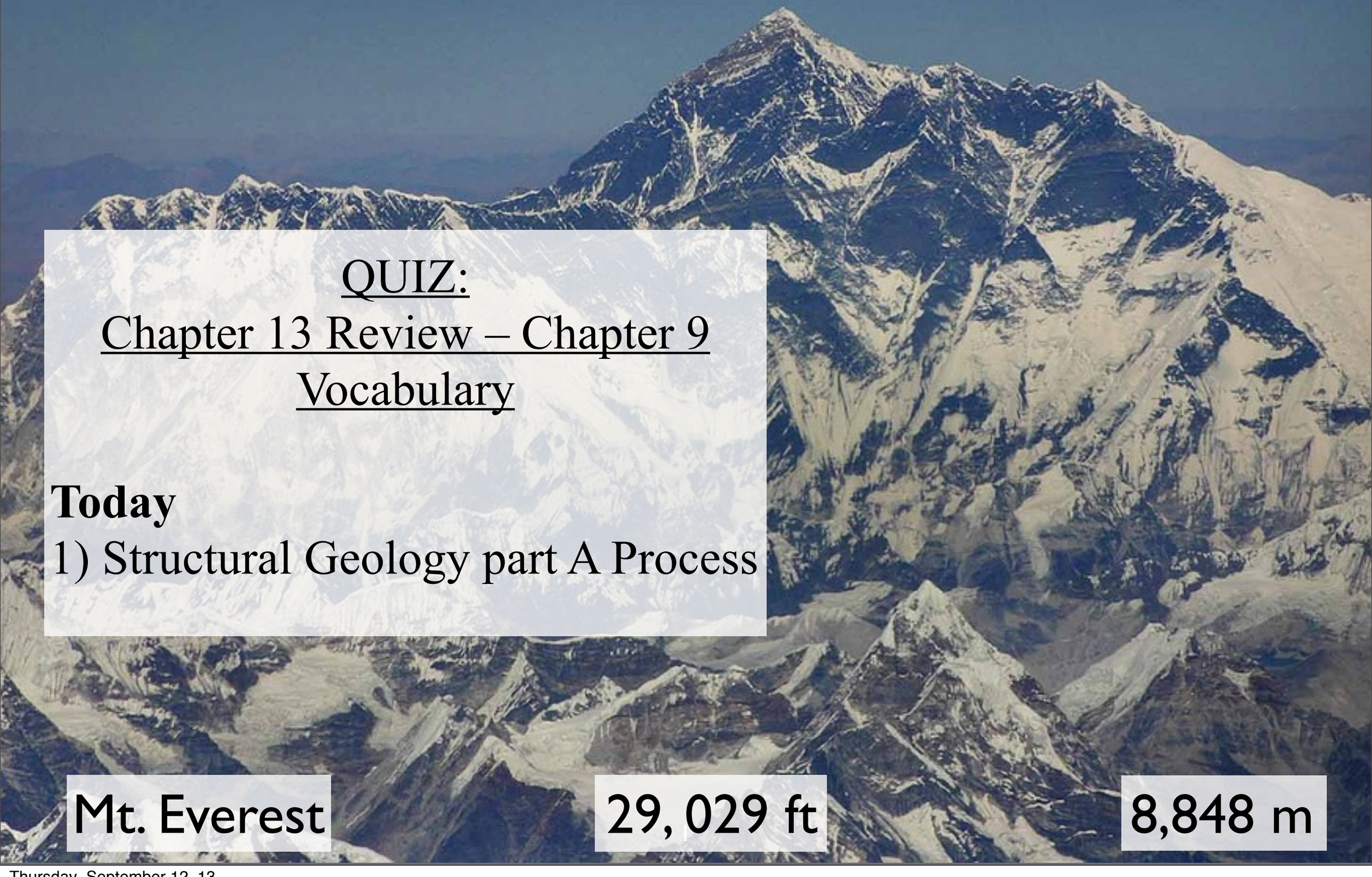
Structural Geology and Deformation

Chapter 9



QUIZ:

Chapter 13 Review – Chapter 9 Vocabulary

Today

1) Structural Geology part A Process

Mt. Everest 29, 029 ft 8,848 m

City College of San Francisco

Select Language | Enter Keyword | Search

CCSF Guides: Future Students | Community

Employee Directory | Contact Us | MyCCSF

Student Services | Educational Programs | Our Campuses | Library | Employee Services | About City College

Educational Programs | Schools & Departments | School of Science & Mathematics | Earth Sciences | Study Sessions | Send to a Friend | Print Page

- Earth Sciences
  - Earth Science Students
  - Study Sessions
  - Courses
  - Faculty
  - Earth Science News
  - Department Newsletter
  - Location
  - Be A Contributor!

Study Sessions

JUST WHAT IS A STUDY SESSION?
Study sessions are times and places when students from a particular class can study together. Where possible, the Earth Sciences Department will provide mentors and/or instructors to assist with questions and to facilitate students working together. The intention is that students use these study sessions to help succeed in the class, by reviewing material, studying for exams and quizzes, and practicing in-class material. Please be respectful of everyone's time and energy during study sessions. Prepare ahead by reading your textbook, reviewing your notes, and identifying the specific areas in which you need help, practice, or review.

Spring 2012 Study Sessions

MONDAY:
11 am to 1 pm (HESS/LEWIS/WIESE)
4 - 6 pm (GRANDY/DUNCAN)

TUESDAY:
12:30-2 pm (LUCAS-CLARK/WIESE)
6-6:30 pm (WIESE/DEVECCHIO)

WEDNESDAY:
11 am to 1 pm (HESS/LEWIS/GRANDY)
4 - 6 pm (GRANDY/WIESE)

THURSDAY:
12:30-2 pm (LUCAS-CLARK/WIESE)

FRIDAY:
11 am - 1 pm (H

SPRING 2

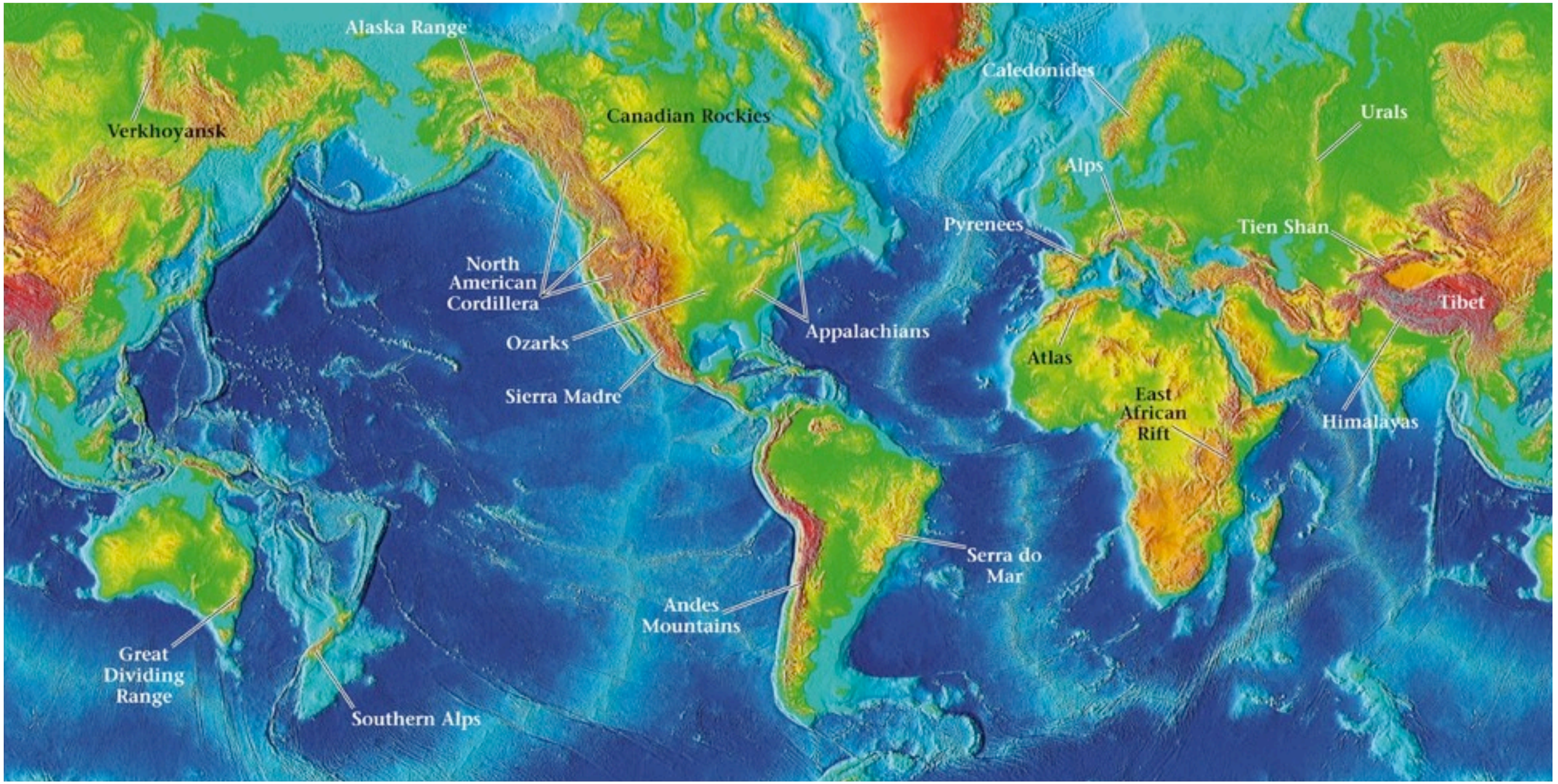
Study halls are open during normal class days (thus they are not open during finals week, and unfortunately there are no summer study halls). Study Sessions occur in Science 45, unless otherwise stated.

Learn more:

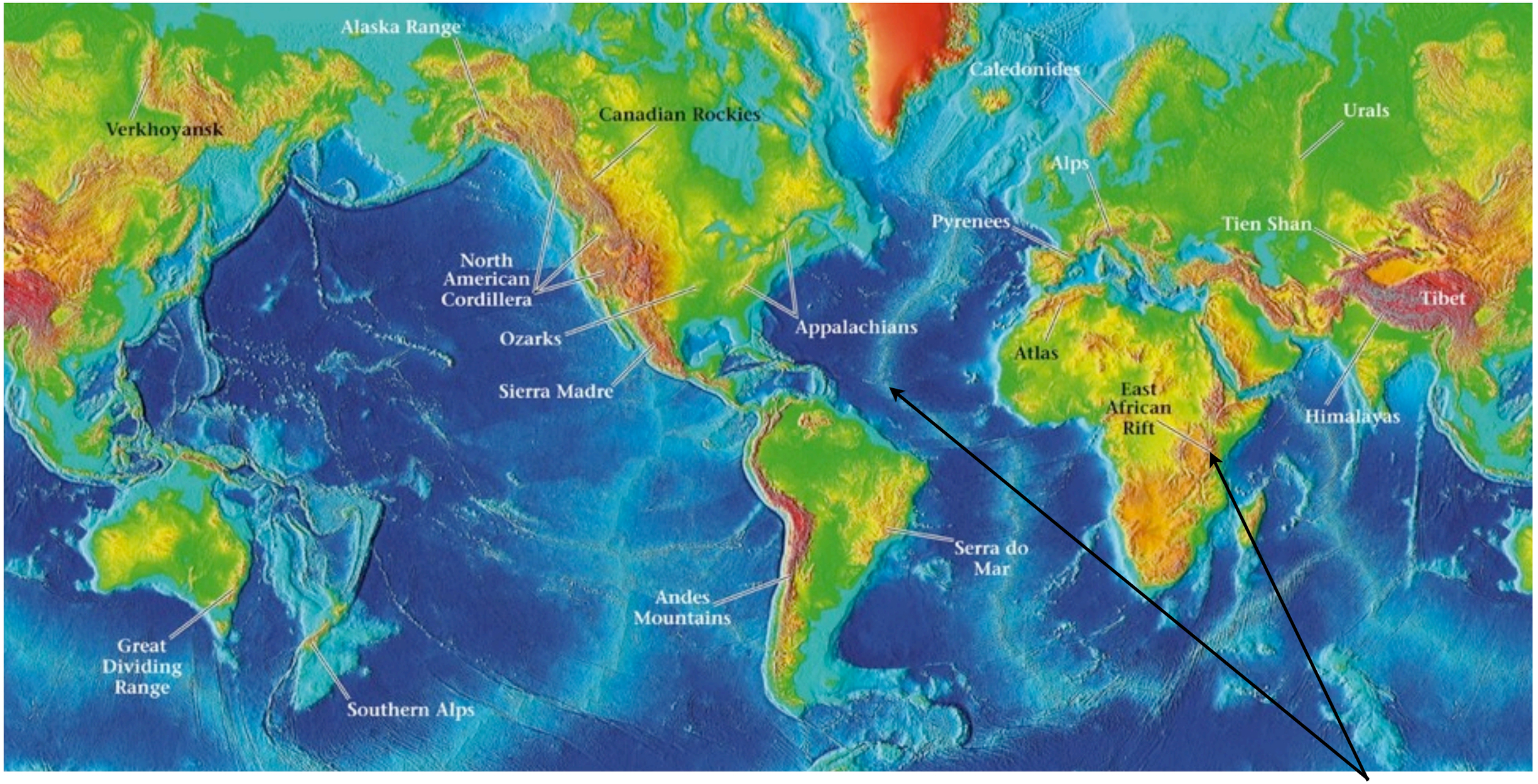
- Study Skills Tutoring at the Learning Assistance Resource Center R207 -- 415.452.5502
- Become a Mentor or Lab Aide

