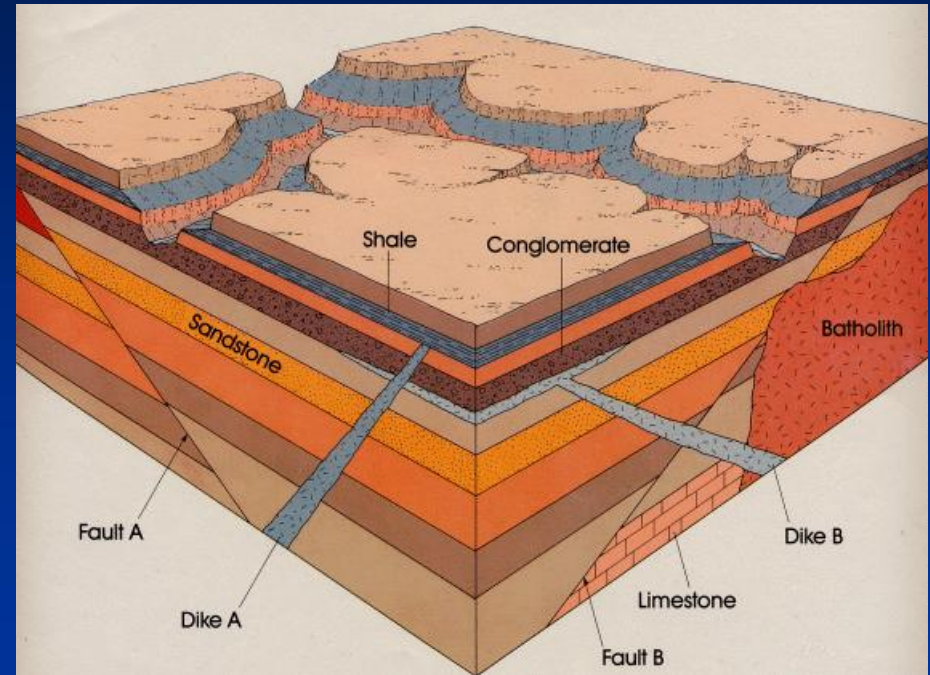


# Structural Geology and Geology Maps Lab



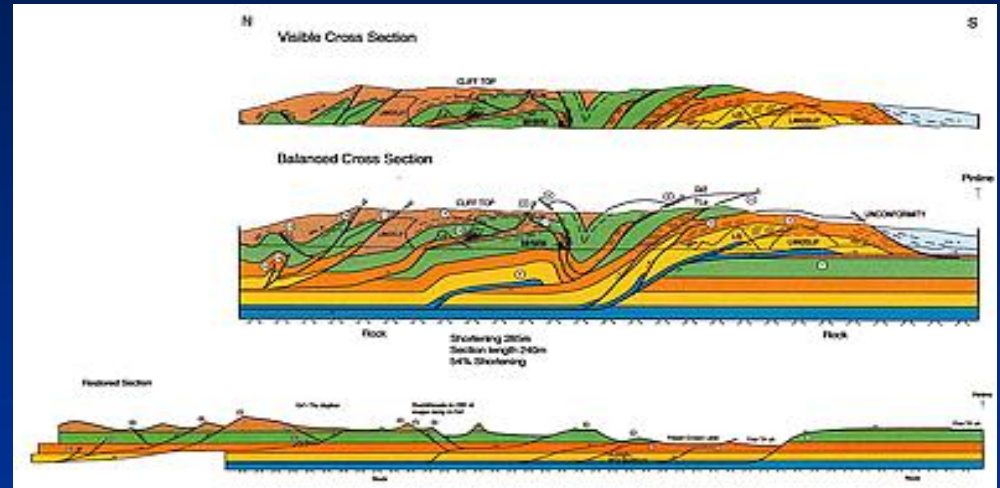
Mesa College  
Geology 101 Lab  
Ray Rector: Instructor





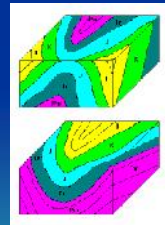
# Structural Geology Lab

## Pre-Lab Resources

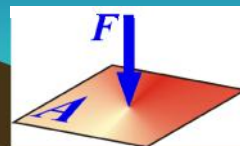


### Pre-Lab Internet Links

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.



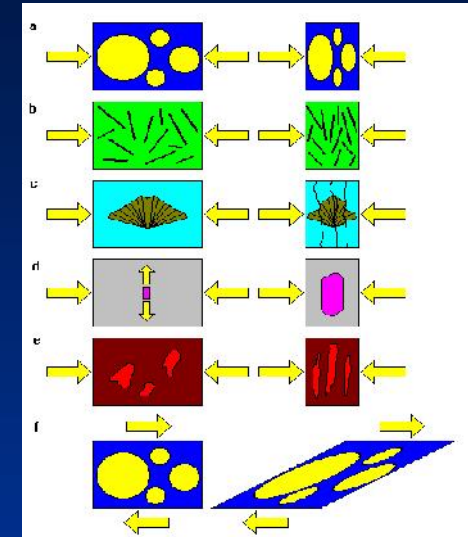
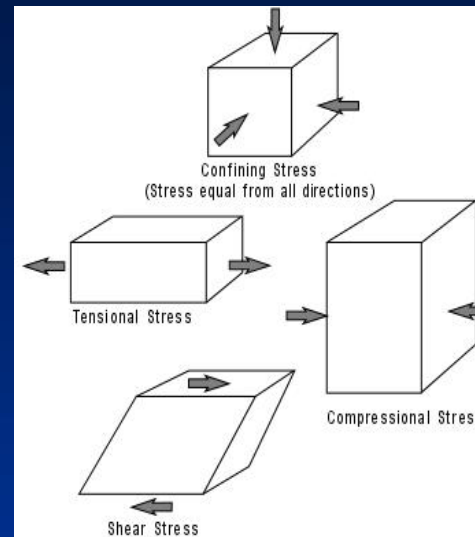
# Origin and Nature of Rock Deformation

## A. Stress Leads to Strain

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

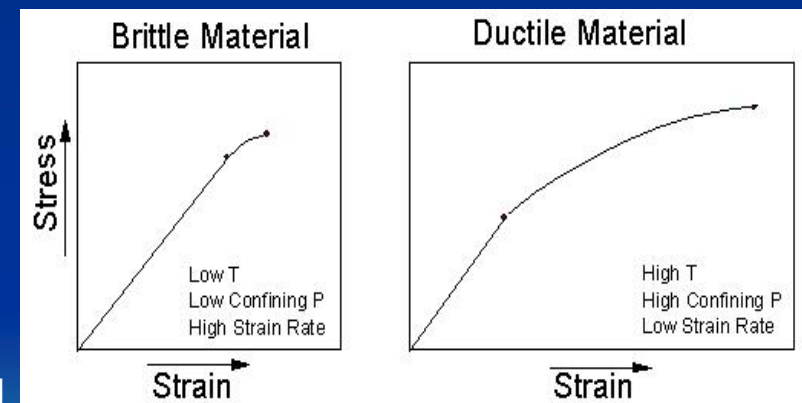
## B. Different Types of Stress

- ✓ 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

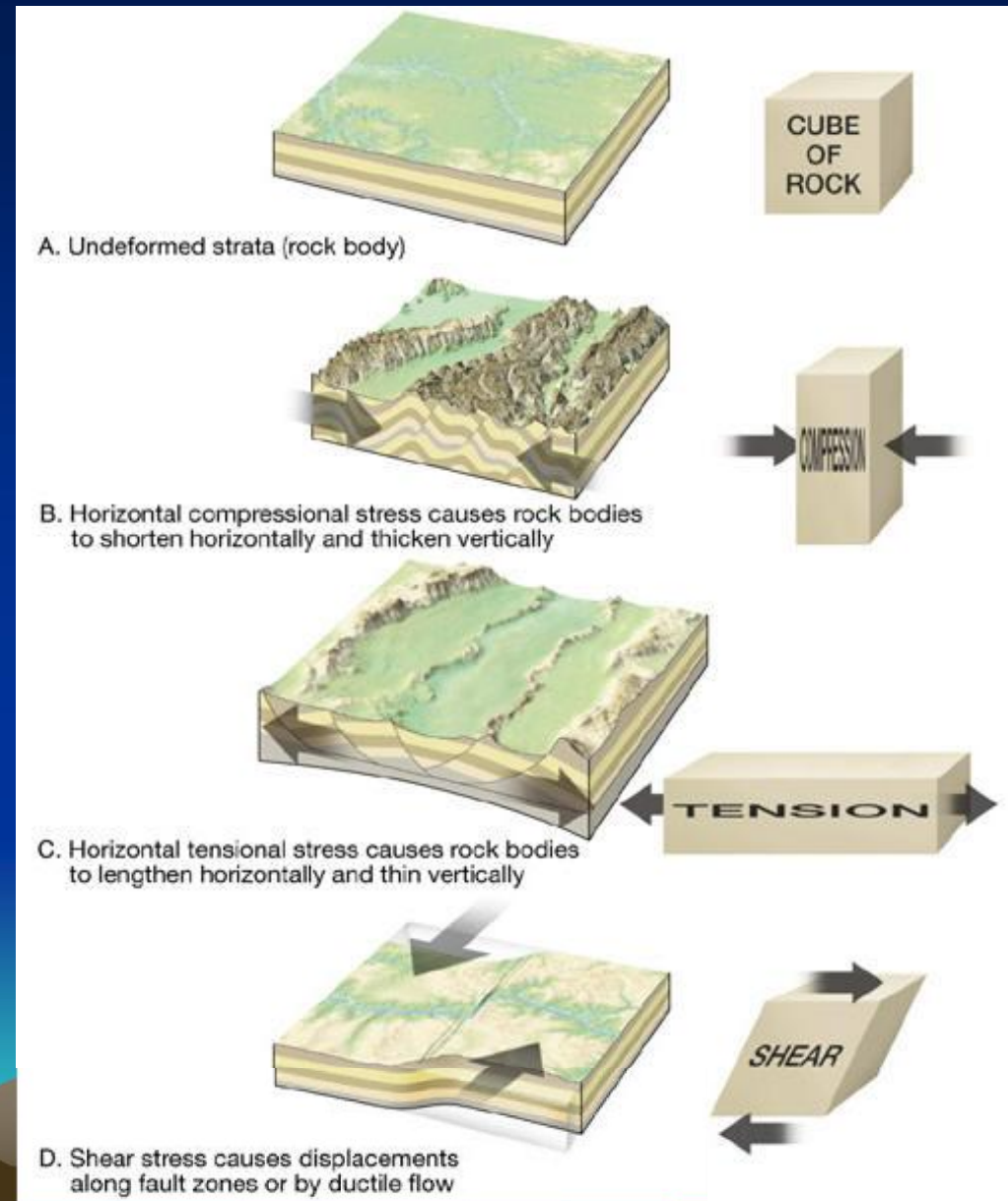
- ✓ Shorten horizontally
- ✓ Thicken vertically
- ✓ Folding and Reverse Faulting

## C. Tensional Stresses

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

## D. Shear Stresses

- ✓ Lateral displacement
- ✓ Strike-slip Faulting



# Resultant Rock Strain from Specific Stresses

## A. Undeformed Strata

- ✓ Original Horizontal layering

## B. Tensional Stresses

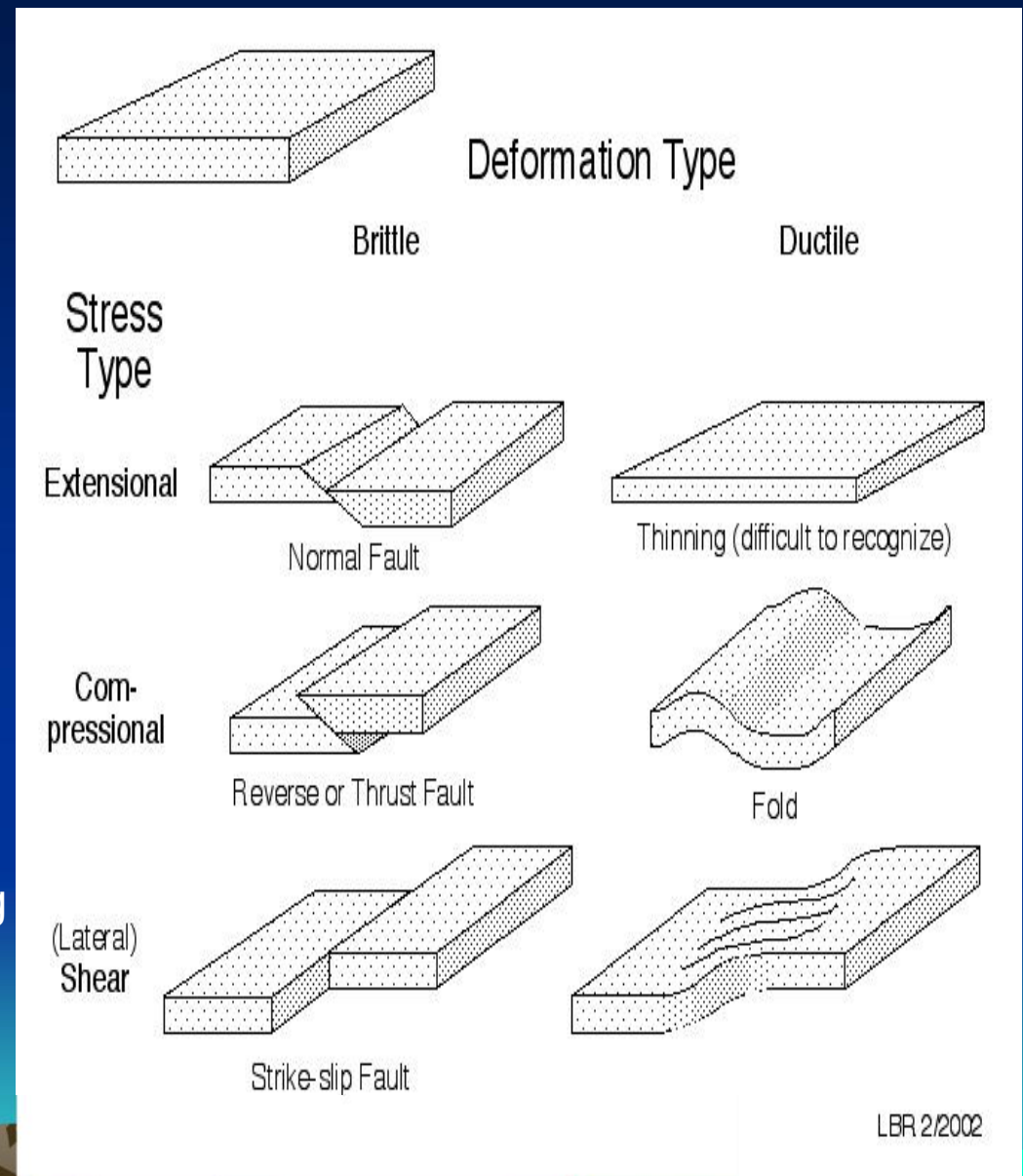
- ✓ Lengthen horizontally
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## C. Compressional Stresses

