Amherst College
Department of Geology

GEOLOGIC STRUCTURES IN THREE DIMENSIONS

This exercise will develop your ability to define, describe, and interpret geological structures in three dimensions. To do this, we will use three-dimensional block diagrams that combine geologic maps with geologic cross-sections. In some places geologists have access to actual cross-sectional exposures, such as cliff faces or road cuts. More often, however, we are limited to studying the geology exposed only on the horizontal surface of the earth, in a map view. Geologists produce cross-sections from map view geology by interpretation and extrapolation, and use the cross-sections to accurately illustrate the three-dimensional geometry of the geology exposed at the surface. We have discussed some of the important principles that guide three-dimensional interpretation and allow geologists to extrapolate between exposures. Remember that it is reasonable to have expectations as to the shapes and relative ages of rock bodies, for example we assume sedimentary units to have been deposited as horizontal, tabular, laterally continuous sheets of constant thickness with the oldest on the bottom.

Your objective in this assignment is to complete a series of block diagrams that are included in the exercise. Use a ruler and a protractor to be as accurate as possible.

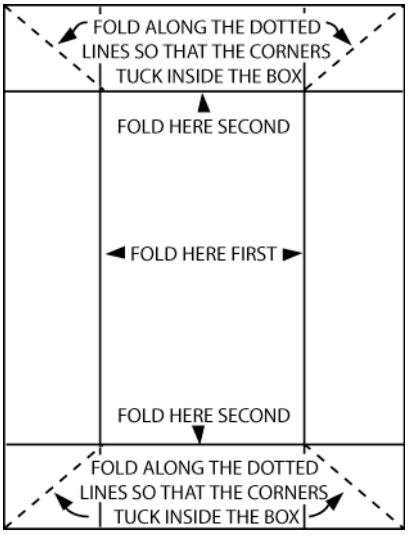
PART I: ORIGAMI

You are provided with four flat diagrams that can be folded into 3-D blocks. It isn't necessary to do the folding to complete the exercise, but you may find it helpful. To fold the blocks, unstaple the sheets and fold according to the diagram below.

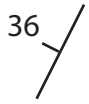
Each diagram has a series of geologic units that are drawn in on some but not all of the faces. Your job is to draw the contacts of the units on the remaining faces. Remember that along the edges of the 3-D box - where the sides meet the top or where the sides meet each other - the geology must match. That is, the geology along a cross-section must match the geology of the map where the two planes intersect. You can use this to accurately transfer information from the map to the cross sections or visa versa.

Remember to think about what you have learned from completing an exercise, as each successive diagram builds on the skills learned from the previous boxes!

Once your diagrams are complete, answer the questions on the back of each sheet.

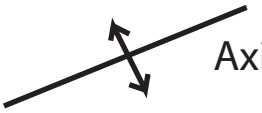


KEY TO SYMBOLS

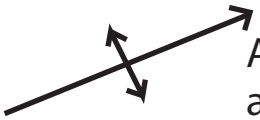


Strike and Dip of Strata

Fault; arrows indicate relative movement in cross section

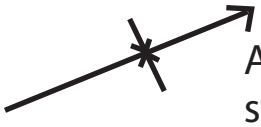


Axis of an anticline



Axis of a plunging anticline

Axis of a syncline



Axis of a plunging syncline

Cz Cenozoic

K Cretaceous

J Jurassic

Tr Triassic

P Permian

C Carboniferous

D Devonian

S Silurian

O Ordovician

€ Cambrian

p€ Precambrian

BLOCK A

1) Complete the map portion of this block diagram.
   Draw in all necessary contacts and label each unit.

2) Name the structure that occurs in the diagram.

