GEOL 3442 Stratigraphy and Sedimentary Petrology and Petrography
Laboratory Exercise 1
Sediment Textural Analysis

PURPOSE: To acquaint you with some of the basic techniques used in grain-size analysis.

SIZE ANALYSIS: You will determine grain size distribution of two sand samples by dry sieving. For each sample you will:

A. Determine the weight percent of sediment in each of several grain-size intervals (note the appended grain-size scale for sediments).
B. Plot a cumulative curve from the data in Part A.
C. Derive statistically useful parameters from the curve in Part B.
D. Determine degree of sorting (refer to empirical scale on p. 3).
E. Determine average roundness of 100 grains from modal grain size of sample.
F. Determine the state of textual maturity of the samples.
G. Compare cumulative curve shapes with standard curves for comparable environments.
H. For sample B (coarser maximum grain size), prepare a silt to very coarse sand grain-size card for visual estimation of grain size. Label each size fraction.

PROCEDURE:

A. Sieving. Use the supplied stack of sieves to complete the following procedure:

1. Weight your initial sample and record the weight on the 'Mechanical Analysis' sheet.
2. Clean each sieve by rapping it firmly and evenly on the laboratory bench, which should be first covered with a piece of kraft paper. Do not touch the mesh or try to force grains through.
3. Nest the sieves in order of successively increasing mesh sizes---pan on the bottom, coarsest mesh on top. Gently pour the supplied sample into the top sieve, and place the cover on that sieve.
4. Place the sieve stack in the sieve shaker and make it secure. Run the shaker for 15 minutes, then remove the sieve stack.
5. Get a sheet of kraft paper, crease it in the middle, and place it on the laboratory bench. Do the same with a sheet of notebook paper, placing it on top of the kraft paper. Finally, place another sheet of white paper beside the other papers.
6. Pour the sand from the coarsest sieve onto the white paper. Invert the sieve over that paper, and tap the rim gently, with the heel of your hand---diagonally to the mesh. Pour the sand from the paper into the balance pan of the scales. Now, invert the sieve over the creased notebook paper, and rap it on the paper, making sure that the rim is parallel with the table. Add any additional sand to the balance pan.
7. Weigh this fraction and record its weight and the mesh size on the attached form (Table 1). Place the fraction in a properly labeled envelope or paper bag.
8. Repeat steps 5-7 for each size fraction remaining.
9. Sieve the second sample following steps 1-7.

(Note: While handling the sediment, be careful not to loose any dust, the finest particles can easily blow away.)

B. Cumulative Curve. See Folk (1965, p. 41-49), cited in references on p. 7, for further information.

1. Obtaining cumulative weight and cumulative percent values: On the "Mechanical Analysis" form, you should record (a) the weight of the coarsest fraction in the column headed "cumulative weight," (b) add the weight of the next finer fraction to it and place their sum on the second line, and (c) repeat with successively

finer fractions until all are accounted for. Cumulative percent values are obtained by dividing each number in the "cumulative weight" column by the last number in that column (e.g., in the following example, 2/26, 6/26, 18/26, etc...). Record your data on the appropriate line under "cumulative percent."

EXAMPLE

ϕ	raw wt.	cum. wt.	cum. %
1.0	2.0 gm.	2.0 gm.	7.7
1.5	4.0 gm.	6.0 gm.	23.1
2.0	12.0 gm.	18.0 gm.	69.1
2.5	5.0 gm.	23.0 gm.	88.5
3.0	3.0 gm.	26.0 gm.	100.0

If there is a discrepancy between your total cumulative weight and the "starting weight" record on the form, briefly explain the reason under "Comments" on Table 1.

