



Crustal Deformation and Mountain Building



What is a
mountain?



What is a mountain?

A landmass that projects conspicuously above its surroundings and is higher than a hill.

Types of Mountain Belts

- Volcanoes
- Collisional Mountains
- Fault-Block Mountains



Rocky Mountains





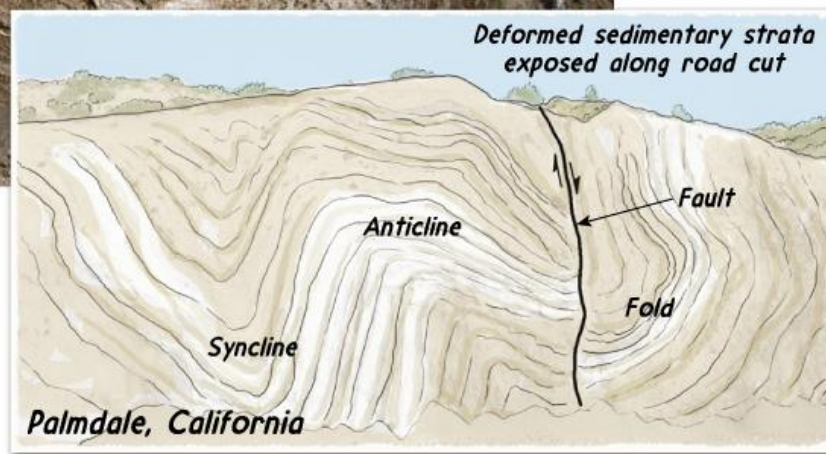
What is crustal deformation?



What is crustal deformation?

All the changes that occur in the shape or position of a rock body in response to stress. (interaction of tectonic plates)

- *Folds*
- *Faults*
- *Joints*



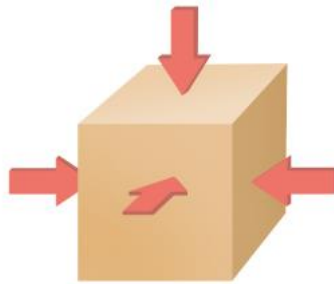
Geologist's Sketch



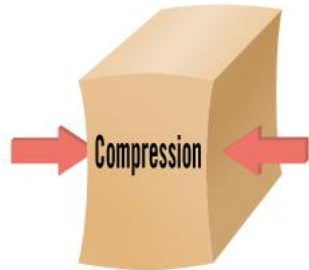
It's all about
Stress!!

Types of stress:

- Compressional
- Tensional
- Shear



A. Confining pressure



**B. Compressional stress
(shortening)**

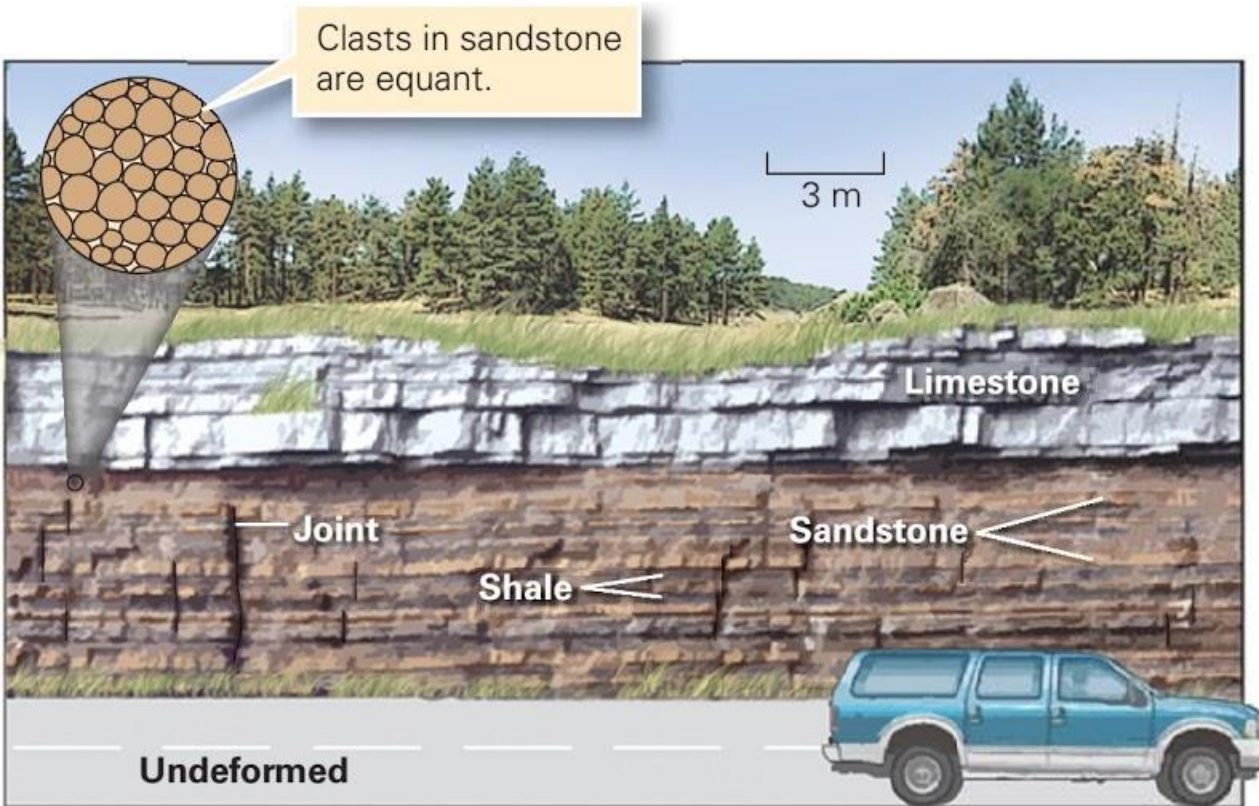


**C. Tensional stress
(stretching)**

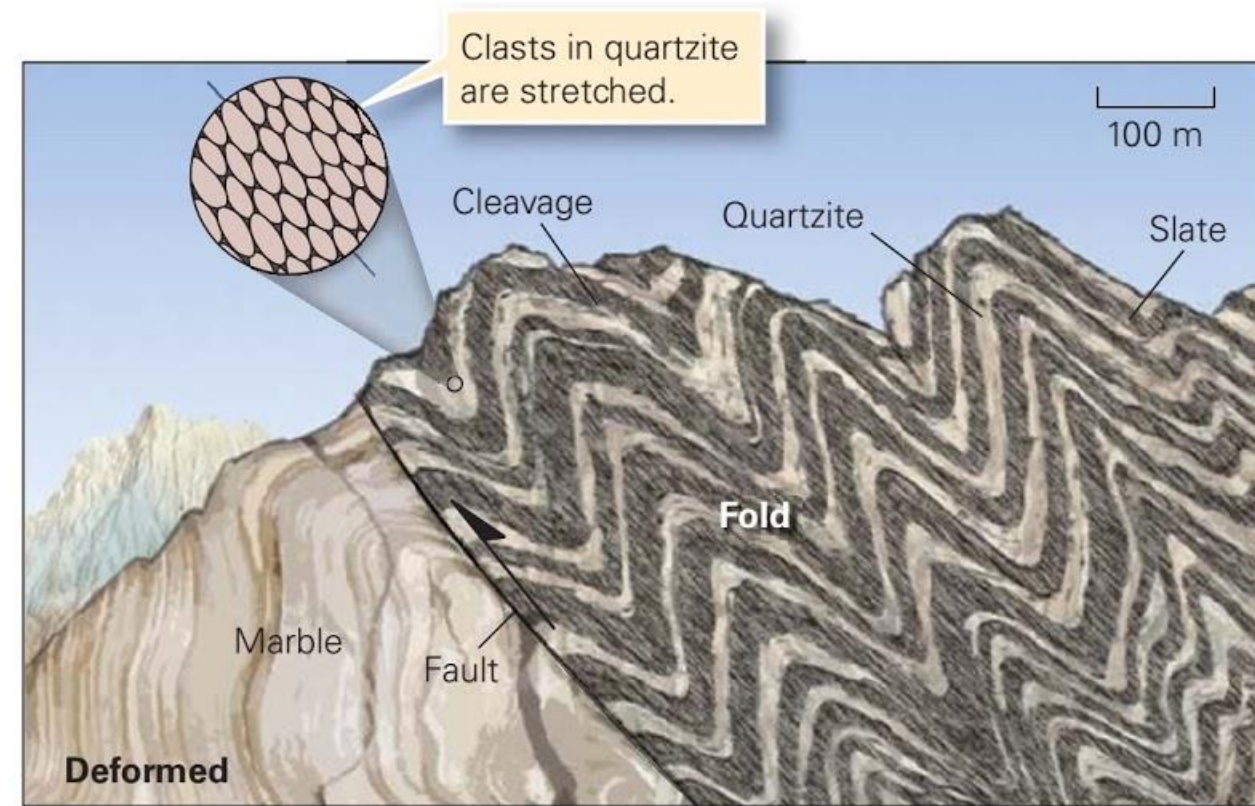


**D. Shear stress
(sliding and tearing)**

Strain is a change caused by stress. Strain is the change in the shape of the rock.

