37. CARBONATE DISSOLUTION FACIES OF LATE MIOCENE TO PLEISTOCENE SEDIMENTS FROM LEG 73, SITES 519 AND 520 (SOUTH ATLANTIC)[1]

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ABSTRACT

The dissolution facies of 68 sediment samples from Leg 73 were determined by analyzing carbonate content and grain size. All sediments (Miocene to Pleistocene) from Site 519 and the Pliocene sediments from Site 520 were eolytic or oligolytic; that is, they were deposited above the lysocline. Miocene sediments from Site 520 were mesolytic or pleistolytic (deposited below the lysocline).

INTRODUCTION

Hsü and Andrews established five dissolution facies for pelagic sediments (1970). This definition was slightly modified by Violanti et al. (1979), a modification that resulted in the following scheme:

Facies	Terrigenous matter	Sand fraction ($>63\mu m$)
Alytic	Idealized sediment only	
Eolytic	$<10\%$	$>6\%$
Oligolytic	$<30\%$	$<6\%$
Mesolytic	30–70%	Commonly $<1\%$
Pleistolytic	$>70\%$	Commonly $<1\%$
Hololytic	Abyssal clay devoid of calcium carbonate	

In other words, the dissolution facies of a sediment can be defined by determining the content of terrigenous clastics (or the $CaCO_3$ content) and the percentage of foraminifers (i.e., the size of the fraction $>63\mu m$.) This work was done on sediment samples from Leg 73, Sites 519 and 520, and the results are reported herein. Other parameters that could define a dissolution facies, like the ratio between planktonic and benthic foraminifers, the diversity of the planktonic fauna, and the number of whole tests per gram of fraction $>100\mu m$ (e.g., Violanti et al., 1979; Thunell, 1976), have not been investigated.

METHODOLOGY

Sixty-one samples from Site 519 and eight samples from Site 520 were analyzed. The sub-bottom depths, lithologic units, and ages of the samples are listed in Table 1. About 5 to 10 g of each sample were freeze dried. One part of each dried sample, about 1 g, was used for the determination of $CaCO_3$ content. The analysis was done with a Ströhlein Coulomat. The sediment is burned in a O_2 current, the resulting CO_2 is volumetrically analyzed, and the total carbon content of the sample is printed out. By operating the Coulomat with N_2, only the CO_2 from the carbonates is measured, because the organic carbon is not oxidized as it is in the O_2 current. The difference between the two measurements is equal to the organic carbon content. The sediments of Sites 519 and 520 do not contain a significant amount of organic carbon.

For our purposes, the carbon contents (measured with N_2) of the samples were multiplied by the stoichiometric factor 8.33 to obtain the $CaCO_3$ percentage (see Table 1). The percentage of terrigenous matter is 100% minus the percentage of $CaCO_3$.

The second part of the dried sample was used for the grain-size analysis. About 3 to 6 g of each sample were weighed exactly and soaked with H_2O_2. After 30 min. the samples were placed in an ultrasonic bath for 30 s. Distilled water was added and the samples were wet sieved through $180\mu m$, $90\mu m$, and $63\mu m$ sieves and a filter. The sieve fractions were dried and weighed.

Calculations were made to acquire the weight percentages of the fractions $>180\mu m$, 90 to $180\mu m$, $>90\mu m$, 63 to $90\mu m$, $>63\mu m$, and the proportions $>90\mu m/>63\mu m$ and $>180\mu m/>90\mu m$ (see Table 1). Graphical representations of the results are shown in Figures 1, 2, and 3.

RESULTS

All samples of Lithologic Unit 1 of Site 519 are eolytic (see Fig. 1). The foraminiferal sands of Core 4 have very high $>63\mu m$ values (more than 70%). The foraminifer-nannofossil oozes still contain more than 10% $>63\mu m$ fraction. The $>90\mu m/>63\mu m$ and $>180\mu m/>90\mu m$ ratios are relatively high, especially those of the foraminiferal sands (see Figs. 2 and 3). The foraminifer-nannofossil oozes of Unit 2 are also eolytic, with $>90\mu m/>63\mu m$ ratios in general between 70 and 90%. Samples 31 and 32 are nannofossil oozes that lie in the oligolytic area (Fig. 1). The diatom nannofossil oozes (Cores 16 and 24) contain sand fractions in the range of an eolytic sediment, with the exception of Sample 41. The $CaCO_3$ content of these oozes often is below 90% as a result of the presence of the siliceous tests of the diatoms.

