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23. ALIPHATIC HYDROCARBONS IN SEDIMENTS FROM PRYDZ BAY, ANTARCTICA[1]

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ABSTRACT

High molecular weight aliphatic hydrocarbons were extracted from sediments at two sites (741 and 742) drilled during Ocean Drilling Program Leg 119 in Prydz Bay, a major embayment on the continental shelf of East Antarctica. The distributions of *n*-alkanes and triterpenoid and steroid hydrocarbons suggest that the *n*-alkanes and steranes are mainly of terrestrial origin and that the hydrocarbons are immature to slightly mature in the Lower Cretaceous sediments and immature to mature in the Tertiary sediments. At Site 741, the Lower Cretaceous depositional sequence, which is generally characterized by immature hydrocarbons, is interrupted by sediment having more mature components, suggesting a change of source during part of Early Cretaceous time. At Site 742, the mature geochemical parameters of a Pliocene sample correlate with results reported elsewhere for Site 739. In all but one of the other Tertiary samples, the geochemical parameters indicate intermediate maturity. The Lower Cretaceous and Pliocene sediments average about 1.9% organic carbon, a value of interest from the point of view of potential sources of petroleum offshore from Antarctica.

INTRODUCTION

Isolated by three major oceans, Antarctica provides settings where relatively pristine conditions aid in the study of geochemical processes in offshore sediment. Early studies of kerogen (Sackett et al., 1974) recognized the importance of organic matter recycling in sediment of the Ross Sea (Fig. 1); this same process accounts for the distributions of hydrocarbons, not only in sediment of the Ross Sea (Kvenvolden et al., 1987; Venkatesan, 1988), but also in the Bransfield Strait (Venkatesan and Kaplan, 1987), Weddell Sea (Kvenvolden et al., 1990), and the Wilkes Land margin (Kvenvolden et al., 1987). The Bransfield Strait (Fig. 1) is the setting for thermal processes (Whiticar et al., 1985; Brault and Simoneit, 1988) that locally have altered the distribution of hydrocarbons in sediment, and the Weddell Sea (Fig. 1) contains sediment that is considered to be a potential source of petroleum (Kvenvolden et al., 1990).

Ocean Drilling Program (ODP) Leg 119 provided the opportunity to extend the investigation of hydrocarbons in sediment offshore from Antarctica to Prydz Bay, a major embayment on the shelf of East Antarctica (Fig. 1). Prydz Bay is at the oceanward end of a graben occupied by a major glacier system and the Amery Ice Shelf (Fig. 1). The continental shelf under Prydz Bay is typical of antarctic continental shelves in general: the inner parts of the shelf have deeper water than that found at the outer parts. We obtained samples from two of the five sites drilled during Leg 119 in Prydz Bay: Sites 741 (inner shelf, 551.4-m water depth) and 742 (middle shelf, 415.7-m water depth). At Site 741 we obtained seven samples of Early Cretaceous age at drilling depths ranging from 27.3 to 121.2 m below seafloor (mbsf); the samples are composed of mainly siltstone with some fine-grained sandstone. Our eight samples from Site 742 range in age from early Eocene and Oligocene to Pliocene. From 135.2 mbsf, the shallowest sampling depth, to 288.8 mbsf, the sediments are principally diamictite, reflecting glaciation and marine conditions. Two samples taken at 313.4 and 314.0 mbsf, near the base of the cored sequence at 316 mbsf, are composed of claystone and siltstone, interstratified with diamictite. These 15 samples provide the basis of this report.

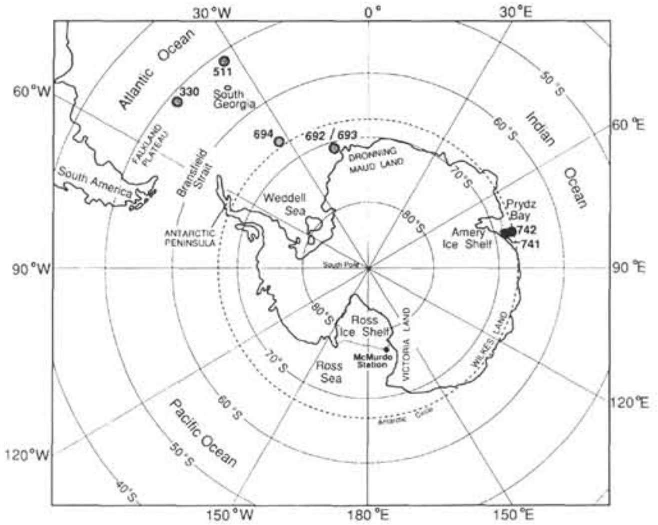

Figure 1. Map of Antarctica showing geographic features and sampling sites for this and other organic-geochemical studies. Leg 119 Sites 741 and 742 (this study) are in Prydz Bay; also shown are Deep Sea Drilling Project Sites 330 and 511 in the Atlantic Ocean, northeast of the Bransfield Strait, and ODP Leg 113 Sites 692, 693, and 694 in the Weddell Sea.

