UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

INTRA-LAMINA GRAIN SIZE DISTRIBUTIONS:

1. HEAVY AND LIGHT MINERALS FROM SUBAERIAL AND SUBAQUEOUS GRAIN FLOW DEPOSITS

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OPEN FILE REPORT

83-351

INTRODUCTION

This report contains data on the grain-size frequency distributions of quartz (ρ = 2.65 gm/cm^3) and heavy minerals (ρ = 3.1 - 3.3 gm/cm^3) found within a subaerial grain-flow lamination generated in the laboratory and a beach foreshore lamination. Samples were obtained at many horizons within each lamination so that the vertical variations of grain size and density could be investigated. The data were previously used to explain how inverse size grading develops and to verify a hydraulic equivalence relationship for grain flows (Sallenger, 1979). The statistical data are published here so that other investigators may use the data to test different models of hydraulic equivalence.

METHODS

Subaerial Grain Flow Lamination

A subaerial grain flow was generated in the laboratory using an avalanche flume and natural beach sand. The channel of the flume was 8 cm wide and 46 cm long, and was artificially roughened. The channel was set at approximately the angle of repose and sand was introduced from a repository at the head of the channel. A sluice gate regulated the flow thickness. When the flow thickness exceeded approximately 0.7 cm, the sediment did not appear to shear throughout the flow, and a surficial layer of sediment flowed as a plug. Care was taken, therefore, to limit the flow thickness to less than 0.5 cm. The channel was hinged at its upper end, so that once a steady grain flow was established the channel could be rapidly rotated to horizontal, freezing the flow. This deposit was sampled by sequentially applying pieces of adhesive tape, 6 cm wide and 20 cm long, to its surface, thereby obtaining samples approximately one grain diameter thick through the thickenss of the flow.

Approximately 1 cm was trimmed from the borders of each piece of tape and the sediment was collected from the remaining tape.

Portions of each sample in the density ranges of < 2.9 and 3.1-3.3 gm/cm^3 were separated using heavy liquids. Using a binocular microscope with a micrometer eyepiece, long axes of approximately 400 grains in the 3.1-3.3 gm/cm^3 fraction and 400 grains of visually identified quartz ($\rho = 2.65$) in the < 2.9 gm/cm^3 fraction were measured for each sample. A few of the heavy mineral subsamples in the upper part of the deposit contained significantly less than 400 grains and accordingly were omitted from subsequence analysis. Also, the percent by weight of all heavy minerals ($\rho > 2.9$ gm/cm^3) and of the 3.1-3.3 gm/cm^3 fraction were determined for each sample.

Beach Foreshore Lamination

A beach foreshore lamination, found on the beach that supplied the sand for the subaerial experiment, was sampled using the procedure described above. The lamination was visibly inversely graded, with predominantly coarse light minerals at the surface grading down to predominantly fine heavy minerals near the base. Seventeen subsamples were taken from the upper 75% of the 0.5 cm thick lamination. Sampling was not continued through the entire lamination because the sampled layers became visibly oblique to the lamination itself. Beginning with the sample obtained at the surface, every other sample was processed as before, yielding nine data sets.

DATA

The following data are presented: 1) percent of heavy minerals for each sample, 2) perspective contour plots of size frequency versus relative depth for light and heavy minerals and, 3) tables of grains size frequency distributions and the first four moments of each distribution.

Percent heavy minerals

Percents of heavy minerals for each subsample are given in Tables 1 and 2.

Table 1. Percent heavy minerals for each subsample for the subaerial grain flow lamination.

Relative Depth[1]	Percent Heavy Minerals	
	$\rho > 2.9$	$\rho = 3.1\text{-}3.3$
1	2.0	0.3
2	4.2	1.0
3	7.2	4.6
4	13.4	5.6
5	12.8	5.1
6	18.4	8.7
7	25.7	7.1
8	35.5	9.2
9	47.5	13.1
10	82.6	38.7

[1]Number 1 is at the surface of the lamination, number 2 is the second sample taken, etc.

Table 2. Percent heavy minerals for each subsample for the beach foreshore lamination.

Relative Depth[1]	Percent Heavy Minerals	
	$\rho > 2.9$	$\rho = 3.1\text{-}3.3$
1	1.3	0.3
3	1.8	0.5
5	3.4	0.8
7	6.2	2.7
9	6.7	3.3
11	7.8	2.3
13	8.1	3.0
15	10.3	3.6
17	11.0	4.8

[1]Number 1 is at the surface of the lamination, number 3 is the third sample taken etc.

