

Name: _____

Geology 101 Lab Worksheet: Geologic Structures

Refer to the Geologic Structures Lab for the information you need to complete this worksheet (<http://commons.wvc.edu/rdawes/G101OCL/Labs/StructureLab.html>).

To learn about geologic structures, you will work block diagrams, cross-sections, and geologic maps. Developing your understanding of geologic structures will require you to apply what you have learned previously, including the principles of relative geologic age and the rock cycle.

Materials Needed

- This worksheet
- A computer with access to the Internet
- Colored pencils and a ruler

There are three parts to this lab:

Part 1: Work with a simplified geologic map to better understand how rock and sediment units and geologic structures are portrayed on a geologic map.

Part 2: Interpret geologic structures on block diagrams with simplified cross-sections and geologic maps.

Part 3: Work with simplified cross-sections that correspond to a real geologic map.

Due by the time the next lab begins next week:

1. This work sheet, completed.

PART 1: A MAP EXERCISE WITH A GEOLOGIC MAP OF THE WENATCHEE AREA

In this exercise your task is to complete a simplified geologic map of the Wenatchee area, using the information I provide you. The goal is for you to become familiar with the essential parts of a geologic map, and how they relate to each other.

Page 3 contains an uncolored, simplified geologic map of the Wenatchee area. The map shows four geologic formations. Three of the geologic formations of the Wenatchee area are bedrock (solid rock in the local crust), and the other formation is unconsolidated deposits of stream sediments and landslides.

I will give you rock samples from the three bedrock formations. You name the rock types.

Rock Number	Rock Type
1.	
2.	
3.	

Based on your identification of the rocks, fill in the blanks to complete the names of the three rock formations. (The names are those recognized by the US Geological Survey.)

Rock 1 is from the Columbia River _____ Group. (Fill in the blank with the rock type you identified.)

Rock 2 is from the Chumstick Formation commonly referred to as the Chumstick _____. (Fill in the blank with the rock type you identified, using the general name for rocks of that grain size.)

Rock 3 is from the Swakane Biotite _____. (Fill in the blank with the rock type you identified. Hint: Depending on your specific rock sample, there are two possible names for this type of rock. The official name of this rock is based on its dark and light layers and high metamorphic grade, rather than its micaceous nature.)

The map has a north arrow and a scale, but it is missing an essential component of any geologic map – a map legend.

