

### 13. GRAIN-SIZE AND CARBON/CARBONATE ANALYSES, LEG 45

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#### GRAIN-SIZE ANALYSES

Sand-silt-clay distribution was determined on 10-cm<sup>3</sup> sediment samples collected at the time the cores were split and described. The results are listed in Tables 1 and 2.

The sediment classification used here is that of Shepard (1954), with the sand, silt, and clay boundaries based on the Wentworth (1922) scale (Figure 1). Thus, the sand, silt, and clay fractions are composed of particles whose diameters range from 2000 to 62.5 μm, 62.5 to 3.91 μm, and less than 3.91 μm, respectively. This classification is applied regardless of sediment type and origin. Therefore, the sediment names used in this table may differ from those used elsewhere in this volume; e.g., a silt composed of nannofossils in this table may be called a nannofossil ooze in a site chapter.

Standard sieve and pipette methods were used to determine the grain-size distribution. The sediment sample was dried and dispersed in a Calgon solution. If a sediment sample failed to disaggregate, it was treated with a sonic probe and, if necessary, hydrogen peroxide. Sediment samples which resisted the above treatment were not analyzed.

The sand fraction was removed by wet sieving using a 63 μm sieve, and the silt and clay fractions were analyzed by standard pipette analysis. Sampling depths and times were calculated using equations derived from the Stokes settling velocity equation (Krumbein and Pettijohn, 1938, p. 95-96):

$$\frac{D}{t} = V = \frac{2gr^2(d_1 - d_2)}{9\eta}$$

$$t = \frac{9D\eta}{2gr^2(d_1 - d_2)}$$

where

$V$  = velocity, in cm/sec

$t$  = time, in sec\*

$D$  = depth pipette is inserted, in cm

$g$  = gravity, in cm/sec<sup>2</sup>\*

$r$  = radius of individual particles, in cm\*

$d_1$  = density of solid particles arbitrarily set at 2.675 g/cm<sup>3</sup>

$d_2$  = absolute density of distilled water at different temperatures (Hodgman et al., 1960, p. 2129)

$\eta$  = viscosity of distilled water in poises at different temperatures (Hodgman et al., 1960, p. 2181)

\*Five figures were used in calculations to avoid rounding off variations.

TABLE 1  
Grain-Size Determination, Site 395

Sample (Interval in cm)	Depth (m)	Sand (%)	Silt (%)	Clay (%)	Classification
1-1, 46	0.46	86.9	4.0	9.0	Sand
1-4, 50	5.00	15.8	20.7	63.5	Silty clay
2-4, 50	12.50	6.8	39.3	53.9	Silty clay
3-4, 50	22.33	0.0	14.1	85.9	Clay
4-4, 50	31.57	0.1	16.3	83.6	Clay
5-4, 50	41.30	2.7	23.3	73.9	Silty clay
6-2, 65	47.78	0.3	18.6	81.1	Clay
7-4, 50	60.15	0.3	17.3	82.5	Clay
8-4, 50	69.65	0.9	16.2	82.9	Clay
9-4, 50	79.19	0.3	18.1	81.6	Clay

TABLE 2  
Grain-Size Determination, Site 396

Sample (Interval in cm)	Depth (m)	Sand (%)	Silt (%)	Clay (%)	Classification
1-4, 144	5.94	0.8	12.4	86.8	Clay
2-4, 50	10.00	25.6	16.8	57.7	Sandy clay
3-4, 50	19.28	0.1	15.7	84.2	Clay
5-4, 50	38.10	0.8	16.7	82.5	Clay
6-2, 50	44.37	14.8	34.0	51.2	Silty clay
6, CC	51.47	2.2	22.2	75.6	Clay
7-4, 50	56.92	0.1	26.3	73.7	Silty clay
8-4, 50	66.16	8.4	24.8	66.8	Silty clay
9-4, 50	75.41	0.0	35.8	64.1	Silty clay
10-4, 50	84.64	30.3	44.1	25.6	Sand-silt-clay
11-4, 52	94.20	0.1	25.9	74.0	Silty clay
12-4, 50	103.41	0.0	32.6	67.4	Silty clay
13-4, 52	113.75	0.6	32.9	66.6	Silty clay
14-4, 50	122.60	1.7	49.4	48.8	Clayey silt

