34. PHYSICAL PROPERTIES OF SEDIMENTS FROM THE MOUTH OF THE GULF OF CALIFORNIA, LEG 65, DEEP SEA DRILLING PROJECT[1]

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ABSTRACT

The physical properties of 138 unconsolidated hemipelagic silty clays and turbidites from the mouth of the Gulf of California were analyzed in order to determine their grain size, shear strength, compressional wave velocity, porosity, specific gravity, wet-bulk density, water content, void ratio, and degree of saturation. As at other Deep Sea Drilling Project (DSDP) sites, the wet-bulk density, sonic velocity, and shear strength tended to increase with depth while the porosity and water content decreased in response to increasing compaction. The grain size and clay fraction varied irregularly with depth.

The wet-bulk density ranged from 1.34 to 2.58 g/cm^3, while the shear strength and compressional wave velocity ranged from 0.03 to 1.05 tons/ft.^{2} and 1.47 to 4.25 km/s, respectively. The porosity varied between 8 and 79%, while the water content ranged from 28.0 to 175.6%; most samples were effectively 100% saturated. The specific gravity ranged from 1.71 to 3.24 and showed a tendency to be directly related to the wet-bulk density and thus inversely related to porosity.

The physical properties of the hemipelagic sediments and turbidites are noticeably different, and the properties of both were modified by diagenesis near the basement.

INTRODUCTION

There are three principal methods of characterizing sediments: (1) microscopic and laboratory investigation of their constituents, (2) geochemical analysis, and (3) laboratory or field measurements of physical or engineering properties (Shepard, 1960; Richards, 1962). We shall here consider the physical properties (grain size, porosity, wet-bulk density, water content, specific gravity of solids, void ratio, degree of saturation, volume, shear strength, and compressional wave velocity) of 138 unconsolidated sediment samples of late Cenozoic age collected at four sites east of the tip of Baja California during DSDP Leg 65 (Fig. 1). The measurements reported were performed by the authors in the Laboratorio de Geología, Instituto de Ciencias del Mar y Limnología and Laboratorio de Sedimentología, Instituto de Geología, Universidad Nacional Autónoma de México. Terms and symbols used conform in general to those published in 1958 by the Joint Committee on Glossary of Terms and Definitions in Soil Mechanics of the American Society of Civil Engineers and the American Society for Testing Materials.

Measurements of wet-bulk density, porosity, compressional wave velocity, and shear strength were made at closely spaced intervals throughout the sediment column at all four sites. The values of wet-bulk density were determined at room temperature and pressure by means of the cylinder technique and are considered accurate to ±2% (Boyce, 1973). The porosities of the sediments were calculated from the densities of the samples before and after drying. The specific gravity of the solids, G_s, was determined from the relation,

$$G_s = \frac{W_s G_T}{W_s - W_1 + W_2} \quad (1)$$

where W_s is the weight of the sample after drying; G_T is the specific gravity of distilled water at temperature T; W_1 is the weight of the sediment immersed in air-free distilled water; and W_2 is the weight of the volumetric flask and air-free water.

The water content, W, was computed from the relation,

$$W = \frac{W_w}{W_s} \times 100 \quad (2)$$

and is the ratio of the weight of water in a given sample, W_w, to the weight of the sample after drying, W_s. As suggested by Richards (1962), we have also calculated the water content, WC, as a percentage of the total wet weight of the sample from the relation,

$$WC = \frac{W_w}{W_s + W_w} \times 100 \quad (3)$$

and calculated the void ratio, e, which is the ratio of the volume of void space, V_v, to the volume of solid particles, V_s, in the sediment, as indicated in the relation,

[1] Lewis, B. T. R., Robinson, P., et al., *Init. Repts. DSDP*, 65: Washington (U.S. Govt. Printing Office).
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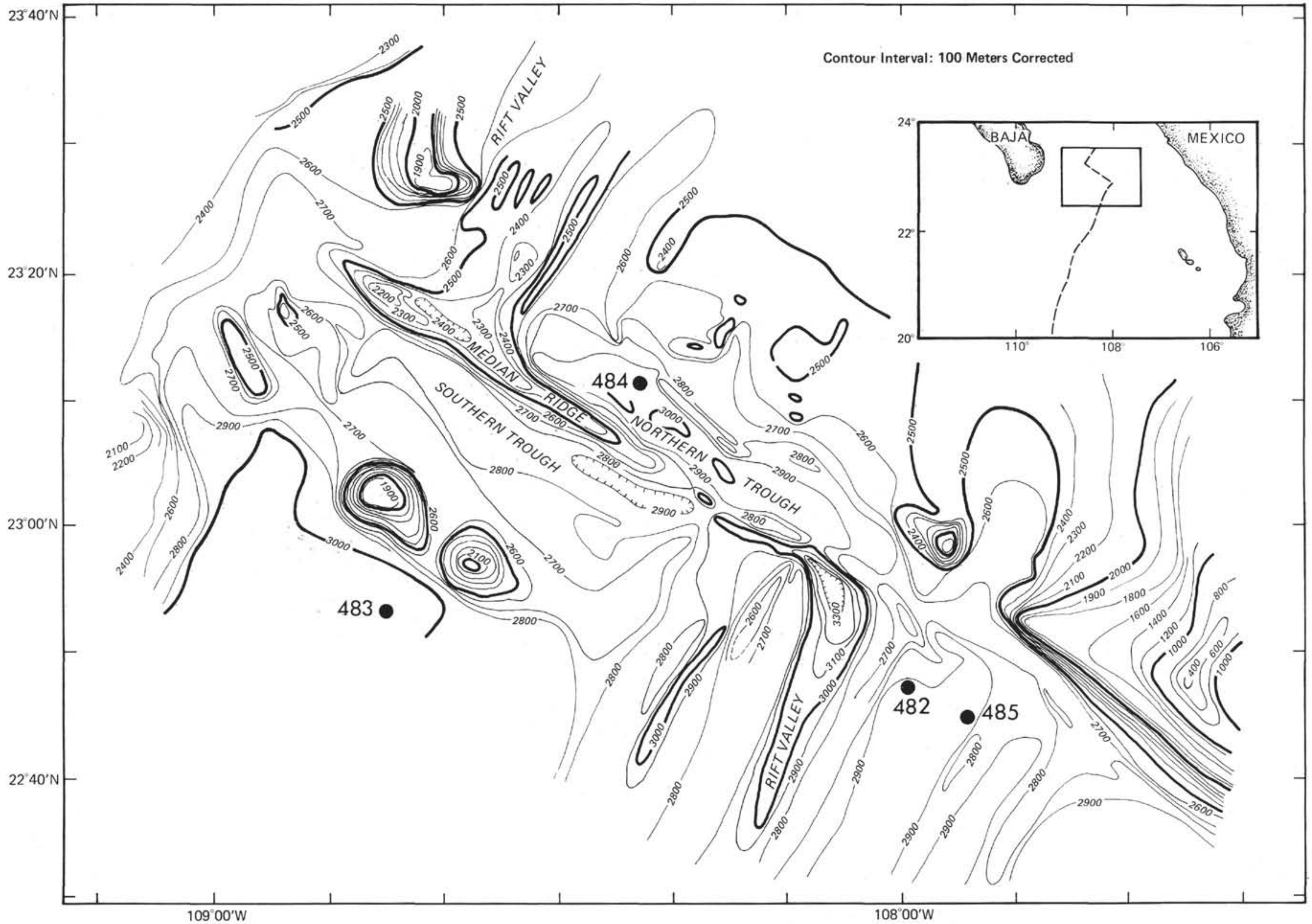