Except for Sample 54, which is a foraminiferal-nannofossil ooze, all the samples from Lithologic Unit 3 are oligolytic nannofossil oozes, with sand fractions between 1 and 6%. The $>90\mu m/>63\mu m$ ratios are between 50 and 80%. Three samples from Site 520 are oligolytic. The nannofossil oozes of Samples 61 and 62 are even close to the eolytic area. Four samples are mesolytic nannofossil clays or marly nannofossil oozes, and one is pleistolytic (see Fig. 1 and Table 1).

DISCUSSION

The inverse correlation of the two parameters ([1] terrigenous content and [2] weight percentage of the fraction $>63\mu m$), as stated in Hsü and Andrews (1970), can be confirmed by our investigations. As the sand fraction

[1] Hsü, K. J., LaBrecque, J. L., et al., *Init. Repts. DSDP*, 73: Washington (U.S. Govt. Printing Office).

Table 1. $CaCO_3$ content, grain size, and dissolution facies of the samples.

Sample	Sub-bottom depth (cm)	Core-Section, (interval in cm)	Carbon (wt.%)	$CaCO_3$ (wt.%)	Wt.% of the fractions: >180µm	90-180µm	>90µm	63-90µm	>63µm	>90µm/>63µm (%)	>180µm/>90µm (%)	Dissolution facies[a]	Lithologic Unit	Age
Site 519														
1	1,271	4-2, 140-142	11.13	92.75	44.7	22.5	67.2	3.9	71.1	94.5	66.5	E		
2	1,278	4-2, 147-149	10.98	91.50	4.2	10.4	14.6	6.4	21.0	69.5	29.5	E		
3	1,300	4-3, 19-21	11.05	92.08	52.8	23.7	76.5	3.8	80.3	95.3	69.0	E		
4	1,305	4-3, 24-26	11.22	93.50	56.6	15.7	72.3	3.1	75.4	95.9	78.3	E		
5	1,311	4-3, 31-33	11.05	92.08	66.5	12.7	79.2	2.2	81.4	97.3	84.0	E		Pleistocene
6	1,319	4-3, 38-40	10.99	91.58	63.6	8.6	72.2	2.1	74.4	95.9	78.3	E		
7	1,324	4-3, 43-45	11.16	93.00	57.3	12.2	69.5	4.2	73.7	94.3	82.5	E		
8	1,329	4-3, 48-50	11.16	93.00	62.6	7.4	70.0	2.4	72.4	96.7	89.4	E	1	
9	1,344	4-3, 63-65	11.42	95.17	6.9	4.7	11.6	2.8	14.4	80.6	59.5	E		
10	1,779	5-2, 98-100	10.89	90.75	6.5	4.9	11.4	3.9	15.3	74.5	57.0	E		
11	3,370	9-2, 89-91	11.07	92.25	4.8	4.7	9.5	2.5	12.0	79.2	50.5	E		
12	3,376	9-2, 96-97	10.89	90.75	4.5	5.8	10.3	2.4	12.7	81.1	43.7	E		
13	3,378	9-2, 98-99	11.16	93.00	8.3	16.3	24.6	6.2	30.8	79.9	33.7	E		
14	3,381	9-2, 101-102	11.08	92.33	10.2	18.8	29.0	10.8	39.8	72.9	35.2	E		
15	3,382	9-2, 102-104	11.07	92.25	6.2	6.1	12.3	3.3	15.6	78.9	50.4	E		
16	6,225	16-1, 55-56	11.01	91.75	3.8	3.7	7.5	1.9	9.4	79.8	50.7	E		
17	6,227	16-1, 57-58	10.95	91.25	2.5	4.1	6.6	1.9	8.5	77.7	37.9	E		
18	6,232	16-1, 62-63	10.12	84.33	3.4	6.0	9.4	2.8	12.2	77.1	36.2	E		
19	6,235	16-1, 65-66	10.43	86.92	4.3	4.5	8.8	3.2	12.0	73.3	48.9	E		
20	6,246	16-1, 75-77	10.99	91.58	4.0	2.7	6.7	1.4	8.1	82.7	59.7	E		
21	6,257	16-1, 87-88	10.90	90.83	3.7	2.4	6.1	0.9	7.0	87.1	60.7	E		
22	6,260	16-1, 90-91	10.83	90.25	4.1	3.0	7.1	1.6	8.7	81.6	57.8	E		
23	6,263	16-1, 93-94	10.38	86.50	5.1	3.1	8.2	2.0	10.2	80.4	62.2	E		
24	6,264	16-1, 94-95	9.20	76.67	4.5	4.0	8.5	2.1	10.6	80.2	52.9	E		
25	6,269	16-1, 99-100	9.13	76.08	3.9	5.3	9.2	4.2	13.4	68.7	42.4	E		
26	6,271	16-1, 101-102	7.68	64.00	2.8	7.8	10.6	4.8	15.4	68.8	26.4	E		
