SURFACE GEOLOGY OF MICHIGAN
Reading, observation, and recording information in class.

This section should be introduced after students have learned about the rock cycle, processes in which rock and soil are formed, and are able to distinguish between igneous, sedimentary, metamorphic, and molten rock types. They should also have a rudimentary knowledge of glaciers, and the role they play in shaping physical geography and depositing rock and soil. This unit is designed to narrow the student's study of Geology to their local region, beginning with Michigan, and eventually focusing on Southwest Michigan. Broader geographical and geological concepts will be placed in the context of local Fruit Agriculture. The following material will serve as an introduction to the Surface Geology lessons on this website and in the educational guide, *Preserve the Fruit Belt*.

Surface geology is concerned with the geologic layers of topsoil and subsoil, making it the discipline of geology that is most relevant to agriculture. Many factors helped shape Michigan's surface, but the glacial advances occurring during the last ice age had the most impact on Michigan's current composition. During this period, giant glaciers mixed soils that were previously separate, adding some from other areas, and scraping others away. Bedrock was ground beneath the immense pressure, often reduced to a smooth, rounded surface. Topographical surface features we see in Michigan today can be classified into three groups:

Formations produced by the direct action of ice
Often, the distinct substances of clay, sand, and gravel mixed, resulting in a soil of sandy, gravely, loam. Proportions depend on what rocks the glacier rolled over when depositing the material. All of this can be grouped together as either till, or hardpan soil.

When hardpan is formed into smooth hills, they are called drumlins. As a glacier moves, material tends to accumulate at the end due to downward pressure on the earth's surface. This material is carried in front of, on top of, or within the glacier, and is deposited as the glacier melts or recedes. Sometimes the material is pushed up into irregular ridges. When these large deposits form a well-defined belt, it is known as a *terminal moraine.* The till that is laid down beneath the ice in a smooth shape is known as a *Till Plane.*

Formations produced by ice and water combined

- *Eskers:* Coarse, sandy gravel. Eskers are often products of streams running in, on, or under the ice. These can cut deep crevices in the earth that the moving glacier fills with rock.
- *Kames:* Irregular heaps of assorted drift at the ends of the glacier. Along with moraines, they are associated with undrained hollows, inland lakes, and areas with no direct surface line of drainage.
- *Outwash aprons:* These are pitted gravel plains. These are made up of all material (gravel, sand, or silt), are generally coarse, and slope away from the old ice fronts.

Formations produced by water from melting ice after its issue from the ice sheet

- *Road Gravels:* These are the old beach lines and highest lake borders, where they cut and concentrate gravel from stony till and overwash gravels, kames, and eskers that connected with the ice fronts.
- *Bog Lime:* This is the white or blue slime that fills lake bottoms. Waters in Lower Michigan are hard because of high lime content in the clay. When exposed to air and sunlight, this substance is rapidly decomposed and the carbonate of lime is thrown out. Lake weeds and shellfish perform this process. Bog lime is often covered with peat, and occurs with more frequency in lakes that are spring fed by cold water.
- *Peat:* this includes all accumulations of nearly pure vegetable matter. Peat is extremely fertile, and the oldest, blackest, and most decomposed deposits are found in the Southern Lower Peninsula along the old glacial drainage channel system. This extends from Niles (in Berrien County) up through Van Buren and southern Allegan Counties, northwest up towards Saginaw Bay.
- *River Silts:* Many Michigan Rivers regularly overflow their banks. The muddy waters spread over their flood plains, and a layer of mud is deposited. This is often a very fertile and constantly renewed soil source.

SOILS

There is a close connection between surface deposits and soils. We are basically classifying the same substances from a different point of view. The Surface Geologist studies this material to see how it came to be. The Soil Expert, on the other hand, studies this same material to see what it is good for agriculturally.

Michigan Soil Types

- *Dune Sand:* Loose, *incoherent* sand that forms hills or *ridges* of various heights. These are found along the shores of lakes and rivers. They have no agricultural value due to their irregular surface and loose, open nature. They cannot hold water, and often drift with the wind. This can be controlled by *windbreaks,* which were often used in Southwest Michigan to protect adjacent agricultural land.
- *Peat:* Vegetable matter in various stages of *decomposition,* occurring as *muck, bog,* or *turf,* usually in low areas. It is generally saturated with water, and is representative of advanced stages of partially drained swamp.
- *Muck:* Muck is more thoroughly decomposed peat, like the type found in the Kalamazoo area. This soil type made the county an excellent region for growing celery and peppermint. It also occurs in many other swampy areas in southern Michigan, often overlying other soils, like *marl* or *bog lime.*
- *Meadow:* Low-lying, flat, usually poorly drained land of any soil type.