http://www.ccsf.edu/Earth

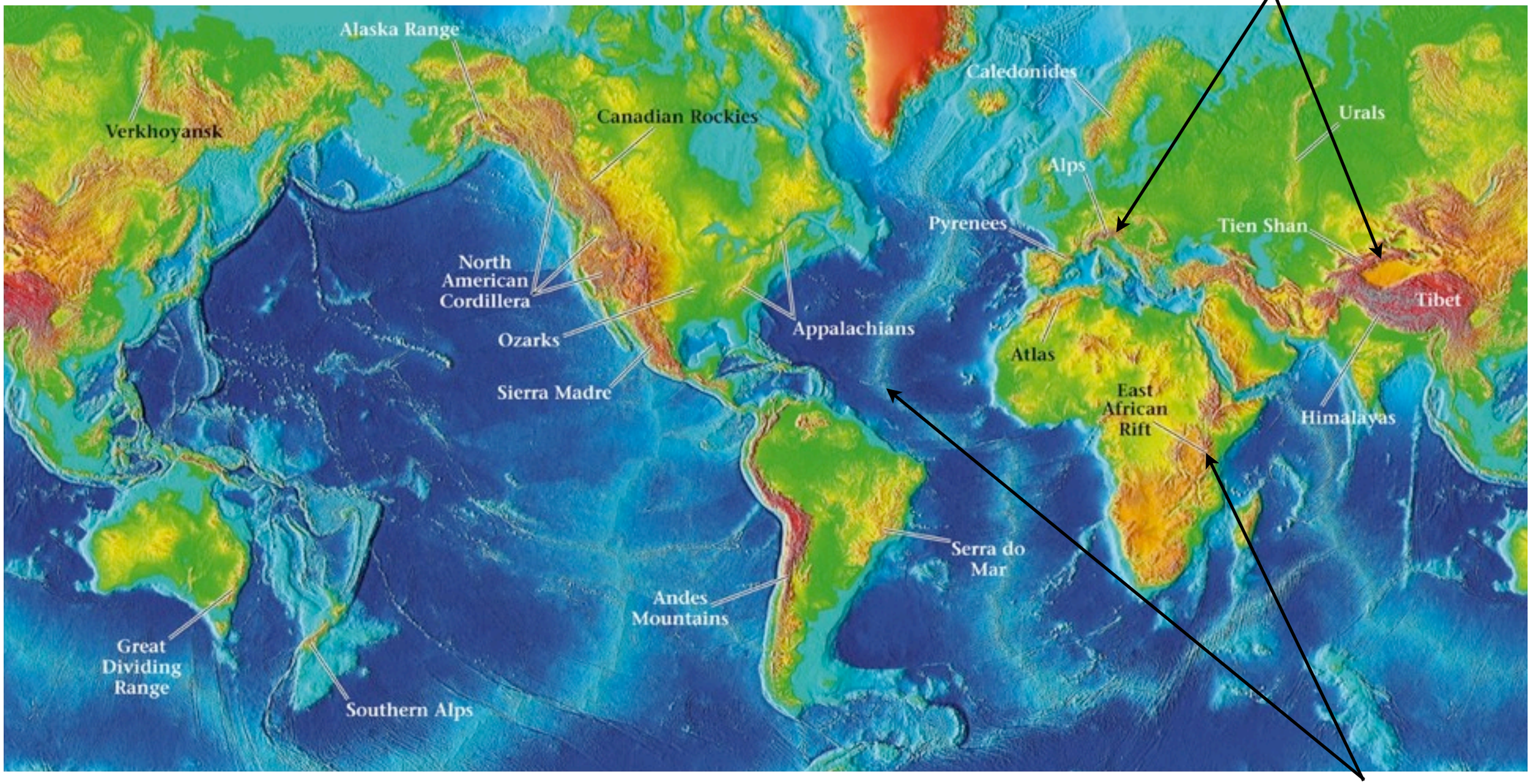
Mountain Ranges of the World



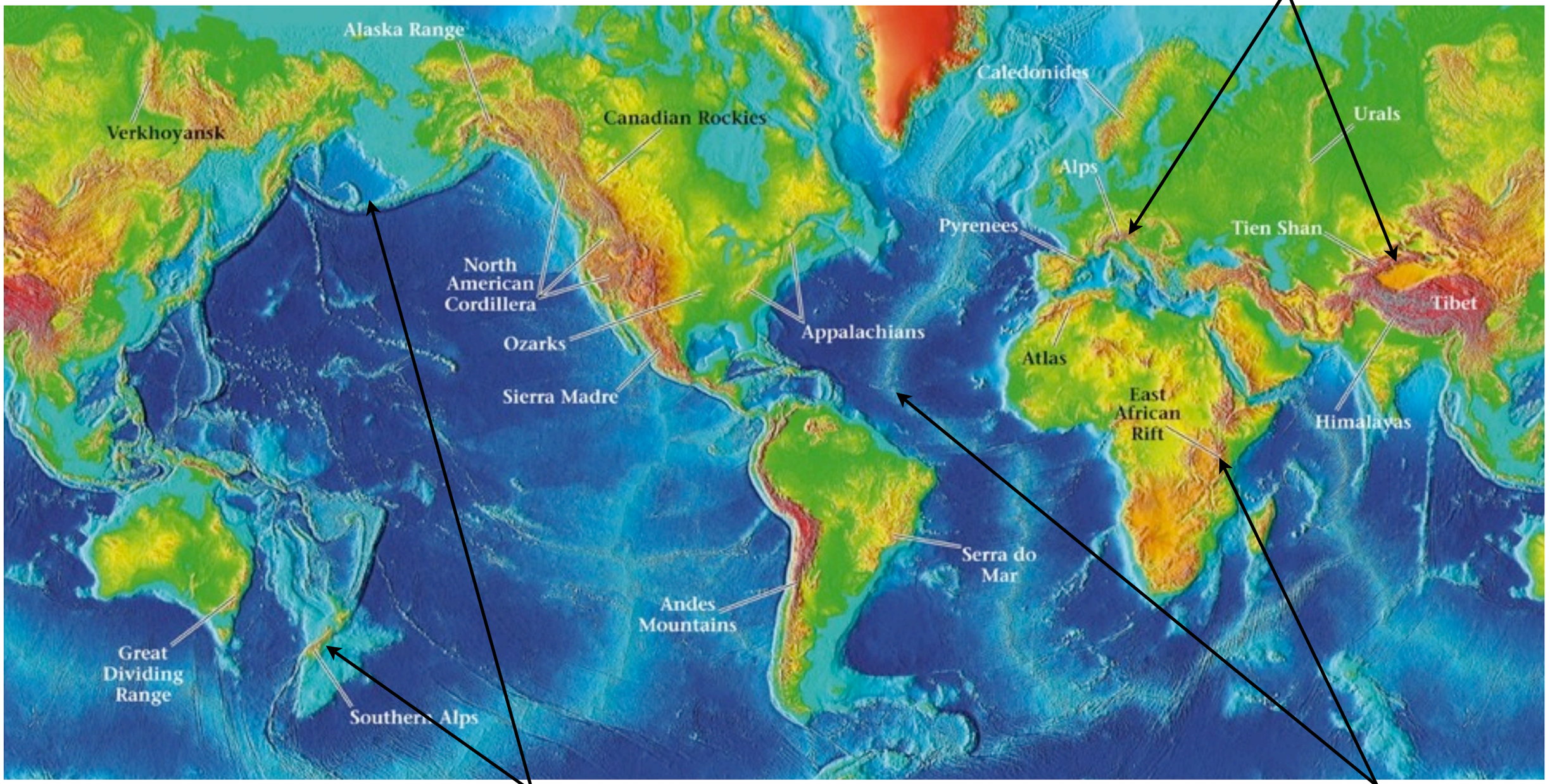
Mountain Ranges of the World



Mountain Ranges of the World



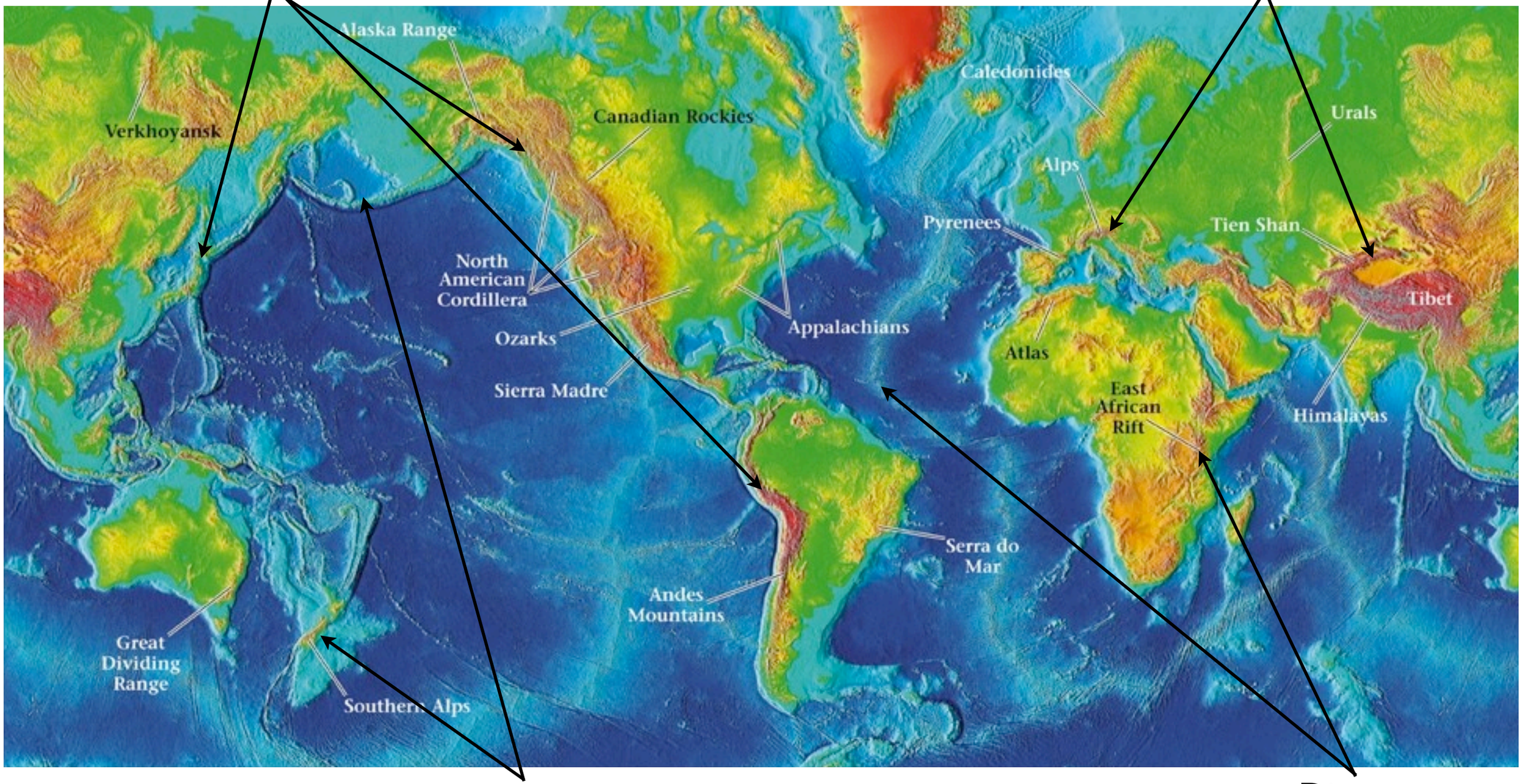
Mountain Ranges of the World



Mountain Ranges of the World

Ocean-Continent Convergent

Continent-Continent Convergent



Ocean-Ocean Convergent

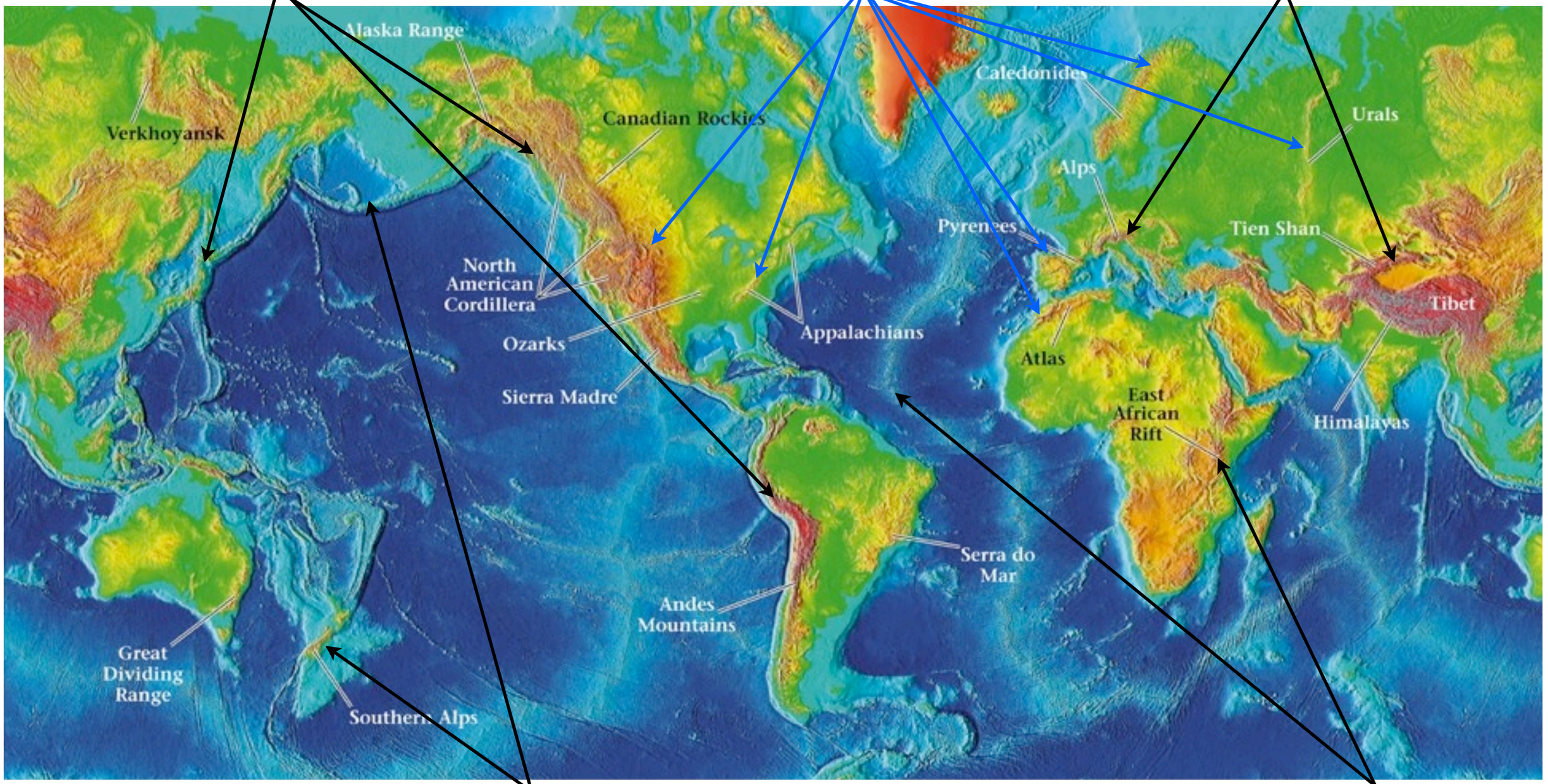
Divergent

Mountain Ranges of the World

Ocean-Continent Convergent

Continent-Continent Relic

Continent-Continent Convergent



Ocean-Ocean Convergent

Divergent

Master Table

Plate Boundary Type	Stress Type	Strain Type	Mountain Type	Other Geologic Features	Common Rocks Formation	Other
Convergent (Continent-Continent)						
Convergent (Subduction)						
Divergent						
Transform						

Stress and Strain

Stress- The push, pull, or shear that a rock feels when subjected to a force (Units = force/area).

Strain (deformation)- The change in shape of a rock as a result of applied stress.

Stress and Strain

Stress- The push, pull, or shear that a rock feels when subjected to a force (Units = force/area).

Strain (deformation)- The change in shape of a rock as a result of applied stress.

Types of Stress

Compressional- Squeezing, shortening

Tensional- Stretching, extensional, lengthening

Shearing- Translational

Types of Stress

At what type of plate boundary would you expect to find Tensional stress?

A) Convergent
B) Divergent
C) Continent-Continent collision
D) Transform

Types of Stress

At what type of plate boundary would you expect to find Tensional stress?

A) Convergent
B) Divergent
C) Continent-Continent collision
D) Transform

Compressional- Squeezing, shortening
Tensional- Stretching, extensional, lengthening
Shearing- Translational

Stress and Strain

Stress- The push, pull, or shear that a rock feels when subjected to a force. Units = force/area

Strain (deformation)- The change in shape of a rock as a result of applied stress.