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

## D. Shear Stresses

- ✓ Lateral displacement
- ✓ Strike-slip Faulting





# Geologic Structures



Rock Layering



Tilted Rock Layers




Folded Rock Layers



Faulted Rock Layers

# The Basic Rules of Structure

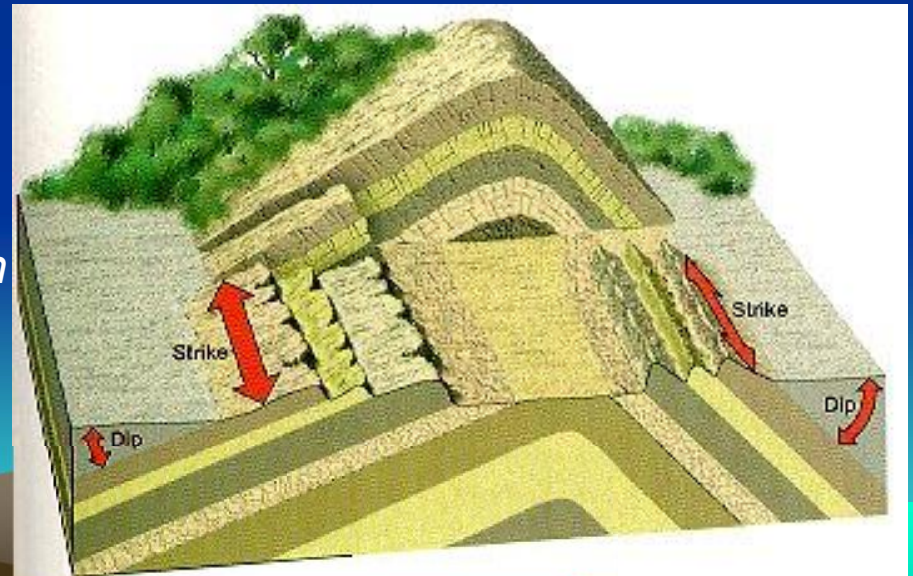
- 1) Strike of beds is always parallel to the direction of the contacts.
  - 2) Rock layers dip towards the youngest exposed rock layers.
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  - 8) Steeper the dip of the layer, the more narrow the width of its outcrop.
  - 9) Hanging wall *moves up* 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

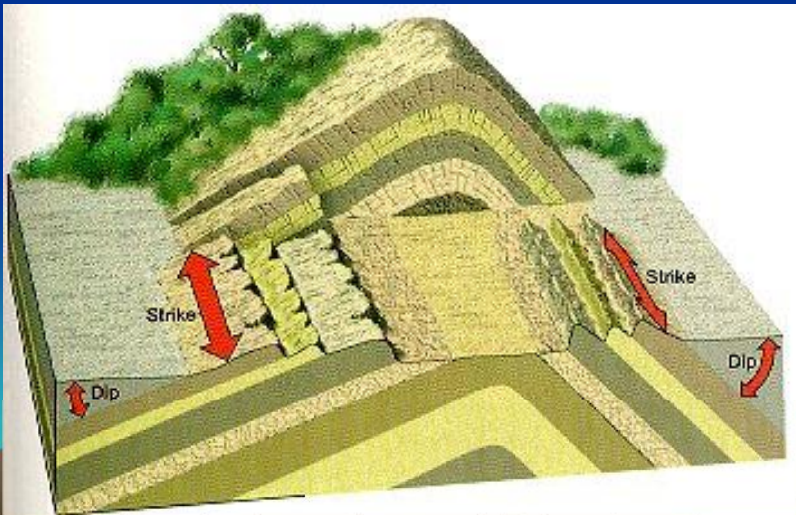
## Strike and Dip



Measuring Strike Azimuth



Measuring Dip Angle



Strike Azimuth and Dip Angle



Completed Strike and Dip Measurement



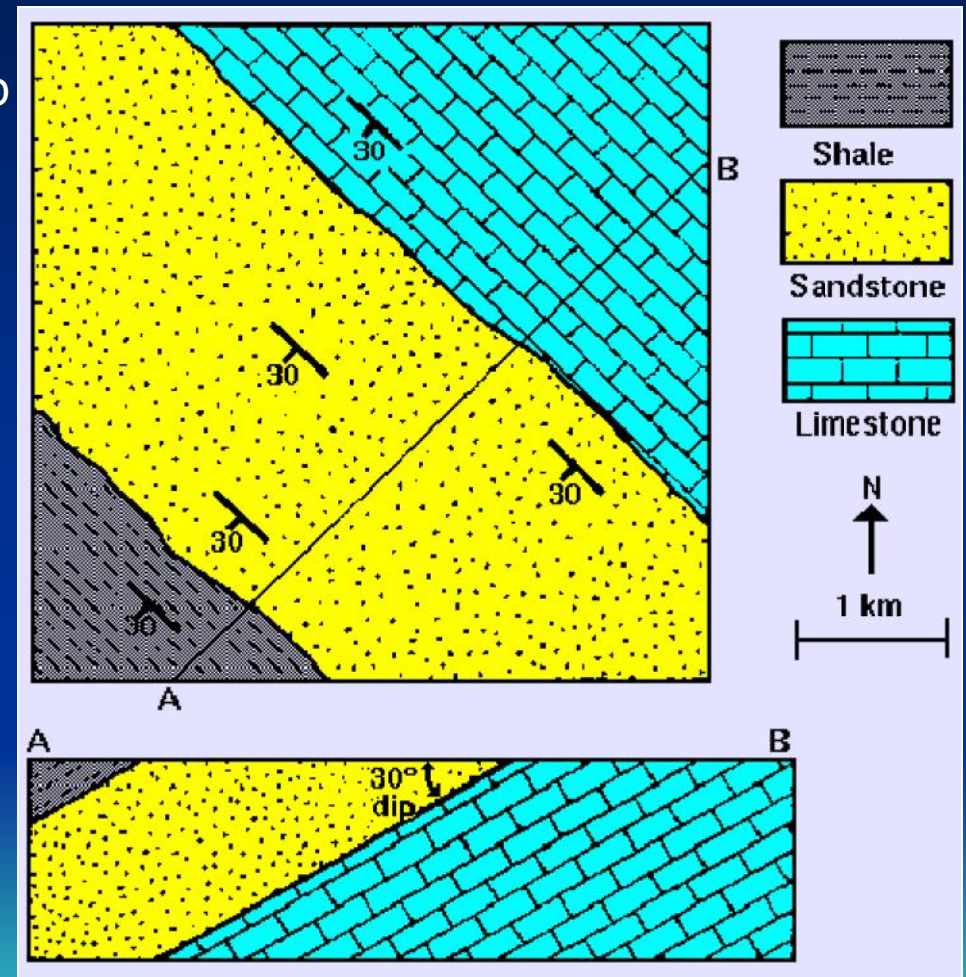
# Spatial Orientation of Layers

## Strike and Dip

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



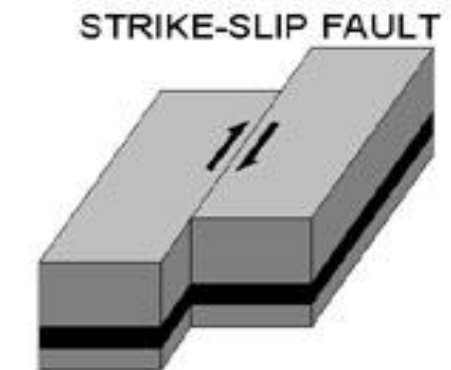
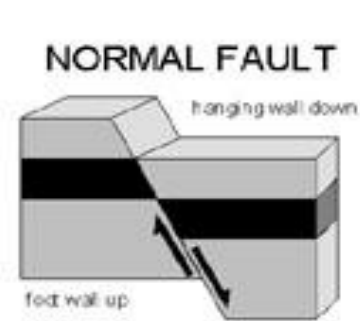
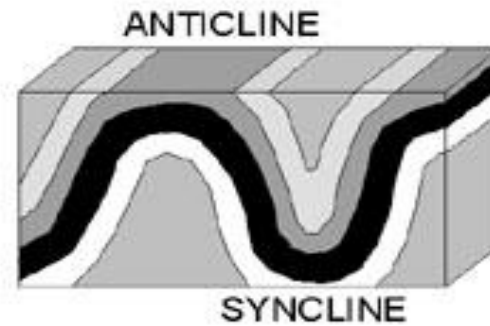
- ✓ The long bar is the strike trend
- ✓ The short bar points to the down dip direction with dip angle



# Folds and Faults

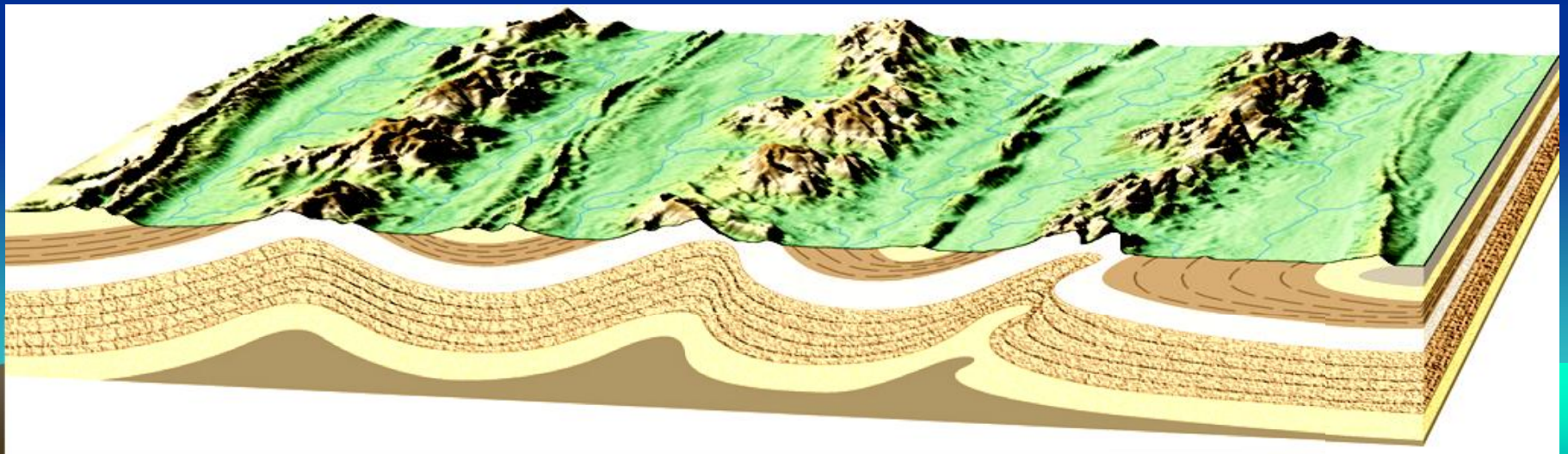
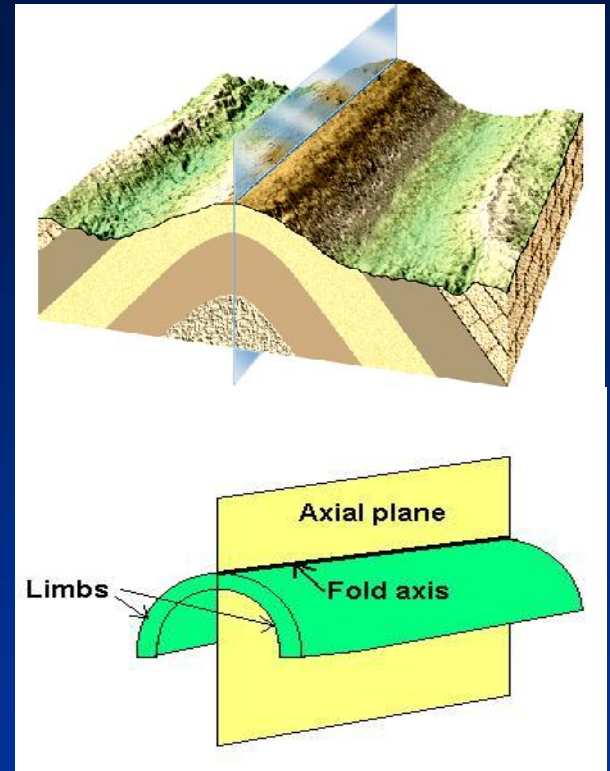
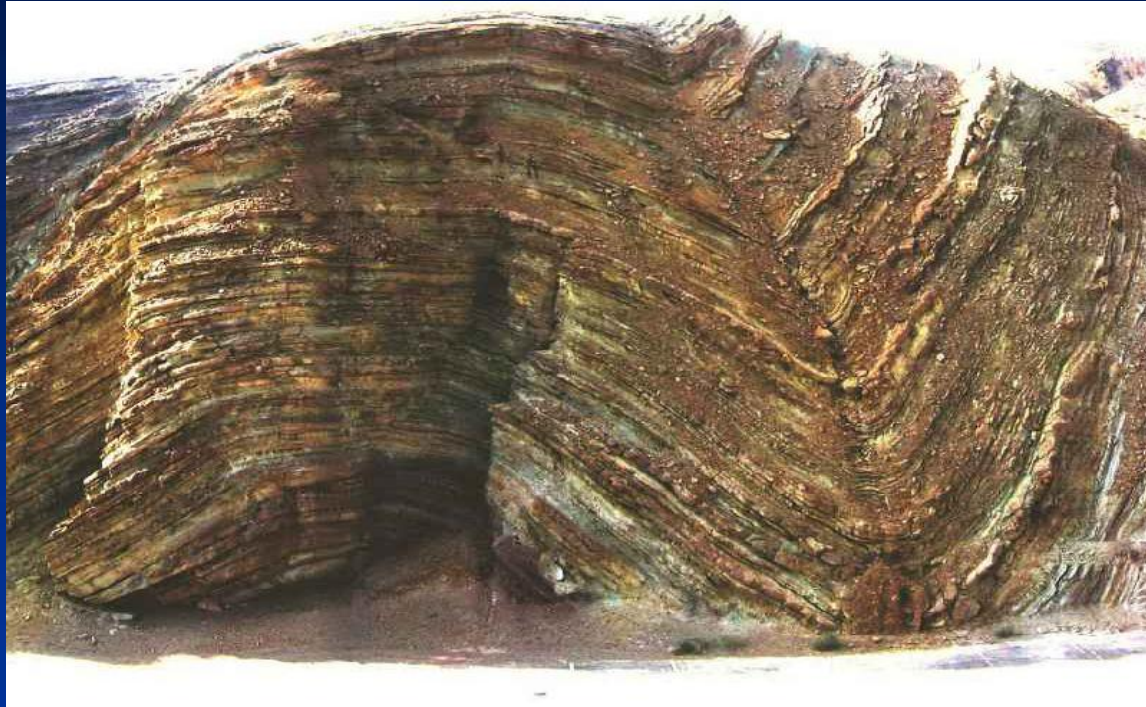


