Lab 3: Soil Mapping

No soil pits have been dug for you! You will be examining soils that have formed from glacial till and lacustrine deposit that occur in different topographic positions on a hillside complex. The soils at this site belong to a range of drainage classes and some meet the criteria for hydric soils. Your task will be to conduct a survey of the soils and to characterize, map, and interpret your findings.

Objectives

- Measure slope with a clinometer
- Determine effects of topography on soil properties
- Recognize hydric soil indicators and determine soil drainage class
- Use a simple key to determine a soil series
- Learn how to map soil boundaries
- Recognize the variability of soils within a soil mapping unit

Reading

Laboratory materials posted on the course website:

- Hydric Soils and indicators
- Drainage and Slope Sheets
- Map Concept Field Sheet

Nature and Properties of Soils, Chapter 19: Geographic Soils Information

Soil Survey

Farmers utilize the information in soil surveys to decide which crops to grow and which fields to irrigate. Park rangers use them when developing management plans for minimizing compaction and erosion at outdoor recreational facilities and parks. They are essential for sanitary engineers and county planners when deciding where to cite a landfill. Even homeowners benefit from soil surveys when building additions, garages or swimming pools. A soil survey report is essentially an inventory of soil resources for a particular area (usually a county), containing soil descriptions, tables of soil properties, and detailed soil maps drawn over aerial photographs showing the locations of different soils in the landscape. The county soil survey report describes soils in terms of their location in the landscape, their profile description, their suitability for various uses, their agricultural productivity potential, and their requirements for special management practices.

The earliest soil surveys, begun in the 1890s in the United States, investigated the uses of soils for farming, ranching and forestry. Beginning in the

1950s and 1960s, non-farm uses of soil increased substantially. In response, soil survey reports were broadened to include soils suitable for highways, factory locations, and waste disposal, to name a few. As part of the National Cooperative Soil Survey (http://soils.usda.gov/partnerships/ncss/), Federal, State, and local governments are working together in many states to complete modern soil surveys for most or all of their counties, with the highest priority occurring in rapidly urbanizing areas of the U.S., and in many developing countries, only very broad surveys have been made.

The objectives of a soil survey are to (1) determine the important characteristics of soils, (2) classify and map soils into map units by defined types or management requirements, (3) predict the performance of the soil for non-agricultural uses.

Mapping Soils

Soil map units delineate an area consisting of one or several kinds of soils and are named according to the soil series classification of the dominant soil. By their nature soils can vary across short distances, such as changes in slope or degree of erosion from the top of a hill to the bottom. This type of variability is noted in the soil map unit name. For instance, HsB is a Hudson silty clay loam, 2 to 6 percent slope, whereas a HsC3 is a Hudson clam loam, 6 to 12 percent slopes, eroded. The letters "B" and "C" in the soil map unit name designate the soil phase, in this case modified by the slope. The number "3" in the HsC3 means that this soil is found on eroded slopes.

Landscape position affects water movement, drainage, microclimate, and ultimately the physical, chemical, and biological properties of soil. So even though a group of soils may have the same age, climate, and parent material, their properties can differ due to their position along the catena. The sequence of soils may fall within a relatively small area depending on the steepness of slope. The summit, being on the highest portion of the landscape, would have the best drainage and the most developed profile. The backslope, located below the summit, would have a lot of water moving through the profile. However, the water would drain down slope and collect in the footslope and eventually the lower toeslope.