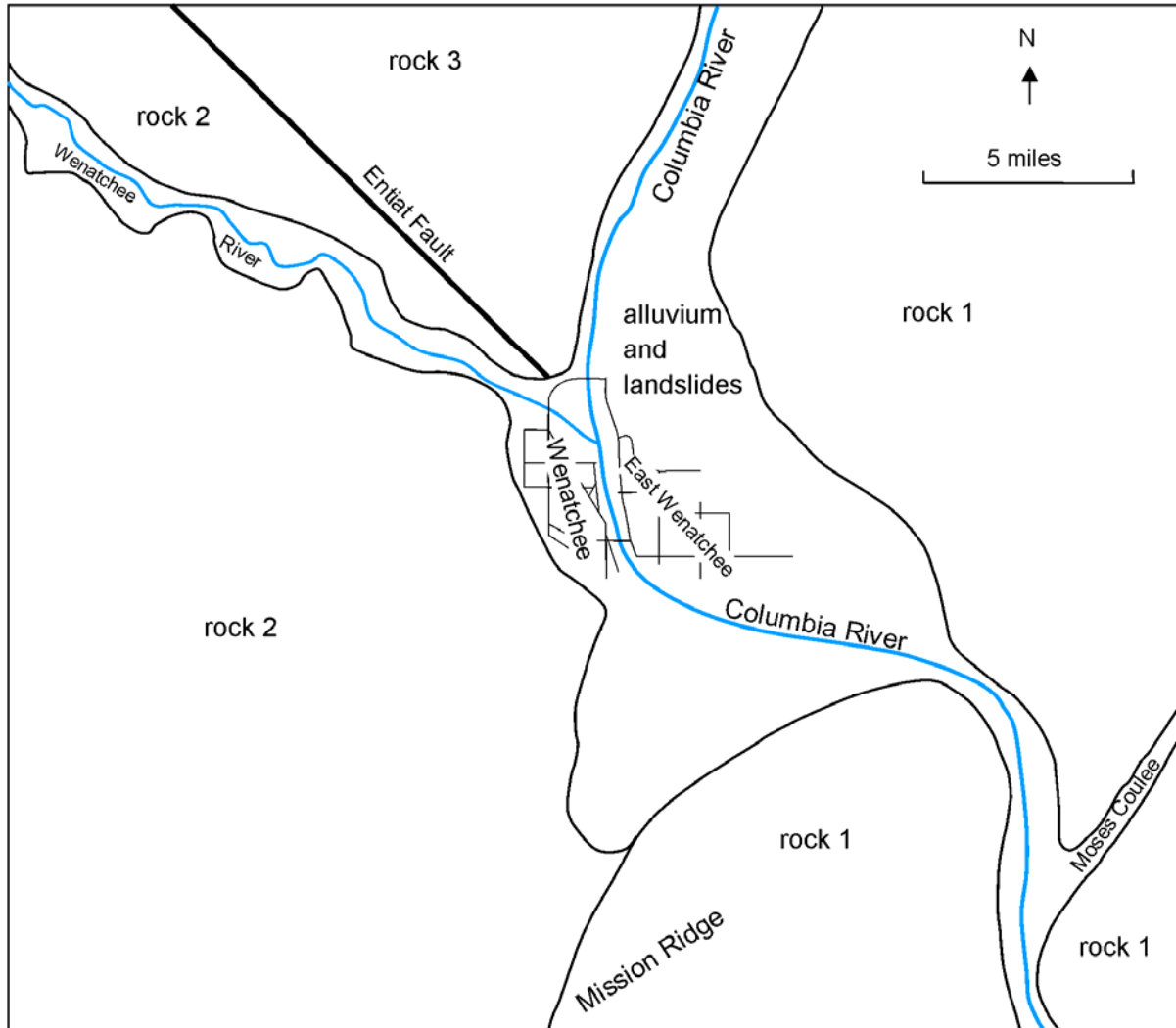
Map Legend

Geologic Units

Geologic Structures

Complete the map legend above. The four geologic units must be in age sequence, oldest at the bottom, youngest at the top. The alluvium and landslides unit is Quaternary in age; it must be colored yellow in accord with geologic map custom. Assign a color of your choice to each of the other three units. Color in each of the boxes and write the age, name, and rock type of the geologic unit to the right of each box.

The Entiat fault is the only geologic structure shown on the map. It is an oblique-slip fault that combines right-lateral strike-slip offset with northeast side up offset. Draw the appropriate fault symbol in the geologic structures part of the map legend and write the explanation of what it stands for to the right of the symbol.



Color the geologic map according to the geologic map legend. Add the appropriate fault symbol to the Entiat fault on the map.

You now have a complete geologic map of the Wenatchee area. The geologic map of the area published by the US Geologic Survey contains several more geologic units and shows numerous strikes and dips, folds, and faults not shown on this simplified version. Nonetheless, the geologic map you have completed is useful guide to the rock formations that dominate the land around Wenatchee and the location of a major fault in the area.

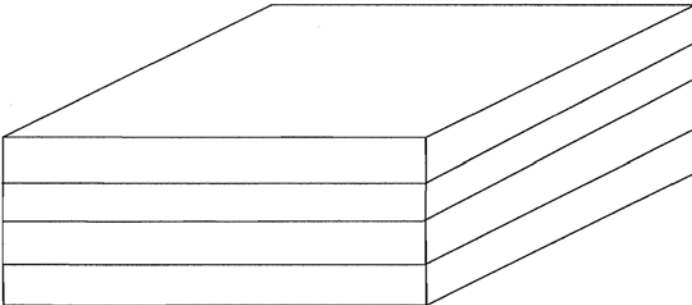
PART 2: IDENTIFYING GEOLOGIC STRUCTURES

To understand geologic structures and how they relate to formations of rock and the geologic history of an area, we can measure the horizontal run and tilt (strike and dip) of sedimentary strata, record that information on a map, and draw the contacts (lines) between the mappable units. The data we record on the map allow us to recognize geologic structures and enables us to project what the structures look like beneath Earth's surface. That projection is what we depict on the cross-section diagrams based on the map.

