

## EaES 350 Laboratory 1: Grain-size analysis

Grain-size analysis, also known as particle-size analysis or granulometric analysis, is perhaps the most basic sedimentological technique to characterize and interpret sediments and sedimentary rocks. The purpose of this lab is to analyze two grain-size measurements of samples from the Rhine-Meuse Delta, The Netherlands. The two samples were collected from distinctly different depositional environments, but they have been mislabeled, so one of your tasks is to figure out which sample is from which location. Furthermore, you will get some practice using Microsoft Excel to carry out spreadsheet calculations.

The grain-size measurements were carried out in the early 1990s by means of the classical sieve-pipette technique (i.e., sieving of the sand fractions; pipette extraction of the mud fractions using settling tubes). Nowadays, grain-size analysis is commonly performed with high-tech instruments like laser particle sizers. It is widely known that different measurement techniques provide different results; this is a particularly important issue when samples measured by different techniques are to be compared.

Although the actual grain-size measurement by means of a state-of-the-art instruments is a matter of seconds, chemical sample preparation (i.e., removal of organics and carbonates with  $\text{H}_2\text{O}_2$  and  $\text{HCl}$ ; dispersion of clay particles with sodium pyrophosphate) involves quite some work. In our case, all the necessary measurements have been done already, and you will work with data provided in a spreadsheet (Excel-file EaES350-lab1). The spreadsheet contains, for each measured size fraction, its upper and lower values in both  $\mu\text{m}$  and  $\Phi$  units, as well as the weight percentages of sediment grains in that size fraction. The theoretical background and techniques to be used are described in the textbook and in the lecture notes (section “Unconsolidated clastic sediments”). Apart from your answers to the questions below, you will have to turn in your spreadsheet.

1. Classify the two samples according to the USDA textural triangle. Keep in mind that USDA defines the clay–silt transition at  $2\ \mu\text{m}$  and the silt–sand transition at  $50\ \mu\text{m}$  (which you can assume to equal  $53\ \mu\text{m}$ ).

2. The next step is to inspect the two samples graphically. Depict the grain-size distributions both as a grain-size histogram and as a cumulative frequency curve. Provide a brief description of the shape of the grain-size histograms. Based on the raw data and both graphs, determine the mode and the median size fractions of the two samples. How well do these two parameters characterize the two grain-size measurements?

3. Calculate the first three moments (mean, variance, and skewness) for both samples. Adhering to common practice, you subsequently want to convert these parameters to  $\Phi$  units (variance is  $\Phi^2$ , skewness is initially  $\Phi^3$ ); the square root of the variance provides the standard deviation, whereas the skewness divided by the standard deviation cubed provides the skewness in  $\Phi$  units. Using Fig. 2.8 in your textbook, infer

the degree of sorting of the two samples. How do they compare? And what can you infer from the values for the skewness? Are they any useful?

4. Both samples were obtained from deposits that were formed during the last cold spell of the last glacial (Younger Dryas), about 12,000 years ago. One was collected from a ~1-m-thick, so-called “overbank deposit”, a fluvial (river) deposit that forms during inundation of a wide floodplain during peak discharge. The other sample was collected from a ~10-m-high eolian dune formed by wind-blown sediment. Argue which sample belongs to which environment, and motivate your answer. If you look carefully at the grain-size distributions of the two samples (notably the grain-size histograms), you can observe a striking relationship between the two samples. Speculate on the origin of this relationship.

Pointers:

- note that the grain-size fraction  $>2000 \mu\text{m}$  ( $<-1 \Phi$ ) is excluded from all calculations
- carrying out the moment measure calculations is a little more complicated since we are dealing with grouped data (i.e., size fractions); therefore, it is necessary to use the  $\Phi$  midpoint value for each size fraction
- since grain-size weight percentages are unevenly distributed among the size fractions, it is necessary to multiply the  $\Phi$  midpoint values with the corresponding weight percentages; in these cases  $n = 100 (\%)$

