43. PRELIMINARY DATA ON DISSOLVED ORGANIC CARBON AND SUGAR IN INTERSTITIAL WATER FROM THE MISSISSIPPI FAN AND ORCA AND PIGMY BASINS, DEEP SEA DRILLING PROJECT LEG 96[1]

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ABSTRACT

Preliminary data on dissolved organic carbon (DOC) and dissolved sugars in interstitial water samples collected at Sites 618, 619, and 623 of Deep Sea Drilling Project Leg 96 are presented.

At Site 618 in Orca Basin, the DOC content of the interstitial water peaks in the hypersaline sulfate reduction zone. The sugar content reaches a maximum and the DOC content begins to decrease at the depth of methane gas generation. Below that depth, the sugar and DOC contents are about constant.

At Site 619 in Pigmy Basin, the DOC content increases slightly with depth in the sulfate reduction and the methane fermentation zones. The sugar content is lower in the sulfate reduction zone than in the methane fermentation zone; sugar concentration increases and fluctuates with methane gas percentages within the methane fermentation zone.

At Site 623 in the lower fan region of the Mississippi Fan, there is no sulfate reduction zone. The DOC and sugar contents of the interstitial water are almost constant with depth.

INTRODUCTION

Understanding the behavior of organic matter under conditions of sulfate reduction and methane fermentation is important in geochemical studies, especially those relating to early diagenesis of organic matter. Although many studies have focused attention on organic matter in sediments (e.g., Müller and Suess, 1977; Degens and Mopper, 1979), few have addressed problems concerning the quantity and nature of organic matter present in sediment interstitial water (Henricks and Farrington, 1979; Krom and Sholkovitz, 1977; Nissenbaum et al., 1971). With respect to deep-sea sediments, information is still scarce. Available data indicate that the dissolved organic carbon (DOC) content of interstitial waters of deep-sea sediments can be much greater than that of the overlying water column (Michaelis et al., 1982).

Preliminary results of DOC and sugar analyses of interstitial water samples collected at Sites 618, 619, and 623 in the Gulf of Mexico are presented here. Site 618 is located in Orca Basin; Site 619 in Pigmy Basin, and Site 623 on the lower fan region of the Mississippi Fan (Fig. 1; introductory chapter, this volume).

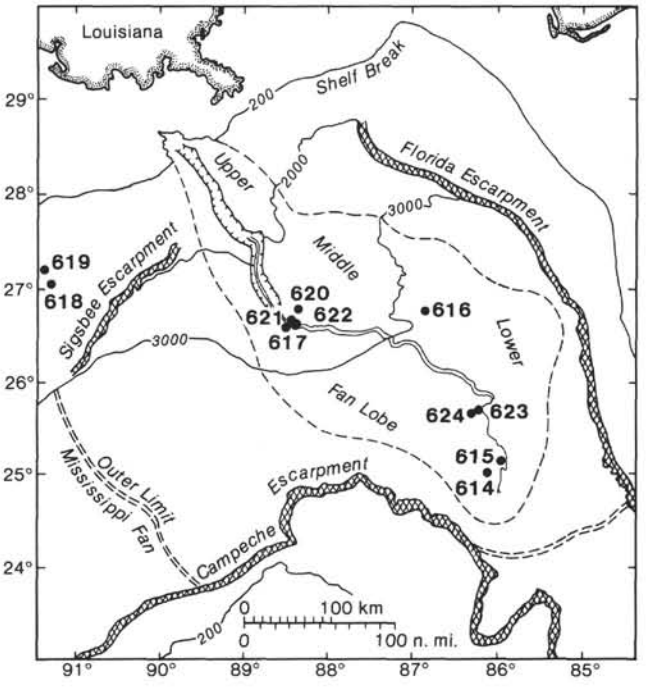

Figure 1. Location map showing sites visited on DSDP Leg 96. DOC and sugar results presented in this study come from Site 618 (Orca Basin), Site 619 (Pigmy Basin), and Site 623 (Mississippi Fan).

