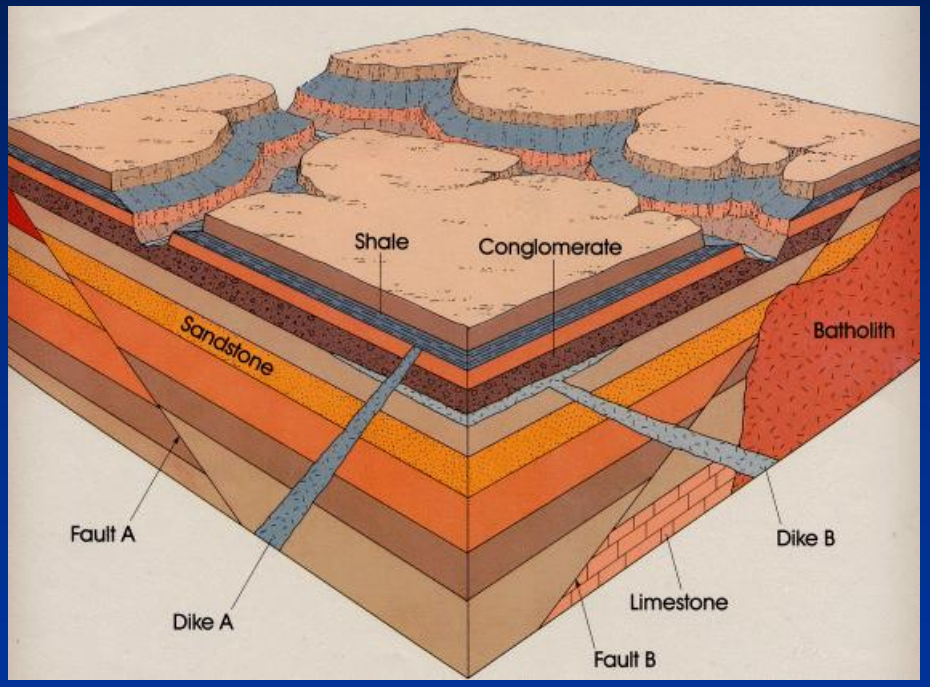
Structural Geology and Geology Maps Lab

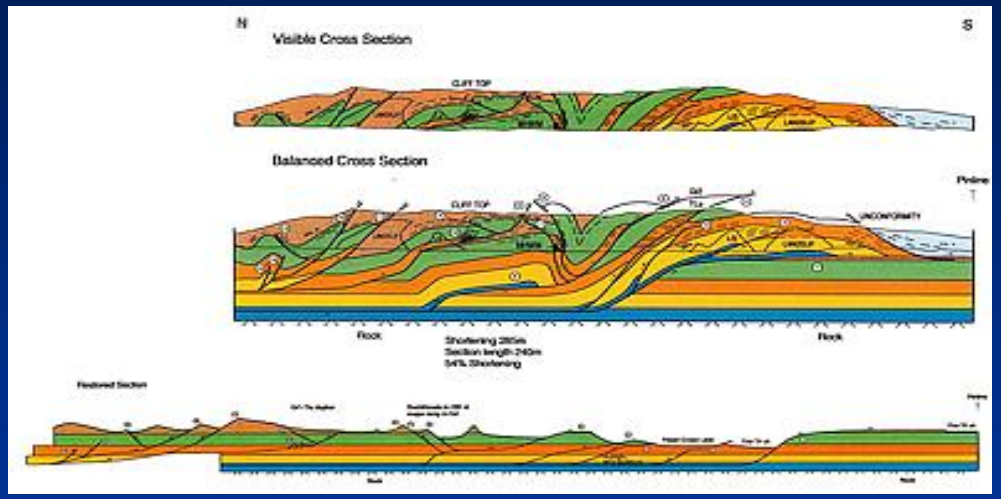


Mesa College

Geology 101 Lab

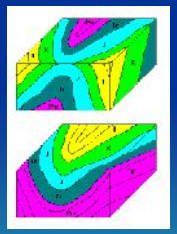
Ray Rector: Instructor

Structural Geology Lab
Pre-Lab Resources

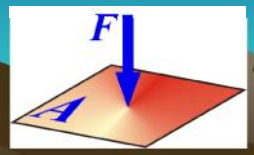


Pre-Lab Internet Links

1) Fundamentals of Structural Geology



2) Visualizing Bed Attitude



Structure Lab Learning Objectives

The student should understand and know:

1) The terminology and basic concepts of structural geology

2) The general techniques and methods used in structural geology

3) The spatial form and deformational development of folds and faults.

4) How to interpret and create geologic block diagrams.

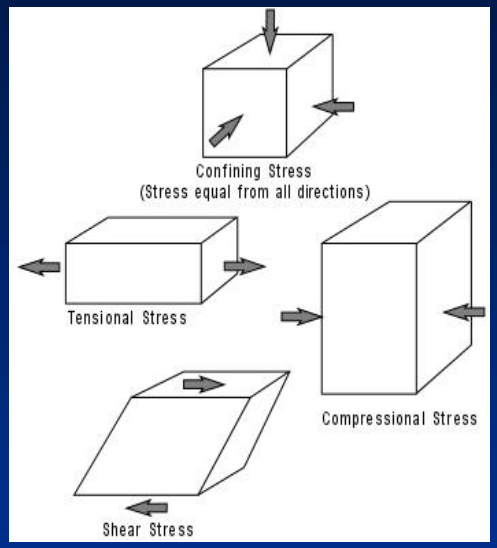
5) How to use the geological compass.

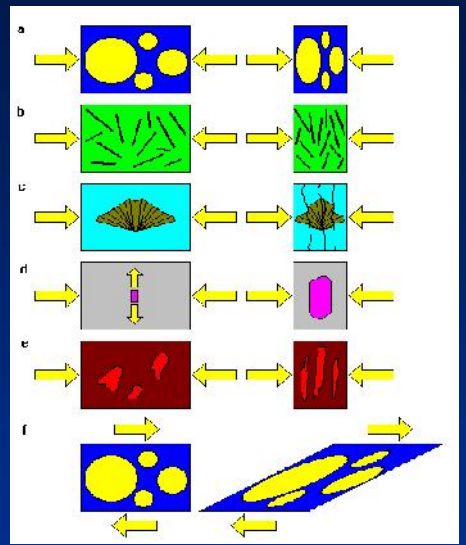
6) How to read a geologic map.

Origin and Nature of Rock Deformation

A. Stress Leads to Strain

- ✓ Stress is an applied force over an area
- ✓ Strain is the deformation of a solid body



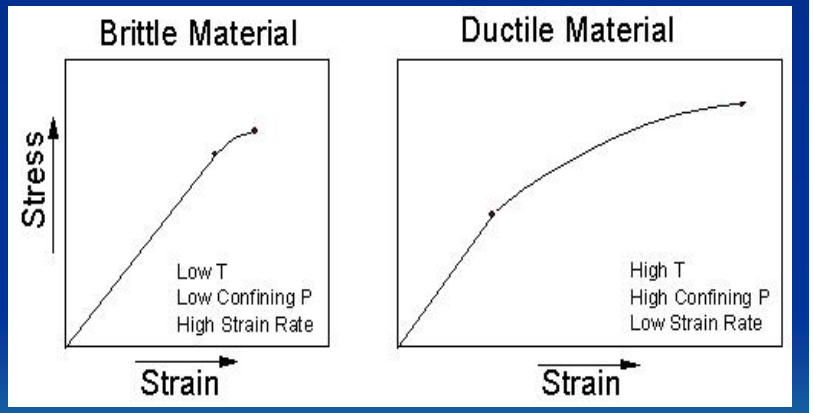


B. Different Types of Stress

- ✓ Tensional = pulling apart forces
- ✓ Compressional = pushing together forces
- ✓ Shear = grinding past each other force

C. Different Types of Strain

- ✓ Brittle = breaking into pieces
- ✓ Ductile = changing shape without breaking
- ✓ Elastic = deformed body returns to normal shape after stress released
- ✓ Plastic = deformed body remains deformed after stress released



Rocks strain in a predictable fashion, according to the amount and duration of strain under a given set of temperature-pressure conditions

Resultant Rock Strain from Specific Stresses

A. Undeformed Strata

- ✓ Original Horizontal layering

B. Compressional Stresses

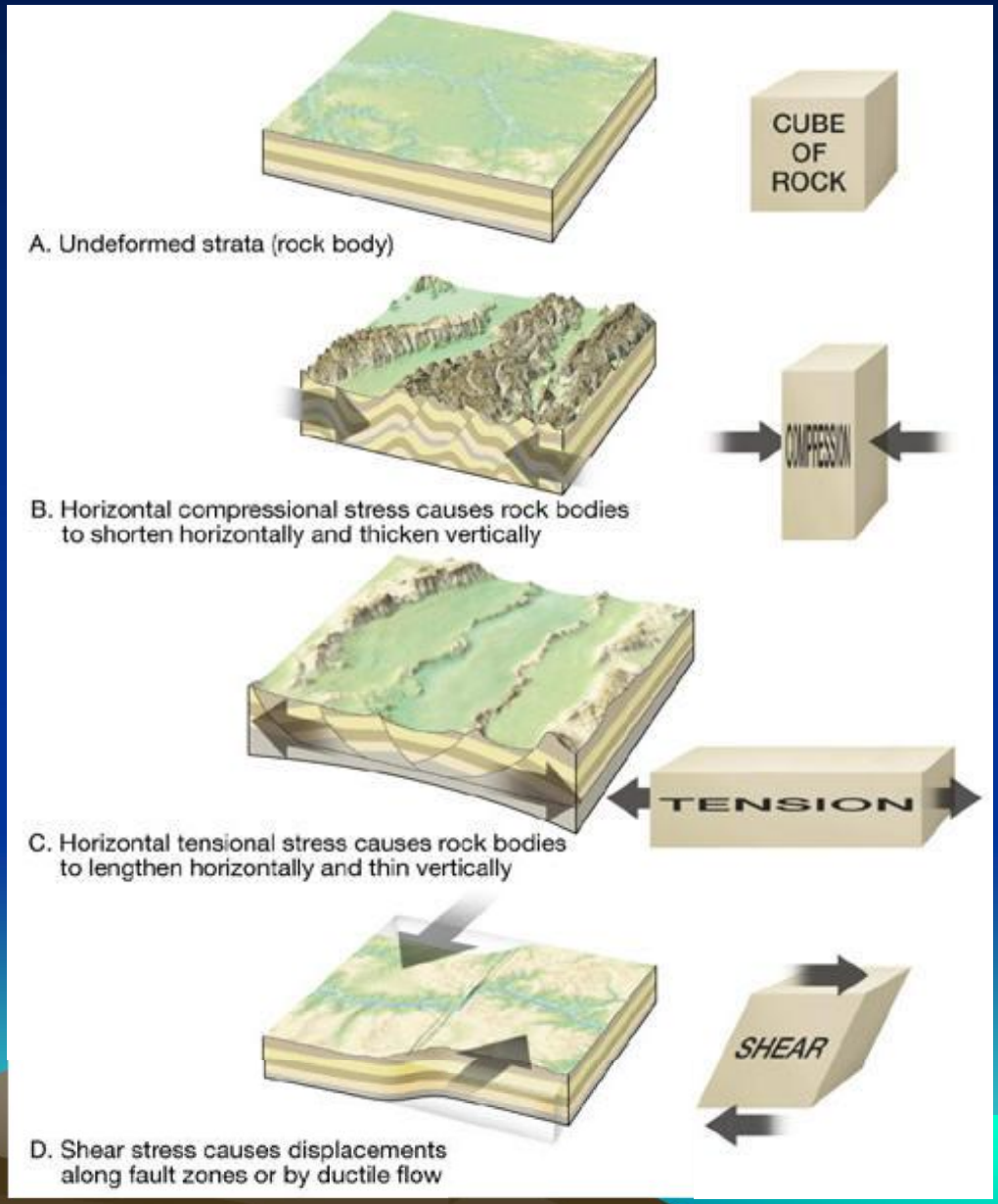
- ✓ Shorten horizontally
- ✓ Thicken vertically
- ✓ Folding and Reverse Faulting

C. Tensional Stresses

- ✓ Lengthen horizontally
- ✓ Thin vertically
- ✓ Tilting and Normal Faulting

D. Shear Stresses

- ✓ Lateral displacement
- ✓ Strike-slip Faulting



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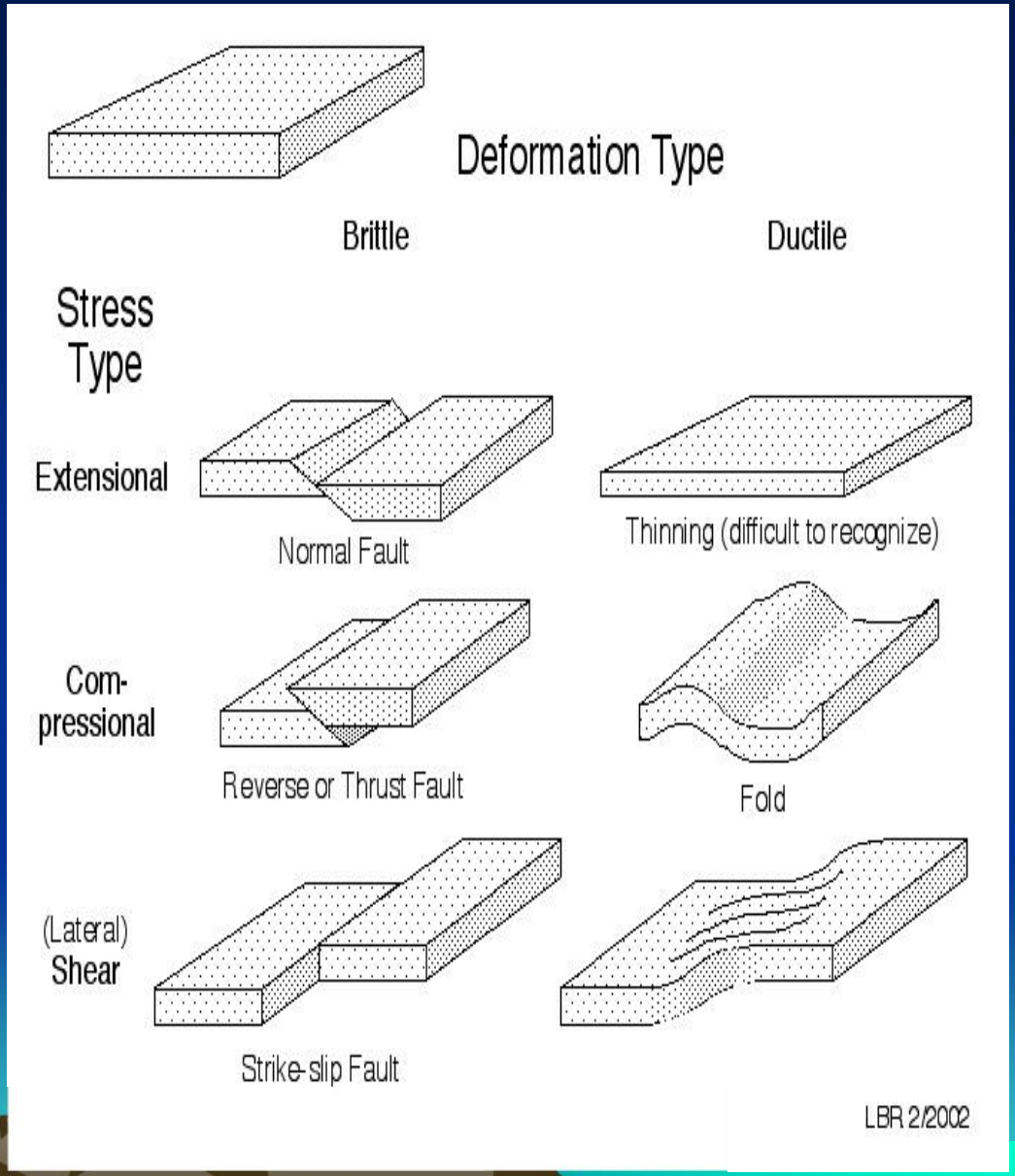
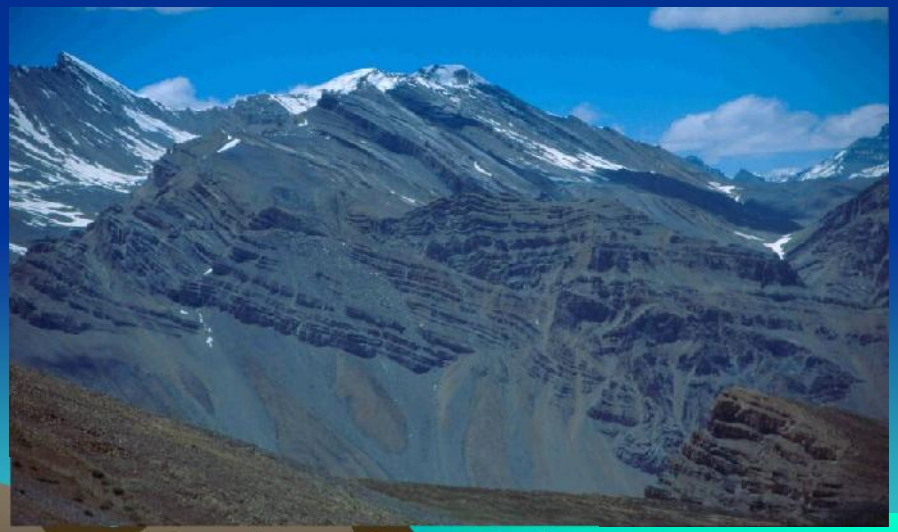


Geologic Structures

Rock Layering

Tilted Rock Layers

Folded Rock Layers



Faulted Rock Layers

The Basic Rules of Structure

1) Strike of beds is always parallel to the direction of the contacts.

