	7.69	140	0.91	6.85
8398	4810	3.58	7.11	1.31	434	45.91	7.14	199	0.87	4.40
8399	4820	2.22	6.94	1.14	437	35.69	4.48	202	0.89	3.33
8400	4835	2.16	8.57	1.06	437	24.76	4.94	228	0.83	2.47
8401	4840	2.42	9.24	1.03	435	22.04	5.50	228	0.80	2.29

Table 4 continued										
8402	4850	5.27	9.07	1.77	446	45.51	10.84	206	0.81	4.68
8403	4860	2.60	11.46	0.92	437	42.46	5.53	213	0.88	3.98
8404	4870	3.39	7.34	1.35	437	37.95	7.21	213	0.84	3.75
8405	4880	2.45	9.00	0.97	435	33.90	5.71	233	0.86	3.29
8406	4890	2.13	10.34	1.01	437	38.51	7.36	346	0.84	3.81
8407	4900	3.22	8.32	1.26	435	38.59	7.26	226	0.84	3.81
8408	4910	3.37	7.43	1.27	435	36.45	7.22	214	0.83	3.62
8409	4920	4.40	7.51	1.66	435	42.81	8.97	204	0.83	4.30
8410	4930	7.17	10.48	2.56	448	43.40	15.44	215	0.74	4.88
8411	4940	2.77	9.89	1.34	438	22.63	7.36	266	0.75	2.49
8412	4950	3.03	9.29	1.68	410	32.71	5.27	174	0.86	3.15
8413	4960	3.09	8.65	1.84	436	29.63	6.05	196	0.83	2.96
8414	4970	4.44	8.78	1.92	439	41.74	9.47	213	0.82	4.25
8415	4980	3.92	7.13	1.76	432	30.56	8.29	212	0.79	3.22
8416	4990	2.03	9.32	1.39	437	18.64	5.50	271	0.77	2.00
8417	5000	2.73	9.63	1.60	435	26.49	6.76	248	0.80	2.76
8418	5009	5.74	11.26	2.08	442	31.97	10.84	189	0.75	3.55
8419	5018	7.00	11.99	3.05	443	41.12	13.16	188	0.76	4.51
8420	5027	4.53	11.70	2.03	441	34.26	8.95	197	0.79	3.59
8421	5036	5.61	9.14	1.94	440	38.21	12.42	221	0.75	4.20
8422	5045	4.74	7.81	2.01	433	43.74	10.51	222	0.81	4.50
8423	5054	4.42	7.77	2.35	434	21.72	6.89	156	0.76	2.37
8424	5063	6.45	9.65	3.37	437	31.51	9.27	144	0.77	3.38
8425	5072	9.82	13.89	3.82	444	49.07	18.04	184	0.73	5.57
8426	5081	4.55	10.14	2.65	438	20.36	8.57	188	0.70	2.40
8427	5090	6.10	10.53	3.94	435	33.45	9.46	155	0.78	3.56
8428	5099				437	25.04	8.93		0.74	2.82
8429	5108		2.97	1.50	426	9.71	2.78		0.78	1.04
8431	5145	4.13	7.23	2.05	436	31.74	11.79	285	0.73	3.61
8433	5163		7.15	2.57	440	26.91	10.78		0.71	3.13
8434	5172		5.70	1.44	437	24.85	9.89		0.72	2.88
8435	5181	3.79	5.86	1.65	430	28.09	9.02	238	0.76	3.08
8436	5190	3.29	4.89	1.25	434	24.39	7.53	229	0.76	2.65

Table 5: Screening data, Svane-1 well

GEUS Labno.	MDRT (m)	TOC (wt.%)	TC (wt.%)	TS (wt.%)	Tmax (°C)	S_1 (mg HC/g rock)	S_2	HI	PI	PC
7848	170				326	5.69	34.88		0.14	3.37
7849	270	3.56	9.10	13.25	329	0.46	5.21	146	0.08	0.47
7850	370	0.09	10.61	0.27	413	0.01	0.10	108	0.09	0.01
7851	450	0.19	10.34	1.92	398	0.10	0.20	106	0.33	0.02
7852	570	28.41	33.46	1.68	362	1.87	39.61	139	0.05	3.44
7853	1020	2.01	7.04	1.51	448	27.25	7.37	366	0.79	2.87
7854	1120	1.42	7.58	3.82	452	27.89	12.36	869	0.69	3.34
7855	1220	2.65	3.42	0.98	422	21.72	5.06	191	0.81	2.22
7856	1320	2.45	2.98	0.71	425	17.96	4.75	194	0.79	1.88
7857	1420	4.48	5.47	0.97	427	42.26	10.38	232	0.80	4.37
7858	1530	7.12	8.53	1.63	417	28.03	12.51	176	0.69	3.36
7859	1620	4.68	5.36	1.54	415	11.42	9.30	199	0.55	1.72
7860	1730	3.64	4.99	1.31	426	17.71	10.34	284	0.63	2.33
7861	1820	5.06	5.86	1.41	420	20.72	10.91	216	0.66	2.63
7862	1920	4.38	5.25	1.34	421	33.77	8.11	185	0.81	3.48
7863	2020	3.46	4.49	1.33	432	33.36	6.89	199	0.83	3.34
7864	2120	3.70	4.77	1.19	425	34.13	6.61	179	0.84	3.38
7865	2230	3.04	3.92	1.29	431	23.90	6.18	204	0.79	2.50
7866	2340	3.01	4.96	0.97	422	23.40	6.23	207	0.79	2.46
7867	2420	2.08	11.22	0.55	409	31.62	3.10	149	0.91	2.88
7868	2520	1.76	7.94	0.27	405	25.06	2.45	139	0.91	2.28
7869	2620	1.32	6.54	0.56	295	7.27	2.24	169	0.76	0.79
7870	2720	2.10	4.96	4.96	293	21.53	3.56	169	0.86	2.08
7871	2820				408	9.64	1.78		0.84	0.95
7872	2920	1.47			416	6.62	3.36	229	0.66	0.83
7873	3025	1.25	10.58	0.17	433	31.90	3.97	318	0.89	2.98
7874	3120	0.63	13.79	0.18	425	38.07	3.88	613	0.91	3.48
7875	3220	0.38	13.42	0.14	427	30.09	3.35	877	0.90	2.78
7876	3320	0.85	12.55	0.26	427	27.93	4.69	553	0.86	2.71
7877	3420	1.11	13.02	0.24	433	36.29	5.14	465	0.88	3.44
7878	3750	2.11	5.98	0.70	436	16.82	4.46	211	0.79	1.77
7879	3800	2.04	9.79	0.54	437	28.59	5.14	252	0.85	2.80
7880	3825	1.83	5.19	0.77	431	11.51	4.24	232	0.73	1.31
7881	3850	1.29	3.35	2.76	428	5.76	2.96	230	0.66	0.72
7882	3876	7.46	14.18	2.81	432	34.03	31.05	416	0.52	5.40
7883	3900	1.67	11.02	0.22	440	22.37	6.67	399	0.77	2.41
7884	3921	4.78	12.51	1.92	431	27.22	16.55	346	0.62	3.63
7885	3951	1.25			427	10.21	4.71	376	0.68	1.24
7886	3972	1.68	10.47	1.94	406	33.71	2.71	161	0.93	3.02
7887	4000	1.36	10.30	0.89	395	30.10	1.93	142	0.94	2.66
7888	4025	1.34	11.39	0.35	395	37.71	1.79	133	0.95	3.28
7889	4050	1.42	11.56	0.36	403	41.45	1.84	130	0.96	3.59

Table 5 continued										
7890	4080	3.51	8.57	1.75	306	80.18	10.23	291	0.89	7.50
7891	4100	2.91	7.98	1.09	418	48.32	3.98	137	0.92	4.34
7892	4115	2.03	13.17	0.45	440	41.83	5.49	270	0.88	3.93
7893	4130	3.03	7.42	1.35	434	27.98	7.06	233	0.80	2.91
7894	4145	3.65	8.45	1.54	433	51.30	8.15	223	0.86	4.93
7895	4160	4.46	9.69	1.20	437	54.88	12.28	275	0.82	5.57
7896	4175	5.83	9.28	1.44	436	68.22	16.40	281	0.81	7.02
7897	4190	3.08	9.93	1.38	434	28.16	7.64	248	0.79	2.97
7898	4205	6.92	13.14	2.03	436	85.09	20.53	297	0.81	8.77
7899	4220	8.39	12.38	2.17	439	88.17	26.68	318	0.77	9.53
7900	4235	9.42	14.32	2.08	439	112.30	30.06	319	0.79	11.82
7901	4250	8.41	12.69	2.98	439	81.52	28.89	343	0.74	9.16
7902	4265	6.84			442	87.57	17.30	253	0.84	8.70
7903	4280	3.47			434	33.93	5.28	152	0.87	3.25
7904	4295	4.22			438	35.77	10.86	258	0.77	3.87
7905	4310	4.35	7.30	3.39	440	52.32	10.12	233	0.84	5.18
7906	4325	3.23			435	29.99	7.49	232	0.80	3.11
7907	4340	4.73	8.63	1.06	437	64.91	9.02	191	0.88	6.14
7909	4370	1.94	10.00	1.14	437	30.45	3.47	179	0.90	2.82
7910	4385	4.16	9.72	1.88	437	61.85	6.53	157	0.90	5.68
7911	4400	3.54	8.75	1.74	441	33.46	7.77	219	0.81	3.42
7912	4415	6.92			429	81.82	8.47	122	0.91	7.49
7913	4430	1.55	10.59	0.67	437	7.87	3.63	235	0.68	0.95
7914	4445	3.34	10.16	1.24	434	39.19	8.08	242	0.83	3.92
7915	4460	2.01	8.24	1.12	436	11.10	4.76	237	0.70	1.32
7916	4475	3.83	18.30	0.33	426	143.82	6.72	176	0.96	12.49
7917	4490	5.60	8.82	2.09	422	70.81	10.80	193	0.87	6.77
7918	4505	5.38	9.06	2.08	421	66.38	10.05	187	0.87	6.34
7919	4520	4.84	7.73	2.13	427	42.72	10.49	217	0.80	4.42
7920	4535	5.32	8.98	1.77	338	42.71	7.75	146	0.85	4.19
7921	4550	6.72	10.06	2.22	414	65.00	10.80	161	0.86	6.29
7922	4565	5.18	7.73	2.29	344	52.15	11.14	215	0.82	5.25
7923	4580	4.49	6.65	2.03	419	41.03	9.61	214	0.81	4.20
7924	4595	3.38	7.10	1.23	421	21.76	7.08	210	0.75	2.39
7925	4610	3.16	5.39	1.23	416	26.30	7.08	224	0.79	2.77
7926	4625	3.77	6.35	1.21	418	36.67	8.23	218	0.82	3.73
7927	4640	2.87	6.17	1.22	419	27.61	7.56	264	0.79	2.92
7928	4655	2.83	5.96	1.05	305	21.81	6.29	222	0.78	2.33
7929	4670	2.07	7.71	0.93	417	11.28	5.35	258	0.68	1.38
7930	4685	2.27	7.50	1.05	420	13.02	4.75	209	0.73	1.47
7931	4700	3.22	7.15	1.14	425	27.96	6.18	192	0.82	2.83
7932	4715	3.13	7.10	1.17	421	23.54	5.82	186	0.80	2.44
7933	4730	3.40	6.87	1.43	420	16.22	6.56	193	0.71	1.89
7934	4745	2.92	6.96	1.39	420	18.29	6.09	209	0.75	2.02
7935	4760	2.33	8.78	1.12	417	14.67	4.19	180	0.78	1.57

Table 5 continued										
7936	4775	1.18	9.47	0.73	421	4.30	2.31	195	0.65	0.55
7937	4790	1.43	8.22	1.13	337	5.15	3.65	255	0.59	0.73
7938	4805	2.49	5.88	1.99	419	9.97	5.60	225	0.64	1.29
7939	4820	1.54	7.99	1.32	416	5.08	3.10	201	0.62	0.68
7940	4840	2.58	7.29	1.60	426	9.75	4.81	186	0.67	1.21
7941	4850	1.20	9.58	0.77	427	4.18	3.05	254	0.58	0.60
7942	4865	3.54	7.94	1.66	427	21.86	8.40	237	0.72	2.51
7943	4880	2.17	8.62	1.24	438	9.80	6.11	282	0.62	1.32
7944	4900	1.83	8.58	1.36	429	7.74	4.11	224	0.65	0.98
7945	4915	2.78	7.42	1.60	420	10.31	5.83	210	0.64	1.34
7946	4930	2.47	8.96	1.20	432	9.87	4.69	190	0.68	1.21

Table 6: Screening data, Svane-1A

GEUS Labno.	MDRT (m)	TOC (wt.%)	TC (wt.%)	TS (wt.%)	Tmax (°C)	S_1 (mg HC/g rock)	S_2	HI	PI	PC
7947	4055	4.50	9.10	2.45	424	85.85	7.25	161	0.92	7.73
7948	4070	3.63	6.55	1.21	420	57.70	6.38	176	0.90	5.32
7949	4085	3.56	7.13	1.12	424	56.70	5.54	156	0.91	5.17
7950	4100	3.70	7.46	0.96	428	55.61	6.23	168	0.90	5.13
7951	4114	2.92	11.40	1.05	434	56.24	6.43	220	0.90	5.20
7952	4130	4.43	9.18	1.39	429	68.72	7.17	162	0.91	6.30
7953	4150	3.27	11.86	0.87	433	57.71	6.34	194	0.90	5.32
7954	4162	4.42	8.07	1.39	431	60.49	6.85	155	0.90	5.59
7955	4176	5.53	9.59	1.89	429	73.82	8.33	151	0.90	6.82
7956	4188	5.55	10.64	1.54	430	64.07	7.03	127	0.90	5.90
7957	4206	7.13	11.51	1.64	435	54.79	11.82	166	0.82	5.53
7958	4220	8.18	12.16	1.87	435	57.29	13.37	164	0.81	5.86
7959	4235	7.62	11.56	1.81	430	53.16	10.67	140	0.83	5.30
7960	4250	6.86	10.90	1.82	433	53.79	11.29	165	0.83	5.40
7961	4265	3.03	9.42	1.37	436	27.75	6.85	226	0.80	2.87
7962	4280	6.01	9.79	1.96	440	50.69	10.98	183	0.82	5.12
7963	4295	6.20	9.56	1.88	423	46.51	10.43	168	0.82	4.73
7964	4310	3.51	11.79	1.00	436	34.12	8.12	232	0.81	3.51
7965	4325	5.25	8.72	1.86	424	40.76	9.39	179	0.81	4.16
7966	4345	4.74	7.96	1.66	425	36.99	9.17	194	0.80	3.83
7967	4355	6.00	8.27	1.90	429	42.79	9.88	165	0.81	4.37
7968	4370	3.90	8.74	1.45	427	30.05	6.66	171	0.82	3.05
7969	4385	4.55	9.72	1.09	435	19.21	4.74	104	0.80	1.99
7970	4400	2.27	8.85	1.48	432	15.73	4.96	219	0.76	1.72
7971	4415	2.25	9.79	1.12	439	12.95	4.20	187	0.76	1.42
7972	4430	3.15	9.65	1.25	432	22.09	6.31	200	0.78	2.36
7973	4445	7.71	12.37	1.62	432	39.43	10.12	131	0.80	4.11
7974	4460	4.56	10.45	1.28	433	25.30	7.15	157	0.78	2.69
7975	4475	2.72	8.96	1.35	435	17.03	5.97	220	0.74	1.91
7976	4490	4.81	9.84	1.62	434	23.52	7.39	154	0.76	2.57
7977	4505	5.93	9.16	1.66	435	40.84	11.93	201	0.77	4.38
7978	4520	3.33	8.62	1.39	432	20.65	8.45	254	0.71	2.42
7979	4535	4.70	7.84	1.44	437	29.18	12.43	265	0.70	3.45
7980	4550	4.39	8.39	1.46	433	22.88	8.10	185	0.74	2.57
7981	4565	5.53	9.53	1.39	435	19.01	7.44	135	0.72	2.20
7982	4580	3.47	8.64	2.74	337	9.03	10.20	294	0.47	1.60
7983	4595	4.63	8.86	2.46	428	33.31	9.19	199	0.78	3.53
7984	4610	2.60	9.42	1.19	427	20.28	5.73	220	0.78	2.16
7985	4635	3.06	9.39	1.79	428	26.72	7.28	238	0.79	2.82
7986	4650	1.78	11.09	0.66	432	15.37	3.87	218	0.80	1.60
7987	4665	3.96	7.09	1.17	423	42.61	8.80	222	0.83	4.27
7988	4680	5.61	8.89	1.47	421	72.24	11.14	198	0.87	6.92

Table 6 continued										
7989	4695	2.41	9.36	0.77	428	22.38	5.05	209	0.82	2.28
7990	4710	4.68	9.70	1.26	424	50.98	7.66	164	0.87	4.87
7991	4725	4.00	9.11	1.08	428	46.07	7.19	180	0.87	4.42
7992	4740	2.44	9.06	1.00	425	19.57	4.45	182	0.81	1.99
7993	4755	2.18	9.14	1.03	427	18.13	4.31	198	0.81	1.86
7994	4770	1.45	10.01	0.98	432	11.12	3.05	211	0.78	1.18
7995	4785	2.87	10.12	1.33	430	12.26	4.28	149	0.74	1.37
7996	4800	2.41	10.38	1.13	430	17.05	4.30	179	0.80	1.77
7997	4815	2.55	8.59	1.34	423	15.60	4.86	191	0.76	1.70
7998	4830	10.19	14.23	2.21	425	38.70	10.04	99	0.79	4.05
7999	4845	5.13	8.18	1.98	421	32.73	8.88	173	0.79	3.45
8000	4860	3.17	11.17	1.07	430	26.33	7.04	222	0.79	2.77
8001	4880	4.30	8.49	1.69	423	28.76	8.21	191	0.78	3.07
8002	4890	4.88	9.53	1.70	422	32.45	9.34	191	0.78	3.47
8003	4905	4.66	7.80	1.88	421	27.37	9.47	203	0.74	3.06
8004	4920	4.77	8.33	1.99	425	26.01	9.22	193	0.74	2.92
8005	4940	1.18	9.23	0.83	434	3.75	3.22	272	0.54	0.58
8006	4950	2.39	9.70	1.22	431	13.00	6.32	265	0.67	1.60
8007	4965	3.12	8.75	1.61	425	20.37	7.31	235	0.74	2.30
8008	4980	4.37	8.50	1.86	426	25.85	8.73	200	0.75	2.87
8009	4990	5.12	8.85	2.25	428	30.11	10.34	202	0.74	3.36
8010	5010	5.27	8.42	2.41	422	32.40	10.58	201	0.75	3.57
8011	5025	4.62	7.50	2.13	423	28.13	8.86	192	0.76	3.07
8012	5040	7.39	12.01	1.78	419	29.53	7.34	99	0.80	3.06
8013	5055	5.93	9.23	1.85	419	42.11	11.08	187	0.79	4.41
8014	5070	5.66	8.80	2.03	422	43.94	12.33	218	0.78	4.67
8015	5080	5.26	7.87	2.52	423	37.66	11.82	225	0.76	4.11
8016	5090	4.10	6.70	2.18	417	27.48	8.80	215	0.76	3.01
8017	5100	5.91	9.08	2.40	421	41.83	12.01	203	0.78	4.47
8018	5110	4.70	9.90	2.04	423	34.35	9.64	205	0.78	3.65
8019	5120	6.56	10.24	2.74	426	48.29	14.98	228	0.76	5.25
8020	5130	6.38	10.20	2.42	421	44.43	12.32	193	0.78	4.71
8021	5140	4.99	9.34	2.08	425	33.68	10.54	211	0.76	3.67
8022	5150	5.52	8.11	2.31	419	35.67	9.44	171	0.79	3.74
8023	5160	5.86	7.84	2.44	420	33.06	9.80	167	0.77	3.56
8024	5170	8.28	11.04	3.24	422	38.89	11.46	138	0.77	4.18
8025	5180	6.28	8.84	2.24	422	46.07	11.81	188	0.80	4.80
8026	5190	6.95	10.74	2.57	424	44.39	13.49	194	0.77	4.80
8027	5200	7.11	10.87	2.99	425	48.34	13.49	190	0.78	5.13
8028	5210	6.69	9.76	2.89	421	42.11	12.57	188	0.77	4.54
8029	5220	6.48	10.28	2.65	425	41.58	12.33	190	0.77	4.47
8030	5230	6.65	9.57	2.87	425	44.52	11.97	180	0.79	4.69
8031	5240	6.49	9.11	3.16	425	41.44	11.84	183	0.78	4.42
8032	5250	5.18	8.30	2.74	419	31.70	8.60	166	0.79	3.34
8033	5260	6.71	9.33	3.24	424	31.55	10.14	151	0.76	3.46

Table 6 continued										
8034	5270	7.45	10.64	3.27	428	45.02	12.76	171	0.78	4.80
8035	5280	5.79	9.47	2.87	427	30.88	9.86	170	0.76	3.38
8036	5290	5.25	8.12	2.67	424	30.06	9.05	172	0.77	3.25
8037	5300	6.88	10.05	2.99	422	40.85	10.40	151	0.80	4.25
8038	5310	5.02	7.69	2.75	425	29.96	8.41	168	0.78	3.18
8039	5320	5.67	8.90	2.71	431	40.42	10.48	185	0.79	4.22
8040	5330	5.17	7.84	3.15	423	35.68	8.36	162	0.81	3.66
8041	5340	5.13	7.91	2.69	427	37.34	7.64	149	0.83	3.73
8042	5350	4.99	7.52	3.11	423	33.24	7.17	144	0.82	3.35
8043	5360	4.78	6.39	2.72	421	22.86	6.78	142	0.77	2.46
8044	5380	6.13	8.10	3.47	420	32.93	8.70	142	0.79	3.46
8045	5390	5.54	7.52	3.32	420	30.75	7.75	140	0.80	3.20
8046	5400	5.45	7.26	3.05	424	28.72	7.33	135	0.80	2.99
8047	5410	4.51	6.55	2.79	421	26.07	7.06	157	0.79	2.75
8048	5420	3.45	4.90	2.40	421	14.04	5.22	151	0.73	1.60
8049	5430	3.32	5.34	1.77	422	27.03	5.59	168	0.83	2.71
8050	5440	5.47	7.80	2.29	427	33.00	5.78	106	0.85	3.22
8051	5450	4.54	6.83	2.80	426	34.81	7.36	162	0.83	3.50
8052	5460	4.47	6.22	2.96	425	26.75	7.58	170	0.78	2.85
8053	5470	4.54	6.71	2.92	426	30.03	6.93	153	0.81	3.07
8054	5480	5.56	7.76	3.32	420	35.59	7.77	140	0.82	3.60
8055	5490	3.57	5.84	1.89	426	30.17	6.33	177	0.83	3.03
8056	5500	4.60	6.98	2.99	420	25.09	8.93	194	0.74	2.82
8057	5514	4.97	6.50	2.80	427	34.20	8.79	177	0.80	3.57
8058	5529	5.06	9.09	2.20	421	41.07	8.68	172	0.83	4.13
8059	5544	3.36	5.19	2.28	424	30.33	5.11	152	0.86	2.94
8060	5562	3.62	5.65	2.43	428	33.62	5.39	149	0.86	3.24
8061	5574	2.47	3.56	1.88	427	21.02	3.70	150	0.85	2.05
8062	5589	4.15	6.26	2.46	427	33.89	6.20	149	0.85	3.33
8063	5607	4.71	6.76	2.71	423	32.04	7.41	157	0.81	3.27
8064	5619	5.36	7.96	3.11	423	30.20	7.15	133	0.81	3.10
8065	5634	7.83	10.66	2.90	425	43.49	10.51	134	0.81	4.48
8066	5649	6.01	8.35	2.94	425	31.47	8.57	143	0.79	3.32
8067	5665	5.09	7.16	2.89	423	44.47	7.22	142	0.86	4.29
8068	5680	3.27	5.11	1.91	420	28.14	5.63	172	0.83	2.80
8069	5695	5.20	7.82	2.63	423	55.03	9.31	179	0.86	5.34
8070	5710	4.67	8.07	2.56	423	41.89	7.99	171	0.84	4.14
8071	5725	4.72	7.67	2.50	426	35.14	8.97	190	0.80	3.66
8072	5740	5.41	7.83	3.53	424	45.66	8.67	160	0.84	4.51
8073	5755	7.44	9.68	3.08	420	77.05	11.91	160	0.87	7.38
8074	5769	6.53	8.87	3.02	426	77.36	10.54	161	0.88	7.30
8075	5784	3.88	5.65	2.07	425	41.79	5.71	147	0.88	3.94
8076	5799	3.05	4.61	1.59	423	41.79	4.02	132	0.91	3.80
8077	5814	4.11	6.47	2.14	418	37.53	6.19	151	0.86	3.63
8078	5829	3.09	5.14	2.11	426	29.76	4.24	137	0.88	2.82

Table 6 continued										
8079	5847	2.82	3.83	3.57	426	17.34	5.11	181	0.77	1.86
8080	5862	4.92	6.17	3.05	431	46.89	7.75	157	0.86	4.54
8081	5877	5.27	6.18	3.26	430	46.93	8.82	167	0.84	4.63
8082	5889	3.54	4.32	2.83	428	25.13	4.82	136	0.84	2.49
8083	5907	4.35	5.06	3.31	424	26.70	6.84	157	0.80	2.78
8084	5919	3.87	4.44	2.52	426	23.67	5.20	134	0.82	2.40
8085	5937	3.79	4.46	2.92	428	28.18	5.79	153	0.83	2.82
8086	5943	3.08	3.95	1.95	426	25.97	3.55	115	0.88	2.45
8087	5952	5.53	6.91	4.16	430	46.10	9.94	180	0.82	4.65

Consultant data on extracted samples demonstrate that such pre-treatment of the samples does not produce reliable data either (Geochemical Investigations Limited, 2002a, b). More or less similar S_1 yields with only minor fluctuations through the lowermost part of the Cromer Knoll Group and the entire Tyne Group may together with unusual low T_{max} values indicate inefficient extraction and should warrant caution with respect to source rock interpretations. Very low T_{max} values in some intervals are assigned to 'suppression' partly by graphite contamination. However, in theory graphite should not influence T_{max}, because it does not contain any pyrolysable moieties; in contrast, in the worst case the presence of graphite would result in unrealistic high T_{max} values.

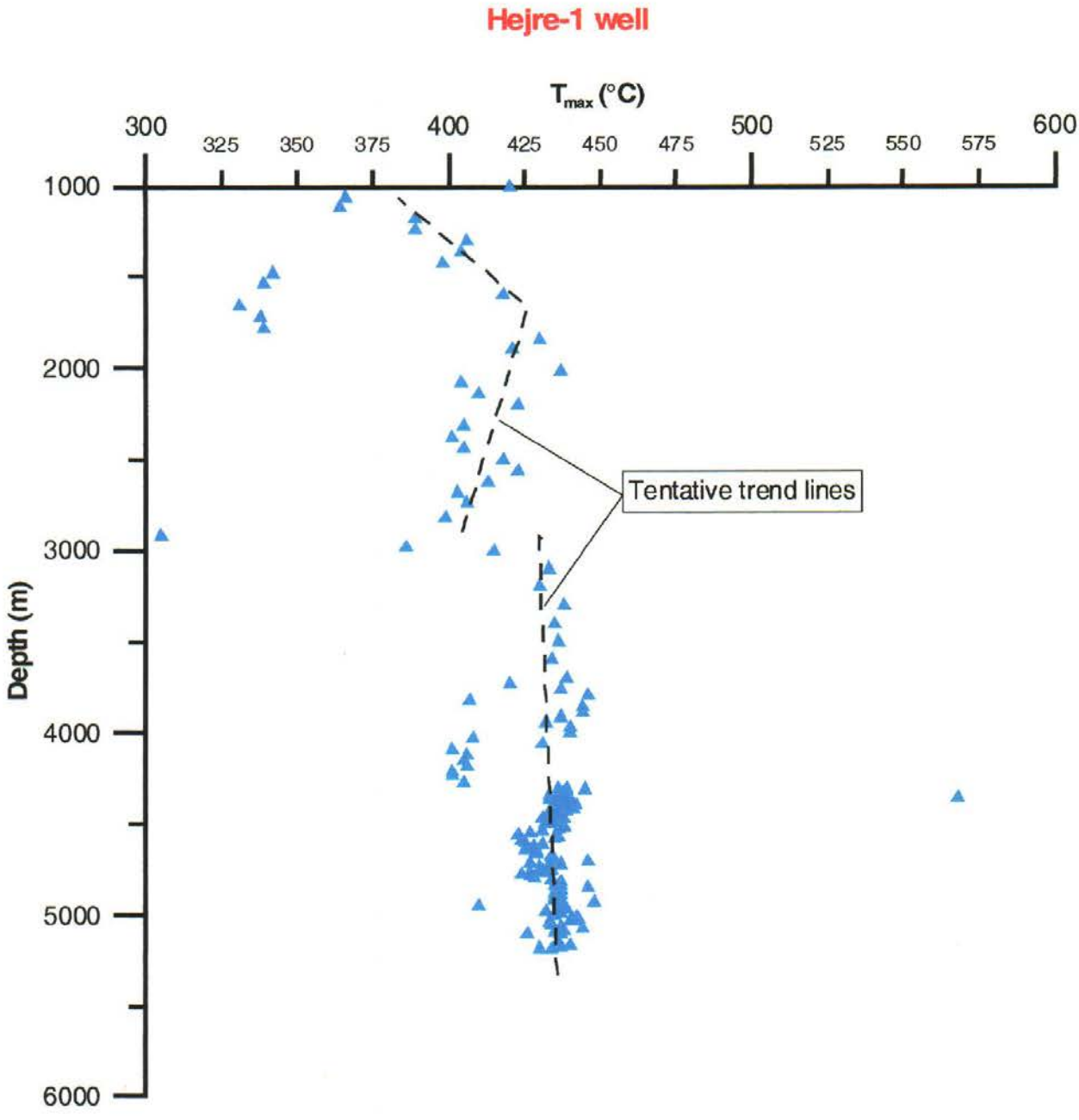

Figure 3. Tentative trend lines for T_{max} in the Hejre-1 well. The lack of an increasing T_{max} with increasing burial depth and temperature is evident, and is caused by contamination by oil-based mud.

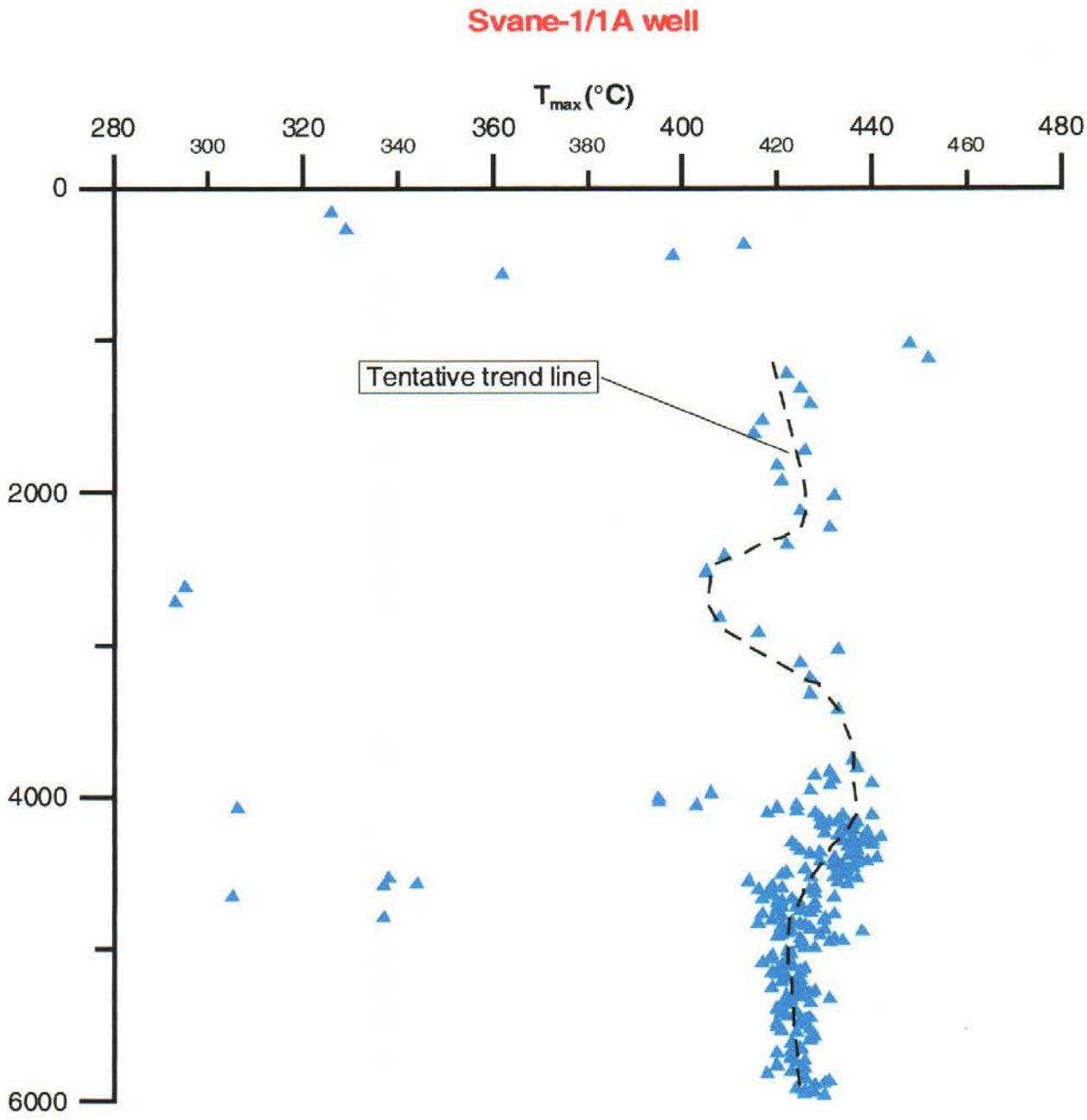

Figure 4. Tentative trend line for T_{max} in the Svane-1/1A well. The lack of an increasing T_{max} with increasing burial depth and temperature is evident, and is caused by contamination by oil-based mud.

4.2. Organic maturity assessment

The mean random vitrinite reflectance values for the Hejre-1 and Svane-1/1A wells are listed in Tables 7, 8 and 9. Compared to coals a wider scatter in the reflectance measurements performed on sedimentary organic matter must be expected (e.g. Bostick and Foster, 1975; Taylor et al., 1998). The listed standard deviations are acceptable for the measured whole rock samples, which, compared to kerogen concentrates, has the advantage that its easier to identify the primary vitrinite particles (e.g. Barker, 1996). 'Primary' vitrinite means that it is indigenous/autochthonous and therefore reflects the actual maturity of the organic matter at the considered depth. Generally this will correspond to the lowest reflecting vitrinite (but omitting lignite added during drilling) as maturation of organic matter is an irreversible time-temperature dependent process; the presence of higher reflecting vitrinite particles will thus indicate recycled organic matter that has attained the higher maturity from deeper burial in the former host rock (e.g. Bostick, 1979; Hunt, 1996; Taylor et al., 1998).

In addition, some low-reflecting vitrinite may be suppressed (Buiskool Toxopeus, 1983). This phenomena is caused by either a higher hydrogen content in the vitrinite, which is inherited from marine-influenced depositional conditions (e.g. Hao Fang and Chen Jianyu, 1992; George et al., 1994; Suarez-Ruiz et al., 1994; Diessel and Gammidge, 1998; Petersen and Rosenberg, 1998), or absorption of lipid substances from associated liptinite into the vitrinite structure (Hutton and Cook, 1980; Kalkreuth, 1982; Price and Barker, 1985; Petersen and Vosgerau, 1999). Hence, in marine shales with hydrogen-rich amorphous organic matter and alginite, such as the marine Mandal and Farsund formations, suppression of vitrinite reflectance may constitute a serious problem. The anomalies in VR values and the causes of these have recently been thoroughly discussed by Carr (2000a, b). It is, however, evident from the VR *vs* depth plots of the Hejre-1 and Svane-1/1A wells, that the VR values comprise a rather well-defined maturity trend with no obvious outlier values that may be suppressed (Figs. 5a and 6a).

