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33. GRAIN-SIZE ANALYSIS: LEG 116, BENGAL FAN[1]

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INTRODUCTION

Ocean Drilling Program (ODP) Leg 116 cored the distal part of the Bengal Fan at three closely spaced sites (717–719). The recovered sediments consisted dominantly of turbidites that varied in thickness between a few centimeters and 2 m or more. A number of different facies have been identified in the sequence and are described by Stow et al. (this volume). Representative examples of these facies types were selected and sampled for grain-size analysis. The results of these analyses are tabulated in this data report.

METHODS

Sediment samples of approximately 2-g dry weight were placed in 50-cm^3 beakers and disaggregated in a solution of 10% Calgon. To assist in complete disaggregation of the sediment, an ultrasonic probe was used for approximately 2 min. on each sample. Suspended sample concentrations were of the order of 20 g/L. The prepared suspensions were stored in 150-cm^3 plastic bottles.

The grain-size analyses were performed by laser diffraction using Malvern particle sizers, models 3500D and 2600C. The principles of particle-size analysis by laser diffraction are described by Butters and Wheatley (1982) and McCave et al. (1986). Laser diffraction is a sizing technique in which the degree of scattering of a laser beam reflects the size of the grains that pass through the beam. The data obtained is therefore quite different from that derived from settling techniques such as the Andreason pipette and Sedigraph.

The Malvern laser-sizers consist of a laser source, beam expander, sample chamber, focusing lens, ring detector, and a microcomputer. In this study each analysis used a 100-mm focal length focusing lens yielding data consisting of 15 size classes between 1.9 and 188 μm. A percentage of sample outside of this range above and below these limits is also given. The grain-size distribution was computed using the model-independent program option. The sample suspension is introduced into a small ultrasonic tank from which the suspension is continuously pumped through the sample chamber in the path of the laser. The main attraction of laser diffraction analysis for this study was the relatively small sample size required for analysis. Only 2–5 cm^3 of the prepared suspensions are required for each analysis. Several repeat analyses can therefore be performed even on very small original samples. An additional advantage is the speed with which analyses can be performed, generally about 10 min per sample.

For many of the samples, duplicate or triplicate analyses were performed to test the reproducibility of the results. Results proved to be very reproducible both for repeated analyses of the same sample and for multiple subsamples, which is in accordance with the findings of Butters and Wheatley (1982), and McCave et al. (1986). Butters and Wheatley (1982) found an acceptable level of agreement between particle-size analyses of quartz standards obtained with a Malvern laser-sizer and standard certified data. Some authors, however, have found deficiencies in laser-sizers, especially where large quantities of fine material are present e.g., McCave et al. (1986) and Singer et al. (1988), in particular a tendency to underestimate the quantity of clay (<1.9 μm in those studies) present. The data presented herein should be viewed with this possible limitation in mind.

RESULTS

A total of 139 samples have been analyzed and the results tabulated in Tables 1, 2, and 3. The mean (M_z), sorting (σ_i) and skewness (Sk_i) were calculated for all samples according to methods of Folk and Ward (1957). The lithological symbols used relate to the classification of Shepard (1954) and are an extended form of symbols used in the Leg 116 shipboard descriptions (See Fig. 1).

The results include spot samples from a variety of sediment facies in Site 717 holes (Samples 1–42). Suites of samples taken from selected individual turbidites in Sites 717, 718, and 719 holes (Samples 121–210) and a single suite of eight closely spaced samples (Samples 43–50) were used to test grain-size variations over a short vertical sequence (16 cm) within a thick turbidite unit. They also were used to examine the scatter of results to be expected from the analytical method. The results for Samples 43–50 show that grain-size characteristics are very consistent over a short vertical sequence, and no clear trends are visible. This conclusion is supported by the more widely spaced data points represented by Samples 121–210, which show smooth trends with very little "noise," that might be attributed to the analytical method. The grain-size characteristics of the turbidite facies are discussed in the sediment synthesis paper by Stow et al. (this volume). The sediment facies from which samples were taken are given in Tables 1–3. These are as follows:

Facies 1: light gray silt and mud turbidites
Facies 2: light gray organic-poor mud turbidites
Facies 3: dark gray organic-rich mud turbidites
Facies 4: biogenic mud turbidites
Facies 5: pelagic clays
Facies 6: pelagic calcareous clays
Facies 7: structureless bioturbated muds

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Table 1. Hole 717C grain-size analysis data.