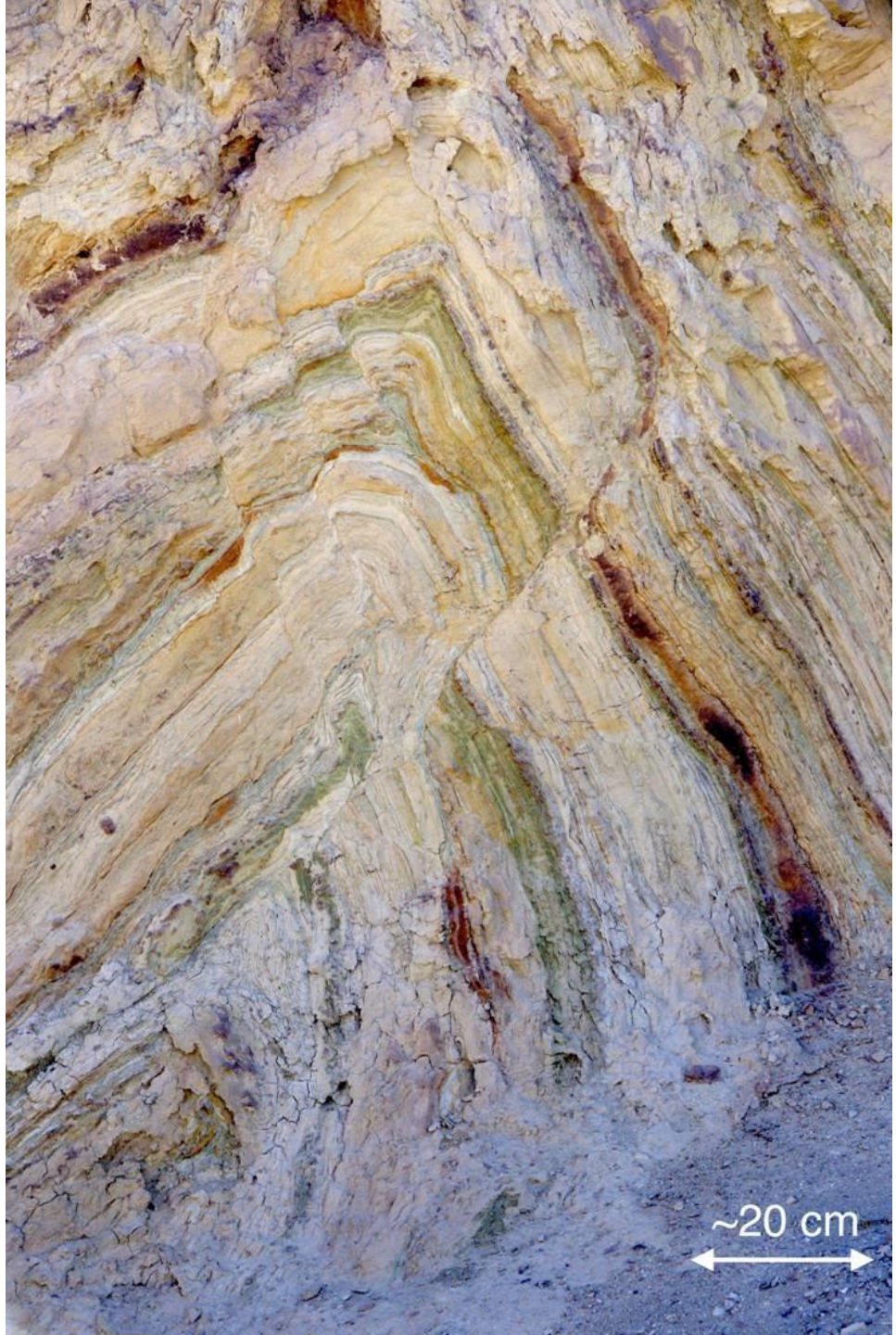


(a) Flat-lying beds of strata along a highway in the Great Plains of North America are essentially undeformed. A few joints, formed when overlying rock eroded away, are visible.



(b) In a mountain belt, deformation may cause layers to undergo folding and faulting. In addition, foliation (such as slaty cleavage) and stretched clasts may develop.





~20 cm



Types of Deformation

- Elastic – rock returns to original shape when stress is removed
- Brittle – rock breaks
- Ductile – rock bends

Factors that Affect How Rocks Deform

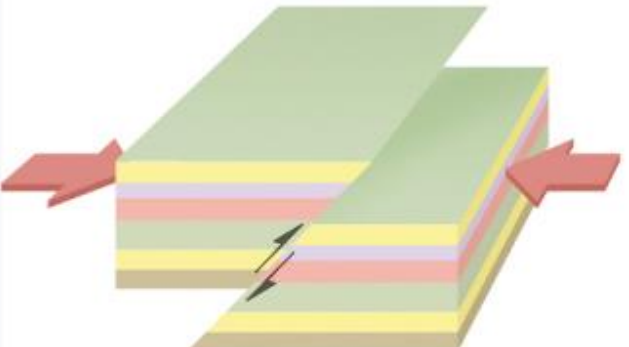

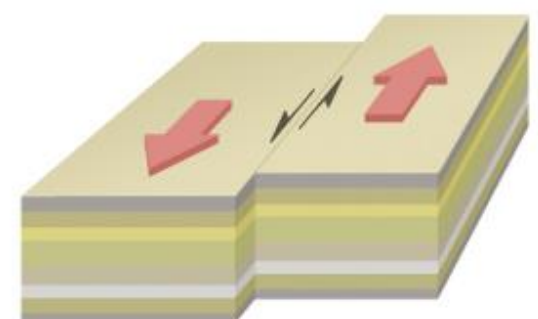
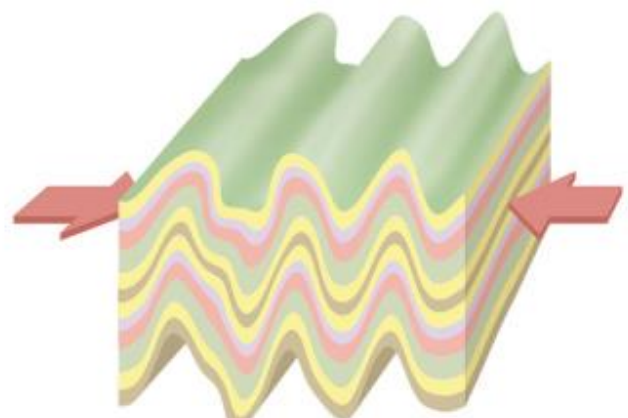

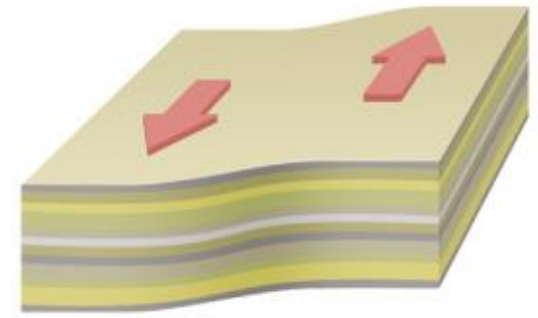
Temperature

Confining pressure

Rock type

Time

How Rocks Respond to Differential Stress

DEPTH		COMPRESSION (Causes shortening)	TENSION (Causes lengthening)	SHEAR (Causes tearing or bending)
SHALLOW	At shallow depths rocks tend to exhibit brittle fracture	 <p>Reverse faulting</p>	 <p>Normal faulting</p>	 <p>Strike-slip faulting</p>
		 <p>Folding</p>	 <p>Stretching</p>	 <p>Shearing</p>
DEEP	At greater depths rocks tend to deform by ductile flow			

Faults vs Joints

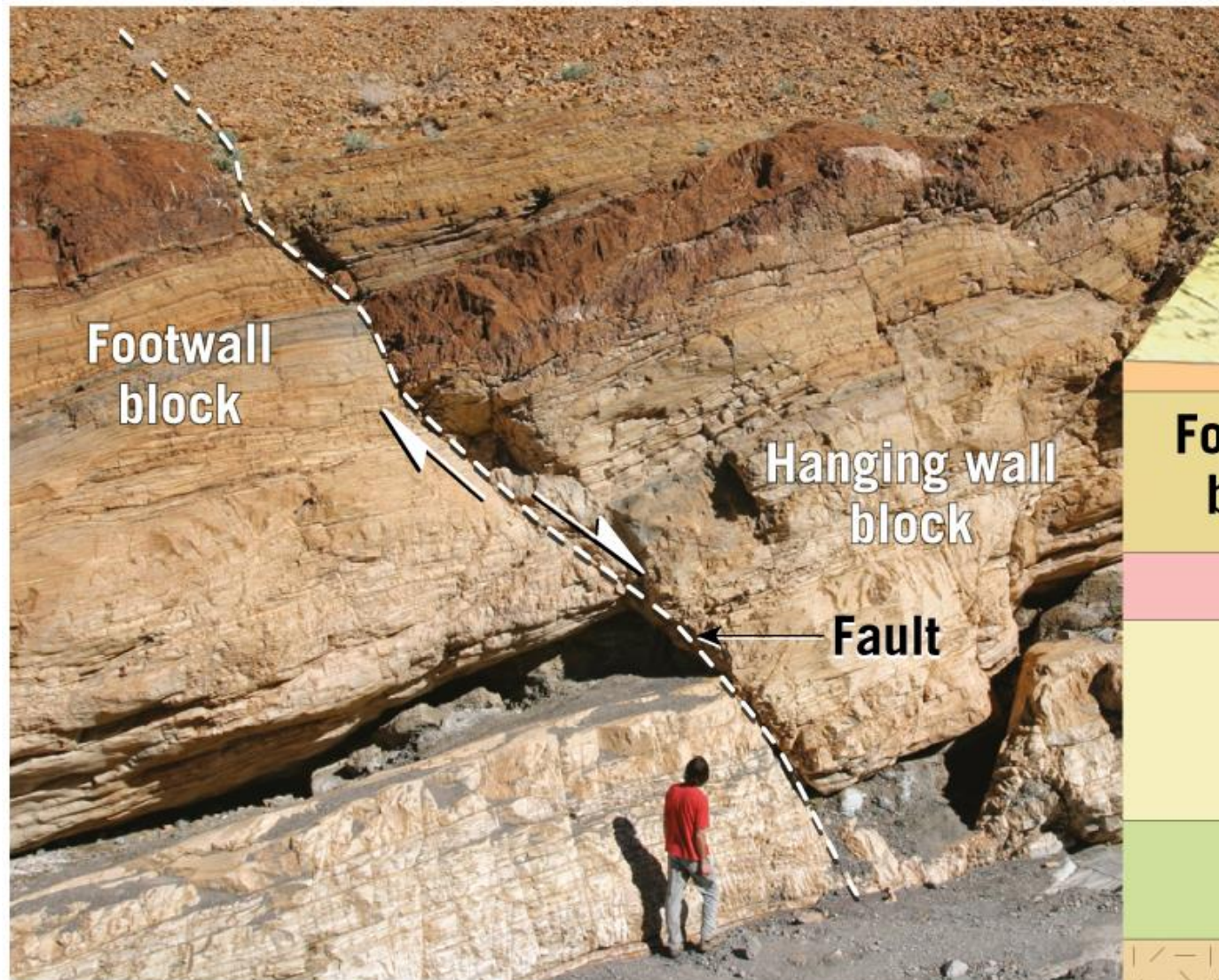
Both faults and joints are fractures.