Figure 1. Location of Sites 482, 483, 484, and 485.

$$e = \frac{V_v}{V_s}. \quad (4)$$

This ratio, which is particularly applicable to water-saturated sediments, is determined in the laboratory from the relation,

$$e = \frac{G_s \gamma_w V}{W_s} - 1 \quad (5)$$

where γ_w is the unit weight of water and V is the volume of the sample.

The void ratio may also be recomputed at 100% saturation from the equation

$$e_{sat} = \frac{G_s W}{100} \quad (6)$$

At 100% saturation, the water content is related to the porosity, ϕ, and may be computed from the equation,

$$W = \frac{\phi}{(100 - \phi) G_s} \times 100. \quad (7)$$

The percent or degree of saturation, S, was computed from the relation

$$S = \frac{W_w}{\gamma_w \left[V - \left(\frac{W_s}{G_s \gamma_w} \right) \right]} \times 100 \quad (8)$$

where the term in large brackets is the volume of voids, V_v.

The shear-strength measurements were made using a Torvane meter with interchangeable blade attachments. The compressional wave-velocity data were obtained at room temperature and pressure using the Hamilton Frame Velocimeter (Boyce, 1973). The grain-size information was determined by sieve and pipette techniques (Gutiérrez-Estrada, this volume). For samples with a cumulative percentage of less than 95% at 11 ϕ, the unsampled fine population was extrapolated to 100% at 14 ϕ.

RESULTS

Site 482

The sediments at Site 482 (Fig. 2) consist predominantly of fine-grained hemipelagic silty clay and clayey silt containing 40% clay, with fine-grained turbidites containing up to 30% sand near the base of the section. As can be seen in Table 1, the values of wet-bulk density and porosity vary regularly with depth, the density increasing from approximately 1.6 g/cm^3 near the top of the column to about 1.9 g/cm^3 near the base. The only significant departures from this trend are observed in diagenetically altered sediments recovered near the basement where densities as high as 2.58 g/cm^3 and porosities as low as 13% are present.

With the exception of the altered sediments recovered in the lower parts of the section, which display compressional wave velocities as high as 4.25 km/s, the sediment velocities shown in Table 1 range for the most part between 1.5 and 1.6 km/s and show a weak tendency to increase with depth. The velocities in the sediments between 40 and 70 meters sub-bottom could not be determined because of high signal attenuation caused by gas bubbles.

The shear strength was quite low throughout most of the column, ranging from about 0.2 to 0.4 tons/ft.^{2} throughout most of the section except near the base, between 100 and 135 meters, where values as high as 0.8 tons/ft.^{2} were encountered. Since the sediments are predominantly fine-grained throughout the column, the change near the base of the column is tentatively attributed either to a change in packing or to incipient diagenesis.

The specific gravities of the solids fall between 1.76 and 3.06 with most displaying values of 1.90 to 2.35. The average for all of the samples is 2.15. There is a tendency for the specific gravities to decrease with depth and thus to be inversely related to the wet-bulk density. For most of the sediments, the water content, W, ranges between 60.0 and 85.0%, with the average being 62% and the extremes being 47% and 83%. The degree of saturation fluctuates between 90% at a sub-bottom depth of 39.25 meters and 134% near the bottom of the sedimentary section.

Site 483

As can be seen in Figure 2, the sediments at Site 483 consist of soft to very soft, fossiliferous silty clay clayey silt and fine-grained turbidites. Between the mud line and a depth of 73 meters, the average grain size is 8.3 ϕ and the clay fraction ranges from 30 to 70%. Between 73 meters and the top of the basement at 109 meters, the average grain size is 8.3 ϕ and the clay fraction averages 45%. The sediments interlayered in the basement have an average grain size of 6.7 to 8.1ϕ and a clay fraction of 24 to 49%.

With the exception of the shear strength, which increases from 0.04 to about 0.25 tons/ft.^{2} in the upper 73 meters of the sediment column, the physical properties of the upper sediments show remarkably little variation with depth: the wet-bulk density ranges narrowly between 1.36 and 1.45 g/cm^3, the compressional wave velocity ranges from 1.47 to 1.49 km/s, the porosity ranges between 72 and 77%, and the specific gravity of the solids fluctuates from 1.73 to 2.54. Similarly, the water content, W, varies slightly from 124% to 172%, the degree of saturation ranges from 108% to 120%, and the void ratio ranges from 2.63 to 3.44.