The stippled lines in Figs. 5a and 6a indicate the tentative VR trends in the two wells. The data points in the Cenozoic and Cretaceous sections are scarse, but in particular the data points in Svane-1/1A define an upper linear segment, which cuts the surface at

Table 7: Hejre-1 well, vitrinite reflectance values

GEUS labno.	MDRT (m)	%Ro	N (VR)	Stdv.	N (total)
8204	1480	0.29	12	0.07	19
8207	1660	0.29	41	0.04	42
8209	1780	0.32	47	0.05	50
8220	2440	*n.d.*			
8223	2620	*n.d.*			
8226	2820	*n.d.*			
8230	3000	0.52	5	0.07	6
8232	3200	*n.d.*			
8234	3400	*n.d.*			
8236	3600	*n.d.*			
8250	3760	*n.d.*			
8255	3910	*n.d.*			
8260	4060	*n.d.*			
8265	4210	*n.d.*			
8330	4305	0.74	14	0.08	22
8336	4335	0.69	28	0.08	68
8343	4370	0.72	33	0.08	62
8350	4410	0.65	31	0.08	57
8358	4455	*n.d.*			
8365	4490	*n.d.*			
8370	4530	*n.d.*			
8375	4580	*n.d.*			
8379	4620	*n.d.*			
8383	4660	0.82	3	0.05	11
8387	4700	0.84	4	0.09	15
8391	4740	*n.d.*			
8395	4780	0.88	4	0.11	20
8399	4820	*n.d.*			
8403	4860	0.93	8	0.06	20
8407	4900	0.95	9	0.07	30
8411	4940	0.91	15	0.06	30
8414	4970	0.93	15	0.07	58
8418	5009	0.94	19	0.07	40
8422	5045	1.05	11	0.06	30
8427	5090	1.10	4	0.04	20
8431	5145	1.12	17	0.05	44
8435	5181	1.12	9	0.09	12
8440	5226	1.20	6	0.03	10
8444	5262	1.16	10	0.05	23

MDRT: Mean depth below rotary table
$\%R_o$: Mean vitrinite reflectance (random)
N(VR): Number of reflectance measurements used for calculation of mean vitrinite reflectance
Stdv.: Standard deviation
N(total): Total number of vitrinite reflectance measurements

Table 8: Svane-1, vitrinite reflectance values

GEUS labno.	MDRT (m)	%Ro	N (VR)	Stdv.	N (total)
7856	1320	0.27	6	0.06	20
7858	1530	0.23	36	0.04	51
7860	1730	0.28	13	0.05	20
7867	2420	0.34	4	0.05	5
7873	3025	*n.d.*			
7875	3220	*n.d.*			
7878	3750	0.65	9	0.04	30
7883	3900	*n.d.*			
7891	4100	*n.d.*			
7895	4160	0.76	14	0.07	50
7898	4205	0.74	13	0.05	40
7901	4250	0.8	9	0.07	33
7904	4295	0.83	6	0.08	17
7907	4340	0.85	12	0.06	34
7910	4385	0.89	4	0.89	31
7914	4445	0.93	8	0.06	36
7917	4490	*n.d.*			
7920	4535	0.97	9	0.08	20
7923	4580	1.06	9	0.06	22
7926	4625	*n.d.*			
7929	4670	1.16	12	0.07	35
7932	4715	1.05	7	0.06	25
7935	4760	1.06	7	0.05	53
7938	4805	1.15	6	0.05	17
7941	4850	1.13	14	0.07	25
7943	4880	1.07	24	0.06	82
7945	4915	1.07	12	0.08	23

MDRT: Mean depth below rotary table
$\%R_o$: Mean vitrinite reflectance (random)
N(VR): Number of reflectance measurements used for calculation of mean vitrinite reflectance
Stdv.: Standard deviation
N(total): Total number of vitrinite reflectance measurements

Table 9: Svane-1A, vitrinite reflectance values

GEUS labno.	MDRT (m)	TVMDRT (m)	%Ro	N (VR)	Stdv.	N (total)
7947	4055	3966	0.87	11	0.05	43
7950	4100	3981	*n.d.*			
7953	4150	4065	*n.d.*			
7956	4188	4153	*n.d.*			
7959	4235	4204	*n.d.*			
7962	4280	4249	0.97	10	0.07	19
7965	4325	4294	0.95	8	0.06	24
7968	4370	4339	0.92	8	0.06	41
7971	4415	4384	1.00	9	0.07	41
7975	4475	4443	1.06	12	0.07	48
7977	4505	4473	0.94	12	0.06	50
7980	4550	4518	1.08	32	0.09	80
7986	4650	4618	1.08	4	0.07	13
7989	4695	4662	*n.d.*			
7992	4740	4707	1.03	7	0.07	16
7995	4785	4752	1.04	5	0.10	29
7998	4830	4797	1.25	7	0.08	9
8001	4880	4847	*n.d.*			
8004	4920	4887	1.13	11	0.06	32
8007	4965	4931	1.17	9	0.07	39
8010	5010	4976	1.12	8	0.08	24
8013	5055	5021	1.18	10	0.08	19
8017	5100	5066	1.18	27	0.09	50
8021	5140	5106	1.20	12	0.08	26
8025	5180	5146	*n.d.*			
8029	5220	5185	1.23	10	0.09	21
8033	5260	5225	1.43	11	0.07	13
8037	5300	5265	*n.d.*			
8041	5340	5304	1.34	24	0.08	36
8044	5380	5343	1.31	9	0.07	27
8048	5420	5383	1.38	16	0.09	41
8051	5450	5412	1.39	10	0.09	12
8055	5490	5451	*n.d.*			
8058	5529	5489	1.36	11	0.10	25
8061	5574	5533	*n.d.*			
8064	5619	5577	*n.d.*			
8067	5665	5622	*n.d.*			
8070	5710	5666	1.36	24	0.08	60
8073	5755	5710	1.46	15	0.07	35
8076	5799	5753	*n.d.*			
8078	5829	5783	1.53	7	0.03	26
8080	5862	5815	1.57	5	0.06	45
8083	5907	5859	1.49	7	0.09	40
8086	5943	5894	*n.d.*			

TVMDRT: True vertical mean depth below rotary table
(see also Table 8 for legend)

Hejre-1 well

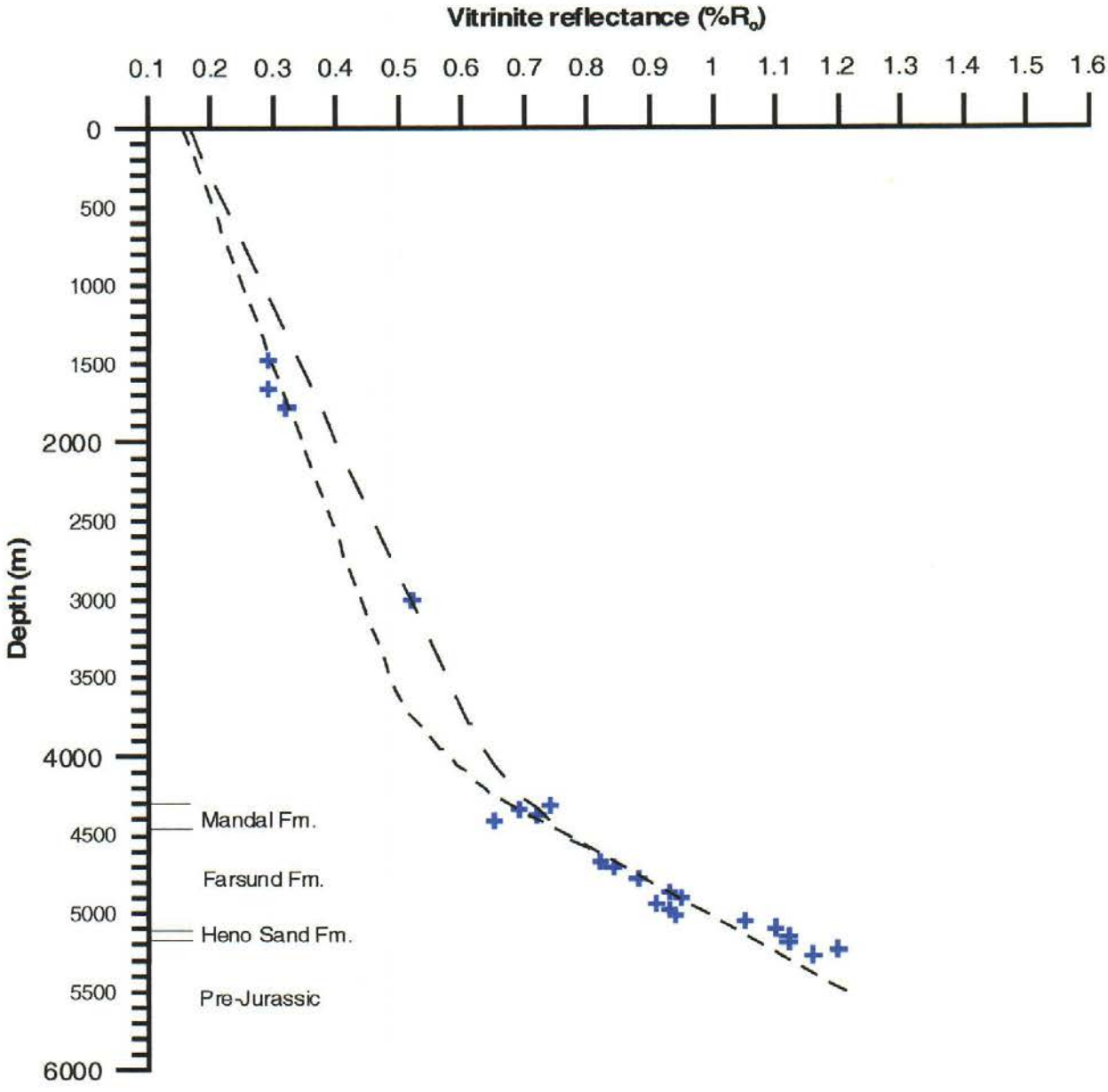

Figure 5a. Vitrinite reflectance profile for the Hejre-1 well. The reflectance line cuts the surface at c. 0.17%R_o and shows the expected three segments for undisturbed strata: an upper linear increase in reflectance; a middle rapid increase in reflectance; and a lower linear increase in reflectance but with a larger gradient than the upper part. See text for further discussion.

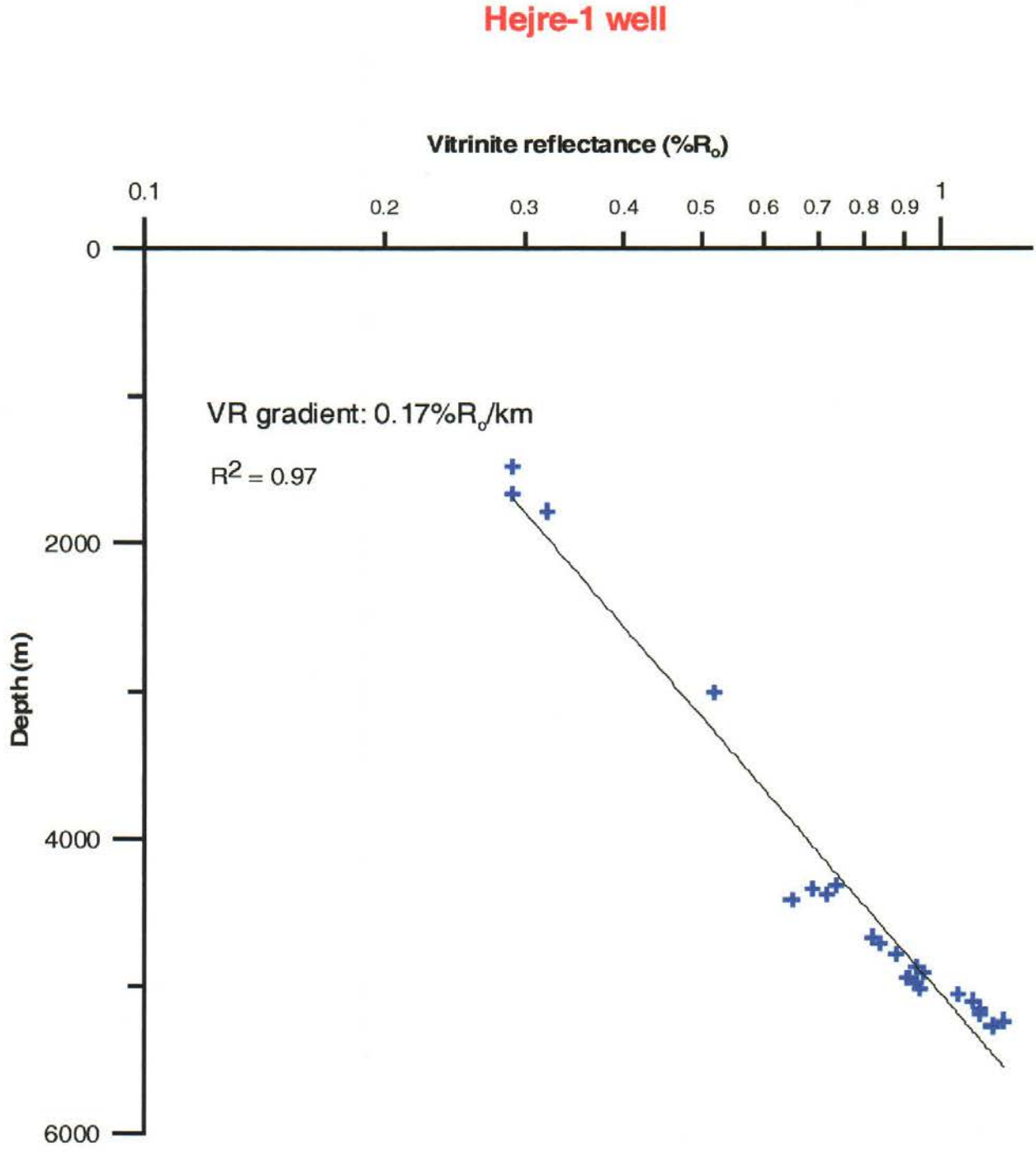

Figure 5b. Semilog plot of vitrinite reflectance *vs* depth. The data define a straight line with a good correlation coefficient. The vitrinite reflectance gradient is 0.17%R_o/km.

Svane-1/1A well

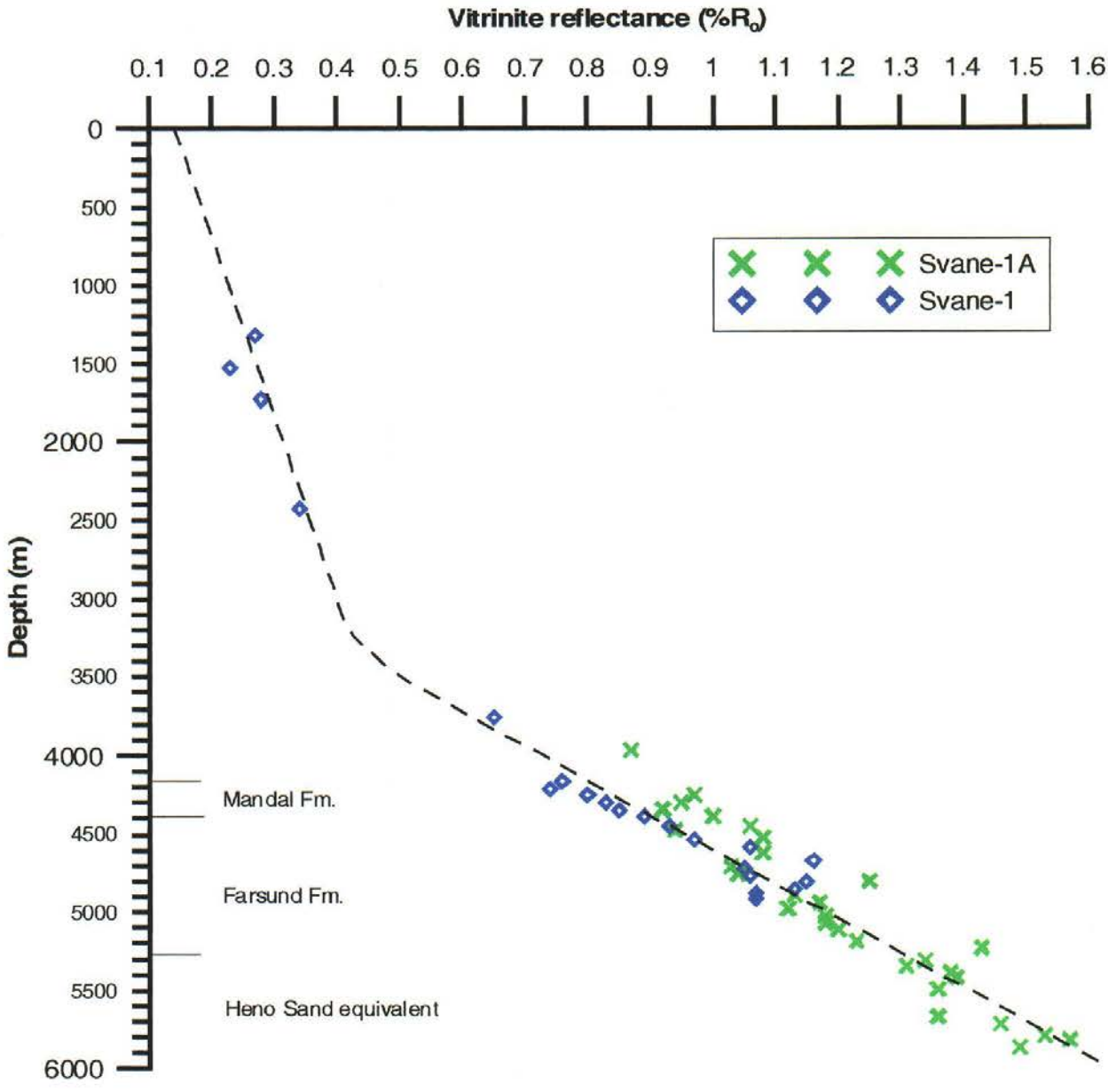

Figure 6a. Vitrinite reflectance profile for the Svane-1/1A well. The reflectance line cuts the surface at c. 0.14%R_o and shows the expected three segments for undisturbed strata: an upper linear increase in reflectance; a middle rapid increase in reflectance; and a lower linear increase in reflectance but with a larger gradient than the upper part.

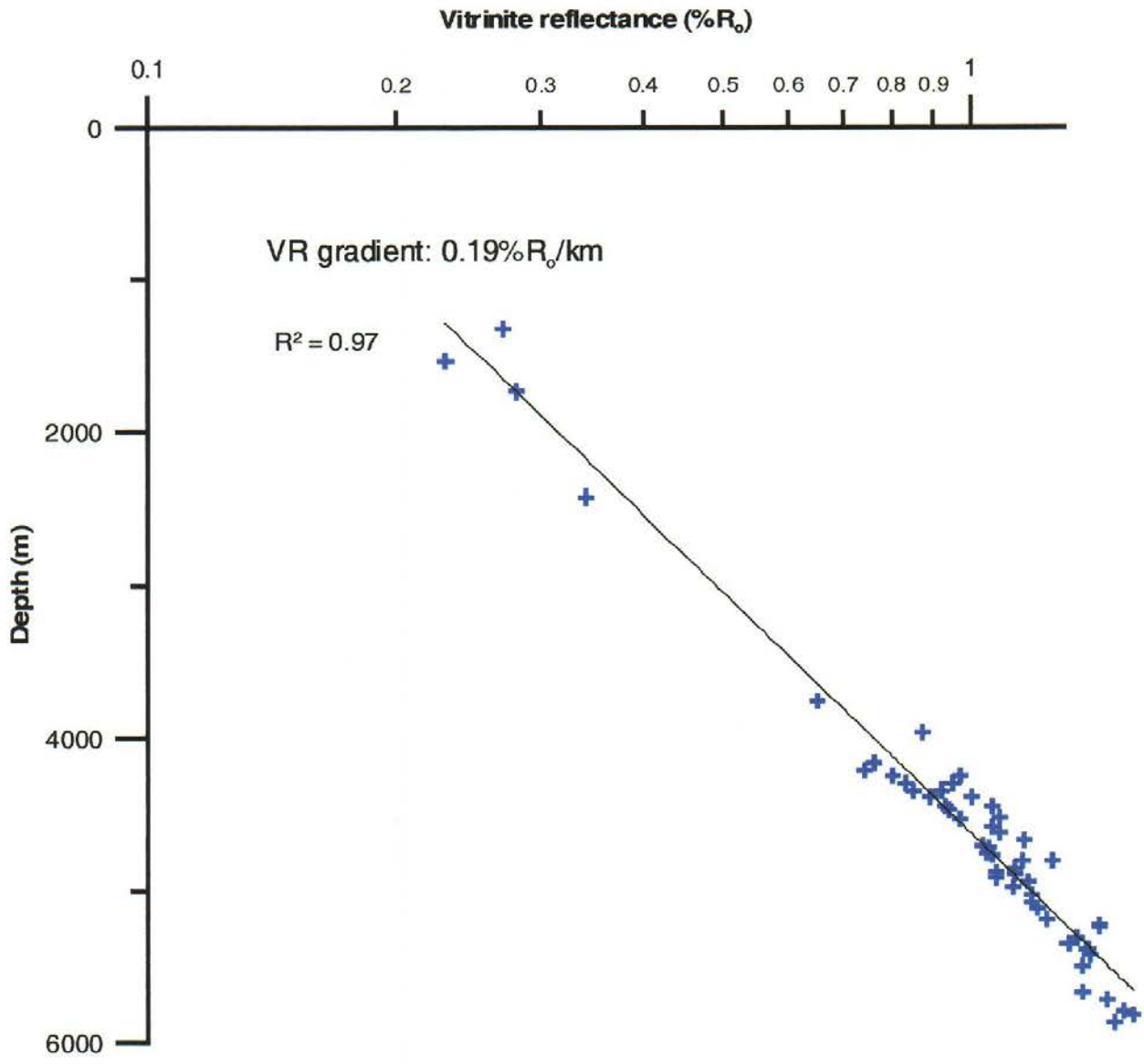

Figure 6b. Semilog plot of vitrinite reflectance *vs* depth. The data define a straight line with a good correlation coefficient. The vitrinite reflectance gradient is 0.19%R$_o$/km.

a VR value of ~0.14%R_o. This also holds for the upper segment in the Hejre-1 well, which cuts the surface at a VR of ~0.17%R_o. VR values between about 0.10%R_o to 0.25%R_o are normally recorded for peaty organic matter at the surface (e.g. Cohen et al., 1987). The Hejre-1 and Svane-1/1A wells are thus not missing any overburden, which could have been removed by uplift and erosion. It seems to be a general feature of undisturbed strata that the VR data constitute a linear gradient from about 0.10–0.25%R_o at the surface down to about 0.6–0.7%R_o (Suggate, 1998). This is normally followed by a middle segment, where the VR display a rapid increase up to c. 1.0%R_o. This is not the case for the Svane1/1A well, where this rapid increase occurs around 0.4%R_o (Fig. 6a). However, the data points are few and the definition of the VR trend line in this part is rather speculative. This is particular true for the Hejre-1 well (Fig. 5a), where two alternative VR trend lines for the upper part are shown. Both wells show a well-defined lower, linear gradient, which due to the much larger number of data points are more robust than the upper segments (Figs. 5a and 6a). Such a lower segment characterised by a linear gradient, but with a more rapid increase in VR, is normally observed in undisturbed strata after the rapid middle increase in VR (Suggate, 1998). The three segments in the VR profiles of the Hejre-1 and Svane-1/1A wells are, thus, defining typical undisturbed maturation profiles. The shape of the VR-curve is independent on the geothermal gradient in the basin, which, however, determines the depth at which the middle rapid increase in VR occurs.

An alternative way to display measured VR values is in a semi-log plot. Correct determined VR values will in such a plot define a straight line (Dow, 1977). Semi-log plots of VR *vs* depth are shown for the Hejre-1 and Svane-1/1A wells in Figs. 5b and 6b. Both data sets yield well-defined linear regression lines with R^2 values of 0.97, which indicate that the VR values actually constitute a continuous maturation continuum. The calculated VR gradients are for Hejre-1 c. 0.17%R_o/km and for Svane1/1A c. 0.19%R_o/km.

At a depth above 5200 m in Hejre-1 VR values of 1.16%R_o and 1.20%R_o (mean = 1.18%R_o) were recorded (Table 7). In Svane-1/1A VR values of 1.49%R_o, 1.53%R_o and

1.57%R_o (mean = 1.53%R_o) were recorded at depth above c. 5780 m (Table 9). At the same time a temperature of about 169°C has been estimated at TD (5303 m) in the Hejre-1 well, and c. 190°C has been estimated in Svane-1/1A at about 6000 m depth. These temperatures may be related to VR values by using the correlation between VR and maximum burial temperature established by Barker and Pawlewicz (1994)*. A TD temperature of 169°C will correspond to a VR of 1.5%R_o and a TD temperature of 190°C to a VR of 1.95%R_o, which is about 0.32%R_o and 0.42%R_o higher than the measured values in Hejre-1 and Svane-1/1A, respectively.

A sound explanation for this 'discrepancy' could be overpressure-induced retardation of organic matter maturation. Retardation phenomena in overpressured basins has been thoroughly discussed by Carr (1999, 2000a,b, 2003). Retardation affects, in contrast to suppression that only is related the vitrinite, *all* the organic matter in the source rock, i.e. also the oil-generating kerogen. Retardation of organic matter maturation may on occasion result in a near-cessation in the evolution of VR, which for example has been demonstrated for strongly overpressured sections in the Yinggehai Basin in the South China Sea (Hao Fang et al., 1995). Retardation phenomena are known from the West of Shetland Basin and the Norwegian Viking Graben (McTavish, 1998), and more locally parts of the Lulu-1 well in the Søgne Basin has been shown to be overpressured (Carr, 2003), in addition to the suppressed vitrinite that occurs in the Middle Jurassic coals (Petersen and Rosenberg, 1998; Carr, 2000b). The Amalie-1 and Lulita-1Xc wells, also in the Søgne Basin, are likewise overpressured in the Upper–Middle Jurassic parts.

VR data are disregarded in the consultant report on the Hejre-1 well (Geochemical Investigations Limited, 2002a). The argument is that indigenous vitrinite is almost entirely absent and that VR values commonly are measured on reworked, oxidised vitrinite. A VR *vs* depth plot shows all calculated VR populations from each analysed

* It may be noted, that their correlation is based on the assumption that the maximum temperature (T_{peak}) is the major factor influencing VR. This means, that VR increases up to T_{peak} has been reached after which the evolution in VR is negligible. Time is only important until T_{peak} has been approached. This contrasts to kinetic models used to predict VR, such as the EASY%R_o model of Burnham and Sweeney (1989) and Sweeney and Burham (1990), which allows time to influence the VR during the entire burial history of the sediments. Experimental data suggest that maturation is more controlled by temperature than time (Wuu-Liang Huang, 1996).

sample (up to three VR values for each sample), which is used as an argument for the absence of a well-defined, unique maturity profile. However, almost all disperse organic matter in sedimentary rocks will contain oxidised organic material, so this is no criteria for disregarding the VR measurements. The crucial part is to select the vitrinite particles with the true indigenous maturity. The GEUS data demonstrate that such vitrinite is present in many of the samples and that they define a quite unique maturity profile. The maturity profile in the consultant report is instead based on 6 spore colour indices and five biomarker ratios, mainly from below 4200 m, which have been related to an equivalent VR value (Geochemical Investigations Limited, 2002a). Such a correlation can only be rough and the maturity profile is only poorly constrained. The VR at TD is only c. 0.8%R_o, which is extraordinary low at a depth of about 5200 m and a temperature of about 169°C. This should call for some explanation, which, however, is not provided.

The maturity profile of Svane-1/1A in the consultant report is defined by six VR measurements and two spore colour indices (Geochemical Investigations Limited, 2002b). The data are limited to a depth below 3800 m, and the few selected data points provide a well-defined maturity profile. However, the line cuts the surface at a VR value above 0.3%R_o, which either indicate uplift of the strata or a wrong maturity profile. Also, the VR value of c. 1.1%R_o at a TD of about 5900 m and a temperature of 190°C is extremely low, even when incorporating maturity retardation. These two points may suggest that the proposed maturity profile is not justified.

4.3. Comments on the potential hydrocarbon sources

A significant consequence of the retarded organic matter maturation is a 'translation' of the oil window to greater burial depths. This has implications for the prospectivity of the basin as oil-generation may occur at depths, where the source rock normally would be considered to be exhausted. In particular this is relevant for coal and type III source rocks. Recently it has been demonstrated that the effective oil window, i.e. the depth range in which liquid hydrocarbons are expelled, for such source rocks must be re-considered (Petersen, 2002). The start of the effective oil window occurs at considerably higher VR (maturity) than the conventional 0.5–0.6%R_o and in addition extends to a maturity corresponding to a VR of c. 1.8%R_o. Combined with a potential

retardation effect on organic matter maturation this suggests, that especially coaly source rocks may be active oil-generators at depth >6000 m in the Hejre1 and Svane-1/1A locations independent of the high temperatures at TD. Cracking of the generated hydrocarbons is likewise retarded, in addition to the increasing evidence for the higher thermal stability of liquid hydrocarbons in general (e.g. Horsfield et al., 1992; Price, 1993; Schenk et al., 1997; Sajgó, 2000; Domine et al., 2001).

The maturity of the paraffinic Hejre-1 oil has been inferred to be >1%R_o, which would agree with a terrestrial (or at least terrestrially influenced) source (Geochemical Investigations Limited, 2002a). The VR values of the Hejre-1 well exceeds 1%R_o at slightly above 5000 m (Fig. 5), which at the well site would correspond to the lower part of the Farsund Formation and older rocks. The source for the Hejre-1 discovery is suggested to be an Upper Jurassic marine rock (Geochemical Investigations Limited, 2002a; PPIC-D, 2002), however, the lower part of the Farsund Formation is generally considered to be more influenced by terrestrial kerogen (Damtoft et al., 1992). The isotopic composition of the saturate and aromatic fractions of the Hejre-1 oil is $\delta^{13}C_{sat}$ = -28.2 and $\delta^{13}C_{aro}$ = -26.8, respectively (Applied Petroelum Technology AS, 2003). These values are comparable to those obtained from oils and condensates from the Amalie-1, Lulita-1, West Lulu-1, West Lulu-3T, and 3/7-4 (Trym) wells in the Søgne Basin, where the source is Middle Jurassic coals (e.g. Petersen et al., 1998; 2000; Petersen and Brekke, 2001).

The maturity of the DST2 condensate in Svane-1/1A has been inferred to be >1.3%R_o (Geochemical Investigations Limited, 2002b), which approximately corresponds to a depth >5300 m (Heno Formation equivalent and older rocks) at the well site (Fig. 6). The isotopic composition of the DST2 condensate in Svane-1/1A is heavy ($\delta^{13}C$ = -26.2; Applied Petroleum Technology AS, 2002), which could suggest a terrestrial source (see above). The isotopic signature of the methane (C_1) of the DST2 compares very well to values from Middle Jurassic coals, whereas the isotopic composition of the C_1 to C_4 gases correlates well with Carboniferous coals (ConocoPhillips PIC-D, 2003). Likewise the condensate is considered to have a Carboniferous coal source.

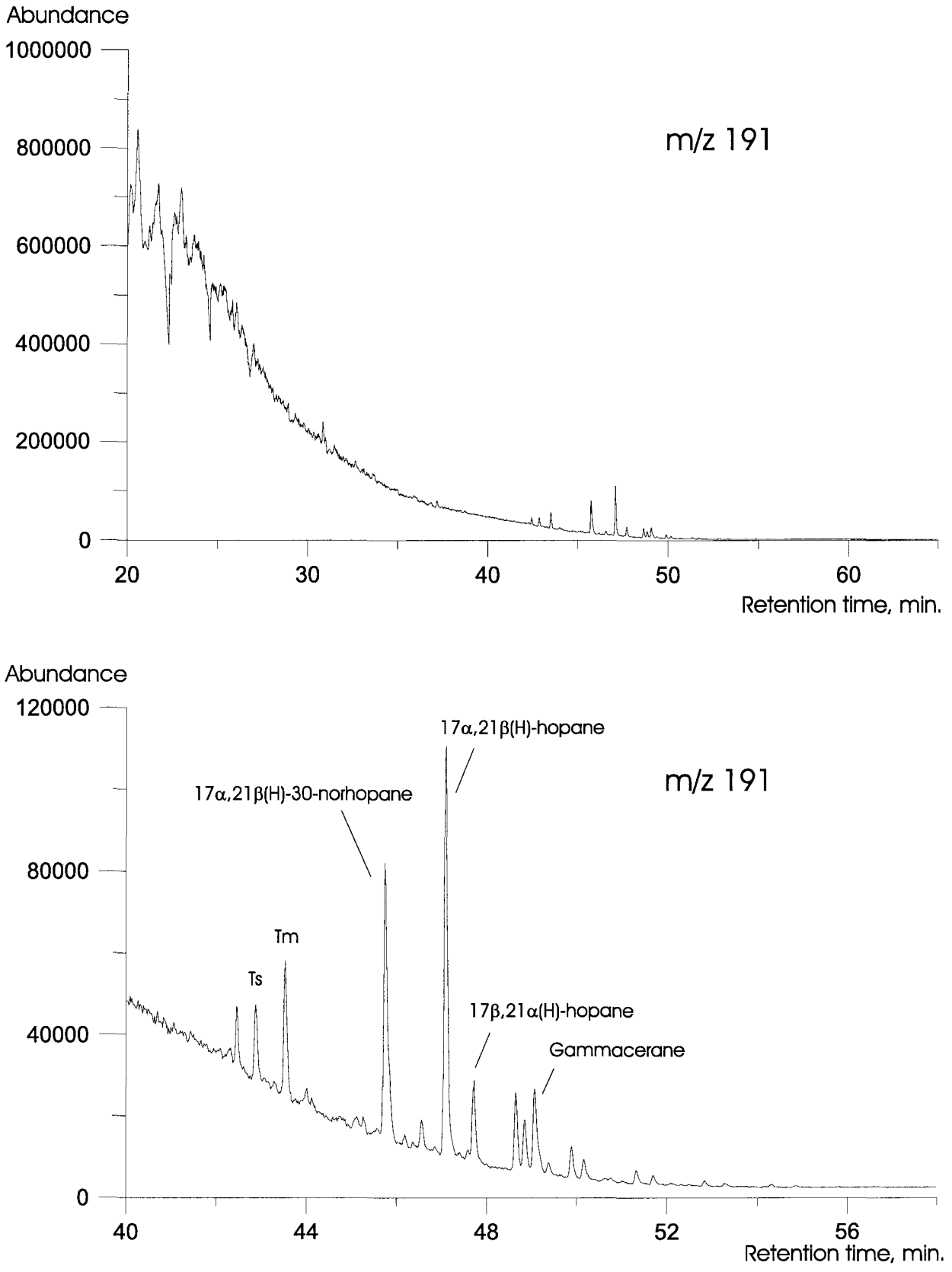

Figure 7. M/z 191 mass chromatogram of a triterpane concentrate from the Svane DST #2 condensate.

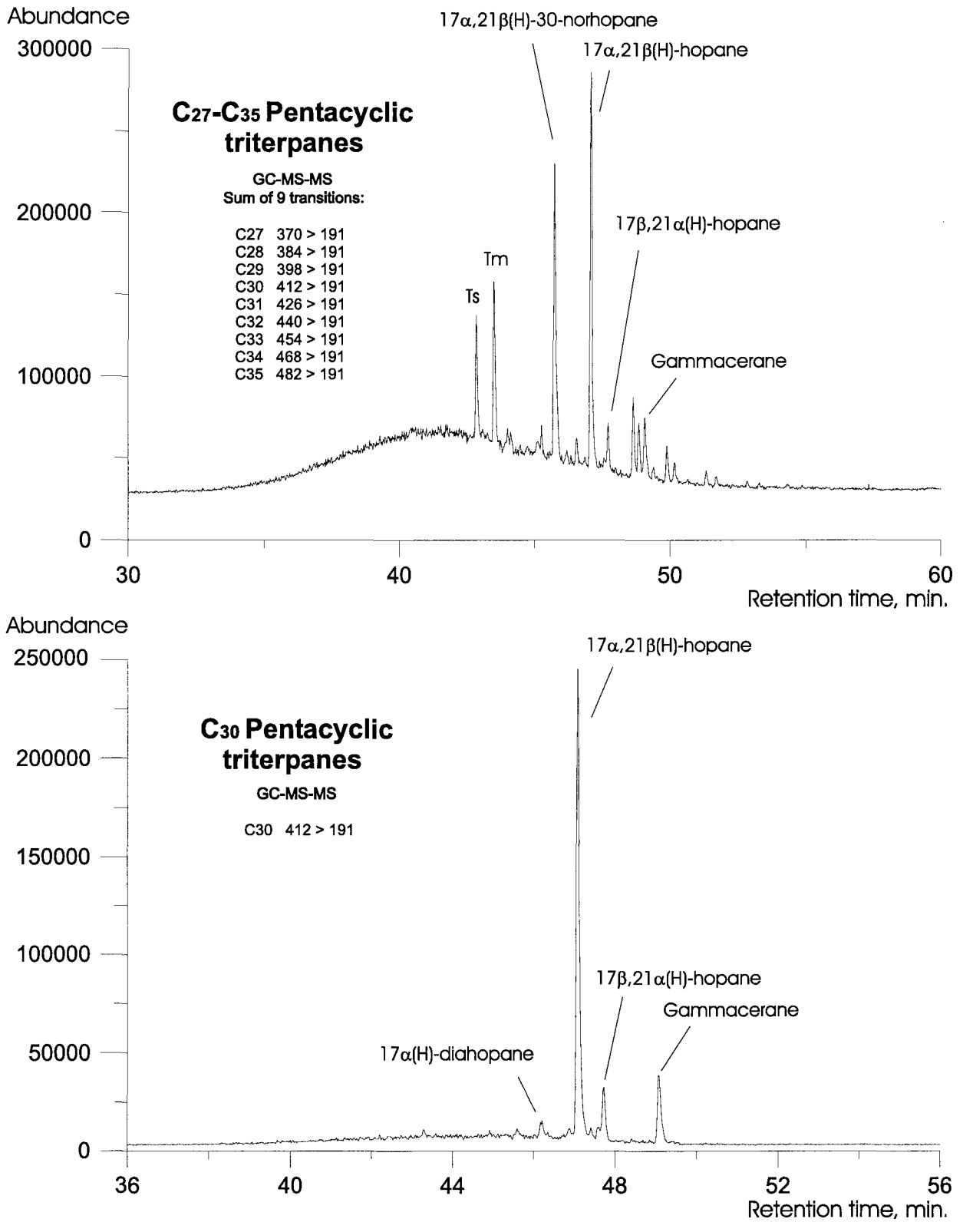

Figure 8. GC-MS-MS analysis of a triterpane concentrate from the Svane DST #2 condensate
Top: sum of 9 transitions showing C_{27}-C_{35} pentacyclic triterpanes.
Bottom: 412 > 191 transition showing only the C_{30} compounds.

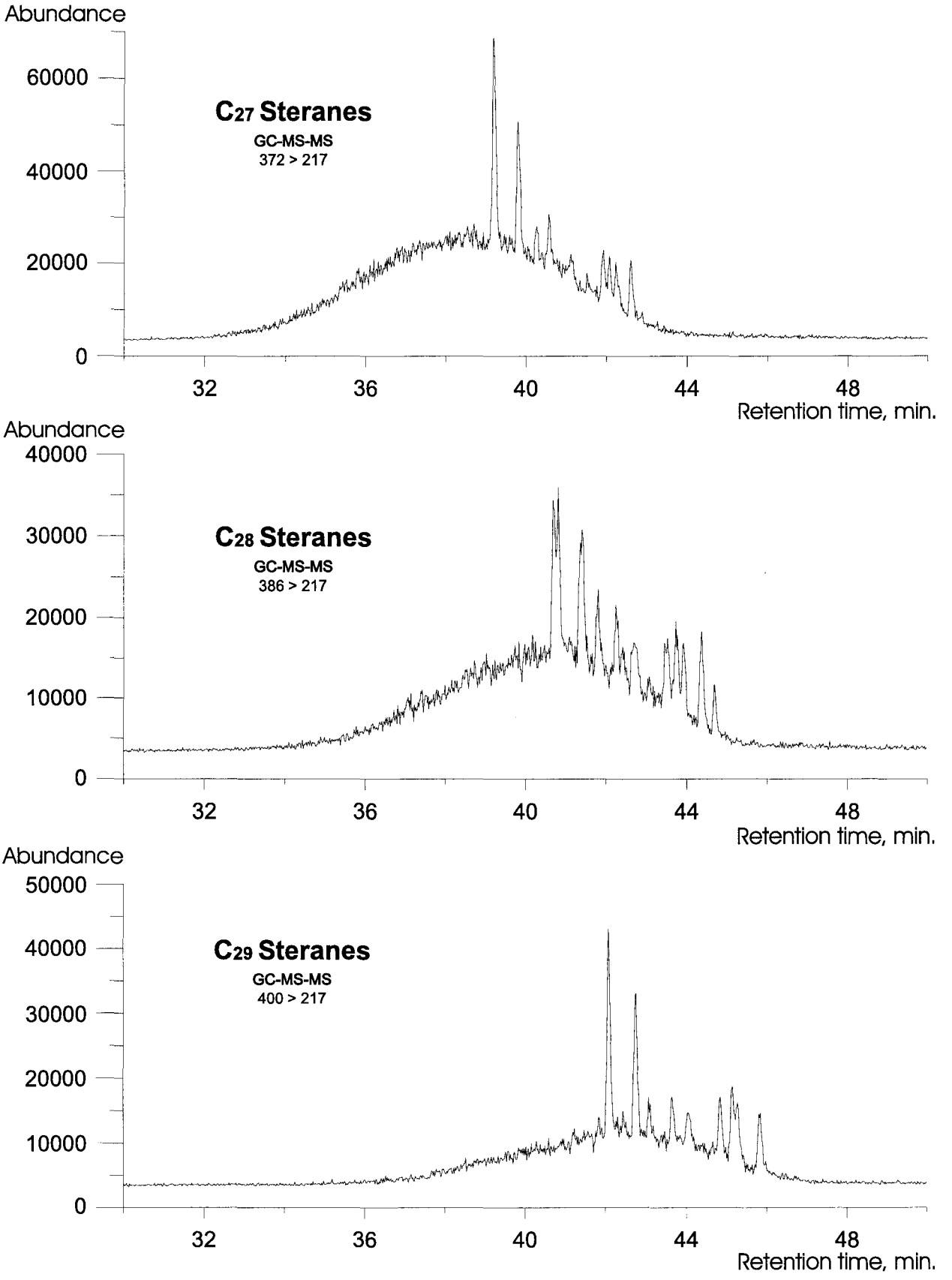

Figure 9. GC-MS-MS analysis of a triterpane concentrate from the Svane DST #2 condensate showing the C_{27}-C_{29} steranes.

The concentration of biomarkers in the Svane DST2 condensate is extremely low. Hopanes and steranes could only be detected after concentration (>100x) using MPLC. The m/z 191 mass chromatogram (Fig. 7) and the MS-MS data (Fig. 8) show a relative concentration of gammacerane which is significantly higher than that found in the usual North Sea crude oils originating from Upper Jurassic source rocks. Low concentrations of gammacerane can be detected in most oils, whereas higher concentrations are more rare (ten Haven et al., 1989). Gammacerane has been tentatively suggested as a marker for hypersaline episodes of source rock deposition, which may occur in alkaline lakes or lagoonal carbonate-evaporate deposits (Peters and Moldowan, 1993) or just as an indicator of water column stratification (Sinninghe Damsté et al., 1995) The relative content of rearranged hopanes (neohopanes and diahopanes) in the Svane DST2 condensate is lower than usual, suggesting an origin from a source rock having a low clay content. Neohopanes and diahopanes are more thermally stable than regular hopanes and are sometimes very prominent in oils and source rocks generated from very mature clay-rich source rocks. Isomerization of regular steranes = 20S/(20S+20R) is close to equilibrium, but the steranes do not yield further information about the source rock.