2) Rock layers dip towards the youngest exposed rock layers.

3) Oldest rocks exposed in the center of eroded anticlines and domes.

4) Youngest rocks exposed in the center of eroded synclines and basins.

5) Horizontal folds form parallel sets of belt-like outcrop patterns.

6) Plunging anticlines form “V” of "U" shaped, belt-like outcrop patterns.

- ✓ Anticline fold plunges toward *closed* end of “V” or “U” pattern.

7) Plunging synclines form ”V” of “U" shaped, belt-like outcrop patterns.

- ✓ Syncline fold plunges toward *open* end of “U” pattern.

8) Steeper the dip of the layer, the more narrow the width of its outcrop.

9) Hanging wall *moves up* relative to foot wall in reverse and thrust faults.

10) Hanging wall *moves down* relative to foot wall in normal faults.

Spatial Orientation of Layers

Strike and Dip

1) The spatial orientation, or ***attitude*** of a planar rock layer or structural feature can be measured and recorded in the field.

2) Two spatial aspects are needed:

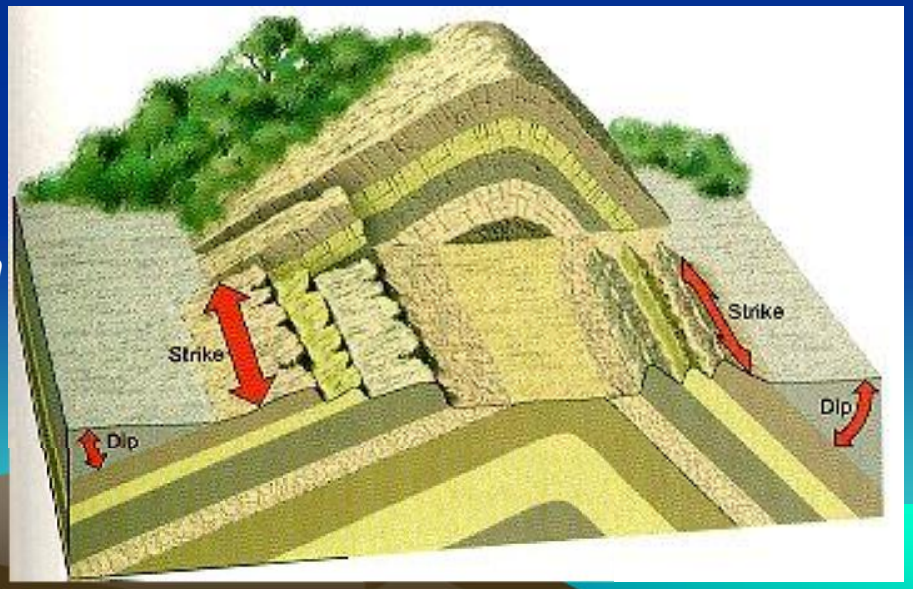
- ✓ **Strike** = horizontal component
- ✓ **Dip** = angle below the horizontal

3) The **Strike** is the line, or *trend* that represents the intersection of the planar feature with the horizontal.

4) **Strike** is measured with a compass.

5) **Dip** is the downward angle, or *inclination* of the feature from horizontal at a right angle to the strike.

6) **Dip** is measured with a clinometer.

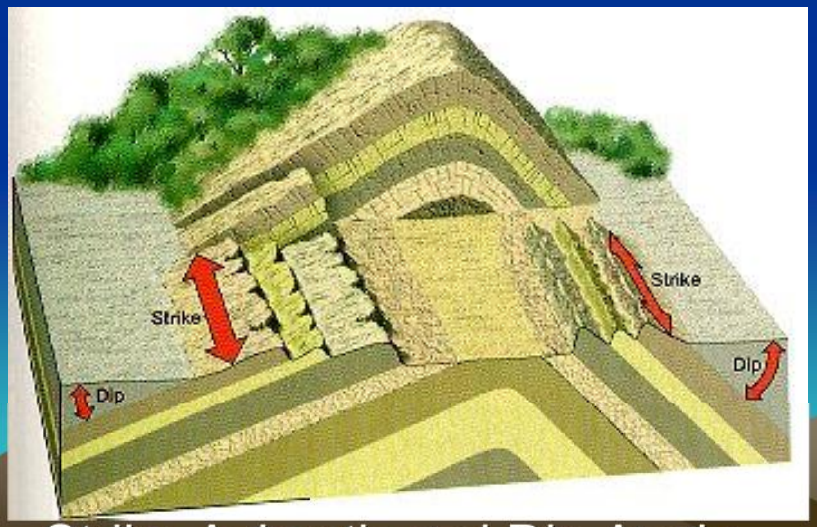


Spatial Orientation of Layers

Strike and Dip

Measuring Strike Azimuth

Measuring Dip Angle



Strike Azimuth and Dip Angle

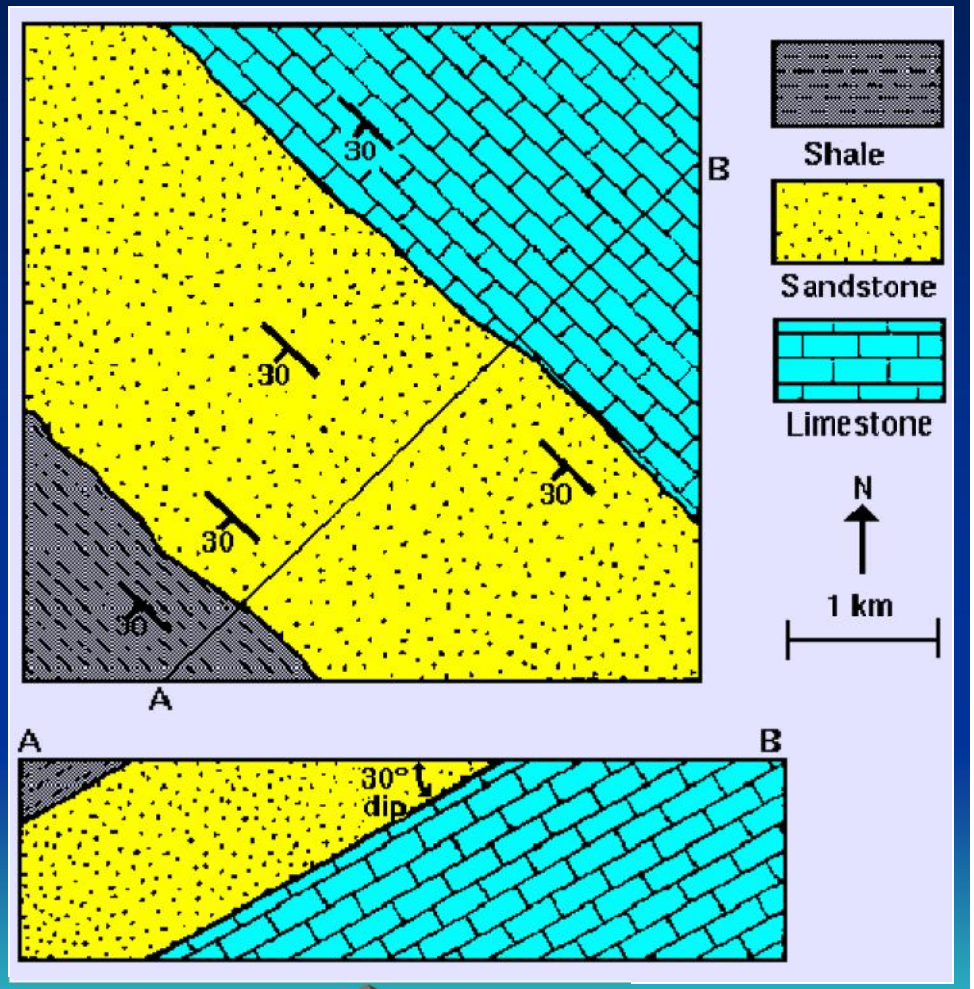
Completed Strike and Dip Measurement

Spatial Orientation of Layers

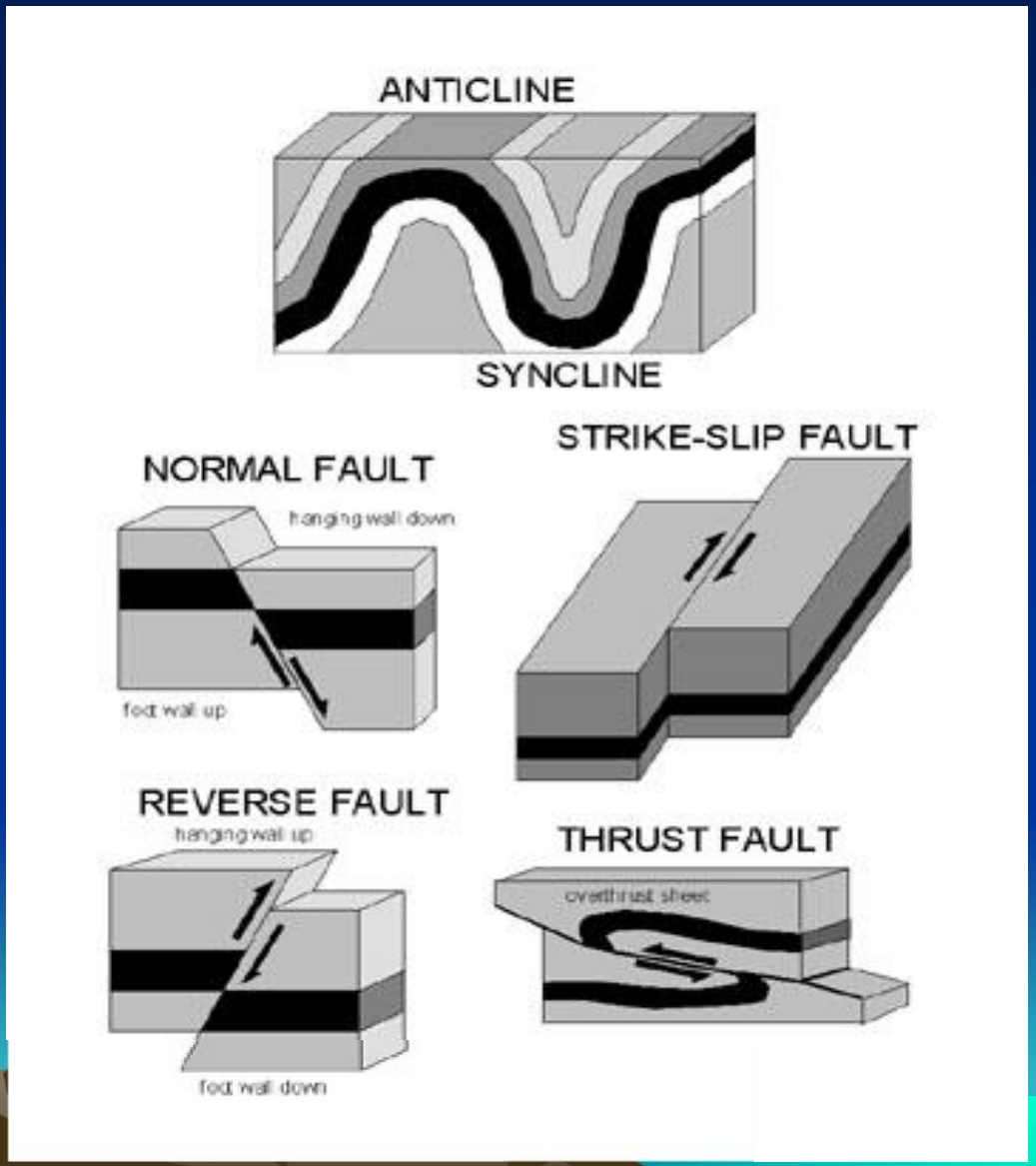
Strike and Dip

The **Strike** and **Dip** of a planar rock layer or feature is symbolized on a geology map by a

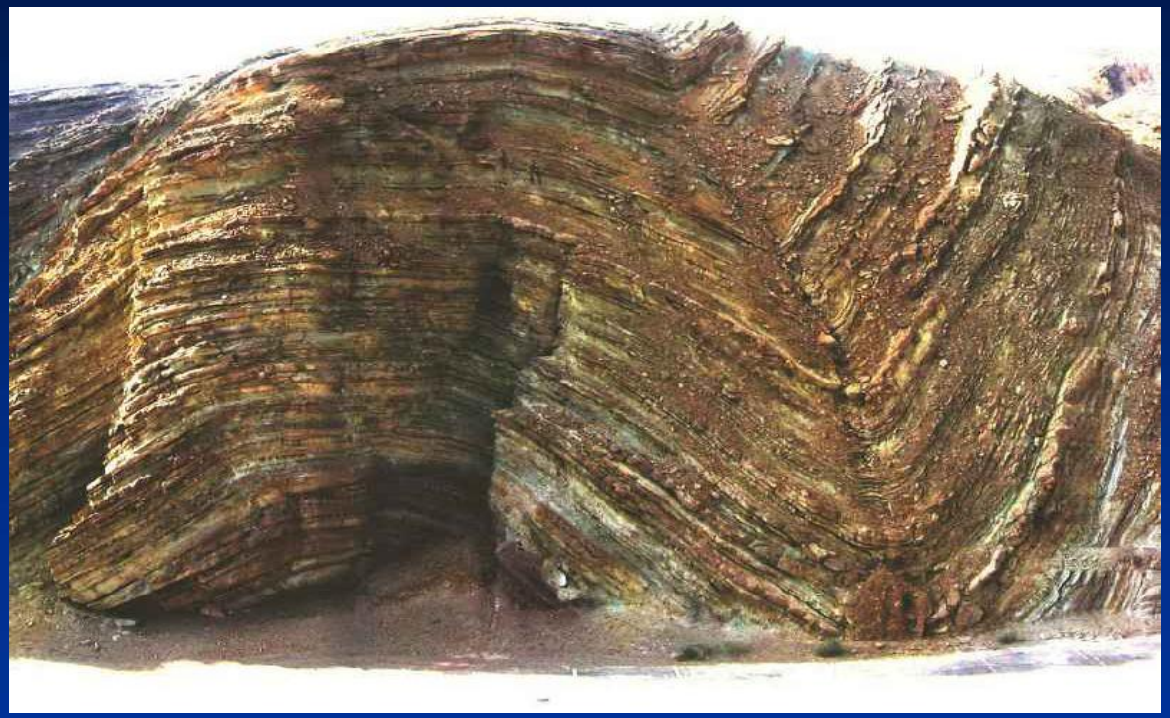
- ✓ The long bar is the strike trend
- ✓ The short bar points to the down dip direction with dip angle