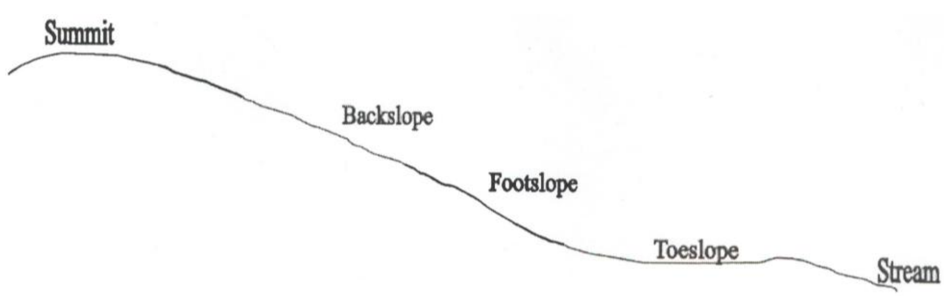

Figure Catena

Soil surveys are conducted at different soil map orders, depending on the designated land use of an area. For instance, some surveys are needed to distinguish differences over a small area of seemingly similar soils, whereas other surveys are needed for larger and more heterogeneous areas. The intensity of a soil survey, and accordingly the soil map scale, determines its order. A first order soil survey is the most detailed and is used for highly intensive land use planning, such as for citing agricultural experiment stations. The scale of first order maps is 1:12,000 indicating that 1 cm on the map equals 12,000 cm (or .12km) on the ground. The Soil Survey of Cornell University and Adjacent Properties is an example of a first order survey. Most county soil surveys are done as second order surveys, with a map scale of 1:20,000. These surveys provide information for intensive land use, whether for agricultural or non-agricultural purposes. Third order soil surveys have map scales from 1:24,000 up to 1:250,000 and provide for extensive land use activities such as woodland and watershed management. Fourth order surveys provide information about general land use planning and have a scale of 1:100,000 to 1:300,000. Fifth order soil surveys are used for general land use planning at regional or national levels, such as general land potential for crops, forest, or urban development. The scale of these maps is from 1:250,000 to 1:1,000,000.

How are soil surveys carried out? Methods vary with the scale of the map. For county level surveys, trained soil scientists develop conceptual models of the relationship between landforms and soil types in specific regions (see figure 2). For example, careful field exploration might reveal that soils developed on river bottomlands in areas of calcareous glacial till are derived from deep deposits of poorly-drained alluvium with high pH. Hence, the conceptual model for this region would link these landforms to the alluvial Wayland soil series. Equipped with aerial photographs, topographic maps, and knowledge of surficial and bedrock geology, soil surveyors use conceptual models to predict the presence of specific soil types based on landform analysis. Noting variations in topographic relief, vegetation, and surface wetness assists the process of defining boundaries between soil types. Using augers and the occasional soil pit, soil surveyors devise sampling schemes to observe soil properties and to test predictions from the conceptual models. Site-specific investigations (e.g. 1:12.000) for smaller geographic areas use similar approaches but typically entail many more direct soil observations. These types of investigations often precede the county mapping efforts and are used to build soil-landform models.