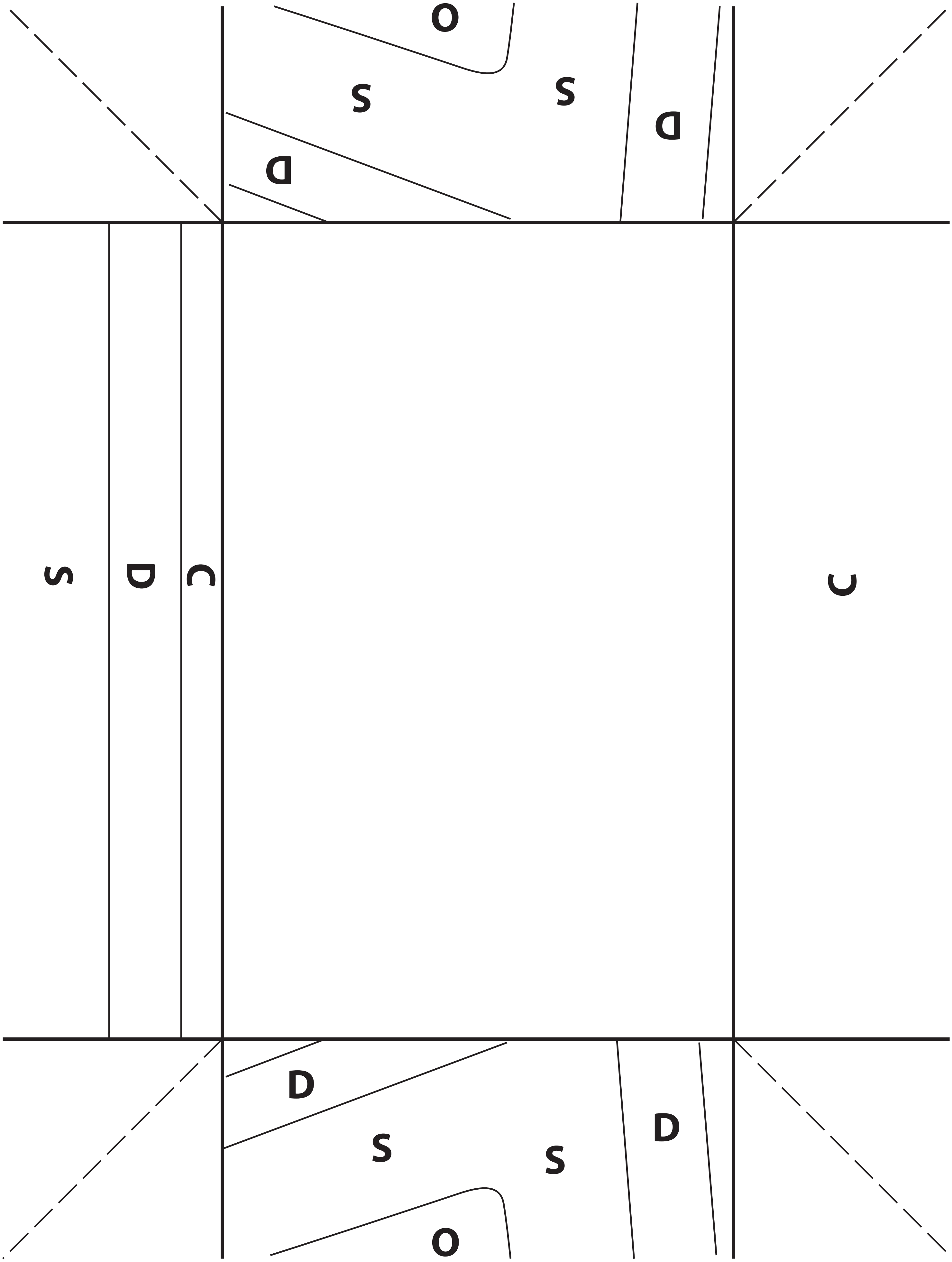
   _____

   Draw the proper symbol for that structure on the map portion of the diagram.

3) On the map, add one representative strike and dip symbol for each limb of the fold.

