22. ORGANIC CARBON AND *N*–ALKANE DISTRIBUTION IN LATE CENOZOIC SEDIMENTS OF ARCTIC GATEWAYS SITES 909 AND 911 AND THEIR PALEOENVIRONMENTAL IMPLICATIONS: PRELIMINARY RESULTS[1]

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ABSTRACT

High northern latitude Sites 909 and 911 were drilled to gain information about the development of paleoclimatic and paleoceanographic conditions of the North Atlantic region during late Cenozoic times. In the Miocene to Quaternary sediments, organic carbon values vary between 0.3% and about 2%. Organic geochemical investigations confirm the dominance of terrestrial organic matter in most of the samples. Flux rates of organic carbon are distinctly higher than those observed in normal open-ocean environments. This is the result of the interplay between the warm West Spitsbergen Current and the Arctic sea-ice cover. One of the main depositional processes is the melting of drift-ice masses, which releases high amounts of terrigenous siliciclastic and organic particles. Changes in sea-ice cover also influence the surface-water productivity and, thus, the marine organic fraction of the sediment.

INTRODUCTION

The high northern latitudes are key areas for understanding the global climate system and its change through time (ARCSS Workshop Steering Committee, 1990; NAD Science Committee, 1992). The deep-water exchange between the Arctic and Atlantic Oceans, for instance, is a major driver of the global thermohaline circulation controlling global heat transfer and climate. The permanent Arctic sea-ice cover with its strong seasonal variations in the marginal areas has a strong influence on the earth's albedo, marine ecosystem, and oceanic circulation, which are all major mechanisms affecting the global climate. Despite the importance of the Arctic Ocean and its marginal seas for the global climate system, its exploration has remained relatively small in comparison to the other world oceans. Information about the long-term evolution of paleoclimate, based on studies of boreholes, is restricted to a few Deep Sea Drilling Project (DSDP)/Ocean Drilling Program (ODP) holes from the northern North Atlantic (DSDP Leg 38; ODP Legs 104 and 105) and from the northern North Pacific and the Bering Sea (DSDP Leg 19 and ODP Leg 145).

Drilling was performed at the following seven sites during Leg 151 to study the paleoceanographic and tectonic history in the Arctic Gateway region in more detail: on the Iceland Plateau (Site 907), in the Fram Strait (Sites 908 and 909), on the southern Yermak Plateau (Sites 910 through 912), and at the East Greenland Continental Margin (Site 913) (Fig. 1). At the different locations, sedimentary sequences that were 200–1040 m thick and of Quaternary to middle Eocene age were recovered (Myhre, Thiede, Firth, et al., 1995).

As already shown in shipboard analyses, the total organic carbon (TOC) contents of the sediments recovered during Leg 151 are surprisingly high (0.2–5.5 wt%; Myhre, Thiede, Firth, et al., 1995), significantly higher than those typical for the normal modern open-ocean environment (0.3 wt%; e.g., Suess, 1980). They also show distinct variations in time and space. The major aims of this paper are to study these changes in amount and composition of organic carbon and their relationships to the paleoceanographic and paleoclimatic evolution in more detail. For this, total organic carbon and carbonate contents, Rock-Eval pyrolysis parameters, maceral composition, and

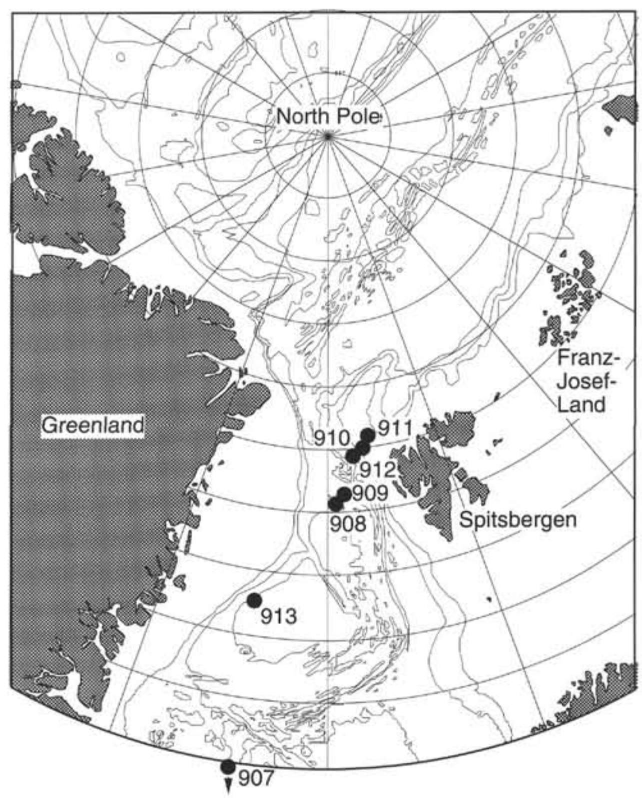

Figure 1. Map of the North Atlantic and the Arctic Ocean and locations of Sites 907 through 913.

[1]Thiede, J., Myhre, A.M., Firth, J.V., Johnson, G.L., and Ruddiman, W.F. (Eds.), 1996. *Proc. ODP, Sci. Results,* 151: College Station, TX (Ocean Drilling Program).

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specific biomarkers were determined on sediment samples from Sites 909 and 911.

Major Lithologies at Sites 909 and 911

Site 909 was drilled in Fram Strait at 78°35.064′N, 03°04.374′E in a water depth of 2519 m. The sedimentary sequence consists of three lithologic units. Unit I (0–248.8 m below seafloor [mbsf]; Quaternary/Pliocene age) is composed of interbedded clay, silty clay, and clayey mud with significant amounts of dropstones. In the upper 50 m, minor occurrences of calcareous nannofossils were determined. Unit II (287.5–518.3 mbsf; Pliocene/Miocene age) consists of silty clay and clayey silt; pyrite is common. Unit III (518.3–1061.8 mbsf) can be divided into two subunits. Subunit IIIA (518.3–923.4 mbsf; Miocene age) consists of silty clay, clayey silt, clayey mud, carbonate-bearing silty clay, and carbonate clay. Meter-scale intervals of thin bioturbated layers and laminations are typical for this subunit. Subunit IIIB (923.4–1061.8 mbsf; Miocene age) is composed of silty clay, clayey silt, clayey mud, and silty mud. This subunit is characterized by commonly folded and otherwise deformed bedding (Myhre, Thiede, Firth, et al., 1995).

Site 911 was drilled on the southern Yermak Plateau at 80°28.466′N, 08°13.640′E, in a water depth of 901.6 m. The 505.8-m-thick sedimentary sequence consists of one lithological unit that can be divided into two subunits. Subunit IA (Quaternary to Pliocene age) is mainly composed of homogeneous silty clay and clayey silt with common occurrences of large dropstones. Subunit IB (Pliocene age) is also dominated by homogeneous silty clay and clayey silt; however, the dropstone abundances are significantly lower (Myhre, Thiede, Firth, et al., 1995).

METHODS

Total carbon, total nitrogen, and total organic carbon were determined on ground bulk samples and carbonate-free sediment samples by means of a Heraeus CHN-analyzer. Carbon measurements have an accuracy of 0.02%. The carbonate content was calculated as

$$CaCO_3 = (TC - TOC) \times 8.333,$$

where TC = total carbon and TOC = total organic carbon (both in weight percentage of the bulk sample). It is assumed that all carbonate is calcite, which has been proved by X-ray diffraction (XRD) analysis for a selected set of samples. C/N ratios were calculated as "total organic carbon/total nitrogen ratios."

Rock-Eval pyrolysis was conducted on bulk sediment samples to determine (1) the amount of hydrocarbons already present in the sample (S1 peak in milligrams of hydrocarbons per gram of sediment), (2) the amount of hydrocarbons generated by pyrolytic degradation of the kerogen during heating of up to 550°C (S2 peak in milligrams of hydrocarbons per gram of sediment), (3) the amount of carbon dioxide generated during heating of up to 390°C (S3 peak in milligram of carbon dioxide per gram of sediment), and (4) the temperature of maximum pyrolysis yield (T_{max} value in degrees Celsius) (Espitalié et al., 1977; Peters, 1986). As further indicators of the composition of the organic matter, the Rock-Eval parameters hydrogen (HI) and oxygen index values (OI) were used (cf. Tissot and Welte, 1984; Stein, 1991, and further references therein). The HI value corresponds to the quantity of pyrolyzable hydrocarbons per gram TOC (mgHC/gC); the OI value corresponds to the quantity of carbon dioxide per gram TOC ($mgCO_2/gC$).

For a selected set of samples, kerogen microscopy was performed on polished, epoxy-impregnated blocks of sediment; the macerals were classified according to the nomenclature described by Stach et al. (1982).

For lipid extraction, samples were treated successively with methanol, methanol/dichloromethane (1:1), and dichloromethane (cf. Farrimond et al., 1990). After each step, the sample was centrifuged and its clear extract decanted; all extracts were combined. As an internal standard, squalane was added. Then, the total extract was fractionated by column chromatography. The "hydrocarbon fraction" was collected upon elution with hexane and injected into a HP5890 (Series II) gas chromatograph (GC). Helium was used as the carrier gas. The GC was equipped with a silica capillary column (50 m × 0.32 mm; 0.17-µm film of dimethyl-polysiloxan). The temperature program was as follows: 60°C for 1 min; from 60° to 150°C at 10°C/min; from 150° to 300°C at 4°C/min; and isothermal at 300°C for 45 min. The *n*-alkanes (C_{15}–C_{32}), and phytane and pristane were identified on the basis of retention times.

RESULTS

Quantity of Organic Carbon

In the lowermost part of the sedimentary sequence of Fram Strait Site 909 (below 990 mbsf), maximum TOC concentrations were recorded; most of them vary between 1 and 2 wt%, with a maximum of 4.3 wt% (Fig. 2; Table 1). Between 990 and 310 mbsf, organic contents range from 0.2 to 1.7 wt%. Within this interval, maximum values are reduced to about 1.1% between 820 and 640 mbsf. In the Quaternary to Pliocene sediments (upper 310 m), a general decrease in organic carbon content occurs. The Quaternary interval is characterized by high-amplitude variations between 0.2 and 1.3 wt%.

At Site 911, the TOC contents vary between 0.5 and 1.5 wt% (Fig. 3; Table 2). The higher values of 0.7 to 1.5 wt% (mean values of about 1.2 wt%) occur in the upper Pliocene interval between 350 and 500 mbsf, whereas the upper 240 m (Quaternary) is characterized by lower values mostly varying between 0.5 and 1.3 wt% (mean value of 0.9 wt%).

In the high-resolution record of organic carbon content vs. age, it is obvious that distinct short-term fluctuations occur throughout the last 3.5 Ma (Fig. 4). At about 2.75 Ma, the minimum TOC values seem to decrease, resulting in an increased amplitude of variation. At about 1 Ma, the maximum values decrease. In general, carbonate contents are low, ranging between 0 and 4 wt% (Fig. 4). Single carbonate peaks of 5 to 24 wt% occasionally occur throughout, with increasing abundance in the last 1 Ma.

Composition of Organic Carbon

In order to interpret the organic carbon data in terms of paleoenvironmental change, it is absolutely necessary to have information about the composition of the organic matter (i.e., to distinguish between marine and terrigenous sources; e.g., Stein, 1991, and further references therein). As a first approach, HI values derived from pyrolysis analysis were used (Espitalié et al., 1977). In immature sediments, organic matter dominated by marine components has HI values of 200–400 mgHC/gC, whereas terrigenous organic matter has HI values of 100 mgHC/gC or less (e.g., Stein, 1991). The pyrolysis methods have their limits in organic carbon-lean sediments (e.g., Peters, 1986), and pyrolysis data should be interpreted cautiously and supported by other methods (e.g., Stein, 1991). Besides hydrogen indices, which were determined on a large number of samples, maceral composition and biomarker data were used to characterize the organic carbon fraction.

Rock-Eval pyrolysis data indicate a clear dominance of terrigenous organic matter at both sites, as shown in the van Krevelen diagrams (Figs. 5, 6), by generally low hydrogen index values and low to high oxygen index values ("kerogen type III"). At Site 909, most of the hydrogen index values vary between 30 and 130 mgHC/gC (Fig. 2). Significantly higher hydrogen indices occur in the lowermost Miocene interval, where values vary between 110 and 200

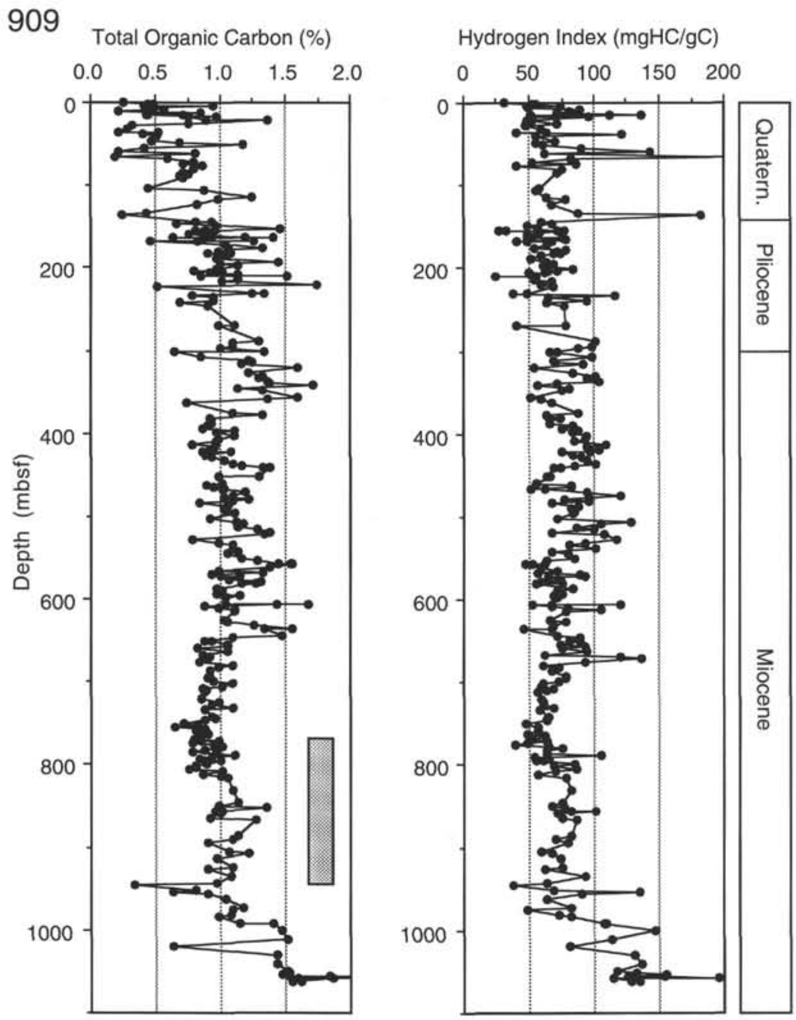

Figure 2. Total organic carbon and hydrogen index of Site 909 sediments vs. depth values. Hatched bar marks intervals of significant amounts of reworked organic matter (based on high T_{max} values; cf. Stein et al., 1995).

mgHC/gC. In the upper Quaternary interval, a couple of single, high values of 130–200 mgHC/gC were determined. Low T_{max} values of <435°C (Table 1) suggest a dominance of immature organic matter. In the lower Miocene interval (i.e., about 780–930 mbsf; Fig. 2), reworked, more mature organic matter appears to be present, as indicated by distinctly increased T_{max} values of 440°–490°C (Table 1; Stein et al., 1995).

