Geology 110
Spring 1999

Northfield Topography and Field Trip to Little Chicago

This lab has two parts. After the spot test on the geologic time scale, we will spend the next few hours at a gravel pit near Little Chicago (west of I-35). Not only will we have an opportunity to practice rock identification skills at Little Chicago, we will also examine sedimentary deposits that formed about 14,000 years ago - very recently, by geologic standards! Then we will spend time in the lab working with rocks we've brought back and briefly discussing the topography of the Northfield/Little Chicago area. In Friday's class, each lab group will tell us everything they've figured out about one or two interesting rocks they've brought back. There is no separate write-up for this lab.

Bring to the lab: a notebook to record field observations; a pencil, pencil sharpener and eraser; a ruler (your C-Thru W-8); your hand lens on a string around your neck; old pants and sturdy shoes. Because of melting snow, the gravel pit may be wet underfoot**. If possible, wear glasses rather than contact lenses.**

We will provide: hammers (one per group), hard hats, shovels, paper bags or boxes for pebble collections, map boards, and compasses, measuring tapes.

An Introduction to the Topography of the Northfield area

Most of the field labs in this class will be in the areas east, north and south of the city of Northfield, which have particularly good exposures of the local bedrock. Our trip to Little Chicago is our only trip west of Northfield during this course. In this part of the lab, you want to locate the Little Chicago gravel pit and the route we took to get there. You also want to compare the topography west of Northfield (especially west of I-35) with that east of Northfield. We have two sources available to us in the lab to check topography: topographic maps and a satellite image.

1. First, make observations on the topography as we drive to the Little Chicago gravel pit. You should consider whether the terrain is flat or rolling, the height of whatever hills there are (the relief), whether there is standing water and wetlands (which might indicate topographic depressions and poorly drained areas), whether you can see the material that underlies the hills and valleys, etc. Strive to come up with descriptions that contrast the topography between Northfield and the Interstate, and west of the Interstate.

2. Back in the lab, examine the Northfield and Little Chicago topographic maps. Describe these things to a lab assistant: the map scale, the direction of north (and south, east and west!), the elevations, the contour interval, the date at which the maps were made, the location of the Carleton campus and the location of the Little Chicago gravel pit. Explain what the contour lines on the map mean.

Now open the SPOT images on one of the computers. (You can read about SPOT at this site: http://edcwww.cr.usgs.gov/glis/hyper/guide/spot.) The three SPOT bands correspond to the green, red and near infrared bands of LANDSAT. Thus a color composite SPOT image is like a 432 color composite made from a LANDSAT image. We have two composites on the Geology 110 folder on Fabio, one taken in April 1993 and the other in August 1989.

3. Locate yourself on the SPOT image, using the topographic maps for reference. Show a lab assistant the locations of the Carleton and St. Olaf campuses, I-35, Union Lake and the Little Chicago gravel pit.

4. Compare the topography east of the Cannon River with the topography west of I-35 on the maps and air photos, referring to your field observations. Here are some things to look for: are the contour lines evenly spaced or irregularly spaced? Are the many areas of lakes and marshes? Do valleys increase in size regularly? What is the local relief (difference between highest and lowest elevations?) Recalling that the SPOT image should show wet areas as black (because of strong IR absorption), what is the

distribution of wetter areas? Write down these descriptions in a notebook so that you have them available later this term.

Field Trip to Little Chicago gravel pit

This is the first of several field trips to interesting local sites. Your observations and notes on this site will be incorporated in the discussion on the geology of southeastern Minnesota, due near the end of the term. The group you will be working with today will be your group for all of the field labs and for this poster.

Safety precautions: Please wear your hard hat all the time while in the gravel pit. It is not necessary to climb up vertical faces - most of the stratigraphy is accessible in other ways. Be careful about knocking rocks and loose material onto people below you. Follow instructions about using rock hammers safely - protect your eyes when someone is hammering near you.

When we return to Carleton, please take off your muddy boots before entering the building. This precaution will help the custodial staff immensely!

Although there is no required writeup for this lab, you will want to follow the outline below while we are in the gravel pit, showing your sketches and discussing your observations with the lab assistants. Each group should bring back one or two fascinating (but hopefully understandable) rocks to talk about on Friday.

Procedure:

- Locate the Little Chicago gravel pit on the topographic maps before leaving Mudd.

- At the gravel pit, make a rapid visual scan of the exposures. Locate one or two places where the exposures are good.

- At each exposure, make observations of the units. Use the questions below to help you make your observations. You'll want to develop **a list of important things to look for** at each exposure and within each unit. Use the last sections of the lab handout on making field observations to develop such a list. For this exposure, you will want to note at least the following characteristics of each unit: **the grain size, color, sorting** (are all the grains the same size?), **internal structures**, and the **types of rocks**.

- Draw a detailed sketch showing the relationships between the sedimentary units. The sketches should include **compass directions** (see a lab assistant for help using the compass) and a **vertical and horizontal scale**. Stretch the tape over the side of the exposure to help you get the relative elevations of vertical boundaries between units and thicknesses of units. Each sketch should show **boundaries** between all the major sedimentary units, a pattern within each unit to display grain size and bedding and symbols for any other internal features that you think are worth noting. If you have multiple exposures where the sedimentary units overlap, indicate the overlaps on the sketches.