4) Consider the way unit D occurs in the map view.
   Why is its outcrop width different on each limb of the fold, while its thickness in cross-section remains constant?
   You may conclude that outcrop width of a unit depends upon:
   a) Its true depositional thickness as measured perpendicular to bedding, and

   b)_____


O
S
S
D
D
S
D
C
C
D
S
S
D
O

BLOCK B

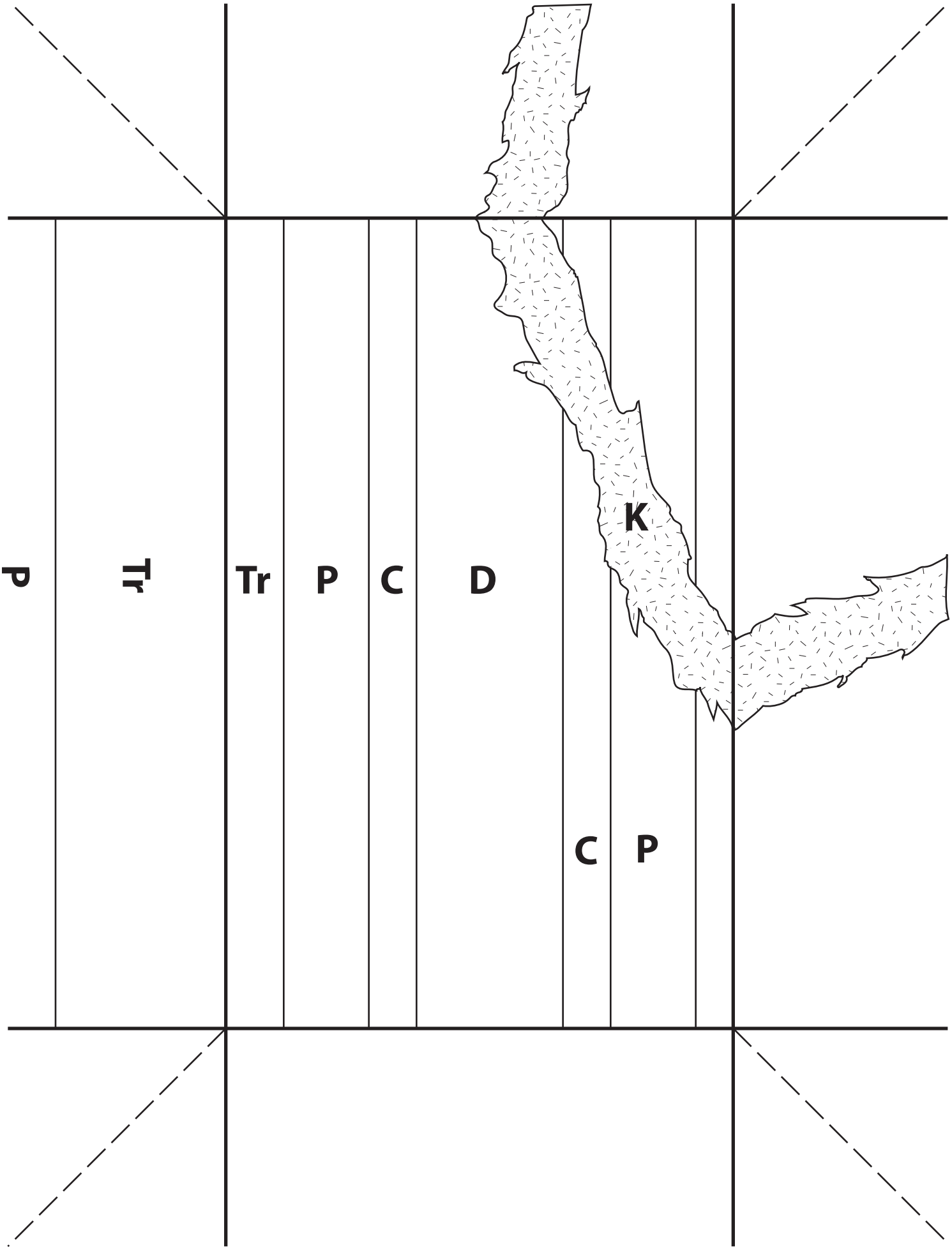
1) Complete all three remaining sides of this block diagram. (Some information has been provided for you.) Draw in all contacts and label all units.

2) Put accurate strike and dip symbols on each unit on the map.

3) What structure(s) occurs in this diagram?

Is the structure plunging or not plunging?

Draw the appropriate symbol for this structure on the map view.