Between 73 meters and the basement, the physical properties of the sediments change markedly with depth in response to increasing compaction: the wet-bulk densities increase to about 1.7 g/cm^3, the compressional

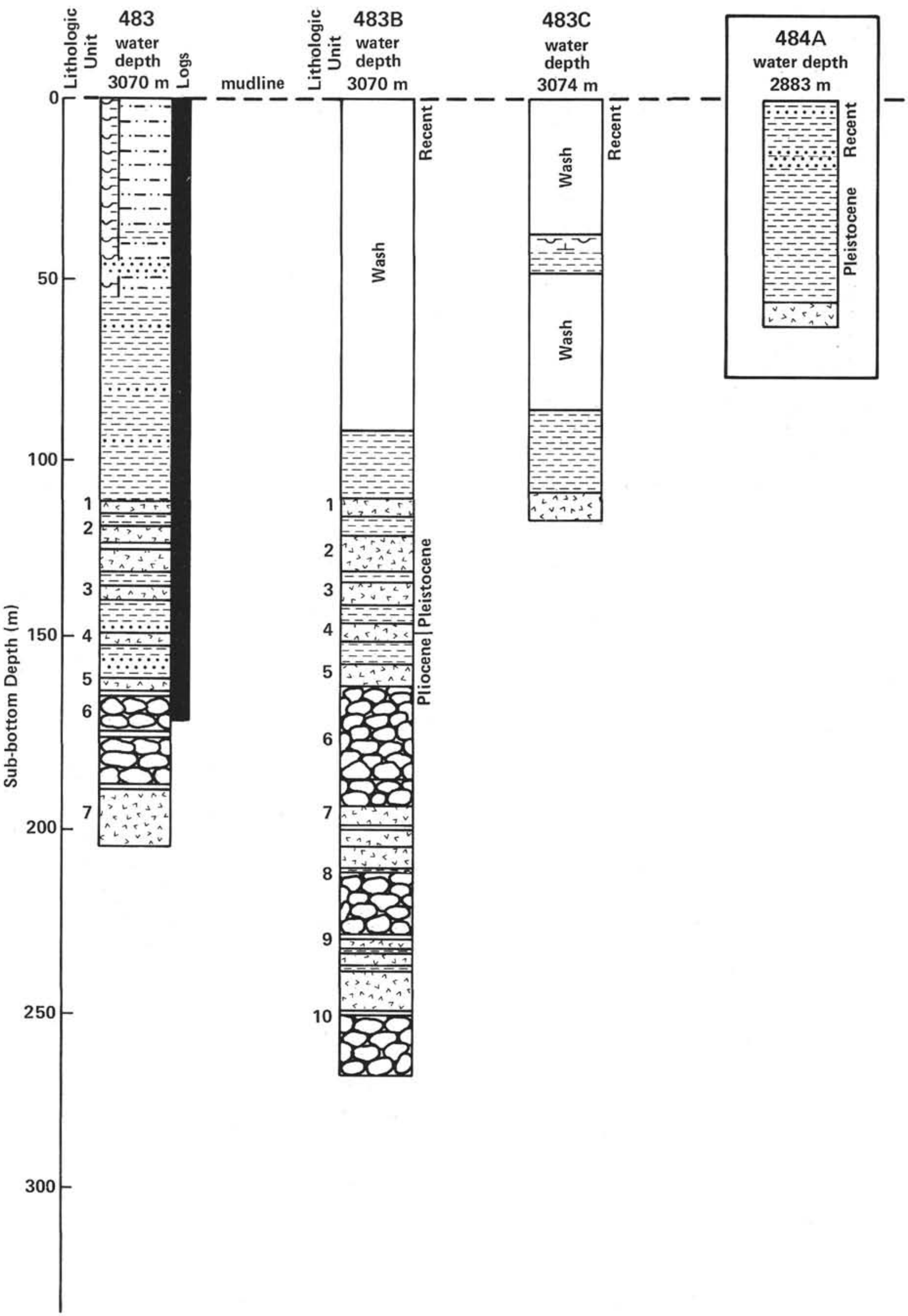

Figure 2. Lithologic columns for Sites 482, 483, 484, and 485.

