Structural Geology

Strike and Dip

• **Strike** is the direction of the line that is formed by the intersection of the plane of the rock bed with a horizontal surface.

• **Dip** is the direction in which the steepest angle is formed between the plane of the rock bed and the horizontal surface.
I think that the red bed came first, then green, then yellow, then black, then the whole sequence was tilted 45º to the North.

Common structural features

- Tilted beds
- Joints
- Faults
- Folds
- Boudinage

Stress and Strain

- Stress is a force applied over a volume of rock.
  - Compression, Tension, and Shear
- Strain is the deformation of a rock in response to stress.
  - Brittle, Ductile, and Elastic
Here the strain is more akin to brittle as the cards slide past each other without deforming.

GEOLOGIC STRUCTURES

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- Monoclinal folds
- Strike-slip (Transform) faults
- Normal faults
- Boudinage
- Folding
- Reverse faults (Thrust faults)
- Tension
- Compression
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- **STRAIN**: Brittle, Ductile, Elastic
- **STRESS**: Compression, Tension, Shear
Slickensides
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STRAIN
- Elastic
- Ductile
- Brittle

STRESS
- Compression
- Tension
- Shear

Elasticity and stress relationship:
- Elastic: behavior that returns to its original state after removal of stress.
- Ductile: behavior that deforms permanently without breaking.
- Brittle: behavior that breaks upon application of stress.
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[Image of geological structures and joint sets]

[Images of geological structures]
Continental Structure, Mountain Building and Differentially Weathered Landforms

**Shield or Craton** is the stable interior of a continent characteristically composed of ancient crystalline basement rock.

**Platform** is the relatively horizontal undeformed sedimentary rocks onlapping the basement rock.
ISOSTASY

The floating of the Earth’s crust on the denser mantle so that vertical motions take place to achieve a balance between upward buoyancy and downward gravity.

3 ways mountains can form.
1. Compressive belts
2. Fault block
3. Volcanic
Appalachian Orogeny

A. 600 million years ago

North America | Microcontinent | Island arc | Africa

B. 450–500 million years ago

North America | Blue Ridge/ Western Piedmont | Island arc | Africa

C. 400 million years ago

North America | Carolina Slate Belt/ Eastern Piedmont | Africa

D. 250–300 million years ago

North America | Valley and Ridge Province | Ancestral Atlantic | Africa

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Figure 14.12DE

Figure 14.12F

Figure 14.13

Cordilleran Orogeny

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Terranes are foreign pieces of land pasted on to the edge of a continent. Usually start of as ocean islands.

Fault-block mountains

- Mountains can also be formed by the extension of the Earth’s crust.
- Produces Horst and Graben topography in which the higher Horsts become mountains.
- Grand Teton mountains in Wyoming are a prime example of this type of mountain.
Epeirogeny and landforms

- Epeirogenic movements are gradual upward or downward movements of the continental crust.
- Occur with little deformation.
  - Minor tilting and slight faulting.
- Can still produce spectacular landforms when uplift occurs due to downcutting of stream systems and differential weathering.
Cuestas
Mass Wasting

• Shear stress vs. Shear strength
• Shear stress created by gravity pulling on a slope
  – Controlled by mass and slope
• Shear strength provided by the internal friction within the slope material

Safety factor (S.F.)

• S.F.=shear stress/shear strength
• S.F.<1
  – Shear stress<<Shear strength --> stable
• S.F.=1
  – Shear stress=Shear strength --> slope failure

Slope Stability

• Mass and slope
• Climate, Vegetation
• Water (groundwater)
• Materials
  – Rock type, sediment (fine vs. coarse), soil.

Classification of Mass Wasting

• RATE of MOVEMENT
  – Extremely slow (~1mm/year) to very rapid
  (>100 km/hour)
• MATERIAL IN MOTION
  – Bedrock
  – Debris- (“soil”, sediment)
Classification of Mass Wasting

Types of movement:
- Flows - materials mix together
  - creep, mud, debris, avalanche
- Slides - coherent blocks/units
  - translational
  - rotational
- Falls - free falling
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Controlling Factors

• Slope angle
• Local relief
• Thickness of debris over bedrock
• Planes of weakness (in bedrock)
  – bedding planes; foliation; joints
  – parallel to slope most dangerous
Controlling Factors

- Climatic controls
  - Ice
  - Water
  - Precipitation
  - Vegetation
- Gravity
  - Shear force
  - Normal force
  - Shear strength

Mass Wasting

Triggers:
- Natural/transient
  - Climate/Weather changes
    - Sudden increase in moisture
  - Earthquakes
- Anthropogenic
  - Loading
  - Slope perturbation (excavation or filling)
  - Changes in water content

Preventing Landslides

- Preventing mass wasting of debris
- Preventing rockfalls and rockslides on highways
Slope stabilization:
keeping the water out

Drains and trenches keep water from infiltrating the top of a slump
Revegetation and drainage

Mass Wasting Prevention
Water trapped in soil causes movement, pushing down retaining wall.

Water drains through pipe, allowing wall to keep slope from moving.

Safe and Hazardous Road Cuts

Planes of weakness in bed rock
Portion of hill removed
Stable
Unstable

Slope "Stitching" to Prevent Sliding

Short-term precaution against further water input and erosion
Revegetation and drainage