2. Plotting the cumulative curve:
   a. use probability paper
   b. plot the data from Part 1 (above); cum. % goes on the vertical axis, and ϕ units on the horizontal axis - coarsest to the left
   c. connect the points with 'best fit' lines
   d. determine the diameters in ϕ units that correspond to the 5%, 16%, 50%, 84%, and 95% points on the cumulative curve
   e. calculate the Graphic Mean (M_z), as follows:
      $M_z = (\phi16 + \phi50 + \phi84)/3$
   f. calculate the Inclusive Graphic Standard Deviation (σ), by:
      $\sigma_I = (\phi84 - \phi16)/4 + (\phi95 - \phi5)/6.6$
      state the degree of sorting (on Table 1) in your samples, using the scale below:

σ_I	Sorting
under 0.35ϕ	very well sorted
0.35-0.50ϕ	well sorted
0.50-0.71ϕ	moderately well sorted
0.71-1.00ϕ	moderately sorted
1.00-2.00ϕ	poorly sorted
2.00-4.00ϕ	very poorly sorted
over 4.00ϕ	extremely poorly sorted

   g. repeat steps a-g using the second sample (B).

C. Roundness (p).
   1. Via the appended visual estimation chart, determine the numerical roundness values for 100 grains in the modal size class.
   2. Using squared graph paper, show the distribution of these roundness values by means of histograms.
   3. For each sample, determine average roundness, Mp (sum up the roundness values and divide by 100).

D. Textual Maturity. Determine the textual maturity of each sample with respect to the table presented below. Record the result on Table 1.

Table of Textual Maturity

Much clay, poorly sorted, grains angular = immature
Little or no clay, poorly sorted, grains angular = submature
Little or no clay, well sorted, grains subangular = mature
Little or no clay, very well sorted, grains well rounded = supermature

E. Analysis of Environment. By reference to the shapes of cumulative curves published by Visher (1969) and Glaister & Nelson (1974) (see charts on blackboard), determine the probable depositional environment. For each sample, answer the questions at the bottom of Table 1.

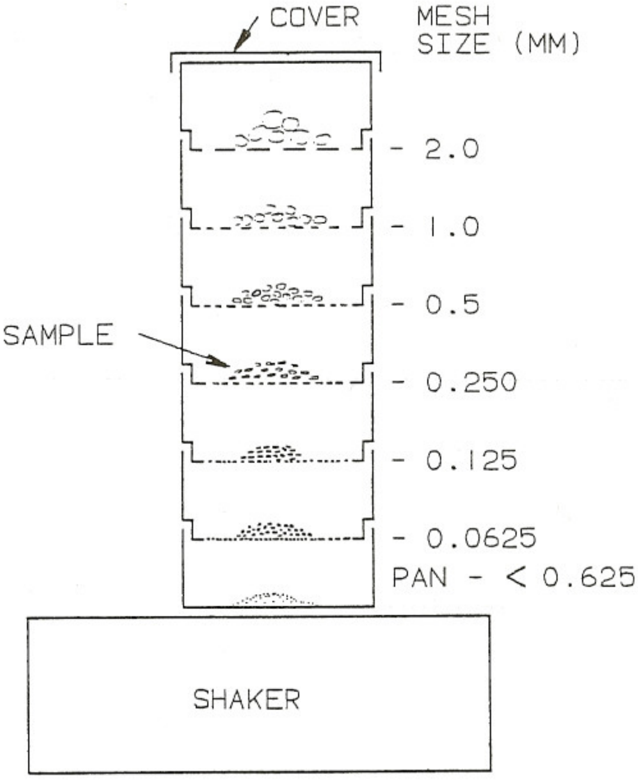

Figure 3.18. Illustration of sand-size analysis by sieving. The "nest" illustrated is for one phi intervals. Analysis by one-half phi increments would require twice as many sieves. Note that the weight in a particular sieve is the size between that opening and the next largest opening above. For example, the sediment contained in the 0.250mm sieve is between 0.5 and 0.250mm in diameter (between one and two phi).

YOU WILL NEED

-Probability paper
-Normal graph paper, divided into tenths or an inch
-(Both of these are included)

REFERENCES

Folk, R. L., 1965, Petrology of sedimentary rocks: Austin, Texas, Hamphill Book Store, University of Texas, 159 p.

Selley, R. C., 1976, Introduction to sedimentology: New York, Pergammon Press, Chapter 2.

Visher, G. S., 1969, Grain size distributions and depositional processes: Jour. Sed. Petrology, v. 39, p. 1074-1106.