Faults are fractures where *movement has occurred*. Joints are fractures *without displacement*.

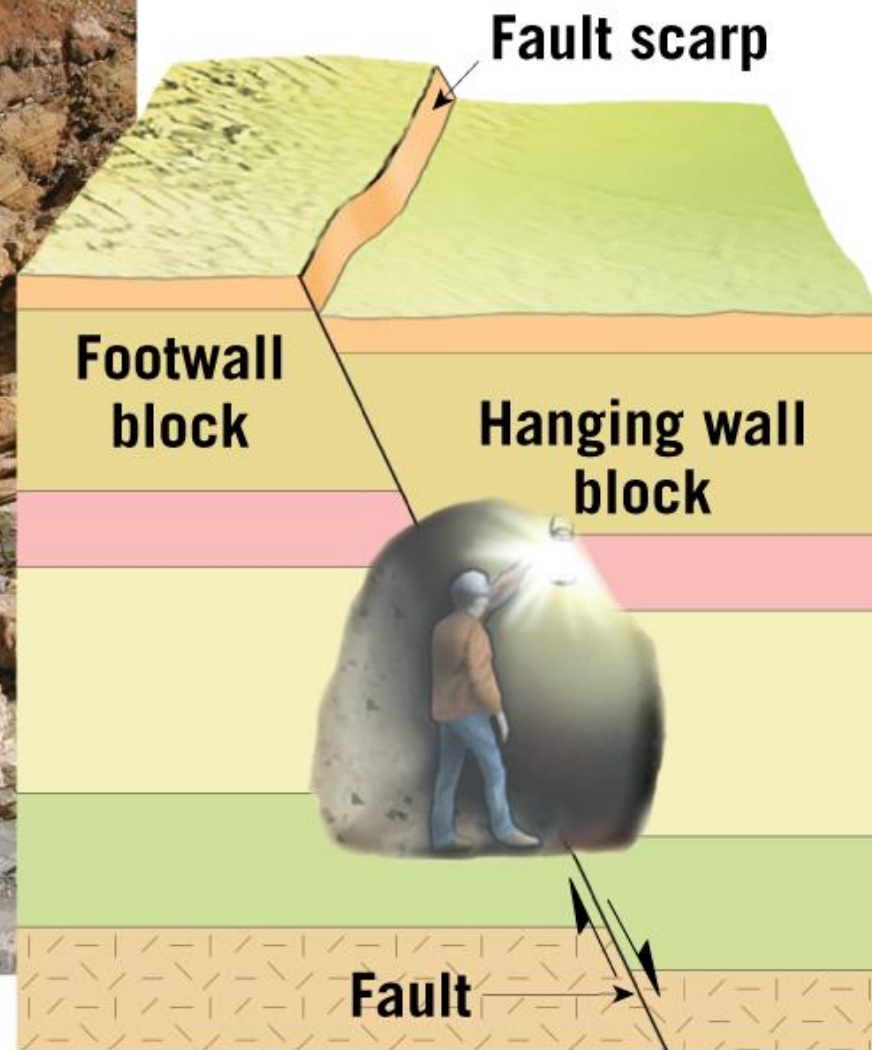




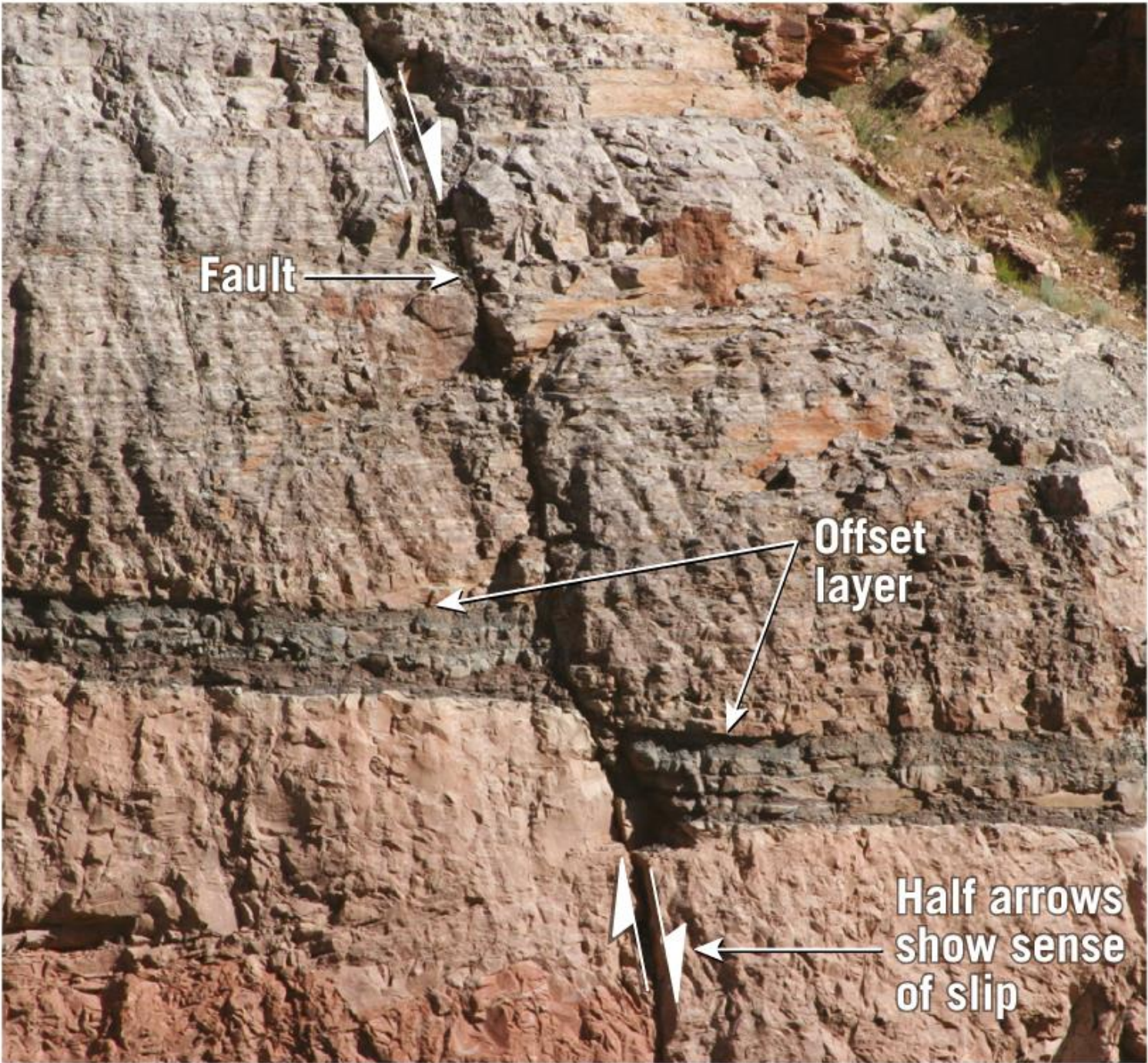




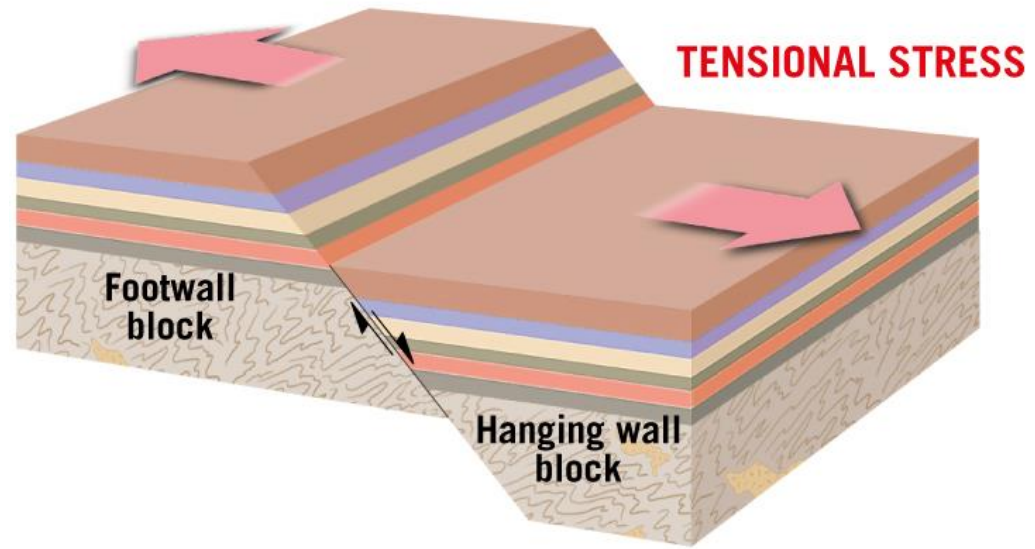
A.