P
Tr
Tr
P
C
D
K
C
P

BLOCK C

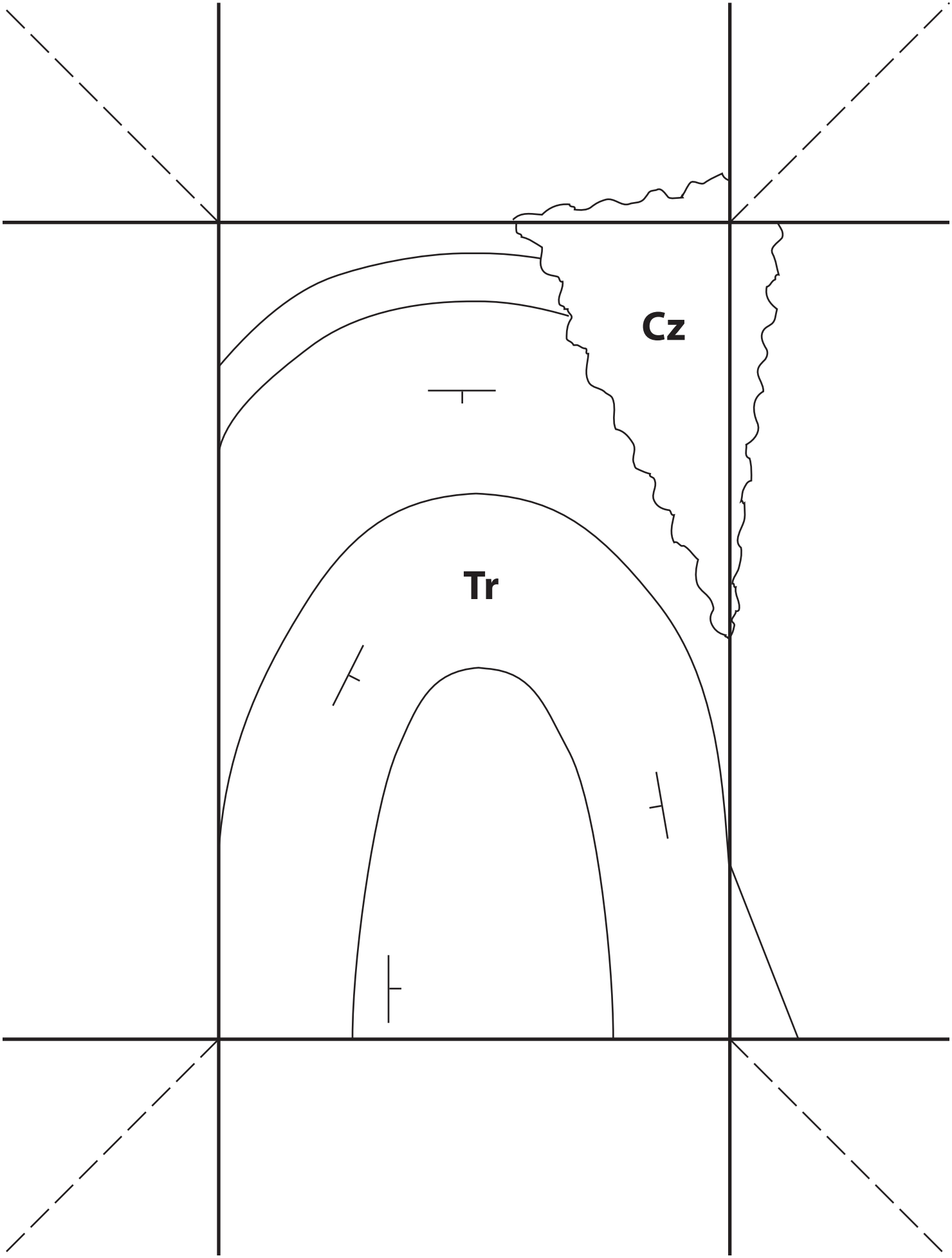
1) Complete all four cross-sections for this diagram. (One cross-section has been started for you.)

2) What is the structure(s) that occurs in this diagram?

Is it plunging or not plunging? If plunging, what is its direction of plunge?

Add the proper symbol for this structure to the map view.

3) Label the remaining units of the map with symbols for ages that are appropriate.