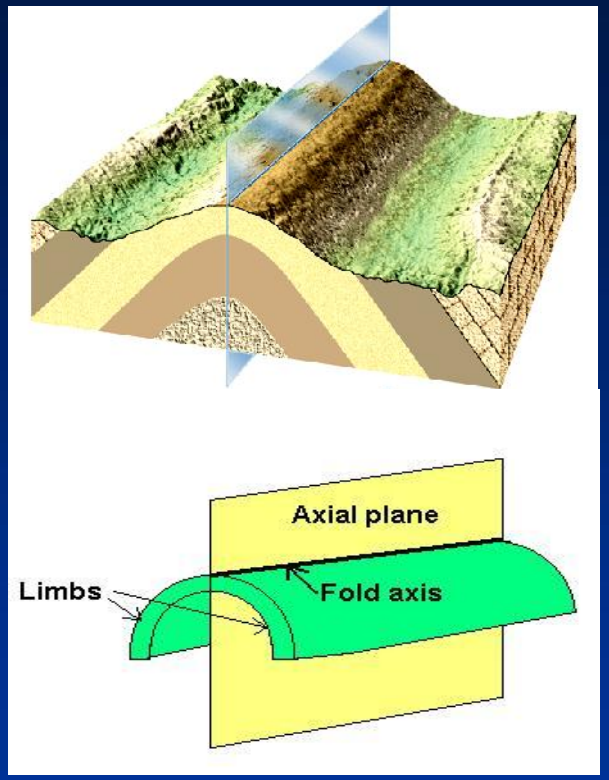


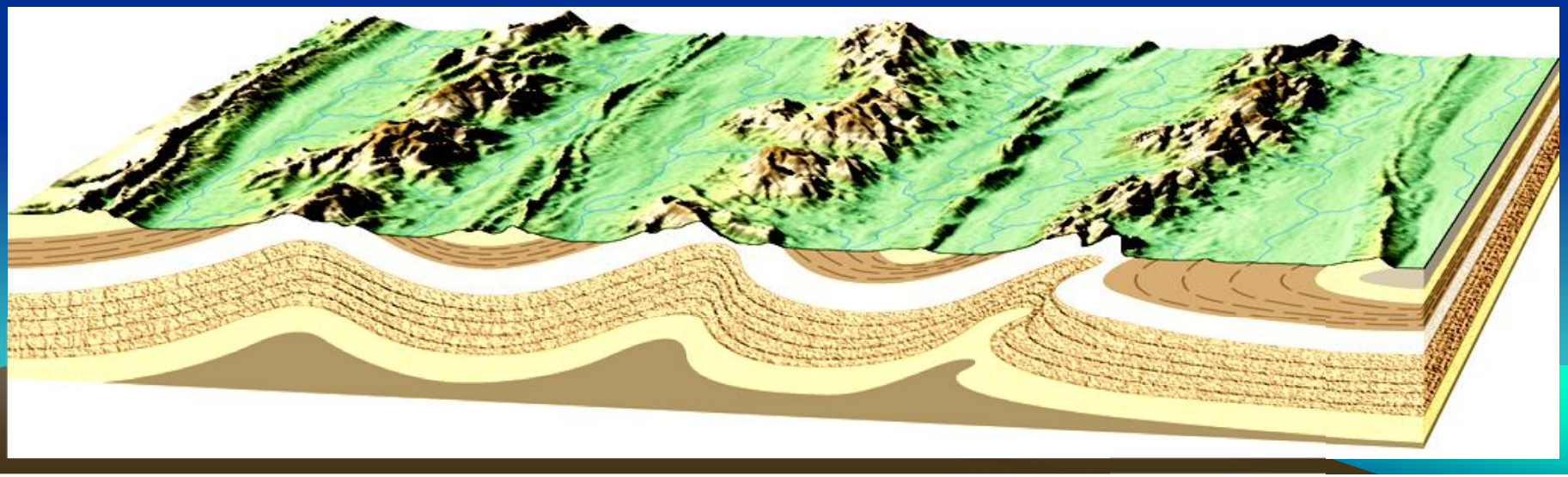
Folds and Faults



Fold Basics







Fold Basics

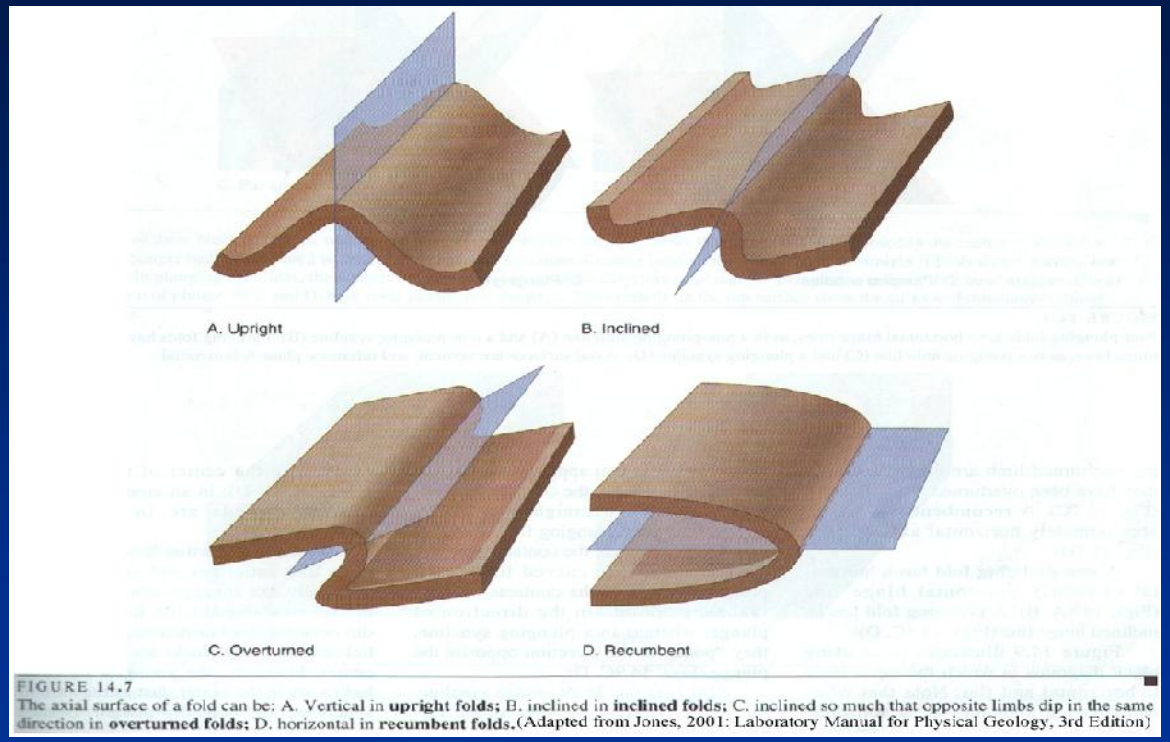
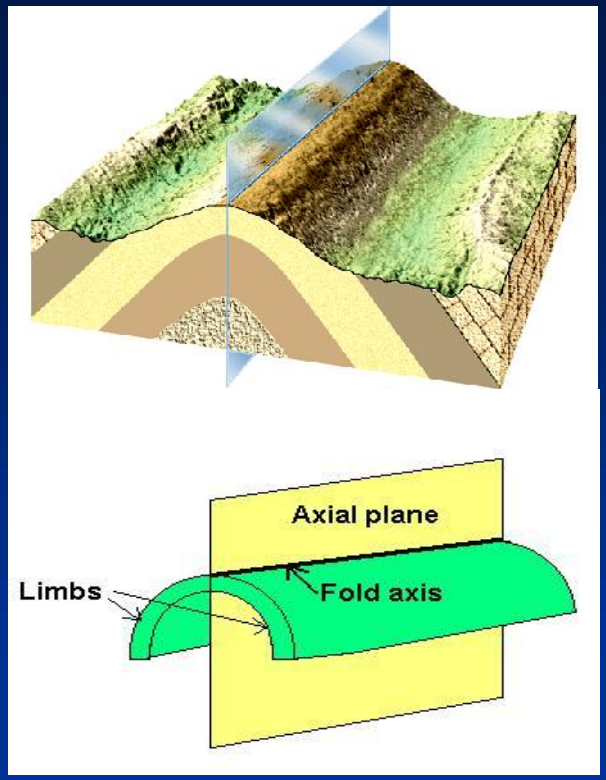
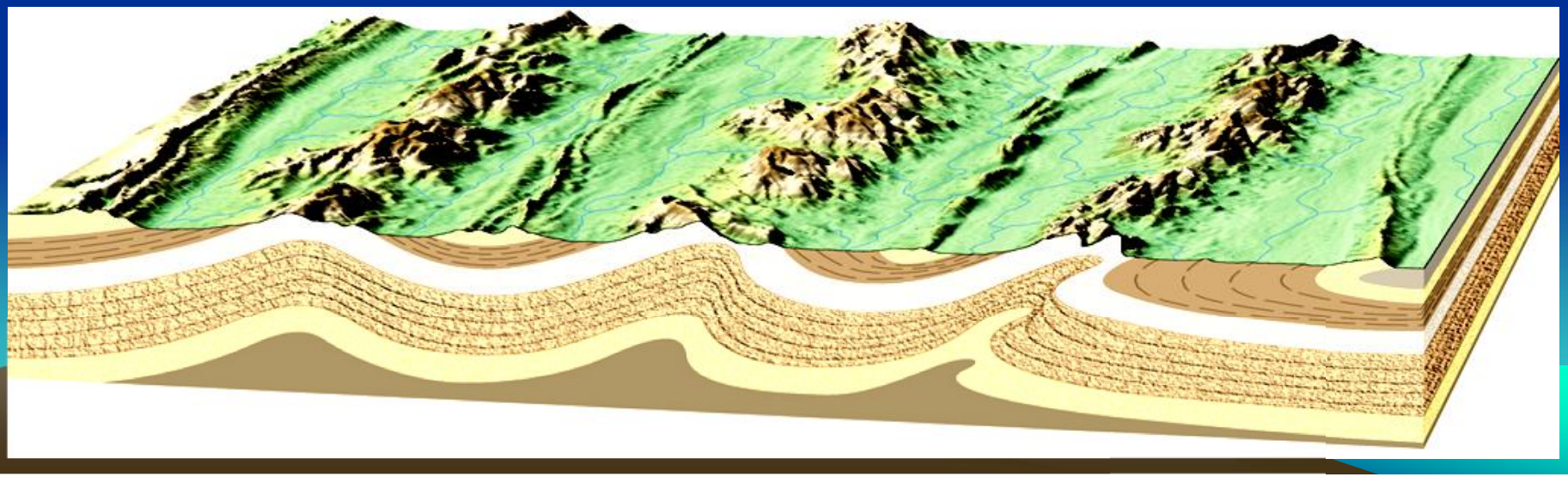
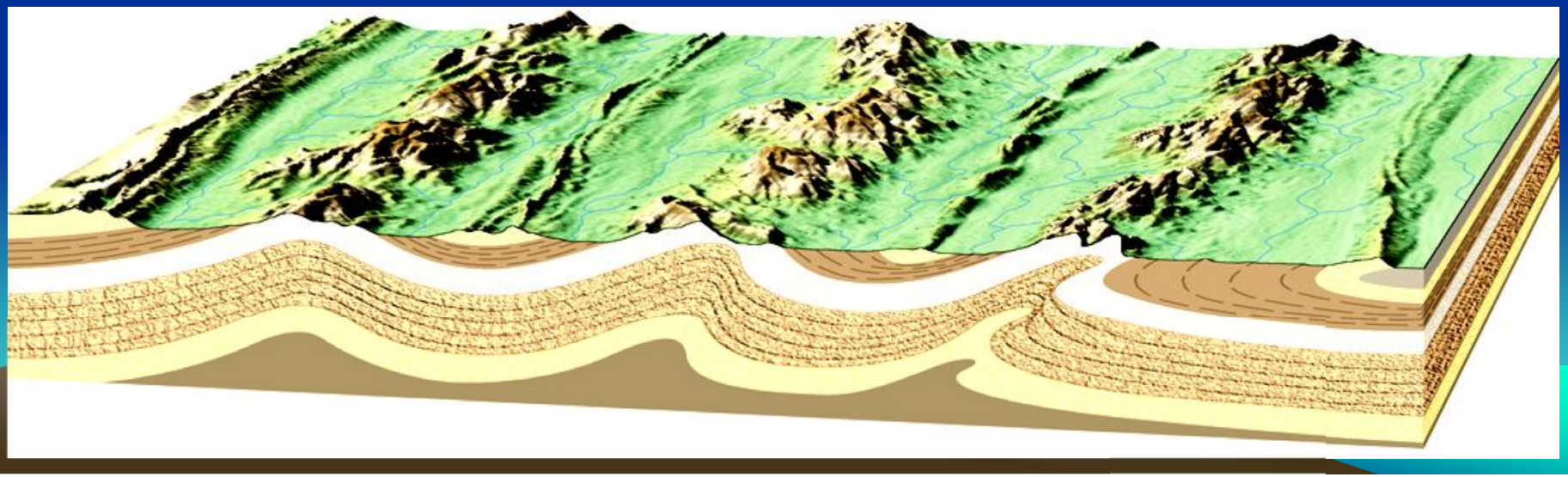


FIGURE 14.7
The axial surface of a fold can be: A. Vertical in **upright folds;** B. inclined in **inclined folds;** C. inclined so much that opposite limbs dip in the same direction in **overturned folds;** D. horizontal in **recumbent folds.** (Adapted from Jones, 2001: Laboratory Manual for Physical Geology, 3rd Edition)





Fold Basics



Rules of Folds

Anticlines

1) Oldest unit in center
2) Limbs dip outward

Synclines

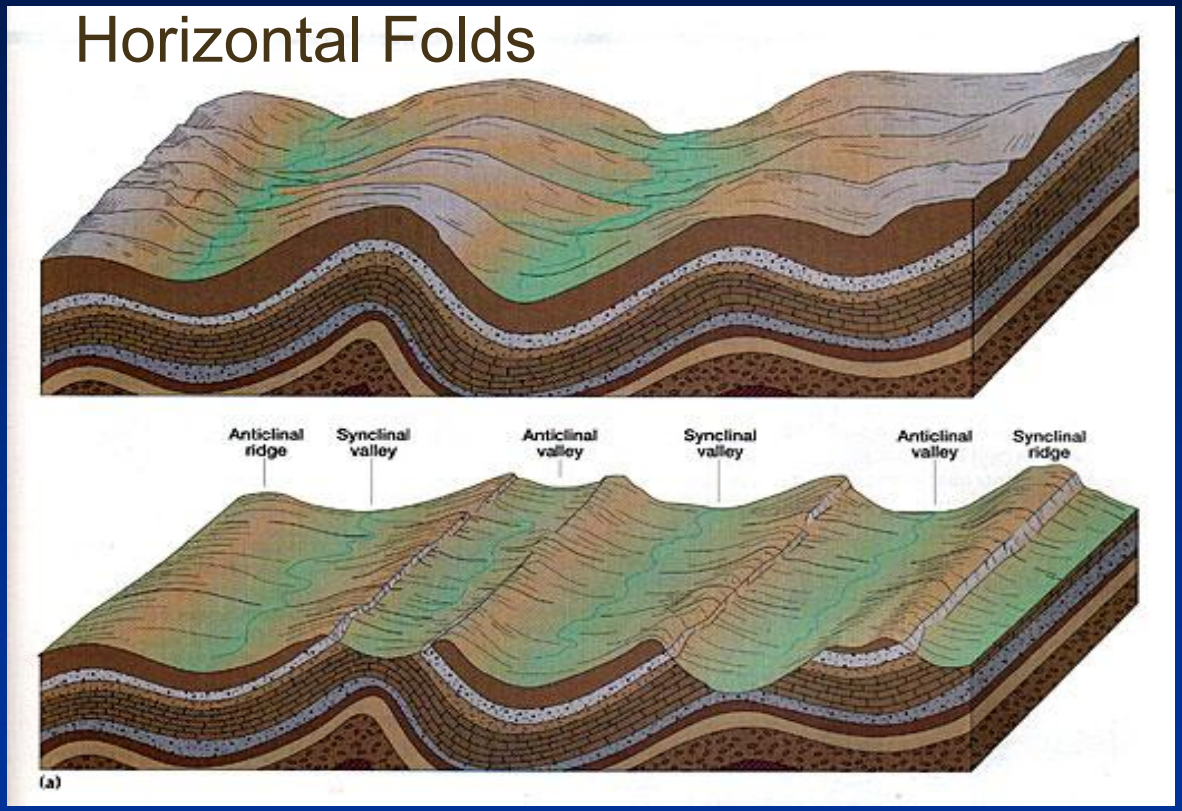
1) Youngest unit in center
2) Limbs dip inward

Horizontal Folds

1) Strikes of opposing fold limbs are all parallel
2) Folds form parallel striped pattern on geology map

Plunging Folds

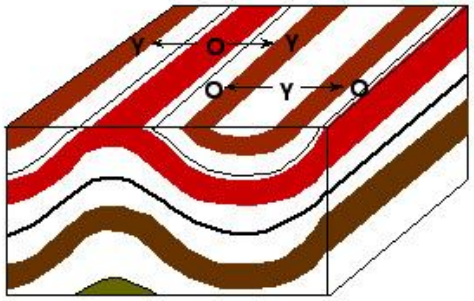
1) Strikes of opposing fold limbs are not parallel
2) Folds form V-shaped pattern on geology map



3) Anticlines plunge toward closed end of "V"-shaped bedding pattern
4) Synclines plunge toward open end of "V"-shaped bedding pattern

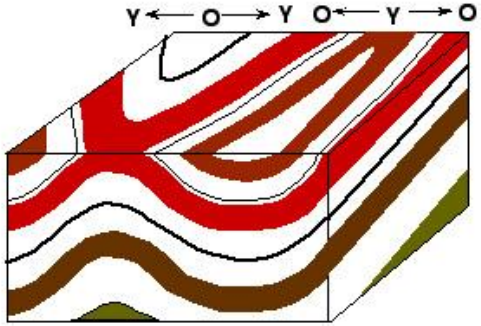
Plunging Folds

Plunging Folds

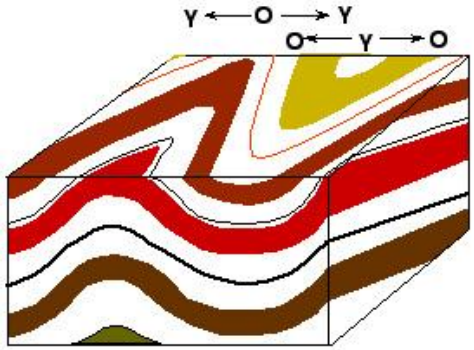


Anticline and Syncline in 3-dimensional view

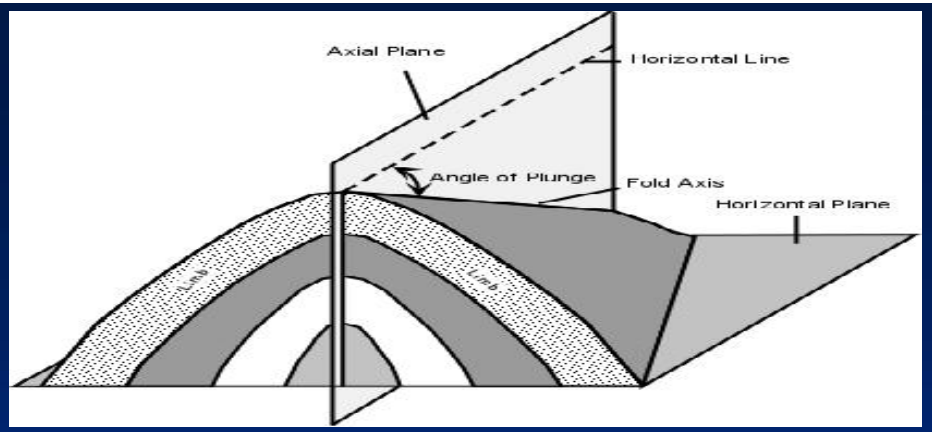
Oldest beds are in centers of anticlines; youngest beds are in centers of synclines.

