Geology 29 - Structural Geology

SUPERPOSED FOLDING AT WHATELY

After the Ordovician Taconian orogeny, a thick deep-water marine clastic sequence was deposited across central New England. We have already seen one Devonian formation of the western part of this basin when we studied the Goshen Formation meta-turbidites at Cummington. This week we will be working in the Devonian Gile Mountain Formation - a more easterly facies equivalent of the Goshen. The Gile Mountain Formation at Whately consists of thinly laminated, fine-grained, grey quartzite and fine-grained, garnet-bearing quartz-mica phyllite. The Gile Mountain Formation was most likely interbedded fine sandstone and mudstone prior to metamorphism and deformation. The Goshen and Gile Mountain formations occur in a very large-scale tectonic domain known as the "Connecticut Valley Belt". This domain underlies much of central Massachusetts, and is essentially split in two by the younger Triassic graben.

This week we will study the evidence for multiple phases of folding of the Gile Mountain Formation in two small exposures located in Whately. It is often said that structural geology mimics itself at all scales. This means to say that the orientation and character of small, outcrop scale structures commonly indicates the nature of larger (local to regional) scale structures produced at the same time. Perhaps the small-scale structures available for analysis at Whately will yield information about the nature of the Connecticut Valley Belt, as it is too large and too poorly exposed to analyze directly.

IN THE FIELD:

There are two outcrop areas to be studied for this lab: one that we will call "the barn outcrop" and one we will call "the woods outcrop" (you will see why!).

In each of these areas you should:

a) Look *carefully* for any and all structures you can find. These *may* include folds, faults, and fabric. Can you observe something that you believe to be original sedimentary layering? Observe and think about the geometric relationship between the structures that are present. Are there families of related structures? Are there crosscutting structures?

b) Measure the orientation of all the structures you observe. Take as many measurements as you feel you need to fully characterize the structure you are studying. For example, have you taken enough measurements to find the orientation of a fold axis from a π or a β plot should you need to? Be *sure* that your field notes indicate the nature of the measurement you have taken. "34/289" alone in your notes is meaningless. Only "34/289 = fold axis" will be interpretable back home! Finally, check with me to be sure you are using the Brunton properly when measuring fold axes.

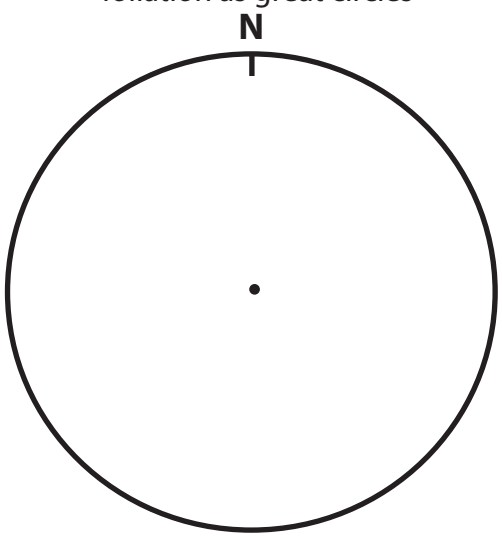
c) Keep a running, schematic lower hemisphere projection of the data you are collecting. Use the primitive circles provided with this lab (next page) to roughly plot in the general orientation of the structures you see. This will help you to see if patterns are developing while you are still in the field to test your hypotheses.

d) Make *plenty* of sketches in your field notes to show the structures you see. You will want to make them relatively quickly, but accurately. Annotate them so you remember why you drew that particular structure once you are home. And *always* remember to put a scale with your drawing and to orient your sketch. (Ask me what this means!) Describe the character of the structures observed (for folds this would include, for example, wavelength, interlimb angle, fold form, axial plane attitude, fold axis attitude). You need not describe each individual structure one-by-one, but rather you should decide what structures are geometrically equivalent and describe them as a group. These descriptions can be in list form - brief and concise.