5. Conclusions

1. The Hejre-1 well had TD in 5294 m depth in pre-Jurassic rocks of unknown age, where the temperature is c. 169°C. The well encountered an oil column of 20.5 m in the Heno Sand Formation with 19 m with a hydrocarbon saturation of 93%. The oil has an isotopic signature comparable to coaly sourced hydrocarbons.
2. The Svane-1/1A well had TD in 5903 m depth in Upper Jurassic rocks, where the temperature is c. 190°C. The well encountered a 110 m thick condensate interval with a hydrocarbon saturation of 69% in the Heno Sand equivalent. Geochemical data suggest a coaly source.
3. Measured VR trends of both wells display (i) an upper linear segment, (ii) a middle part with a rapid increase in VR, and (iii) a lower linear segment with a higher gradient than the upper linear part. The VR curve for Hejre-1 cuts the surface at a VR of c. 0.17%R_o and that of Svane-1/1A at c. 0.14%R_o. The VR trends thus show that the drilled sediment packages of both wells are undisturbed.
4. Semilog plots yield well-defined straight lines for both wells with a VR gradient of 0.17%R_o/km for Hejre-1 and 0.19%R_o/km for Svane-1/1A.
5. The mean VR close to TD in the Hejre-1 well is 1.18%R_o and in the Svane-1/1A well 1.53%R_o. Both values seem too low compared to the temperature, which may be caused by overpressure induced retardation of organic matter maturation.
6. Maturation retardation has implications for the prospectivity of deep prospects as the oil window will be moved to greater burial depth. This in particular holds for terrestrial (coaly) source rocks.
7. The Svane DST2 condensate has, compared to the usual North Sea oils derived from Upper Jurassic source rocks, a relative significantly higher content of gammecerane and a lower content of rearranged hopanes (neohopanes and diahopanes).

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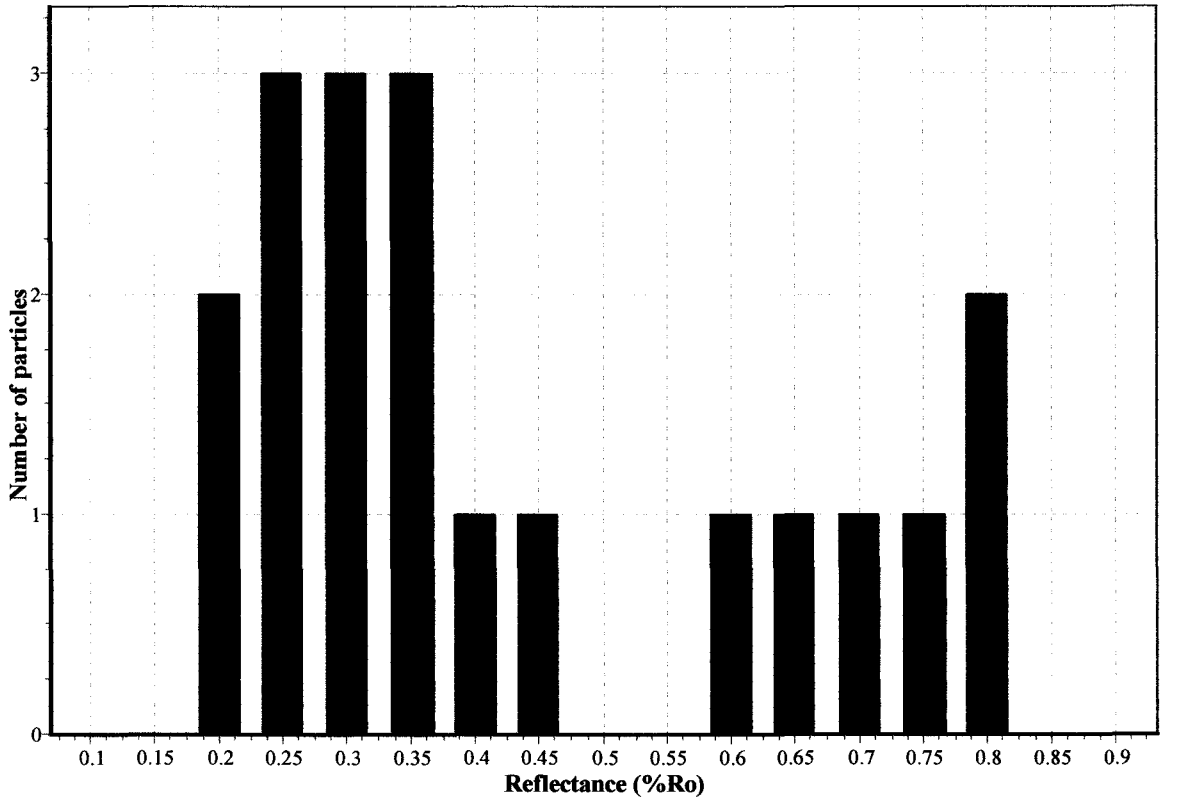
APPENDIX

Vitrinite reflectance histograms

HEJRE-1

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8204
Depth:	1480 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030704
Seam:		Operator:	cgu
Interval:		Standard:	0.515%
Formation:	Nordland Group	Client:	
Age:	L. Miocene		

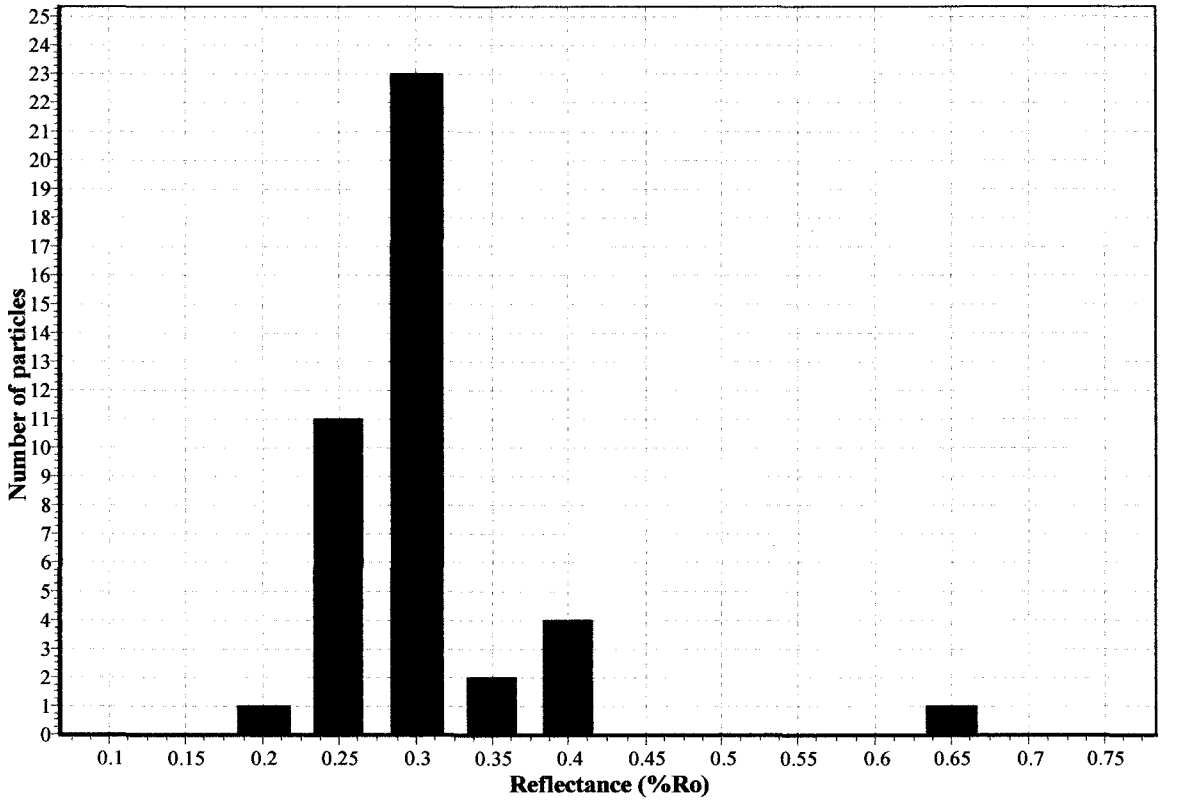


Mean %R= 0.44 Minimum %R= 0.18 Maximum %R= 0.82
Standard deviation= 0.216 Number of particles= 19

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8207
Depth:	1660 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030704
Seam:		Operator:	cgu
Interval:		Standard:	0.515%
Formation:	Hordaland Group	Client:	
Age:	M. Miocene		

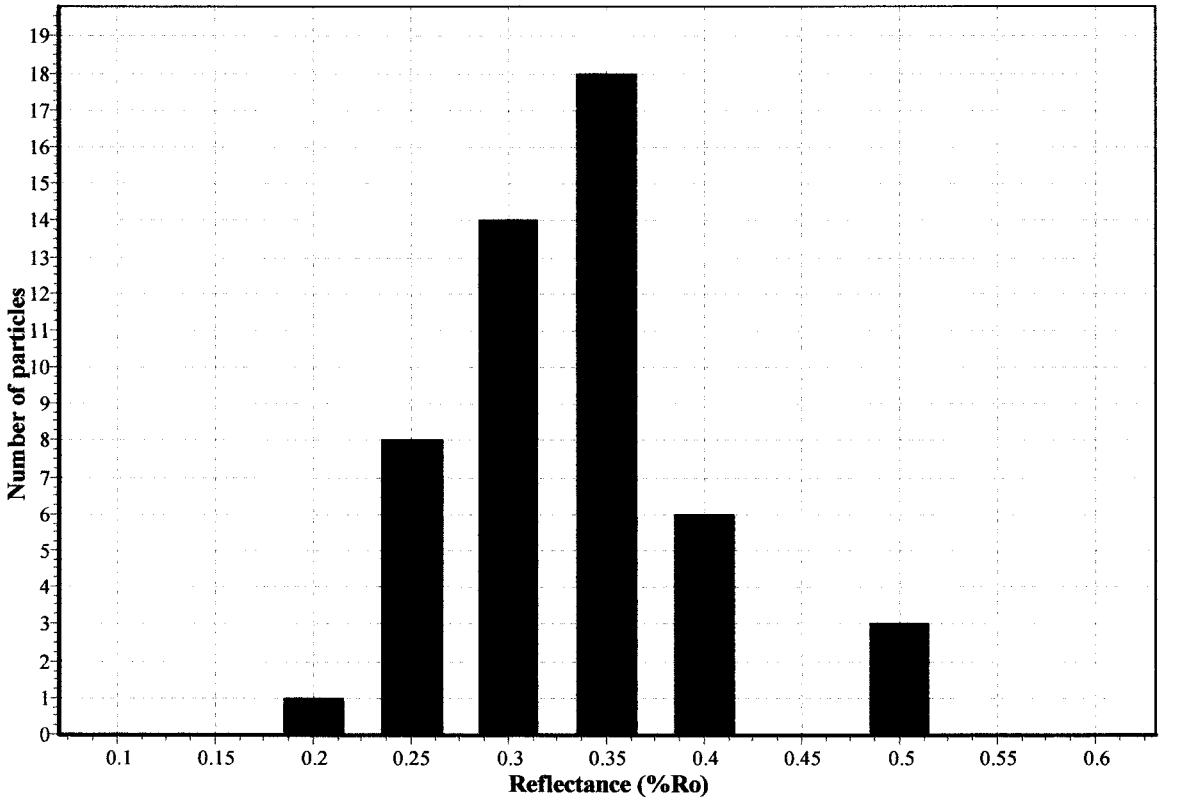


Mean %R= 0.3 Minimum %R= 0.21 Maximum %R= 0.64
Standard deviation= 0.068 Number of particles= 42

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8209
Depth:	1780 m	Activity no.:	202031
Material:	Cuttings	Date:	20030714
Seam:		Operator:	cgu
Interval:		Standard:	0.515%
Formation:	Hordaland Group	Client:	
Age:	E. Miocene - ?L. Oligocene		

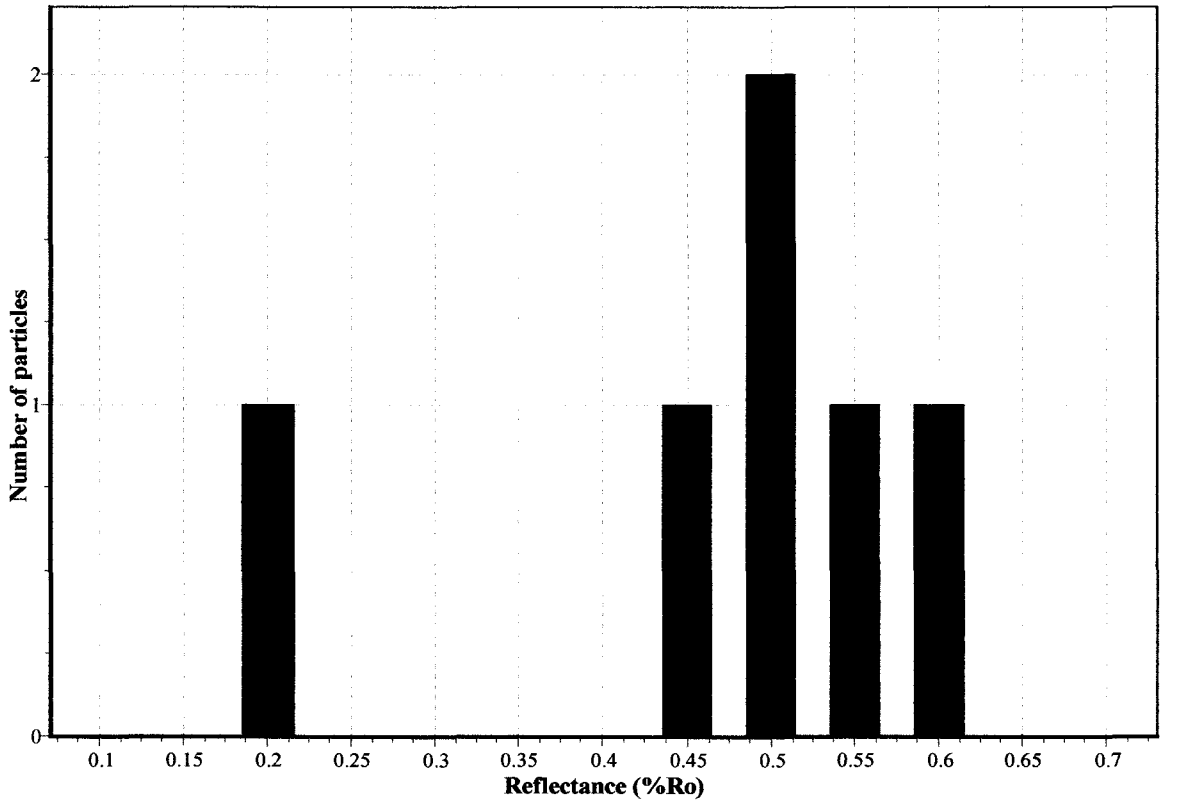


Mean %R= 0.33 Minimum %R= 0.2 Maximum %R= 0.51
Standard deviation= 0.065 Number of particles= 50

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8230
Depth:	3000 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030715
Seam:		Operator:	cgu
Interval:		Standard:	0.515%
Formation:	Hordaland Group	Client:	
Age:	E. Eocene		

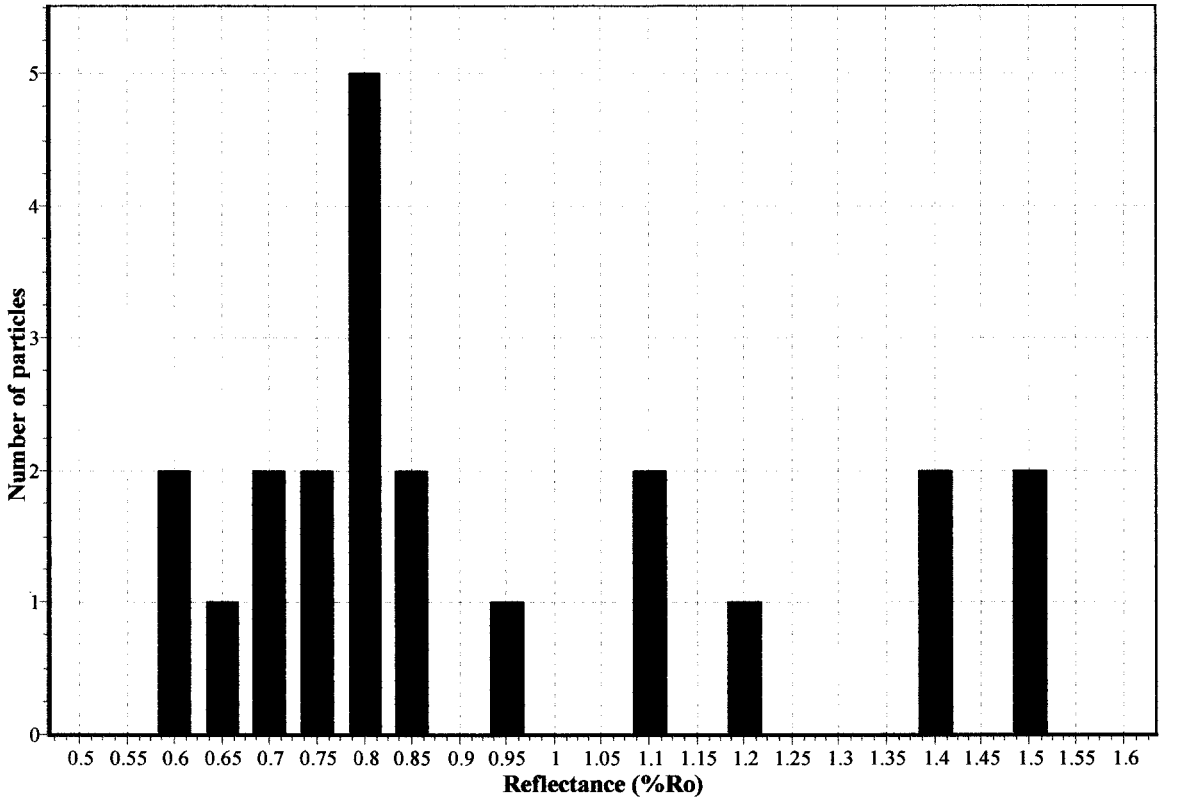


Mean %R= 0.47 Minimum %R= 0.2 Maximum %R= 0.62
Standard deviation= 0.146 Number of particles= 6

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8330
Depth:	4305 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030918
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Mandal Fm	Client:	
Age:	E. Valanginian - L. Ryazanian		

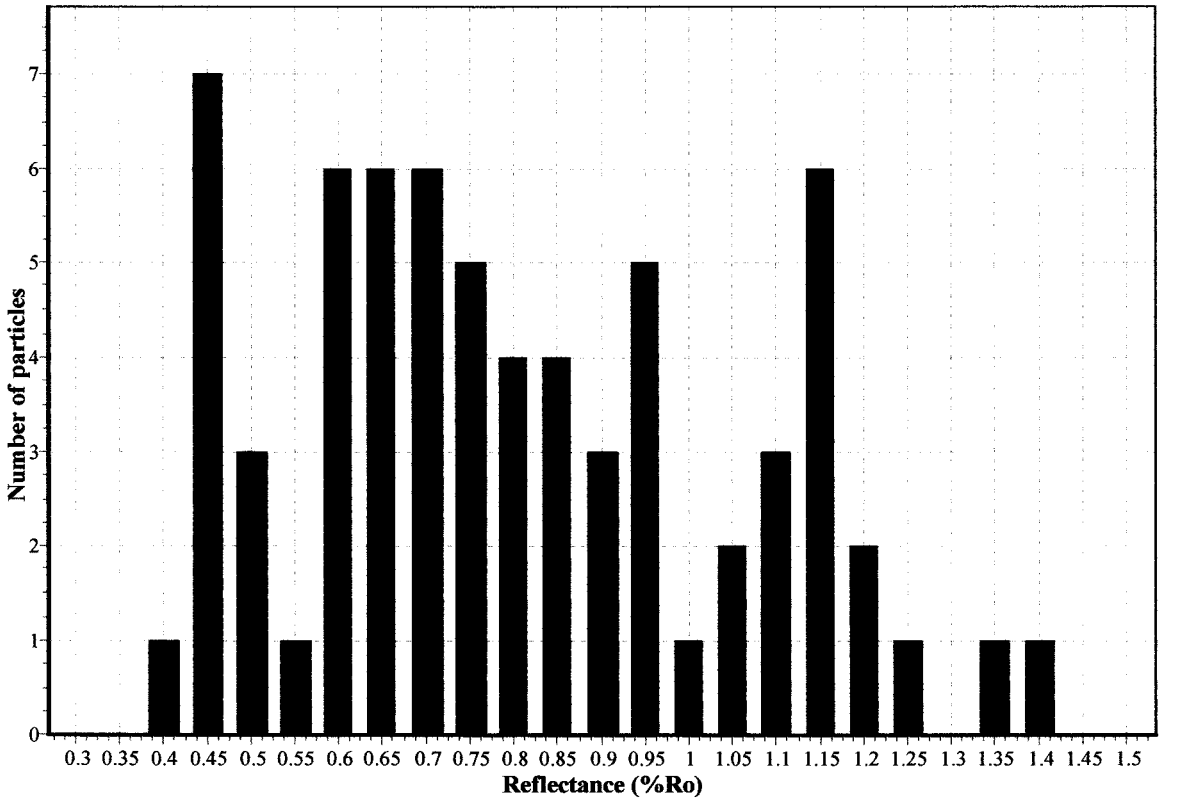


Mean %R= 0.93 Minimum %R= 0.61 Maximum %R= 1.51
Standard deviation= 0.296 Number of particles= 22

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8336
Depth:	4335 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030918
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Mandal Fm	Client:	
Age:	E. Valanginian - L. Ryazanian		

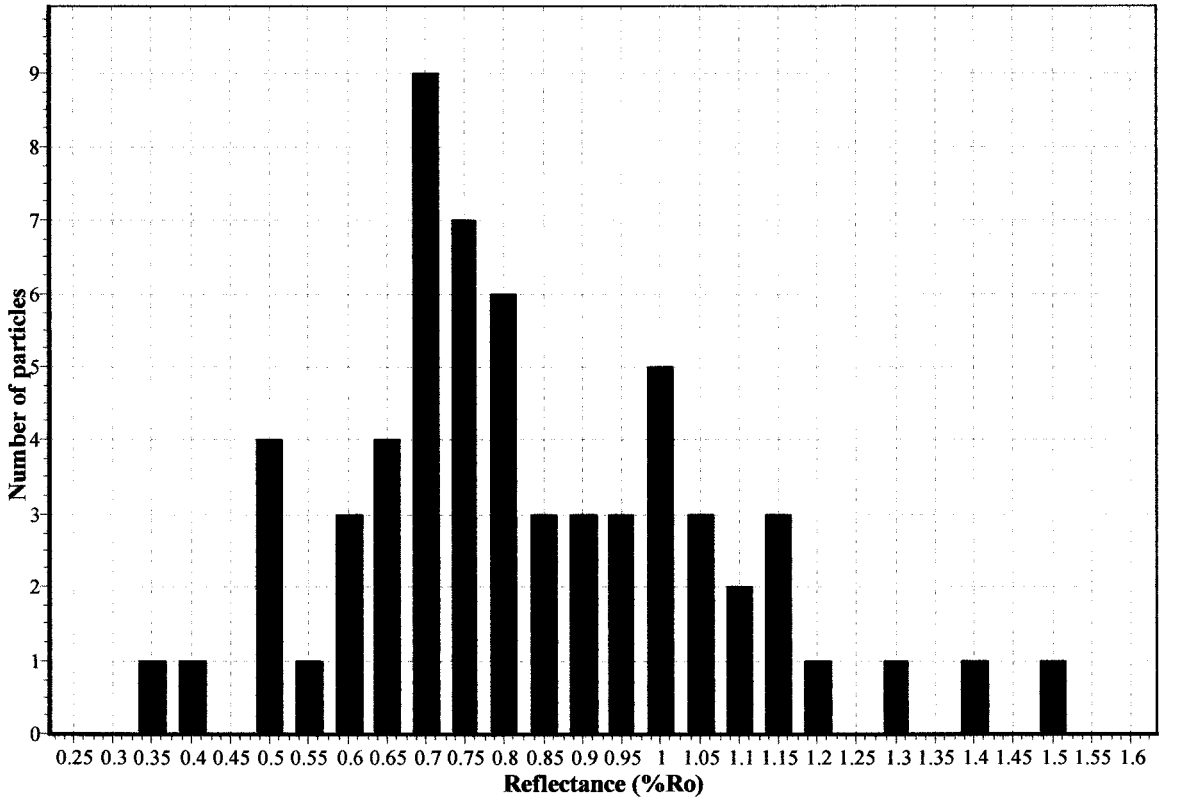


Mean %R= 0.81 Minimum %R= 0.38 Maximum %R= 1.41
Standard deviation= 0.25 Number of particles= 68

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8343
Depth:	4370 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030918
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Mandal Fm	Client:	
Age:	L. Volgian		

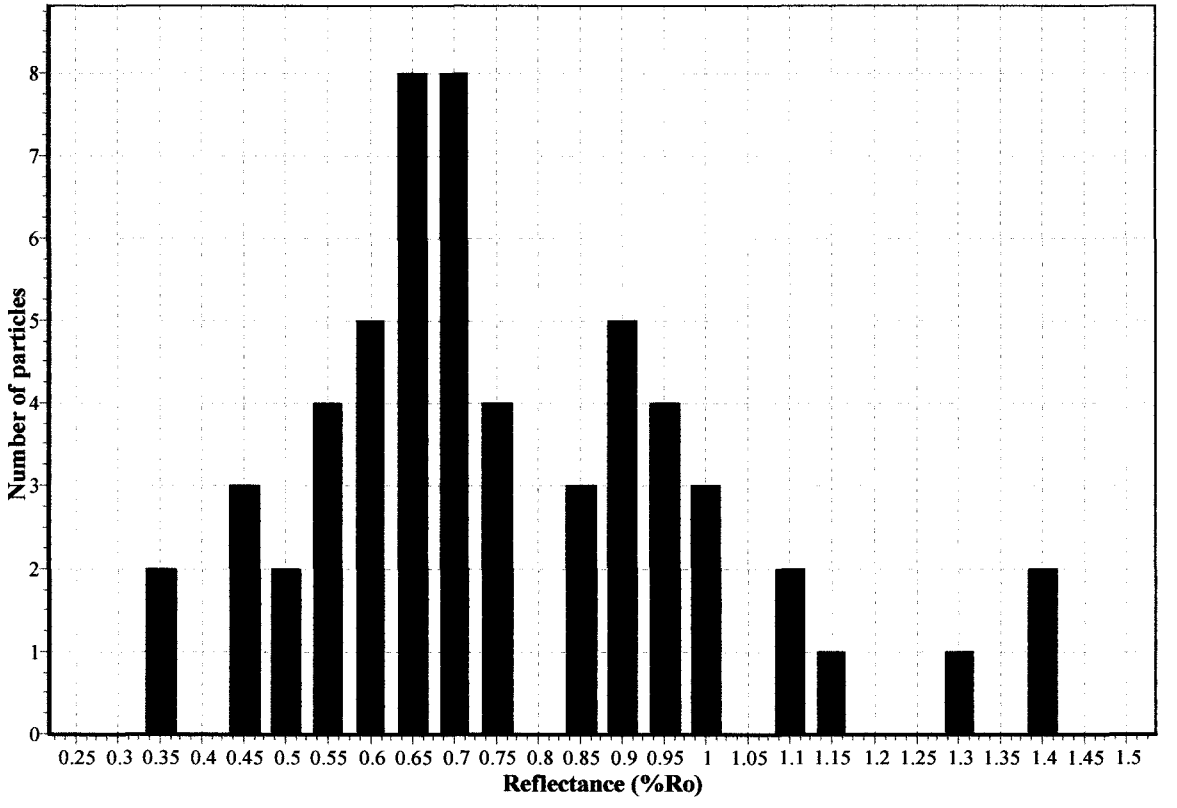


Mean %R= 0.83 Minimum %R= 0.36 Maximum %R= 1.52
Standard deviation= 0.236 Number of particles= 62

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8350
Depth:	4410 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030919
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Mandal Fm	Client:	
Age:	M. Volgian		

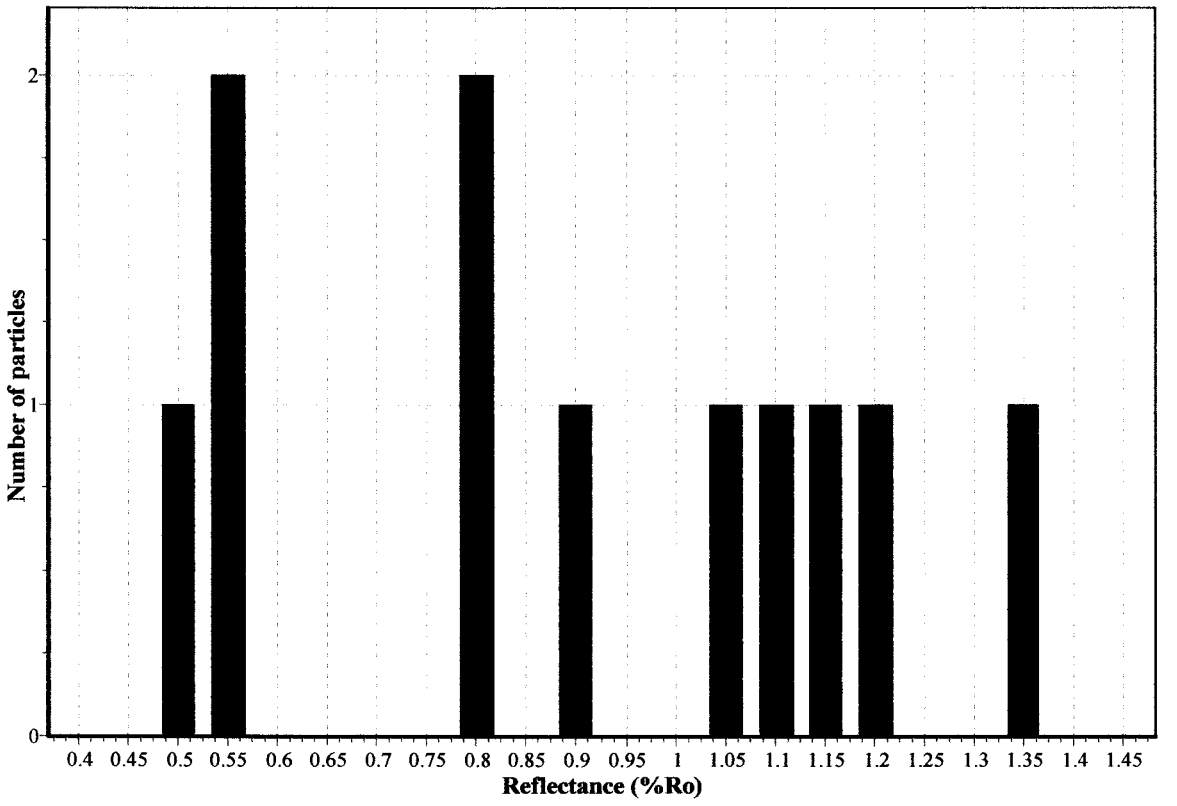


Mean %R= 0.76 Minimum %R= 0.34 Maximum %R= 1.4
Standard deviation= 0.235 Number of particles= 57

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8383
Depth:	4660 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030723
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian		

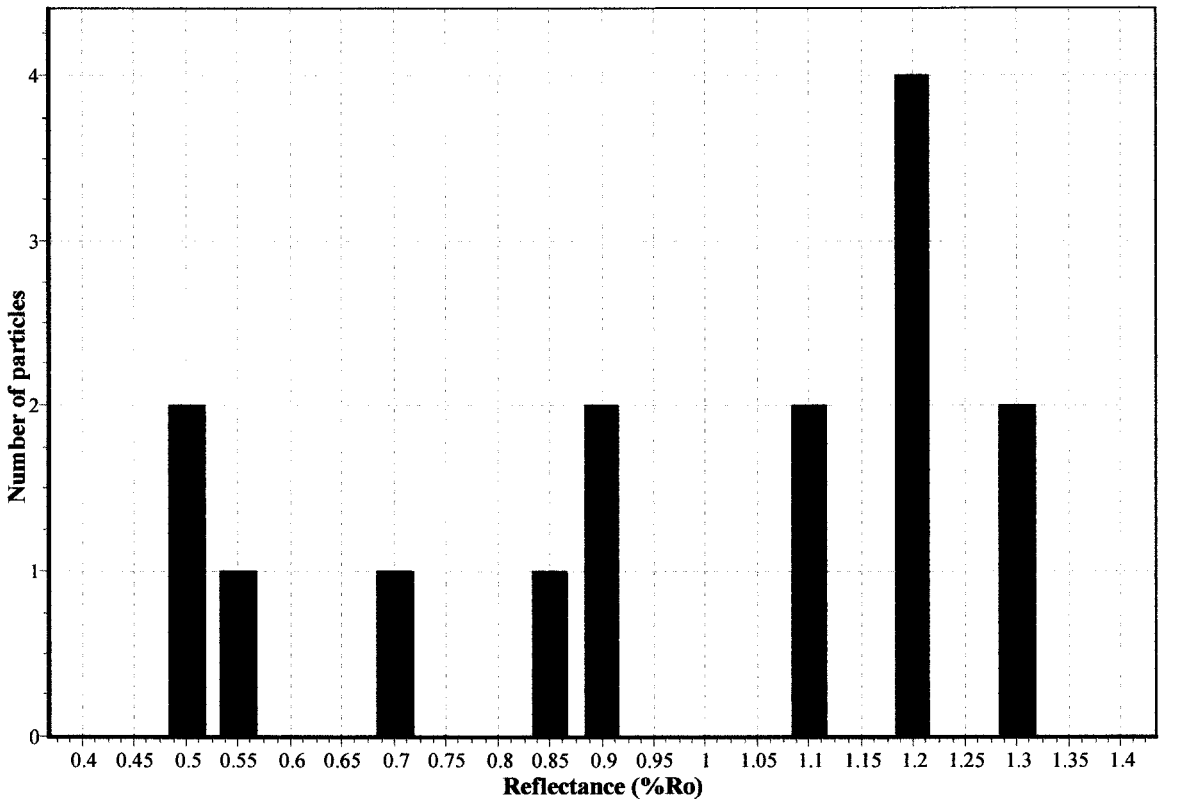


Mean %R= 0.89 Minimum %R= 0.49 Maximum %R= 1.34
Standard deviation= 0.29 Number of particles= 11

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8387
Depth:	4700 m	Activity no.:	2002031
Material:	Cutting	Date:	20030723
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian		

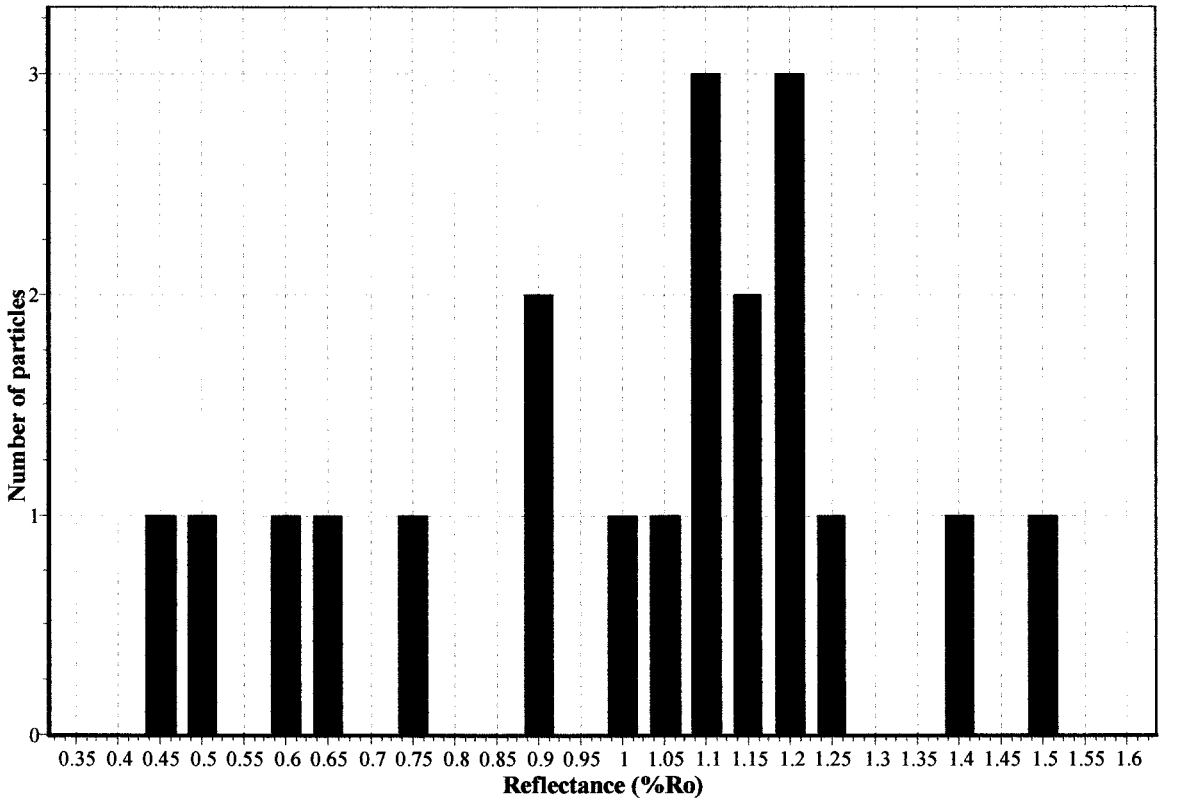


Mean %R= 0.97 Minimum %R= 0.51 Maximum %R= 1.31
Standard deviation= 0.287 Number of particles= 15

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8395
Depth:	4780 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030815
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian		

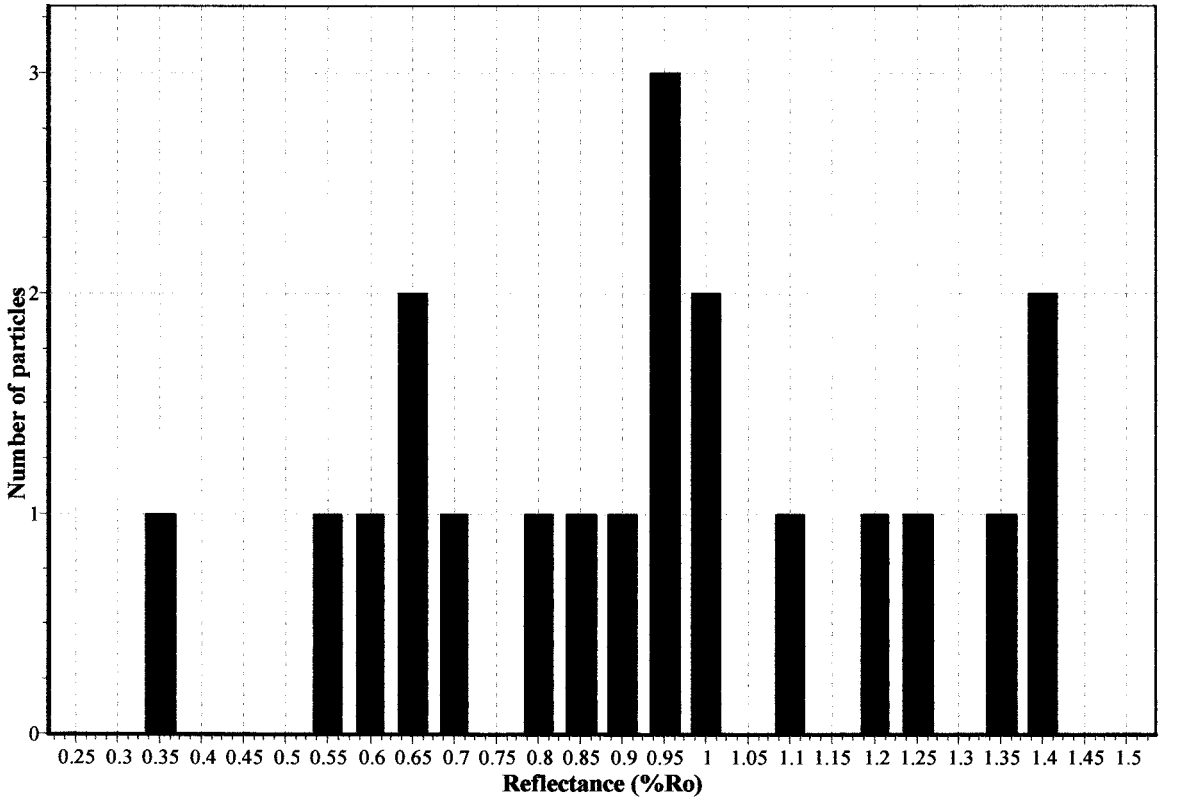


Mean %R= 1 Minimum %R= 0.43 Maximum %R= 1.49
Standard deviation= 0.289 Number of particles= 20