PROCEDURES

The geochemical procedures that we used were described previously (Kvenvolden et al., 1987, 1990) and are only summarized here. The sediment samples, collected aboard ship, were carefully wrapped in clean aluminum foil and immediately frozen in Kapak plastic bags for storage. For analysis, water was removed by freeze-drying, and the samples were gently pulverized and sieved through a no. 32-mesh screen. Because of the small size of each sample, we used all of the pulverized and sieved material (from 32 to 96 g) for extraction and identification of hydrocarbons. Organic carbon content was determined on small portions of the extracted sediment by a wet combustion method (Bush, 1970). Each sample analyzed for hydrocarbons was triple-extracted with dichloromethane by shaking on a wrist-action shaker. The filtered extracts were combined and then concentrated by rotary evaporation. Any sulfur was re-

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moved by filtration through activated copper. A portion of the filtrate was used to determine the weight of sulfur-free extract (SFE). The dichloromethane solvent was then exchanged for *n*-hexane.

The extracts in *n*-hexane were fractionated by liquid-solid chromatography using a column packed with activated silica gel and deactivated alumina. The column was sequentially eluted with *n*-hexane, benzene, and methanol to yield fractions containing mainly aliphatic hydrocarbons, intermediate polarity compounds (including aromatic hydrocarbons), and polar N-, S-, O-containing compounds, respectively. Only the aliphatic hydrocarbons were studied in detail by high-resolution gas chromatography, using a 30-m by 0.3-mm, DB-1 bonded-phase, fused-silica capillary column. Identification of alkanes was based on retention times and comparison with standards. Relative proportions of individual compounds were determined from peak heights. The *n*-hexane fractions were examined by combined gas chromatography and mass spectrometry, using a 30-m by 0.3-mm, DB-5 bonded-phase, fused-silica column. Single-ion monitoring of mass to charge ratios (m/z) 191 and 217 produced mass fragmentograms from which triterpanes and steranes/diasteranes, respectively, were identified. Relative amounts of the compounds were determined using peak heights measured from the baseline of the fragmentograms.

RESULTS

Geochemical results for the 15 samples are shown in Tables 1 and 2. The organic carbon contents of six samples of Early Cretaceous age from Site 741 range from 0.54% to 3.0%. At Site 742, the organic carbon in two samples of Pliocene sediment measures 1.4% and 2.3%; in the Eocene to Oligocene part of the section, organic carbon ranges from 0.23% to 0.58%. The two deepest samples of early Eocene to Oligocene age have contrasting organic carbon contents of 0.22% and 1.6% (Table 1).

Table 1. Description of sediment samples from Prydz Bay, Antarctica.

Core, section, interval (cm)	Depth (mbsf)	Age	Organic carbon (%)	Sulfur-free extract (μg/g)	Hexane fraction (μg/g)
119-741A-					
4R-3, 38–44	27.3	Early Cretaceous	1.5	[a]44	8
5R-1, 54–60	34.1	Early Cretaceous	1.4	[a]72	16
6R-3, 53–59	46.8	Early Cretaceous	2.6	150	24
10R-1, 16–22	82.1	Early Cretaceous	0.54	4	2
12R-1, 0–6	101.2	Early Cretaceous	1.2	[a]6	2
13R-3, 17–23	114.0	Early Cretaceous	1.8	160	37
14R-1, 64–70	121.1	Early Cretaceous	3.0	44	3
119-742A-					
16R-2, 94–100	135.2	Pliocene	1.4	52	3
17R-3, 30–36	145.6	Pliocene	2.3	[a]87	5
21R-1, 80–86	181.8	Eocene to Oligocene(?)	0.58	31	7
26R-4, 83–91	234.6	Eocene to Oligocene(?)	0.56	32	5
29R-1, 25–31	258.4	Eocene to Oligocene(?)	0.23	43	6
32R-2, 21–27	288.8	Eocene to Oligocene(?)	0.26	20	5
34R-5, 110–116	313.4	early Eocene to Oligocene	0.22	8	1
34R-6, 17–20	314.0	early Eocene to Oligocene	1.6	70	9

[a] Aliquot for measurement taken after solvent exchange with *n*-hexane.

Table 2. Organic geochemical parameters in sediment samples from Prydz Bay, Antarctica.