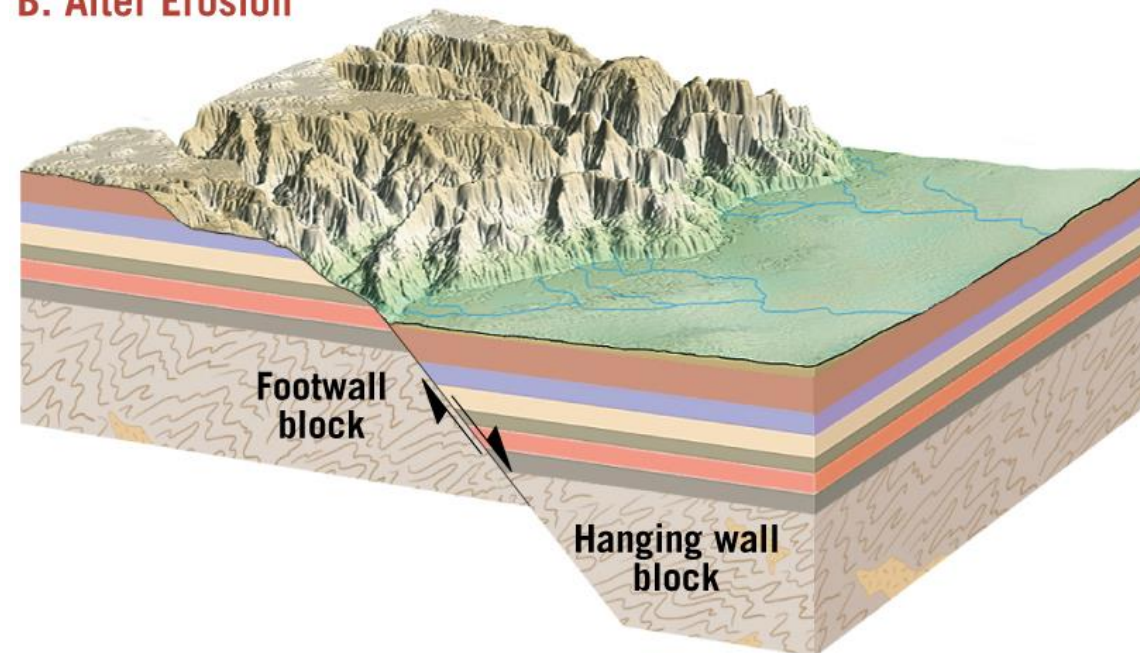
B.