The diagrams in Part 2 are block diagrams. The top of a block diagram is an oblique view of the Earth's surface, a geologic map that you are viewing at an angle from above. The vertical sides of a block diagram are cross-sections, cut-away views that show how the rocks and structures extend into the Earth. Cross-sections typically don't contain geologic map symbols. However, to demonstrate that you understand relative motion on faults, you will put half-arrows on each side of any fault in the cross-sections. All other geologic structure symbols appear only on the map (top) of the block diagrams.

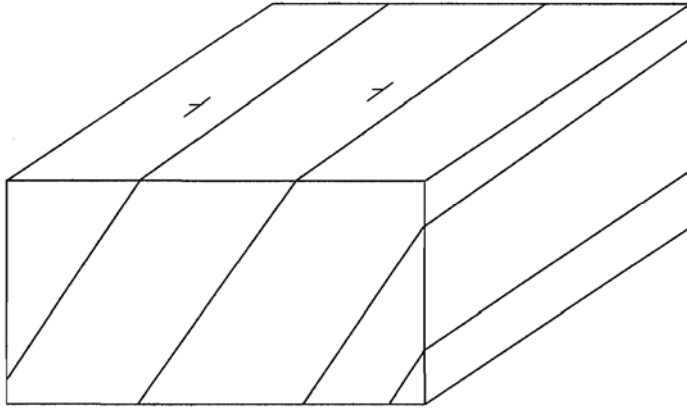
Refer to the Basics Table of geologic map symbols for more information on strike and dip (<http://commons.wvc.edu/rdawes/G101OCL/Basics/BscsTables/geomapsymb.html#shtable>). The dip angle is written next to the strike and dip symbol on a real geologic map. However, for this exercise, you will be asked measure the dip angle and write it down next to the strike and dip symbol on only a few of the block diagrams.

Horizontal and tilted strata (block diagrams 1 – 3) Block diagram 1



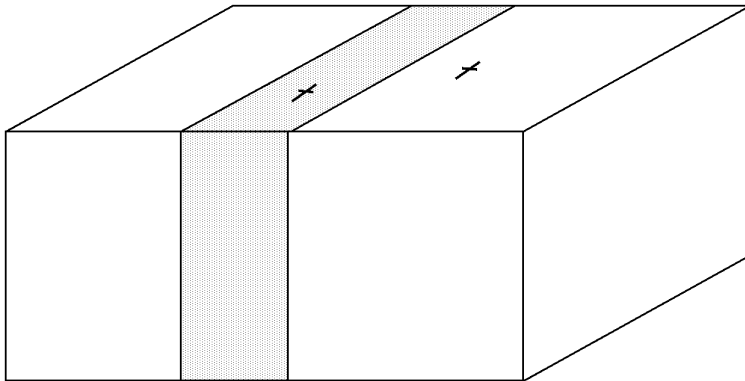
1. Label the strata in age sequence, starting with 1 for the oldest stratum. Label the strata on all faces of the block diagram – both of the cross-sections (sides) and the map (top).
2. Draw the correct strike and dip symbol on the map of block diagram 1.
3. Have the strata been deformed in any noticeable way (folded, faulted, tilted) since they originated?

Block diagram 2



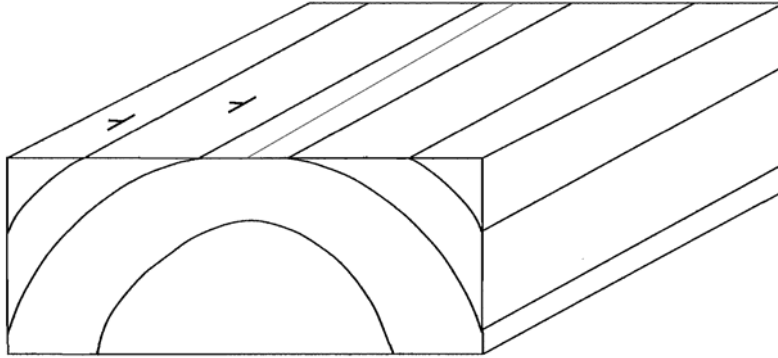
1. Draw a third strike and dip symbol on the map in the stratum without one.
2. The strata are all tilted to the same angle, at a dip between 0° and 90° . What is the dip angle? Once you have determined the dip, write the number next to each of the dip symbols on the map. All dips are known to be in degrees, so following custom, do not include the degree symbol ($^\circ$).
I have a protractor you can borrow to measure the dip.