Landform Slides





# Fold Basics





# Fold Basics

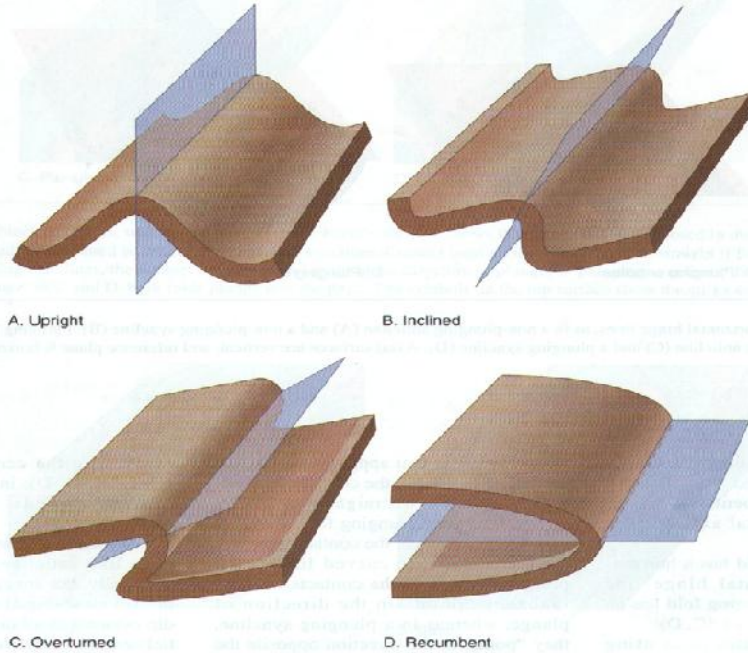
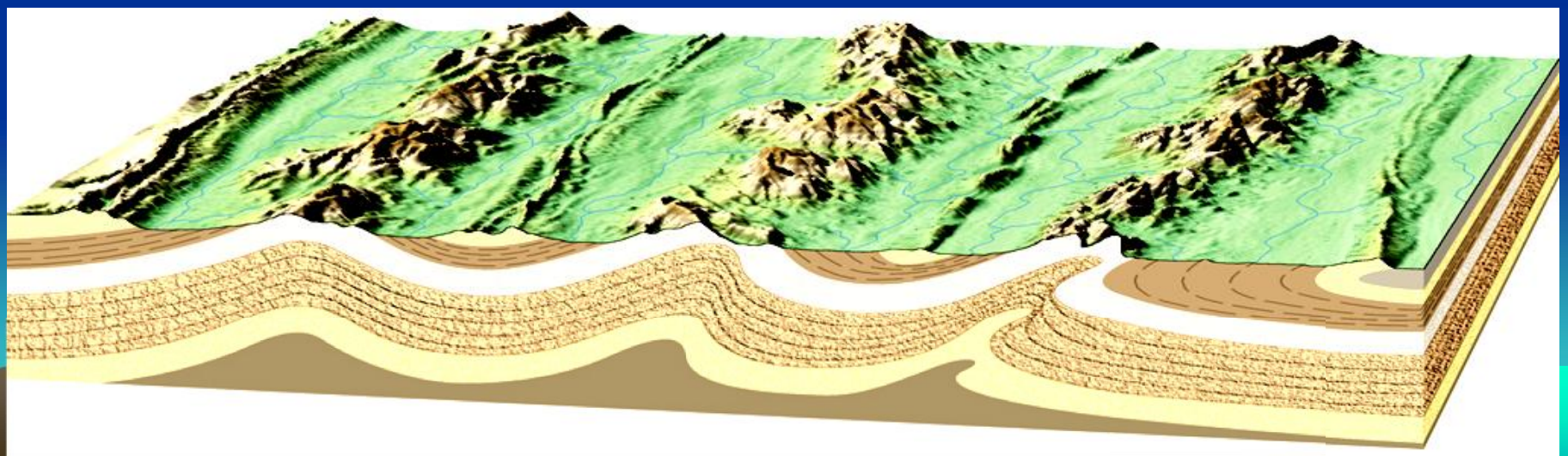
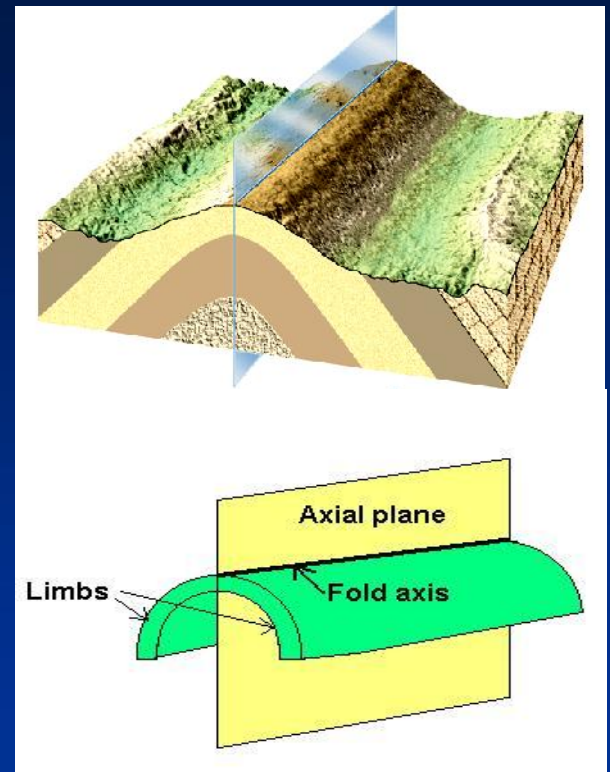
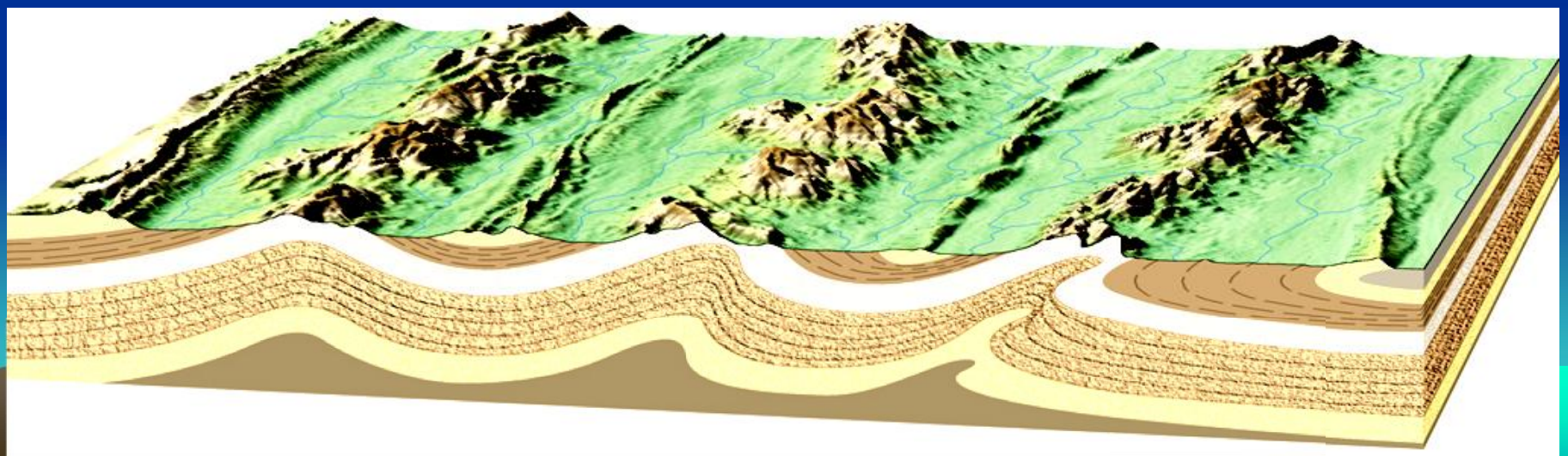


FIGURE 14.7 The axial surface of a fold can be: A. Vertical in **upright folds**; B. inclined in **inclined folds**; C. inclined so much that opposite limbs dip in the same direction in **overturned folds**; D. horizontal in **recumbent folds**. (Adapted from Jones, 2001: Laboratory Manual for Physical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





# Fold Basics





# Rules of Folds

## Anticlines

- 1) Oldest unit in center
- 2) Limbs dip outward

## Synclines

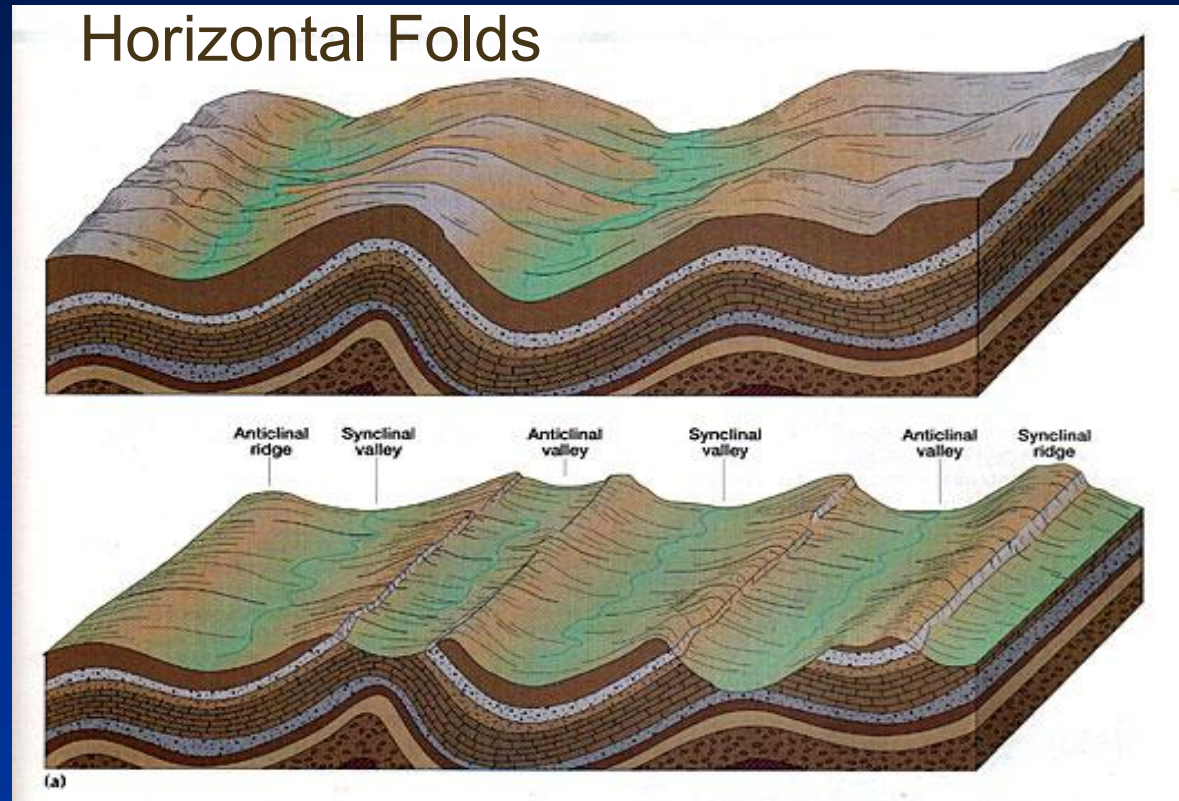
- 1) Youngest unit in center
- 2) Limbs dip inward