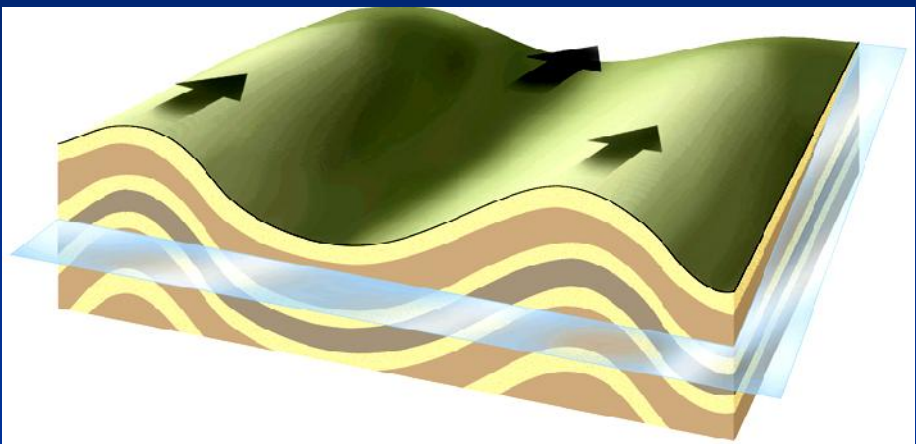


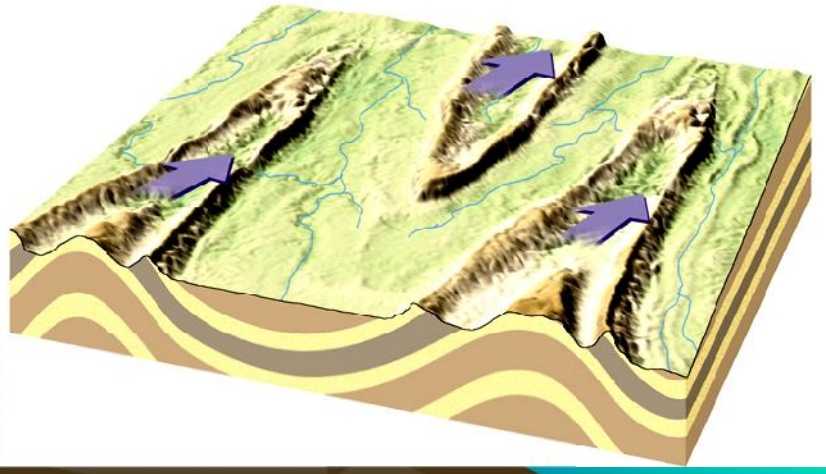
Anticline and Syncline plunging toward viewer



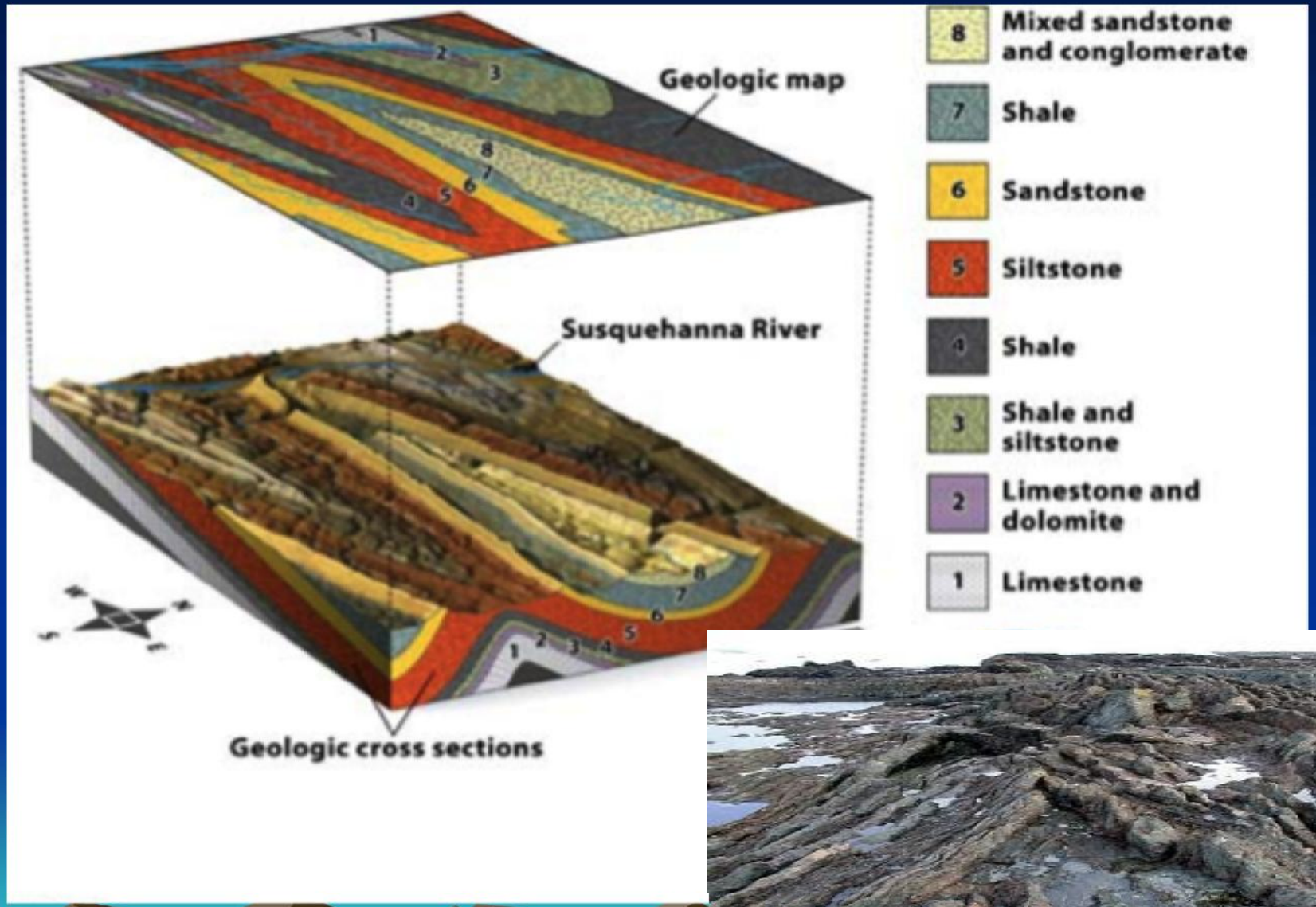
Anticline and Syncline plunging away from viewer



