Environmental Geology

Well-Site Data Interpretation

Fall, 2007

My objective for the assignment: *This assignment will build on topographic map and groundwater skills learned in ESC 115 in order to for you to become competent at the tasks you may face at the well site as an environmental consultant.*

When drilling test borings and environmental monitoring wells, samples of unconsolidated soils are usually collected. These samples are often sufficiently disturbed to make them useless for permeameter measurements of hydraulic conductivity. However, the collection disturbance does not alter their grain-size distributions. Therefore this information may be useful for obtaining rough estimates of K.

Hydraulic conductivity estimates from grain-size distributions are usually based on one or more representative measurement, such as the median grain diameter, ϕ_{50}, the sieve size through which half by weight of the sample passes. Two other common measurements are the mean and standard deviation, a measure of sorting. The Folk method, commonly used for estimating the mean and standard deviation, uses the equations,

$$\mu = \frac{\phi_{84} + \phi_{50} + \phi_{16}}{3}$$

and

$$\sigma = \frac{\phi_{84} - \phi_{16}}{2}.$$

Median grain size and standard deviation are particularly useful if the grain-size distribution is approximately normal. Additional measurements that may be useful are grain angularity and packing. However, packing is generally disturbed during sampling of unconsolidated samples, though it may be a very important factor, especially if a significant clay fraction is present.

Numerous studies have been performed to determine the relationship between grain-size distribution and hydraulic conductivity. Masch and Denny (1966) produced a set of curves relating median diameter, standard deviation and hydraulic conductivity (Fig. 1). Shepherd (1989) studied published values of grain diameter and hydraulic conductivity and developed a chart relating depositional environment and grain size to hydraulic conductivity. Subsequent studies (Panda and Lake, 1994; Alyamani and Sen, 1993) use the entire grain-size distribution to estimate hydraulic conductivity.

Assignment 1

The Coastal Laboratory of the Department of Geology and Geophysics, UNO, analyzed samples at one-foot intervals in a core taken by vibracore. The core was taken offshore near Grand Isle, LA, a barrier island. The particle-size data are in the file grainsize.wk1, posted on the class website.

Tasks

1. Calculate sorting for each depth using the Folk statistic.
2. Calculate the percentage of sand at each depth. Consider all sediments courser than $\phi = 4$ as sand. You will have to linearly interpolate to estimate this value.
3. Plot the median grainsize as a function of depth.
4. Plot the grainsize distribution for each depth, with cumulative percentage on the y axis and ϕ size on the x.
5. Use Fig. 1 to estimate a hydraulic conductivity for each depth, whenever possible.
6. Both pumping and slug tests require the installation of a well. Pumping tests require significant time and equipment. Discuss briefly when you would use the grain-size estimates of K.

Assignment 2

In field studies, determining the direction of groundwater flow is crucial for estimating contaminant source and migration. Below in Table 1 are data for three wells installed here on UNO's campus. Shown are the elevation of the top of casing (TOC) and the depth to water in the wells (DTW). Locations of wells are given in Table 2.

Well	TOC (ft)	DTW (ft)
B4	1.57	2.64
B5	2.44	3.47
B6	2.18	3.26

Table 1: Water level data.

Tasks

1. Create a simple sketch of the well locations.
2. Calculate the hydraulic head for each well.

Wells	Distance (ft)
B4-B5	75
B4-B6	76
B5-B6	36

Table 2: Distance between wells. The direction from well B5 to B6 is S65E.

3. Determine the direction and gradient of hydraulic head.
4. Assume for the aquifer a porosity of 30% and use $K = 150 \frac{gpd}{ft^2}$, an estimate obtained from pumping tests at the site. Calculate a ground-water velocity. Pay attention to units.

Figure 1: Curves for predicting hydraulic conductivity from grain-size analysis of unconsolidated sediments, from Masch and Denny (1966).