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8403
Depth:	4860 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030818
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	Jurassic unspecified		

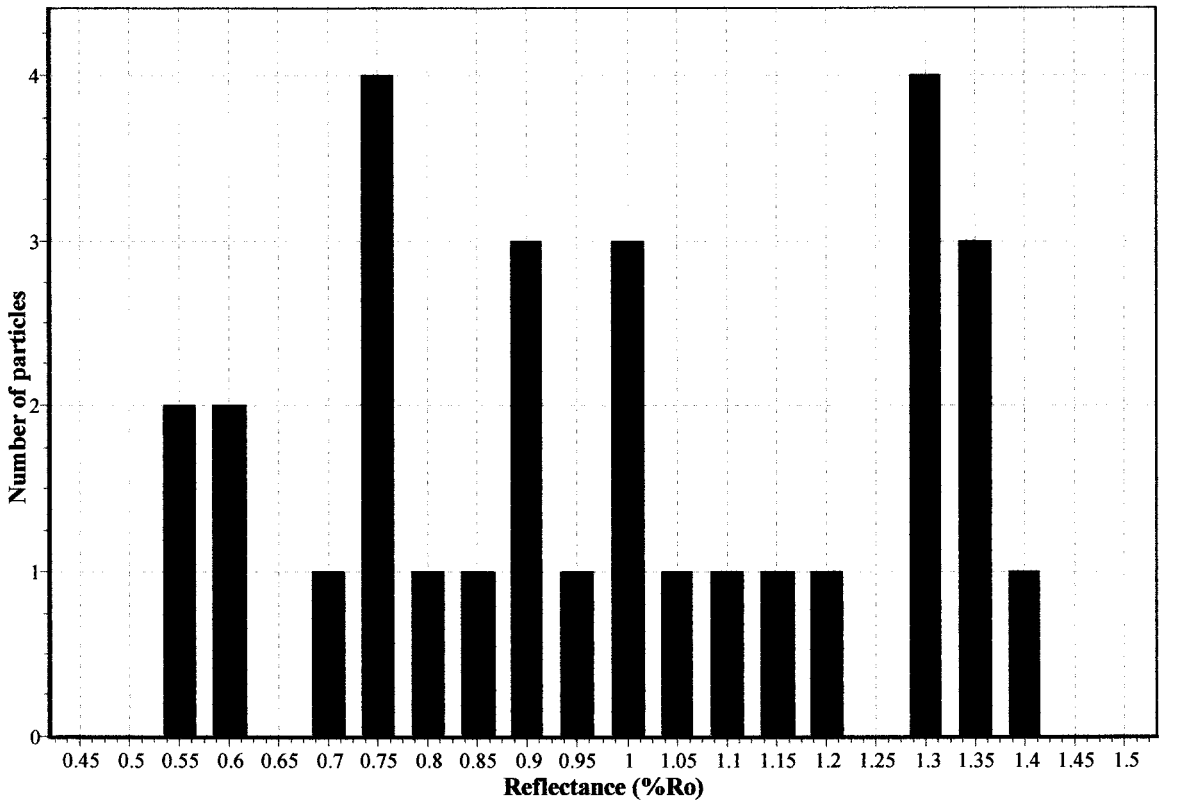


Mean %R= 0.93 Minimum %R= 0.37 Maximum %R= 1.42
Standard deviation= 0.299 Number of particles= 20

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8407
Depth:	4900 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030818
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	Jurassic unspecified		

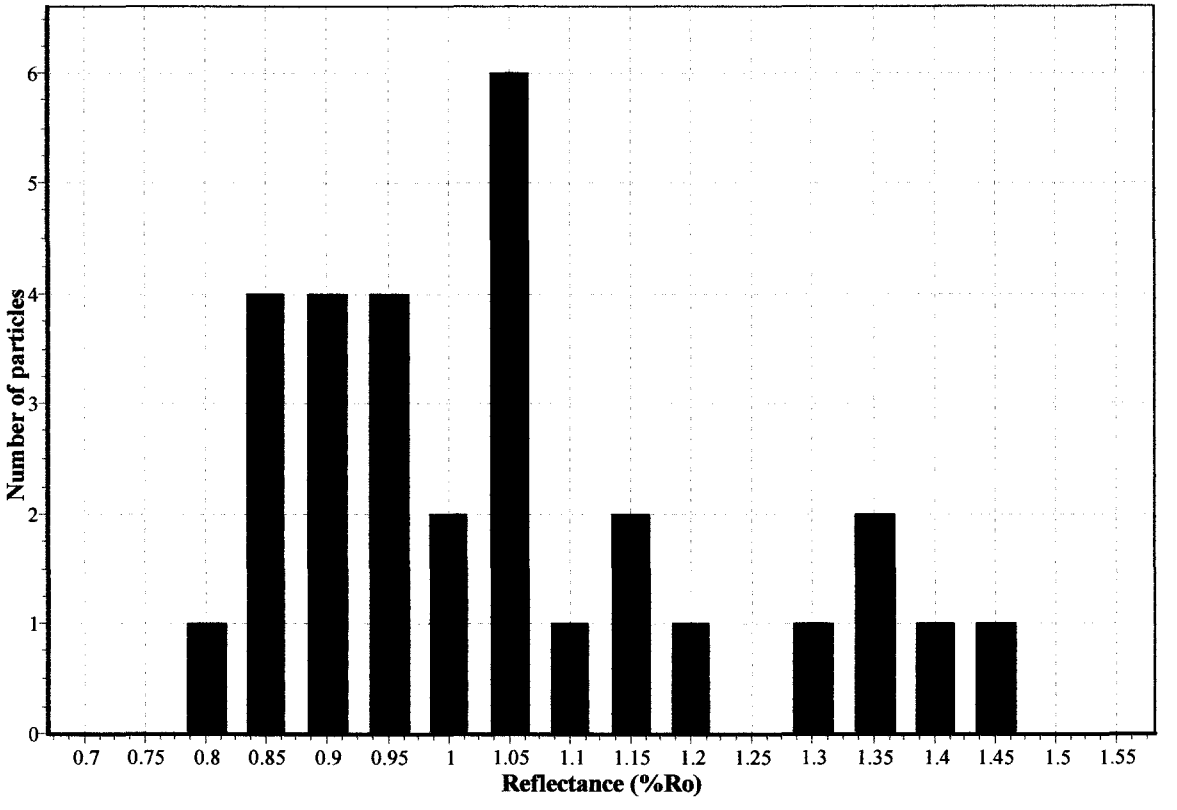


Mean %R= 0.98 Minimum %R= 0.56 Maximum %R= 1.42
Standard deviation= 0.269 Number of particles= 30

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8411
Depth:	4940 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030813
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	Jurassic unspecified		

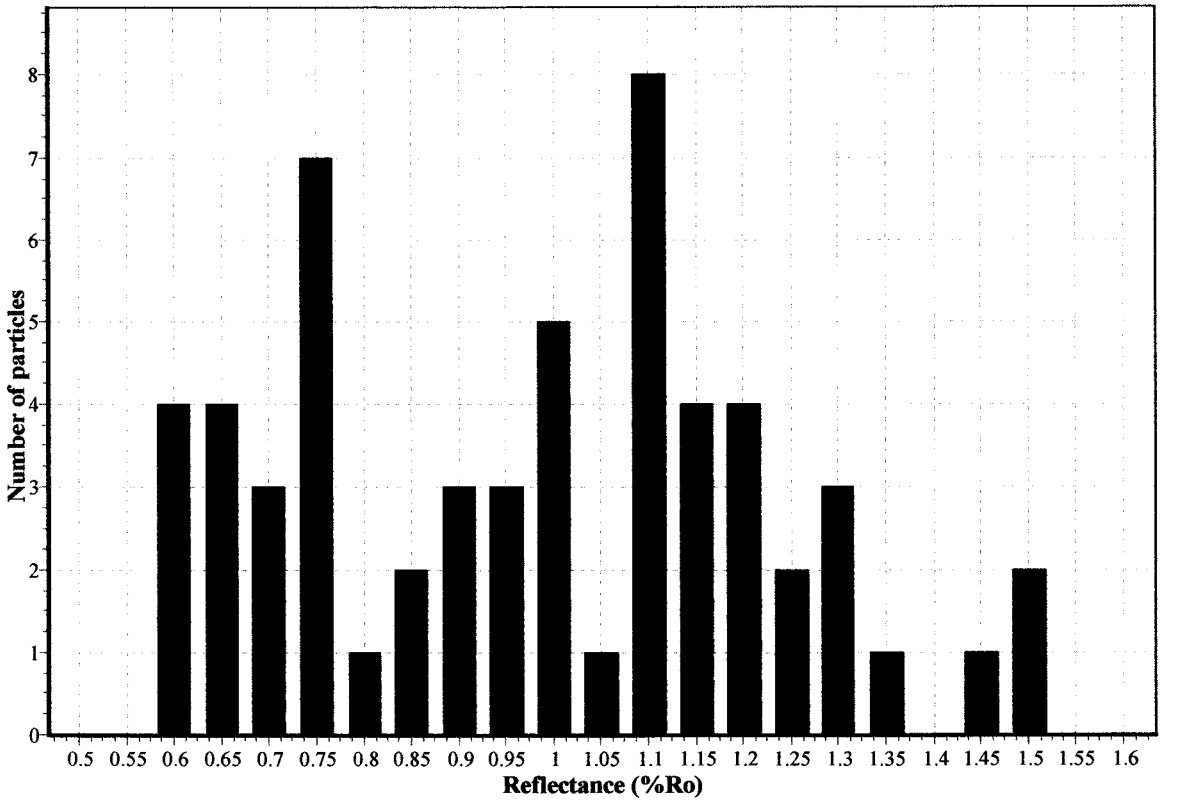


Mean %R= 1.05 Minimum %R= 0.82 Maximum %R= 1.46
Standard deviation= 0.177 Number of particles= 30

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8414
Depth:	4970 m	Activity no.:	2002031
Material:	Cuttiings	Date:	20030812
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	Jurassic unspecified		

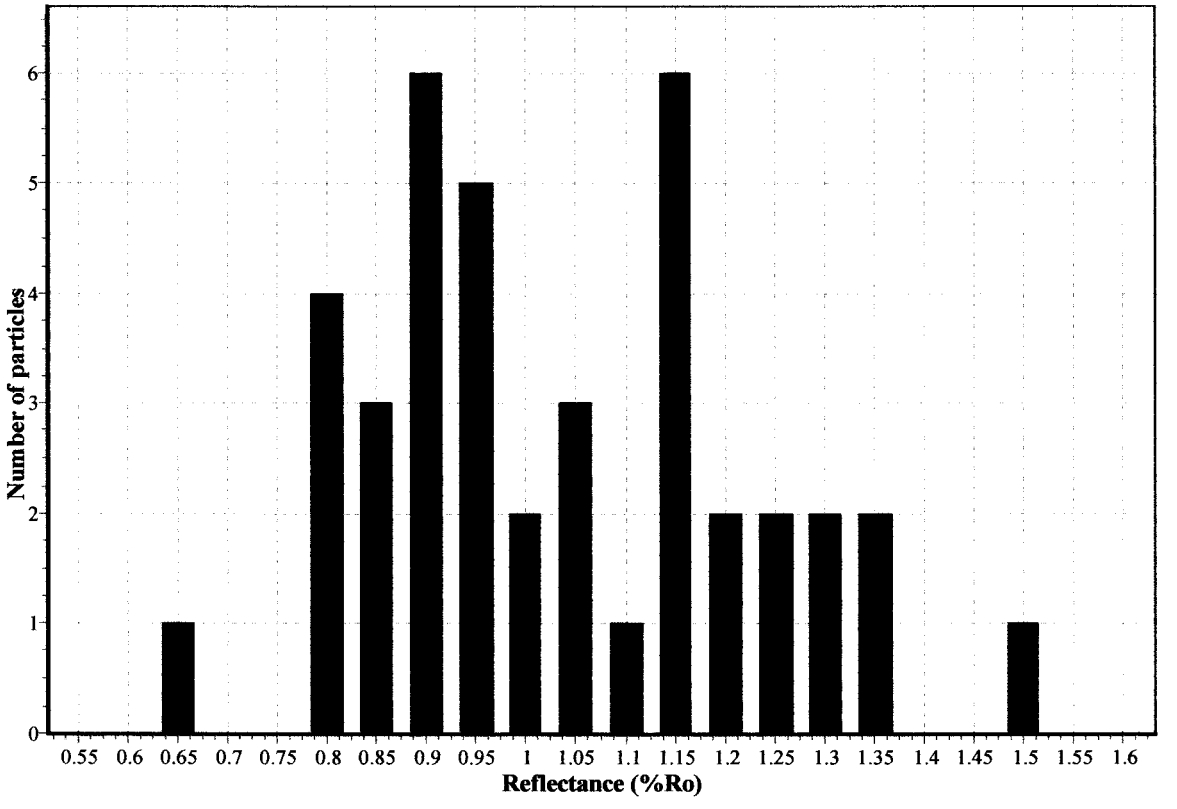


Mean %R= 0.98 Minimum %R= 0.61 Maximum %R= 1.52
Standard deviation= 0.245 Number of particles= 58

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8418
Depth:	5009 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030813
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	Jurassic unspecified		

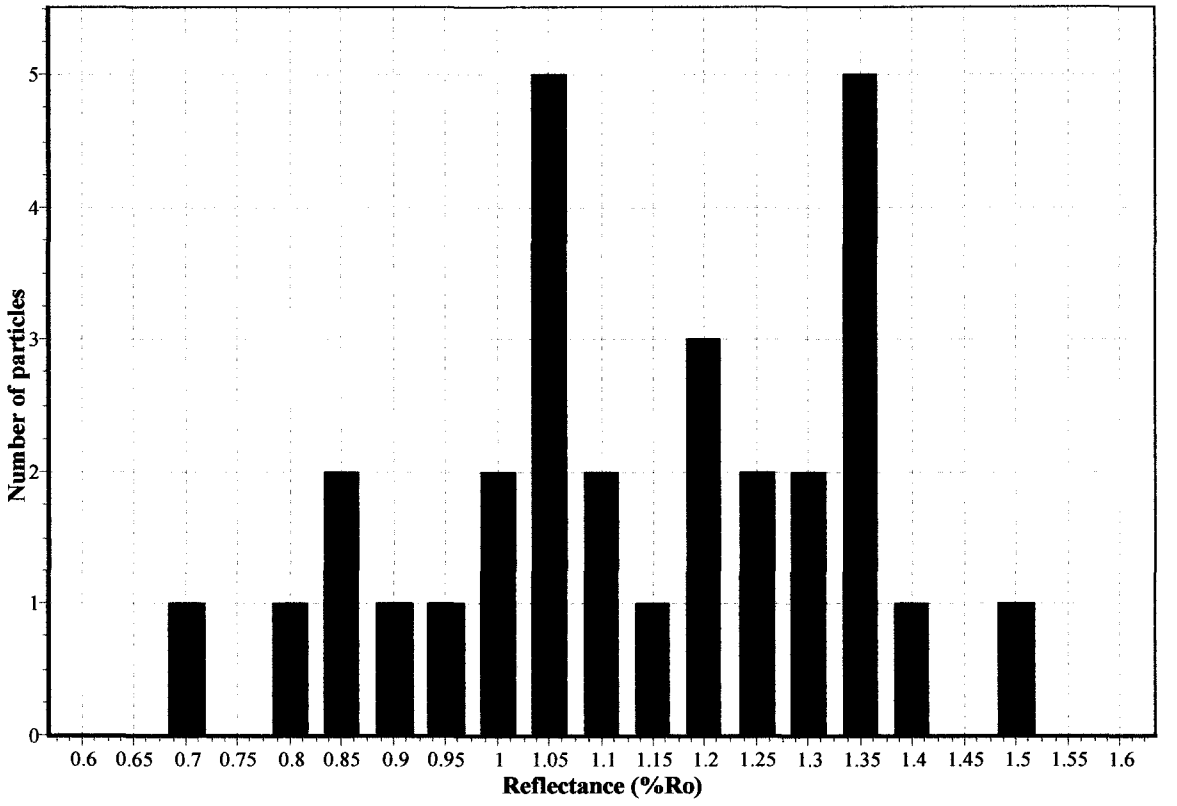


Mean %R= 1.03 Minimum %R= 0.64 Maximum %R= 1.49
Standard deviation= 0.192 Number of particles= 40

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8422
Depth:	5045 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030813
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	Jurassic unspecified		

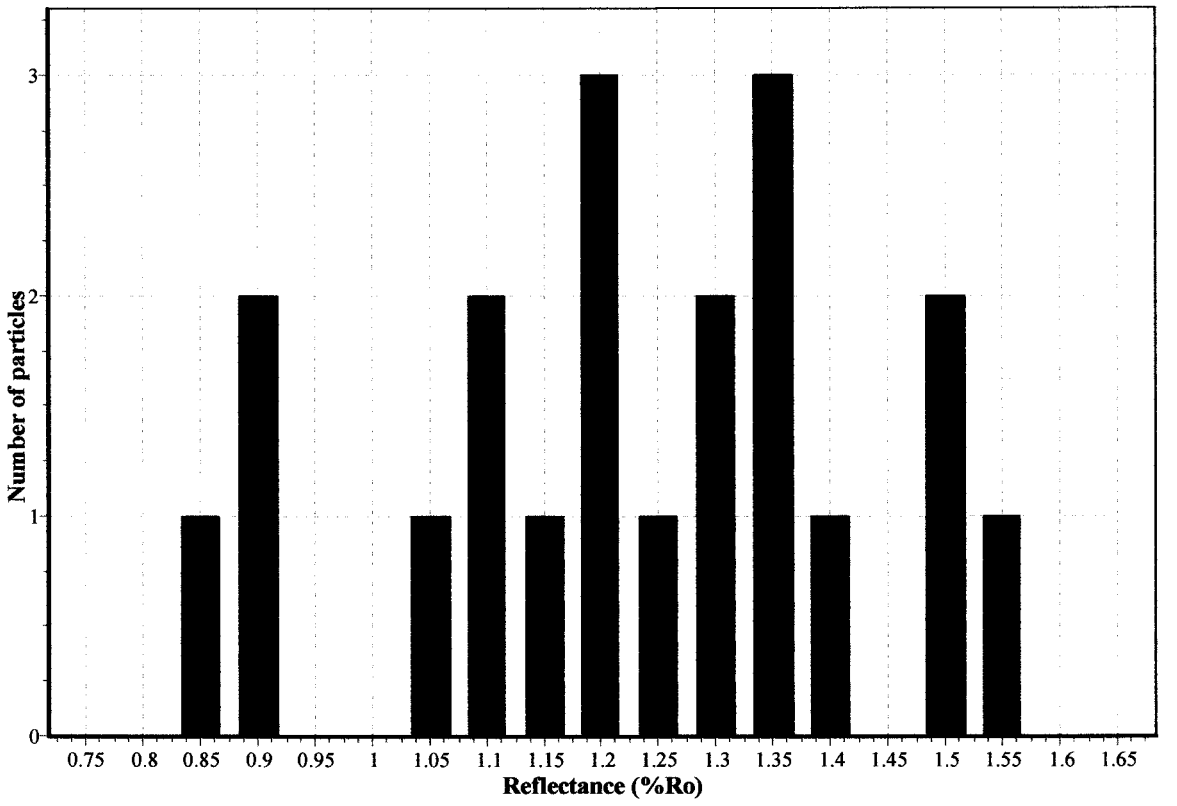


Mean %R= 1.13 Minimum %R= 0.7 Maximum %R= 1.52
Standard deviation= 0.201 Number of particles= 30

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8427
Depth:	5090 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030813
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	Jurassic unspecified		

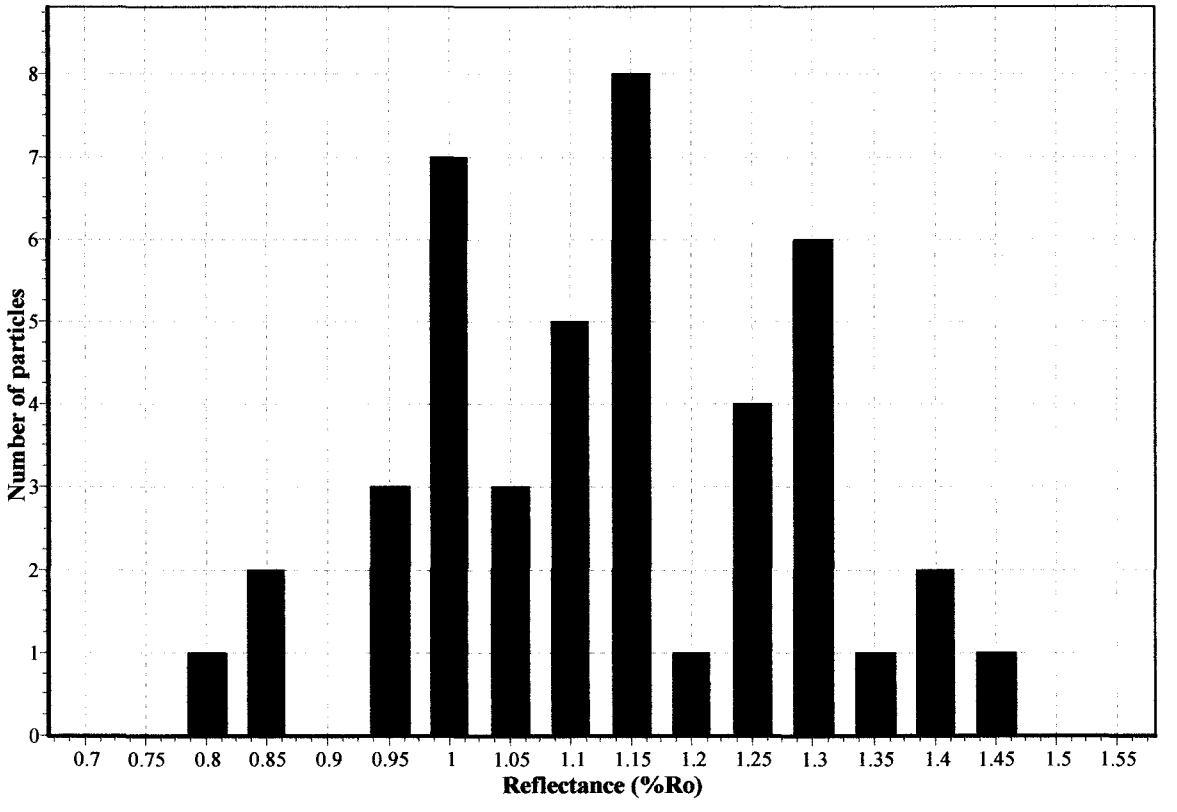


Mean %R= 1.23 Minimum %R= 0.85 Maximum %R= 1.53
Standard deviation= 0.199 Number of particles= 20

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8431
Depth:	5145 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030814
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Heno Sand Fm	Client:	
Age:	Jurassic unspecified		

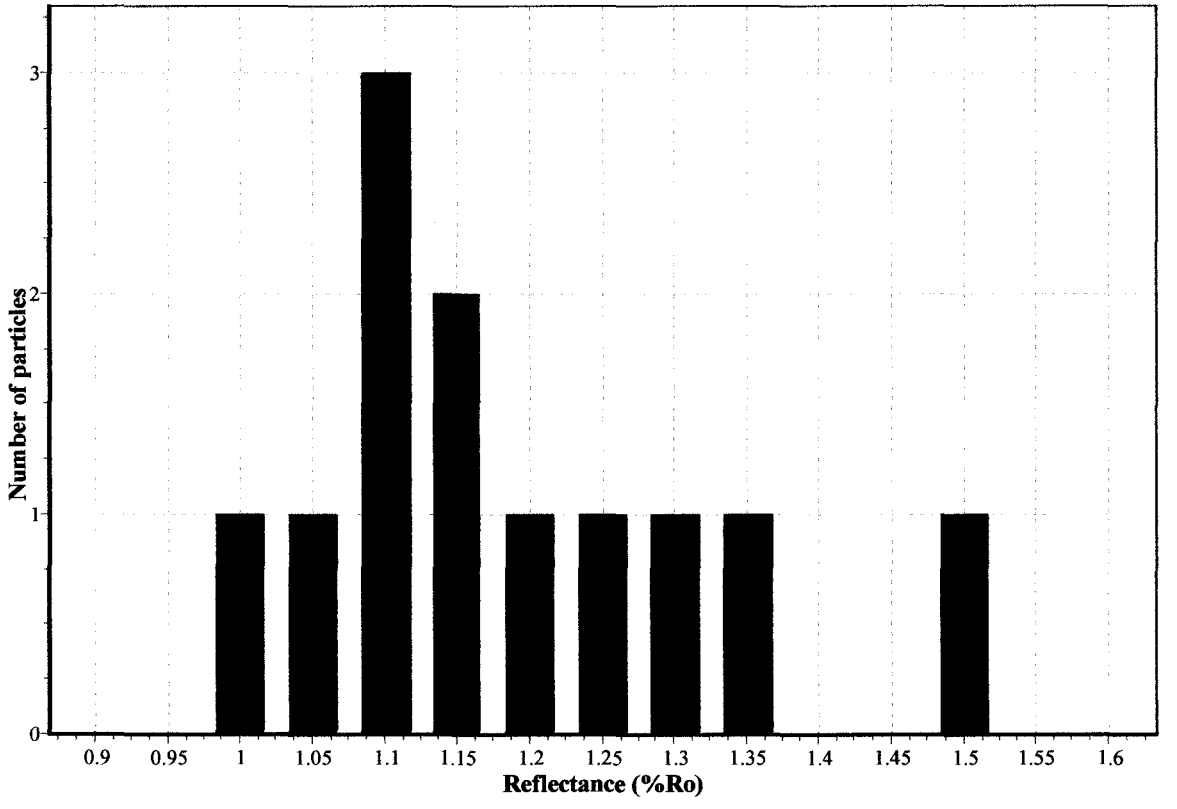


Mean %R= 1.13 Minimum %R= 0.8 Maximum %R= 1.46
Standard deviation= 0.152 Number of particles= 44

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8435
Depth:	5181 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030814
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Heno Sand Fm	Client:	
Age:	Jurassic unspecified		

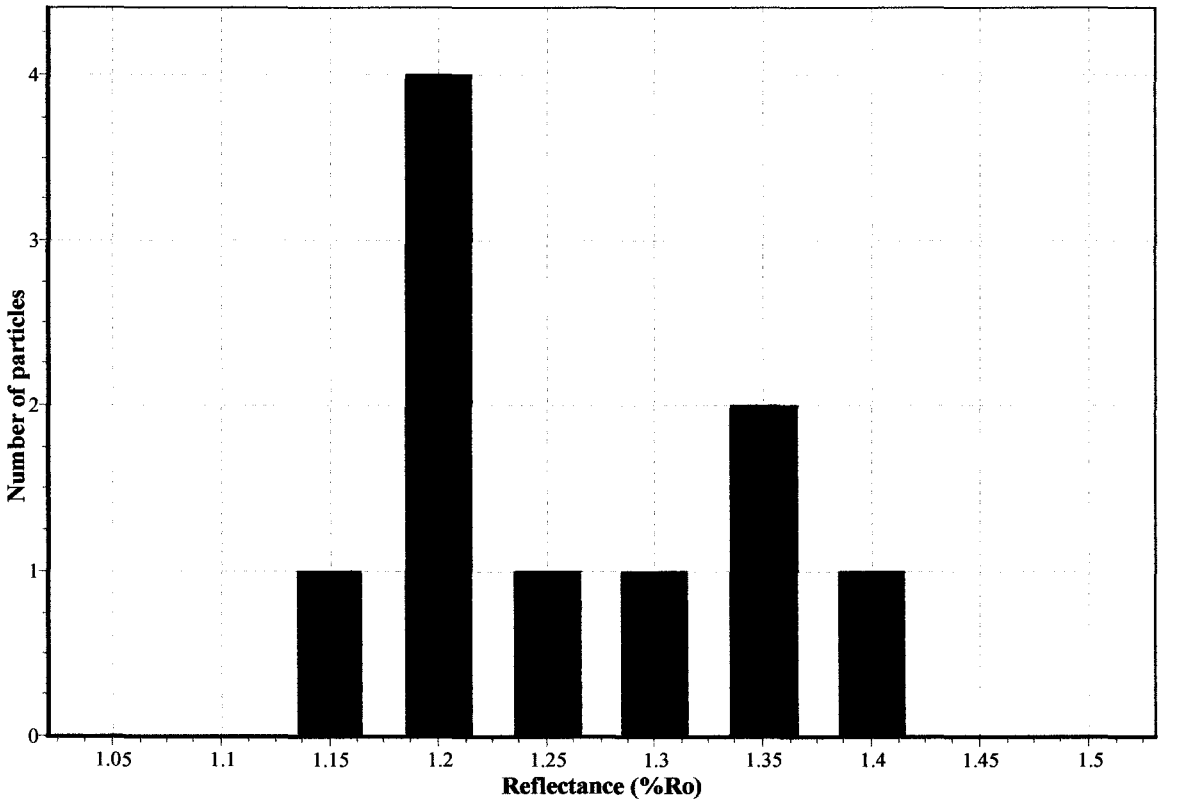


Mean %R= 1.19 Minimum %R= 1 Maximum %R= 1.51
Standard deviation= 0.148 Number of particles= 12

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8440
Depth:	5226 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030814
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:		Client:	
Age:	Pre-Jurassic		

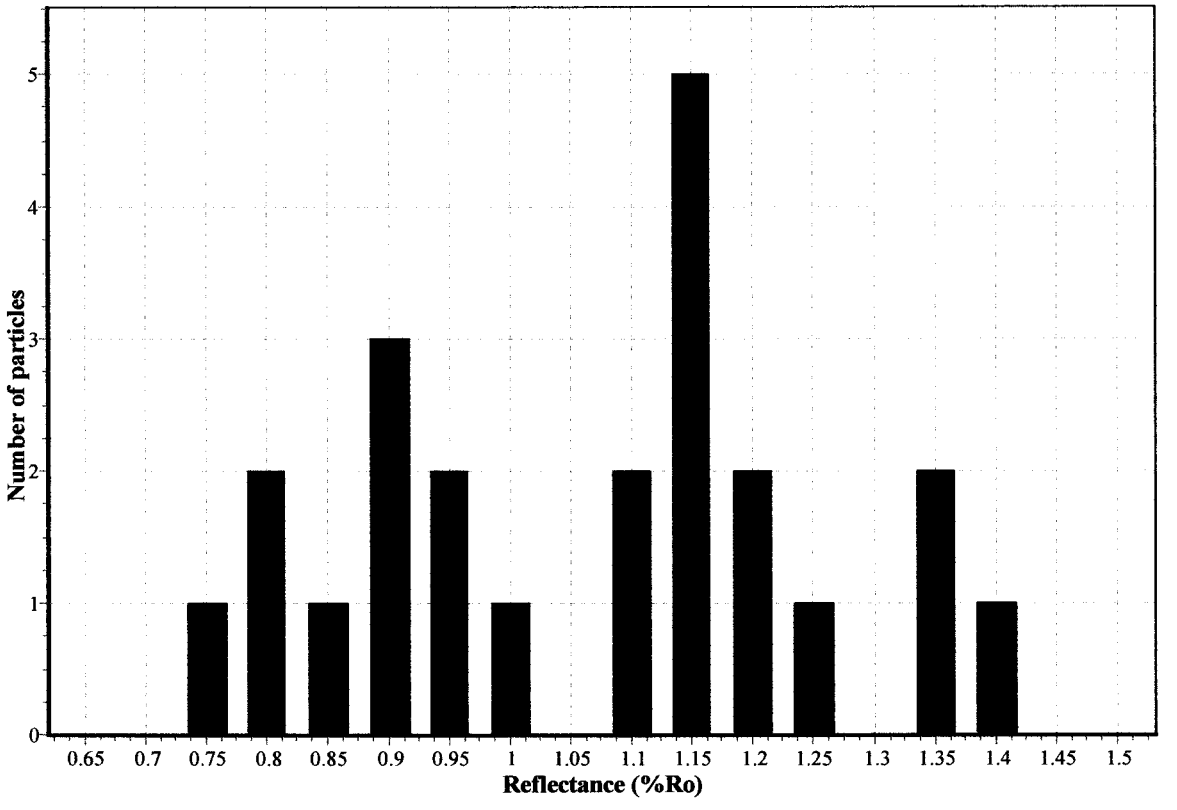


Mean %R= 1.26 Minimum %R= 1.16 Maximum %R= 1.39
Standard deviation= 0.079 Number of particles= 10

Comments:

Vitrinite Reflectance (Random)

Locality:	Hejre-1	Lab. no.:	8444
Depth:	5262 m	Activity no.:	2002031
Material:	Cuttings	Date:	20030814
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:		Client:	
Age:	Pre-Jurassic		



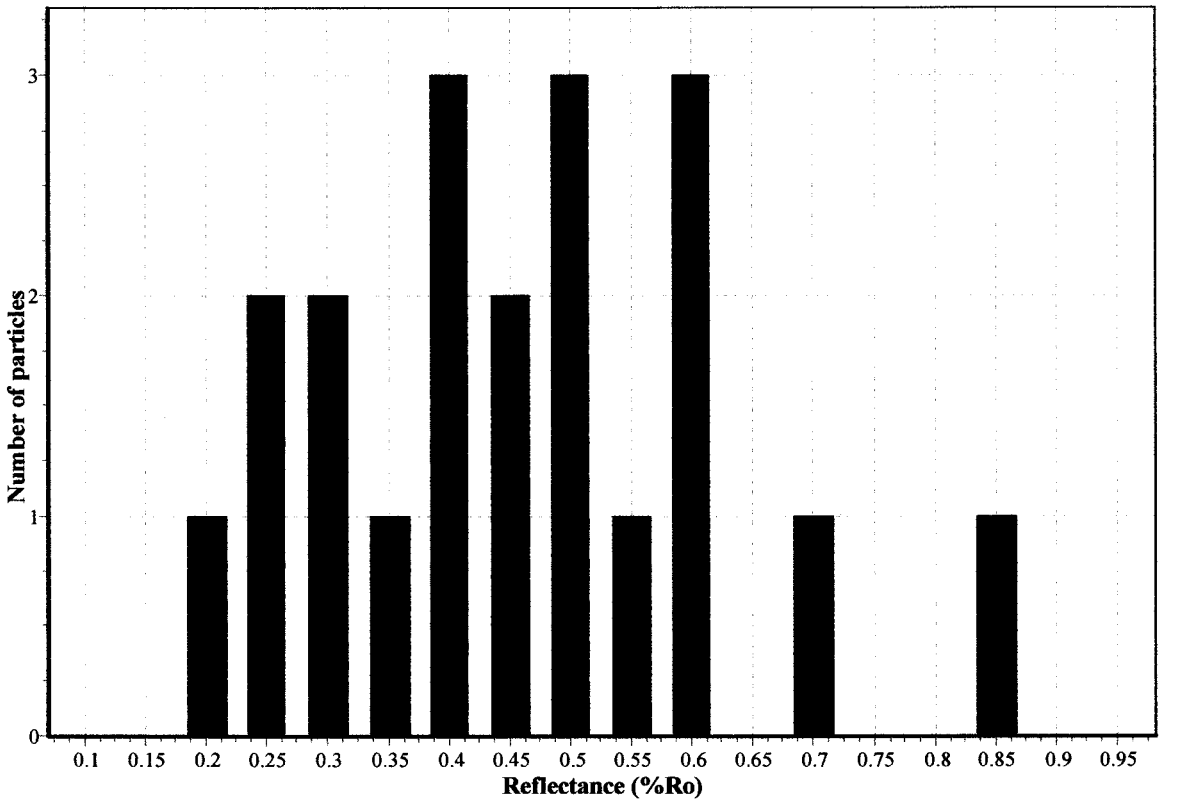
Mean %R= 1.07 Minimum %R= 0.75 Maximum %R= 1.42
Standard deviation= 0.193 Number of particles= 23

Comments:

SVANE-1

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7856
Depth:	1320 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030819
Seam:		Operator:	cgu
Interval:		Standard:	0.515%
Formation:	Nordland Group	Client:	
Age:	L. Miocene		

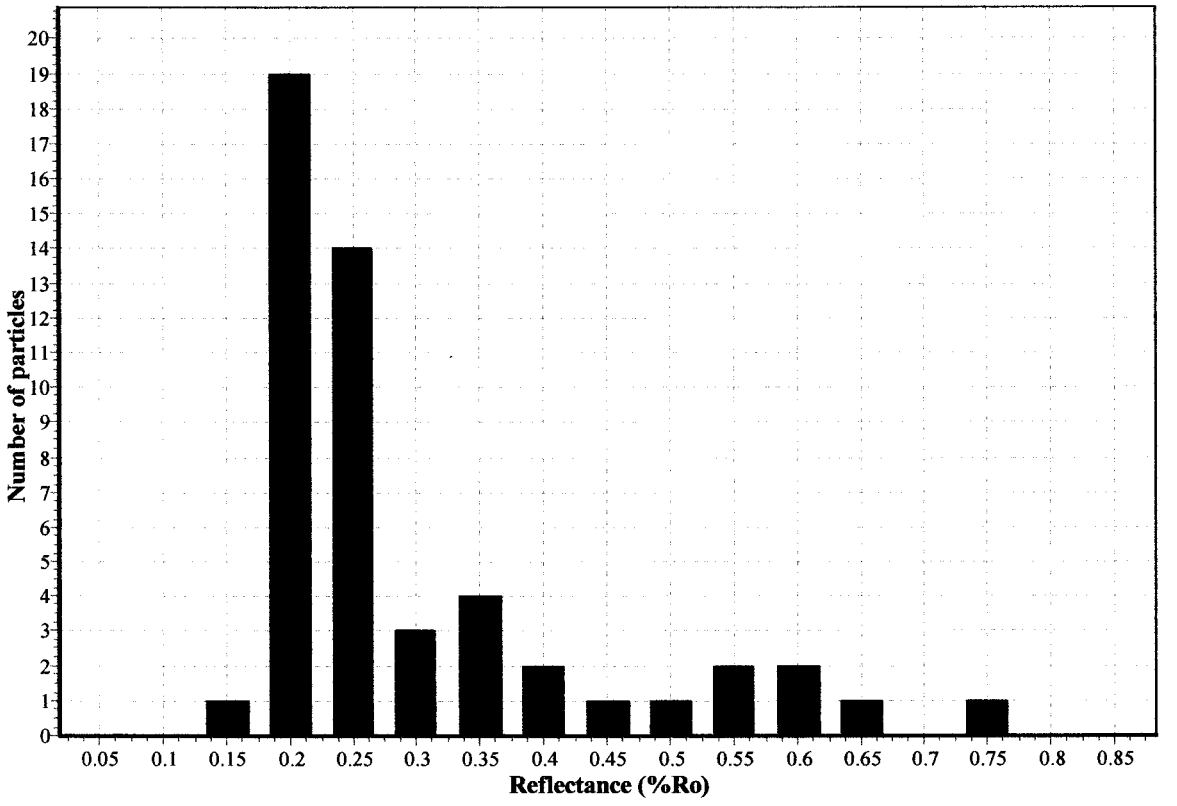


Mean %R= 0.45 Minimum %R= 0.18 Maximum %R= 0.83
Standard deviation= 0.162 Number of particles= 20