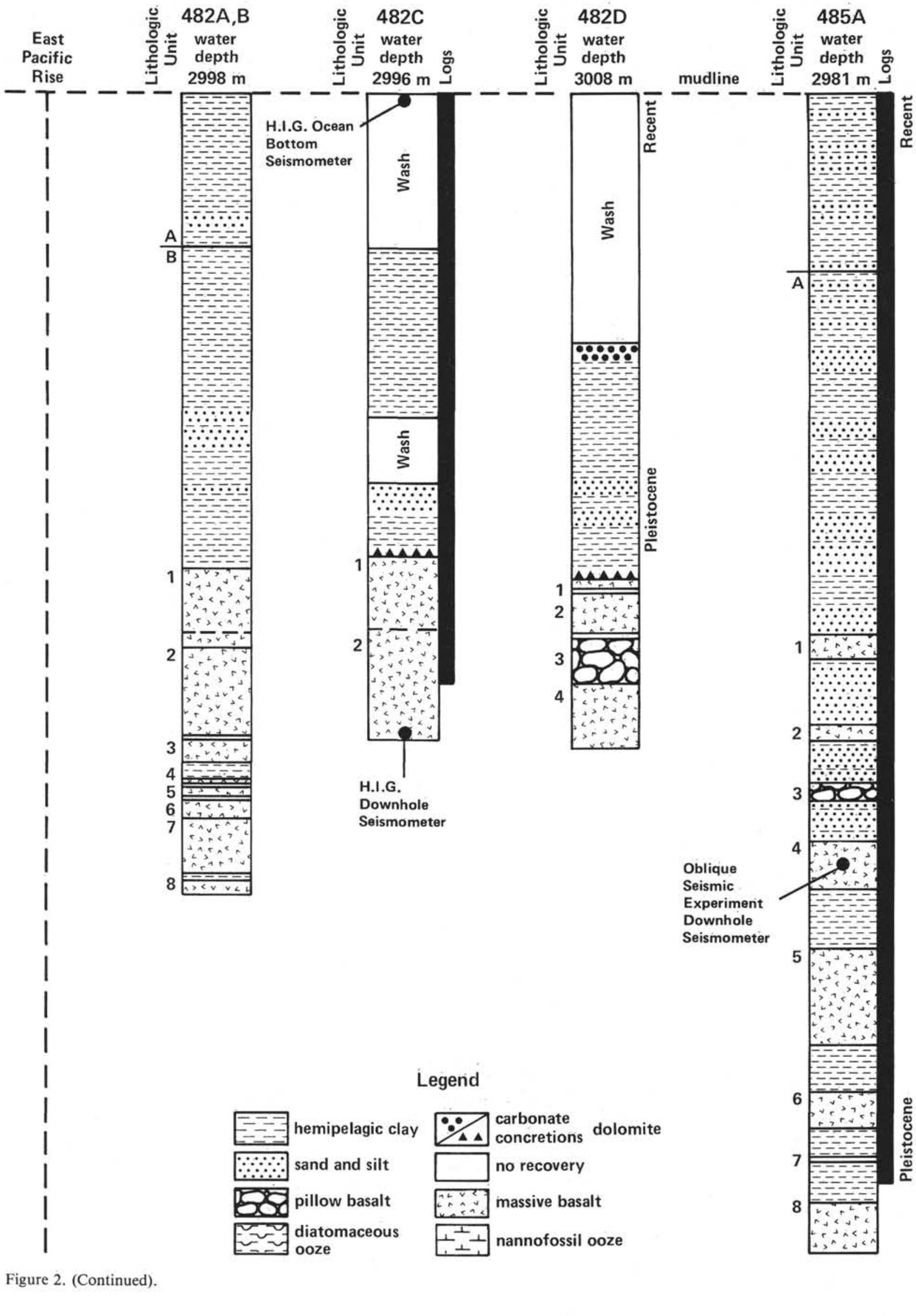

Figure 2. (Continued).

Table 1. Physical properties of sediments, Leg 65.

Sample (interval in cm)	Depth (m)	Wet-Bulk Density (g/cm^3)	Porosity (%)	Water Content (%) *WC*	Water Content (%) *W*	Specific Gravity of Solids	Void Ratio	Degree of Saturation (%)	Shear Strength (tons/ft.^{2})	*P*-Wave Velocity (km/s)	Clay Fraction (%)	Mean Grain Size (ϕ)	Lithology
482A													
1-2, 14–17	1.64										62	8.3	Silty clay
1-4, 80–90	5.30	1.57	64										
2-2, 18–21	7.68										39	7.4	Clayey silt
2-4, 60–68	11.10	1.51	68										
4-4, 37–49	29.87	1.65	59										
4-4, 80–82	30.30									1.52			
4-4, 25–27	39.25	1.66	59	32	47	3.06	1.43	90			28	5.9	Clayey silt, sandy silt
5-4, 76–78	39.76								0.23				
482B													
1-4, 115–117	49.65								0.18				
1-4, 139–141	49.89	1.55	66	45	83	2.34	1.93	106			63	8.1	Silty clay
2-4, 35–41	58.35	1.65	59	40	67	2.16	1.43	112	0.18		40	7.5	Clayey silt
4-3, 63–76	76.13								0.19	1.54			
4-3, 95–97	76.45	1.63	61	42	72	2.17	1.56	112			33	7.3	Clayey silt
5-3, 5–7	85.05								0.26				
5-3, 36–38	85.36	1.62	61	41	71	2.21	1.56	110			34	7.5	Clayey silt
6-4, 24–36	96.24	1.75	53	32	48	2.35	1.12	107	0.08	1.58	12	4.9	Silty sand
7-2, 50–63	103.00	1.70	56	38	61	2.09	1.27	115	0.57	1.49	46	8.4	Clayey silt
8-4, 71–74	115.71	1.77	52	36	56	1.94	1.08	122			38	7.8	Clayey silt
8-4, 95–97	115.95								0.80				
8-4, 116–118	116.16									1.52			
9-3, 17–28	123.17	1.75	53	36	57	1.99	1.13	119			29	7.7	Clayey silt
10-5, 75–77	136.25									1.53			
10-5, 95–105	136.45	1.81	49	33	50	1.91	0.96	124			54	8.1	Silty clay
19-1, 31–33	193.31	1.9	44							1.99			
482C													
8-1, 72–75	130.72	2.58	13							4.25			Dolostone
9-1, 8–10	132.08									2.76			Dolostone
482D													
1-3, 35–37	74.85	1.64							0.35		42	7.5	Clayey silt
1-3, 120–131	75.70	1.64	60							1.47			
2-3, 95–100	84.95	1.73	54	39	65	1.80	1.17	126			48	8.1	Clayey silt
2-3, 143–145	85.43								0.35				
3-2, 63–65	92.63									1.48			
3-2, 100–114	93.00	1.71	56	42	72	1.76	1.27	128			34	7.8	Clayey silt
4-2, 99–117	102.49	1.71									59	8.5	Silty clay
5-1, 49–54	109.99								0.63	1.51			
5-1, 95–98	110.45	1.72	55	38	63	1.95	1.22	120			32	7.4	Clayey silt
6-2, 13–16	120.63	1.59						134			23	6.6	Clayey silt
6-2, 40–43	120.90	1.74	57							1.67			
7-2, 20–29	130.20	1.80							0.40		50	7.9	Clayey silt
7-2, 80–82	130.80	1.69	59										
482F													
4-3, 37–39	135.37	1.75	54							1.66			
483													
2-3, 54–77	4.54	1.39	76	60	153	2.07	3.15	111	0.04	1.47	55	8.2	Silty clay
3-2, 65–88	12.65	1.44	73	58	135	1.99	2.69	113	0.05	1.48	68	9.3	Silty clay
4-2, 43–78	21.93	1.41	74	57	135	2.11	2.84	109	0.11	1.49		9.0	Silty clay
6-2, 75–97	41.25	1.42	74	58	136	2.10	2.86	111	0.13	1.49		8.3	Clayey silt
7-4, 88–103	53.88	1.41	74	57	131	2.17	2.84	108	0.04	1.49		8.4	Silty clay
8-4, 44–67	62.94	1.42	74	58	136	2.09	2.84	111	0.11	1.49		7.6	Clayey silt
9-4, 70–89	72.70	1.43	73	55	124	2.18	2.70	108	0.25	1.49		7.6	Clayey silt
10-2, 41–56	78.91	1.54	66	49	97	1.99	1.94	115	0.18	1.49		7.3	Clayey silt
11-4, 52–67	91.52	1.57	64	46	84	2.10	1.77	112	0.20	1.51		8.2	Clayey silt
12-4, 53–80	101.03	1.70							0.48	1.51		7.3	Clayey silt
13-2, 39–72	107.39	1.64	60	45	82	1.83	1.49	123	0.69	1.50	37	7.6	Clayey silt
18-4, 24–57	155.74	1.76							0.68	1.58		8.1	Clayey silt
483B													
1-3, 102–111	95.52	1.58	64	49	96	1.85	1.77	121		1.52	46	8.2	Clayey silt
1-3, 128–143	95.78	1.57	64	44	79	2.23	1.77	109	0.37		33	7.5	Clayey silt
1-5, 80–82	98.30	1.57	64	48	92	1.92	1.77	118		1.52	57	8.6	Silty clay
2-3, 98–124	104.98	1.65	60	44	78	1.92	1.49	121	0.46	1.57	43	8.1	Clayey silt
2-4, 60–62	106.10	1.60	62	43	77	2.16	1.66	112			49	8.3	Clayey silt
2-6, 95–112	109.45	1.70	56	40	67	1.90	1.27	122		1.53	44	8.2	Clayey silt
20-2, 120–129	211.20	1.93	45							1.93	24	6.7	Clayey silt
25-2, 5–24	232.55	2.19	29							2.22	38	7.7	Clayey silt
483C													
1-1, 35–37	38.85	1.45	72								58	8.9	Silty clay
1-2, 96–98	40.96	1.36	77	63	172	2.00	3.44	111			65	8.5	Silty clay
1-3, 55–57	42.05	1.37	77	57	132	2.54	3.34	102			53	8.3	Silty clay
1-4, 60–62	43.60	1.36	77	58	138	2.50	3.44	102			41	7.8	Clayey silt
1-5, 90–92	45.40	1.44	72	60	152	1.73	2.63	120			46	8.1	Clayey silt
2-3, 9–12	89.09	1.50	69	49	96	2.32	2.22	106			53	8.3	Silty clay
2-7, 90–107	92.90	1.52								1.48	56	8.6	Silty clay

