Exercise 2:
Grain-size analysis

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1 Introduction

The Grain-Size-Analysis was done on April 17th. The experiment began with an introduction to the process by lab technician Juri. Sample 8 was analysed, by first doing a visual description, and then dry sieving it to determine the grain size distribution. Afterwards the results of the sieving process were further examined and evaluated using R.

2 Visual description

The loose sediment had an overall light grey, almost white colour, with a few small, black particles. The largest grains were all muscovite crystals of up to 3,8 mm, the smallest were indistinguishable by eye, below 63 µm, and milky white. The very large pieces were quite rare, with most of the grains being below 0,6 mm. Overall, the span of the grain sizes was very large, the sample was poorly sorted.
Multiple different minerals were distinguishable. The largest pieces were all muscovite, as described above. Around the grain size of 0,5 mm opaque, angular, light grey plagioclase crystals as well as translucent quartz grains could be observed. The black grains, which were all below 0,4 mm and a little shiny, could be biotite. This composition suggest that the source rock was a granite.
The grains were extremely angular, with sharp corners and did not react to HCl.

Determining how this sample developed from a granite was not easy. The large mica crystals found in the sample do not usually survive the weathering process. The extreme angularity and poor sorting point towards a very short transport distance, which is also unusual for a sedimentary sample. Lab technician Juri helped with an explanation: The sediment was not a natural sample. It is a granite from the Alps, that was ground up in the lab for absolute dating using zirkon crystals by another scientist.

3 Methods

3.1 Dry Sieving

The grain size analysis test is performed to determine the particle size distribution of soils by investigating the percentage of each size of grain contained within a soil sample. Using this information, soil can be classified and it's behavior predicted. In the laboratory, a dry sieving process was used to determine the grain size distribution of particles that are larger than 63 µm. For a description of the distribution of even smaller particles a hydrometer analysis would be needed. The analysis was carried out using a set of sieves with different mesh sizes (listed in Table 1) . Each sieve separates larger from smaller particles by letting smaller diameter grains pass through its square shaped openings while grains with diameters larger than the size of the openings are retained.
The directions of DIN28 123 were followed during the process. To determine the sample size needed and choice of the largest sieve diameter the largest grains were visually examined to be around 3,8 mm. Using this size DIN28 123 determined that the sample used for the dry sieving had to weigh at least 300g and the diameter of the largest sieve chosen should be 4 mm.
The test was conducted by placing a series of sieves with progressively larger mesh sizes on

top of each other, creating a "tower" with a pan on the bottom to collect grains below 63 µm. Between the sieves, rubber seals were placed to prevent sieving loss. The sample was then poured onto the sieves and a lid placed on top. This tower was secured on top of a mechanical shaker with two straps. The horizontal Position of the shaker was checked, then the shaker was turned on for a duration of about 20 minutes. After the sieving process the individual sieves were weighed with the grains they retained. These values will later be compared to the weight of the sieves without the grains to determine the weight of the grains.

3.2 Statistical Analysis

To analyse the sample, the G2Sd R-Package was used, which is specifically developed for grain size analysis by Regis K. Gallon and Jerome Fournier (https://cran.r-project.org/package=G2Sd). With the package, values such as the percentiles, which are necessary for further analysis, and statistical reference values using phi, which are needed to place the sample in the categories provided on the worksheet, were calculated.

To assure that the package was working properly P10, P50 and P90 values were visually compared to the hand drawn graph. The formulas used in the source code are identical to the formulas given on the worksheet for the ϕ-operations Mz, σ_1, SK_1 and K_G, but not for the metric values. The percentiles calculated are therefore used to determine the metric values by hand.

