Exercise 6: Geologic Map & Cross Section Field Project

In this lab you will be transported to a interesting geological site for a mapping project where you will collect basic geological structure data and turn that data into a geologic map and cross section. Below are some helpful hints to guide you to a successful conclusion.

Items required for the day of the field exercise

1. Notebook for taking notes. It should be able to survive getting wet if it does rain.
2. Lead and color pencils.
3. Clipboard or similar planar item to use for measuring strike and dip. Your notebook may serve for this purpose if it has a stiff backing. You will also use this as a backing for plotting symbols on your map so try to get a clipboard that is larger than your 8.5 x 11" base map.
4. Tracing paper for stereonet.
5. Stereonet.
6. Marker for samples.
7. One backpack or rucksack per group for samples
8. One rock hammer per group for samples.
9. If a Brunton has been assigned to you please do not forget to bring it with you to the field exercise site!
10. Make sure that you bring some type of rain gear for protection from inclement weather.

Guidelines for Collecting Field Data

(1) **KNOW WHERE YOU ARE!** Before you get into the details of collecting data at the exposure, mark your location on the map and label it with the station number. Use the GPS, topographic contours, stream drainage, roads, etc., to estimate where you are. If you don't plot you position on the map accurately, your data may be worthless. If necessary, use pace and compass techniques to determine your position on the base map.

(2) Inspect all of the outcrop before taking measurements. You will need to guard against becoming so involved with making measurements and writing them down that you forget to investigate all of the exposure.

(3) Use teamwork. You will be in groups of two or three. There will be one Brunton compass per group. One person makes measurements with the Brunton while the other takes notes. If there is a third person, he/she stands over the person making measurements to make sure that the measurements are done correctly. The third person should also read over the notes taken to make sure that everything was taken down correctly. At 2:00PM you can copy each others notes for the day (i.e. data is copied to one notebook during data collection).

(4) Systematically record the following outcrop characteristics, if present, at the exposure:

> a. Lithologic type and mineralogy. Is it sedimentary, igneous, or metamorphic? What is the mineralogy, and proportions of minerals? Describe any distinctive textures.

b. Primary features should be described. If bedding is present, describe the thickness. Does the texture change up or down in the section? Are ripple marks or crossbeds present? Do any of these features indicate a **facing direction**? If the rock is metamorphic, is there a preferred alignment of minerals? If so, is a foliation or lineation defined?

c. Are there identifiable units present at the exposure that are thick enough to plot on the map scale? If so, try to walk along the contact as far as you can. Trace the contact on the map as you go.

d. After all primary and secondary structures have been identified and noted, systematically measure the attitude of each and record these readings in your notebook. Remember to use the correct format for planar versus linear structures. If you can identify outcrop-scale folds, measure the hinge and axial plane attitudes. Don't forget to measure primary sedimentary structures such as crossbedding or ripple marks. When you measure a planar structure, don't forget to note the dip direction quadrant.

e. If a contact is present at the exposure, carefully note its relationship with other contacts. Does it offset or truncate other contacts? What relative age relationships are suggested at the exposure? Are there **slickensides** or **cataclastic** textures associated with the contact?

f. Before leaving the exposure, think about any possible geometric relationships between structural elements. Is the foliation axial planar to folds? Does bedding always dip steeper than foliation? Are mineral lineations and fold hinges parallel? If these types of relationships are discovered, note them in your notebook.

g. If you think that you need more time to fully describe the texture and/or mineralogy of the lithology, take a hand sample. Label the hand sample with the station label.

(5) As you collect data and if you have time, roughly sketch in structure symbols and contacts on your base maps. You can plot these more accurately with a protractor at the end of the day. As you collect data through the day, periodically look at you map. Try to recognize any systematic pattern to the structure data and/or contacts.

Exercise 6A: High Fall Branch Geologic Map & Cross-Section

Problem 1: Collect data within the High Fall Branch map area with you assigned group. Do not split up during the course of the project. You will have from approximately 8:00AM to 2:00PM to collect data. You must have a minimum of 15 stations to sample the map area adequately, so this gives you an average of 15-20 minutes per station. You must also disperse the station locations so that they are not grouped at one location on the map. The exposure is very good in this area so there is a danger that you might spend too much time in one location. I suggest that you make sure that the first 15 stations cover the map area, then come back to exposures that interest you. The following structures may be found at a any given station:

Bedding and crossbedding (S_0)
Pebble lineation or intersection lineation (L_1)
Crenulation Fold Hinge (C_1)
Axial Plane (AP_1)

It is important that you accurately determine the location of a station by recognizing topographic features and relating them to your base map. The road, hiking trail, and stream are particularly useful for this. If you finish collecting data before other groups, use that time to plot the structure data on the stereonet. You can also qualitatively plot the structure symbols on your map to see if any fold or fault structures are apparent. Since only one of the group should be recording notes, the other members should use this time to make copies of the data.

The formal designation for the lithology that outcrops throughout the exercise area is the Devonian Cheaha Quartzite (Dtcq). It is actually a metasandstone since primary depositional features such as bedding, crossbedding, channel lag deposits, and ripple marks can be found in this formation. At each data station describe to the best of your ability what occurs at the location. Look for primary features such as bedding, cross-bedding, graded beds, etc. Also describe secondary structures related to deformation such as stretch pebble lineation. Also outcropping in the study area is the Devonian Erin Slate (Dtes) which actually is a phyllite in this particular area. The phyllite will contain a strong rock cleavage which should be recorded as a planar S_1 reading. A major goal of the mapping will be to discover the contact between the quartzite and phyllite.

The following list defines the various products that you should turn in for problem 2.