No.	Core	Sect.	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	M_z (ϕ)	σ_i (ϕ)	Sk_i	Lith.	Facies
1	2H	2	85–90	47	50	3	4.32	1.50	0.32	T7B	1
2	14X	2	8–13	0	78	22	7.01	0.99	−0.03	T5	1
3	19X	1	40–45	13	76	11	5.85	1.61	0.01	T5	1
4	20X	1	80–85	24	70	6	5.16	1.60	0.13	T7B	1
5	20X	3	50–55	0	72	28	7.24	0.88	−0.03	T8A	2
6	21X	2	138–143	0	60	40	7.55	0.86	−0.17	T8A	4
7	22X	cc	28–30	0	52	48	7.78	0.78	−0.08	T8A	4
8	26X	4	80–85	8	77	15	6.03	1.46	0.19	T5	1
9	29X	2	83–88	0	67	33	7.14	1.03	0.04	T8A	3
10	31X	2	100–105	0	73	27	6.86	1.17	0.10	T8A	3
11	31X	2	132–137	0	62	38	7.39	0.98	−0.09	T8A	3
12	34X	2	80–85	0	71	29	7.05	1.10	0.01	T8A	4
13	36X	2	82–87	0	53	47	7.76	0.77	−0.07	T8A	3
14	37X	1	82–87	16	80	4	5.21	1.37	0.15	T5	1
15	38X	2	85–90	0	81	19	6.96	0.93	0.07	T5	2
16	40X	1	80–85	0	69	31	7.38	0.75	−0.10	T8A	3
17	40X	3	115–120	0	47	53	7.95	0.64	0.15	T8B	4
18	42X	2	98–103	0	74	26	7.71	1.01	−0.07	T8A	2
19	43X	5	80–85	0	55	45	7.58	0.94	−0.16	T8A	3
20	44X	2	53–58	0	69	31	7.28	1.02	−0.11	T8A	4
21	45X	6	73–78	0	71	29	7.12	1.07	−0.05	T8A	3
22	46X	2	56–61	0	67	33	7.38	0.93	−0.09	T8A	7
23	47X	2	113–118	0	70	30	7.31	0.93	−0.05	T8A	2
24	48X	2	83–88	0	57	43	7.41	1.02	−0.05	T8A	3
26	51X	3	12–17	0.4	75.2	24.4	6.53	1.30	0.14	T5	3
27	53X	2	80–85	0	77	23	7.05	1.02	−0.03	T5	2
28	53X	5	80–84	1	89	10	6.13	1.19	0.16	T5	1
29	54X	2	80–85	0	77	23	7.00	1.04	−0.02	T5	2
30	56X	4	78–83	0	67	33	7.37	0.95	−0.08	T8A	7
31	57X	5	80–85	0	43	57	7.90	0.78	−0.16	T8B	5
32	59X	1	27–32	1	87	12	6.35	1.21	0.13	T5	1
33	61X	2	85–90	1	86	13	6.44	1.27	−0.02	T5	1
34	64X	3	90–95	0	70	30	7.32	0.94	−0.07	T8A	2
35	65X	3	30–37	0	69	31	7.02	0.97	0.08	T8A	3
36	65X	3	52–57	0	75	25	7.21	0.93	0.00	T5	3
37	65X	3	117–122	0.4	74.5	25.1	6.62	1.33	0.06	T8A	3
38	68X	2	70–75	0	62	38	7.47	0.87	−0.11	T8A	2
39	70X	6	7–12	0	75	25	7.15	0.98	−0.03	T5	7
40	71X	2	29–34	0	82	18	6.85	1.04	0.03	T5	1
41	72X	2	75–80	0	77	23	7.05	0.98	0.01	T5	2
42	74X	1	80–84	12	80	8	5.69	1.53	0.04	T5	1
43	22X	4	134–136	0	57	43	7.65	0.87	−0.16	T8A	2
44	22X	4	136–138	0	51	49	7.84	0.69	−0.02	T8A	2
45	22X	4	138–140	0	52	48	7.79	0.75	−0.06	T8A	2
46	22X	4	140–142	0	54	46	7.77	0.76	−0.05	T8A	2
47	22X	4	142–144	0	55	45	7.77	0.75	−0.07	T8A	2
48	22X	4	144–146	0	53	47	7.77	0.76	−0.06	T8A	2
49	22X	4	146–148	0	55	45	7.75	0.77	−0.10	T8A	2
50	22X	4	148–150	0	52	48	7.80	0.75	−0.05	T8A	2
121	2H	4	2–3	0	69	31	7.28	0.84	−0.16	T8A	6
122	2H	4	11–12	5	83	12	6.20	1.41	0.00	T5	1
123	2H	4	25–26	9	86	5	5.59	1.32	0.15	T5	1
124	2H	4	51–52	13	83	4	5.21	1.25	0.25	T5	1
125	2H	4	100–101	29	68	3	4.88	1.44	0.16	T7B	1
126	2H	4	140–141	39	58	3	4.60	1.42	0.17	T7B	1
127	2H	5	14–15	29	68	3	4.81	1.44	0.13	T7B	1
128	23X	2	20–21	0	64	36	7.43	0.94	−0.13	T8A	5/6
129	23X	2	50–51	0.3	65.1	34.6	7.17	1.19	−0.13	T8A	4
130	23X	2	100–101	1	66	33	6.95	1.41	−0.16	T8A	4
131	23X	2	140–141	7	69	24	6.43	1.64	−0.13	T8A	4
132	23X	3	6–7	20	67	13	5.52	1.72	0.22	T7B	4
133	23X	3	15–16	0	49	51	7.86	0.72	−0.04	T8B	5
134	23X	3	24–25	0	59	41	7.63	0.81	−0.21	T8A	3
135	23X	3	40–41	0	63	37	7.38	0.97	−0.06	T8A	3
136	23X	3	66–67	0	64	36	7.29	1.07	−0.07	T8A	3
137	23X	3	87–88	0	68	32	7.13	1.12	−0.03	T8A	3
138	23X	3	96–97	1	82	17	6.39	1.27	0.12	T5	3
139	33X	5	26–27	0	56	44	7.68	0.79	0.06	T8A	5/7
140	33X	5	39–40	0	65	35	7.42	0.82	0.00	T8A	3
141	33X	5	56–57	0	38	62	7.98	0.67	−0.20	T8B	3
142	33X	5	70–71	0	52	48	7.73	0.79	0.05	T8A	3
143	33X	5	86–87	0	51	49	7.76	0.75	0.09	T8A	3
144	36X	2	75–76	0	50	50	7.79	0.74	0.07	T8AB	7
145	36X	2	100–101	0	54	46	7.70	0.79	0.08	T8A	3
146	36X	2	135–136	0	54	46	7.70	0.79	0.12	T8A	3
147	36X	3	1–2	0	57	43	7.62	0.84	0.10	T8A	3
148	36X	3	11–12	0	46	54	7.84	0.75	0.08	T8B	7