Stress and Strain

Stress- The push, pull, or shear that a rock feels when subjected to a force. Units = force/area

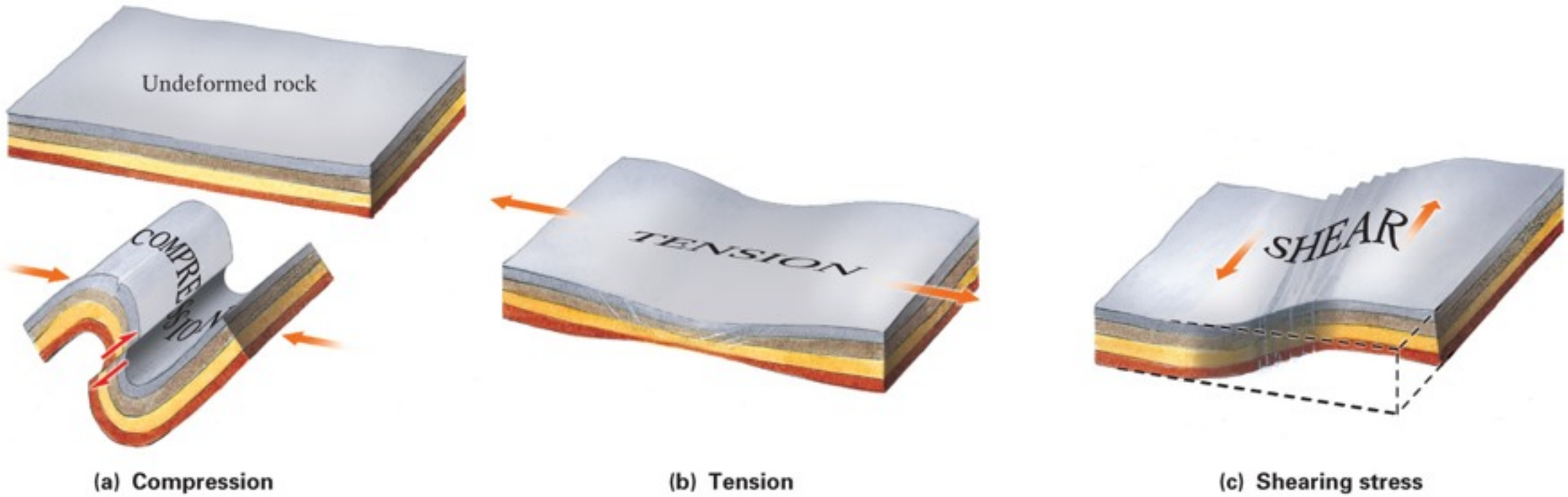
Strain- The change in shape of a rock as a result of applied stress (Deformation).

Units = $\frac{\text{Length final (m) - Length initial (m)}}{\text{Length initial (m)}}$

or

A distance of displacement (m)

Types of Deformation/Strain as a result of Applied Stress



(a) Compression (b) Tension (c) Shearing stress

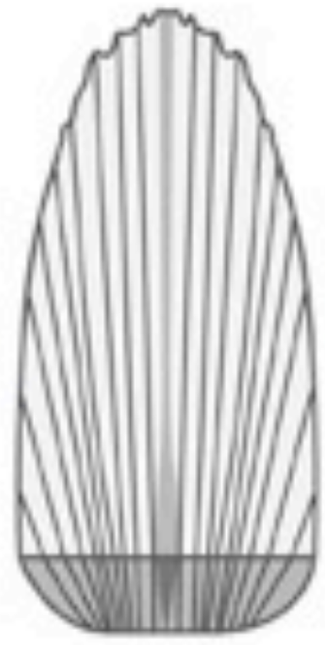
Stress	Strain
Compressional	folding, faulting, thickening
Tensional	thinning, faulting, extension
Shearing	translation (lateral displacement)

You are a field geologist, and while mapping you discover the <u>deformed</u> fossil shown below. To determine how it was deformed you would need to?

A) take some measurements of the fossil to determine the orientation and the amount of strain because that would tell you about tectonic stresses that have been applied to the fossil.

B) take some measurements of the fossil to assess the degree of stress because that would tell you about the strain applied to the fossil.

Undeformed fossil



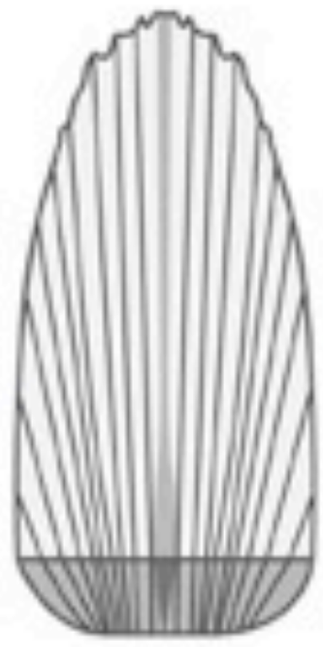
Deformed fossil

You are a field geologist, and while mapping you discover the <u>deformed</u> fossil shown below. To determine how it was deformed you would need to?

A) take some measurements of the fossil to determine the orientation and the amount of strain because that would tell you about tectonic stresses that have been applied to the fossil.

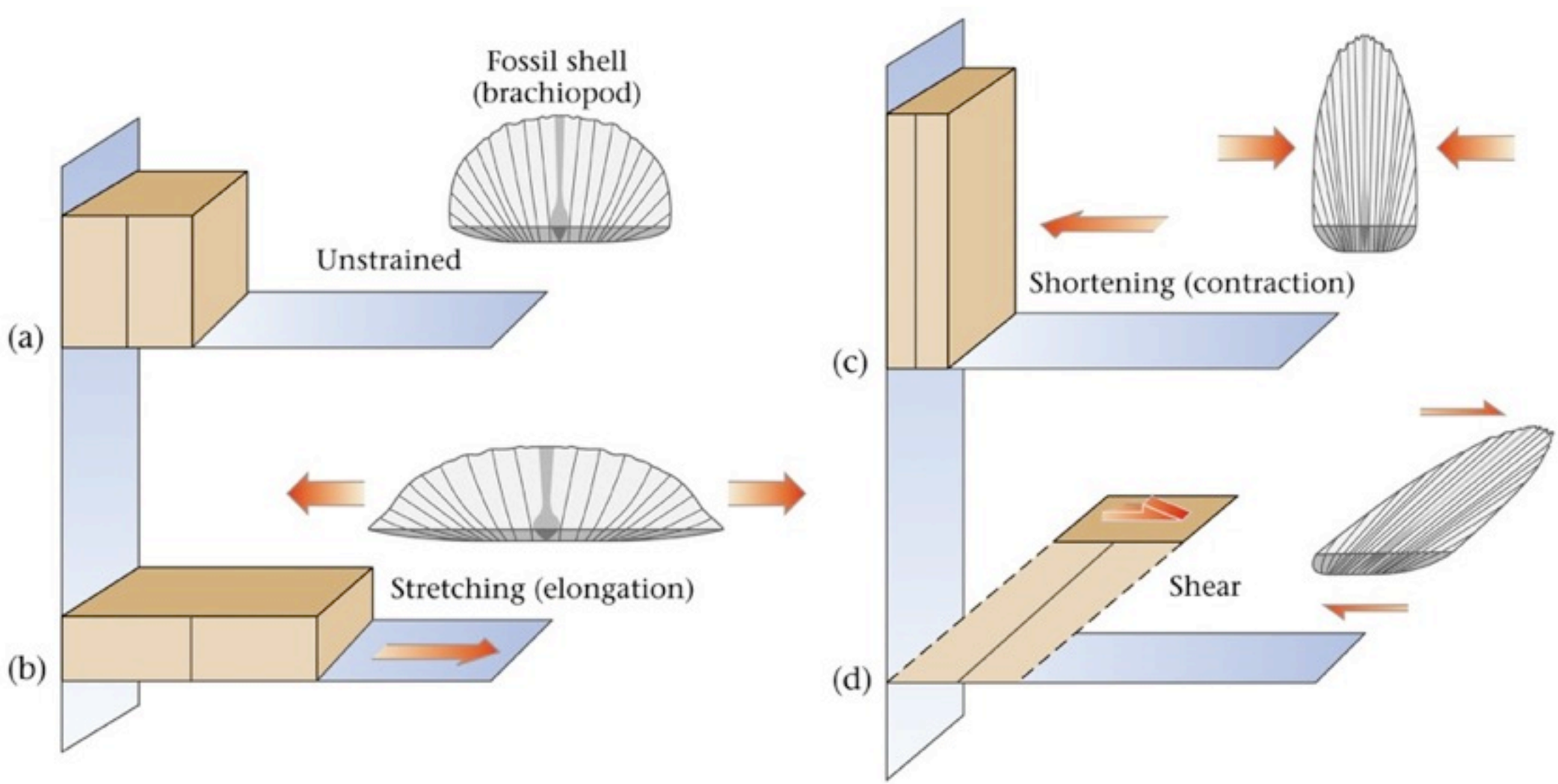
B) take some measurements of the fossil to assess the degree of stress because that would tell you about the strain applied to the fossil.

Uneformed fossil



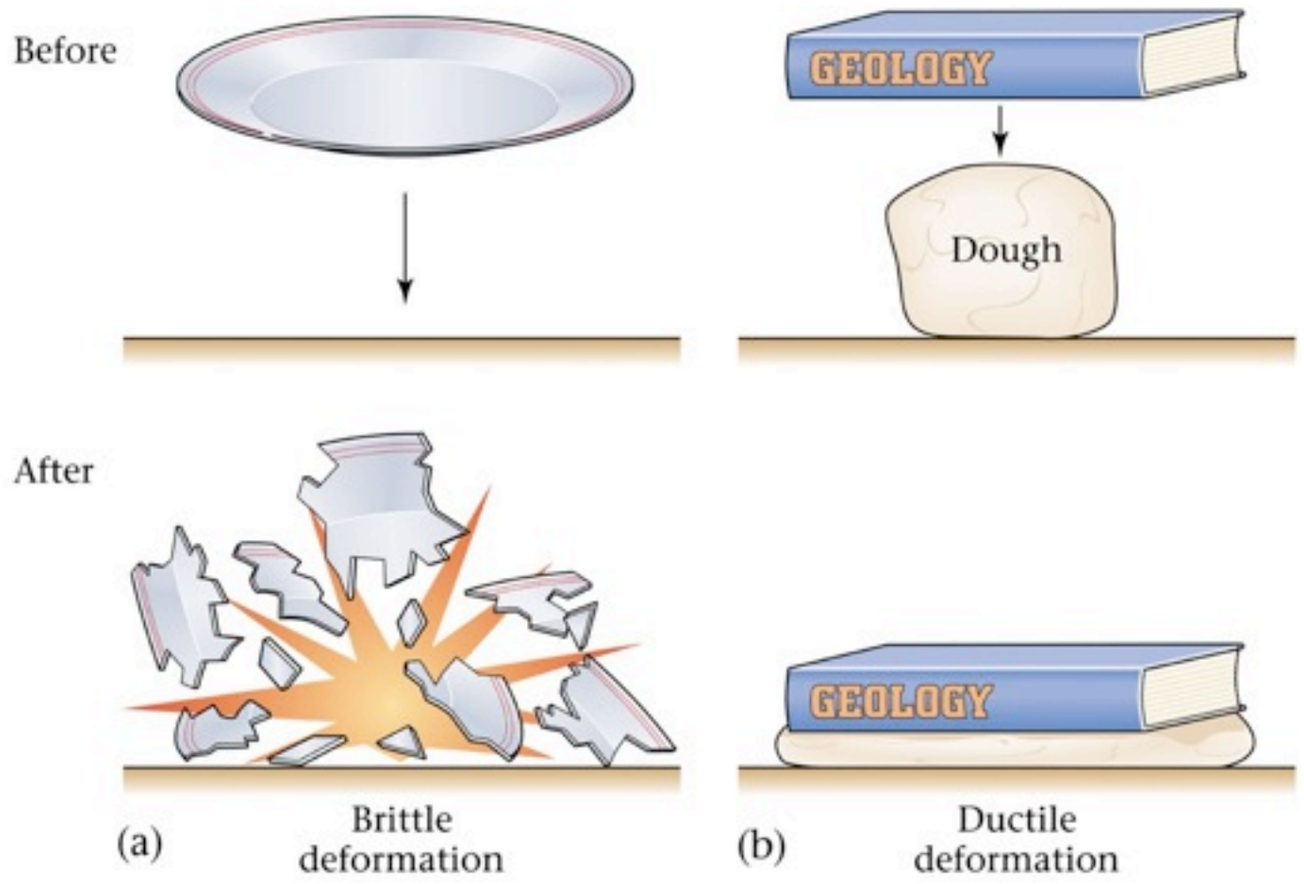
Deformed fossil

3 types of plate boundaries = 3 types of Stress = 3 types of strain



Combinations of Ductile and Brittle Deformation/ Strain

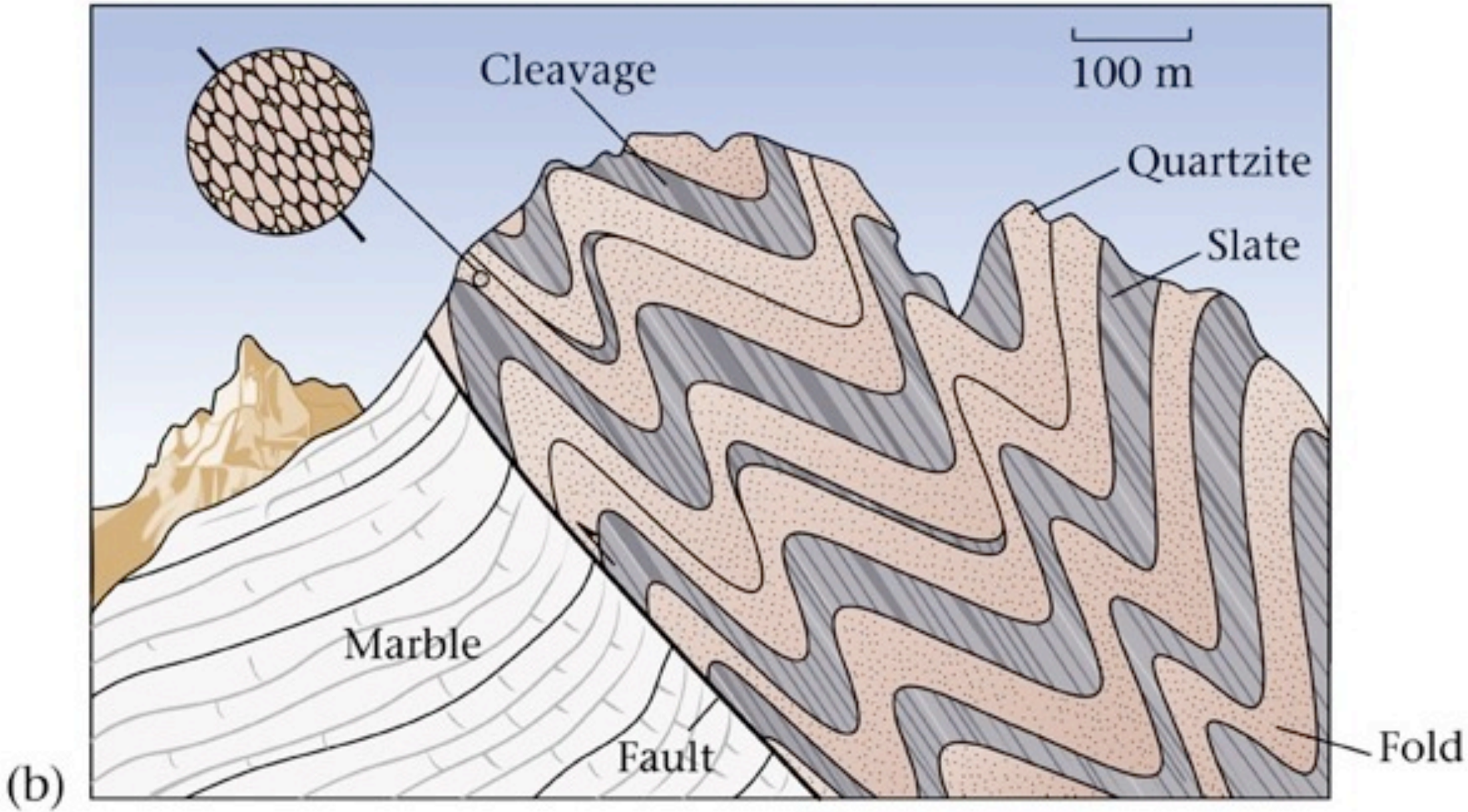
Types of Deformation/Strain as a result of Applied Stress