Table 1. (Continued).

Sample (interval in cm)	Depth (m)	Wet-Bulk Density (g/cm^3)	Porosity (%)	Water Content (%)		Specific Gravity of Solids	Void Ratio	Degree of Saturation (%)	Shear Strength ($tons/ft.^2$)	*P*-Wave Velocity (km/s)	Clay Fraction (%)	Mean Grain Size (ϕ)	Lithology
				WC	*W*								
483C (cont.)													
2-7, 15–17	95.15	1.56	65	43	75	2.48	1.85	105		1.55	31	7.2	Clayey silt
3-2, 75–77	97.75	1.61	62	45	76	2.15	1.62	112			45	7.9	Clayey silt
3-2, 105–107	98.05									1.55			
4-1, 19–21	105.19	1.60	62	46	86	1.93	1.66	122			51	8.5	Silty clay
4-1, 34–36	105.34									1.67			
4-2, 16–32	106.66	1.47	71	54	115	2.13	2.45	113		1.62	59	8.1	Silty clay
484													
1-1, 112–115	1.12									1.49			
1-2, 107–124	2.57	1.45	72	52	110	2.34	2.57	106	0.09		38	7.6	Clayey silt
1-4, 12–30	4.62	1.46	71	49	98	2.50	2.45	103	0.13	1.50	48	8.1	Silty clay
484A													
1-3, 93–110	3.93	1.42	74	61	156	1.82	2.84	117			51	8.2	Silty clay
1-4, 61–100	5.11	1.50	69	49	95	2.33	2.22	106			54	8.1	Clayey silt
2-4, 99–116	13.49	1.56									55	8.1	Silty clay
2-5, 80–94	14.80	1.40	75	56	125	2.40	3.00	104			53	8.5	Silty clay
3-4, 105–142	23.05	1.50	69	53	113	1.97	2.22	121	0.25	1.68	67	9.1	Silty clay
3-6, 4–15	25.04	1.50	69	54	118	1.88	2.22	118	0.24	1.47	58	8.5	Silty clay
4-3, 23–36	30.23	1.47	71	58	136	1.80	2.44	120	0.18	1.48	49	8.2	Silty clay
4-4, 44–68	31.94	1.44	72	59	143	1.83	2.62	117	0.11	1.48	48	8.5	Clayey silt
5-4, 65–87	41.65	1.43	73	55	125	2.17	2.70	109	0.16	1.63			
6-4, 127–142	51.77	1.50	69	53	115	1.94	2.22	117	0.39	1.48	49	8.5	Clayey silt
6-5, 13–32	52.13	1.46	71	54	119	2.05	2.44	112	0.33	1.44	52	8.4	Silty clay
485													
1-1, 109–113	1.09								0.03				
1-2, 64–77	2.14	1.34	79	64	176	2.15	3.77	108	0.05	1.50	30	6.8	Clayey silt
2-1, 73–77	3.73								0.07				
2-2, 102–105	5.52								0.05				
2-3, 71–110	6.71	1.46	71	12	132	1.85	2.44	117	0.18	1.50	62	8.5	Silty clay
3-2, 119–121	15.19								0.10				
3-4, 22–24	17.22								0.14				
3-6, 95–110	20.95	1.49	69	53	111	2.01	2.22	114	0.14	1.50	38	7.9	Clayey silt
4-2, 110–112	24.60								0.22				
4-3, 32–47	25.32	1.50	69	49	98	2.27	2.22	108	0.25	1.51	48	8.3	Clayey silt
5-2, 44–46	33.44								0.19				
5-2, 86–88	33.86								0.25				
5-4, 36–47	36.36	1.74							0.10	1.57			
5-4, 124–137	37.24	1.59	63	44	79	2.14	1.70	112	0.30	1.53	43	8.1	Clayey silt
6-2, 82–84	43.32								0.20				
6-4, 120–122	46.70								0.13				
6-5, 138–140	48.38								0.17				
6-7, 3–19	50.03	1.54	66	45	82	2.37	1.94	105	0.33	1.48	43	8.0	Clayey silt
485A													
1-2, 70–72	52.70								0.32				
1-4, 63–65	55.63								0.29				
1-6, 130–145	59.30	1.61	62	44	80	2.05	1.62	115	0.46	1.52	42	8.2	Clayey silt
2-3, 107–109	64.07								0.35				
2-4, 48–59	64.98	1.65	59	46	84	1.71	1.43	128	0.48	1.49	37	7.3	Clayey silt
3-2, 110–118	72.10	1.57	64	47	89	1.99	1.77	116	0.45		36	7.4	Clayey silt
3-3, 41–44	72.91									1.45			
4-1, 42–70	79.42	1.65	59	42	73	1.97	1.43	118	0.54	1.49	40	7.9	Clayey silt
5-3, 110–123	92.60	1.82							0.53	1.55	40	7.9	Clayey silt
5-4, 32–48	93.32	1.83	48	29	41	2.24	0.92	111	0.38	1.57	26	6.6	Clayey silt
6-3, 42–77	101.42	1.83	48	31	46	2.03	0.92	119	0.55	1.61	35	7.2	Clayey silt
6-3, 100–107	102.00	1.80	50	24	31	3.24	1.00	85		1.55	8	4.8	Sandy silt
7-2, 7–25	109.07	1.73	54	38	61	1.91	1.17	122	0.69	1.69	44	8.2	Clayey silt
8-2, 103–125	119.53	1.80	50	34	52	1.92	0.99	123	1.05	1.60	48	8.4	Clayey silt
9-2, 87–104	128.87	1.93	42						0.06	1.73	15	5.7	Sandy silt
10-1, 121–130	137.21	1.64	60						0.33				
10-2, 62–78	138.12	1.78	51	35	54	1.92	1.04	123	1.03	1.65	45	7.7	Clayey silt
11-1, 104–140	146.54	1.78	53							1.67			
18-1, 103–112	185.16	1.92							0.24		10	5.3	Silt
19-2, 16–42	189.66	1.85	47	29	41	2.17	0.88	114	0.40	1.54	8	4.8	Sandy silt
19-2, 78–137	190.28	1.82	49	33	48	1.98	0.96	121			37	7.7	Clayey silt
20-1, 95–121	193.45	1.83	51										
20,CC-(21–33)	194.56	2.57	8										Sandstone
22-1, 77–80	202.27	1.80	54										
22-3, 138–143	205.88	1.84	49										
26-1, 51–118	226.51	1.79	51	27	37	2.81	1.04	95			34	7.9	Clayey silt
27-1, 121–128	231.71	1.81	50	27	36	2.65	0.96	101			44	8.2	Clayey silt
28-1, 113–134	236.13	1.84	48	27	37	2.41	0.88	105			46	8.2	Clayey silt
34-1, 41–43	277.41	1.93	42	22	28	2.58	0.72	101			19	6.1	Silt
36-1, 20–23	295.20									2.35			
36-1, 101–140	296.01	1.93	46										
37-1, 41–70	304.41	1.87	46	23	29	2.91	0.85	92			49	8.1	Clayey silt
38-1, 18–19	313.18									2.17			