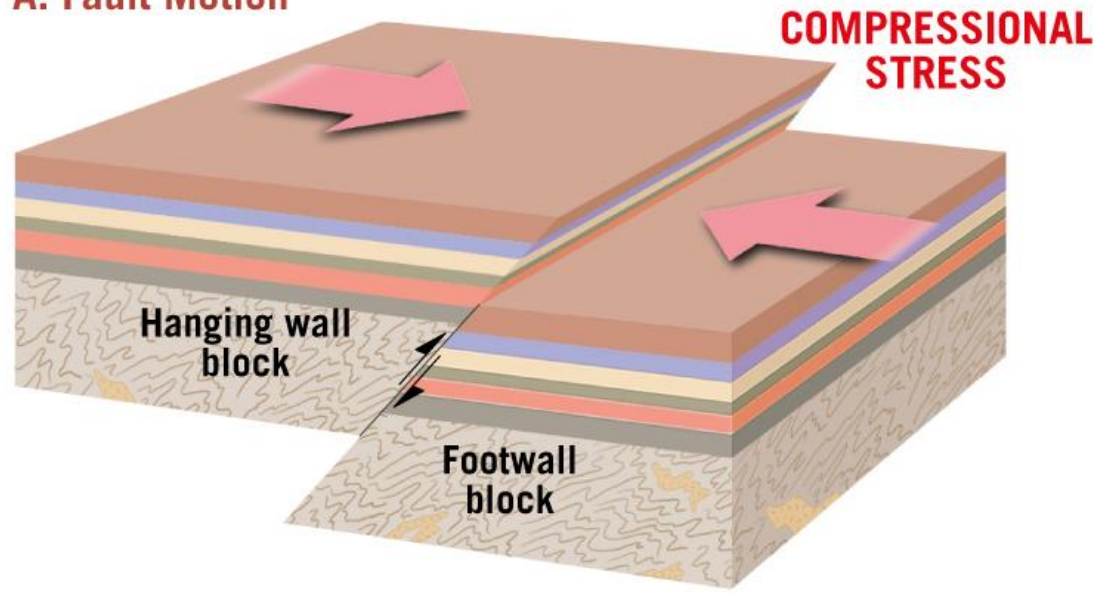
A. Fault Motion



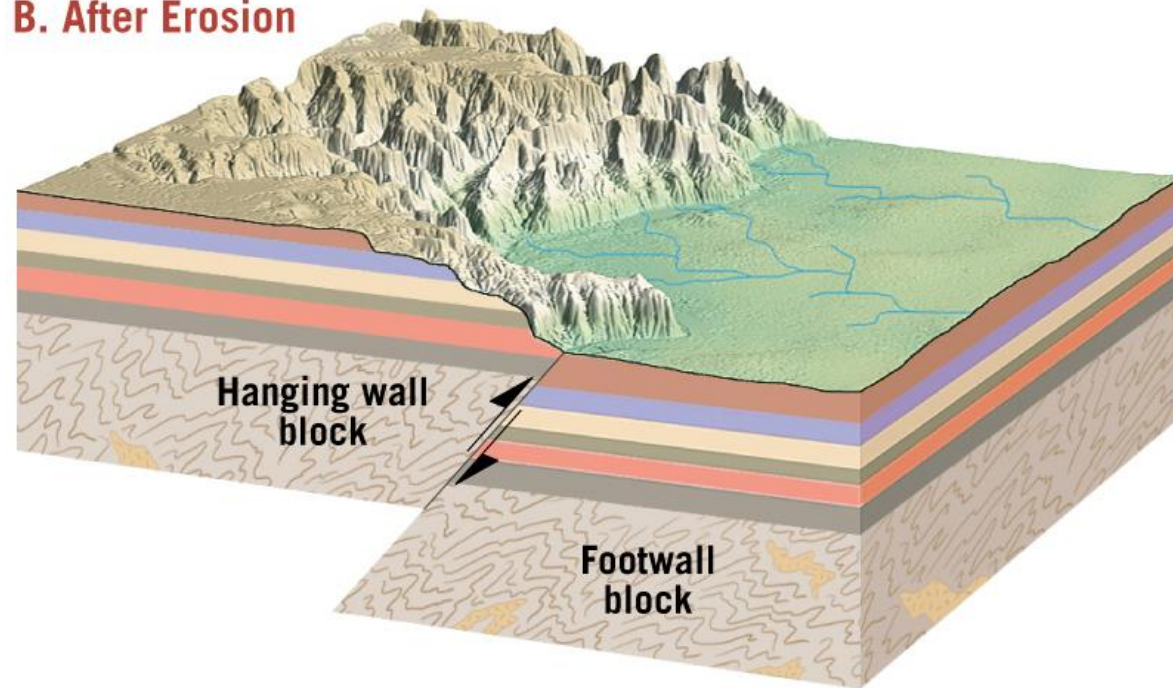
B. After Erosion



A. Fault Motion



B. After Erosion







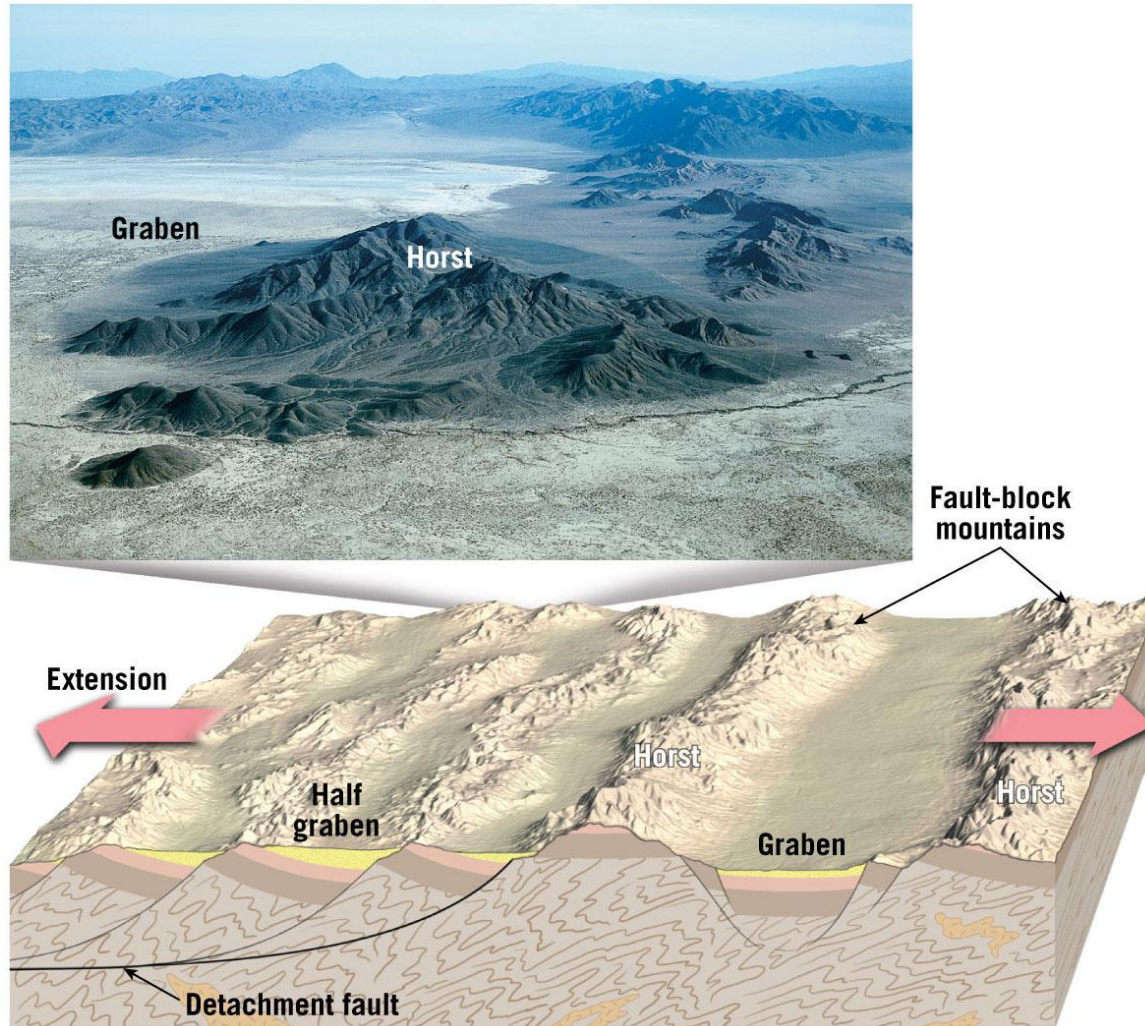








Normal Faulting in the Basin and Range Province



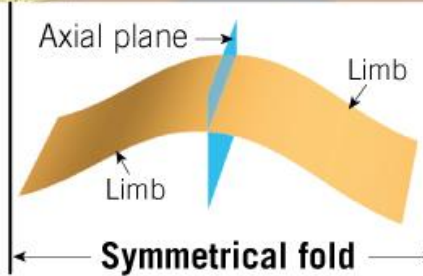
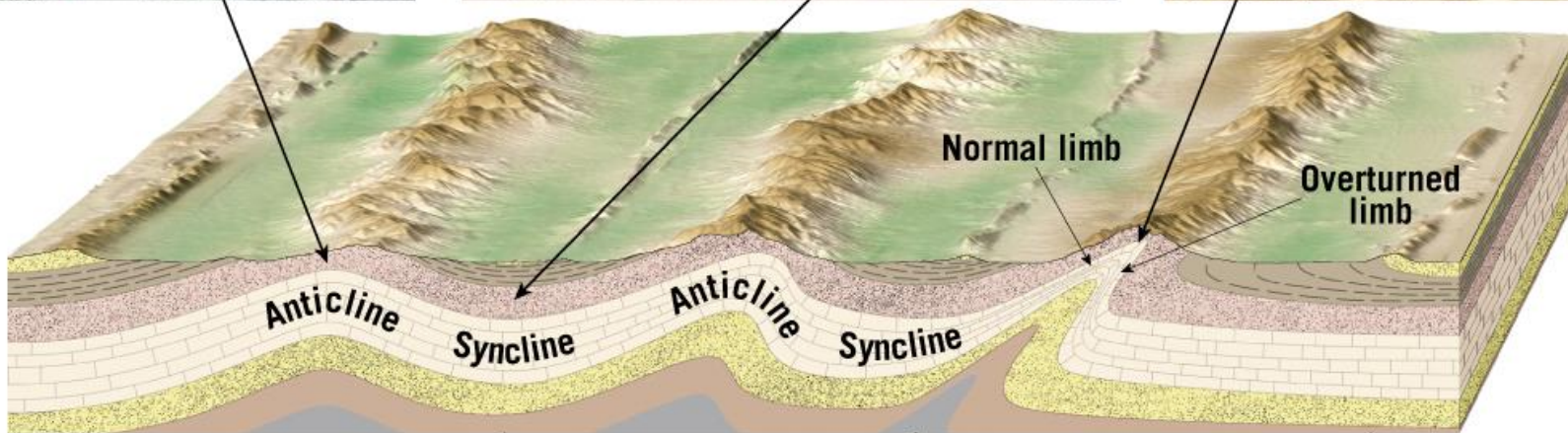
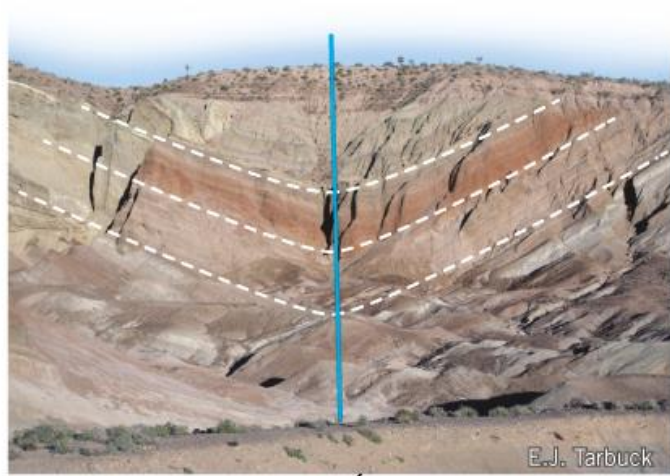
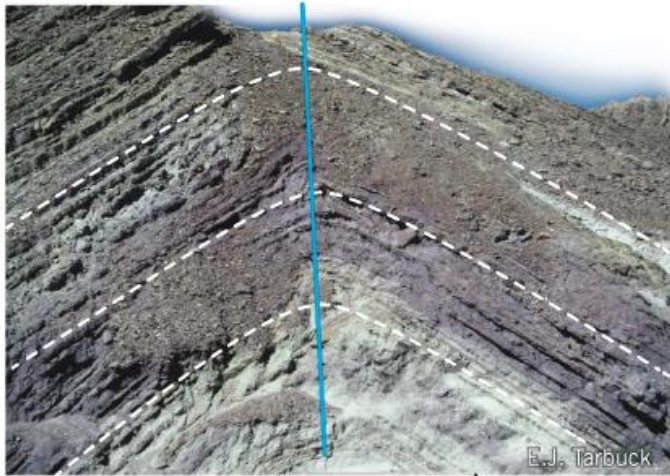


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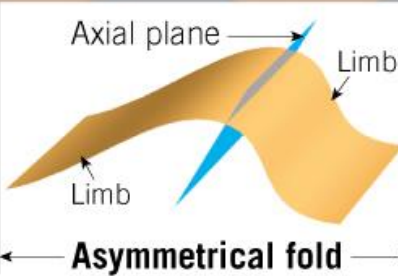




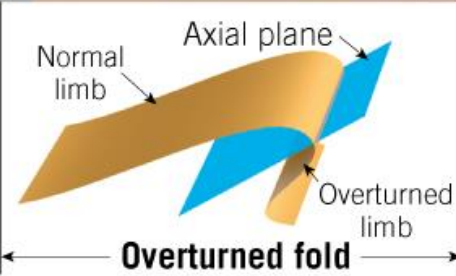
Folding



The limbs of a symmetrical fold tip in opposite directions, at about the same angle.



The limbs in an asymmetrical fold dip in opposite directions and at different angles.



Both limbs of an overturned fold dip in the same direction, but one has been tilted beyond the vertical.

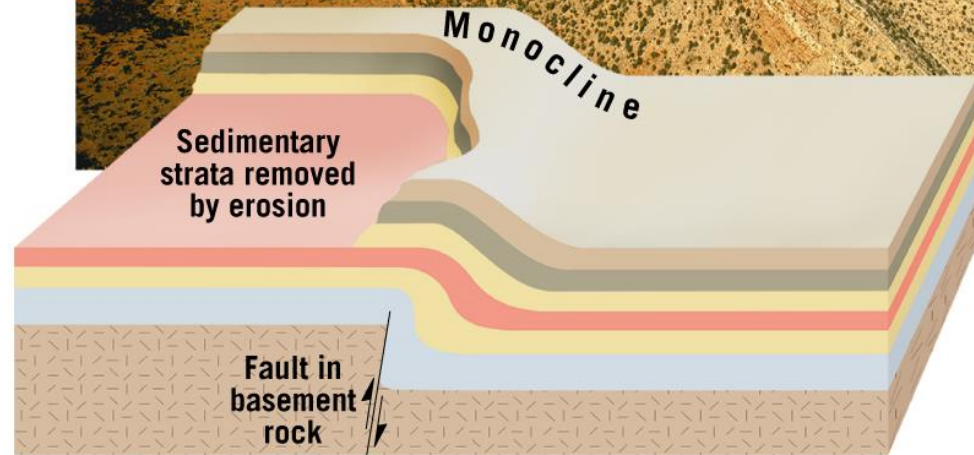
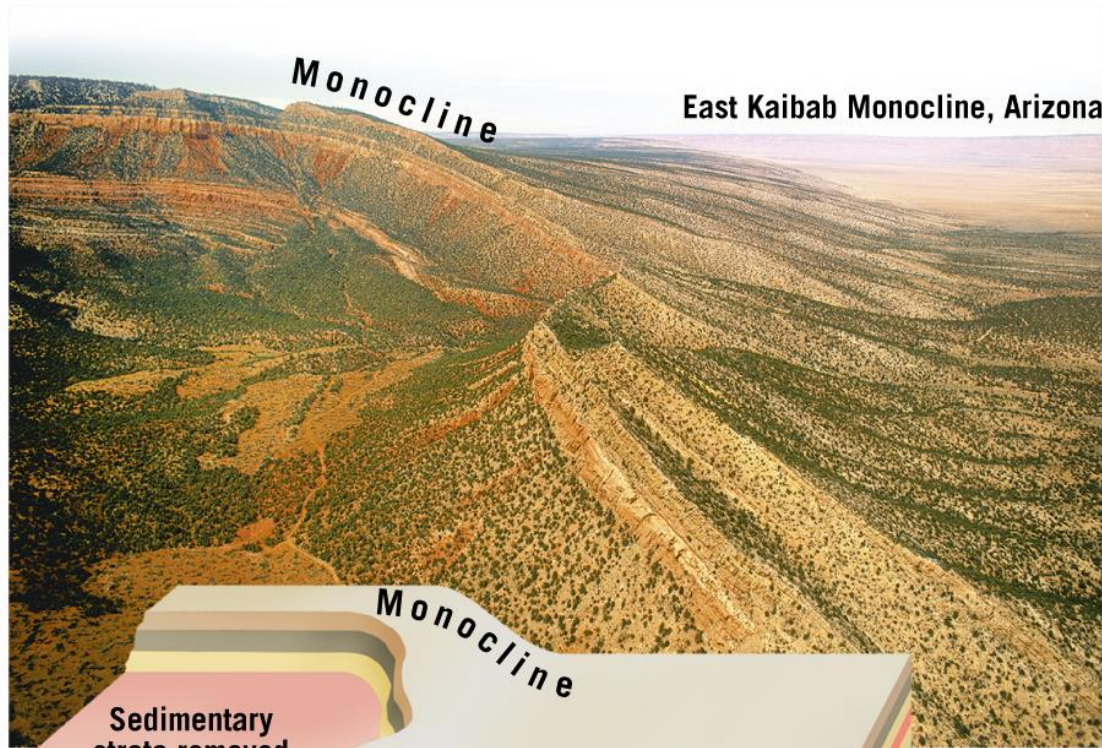