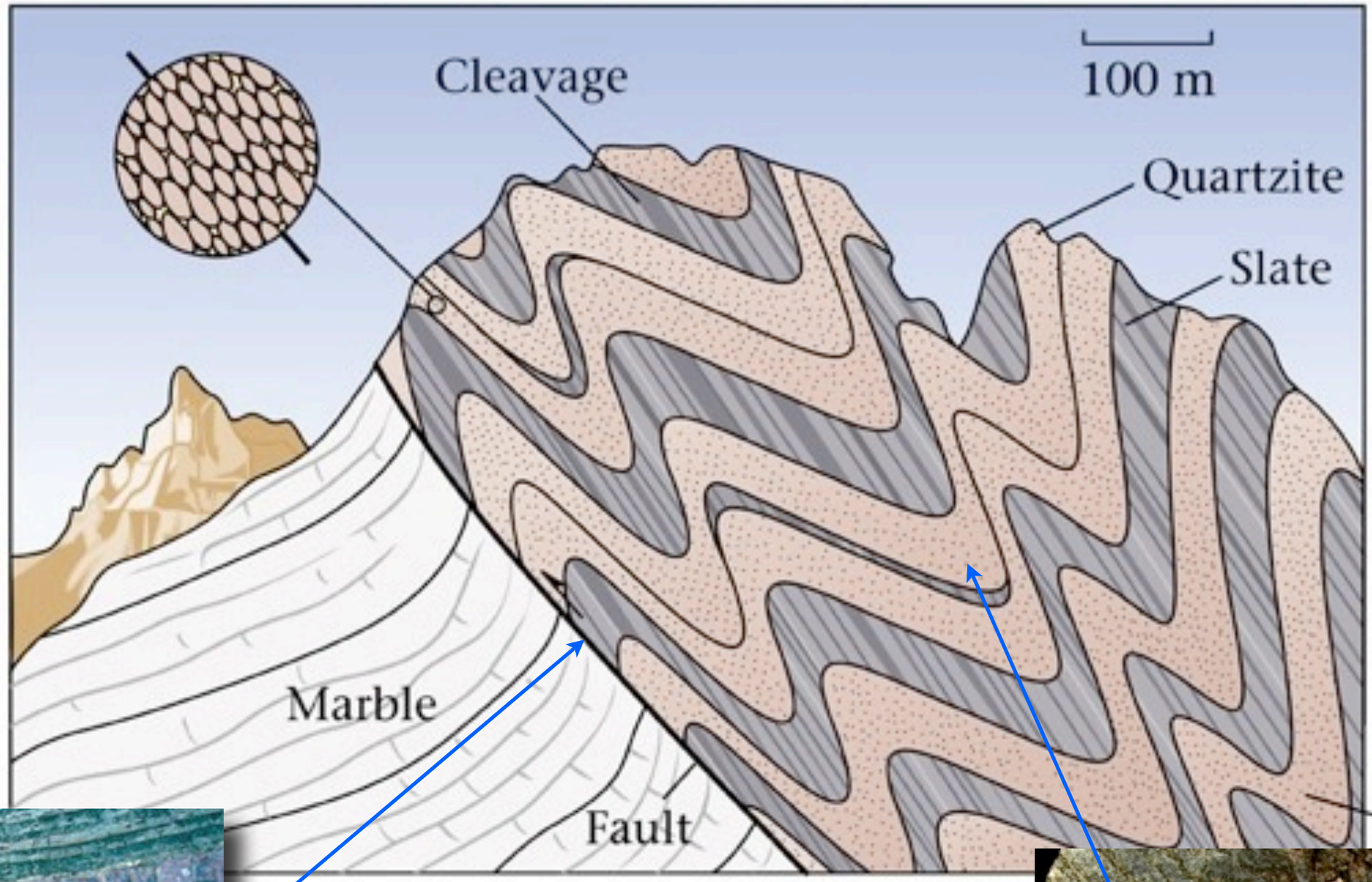
Brittle - Rocks change shape by fracturing

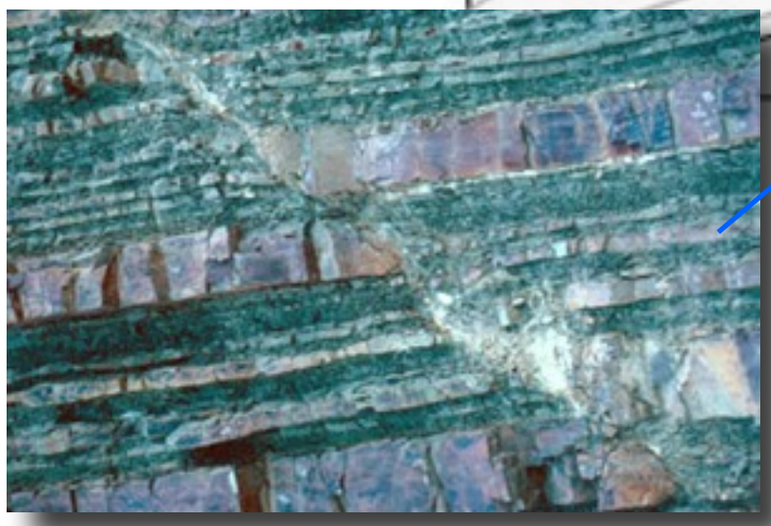
Ductile - Rocks change shape without visibly fracturing

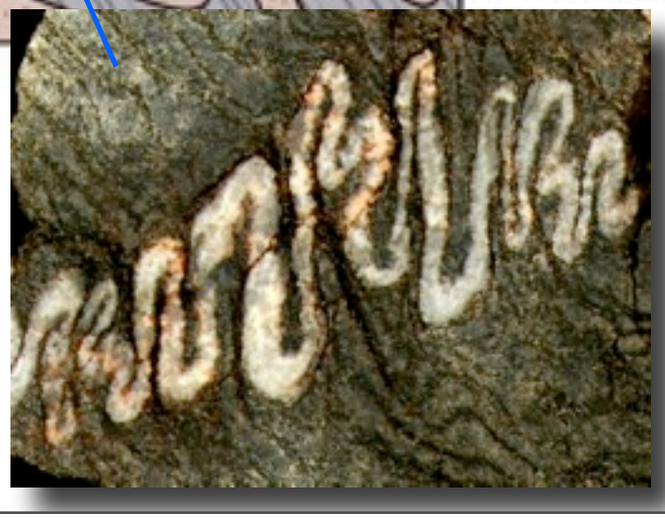
Brittle and Ductile Deformation



Brittle and Ductile Deformation

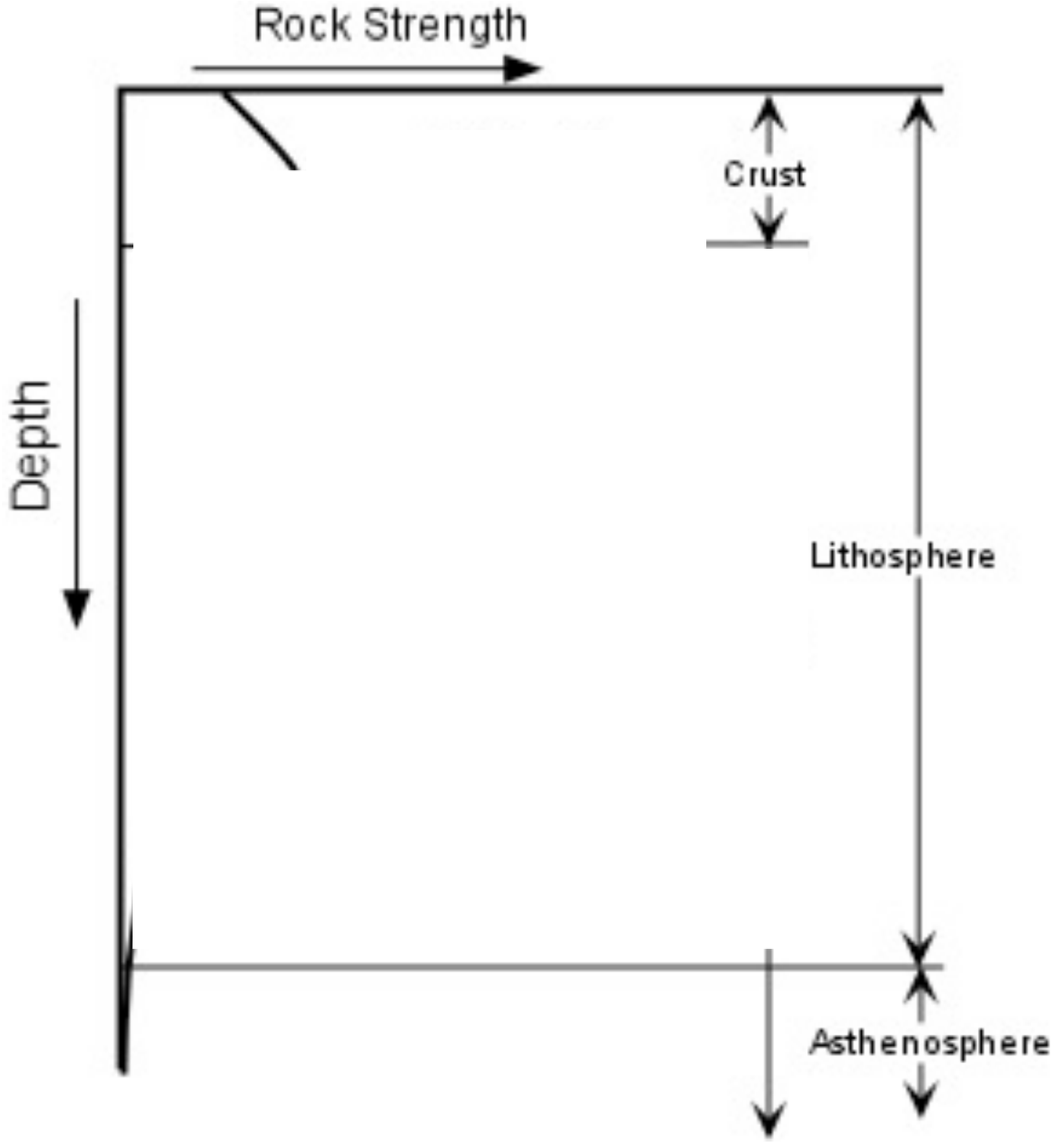






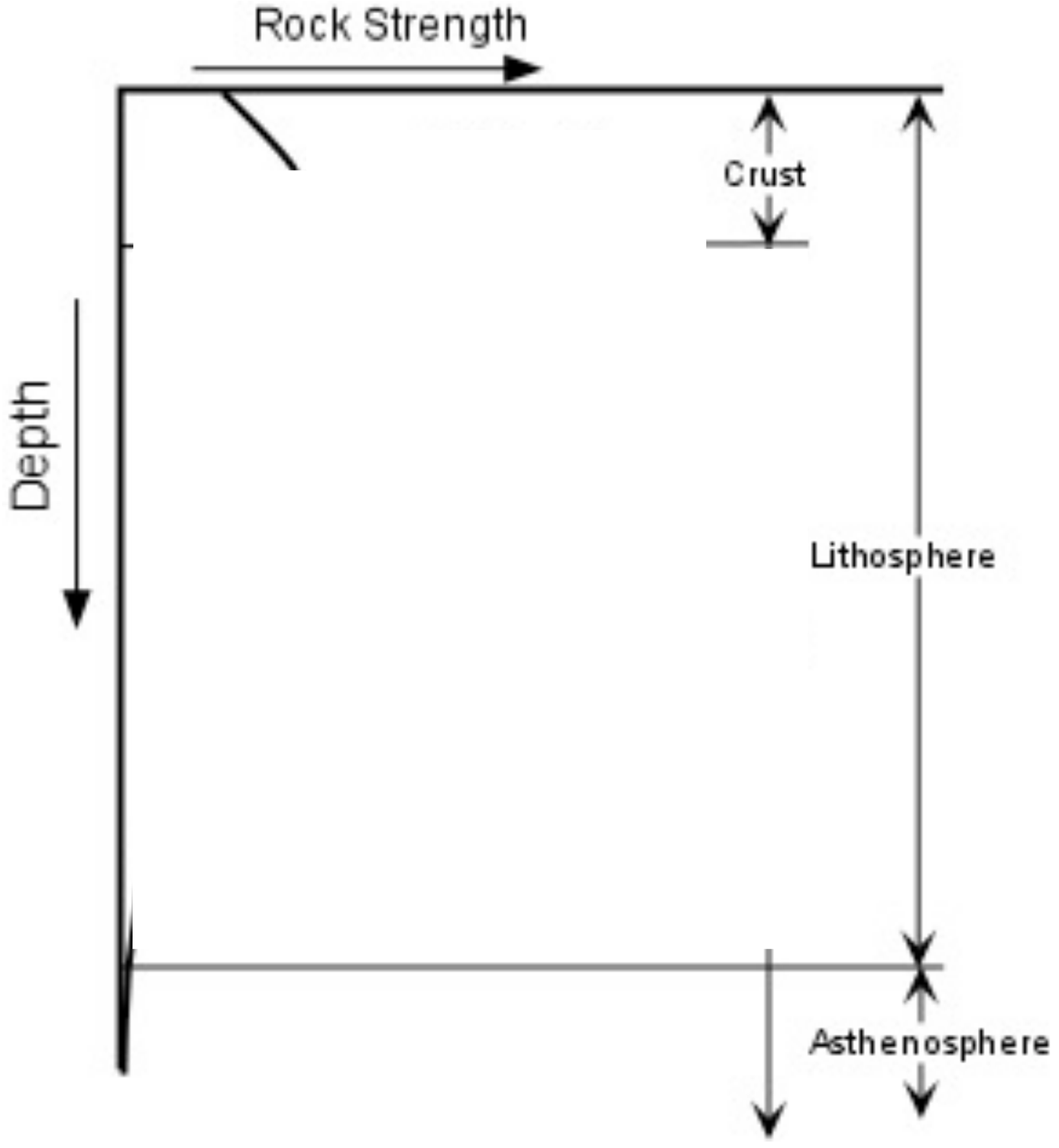
Look at the line on the graph which shows the relationship between rock strength and depth:
Do rocks get weaker or stronger as they get deeper into in Earth's Crust?