Block diagram 3



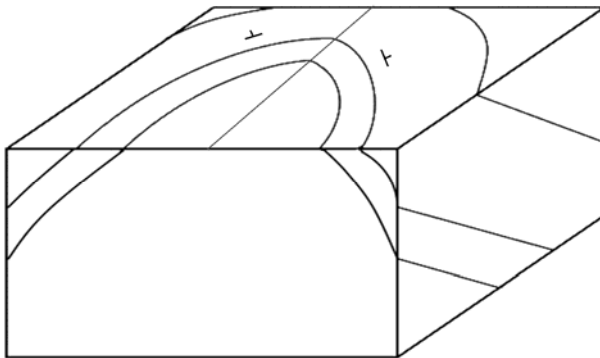
1. Are the strata in block diagram 3 tilted, folded, or faulted?
2. Are the strata oriented horizontally, vertically or in-between?
3. Draw a third strike and dip symbol on the map in the blank formation.
4. Can you apply the principle of superposition to determine the age sequence of the strata in the diagram? Explain.
5. What could you look for in sedimentary beds to determine which way was originally up?

Folds (block diagrams 4 – 9) Block diagram 4



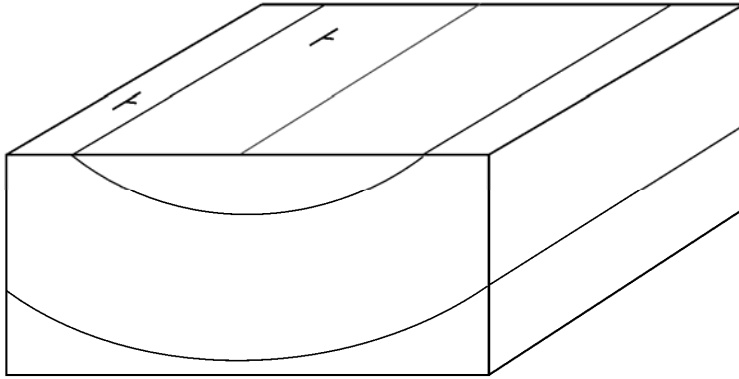
1. Assuming the strata have not been turned upside down, label the strata in age sequence, starting with 1 for the oldest stratum. Label the strata on all faces of the block diagram – both of the cross-sections (sides) and the map (top).
2. At least one more strike and dip symbol is needed for a complete map. Draw a correctly oriented strike and dip symbol in one of the strata in the eastern (right) limb of the fold. Estimate or measure dips to within 5° and write them next to all the dip symbols.
3. What is the name of this type of geologic structure?
4. Complete the appropriate fold symbol on the axis line of the fold.
5. Color at least every other stratum so the structure is clearly defined.

Block diagram 5



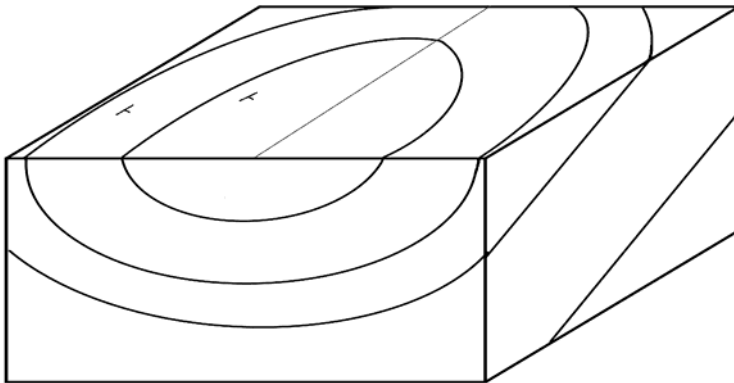
1. Assuming the strata have not been turned upside down, label the strata in age sequence, starting with 1 for the oldest stratum. Label the strata on all faces of the block diagram.
2. Add one more strike and dip symbol to the map, correctly oriented, in a blank stratum. In this case, do not write in the dip angles.
3. What is the name of this type of geologic structure?
4. Complete the appropriate fold symbol on the axis line of the fold.
5. Color at least every other stratum so the structure is clearly defined.