At Site 911, most of the hydrogen index values vary between 30 and 80 mgHC/gC (Fig. 3). Only in the lowermost interval (i.e., below 400 mbsf), do some higher values of 90–120 mgHC/gC occur.

The aliphatic fraction of Sites 909 (Fig. 7) and 911 (Fig. 8) is dominated by long-chain *n*-alkanes (Table 3), also pointing to a terrigenous source of the organic matter. However, the *n*-alkane and odd/even carbon number ratio (e.g., carbon preference index [CPI]) data set has to be completed to gain more information about the terrigenous vs. marine proportion and the degradational condition of the organic material in the sediments.

The maceral composition determined in a first restricted set of samples also supports the dominance of terrigenous organic matter at both sites. According to preliminary results, vitrinite is clearly the most abundant maceral. Due to the instability of marine organic material, liptinites of marine origin can be recognized only as very fine dispersed background fluorescence. Further microscopy work is in progress to get some more quantitative estimates about the maceral composition.

Flux of Organic Carbon

Since changes in organic carbon concentrations can result from changes in both mineral components and organic carbon content, the percentage values have to be transformed into mass accumulation (flux) rates before an interpretation of the data in terms of changes in organic carbon supply is possible (cf. van Andel et al., 1975). Based on shipboard stratigraphy and physical properties data, flux rates were calculated for Quaternary and late Pliocene intervals of the organic carbon-rich sediments of Site 911 (Yermak Plateau). At this site, accumulation rates are relatively high throughout. In the late Pliocene to early Quaternary time interval (3.5–1 Ma), they vary from 0.15 to 0.3 gC/cm^2/k.y. During the last 1 Ma, they decrease to values of 0.05 to 0.15 gC/cm^2/k.y.

These accumulation rates are significantly higher than those recorded in the less organic carbon-rich sediments of Site 907 (Iceland Plateau). In general, the average mass accumulation rates of total organic carbon are low at Site 907, varying from 0.004 and 0.030 gC/cm^2 /k.y. The minimum values occur in the upper Miocene to Quaternary intervals, with values very similar to those observed in modern

Table 1. Summary table of Site 909 data.

Core, section, interval (cm)	Depth (mbsf)	TC	IC	TOC	$CaCO_3$	N_2	T_{max} (°C)	S1	S2	S3	HI	OI	C/N ratio
151-909A-													
1H-1, 55–56	0.55	1.37	1.11	0.26	9.20	—	405	0.05	0.08	1.67	31	642	—
1H-1, 115–116	1.15	0.81	0.36	0.45	3.00	0.08	—	0.06	0.25	1.26	56	280	5.60
1H-2, 56–57	2.06	0.89	0.40	0.49	3.30	0.08	427	0.09	0.26	1.52	53	310	6.10
1H-3, 55–56	3.55	0.81	0.39	0.42	3.20	0.10	—	0.09	0.31	1.46	74	348	4.20
1H-4, 26–27	4.76	1.23	0.29	0.94	2.40	0.05	432	0.02	0.45	2.25	48	239	18.8
1H-5, 54–55	6.54	1.04	0.56	0.48	4.70	0.07	416	0.07	0.24	1.23	50	256	6.80
2H-1, 55–56	8.05	0.73	0.16	0.57	1.30	0.09	—	0.05	0.51	1.15	89	202	6.30
2H-2, 114–115	10.14	0.63	0.42	0.21	3.50	0.06	—	0.06	0.17	1.38	81	657	3.50
2H-3, 118–119	11.68	0.93	0.08	0.85	0.70	0.06	433	0.03	0.61	0.58	72	68	14.17
2H-4, 7–8	12.07	0.48	0.05	0.43	0.40	0.06	—	0.01	0.37	0.76	86	177	7.10
2H-5, 44–45	13.94	0.52	0.07	0.45	0.60	0.09	—	0.07	0.61	0.80	136	178	5.00
2H-5, 105–106	14.55	0.82	0.11	0.71	0.90	0.07	425	0.04	0.37	0.88	52	124	10.10
2H-6, 45–46	15.45	0.56	0.13	0.43	1.10	—	—	0.03	0.48	0.53	112	123	—
2H-6, 139–140	16.39	1.23	0.26	0.97	2.20	0.07	432	0.01	0.51	2.42	532	49	13.86
3H-1, 65–66	17.65	0.77	0.02	0.75	0.20	0.12	—	0.12	0.72	0.83	96	111	6.20
3H-3, 71–72	20.71	1.16	0.27	0.89	2.20	0.09	428	0.04	0.44	1.27	49	143	9.90
3H-4, 58–59	22.08	1.41	0.05	1.36	0.40	0.11	428	0.02	0.72	0.71	53	52	12.36
3H-6, 64–65	25.14	0.82	0.07	0.75	0.60	0.09	439	0.06	0.54	0.57	72	76	8.30
4H-1, 49–50	26.99	0.48	0.16	0.32	1.30	0.07	—	0.01	0.15	0.67	47	209	4.60
4H-4, 106–107	32.06	0.55	0.26	0.29	2.20	0.07	—	0.03	0.17	1.11	59	383	4.10
4H-6, 107–108	35.07	0.55	0.33	0.22	2.70	—	—	0.01	0.14	0.94	64	427	—
5H-1, 72–73	36.72	0.74	0.21	0.53	1.70	0.08	431	0.03	0.21	0.67	40	126	6.60
5H-2, 101–103	38.51	0.44	0.03	0.41	0.20	0.07	—	0.10	0.50	0.47	122	115	5.80
5H-4, 37–38	40.87	0.55	0.04	0.51	0.30	0.09	441	0.04	0.28	0.54	55	106	5.60
6H-1, 37–39	45.87	0.68	0.21	0.47	1.70	0.08	428	0.04	0.33	0.66	70	140	5.90
6H-3, 49–51	48.26	0.86	0.17	0.69	1.40	0.09	433	0.05	0.38	0.57	55	83	7.60
6H-5, 114–115	51.16	1.26	0.09	1.17	0.70	0.12	427	0.05	0.71	1.16	61	99	9.75
7H-1, 26–27	55.76	0.53	0.11	0.42	0.90	0.03	440	0.03	0.38	0.61	90	145	14.0
7H-3, 28–29	58.60	0.30	0.09	0.21	0.70	0.06	—	0.01	0.30	0.51	143	243	3.50
7H-5, 27–28	61.41	1.08	0.27	0.81	2.20	0.11	428	0.07	0.50	0.99	621	22	7.30
8H-1, 109–110	66.09	0.43	0.24	0.19	2.00	0.09	—	0.05	0.44	0.47	232	247	2.10
8H-3, 26–27	68.06	0.67	0.07	0.60	0.60	0.10	465	0.04	0.50	0.58	83	97	6.00
8H-5, 71–72	71.33	3.62	2.82	0.80	23.50	0.08	433	0.01	0.42	6.08	53	760	10.0
9H-1, 102–103	75.02	0.93	0.21	0.72	1.70	0.10	435	0.08	0.62	0.82	86	114	7.20
9H-3, 28–29	77.08	1.03	0.16	0.87	1.30	0.12	422	0.04	0.36	1.41	41	162	7.20
9H-5, 28–29	79.88	0.89	0.09	0.80	0.70	0.11	422	0.12	0.61	1.07	76	134	7.30
151-909C-													
1R-1, 29–30	85.29	0.81	0.09	0.72	0.70	0.10	429	0.06	0.51	0.75	71	104	7.20
11H-2, 27–28	86.07	0.88	0.12	0.76	1.00	0.09	—	—	—	—	—	0	8.40
11H-3, 99–100	88.19	0.82	0.13	0.69	1.10	0.10	—	—	—	—	—	0	6.90
11H-5, 27–28	90.27	0.73	0.02	0.71	0.20	0.11	—	—	—	—	—	0	6.40
3R-1, 33–34	104.63	0.48	0.03	0.45	0.20	0.07	452	0.02	0.26	0.40	58	89	6.40
3R-2, 33–34	106.13	0.98	0.10	0.88	0.80	0.12	430	0.06	0.49	0.73	56	83	7.30
4R-1, 27–28	114.17	1.53	0.28	1.25	2.30	0.11	433	0.06	0.80	2.48	64	198	11.36
4R-3, 27–28	117.10	1.14	0.15	0.99	1.20	0.12	424	0.12	0.77	1.00	78	101	8.20
5R-1, 32–33	123.92	0.88	0.05	0.83	0.40	0.11	433	0.05	0.56	0.51	67	61	7.50
6R-1, 38–39	133.58	0.46	0.03	0.43	0.20	0.09	452	0.04	0.38	0.39	88	91	4.80
6R-3, 38–39	136.58	0.69	0.45	0.24	3.70	0.09	433	0.04	0.44	0.62	183	258	2.60
7R-1, 32–33	143.22	0.87	0.06	0.81	0.50	0.11	441	0.05	0.48	0.66	59	81	7.30
7R-1, 48–49	143.38	4.42	3.49	0.93	29.10	0.11	435	0.04	0.55	8.91	59	958	8.40
7R-3, 23–24	146.13	0.82	0.16	0.66	1.30	0.10	425	0.05	0.45	1.03	68	156	6.60
7R-4, 55–56	147.95	4.13	3.17	0.96	26.40	0.10	434	0.01	0.46	6.81	48	709	9.60
8R-1, 39–40	152.99	1.49	0.03	1.46	0.20	0.15	432	0.04	0.83	0.98	57	67	9.73
8R-3, 4–5	155.64	1.04	0.08	0.96	0.70	0.13	431	0.08	0.68	0.67	71	70	7.40
8R-3, 10–11	155.70	1.79	0.98	0.81	8.20	0.11	435	0.03	0.26	2.51	32	310	7.30
8R-3, 14–15	155.74	2.54	1.65	0.89	13.70	0.09	442	0.01	0.24	3.49	27	392	9.90
8R-3, 18–19	155.78	1.00	0.12	0.88	1.00	0.11	432	0.07	0.68	0.78	77	89	8.00
8R-3, 28–29	155.88	1.04	0.14	0.90	1.20	0.11	432	0.06	0.52	0.77	58	86	8.20
8R-5, 82–83	159.42	0.82	0.07	0.75	0.60	0.10	429	0.02	0.36	0.53	48	71	7.50
9R-1, 28–29	162.58	1.37	0.18	1.19	1.50	0.13	431	0.04	0.58	1.14	49	96	9.15
9R-1, 91–92	163.21	3.59	2.96	0.63	24.70	—	435	0.02	0.30	5.01	48	795	—
9R-1, 96–97	163.26	1.61	0.21	1.40	1.70	0.16	434	0.09	1.07	1.06	76	76	8.75
9R-2, 29–30	164.09	1.08	0.15	0.93	1.20	0.13	431	0.03	0.49	0.70	53	75	7.10
9R-3, 28–29	165.58	0.95	0.08	0.87	0.70	0.11	431	0.06	0.69	0.60	79	69	7.90
9R-3, 134–135	166.64	4.19	3.37	0.82	28.10	0.09	430	0.01	0.34	5.89	41	718	9.10
9R-3, 142–143	166.72	1.50	0.24	1.26	2.00	0.15	429	0.04	0.62	1.40	49	111	8.40
9R-4, 28–29	167.08	0.53	0.07	0.46	0.60	0.10	433	0.03	0.31	0.53	67	115	4.60
10R-1, 23–24	172.13	1.41	0.37	1.04	3.10	0.09	433	0.04	0.65	1.84	63	177	11.56
10R-3, 31–32	175.21	2.02	0.69	1.33	5.70	0.12	428	0.04	0.72	3.29	54	247	11.08
10R-5, 28–29	178.18	1.30	0.23	1.07	1.90	0.12	430	0.08	0.84	1.21	79	113	8.91
10R-6, 0–2	179.40	1.06	0.08	0.98	0.70	0.12	430	0.09	0.70	0.66	71	67	8.10
10R-7, 39–40	181.29	1.28	0.20	1.08	1.70	0.11	437	0.03	0.75	0.96	69	89	9.82
11R-1, 14–15	181.74	1.07	0.17	0.90	1.40	0.11	434	0.06	0.67	0.96	74	107	8.20
11R-3, 80–81	185.40	1.17	0.12	1.05	1.00	0.12	426	0.05	0.63	0.64	60	61	8.75
11R-5, 81–82	188.41	1.18	0.21	0.97	1.70	0.07	429	0.02	0.49	1.12	51	115	13.86
12R-1, 86–87	192.06	2.17	0.73	1.44	6.10	0.11	441	0.07	0.90	2.55	63	177	13.09
12R-3, 91–92	195.11	1.12	0.12	1.00	1.00	0.12	426	0.06	0.69	0.93	69	93	8.33
12R-5, 30–31	197.50	1.22	0.09	1.13	0.70	0.13	432	0.05	0.69	0.68	61	60	8.69
13R-1, 113–114	201.93	1.01	0.04	0.97	0.30	0.12	420	0.10	0.81	0.56	84	58	8.10
13R-2, 24–25	202.54	1.12	0.11	1.01	0.90	0.12	422	0.09	0.66	0.76	65	75	8.41
13R-3, 41–42	204.21	0.87	0.07	0.80	0.60	0.10	417	0.07	0.57	0.55	71	69	8.00
13R-3, 95–96	204.75	1.13	0.16	0.97	1.30	0.12	410	0.08	0.60	0.68	62	70	8.10
13R-4, 40–41	205.70	0.98	0.06	0.92	0.50	0.11	423	0.04	0.46	0.75	50	82	8.30
13R-5, 33–34	207.13	1.26	0.12	1.14	1.00	0.12	425	0.05	0.58	1.02	51	89	9.50
13R-6, 63–64	208.93	1.02	0.17	0.85	1.40	0.10	432	0.05	0.48	0.65	56	76	8.50
13R-6, 106–107	209.36	4.30	2.79	1.51	23.20	0.11	434	0.03	0.38	2.67	25	177	13.73

Table 1 (continued).