Cz
Tr

BLOCK D

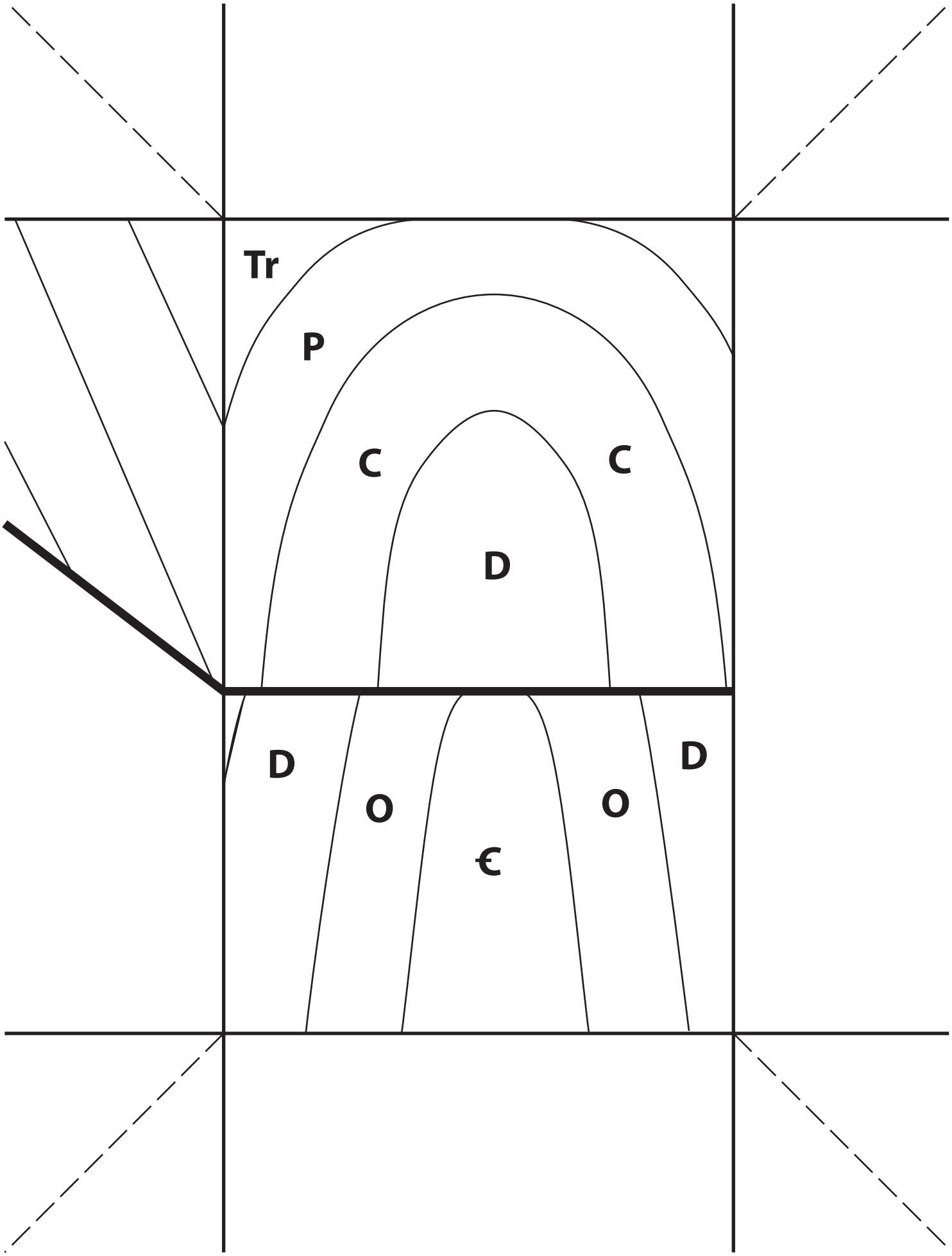
1) Add representative strike and dip symbols to the map view of this diagram.

2) What are the structures that occur in this diagram?

Add the correct symbol for the fold to the map.

3) Complete all four cross-sections of the block diagram. (One section has been started for you.)