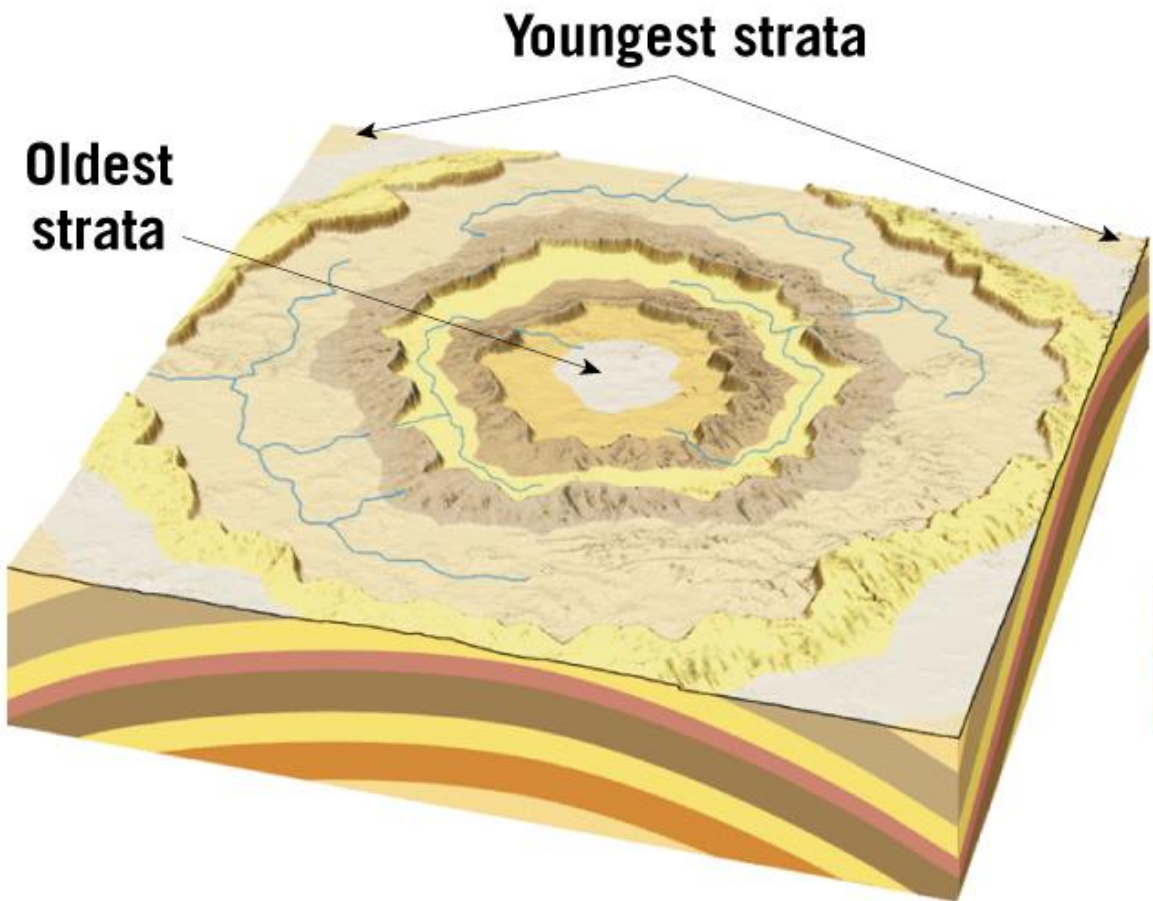




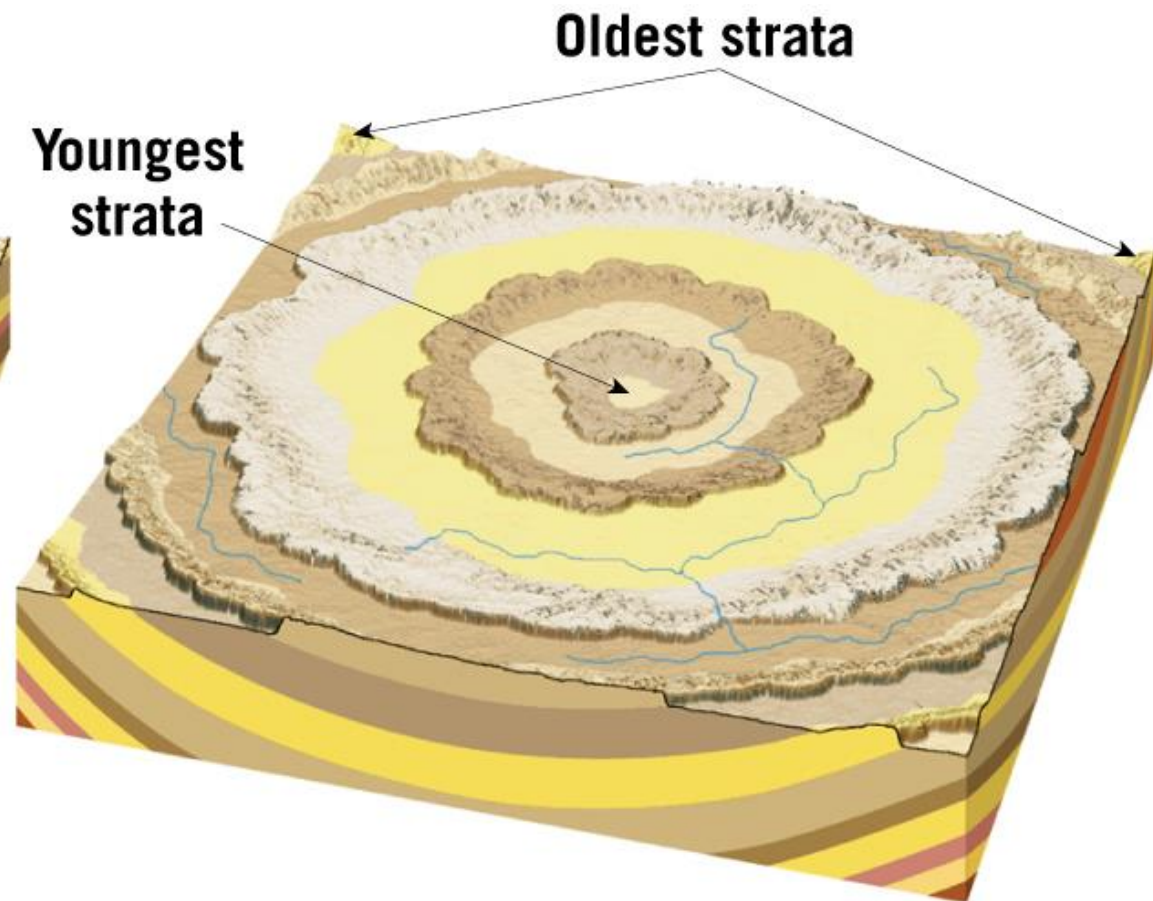








A. Upwarping produces a *dome*.

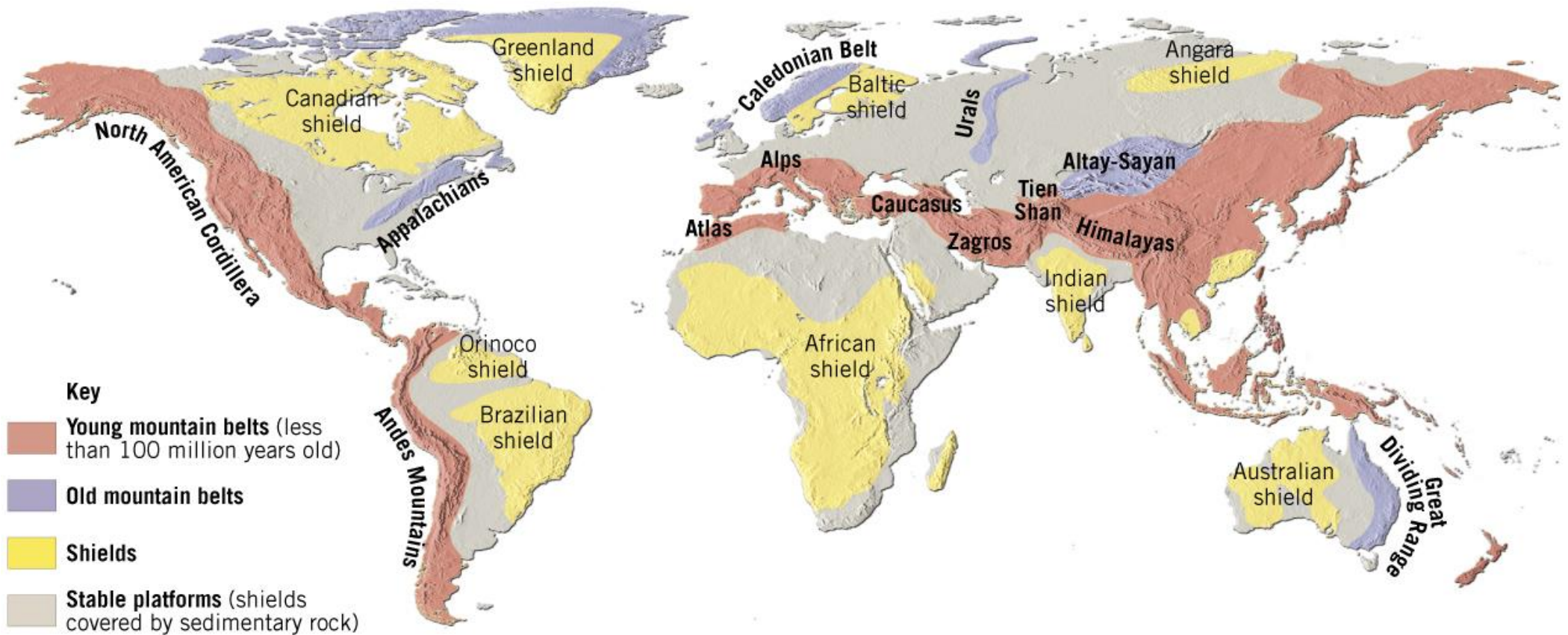


B. Downwarping produces a *basin*.



Orogenesis

collection of processes that produce
a mountain belt



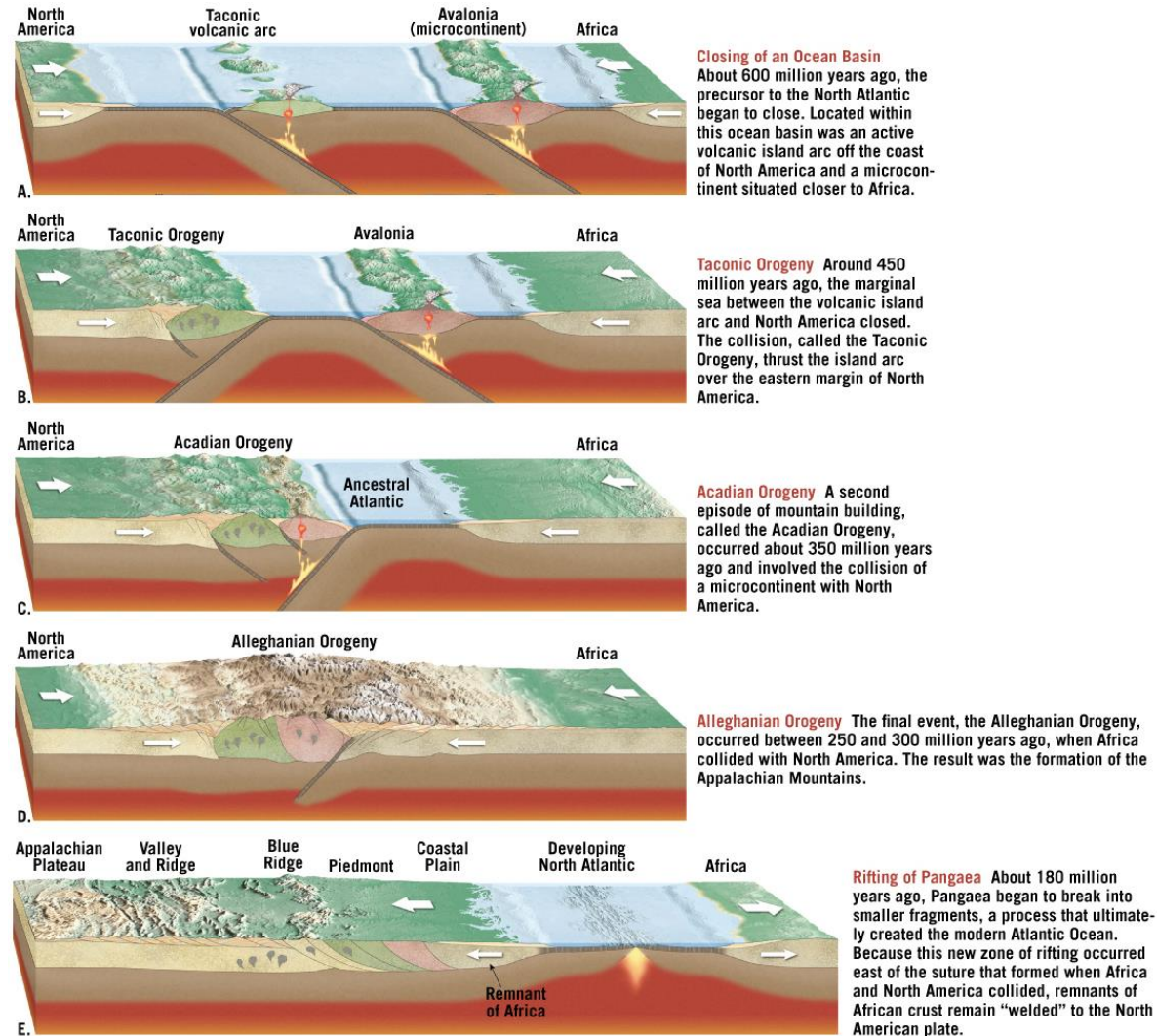
Key

- Young mountain belts** (less than 100 million years old)
- Old mountain belts**
- Shields**
- Stable platforms** (shields covered by sedimentary rock)

Appalachian Mountains



Formation of the Appalachian Mountains

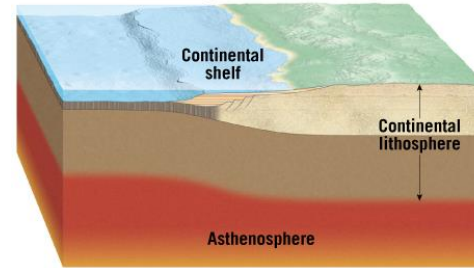


Mount Shasta

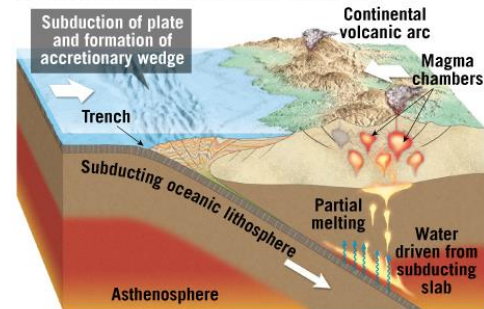


Andean-Type Mountain Building

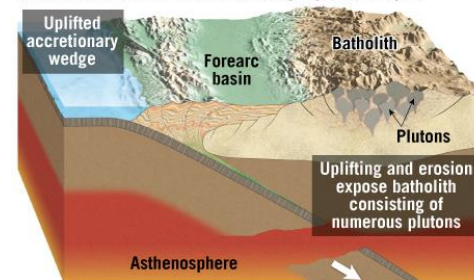
