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12.001 Introduction to Geology
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LAB 5: GEOLOGIC MAPPING EXERCISE

DUE: Wednesday, March 19

In this lab exercise on mapping, you'll have the chance to get a fairly realistic picture of how geologists go about making a geological map. Think of the lab room as a land area a few kilometers on a side with no topographic relief. Assume that the land surface is the tabletops, but that there's enough local relief for you to see bedrock outcrops.

On the tables are rocks samples. Some are oriented using plasticine (do not move them!), others are loose, but should be placed over the X marked on the poster board. There are also some pictures set up around the room showing exposed contacts between the rock units. We've tried to match the rock types in the pictures with the rocks in the lab, but if the match is not perfect, pay more attention to the type on contact shown in the picture. All localities are keyed on your base map, so it'll be easy for you to figure out where you are. When in doubt, go by the location on your base map rather than the location in which you actually find the sample. Normally when mapping, locating yourself is one of the challenges as it can often be quite difficult.

Each rock sample represents an actual outcrop in your field area. You should attempt to get from them not only the rock type, but also an approximate orientation of bedding or foliation where applicable. Mark your estimated strike and dips on the map.

You will create a geologic map by inspecting each sample, plotting rock type and orientation on your base-map, and eventually drawing in appropriate contacts and structural features. Extend your contacts to the edge of the map, but not beyond. Extra base-maps will be available. Once you have a completed map (you should have it checked by your instructors first), you will complete other tasks.

Your responsibilities for this lab are to turn in the following:

- a completed, colored and inked map which includes
 - a legend showing symbols/colors you used on the map for each rock type
 - strike and dip symbols (for beds and foliation)
 - fold axes and faults with dips labeled
- a cross section through A-A'
- a cross section through B-B'
- a stratigraphic column including a short description of each rock unit (this includes details that help to distinguish units in the field area)
- a narrative statement on the geologic history of your map area, based on your understanding of the map relationships.

How to get started:

You may feel at a loss about how or where to begin the mapping. Here are some comments designed to help you with that.

There are two different styles in starting mapping. One is to dive right in to some local part of your map area and start to figure out relationships there, and then work progressively from area to area to extend your understanding. Another way is to cruise widely over the whole map area initially to get an idea what you're up against and develop some preliminary ideas about map relationships before deciding where to start in on detailed work. It's a matter of personal style, you can do either.

In either case, the really important thing for you to do is to try to recognize natural rock units as you examine the outcrops. Think about degrees of similarity and differences among adjacent outcrops. You should expect differences in rock type *within* the rock units themselves, but the important thing is to recognize that such differences are less significant than differences *among* rock units. The naturalness with which this can be done varies; your exercise has purposely been made fairly realistic in this respect.

WARNING: The Bruntons are very sensitive to all the steel in the Green Building, as well as the table legs in the classroom. If you try to measure azimuths with them, you may get confused and frustrated very quickly. Instead, use the bulls-eye level to line up the edge of the Brunton with a horizontal intersection of a bedding plane, and estimate the azimuth that the Brunton is pointing to, knowing that the front of the classroom is north. Measuring dips will not be a problem.

Contacts

Once you start seeing rock units, the critically important thing is to locate as accurately as possible on your map the contacts between adjacent rock units. You do this by a technique of bracketing the position of a given contact between adjacent pairs of outcrops that expose the two units, and then fit the most natural curve representing the trace of the contact. The general rule to follow is to make the contact as geometrically simple as possible consistent with the constraints imposed by the outcrops.

Experience has shown us that students starting this exercise have a tendency to draw blobby closed curves that surround a group of outcrops that belong to the same rock unit. Don't do that! Instead, locate and draw contacts as described above. Keep in mind that you have to partition your entire map exhaustively and non-overlappingly into sub-area underlain by the various rock units and bounded by contacts between the rock units.

Pieces of tape marked as A1 – A8 represent outcrops in the field where contacts can be identified between different rock types. It is part of your job to figure out what type of contact each of these represents (eg. a fault, an unconformity, or an intrusive contact), based on the pictures you see and the types and orientations of the rocks being juxtaposed.

There are several kinds of contacts:

- Fault contacts
- Intrusive contacts
- Conformable depositional contacts
- Unconformable depositional contacts

There may or may not be more than one choice of possibilities for a given contact. For example, suppose you see an intrusive igneous unit in contact with a sedimentary unit. What are the possibilities for the nature of that contact?

- Fault contact
- Intrusive contact: In that case, the sedimentary unit is the older and the igneous unit is the younger. The contact may be parallel to the stratification in the sedimentary unit (“concordant”) or it may cut across stratigraphy (“discordant”).
- Unconformable contact: In this case, the sedimentary unit is younger than the igneous unit.

Each time you encounter and map a contact between rock units, you should think carefully about the possibilities for the nature of that contact. If there’s more than one possibility and you don’t have enough evidence to decide which is the right one, wait for more evidence. In geologic mapping, you often must develop multiple working hypotheses and then try to find evidence to eliminate all but one of them. Good luck.

HOW TO DRAW A CROSS SECTION (WITHOUT TOPOGRAPHIC INFORMATION)

1. On a blank sheet of paper draw a section line (in the middle of the paper) that is the same length as a line between A-A’.
2. Label the endpoints of the line A and A’.
3. Place the sheet of paper on the geologic map and match up the endpoints.
4. Make a small tick mark on the section line everywhere it is intersected by a geologic contact or structure.
5. Now extrapolate those contacts and structures downward with the appropriate sense and magnitude of dip. Do not forget to take into account the effect of apparent dip. Think carefully about how the various units and contacts interact at depth before deciding how to draw things below the surface.
 - a. Rules for true and apparent dip:
 - i. True dip occurs when the strike of a unit is perpendicular to the cross section line where they intersect. This means you draw a unit in on the cross section with the dip given on the geologic map.
 - ii. Apparent dip occurs when the cross section line does not intersect a planar feature perpendicular to strike. The further away from perpendicular the strike and section line are, the less the dip of the unit will appear to be in the cross section rendering.
6. If appropriate, extrapolate the relationships between units above the section line (for example, a fold) to show the pre-erosion geology. Use a dotted line to express contacts above the section line.

Other notes:

- Below the section line, contacts and structures should be delineated by a solid line.
- Faults should be a heavier line than the contacts and should include arrows that indicate the direction of fault motion.
- You should not plot strikes and dips on your cross section. They’re only relevant in map view.
- Past the endpoints of the section line, just let the geology “fade out”.
- Extend your cross section downward as far as seems reasonable (when in doubt, ask). Then let the geology “fade out” both below and above the section line.