Block diagram 6



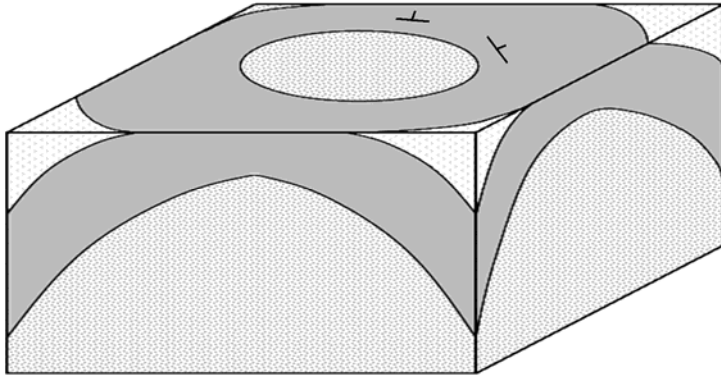
1. Assuming the strata have not been turned upside down, label the strata in age sequence, starting with 1 for the oldest stratum. Label the strata on all faces of the block diagram.
2. Draw one strike and dip symbol in one of the strata in the eastern (right) limb of the fold. Estimate or measure the dips to within 5° and write them next to all the dip symbols.
3. What is the name of this type of geologic structure?
4. Complete the appropriate fold symbol on the axis line of the fold.
5. Color at least every other stratum so the structure is clearly defined.

Block diagram 7



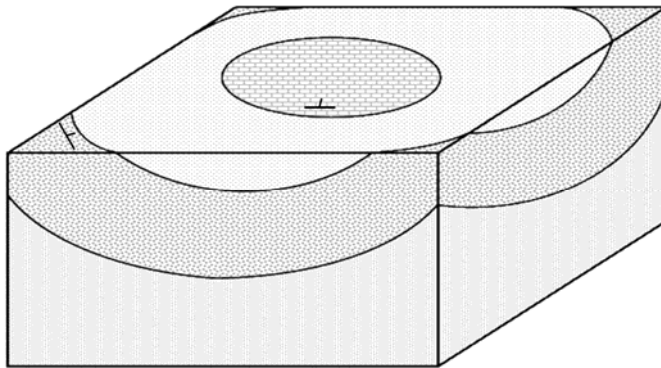
1. Assuming the strata have not been turned upside down, label the strata in age sequence, starting with 1 for the oldest stratum. Label the strata on all faces of the block diagram.
2. Add one more strike and dip symbol to the map, correctly oriented, in a blank stratum. In this case, do not write in the dip angles.
3. What is the name of this type of geologic structure?
4. Complete the appropriate fold symbol on the axis line of the fold.
5. Color at least every other stratum so the structure is clearly defined.

Block diagram 8



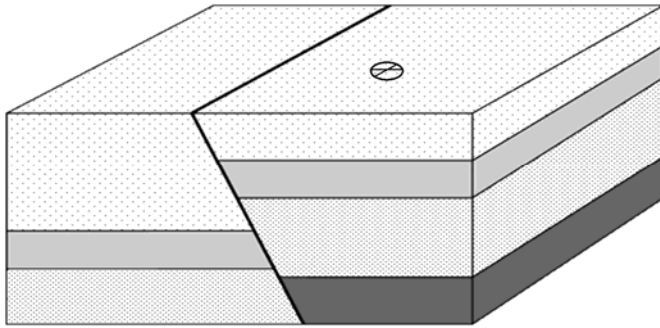
1. Assuming the strata have not been turned upside down, label the strata in age sequence, starting with 1 for the oldest stratum. Label the strata on all faces of the block diagram.
2. Add one more strike and dip symbol to the map, correctly oriented, in a blank stratum. In this case, do not write in the dip angles.
3. What is the name of this type of geologic structure?