METHODS

DOC

Analyses of DOC were carried out on a commercially available Total Carbon Monitor TCM 400/P from Erba Science, which operates on the principle of high temperature wet oxidation. Methods used were similar to those employed by Michaelis et al. (1982) on DSDP samples from Leg 64.

Dissolved Sugars

0.5 to 1 ml of interstitial water was hydrolyzed with 2 *N* HCl at 100°C for 3.5 hr. The hydrolysate was then desalted by electrodialysis using ion-exchange membranes (Joseffson, 1970). The desalted sample

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was evaporated to dryness in a rotary evaporator after adding 40 μl of glycerine–ethanol mixture to prevent condensation reactions on the walls of the glass vessel. The residue was then taken up in a small volume of double-distilled water. An aliquot of this was analyzed for dissolved sugars on an automatic sugar analyzer (Biotronik, Frankfurt). Details of these analysis techniques are found in Mopper (1978). Total dissolved sugar data are the sum of individual sugars identified and quantified.

RESULTS AND DISCUSSION

Site 618

Site 618 is near the center of a northern sub-basin of Orca Basin, an intraslope basin depression formed between salt diapirs (introductory chapter, this volume). The surrounding salt diapirs may either outcrop or come close to the water/sediment interface.

Orca Basin is well known because of its hypersaline bottom seawater (Addy and Behrens, 1980). Drilling at Site 618 was terminated at 92.5 m sub-bottom. The major chemical composition of the interstitial water indicates that the source of the bottom water brine is the diapirs. Interstitial water analysis shows a rapid decrease in salinity from about 270‰ at the seafloor surface to about 40‰ at a sub-bottom depth of 30 m, below which it remains constant (Site 618 chapter, this volume). The sulfate reduction zone ends at a sub-bottom depth of 15 m; methane gas begins to exist in the sediment at 20-m depth.

The vertical distribution pattern of DOC in interstitial water at this site is similar to that of alkalinity (Site 618 chapter, this volume; Fig. 2; Table 1). Maximum concentrations of both DOC (225 μg/ml) and dissolved sugars (114.4 μmol/L) are observed in the zone of sulfate reduction.

At depths where methane is present, DOC remains constant at about 100 μg/ml, with a slightly higher value in the bottom sample. Sugar concentrations follow a pattern similar to the DOC, with concentrations ranging from about 20 to 50 μmol/L.

Table 1. DOC and sugar of interstitial water, Leg 96.

Core-Section (interval in cm)	Sub-bottom depth (m)	DOC (μg/ml)	Sugar (μmol/L)
Hole 618			
1-2, 140–150	3	63	12.7
2-4, 140–150	12	225	89.7
3-2, 140–150	19	189	114.4
4-2, 140–150	29	114	31.8
5-5, 140–150	43	98	24.6
6-3, 140–150	49	99	53.1
7-1, 138–150	52	92	16.9
8-1, 140–150	58	81	29.9
9-2, 138–150	73	96	27.0
10-2, 135–150	77	90	36.1
11-1, 135–150	91	123	70.5
Hole 619			
1-6, 138–150	10	72	59.3
3-5, 138–150	18	78	33.4
4-4, 138–150	26	68	50.5
5-3, 138–150	34	84	39.8
6-2, 138–150	43	79	30.7
7-2, 138–150	52	62	23.3
8-2, 135–150	62	66	14.3
9-2, 135–150	72	59	24.0
10-2, 135–150	76	92	73.9
11-2, 135–150	91	65	56.1
12-2, 135–150	101	66	98.7
13-2, 135–150	110	72	35.4
14-1, 135–150	118	85	180.3
15-2, 135–150	129	56	142.9
16-2, 135–150	139	71	55.7
17-2, 135–150	149	88	50.7
18-2, 112–127	158	94	157.5
19-1, 135–150	167	82	197.1
20-2, 135–150	178	120	192.6
22-1, 135–150	189	97	106.8
Hole 623			
1-3, 135–150	4	23	9.7
3-2, 135–150	19	24	21.7
5-2, 135–150	38	22	7.3
7-2, 135–150	58	24	8.9
9-5, 0–15	80	25	27.5
11-3, 135–150	97	25	16.8
14-2, 135–150	124	27	17.0
17-3, 1–15	152	43	11.6