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7858
Depth:	1530 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030819
Seam:		Operator:	cgu
Interval:		Standard:	0.515%
Formation:	Hordaland Group	Client:	
Age:	M. Miocene		

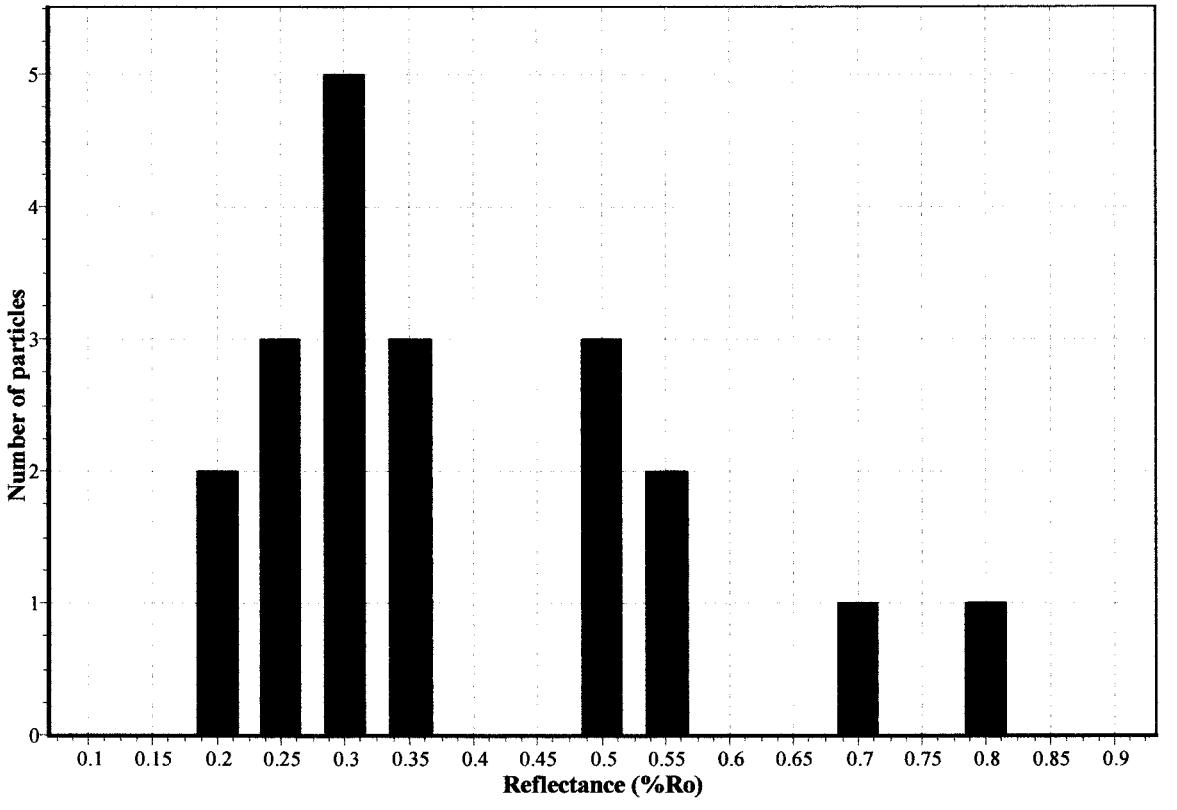


Mean %R= 0.3 Minimum %R= 0.14 Maximum %R= 0.77
Standard deviation= 0.14 Number of particles= 51

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7860
Depth:	1730 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030819
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Hordaland Group	Client:	
Age:	E. Miocene		

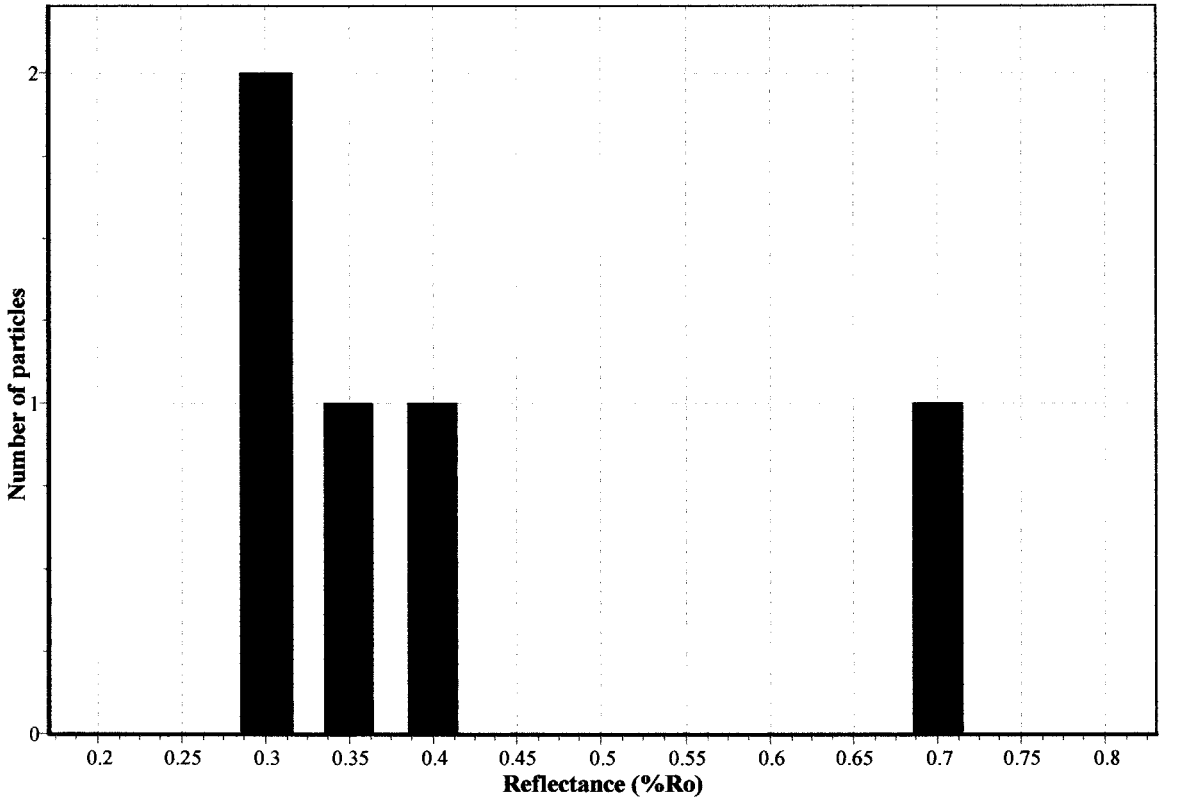


Mean %R= 0.39 Minimum %R= 0.2 Maximum %R= 0.79
Standard deviation= 0.167 Number of particles= 20

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7867
Depth:	2420 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030820
Seam:		Operator:	cgu
Interval:		Standard:	0.515%
Formation:	Hordaland Group	Client:	
Age:	M. Eocene		

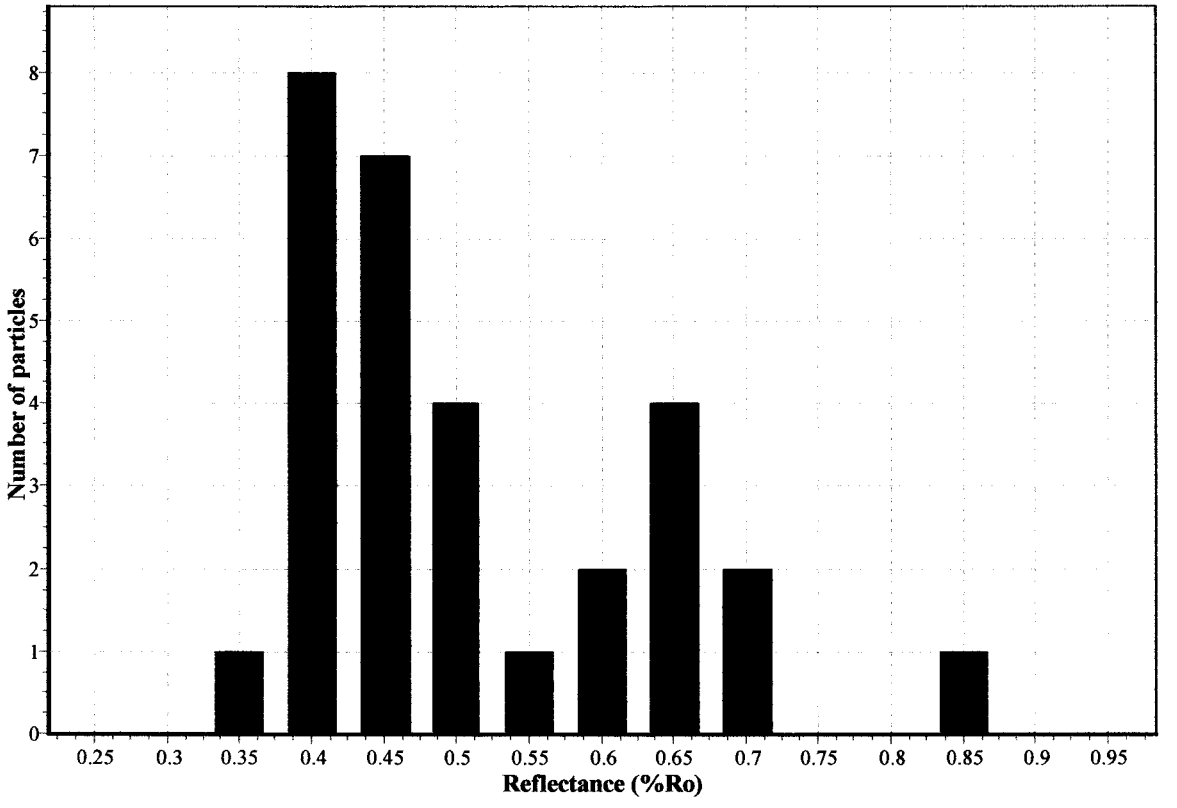


Mean %R= 0.41 Minimum %R= 0.28 Maximum %R= 0.71
Standard deviation= 0.17 Number of particles= 5

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7878
Depth:	3750 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030820
Seam:		Operator:	cgu
Interval:		Standard:	0.515%
Formation:	Chalk Group	Client:	
Age:	E. Coniacian		

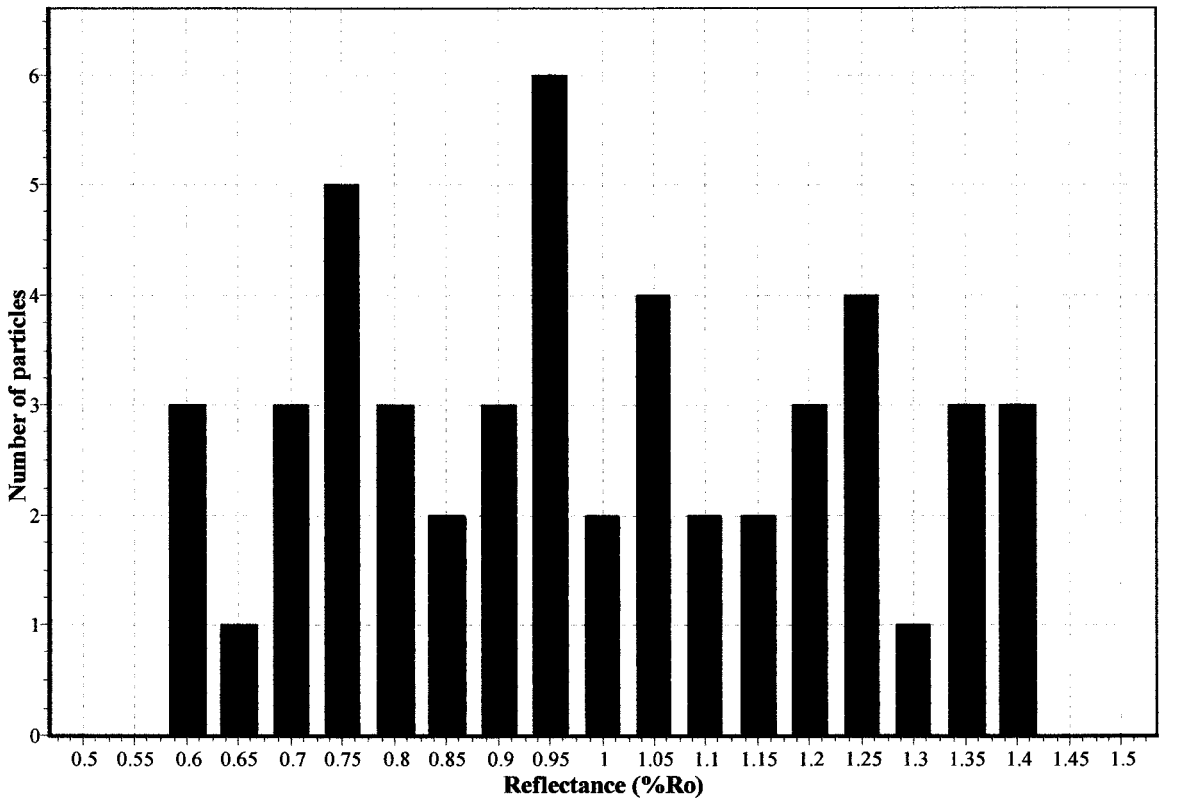


Mean %R= 0.51 Minimum %R= 0.36 Maximum %R= 0.84
Standard deviation= 0.123 Number of particles= 30

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7895
Depth:	4160 m	Activity no.:	2002027
Material:	Cuttings	Date:	20031007
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Mandal Fm	Client:	
Age:	E. Valanginian - L. Ryazanian		

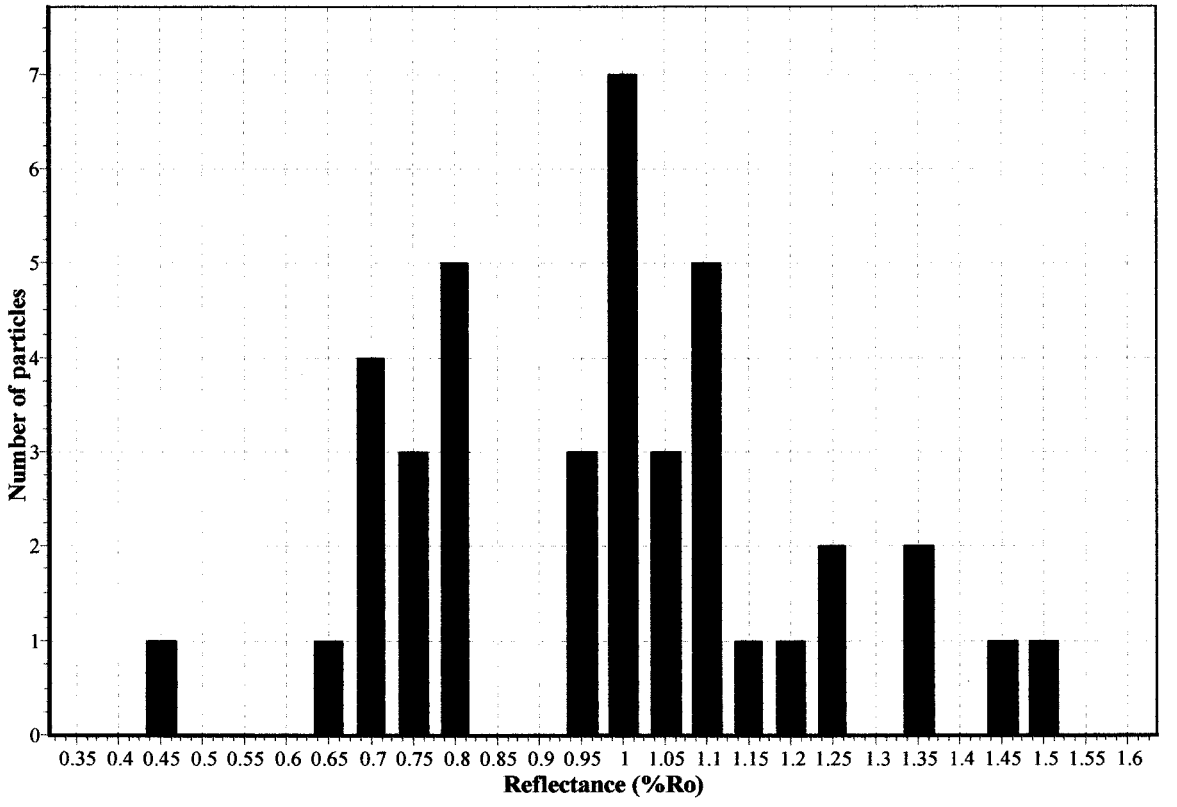


Mean %R= 0.99 Minimum %R= 0.59 Maximum %R= 1.4
Standard deviation= 0.237 Number of particles= 50

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7898
Depth:	4205 m	Activity no.:	2002027
Material:	Cuttings	Date:	20031008
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Mandal Fm	Client:	
Age:	Ryazanian - L. Volgian		

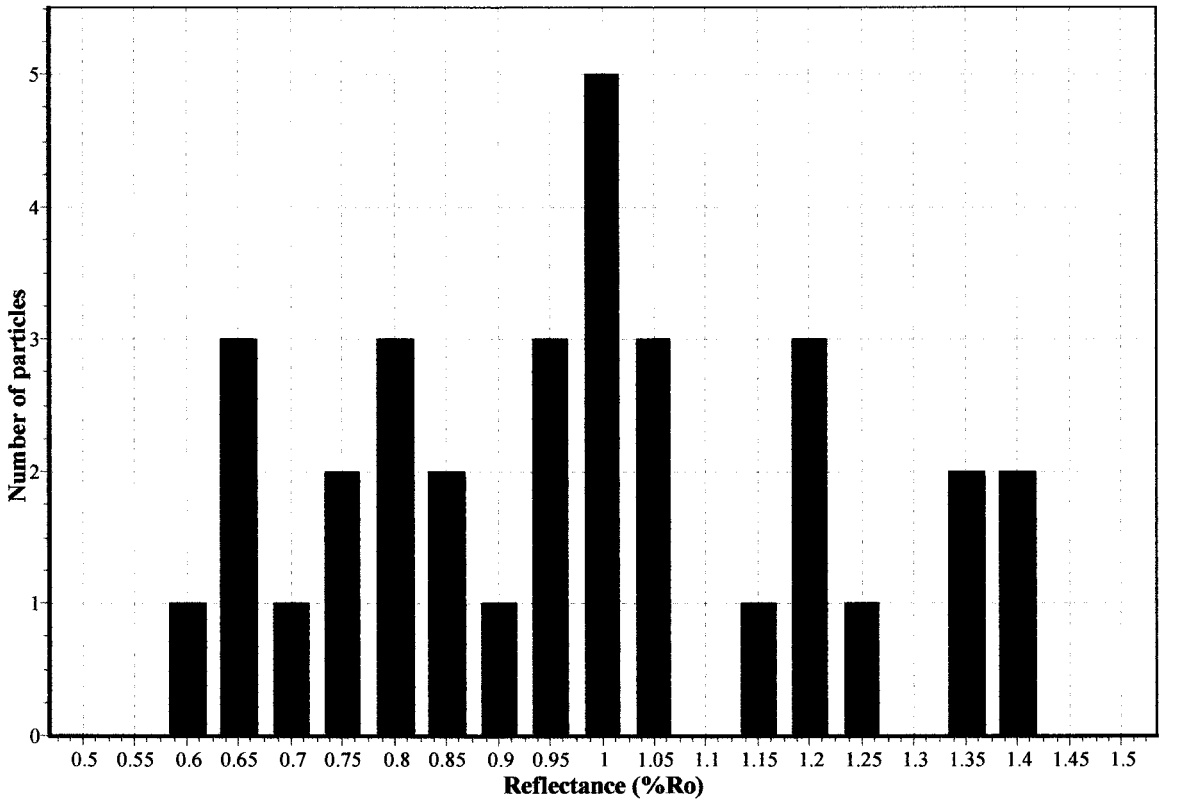


Mean %R= 0.98 Minimum %R= 0.47 Maximum %R= 1.51
Standard deviation= 0.233 Number of particles= 40

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7901
Depth:	4250 m	Activity no.:	2002027
Material:	Cuttings	Date:	20031008
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Mandal Fm	Client:	
Age:	M. Volgian		

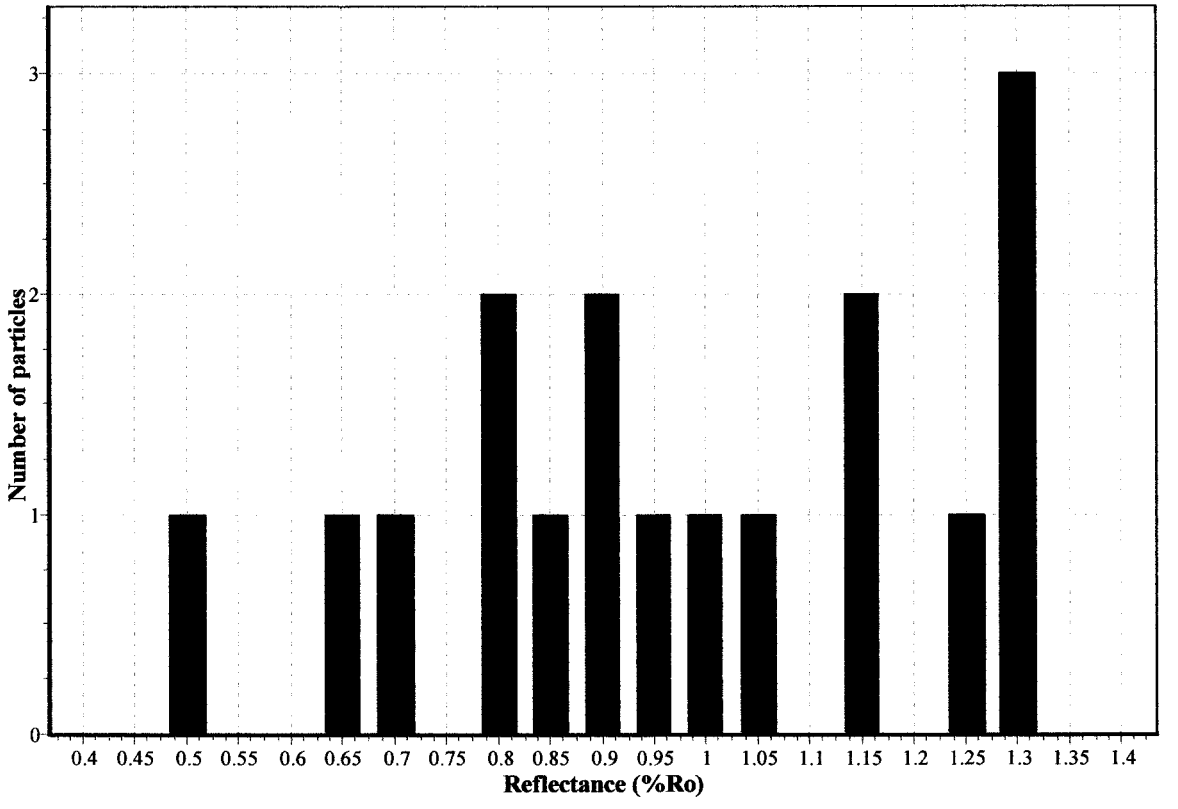


Mean %R= 0.98 Minimum %R= 0.6 Maximum %R= 1.4
Standard deviation= 0.227 Number of particles= 33

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7904
Depth:	4295 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030821
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		

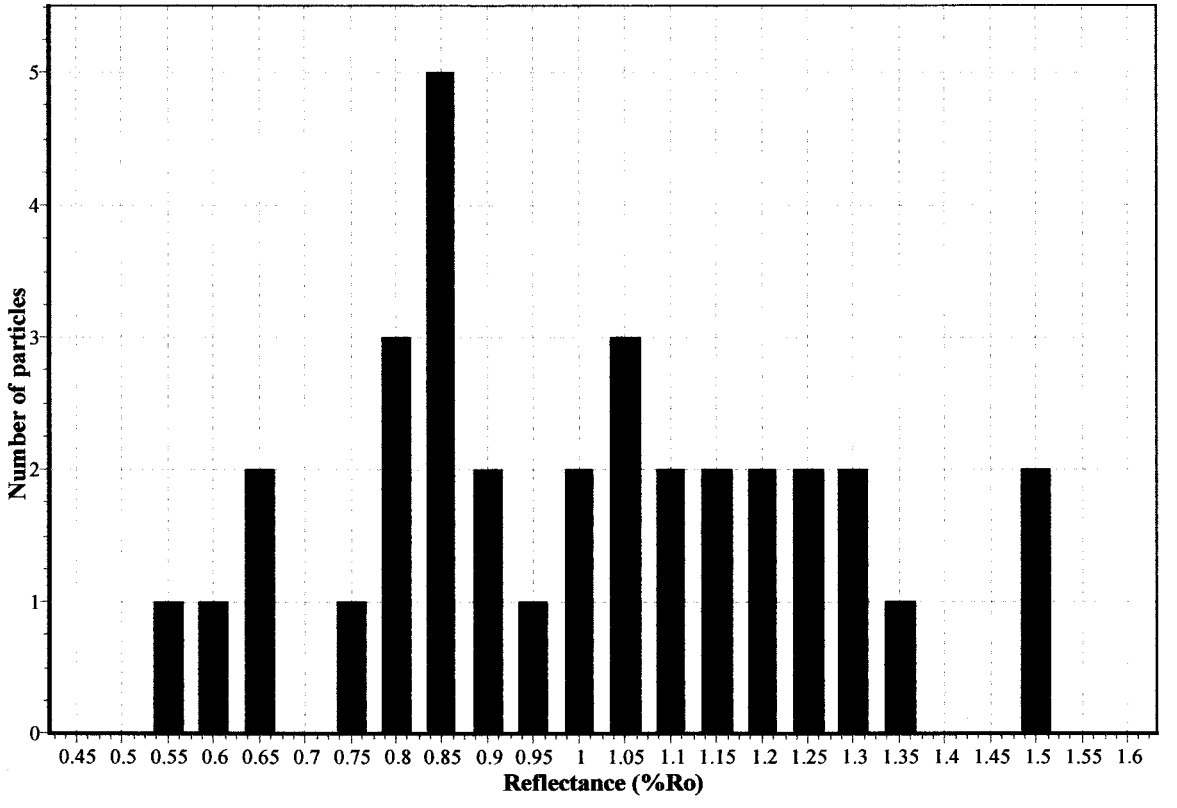


Mean %R= 0.98 Minimum %R= 0.52 Maximum %R= 1.3
Standard deviation= 0.243 Number of particles= 17

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7907
Depth:	4340 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030909
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		

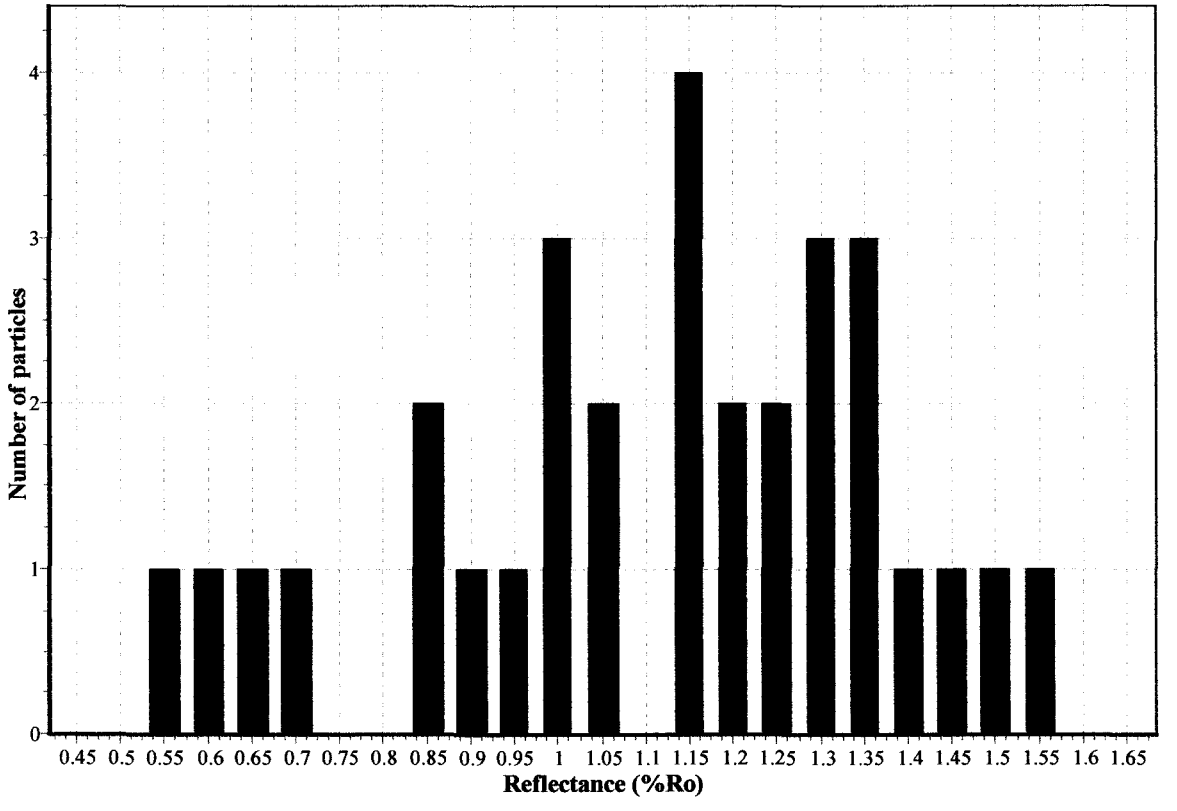


Mean %R= 1.01 Minimum %R= 0.57 Maximum %R= 1.52
Standard deviation= 0.245 Number of particles= 34

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7910
Depth:	4385 m	Activity no.:	2002027
Material:	Cutings	Date:	20030909
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		

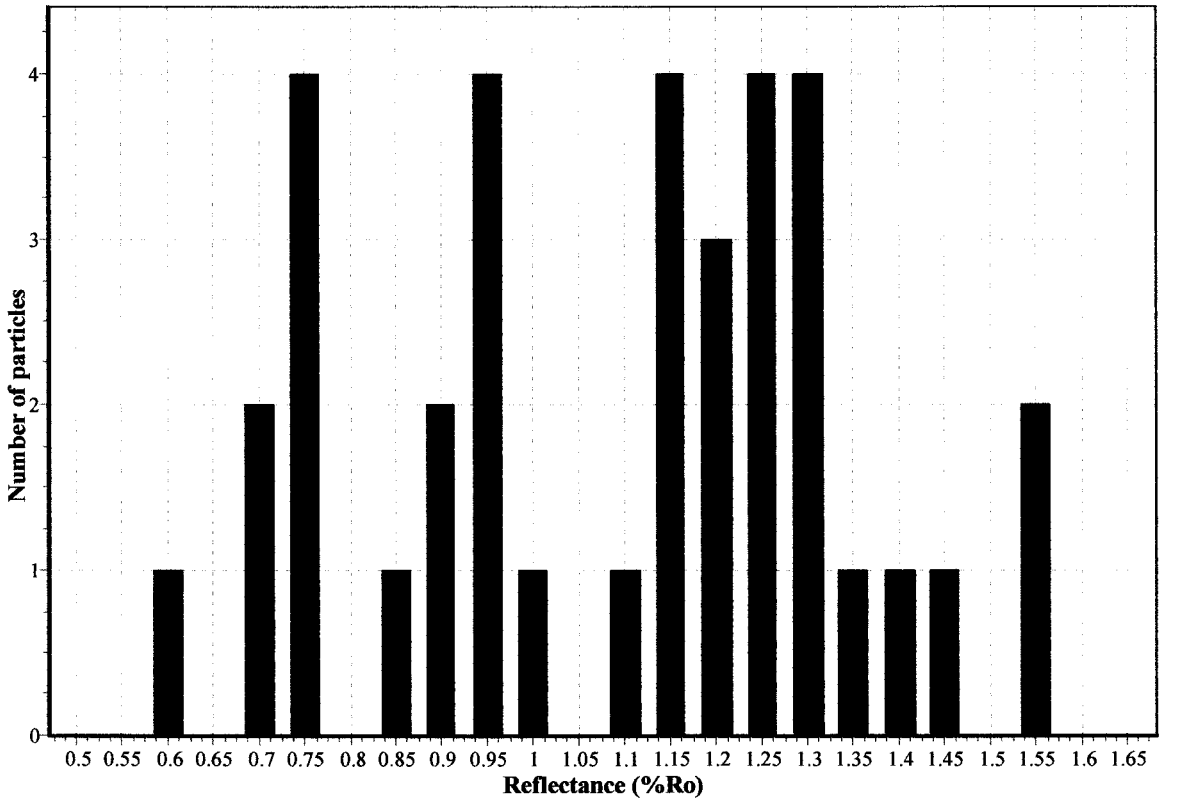


Mean %R= 1.11 Minimum %R= 0.54 Maximum %R= 1.53
Standard deviation= 0.265 Number of particles= 31

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7914
Depth:	4445 m	Activity no.:	2002027
Material:	Cutings	Date:	20030909
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		

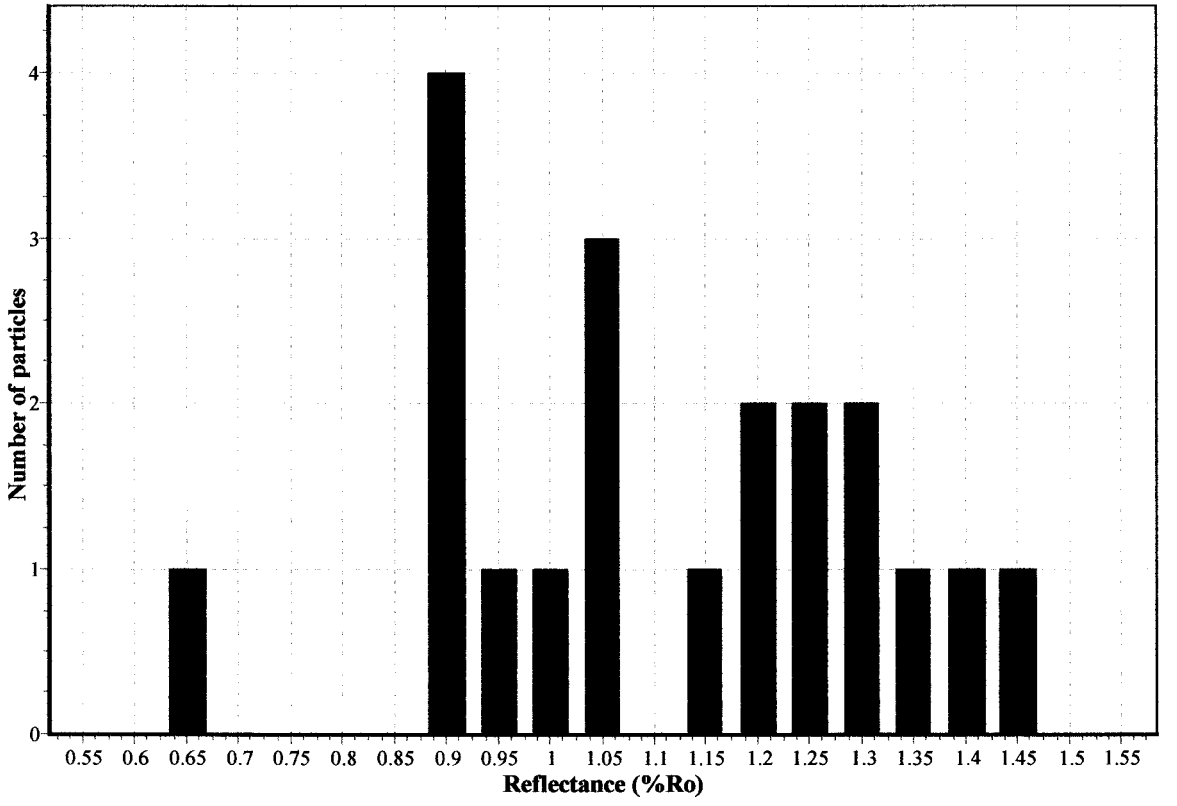


Mean %R= 1.09 Minimum %R= 0.59 Maximum %R= 1.53
Standard deviation= 0.256 Number of particles= 36

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7920
Depth:	4535 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030911
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		

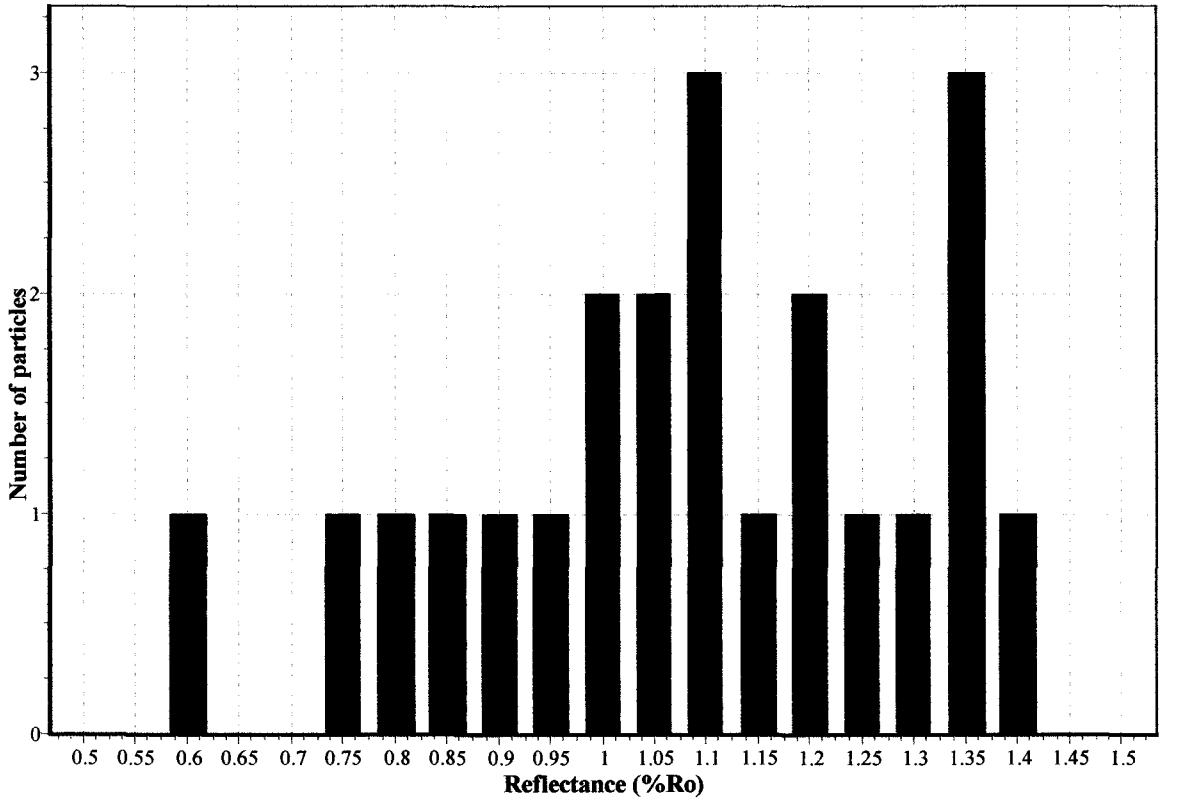


Mean %R= 1.11 Minimum %R= 0.66 Maximum %R= 1.44
Standard deviation= 0.204 Number of particles= 20

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7923
Depth:	4580 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030911
Seam:		Operator:	cg
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		