Block diagram 9



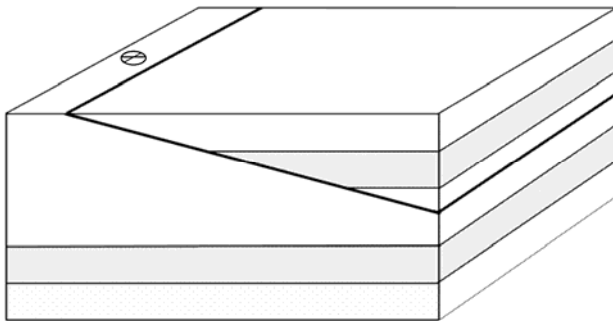
1. Assuming the strata have not been turned upside down, label the strata in age sequence, starting with 1 for the oldest stratum
2. Add one more strike and dip symbol to the map, correctly oriented, in a blank stratum. In this case, do not write in the dip angles.
3. What is the name of this type of geologic structure?

Faults (block diagrams 10 – 11) Block diagram 10



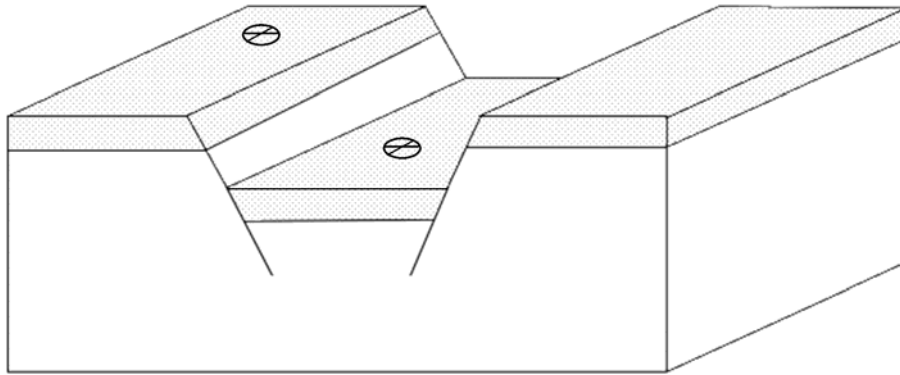
1. Assuming the strata have not been turned upside down, label the strata in age sequence, starting with 1 for the oldest stratum. Label the strata on all faces of the block diagram and both sides of the fault.
2. Estimate or measure the dip of the fault to within 5°. What is the dip of the fault?
3. What is the name of this type of fault?
4. Draw the appropriate fault symbol along the line that marks the fault on the map.
5. Draw half-arrows on the fault in cross-section that indicate the relative direction of motion of the rocks along the fault.

Block diagram 11



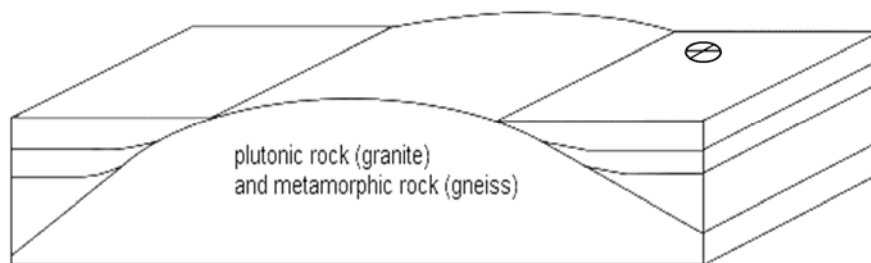
1. Assuming the strata have not been turned upside down, label the strata in age sequence, starting with 1 for the oldest stratum. Label the strata on all faces of the block diagram and both sides of the fault.
2. Estimate or measure the dip of the fault to within 5°. What is the dip of the fault?
3. What is the name of this type of fault?
4. Draw the appropriate fault symbol along the line that marks the fault on the map.
5. Draw half-arrows on the fault in cross-section that indicate the relative direction of motion of the rocks along the fault.

Fault-bounded structures (block diagrams 12 – 13) Block diagram 12



1. Assuming the strata have not been turned upside down, label the strata in age sequence, starting with 1 for the oldest stratum. Label the strata on all faces of the block diagram.
2. There are two faults in block diagram 12. What type of faults are they?
3. Draw half-arrows on the fault in cross-section that indicate the relative direction of motion of the rocks along the fault.
4. What is the name of the fault-bounded structure in block diagram 12?