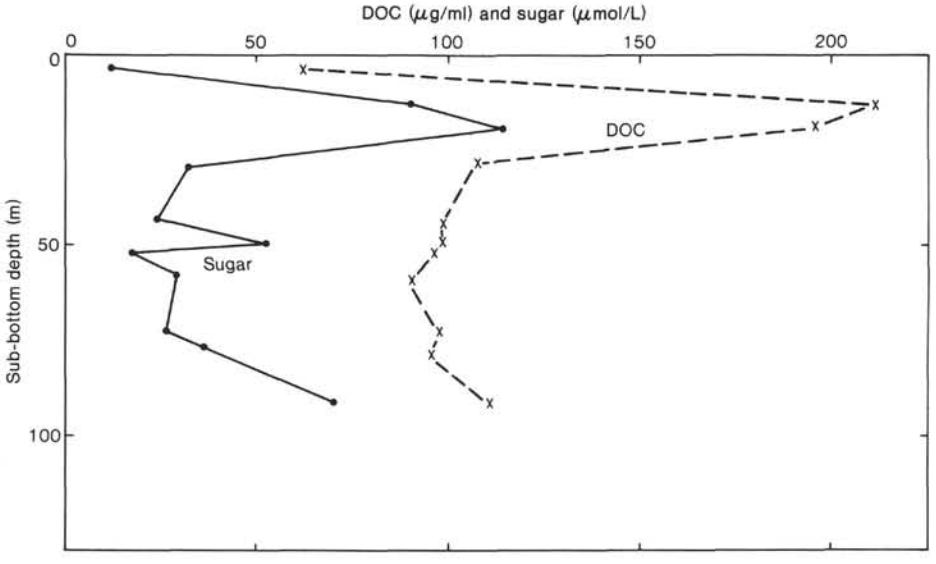

Figure 2. Vertical profile of sugar and DOC contents of interstitial water in Orca Basin, Site 618.

Site 619

Site 619 is in Pigmy Basin, a blocked-canyon type of intraslope basin (introductory chapter, this volume), which has a flat floor at a water depth of about 2260 m. The bottom water in Pigmy Basin has a normal 35‰ salinity, in contrast with the high bottom-water salinity at Orca Basin.

Salinity in the sediment column decreases with the decrease in sulfate content of the interstitial water to 70 m and is constant below that depth; chlorinity increases slightly from 18 to 19‰ with depth (Site 619 chapter, this volume).

The salinity decrease is caused by the decrease in sulfate, Mg, Ca, and K contents of the interstitial water. Those chemical compositions of interstitial water within the sulfate reduction zone (0–75 m sub-bottom) show large downhole gradients, whereas those in the methane fermentation zone (100–190 m sub-bottom) are constant with depth. Those results suggest that sulfate reduction influences major chemical composition of the interstitial water and decomposition of organic material more dramatically than does methane fermentation.

DOC concentrations from the seafloor to a depth of 70 m range from 62 to 84 μg/ml, whereas sugars range from 14 to 60 μmol/L (Fig. 3; Table 1). Below this interval (i.e., in the methane fermentation zone), there is a slight increase in DOC to a maximum of 120 μg/ml. Sugar concentrations increase substantially with values up to about 200 μmol/L. At this site, the sugar distribution pattern matches that of methane. Even the minimum values for sugars (50 and 55 μmol/L) and methane coincide with each other.

Site 623

Site 623 is located adjacent to a channel on the lower Mississippi Fan. Major ion concentrations of interstitial water (including sulfate) are constant with depth (Ishizuka, Kawahata, et al., this volume).