A) Stronger
B) Weaker
C) Cannot tell

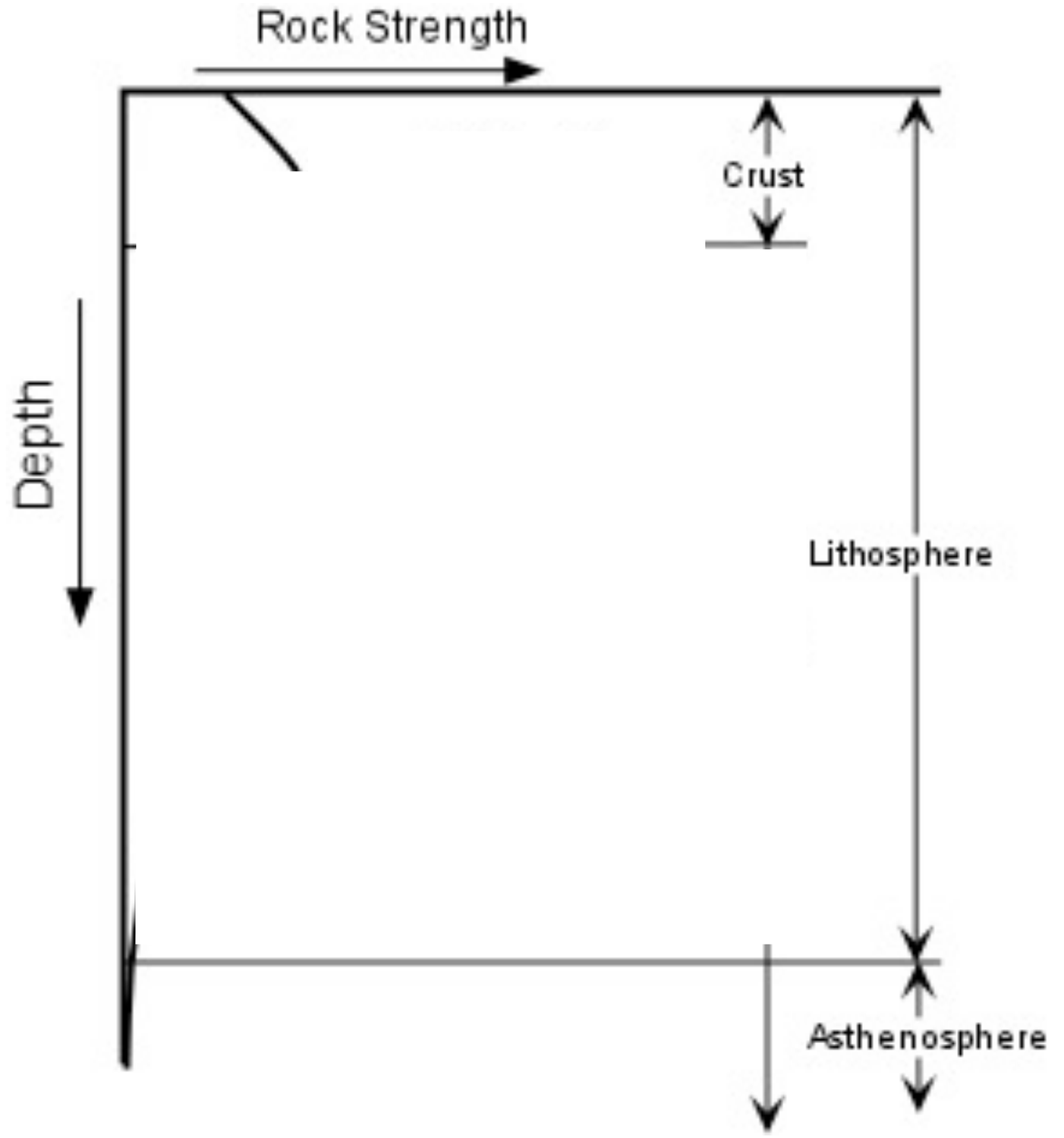


Look at the line on the graph which shows the relationship between rock strength and depth:
Do rocks get weaker or stronger as they get deeper into in Earth's Crust?

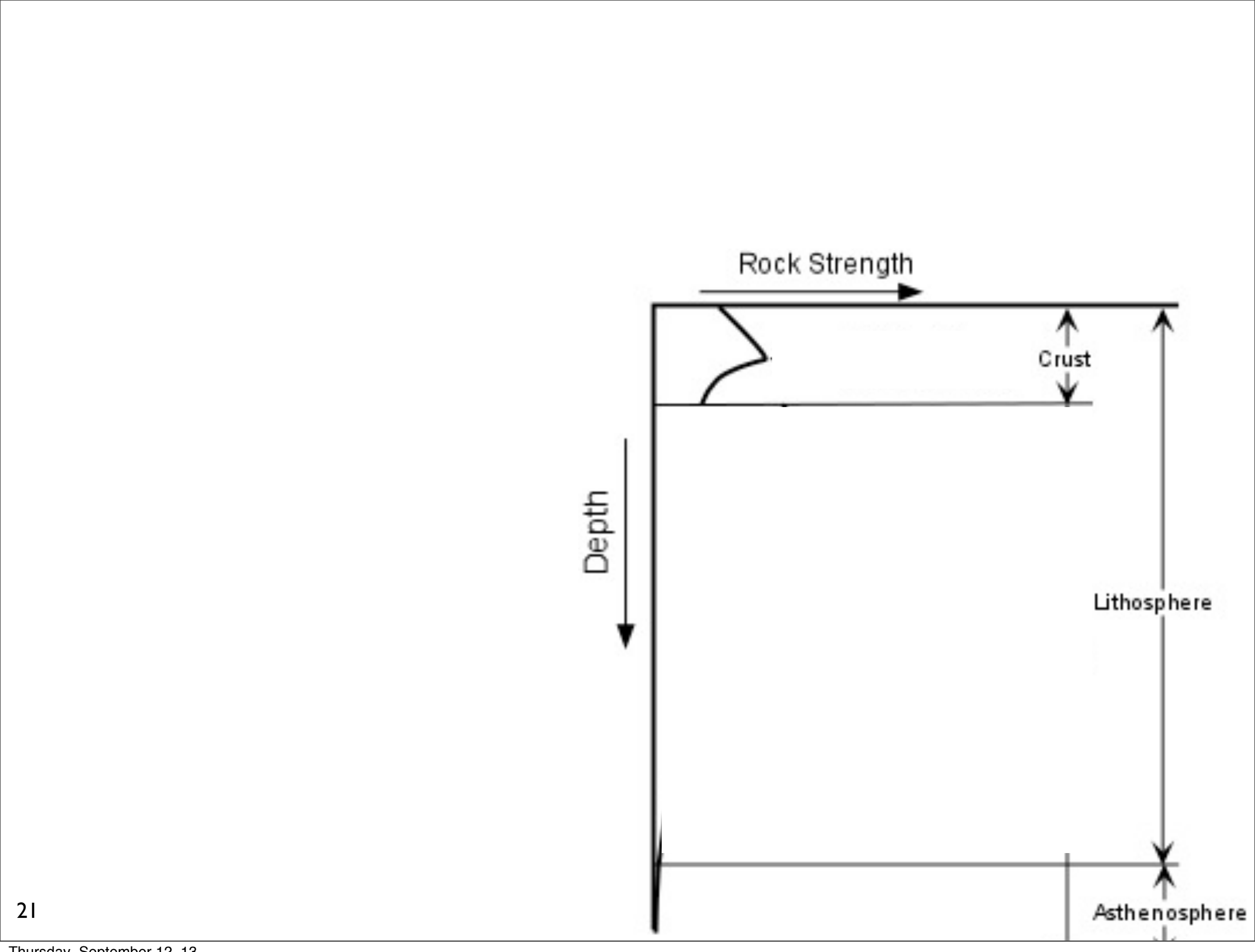
A) Stronger
B) Weaker
C) Cannot tell



In your Groups: Discuss why rocks get stronger <u>in the crust</u> at greater depths.



Take a 1-2 minutes to discuss in your groups


Rock Strength
Crust
Depth
Lithosphere
Asthenosphere

Notice that at ~15 km within the Earth's curst the rocks begin to weaken with depth. This is likely the result of_____.

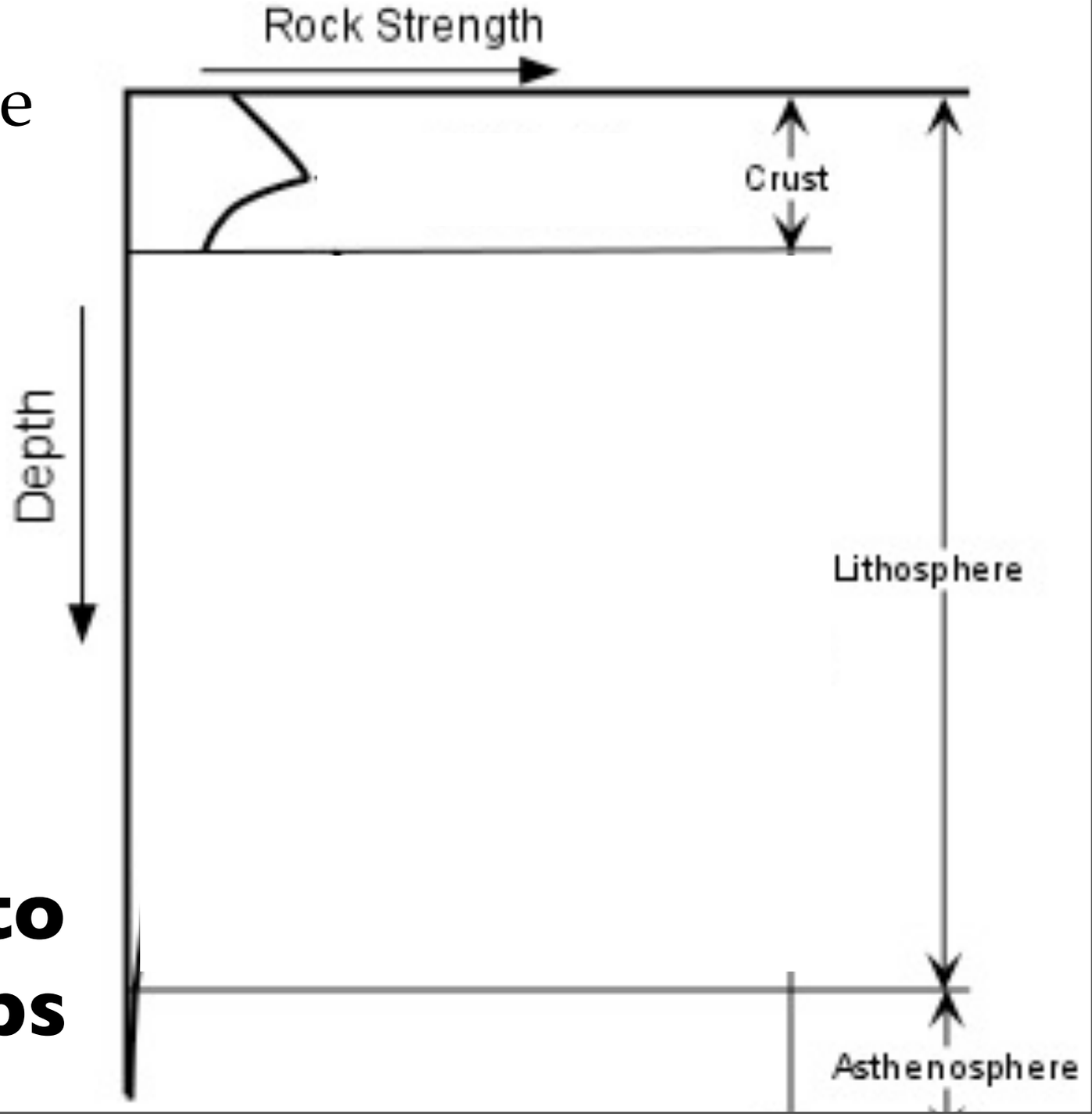
A) of a compositional change in the rocks