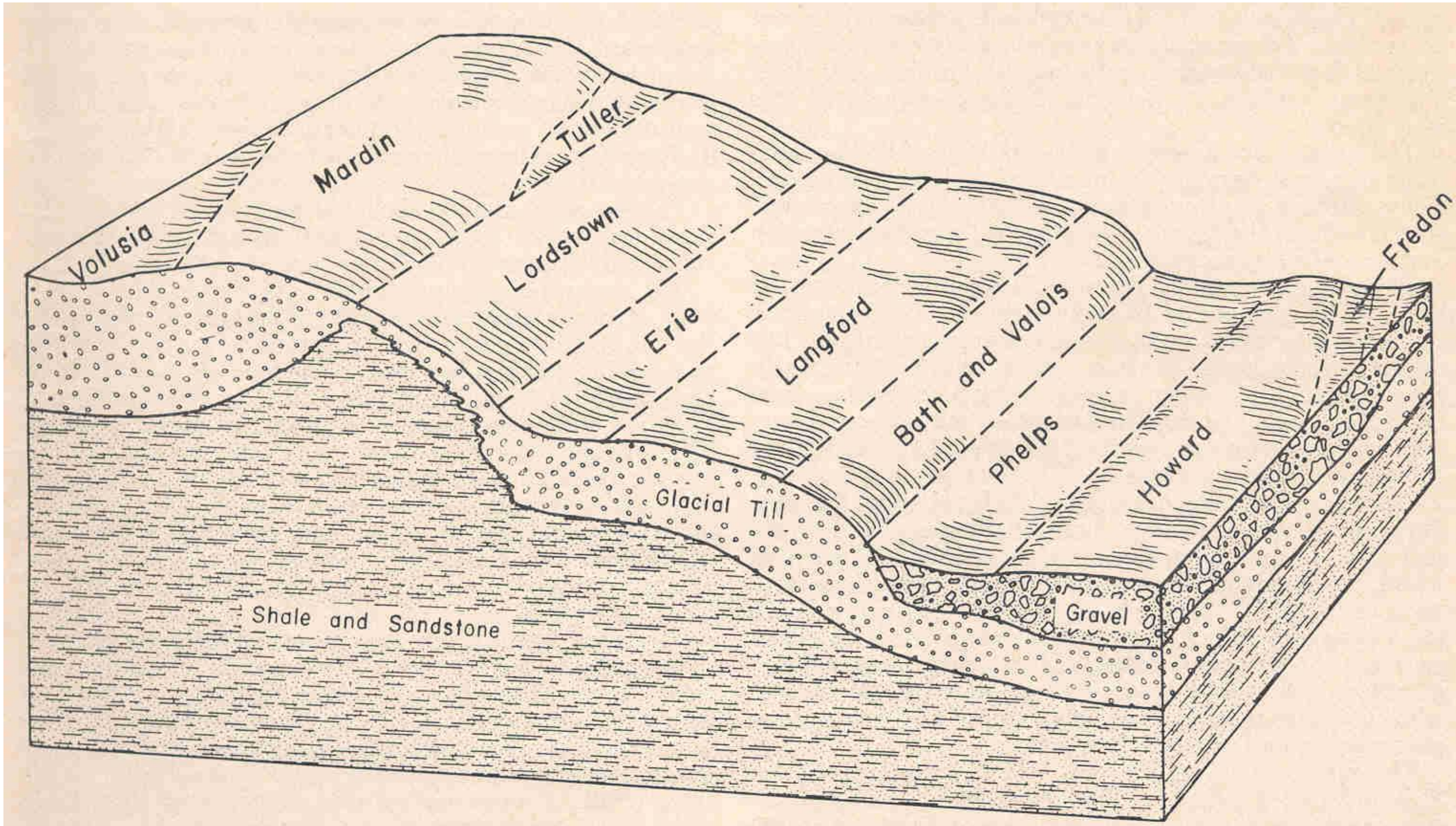

Figure 2. Typical cross section of southern Tompkins County soils, consisting of mainly low-lime and very low-lime soils with a fragipans. Source: Tompkins Co. Soil Survey

Observations from auger borings and the more comprehensive soil pit descriptions include enough descriptive information to definitely place the soil into a specific series. Amount common data elements:

- Depth to bedrock and/or restrictive layers (e.g. fragipan);
- observed internal properties of the pedon, such as horizon thickness,
- color, texture, structure, and pH;
- inferred soil drainage class;
- inferred soil parent material;
- Landform type and position within the landscape;
- dominant vegetation and/or use of the site.

Exercise A Mapping Soils

Materials

- base map
- soil auger
- Field Kits
- Clinometer

Steps

1) Visually evaluate features of the parcel and recognize the summit, backslope, footslope, and toeslope and relate them to your basemap (aerial photo).

2) Considering topographic position, landscape signatures of edaphic properties (e.g. vegetation changes or surface wetness) and your concept of possible soil distribution along a transect from the summit to the toe slope. Delineate – in pencil – probable boundaries between soil types (no more than 6 total map units!).

3) To develop an understanding of how soils vary on this parcel, conduct a sampling transect starting at the top of the hillslope, working towards the creek, both within possible soil map units and near the probable boundaries between and with your delineated units. At each sample point, record the parent material, horizon information and the depth to redox features (if present). Mark the approximate sample location on your map.

This transect will be completed by the entire class (ie you won't be expected to complete the entire transect) and the data will be collected will shared with everyone. We (collectively) won't take more than 3 samples within a map units or 1 to 2 near boundaries between soil types. Through these samples you are trying to ascertain the uniformity of the soil(s) within the unit and their boundaries.

4) Ascertain the slope class for each division in the parcel by using a clinometer.

5) At each sampling location use the soil auger to characterize each soil to a depth of at least 24 inches (or presence of a restrictive layer) with a specific reference to parent material, depth of A horizon, color of A horizon, depth to redox features, presence or absence or a fragipan, textural class of the soil fines, and pH of the B horizon. Also record the dominate vegetation types and mark the approximate position of the sampling locations on your map.

6) Evaluate the sample date within your delineations – see exercise B below.. Determine what probably soil it is and document how it may vary within your delineation. Correct your boundaries to reflect this variation to better reflect soil distribution along the transect. Consider the samples near the edge of the map unit boundaries if your boundaries need to be corrected.

Exercise B Developing a Soil Concept Map

Materials

- Hydric Soil Indicators
- Acidity, Drainage and Slope Cheat Sheet
- Map Concept Field Sheet
- Official Series Descriptions (OSDs) at NRCS web site.

Steps

1) Examine and evaluate the three support documents.

2) Review the OSDs of each Soil Series to develop an understanding of the range of characteristics represented in each of the soils.

3) Using these support documents and OSDs examine the data collected by the class along the transect and determine what soils are present and where they are located along the transect.

4) Move delineation lines as necessary and develop and diagram a toposequence concept of the soils along the transect.

Assignment

Write a report that includes the following:

- Your proposed toposequence of soils along the classes transect

- Descriptions of the major properties of each soil series identified including: parent material, master horizons (depth, color, pH in B horizon, hydric features, etc.), slope, drainage class, and vegetation. This should also be provided as a matrix of each map unit.