Core, section, interval (cm)	Depth (mbsf)	TC	IC	TOC	$CaCO_3$	N_2	T_{max} (°C)	S1	S2	S3	HI	OI	C/N ratio
14R-1, 25–26	210.75	1.47	0.34	1.13	2.80	0.12	432	0.05	0.62	1.04	55	92	9.41
14R-3, 26–27	213.76	1.38	0.25	1.13	2.10	0.13	433	0.04	0.61	0.87	54	77	8.69
14R-5, 44–45	216.94	1.25	0.24	1.01	2.00	0.12	429	0.05	0.69	0.91	68	90	8.41
15R-1, 28–29	220.38	2.22	0.48	1.74	4.00	0.14	436	0.04	1.02	2.48	59	143	12.43
15R-3, 32–33	223.42	0.80	0.29	0.51	2.40	0.09	428	0.04	0.35	0.63	69	124	5.60
16R-1, 51–52	230.11	1.58	0.24	1.34	2.00	0.13	431	0.04	0.64	0.83	48	62	10.31
16R-2, 19–20	231.29	4.01	2.76	1.25	23.00	0.11	434	0.03	0.48	2.68	38	214	11.36
16R-3, 25–26	232.85	0.87	0.08	0.79	0.70	0.10	426	0.14	0.92	0.73	116	92	7.90
16R-5, 25–26	235.85	1.04	0.09	0.95	0.70	0.12	424	0.05	0.62	0.75	65	79	7.90
17R-1, 30–31	239.50	1.03	0.09	0.94	0.70	0.11	426	0.07	0.89	0.63	95	67	8.50
17R-3, 43–44	242.63	0.81	0.12	0.69	1.00	0.11	418	0.04	0.44	0.80	64	116	6.30
17R-5, 33–34	245.53	0.99	0.08	0.91	0.70	0.11	424	0.06	0.70	0.72	77	79	8.30
20R-C, 7–8	268.17	1.30	0.19	1.11	1.60	0.12	484	0.00	0.88	0.00	79	0	9.25
20R-C, 14–15	268.24	6.78	5.80	0.98	48.30	0.08	432	0.03	0.40	3.32	41	339	12.25
22R-1, 19–20	287.69	1.71	0.41	1.30	3.40	0.13	441	0.13	1.32	1.25	102	96	10.0
22R-3, 69–70	291.19	1.24	0.15	1.09	1.20	0.12	—	—	—	—	—	0	9.08
22R-5, 79–80	294.29	1.20	0.10	1.10	0.80	0.12	423	0.09	1.08	0.64	98	58	9.16
23R-1, 23–24	297.33	1.07	0.07	1.00	0.60	0.11	424	0.06	0.88	0.76	88	76	9.09
23R-3, 31–32	300.41	1.53	0.19	1.34	1.60	0.13	434	0.05	0.97	1.04	72	78	10.31
23R-3, 85–86	300.95	6.82	6.17	0.65	51.40	0.08	426	0.04	0.43	1.76	66	271	8.10
24R-1, 42–43	307.22	0.96	0.11	0.85	0.90	0.11	422	0.05	0.83	0.71	98	84	7.70
24R-3, 98–99	310.78	1.46	0.25	1.21	2.10	0.14	430	0.06	0.83	1.07	69	88	8.64
24R-5, 99–100	313.79	1.41	0.16	1.25	1.30	0.14	427	0.07	0.88	0.60	70	48	8.93
25R-1, 17–18	316.57	1.26	0.10	1.16	0.80	0.13	431	0.07	1.07	0.61	92	53	8.92
25R-3, 25–26	319.65	1.75	0.16	1.59	1.30	0.14	438	0.04	0.86	0.89	54	56	11.36
26R-1, 31–32	326.31	1.45	0.23	1.22	1.90	0.12	433	0.07	1.03	0.72	84	59	10.17
26R-3, 123–124	330.23	1.54	0.21	1.33	1.70	0.14	432	0.07	1.36	0.97	102	73	9.50
26R-5, 122–123	333.22	1.51	0.21	1.30	1.70	0.13	433	0.08	1.24	0.96	95	74	10.0
27R-1, 25–26	335.95	1.60	0.23	1.37	1.90	0.14	430	0.09	1.42	1.03	104	75	9.78
27R-3, 26–27	338.96	1.60	0.22	1.38	1.80	0.13	436	0.06	0.98	0.99	71	72	10.62
27R-4, 33–34	340.53	—	7.02	—	58.50	—	440	0.02	0.56	3.08	—	—	—
27R-4, 37–38	340.57	2.05	0.34	1.71	2.80	0.16	429	0.06	0.97	1.23	57	72	10.69
28R-1, 54–55	345.84	1.37	0.24	1.13	2.00	0.12	433	0.04	0.92	0.85	81	75	9.41
28R-3, 33–34	348.63	1.66	0.34	1.32	2.80	0.14	433	0.05	0.99	1.06	75	80	9.43
29R-1, 86–87	355.76	2.05	0.45	1.60	3.70	0.13	437	0.04	0.81	1.87	51	117	12.31
29R-3, 80–81	358.70	4.66	3.29	1.37	27.40	0.12	442	0.03	0.82	2.34	60	171	11.42
29R-5, 78–79	361.68	1.17	0.43	0.74	3.60	0.11	432	0.04	0.50	1.78	68	241	6.70
31R-1, 89–90	374.99	1.34	0.24	1.10	2.00	0.13	431	0.06	0.97	0.98	88	89	8.46
31R-3, 78–79	377.88	1.88	0.56	1.32	4.70	0.13	437	0.05	0.84	1.81	64	137	10.16
31R-5, 72–73	380.82	1.15	0.23	0.92	1.90	0.13	433	0.04	0.68	1.46	74	159	7.10
32R-1, 49–50	384.09	1.15	0.22	0.93	1.80	0.13	480	0.00	0.61	0.02	66	2	7.10
32R-3, 55–56	387.15	1.06	0.13	0.93	1.10	0.13	430	0.05	0.61	0.72	66	77	7.10
32R-5, 51–52	390.11	1.14	0.23	0.91	1.90	0.12	425	0.07	0.76	1.02	84	112	7.60
33R-1, 24–25	393.34	1.12	0.25	0.87	2.10	0.12	422	0.06	0.66	1.34	76	154	7.20
33R-3, 24–25	396.34	1.22	0.11	1.11	0.90	0.13	429	0.05	0.98	0.83	88	75	8.54
33R-5, 24–25	399.34	1.28	0.31	0.97	2.60	0.12	424	0.07	0.81	1.75	84	180	8.10
34R-1, 69–70	403.49	1.26	0.15	1.11	1.20	0.13	426	0.08	1.04	0.90	94	81	8.54
34R-3, 66–67	406.46	1.15	0.16	0.99	1.30	0.13	425	0.08	0.92	0.94	93	95	7.60
34R-4, 87–88	408.17	—	0.23	—	1.90	—	—	—	—	—	—	—	—
34R-5, 87–88	409.67	1.18	0.21	0.97	1.70	0.13	428	0.05	0.82	1.08	85	111	7.40
35R-1, 89–90	413.29	0.90	0.12	0.78	1.00	0.10	425	0.06	0.86	0.60	110	77	7.80
35R-3, 91–92	416.31	1.06	0.10	0.96	0.80	0.13	425	0.05	0.90	0.68	94	71	7.40
35R-5, 90–91	419.30	1.02	0.09	0.92	0.70	0.11	426	0.08	0.96	0.54	104	59	8.30
35R-7, 52–53	421.92	1.00	0.13	0.87	1.10	0.13	426	0.05	0.84	0.77	97	89	6.70
36R-1, 20–21	422.30	1.25	0.17	1.08	1.40	0.14	427	0.05	0.82	0.79	76	73	7.71
36R-3, 20–21	425.30	1.00	0.12	0.88	1.00	0.12	425	0.04	0.74	0.77	84	88	7.30
36R-5, 20–21	428.30	1.12	0.19	0.93	1.60	0.13	427	0.04	0.85	0.87	91	94	7.10
37R-1, 28–29	431.98	1.20	0.17	1.03	1.40	0.13	426	0.06	0.98	0.70	95	68	7.92
37R-3, 108–109	435.78	1.23	0.13	1.10	1.10	0.13	427	0.07	1.12	0.66	102	60	8.46
37R-5, 94–95	438.64	1.42	0.26	1.16	2.20	0.13	431	0.06	0.99	0.76	85	66	8.92
37R-7, 42–43	441.12	1.67	0.34	1.33	2.80	0.12	433	0.06	0.98	1.04	74	78	11.08
38R-1, 34–35	441.64	1.88	0.50	1.38	4.20	0.13	428	0.06	0.95	1.58	69	114	10.62
38R-2, 118–119	443.98	—	5.64	—	47.00	—	428	0.02	0.66	2.64	—	—	—
38R-3, 64–65	444.94	—	0.37	—	3.10	—	430	0.03	0.74	1.38	—	—	—
39R-1, 24–25	451.24	3.87	2.57	1.30	21.40	0.12	442	0.05	0.83	2.91	64	224	10.83
39R-1, 89–90	451.89	1.32	0.34	0.98	2.80	0.12	427	0.07	0.65	1.40	66	143	8.10
40R-1, 33–33	460.93	1.17	0.16	1.01	1.30	0.12	492	0.00	0.57	0.00	56	0	8.41
40R-2, 93–94	463.03	0.99	0.10	0.89	0.80	0.12	432	0.05	0.73	0.75	82	84	7.40
40R-3, 42–43	464.02	1.13	0.19	0.94	1.60	0.13	430	0.06	0.78	1.46	83	155	7.20
40R-4, 65–66	465.75	1.16	0.13	1.03	1.10	0.12	427	0.01	0.54	1.07	52	104	8.58
40R-5, 10–11	466.70	1.12	0.11	1.01	0.90	0.12	429	0.01	0.63	0.85	62	84	8.41
41R-1, 68–69	470.98	1.30	0.11	1.19	0.90	0.14	419	0.06	1.13	0.65	95	55	8.50
41R-3, 78–79	474.08	1.31	0.21	1.10	1.70	0.13	425	0.09	1.32	0.89	120	81	8.46
41R-5, 64–65	476.94	1.24	0.21	1.03	1.70	0.12	424	0.03	0.99	0.73	96	71	8.58
41R-7, 21–22	479.51	1.46	0.24	1.22	2.00	0.13	424	0.04	0.94	0.65	77	53	9.38
42R-1, 58–59	480.58	1.34	0.24	1.10	2.00	0.13	425	0.04	1.06	0.89	96	81	8.46
42R-3, 82–83	483.82	1.04	0.20	0.84	1.70	0.11	425	0.03	0.56	0.86	67	102	7.60
42R-5, 72–73	486.72	1.35	0.30	1.05	2.50	0.14	425	0.05	0.92	1.15	88	110	7.50
43R-1, 61–62	490.11	1.21	0.18	1.03	1.50	0.14	425	0.07	0.86	0.72	83	70	7.36
43R-3, 43–44	492.93	1.21	0.17	1.04	1.40	0.11	427	0.07	0.88	0.59	85	57	9.45
43R-5, 86–87	496.36	1.38	0.27	1.11	2.20	0.12	430	0.07	0.93	1.02	84	92	9.25
44R-1, 27–28	499.27	—	0.38	—	3.20	—	425	0.06	0.73	1.68	—	—	—
44R-3, 52–53	502.52	1.00	0.08	0.92	0.70	0.10	427	0.04	0.66	0.66	72	72	9.20
44R-5, 64–65	505.64	1.34	0.22	1.12	1.80	0.12	425	0.05	1.43	1.30	128	116	9.33
45R-1, 81–82	509.41	1.43	0.26	1.17	2.20	0.13	424	0.05	1.24	0.83	106	71	9.00
45R-3, 70–71	512.30	1.52	0.39	1.13	3.20	0.09	432	0.03	0.97	0.81	86	72	12.56
45R-5, 69–70	515.29	2.45	1.16	1.29	9.70	0.13	431	0.03	1.29	1.47	100	114	9.92
46R-1, 35–36	518.65	1.74	0.36	1.38	3.00	0.12	432	0.08	0.92	1.56	67	113	11.5

Table 1 (continued).