## Horizontal Folds

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

## Plunging Folds

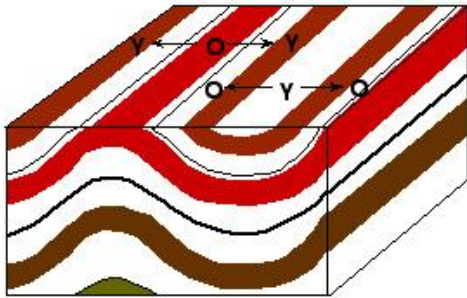
- 1) Strikes of opposing fold limbs are not parallel
- 2) Folds form V-shaped pattern on geology map
- 3) Anticlines plunge toward closed end of "V"-shaped bedding pattern
- 4) Synclines plunge toward open end of "V"-shaped bedding pattern





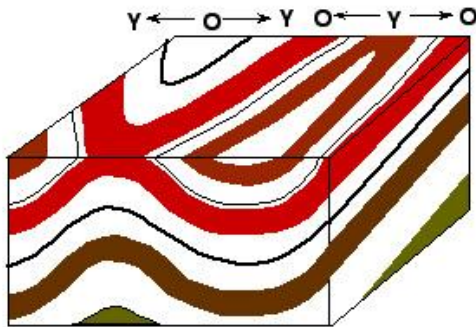
# Plunging Folds

## Plunging Folds

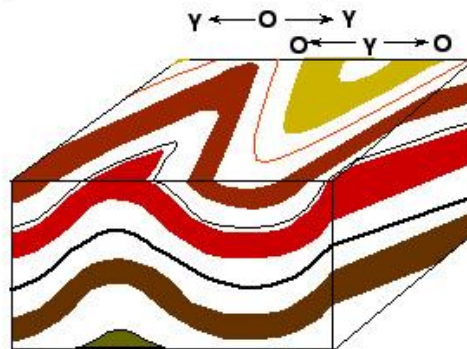


Anticline and Syncline in 3-dimensional view

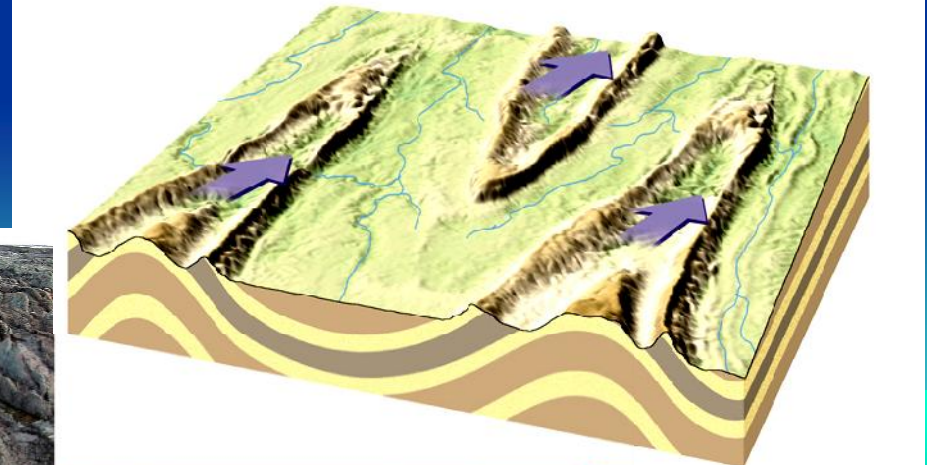
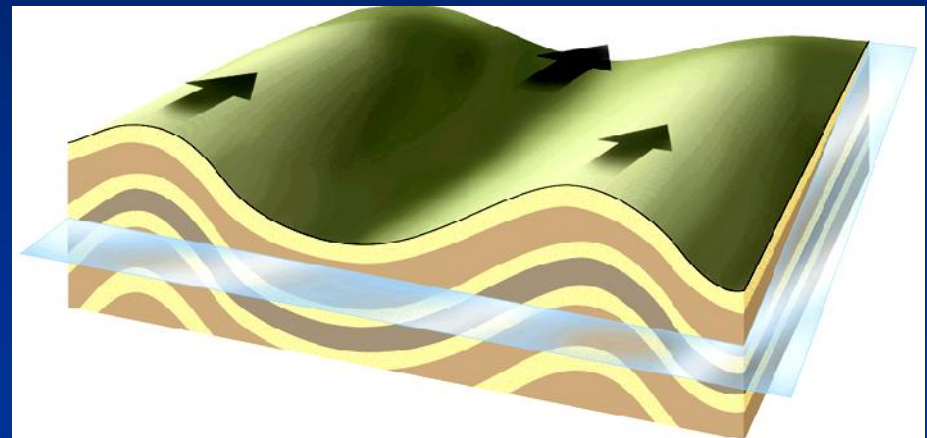
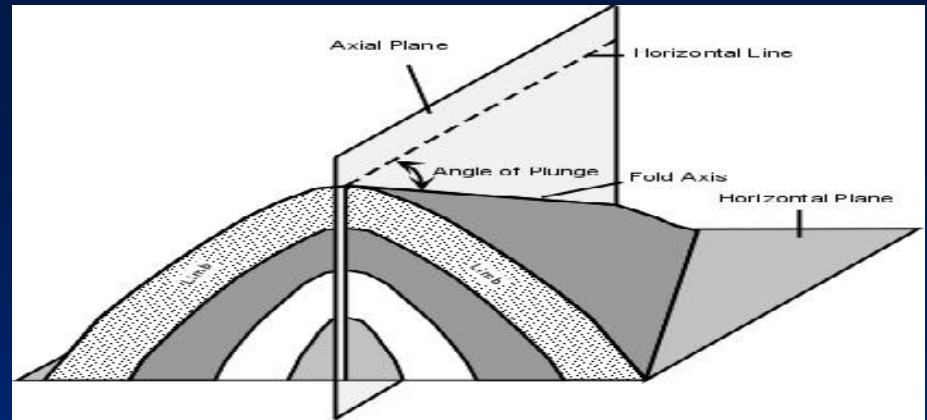
Oldest beds are in centers of anticlines; youngest beds are in centers of synclines.



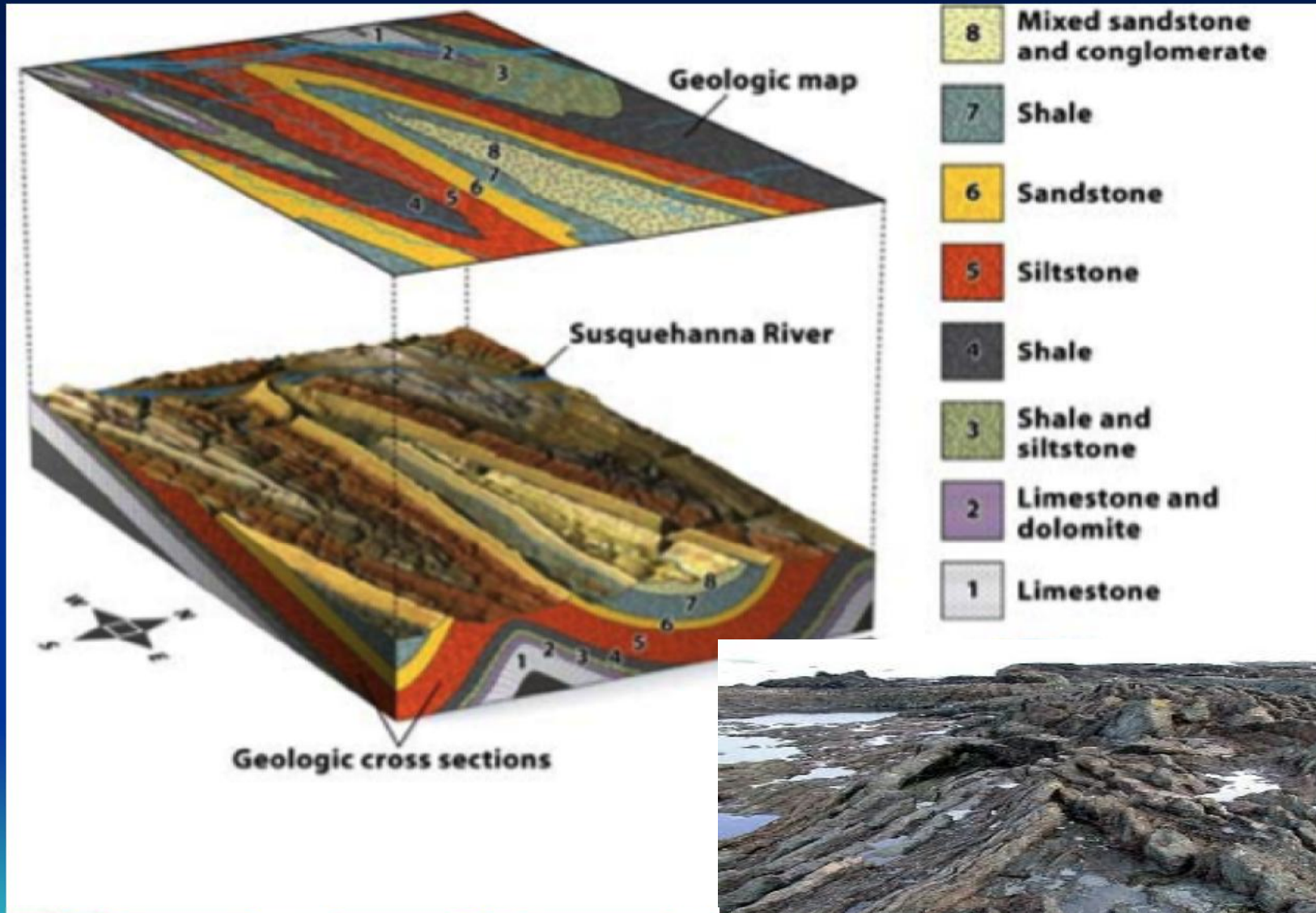
Anticline and Syncline plunging toward viewer



Anticline and Syncline plunging away from viewer

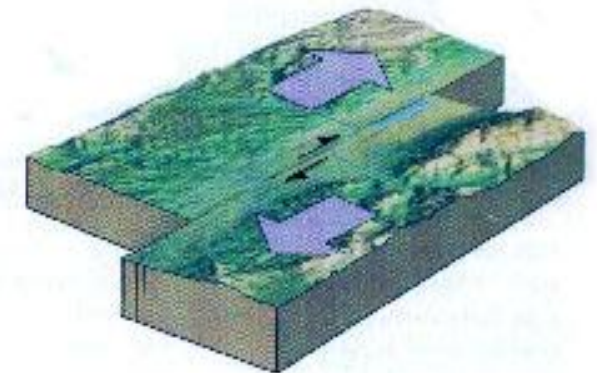
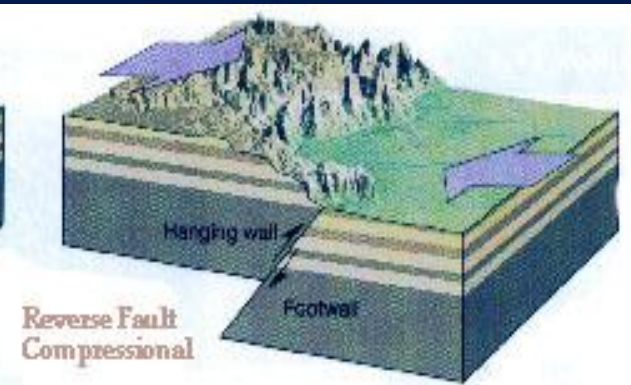
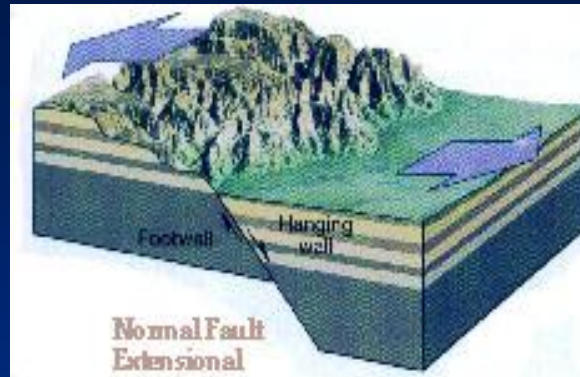
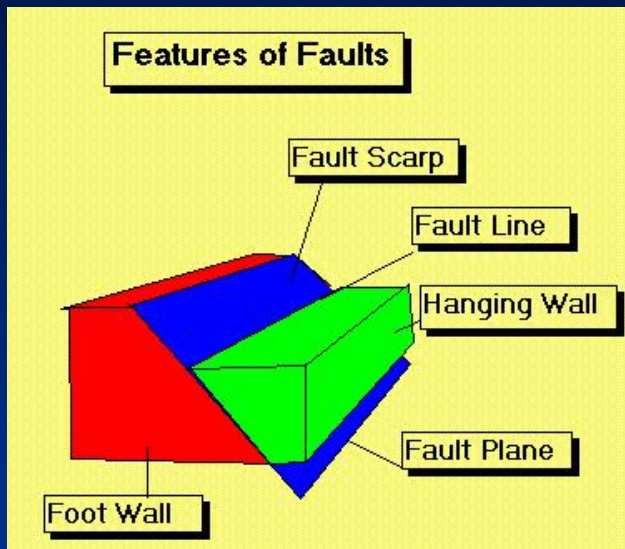


