

This exercise is meant to mimic a field experience in which you, the student, will measure bedding-cleavage relationships and asymmetric folds in order to map a regional-scale structure. You will build your experience in the following structural skills:

- Measuring attitudes of lines and planes with a Brunton compass
- Taking detailed field notes of lithologies and structures
- Compiling field data to inform your interpretation of regional structures

In addition, through completing this exercise you will learn about important relationships between:

- Axial-planar cleavage - bedding angles and regional fold hinges
- Parasitic fold asymmetry and regional fold hinges
- Bedding-cleavage intersection lineations and regional fold hinges
- Parasitic fold hinges and regional fold hinges
- Axial-planar cleavage – bedding angles and fold geometries

Your mission, should you choose to accept it, is to **complete a structural map and interpretive cross-section** of the regional fold geometry based on measurements. You won't balance the cross section, so please draw a sketch with smoothed curves not sharp angles. Steps to completing your mission are as follows:

1. OBSERVE AND MEASURE (90 – 120 minutes, in class)
 - a. Measure, and record in your “field notebook*,” the strikes and dips of bedding and cleavage on the five rocks labeled PA060# (# = 1-5);
 - b. Measure, and record in your “field notebook*,” the plunges and trends of bedding – cleavage intersection lineations on the five rocks labeled PA060# (# = 1-5);
 - c. Observe, and record in your “field notebook*,” what defines bedding and cleavage in the rocks (mineralogy, grain size, grain shape, etc);
 - d. Determine, and record in your “field notebook*,” the angle between bedding and cleavage and the direction from cleavage to bedding through the acute angle;
 - e. Measure, and record in your “field notebook*,” the plunges and trends of hinges of asymmetric folds on the five additional rocks;
 - f. Observe, and record in your “field notebook*,” the asymmetry of the parasitic folds, include in your notes your view direction (viewing towards the north or south). You should NOT include notes about these lithologies; they don't match the others. One of these samples shows more than one type of parasitic fold; study this one VERY closely.
 - g. Remark in your “field notebook*” what the asymmetry of the parasitic fold suggests about the location of the regional anticline axis.

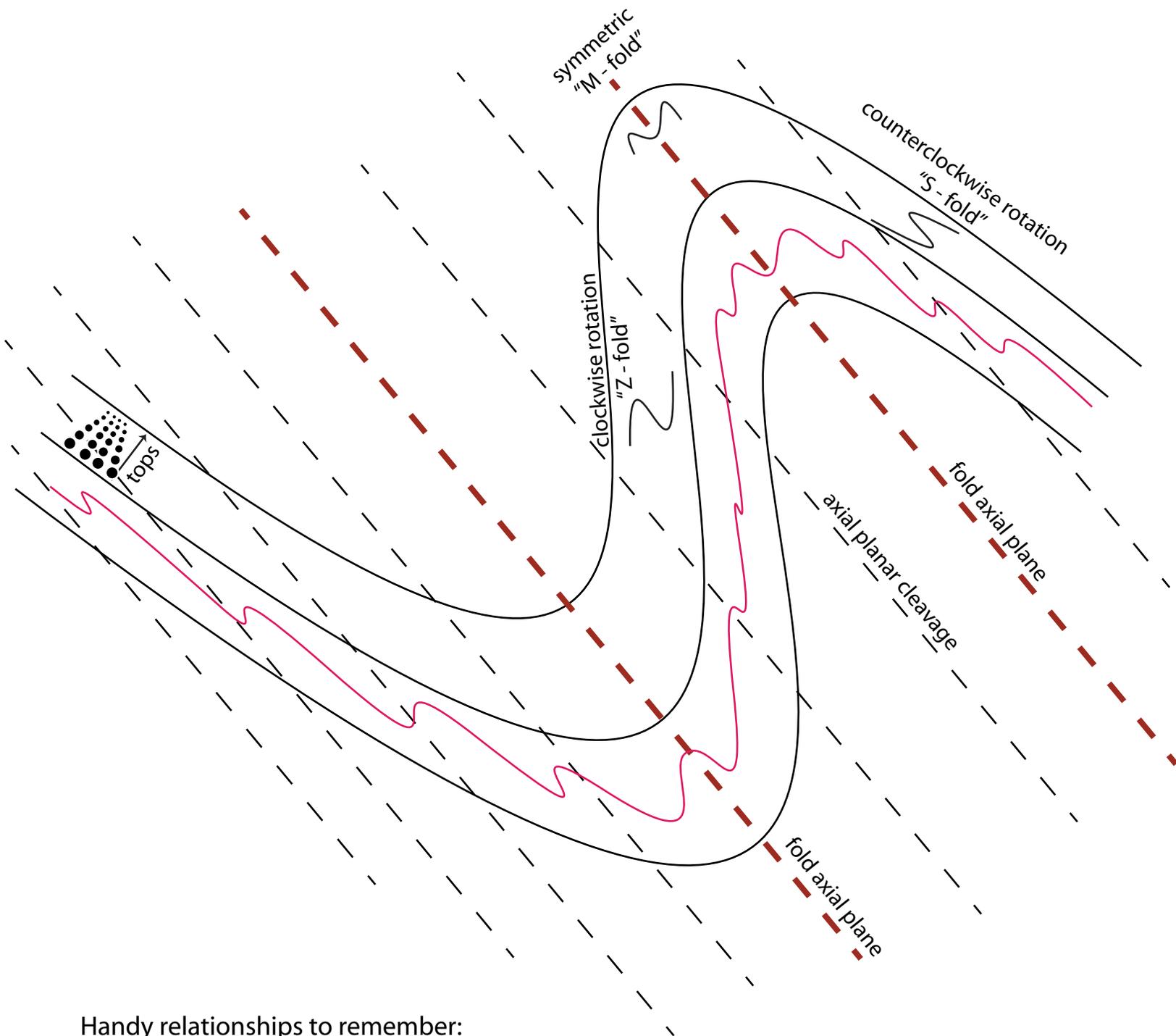
**Annotated sketches are an important part of excellent field notes. The more detailed sketches you draw, the closer you are observing the rocks and the more you will understand about the geology.*