B) greater pressure at depth

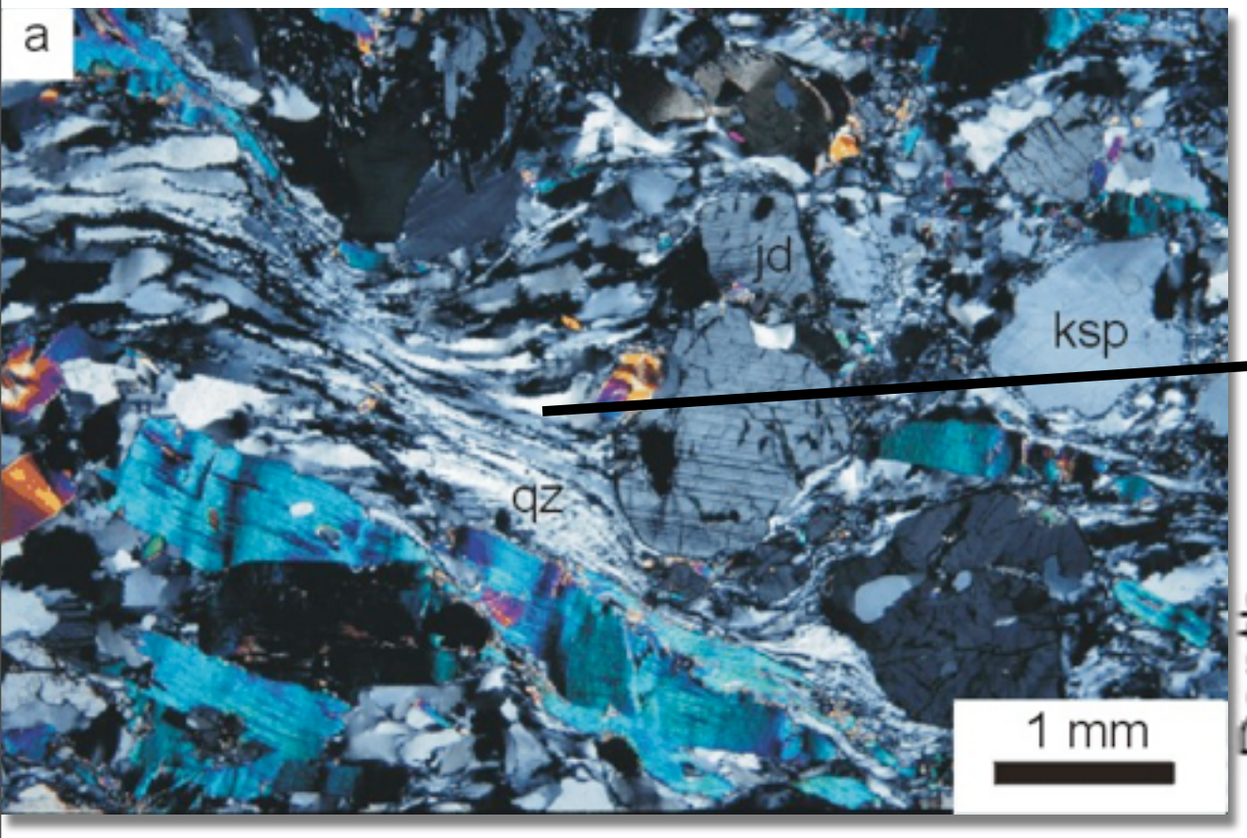
C) greater temperature at depth

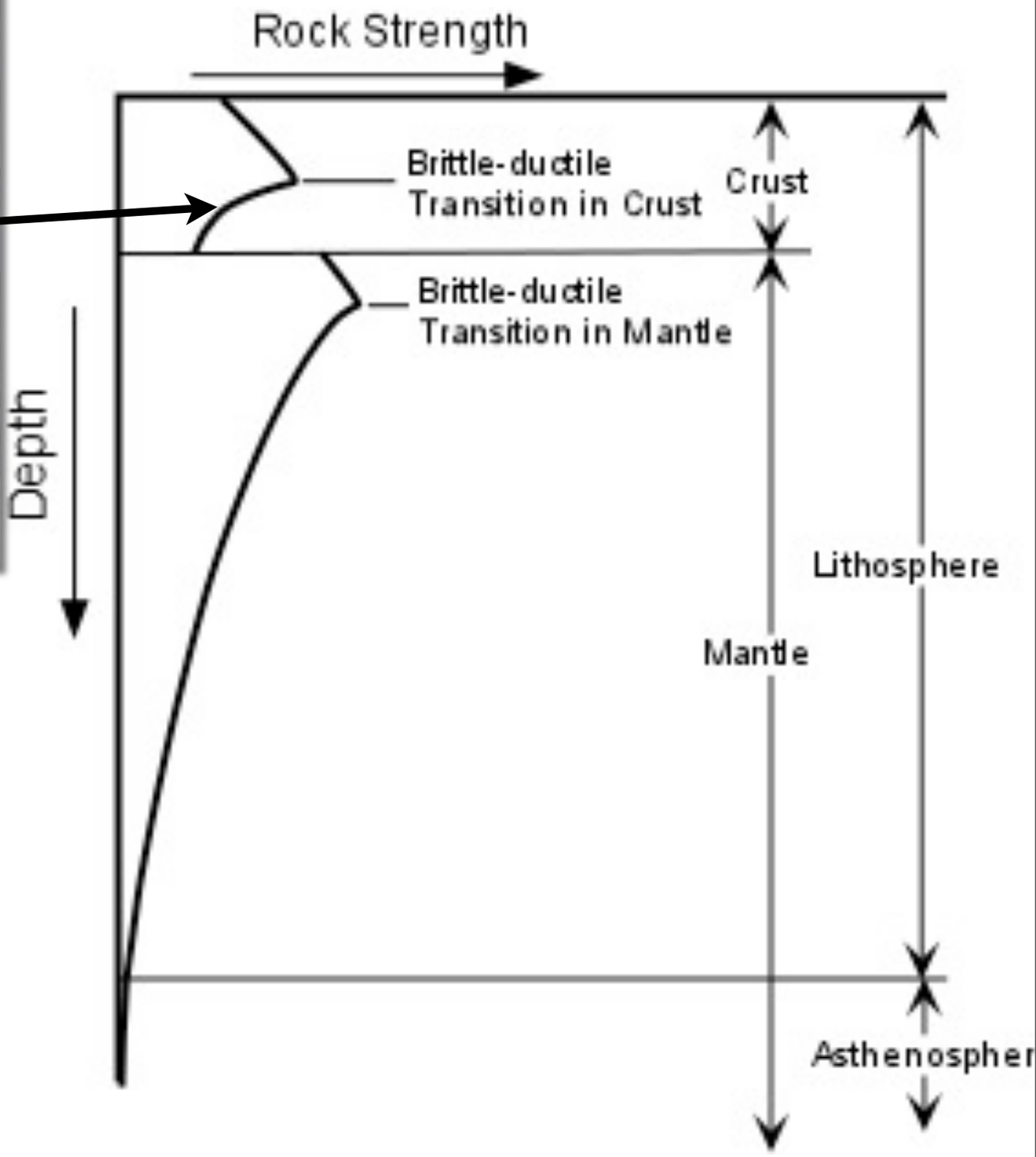
D) plate tectonics

Take a 1-2 minutes to discuss in your groups

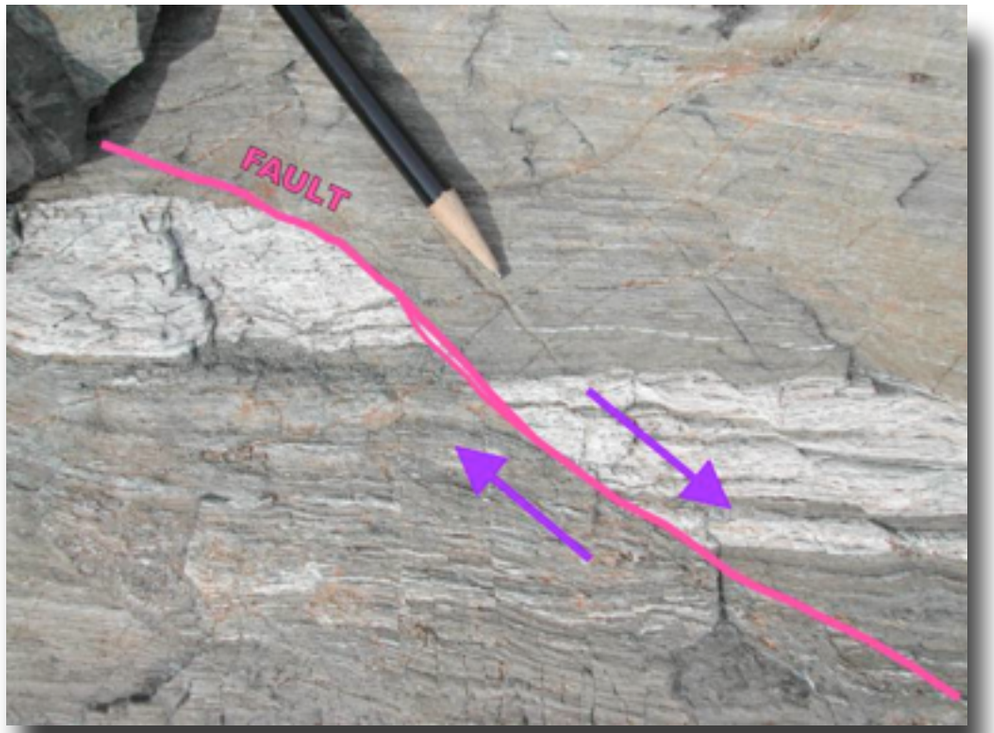


Rock Strength
(Brittle-Ductile Transition)





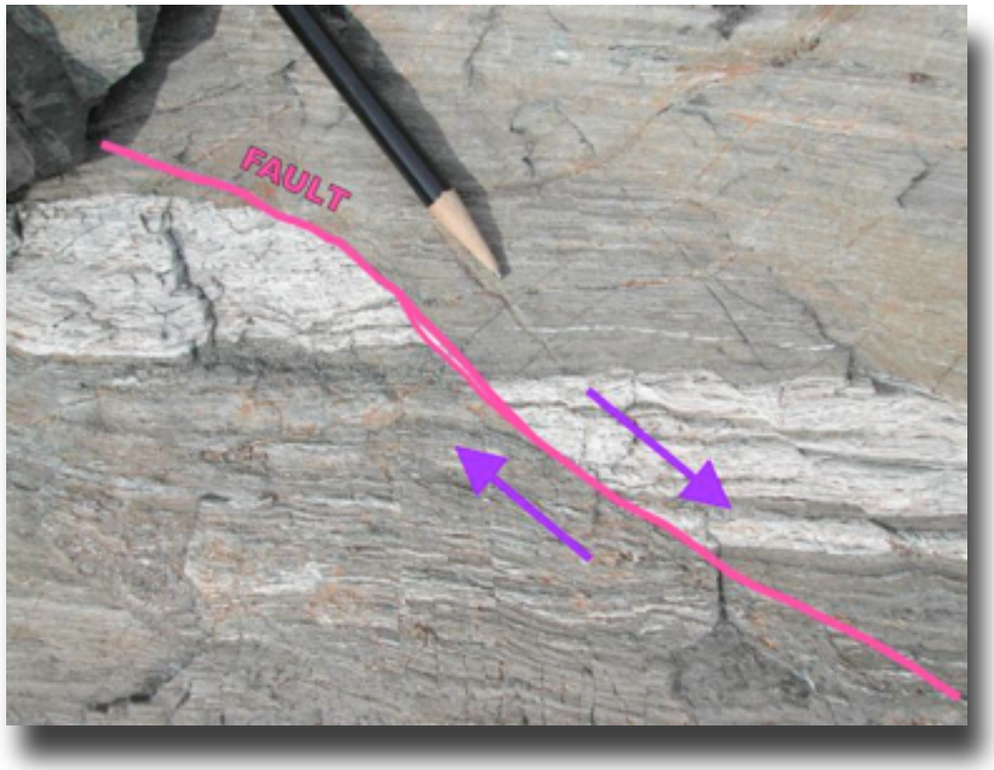
Why do rocks deform in two different ways?



Brittle

Ductile

Why do rocks deform in two different ways?

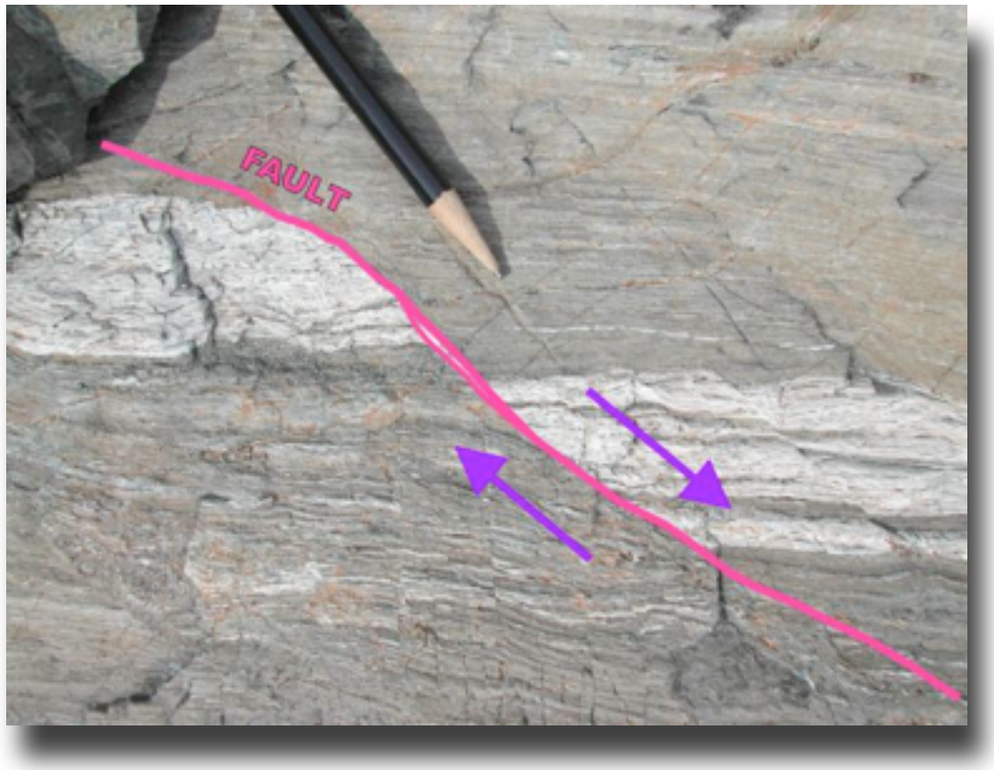


Brittle

Ductile

Composition, Temperature, Pressure

Why do rocks deform in two different ways?

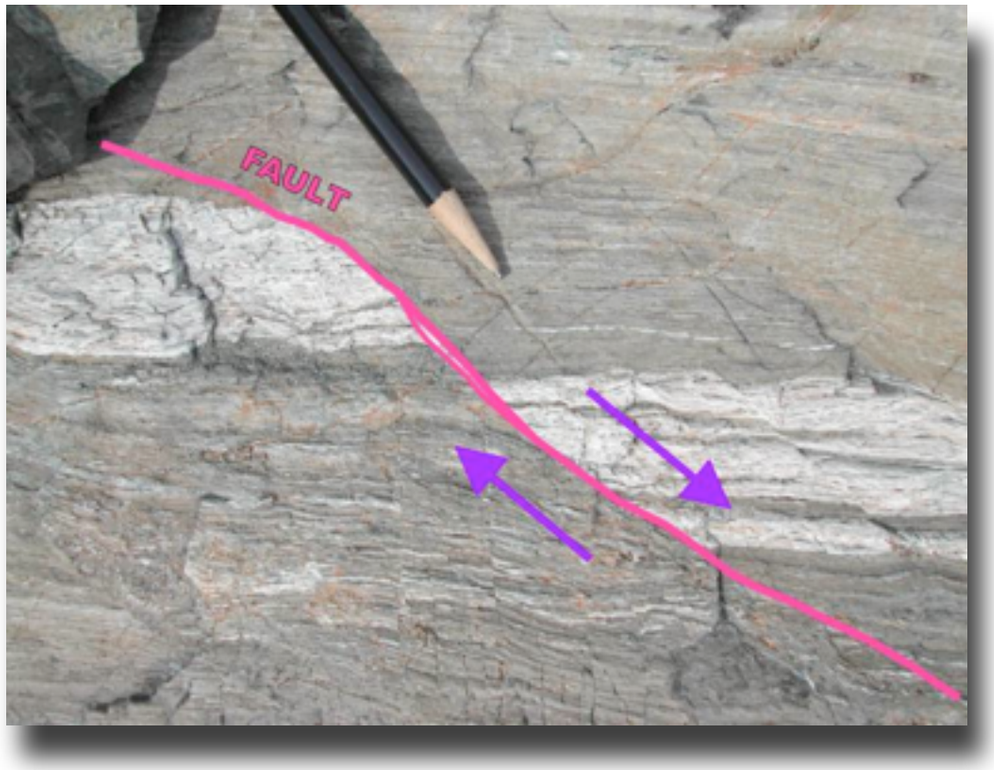


Brittle

Ductile

Composition, Temperature, Pressure and

Why do rocks deform in two different ways?



Brittle

Ductile

Composition, Temperature, Pressure and Strain Rate

Strain Rate

The rate at which strain accumulates in the rock (strain rate) affects whether a rock deforms as a brittle solid or as a ductile solid.

Group clicker Question:
What would cause the Brittle-ductile transition to be at a more shallow depth in Earth's crust?

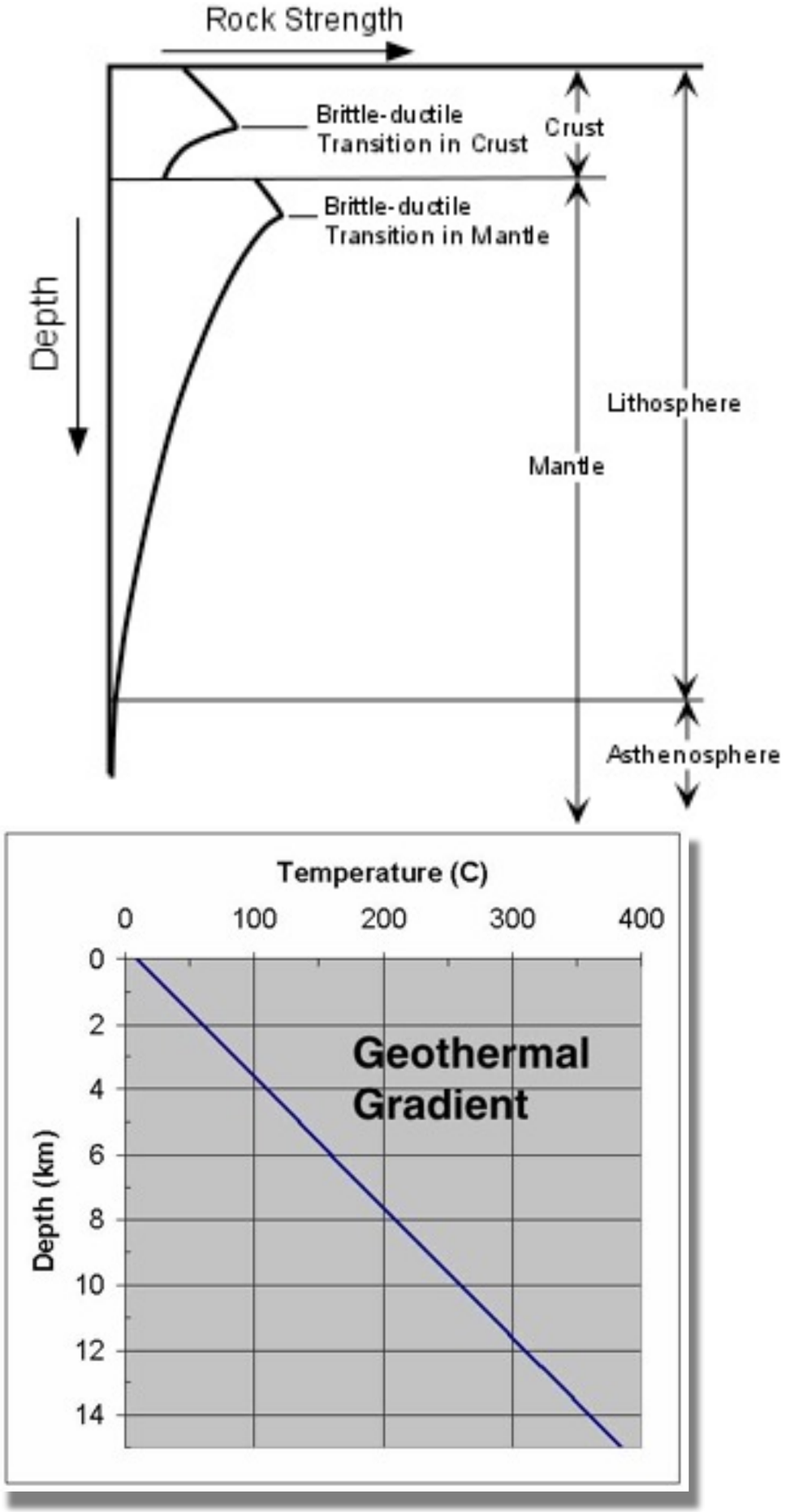
A) low strain rates

B) steepening of Earth's geothermal gradient.