# Plunging Folds

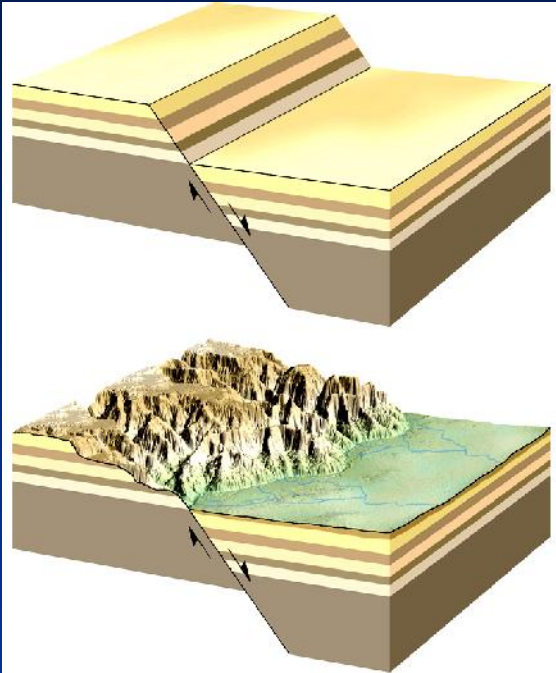




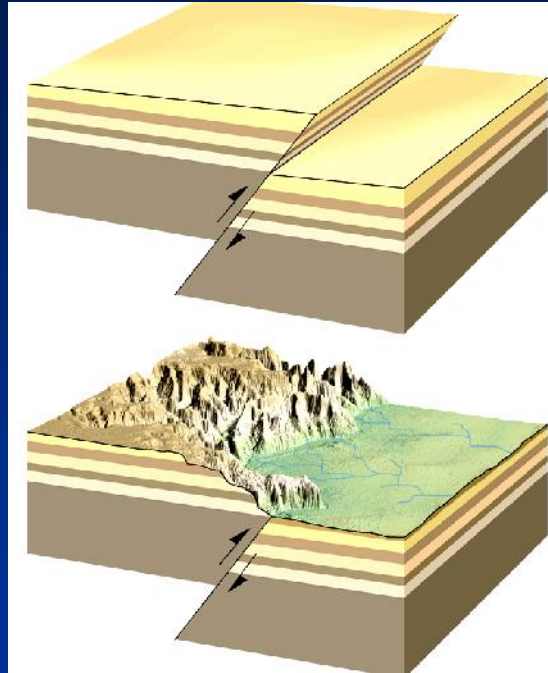
# Fault Terminology



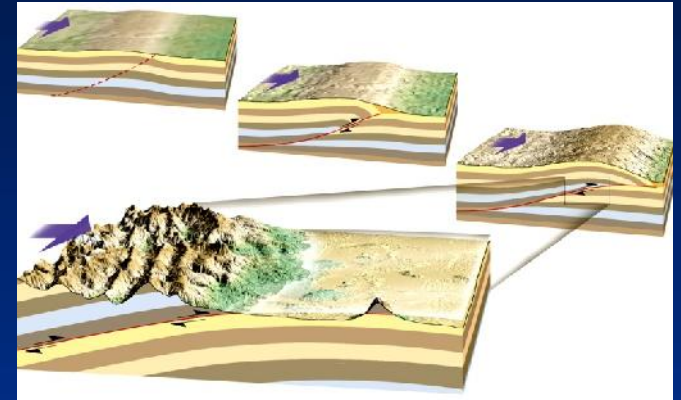
# Types of Faults



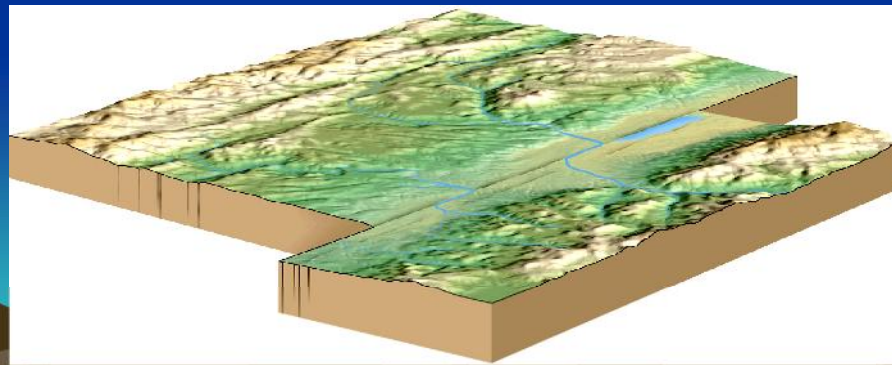
**Normal Fault**



**Reverse Fault**



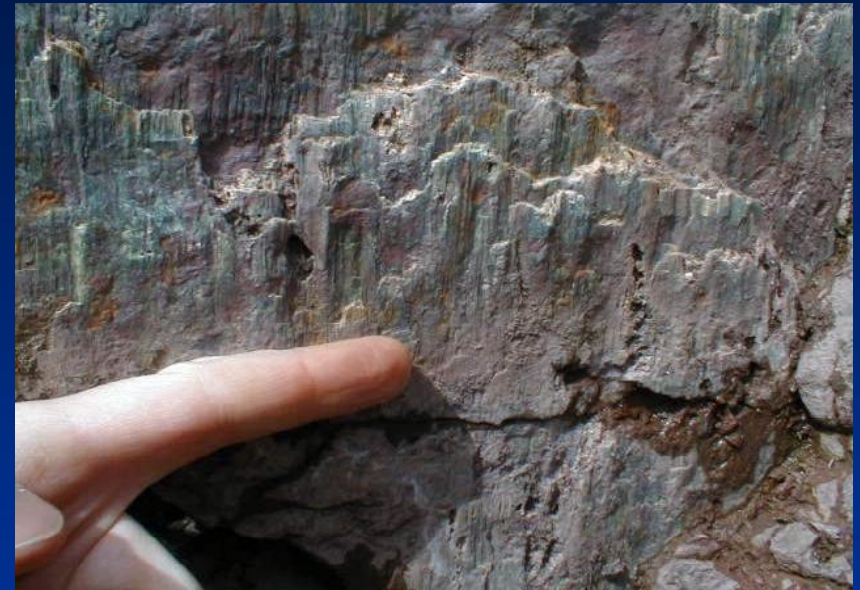
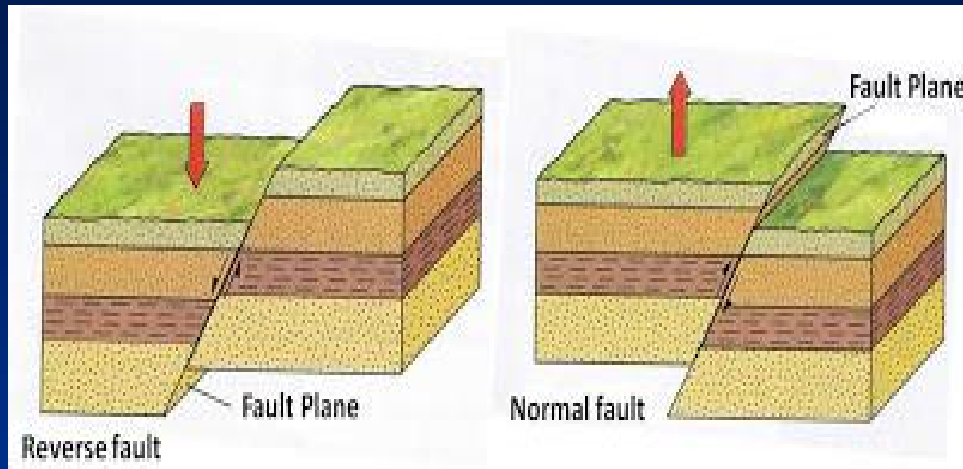
**Thrust Fault**