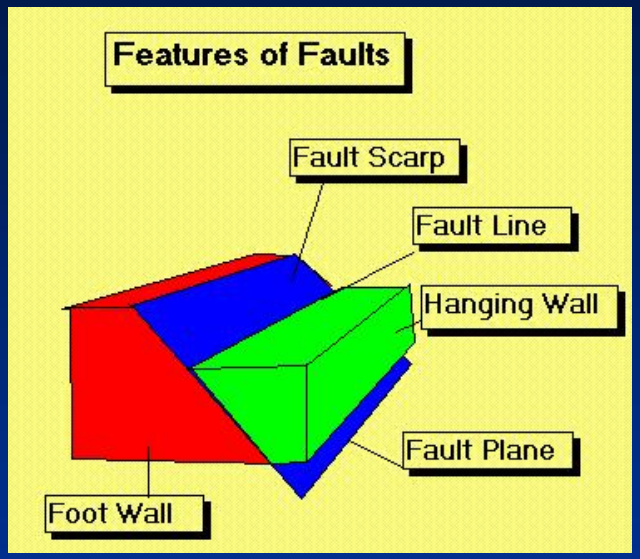


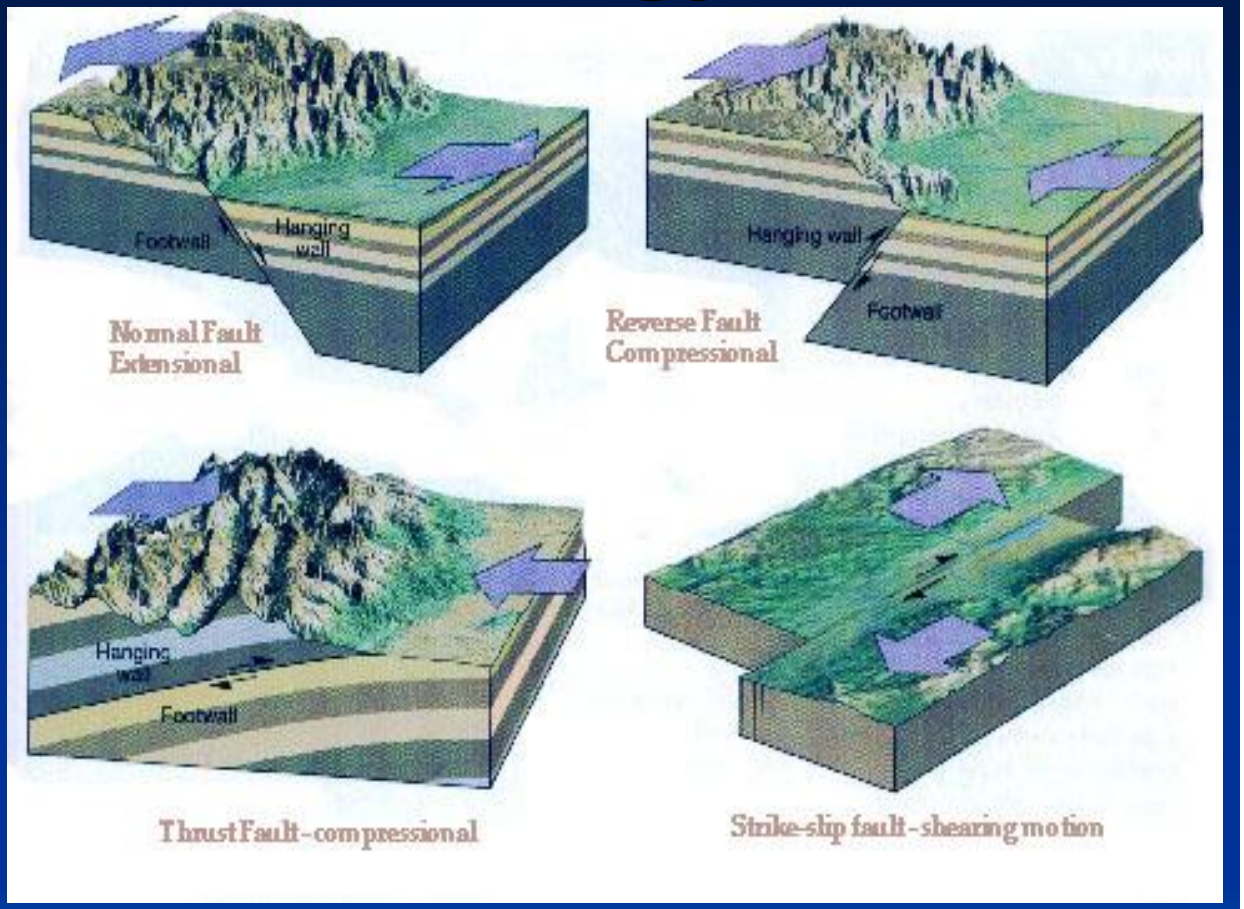


Plunging Folds

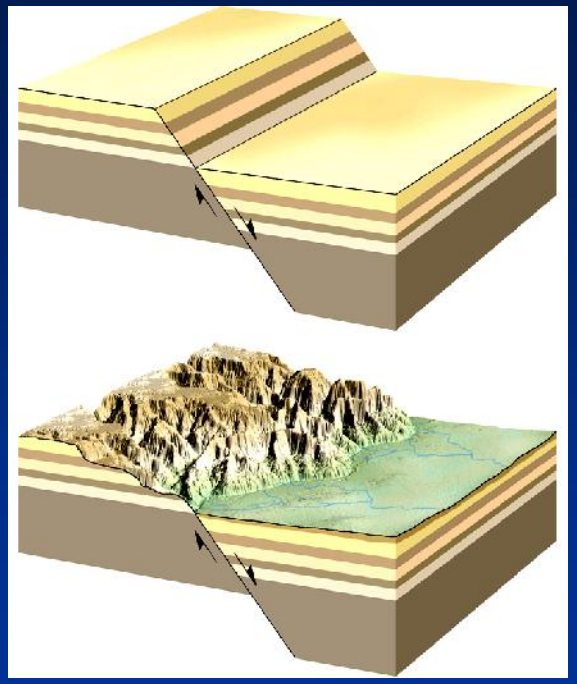


Fault Terminology

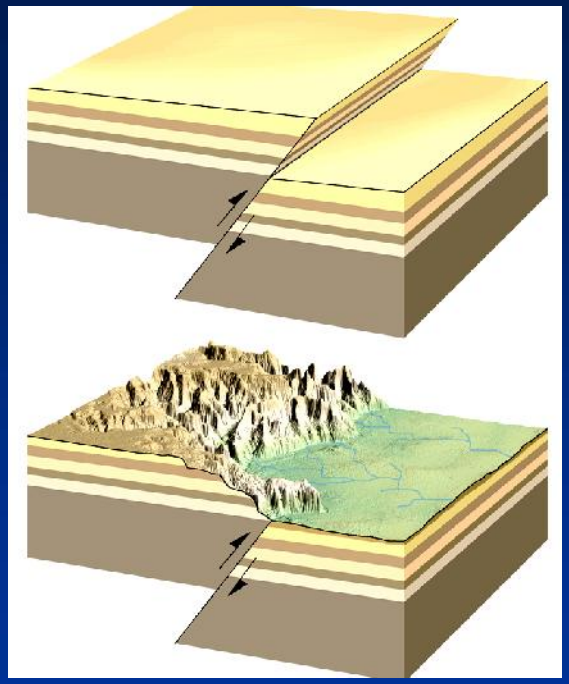




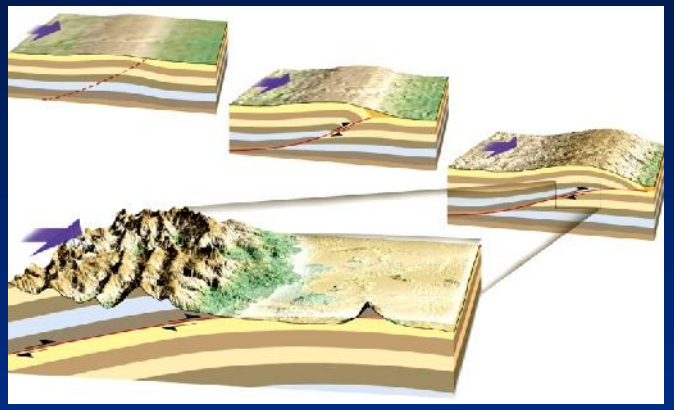
Types of Faults



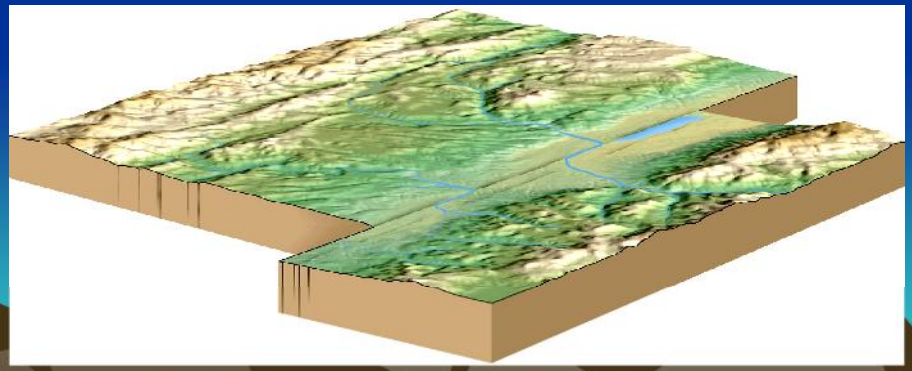
Normal Fault



Reverse Fault

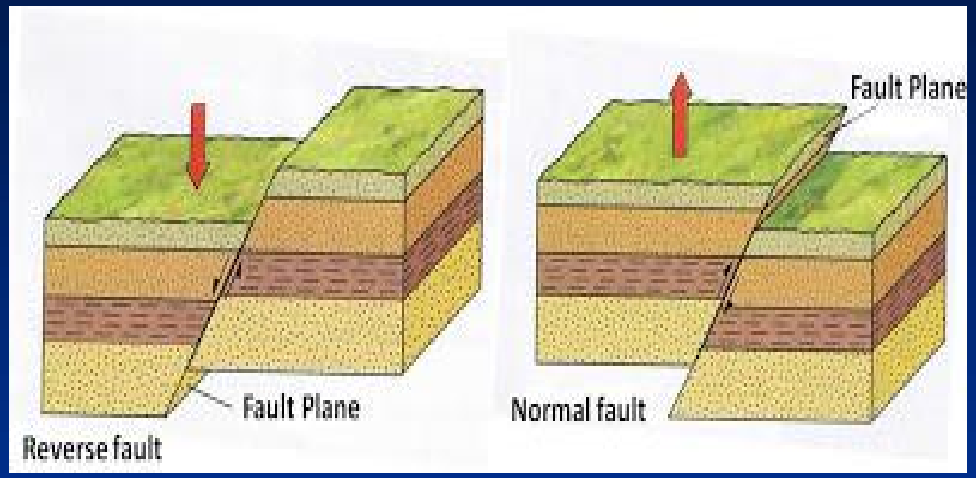


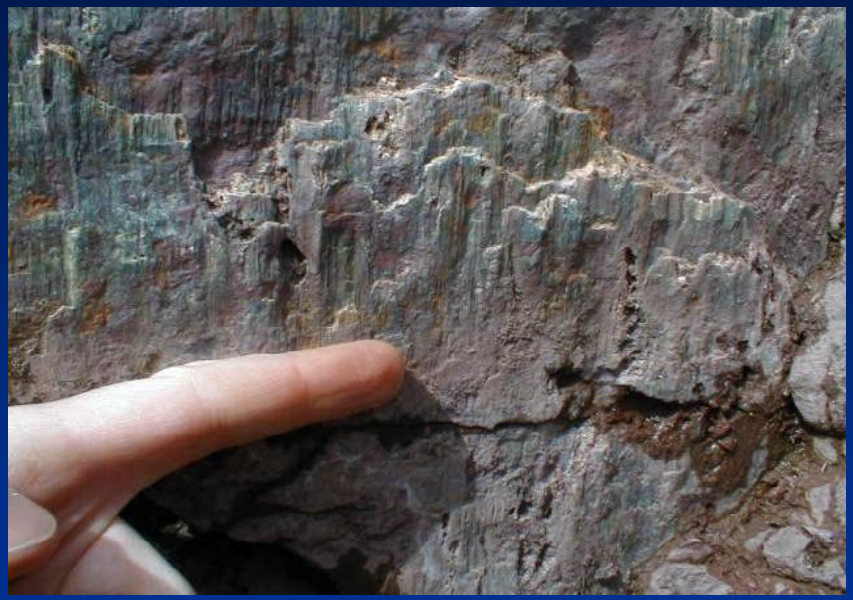
Thrust Fault



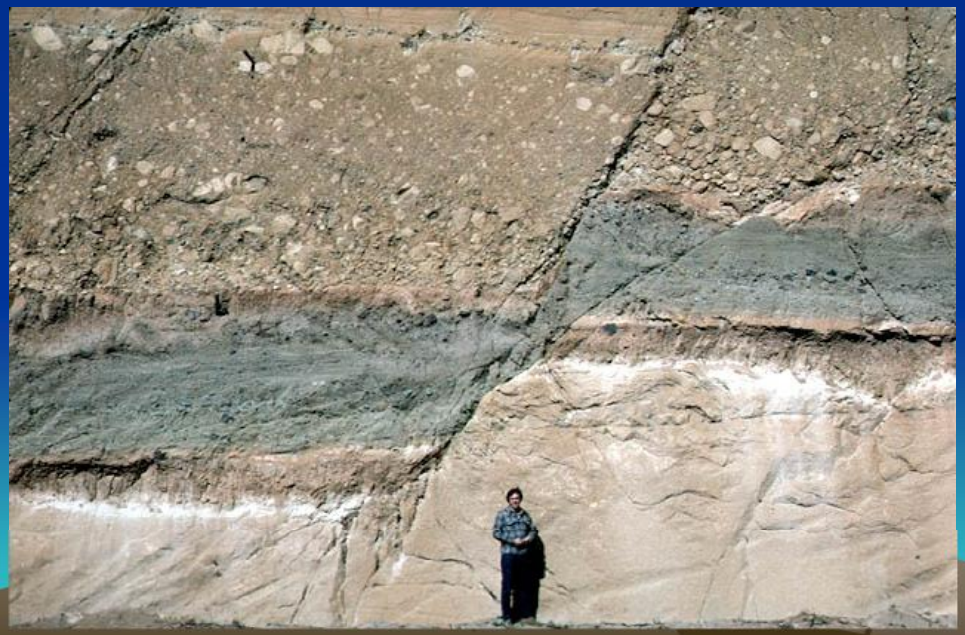
Strike-Slip Fault

Fault Slickensides



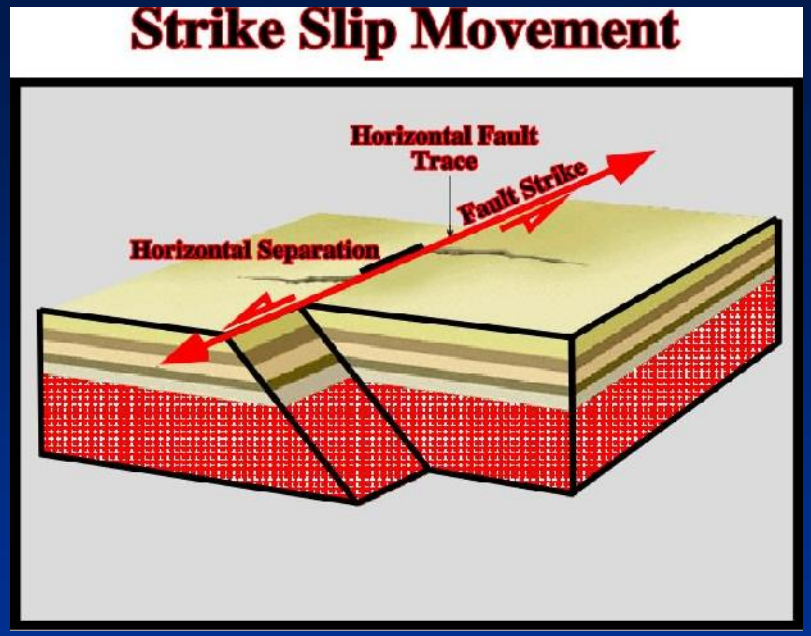


Dip-slip oriented slickensides



Normal-sense, dip-slip offset

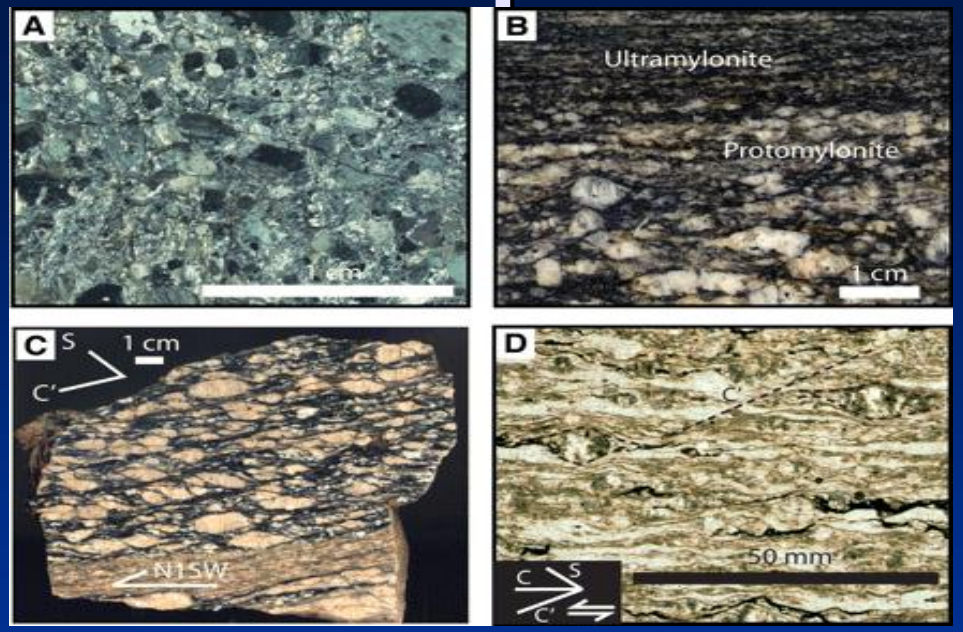
Fault Slickensides

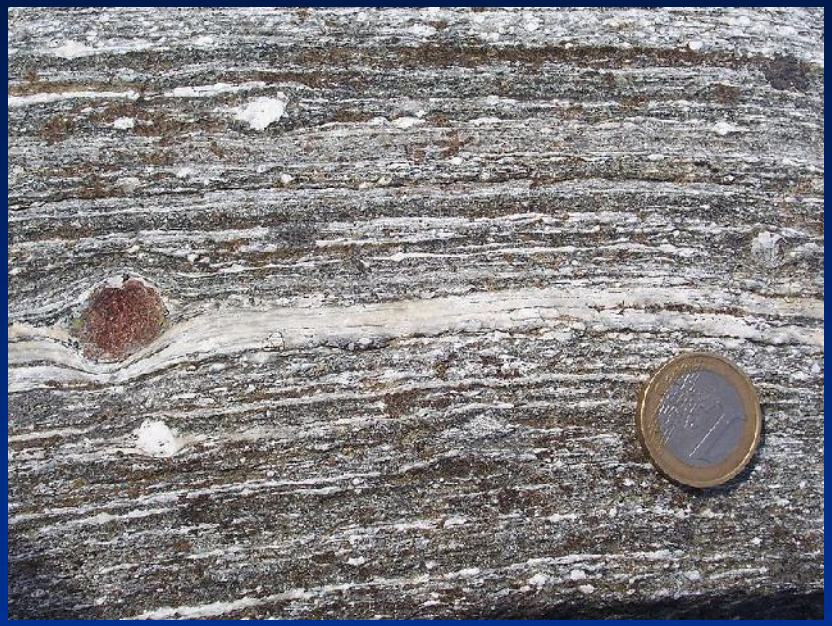


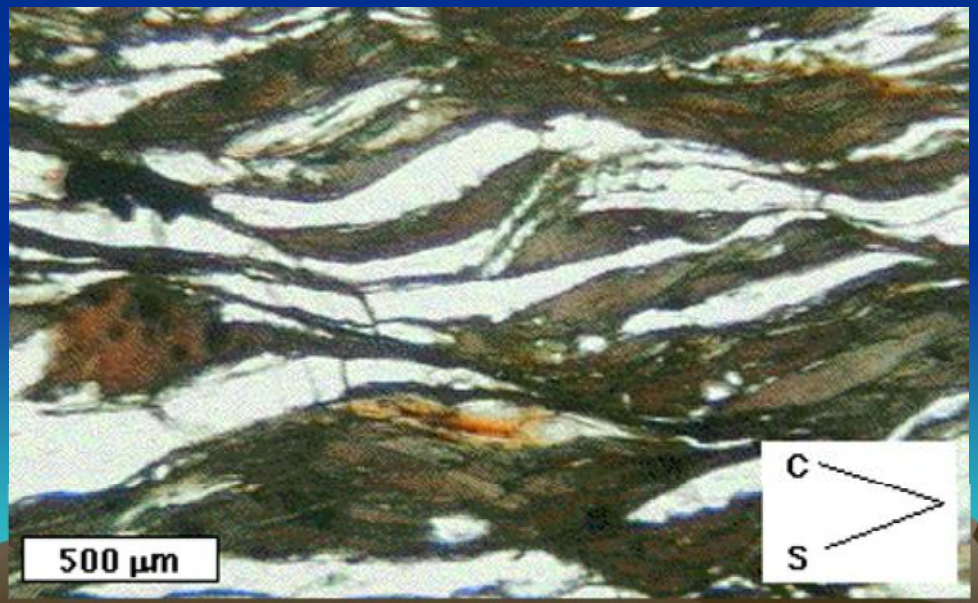
Strike-slip oriented slickensides

Right-lateral, strike-slip offset

Special Fault Rocks







Mylonite

Brittle-ductile shear-like deformation along fault zone resulting in a special kind of foliation termed “S-C fabric”.

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4) Youngest rocks exposed in the center of eroded synclines and basins.

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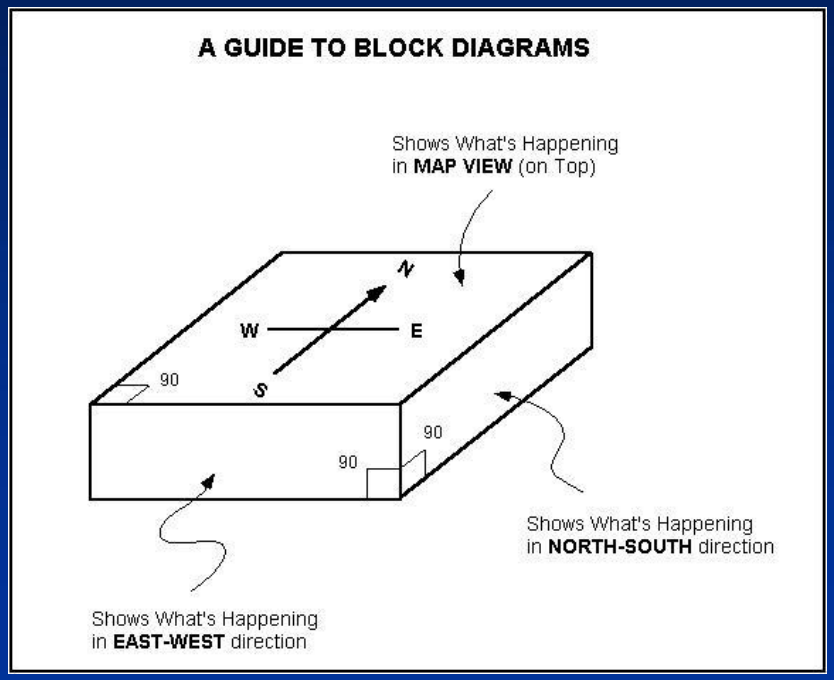
- ✓ Syncline fold plunges toward *open* end of “U” pattern.

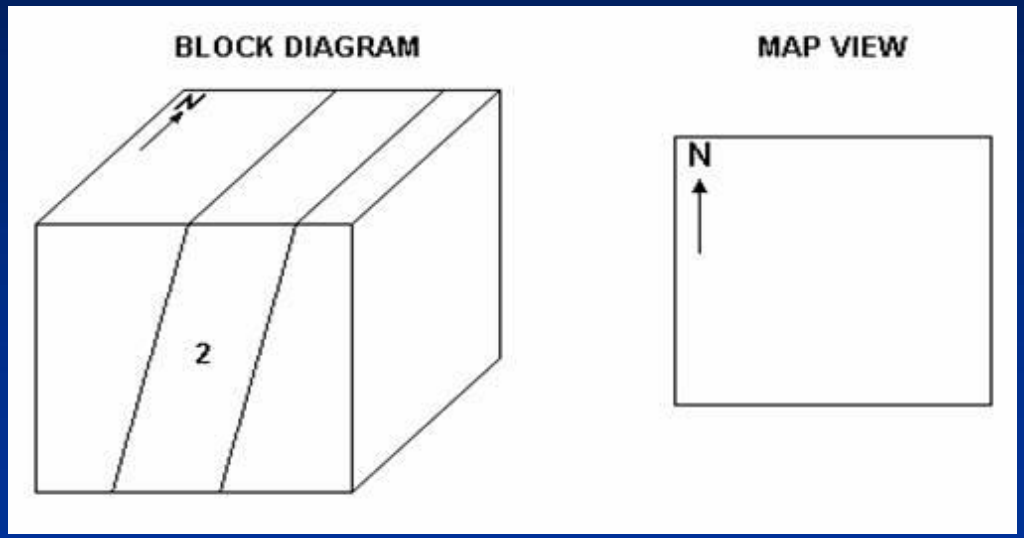
8) Steeper the dip of the layer, the more narrow the width of its outcrop.