Perspective contour plots of grain size distributions

Figures 1-4 are perspective contour plots of grain size distributions versus relative depth. Figures 1 and 2 are of light and heavy minerals respectively from the subaerial grain flow laminatation. Figures 3 and 4 are of light and heavy minerals respectively from the beach foreshore lamination. In these figures the x axis is grain size in phi units, the y axis is relative depth for each sample (1 is at the surface of the lamination), and the contours are frequency percents. These figures show vertical grading of the size distributions. For example, Figure 1 shows a distribution whose center shifts progressively to smaller grains sizes with increasing depth, a pattern which clearly demonstrates inverse grading.

Grain size frequency distributions

A variety of statistical parameters were computed for the size data. The FL series contains light mineral statistics and the FH series contains heavy mineral statistics for the subaerial grain flow lamination. The DL series contains light mineral statistics and the DH series contains heavy mineral statistics for the beach foreshore lamination. The number associated with the series name indicates the relative depth of the sample. For example, FL3 is the third sample from the surface of the subaerial deposit and contains statistics on light minerals. The size frequency distributions are based on number frequency. The first four moments of the distribution were calculated using the size data in millimeters. There are some minor differences between mean sizes reported here and those reported in Sallenger (1979). The values reported here are correct. Data from sample D9H was, unfortunately, lost. The mean size for D9H was .383 mm.

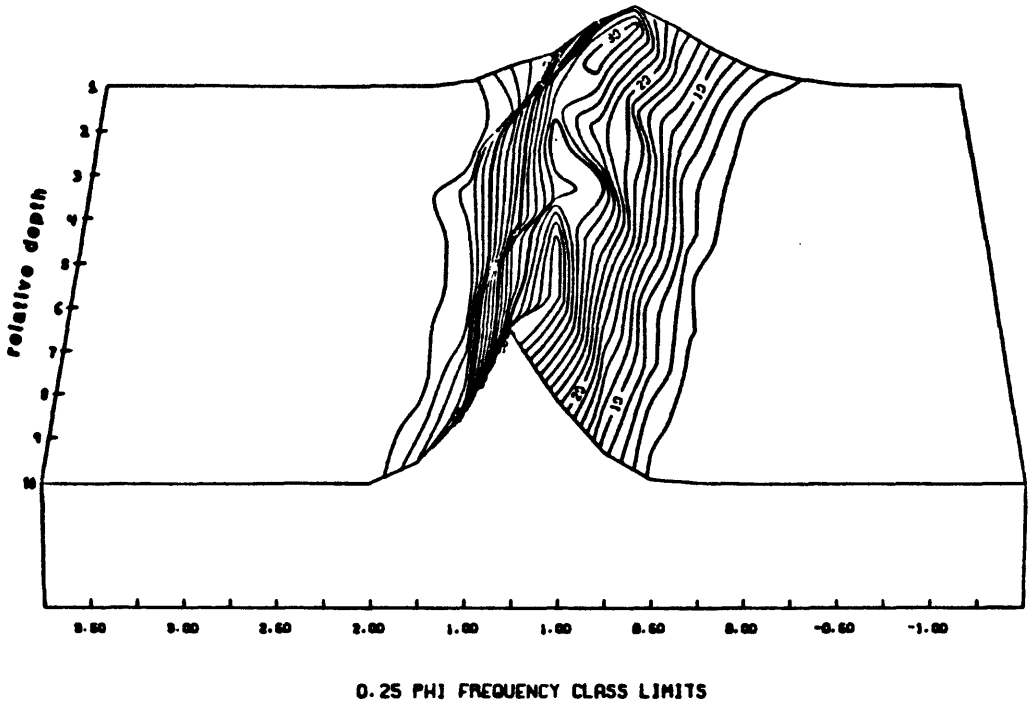

Figure 1. Grain size distributions of light minerals versus depth for the subaerial grain flow lamination.

