**Soils —Field Characterization, Collection, and Laboratory Analysis**

**Background**

As rocky substrates are weathered, biota are emplaced and soils begin to form. As we have discussed, the soils that form at a given location can vary based on Jenny’s five soil forming factors of time, geology, climate, biota, and topography. Soils evolve to produce horizons that are characteristic of different ecosystems, though soil profiles can be quite heterogeneous over small distances due to differences in topography, biota, geology, etc. Digging soil pits and characterizing the soil profiles is a useful approach to investigating the connections between geology and biology in the field and provide a researcher with an understanding of the foundation underlying the ecosystem at the surface.



**Chapin Figure 3.9.** A generic soil profile showing the major horizons that are formed during soil development. Density of dots reflects the concentration of soil organic matter. (from **Chapin Ch. 3.)**

**Project Summary**

During weeks 2 and 3 you will be examining soils in the field at the nearby Kiefer Plot and then analyzing them in the laboratory. **Through careful observations and hands-on field work, you will develop skills in characterizing soils and in making connections between geology, soils, and biology—and you will be able to contrast soils at coniferous vs. deciduous sites.** Soil analysis is an important method of looking at ecosystem scale carbon cycling and sequestration, as well as nutrient cycling on short- and long-time scales. You will be collecting soils at one of these soil profiles and will be analyzing soil moisture and organic carbon content in the laboratory, in addition to quantifying the grain size distribution. **You will be keeping detailed notes of your observations (in the field and in the lab), your laboratory methods, and your data. You will be handing a Lab Report including interpretations of the soils you have been examining in the field and lab** (details on page 4).

**Protocol**

***Day 1—In the Field (Kiefer Plot, near TESC Organic Farm)***

Students will be divided among the 6 sites (coniferous sites: CONIF 01, CONIF 02, CONIF 03 and deciduous sites DECID1, DECID2, and DECID3). Groups will be pre-assigned.

**Each person’s field/lab notes/notebook should include:**

• General information about this field work--day, time, group members, weather, as well as where you are and how you got there, etc.

•A brief introduction to the site, where it is, how you think it formed, processes that brought material here in the past, processes that are influencing the site in modern times and/or today

• A general **map** of the site, including a **scale**, the **locations of all of the soil cores**, the **road** and any other features that would help you find your sites again, **changes in vegetation** (with details regarding dominant species if known—or at least coniferous, deciduous, etc.) as well as changes in **topography**.

• Other lab and field details as outlined in the protocols below

• Each person should complete a detailed account of the group’s field work in their own notebook/notes. You may need to cut/paste your field notes into your geology notebook such that your geology notebook will have the complete record of your work.

**(1)** In your pre-assigned group of 3-4 students first find your assigned soil pit. Record the GPS reading of your core site. As a group, you will work together to dig down into your soil pit (at the Keifer Plot) to a depth of 1m and cut the face back to reveal fresh soil.

**(2)** • You need to stake in your meter tape for scale and as a reference for depths at which

 you identify specific features.

 • Each person will (individually) draw and characterize your entire (1m) soil profile

 • From the surface to through the entire 1m depth (or more) of the soil core, note:

-**changes in color** through the profile (using a **Munsell soil chart**),

-**changes in organic content**,

-**presence of roots or buried wood or soot**,

-obvious **changes in grain size** (gravel/pebble, sand, silt, clay—or a mixture)

-any other noteworthy features

• Note where you think the O horizon, the A horizon, and the B horizon are, and include notations -- EXPLAINING your reasoning behind the distinctions you make in your field notebook.

• The more detail the better.

**(3)** Each group will collect a 1/2 gallon bag of surficial soil AND a 1/2 gallon bag of soil from ~1m depth to take back to the lab. LABEL (in sharpie) THE BAG WITH YOUR GROUP MEMBERS, SOIL PLOT, and DEPTH. Characterize each sample in detail qualitatively (color and other observations) in the field (the color and texture of the soil will change as the soil dries out)

*At this point, groups will trade soil pits—Coniferous sites 1,2, and 3 trade with Deciduous sites 1,2, and 3 respectively such that groups now have the chance to investigate the other kind of soil environment.*

**(4)** Repeat ALL OF THE steps in (2) – now for a different type of soil. Note that you do not collect soils at this soil pit. Make sure that your notes clearly indicate the soil pits that you worked at and that a person reading your field notes can distinguish between your notes and field drawings from each of the 2 sites you visited. \*\* If time is limiting, you ask another group for the Munsell soil colors and just record your visual observation\*\*

**(5)** Before leaving the Kiefer plot, **VISIT ALL of the soil pits** making sure to look for heterogeneity between nearby soil profiles and taking notes on differences observed between the deciduous soil sites and coniferous soil sites

***Day 1 (cont.)—In the Geology Lab***

Here, you will be working to quantify moisture content of your soils and to quantify organic carbon content of your soils. (In week 3 you will sieve your soils to determine grain size distribution.)