9) Hanging wall *moves up* relative to foot wall in reverse and thrust faults.

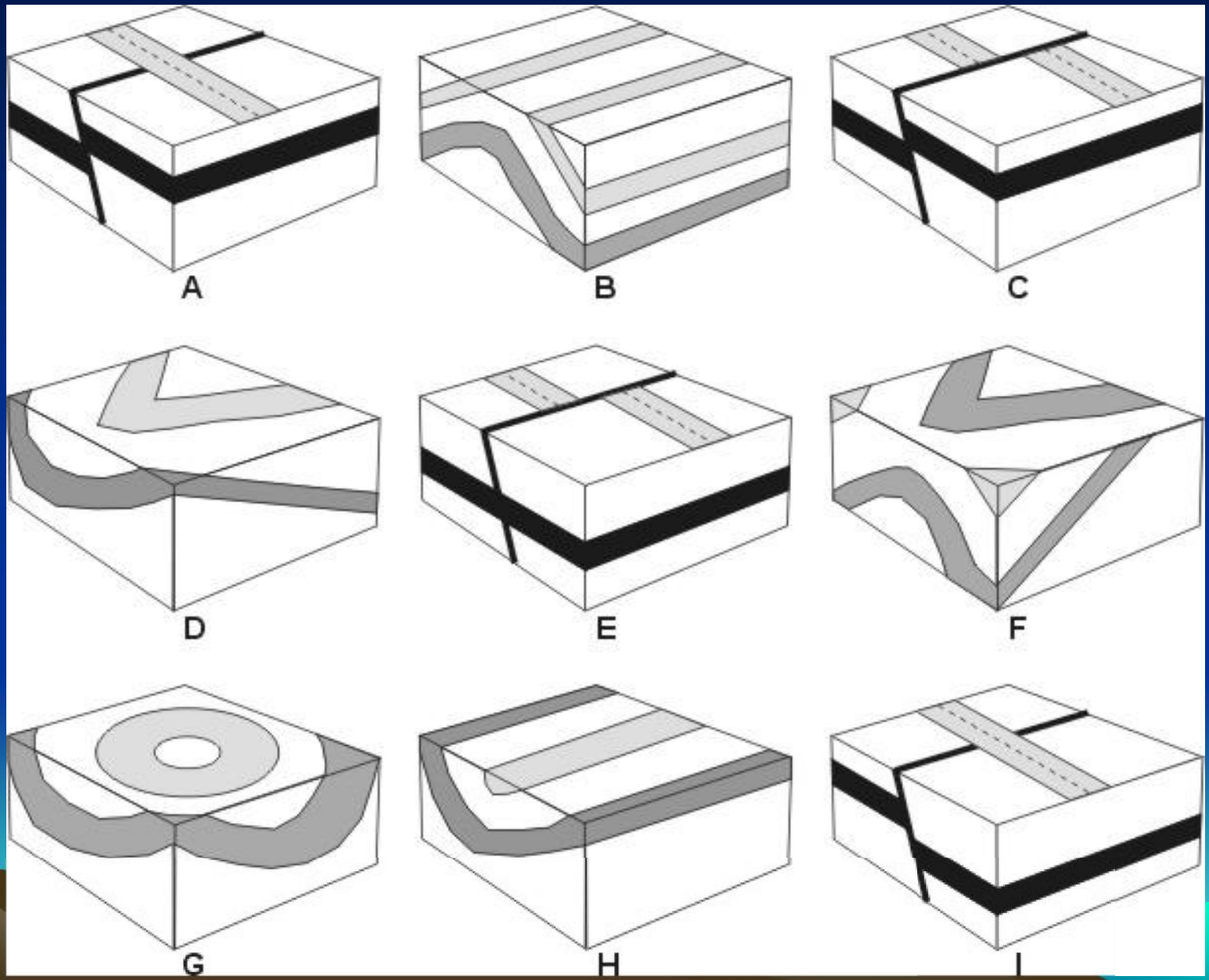
10) Hanging wall *moves down* relative to foot wall in normal faults.

Working with Block Diagrams





Working with Block Diagrams



Working with Block Diagrams

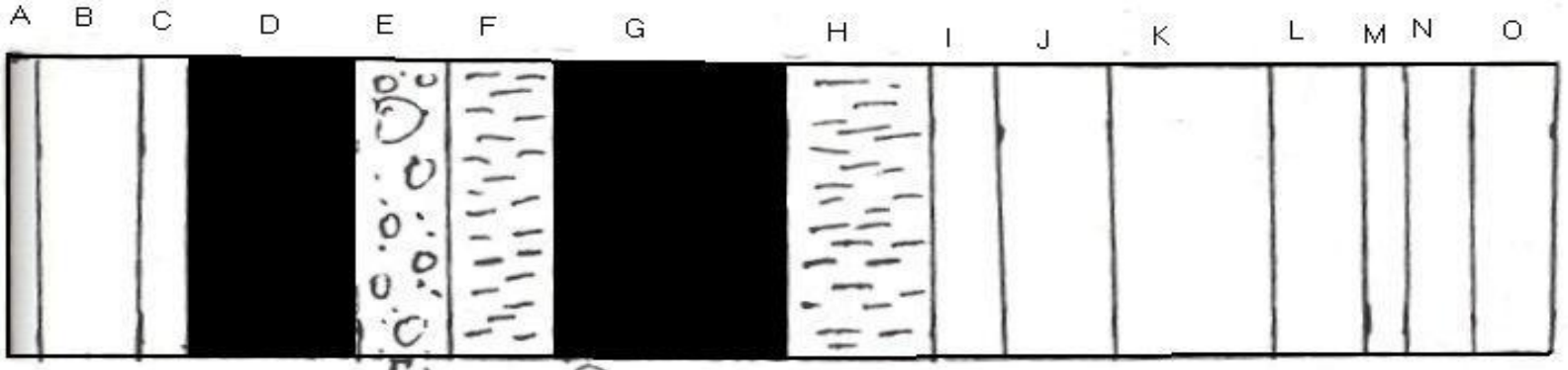
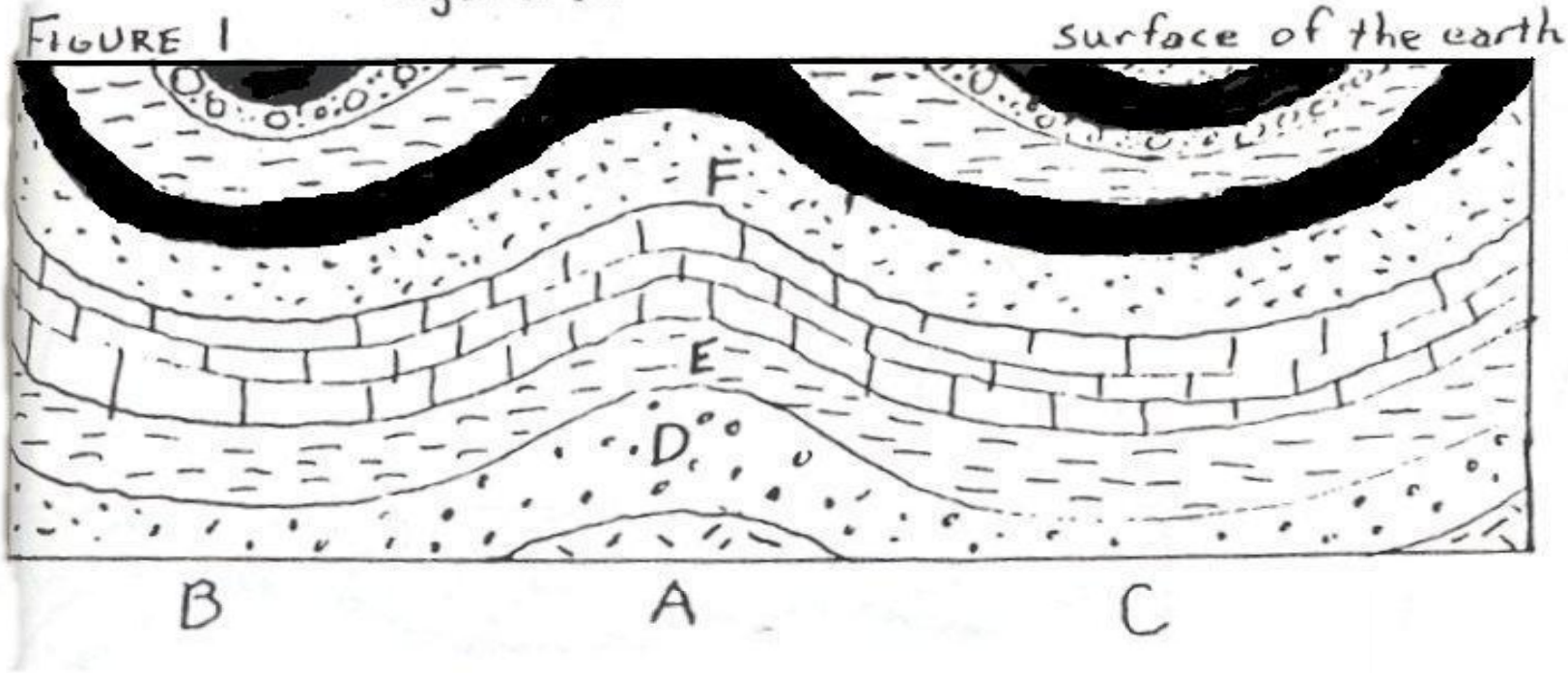
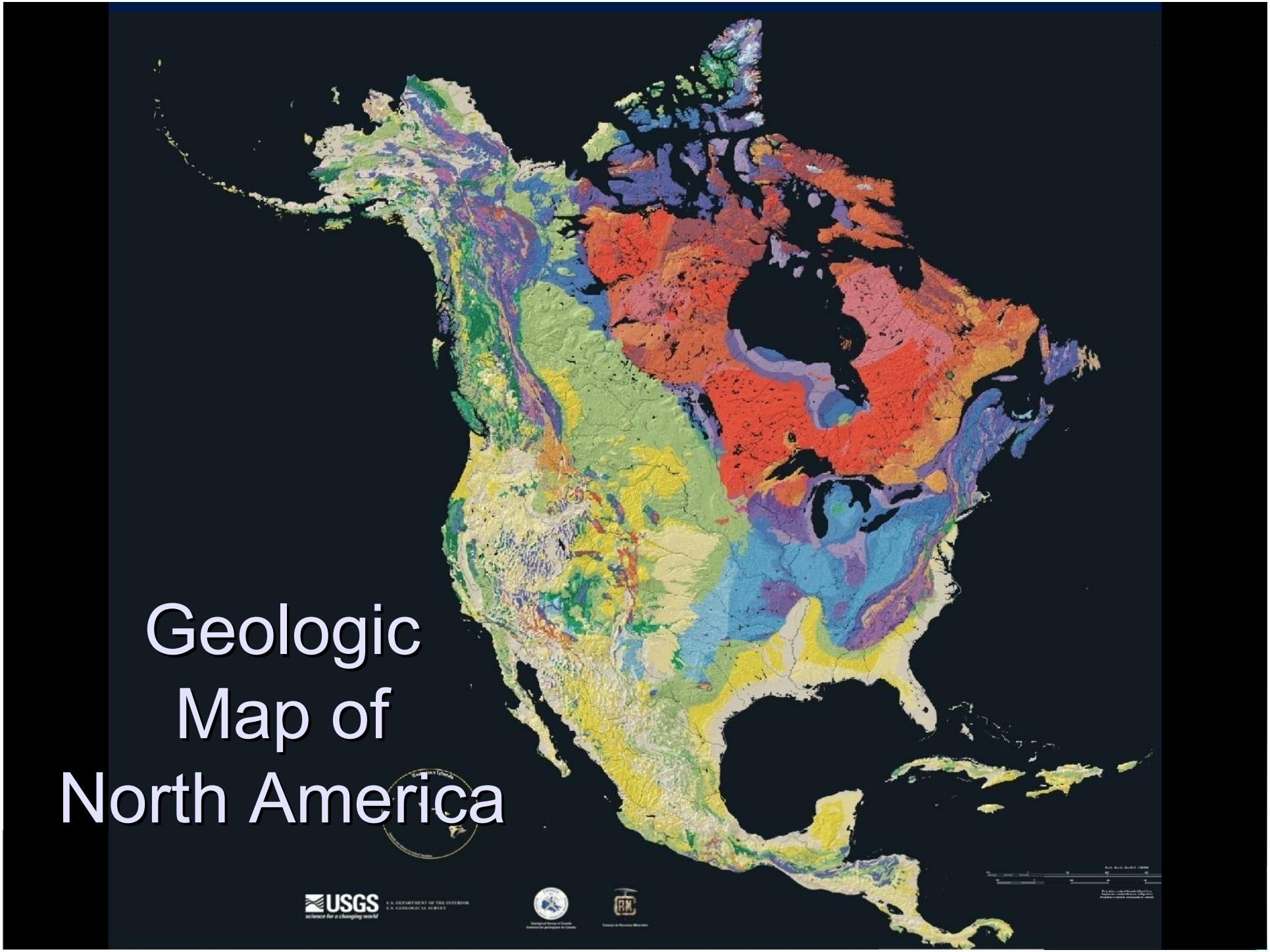