Block diagram 13

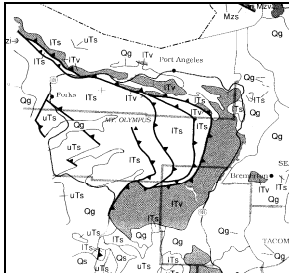


1. What type of faults are the two faults in block diagram 13?
2. On the front cross-section, draw half arrows showing the relative direction of motion on each side of each fault.
3. On the map, draw the appropriate symbol for each fault.
4. What is the name of the fault-bounded geologic structure in block diagram 13?

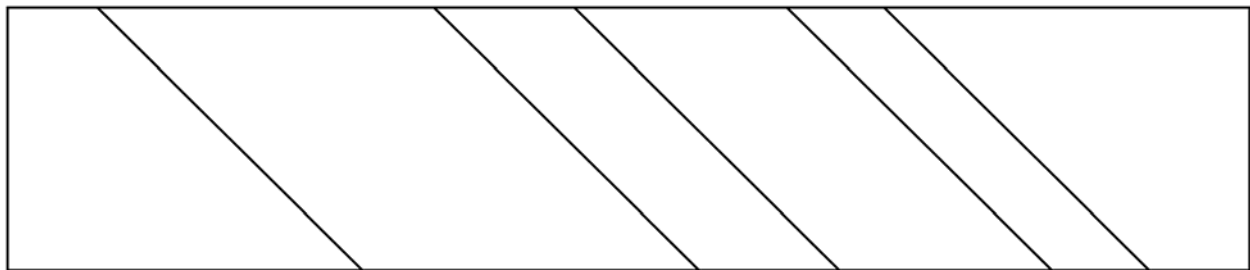
PART 3: CROSS-SECTIONS (SEEING BENEATH THE MAP)

To take a real-world look at geologic structures and how they appear on geologic maps, we will use the geologic map of Washington State published by the Washington State Department of Natural Resources. You can download it at http://www.dnr.wa.gov/Publications/ger_geol_map_washington_pagesize.pdf

The Olympic Peninsula



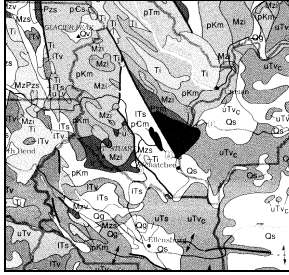
The simplified cross-section below corresponds to a cross-section line drawn across the Olympic Peninsula, part of the geologic map of Washington. <http://commons.wvc.edu/rdawes/G101OCL/Labs/StructureLab.html#StructL8> To complete the cross-section below, refer to the lab web page, where you can see the blue cross-section line and read the geologic unit labels. The top of the cross-section box below corresponds to the cross-section line on the map. The five faults spanned by the cross-section line on the map are those shown in the cross-section box below.



To complete the cross-section above:

1. Draw half-arrows along each fault to show the relative motion of rocks on either side of the fault.
2. The faults are all the same type. What type of fault are they?
3. When the structures in the cross-section were forming, was the crust being pushed together or was it being pulled apart?
4. Within all of the blocks between faults on the cross section, write the three-letter abbreviations of the geologic units that correspond to the rock types along the cross-section line on the map.
5. Write out what each of the geologic abbreviations stands for. Use the map legend. Write out both age and rock type. For example, if one of the units is uTv, the abbreviation stands for upper Tertiary volcanic rock.