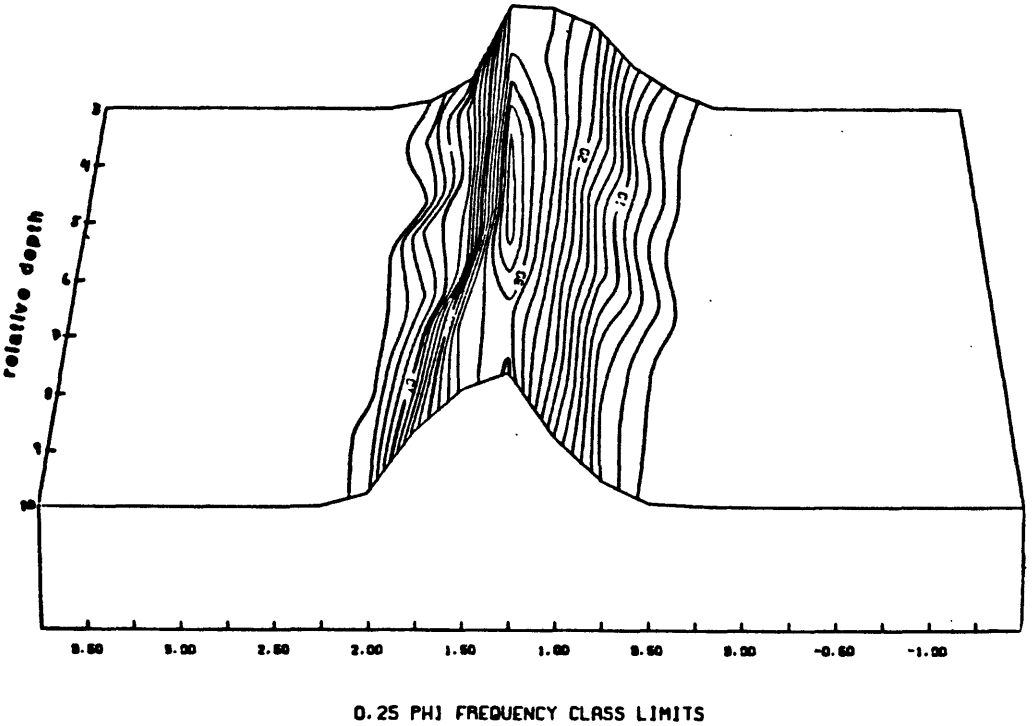

Figure 2. Grain size distributions of heavy minerals versus depth for the subaerial grain flow lamination.

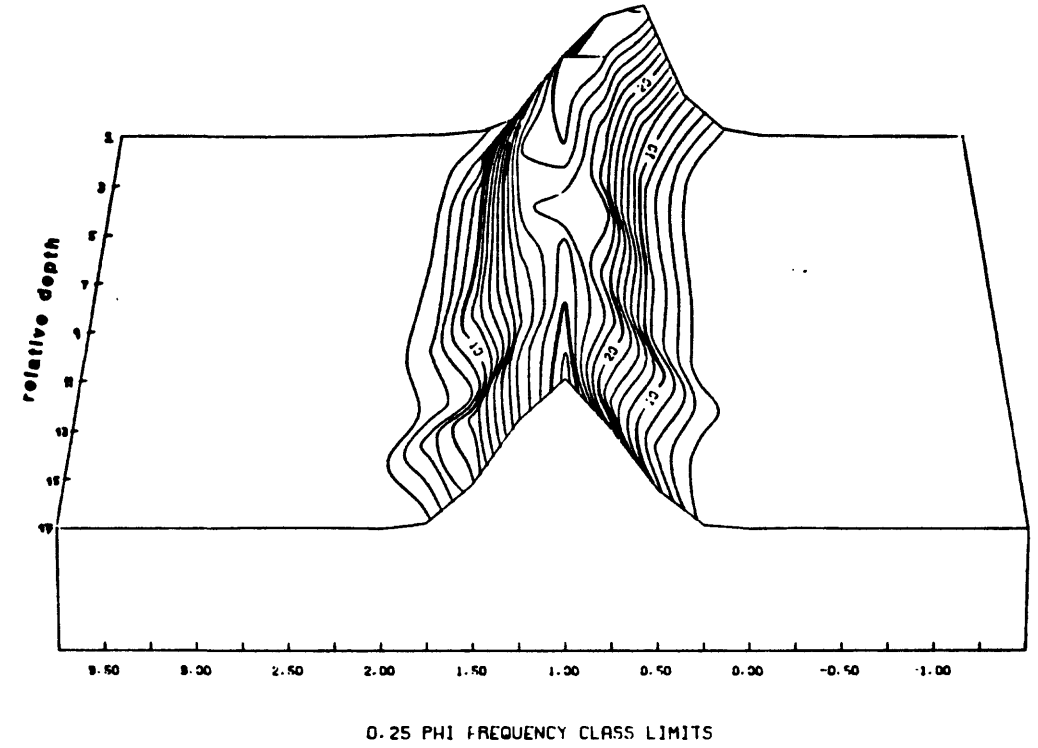

Figure 3. Grain Size distributions of light minerals versus depth for the beach foreshore laminations.