Table 1 (continued).

No.	Core	Sect.	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	M_z (ϕ)	σ_i (ϕ)	Sk_i	Lith.	Facies
149	36X	3	33–34	0	57	43	7.61	0.84	0.10	T8A	3
150	36X	3	55–56	0	70	30	7.26	0.98	0.08	T8A	3
151	36X	3	85–86	0	72	28	7.13	1.01	0.06	T8A	3
152	36X	3	115–116	0.3	77.6	22.1	6.72	1.17	0.04	T5	3
153	36X	3	131–132	0.7	87.8	11.5	5.99	1.22	0.28	T5	3
154	36X	3	136–137	0	59	41	7.66	0.78	0.09	T8A	5
155	48X	2	55–56	0	50	50	7.78	0.75	0.15	T8AB	7
156	48X	2	77–78	0	44	56	7.87	0.75	−0.03	T8B	3
157	48X	2	94–95	0	58	42	7.59	0.86	0.09	T8A	3
158	48X	2	112–113	0	62	38	7.45	0.95	0.08	T8A	3
159	48X	2	134–135	0	61	39	7.42	1.00	0.02	T8A	3
160	48X	3	24–25	0.6	81.4	18.0	6.29	1.30	0.25	T5	3
161	48X	3	33–34	0	63	37	7.54	0.82	0.10	T8A	5
162	48X	3	44–45	0	58	42	7.66	0.80	0.11	T8A	5
163	48X	3	64–65	0	69	31	7.33	0.87	0.00	T8A	2
164	48X	3	84–85	0	70	30	7.28	0.90	0.00	T8A	2
165	48X	3	103–104	0	74	26	7.01	1.01	0.04	T8A	2
166	68X	1	63–64	0	78	22	7.14	0.86	0.05	T5	1
167	68X	1	64–65	0.2	88.7	11.1	6.56	0.98	0.13	T5	1
168	68X	1	67–68	0	82	18	7.11	0.91	0.02	T5	1
169	68X	1	71–72	0.1	89.8	10.1	6.53	1.05	0.07	T5	1
170	68X	1	75–76	1.4	86.0	12.6	6.27	1.30	0.08	T5	1
171	68X	1	80–81	0	64	36	7.46	0.92	−0.10	T8A	5
172	68X	1	93–94	0	64	36	7.50	0.88	−0.08	T8A	1
173	68X	1	104–105	0	83	17	6.88	0.99	0.06	T5	1
174	68X	1	115–116	13	82	5	5.53	1.42	0.10	T5	1
175	68X	1	129–130	11	83	6	5.64	1.40	0.11	T5	1

Table 2. Holes 718A, 718B, 718C, and 718D grain-size analysis data.

