17. CARBOHYDRATE RESIDUES IN CORE SAMPLES FROM THE MOUTH OF THE GULF OF CALIFORNIA[1]

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INTRODUCTION

Selected parts of ten frozen core samples from Holes 482A, 482B, 483A, and 485A, Leg 65 of the Deep Sea Drilling Project (DSDP), were analyzed for residual carbohydrates in order to determine the provenance and history of the organic material in the sediments. The samples, which represented silty-clay, shale, and nannofossil-chalk sediments, were analyzed for water-soluble monosaccharides, acid-soluble monosaccharides, and for starch and cellulose.

Most samples yielded positive results for acid-extractable (polymeric) arabinose, fucose, xylose, mannose, galactose, and glucose. Amylose was detected in seven of the samples, whereas cellulose was found in only one. Possible explanations for the relatively high levels of free sugars are suggested in the conclusions to this chapter.

PROCEDURES

Samples ranging from 7.5 to 37.8 g were extracted with boiling water under reflux conditions for 24 hr., and then extracted with 0.5 *N* sulfuric acid for 24 hr. The two extracts were further processed as described previously (Swain, 1970) for analysis of free sugars and polysaccharide residues in the water extracts, and for polymeric sugars in the acid extracts. Monosaccharides were analyzed by gas-liquid chromatography of trimethylsilyl-ether derivatives of the constituent sugars as previously reported for Leg 64 samples (Swain and Bratt, in press). Analyses for starch and cellulose were made using cellulase and amylase enzyme preparations, respectively. The results are shown in Table 1.

RESULTS

The water-soluble carbohydrates, representing free monosaccharides, range from 0.0 to 6.7 μg/g of dry sediment. The samples from Zones NN20/21 generally yielded more free sugars than those from Zone NN19. Glucose and galactose are the most abundant monosaccharides in most samples, but xylose and mannose are present in significant amounts in four samples. Arabinose is present in three samples, but fucose was not found in the water extracts. This assemblage of free sugars suggests a primary source in land-derived vegetation (Swain, 1969). The absence of fucose suggests that larger algae were not a major source of these carbohydrates. The free sugar fraction in the sediments may result from the degradation, in place, of parts of incorporated polymeric sugars. The levels of free sugars in Leg 65 samples are higher than in most Leg 64 samples from Guaymas Basin, most of which yielded little or no sugar.

The acid-extractable monosaccharides of the Leg 65 samples are shown in Table 1. These range from 0.0 μg/g in two indurated samples (which also lack free sugars) to about 210 μg/g. The values are in the same general range as those of the Quaternary samples from Leg 64 (Swain and Bratt, in press). The two indurated samples lack or have only traces of carbohydrates, probably because of heating effects by igneous rocks lying beneath the sedimentary section. The polymeric sugars suggest a variety of sources including terrestrial plants, marine algae, and bacteria (Swain, 1969). As in Leg 64 samples, the level of polymeric carbohydrates is higher than in most other offshore oceanic samples previously analyzed (Swain and Bratt, 1972, 1978).

Amounts of alpha- and beta-amylose are higher in Leg 65 samples than in those from Leg 64, where only one sample contained measurable amounts of polysaccharides. Cellulose, however, was detected in only one Leg 65 sample, that in which no starch was found (Table 1). There is no explanation for these variations.

CONCLUSIONS

The levels of free sugars are relatively higher and include a wider variety of monosaccharides than in most other marine samples we have analyzed, including those of Leg 64. Though present explanations are only speculative, the higher content may be due to: (1) more strongly reducing conditions in the bottom sediments penetrated in Leg 65 than in those of the Guaymas Basin of Leg 64, (2) to enriched sources in Leg 65, or (3) to higher heat-flow effects in the Leg 64 sediments. At the same time, polysaccharide residues are higher in Leg 65 than in Leg 64 samples.

Among the polymeric sugar residues, the relatively high amount of xylose in Leg 65 samples is noteworthy. It is thought to indicate a major source in terrestrial plants that have been transported to the area, perhaps by turbidity currents.

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Table 1. Water-extractable and acid-extractable carbohydrates in Leg 65 samples.

Sample (interval in cm) and Carbohydrate Fraction	Sediment Age and Description	Carbohydrate (µg/g)						
		Arabinose	Fucose	Xylose	Mannose	Galactose	Glucose	Sum
482A-2-4, 120-127	late Quaternary, Zones NN20/21, Grayish olive, silty diatomaceous clay							
Water extract		0.44	0	0.60	0.71	1.31	1.34	4.4
Acid-extract		7.75	51.1	20.12	0.72	39.25	24.2	143.14
Alpha-amylose							0	
Beta-amylose							55.04	
Cellulose							0	
482A-5-5, 116-124	late Quaternary, Zones NN20/21, Olive gray silty clay							
Water-extract		0	0	0.89	0.46	1.48	1.15	3.98
Acid-extract		23.84	34.18	47.50	16.22	45.00	43.24	210.00
Alpha-amylose							2.04	
Beta-amylose							8.43	
Cellulose							0	
482B-2-2, 120-128	late Quaternary, Zones NN20/21, Olive gray silty clay							
Water-extract		0	0	0	0.6	0	1.3	1.9
Acid-extract		4.0	13.0	6.0	5.0	16.0	18.0	62.0
Alpha-amylose							6.8	
Beta-amylose							1.7	
Cellulose							0	
482B-5-2, 120-125	late Quaternary, Zones NN20/21, Olive gray silty clay							
Water-extract		0	0	0	0	1.42	1.49	2.91
Acid-extract		1.42	0	1.48	0.91	1.76	3.54	9.1
Alpha-amylose							0	
Beta-amylose							0	
Cellulose							0	
482B-8-4, 120-128	late Quaternary, Zones NN20/21, Stiff, indurated, silty clay							
Water-extract		0	0	0	0	0	0	
Acid-extract		0	0	0	0	0	0	
Alpha-amylose							1.24	
Beta-amylose							0	
Cellulose							0	
482B-10-4, 120-128	late Quaternary, Zones NN20/21, Olive gray fissile shale, dehydrated and compacted							
Water-extract		0	0	0	0	0	0	
Acid-extract		0	0	0	0	0	0	
Alpha-amylose							0	
Beta-amylose							0	
Cellulose							7	
483B-2-4, 120-130	early Quaternary, Zone NN19, hemipelagic olive gray to olive black silty clay							
Water-extract		0	0	0	0	0	0	
Acid-extract		10.97	4.62	14.38	6.91	9.50	13.68	60.06
Alpha-amylose							2.15	
Beta-amylose							2.31	
Cellulose							0	
485A-5-2, 120-127	early Quaternary, Zone NN19, olive gray-gray olive silty clay							
Water-extract		0	0	0	0	0	0	
Acid-extract		0.63	1.33	5.09	0.78	1.44	1.92	11.19
Alpha-amylose							0	
Beta-amylose							0	
Cellulose							0	
485A-8-1, 120-128	early Quaternary, Zone NN19, grayish olive firm silty clay							
Water-extract		0.4	0	3.24	0	1.15	1.86	6.7
Acid-extract		0	0	trace	0	trace	0	
Alpha-amylose							1.3	
Beta-amylose							15.0	
Cellulose							0	
485A-22-5, 110-116	early Quaternary, Zone NN19, gray nannofossil chalk							
Water-extract		0	0	0.53	0	0.86	1.07	2.5
Acid-extract		0	0	trace	0	0	0	
Alpha-amylose							0.26	
Beta-amylose							0	
Cellulose							0	

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