	Alkanes		Triterpanes (m/z 191)				Steranes (m/z 217)	
Core, section, interval (cm)	OEP$_{27}$	Maximum carbon number	$C_{30}\beta\beta/\alpha\beta$	$C_{30}\alpha\beta/\beta\alpha$	$C_{31}\alpha\beta 22S/(22S + 22R)$	Tm/Ts	$C_{29}\alpha\alpha\alpha 20S/(20S + 20R)$	Dominant steroid hydrocarbon
119-741A-								
4R-3, 38–44	2.9	31	0.31	1.7	0.05	9.5	R only	St
5R-1, 54–60	2.3	27	0.78	1.6	R only	15	R only	St
6R-3, 53–59	2.4	31	2.0	1.5	0.11	15	R only	St
10R-1, 16–22	2.1	27	$\alpha\beta$ only	3.9	0.28	1.0	R only	D
12R-1, 0–6	3.3	27	$\alpha\beta$ only	3.8	0.45	2.0	R only	D
13R-3, 17–23	3.1	27	2.3	1.6	0.08	18	R only	St
14R-1, 64–70	2.9	27	1.3	1.6	0.05	15	R only	St
119-742A-								
16R-2, 94–100	2.6	29	2.4	1.2	0.06	16	R only	St
17R-3, 30–36	1.4	19	$\alpha\beta$ only	4.6	0.57	11 21	0.41	St
21R-1, 80–86	3.9	25	0.82	2.1	0.18	21	0.09	St
26R-4, 83–91	4.0	25	0.65	2.2	0.26	18	0.10	St
29R-1, 25–31	3.8	25	0.45	2.4	0.25	12	0.11	St
32R-2, 21–27	4.0	25	0.58	2.4	0.25	14	0.10	St
34R-5, 110–116	1.5	23	$\alpha\beta$ only	6.2	0.53	0.91	0.40	D
34R-6, 17–20	3.2	27	1.1	1.4	0.05	13	R only	St

Note: OEP$_{27}$ = odd/even carbon number predominance; $\alpha\beta$, $\beta\alpha$, and $\beta\beta$ = hopanes; Tm and Ts = terpanes; $\alpha\alpha\alpha$ = $\alpha\alpha\alpha$-sterane; R and S = epimer configuration; m/z = mass to charge ratio of fragment ion.

The aliphatic hydrocarbon fractions all contain n-alkanes ranging from about n-C_{14} to about n-C_{35} (Fig. 2). With the exception of Samples 119-742A-17R-3, 30–36 cm, and 119-742A-34R-5, 110–116 cm, the n-alkanes of the samples are distributed in a single mode with a strong dominance of odd carbon numbers centered at either n-C_{25}, n-C_{27}, n-C_{29}, or n-C_{31} (Table 2). The odd/even carbon number predominance (OEP_{27}) for the n-alkanes in the range of n-C_{25} to n-C_{29} was calculated by the method of Scalan and Smith (1970); except for the two samples mentioned previously, values of OEP_{27} range from 2.1 to 4.0 (Table 2). In the two previously mentioned Samples 119-742A-17R-3, 30–36 cm, and 119-742A-34R-5, 110–116 cm, the n-alkanes are also distributed in a single mode but at lower molecular weights, centered at n-C_{19} and n-C_{23}, respectively (Fig. 2). The respective OEP_{27} values of these samples are 1.4 and 1.5 (Table 2), reflecting a substantially lower odd carbon number predominance than in the majority of samples. The isoprenoid hydrocarbons, pristane and phytane, are commonly not detected or are minor components along with the low-range n-alkanes relative to the dominant high molecular weight n-alkanes (Fig. 2), except in Sample 119-742A-17R-3, 30–36 cm, where the pristane/phytane ratio is 6.1.

Triterpenoid- and steroid-derived hydrocarbons are present in all samples, and representative mass fragmentograms are shown in Figures 3 and 4. At both sites, the triterpenoid hydrocarbons (Fig. 3) are series of 17α(H),21β(H)-hopanes, 17β(H),21α(H)-hopanes (previously called moretanes), and 17β(H)21β(H)-hopanes (found in variable amounts in 11 samples). Ratios among the C_{30} members of these series are shown in Table 2. In addition, there are three C_{27}-hopanes: Tm (17α(H)-22,29,30-trisnorhopane), Ts (18α(H)-22,29,30-trisnorneohopane), and Tβ (17β(H)-22,29,30-trisnorhopane). Tm/Ts ratios, originally defined and used by Seifert and Moldowan (1978), are generally large—with three exceptions—and range from 0.91 to 21 (Table 2). Tβ is present in all but two samples (Fig. 3). Except for Sample 119-741A-5R-1, 54–60 cm, both the 22S and 22R epimers of 17α(H),21β(H)-homohopane (C_{31}) and of 17α(H),21β(H)-bishomohopane (C_{32}) are present. The epimer ratios 22S/(22S + 22R) of the C_{31} compound at Site 741 are generally low—ranging from 0 (only the R isomer present) in Sample 119-741A-5R-1, 54–60 cm, to 0.11 in Sample 119-741A-6R-3, 53–59 cm—except for Samples 119-741A-10R-1, 16–22 cm, and 119-741A-12R-1, 0–6 cm, in which significantly larger ratios of 0.28 and 0.45, respectively, are found. These latter samples lack ββ-hopanes and have low Tm/Ts ratios of 1.0 and 2.0, respectively (Table 2). At Site 742, the C_{31} epimer ratios for all samples, except two, fall in the range 0.05 to 0.26 (Table 2). Samples 119-742A-17R-3, 30–36 cm, and 119-742A-34R-5, 110–116 cm, have significantly higher ratios of 0.57 and 0.53, respectively; these samples also lack the ββ-hopanes, and the latter has the lowest Tm/Ts ratio (0.91) of all samples. The four samples, two from each site, with the highest C_{31}-hopane epimer ratios also have the highest ratios of the C_{30}-hopane to the C_{30}-moretane (Table 2).