The reproducibility of the grain-size analysis has been previously tested (Boyce, 1972), and it was found that over a period of time with several operators the reproducibility for the sand-silt-clay fractions is ±2.5 per cent (absolute). For detailed step-by-step procedures, see Volume 4 of the *Initial Reports*.

#### CARBON AND CARBONATE ANALYSES

Leg 45 sediments were analyzed for total carbon and acid-insoluble (organic) carbon, using a LECO WR-12 Analyzer according to the standard technique outlined below. Because there were only a few samples, no control standards were run. But the reproducibility of the LECO was verified in extensive tests before Leg 45, and also in standards run for subsequent legs.

The 3-cm<sup>3</sup> sediment samples were first dried and ground into a homogeneous powder. The ground sediment was redried at 105° to 110°C, and two samples, a 0.1-g and a 0.5-g sample, were weighed into LECO clay

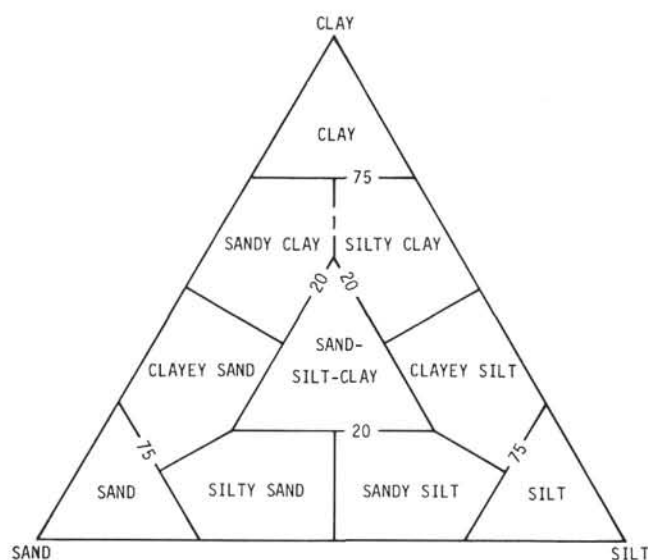


Figure 1. Sediment classification after Shepard (1954), with the sand, silt, and clay size fractions based on the Wentworth (1922) Grade Scale: sand, silt, and clay size particles having respective diameters of 2000 to 62.5  $\mu\text{m}$ , 62.5 to 3.91  $\mu\text{m}$ , and less than 3.91  $\mu\text{m}$ . Shepard's (1954) sediment classification is a function of sand, silt, and clay size percentages and not composition.

crucibles. The 0.5-g sample was acidified with 10 per cent hydrochloric acid and washed with distilled water. The sample was then dried and analyzed for acid-insoluble carbon. The 0.1-g sample was analyzed for total carbon without further treatment. If the sample contained less than 10 per cent  $\text{CaCO}_3$ , an additional 0.5-g sample was analyzed for greater accuracy. The calcium carbonate percentages were calculated as follows:  $(\% \text{ total C} - \% \text{ organic C}) \times 8.33 = \% \text{ CaCO}_3$ . Although other carbonates may be present, all acid-soluble carbon was calculated as calcium carbonate. All results are given in weight percent (Tables 3 and 4).

Detailed descriptions of the technique and theory may be found in Bader, Gerard, et al. (1970) and Boyce and Bode (1972).