A. Passive continental margin with an extensive platform of sediments and sedimentary rocks.



B. Plate convergence generates a subduction zone, and partial melting produces a continental volcanic arc. Compressional forces and igneous activity further deform and thicken the crust, elevating the mountain belt.

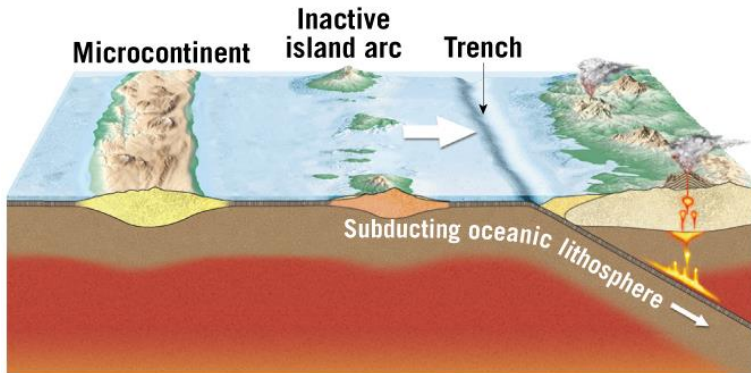


C. Subduction ends and is followed by a period of uplift.

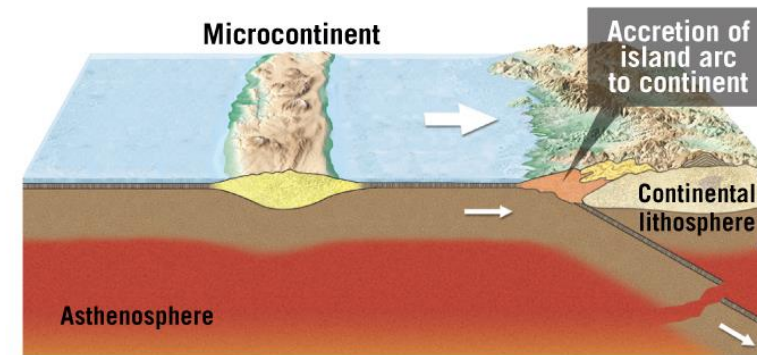


Collision and Accretion of Small Crustal Fragments to a Continental Margin

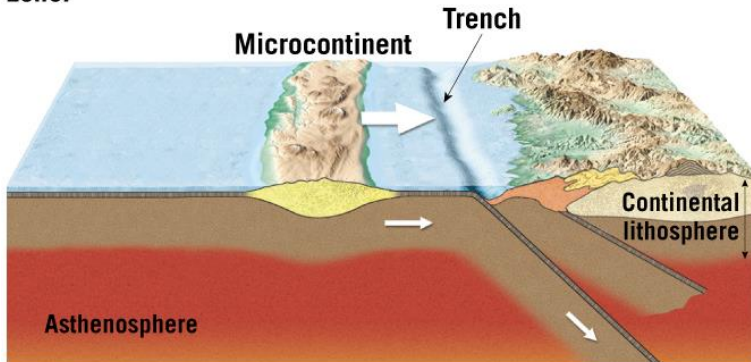
A. A microcontinent and a volcanic island arc are being carried toward a subduction zone.



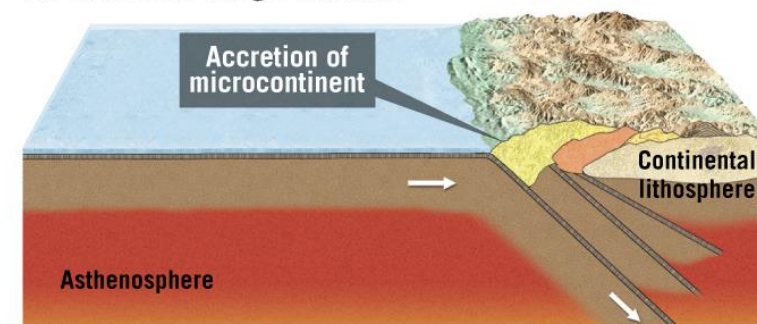
B. The volcanic island arc is sliced off the subducting plate and thrust onto the continent.