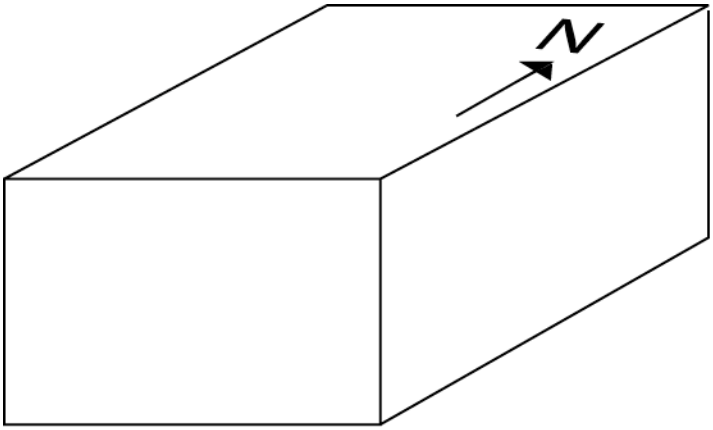
4) Add arrows to the map or cross-sections of the block diagram to indicate the nature of offset on the fault.


Tr
P
C
C
D
D
O
O
€
D
D

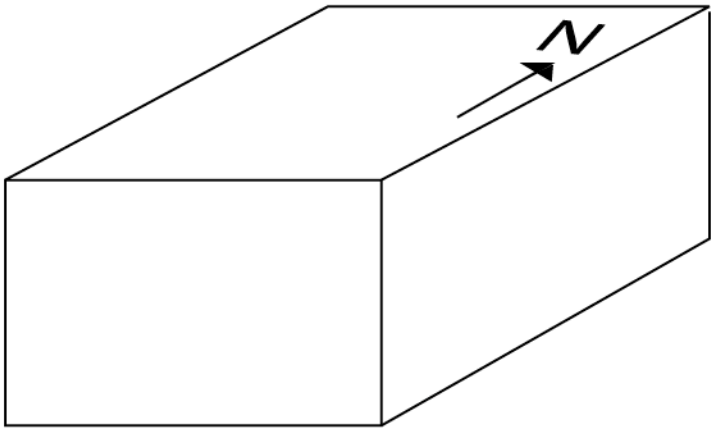
PART II: 3-D VISUALIZATIONS

Each of the perspective blank block diagrams below is accompanied by a description of a structure. Utilizing the principles and techniques you gathered from the previous part of this exercise, for each of the diagrams draw in a structure that fits the description provided. The exact form of the structure is up to you, as long as it conforms to the description given - but each diagram should show representative strike and dip symbols and the symbol for the structure on the map view. Label the beds in each diagram to show the relative ages of the units.

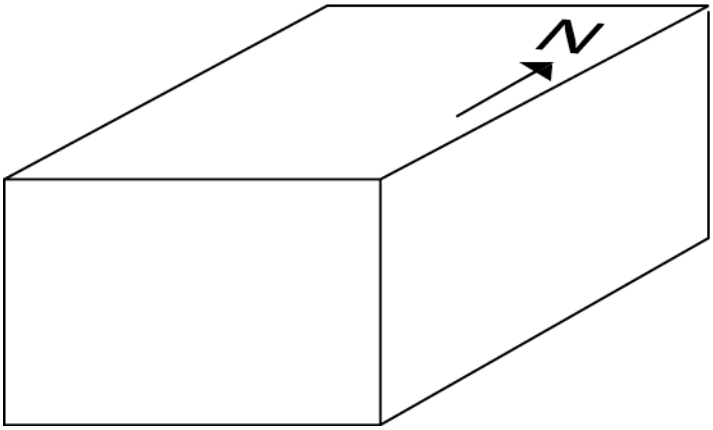
If you get stumped - go back and look at your 3-D diagrams. Each of these three new problems is a variation (reorientation) of a structure you have already worked with!



1) An asymmetrical syncline with axis striking N-S, and the steep limb on the W side.



2) A symmetrical plunging syncline with its axis plunging E.



3) An asymmetrical plunging anticline with its axis plunging to the W, and its steep limb on the S.