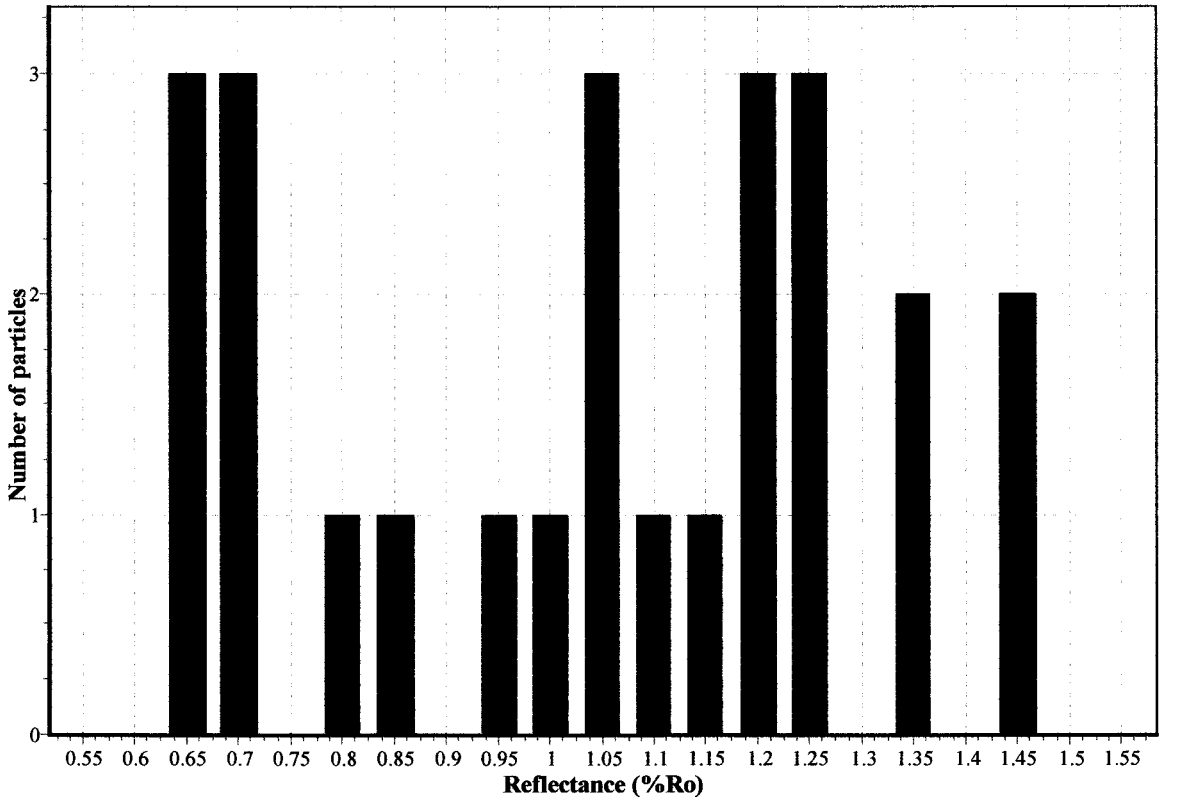


Mean %R= 1.08 Minimum %R= 0.62 Maximum %R= 1.38
Standard deviation= 0.213 Number of particles= 22

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7932
Depth:	4715 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030912
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ?L. Kimmeridgian		

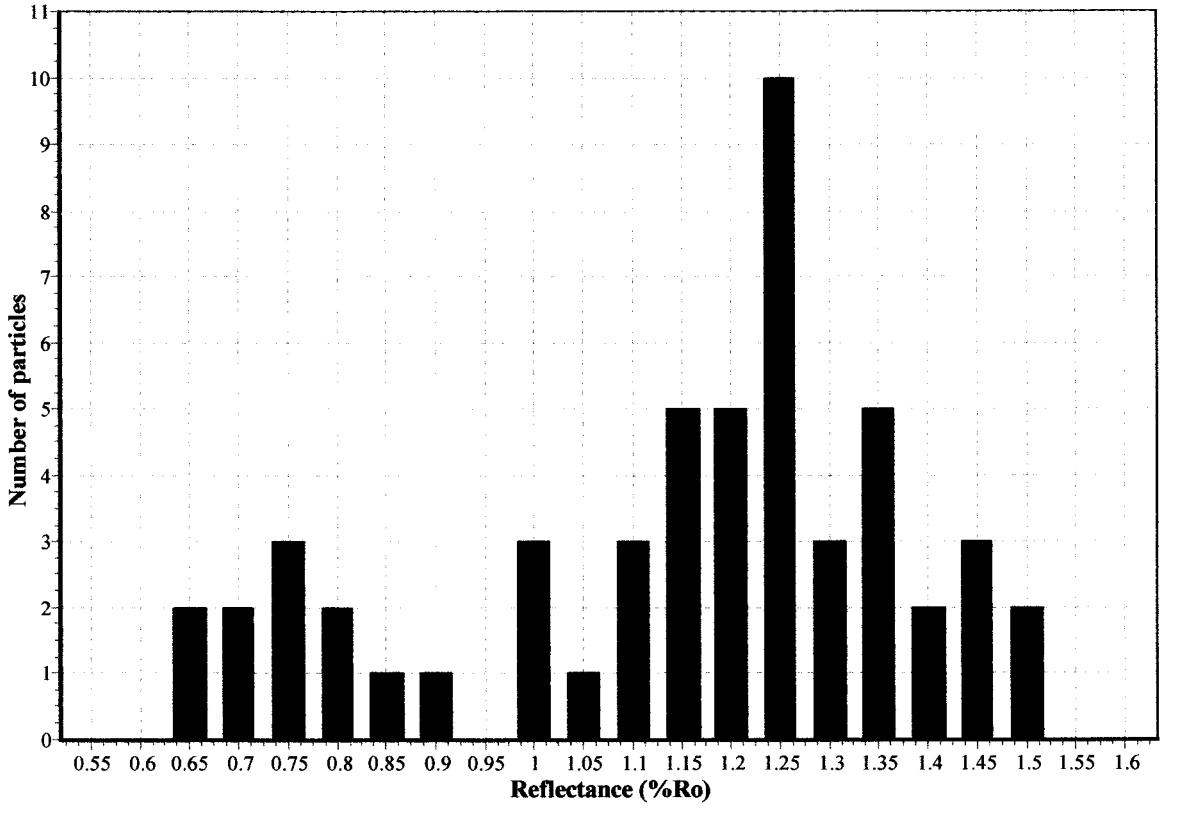


Mean %R= 1.04 Minimum %R= 0.64 Maximum %R= 1.46
Standard deviation= 0.266 Number of particles= 25

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7935
Depth:	4760 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030912
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ?L. Kimmeridgian		

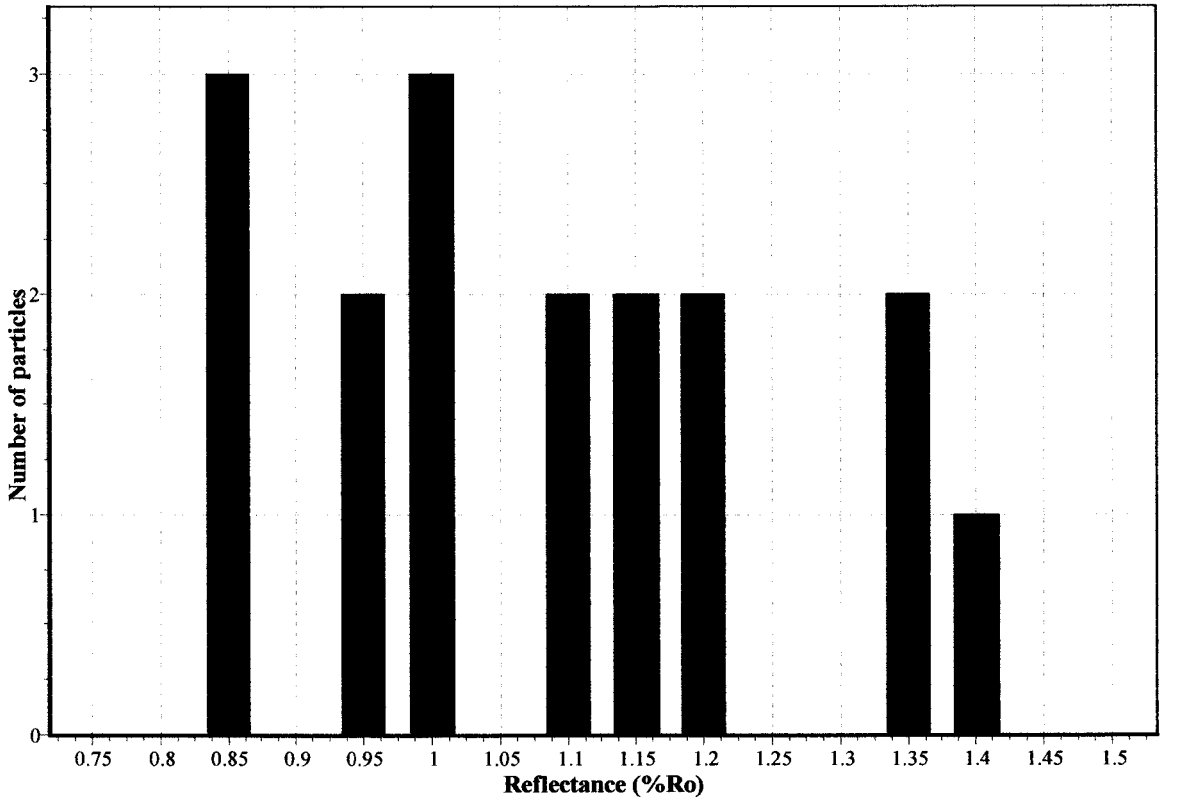


Mean %R= 1.15 Minimum %R= 0.63 Maximum %R= 1.48
Standard deviation= 0.238 Number of particles= 53

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7938
Depth:	4805 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030912
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ?L. Kimmeridgian		

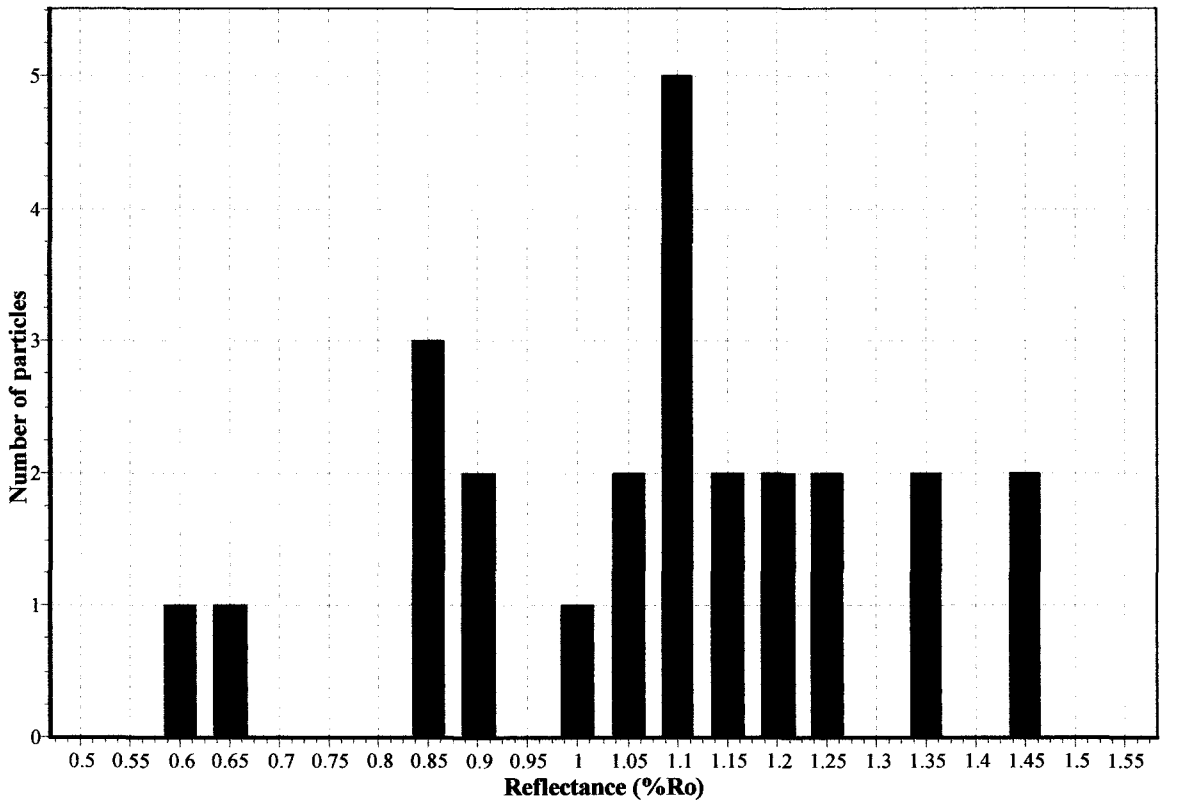


Mean %R= 1.08 Minimum %R= 0.83 Maximum %R= 1.38
Standard deviation= 0.18 Number of particles= 17

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7941
Depth:	4850 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030916
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ?L. Kimmeridgian		

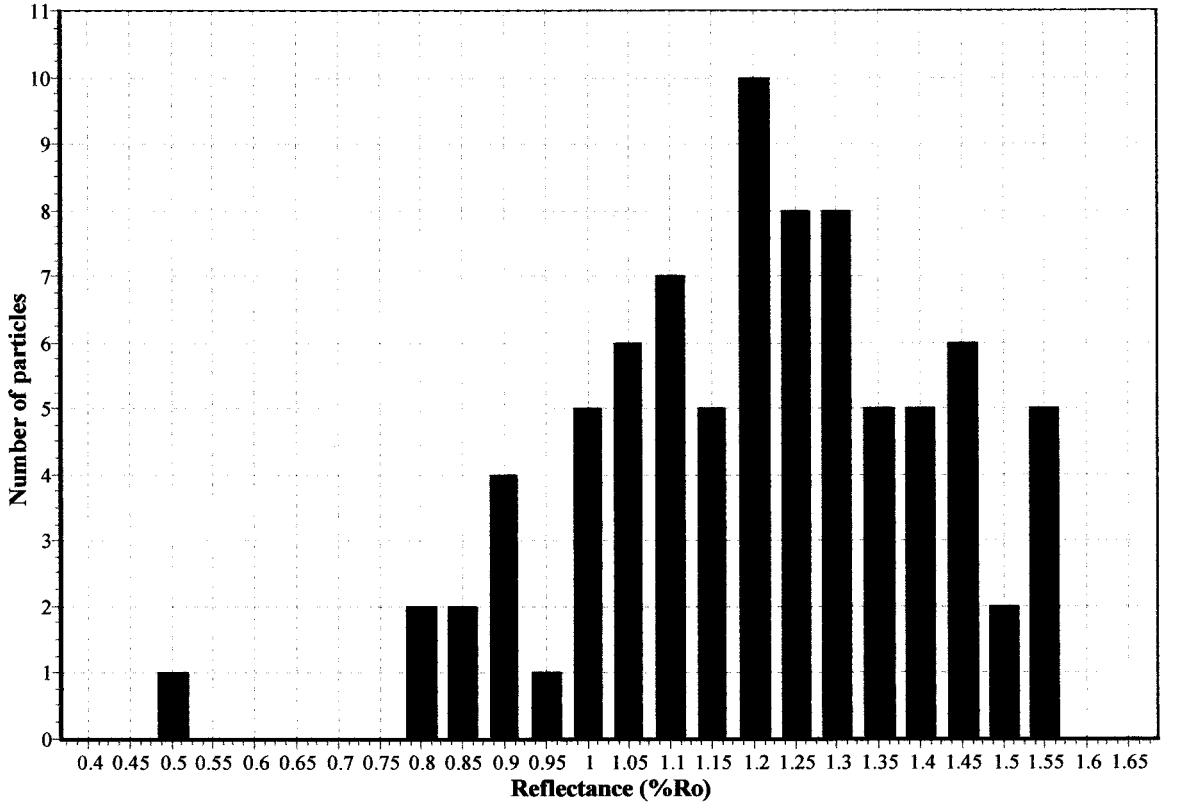


Mean %R= 1.08 Minimum %R= 0.58 Maximum %R= 1.46
Standard deviation= 0.221 Number of particles= 25

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7943
Depth:	4880 m	Activity no.:	2002027
Material:	Cuttings	Date:	20030916
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ?L. Kimmeridgian		

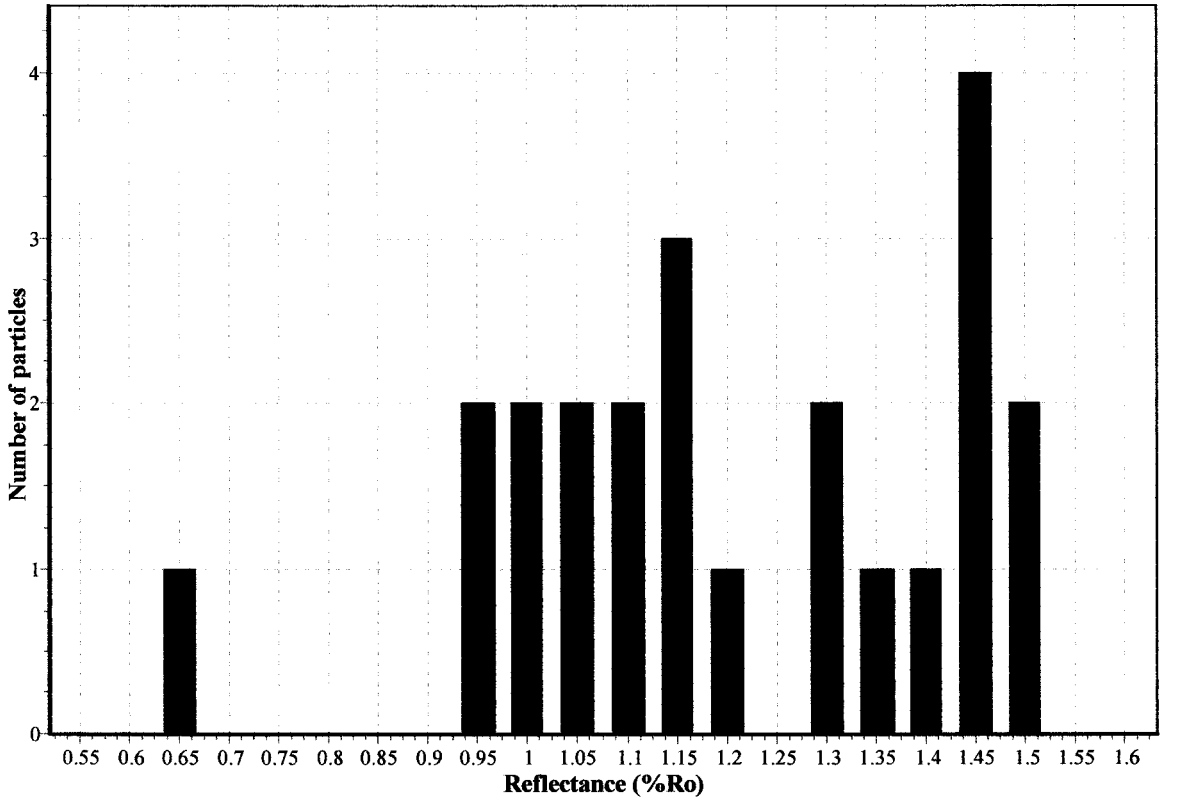


Mean %R= 1.2 Minimum %R= 0.51 Maximum %R= 1.53
Standard deviation= 0.206 Number of particles= 82

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1	Lab. no.:	7945
Depth:	4915 m	Activity no.:	2002027
Material:	Cuttings	Date:	2030916
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ?L. Kimmeridgian		



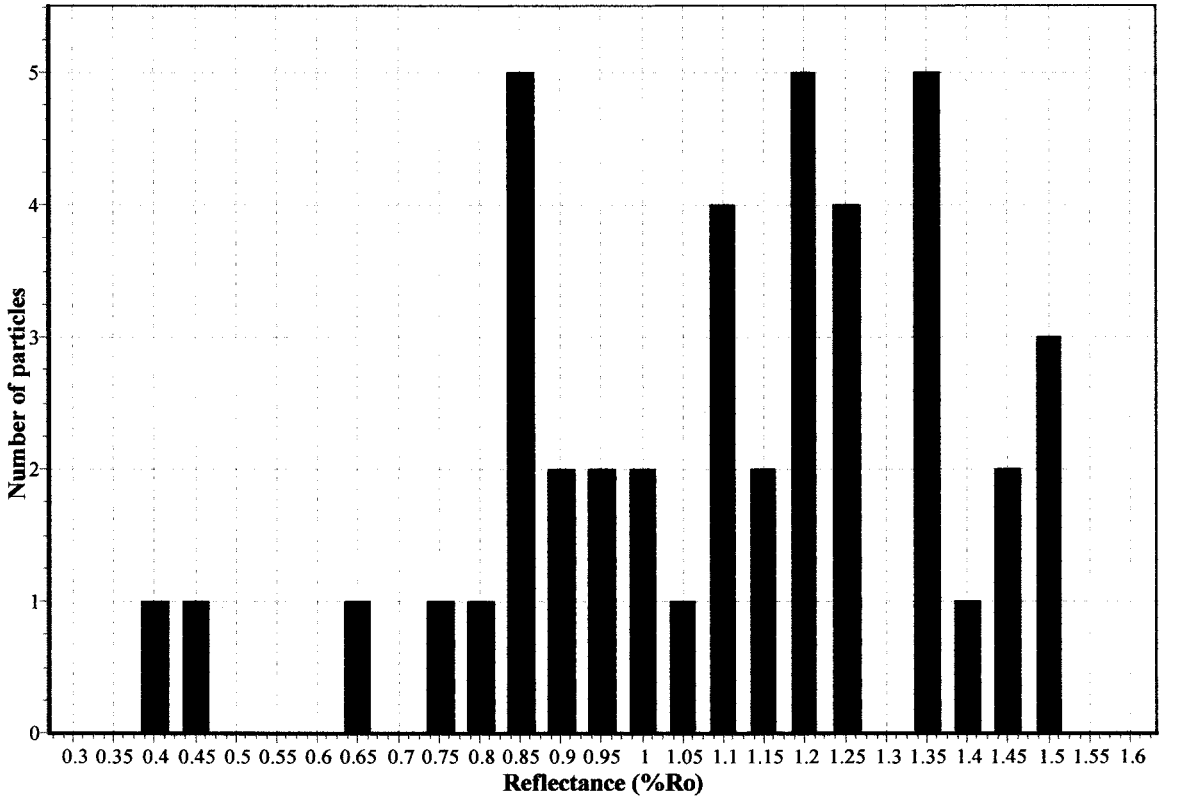
Mean %R= 1.2 Minimum %R= 0.67 Maximum %R= 1.5
Standard deviation= 0.217 Number of particles= 23

Comments:

SVANE-1A

Vitrinite Reflectance (Random)

Locality:	Svane-1A (Side track)	Lab. no.:	7947
Depth:	MDRT 4055 m / TVMDRT 3966 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030917
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Cromer Knoll Group	Client:	
Age:	E. Valanginian - L. Ryazanian		

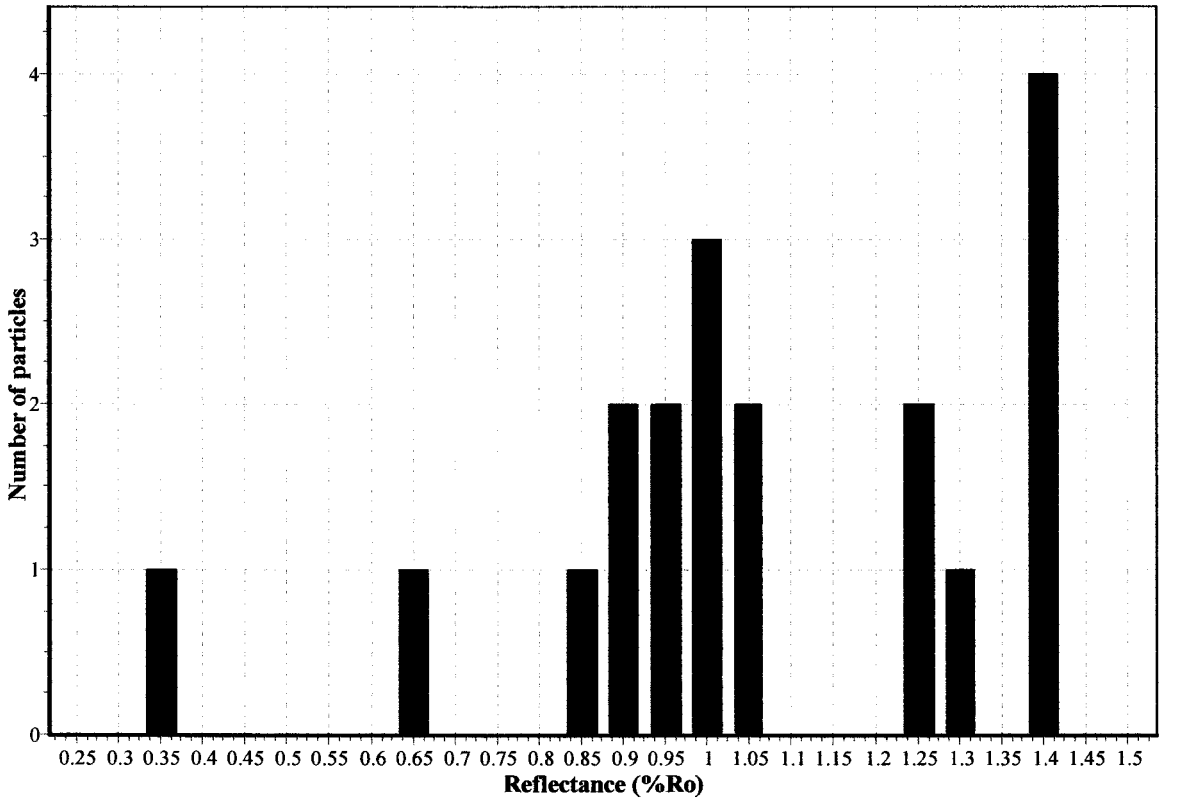


Mean %R= 1.1 Minimum %R= 0.42 Maximum %R= 1.5
Standard deviation= 0.268 Number of particles= 43

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	7962
Depth:	MDRT 4280 m / TVMDRT 4249 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030922
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Mandal Fm	Client:	
Age:	M. Volgian		

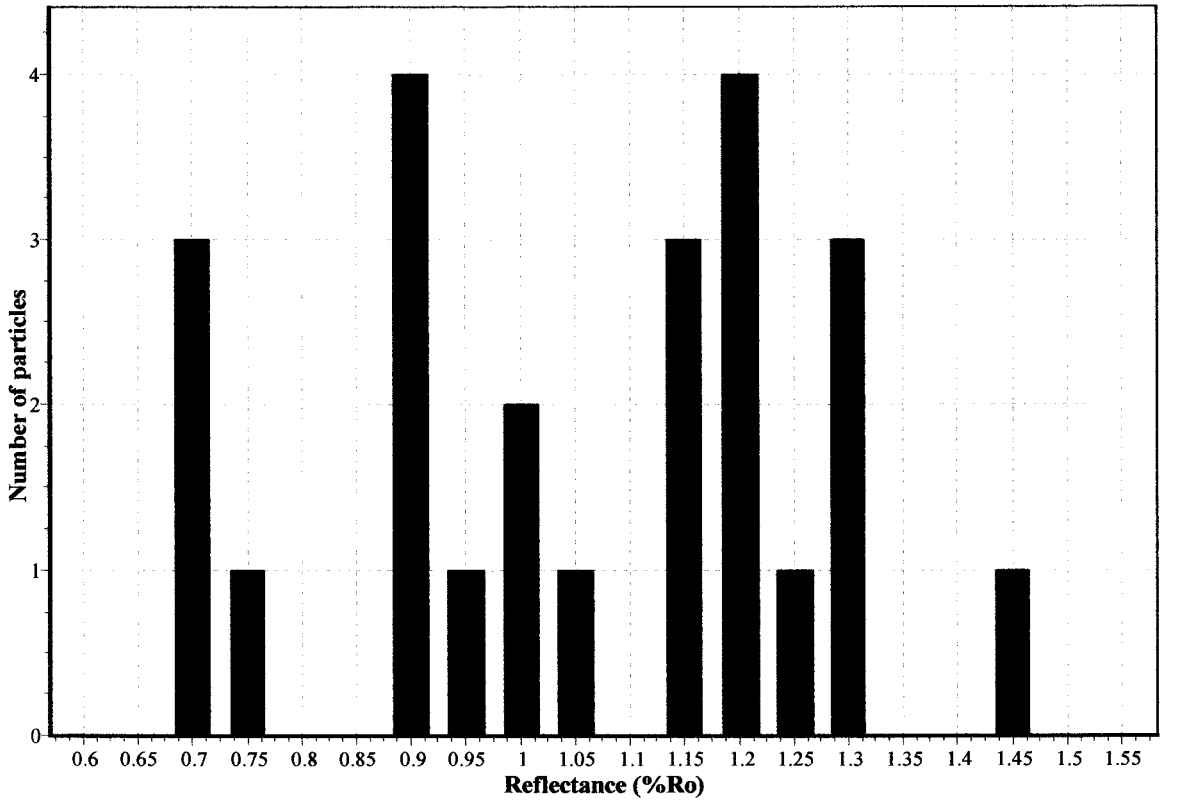


Mean %R= 1.05 Minimum %R= 0.33 Maximum %R= 1.42
Standard deviation= 0.28 Number of particles= 19

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	7965
Depth:	MDRT 4325 m / TVMDRT 4294 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030922
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		

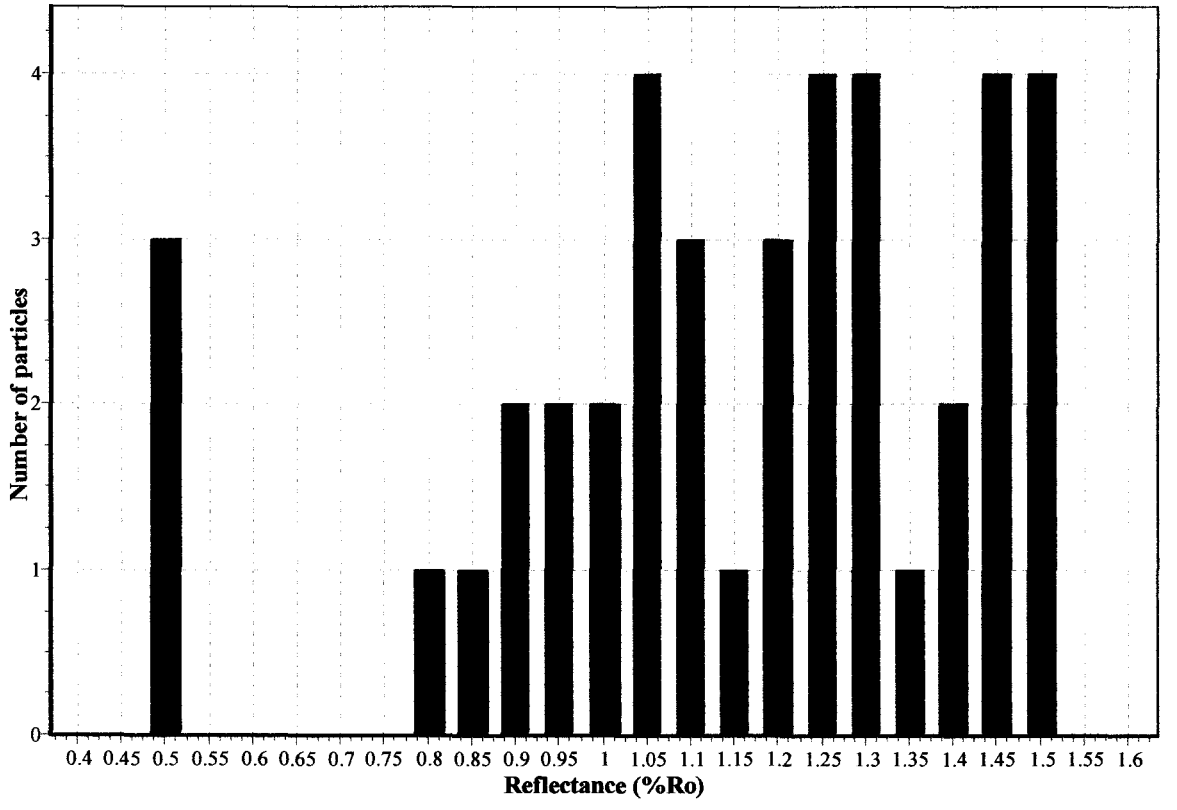


Mean %R= 1.05 Minimum %R= 0.7 Maximum %R= 1.43
Standard deviation= 0.216 Number of particles= 24

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	7968
Depth:	MDRT 4370 m / TVMDRT 4339 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030922
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		



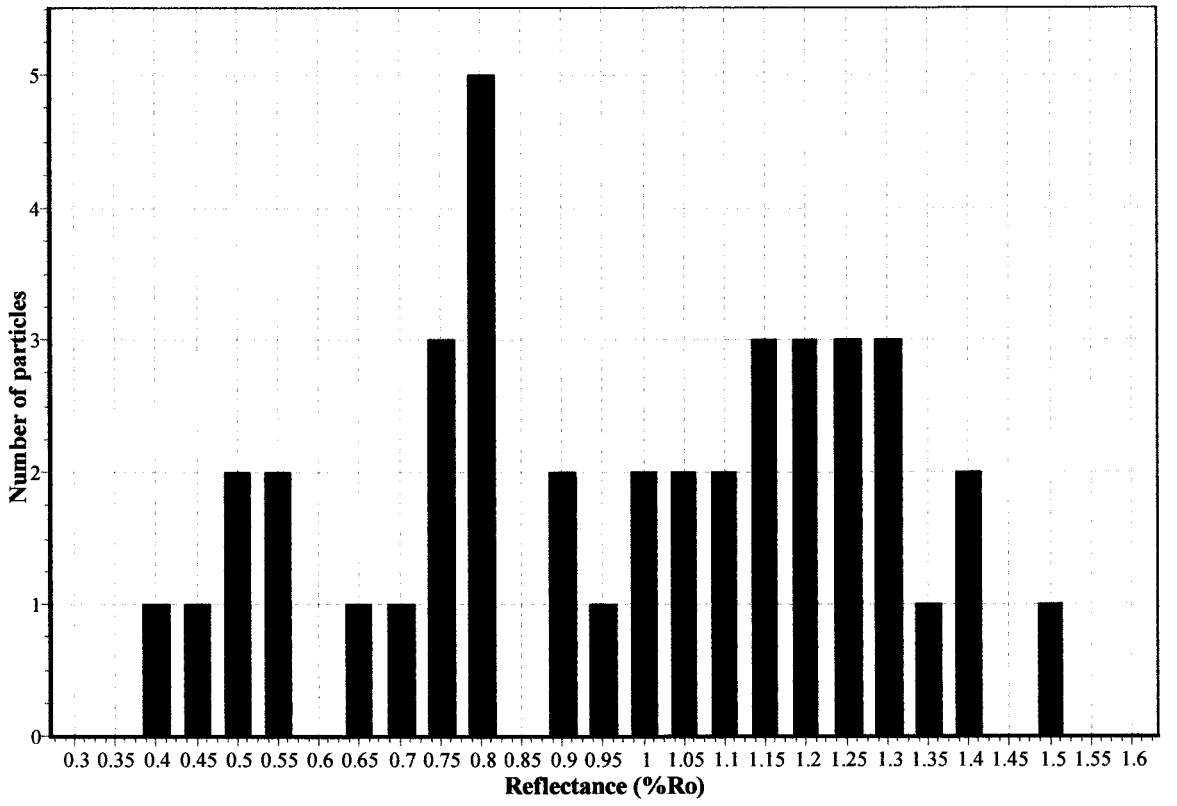
Mean %R= 1.15 Minimum %R= 0.49 Maximum %R= 1.5

Standard deviation= 0.267 Number of particles= 41

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane- 1A (side track)	Lab. no.:	7971
Depth:	MDRT 4415 m / TVMDRT 4384 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030922
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		



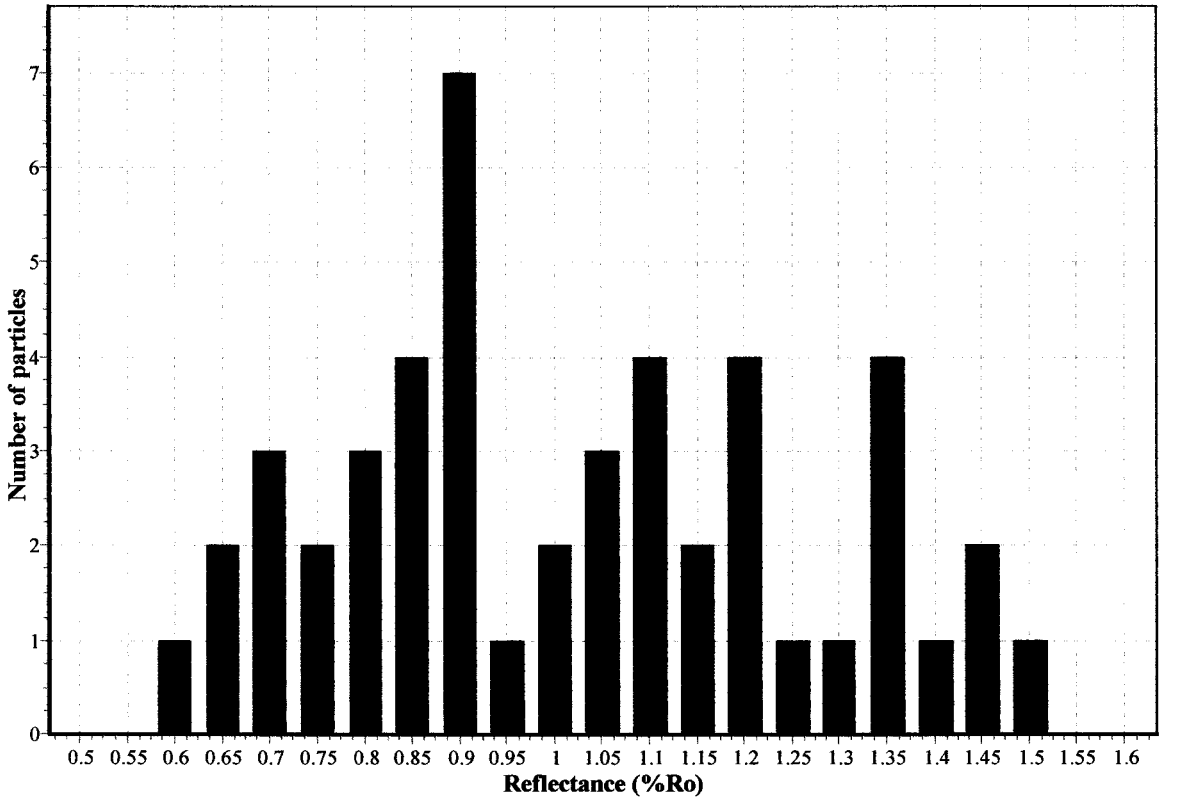
Mean %R= 0.98 Minimum %R= 0.41 Maximum %R= 1.5

Standard deviation= 0.293 Number of particles= 41

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	7975
Depth:	MDRT 4475 m / TVMDRT 4443 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030923
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		