Glaister, R. P., and H. W. Nelson, 1974, Grain size distribution, an aid in facies identification: Bull. Canadian Petroleum Geology, v. 32, p. 203-240.

Questions: Answer the following questions for each of the two samples.

1. How far have the grains in each sample traveled from their respective source areas (short, intermediate, or long distance)? Support your answer using data on the textural and mineralogic maturity of each sample.

2. Are textural and mineralogic maturity of the samples in harmony with the depositional environments suggested by the Visher curves? Support your answer.

3. Are there any other observations besides similarities in curve shape that support or weaken your original environmental interpretations (e.g. rounding, composition, etc...)? Explain.

4. For each sample, offer a second interpretation for sediment deposition that explains all your observations equally as well as your first interpretation. What characteristics do the two environments share that would explain this similarity?

TABLE 1

MECHANICAL ANALYSIS

Sample Number ____________ Starting Weight ____________

Held on:

(U.S.) Mesh	ϕ	raw wt.	% agg.	cor. wt.	wt. %	cum. wt.	cum. %

$\phi 5$ ______ M_z ______
$\phi 16$ ______ M_r ______
$\phi 50$ ______ σI ______
$\phi 84$ ______
$\phi 95$ ______

Statistical Data
Degree of sorting (verbal scale) ____________
Textural maturity (verbal scale) ____________
Probable environment (from Visher curves) ____________

Comments: Starting weight vs. cumulative weight: ____________

GRAIN SIZE SCALES FOR SEDIMENTS

The grade scale most commonly used for sediments is the Wentworth scale (actually first proposed by Udden), which is a logarithmic scale in that each grade limit is twice as large as the next smaller grade limit. For more detailed work, sieves have been constructed at intervals $2\sqrt{2}$ and $4\sqrt{2}$. The Ø (phi) scale, devised by Krumbein, is a much more convenient way of presenting data than if the values are expressed in millimeters, and is used almost entirely in recent work.

U.S. Standard Sieve Mesh #		Millimeters	Microns	Phi (Ø)	Wentworth Size Class
		4096		-12	
		1024		-10	Boulder (-8 to -12Ø)
Use		256		-8	
wire		64		-6	Cobble (-6 to -8Ø)
squares		16		-4	Pebble (-2 to -6Ø)
5		4		-2	
6		3.36		-1.75	
7		2.83		-1.5	Granule
8		2.38		-1.25	
10		2.00		-1.0	
12		1.68		-0.75	
14		1.41		-0.5	Very coarse sand
16		1.19		-0.25	
18		1.00		0.0	
20		0.84		0.25	
25		0.71		0.5	Coarse sand
30		0.59		0.75	
35	½	0.50	500	1.0	
40		0.42	420	1.25	
45		0.35	350	1.5	Medium sand
50		0.30	300	1.75	
60	¼	0.25	250	2.0	
70		0.210	210	2.25	
80		0.177	177	2.5	Fine sand
100		-0.149	149	2.75	
120	1/8	0.125	125	3.0	
140		0.105	105	3.25	
170		0.088	88	3.5	Very fine sand
200		0.074	74	3.75	
230	1/16	0.0625	62.5	4.0	
270		0.053	53	4.25	
325		0.044	44	4.5	Coarse silt
		0.037	37	4.75	
	1/32	0.031	31	5.0	
	1/64	0.0156	15.6	6.0	Medium silt
(Analyzed	1/128	0.0078	7.8	7.0	Fine silt
by	1/256	0.0039	3.9	8.0	Very fine silt
		0.0020	2.0	9.0	
Pipette		0.00098	0.98	10.0	Clay
		0.00049	0.49	11.0	
or		0.00024	0.24	12.0	
		0.00012	0.12	13.0	
Hydrometer)		0.00006	0.06	14.0	

Lynn 19-1790 (R-2470-P-90)
Probability x 90

No. 19-1790 (R-2470-P-90) Probability x 90 • Made in U.S.A.

VERNON McMILLAN, INC., ELIZABETH, N.J. 07208

0.01 0.05 0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 99.8 99.9 99.99

99.99 99.9 99.8 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01