C. A new subduction zone forms seaward of the old subduction zone.

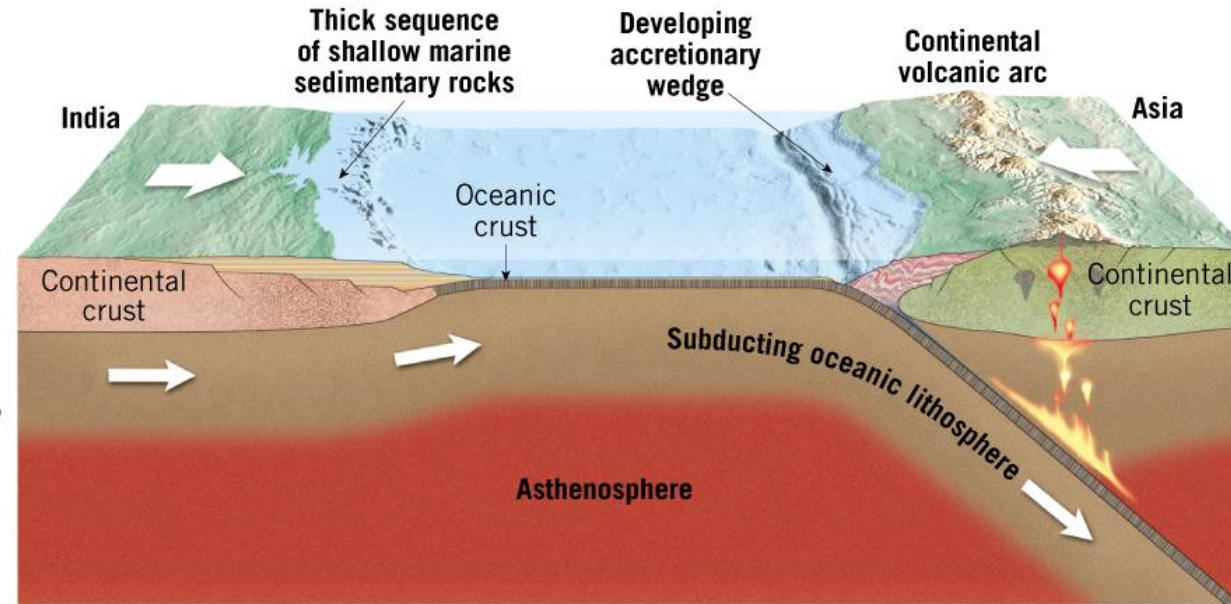


D. The accretion of the microcontinent to the continental margin shoves the remnant island arc further inland and grows the continental margin seaward.

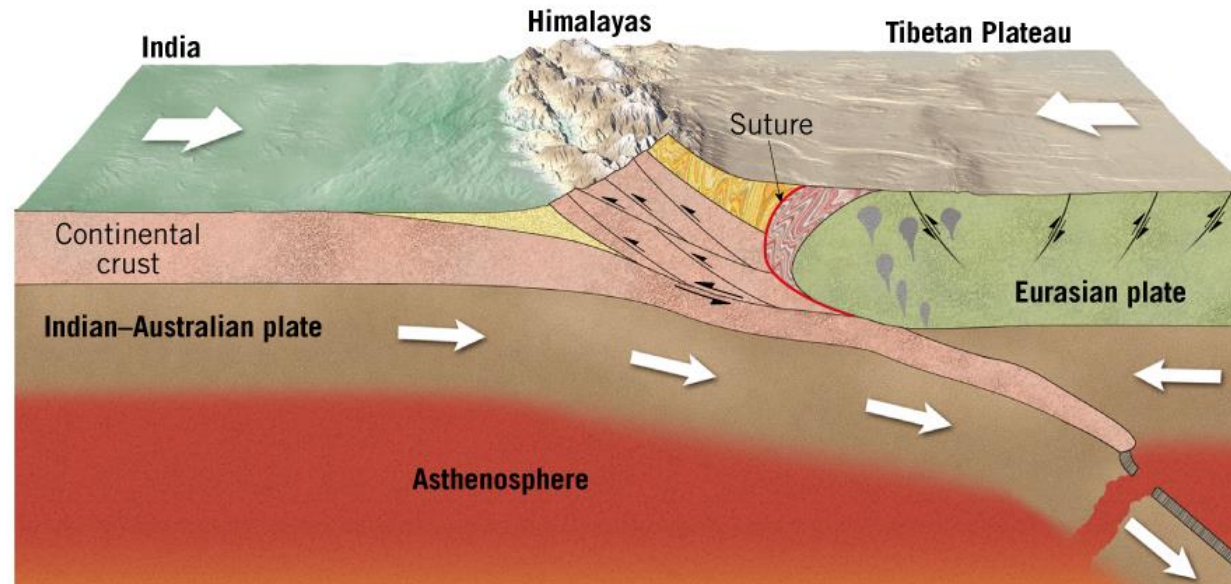




A. Prior to the collision of India and Asia, India's northern margin consisted of a thick platform of continental shelf sediments, whereas Asia's was an active continental margin with a well developed accretionary wedge and volcanic arc.



B. The continental collision folded and faulted crustal rocks along the margins of these continents to form the Himalayas. This event was followed by the gradual uplift of the Tibetan Plateau as the subcontinent of India was shoved under Asia.



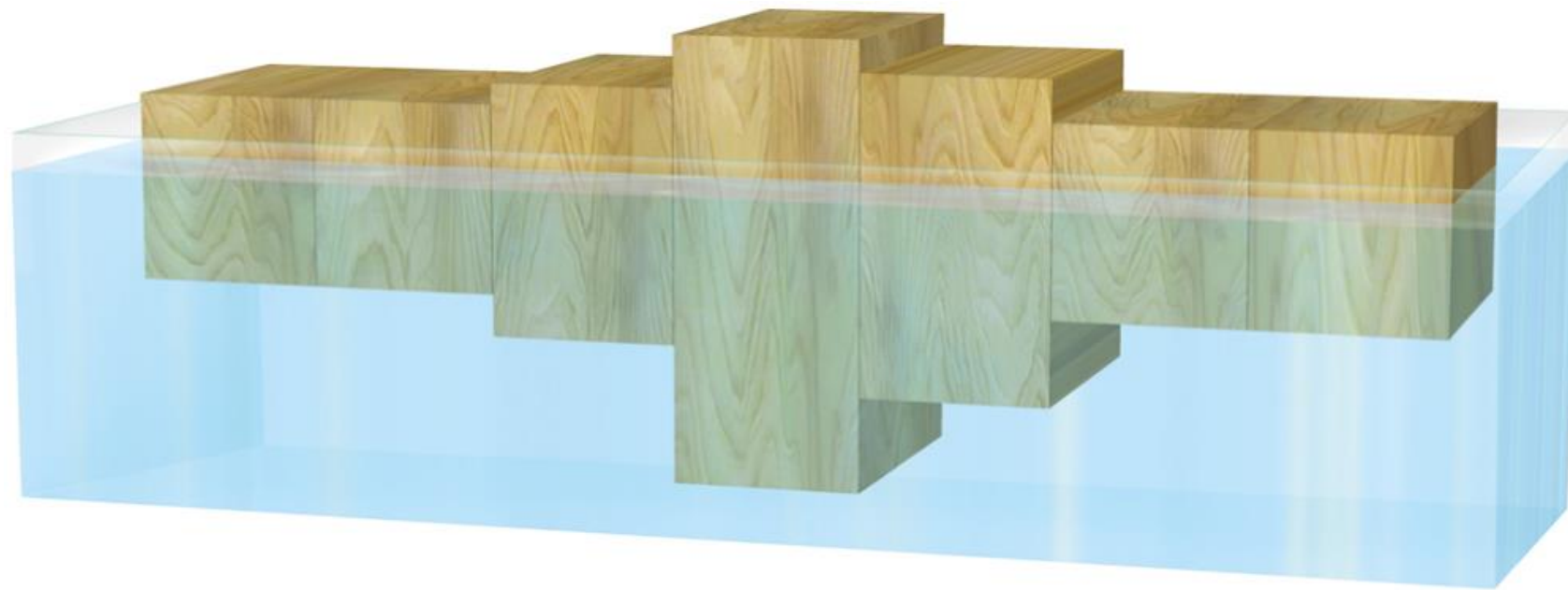
Rocky Mountains



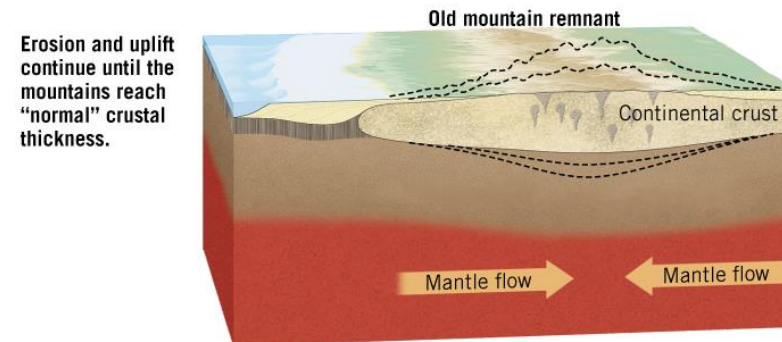
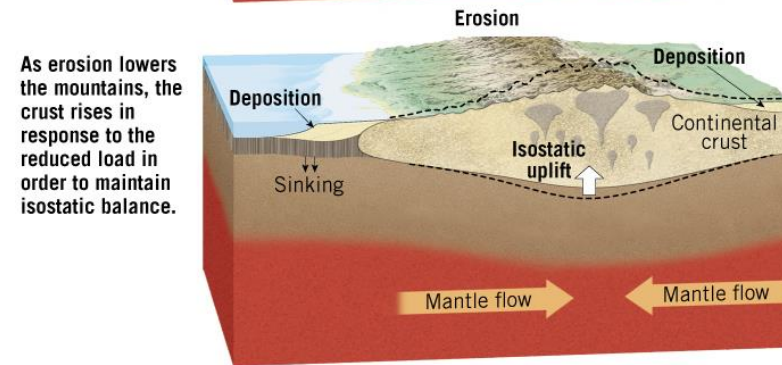
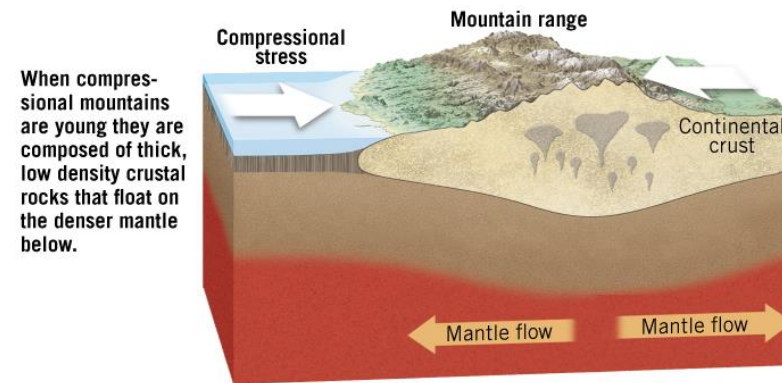


WESTERN INTERIOR SEAWAY

The Principle of Isostasy



Effects of Isostatic Adjustment and Erosion



Gravitational Collapse

