**Geology 103 Lab #1**

**Grain size analysis**

**Objectives**

The purpose of this lab is to determine the grain size distribution and texture of an unconsolidated sediment sample. We will use a standard sieve set, a Ro-tap automatic shaker and graphical methods of data analysis. We will also examine the sample using a dissecting microscope, and compare our sieve results to the visual analysis. This lab has two major objectives: to introduce Geol 103 students to grain size analysis, and to set the standards for data presentation in a technical report.

**Methods**

Samples should be oven-dried (at about 60° C) and free of large twigs, leaves or other organic debris. Take 25-30 grams of dried sample, weigh the sample carefully, and record the initial weight. Assemble the sieve stack with largest mesh spacings on the top, progressively smaller mesh spacings downward, and a pan on the bottom. Pour the sample in the top sieve, Ro-tap for 20 minutes, and record the weight retained in each pan. We will weigh by difference, so first record the weight of the weighing paper or weighing tray. Then record the gross weight (weighing paper + sand retained) and finally subtract the paper weight from the gross weight to obtain the net sample weight retained.

When you are ready to plot your data you will use a spreadsheet that is posted on the Geology 103 web page. This spreadsheet will calculate the individual weight percent for each sand fraction by dividing the fraction weight by the total weight retained. The spreadsheet will also calculate cumulative weight percent for the entire sand sample by adding the individual weight percents. There are tabs for a data table, a cumulative frequency graph and a histogram that you will present in your report.

**Calculations**

Part of your assignment is to determine the mean, median, sorting and skewness of the sample. We will construct a data table, a grain size histogram, and an arithmetic cumulative frequency diagram to make these calculations. You will be able to read the mode from your histogram. When you have constructed the cumulative frequency diagram, you will be able to read values for φ5, φ16 ,φ50, φ84 and φ95 from this curve. These values are then substituted into the equations below to determine the graphic mean, median, inclusive graphic standard deviation (sorting) and inclusive graphic skewness (skewness) for your sand sample. Formulas for these measures are given below:

**Graphic Mean (Mz)** = (φ16 +φ50 +φ84)

3

**Median =**  φ50 from the cumulative frequency curve

**Inclusive graphic standard deviation" σi (sigma)** = (φ84 - φ16) + (φ95 - φ5)

4 6.6

**Inclusive graphic skewness SKi** = (φ84 + φ16 - 2φ50) + (φ95 + φ5  - 2φ50)

2 (φ84 - φ16) 2 (φ95 - φ5 )

**Activities**

We will complete these activities during lab:

* Listen to a brief lecture about grain size and sieves.
* Look at examples of roundness and sorting using a binocular microscope. I will provide the samples, and they will be available for the next week if you want to look at them again.
* Look at your unknown sample using a binocular microscope. Describe the roundness and the sorting of the sample using this visual method.
* Sieve your unknown sand sample with the rotap machine, and enter the weights for each fraction in the worksheet attached to this lab handout. Each lab will sieve one sample, and we will share the results.

**Interpretation**

Engineering geologists and engineers use grain size analysis for site evaluations, building and roadway construction, well construction and to evaluate slope stability. This is the most common use of grain size analysis. These professionals use the d50 value as a quick reference for grain size of a sample, and sometimes calculate the mean, median, mode, sorting or skewness of a sample using the equations from the last section.

Other geologists have attempted to use grain size data to interpret the environment of deposition for a sample. Some environmental interpretations are obvious: dunes and beaches contain well sorted sediment, river sediment is moderately sorted, and glacial sediment is poorly sorted. The problem with environmental interpretations is the overlap between different environments. Many environments produce sediment with similar textural properties.

Sedimentary grains become more rounded as they move farther from the source, so roundness may also provide environmental information. One complication with this approach is that different minerals have different resistance to weathering. A quartz grain may be transported 100’s or 1000’s of kilometers before it becomes rounded, while a volcanic rock fragment may be rounded within a few kilometers.

A good discussion of the uses of grain size data and textures for environmental interpretations is included in your textbook. For additional information you may also want to look at Friedman and Sanders (1978), Blatt, Middleton and Murray (1980), Boggs (1987) and Friedman, Sanders and Kopaska-Merkel (1992). Copies of these references are on the back table in the lab room (Placer Hall 1006).

**References**

Blatt, H., Middleton, G, and Murray, R., 1980, Origin of sedimentary rocks, Englewood Cliffs, Prentice Hall, 782 p.

Boggs, S., 1987, Principles of sedimentology and stratigraphy, New York, Macmillan, 784 p.

Friedman, G. M., and Sanders, J. E., 1978, Principles of sedimentology, New York,

792 p.

Friedman, G. M., Sanders, J. E., and Kopaska-Merkel, D. C., 1992, Principles of sedimentary deposits, New York, Macmillan, 717 p.

