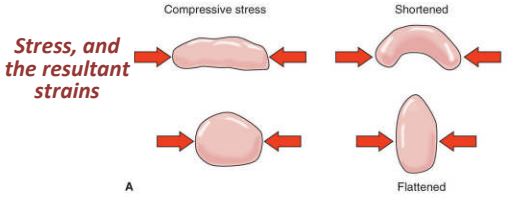
Chapter Outlines

NOTE: This is intended to help students 'organize' their understanding of each topic. It is <u>not</u> a comprehensive study guide for quizzes or midterms, i.e. <u>study your text!</u>

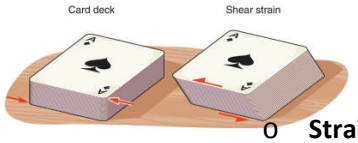
Geologic Structures

Geologic structures are usually the result of the powerful tectonic forces that occur within Earth. These forces very very slowly fold and break rocks, form deep faults, and build mountains. Repeated applications of force—the folding of already folded rocks or the faulting and offsetting of already faulted rocks—can create a very complex geologic picture that is difficult to interpret. Most of these forces are related to plate tectonic activity. Some of the natural resources we depend on, such as metallic ores and petroleum, often form along or near geologic structures.

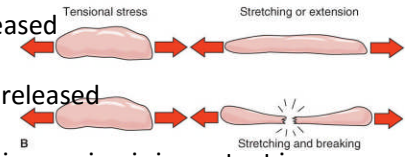


Stress, and the resultant strains

- **Tectonic Forces** – Rocks at depth are under stress.
  - **Stress** *(force per unit area)*
    - **Tensional** stress – pulling apart
    - **Compressive** stress – pushing together
    - **Shear** stress – sliding past *(offset compression)*
  - **Strain** – the result of stress *(behavior of rock when stressed).*
    - **Elastic** strain – material returns to original shape when stress is released
    - **Brittle** strain – material will brake instead of deforming
    - **Plastic** strain – material will retain its new shape when the stress is released



An example of 'shear'



- **Interpreting Structures** – understanding the formation of geologic structures in a region is important in reconstructing its geologic history. Offsets, rearrangement, and burial make geologic interpretation more difficult. Structural events can be inferred from how bedrock has moved.

- **Geologic Mapping** – the ease with which structural geology can be understood is largely dependent on how much of the bedrock is available for study. In areas such as northern Canada, where much of the bedrock has been exposed by glaciations, as much as 75 percent of the bedrock can be walked on and studied. Alternatively, in the southeastern United States, often less than 10 percent of the bedrock is exposed because of abundant weathering, soil cover, and vegetation. Reconstructing the geologic history of an area can be especially challenging *(and creative)* if little rock is exposed.
  - **Outcrops** – bedrock exposures can be used to identify…
    - Rock types, relationships, textures, and structures.
    - **Strike & dip** – a bed's intersection with an imaginary horizontal plane, & the angle of tilted beds.

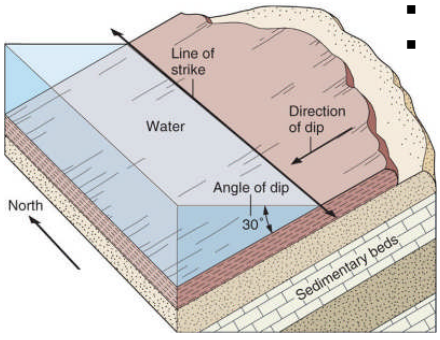
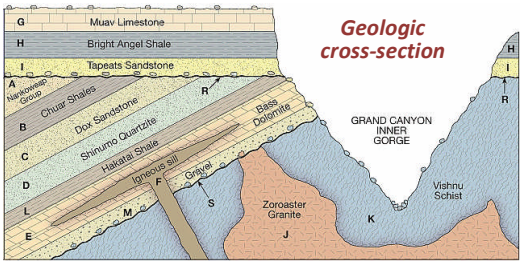


Illustration showing strike and dip (with an imaginary body of water)

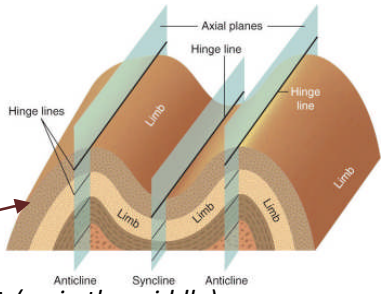
Sample of a geologic map

  - **Geologic maps** - shows locations & shapes of outcrops through the use of a variety of geologic symbols *(and a variety of colors!)*



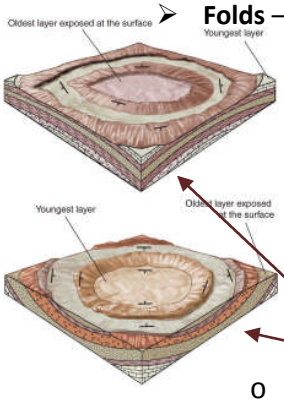
Geologic cross-section

- **Geologic cross section** – a vertical slice across a map area. It depicts the subsurface materials.