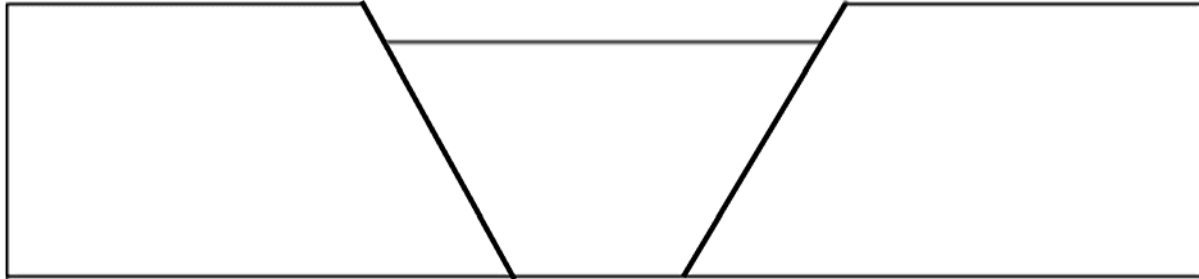
The Chiwaukum Graben



The simplified cross-section below corresponds to a cross-section line drawn across the Chiwaukum graben, part of the geologic map of Washington.

<http://commons.wvc.edu/rdawes/G101OCL/Labs/StructureLab.html#StructL8>

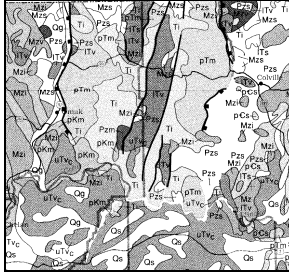
To complete the cross-section below, refer to the lab web page, where you can see the blue cross-section line and read the geologic unit labels. The top of the cross-section box below corresponds to the cross-section line on the map. The two faults spanned by the cross-section line on the map are those shown in the cross-section box below.



To complete the cross-section above:

1. Draw half-arrows along each fault to show the relative motion of rocks on either side of the fault.
2. The two faults are the same type. What type of fault are they?
3. When the structures in the cross-section were forming, was the crust being pushed together or was it being pulled apart?
4. Within each block between faults on the cross section, write the three-letter abbreviations of the geologic units that correspond to the rock types along the cross-section line on the map. Remember the note on the Lab web page about identifying the correct rock unit labels on the map.
5. Write out what each of the geologic abbreviations stands for. Use the map legend. Write out both age and rock type.
6. What type of geologic structure is bounded by the two faults?

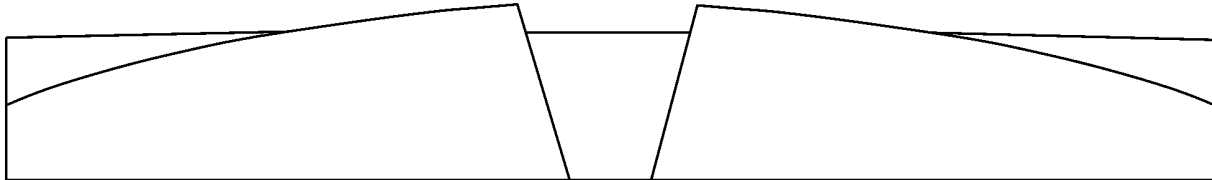
Okanogan Metamorphic Core Complex, Republic Graben, and Kettle Metamorphic Core Complex



The simplified cross-section below corresponds to a line drawn on the geologic map of Washington across the Okanogan metamorphic core complex, the Republic graben, and the Kettle metamorphic core complex.

<http://commons.wvc.edu/rdawes/G101OCL/Labs/StructureLab.html#StructL8>

To complete the cross-section below, refer to the lab web page, where you can see the blue cross-section line and read the geologic unit labels. The top of the cross-section box below corresponds to the cross-section line on the map. The two faults spanned by the cross-section line on the map are those shown in the cross-section box below.



To complete the cross-section above:

1. There are four faults in the cross-section. Draw half-arrows along each fault to show the relative motion of rocks on either side of the fault
2. Two of the faults in the cross-section dip at low angles. What type of fault are they?
3. Within each block on the cross section, write the two- or three-letter abbreviations of the geologic units that correspond to the rock types along the cross-section line on the map. Remember the note on the Lab web page about identifying the correct rock unit labels on the map.
4. Write out what each of the geologic abbreviations stands for. Use the map legend. Write out both age and rock type.
5. What type of fault-bounded structure is in the footwall of each of the detachment faults?
6. Are the rock types in that structure from the shallow crust or the deep crust?
7. What is the name of the type of geologic structure that has dropped down between the two steep faults in the center of the cross-section?
8. When the structures in the cross-section were forming, was the crust being pushed together or was it being pulled apart?