27	6,273	16-1, 103-104	7.43	61.92	1.8	5.3	7.1	2.9	10.0	71.0	25.4	E		
28	6,278	16-1, 108-109	8.02	66.83	2.6	4.6	7.2	2.9	10.1	71.3	36.1	E		
29	6,282	16-1, 112-113	8.70	72.50	2.8	2.1	4.9	3.1	8.0	61.3	57.1	E	2	
30	6,286	16-1, 116-117	10.25	85.42	4.3	3.5	7.8	1.7	9.5	82.1	55.1	E		
31	9,502	23-2, 101-103	11.48	95.67	2.4	1.1	3.5	0.8	4.3	81.4	68.6	O		Pliocene
32	9,527	23-2, 126-128	11.49	95.75	0.6	0.8	1.4	0.6	2.0	70.0	42.9	O		
33	9,546	23-2, 145-147	11.43	95.25	0.1	11.0	11.1	17.9	29.0	37.9	0.9	E		
34	9,549	23-2, 149-150	11.49	95.75	4.8	31.5	36.3	8.3	44.6	81.4	13.2	E		
35	9,557	23-3, 6-8	11.41	95.08	29.3	15.1	44.4	4.6	49.0	90.6	66.0	E		
36	9,564	23-3, 14-15	11.36	94.67	5.5	2.7	8.2	2.0	10.2	80.4	67.1	E		
37	9,568	23-3, 18-19	11.52	96.00	17.9	23.3	41.2	7.0	48.2	85.5	43.5	E		
38	10,002	24-3, 12-13	6.51	54.25	2.4	9.7	12.1	6.2	18.3	66.1	19.8	E		
39	10,003	24-3, 13-14	9.57	79.75	12.0	17.9	29.9	7.3	37.2	80.4	40.1	E		
40	10,005	24-3, 15-16	11.12	92.67	2.1	2.8	4.9	2.6	7.4	66.2	42.9	O		
41	10,010	24-3, 20-21	10.34	86.17	0.9	0.9	1.8	0.6	2.4	75.0	50.0	E		
42	10,013	24-3, 23-24	7.37	61.42	2.7	4.0	6.7	3.6	10.3	65.1	40.3	E		
43	10,015	24-3, 25-26	11.29	94.08	1.9	3.6	5.6	2.4	8.0	70.0	33.9	O		
44	10,636	26-1, 65-67	11.06	92.17	0.4	0.5	0.9	0.4	1.3	69.2	44.4	O		
45	10,682	26-1, 111-113	10.17	84.75	0.5	0.9	1.4	1.0	2.4	58.3	35.7	O		
46	11,242	27-2, 81-83	9.66	80.50	0.4	0.5	0.9	0.4	1.3	69.2	44.4	O		
47	11,271	27-2, 110-112	10.88	90.67	0.6	0.6	1.2	0.7	1.9	63.2	50.0	O		
48	11,580	28-1, 129-131	10.17	84.75	0.3	0.3	0.6	0.4	1.0	60.0	50.0	O		
49	11,620	28-2, 19-21	10.59	88.25	0.3	0.4	0.7	0.5	1.2	58.3	42.9	O		
50	11,650	28-2, 59-61	9.48	79.00	0.3	0.3	0.6	0.5	1.1	54.6	50.0	O		
51	12,111	29-2, 110-112	9.33	77.75	0.2	0.5	0.7	0.7	1.4	50.0	28.6	O		
52	12,129	29-2, 128-130	9.78	81.50	0.3	1.7	2.0	1.6	3.6	55.6	15.0	O	3	
53	12,492	30-2, 51-53	11.09	92.42	2.0	1.4	3.4	0.9	4.3	79.1	58.8	O		
54	12,500	30-2, 60-61	11.13	92.75	3.9	4.0	7.9	2.3	10.2	77.5	49.4	E		
55	12,556	30-2, 115-117	10.97	91.42	0.9	1.3	2.2	0.7	2.8	78.6	40.9	O		
56	12,641	30-3, 50-52	11.32	94.33	0.8	0.9	1.7	0.5	2.2	77.3	47.1	O		late
57	12,781	31-1, 90-92	11.00	91.67	2.8	3.0	5.8	1.5	7.3	79.5	48.3	E		Miocene
58	12,801	31-1, 110-112	11.39	94.92	0.9	1.1	2.0	0.8	2.8	71.4	45.0	O		
59	13,004	31-3, 13-15	11.14	92.83	2.3	1.3	3.6	0.9	4.5	80.0	63.9	O		
60	13,045	31-1, 54-56	11.27	93.92	1.7	2.0	3.7	1.0	4.7	78.7	46.0	O		
Site 520														
61	17,158	4-1, 107-109	11.26	93.83	1.1	3.0	4.1	1.5	5.6	73.2	26.8	O		
62	17,163	4-1, 113-114	10.97	91.42	1.0	2.8	3.8	1.2	5.0	79.0	26.3	O		Pliocene
63	25,743	9-5, 142-144	5.61	46.75	0.0	0.0	0.0	0.4	0.4	0.0	0.0	M		
64	25,747	9-5, 146-148	10.24	85.33	0.3	0.3	0.6	0.1	0.7	71.4	60.0	O		
65	30,385	15-1, 34-36	4.14	34.50	0.0	0.2	0.2	0.5	0.7	29.6	0.0	M		
66	30,455	15-1, 104-106	8.12	67.67	0.0	0.3	0.3	0.6	0.9	33.3	0.0	M	2	late
67	30,538	15-2, 37-39	3.15	26.25	0.0	0.2	0.2	0.4	0.6	33.3	0.0	P		Miocene
68	30,577	15-2, 76-78	8.04	67.00	0.0	0.3	0.3	0.4	0.7	40.9	0.0	M		