Core, section, interval (cm)	Depth (mbsf)	TC	IC	TOC	$CaCO_3$	N_2	T_{max} (°C)	S1	S2	S3	HI	OI	C/N ratio
46R-3, 78–79	522.08	1.61	0.27	1.34	2.20	0.13	427	0.06	1.45	0.96	108	72	10.31
47R-1, 74–75	528.74	1.02	0.23	0.79	1.90	0.13	423	0.02	0.93	0.78	118	99	6.10
47R-3, 84–85	531.84	1.36	0.37	0.99	3.10	0.08	426	0.03	0.92	2.11	93	213	12.38
47R-5, 75–76	534.75	1.36	0.26	1.10	2.20	0.13	430	0.02	0.89	1.31	81	119	8.46
48R-1, 46–47	538.16	1.33	0.24	1.09	2.00	0.13	427	0.04	1.10	0.98	101	90	8.38
48R-3, 106–107	541.76	1.83	0.70	1.13	5.80	0.12	434	0.03	0.76	2.76	67	244	9.41
48R-5, 74–75	544.44	1.14	0.09	1.05	0.70	0.12	418	0.07	0.84	0.62	80	59	8.75
49R-1, 27–28	547.57	1.31	—	—	—	0.08	433	0.06	0.79	1.05	—	—	—
49R-3, 49–50	550.09	1.36	0.20	1.16	1.70	0.13	425	0.03	0.99	0.77	85	66	8.92
49R-5, 57–58	553.17	1.64	0.36	1.28	3.00	0.13	428	0.02	0.82	0.79	64	62	9.84
49R-7, 85–86	556.39	1.66	0.21	1.45	1.70	0.14	423	0.04	0.90	1.06	62	73	10.36
49R-7, 123–124	556.77	1.79	0.23	1.56	1.90	0.14	428	0.02	0.82	0.92	53	59	11.14
50R-1, 34–35	557.24	1.95	0.41	1.54	3.40	0.14	430	0.02	0.73	0.78	47	51	11.0
50R-3, 76–77	560.66	1.55	0.17	1.38	1.40	0.15	430	0.06	0.83	1.18	60	86	9.20
51R-1, 32–33	566.92	1.33	0.35	0.98	2.90	0.11	427	0.05	0.70	1.76	71	180	8.90
51R-1, 63–64	567.23	5.15	3.82	1.33	31.80	0.10	437	0.04	0.76	6.76	57	508	13.3
51R-3, 59–60	570.19	1.03	0.10	0.93	0.80	0.13	421	0.03	0.83	0.64	89	69	7.10
51R-4, 110–111	572.20	1.48	0.48	1.00	4.00	0.13	426	0.03	0.93	1.57	93	157	7.69
51R-4, 135–136	572.45	1.48	0.33	1.15	2.70	0.13	427	0.02	0.75	1.64	65	143	8.84
52R-1, 7–8	576.27	1.26	0.19	1.07	1.60	0.13	430	0.04	0.79	1.07	74	100	8.23
52R-2, 38–39	578.08	1.45	0.14	1.31	1.20	0.12	433	0.01	0.77	1.03	59	79	10.92
52R-3, 94–95	580.14	1.42	0.26	1.16	2.20	0.12	431	0.05	0.87	1.23	75	106	9.66
52R-4, 61–62	581.31	6.93	5.66	1.27	47.10	0.09	433	0.08	0.70	5.44	55	428	14.11
53R-1, 33–34	586.13	1.08	0.11	0.97	0.90	0.12	427	0.05	0.81	1.21	84	125	8.10
53R-3, 57–58	589.37	1.20	0.18	1.02	1.50	0.12	429	0.03	0.72	0.99	71	97	8.50
53R-5, 77–78	592.57	1.07	0.10	0.97	0.80	0.11	425	0.02	0.74	0.61	76	63	8.80
54R-1, 19–20	595.69	1.32	0.17	1.15	1.40	0.12	427	0.05	0.79	0.79	69	69	9.58
54R-2, 63–64	597.63	1.16	0.12	1.04	1.00	0.12	430	0.03	0.74	0.97	71	93	8.66
55R-1, 14–15	605.24	5.52	4.48	1.04	37.30	0.09	439	0.01	0.70	1.93	67	186	11.56
55R-1, 18–19	605.28	2.05	0.38	1.67	3.20	0.15	354	0.15	2.00	1.18	120	71	11.13
55R-1, 26–27	605.36	2.32	0.89	1.43	7.40	0.14	467	0.00	0.76	0.38	53	27	10.21
55R-3, 33–34	608.43	1.06	0.18	0.88	1.50	0.12	427	0.03	0.60	1.43	68	163	7.30
55R-5, 32–33	611.42	1.05	0.06	0.99	0.50	0.12	423	0.03	0.79	0.46	80	46	8.20
55R-6, 0–2	612.60	1.20	0.09	1.11	0.70	0.13	419	0.05	1.17	0.64	105	58	8.54
56R-1, 40–41	615.20	1.33	0.22	1.11	1.80	0.14	425	0.05	0.87	0.87	78	78	7.93
57R-1, 48–49	624.88	1.16	0.13	1.03	1.10	0.13	429	0.02	0.68	0.80	66	78	7.92
57R-3, 44–45	627.84	1.21	0.16	1.05	1.30	0.12	405	0.03	0.82	0.89	78	85	8.75
57R-5, 55–56	630.95	1.62	0.36	1.26	3.00	0.13	429	0.02	0.87	0.70	69	56	9.69
58R-1, 69–70	634.79	2.05	0.50	1.55	4.20	0.16	430	0.06	1.05	1.44	68	93	9.69
58R-2, 14–15	635.74	1.65	0.31	1.34	2.60	0.13	426	0.03	0.62	0.59	46	44	10.31
59R-1, 56–57	644.26	1.82	0.35	1.47	2.90	0.14	425	0.03	1.05	1.22	71	83	10.5
59R-3, 52–53	647.22	1.45	0.35	1.10	2.90	0.13	428	0.07	0.98	1.37	89	125	8.46
59R-5, 42–43	650.12	0.99	0.11	0.88	0.90	0.11	428	0.05	0.71	0.76	81	86	8.00
59R-6, 20–21	651.40	0.97	0.04	0.93	0.30	0.12	428	0.04	0.83	0.44	89	47	7.70
60R-1, 53–54	653.93	1.21	0.16	1.05	1.30	0.13	402	0.03	0.78	0.72	74	69	8.07
60R-3, 32–33	656.72	1.71	0.65	1.06	5.40	0.12	433	0.05	0.99	1.78	93	168	8.83
60R-5, 48–49	659.88	0.89	0.06	0.83	0.50	0.11	425	0.02	0.62	0.47	75	57	7.50
61R-1, 101–102	664.01	1.25	0.19	1.06	1.60	0.13	431	0.04	1.00	0.91	94	86	8.15
61R-3, 118–119	667.18	1.03	0.17	0.86	1.40	0.12	411	0.00	0.53	1.65	62	192	7.10
61R-5, 75–76	669.75	1.15	0.23	0.92	1.90	0.12	431	0.02	1.10	1.29	120	140	7.60
62R-1, 20–21	672.90	0.99	0.09	0.90	0.70	0.12	430	0.08	1.22	0.95	136	106	7.50
62R-3, 54–55	676.24	1.05	0.21	0.84	1.70	0.12	431	0.03	0.78	1.08	93	129	7.00
62R-5, 75–76	679.45	1.27	0.17	1.10	1.40	0.12	431	0.03	0.67	1.34	61	122	9.16
63R-1, 37–38	682.67	1.09	0.10	0.99	0.80	0.12	424	0.06	0.72	0.71	73	72	8.20
63R-3, 57–58	685.87	1.02	0.10	0.92	0.80	0.12	424	0.03	0.62	0.66	67	72	7.60
64R-1, 33–34	692.33	1.05	0.13	0.92	1.10	0.13	428	0.04	0.72	0.55	78	60	7.10
64R-3, 124–125	696.24	1.09	0.18	0.91	1.50	0.12	427	0.03	0.71	0.82	78	90	7.60
64R-5, 128–129	699.28	1.03	0.09	0.94	0.70	0.14	426	0.02	0.69	0.61	73	65	6.70
65R-1, 22–23	701.82	1.22	0.13	1.09	1.10	0.13	409	0.01	0.67	0.66	61	61	8.38
65R-3, 28–29	704.88	1.12	0.11	1.01	0.90	0.13	407	0.02	0.61	0.22	60	22	7.77
65R-5, 26–27	707.86	0.99	0.13	0.86	1.10	0.12	409	0.02	0.59	0.38	69	44	7.10
65R-7, 10–11	710.70	1.13	0.24	0.89	2.00	0.12	413	0.01	0.57	1.34	64	151	7.40
66R-1, 22–23	711.32	0.93	0.05	0.88	0.40	0.12	412	0.01	0.50	0.05	57	6	7.30
67R-1, 59–60	721.39	1.01	0.16	0.85	1.30	0.13	410	0.01	0.50	1.24	59	146	6.50
67R-3, 74–75	724.54	1.24	0.26	0.98	2.20	0.13	436	0.01	0.60	0.40	61	41	7.50
67R-5, 53–54	727.33	1.09	0.16	0.93	1.30	0.12	408	0.01	0.57	1.75	61	188	7.70
68R-1, 44–45	730.84	1.51	0.42	1.09	3.50	0.13	426	0.04	0.75	2.72	69	250	8.38
68R-3, 55–56	733.95	1.97	1.09	0.88	9.10	0.11	421	0.02	0.51	4.73	58	538	8.00
69R-1, 78–79	740.78	1.79	0.86	0.93	7.20	0.12	418	0.02	0.60	4.68	65	503	7.70
69R-3, 96–97	743.96	1.08	0.12	0.96	1.00	0.11	413	0.00	0.61	0.67	64	70	8.70
69R-5, 76–77	746.76	1.02	0.14	0.88	1.20	0.11	414	0.03	0.56	2.51	64	285	8.00
70R-1, 73–74	750.33	2.49	1.77	0.72	14.70	0.10	431	0.00	0.34	1.63	47	226	7.20
70R-3, 0–2	752.60	1.22	0.39	0.83	3.20	0.10	—	—	—	—	—	—	8.30
70R-3, 87–88	753.47	0.73	0.08	0.65	0.70	0.10	413	0.00	0.37	0.08	57	12	6.50
70R-5, 33–35	755.93	1.00	0.12	0.88	1.00	0.12	—	—	—	—	—	—	7.30
71R-1, 12–13	759.42	0.98	0.17	0.81	1.40	0.11	440	0.00	0.46	0.00	57	—	7.30
71R-3, 70–71	763.00	1.12	0.21	0.91	1.70	0.12	444	0.00	0.45	0.00	49	—	7.60
71R-5, 70–71	766.00	0.97	0.12	0.85	1.00	0.11	451	0.00	0.53	0.00	62	—	7.70
72R-1, 22–23	769.22	0.87	0.07	0.80	0.60	0.11	434	0.00	0.42	0.00	53	—	7.30
72R-2, 45–46	770.95	1.09	0.10	0.99	0.80	0.12	445	0.00	0.62	0.00	63	—	8.20
72R-3, 45–46	772.45	0.97	0.12	0.85	1.00	0.11	—	—	—	—	—	—	7.70
72R-4, 45–46	773.95	0.91	0.12	0.79	1.00	0.11	489	0.00	0.38	0.00	48	—	7.20
72R-5, 45–46	775.45	1.14	0.20	0.94	1.70	0.13	497	0.00	0.37	0.00	39	—	7.20
72R-6, 34–35	776.84	1.13	0.11	1.02	0.90	0.13	421	0.02	0.66	0.46	65	45	7.84
73R-2, 22–23	780.42	1.01	0.05	0.96	0.40	0.11	427	0.04	0.72	0.35	75	36	8.70
73R-3, 58–59	782.28	0.94	0.06	0.88	0.50	0.11	462	0.00	0.56	0.00	64	—	8.00
73R-5, 54–55	785.24	0.90	0.11	0.79	0.90	0.11	—	—	—	—	—	—	7.20
73R-6, 15–16	786.35	4.12	3.15	0.97	26.20	0.11	436	0.02	0.62	1.31	64	135	8.80

Table 1 (continued).