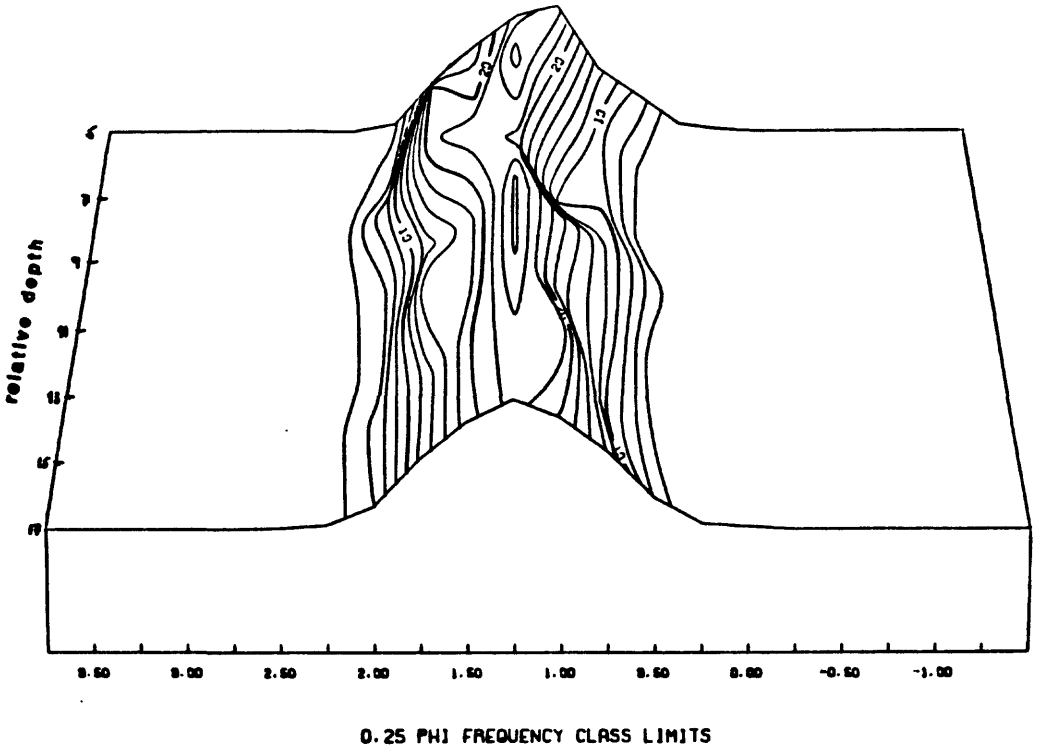

Figure 4. Grain Size distributions of heavy minerals versus depth for the beach foreshore laminations.

SAMPLE F1L

AVALANCHE FLUME

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 1

NUMBER OF DATA POINTS- 408

STATISTICS

mean= 0.6820D+00

variance= 0.4261D-01

skewness= 0.8573D-02

kurtosis= 0.8341D-02

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.245	100.000
0.300	1.75	0.000	99.755
0.350	1.50	1.471	99.755
0.420	1.25	6.373	98.284
0.500	1.00	10.049	91.912
0.590	0.75	19.608	81.863
0.710	0.50	24.755	62.255
0.840	0.25	18.627	37.500
1.000	0.00	11.029	18.873
1.190	-0.25	5.147	7.843
1.410	-0.50	2.206	2.696
1.680	-0.75	0.490	0.490
2.000	-1.00	0.000	0.000

SAMPLE F2L

AVALANCHE FLUME

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 2

NUMBER OF DATA POINTS- 404

STATISTICS

mean= 0.6053D+00

variance= 0.1686D-01

skewness= 0.1220D-02

kurtosis= 0.8623D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.000	100.000
0.300	1.75	0.000	100.000
0.350	1.50	0.743	100.000
0.420	1.25	3.960	99.257
0.500	1.00	16.832	95.297
0.590	0.75	27.475	78.465
0.710	0.50	30.693	50.990
0.840	0.25	14.604	20.297
1.000	0.00	5.446	5.693
1.190	-0.25	0.248	0.248
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F3L

AVALANCHE FLUME

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 3

NUMBER OF DATA POINTS- 435

STATISTICS

mean= 0.5454D+00

variance= 0.1630D-01

skewness= 0.1852D-02

kurtosis= 0.1030D-02

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.000	100.000
0.300	1.75	0.460	100.000
0.350	1.50	1.609	99.540
0.420	1.25	12.874	97.931
0.500	1.00	26.207	85.057
0.590	0.75	31.724	58.851
0.710	0.50	15.632	27.126
0.840	0.25	8.736	11.494
1.000	0.00	2.759	2.759
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F41