wave velocities increase to values as high as 1.67 km/s, and the shear strength rises to about 0.7 tons/ft.[2] Similarly, the porosity decreases to about 55%, the water content decreases rapidly to values as low as 67%, the degree of saturation increases to about 120%, and the void ratio decreases to 1.27. At the same time, the specific gravity of the solids varies irregularly between 1.73 and 2.54.

The physical properties of the sediments interlayered in the basement are quite variable but, in general, reflect increased compaction and incipient diagenesis. The wet-bulk density, for example, ranges between 1.76 and 2.19 g/cm^3, the compressional wave velocity varies between 1.58 and 2.22 km/s, and the porosity ranges between 29 and 45%.

Site 484

The sediments at Site 484 consist of 55 meters of hemipelagic clayey silt and silty clay with interlayered beds of sandy silt. The average clay fraction is 52% and the mean grain size is 8.3 ϕ.

The physical properties of the sediments recovered in Holes 484 and 484A are somewhat anomalous, both with respect to those observed at Sites 482 and 483 and to those observed at DSDP sites in general. Although the average wet-bulk density, 1.45 g/cm^3, is fairly typical of sediments recovered near the mud line, the maximum compressional wave velocity observed at Site 484, 1.68 km/g, and the average shear strength, 0.20 tons/ft.^{2}, are unexpectedly high. Similarly, the average porosity, 72%, the average water content, 111%, and the average void ratio, 2.31, are somewhat lower than expected. The average specific gravity of the solids and the average degree of saturation are 1.92 and 104%, respectively. Although most of these values are not unusual, they are atypical of shallow sediments.

Site 485

The sediments overlying the basement at Site 485 consist of very poorly sorted hemipelagic clayey silt and silty clay with minor amounts of terrigenous silt and sandy silt. The average particle size ranges from 4.8 ϕ to 8.5, and the clay fraction ranges from 7 to 61%, about an average of 35%.

As at the other sites drilled on Leg 65, most of the physical properties change markedly with depth in response to compaction. The wet-bulk density, for example, increases irregularly from about 1.40 g/cm^3 at the mud line to about 1.80 g/cm^3 near the basement contact while the compressional wave velocity increases from 1.5 to about 1.7 km/s and the shear strength increases from 0.03 tons/ft.^{2} to values as high as 1.05 tons/ft.^{2} Over this same interval, the porosity decreases from 79 to 53%, the water content decreases from 176 to 54% and the void ratio diminishes from about 3.8 to 1.0. The specific gravity of the solids and the degree of saturation range irregularly with depth from 1.71 to 3.24 and from 85% to 128%, respectively.