[a] E = eolytic, O = oligolytic, M = mesolytic, P = pleistolytic.

decreases as a result of the fragmentation and the preferred dissolution of the foraminiferal tests, the concentration of terrigenous matter in the sediments increases; that is, the percentage of noncarbonates increases.

The only sediments that do not fit the scheme presented in Violanti et al. (1979) are the diatom nannofossil oozes. Therefore these sediments are neglected in the following discussions of the >90µm/>63µm and >180µm/>90µm ratios in relation to the noncarbonate content.

The >90µm/>63µm ratio is regarded as a measure of whole foraminiferal tests in relation to partially fragmented tests. This ratio shows an inverse correlation to the percentage of noncarbonates (Fig. 2). Mesolytic and pleistolytic sediments have the lowest ratios (less than 50%). Ratios over 50% are generally found in the oligolytic and eolytic samples. A not very sharp differentiation can be made between oligolytic (ratios between 50 and 80%) and eolytic (ratios between 70 and 95%) sediments.

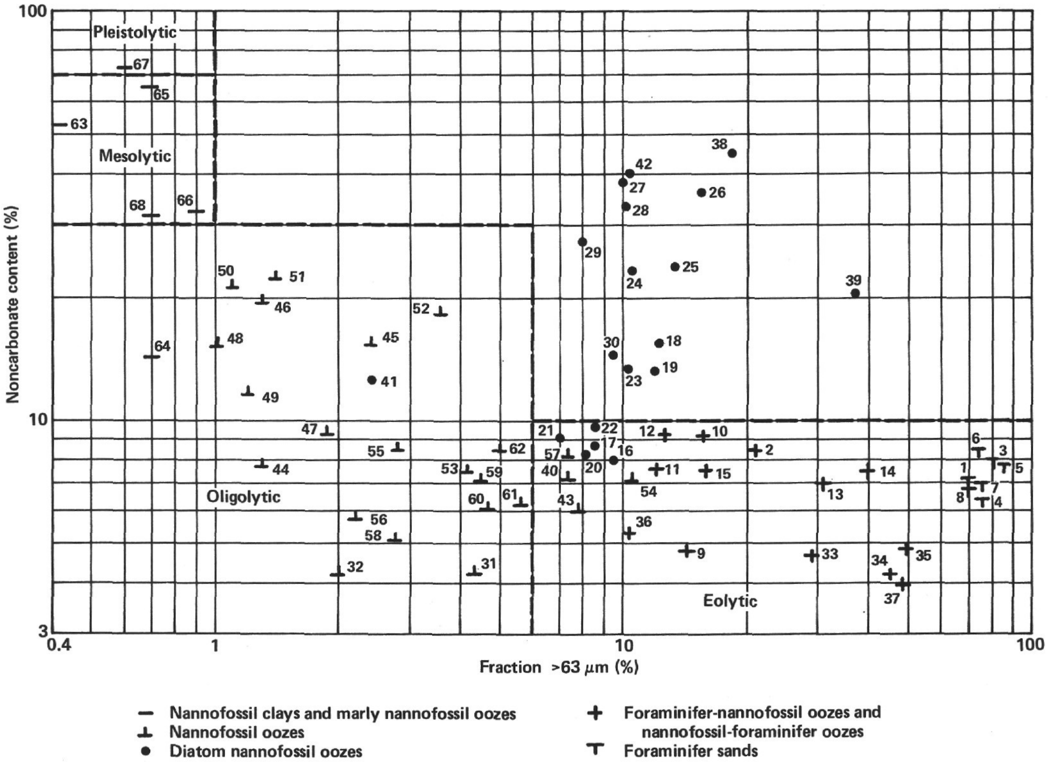

Figure 1. Terrigenous content plotted versus percentage of sand fraction. Areas of dissolution facies as defined by Violanti et al. (1979) are framed. The only sediments that do not fit the scheme are the diatom nannofossil oozes. Sample numbers refer to those in Table 1.