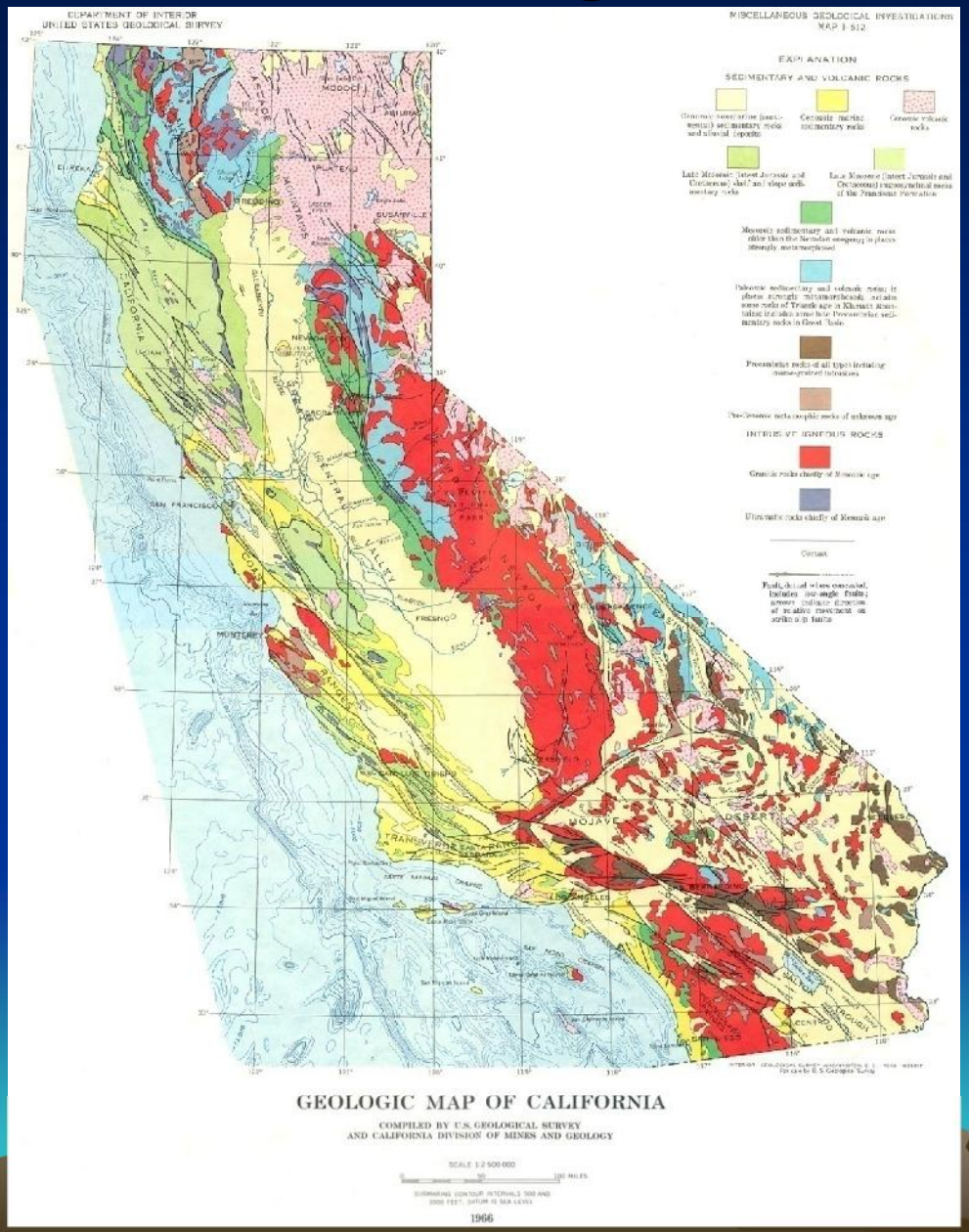
Figure 2

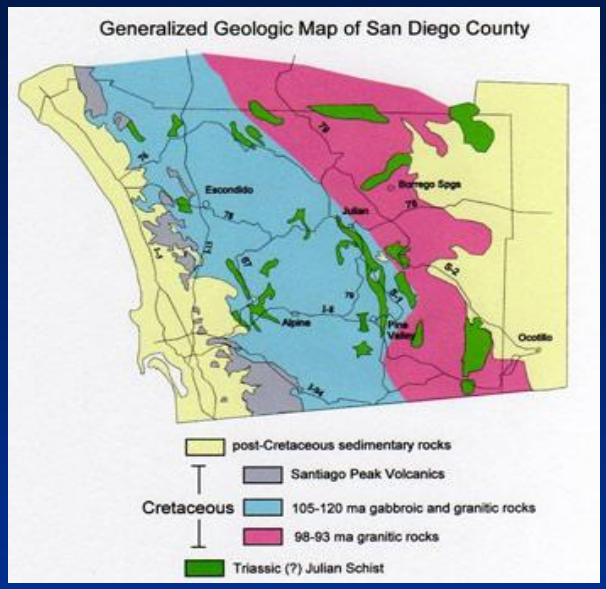
FIGURE 1

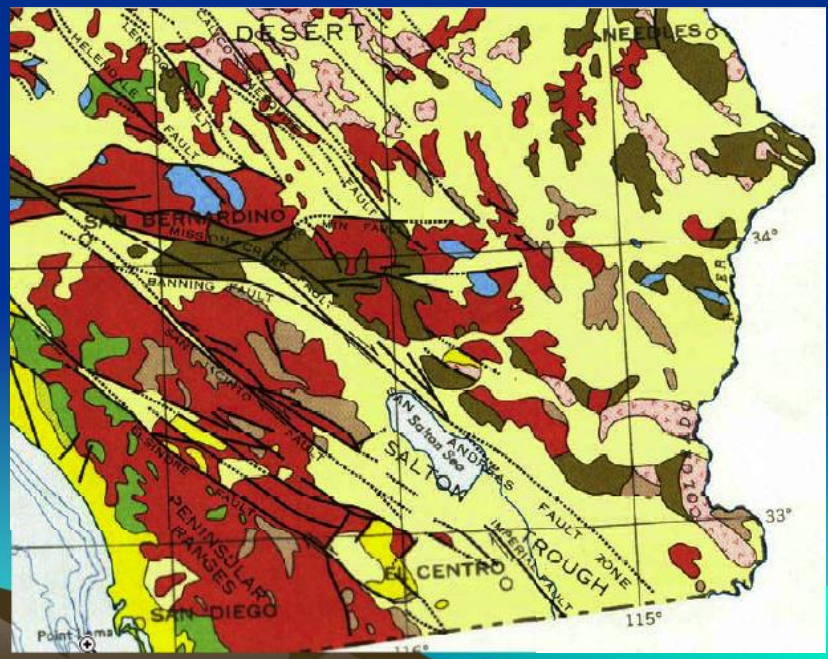



Geologic
Map of
North America
USGS
science for a changing world
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Geologic Maps of California

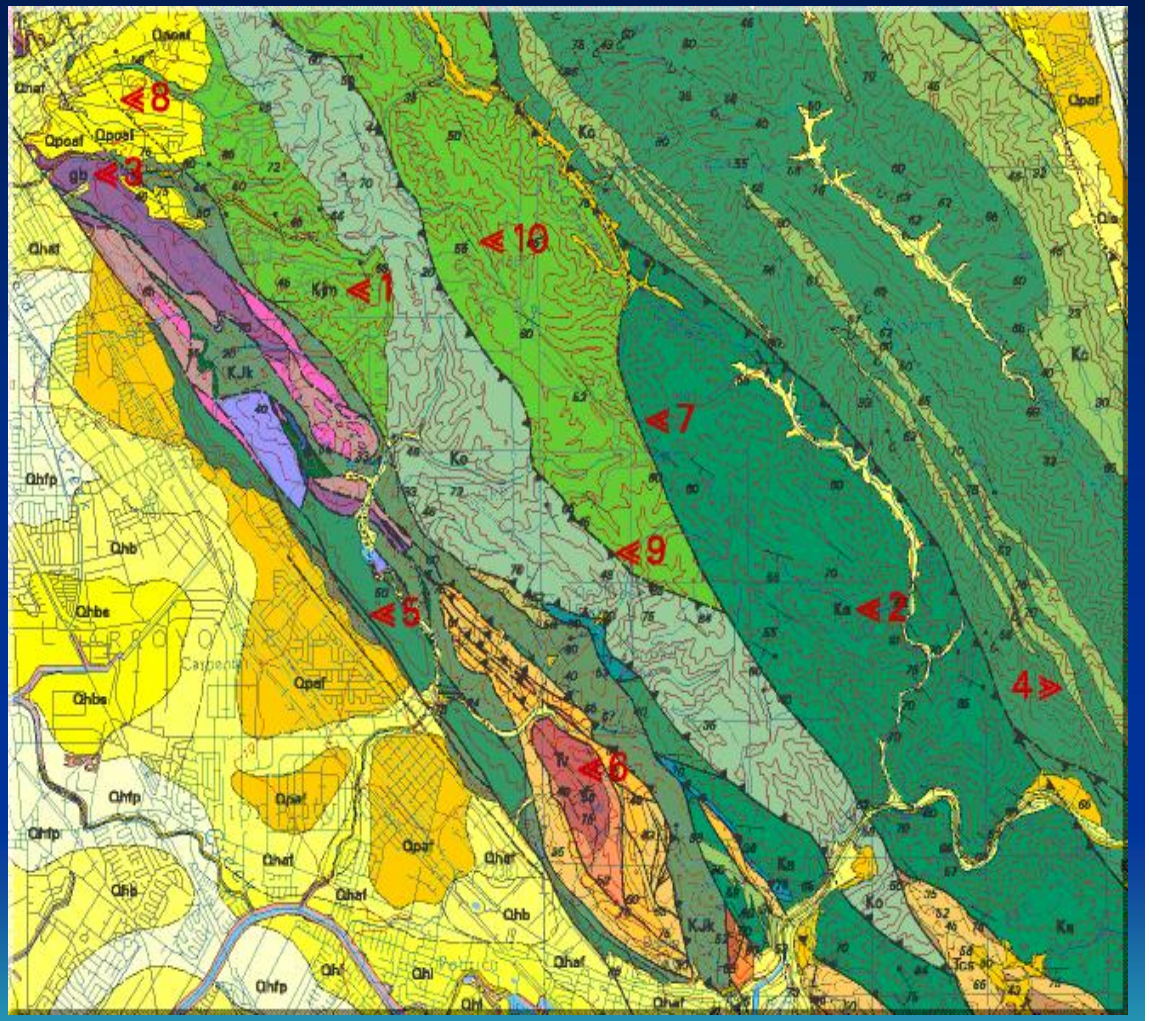






What is a Geology Map

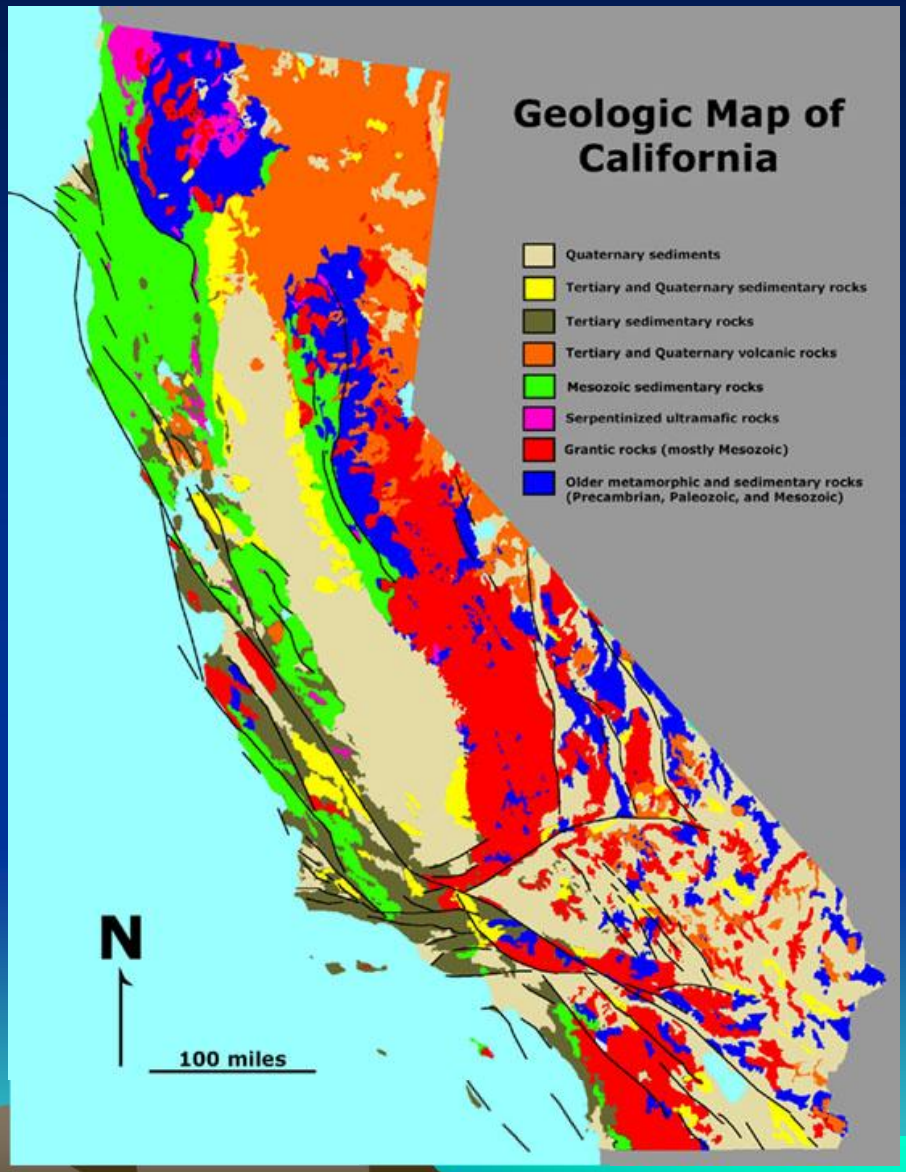
1) A map that displays the types of rocks and sediment exposed at the surface
2) Displays the spatial orientation of rock units and rock structures like folds and faults.
3) Geology information is typically overlain on a topographic base map



Usefulness of Geology Maps

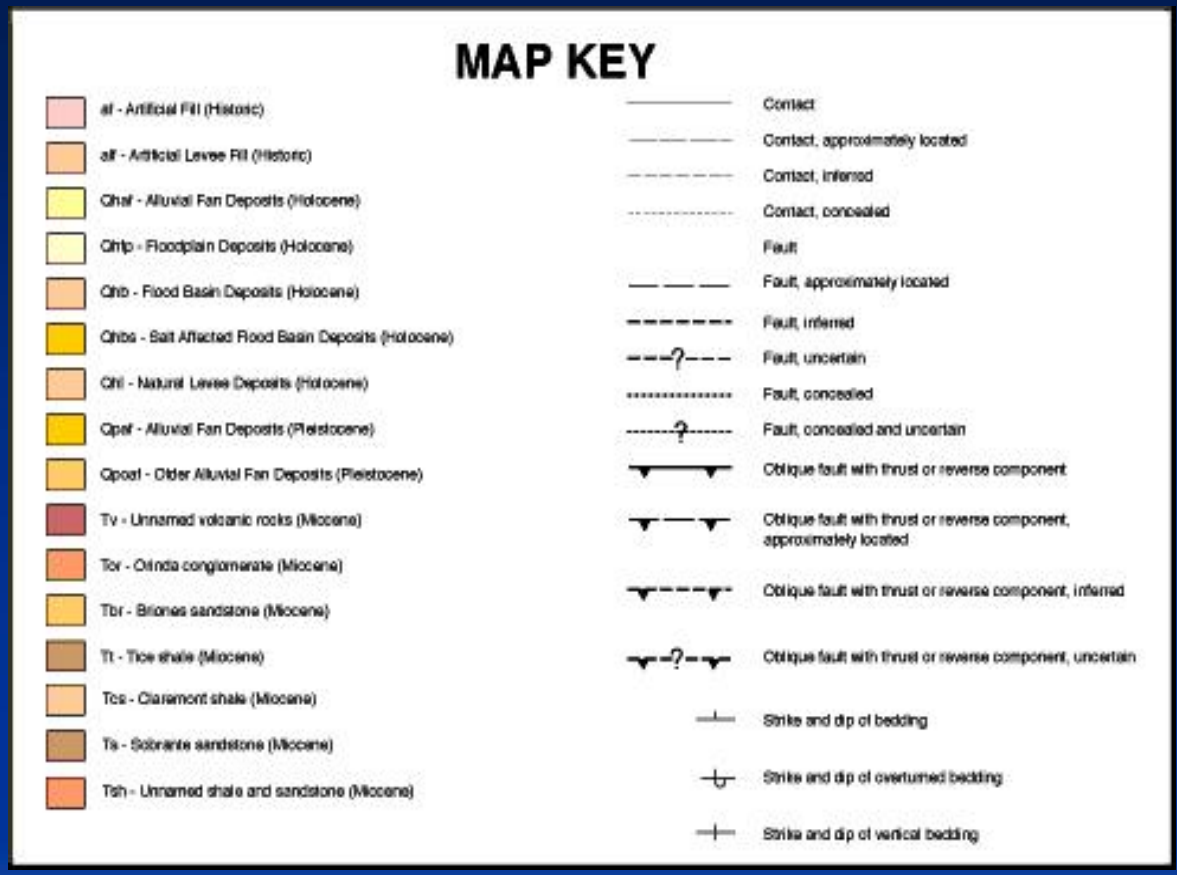
1) Geology maps have many vital uses:
   - ✓ Mineral Prospecting
   - ✓ Engineering
   - ✓ Earthquakes
   - ✓ Historical geology
   - ✓ Landform studies
   - ✓ Soil development
   - ✓ Biological studies

2) Geology maps are even useful when buying a home. Why?



Geology Map Key or Legend

1) The map key lists and explains the geologic rock formations and the structural symbols
   - ✓ Rock Names
   - ✓ Rock Types
   - ✓ Rock Ages
   - ✓ Contacts
   - ✓ Strike and Dip
   - ✓ Faults and Folds



2) Each rock unit has a unique letter symbol and is color-coded

3) Map key is vital to understanding the accompanying geology map

The Basic Rules of Structure

1) Strike of beds is always parallel to the direction of the contacts.

2) Rock layers dip towards the youngest exposed rock layers.

3) Oldest rocks exposed in the center of eroded anticlines and domes.

4) Youngest rocks exposed in the center of eroded synclines and basins.

5) Horizontal folds form parallel sets of belt-like outcrop patterns.

6) Plunging anticlines form “V” of "U" shaped, belt-like outcrop patterns.

- ✓ Anticline fold plunges toward *closed* end of “V” or “U” pattern.

7) Plunging synclines form ”V” of “U" shaped, belt-like outcrop patterns.

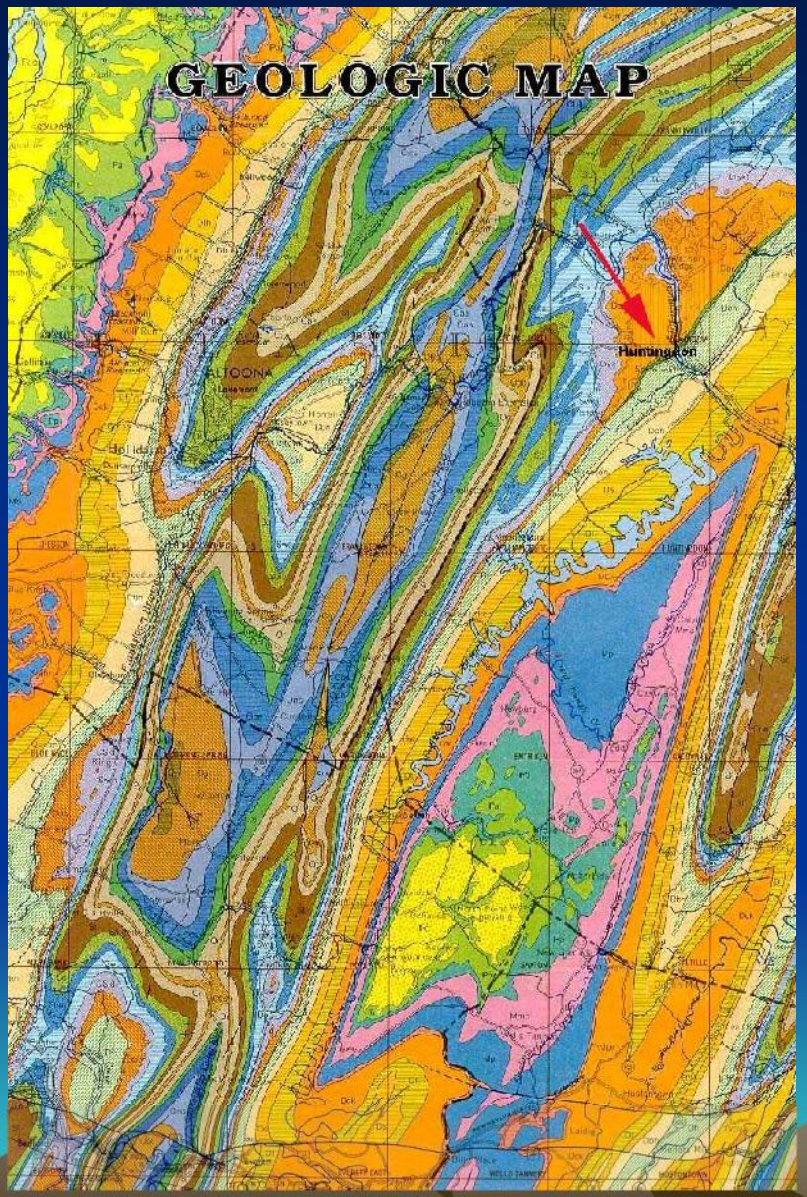
- ✓ Syncline fold plunges toward *open* end of “U” pattern.