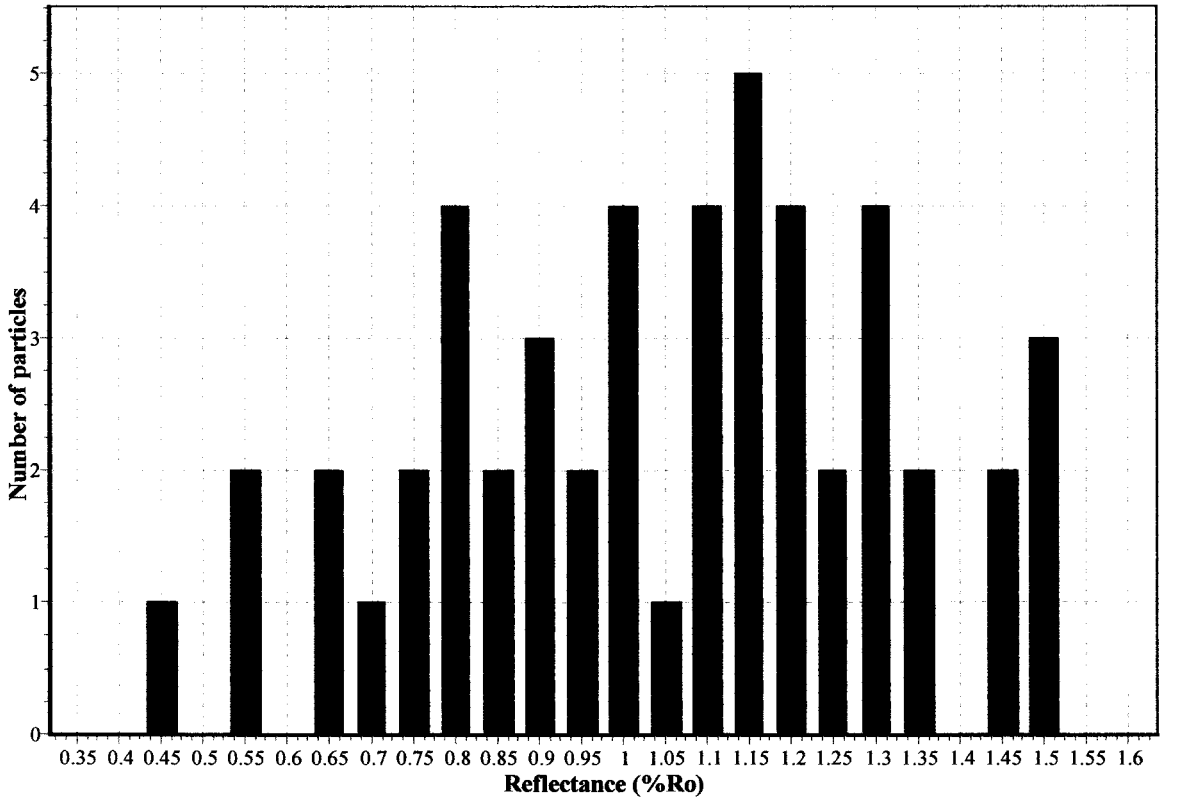
Mean %R= 1.02 Minimum %R= 0.61 Maximum %R= 1.49

Standard deviation= 0.244 Number of particles= 48

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-A1 (side track)	Lab. no.:	7977
Depth:	MDRT 4505 m / TVMDRT 4473 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030924
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		

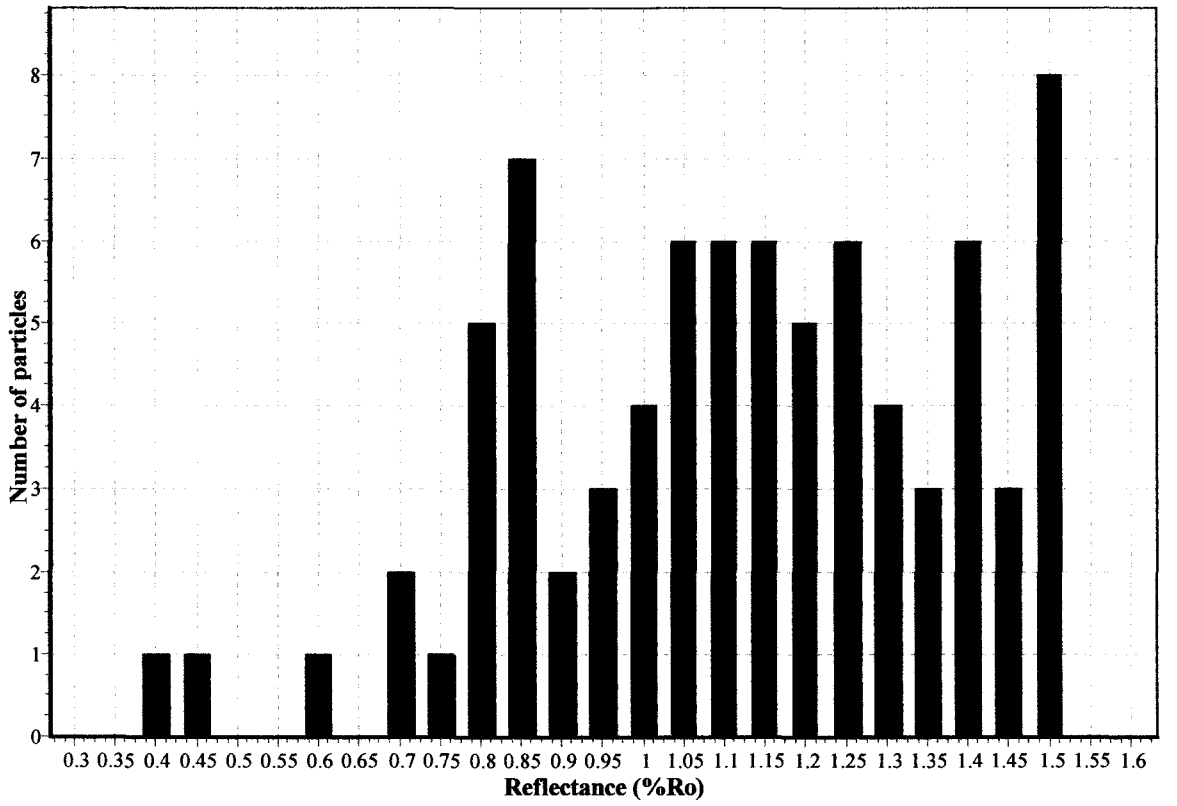


Mean %R= 1.05 Minimum %R= 0.46 Maximum %R= 1.52
Standard deviation= 0.267 Number of particles= 50

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	7980
Depth:	MDRT 4550 m / TVMDRT 4518 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030924
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		

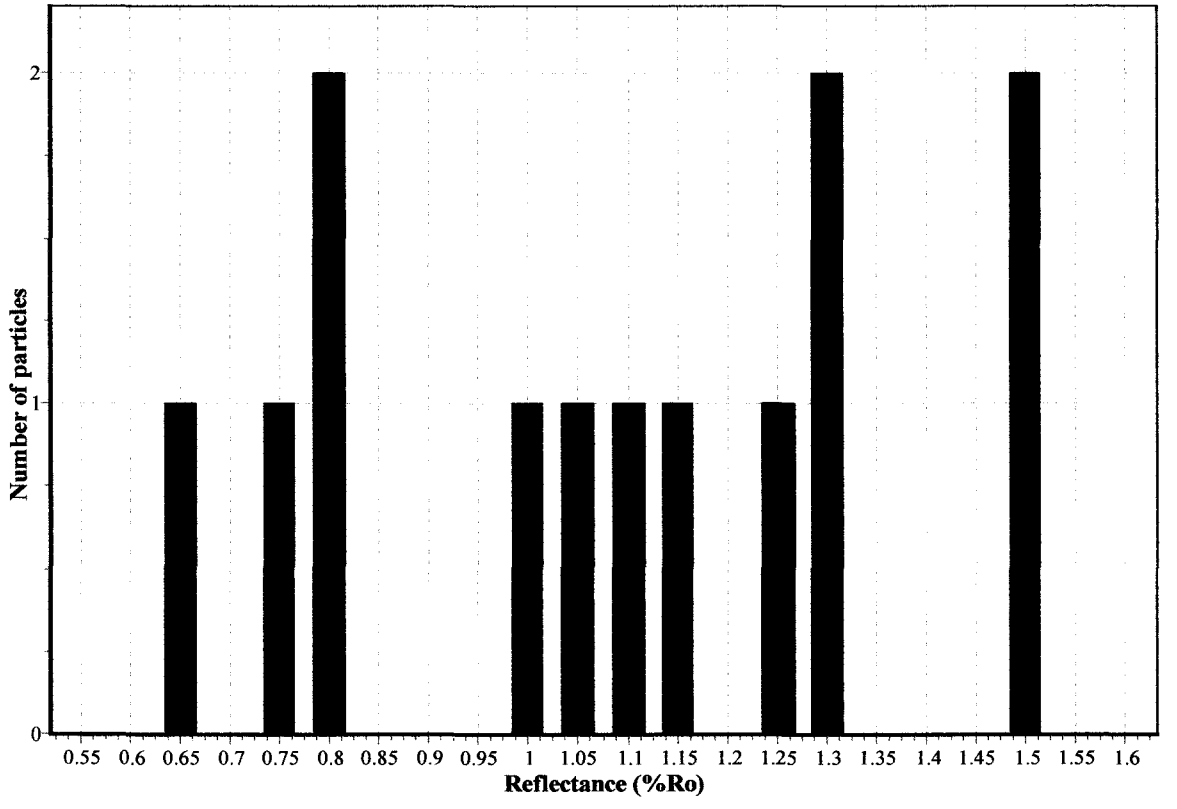


Mean %R= 1.12 Minimum %R= 0.4 Maximum %R= 1.52
Standard deviation= 0.26 Number of particles= 80

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	7986
Depth:	MDRT 4650 m / TVMDRT 4618 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030924
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	M. Volgian		

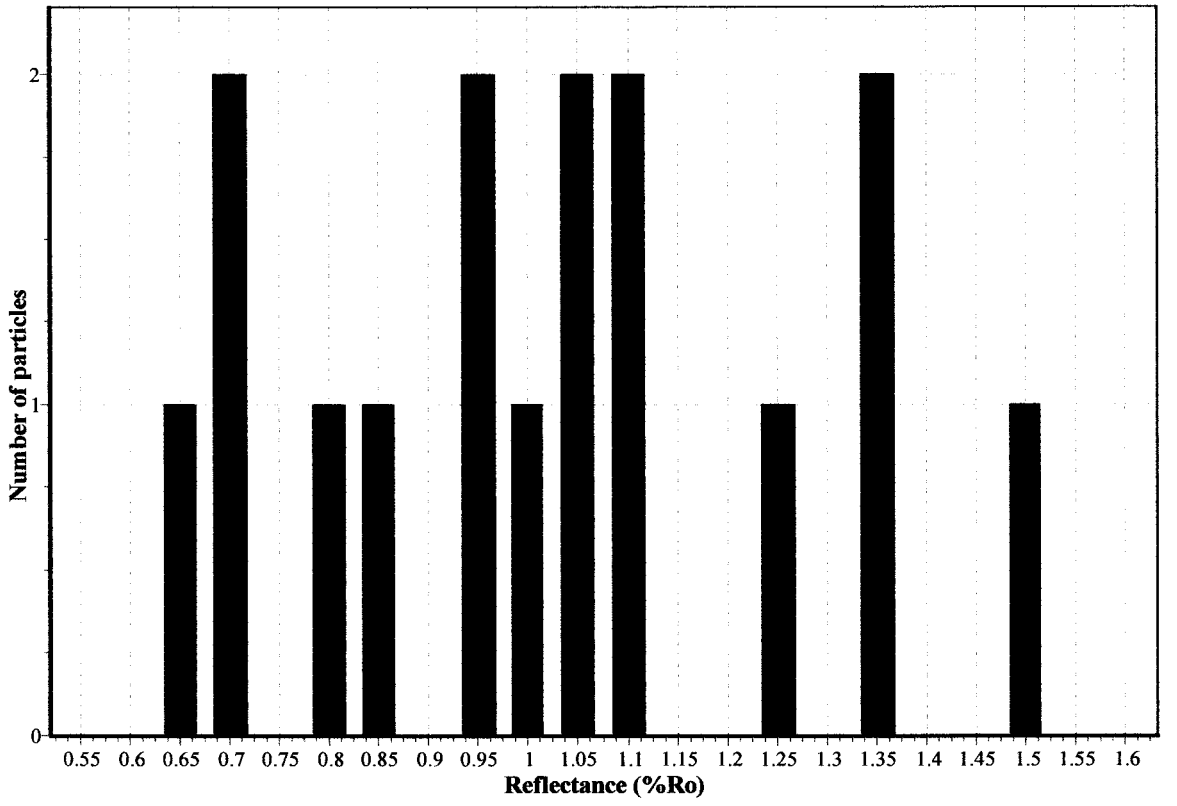


Mean %R= 1.09 Minimum %R= 0.66 Maximum %R= 1.49
Standard deviation= 0.275 Number of particles= 13

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane_1A (side track)	Lab. no.:	7992
Depth:	MDRT 4740 m / TVMDRT 4707 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030925
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

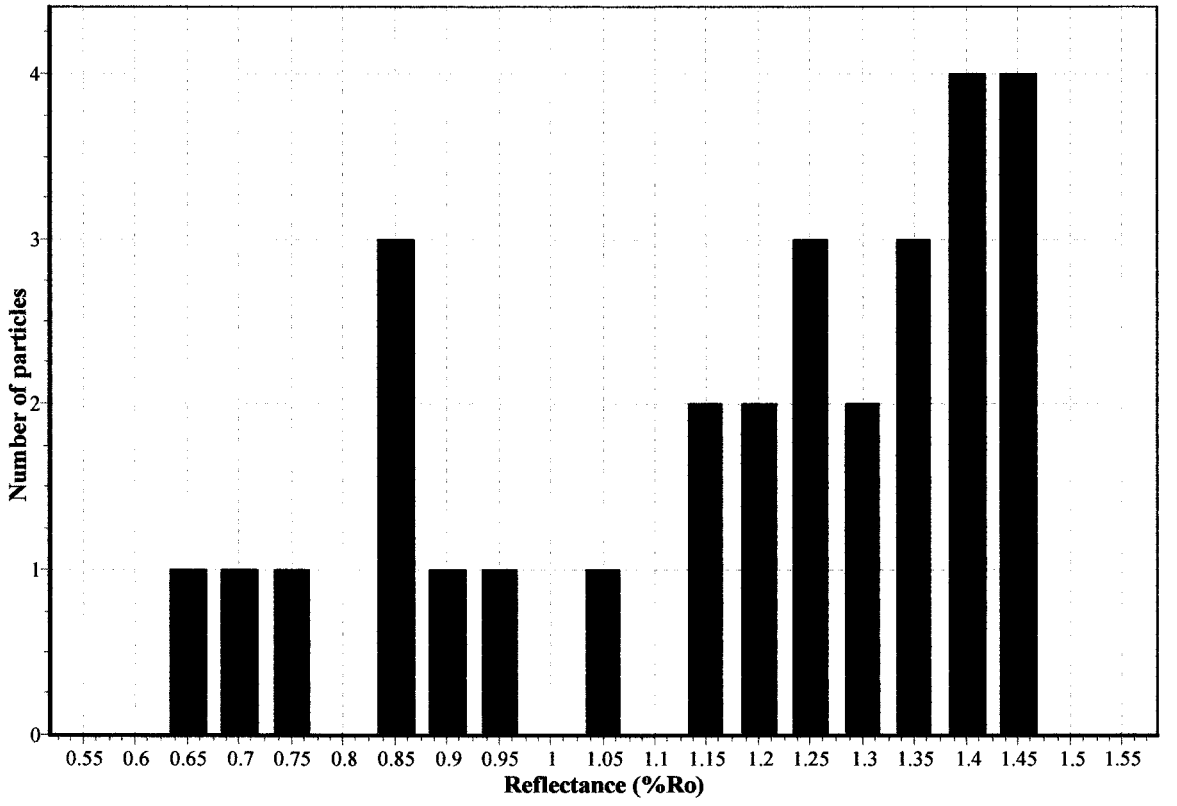


Mean %R= 1.02 Minimum %R= 0.67 Maximum %R= 1.48
Standard deviation= 0.249 Number of particles= 16

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	7995
Depth:	MDRT 4785 m / TVMDRT 4752 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030925
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

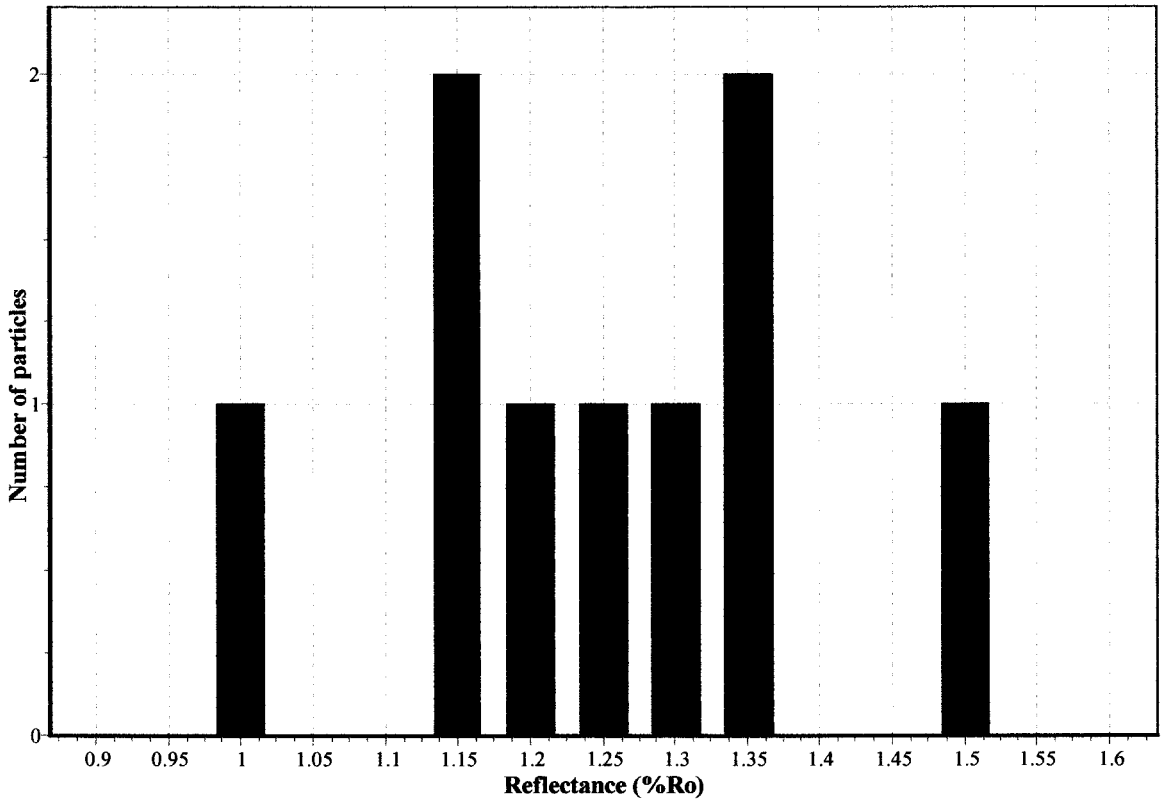


Mean %R= 1.18 Minimum %R= 0.67 Maximum %R= 1.47
Standard deviation= 0.254 Number of particles= 29

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	7998
Depth:	MDRT 4830 m / TVMDRT 4797 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030925
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

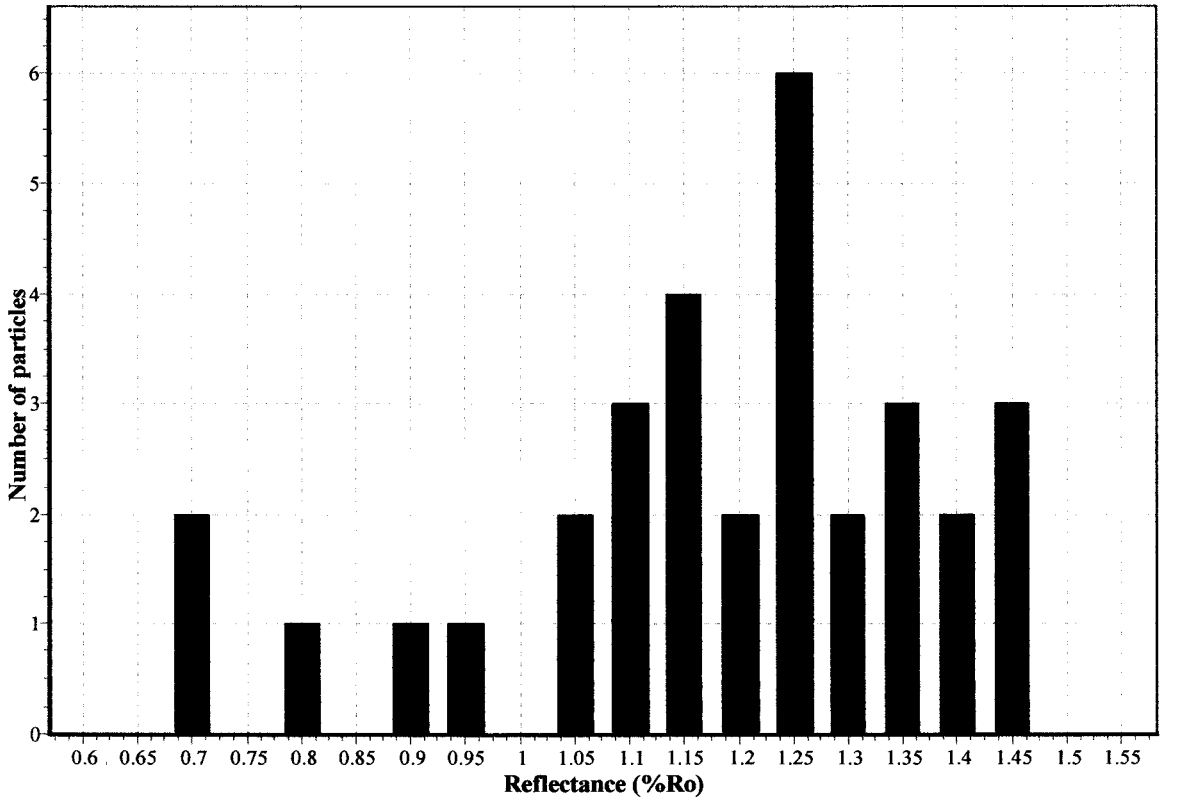


Mean %R= 1.25 Minimum %R= 1 Maximum %R= 1.5
Standard deviation= 0.144 Number of particles= 9

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8004
Depth:	MDRT 4920 m / TVMDRT 4887 m	Activity no.:	2002028
Material:	Cuttings	Date:	2030929
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

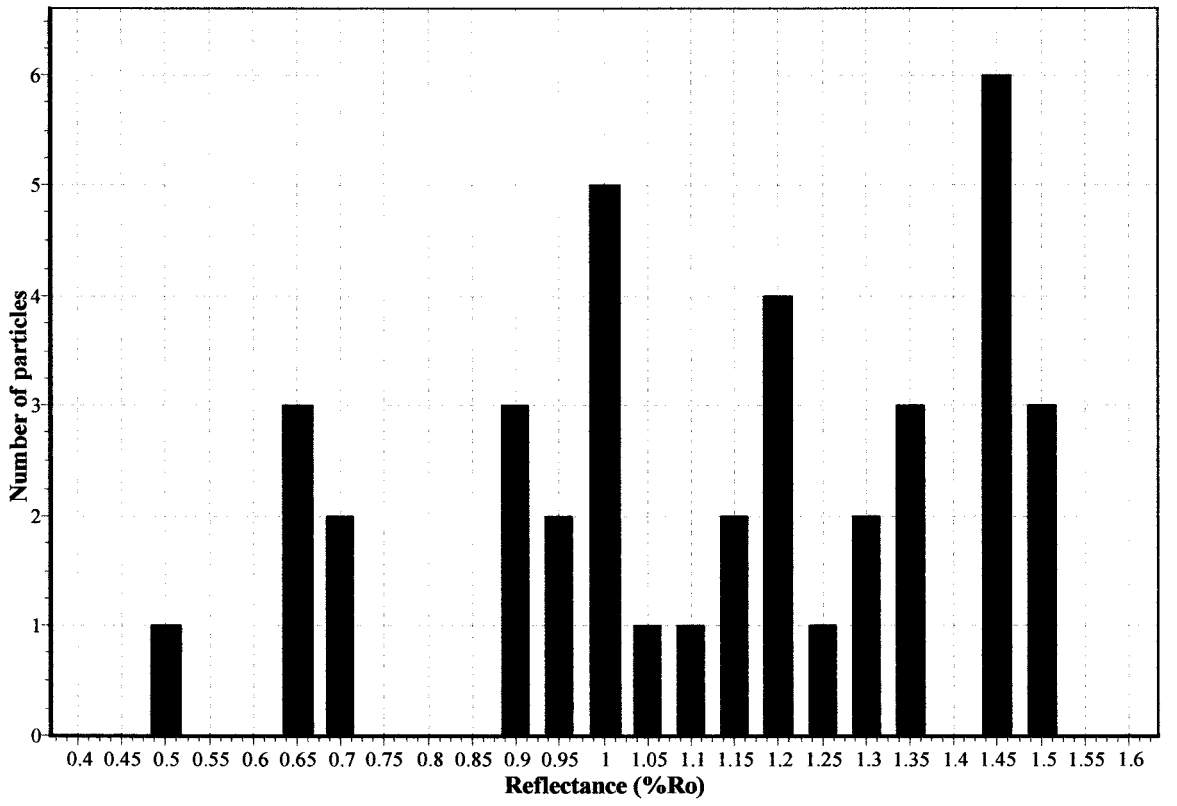


Mean %R= 1.18 Minimum %R= 0.71 Maximum %R= 1.47
Standard deviation= 0.205 Number of particles= 32

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side trak)	Lab. no.:	8007
Depth:	MDRT 4965 m / TVMDRT 4931 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030929
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

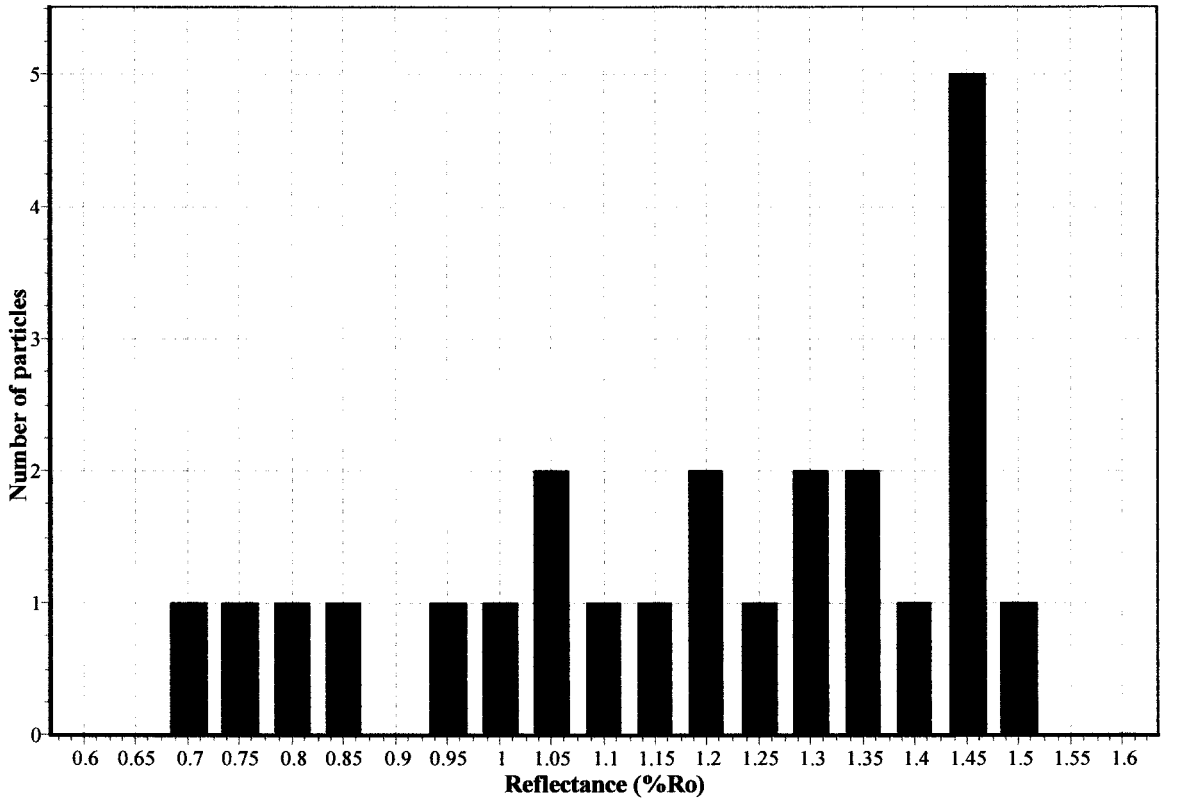


Mean %R= 1.12 Minimum %R= 0.51 Maximum %R= 1.49
Standard deviation= 0.282 Number of particles= 39

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8010
Depth:	MDRT 5010 m / TVMDRT 4976 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030930
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

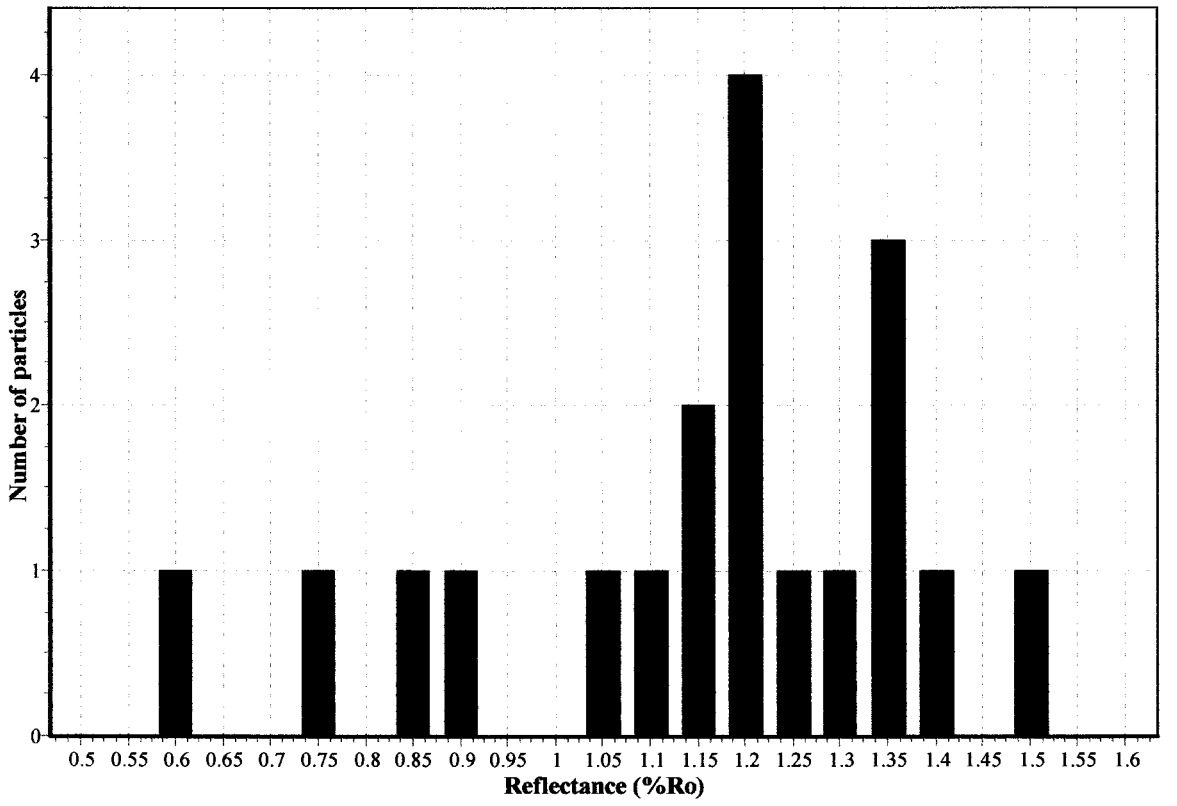


Mean %R= 1.19 Minimum %R= 0.71 Maximum %R= 1.5
Standard deviation= 0.245 Number of particles= 24

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8013
Depth:	MDRT 5055 m / TVMDRT 5021 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030930
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

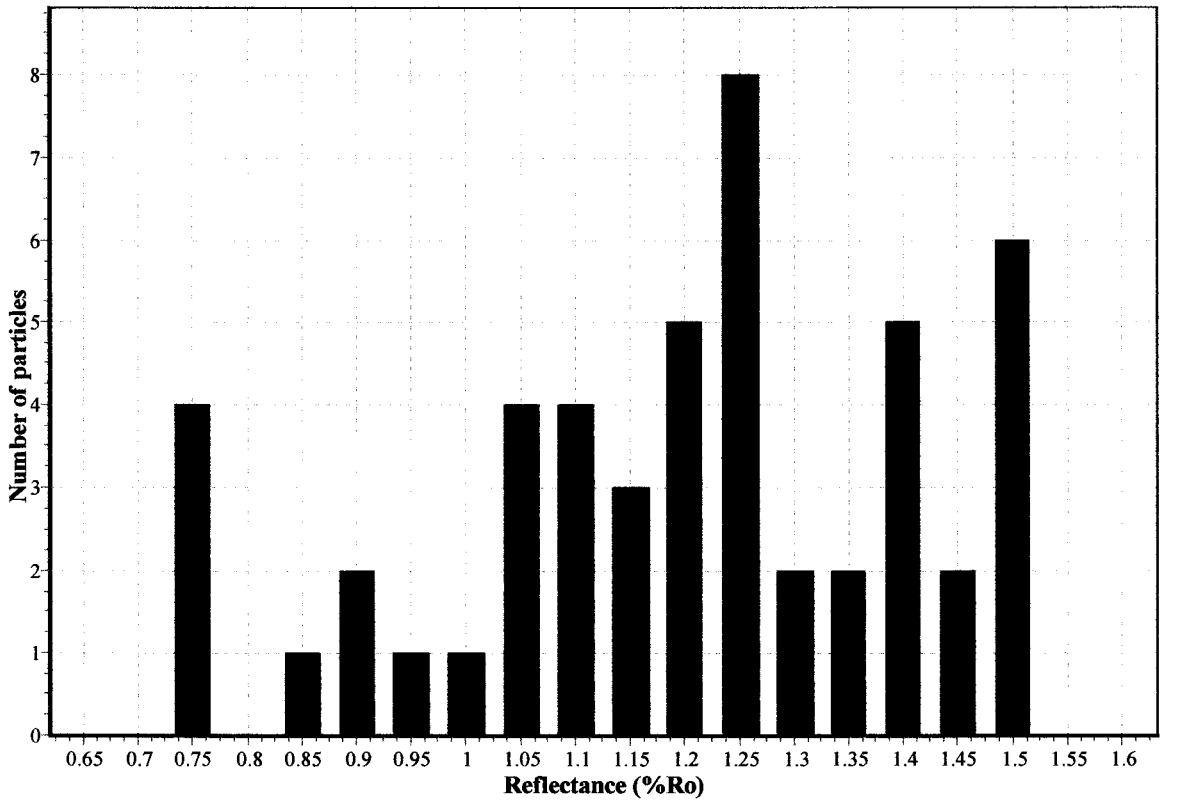


Mean %R= 1.15 Minimum %R= 0.62 Maximum %R= 1.48
Standard deviation= 0.232 Number of particles= 19

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8017
Depth:	MDRT 5100 m / TVMDRT 5066 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030930
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

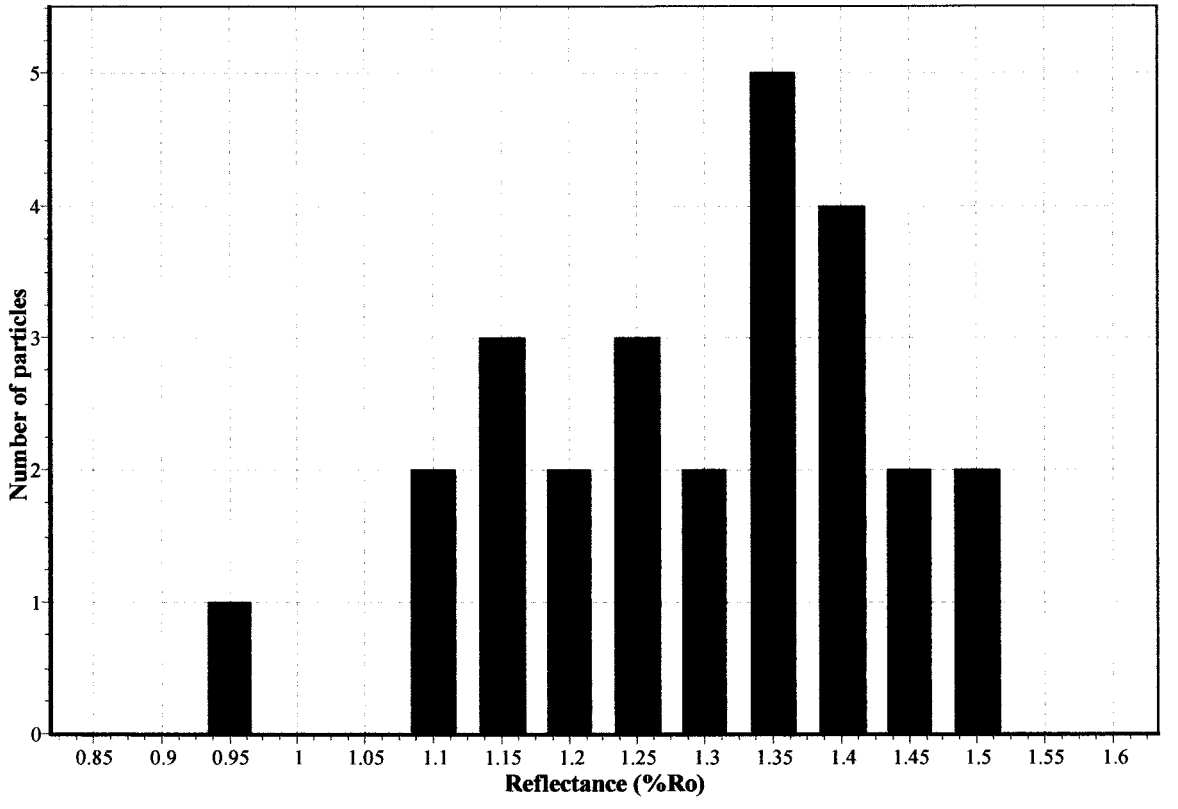


Mean %R= 1.2 Minimum %R= 0.76 Maximum %R= 1.52
Standard deviation= 0.212 Number of particles= 50

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8021
Depth:	MDRT 5140 m / TVMDRT 5106 m	Activity no.:	2002028
Material:	Cuttings	Date:	20030930
Seam:		Operator:	cgu
Interval:		Standard:	0.893%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