AVALANCHE FLUME

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 4

NUMBER OF DATA POINTS- 455

STATISTICS

mean= 0.5191D+00

variance= 0.1666D-01

skewness= 0.1804D-02

kurtosis= 0.1125D-02

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.220	100.000
0.300	1.75	1.538	99.780
0.350	1.50	4.835	98.242
0.420	1.25	15.604	93.407
0.500	1.00	29.011	77.802
0.590	0.75	22.857	48.791
0.710	0.50	18.901	25.934
0.840	0.25	5.055	7.033
1.000	0.00	1.758	1.978
1.190	-0.25	0.220	0.220
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F51

AVALANCHE FLUME

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 5

NUMBER OF DATA POINTS- 405

STATISTICS

mean= 0.5129D+00

variance= 0.1281D-01

skewness= 0.9914D-03

kurtosis= 0.5409D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.000	100.000
0.300	1.75	0.247	100.000
0.350	1.50	3.951	99.753
0.420	1.25	16.296	95.802
0.500	1.00	32.099	79.506
0.590	0.75	25.432	47.407
0.710	0.50	16.296	21.975
0.840	0.25	5.185	5.679
1.000	0.00	0.494	0.494
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F61

AVALANCHE FLUME

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 6

NUMBER OF DATA POINTS- 422

STATISTICS

mean= 0.5033D+00

variance= 0.1116D-01

skewness= 0.8099D-03

kurtosis= 0.5282D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.237	100.000
0.300	1.75	1.422	99.763
0.350	1.50	2.607	98.341
0.420	1.25	18.246	95.735
0.500	1.00	28.673	77.488
0.590	0.75	31.517	48.815
0.710	0.50	14.218	17.299
0.840	0.25	2.133	3.081
1.000	0.00	0.948	0.948
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F71

AVALANCHE FLUME

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 7

NUMBER OF DATA POINTS- 403

STATISTICS

mean= 0.4731D+00

variance= 0.8540D-02

skewness= 0.5783D-03

kurtosis= 0.2707D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.000	100.000
0.300	1.75	1.489	100.000
0.350	1.50	3.970	98.511
0.420	1.25	26.055	94.541
0.500	1.00	34.988	68.486
0.590	0.75	23.821	33.499
0.710	0.50	7.444	9.677
0.840	0.25	2.233	2.233
1.000	0.00	0.000	0.000
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F81

AVALANCHE FLUME

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 8

NUMBER OF DATA POINTS- 396

STATISTICS

mean= 0.4576D+00

variance= 0.6628D-02

skewness= 0.2633D-03

kurtosis= 0.1447D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.253	100.000
0.300	1.75	1.010	99.747
0.350	1.50	6.566	98.737
0.420	1.25	26.263	92.172
0.500	1.00	39.394	65.909
0.590	0.75	18.687	26.515
0.710	0.50	7.323	7.828
0.840	0.25	0.505	0.505
1.000	0.00	0.000	0.000
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F91

AVALANCHE FLUME

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 9

NUMBER OF DATA POINTS- 418

STATISTICS

mean= 0.4335D+00

variance= 0.6199D-02

skewness= 0.1356D-03

kurtosis= 0.1460D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.478	100.000
0.250	2.00	0.478	99.522
0.300	1.75	2.871	99.043
0.350	1.50	8.852	96.172
0.420	1.25	30.861	87.321
0.500	1.00	39.474	56.459
0.590	0.75	13.636	16.986
0.710	0.50	2.871	3.349
0.840	0.25	0.478	0.478
1.000	0.00	0.000	0.000
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F10L

AVALANCHE FLUME

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 10

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.3990D+00

variance= 0.5751D-02

skewness= 0.3000D-03

kurtosis= 0.1438D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.250	100.000
0.210	2.25	0.250	99.750
0.250	2.00	0.250	99.500
0.300	1.75	5.750	99.250
0.350	1.50	18.750	93.500
0.420	1.25	41.750	74.750
0.500	1.00	23.000	33.000
0.590	0.75	8.500	10.000
0.710	0.50	1.250	1.500
0.840	0.25	0.250	0.250
1.000	0.00	0.000	0.000
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F3H

AVALANCHE FLUME

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 3

NUMBER OF DATA POINTS- 305

STATISTICS

mean= 0.4770D+00

variance= 0.1283D-01

skewness= 0.1171D-02

kurtosis= 0.5838D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.000	100.000
0.300	1.75	1.967	100.000
0.350	1.50	7.541	98.033
0.420	1.25	26.885	90.492
0.500	1.00	26.230	63.607
0.590	0.75	21.967	37.377
0.710	0.50	10.820	15.410
0.840	0.25	4.262	4.590
1.000	0.00	0.328	0.328
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F4H