Within the relatively fine-grained (ϕ average = 7.0) silty clay, clayey silt, and claystone found interlayered below the uppermost basalts (Fig. 2), the physical properties continue to change with depth in response to increasing compaction, but much more slowly. The wet-bulk density, velocity, and shear strength commonly reach values as high as 1.93 g/cm^3, 2.17 km/s, and 0.4 tons/ft.^{2}, respectively, with more extreme values being observed in diagenetically altered samples. Similarly, the porosity decreases to about 46% and the water content decreases from about 41 to 29%. The specific gravity of the solids, the degree of saturation, and the void ratio, however, vary irregularly with depth in this interval from 1.98 to 2.91, 92 to 121%, and 0.72 to 1.04, respectively.

DISCUSSION

Most of the sediments analyzed from Sites 482, 483, 484, and 485 were hemipelagic clays with an average grain size of 6.5 to 9.2 ϕ and minor turbidites composed of terrigenous material with an average grain size of 4.9 to 6.0 ϕ.

Practically all of the samples analyzed were sufficiently fine grained to make the 84th percentile.

As can be seen in Figures 3 and 4, both the void ratio and the porosity increase sharply with decreasing grain size. Thus the fine-grained sediments (ϕ > 7.0) have high porosities, as indicated by the empirical boundary line shown in Figure 4. This result is similar to that obtained by Richards (1962).

The specific gravities of the solids analyzed range between 1.7 and 3.2, with the majority of the values falling between 1.8 and 2.2 (Fig. 5). As can be seen in Figure 6, the values of wet-bulk density range from a maximum of 2.6 g/cm^3 at 8.0% porosity to a minimum of

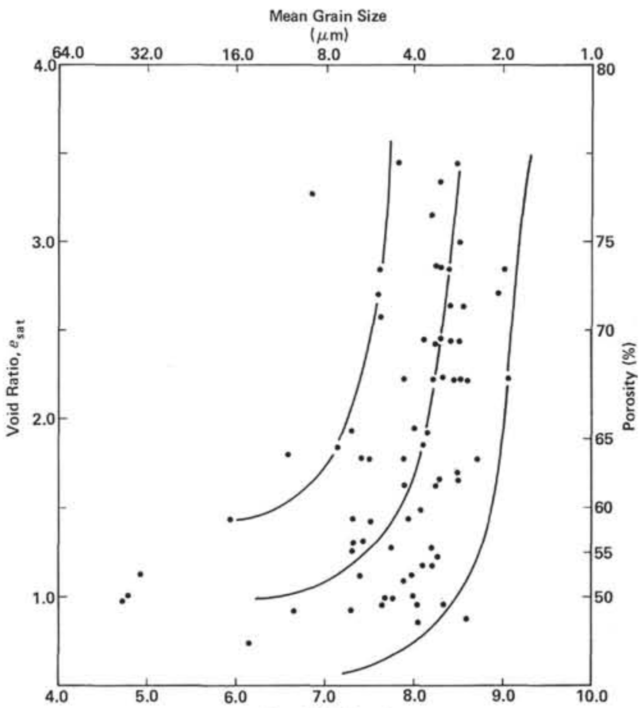

Figure 3. Void ratio vs. mean grain size for Leg 65 sediments. (Lines represent average and extreme values.)

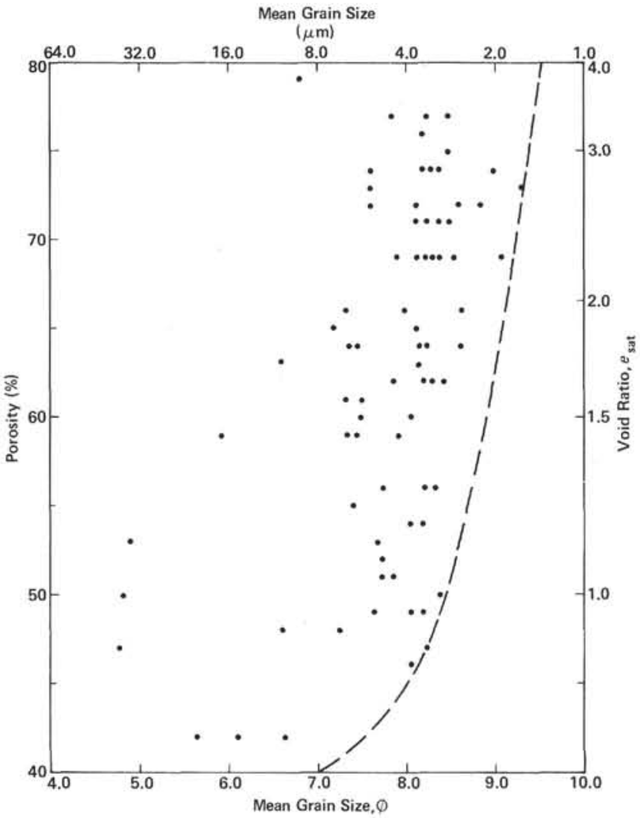

Figure 4. Porosity vs. mean grain size for Leg 65 sediments. (Dashed line represents minimum porosity curve.)

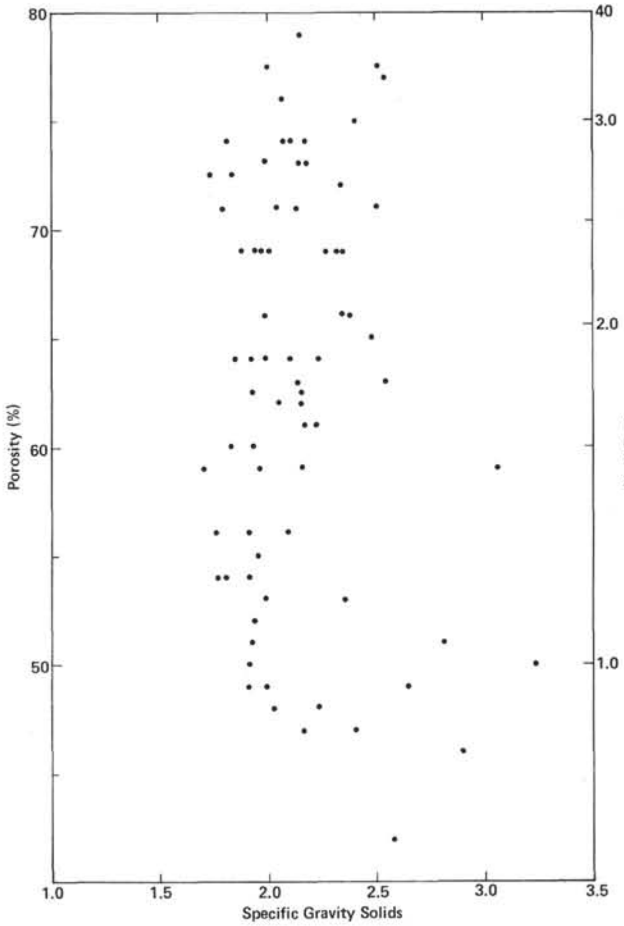

Figure 5. Porosity vs. specific gravity of solids for Leg 65 sediments.