The ratio of whole foraminiferal tests larger than 180μm to those larger than 90μm also shows an inverse correlation to the percentage of noncarbonates (Fig. 3). The trend is not as obvious as that of the >90μm/ >63μm ratio. Clear limits between the dissolution facies cannot be traced.

CONCLUSIONS

All except a few samples from Site 519 are eolytic or oligolytic. The sediments must have been deposited above the lysocline at the time of the late Miocene until the Pleistocene. A reconstruction of the bathymetry of Site 519 and the fluctuation of the lysocline during the late Tertiary (adapted from Berger and Winterer, 1974, and Melguen, 1978) confirms that the depth of deposition of Site 519 always was shallower than the depth of the lysocline in the South Atlantic. Although we can observe an increase in dissolution in the late Miocene and the early Pliocene, the reason may be that during this time the deposition depth was about 200 m closer to the lysocline than in the late Pliocene and the Pleistocene (see Fig. 4). It is understandable that the late Miocene sediments of Site 520 are mesolytic or pleistolytic, because the lysocline was higher than the depth of deposition. The oligolytic samples of Site 520 are from the Pliocene when the lysocline was at a depth of approximately 4200 m, that is, 200 m deeper than the place of deposition.

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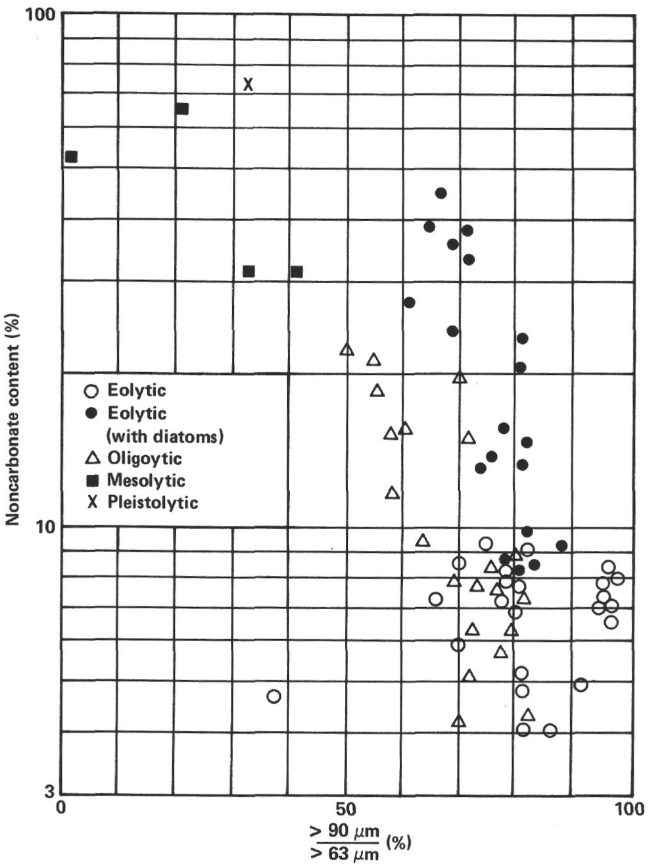

Figure 2. Terrigenous content plotted versus the ratio >90μm/>63μm. The samples are designated with symbols that indicate their dissolution facies. Sites 519 and 520.