Geologic Map

1. Prepare a clean base map by photocopying the base map given to you for the project onto vellum. Alternatively you can trace the information with a rapidograph #0 pen.

2. Plot all contacts and structure symbols (bedding, S_1, L_1, etc.) on the map. You do not have to plot the station labels used in your notes on the map. All elements are to be plotted with a #0 rapidograph unless a fault contact is discovered, in which case use a #2 pen. Dash uncertain contacts. On the map place the label “Dtcq” in the center of the Cheaha Quartzite outcrop area, and likewise for “Dtes”.

3. Include in a legend along the right margin the explanation of lithologic symbols, structure symbols, and contacts. Make sure the lithologic explanation is in proper stratigraphic order. Label the lithologic legend with “Dtldc” and “Dtes”.

4. If any large fault or fold structures are discovered, plot them on the map with appropriate symbols and line width. Fault contacts and megascopic folds should be plotted with a #2 rapidograph. Hinge and axial plane attitude information should be added to the axial trace of the fold (attitude information will be derived from the stereonet).

5. Color the Dtldc a yellow color, and the Dtes a dark brown color.

Cross-Section

Stereonet

With the structure data collected during this exercise, plot each structure element on the same equal-area stereogram. Plot all planar structures as poles, except axial planes which are plotted as great circles. Because you have variety of structures on one stereogram, you must use symbol coding:

• Poles to bedding	filled circle
• lineation (pebble, intersection, etc.)	filled triangle
• Fold hinge	large filled circle
• Axial Plane	great circle

If your geologic map suggests that there may be a large fold or series of folds controlling the structure in the map area, calculate the hinge point on the stereogram and label this point with a "π" point. Plot the fold girdle great circle as a dashed line. From the axial trace on the map, construct the great circle representing the axial plane. Label it as "megascopic axial plane" on the stereogram. With the above elements plotted, calculate the interlimb angle of the fold. Indicate the arc measured for the interlimb angle with a brace along the fold girdle.

If the controlling structure seems to be a fault, plot the fault surface on the stereogram in #2 rapidograph. If structure data seems to systematically change attitude from one fault block to the other, calculate the amount and sense of rotation that would account for this.

Exercise 6B: Tannehill Historical S.P. and Vicinity Geologic Map & Cross-section

Problem 1: You will be provided with a topographic base map with the mapping area indicated by a magenta rectangular area. The cross section will be marked by an A-A' line cutting across the map area. The scale of the map will be 1:24,000 (1 inch = 2000 feet). You will be mapping in an area that is affected by the Birmingham Anticline, and thrust faulting is a definite possibility in this region. You will begin mapping the southeast limb of the anticline along the Tannehill S.P. exit road, which at the entrance is close to the core of the anticline, and work your way into the park itself is on the southeast flank of the fold. Along the way you should note any recognizable formations that range in age from Cambrian to Mississippian. A handout describing the various formations will be given to each group before mapping begins. Each group should measure the orientation of bedding whenever good exposures are encountered even though these exposures may not correspond to the contact between 2 formation. A quick inspection of your topographic base will confirm that some formations are ridge-formers whereas others are valley-formers. Therefore, you should suspect the presence of a contact whenever you encounter a distinctive topographic break that is recognizable on the topographic map. When you take bedding readings and/or find contacts using topographic breaks use the GPS receiver to mark a waypoint and make sure that you describe what is found at the waypoint in your notebook.

After mapping the southeast limb you will be transported to the northwest limb in vans where another transect will be run near the A-A' cross section line. From your data construct the following products:

I. Geologic Map (1:24,000 scale) on 24 x 18 inch vellum (ink with a rapidograph, color with color pencils)

a. Use a #0 for contacts, #2 for faults and megascopic fold structure symbols
b. Geographic North Arrow
c. Explanation (structures and lithology symbols- see example in textbook)
d. A-A' cross section line
e. Formation abbreviation (e.g. Oc, Mf, etc.) inside each lithologic polygon
f. Graphical scale in metric units and RF
g. Thrust faults should have teeth on hanging wall block
h. Megascopic fold axial trace should have hinge and AP attitude information calculated from the stereonet
i. Use topographic ridges and valleys to extrapolate the geology to cover the entire map area. Use dashed contacts for areas far from data control.
j. Label the latitude and longitude at map corners.
k. Lithologic Symbols
    1. |Ppv (Pottsville Fm) Color = Lt. Blue with sandstone & shale pattern
    2. Mpw (Parkwood Fm) color = purple with sandstone & shale pattern
    3. Mf (Floyd Fm.) Color = Lt. Purple with shale pattern
    4. Mh (Hartselle Fm) color = purple with sandstone pattern
    5. Mpm (Pride Mt. Fm.) Color = purple with shale pattern
    6. Mtfp (Fort Payne Fm) color = Lt. purple with chert pattern
    7. Srm (Red Mt. Fm) color = Heliotrope (lavender) with sandstone & shale pattern

8. Oc (Chickamauga Fm.) Color = pink with limestone pattern
9. -COk (Knox Group) color = orange with dolostone pattern
10. -Cc (Conasauga Fm.) Color = redish-tan with dolostone pattern

II. Geologic Cross Section (1:24,000 horz. scale; 1:6000 vert. Scale) constructed below map
   a. Use #0 for contacts, #2 for faults
   b. Label ends with A and A'.
   c. Topographic profile constructed from topographic base map.
   d. Account for apparent dips when A-A' is not perpendicular to strike of contact.

III. Stereonet
   a. Plot Bedding as poles to define fold girdle. Calculate the hinge and AP attitude from the stereonet and map. Estimate the interlimb angle using the pole concentrations.