DOC concentrations of interstitial water remain fairly constant, with values between 22 and 27 μmol/ml except for the bottom sample. Sugar concentrations range from 7.3 μmol/L to 27.5 μmol/L (Fig. 4). The low DOC and sugar concentrations are probably related to the absence of a well-defined sulfate reduction zone. Organic decomposition mediated by anaerobic bacteria is low.

CONCLUSIONS

Only three sites had been analyzed at the time of this writing. These three sites differ from one another in their

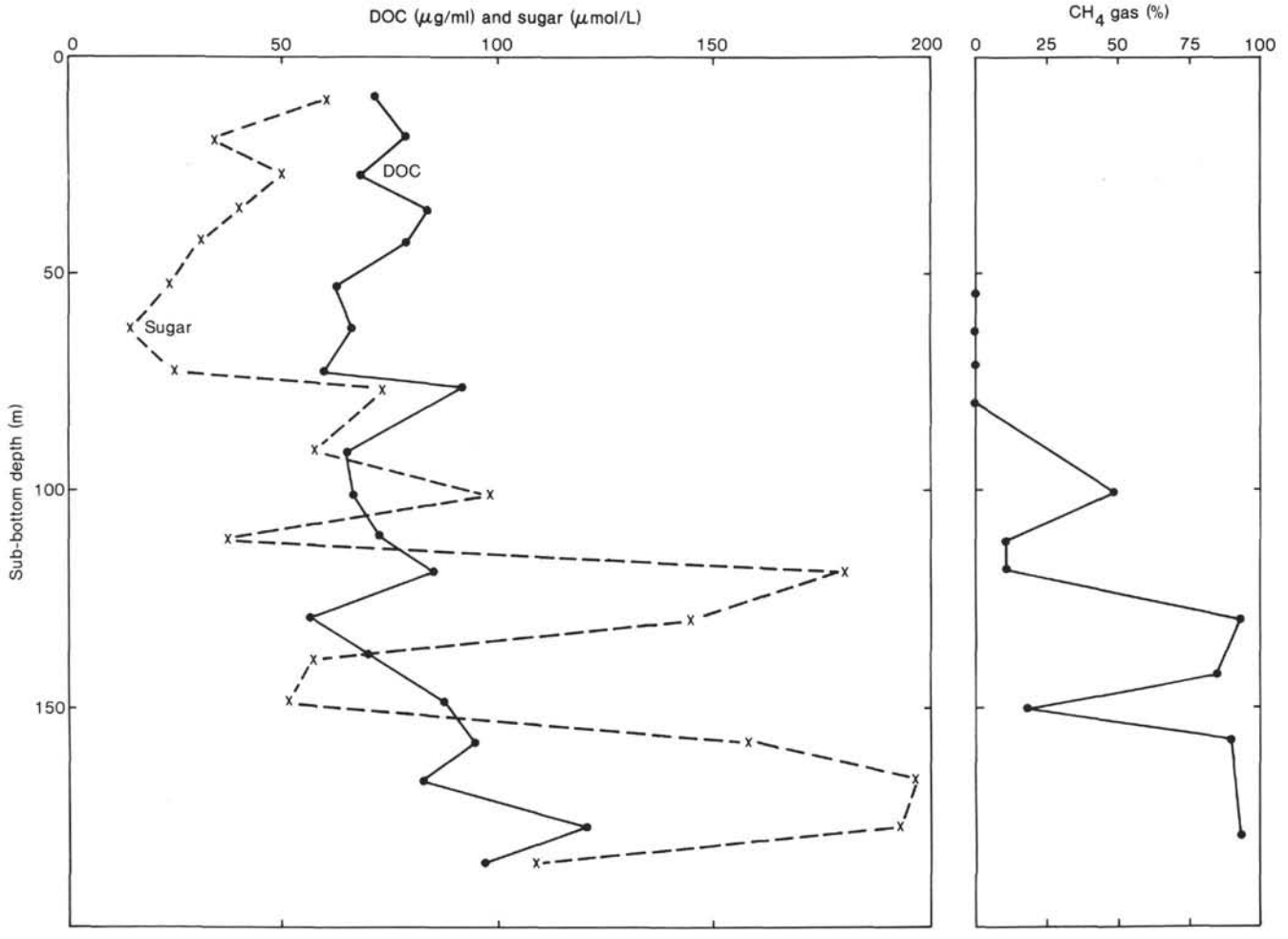

Figure 3. Vertical profile of sugar and DOC contents and percentage methane in interstitial water from Pigmy Basin, Site 619.

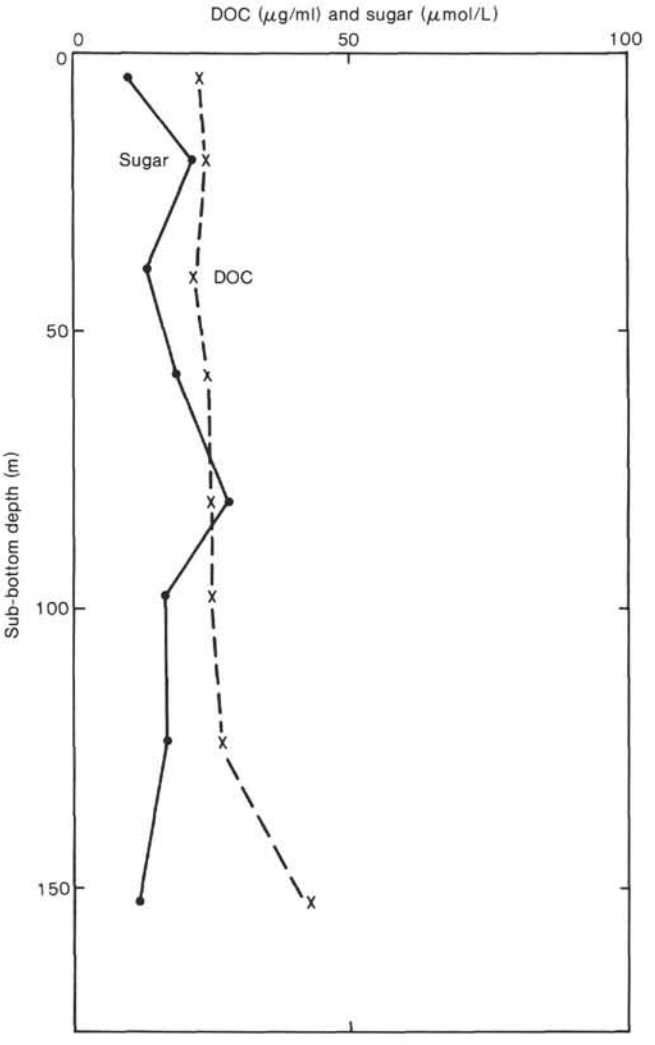

Figure 4. Vertical profile of sugar and DOC contents of interstitial water of the lower Mississippi Fan, Site 623.

DOC and sugar distribution patterns. Strong concentration gradients are observed only in core samples where microbial processes such as sulfate reduction and methane fermentation are evident. However, even within sediments where these processes take place, there are differences in the observed vertical profiles of DOC and sugars. For example, at Site 618, higher concentrations of both DOC and sugars are found in the zone of sulfate reduction. In contrast, Site 619 exhibits maximal sugar concentrations in the zone of methane fermentation. In both instances, values greater than those in interstitial water samples from the surface sediment are found in the zones of sulfate reduction and methane fermentation. Comparison of data from Sites 618 and 619 with those from Site 623 strongly suggests that microbial activity in the anaerobic zone has a pronounced impact on the nature and quantity of organic matter present in interstitial waters.

To what extent microbially degraded organic matter contributes to the dissolved organic matter established in surface sediments has to await more comprehensive studies.

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