1.34 g/cm^3 at 79.0% porosity and display the straight-line relationship between wet-bulk density and porosity shown by Hamilton and Menard (1956), Nafe and Drake (1957) and Richards (1962). There is a slight tendency, however, for the specific gravity to increase with increasing wet-bulk density.

In general, the water content is inversely related to the depth of burial (Fig. 7). The lowest water content measured was 28% in a silt recovered from a sub-bottom depth of 277 meters in Hole 485A and the highest was 176% in a clayey silt cored at about 2 meters depth in Hole 485. The scatter in the data is attributed to turbidites containing sand, silt, and reworked foraminifers which display anomalously high water contents. These layers also display lower shear strengths (about 0.35 tons/ft.^{2}) than the silty clays comprising most of the section and, when more cemented, display higher densities and velocities and lower porosities.

Practically all of the physical properties of unconsolidated sediments are related to the amount of interstitial water present in the sediments (Richards, 1962). All but three of the samples investigated, regardless of type and origin, were more than 95% saturated. Since the sediments are presumably 100% saturated, but the average measured degree of saturation is 111%, the average measurement error is 11%.

The wet-bulk densities and porosities range from 1.34 to 2.58 g/cm^3 and from 8 to 79%, respectively. As at most DSDP sites, the wet-bulk density tends to increase, and the porosity to decrease, with depth in the young sediments at the top of the section. The compressional wave velocities, which range between 1.5 and 1.6 km/s, are typical of weakly consolidated sediments, but higher values were found in the more compact sediments near the base of the sections. The sediments interlayered within the basement tend to have even higher densities and velocities and lower porosities than the sediments above basement in response to increased compaction and diagenesis.

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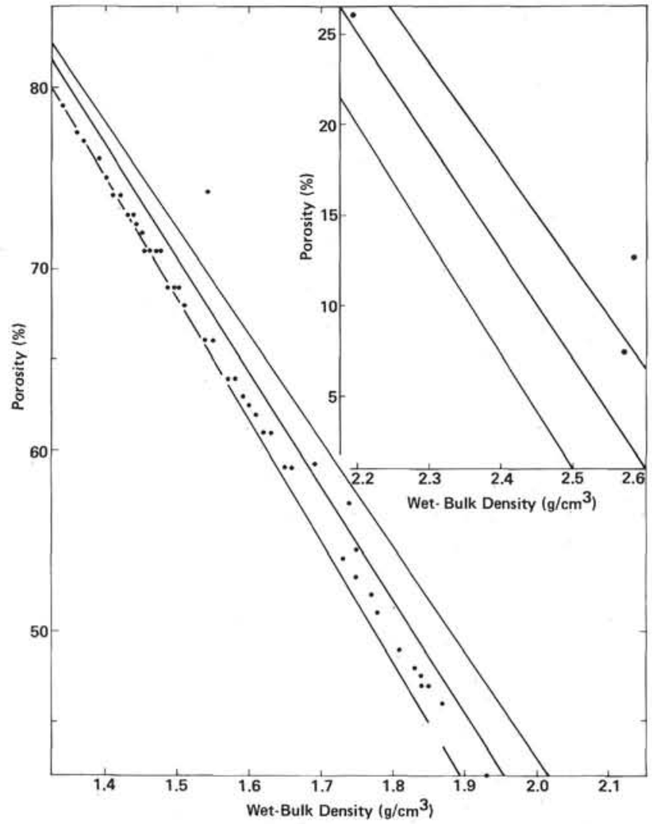

Figure 6. Porosity vs. wet-bulk density for Leg 65 sediments. (Lines of equal specific gravity shown for comparison.)

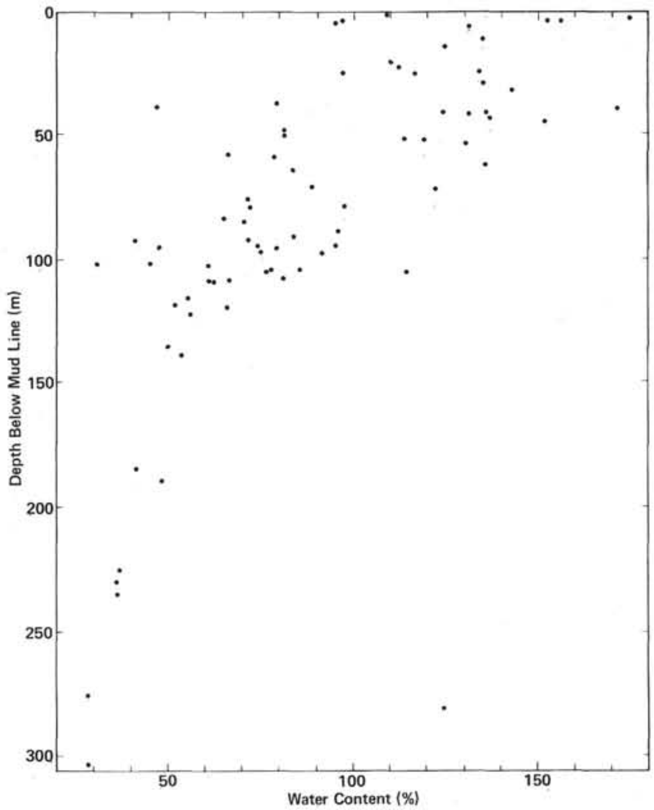

Figure 7. Water content vs. depth below mud line for Leg 65 sediments.