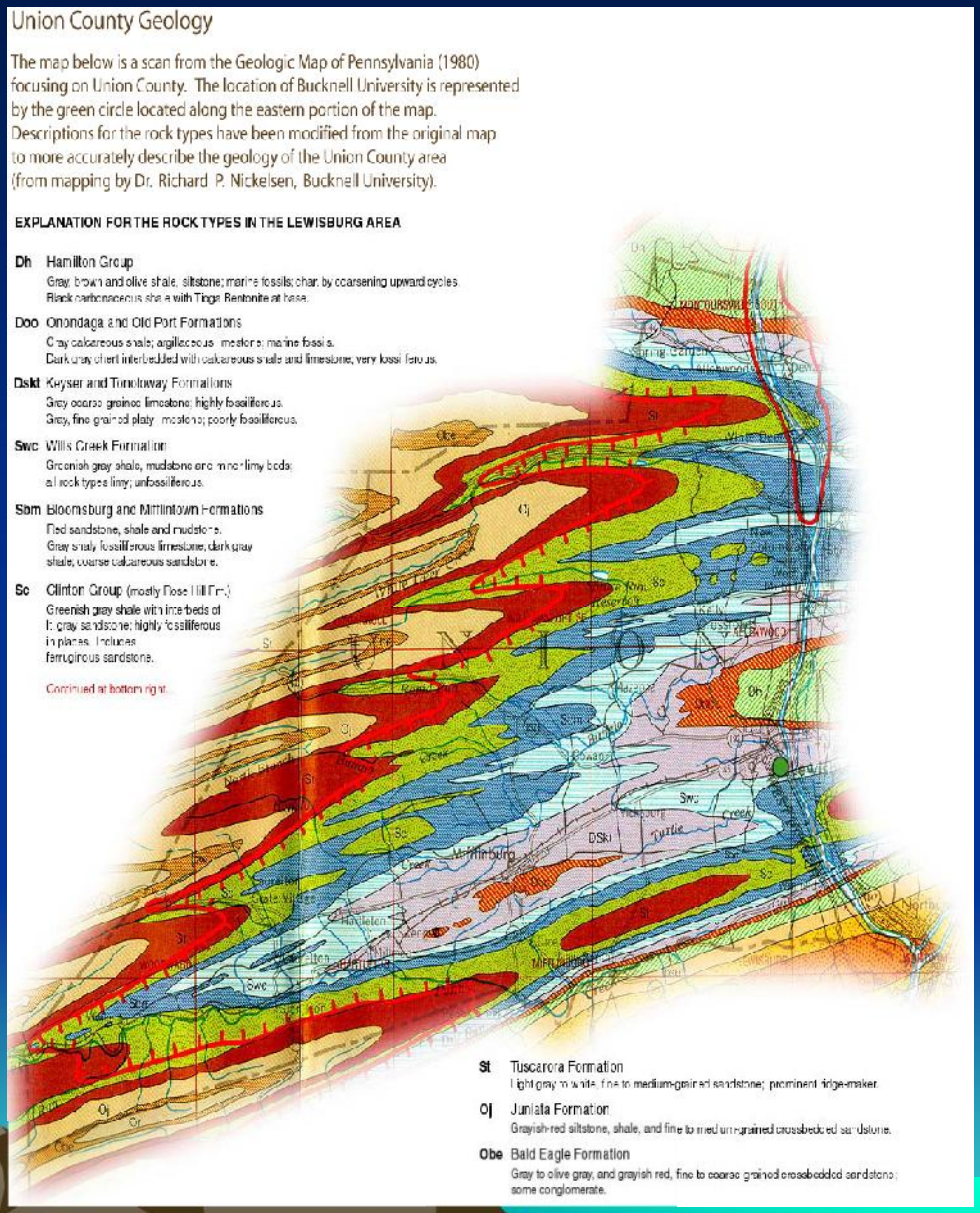
8) Steeper the dip of the layer, the more narrow the width of its outcrop.

9) Hanging wall *moves up* relative to foot wall in reverse and thrust faults.

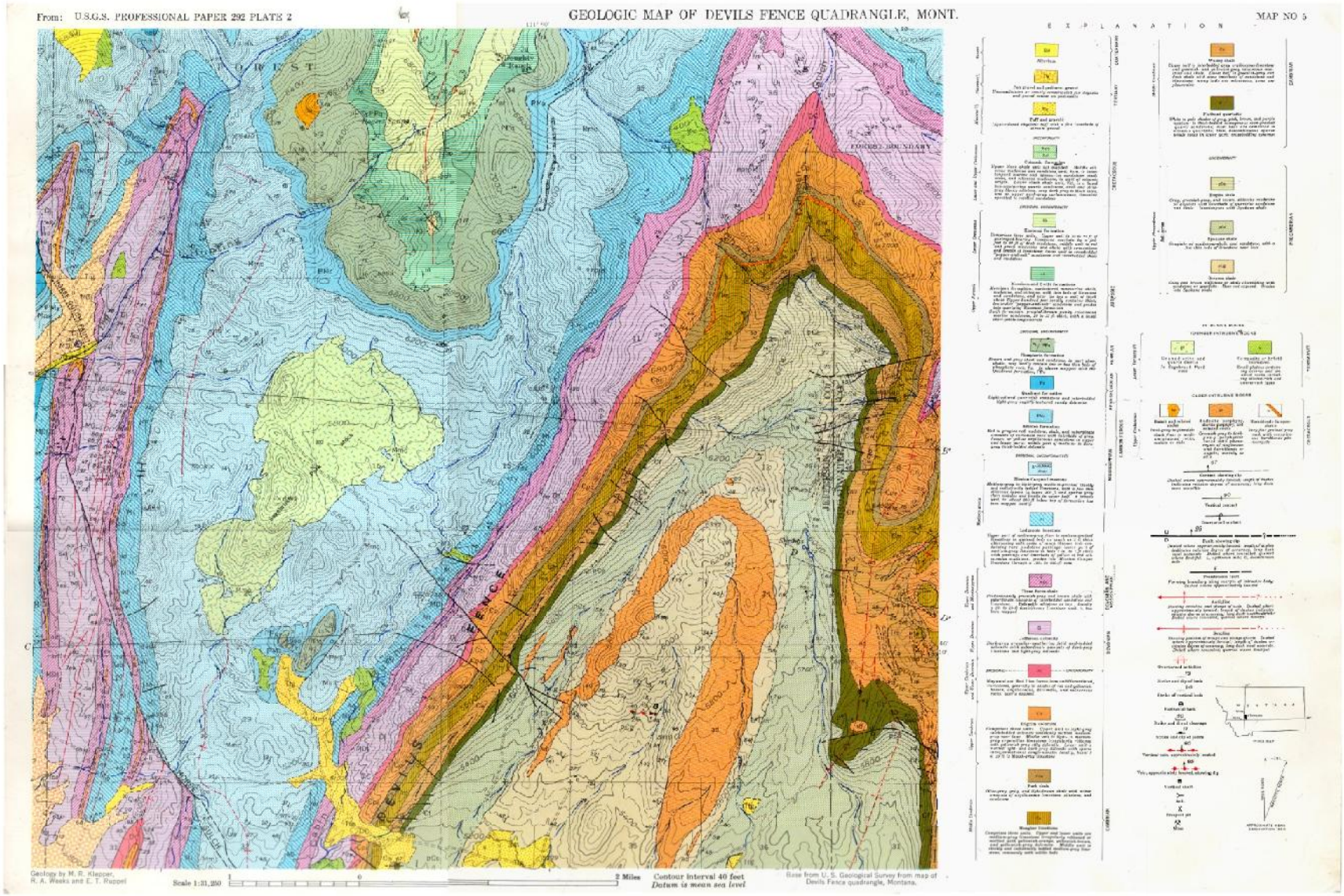
10) Hanging wall *moves down* relative to foot wall in normal faults.

Geologic Maps – Artwork?

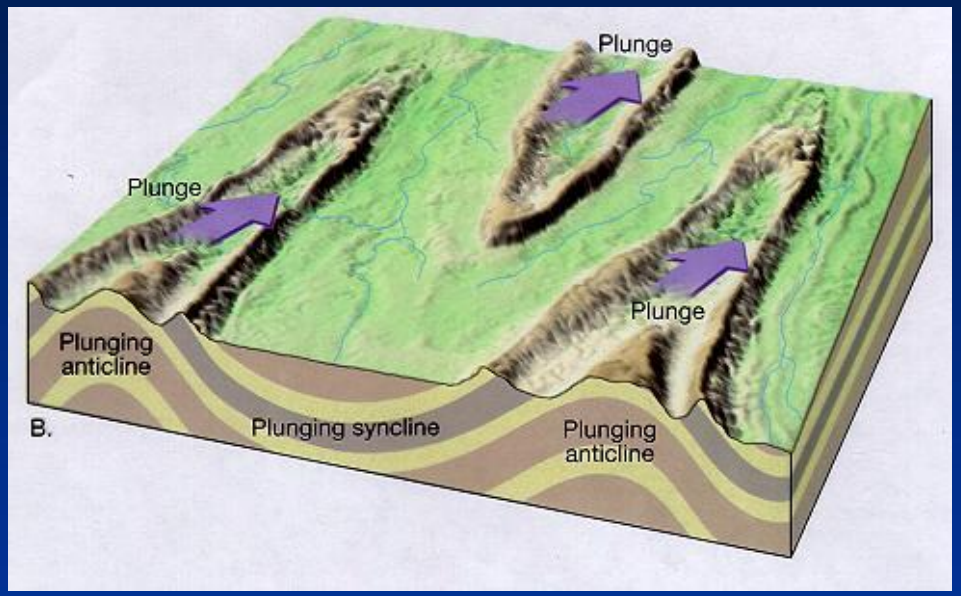


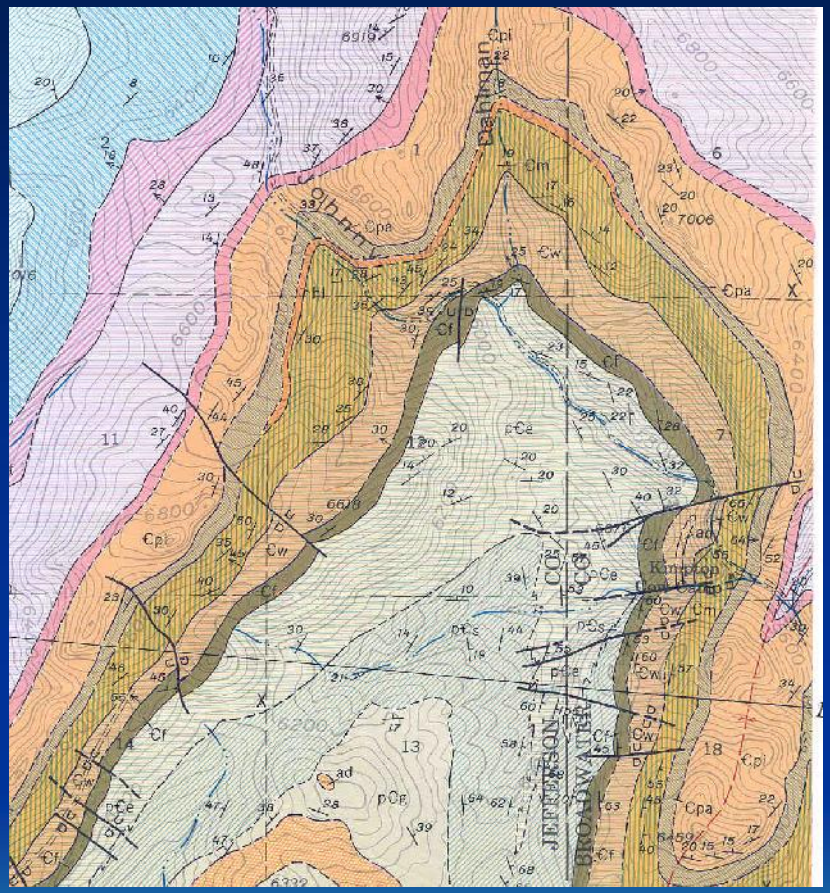


Geologic Maps – Devil's Fence Quad

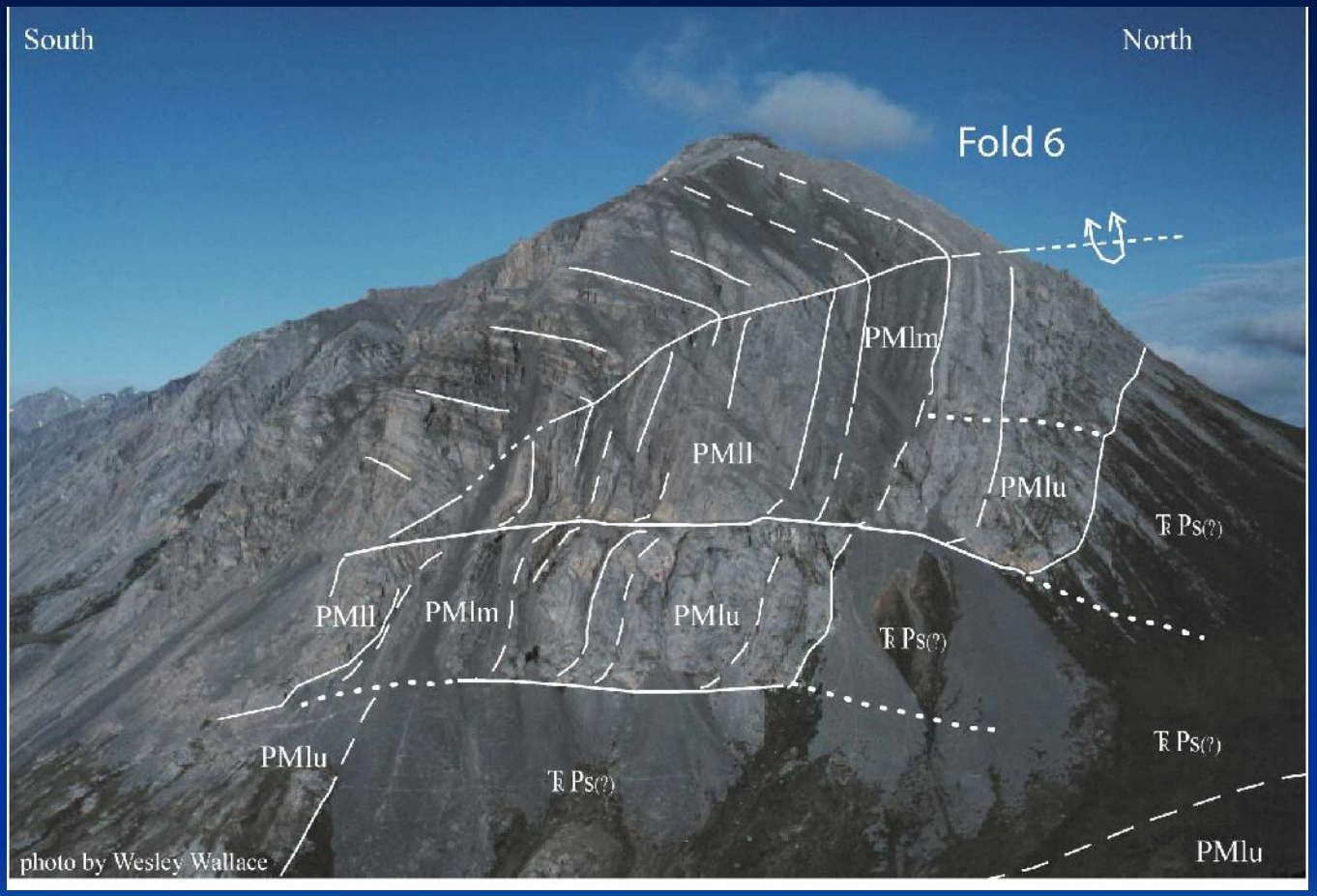


Folds and Geologic Maps





Structure Web References



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