Fine Soil Divisions of The Department of Agriculture

Students should become familiar with the terms used to describe Michigan soils and the basic characteristics of each soil type. Using recent Michigan Geological Soil Surveys, (found on-line or in most libraries) students can do research to find out in what areas these soil types occur, and how this has influenced the types of agriculture carried out in different areas. The Michigan Soil Survey of 1998 will give percentages and locations of each soil variety in Berrien, Van Buren, and Allegan Counties. These should be researched before looking at the Department of

Agriculture output data from these counties that describe the amount of each type of crop produced and how many acres are under cultivation. A lesson could be developed where students make predictions based on soil and topography maps and charts, and check their results against the Department of Agriculture data. (Words in bold print may already be known by this point, or they may need to be discussed further as you go along. After the exercises, students should all be familiar with these terms)

CLAY

Depth	**Color**	**Type**	**Details**	**Sub-Soil**	**Agriculture**
6-9"	Brown or black	*Silty*, clay loam	Darker and Loamier where %of organic matter is higher	Bluish-gray clay. This is derived from glacial deposits and occupies low, wet, level areas.	Good for sugar beets and other general crops

FINE SAND

Depth	**Color**	**Type**	**Details**	**Sub-Soil**	**Agriculture**
4-20”	Dark gray to black	*Fine sand*	Level surface, with natural *drainage*. Formed by the reworking of glacial sands.	Sub-soil has same texture, but with less organic matter	Crop value depends on the amt. of organic matter. It is found in many parts of Allegan Cty, and all along the coast of Lake Michigan. Very good for small fruits, esp. strawberries.

FINE SANDY LOAM

Depth	**Color**	**Type**	**Details**	**Sub-Soil**	**Agriculture**
9-12”	Brownish gray	Very fine sandy loam, *homogenous* texture	Surface is lightly *undulating* with rolling drainage that varies with local topography	Brown or yellow fine sane up to 2ft. deep overlying clay. Both soil and subsoil are devoid of gravel.	Very good for apple and pear orchards, grapes, and also beans, potatoes, and beets.

GRAVELLY SAND

Depth	**Color**	**Type**	**Details**	**Sub-Soil**	**Agriculture**
10”	Dark brown	Loamy sand, lots of gravel	Well drained, with topography varying from gentle slopes to rolling ridges. The soil results from beach or shallow water deposition.	Coarse, incoherent gravely sand.	Good for corn, oats, wheat, rye, beans, potatoes, and sugar beets. Can also be adapted for fruit crops, as in Allegan and Van Buren counties.

GRAVELLY SANDY LOAM

Depth	Color	Type	Details	Agriculture
8-15”	Black	Sandy loam: dark and rich in organic matter and gravel	Level to gently rolling, with good drainage. Formed from glacial material and water deposition	Good for potatoes, grain, onions, hay, and carrots

LOAM

Depth	Color	Type	Details	Agriculture
8-12”	Dark gray, brown or black	Light to heavy; compact, sticky and *impervious* when wet, very hard when dry. Derived from glacial lake deposits that are unmodified by stream action.	Surface is mostly level with some low *knolls*, *swells*, and *depressions.*	When properly drained and cultivated, it can yield good crops of corn, oats, wheat, hay, and sugar beets.

SAND

Depth	Color	Type	Details	Agriculture
12”	Black	Fine, loamy sand	Low and flat, often swampy areas	Corn, wheat, grains, oats, and celery

SANDY LOAM

Depth	Color	Type	Details	Agriculture
8-12”	Dark gray or brown	Sandy loam with a high % of organic matter	Surface is level to gently rolling with good drainage. Easy to till.	Very good for orchard fruits and other general farm crops.

SILT LOAM

Depth	Color	Type	Details	Agriculture
Up to 10”	Light to medium brown	Little or no organic matter, *homogenous texture* with no gravel	Surface is easily tilled, but there are often large boulders and rocks (a problem for early farmers). Topography is rolling with good drainage.	Grain, hay, and other general farm crops

STONEY, SANDY LOAM

Depth	Color	Type	Details	Agriculture
18-24”	Dark brown	Med. textured, gravely and sandy	There are many large granite rocks on or below the surface that must be removed before raising crops. Topography is rolling and well drained.	Corn, oats, wheat, beets, beans, and hay

SUPERIOR SANDY LOAM

Depth	Color	Type	Details	Agriculture
12-24”	Gray to red	Sandy or sandy loam, med. texture	Small rocks strewn over and below the surface. Level, with some gently rolling areas, and good drainage. Warm soil is easily tilled, making it good for small fruits.	Pine timber originally grew on this soil. Fields were normally cultivated following clearing by the lumber industry.