AVALANCHE FLUME

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 4

NUMBER OF DATA POINTS- 414

STATISTICS

mean= 0.4509D+00

variance= 0.1250D-01

skewness= 0.1402D-02

kurtosis= 0.7152D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.000	100.000
0.300	1.75	4.348	100.000
0.350	1.50	12.560	95.652
0.420	1.25	27.778	83.092
0.500	1.00	25.604	55.314
0.590	0.75	20.290	29.710
0.710	0.50	6.763	9.420
0.840	0.25	2.174	2.657
1.000	0.00	0.483	0.483
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F5H

AVALANCHE FLUME

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 5

NUMBER OF DATA POINTS- 415

STATISTICS

mean= 0.4555D+00

variance= 0.1247D-01

skewness= 0.1686D-02

kurtosis= 0.9256D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.241	100.000
0.250	2.00	0.241	99.759
0.300	1.75	1.928	99.518
0.350	1.50	11.325	97.590
0.420	1.25	30.602	86.265
0.500	1.00	26.265	55.663
0.590	0.75	19.036	29.398
0.710	0.50	7.711	10.361
0.840	0.25	1.687	2.651
1.000	0.00	0.723	0.964
1.190	-0.25	0.241	0.241
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F6H

AVALANCHE FLUME

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 6

NUMBER OF DATA POINTS- 363

STATISTICS

mean= 0.4239D+00

variance= 0.9533D-02

skewness= 0.9103D-03

kurtosis= 0.4799D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.275	100.000
0.300	1.75	8.264	99.725
0.350	1.50	12.397	91.460
0.420	1.25	33.884	79.063
0.500	1.00	26.446	45.179
0.590	0.75	13.223	18.733
0.710	0.50	4.959	5.510
0.840	0.25	0.000	0.551
1.000	0.00	0.551	0.551
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F7H

AVALANCHE FLUME

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 7

NUMBER OF DATA POINTS- 401

STATISTICS

mean= 0.4288D+00

variance= 0.9881D-02

skewness= 0.8546D-03

kurtosis= 0.4070D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.998	100.000
0.300	1.75	5.486	99.002
0.350	1.50	13.466	93.516
0.420	1.25	34.913	80.050
0.500	1.00	24.688	45.137
0.590	0.75	13.466	20.449
0.710	0.50	5.985	6.983
0.840	0.25	0.748	0.998
1.000	0.00	0.249	0.249
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F8H

AVALANCHE FLUME

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 8

NUMBER OF DATA POINTS- 475

STATISTICS

mean= 0.3938D+00

variance= 0.7076D-02

skewness= 0.4295D-03

kurtosis= 0.1839D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.421	100.000
0.250	2.00	1.474	99.579
0.300	1.75	9.053	98.105
0.350	1.50	21.895	89.053
0.420	1.25	34.947	67.158
0.500	1.00	21.895	32.211
0.590	0.75	7.789	10.316
0.710	0.50	2.316	2.526
0.840	0.25	0.211	0.211
1.000	0.00	0.000	0.000
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F9H

AVALANCHE FLUME

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 9

NUMBER OF DATA POINTS- 433

STATISTICS

mean= 0.3747D+00

variance= 0.6865D-02

skewness= 0.3525D-03

kurtosis= 0.1694D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.231	100.000
0.210	2.25	0.693	99.769
0.250	2.00	2.771	99.076
0.300	1.75	12.471	96.305
0.350	1.50	27.483	83.834
0.420	1.25	28.637	56.351
0.500	1.00	20.323	27.714
0.590	0.75	5.543	7.390
0.710	0.50	1.848	1.848
0.840	0.25	0.000	0.000
1.000	0.00	0.000	0.000
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE F10H

AVALANCHE FLUME

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 10

NUMBER OF DATA POINTS- 413

STATISTICS

mean= 0.3669D+00

variance= 0.6146D-02

skewness= 0.3939D-03

kurtosis= 0.1505D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.242	100.000
0.250	2.00	3.148	99.758
0.300	1.75	17.191	96.610
0.350	1.50	26.634	79.419
0.420	1.25	30.508	52.785
0.500	1.00	15.496	22.276
0.590	0.75	5.811	6.780
0.710	0.50	0.726	0.969
0.840	0.25	0.242	0.242
1.000	0.00	0.000	0.000
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D1L