No.	Core	Sect.	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	M_z (ϕ)	σ_i (ϕ)	Sk_i	Lith.	Facies
176	17X	5	6–7	0	73	27	7.25	0.93	−0.04	T8A	6
177	17X	5	12–13	0	76	24	7.15	0.96	−0.03	T5	7
178	17X	5	18–19	0	60	40	7.44	0.94	−0.06	T8A	7
179	17X	5	25–26	0	69	31	7.10	1.09	−0.03	T8A	7
180	17X	5	26–27	0	62	38	7.40	0.98	−0.06	T8A	7
181	17X	5	33–34	0	59	41	7.46	0.97	−0.04	T8A	7
182	17X	5	40–41	0	69	31	7.12	1.04	0.02	T8A	3
183	17X	5	42–43	0	64	36	7.38	0.91	−0.08	T8A	3
184	17X	5	64–65	0	64	36	7.32	0.94	−0.08	T8A	2
185	17X	5	79–80	0	70	30	7.30	0.95	−0.06	T8A	2
186	17X	5	88–89	0	72	28	7.23	0.98	−0.05	T8A	2
187	17X	5	96–97	0.3	90.3	9.4	6.31	1.11	0.14	T5	2
188	17X	5	116–117	0	68	32	7.22	1.03	−0.04	T8A	3
189	17X	5	126–127	0	62	38	7.39	0.97	−0.05	T8A	3
190	17X	5	133–134	0	83	17	6.58	1.08	0.21	T5	3
191	52X	1	12–13	3	89	8	5.84	1.37	0.10	T5	1
192	52X	1	37–38	5	83	12	6.02	1.42	0.11	T5	1
193	52X	1	69–70	16	79	5	5.29	1.42	0.20	T7B	1
194	52X	1	96–97	0.3	85.5	14.2	6.52	1.21	0.03	T5	1
195	52X	1	123–124	2	85	13	6.22	1.34	0.08	T5	1
196	94X	5	36–37	0	61	39	7.51	0.85	−0.14	T8A	5
197	94X	5	40–41	0	83	17	6.86	1.01	0.05	T5	2
198	94X	5	43–44	0	87	13	6.72	0.99	0.07	T5	2
199	94X	5	136–137	0	60	40	7.51	0.87	−0.14	T8A	5
200	94X	5	139–140	0	62	38	7.48	0.86	−0.11	T8A	2
201	94X	5	141–142	0	68	32	7.38	0.92	−0.05	T8A	2

Table 3. Holes 719A and 719B grain-size analysis data.

No.	Core	Sect.	Depth (cm)	Sand (%)	Silt (%)	Clay (%)	M_z (ϕ)	σ_i (ϕ)	Sk_i	Lith.	Facies
202	18X	2	27–28	0	59	41	7.44	0.99	−0.09	T8A	7
203	18X	2	37–38	0	61	39	7.42	0.99	−0.09	T8A	7
204	18X	2	50–51	0	66	34	7.36	0.96	−0.06	T8A	7
205	18X	2	60–61	0	58	42	7.54	0.91	−0.02	T8A	7
206	18X	2	64–65	0	58	42	7.53	0.91	−0.03	T8A	3/7
207	18X	3	35–36	0	74	26	7.14	1.00	−0.01	T8A	2/7
208	18X	3	22–23	0	74	26	7.10	1.03	−0.03	T8A	2/7
209	18X	3	44–45	0	77	23	6.96	1.07	0.01	T5	2/7
210	18X	3	54–55	0.5	86.3	13.2	6.37	1.21	0.13	T5	2

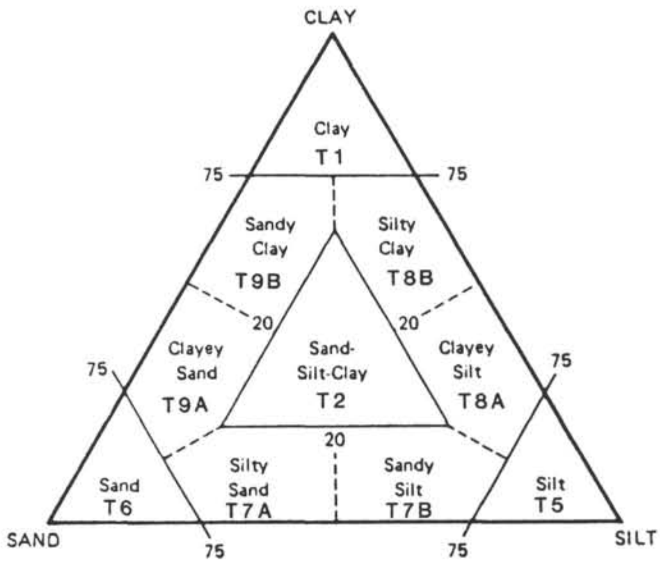

Figure 1. Key to lithologic symbols based on the classification scheme of Shepard (1954).

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