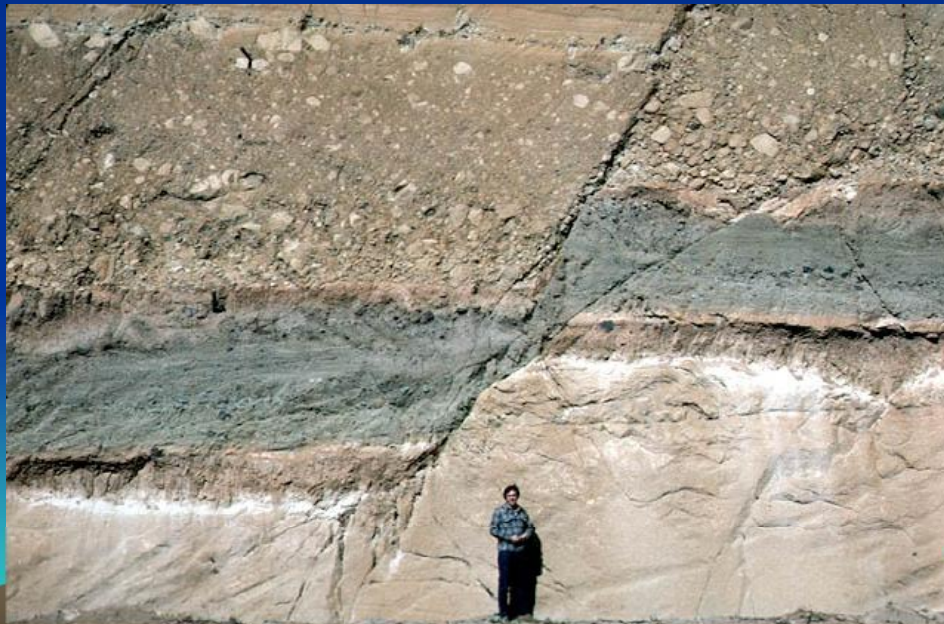
**Strike-Slip Fault**



# Fault Slickensides



Dip-slip oriented slickensides

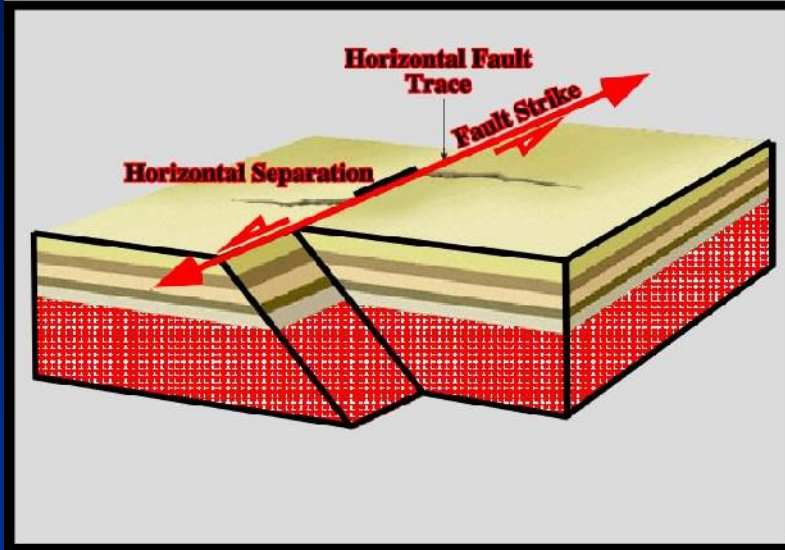


Normal-sense, dip-slip offset



# Fault Slickensides

## Strike Slip Movement



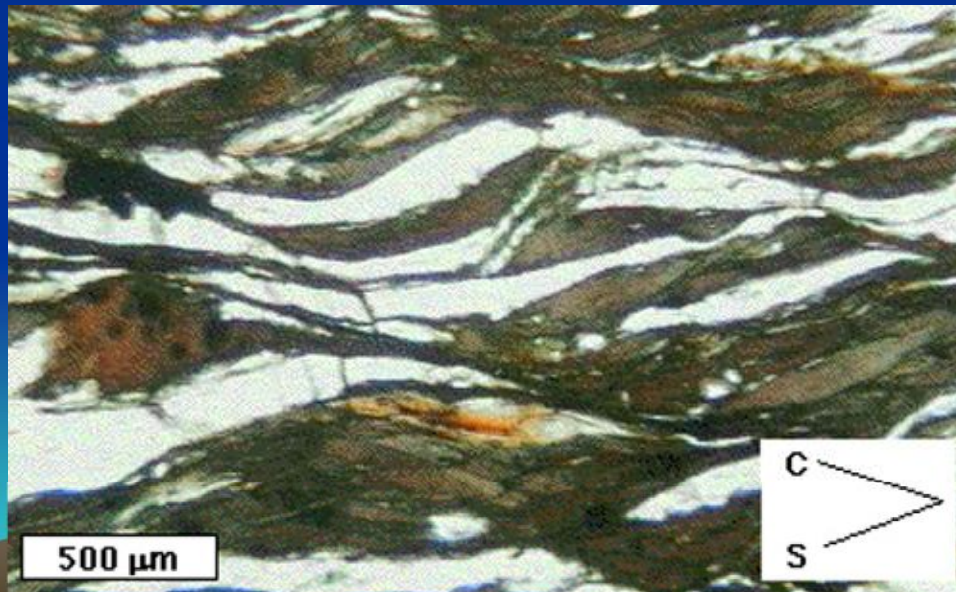
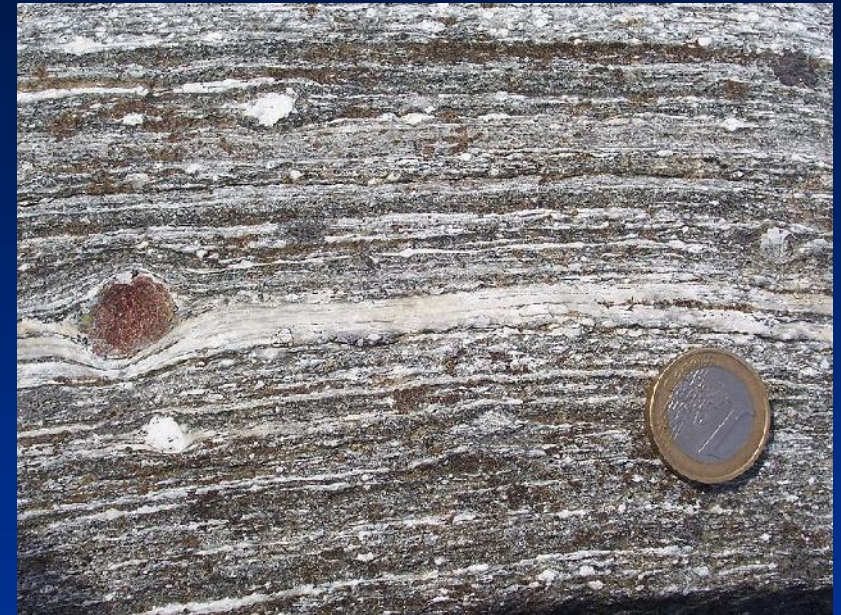
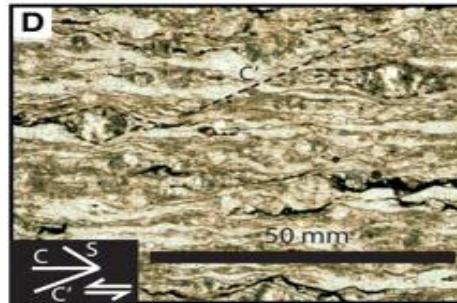
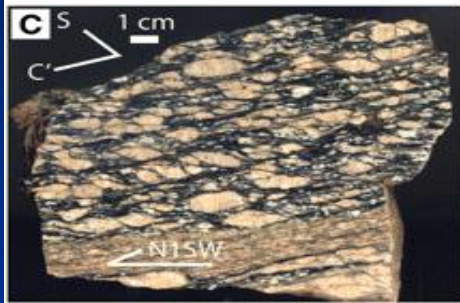
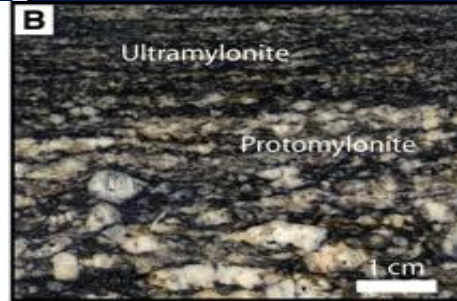
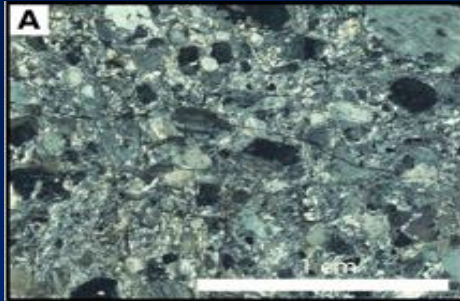
Strike-slip oriented slickensides



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".