Core, section, interval (cm)	Depth (mbsf)	TC	IC	TOC	$CaCO_3$	N_2	T_{max} (°C)	S1	S2	S3	HI	OI	C/N ratio
74R-1, 37–38	788.67	1.23	0.12	1.11	1.00	0.13	434	0.02	1.18	0.55	106	50	8.54
74R-2, 28–29	790.08	1.12	0.19	0.93	1.60	0.11	448	0.00	0.50	0.46	54	49	8.40
74R-3, 52–53	791.82	1.09	0.25	0.84	2.10	0.11	430	0.02	0.55	0.73	65	87	7.60
74R-4, 115–116	793.95	0.98	0.10	0.88	0.80	0.12	448	0.00	0.48	0.05	55	6	7.30
74R-5, 129–130	795.59	1.13	0.13	1.00	1.10	0.12	451	0.00	0.61	0.29	61	29	8.33
75R-1, 79–80	798.79	1.05	0.16	0.89	1.30	0.12	433	0.03	0.76	0.86	85	97	7.40
75R-3, 79–80	801.79	3.07	2.26	0.81	18.80	0.12	442	0.02	0.56	1.68	69	207	6.70
75R-5, 0–2	804.00	0.90	0.09	0.81	0.70	0.77	—	—	—	—	—	—	1.00
75R-5, 118–119	805.18	0.91	0.15	0.76	1.20	0.13	435	0.01	0.66	0.43	87	57	5.80
76R-1, 47–48	808.07	1.24	0.22	1.02	1.80	0.13	434	0.03	0.71	1.01	70	99	7.84
76R-3, 74–75	811.34	1.03	0.16	0.87	1.30	0.15	444	0.00	0.50	0.38	57	44	5.80
76R-5, 77–78	814.37	1.29	0.29	1.00	2.40	0.11	—	—	—	—	—	—	9.09
76R-5, 135–140	814.95	1.36	0.31	1.05	2.60	0.14	430	0.03	0.83	1.28	79	122	7.50
77R-1, 105–106	818.35	—	0.06	—	0.50	—	436	0.03	2.21	0.53	—	—	—
77R-3, 88–89	821.18	—	0.17	—	1.40	—	444	0.00	0.81	0.88	—	—	—
78R-1, 113–114	828.13	—	0.15	—	1.20	—	—	—	—	—	—	—	—
78R-3, 42–43	830.42	1.33	0.23	1.10	1.90	0.13	444	0.00	0.91	0.17	83	15	8.46
80R-1, 22–23	846.42	1.44	0.31	1.13	2.60	0.67	455	0.00	0.85	0.42	75	37	1.68
80R-3, 38–39	849.58	1.23	0.25	0.98	2.10	0.16	467	0.00	0.67	0.46	68	47	6.10
80R-5, 43–44	852.63	1.54	0.19	1.35	1.60	0.14	484	0.00	1.04	0.00	77	0	9.64
80R-7, 21–22	855.41	1.23	0.22	1.01	1.80	0.14	459	0.00	0.83	0.05	82	5	7.21
81R-1, 39–40	856.29	1.15	0.19	0.96	1.60	0.14	428	0.03	0.98	0.61	102	64	6.80
81R-3, 51–52	859.41	1.15	0.15	1.00	1.20	0.10	459	0.00	0.71	0.22	71	22	10.0
82R-1, 19–20	865.69	1.51	0.59	0.92	4.90	0.13	453	0.01	0.69	0.27	75	29	7.10
82R-1, 89–90	866.39	3.94	2.67	1.27	22.20	0.12	454	0.00	1.11	1.65	87	130	10.58
84R-1, 66–67	885.46	1.24	0.10	1.14	0.80	0.12	449	0.00	0.95	0.00	83	—	9.50
84R-3, 64–65	888.44	—	0.06	—	0.50	—	429	0.01	0.87	0.35	—	—	—
84R-5, 13–14	890.93	1.25	0.15	1.10	1.20	0.13	485	0.00	0.77	0.00	70	—	8.46
85R-1, 90–91	895.30	1.15	0.24	0.91	2.00	0.11	429	0.05	0.73	0.54	80	59	8.30
86R-1, 81–82	904.91	1.17	0.10	1.07	0.80	0.12	458	0.00	0.64	0.00	60	—	8.91
86R-3, 33–34	907.43	1.27	0.06	1.21	0.50	0.12	465	0.00	0.82	0.00	68	—	10.08
87R-1, 63–64	914.43	1.13	0.16	0.97	1.30	0.12	469	0.00	0.72	0.00	74	—	8.10
88R-1, 90–91	924.30	1.15	0.05	1.10	0.40	0.13	474	0.00	0.84	0.00	76	—	8.46
88R-2, 90–91	925.80	1.04	0.14	0.90	1.20	0.12	463	0.00	0.56	0.00	62	—	7.50
89R-1, 67–68	933.77	1.37	0.29	1.08	2.40	0.11	469	0.00	1.00	0.00	93	—	9.82
90R-1, 26–27	943.06	2.86	1.89	0.97	15.70	0.10	467	0.00	0.62	0.84	64	87	9.70
90R-1, 112–113	943.92	—	0.18	—	1.50	—	428	0.01	0.69	0.71	—	—	—
90R-2, 70–71	945.00	0.60	0.26	0.34	2.20	0.06	468	0.00	0.13	0.00	38	—	5.60
90R-2, 145–150	945.75	—	0.20	—	1.70	—	428	0.01	0.71	0.76	—	—	—
91R-1, 26–27	952.66	1.09	0.28	0.81	2.30	0.12	492	0.00	0.56	0.00	69	—	6.70
91R-1, 49–50	952.89	2.30	1.67	0.63	13.90	0.11	490	0.00	0.85	0.00	135	—	5.70
91R-2, 79–80	954.69	—	0.30	—	2.50	—	430	0.04	0.74	0.40	—	—	—
91R-2, 110–111	955.00	1.24	0.34	0.90	2.80	0.12	430	0.08	0.81	0.49	90	54	7.50
91R-2, 145–150	955.35	—	0.20	—	1.70	—	428	0.00	0.56	0.50	—	—	—
92R-1, 89–90	962.99	1.20	0.16	1.04	1.30	0.12	488	0.00	0.66	0.02	63	2	8.66
92R-2, 0–5	963.60	—	0.88	—	7.30	—	429	0.01	0.41	0.57	—	—	—
93R-1, 27–28	971.97	1.48	0.30	1.18	2.50	0.12	431	0.01	0.97	0.45	82	38	9.83
93R-2, 103–104	974.23	5.58	4.48	1.10	37.30	0.09	487	0.00	0.53	0.00	48		12.22
94R-1, 88–89	982.18	1.24	0.16	1.08	1.30	0.13	432	0.03	0.79	0.75	73	69	8.31
94R-3, 16–17	984.46	5.46	4.47	0.99	37.20	0.10	429	0.03	0.82	2.43	83	245	9.90
95R-1, 65–66	991.35	1.50	0.35	1.15	2.90	0.13	433	0.03	1.26	0.65	110	57	8.84
95R-2, 0–5	992.20	—	0.23	—	1.90	—	433	0.05	1.11	0.47	—	—	—
95R-2, 11–12	992.31	1.70	0.29	1.41	2.40	0.15	432	0.04	1.52	0.60	108	43	9.40
96R-1, 39–40	1000.79	1.59	0.12	1.47	1.00	0.14	430	0.04	2.16	0.64	147	44	10.5
97R-1, 40–41	1010.40	1.62	0.11	1.51	0.90	0.13	431	0.05	1.72	0.42	114	28	11.62
98R-1, 46–47	1020.16	0.85	0.22	0.63	1.80	0.11	429	0.01	0.51	0.80	81	127	5.70
99R-1, 59–60	1029.79	1.97	0.54	1.43	4.50	0.14	430	0.04	1.87	1.10	131	77	10.21
100R-2, 41–42	1040.71	1.72	0.29	1.43	2.40	0.14	430	0.03	1.95	0.53	136	37	10.21
101R-1, 44–45	1048.84	1.68	0.16	1.52	1.30	0.13	432	0.04	1.78	0.74	117	49	11.69
101R-2, 74–75	1050.64	1.83	0.30	1.53	2.50	0.13	429	0.05	2.03	1.36	133	89	11.69
102R-1, 25–26	1052.95	1.81	0.34	1.47	2.80	0.13	433	0.05	2.29	0.92	156	63	11.31
102R-2, 123–124	1055.43	1.93	0.40	1.53	3.30	0.13	432	0.03	1.93	1.01	126	66	11.69
102R-3, 76–77	1056.46	1.95	0.11	1.84	0.90	0.15	433	0.05	2.83	0.51	154	28	12.27
102R-4, 52–53	1057.72	3.04	0.45	2.59	3.70	0.15	435	0.08	5.08	1.00	196	39	17.27
102R-4, 75–76	1057.95	1.81	0.21	1.60	1.70	0.13	434	0.03	2.08	0.76	130	48	12.31
103R-1, 32–33	1058.32	3.04	1.18	1.86	9.80	0.14	427	0.06	2.14	3.48	115	187	13.29
103R-2, 145–150	1060.95	1.83	0.28	1.55	2.30	0.16	432	0.00	2.10	0.76	135	49	9.69
103R-3, 57–58	1061.57	2.12	0.50	1.62	4.20	0.14	425	0.05	2.09	1.00	129	62	11.57

Note: Total carbon, inorganic carbon, total organic carbon, carbonate, and total nitrogen measured in weight percentage of bulk sediment. Rock-Eval parameters: S1 (mgHC/gSediment), S2 (mgHC/g rock), and S3 ($mgCO_2$/g sediment). HI = hydrogen index (mgHC/g TOC), and OI = oxygen index ($mgCO_2$/g TOC). — = not determined.

open-ocean oxic (low-productivity) environments (0.001–0.007 gC/cm^2/ k.y.; e.g., Stein, 1991). In the middle Miocene interval, accumulation rates of organic carbon increased from about 0.020 to 0.030 gC/cm^2/ k.y. (Myhre, Thiede, Firth, et al., 1995).

DISCUSSION AND CONCLUSION

Very different processes must have controlled organic carbon deposition on the Yermak Plateau and in the Fram Strait area (Figs. 2–9) in comparison to the Greenland Sea and Iceland Plateau areas (Myhre, Thiede, Firth, et al., 1995), as indicated by the distinct differences in flux and composition of the organic carbon fractions. The very high flux of marine and terrigenous organic carbon at the northern sites (909 and 911) requires (paleo-) oceanographic conditions different from the "normal open-ocean" ones. Because the Yermak Plateau and Fram Strait sites are in the area strongly influenced by the warm West Spitsbergen Current and the sea-ice cover, the interaction between both and the variations through time may be a dominant mechanism controlling the organic carbon deposition. Increased sur-

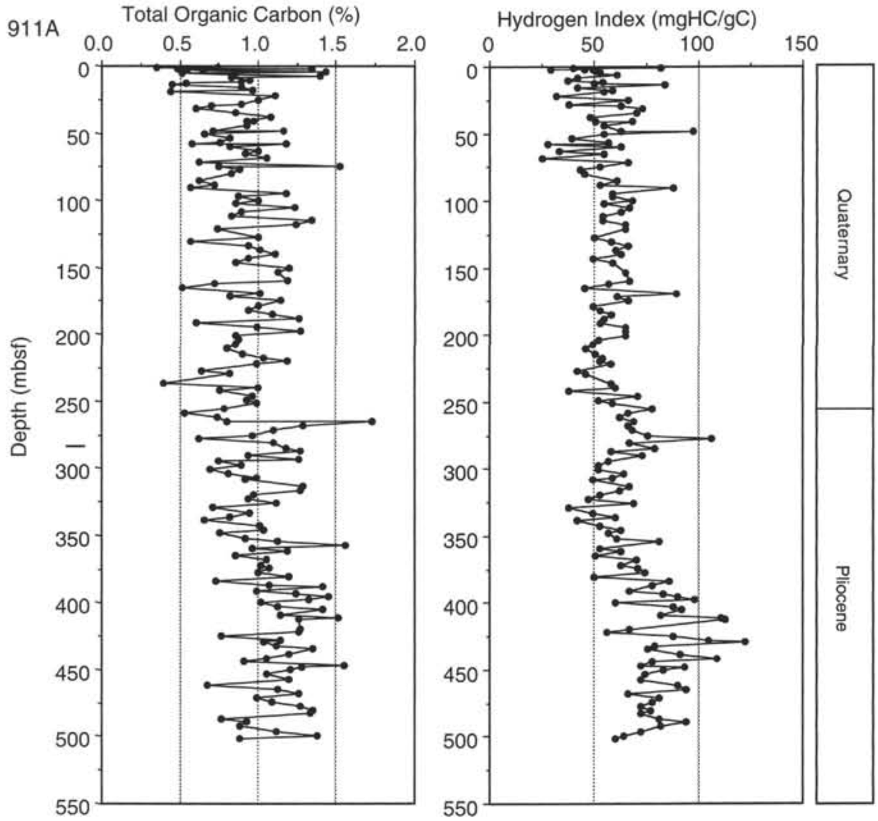

Figure 3. Total organic carbon and hydrogen index of Hole 911A sediments vs. depth values.

face-water productivity near the ice edge might have caused increased marine organic carbon supply. Owing to strong sea-ice melting, major amounts of terrigenous particles (i.e., organic as well as siliciclastic) are released from the ice and settled to the seafloor. The source area of these particles is most likely the Laptev Sea area, where large amounts of sediments were incorporated into the sea ice and transported onto and through the Arctic Ocean (Pfirman et al., 1990; Nürnberg et al., 1994). Seafloor and sea-ice sediments from the Laptev Sea also contain high amounts of (terrigenous) organic matter (Nürnberg et al., 1994). This may explain the high flux rate of terrigenous organic carbon, but also the high flux rates of bulk sediment (which is mainly of terrigenous origin).

The flux of organic carbon decreased significantly from the late Pliocene to the Quaternary. The average accumulation rate of (marine) organic carbon on the Yermak Plateau prior to the major expansion of Northern Hemisphere glaciation at 2.6 Ma was higher by a factor of 3–4 than the middle to late Quaternary rate. These drastic changes very probably reflect changes in sea-ice cover and West Spitsbergen Current intensity, resulting from the expansion of major Northern Hemisphere glaciation. A more closed sea-ice cover would certainly result in a decrease in surface-water productivity.

It appears to be possible to correlate long-term changes in organic carbon deposition during Miocene times between the record of Site 909 and similar records at older ODP sites. The middle Miocene organic carbon maximum (as well as the middle Pliocene decrease) in organic carbon contents recorded at Site 909 also occur at Site 645 (ODP Leg 105, Baffin Bay; Stein, 1991).

In the lowermost part of Hole 909C, the increase in total organic carbon contents (1.5 to 2 wt%; Fig. 2) appears to parallel the sharp increase in gas concentrations (Stein et al., 1995). Furthermore, Rock-Eval data indicate a major change in the composition and thermal maturity of the organic matter fraction. Increased HI values and low temperatures of maximum pyrolysis yield (T_{max} values) suggest the presence of immature mixed (marine + terrigenous) organic material. This is also supported by the position of the data points in the hydrogen index/oxygen index (van Krevelen) diagram (Fig. 5, encircled field).

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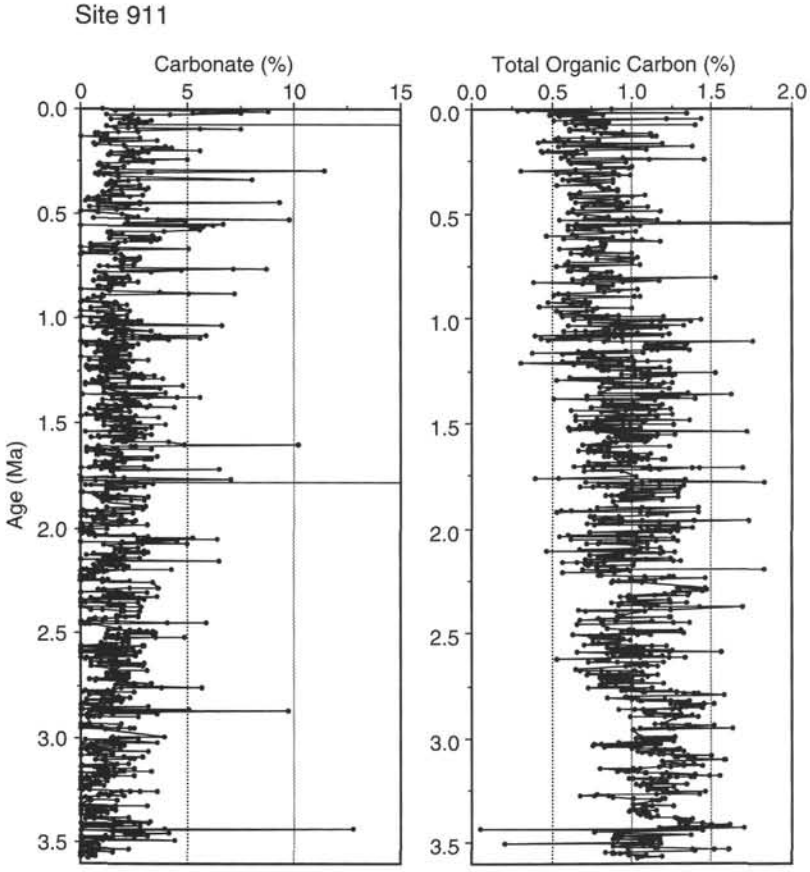

Figure 4. High-resolution record of carbonate and total organic carbon vs. age at Site 911. Age scale based on paleomagnetostratigraphy (Myhre, Thiede, Firth, et al., 1995). Records include shipboard data and data of Wolf-Welling et al. (this volume).