#### REFERENCES

- Bader, R. G., Gerard, R. D., et al., 1970. *Initial Reports of the Deep Sea Drilling Project*, v. 4: Washington (U.S. Government Printing Office).
- Boyce, R. E., 1972. Grain size analyses, Leg 9, Deep Sea Drilling Project, In Hayes, J. D., *Initial Reports of the Deep Sea Drilling Project*, v. 9: Washington (U.S. Government Printing Office), p. 779.
- Boyce, R. E. and Bode, G. W., 1972. Carbon and carbonate analyses, Leg 9, Deep Sea Drilling Project. In Hays, J. D., et al., *Initial Reports of the Deep Sea Drilling Project*, v. 9: Washington (U.S. Government Printing Office), p. 747.
- Hodgman, C. D., Weast, R. C. Y., and Selby, S. M., 1960. *Handbook of chemistry and physics*: Cleveland (Chemical Rubber Publishing Co.).
- Krumbein, W. C. and Pettijohn, F. J., 1938. *Manual of sedimentary petrography*: New York (Appleton-Century-Crofts, Inc.).

TABLE 3  
Carbon-Carbonate Data, Site 395

Sample (Interval in cm)	Depth (m)	Total Carbon (%)	Organic Carbon (%)	$\text{CaCO}_3$ (%)
<b>Hole 395</b>				
1-1, 88	0.9	9.6	0.1	79
1-2, 40	1.9	9.4	0.1	77
1-2, 119	2.7	9.2	0.1	76
1-3, 14	3.1	9.3	0.1	77
1-3, 103	4.0	9.2	0.1	76
1-4, 36	4.9	9.4	0.1	78
1-4, 91	5.4	8.7	0.1	71
1-5, 43	6.4	9.4	0.1	77
1-5, 102	7.0	9.6	0.5	76
2-1, 57	8.1	10.1	0.0	84
2-2, 39	9.4	10.1	0.0	84
2-2, 127	10.3	10.0	0.7	78
3-5, 21	23.5	10.3	0.0	86
3-6, 21	25.0	10.3	0.0	85
3-6, 136	26.2	10.3	0.1	85
4-4, 68	31.8	10.4	0.0	87
4-5, 60	33.2	10.5	0.1	87
8-6, 110	73.3	8.6	0.0	71
8-6, 126	73.4	8.9	0.0	74
9-5, 40	80.6	7.4	0.0	61
9-5, 133	81.5	5.8	0.1	48
9-6, 44	82.1	6.8	0.1	56
1-2, 100	2.5	8.4	0.1	69
2-2, 74	9.7	10.0	0.0	83
3-2, 100	19.8	10.8	0.0	89
5-2, 100	38.8	10.4	0.0	87
6-3, 82	49.5	10.5	0.7	82
7-2, 100	57.7	10.0	0.1	82
8-2, 100	67.2	10.3	0.0	85
9-2, 100	76.7	9.0	0.0	75
<b>Hole 395A</b>				
1-2, 100	5.2	6.9	0.1	57
2-2, 74	3.0	9.0	0.1	74

TABLE 4  
Carbon-Carbonate Data, Site 396

Sample (Interval in cm)	Depth (m)	Total Carbon (%)	Organic Carbon (%)	$\text{CaCO}_3$ (%)
1-2, 100	2.5	9.7	0.1	80
2-2, 100	7.5	8.7	0.0	72
3-2, 100	16.8	10.3	0.0	86
5-2, 100	35.6	10.6	0.0	88
6-4, 100	47.9	10.9	0.0	90
6, CC	51.5	10.7	0.7	83
7-2, 100	54.4	10.6	0.2	86
8-2, 100	63.7	10.8	0.9	83
9-2, 100	72.9	10.8	0.8	83
10-2, 100	82.1	10.7	0.9	82
11-2, 100	91.7	10.9	0.5	87
12-2, 101	100.9	10.8	0.0	89
13-2, 100	111.2	10.0	0.0	83
14-2, 100	120.1	5.2	0.1	43

- Shepard, F. P., 1954. Nomenclature based on sand-silt-clay ratios: *J. Sediment. Petrol.*, v. 24, p. 151.
- Wentworth, C. K., 1922. A scale of grade and class terms for clastic sediments: *J. Geol.*, v. 30, p. 377.