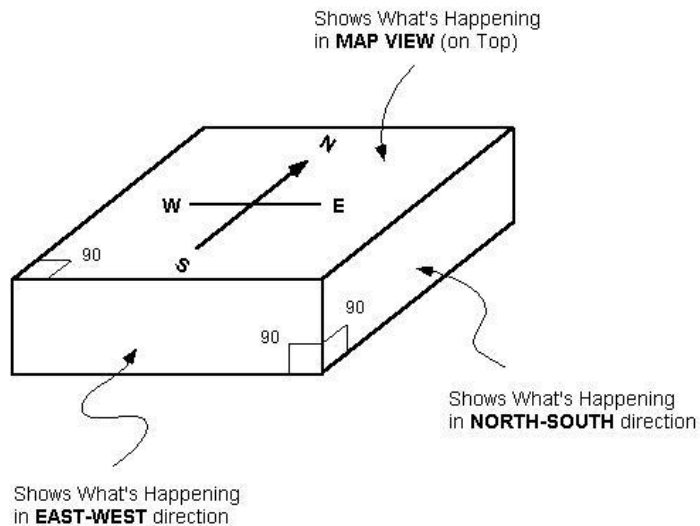
# The Basic Rules of Structure

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

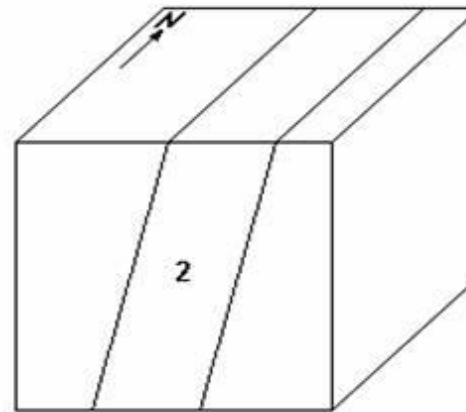


# Working with Block Diagrams

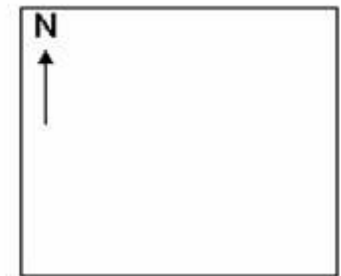
## A GUIDE TO BLOCK DIAGMS



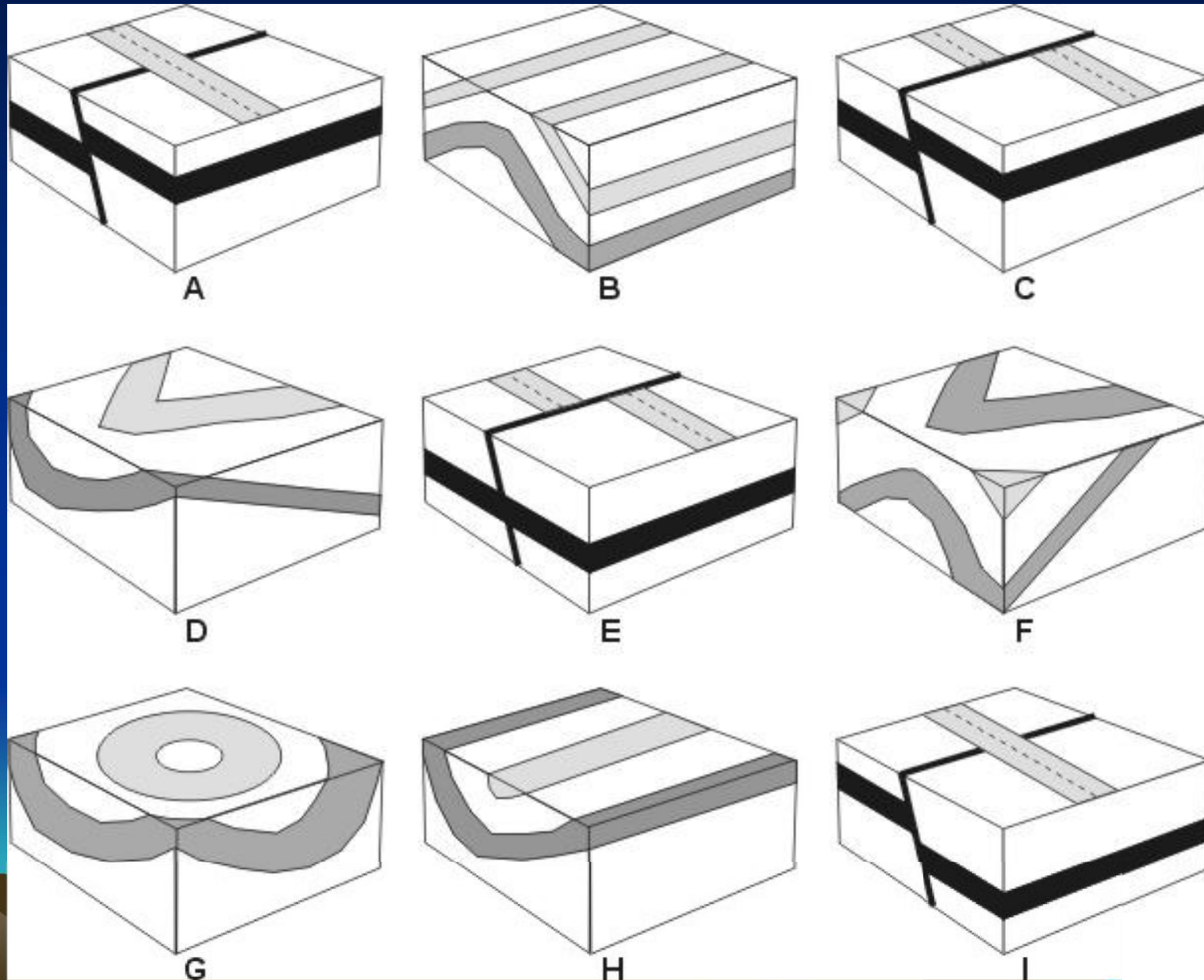
## BLOCK DIAGRAM



## MAP VIEW



# Working with Block Diagrams

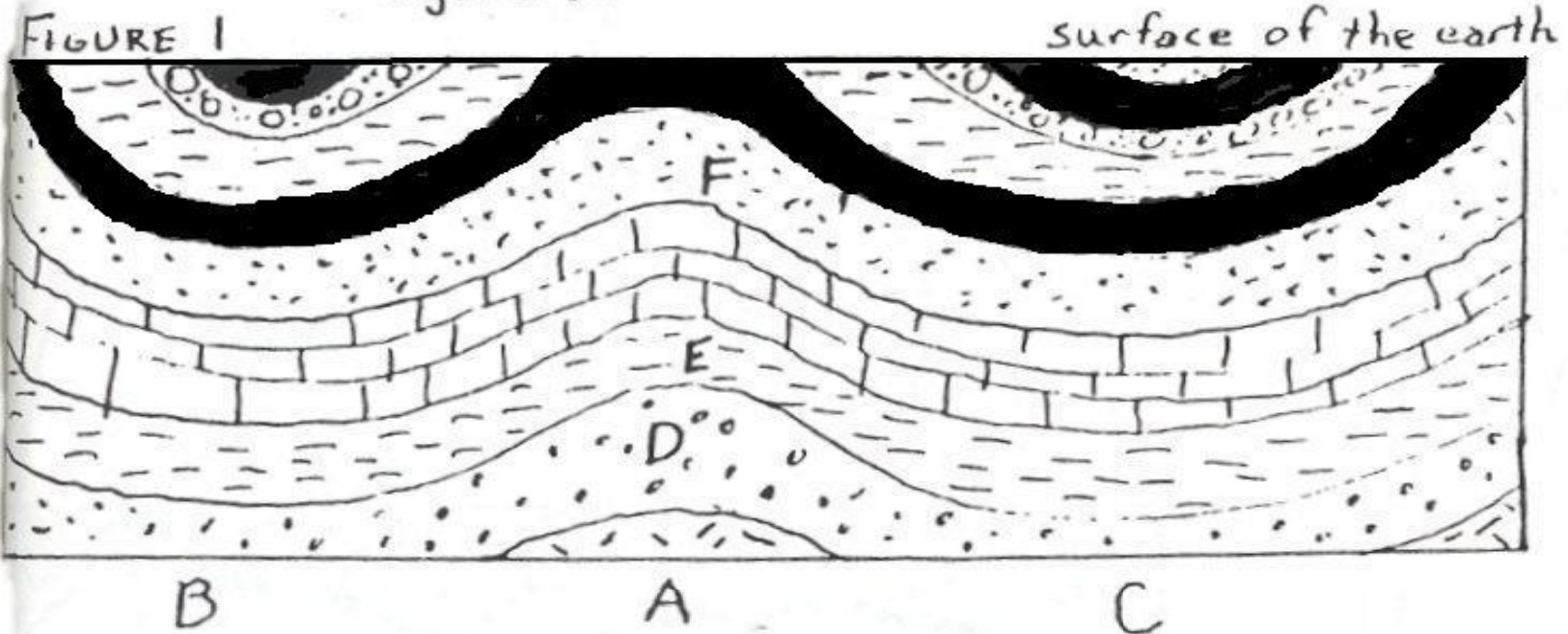




# Working with Block Diagrams



Figure 2



# Geologic Map of North America



U.S. DEPARTMENT OF THE INTERIOR  
U.S. GEOLOGICAL SURVEY



Scale: 1:500,000  
North Arrow

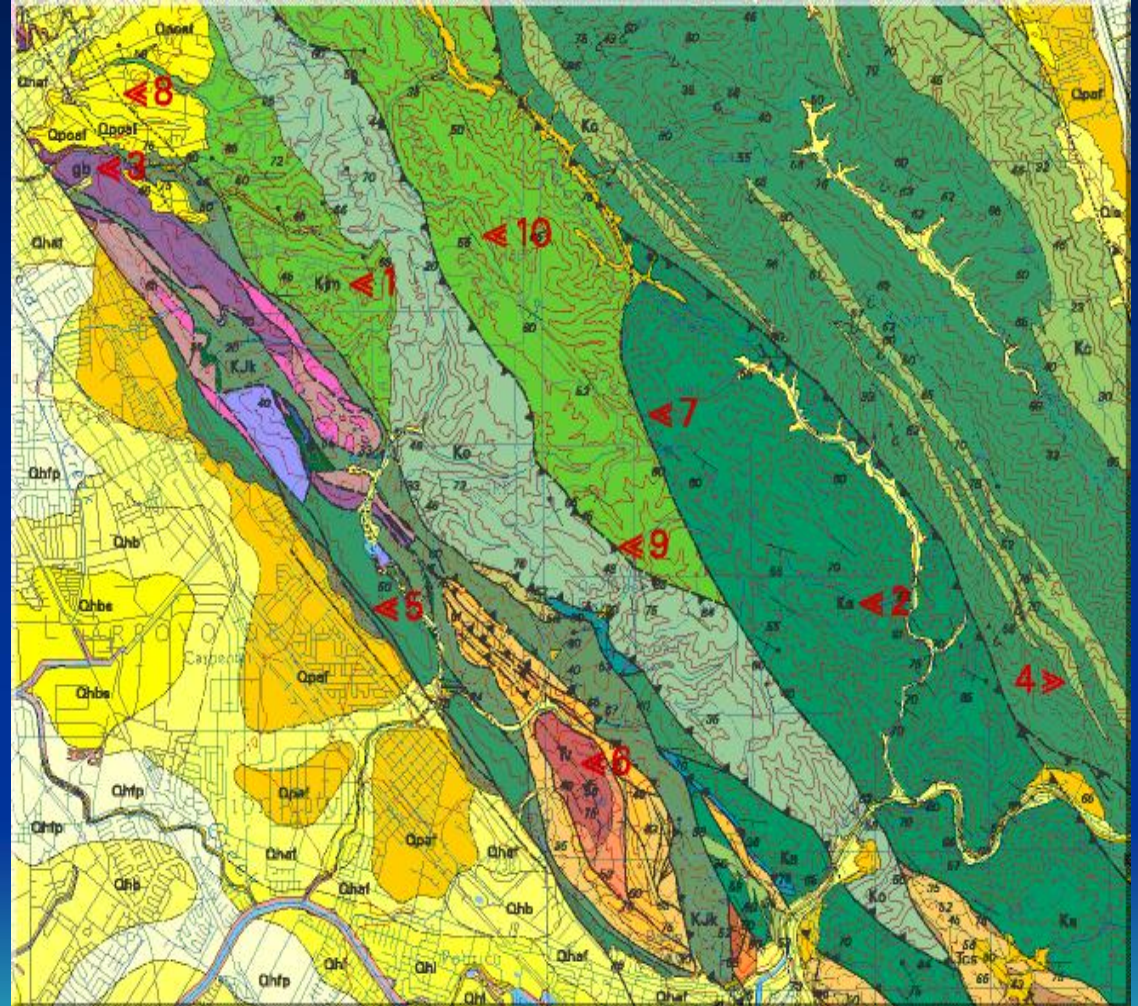






# What is a Geology Map

- 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



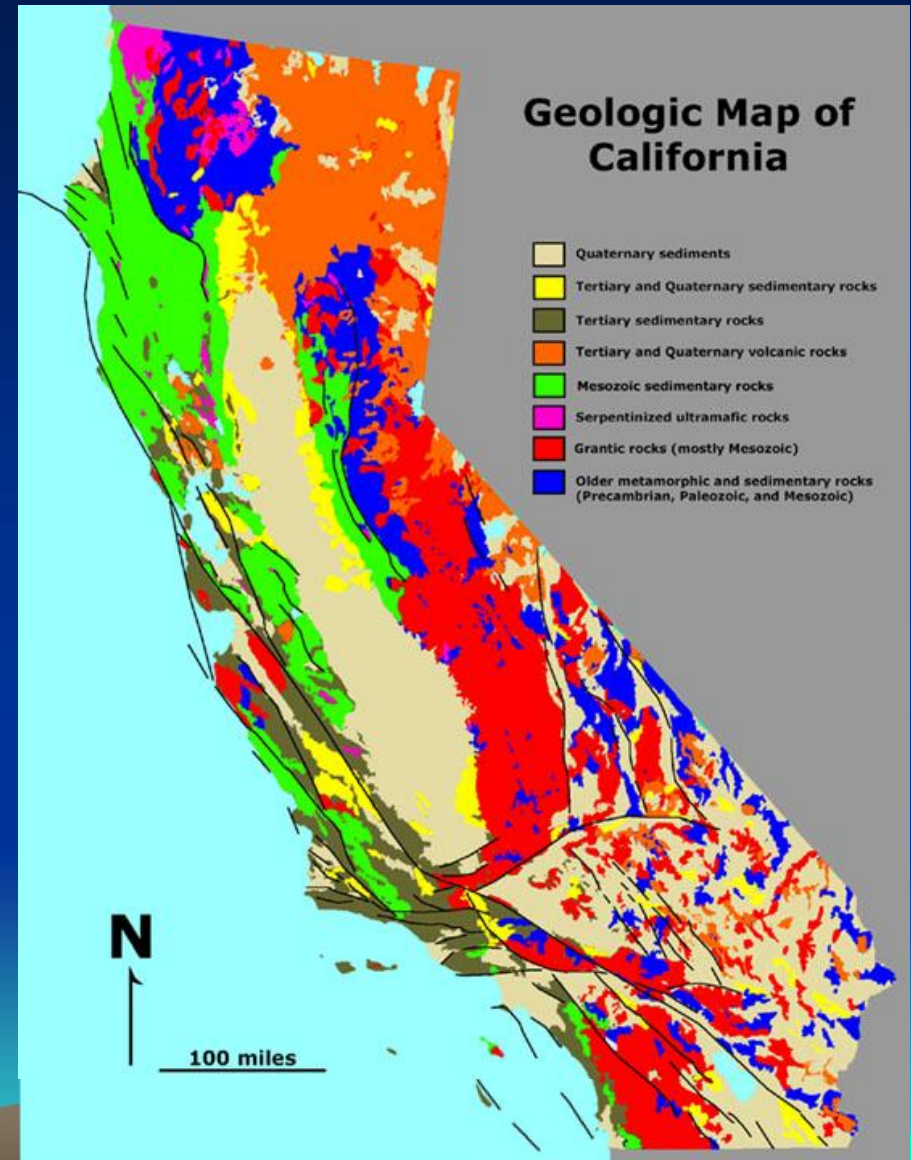


# Usefulness of Geology Maps

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


MAP KEY	
 af - Artificial Fill (Historic)	 Contact
 alf - Artificial Levee Fill (Historic)	 Contact, approximately located
 Qhlf - Alluvial Fan Deposits (Holocene)	 Contact, inferred
 Qhfp - Floodplain Deposits (Holocene)	 Contact, concealed
 Qhfb - Flood Basin Deposits (Holocene)	 Fault
 Qhbs - Salt Affected Flood Basin Deposits (Holocene)	 Fault, approximately located
 Qhl - Natural Levee Deposits (Holocene)	 Fault, inferred
 Qpaf - Alluvial Fan Deposits (Pleistocene)	 Fault, uncertain
 Qpof - Older Alluvial Fan Deposits (Pleistocene)	 Fault, concealed
 Tv - Unnamed volcanic rocks (Miocene)	 Fault, concealed and uncertain
 Tor - Ocala conglomerate (Miocene)	 Oblique fault with thrust or reverse component
 Tbr - Briones sandstone (Miocene)	 Oblique fault with thrust or reverse component, approximately located
 Tt - Tice shale (Miocene)	 Oblique fault with thrust or reverse component, inferred
 Tcs - Claremont shale (Miocene)	 Oblique fault with thrust or reverse component, uncertain
 Ts - Soberanes sandstone (Miocene)	 Strike and dip of bedding
 Tsh - Unnamed shale and sandstone (Miocene)	 Strike and dip of overturned bedding
	 Strike and dip of vertical bedding

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

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

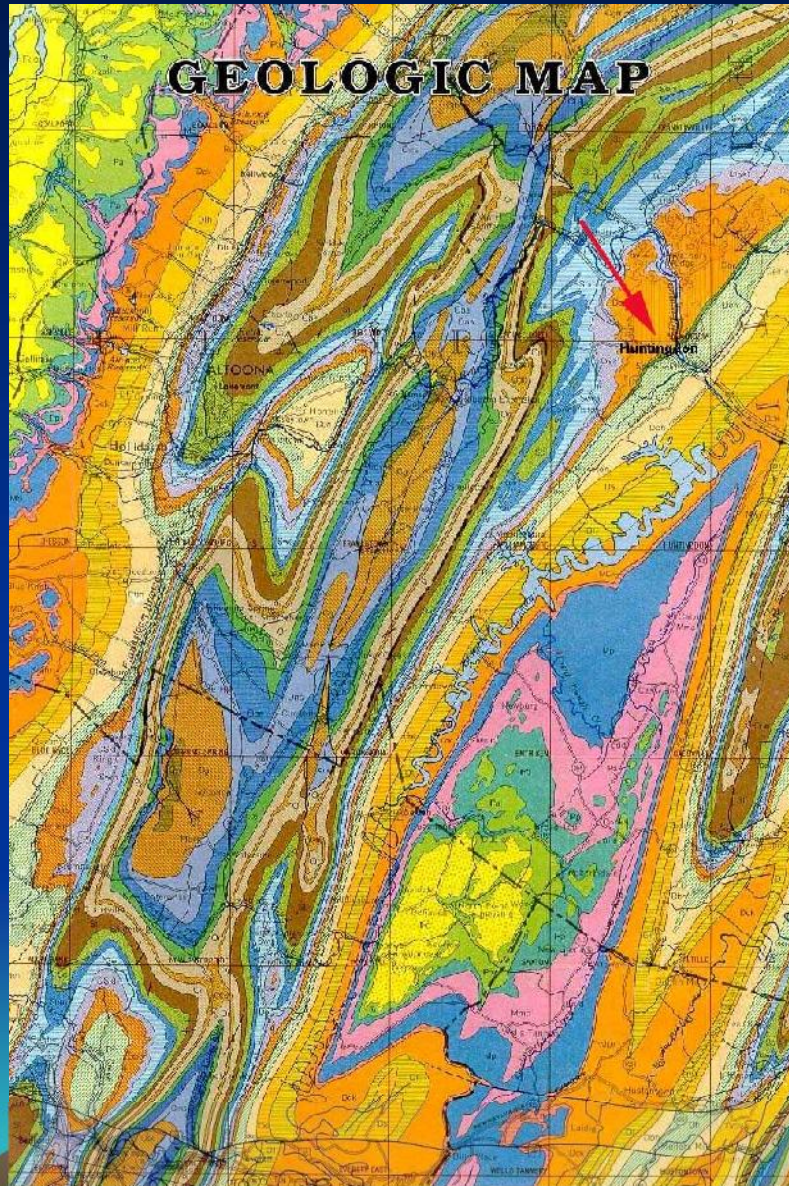


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- 



# Geologic Maps – Artwork?



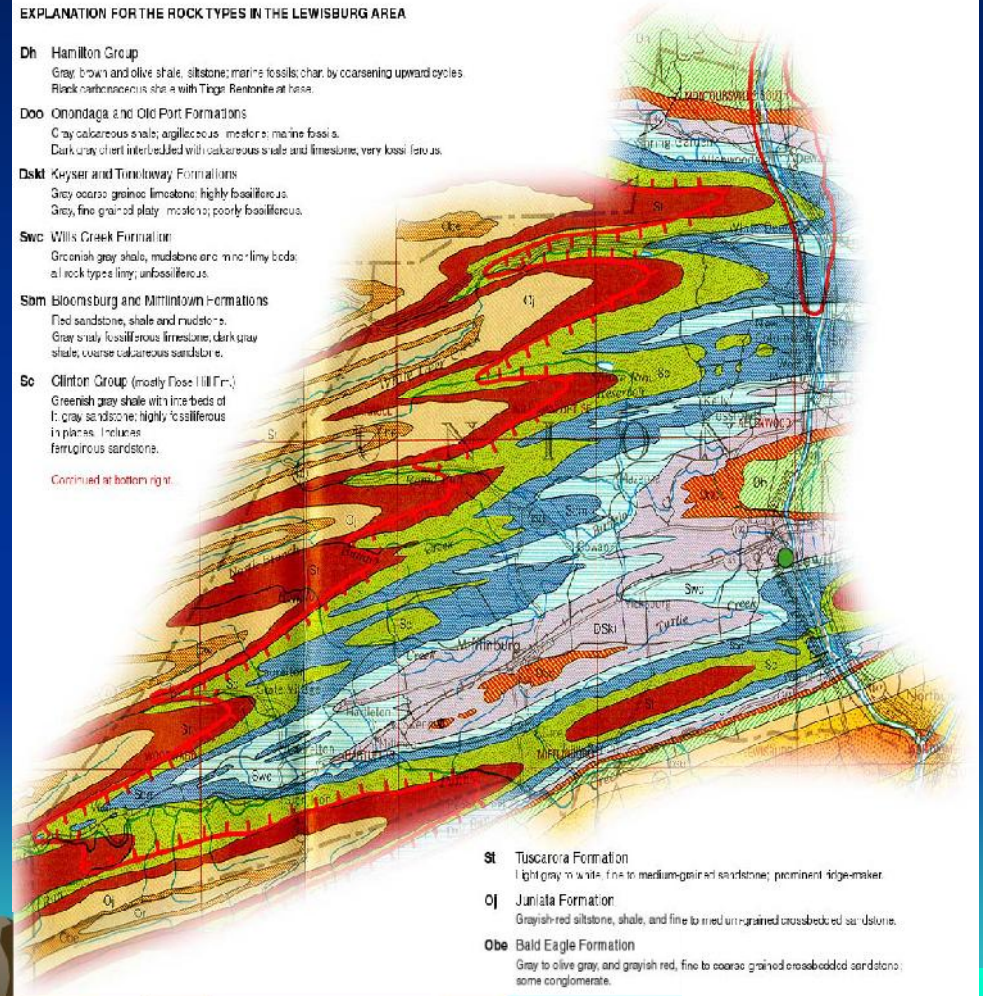
## Union County Geology

The map below is a scan from the Geologic Map of Pennsylvania (1980) focusing on Union County. The location of Bucknell University is represented by the green circle located along the eastern portion of the map. Descriptions for the rock types have been modified from the original map to more accurately describe the geology of the Union County area (from mapping by Dr. Richard P. Nickelsen, Bucknell University).