Table 2. Summary table of Hole 911A data.

Core, section, interval (cm)	Depth (mbsf)	TC	IC	$CaCO_3$	TOC	TN	T_{max} (°C)	S1	S2	S3	HI	OI	C/N ratio
151-911A-													
1H-1, 61–62	0.61	0.93	0.19	1.6	0.74	0.09	426	0.09	0.61	1.21	82	164	8.2
1H-1, 92–93	0.92	1.06	0.71	5.9	0.35	0.07	406	0.06	0.14	1.81	40	517	5.0
1H-2, 48–49	1.98	1.98	0.64	5.3	1.34	0.12	442	0.14	0.60	1.40	45	104	11.1
1H-2, 60–61	2.1	1.45	0.90	7.5	0.55	0.08	401	0.07	0.16	2.07	29	376	6.9
1H-2, 103–104	2.53	0.78	0.29	2.4	0.49	0.08	437	0.07	0.24	1.96	49	400	6.1
1H-3, 42–43	3.42	0.93	0.28	2.3	0.65	0.10	422	0.09	0.33	1.53	51	235	6.5
1H-4, 18–19	4.68	1.67	0.24	2.0	1.43	0.11	432	0.06	0.76	1.70	53	119	13.0
1H-4, 48–49	4.98	0.79	0.28	2.3	0.51	0.08	486	0.04	0.27	2.09	53	410	6.4
1H-5, 48–49	6.48	1.21	0.36	3.0	0.85	0.11	425	0.13	0.52	1.17	61	138	7.7
1H-5, 109–110	7.09	4.34	2.94	24.5	1.40	0.09	—	—	—	—	—	—	15.5
1H-6, 60–61	8.1	1.02	0.19	1.6	0.83	0.10	428	0.08	0.35	1.13	42	136	8.3
2H-1, 75–77	10.25	1.28	0.33	2.7	0.95	0.10	429	0.07	0.35	1.67	37	176	9.5
2H-2, 63–65	11.63	1.03	0.14	1.2	0.89	0.12	428	0.06	0.48	1.22	54	137	7.4
2H-3, 26–28	12.76	0.88	0.34	2.8	0.54	0.10	418	0.07	0.27	0.98	50	181	5.4
2H-4, 16–17	14.16	0.88	0.43	3.6	0.45	0.11	520	0.01	0.38	0.87	84	193	4.1
2H-5, 30–31	15.8	1.13	0.24	2.0	0.89	0.12	434	0.06	0.37	1.75	42	197	7.4
2H-6, 43–45	17.43	1.39	0.43	3.6	0.96	0.13	436	0.08	0.57	1.23	59	128	7.4
3H-1, 24–25	19.24	0.83	0.39	3.2	0.44	0.10	433	0.06	0.24	1.33	55	302	4.4
3H-3, 24–25	22.24	1.71	0.60	5.0	1.11	0.06	436	0.01	0.35	2.05	32	185	18.5
3H-5, 24–25	25.24	1.24	0.24	2.0	1.00	0.12	437	0.11	0.66	0.96	66	96	8.3
3H-7, 24–25	28.24	1.28	0.39	3.2	0.89	0.09	433	0.03	0.34	2.15	38	242	9.9
3H-1, 42–43	28.92	0.79	0.09	0.7	0.70	0.10	518	0.02	0.44	1.41	63	201	7.0
4H-3, 42–43	31.92	0.87	0.27	2.2	0.60	0.10	481	0.07	0.44	1.61	73	268	6.0
4H-5, 42–43	34.92	1.24	0.38	3.2	0.86	0.12	431	0.06	0.60	2.03	70	236	7.1
5H-1, 32–33	38.32	1.43	0.35	2.9	1.08	0.11	433	0.06	0.52	1.70	48	157	9.8
5H-3, 32–33	41.32	1.27	0.34	2.8	0.93	0.10	431	0.06	0.47	1.23	51	132	9.3
5H-3, 43–44	41.43	2.09	1.12	9.3	0.97	0.09	434	0.06	0.66	1.58	68	163	11.0
5H-5, 33–34	44.33	1.30	0.37	3.1	0.93	0.10	434	0.02	0.51	1.27	55	137	9.3
6H-1, 49–50	47.99	0.97	0.26	2.2	0.71	0.09	437	0.06	0.45	1.02	63	144	7.9
6H-1, 133–134	48.83	2.34	1.18	9.8	1.16	0.10	439	0.05	1.13	3.04	97	262	11.6
6H-3, 49–50	50.99	1.47	0.81	6.7	0.66	0.08	433	0.06	0.36	1.17	55	177	8.2
6H-5, 49–50	53.99	1.29	0.47	3.9	0.82	0.10	436	0.06	0.32	1.62	39	198	8.2
6H-7, 49–50	56.99	1.20	0.44	3.7	0.76	0.09	433	0.04	0.43	2.37	57	312	8.4
7H-1, 41–42	57.41	1.00	0.42	3.5	0.58	0.08	435	0.06	0.33	1.10	57	190	7.2
7H-1, 136–137	58.36	1.58	0.40	3.3	1.18	0.12	427	0.02	0.33	3.57	28	303	9.8
7H-3, 40–41	60.4	1.01	0.19	1.6	0.82	0.11	439	0.09	0.52	1.04	63	127	7.4
7H-5, 40–41	63.4	1.01	0.01	0.1	1.00	0.11	439	0.06	0.33	1.47	33	147	9.1
8H-1, 27–28	65.47	1.26	0.34	2.8	0.92	0.12	436	0.05	0.51	1.81	55	197	7.6
8H-3, 27–28	68.47	1.35	0.30	2.5	1.05	0.08	434	0.04	0.26	1.06	25	101	13.1
8H-5, 27–28	71.47	1.18	0.56	4.7	0.62	0.10	444	0.06	0.41	1.01	66	163	6.2
8H-7, 25–26	74.45	1.78	0.26	2.2	1.52	0.11	—	—	—	—	—	—	13.8
9H-1, 24–25	74.94	0.94	0.19	1.6	0.75	0.09	437	0.05	0.40	0.90	53	120	8.3
9H-3, 23–24	77.03	1.12	0.24	2.0	0.88	0.11	438	0.06	0.38	0.87	43	99	8.0
9H-5, 21–22	80.01	1.28	0.45	3.7	0.83	0.10	438	0.07	0.37	1.32	45	159	8.3
10H-1, 76–77	84.96	0.83	0.21	1.7	0.62	0.08	422	0.07	0.38	1.34	61	216	7.7
10H-3, 76–77	87.96	1.00	0.28	2.3	0.72	0.10	429	0.07	0.38	2.96	53	411	7.2
10H-5, 75–76	90.95	0.76	0.19	1.6	0.57	0.09	427	0.07	0.50	0.92	88	161	6.3
11H-1, 56–57	94.26	1.51	0.33	2.7	1.18	0.12	436	0.10	0.70	1.23	59	104	9.8
11H-3, 56–57	97.26	1.16	0.29	2.4	0.87	0.11	433	0.06	0.51	2.02	59	232	7.9
11H-5, 58–59	100.3	1.24	0.24	2.0	1.00	0.11	433	0.09	0.68	2.24	68	224	9.1
12H-1, 28–29	102.2	1.13	0.27	2.2	0.86	0.10	432	0.06	0.47	1.85	55	215	8.6
12H-3, 58–59	105.5	1.48	0.25	2.1	1.23	0.14	433	0.08	0.83	2.10	67	171	8.8
12H-5, 90–91	108.8	1.13	0.24	2.0	0.89	0.11	424	0.08	0.56	1.40	63	157	8.1
13H-1, 26–27	111.7	1.07	0.24	2.0	0.83	0.11	432	0.07	0.45	1.68	54	202	7.5
13H-3, 26–27	114.7	1.66	0.32	2.7	1.34	0.10	432	0.02	0.73	3.24	54	242	13.4
13H-5, 26–27	117.7	1.51	0.27	2.2	1.24	0.13	432	0.09	0.80	1.32	65	106	9.5
14H-1, 37–38	121.3	0.91	0.17	1.4	0.74	0.11	435	0.07	0.48	2.07	65	280	6.7
14H-5, 24–25	127.1	1.17	0.17	1.4	1.00	0.09	430	0.08	0.50	0.81	50	81	11.1
15H-1, 19–20	130.6	0.75	0.18	1.5	0.57	0.10	428	0.04	0.33	0.81	58	142	5.7
15H-3, 34–35	133.7	1.19	0.25	2.1	0.94	0.13	429	0.09	0.62	2.11	66	224	7.2
15H-5, 25–26	136.7	1.27	0.26	2.2	1.01	0.12	429	0.07	0.61	2.26	60	224	8.4
16X-1, 26–27	140.2	1.24	0.13	1.1	1.11	0.12	429	0.07	0.70	1.57	63	141	9.3
16X-2, 110–111	142.5	1.25	0.31	2.6	0.94	0.11	426	0.05	0.46	2.47	49	263	8.5
16X-5, 26–27	146.2	1.14	0.28	2.3	0.86	0.12	420	0.11	0.51	2.21	59	257	7.1
17X-1, 111–112	150.5	1.46	0.26	2.2	1.20	0.12	—	—	—	—	—	—	10.0
17X-3, 111–112	153.5	1.71	0.58	4.8	1.13	0.12	426	0.06	0.73	4.17	65	369	9.4
18X-1, 110–111	160.1	1.67	0.48	4.0	1.19	0.12	427	0.11	0.80	2.11	67	177	9.9
18X-3, 23–24	162.2	0.90	0.18	1.5	0.72	0.06	429	0.03	0.41	1.66	57	231	12.0
18X-5, 26–27	164.9	0.75	0.24	2.0	0.51	0.11	469	0.03	0.23	1.45	45	284	4.6
19X-1, 59–60	169.2	1.26	0.25	2.1	1.01	0.12	427	0.10	0.90	0.97	89	96	8.4
19X-3, 28–29	171.9	0.92	0.10	0.8	0.82	0.12	428	0.06	0.50	0.68	61	83	6.8
19X-5, 27–28	174.9	1.29	0.15	1.2	1.14	0.14	427	0.12	0.75	0.91	66	80	8.1
20X-1, 33–34	178.6	1.08	0.08	0.7	1.00	0.14	427	0.10	0.49	1.08	49	108	7.1
20X-3, 33–34	181.6	1.09	0.15	1.2	0.94	0.11	424	0.10	0.50	0.89	53	95	8.5
20X-5, 33–34	184.6	1.35	0.26	2.2	1.09	0.09	429	0.08	0.63	1.43	58	131	12.1
21X-1, 32–33	188.2	1.53	0.27	2.2	1.26	0.14	427	0.06	0.69	2.13	55	169	9.0
21X-3, 39–40	191.3	0.78	0.18	1.5	0.60	0.11	428	0.04	0.32	0.60	53	100	5.4
21X-5, 23–24	194.1	1.29	0.30	2.5	0.99	0.10	429	0.08	0.64	0.92	65	93	9.9
22X-1, 19–20	197.7	1.58	0.31	2.6	1.27	0.14	430	0.07	0.83	2.26	65	178	9.1
22X-3, 25–26	200.7	1.22	0.36	3.0	0.86	0.12	430	0.07	0.56	1.33	65	155	7.1
22X-5, 114–115	204.4	1.12	0.25	2.1	0.87	0.11	430	0.06	0.45	1.07	52	123	7.9
23X-1, 15–16	207.4	2.09	1.23	10.2	0.86	0.09	429	0.06	0.42	6.08	49	707	9.5
23X-3, 48–49	210.7	1.01	0.21	1.7	0.80	0.12	435	0.05	0.37	1.44	46	180	6.6
23X-5, 88–89	214.1	1.03	0.13	1.1	0.90	0.13	427	0.08	0.46	0.85	51	94	6.9
24X-1, 98–99	217.8	1.47	0.43	3.6	1.04	0.12	435	0.09	0.56	1.83	54	176	8.7
24X-3, 77–78	219.5	1.58	0.39	3.2	1.19	0.13	433	0.07	0.63	2.15	53	181	9.2
24X-5, 89–90	222	1.23	0.24	2.0	0.99	0.11	434	0.08	0.57	1.44	58	145	9.0
25X-1, 24–25	226.6	1.00	0.36	3.0	0.64	0.09	427	0.03	0.27	2.05	42	320	7.1

Table 2 (continued).