FORESHORE

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 1

NUMBER OF DATA POINTS- 332

STATISTICS

mean= 0.5862D+00

variance= 0.1488D-01

skewness= 0.1455D-02

kurtosis= 0.1204D-02

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.301	100.000
0.300	1.75	0.301	99.699
0.350	1.50	1.205	99.398
0.420	1.25	5.120	98.193
0.500	1.00	16.265	93.072
0.590	0.75	30.120	76.807
0.710	0.50	33.133	46.687
0.840	0.25	10.843	13.554
1.000	0.00	2.108	2.711
1.190	-0.25	0.301	0.602
1.410	-0.50	0.301	0.301
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D3L

FORESHORE

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 3

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.4971D+00

variance= 0.9975D-02

skewness= 0.4734D-03

kurtosis= 0.3752D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.250	100.000
0.250	2.00	0.000	99.750
0.300	1.75	1.000	99.750
0.350	1.50	4.500	98.750
0.420	1.25	17.500	94.250
0.500	1.00	30.500	76.750
0.590	0.75	30.500	46.250
0.710	0.50	13.250	15.750
0.840	0.25	2.250	2.500
1.000	0.00	0.250	0.250
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D5L

FORESHORE

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 5

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.4639D+00

variance= 0.1018D-01

skewness= 0.6973D-03

kurtosis= 0.4427D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	1.000	100.000
0.300	1.75	2.000	99.000
0.350	1.50	8.500	97.000
0.420	1.25	24.500	88.500
0.500	1.00	32.250	64.000
0.590	0.75	22.750	31.750
0.710	0.50	7.250	9.000
0.840	0.25	1.250	1.750
1.000	0.00	0.500	0.500
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D7L

FORESHORE

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 7

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.4559D+00

variance= 0.9788D-02

skewness= 0.8152D-03

kurtosis= 0.4074D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.250	100.000
0.300	1.75	2.250	99.750
0.350	1.50	9.750	97.500
0.420	1.25	28.000	87.750
0.500	1.00	30.000	59.750
0.590	0.75	20.500	29.750
0.710	0.50	7.500	9.250
0.840	0.25	1.500	1.750
1.000	0.00	0.250	0.250
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D9L

FORESHORE

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 9

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.4600D+00

variance= 0.1139D-01

skewness= 0.6883D-03

kurtosis= 0.4301D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.000	100.000
0.250	2.00	0.750	100.000
0.300	1.75	2.750	99.250
0.350	1.50	10.750	96.500
0.420	1.25	26.750	85.750
0.500	1.00	24.000	59.000
0.590	0.75	24.500	35.000
0.710	0.50	8.500	10.500
0.840	0.25	1.750	2.000
1.000	0.00	0.250	0.250
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D11L

FORESHORE

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 11

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.4466D+00

variance= 0.1062D-01

skewness= 0.4087D-03

kurtosis= 0.3861D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.250	100.000
0.177	2.50	0.250	99.750
0.210	2.25	0.250	99.500
0.250	2.00	0.500	99.250
0.300	1.75	4.250	98.750
0.350	1.50	13.000	94.500
0.420	1.25	23.500	81.500
0.500	1.00	28.750	58.000
0.590	0.75	20.500	29.250
0.710	0.50	7.500	8.750
0.840	0.25	1.250	1.250
1.000	0.00	0.000	0.000
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D13L

FORESHORE

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 13

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.4824D+00

variance= 0.1369D-01

skewness= 0.1256D-02

kurtosis= 0.8459D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.250	100.000
0.210	2.25	0.000	99.750
0.250	2.00	0.500	99.750
0.300	1.75	2.500	99.250
0.350	1.50	6.250	96.750
0.420	1.25	21.750	90.500
0.500	1.00	29.500	68.750
0.590	0.75	23.250	39.250
0.710	0.50	12.000	16.000
0.840	0.25	3.250	4.000
1.000	0.00	0.500	0.750
1.190	-0.25	0.250	0.250
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D15L

FORESHORE

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 15

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.4348D+00

variance= 0.1192D-01

skewness= 0.1575D-02

kurtosis= 0.1060D-02

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.000	100.000
0.210	2.25	0.250	100.000
0.250	2.00	1.500	99.750
0.300	1.75	7.000	98.250
0.350	1.50	12.750	91.250
0.420	1.25	24.750	78.500
0.500	1.00	31.250	53.750
0.590	0.75	15.500	22.500
0.710	0.50	5.500	7.000
0.840	0.25	0.750	1.500
1.000	0.00	0.500	0.750
1.190	-0.25	0.250	0.250
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D17L