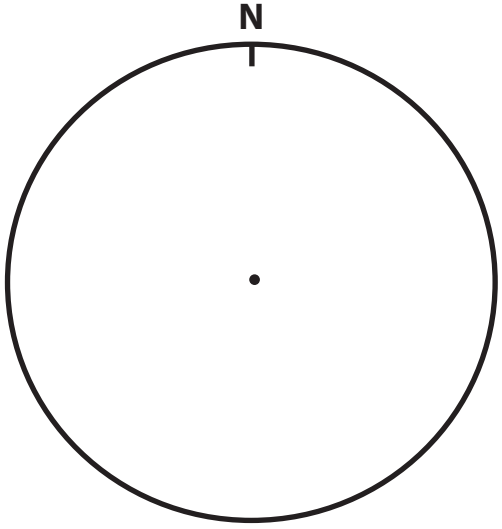
SCHEMATIC STEREOPLOTS

WOODS

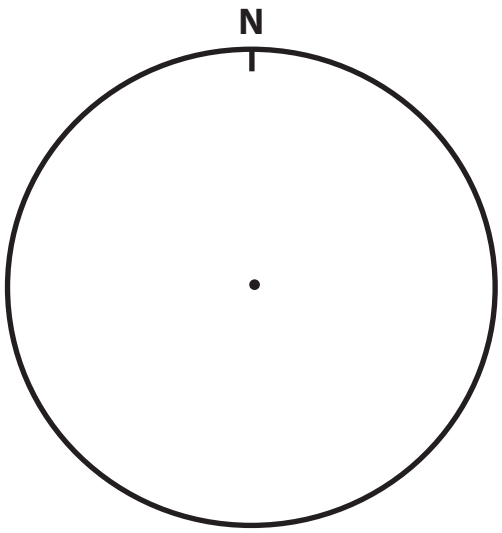
foliation as great circles



poles to foliation

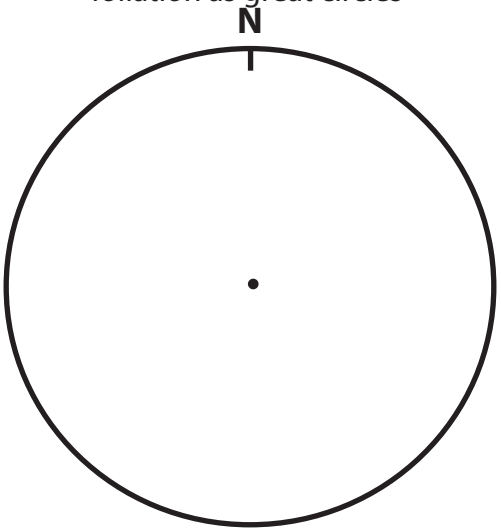


fold axes

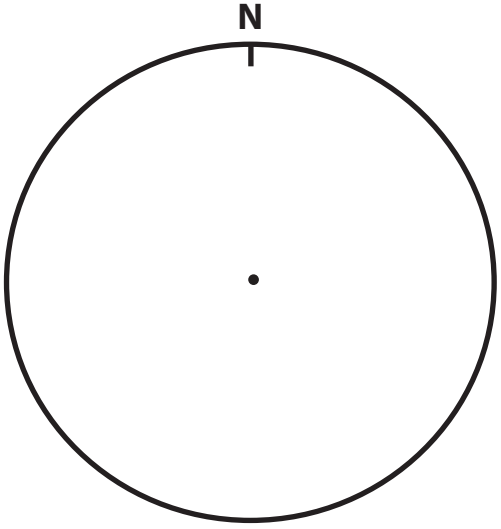


BARN

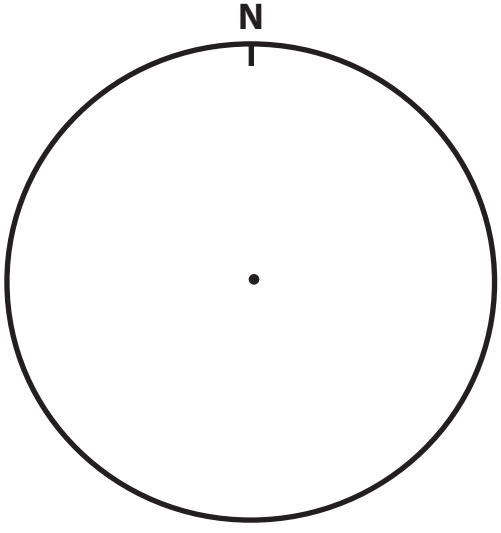
foliation as great circles



poles to foliation



fold axes



TO HAND IN:

1) Your schematic stereoplots from the field exercise. I simply want to check that you don't have any lingering misunderstanding about the use of the stereonet, consequently, do NOT redo these plots, or "clean" them up.

2) Formal stereoplots of all the structures you measured. (Do this with a stereonet and tracing paper overlay.)

On one stereoplot, plot all axial planes (plot them as great circles for this exercise) and all fold axes together. Use separate symbols for fold axes from the woods and barn areas. On this plot, determine the axis about which your measured fold axes are folded. Note that the axial planes are *not* folded. This is because they lie as planes perpendicular to the axis that folds the fold axes you measured.

On another stereoplot, plot all foliation data - in this case pole plots will be more advantageous for your analysis. Use separate symbols or colors for the barn and woods areas. The woods foliations should behave as a π plot, and lie along a great circle that is perpendicular to the woods fold axes. This is because the woods fold axes are all parallel. Your barn foliations should dip in many directions, but be symmetric about the center of the plot. The foliations are symmetric about the intersection of the two "dome" fold axes.

3) A concise (<2 typed pages) discussion of the structures at Whately and of their history. This should include a description of the folds observed. You should not describe or discuss each individual fold on which you made measurements. Instead, discuss geometrically equivalent structures as a group. (Hint: Use your stereoplots along with field observations to decide which folds are equivalent in form and orientation.) Your discussion should also include a summary of the orientation of each group of structures relative to the others, and of the timing of each group relative to others. Please remember that the *organization* of your answer is the most important factor in its clarity and will help to make it concise. I would rather have a detailed outline than a loose essay.

4) A comparison of the structural pattern at Whately and at Cummington. Comparing stereoplots is the best way to accomplish this type of analysis.