The steroid hydrocarbons (Fig. 4) comprise principally the C_{27}-, C_{28}-, and C_{29}-5α(H),14α(H),17α(H)-sterane series, with much less abundant 5β(H),14α(H),17α(H) isomers, and the C_{27}- and C_{29}-13β(H),17α(H)-diasteranes. In these series, the dominant compounds are the C_{29}-sterane (24-ethyl-5α(H),14α(H),17α(H)-cholestane) and the C_{27}-diasterane (13β(H),17α(H)-diacholestane). At each site the steroid distributions are clearly dominated by either steranes or diasteranes (Fig. 4 and Table 2). The samples from Site 741 contain only the 20R epimer of the C_{29}ααα-sterane, whereas both the 20S and 20R epimers of the C_{27}βα-diasterane are present (Fig. 4). In five samples from Site 741, the steranes dominate, whereas in Samples 119-741A-10R-1, 16–22 cm, and 119-741-12R-1, 0–6 cm, diasteranes are predominant (Table 2). These latter two samples are the same ones that lack ββ-hopanes and have the highest C_{31}-hopane epimer ratios and the lowest Tm/Ts ratios. In all eight samples from Site 742 the 20R epimer of the C_{29}ααα-sterane is present. In four of the Site 742 samples the 20S epimer is present in only low amounts, but in Samples 119-742A-17R-3, 30–36 cm, and 119-742A-34R-5, 110–116 cm, the 20S epimer is present in significant concentrations relative to the 20R epimer, with 20S/(20S + 20R) ratios of 0.41 and 0.40, respectively (Table 2). These latter two samples lack ββ-hopanes and have the highest C_{31}-hopane epimer ratios. Steranes dominate the diasteranes in all samples except Sample 119-742A-34R-5, 110–116 cm (Table 2). This sample and Sample 119-742A-17R-3, 30–36 cm, both have unusual n-alkane distributions relative to the other samples (Fig. 2) and low OEP_{27} values (1.5 and 1.4, respectively).

DISCUSSION

The Lower Cretaceous sediment at Site 741 is relatively rich in organic carbon: six of the seven samples have organic carbon contents averaging 1.9% ± 0.7%. These samples are not as rich in organic carbon, however, as are two Lower Cretaceous sediment samples from Site 692 in the Weddell Sea which average 4.2% ± 0.9% organic carbon (Kvenvolden et al., 1990). The organic carbon content of the two Pliocene samples from Site 742 averages 1.9% ± 0.6%. In contrast, five of the six Eocene to Oligocene samples have lower organic carbon values, averaging 0.37% ± 0.18%. Because the Lower Cretaceous and Pliocene sediments contain more than 1% organic carbon, they can be considered potential sources of petroleum, given sufficient thermal maturation and appropriate organic matter type (Peters, 1986).

For the most part, the n-alkanes at both Sites 741 and 742 comprise mainly a high molecular weight distribution (Fig. 2) with a significant odd carbon number predominance (OEP_{27} = 2.1 to 4.0). These high molecular weight n-alkanes (greater than about n-C_{20}) likely represent contributions of vascular plant waxes of continental (terrigenous) origin (Eglinton et al., 1962). In contrast, the low molecular weight n-alkanes in the range from about n-C_{13} to n-C_{20} are in very low relative abundance. These compounds are believed to indicate marine sources (Clark and Blumer, 1967; Han and Calvin, 1969; Simoneit, 1978). Thus, at this site terrestrially derived n-alkanes dominate marine-derived n-alkanes; the continent of Antarctica, where vascular plants were once common, is a possible source of most of the n-alkanes.

The triterpenoid hydrocarbons likely were derived from bacteria and to a lesser extent from algae and ferns (Ourisson et al., 1984). Present in all samples from the two sites are αβ-hopanes and βα-hopanes (moretanes), with αβ-hopanes in greater relative abundance (Table 2). The stereochemistry of the ββ-hopanes matches that of their presumed biological precursors; therefore, these compounds, which are present in all but four of the 15 samples, likely represent immature organic material.