SUPERIOR CLAY

This is heavy, *compact* clay. When wet, it becomes brick red, *adhesive*, and *gummy.* When dry, there are large, visible cracks along the surface and it breaks up into cubical blocks. This usually occupies broad, flat areas toward streams. Improves with use, but not very good for raising any kind of crop.

Geology

Grades 3-5 or beyond

Materials: notebooks, 5-10 soil samples for each group

Examples: Soil A: taken from the lake

Soil B: taken from a driveway

Soil C: taken from the woods

Soil D: sandy soil taken from a field

Soil E: clay-loam soil taken from another field

Soil F: wet, muckish soil taken from a lowland swamp

Soil G: taken from a construction site

Background

This lesson should be done after students have been introduced to the process of soil formation, the rock cycle, and have had the opportunity to observe sand, clay, loam, and have done a soil profile for these. The students will use previous knowledge to make logical hypothesis about where each soil sample was taken from.

1. Explain to students that there is a problem and they must use their scientific skills to solve it:

Someone has stolen Mr. Benton's treasure. Police believe that the treasure is buried somewhere on the estate, but they don't know where to look. Provide a map of the estate farm, with many different areas including possible sources of the five soils. Police found a man's shoe on the estate with several soil samples on it. The police took samples from around the estate but forgot to label them. Now, someone must match the samples from around the estate with the samples taken from the shoe.

Exploration Phase

It is the student's job to actively observe the different soil types and decide which soil goes to which part of the estate. The students work in groups, discussing possible solutions and stating the evidence for their findings. In this phase, students will record findings in their notebooks.

Concept Introduction

Use overhead projector, with a transparency of the FARM/ESTATE MAP, record student ideas about each soil. A few possible questions to ask:

1. Who has a guess where soil A was taken from?

2. What characteristics have you found about soil A that leads you to this conclusion? .

3. Could the soil have been taken from somewhere else? Any other possibilities?

4. What do we notice that is similar about soil C and E? (both are dark soil) What is different about them? (one has twigs, acorns, other doesn't) What can this tell us?

5. Soil G is rather different than any other soil. Any guesses?

If the students disagree with an answer, they have to find information supporting their assertions. They must develop logically coherent, valid arguments for their hypothesis. If the student gives an answer without appropriate evidence, the police need evidenced claims to make these assertions useful in court.

Application Phase

Once the students have identified the soil types, the teacher poses a new problem for the students to solve. They look at the picture of the boot and decide which soil sample goes with which layer on the suspect's boot. The teacher gives a description of each soil layer because the drawing is hard to read.

Layer 1: Red in color, medium texture, small rocks embedded within

Layer 2: Black, very fine, mucky, with organic matter

Layer 3: Brown, silty, lots of organic matter present

Layer 4: Brownish gray in color, very fine and sandy, consistent texture, no gravel or rocks

Possible Questions

The first layer on the boot has small rocks and parts of metal in it. What possible soil sample could this be? Why? The next layer is very dry, yet gets sticky when wet so where could this be from and why? (Do this for each layer)

Students then look at footprints the teacher will draw onto the map and discuss possible solutions to where the treasure is buried. What area did the suspect walk through first? Last? Students can take turns coming up to the enlarged projection picture and discussing possible solutions in groups. After discussion, each group should agree on one possible solution. This means that there will be a great deal of scientific problem solving and debating skills being used.

Possible extensions of this project

The key to this exercise is to keep the students thinking scientifically and guessing. Do not give them the answer at the end of class, but wait until the next class period.

Students should record their findings and ideas about the crime in narration form. The estate could be given accurate measurements in which the students would have to manipulate to solve various math problems.

MEAP Criteria:

Science Strand 1: Standard 1.1 Constructing New Scientific Knowledge

This standard incorporates the ways that scientists and individuals investigate and learn about the world.

Science Strand Five: Standard 5.1 The Geosphere

All students will describe the earth's surface; analyze the effects of technology on the earth's surface and resources. The Geosphere includes surface and geological processes.