4 Results

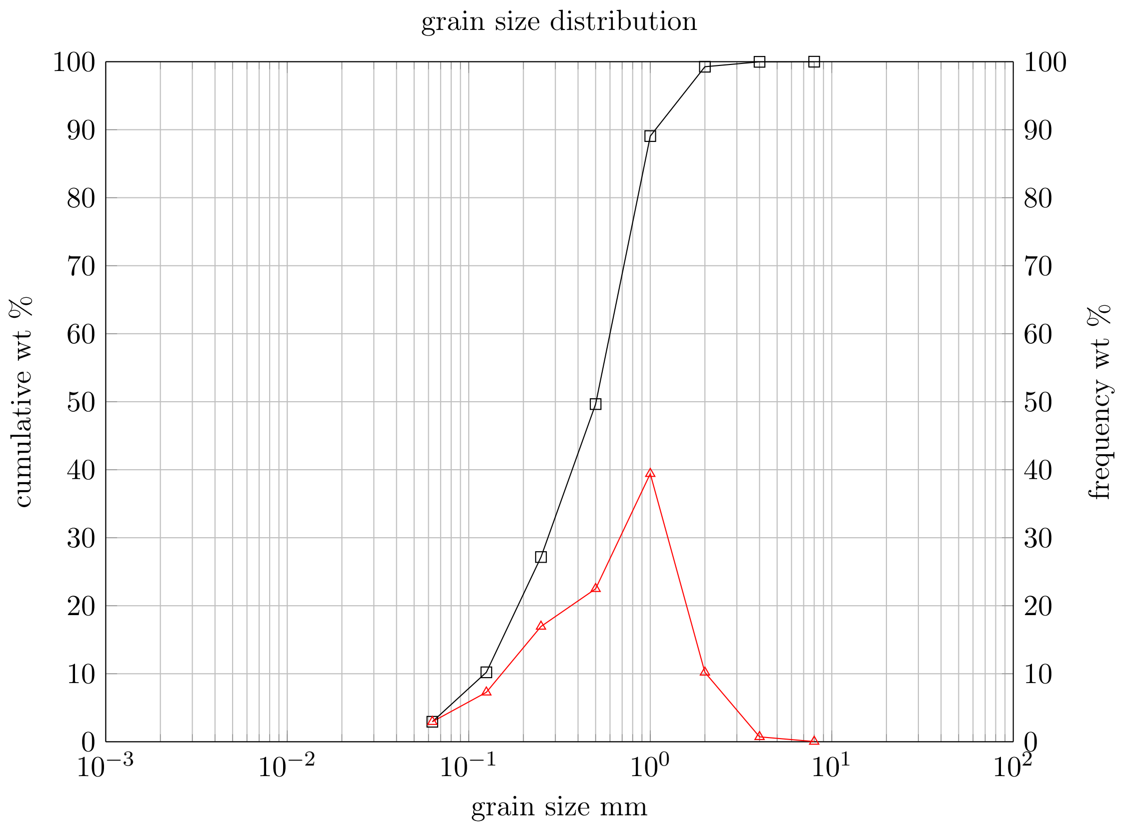
4.1 Grain sizes

The sieving process was started with 343,87 g of loose sediment. The total weight measured after the process was only 338,75 g, which means a loss of more than the 1% of total mass permitted by DIN18123, paragraph 4.4.1.3. Unfortunately, the sieving process could not be repeated due to time constraints. The following analysis is therefore flawed, and only useful as an exercise. Almost all of the sieving loss is suspected to have happened when the 0,5 mm sieve got stuck in the tower. Pulling it off lead to a spill. There was also a bit of loss during the transfer of the sample into the sieves as a fine dust in the air was seen.

The Process of dry sieving the sample yielded the following results:

Table 1: dry sieving results

sieve size in mm	weight retained in g	weight retained in %	cumulative weight % passthrough
8	0.00	0.00	100.01
4	0.11	0.03	99.98
2	2.43	0.72	99.26
1	34.55	10.2	89.06
0.5	133.49	39.41	49.65
0.25	76.17	22.49	27.16
0.125	57.43	16.95	10.21
0.063	24.62	7.27	2.94
<0.063	9.95	2.94	
Sum	338.75	100.01	



4.2 Statistical Analysis

Descriptive categories were assigned using the table on the worksheet. The metric values were calculated using the formulas on the worksheet, whereas the phi Values were calculated in R, using the package mentioned above.

Example calculation for sorting (QDa):

$$QDa = \frac{P75 - P25}{2} = \frac{154 - 579}{2} = -212.5 \quad (1)$$

4.2.1 Calculated statistical Values

Table 2: results using R

Category	Name	Value	Descriptive Category
Metric (µm)	P90	79.46	
	P75	154	
	Median/P50	501	
	P25	579	
	P10	1021	
	Mean	366.5	
	Sorting (QDa)	-212.5	
	Sorting (So)	0.517	
	Skewness (Ska)	-134.5	
	Skewness (Sk)	0.355	
	Kurtosis (Kqa)	0.225	
Phi	Standard Deviation (σ_1)	1.16	poorly sorted
	Skewness (SK_1)	0.577	strongly positively skewed
	Kurtosis (K_G)	0.878	broad-peaked

4.2.2 Interpretation of statistical values

These values point toward the sample being a poorly sorted sand (compare K_G and σ_1) with small amounts of silt. Over 80% of the grains are of sand size (P90 and P10 values are both considered sand), with a focus on medium sand. Only about three percent of the sample is finer than sand, and less than one percent is coarser. On the tertiary grain size diagram, this would place the sample in the sand category.
The positive skew of the distribution makes sense when looking at the origin of the sample: A laboratory mill will not let any pieces that are larger than a set size through (for the examined sample, somewhere between 1 and 2mm), whereas it might crush particles smaller than the set size (for example by smashing two grains together), explaining the tail of the graph in the direction of smaller grain sizes. All grains above the 1 to 2 mm threshold were mica crystals, which might have been soft or flat enough to make it through the mill despite being larger than the set size.

5 Appendix

Korngrößenverteilung Siebanalyse

Probenbezeichnung : ____________ Probe Nr.: 8

Bearbeiter: [illegible] Datum: ____________

Ausgangsgewicht (trocken): 343,87

Siebverlust: ______

Kurve immer mit Durchgängen, nie mit Rückständen!

Maschenweite	Tara	Tara+trockene Probe	Rückstand	Rückstand	~~Summe~~ Durchgang
mm	g	g	g	%	%
63,000	/				
31,500	/				
16,000	/				
8,000	/				
4,000	426,76	426,87	0,11	0,03	100,01
2,000	335,90	338,33	2,43	0,72	99,98
fehlt → 1,000	490,82	525,37	34,55	10,2	99,26
0,500	312,41	445,90	133,49	39,41	89,06
0,250	291,27	367,44	76,17	22,49	49,65
0,125	259,81	317,24	57,43	16,95	27,16
0,063	224,67	249,29	24,62	7,27	10,21
< 0,063	344,46	354,41	9,95	2,94	2,94
Summe:			338,75	100,01	100,01

→ zu hoher Siebverlust (> 1%)

→ Siebe mittig & Maschine horizontal platzieren

→ beim Öffnen verteilt?