The abundance of Tm significantly exceeds that of Ts except in three samples (Table 2). The Tm/Ts ratio is thought to be controlled here mainly by maturation (Seifert and Moldowan, 1978), because the values of these ratios are consistent with other maturity parameters. The large Tm/Ts ratios of the majority of samples suggest that this organic material is at an early phase of maturation. The dominance of Tβ over both Ts and Tm in these same samples also indicates immaturity. Early to intermediate degrees of maturation are suggested by the values of the 22S/(22S + 22R) αβ-homohopane epimer ratios; at Site 741, immaturity is indicated for five Lower Cretaceous sediment samples by ratios ranging from 0 (22R only) to 0.11 (Table 2). The remaining two samples at this site have ratio values indicat-

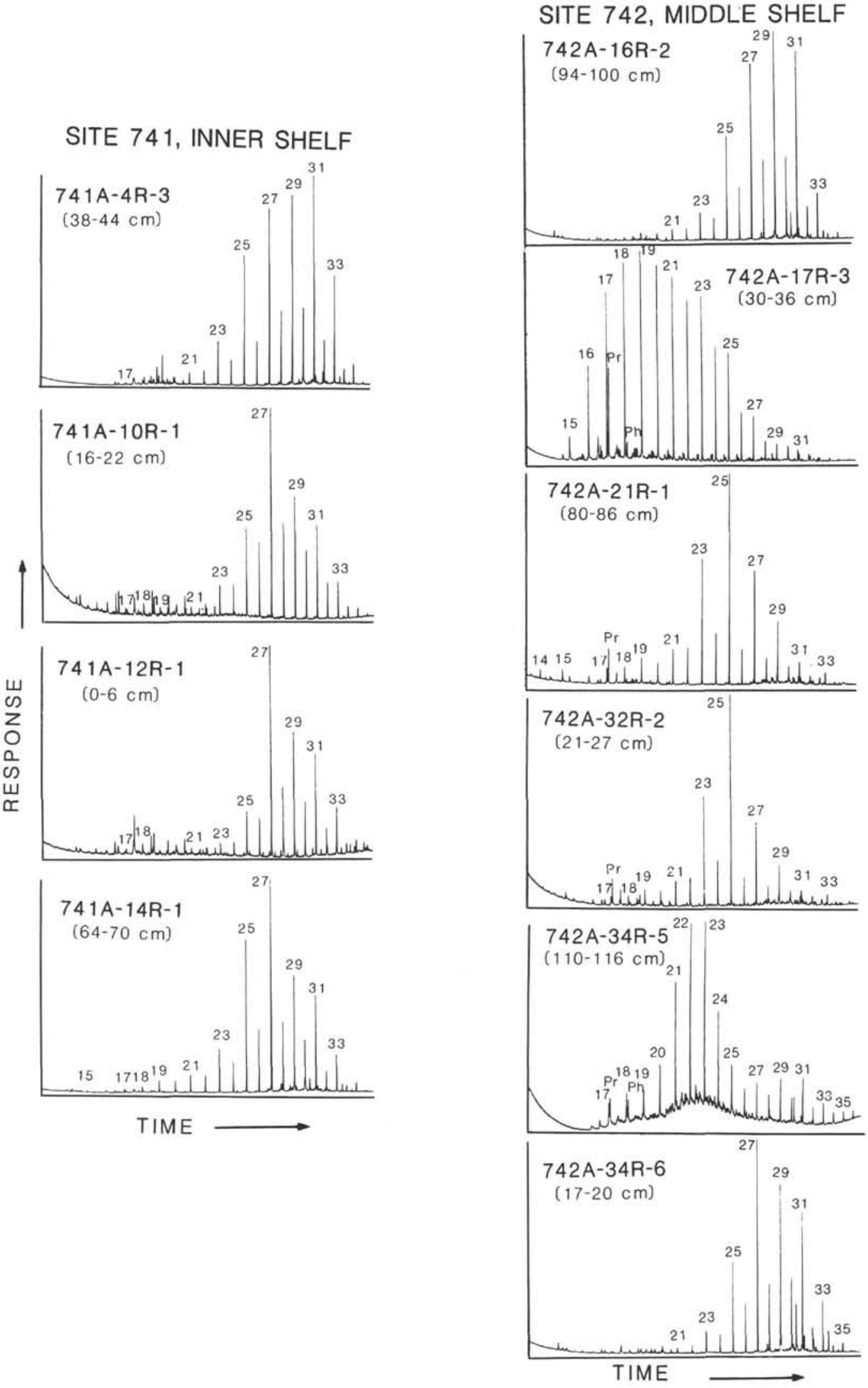
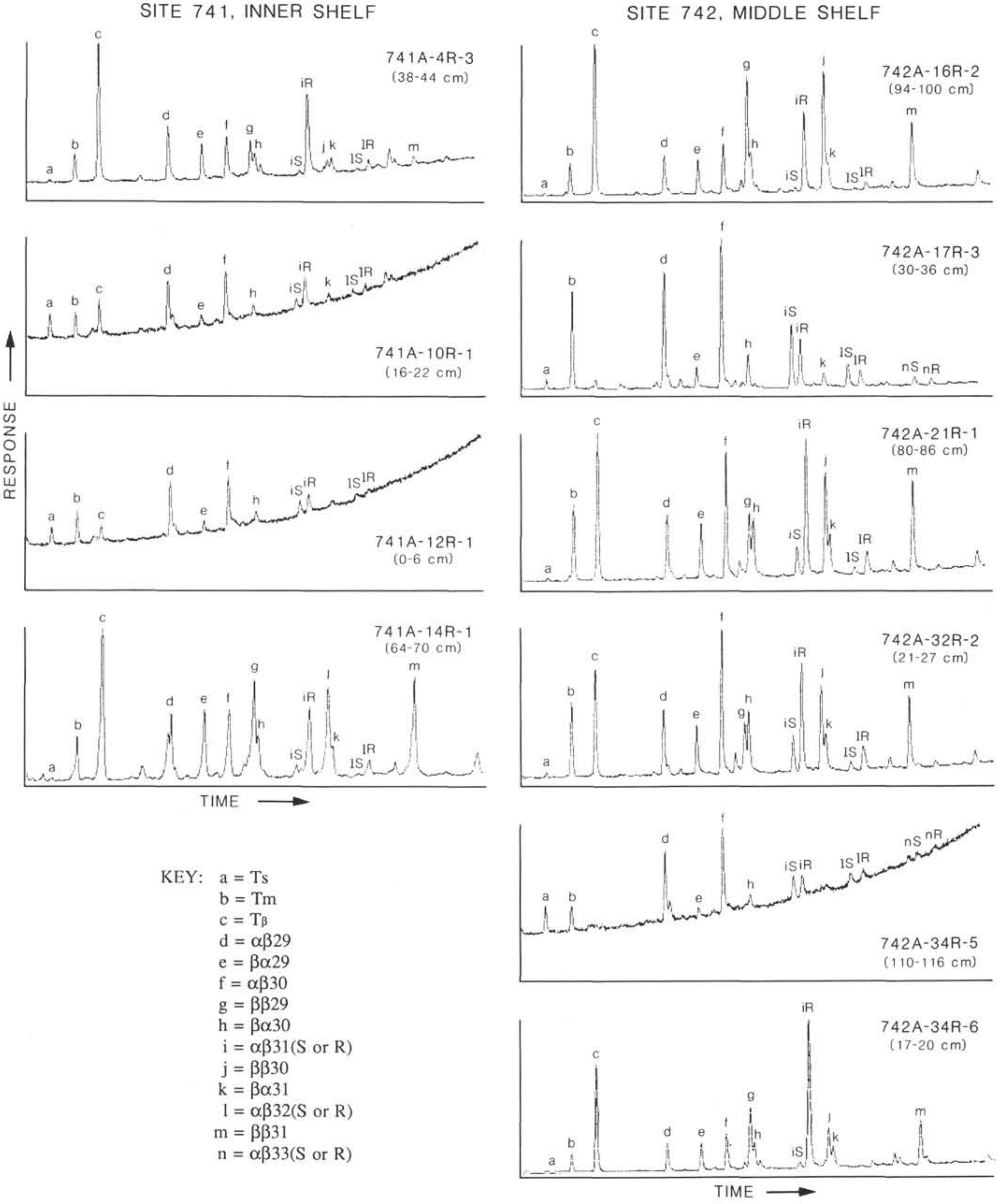