2. MAKE A STRUCTURE MAP (10-20 minutes, in class)
 - a. Transfer your measurements to the structure map (bird's eye view) using the appropriate map symbols;
 - b. Draw strike, dip, and trend lines in the correct orientation (north is noted), write the magnitude of the dip or plunge next to the symbol (see map symbols)
3. CONSTRUCT AND INTERPRETIVE CROSS SECTION (20-40 minutes, at home)
 - a. Using your structure map, drop the dips of cleavage and bedding to the dashed topographic profile in the E-W cross section below the structure map.
 - b. Use the relationships between bedding and cleavage and parasitic folds to sketch the bedding (S_0 , solid line) and cleavage (S_1 , dashed line) relationships. Please use at least two parallel bedding planes to fully show the structure.

4. PLOT STRUCTURAL DATA ON STERONETS (60 minutes, at home)
 - a. Plot all bedding measurements (as planes) on a stereonet using a red pencil;
 - b. Plot the poles to bedding on the same stereonet in red;
 - c. Find the π -axis of the bedding, mark this with a  on the same stereonet;
 - d. Plot the axial plane of folded bedding on the stereonet in green.
 - e. Plot all cleavage measurements on the same stereonet using a blue pencil;
 - i. Is the cleavage more or less parallel to the axial plane you determined? (If not, check your axial plane measurement).
 - f. Plot the bedding-cleavage intersection lineations on the same stereonet with .
 - g. Plot the fold axes of the parasitic folds on the same stereonet with .
 - i. What do you notice about the orientation of the intersection lineations with respect to the π -axis?
 - ii. What do you notice about the orientation of the parasitic fold axes with respect to the π -axis?

Finally, answer this thinking question:

You are mapping in an area where bedrock is very minimally exposed and you suspect there may be a fold present, based on bedding-cleavage relationships and parasitic folds at one outcrop (see sketch below). What information would you gather to deduce whether a) a fold is present, b) the orientations of the fold axis and axial plane, and c) where the fold is located with respect to your position.

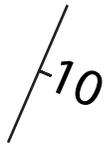


Handy relationships to remember:

- 1) Axial planar cleavage dips more steeply than bedding EXCEPT in overturned limbs!
- 2) S_0 is perpendicular to S_1 at the fold hinge.
- 3) The angle between S_0 and S_1 decreases towards the fold limbs.
- 4) The tighter the fold, the smaller the angle between S_0 and S_1 on the fold limbs.
- 5) The acute angle from cleavage to bedding "points" towards the regional anticline axis.
- 6) The sense of rotation of parasitic folds "points" towards the regional anticline axis.

Map symbols for structure map

All strike and trend lines should be drawn in the proper orientation from north using a protractor on your structure map.

 Strike and dip of bedding

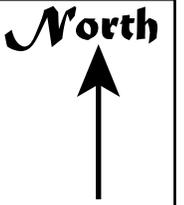
 Strike and dip of cleavage

 Trend and plunge of parasitic fold with clockwise rotation sense

 Trend and plunge of parasitic fold with counterclockwise rotation sense

 Trend and plunge of symmetric parasitic fold

Bird's eye view field measurements map: length of box=length of room 205



West

Draw an interpretive cross section based on your measurements here: (topographic profile dashed in)

East