### EXPLANATION FOR THE ROCK TYPES IN THE LEWISBURG AREA

- Dh** Hamilton Group  
Gray brown and olive shale, siltstone, marine fossils; char. by coarsening upward cycles. Black carbonaceous shale with *Tingia*, *Rensselaeria* at base.
- Doo** Onondaga and Old Port Formations  
Gray calcareous shale; argillaceous, medior. marine fossils. Dark gray, often interbedded with calcareous shale and limestone, very fossiliferous.
- Dskl** Keyser and Tintinaway Formations  
Gray coarse grained limestone, highly fossiliferous.  
Gray, fine grained slaty, (massive), poorly fossiliferous.
- Swc** Willis Creek Formation  
Greenish gray shale, mudstone and thin limy beds.  
all rock types limy, unfossiliferous.
- Sbm** Bloomsburg and Mifflintown Formations  
Red sandstone, shale and mudstone.  
Gray shaly, fossiliferous limestone, dark gray shale, coarse calcareous sandstone.
- Sc** Clinton Group (mostly Foss Hill Fr.)  
Greenish gray shale with thin beds of l. gray sandstone; highly fossiliferous in places. Includes ferruginous sandstone.

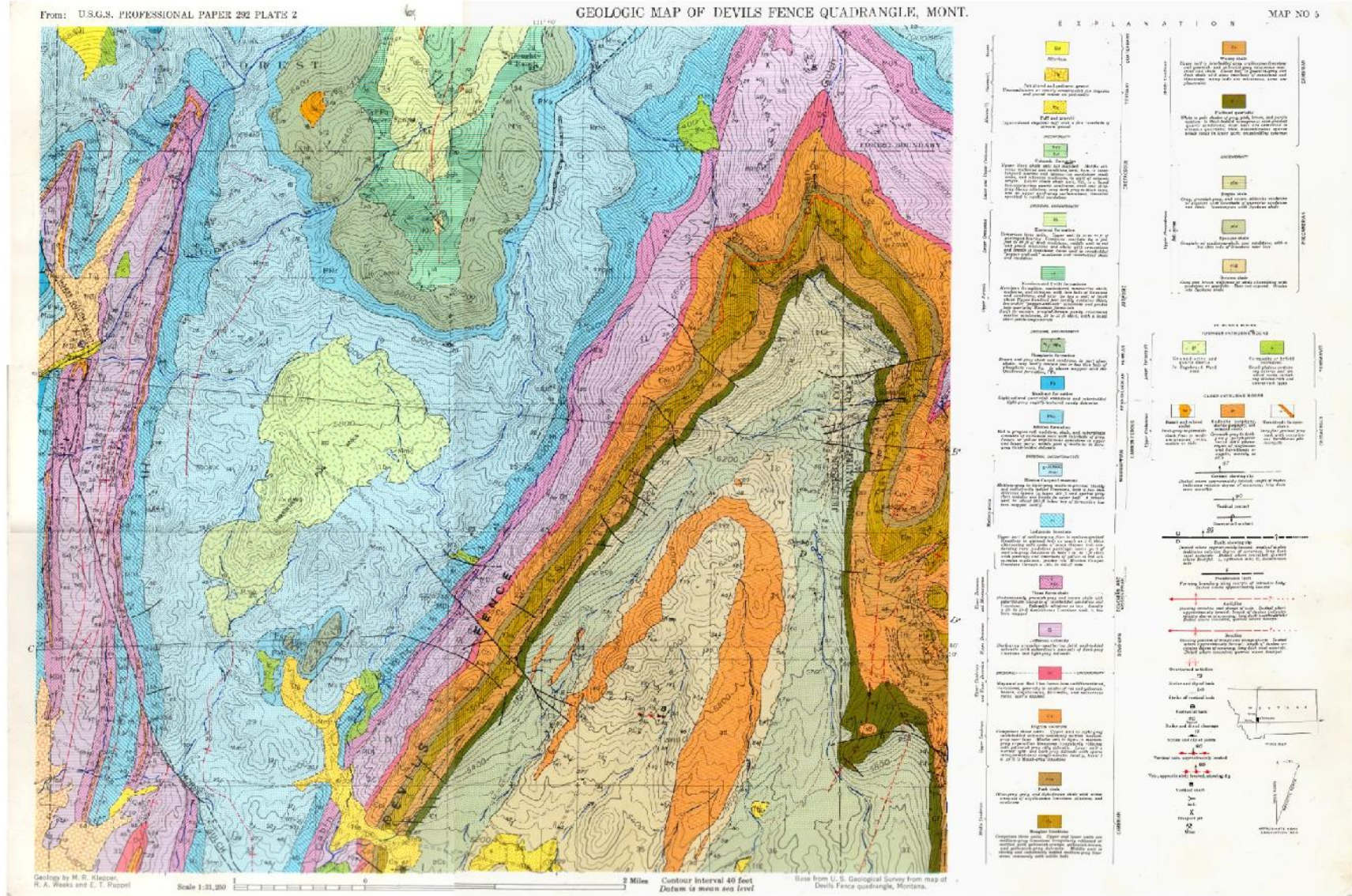
Continued at bottom right.



- St** Tuscarora Formation  
Light gray to white, fine to medium grained sandstone; prominent trigemaster.
- Oj** Juniata Formation  
Grayish-red siltstone, shale, and fine to med. gr. ungrained crossbedded sandstone.
- Obe** Bald Eagle Formation  
Gray to olive gray, and grayish red, fine to coarse grained crossbedded sandstone; some conglomerate.

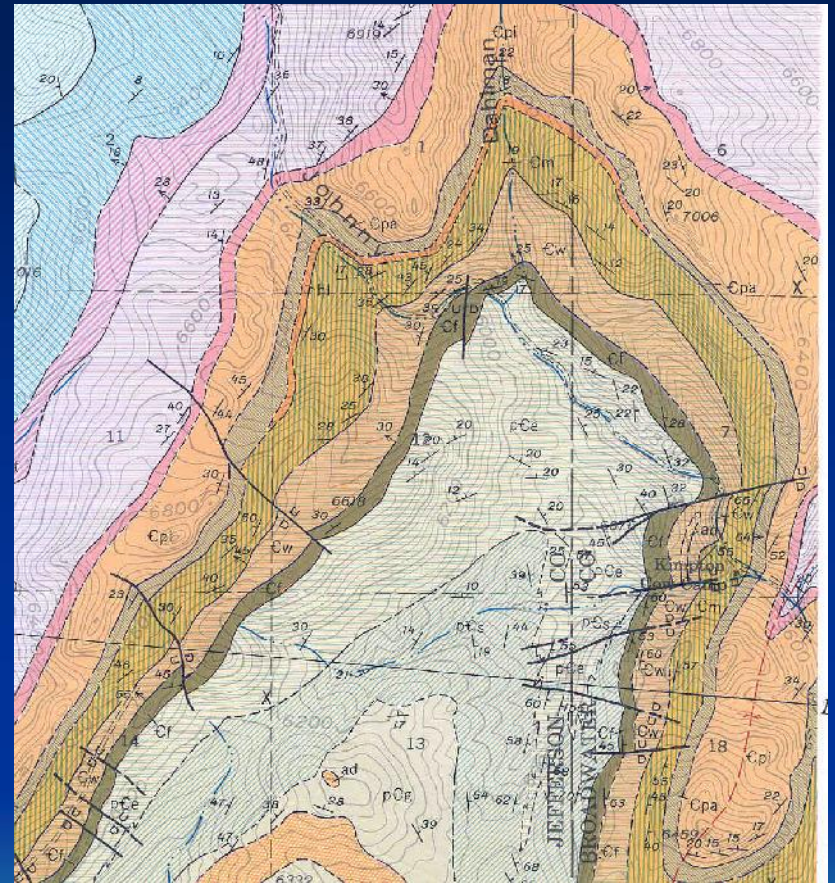
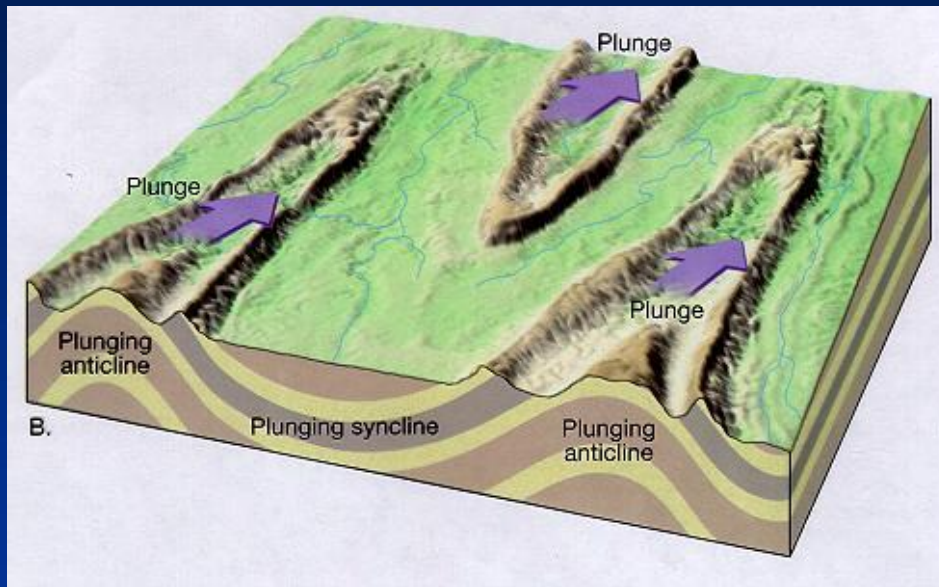


# Geologic Maps – Devil’s Fence Quad



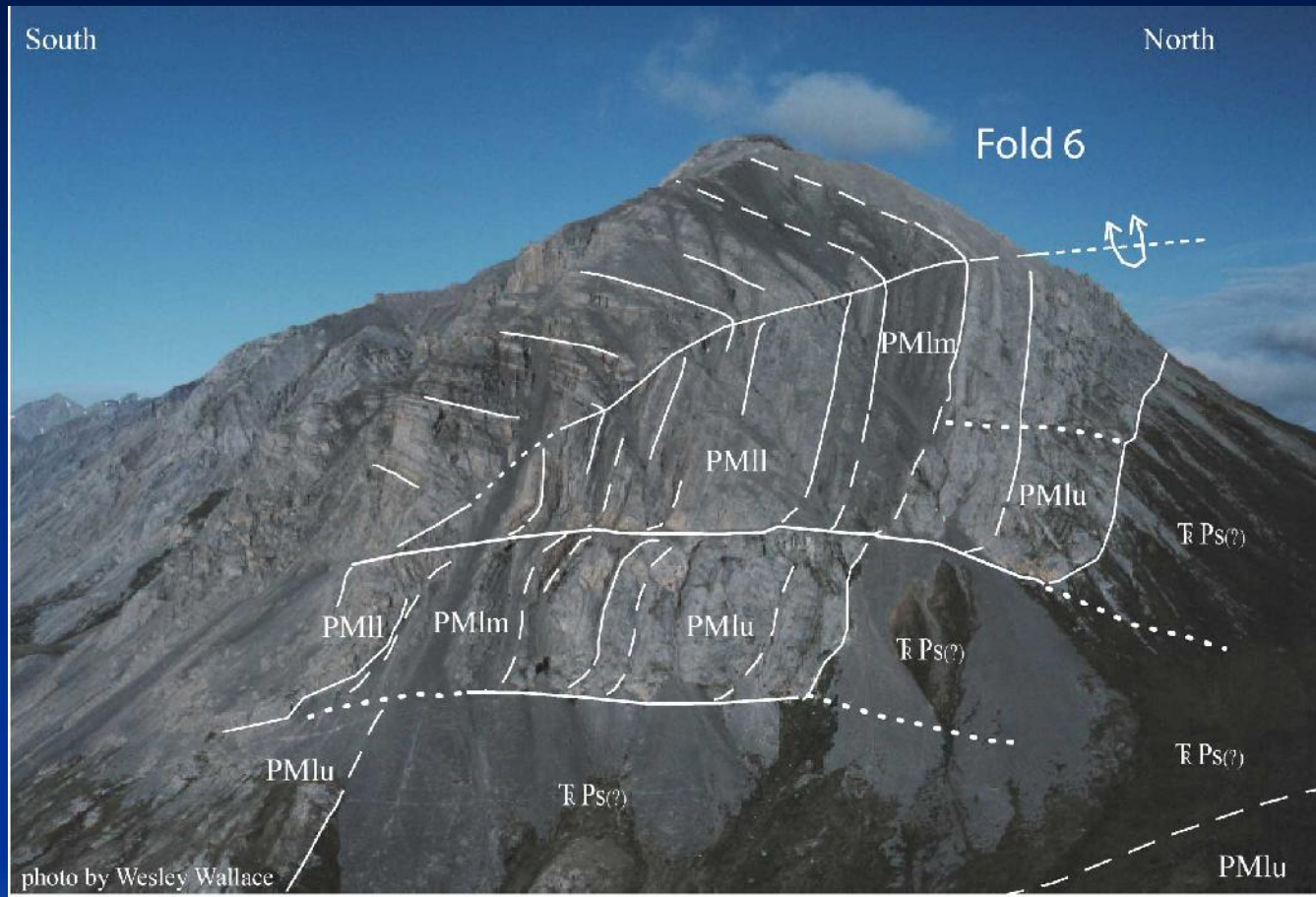


# Folds and Geologic Maps





# Structure Web References



<http://www.nature.nps.gov/geology/usgsnps/gmap/gmap1.html#unique>

<http://www.globalchange.umich.edu/Ben/ES/earthstructure.htm>

<http://www.winona.edu/geology/MRW/maps.htm>

<http://www.nps.gov/archive/yell/slidefile/scenics/outsideynp/Page.htm>