C) A shallowing of the Earth's geothermal gradient

D) composition change to rocks similar to the mantle.

E) Both A and C



Group clicker Question:
What would cause the Brittle-ductile transition to be at a more shallow depth in Earth's crust?

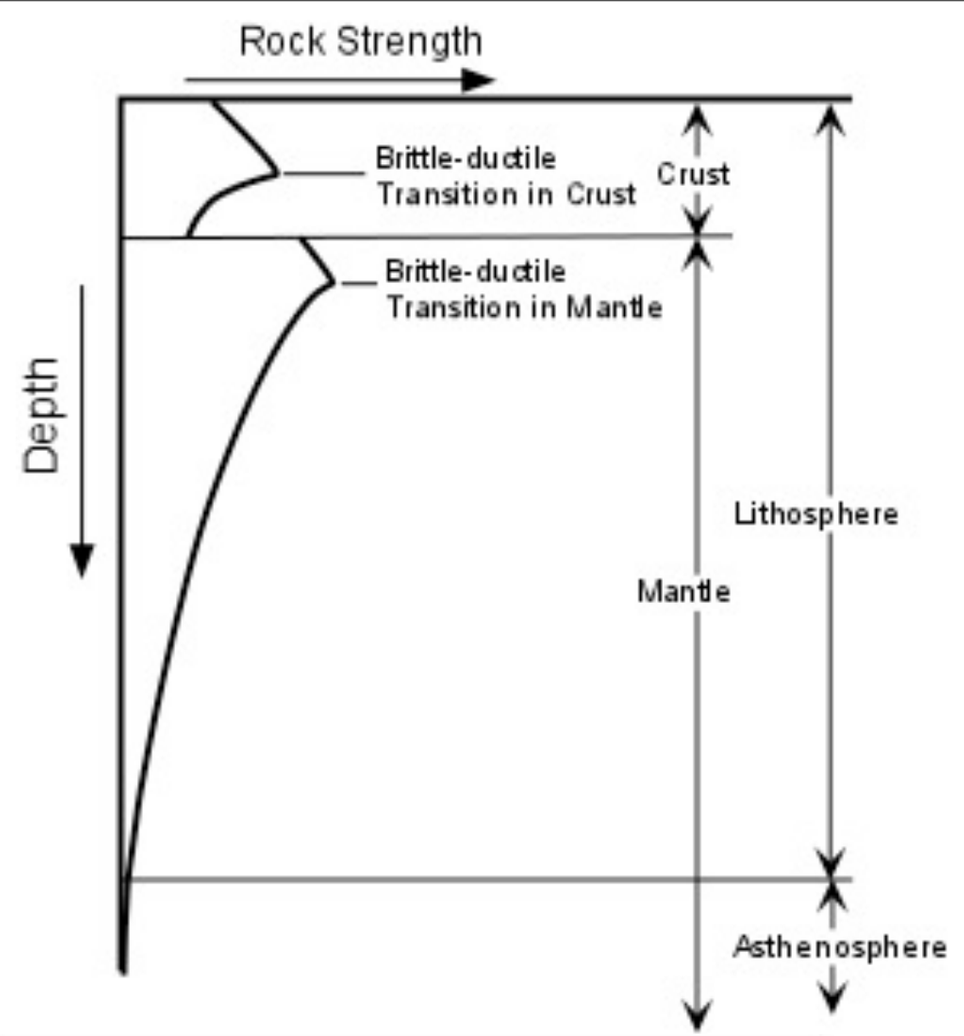
A) low strain rates

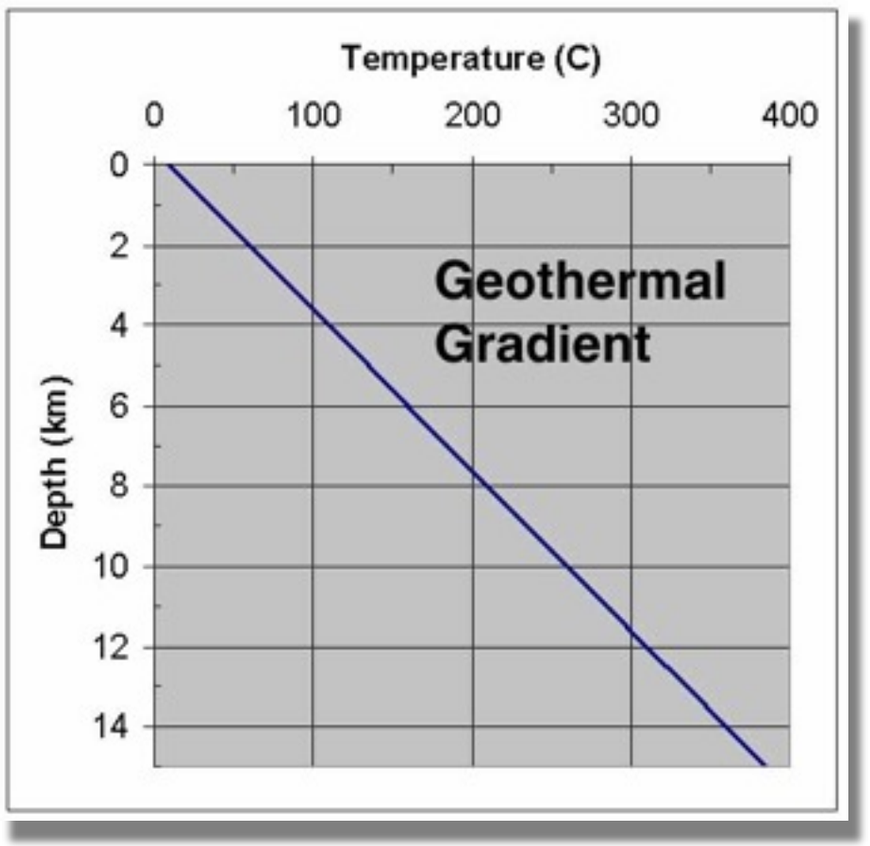
B) steepening of Earth's geothermal gradient.

C) A shallowing of the Earth's geothermal gradient

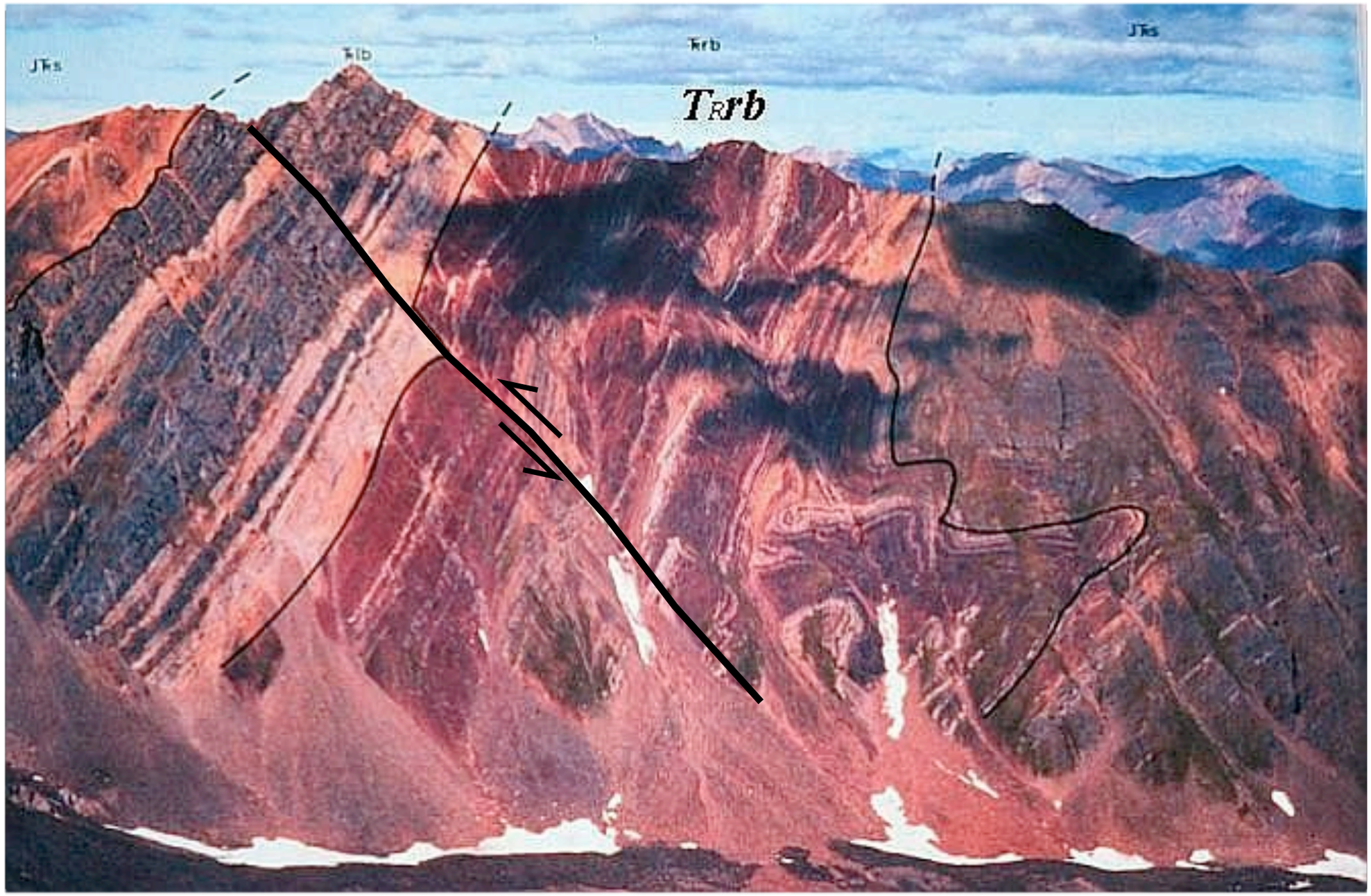
D) composition change to rocks similar to the mantle.