- Also, look carefully at the rock types in pebbles in the sediments . List the kinds of rocks that you see. These observations will help determine where the deposits at Little Chicago came from and how deposition occurred. We won't have time to do a full pebble count, which would involve identifying about 100 rocks from a single layer. When you bring back rocks to Mudd, please crack the pebbles open outside the building on an asphalt surface like the road behind Mudd - not on the concrete, please!

Questions to think about:

Observations to make:

1. What is the general topography of the area near the Little Chicago gravel pit and how does it differ topographically from the area around Northfield and to the east?

2. How many different materials are here? (Distinguish these materials by their grain size, color, sorting, internal structures, by the types of rocks that they contain and by anything else you think is important).

3. How are these different materials arranged in vertical sequences?

4. What kinds of rocks are included among the pebbles?

5. What sorts of structural features are present at these exposures?

Interpretations to make:

6. In what types of environments were these materials deposited? (Think about the differences you might see among wind, water and glacial deposits.)

7. Where did these materials come from? (Use the results of the pebble count to help you here.)

8. What has happened to these materials since deposition? (Perhaps there has been weathering and erosion or even some structural deformation).

ROCK DESCRIPTION

Rocks are **natural aggregates of minerals**. This definition suggests the two most important elements of a rock description: a) What minerals does it contain? and b) How are these minerals arranged or aggregated in the rock?

Texture is the general name given to the arrangement of minerals in rocks. Minerals are naturally occurring, crystalline solids with definite chemical compositions.

A complete description of a rock contains information on its texture and mineralogy, which can be described in a hand specimen and thin section, and other features which can only be described in outcrop. This outline lists the features which must be included in a complete hand specimen description. It includes features common in sedimentary and metamorphic rocks as well as igneous rocks.

A. **Texture**

- Describe the texture as **clastic** (composed of particles cemented together), **crystalline** (composed of crystals that have grown together every which way), **foliated** (composed of layers of minerals) or **glassy**. Note **vesicles** (small air bubbles) if present. Describe the sizes of grains and crystals and the proportion of each. For sediments, describe the **sorting** (of grain size; if a rock has mainly one size of grain, it is said to be "well-sorted") and shapes of grains. Describe the orientation of minerals or fossils in the rock. For crystalline rocks, describe the relative perfection of crystal outlines.

B. **Minerals and other constituents**

- Identify the minerals and other constituents in the rock. If the minerals cannot be named, describe each one in detail (color, hardness, luster etc.). Other constituents may include rock fragments, cements or fossils in sedimentary rocks or **xenoliths** (foreign rock) in igneous rocks. The proportion of each should be noted.

C. **Other**

- Describe the **color**, **density** (how heavy it is, compared to its size), **induration** (how hard is it to break?), **porosity** (how many holes does it have) and **permeability** (how quickly does water penetrate into it) of the rock. Is the sample fresh or weathered?

D. **Finally - Name the rock**.

This is not as important as you may think.
Because of your excellent description, everyone should know the rock you have described! In many cases, analytical work is necessary to determine the precise name.

BASIC OBSERVATIONS AT THE OUTCROP

Some important rock observations can only be made in the field, where several layers of rock are accumulated together. A single hand specimen or two simply doesn't have the information about variations vertically or horizontally. The following features of each outcrop should be described:
location
general topography (hill, valley, etc.)
dimensions

orientation
general appearance
presence of nearby exposures
types of rock
shapes of rock bodies
contacts between rock units
One lithology or several? interbedded?
extent of each unit

Within rock units, a variety of features should be examined. In sediments or sedimentary rocks these include: **fossils**; **grain size, shape and sorting** (how close the sediment is to a single grain size); and **sedimentary structures** (such as **cross-bedding** produced by migration of water ripples and dunes, **graded bedding**, a decrease in grain sizes going up in the bed that indicates diminishing force with time, etc.) It may also be possible to see fractures, faults, and folds in outcrops. It is always a good idea to make a sketch of the outcrop which shows these basic features.

INTERPRETATION OF ROCK OUTCROPS

Once you have described the outcrop and the individual rocks, you can begin to interpret the geologic history. These are several of the important questions to consider (after Compton, 1985, p. 31):

What was the geologic environment or conditions under which the units were originally deposited or crystallized? (for instance "marine below fair-weather wave base" or "product of basaltic volcanism").

How did the environment change with time during formation of the rocks?

What were the specific processes involved in the formation of the rock unit? (for instance "deposition by wind" or "pyroclastic flow").

How are the rock units in the exposure related to each other genetically? (for instance, are they conformable sedimentary units? is there an intrusion?)

How have the rocks been modified after formation by processes such as cementation, compaction, and recrystallization?

How have the rocks been deformed structurally or tectonically?

What is the geologic age of the rock unit and what are the age relationships among the units?

Reference Cited: Compton, R. A., 1985, **Geology in the Field**: New York, John Wiley, 398 p.