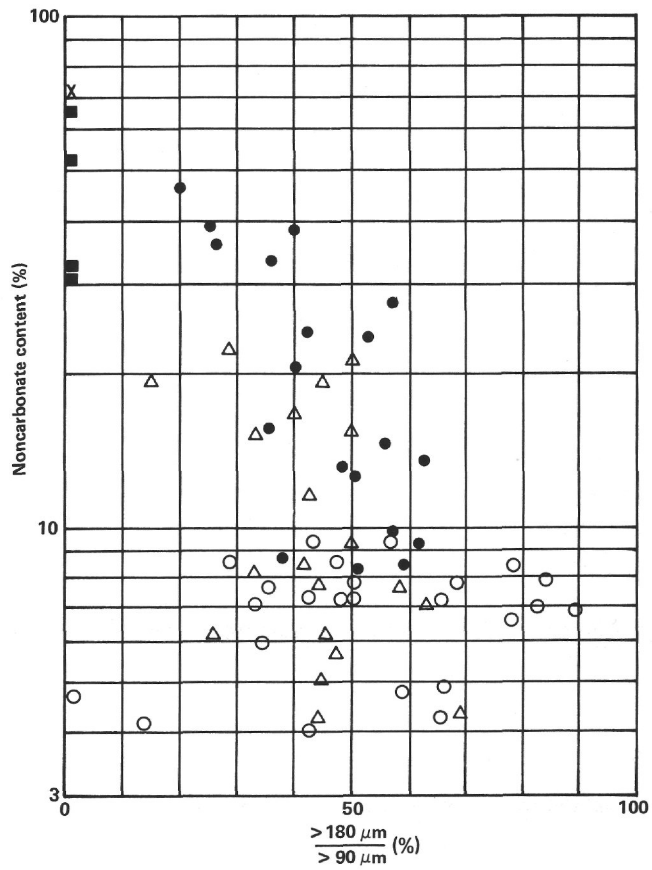

Figure 3. Terrigenous content plotted versus the ratio >180μm/>90 μm. Symbols as in Fig. 2. Sites 519 and 520.

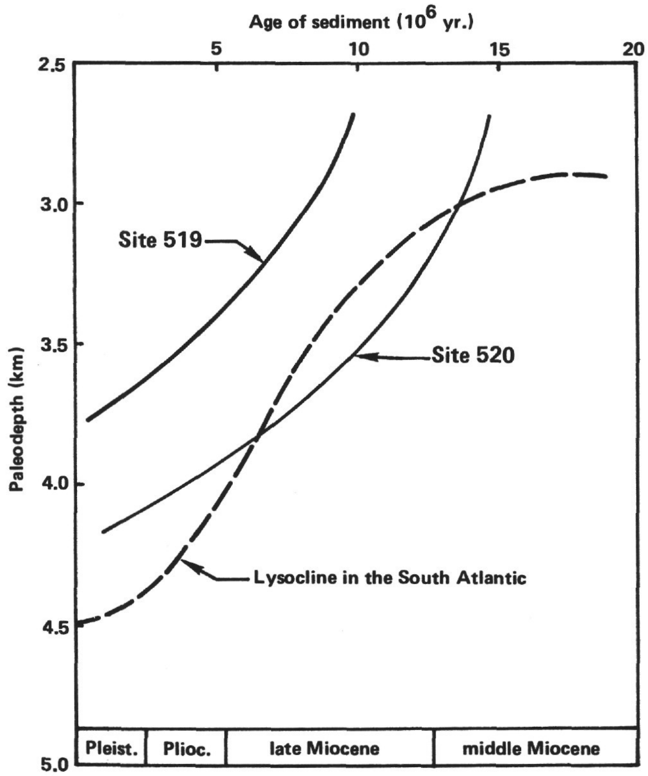

Figure 4. Bathymetry of Sites 519 and 520 (reconstructed using the backtracking method of Berger and Winterer, 1974) and fluctuation of the lysocline in the South Atlantic during the late Tertiary. CCD fluctuation curves for the South Atlantic are given in Berger and Winterer (1974) and Melguen (1978). The lysocline curve in this figure is about 500 m higher than the CCD curves. Data from Violanti et al. (1979) were utilized in addition to data from this study to reconstruct the lysocline curve.