FORESHORE

GRAIN DENSITY- LESS THAN 2.9 GM/CUBIC CM

LAYER NUMBER- 17

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.4624D+00

variance= 0.9981D-02

skewness= 0.9315D-03

kurtosis= 0.7420D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.250	100.000
0.177	2.50	0.250	99.750
0.210	2.25	0.250	99.500
0.250	2.00	0.000	99.250
0.300	1.75	1.250	99.250
0.350	1.50	9.750	98.000
0.420	1.25	24.000	88.250
0.500	1.00	33.000	64.250
0.590	0.75	21.750	31.250
0.710	0.50	8.500	9.500
0.840	0.25	0.750	1.000
1.000	0.00	0.000	0.250
1.190	-0.25	0.250	0.250
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D5H

FORESHORE

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 5

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.4223D+00

variance= 0.1384D-01

skewness= 0.1350D-02

kurtosis= 0.8156D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.250	100.000
0.149	2.75	0.250	99.750
0.177	2.50	0.250	99.500
0.210	2.25	0.000	99.250
0.250	2.00	1.500	99.250
0.300	1.75	10.500	97.750
0.350	1.50	17.250	87.250
0.420	1.25	23.000	70.000
0.500	1.00	25.000	47.000
0.590	0.75	12.750	22.000
0.710	0.50	7.250	9.250
0.840	0.25	1.500	2.000
1.000	0.00	0.500	0.500
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D7H

FORESHORE

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 7

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.3831D+00

variance= 0.1089D-01

skewness= 0.1037D-02

kurtosis= 0.4672D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.250	100.000
0.210	2.25	0.500	99.750
0.250	2.00	3.250	99.250
0.300	1.75	20.250	96.000
0.350	1.50	19.250	75.750
0.420	1.25	27.000	56.500
0.500	1.00	16.500	29.500
0.590	0.75	8.500	13.000
0.710	0.50	3.500	4.500
0.840	0.25	1.000	1.000
1.000	0.00	0.000	0.000
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D11H

FORESHORE

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 11

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.4001D+00

variance= 0.1229D-01

skewness= 0.9568D-03

kurtosis= 0.4984D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.250	100.000
0.210	2.25	1.000	99.750
0.250	2.00	3.750	98.750
0.300	1.75	13.250	95.000
0.350	1.50	17.500	81.750
0.420	1.25	26.250	64.250
0.500	1.00	19.000	38.000
0.590	0.75	12.500	19.000
0.710	0.50	5.750	6.500
0.840	0.25	0.750	0.750
1.000	0.00	0.000	0.000
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D13H

FORESHORE

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 13

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.3925D+00

variance= 0.1292D-01

skewness= 0.1740D-02

kurtosis= 0.9850D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.250	100.000
0.177	2.50	0.250	99.750
0.210	2.25	0.750	99.500
0.250	2.00	3.250	98.750
0.300	1.75	17.500	95.500
0.350	1.50	17.750	78.000
0.420	1.25	26.500	60.250
0.500	1.00	16.750	33.750
0.590	0.75	12.250	17.000
0.710	0.50	3.250	4.750
0.840	0.25	1.000	1.500
1.000	0.00	0.250	0.500
1.190	-0.25	0.250	0.250
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D15H

FORESHORE

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 15

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.3897D+00

variance= 0.1051D-01

skewness= 0.4047D-03

kurtosis= 0.2973D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	1.000	100.000
0.210	2.25	1.000	99.000
0.250	2.00	4.750	98.000
0.300	1.75	12.250	93.250
0.350	1.50	19.750	81.000
0.420	1.25	23.750	61.250
0.500	1.00	23.500	37.500
0.590	0.75	10.000	14.000
0.710	0.50	4.000	4.000
0.840	0.25	0.000	0.000
1.000	0.00	0.000	0.000
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000

SAMPLE D17H

FORESHORE

GRAIN DENSITY- 3.1 TO 3.3 GM/CUBIC CM

LAYER NUMBER- 17

NUMBER OF DATA POINTS- 400

STATISTICS

mean= 0.4083D+00

variance= 0.1408D-01

skewness= 0.1452D-02

kurtosis= 0.8007D-03

class limits mm	phi	frequency percent	culmulative percent coarser
0.105	3.25	0.000	100.000
0.125	3.00	0.000	100.000
0.149	2.75	0.000	100.000
0.177	2.50	0.250	100.000
0.210	2.25	0.750	99.750
0.250	2.00	4.000	99.000
0.300	1.75	12.500	95.000
0.350	1.50	19.000	82.500
0.420	1.25	23.000	63.500
0.500	1.00	19.750	40.500
0.590	0.75	13.750	20.750
0.710	0.50	5.500	7.000
0.840	0.25	1.000	1.500
1.000	0.00	0.500	0.500
1.190	-0.25	0.000	0.000
1.410	-0.50	0.000	0.000
1.680	-0.75	0.000	0.000
2.000	-1.00	0.000	0.000