Core, section, interval (cm)	Depth (mbsf)	TC	IC	$CaCO_3$	TOC	TN	T_{max} (°C)	S1	S2	S3	HI	OI	C/N ratio
25X-3, 24–25	229.6	1.60	0.78	6.5	0.82	0.08	427	0.02	0.38	5.56	46	678	10.0
26X-1, 83–84	236.9	0.64	0.24	2.0	0.40	0.09	428	0.05	0.23	0.56	58	140	4.4
26X-3, 16–17	239.3	3.11	2.11	17.6	1.00	0.08	431	0.02	0.60	5.32	60	532	12.5
26X-5, 19–20	242.3	1.07	0.31	2.6	0.76	0.06	426	0.08	0.29	2.65	38	349	12.0
27X-1, 29–30	246.1	1.11	0.15	1.2	0.96	0.14	432	0.08	0.68	0.81	71	84	6.8
27X-3, 18–19	249	1.31	0.38	3.2	0.93	0.10	433	0.06	0.48	2.19	52	235	9.3
27X-5, 64–65	251.1	1.35	0.36	3.0	0.99	0.14	435	0.07	0.58	2.38	59	240	7.1
28X-1, 34–35	255.8	1.07	0.29	2.4	0.78	0.00	427	0.07	0.61	0.93	78	119	
28X-3, 34–35	258.8	0.65	0.12	1.0	0.53	0.09	433	0.03	0.35	0.72	66	136	5.9
28X-5, 35–36	261.9	0.97	0.23	1.9	0.74	0.11	419	0.26	0.46	1.28	62	173	6.7
28X-7, 13–14	264.6	1.04	0.24	2.0	0.80	0.09	431	0.07	0.55	1.19	69	149	8.9
29X-1, 20–21	265.3	1.98	0.25	2.1	1.73	0.11	—	—	—	—	—	—	15.7
29X-3, 19–20	267.8	1.66	0.37	3.1	1.29	0.12	434	0.11	0.85	1.45	66	112	10.7
29X-5, 22–23	270.9	1.25	0.15	1.2	1.10	0.12	431	0.10	0.75	0.94	68	85	9.2
30X-1, 32–33	275	1.26	0.30	2.5	0.96	0.09	431	0.07	0.73	1.05	76	109	10.0
30X-3, 26–27	278	1.39	0.77	6.4	0.62	0.06	433	0.04	0.66	1.75	106	282	10.0
30X-5, 28–29	280.9	1.70	0.60	5.0	1.10	0.07	433	0.05	0.74	2.64	67	240	15.7
31X-1, 24–25	284.5	1.50	0.32	2.7	1.18	0.10	429	0.12	0.93	1.09	79	92	11.8
31X-3, 23–24	287.5	1.65	0.38	3.2	1.27	0.09	429	0.03	0.74	1.93	58	152	14.1
31X-5, 24–25	290.5	1.13	0.19	1.6	0.94	0.07	434	0.09	0.69	1.00	73	106	13.0
31X-7, 23–24	293.5	1.42	0.16	1.3	1.26	0.16	—	—	—	—	—	—	7.9
32X-1, 28–29	294.3	0.97	0.22	1.8	0.75	0.13	432	0.05	0.43	0.89	57	119	5.7
32X-3, 28–29	297.3	1.15	0.26	2.2	0.89	0.13	431	0.05	0.46	1.81	52	203	6.8
32X-5, 28–29	300.3	0.93	0.24	2.0	0.69	0.14	430	0.04	0.36	1.28	52	186	4.9
33X-1, 17–18	303.8	0.88	0.07	0.6	0.81	0.12	432	0.05	0.52	0.82	64	101	6.7
33X-3, 14–15	306.7	1.15	0.16	1.3	0.99	0.12	430	0.06	0.58	1.25	59	126	8.2
33X-4, 13–14	308.2	1.20	0.28	2.3	0.92	0.11	429	0.03	0.45	1.72	49	187	8.3
34X-1, 16–17	313.5	1.57	0.28	2.3	1.29	0.13	428	0.06	0.86	1.56	67	121	9.9
34X-3, 20–21	316.5	1.64	0.37	3.1	1.27	0.11	429	0.02	0.79	2.81	62	221	11.5
34X-5, 18–19	319.3	1.40	0.43	3.6	0.97	0.12	430	0.06	0.51	2.74	53	282	8.1
35X-1, 44–45	323.3	1.26	0.32	2.7	0.94	0.09	427	0.02	0.44	2.44	47	260	10.0
35X-3, 18–19	326.1	1.35	0.23	1.9	1.12	0.12	429	0.07	0.77	1.27	69	113	9.3
35X-5, 22–23	329.1	1.05	0.34	2.8	0.71	0.08	428	0.01	0.27	2.31	38	325	8.9
36X-1, 26–27	332.9	1.27	0.32	2.7	0.95	0.10	428	0.01	0.47	2.85	49	300	9.5
36X-3, 72–73	336.3	0.87	0.05	0.4	0.82	0.12	425	0.04	0.49	0.85	60	104	6.8
36X-5, 47–48	339	0.69	0.03	0.2	0.66	0.11	431	0.02	0.28	0.44	42	67	6.0
37X-1, 26–27	342.5	1.17	0.16	1.3	1.01	0.09	431	0.02	0.54	1.59	53	157	11.2
37X-3, 99–100	346	1.45	0.41	3.4	1.04	0.12	432	0.07	0.65	2.14	63	206	8.7
37X-5, 83–84	348.6	1.18	0.42	3.5	0.76	0.11	425	0.03	0.43	2.71	57	357	6.9
38X-1, 72–73	352.6	1.18	0.26	2.2	0.92	0.12	418	0.07	0.56	1.47	61	160	7.6
38X-3, 18–19	354.5	1.48	0.35	2.9	1.13	0.13	433	0.09	0.92	1.26	81	112	8.7
38X-5, 63–64	357.9	1.90	0.34	2.8	1.56	0.11	—	—	—	—	—	—	14.2
38X-6, 78–79	359.2	1.14	0.18	1.5	0.96	0.12	428	0.03	0.51	0.88	53	92	8.0
39X-1, 49–50	361.9	1.50	0.31	2.6	1.19	0.13	431	0.07	0.75	1.94	63	163	9.2
39X-3, 15–16	364.4	1.12	0.26	2.2	0.86	0.08	424	0.03	0.44	3.28	51	381	11.0
39X-5, 108–109	368.2	1.40	0.35	2.9	1.05	0.13	426	0.07	0.73	2.13	70	203	8.1
40X-1, 121–122	372.1	1.19	0.17	1.4	1.02	0.12	423	0.07	0.64	0.71	63	70	8.5
40X-3, 83–84	374.7	1.33	0.26	2.2	1.07	0.13	431	0.05	0.76	1.38	71	129	8.2
40X-5, 62–63	377.3	1.27	0.27	2.2	1.00	0.12	430	0.06	0.74	1.32	74	132	8.3
41X-1, 24–25	380.6	1.60	0.40	3.3	1.20	0.12	439	0.05	0.60	3.54	50	295	10.0
41X-3, 18–19	383.6	1.41	0.68	5.7	0.73	0.12	430	0.05	0.63	7.96	86	1090	6.1
41X-5, 24–25	386.6	1.24	0.17	1.4	1.07	0.14	428	0.08	0.83	1.42	78	133	7.6
41X-6, 0–2	387.9	1.59	0.18	1.5	1.41	0.15	—	—	—	—	—	—	9.4
42X-1, 78–79	390.8	1.27	0.28	2.3	0.99	0.11	435	0.05	0.66	1.72	67	174	9.0
42X-3, 79–80	392.9	1.47	0.23	1.9	1.24	0.13	425	0.10	1.03	2.72	83	219	9.5
42X-5, 85–86	395.3	1.62	0.17	1.4	1.45	0.17	428	0.11	1.30	2.28	90	157	8.5
42X-7, 76–77	397.8	1.70	0.38	3.2	1.32	0.17	431	0.11	1.29	2.28	98	173	7.8
43X-1, 21–22	399.8	1.63	0.61	5.1	1.02	0.15	432	0.05	0.61	6.64	60	651	6.8
43X-3, 17–18	402.5	1.31	0.18	1.5	1.13	0.14	430	0.09	1.00	1.50	88	133	8.1
43X-5, 46–47	405.1	1.52	0.11	0.9	1.41	0.13	430	0.10	1.30	1.53	92	109	10.8
44X-1, 13–14	409.4	1.37	0.23	1.9	1.14	0.15	429	0.07	0.94	1.39	82	122	7.6
44X-2, 15–16	411	1.53	0.02	0.2	1.51	0.14	437	0.16	1.68	1.48	111	98	10.8
44X-3, 22–23	412.5	1.56	0.30	2.5	1.26	0.13	434	0.15	1.42	1.69	113	134	9.7
45X-1, 20–21	419.1	1.45	0.18	1.5	1.27	0.13	436	0.07	0.85	1.86	67	146	9.8
45X-3, 17–18	421.9	1.46	0.20	1.7	1.26	0.15	435	0.04	0.71	1.59	56	126	8.4
45X-5, 18–19	424.6	0.99	0.22	1.8	0.77	0.13	435	0.08	0.68	1.03	88	134	5.9
45X-7, 25–26	427.5	1.36	0.22	1.8	1.14	0.14	433	0.09	1.20	1.08	105	95	8.1
46X-1, 21–22	428.8	1.42	0.38	3.2	1.04	0.12	434	0.14	1.27	2.27	122	218	8.7
46X-3, 26–27	431.8	1.29	0.17	1.4	1.12	0.12	427	0.10	0.89	0.98	79	88	9.3
46X-5, 24–25	434.7	1.65	0.30	2.5	1.35	0.14	431	0.07	1.03	2.45	76	181	9.6
47X-1, 20–21	438.4	1.47	0.27	2.2	1.20	0.14	430	0.08	1.09	1.82	91	152	8.6
47X-3, 21–22	441.4	1.35	0.30	2.5	1.05	0.11	433	0.10	1.14	3.26	109	310	9.5
47X-5, 21–22	444.1	1.15	0.24	2.0	0.91	0.13	432	0.06	0.71	2.07	78	227	7.0
47X-7, 37–38	446.7	1.85	0.30	2.5	1.55	0.14	433	0.07	1.11	2.41	72	155	11.1
48X-1, 17–18	448	1.44	0.16	1.3	1.28	0.14	430	0.08	1.19	1.05	93	82	9.1
48X-3, 20–21	450.6	1.36	0.15	1.2	1.21	0.12	429	0.09	1.00	0.79	83	65	10.1
48X-5, 26–27	453.5	1.18	0.13	1.1	1.05	0.12	431	0.06	0.78	0.90	74	86	8.8
49X-1, 27–28	457.8	1.54	0.34	2.8	1.20	0.13	435	0.05	0.86	2.43	72	203	9.2
49X-3, 77–78	461.3	0.92	0.24	2.0	0.68	0.10	434	0.05	0.61	2.58	90	379	6.8
49X-5, 81–82	464.3	1.34	0.21	1.7	1.13	0.15	428	0.10	1.06	1.28	94	113	7.5
50X-1, 73–74	467.9	1.45	0.19	1.6	1.26	0.12	428	0.06	0.83	0.70	66	56	10.5
50X-3, 76–77	471	1.18	0.19	1.6	0.99	0.13	428	0.06	0.80	1.03	81	104	7.6
50X-5, 73–74	473.9	1.24	0.15	1.2	1.09	0.13	427	0.08	0.85	0.84	78	77	8.4
51X-1, 21–22	477	1.53	0.26	2.2	1.27	0.13	428	0.06	0.91	1.49	72	117	9.8
51X-3, 49–50	480.3	1.73	0.38	3.2	1.35	0.15	432	0.06	1.04	1.83	77	136	9.0
51X-5, 42–42	483.2	1.67	0.34	2.8	1.33	0.14	432	0.05	0.96	2.05	72	154	9.5
52X-1, 26–26	486.8	1.12	0.35	2.9	0.77	0.13	430	0.06	0.62	1.55	81	201	5.9
52X-3, 69–70	489.4	1.30	0.37	3.1	0.93	0.12	436	0.09	0.87	2.18	94	234	7.7
52X-5, 58–59	492.3	1.18	0.30	2.5	0.88	0.12	429	0.06	0.72	1.45	82	165	7.3

Table 2 (continued).

Core, section, interval (cm)	Depth (mbsf)	TC	IC	$CaCO_3$	TOC	TN	T_{max} (°C)	S1	S2	S3	HI	OI	C/N ratio
53X-1, 27–28	496.5	1.22	0.10	0.8	1.12	0.14	426	0.07	0.81	0.71	72	63	8.0
53X-3, 109–110	499.5	1.48	0.10	0.8	1.38	0.17	433	0.05	0.88	0.86	64	62	8.1
53X-5, 27–28	501.5	0.96	0.08	0.7	0.88	0.11	431	0.04	0.53	0.70	60	80	8.0

Note: Abbreviations and units of measure as in Table 1.

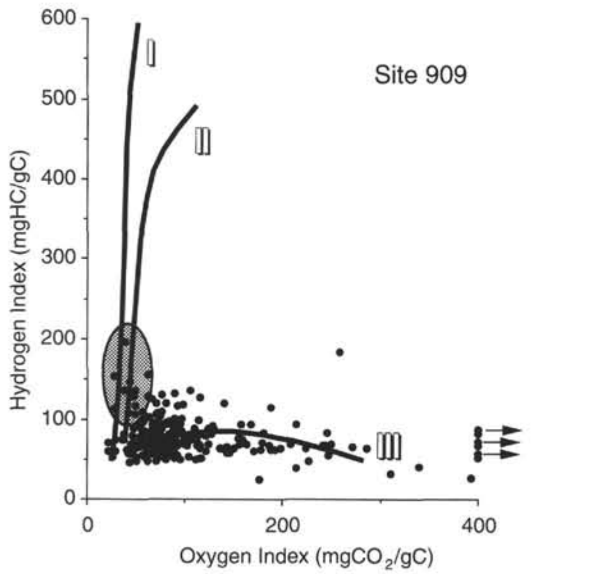

Figure 5. Hydrogen index vs. oxygen index (van Krevelen) diagram of Site 909 sediments. Roman numbers mark different kerogen types: I and II, marine; III, terrigenous organic matter (classification after Espitalié et al., 1977; Peters, 1986).

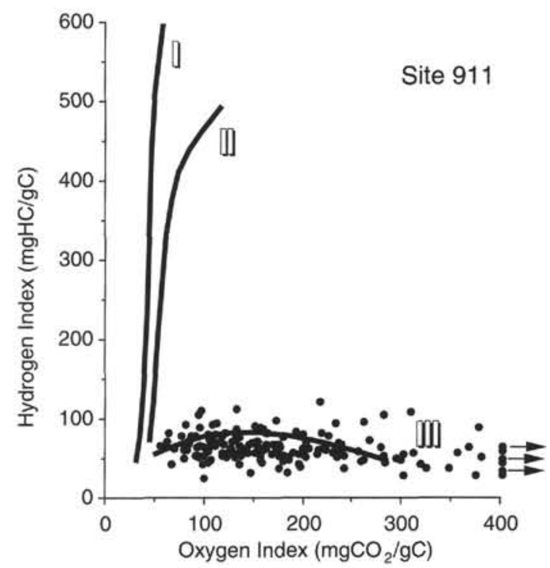

Figure 6. Hydrogen index vs. oxygen index (van Krevelen) diagram of Site 911 sediments. Roman numbers mark different kerogen types: I and II, marine; III, terrigenous organic matter (classification after Espitalié et al., 1977; Peters, 1986).