**(6)** In your lab notebook, make sure to record the masses of your:

•Empty porcelain crucibles, and your porcelain crucibles with (wet) soil (from 2 depths).

•Also make sure to record the masses of your two ½ gallon bags of (wet) soil (we will give you the approximate mass of an empty gallon Ziploc bag to subtract from this mass)

Your subsamples of soils (in the crucibles) and your two gallon bags of soil need to all be placed in the drying oven—where they will dry till Thursday 1/24. MAKE SURE EVERYTHING IS WELL-LABELED!

***Day 2 (short)—(Thursday) in the Geology Lab***

**(7)** You will just need to post-weigh your dried crucible samples and to record these masses in your notebook—you can now determine the percent moisture content of your samples. The samples need to be replaced in the drying oven where our Science Instructional Technician will handle them for determining organic carbon content. [We will discuss how to make this measurement in class]

Our Science Instructional Technician will be taking all of your dried soil subsamples (in well-labeled crucibles) and placing them in a muffle furnace at 550 °C for ~6hrs to ignite all of the organic carbon into carbon dioxide. This protocol is determining carbon content by Loss On Ignition (LOI). Jake will replace your baked-at-550 °C samples in the drying oven.

***Day 3—In the Geology Lab***

**(8)** You will just need to post-weigh your baked-at-550 °C samples and then determine the percent organic carbon values of your samples. [We will discuss how to make this measurement in class. Note that LOI and % organic carbon are not the same thing.]

**(9)** You will also need to postweigh your two ½ gallon bags of (hopefully dry) soil. Seives sets will be laid out for each group. You will have 3 sieves and a pan—so you will need 4 quart-size Ziploc bags for each of your two (1/2 gallon) samples. You can weigh one quart-size Ziploc bag to use as the approximate mass of each bag. LABEL (in sharpie) EACH BAG WITH THE GROUP MEMBERS, SOIL PLOT, DEPTH, and the UPPER AND LOWER SIEVE SIZES for the sample (eg. 1mm> X >0.5 mm). After sieving the soils as well as possible, transfer the material on each sieve into associated pre-labeled Ziploc bag and then weigh the bag with the soil. With the mass of the bag and the bag+soil you should know the mass of the soil that you have on each sieve (and in each size class).

**(10)** You can now weigh each of the grain sizes to determine the grain size distribution among (approximately) sand, silt, and clay-sized particles

**Record all of your raw data throughout your field and lab work in your notebook and make interpretations about differences between coniferous vs. deciduous soils and surface vs. ~1m deep soils.**

**Lab report details-- What are you handing in (due in Week 4)**

Your final product, based on your field notes and laboratory work, will be a detailed Lab Report in which you:

(a) characterize your sampling site and field visit, including the location of your site and how you got there, who you are working with, temperature and weather during sample collection, and any other factors that might influence the samples you collected

(b) draw a very detailed diagram of your entire (1m) soil profile (every person should do this) -- taking time to note all of your observations including changes in color through the profile (the exact color can be determined using a Munsell soil chart), presence of roots or buried wood or soot, obvious changes in grain size (gravel/pebble, sand, silt, clay—or a mixture of them) from the surface to 1 m depth. The more detail the better.

(c) present all of the qualitative and quantitative soil data that you collected in the field and lab regarding your surficial and 1m depth soil

(d) describe and discuss how each of the qualitative/quantitative soil features observed/measured can inform one about soil formation and/or the potential fertility of this soil if it was to be used in a garden (as surface soil).

(e) state your proposal for which soil (surficial or 1m depth) would be more appropriate to collect and use to support a hypothetical garden and support using data and discussion points from part (d)

**References**

Chapin, F.S., III, P.A. Matson, and H.A. Mooney (2002). Principles of Terrestrial Ecosystem Ecology. Springer-Verlag, New York ISBN 0-387-95439-2.