**What to turn in**

You will turn in a lab report at the beginning of next week’s lab. The lab report should use complete sentences and technical writing style. This means you should keep things brief and to the point. Don’t guess, speculate or use emotional terms. Avoid personal reference. Your report should be word processed and ***double spaced***, with 1” margins. Use a “normal” 11 or 12 point font. You do not need to use extra references for this report. Use your own words to describe the activities and results- avoid quotations.

**Your report should have these headings:**

**Introduction and purpose**

Use several concise sentences to describe the purpose of the lab.

**Methods**

Write a brief paragraph that describes the steps you took to collect and interpret your data.

**Results**

Give a brief overview of the results in paragraph form.  Refer to the data table, histogram and cumulative frequency curve.  Example:  “The sample has more fine material than coarse material (Figure 1).”  Every table or figure must have a reference in the text that is similar to this example.

**Include these table and figures in the results section of your report:**

* a data table of your sieving results
* a histogram that shows grain size distribution
* an annotated cumulative frequency curve
* a line graph that shows the mode
* a table that shows your values for phi 5, phi 16, phi 50, phi 84 and phi 96
* a table that shows results of these calculations:

mean, median, mode, standard deviation, skewness

Show your calculations.  Computer-generated calculations can be included in the report, or calculations may be done by hand.  Hand calculations should be on a separate sheet at the end of the report.  Refer to this as an appendix. (“See Appendix A”).

Include a brief visual description of the sample (from the binocular microscope).  Describe the roundness and sorting of the sample.

**Discussion**

Include a brief discussion with your report. What can you say about the grain size and texture of the sample?  Highlight the important findings of your sieve analysis and visual analysis.  Mention the error.  Do these methods agree with each other?  Can you make any environmental interpretations?

**Sieve Analysis Data Sheet**

Sample name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_

Method: \_\_\_\_\_\_\_\_\_\_\_\_ minutes shaking on the Ro-tap machine (normally 20 minutes)

Initial weight of whole sample: \_\_\_\_\_\_\_\_\_\_ gm (normally 25 to 35 grams of dry sand)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Screen  size  (phi units) | Gross  weight | Weighing paper  weight | Net  sample  weight retained | Individual weight percent | Cumulative Percent |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| pan |  |  |  |  |  |

Total weight retained: \_\_\_\_\_\_\_\_\_\_\_\_\_

Difference between initial weight of sample and total weight retained: \_\_\_\_\_\_\_\_\_\_\_\_\_

Percent error: (weight difference x 100) = \_\_\_\_\_\_\_\_\_\_\_\_\_%

total weight retained

Note:

Gross weight = weighing paper weight + sample weight

Weighing paper weight = weight of the empty, dry paper

Net sample weight = gross weight - weighing paper weight

Total weight retained = sum of all individual sample weights

Individual weight percent = (net sample weight) x 100

(total weight retained)

Cumulative weight percent = (sum of weights of all previous (larger) sand fractions)

+ (weight of current sand fraction)

**Sample Figure**

Figure 2: Cumulative frequency distribution of unknown sand sample number 17.

Points to note:

* Center the figure
* Use “normal” fonts- similar to the fonts in your report, no larger than 12 or 14 point.
* Every graph should have a title and axis should have labels. Titles and axis labels should have the largest fonts. Fonts should decrease in size according to the importance of the object.
* Minimize the use of bold.
* Include a figure caption. Left-justify the figure caption. Describe the key point(s) of the figure in the caption.

**Sample Table**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Screen size (phi units)** | **Gross Weight (gms)** | **Weighing Paper Weight (gms)** | **Net Sample Weight Retained (gms)** | **Individual Weight percent** | **Cumulative Weight percent** |
| > -3.0 | 5.34 | 5.34 | 0.00 | 0.00 | 0.00 |
| -3.0 | 6.18 | 5.32 | 0.86 | 4.27 | 4.27 |
| -2.0 | 8.69 | 5.36 | 3.33 | 16.53 | 20.79 |
| -1.0 | 10.05 | 5.43 | 4.62 | 22.93 | 43.72 |
| 0.0 | 11.68 | 5.37 | 6.31 | 31.32 | 75.04 |
| 1.0 | 9.08 | 5.36 | 3.72 | 18.46 | 93.50 |
| 2.0 | 6.45 | 5.30 | 1.15 | 5.71 | 99.21 |
| 3.0 | 5.56 | 5.46 | 0.10 | 0.50 | 99.70 |
| pan | 5.52 | 5.46 | 0.06 | 0.30 | 100.00 |
|  |  | Total: | 20.15 | 100.00 |  |

Table 1: Raw data from the sieve analysis of unknown sand sample 17.

Points to note:

* Center the table.
* Use “normal” fonts- similar to the fonts in your report, no larger than 12 or 14 point.
* Every column in the table should have a title. Include units in the title when appropriate. Column titles and row labels should be distinct. Fonts should decrease in size according to the importance of the object.
* Minimize the use of bold.
* Include a table caption. Left-justify the table caption. Describe the key point(s) of the table in the caption.