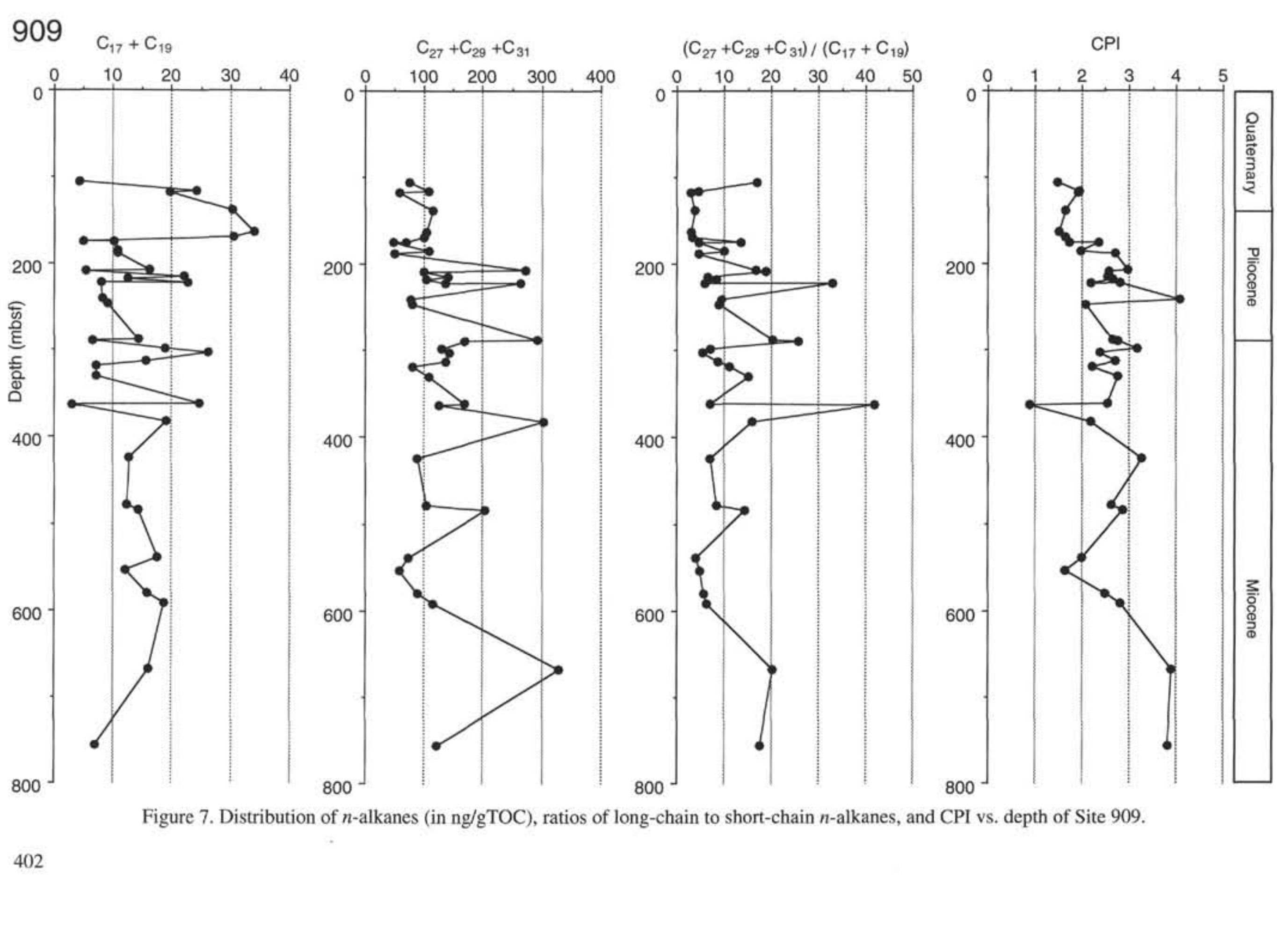

Figure 7. Distribution of *n*-alkanes (in ng/gTOC), ratios of long-chain to short-chain *n*-alkanes, and CPI vs. depth of Site 909.

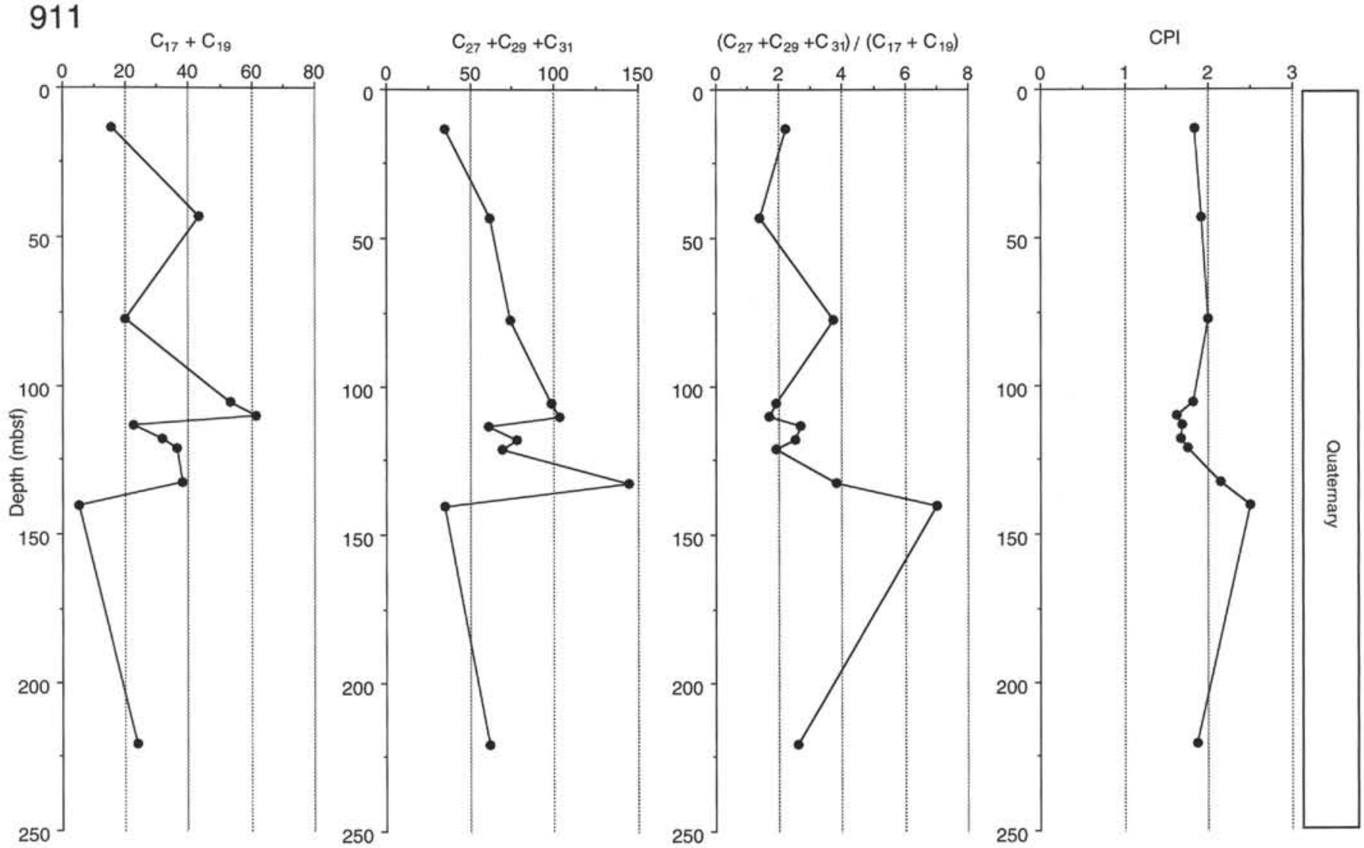

Figure 8. Distribution of *n*-alkanes (in ng/gTOC), ratios of long-chain to short-chain *n*-alkanes, and CPI vs. depth of Quaternary sediments at Site 911.

Table 3. Distribution of *n*-alkanes (in ng/gTOC) and CPI vs. depth in sediments from Sites 909 and 911.

Core, section interval (cm)	Depth (mbsf)	$C_{17} + C_{19}$	$C_{27} + C_{29} + C_{31}$	$C_{27} + C_{29} + C_{31}$/ $C_{17} + C_{19}$	CPI
151-909C-					
3R-1, 49–51	105	4.39	74.80	17.1	1.48
4R-2, 48–50	116	24.30	108.31	4.5	1.94
4R-3, 48–50	117	19.75	58.24	2.9	1.91
6R-4, 49–51	138	30.17	113.69	3.8	1.65
9R-1, 48–50	163	33.87	103.73	3.1	1.50
9R-5, 48–50	169	30.55	99.89	3.3	1.66
10R-2, 49–51	174	5.04	68.76	13.6	1.74
10R-3, 49–51	175	10.17	46.94	4.6	2.34
11R-3, 49–51	185	10.82	107.22	9.9	1.97
11R-5, 49–51	188	10.83	49.78	4.6	2.70
13R-5, 49–51	207	16.26	273.15	16.8	2.96
13R-6, 49–51	209	5.33	100.29	18.8	2.58
14R-3, 49–51	214	22.12	141.33	6.4	2.55
14R-6, 49–51	217	12.49	104.57	8.4	2.65
15R-1, 49–51	221	22.80	135.25	5.9	2.20
15R-2, 49–51	222	7.96	263.80	33.1	2.82
17R-2, 48–50	241	8.12	76.81	9.5	4.07
17R-6, 48–50	247	9.07	81.03	8.9	2.09
22R-1, 49–51	288	14.28	291.72	20.4	2.66
22R-2, 49–51	289	6.56	168.70	25.7	2.76
23R-1, 49–51	298	18.79	129.00	6.9	3.16
23R-4, 49–51	302	26.07	142.95	5.5	2.38
24R- 5, 49–51	313	15.66	136.36	8.7	2.71
25R-2, 49–51	318	7.22	79.25	11.0	2.21
26R-3, 52–54	330	7.15	107.15	15.0	2.76
29R-5, 51–53	361	24.74	169.51	6.9	2.53
29R-CC, 43–45	363	2.99	125.12	41.8	0.88
31R-6, 49–51	382	19.07	303.53	15.9	2.20
36R-2, 49–5	424	12.75	88.35	6.9	3.26
41R-6, 50–52	478	12.26	102.97	8.4	2.61
42R- 4, 48–50	485	14.37	203.46	14.2	2.87
48R-1, 48–50	538	17.57	72.67	4.1	2.00
49R-5, 48–50	553	12.15	58.43	4.8	1.65
52R-3 50–52	580	15.72	88.77	5.6	2.49
53R-5, 49–51	592	18.56	115.14	6.2	2.81
61R-4, 49–51	668	16.07	328.00	20.4	3.89
70R-5, 50–52	756	6.84	121.04	17.7	3.82
151-911A-					
2H-2, 58–60	13.08	15.53	34.67	2.2	1.84
5H-4, 57–59	43.07	43.21	61.60	1.4	1.92
9H-3, 59–61	77.39	19.84	73.41	3.7	2.00
12H-3, 58–60	105.6	53.01	98.32	1.9	1.82
12H-6, 58–60	110	61.49	102.66	1.7	1.62
13H-2, 58–60	113.5	22.68	60.71	2.7	1.68
13H-5, 58–60	118	31.68	78.24	2.5	1.67
13H-7, 58–60	121	36.44	68.96	1.9	1.75
15H-2, 58–60	132.5	37.97	144.18	3.8	2.14
16X-1, 59–61	140.5	5.01	35.00	7.0	2.49
24X-4, 59–61	220.8	23.72	61.74	2.6	1.86

Notes: CPI = carbon preference index. C_{number} = the *n*-alkane chain length.

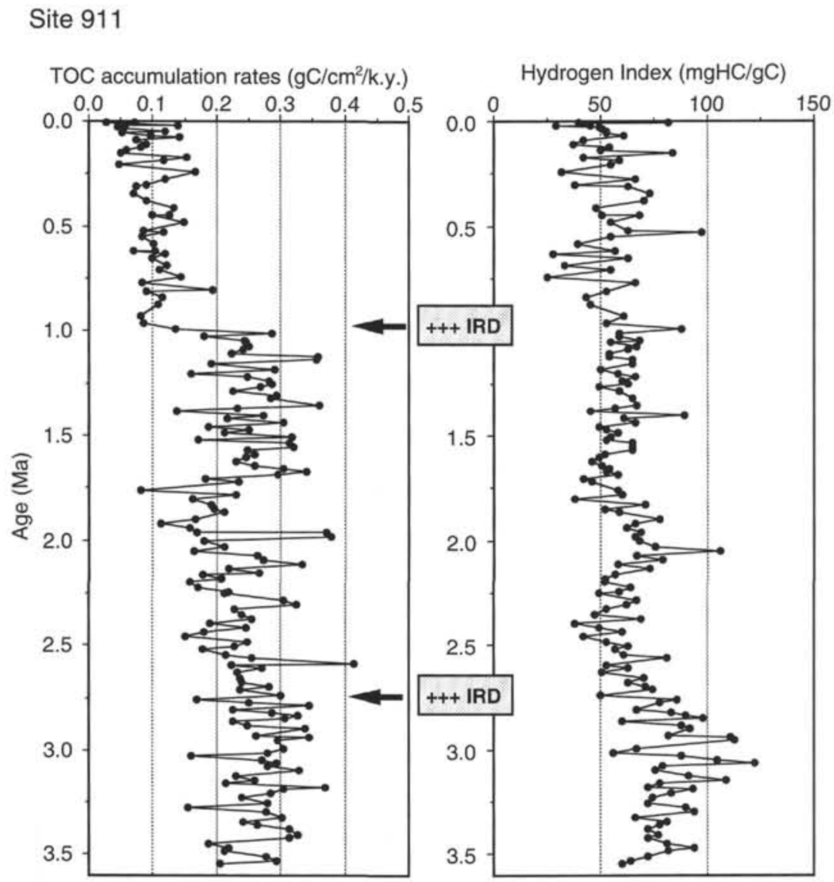

Figure 9. Mean accumulation rates of total organic carbon (gC/cm^2/k.y.) and hydrogen index values (mgHC/gC) vs. age at Site 911. Arrows indicate intensification of input of ice-rafted debris (IRD).