Figure 2. Gas chromatograms of the aliphatic hydrocarbons in 10 sediment samples from Holes 741A and 742A in Prydz Bay. The *n*-alkanes are indicated by carbon number; the carbon number of an unnumbered peak can be inferred from the carbon numbers of nearby homologs. Pr = pristane; Ph = phytane.



KEY: a = Ts
b = Tm
$c = T_{\beta}$
$d = \alpha\beta 29$
$e = \beta\alpha 29$
$f = \alpha\beta 30$
$g = \beta\beta 29$
$h = \beta\alpha 30$
$i = \alpha\beta 31$(S or R)
$j = \beta\beta 30$
$k = \beta\alpha 31$
$l = \alpha\beta 32$(S or R)
$m = \beta\beta 31$
$n = \alpha\beta 33$(S or R)

Figure 3. Mass fragmentograms (m/z 191) of triterpenoid hydrocarbons in 10 sediment samples from Holes 741A and 742A in Prydz Bay. Compound labels are identified in the key. $\alpha\beta$ = $\alpha\beta$-hopanes; $\beta\beta$ = $\beta\beta$-hopanes; $\beta\alpha$ = $\beta\alpha$-hopanes (moretanes); R and S = epimer configuration at C_{22}; Ts and Tm = triterpanes (see text); $T\beta$ = 17β(H)-22,29,30-trisnorhopane.

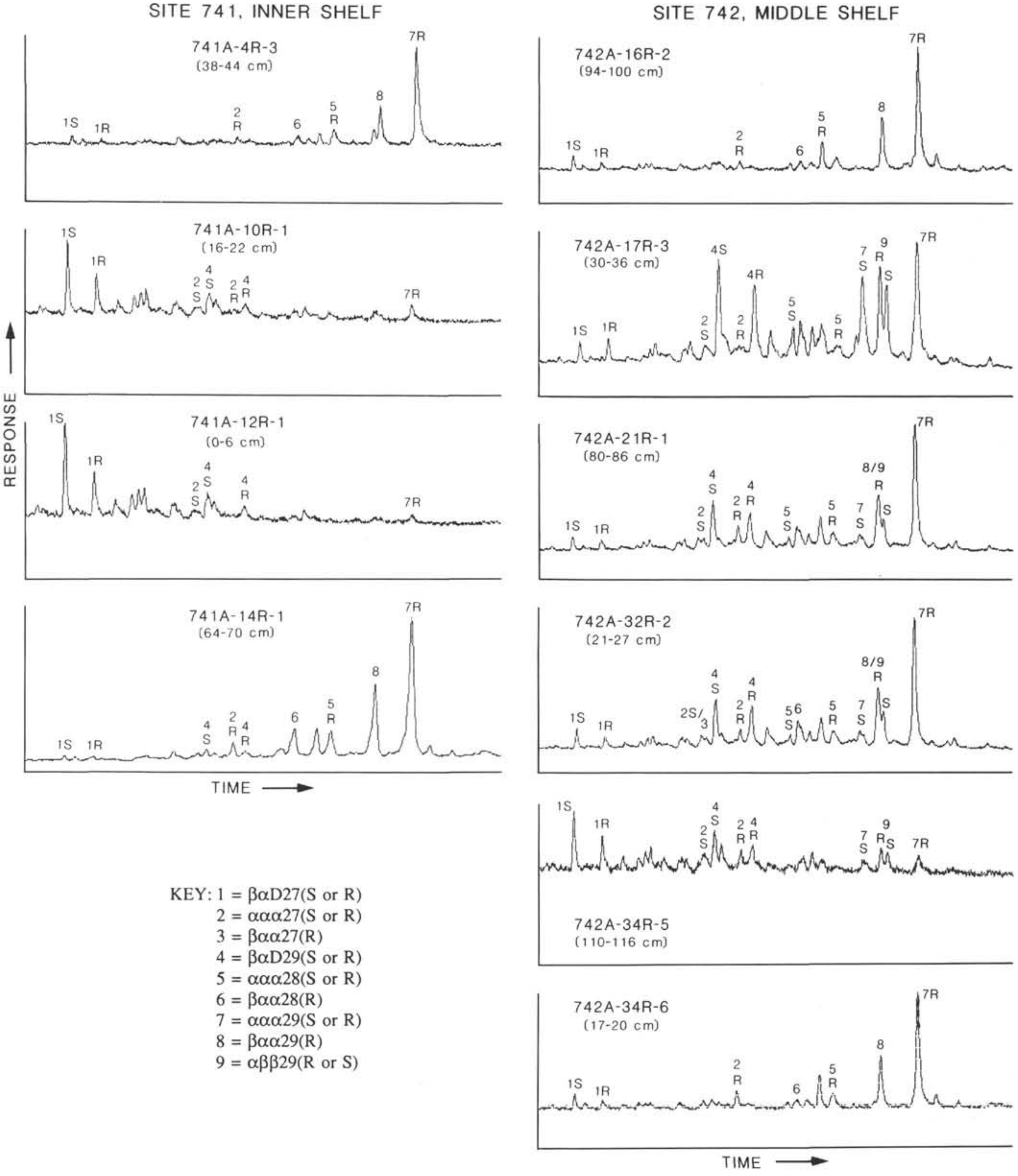


Figure 4. Mass fragmentograms (m/z 217) of steroid hydrocarbons in 10 sediment samples from Holes 741A and 742A in Prydz Bay. Compound labels are identified in the key. βαD = 13β(H),17α(H)-diasteranes; ααα = ααα-steranes; R and S = epimer configuration at C-20.

ing intermediate maturity, 0.28 and 0.45 (Table 2); these samples also have low Tm/Ts values and lack ββ-hopanes, which is further evidence of intermediate maturity. At Site 742 six samples of Tertiary sediment also have αβ-homohopane epimer ratios that suggest immaturity to intermediate maturity, with values ranging from 0.05 to 0.26 (Table 2). Two samples have anomalously high ratios, 0.53 and 0.57, which closely approach full maturity values of about 0.6 (Mackenzie, 1984).

The steroid hydrocarbons add to the interpretation of source and maturity. The dominant sterane in 12 of the 15 samples is the $C_{29}\alpha\alpha\alpha$-sterane, and in nine of these samples only the 20R epimer is present (Table 2). The $C_{29}\alpha\alpha\alpha$-sterane may indicate terrigenous plant sources according to criteria suggested by Huang and Meinschein (1979); however, this interpretation has many exceptions (Grantham, 1986; Volkman, 1986). Certainly, a terrigenous source fits well with our observations of terrigenous *n*-alkanes in the samples. The C-20 epimer ratios of the $C_{29}\alpha\alpha\alpha$-sterane, 20S/(20S + 20R), are generally low, at essentially zero (20R only) in the seven Lower Cretaceous samples and in the two Tertiary samples and ranging from 0.09 to 0.11 in four other Tertiary samples (Table 2). Ratios for two of the Tertiary samples (119-742A-17R-3, 30–36 cm, and 119-742A-34R-5, 110–116 cm) are 0.41 and 0.40, respectively, and these values approach full maturity values of about 0.55 (Mackenzie, 1984). These same two samples also have the highest $\alpha\beta$-homohopane epimer ratios and the lowest OEP_{27} ratios and lack $\beta\beta$-hopanes—all signs of greater maturity. Another indicator of advanced maturity is that one of the two samples has the lowest Tm/Ts ratio (0.91) of all the samples.

In our sample set, the two Lower Cretaceous samples and one of the Tertiary samples, which have the most advanced maturity indicators, also contain diasteranes in greater abundance than steranes (Table 2). Sample 119-742A-17R-3, 30–36 cm, from the Pliocene also has advanced maturity indicators (based on the high $\alpha\beta$-homohopane and $C_{29}\alpha\alpha\alpha$-sterane epimer ratios, the lack of $\beta\beta$-hopanes, and the low OEP_{27} value), but in this sample the diasteranes are less abundant than the steranes (Table 2). The Tm/Ts ratio (11) of this sample is larger than that of the other samples with advanced maturity indicators. This sample also has a lower molecular weight distribution of *n*-alkanes (Fig. 2) compared with the other samples, and the shape of the *n*-alkane distribution suggests a petroleum-like mixture. The geochemical parameters for this sample correlate well with measurements made by McDonald et al. (this volume) on stratigraphically equivalent sediment of lithologic Unit II at Site 739.

The two samples of lower Eocene to Oligocene sediments from near the base of Hole 742A are of interest because their geochemical parameters are so different from each other. Sample 119-742A-34R-5, 110–116 cm, has geochemical parameter values indicating advanced maturity (Table 2), and the *n*-alkane pattern is shifted to lower molecular weights compared with most other samples (Fig. 2). This sample had the lowest SFE concentration (8 μg/g) and the smallest hexane fraction (1 μg/g). In contrast, Sample 119-742A-34R-6, 17–20 cm, collected only 0.6 m below Sample 119-742A-34R-5, 110–116 cm, has geochemical parameter values that consistently indicate immaturity and yields results that are more compatible with our observations of the other samples at this site, except for Sample 119-742A-17R-3, 30–36 cm. The results suggest that varying sources of organic material occurred during the time represented by this short stratigraphic interval.

At Site 741 the general trend of the organic-geochemical results in the Lower Cretaceous sampling interval from 27.3 to 121.1 mbsf is interrupted at 82.1 and 101.2 mbsf; here Samples 119-741A-10R-1, 16–22 cm, and 119-741A-12R-1, 0–6 cm, show intermediate organic maturity, whereas samples of overlying and underlying sediments contain less mature hydrocarbons (Table 2). These two intermediate-maturity samples have low SFE concentrations (4 and 6 μg/g) and low concentrations of the hexane fraction (2 μg/g) compared with the other samples (Table 2). The two sediment samples from Site 741 probably represent a geochemical facies indicating an alternate source with more mature components within the Early Cretaceous record.

SUMMARY

Previous studies of aliphatic hydrocarbons in Quaternary sediment offshore from Antarctica (Kvenvolden et al., 1987; Venkatesan and Kaplan, 1987; Venkatesan, 1988) showed that these hydrocarbons contain terpenoid and steroid components that indicate intermediate to full maturity. The hydrocarbons appear to be mixtures of primary and recycled material from marine and terrigenous sources. The antarctic continent, in an earlier period of geologic time, is postulated to have been the source of vascular plant-derived *n*-alkanes. A geochemical study of Tertiary sediment in the Weddell Sea (Kvenvolden et al., 1990) led to similar conclusions on the basis of finding triterpane and sterane ratios (indicative of partial to full maturity) and distributions of *n*-alkanes attributable to both marine and terrigenous sources.

The aliphatic hydrocarbon distributions in the Prydz Bay Tertiary sediments contrast with the distributions in Tertiary and Quaternary sediment elsewhere offshore from Antarctica. For example, the population of *n*-alkanes in the Prydz Bay sediment is dominated by terrigenous components, and the triterpenoid and steroid hydrocarbons are generally less mature.

The aliphatic hydrocarbons of the Lower Cretaceous sediment at Prydz Bay contrast with those from Lower Cretaceous sediment in the Weddell Sea (Kvenvolden et al., 1990). The *n*-alkanes in the Prydz Bay sediment are dominantly from terrigenous sources, whereas, in the Weddell Sea sediment, *n*-alkanes of both marine and terrigenous sources are well represented. Triterpenoid and steroid hydrocarbons in the Weddell Sea sediments are much less mature than those in the Prydz Bay sediments. The Lower Cretaceous sediment, as well as the Pliocene sediment, of Prydz Bay has adequate organic matter (organic carbon averaging 1.9%) to be considered a potential petroleum source.

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