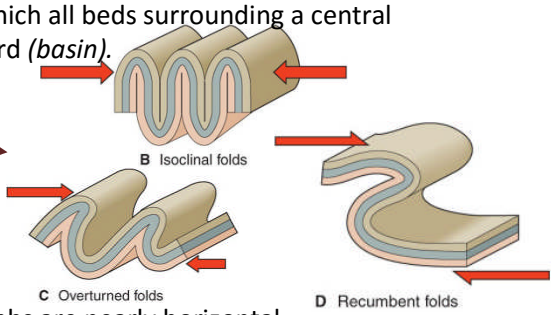
Parts of folds

- **Folds** – a layered rock that exhibits bends is said to be folded.
  - **Anticline** – fold with **limbs** arched downward from a common high point *(up in the middle)*
  - **Syncline** – fold with limbs arched upward from a common low point *(down in the middle)*
  - **Axial plane** – imaginary planar surface symmetrically separating the two limbs.
  - **Hinge line** – surface trace of an axial plane *(ground surface or bed surface)*
  - **Plunging folds** – An anticline or syncline in which the **hinge line** *(on bed surface)* is inclined
  - **Structural dome** & **structural basin** – are structures in which all beds surrounding a central area are either folded downward *(dome)* or folded upward *(basin)*.

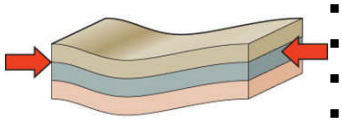


The surface expressions of a 'dome' and a 'basin'

Types of folds



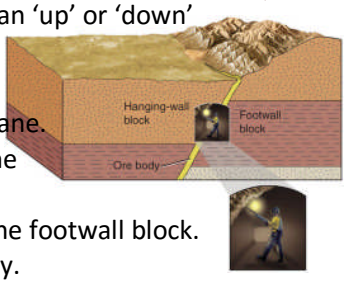
  - Types of folds:
    - **Open** - limbs dip *(or rise)* gently
    - **Isoclinal** – tightly compressed nearly parallel limbs
    - **Overturned** – both limbs dip in the same direction
    - **Recumbent** – overturned to the extent that both limbs are nearly horizontal

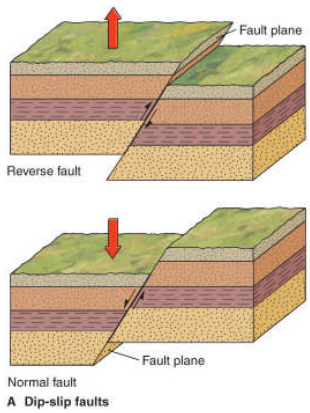


'Open' fold

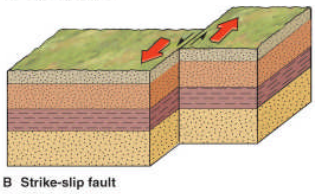
- **Fracturing** – when a rock which is hard and brittle is subjected to relatively sudden strain that overcomes its internal crystalline bonds 'breaks'.
  - **Joint** – are fractures that have had no horizontal or vertical displacement
  - **Fault** – is a fracture that has had horizontal or vertical displacement *(active fault if it has moved within the last 11,000 yrs)*

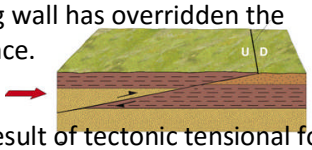
Illustration showing the 'hanging wall' & 'foot wall'



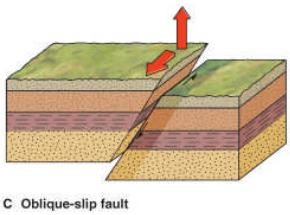


    - **Dip-slip faults** – movement is parallel to the dip of the fault plane in an 'up' or 'down' direction.
      - **Footwall** – the block that underlies the fault plane.
      - **Hanging wall** – the block that rests on top of the inclined fault plane.
      - **Normal fault** – the hanging block has slipped down the fault plane relative to the footwall.
      - **Reverse fault** – the hanging wall has moved upward relative to the footwall block.
    - **Strike-slip fault**– the blocks on either side of a fault move horizontally.
      - **Right-lateral** – the block on the opposite side of the fault *(relative to where you stand)* moves to your right. *(San Andreas is a right lateral strike-slip fault)*
      - **Left-lateral** - the block on the opposite side of the fault *(relative to where you stand)* moves to your left.
    - **Oblique-slip fault** – a fault that has both horizontal and vertical displacement.
    - **Thrust fault** – reverse dip-slip faults in which the hanging wall has overridden the footwall at a very shallow angle often over a great distance.





Thrust fault



  - **Fault blocks** *(the Basin & Range is an example)* – form as a result of tectonic tensional forces. Large blocks *(mountain-size)* slip downward forming basins which are bounded by normal faults and adjacent higher blocks. These higher blocks form the ranges.
    - **Graben** – name given to the descending block forming a basin.
    - **Horst** – name given to the higher block forming the adjacent 'range'.

Types of faults

Horst & graben