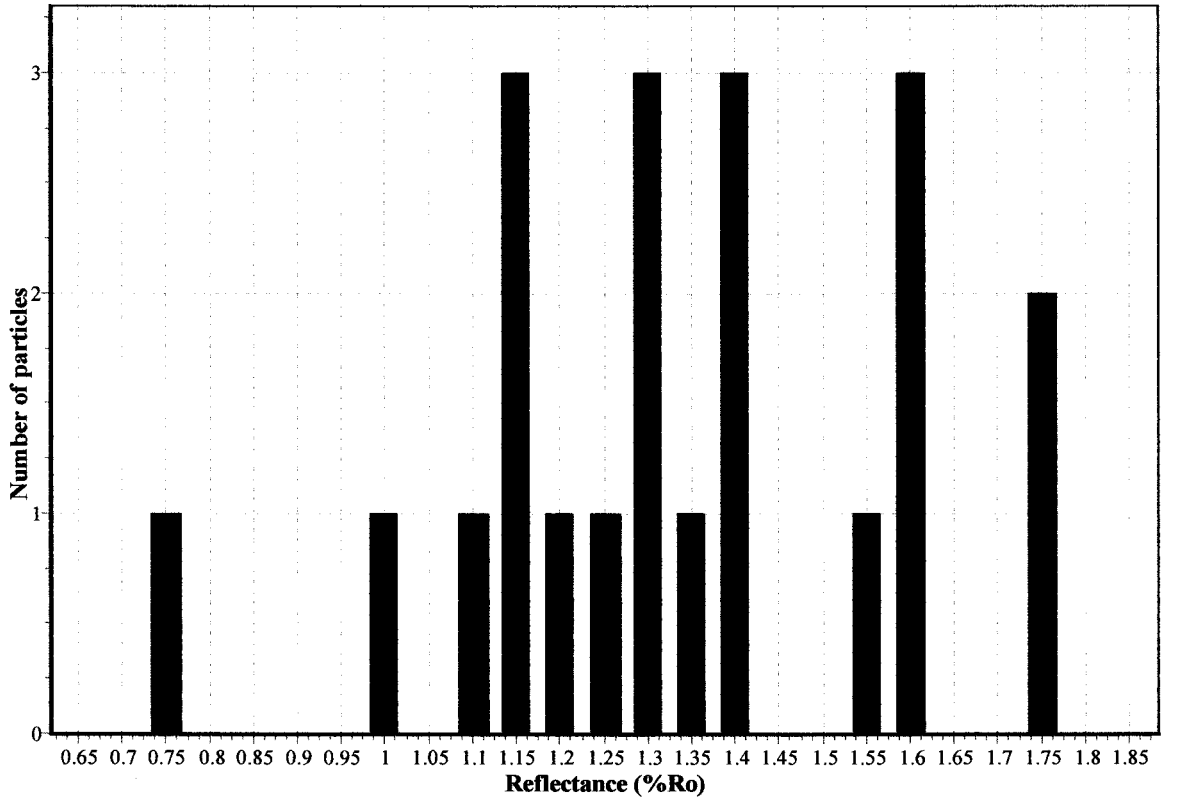


Mean %R= 1.29 Minimum %R= 0.95 Maximum %R= 1.52
Standard deviation= 0.14 Number of particles= 26

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8029
Depth:	MDRT 5220 m / TVMDRT 5185 m	Activity no.:	2002028
Material:	Cuttings	Date:	20031001
Seam:		Operator:	cgu
Interval:		Standard:	1.677%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

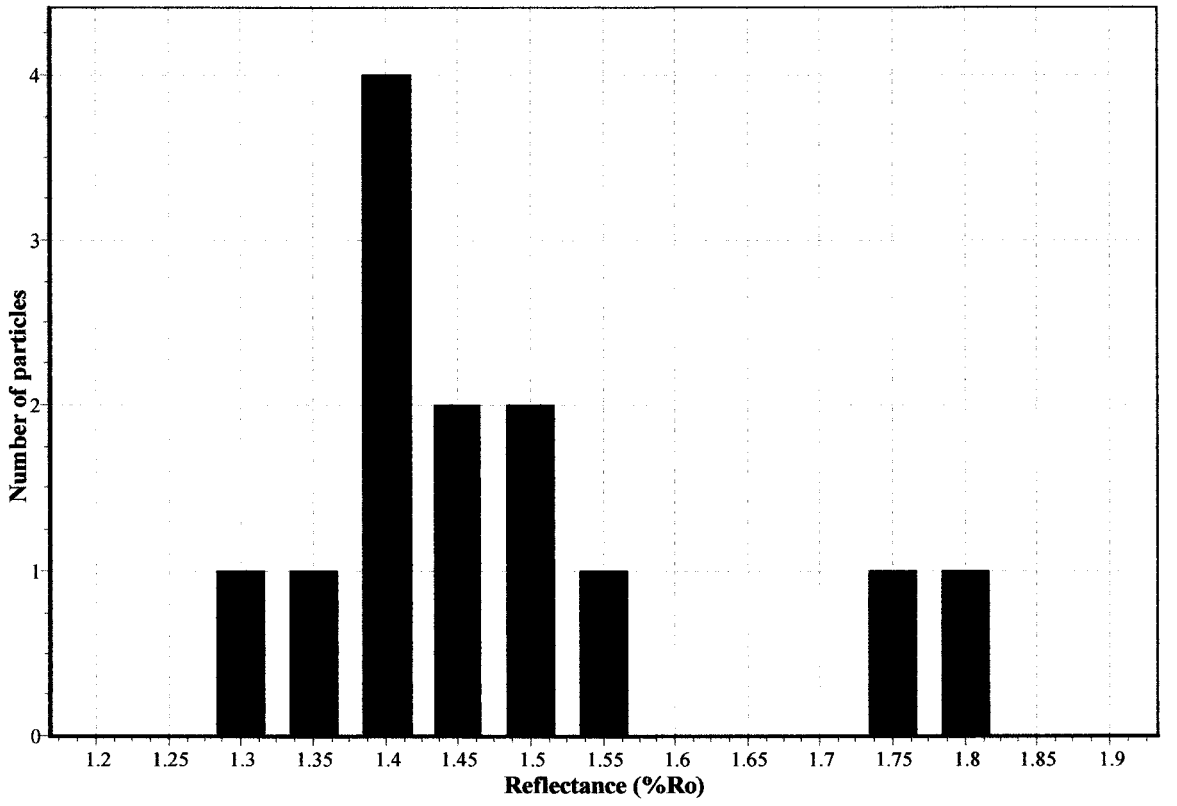


Mean %R= 1.34 Minimum %R= 0.74 Maximum %R= 1.76
Standard deviation= 0.252 Number of particles= 21

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side strack)	Lab. no.:	8033
Depth:	MDRT 5260 m / 5225 m	Activity no.:	2002028
Material:	Cuttings	Date:	20031001
Seam:		Operator:	cgu
Interval:		Standard:	1.677%
Formation:	Farsund Fm	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

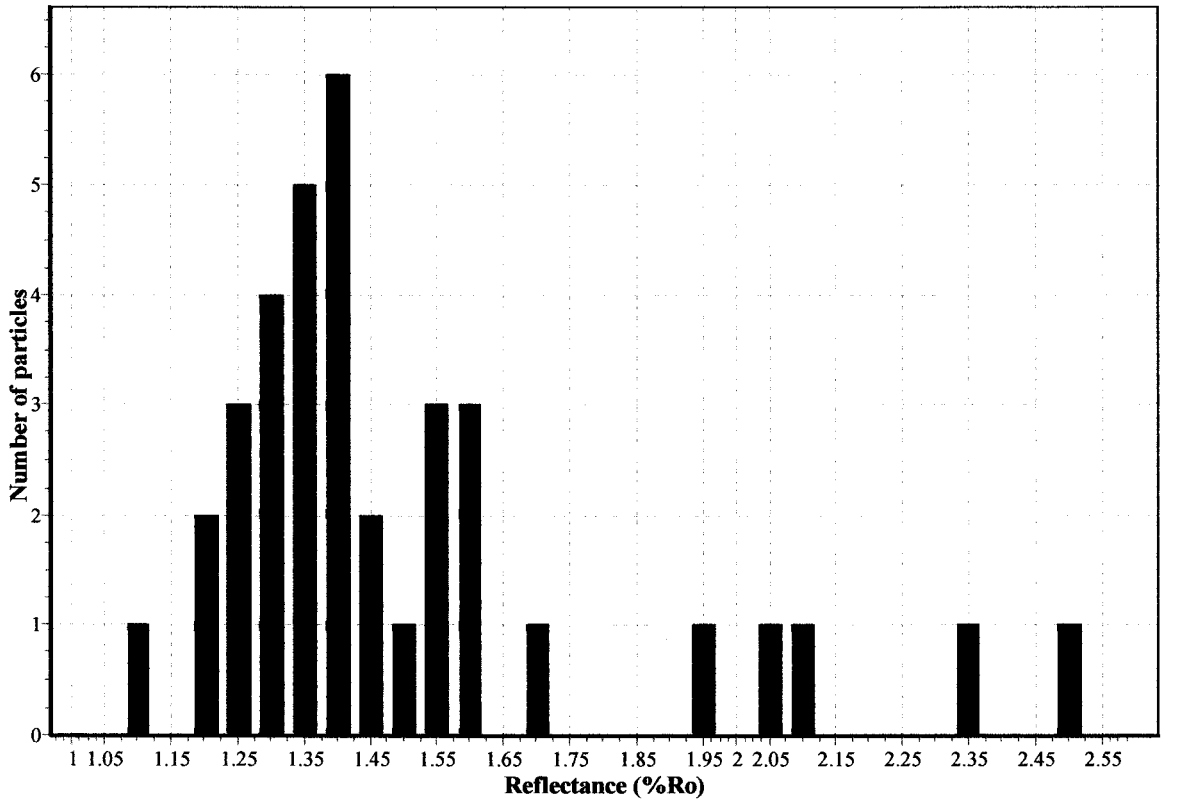


Mean %R= 1.48 Minimum %R= 1.3 Maximum %R= 1.79
Standard deviation= 0.141 Number of particles= 13

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8041
Depth:	MDRT 5340 m / TVMDRT 5304 m	Activity no.:	2002028
Material:	Cuttings	Date:	20031002
Seam:		Operator:	cgu
Interval:		Standard:	1.677%
Formation:	Heno Sand equivalent	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

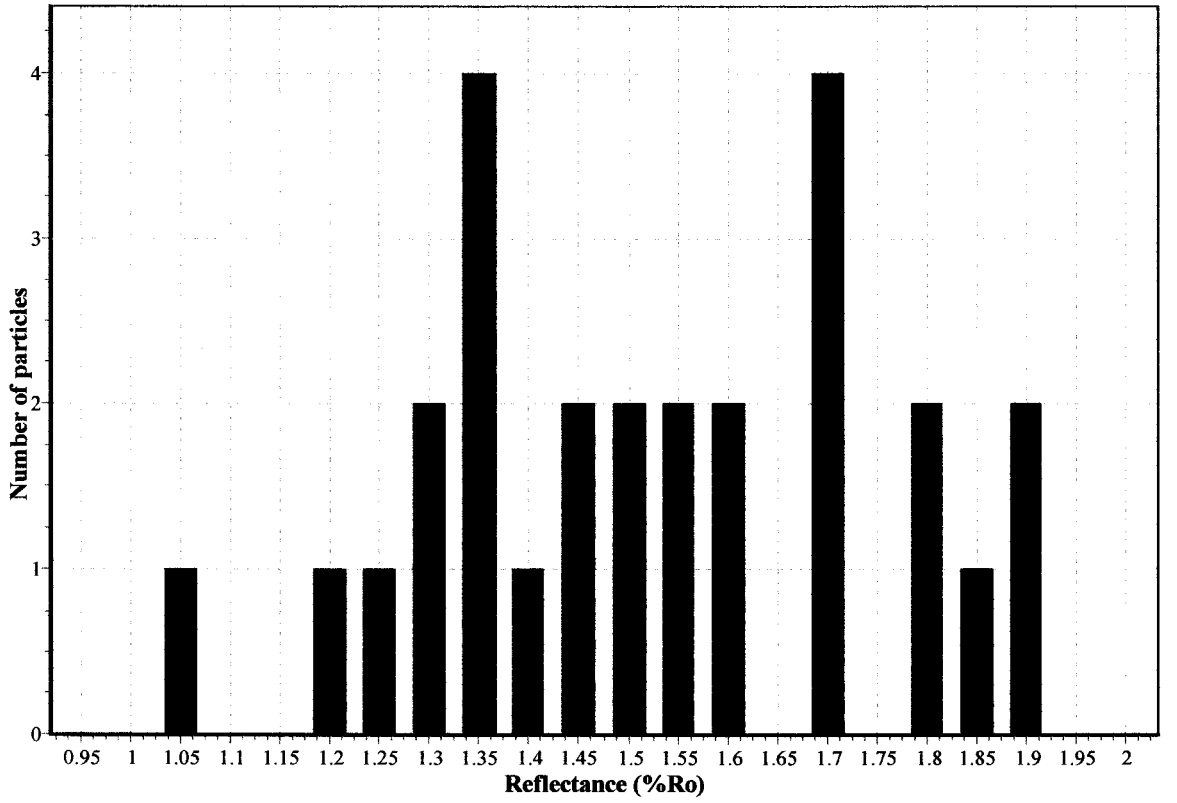


Mean %R= 1.5 Minimum %R= 1.1 Maximum %R= 2.49
Standard deviation= 0.316 Number of particles= 36

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8044
Depth:	MDRT 5380 m / TVMDRT 5343 m	Activity no.:	2002028
Material:	Cuttings	Date:	20031002
Seam:		Operator:	cgu
Interval:		Standard:	1.677%
Formation:	Heno Sand equivalent	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

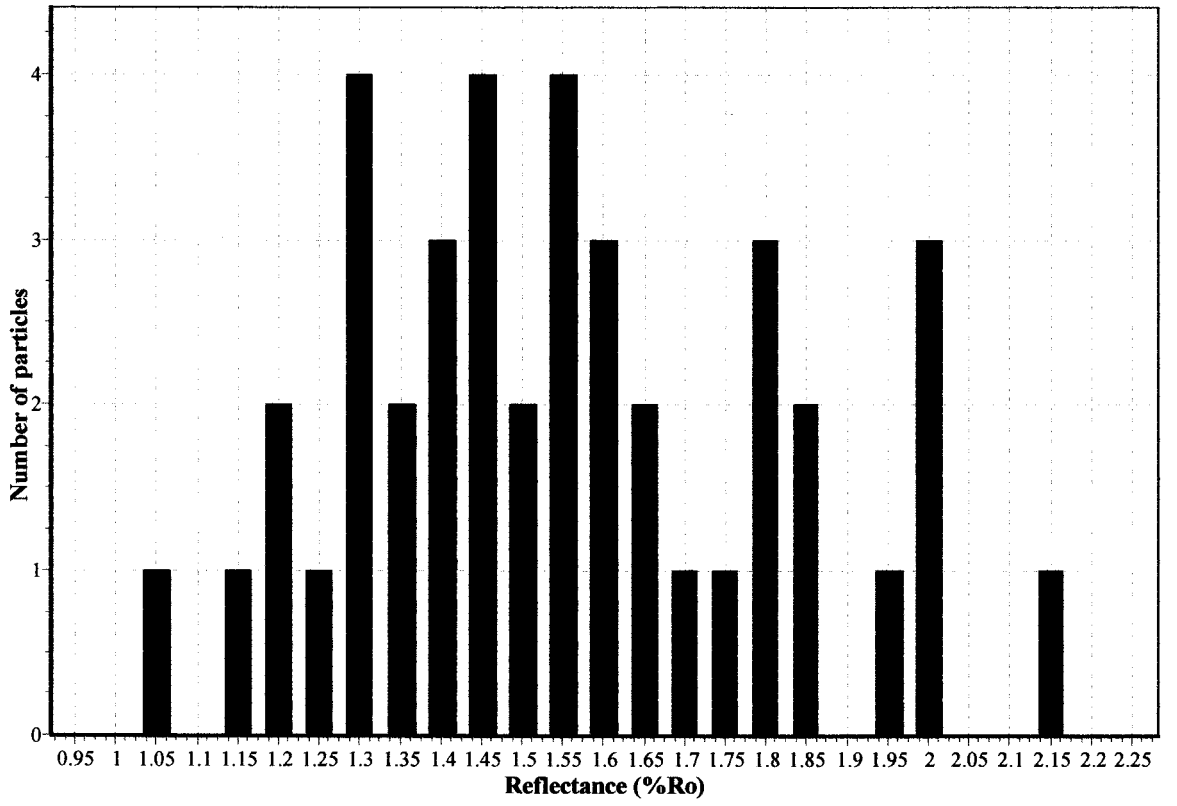


Mean %R= 1.52 Minimum %R= 1.06 Maximum %R= 1.9
Standard deviation= 0.228 Number of particles= 27

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8048
Depth:	MDRT 5420 m / TVMDRT 5383 m	Activity no.:	2002028
Material:	Cuttings	Date:	20031002
Seam:		Operator:	cgu
Interval:		Standard:	1.677%
Formation:	Heno Sand equivalent	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

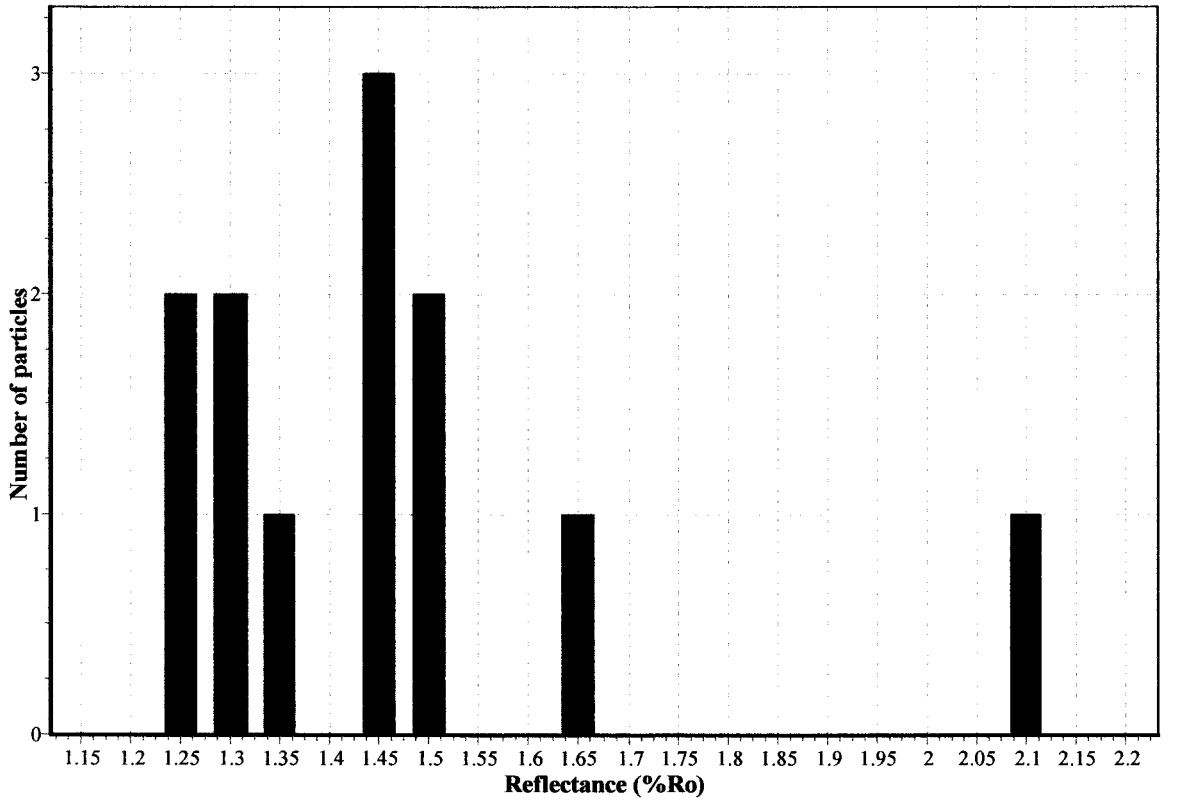


Mean %R= 1.55 Minimum %R= 1.06 Maximum %R= 2.14
Standard deviation= 0.262 Number of particles= 41

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8051
Depth:	MDRT 5450 m / TVMDRT 5412 m	Activity no.:	2002028
Material:	Cuttings	Date:	20031002
Seam:		Operator:	cgu
Interval:		Standard:	1.677%
Formation:	Heno Sand equivalent	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

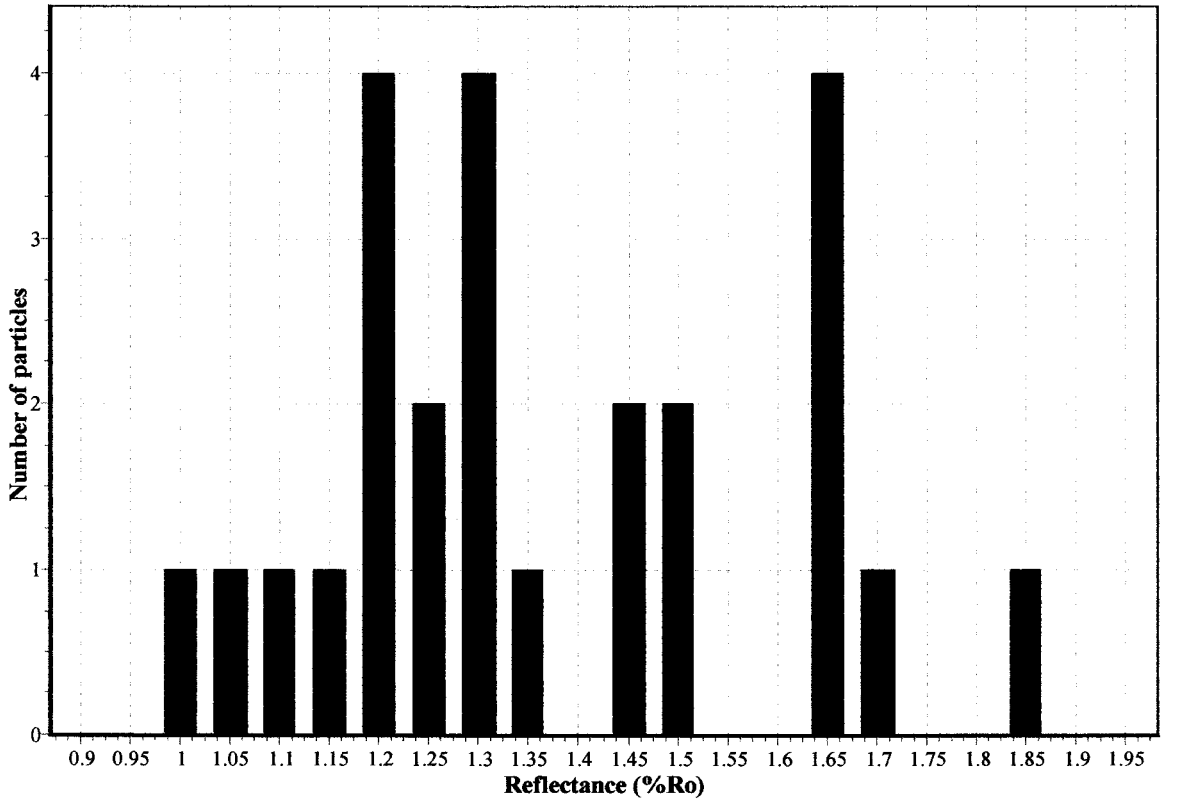


Mean %R= 1.47 Minimum %R= 1.26 Maximum %R= 2.08
Standard deviation= 0.223 Number of particles= 12

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8058
Depth:	MDRT 5529 m / TVMDRT 5489 m	Activity no.:	2002028
Material:	Cuttings	Date:	20031003
Seam:		Operator:	cgu
Interval:		Standard:	1.677%
Formation:	Heno Sand equivalent	Client:	
Age:	E. Volgian - ? L. Kimmeridgian		

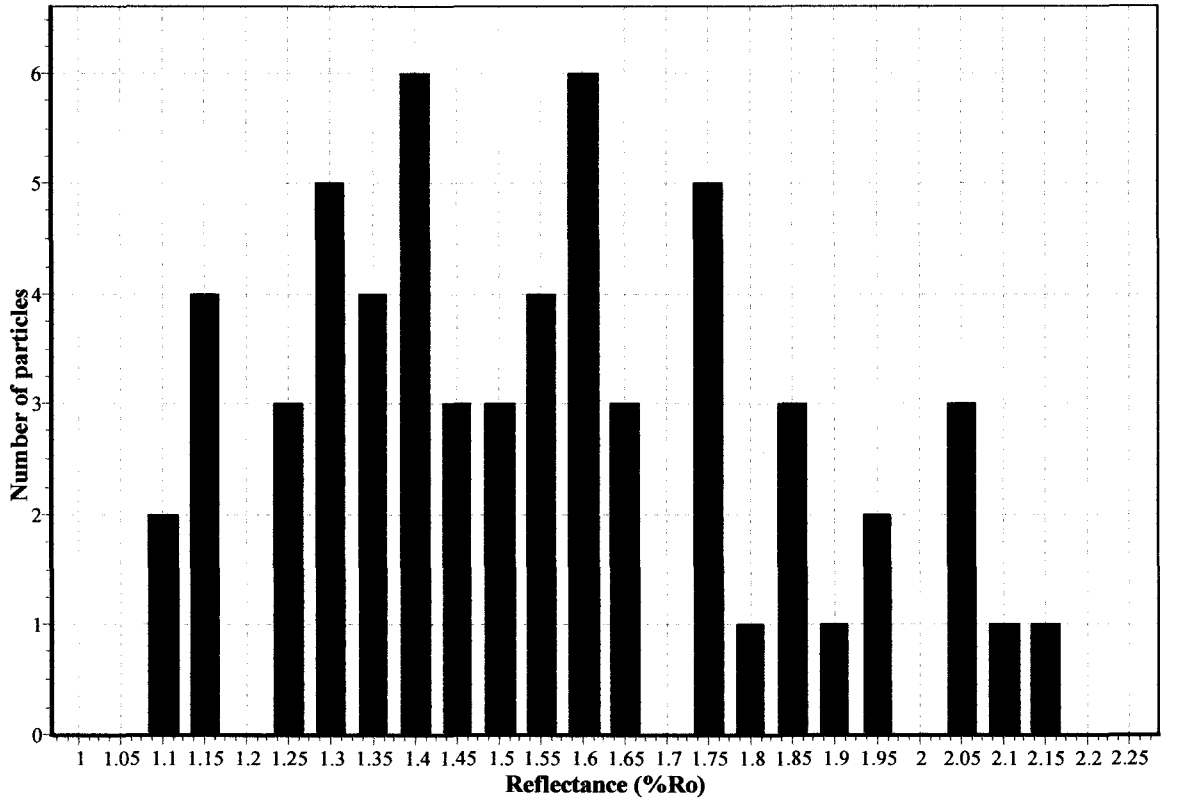


Mean %R= 1.37 Minimum %R= 1.02 Maximum %R= 1.87
Standard deviation= 0.225 Number of particles= 25

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8070
Depth:	MDRT 5710m / TVMDRT 5666 m	Activity no.:	2002028
Material:	Cuttings	Date:	20031003
Seam:		Operator:	cgu
Interval:		Standard:	1.677%
Formation:	Heno Sand equivalent	Client:	
Age:	L. Jurassic unspecified		

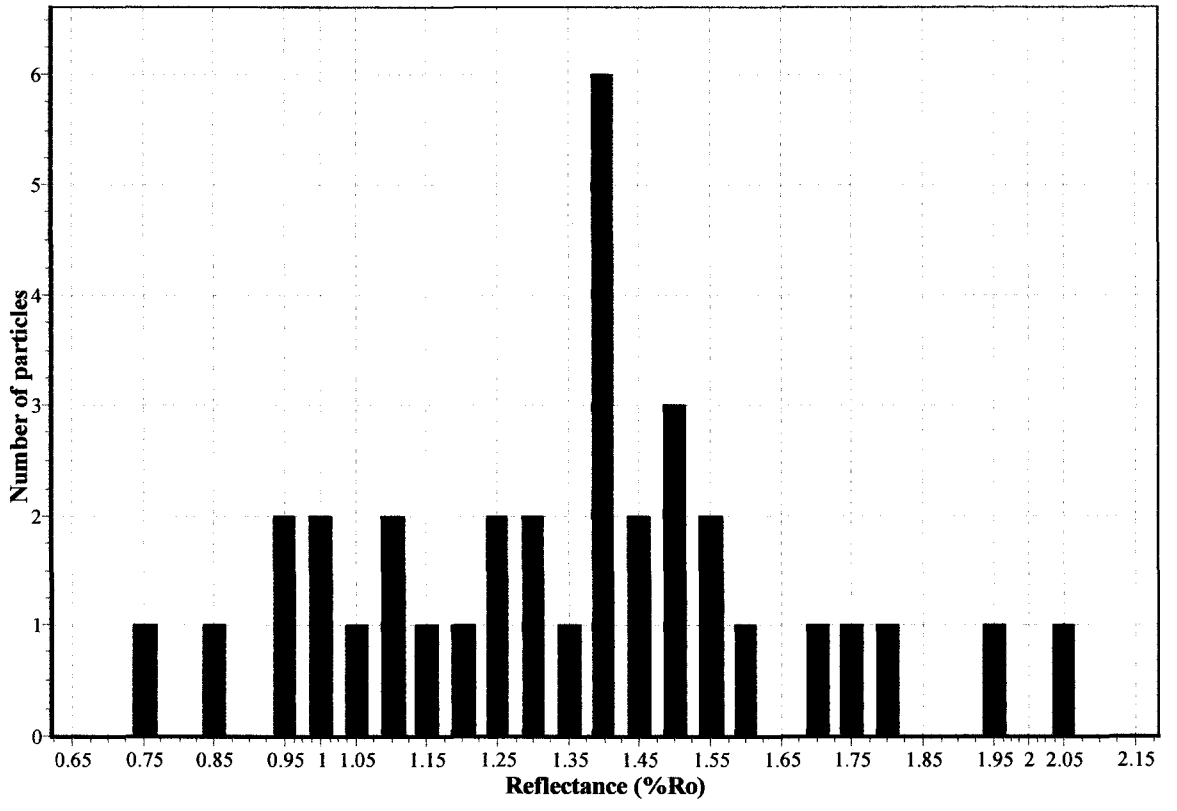


Mean %R= 1.55 Minimum %R= 1.11 Maximum %R= 2.15
Standard deviation= 0.274 Number of particles= 60

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8073
Depth:	MDRT 5755m / TVMDRT 5710 m	Activity no.:	2002028
Material:	Cuttings	Date:	20031006
Seam:		Operator:	cgu
Interval:		Standard:	1.677%
Formation:	Heno Sand equivalent	Client:	
Age:	L. Jurassic unspecified		

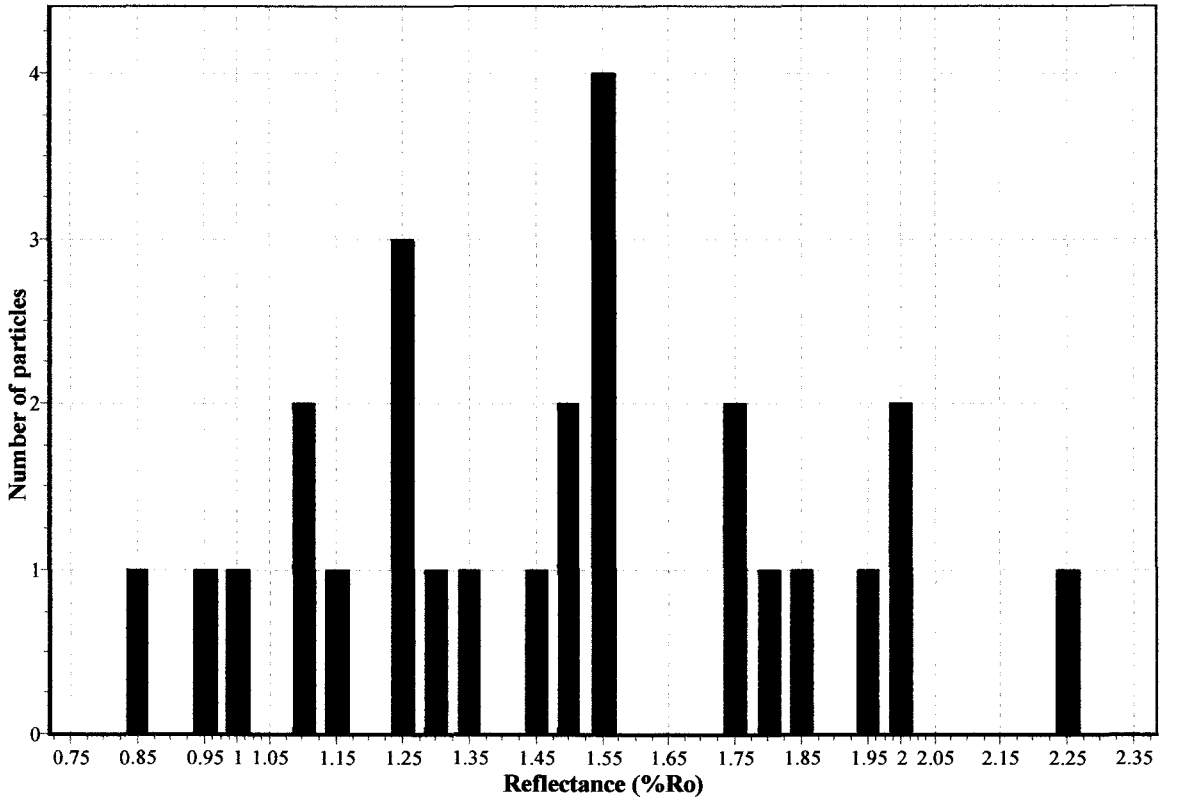


Mean %R= 1.35 Minimum %R= 0.77 Maximum %R= 2.04
Standard deviation= 0.299 Number of particles= 35

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8078
Depth:	MDRT 5829 m / TVMDRT 5783 m	Activity no.:	2002028
Material:	Cuttings	Date:	20031007
Seam:		Operator:	cgu
Interval:		Standard:	1.677%
Formation:	Heno Sand equivalent	Client:	
Age:	L. Jurassic unspecified		

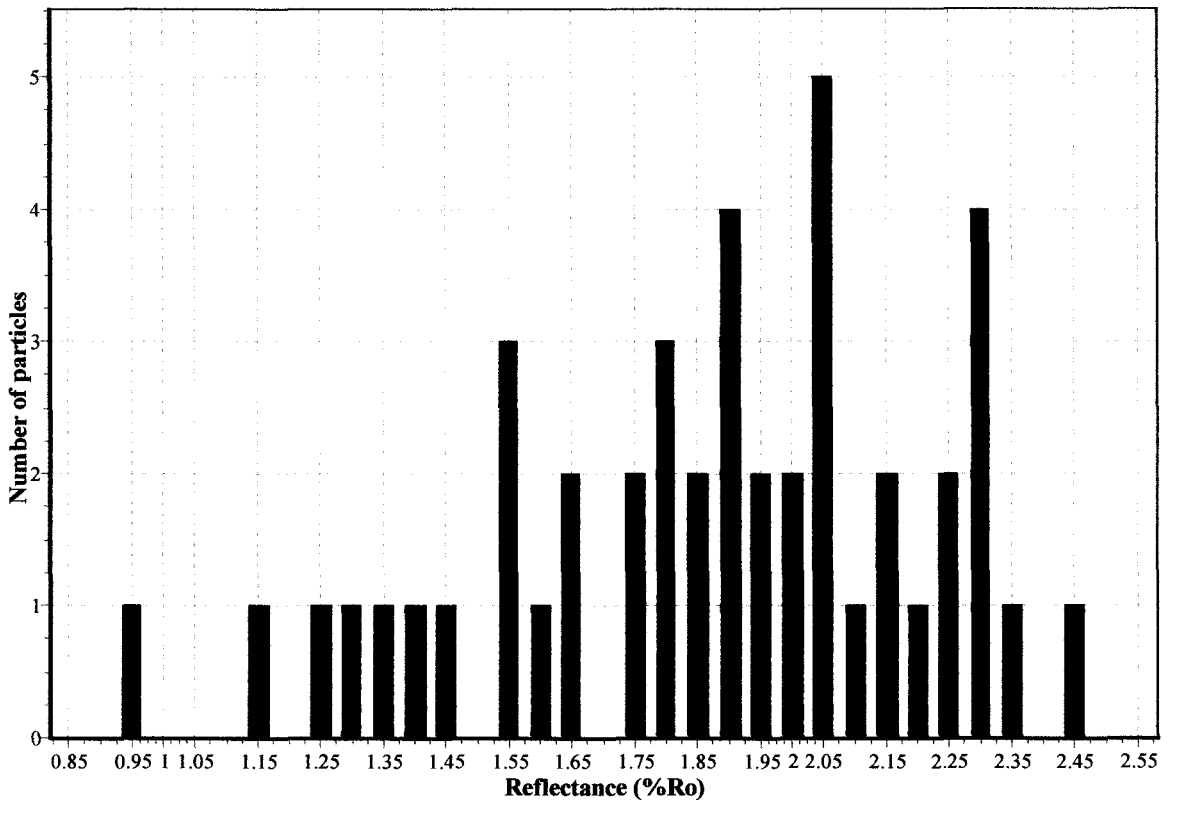


Mean %R= 1.49 Minimum %R= 0.87 Maximum %R= 2.26
Standard deviation= 0.364 Number of particles= 26

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8080
Depth:	MDRT 5862 m / TVMDRT 5815 m	Activity no.:	2002028
Material:	Cuttings	Date:	20031007
Seam:		Operator:	cgu
Interval:		Standard:	1.677%
Formation:	Heno Sand equivalent	Client:	
Age:	L. Jurassic unspecified		



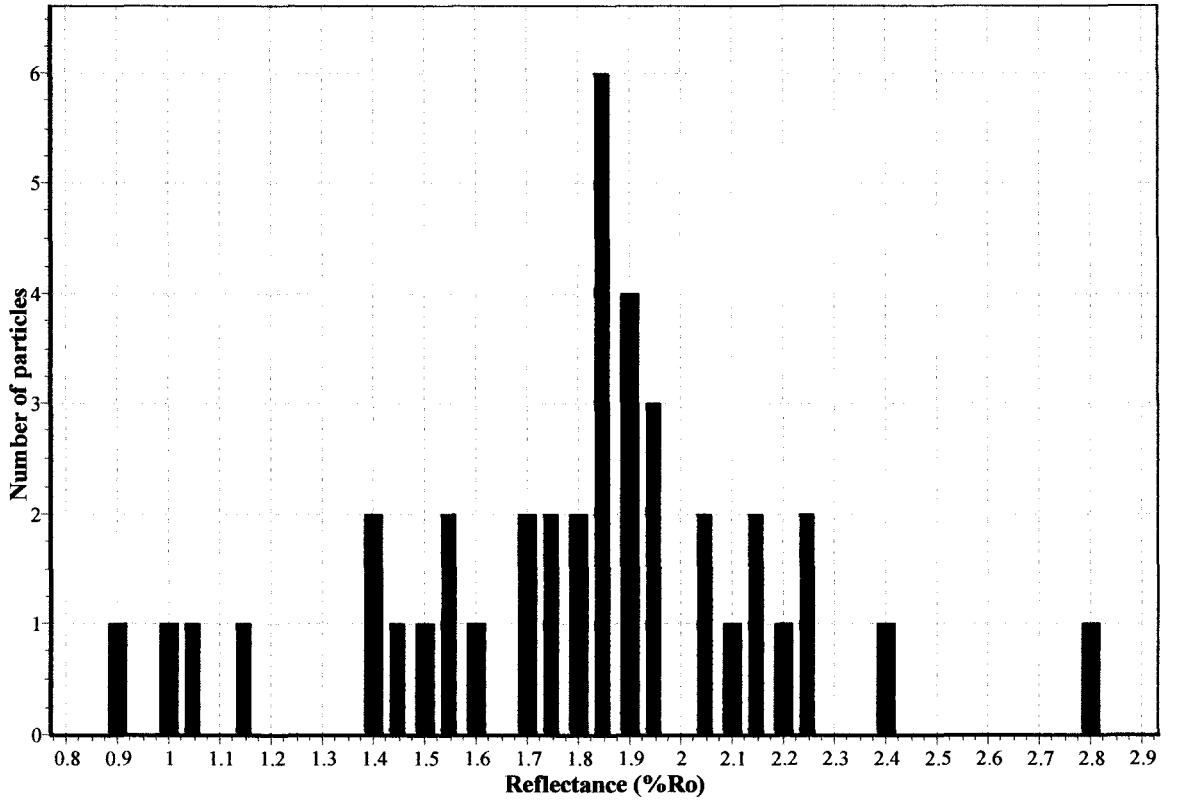
Mean %R= 1.86 Minimum %R= 0.96 Maximum %R= 2.47

Standard deviation= 0.352 Number of particles= 45

Comments:

Vitrinite Reflectance (Random)

Locality:	Svane-1A (side track)	Lab. no.:	8083
Depth:	MDRT 5907 m / TVMDRT 5859 m	Activity no.:	2002028
Material:	Cuttings	Date:	20031007
Seam:		Operator:	cgu
Interval:		Standard:	1.677%
Formation:	Heno Sand equivalent	Client:	
Age:	L. Jurassic unspecified		



Mean %R= 1.8 Minimum %R= 0.9 Maximum %R= 2.82
Standard deviation= 0.383 Number of particles= 40

Comments: