GEOLOGIC MAPS PART II

Introduction

Geologic maps of orogenic belts are much more complex than maps of the stable interior. Just compare the difference in topography in various parts of the United States. **Orogenic belts** are mountainous, unstable parts of the earth’s crust typically found on continental margins.

The stresses within the earth that produce folds also produce faults. **Plastic deformation** of rock bodies leads to the formation of anticlines and synclines, while **brittle deformation** causes rocks to break along a plane. This plane is known as the **fault surface**. We have names for a number of different faults depending on the direction of movement. The intersection of a fault surface with the ground defines an imaginary line termed the **fault trace**. The fault traces of different faults are indicated on a geologic map with the symbols below.

The movement of the fault is usually best seen in a cross-sectional view. The upper block is called the hanging wall and the lower block is the footwall. Both terms are derived from miners who drove tunnels along fault planes to mine ores that had been emplaced there. They could hang their lanterns from the hanging wall and walk upon the footwall.
Faults are classified by the relative movement of the blocks. The footwall moves up with respect to the hanging wall in a normal fault. Normal faults result from extension or pulling apart of the earth's crust.

Faults can be any size. Fault traces may range from a few meters to hundreds of kilometers. In a reverse fault, the footwall moves down with respect to the hanging wall. Reverse faults are compressional features usually associated with mountain building collisions.

Faults can occur singularly or in groups, both situations are common. A low angle reverse fault is known as a thrust fault. The fault plane of a thrust fault has a more shallow dip than that of a reverse fault (less than 30°). Because these fault surfaces are gently inclined, hanging wall blocks can override footwall blocks for considerable distances. This type of fault movement may cause older rocks to overlie younger rocks.
Types of Faults continued

A fault which incurs no vertical displacement is called a **strike-slip fault**. The movement of the beds is parallel with the strike of the fault plane. Displacement is best seen in map view rather than cross sectional view. There are two basic types of strike slip faults: **left lateral** and **right lateral**.

To determine how to name the fault, imagine you are standing on top of the fault trace, with one foot on either side of the fault. Which ever fault block causes your foot to be dragged **backward** as the fault moves, is how you name the fault. Notice the disruption of the formation pattern in map view.

The surface expression of a fault is an abrupt break in an outcrop pattern. Across a fault trace, the oldest beds will be exposed on the upthrown block. When dipping beds are cut by faults, there is an apparent lateral shift in the outcrop pattern. The beds migrate in the direction of dip on the upthrown block as erosion progresses.

Faults are found in many different geological settings. Naturally they are common in earthquake zones. The distribution of earthquakes on earth is explained by the theory of plate tectonics. **Plate tectonics** refers to the rigid plates that make up the skin of the earth and their relative motion with respect to one another. When two plates move away from each other, they form a **divergent margin** and the earth's crust is **extended**. Two plates moving toward each other form a **convergent margin** and **compression** occurs. Where plates slide past each other, a **transform margin** is formed. Earthquakes can only occur where the plate is still rigid, so they do not occur below 700 km. The pattern of earthquake foci is used to define the location of plate margins. Plate tectonic theory is complex and will not be discussed in detail in the lab. Rather, this topic is thoroughly covered in the accompanying lecture class.
Practice Exercise

Complete the front cross-sectional view of each block diagram by drawing the fault plane, labeling the hanging wall (HW), footwall (FW), and show the relative motion along the fault.
Laboratory Exercise

Read the directions thoroughly. Answer all questions and turn in this page along with your cross-sections and stratigraphic columns.

Geologic Map #4  The area shown on this map is located in Washington County, Virginia. Cambrian & Ordovician rocks of sedimentary origin are exposed in map area, including limestones, dolomites, sandstones, siltstones, and shales.

1. Complete cross-section A-A'.

2. Describe the Alvarado Fault.
   a. What type of fault is it?
   b. Which direction does the fault surface dip?
   c. What is the direction of the fault trace on the surface?

3. Describe the Great Knobs syncline.
   a. Is this a plunging syncline?
   b. If so, which direction does the syncline plunge?

4. Draw a stratigraphic column for the cross-section you have drawn. Use p. 18 (stratigraphic columns) as a guide.

Geologic Map #2  The Sheep Creek Quadrangle is near Helena, Montana. The Precambrian rocks are shales which form high mountains and steep sided gulches. The northeast part of the map is characterized by NW/SE trending ridges underlain by folded and faulted Cretaceous sedimentary and igneous rocks. The major unconformity marking the Precambrian/Cambrian boundary is proof of an early period of deformation. The thrust faults and overturned folds shown in the map area are due to the Laramide orogeny of the late Cretaceous age.

1. Draw cross-section D-D'. (Remember, the "pink" rocks are intrusive, they don't follow the older dips towards younger rule).

2. In which direction did the hanging wall block move?

3. In which direction does the fault surface dip?

4. Why are the Quaternary deposits more extensive in the northeast than in the rest of the map area?