- A discussion of the amount of variability of soil properties within you intensively sampled map unit.

- Recommendations for land use and land use restrictions for the different map units. (recall: soil interpretations accessed from Web Soil Survey in our previous lab)

You will be producing a full write up for this laboratory exercise. It is expected that your will follow a science writing format with a clear introduction and method sections followed by your results, a discussion of these results and any conclusions. You are expected to include references as appropriate. Please review the format information that we have online on the laboratory web page.

References

Cline. M.G., and Bloom, A.L. (1965). 'Soil survey of Cornell University property and adjacent areas', New York State College of Agriculture at Cornell University, Ithaca.

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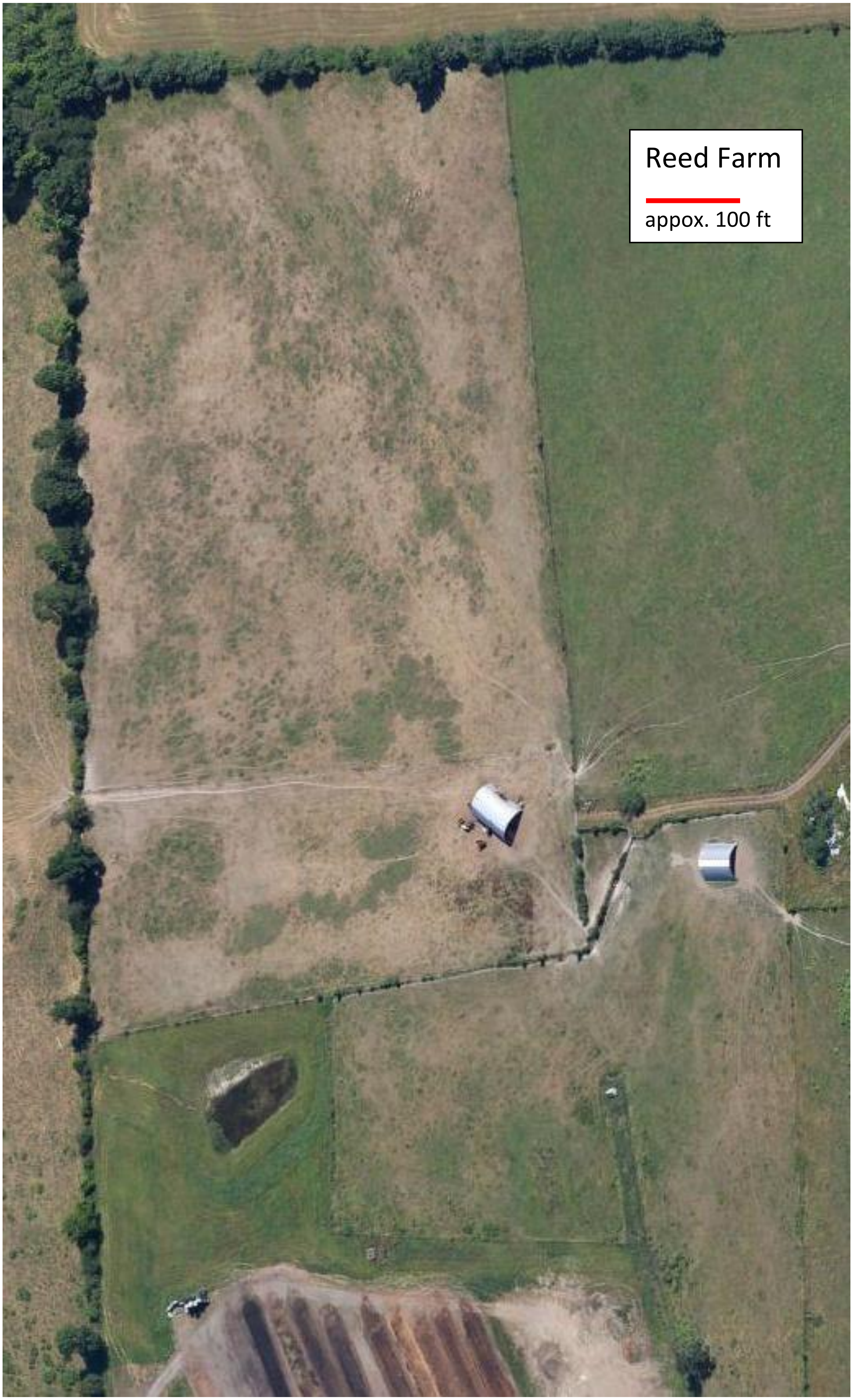
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