E) Both A and C

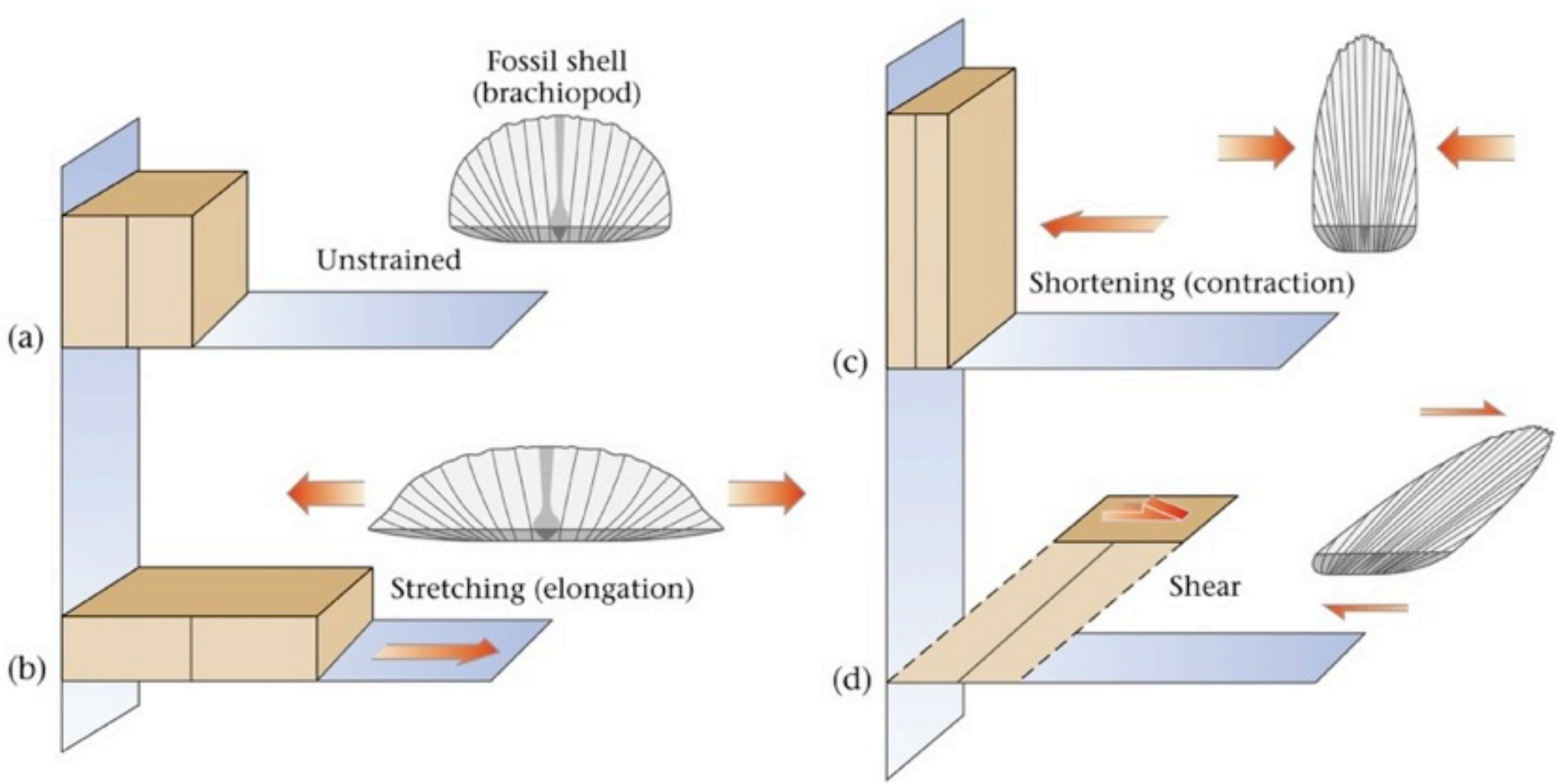




Denali Brittle Ductile Transition

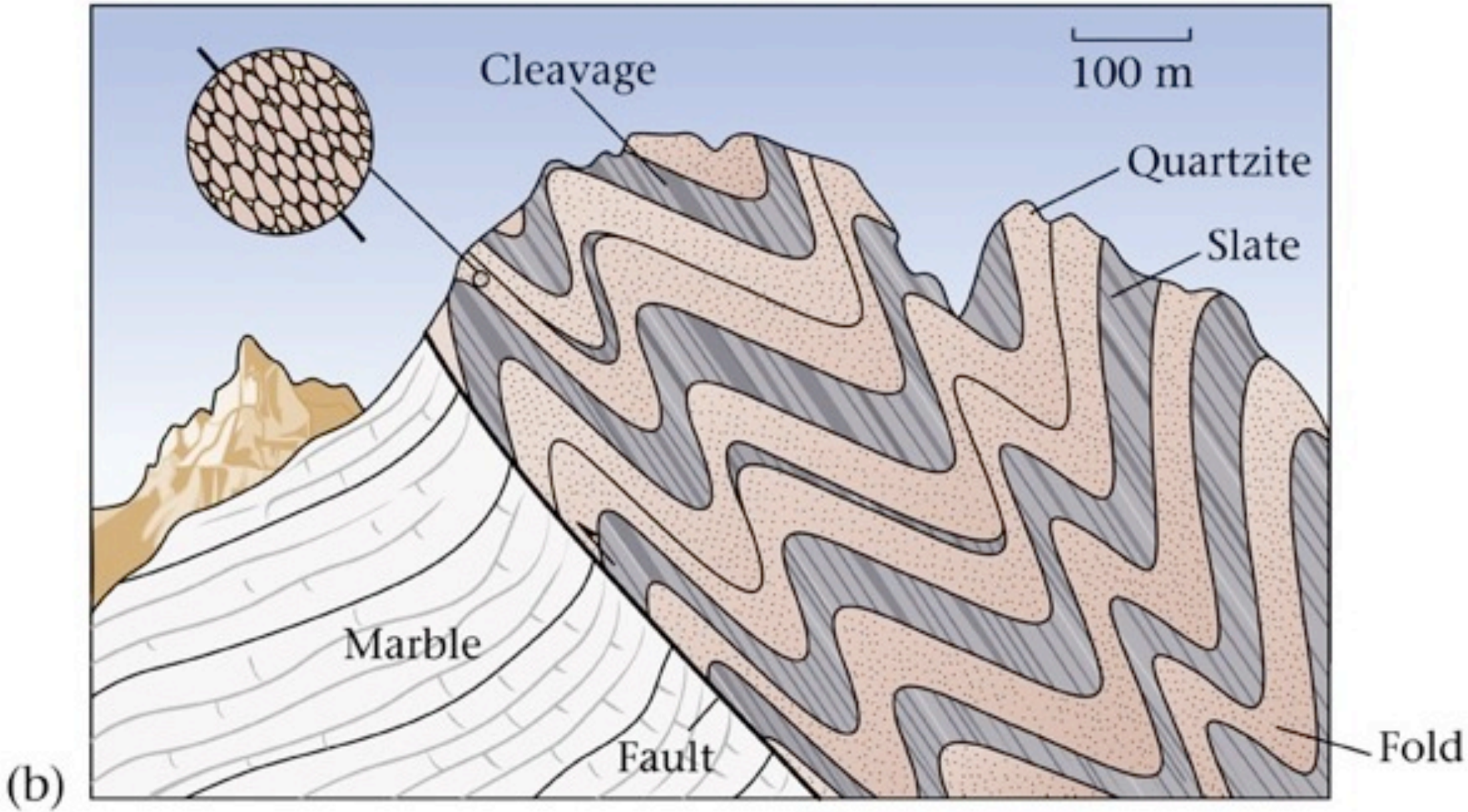


3 types of plate boundaries = 3 types of Stress = 3 types of strain

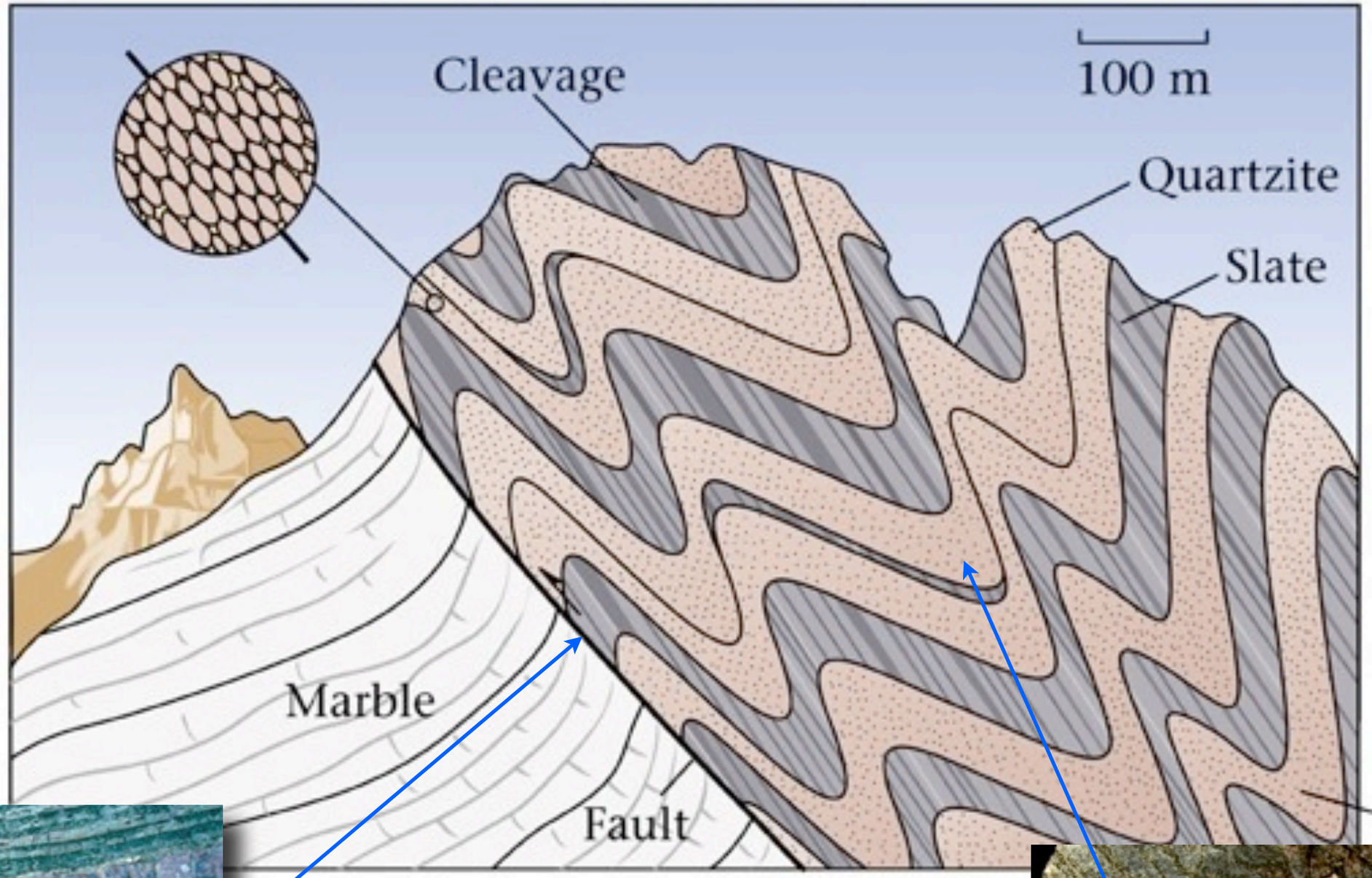


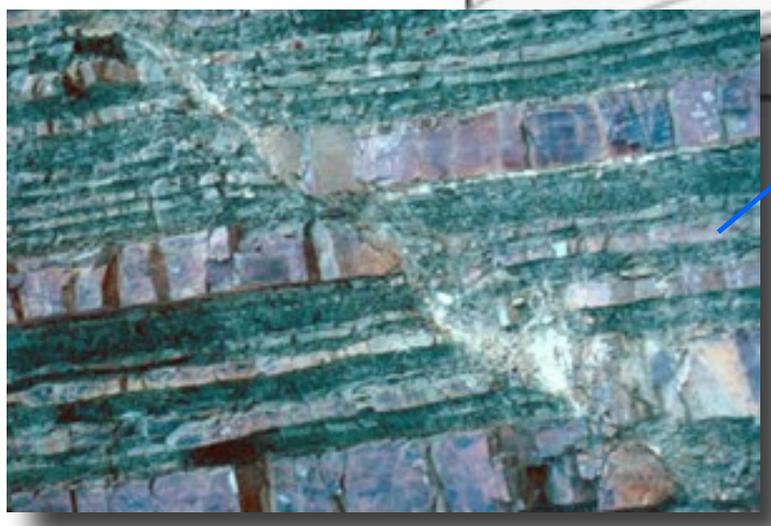
Combinations of Ductile and Brittle Deformation/ Strain

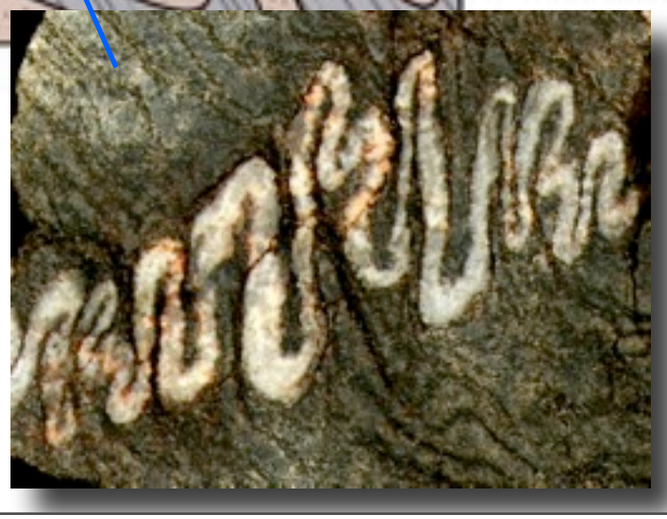
Brittle and Ductile Deformation



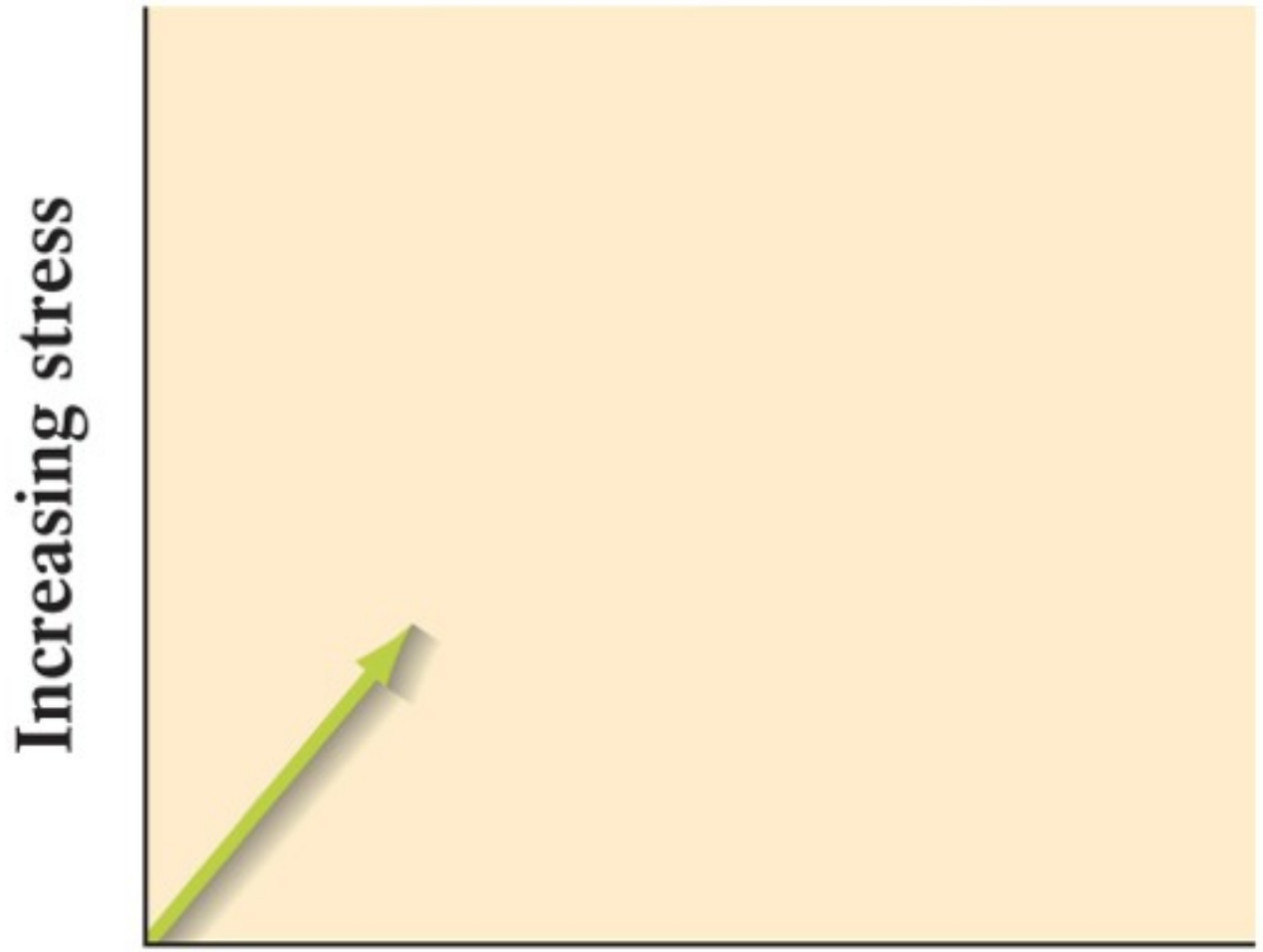
Brittle and Ductile Deformation





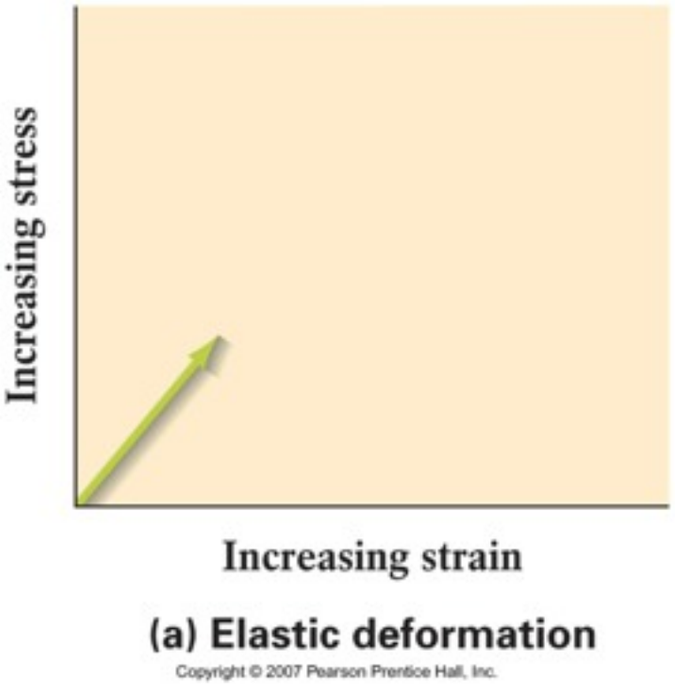


Elastic Strain (recoverable deformation)

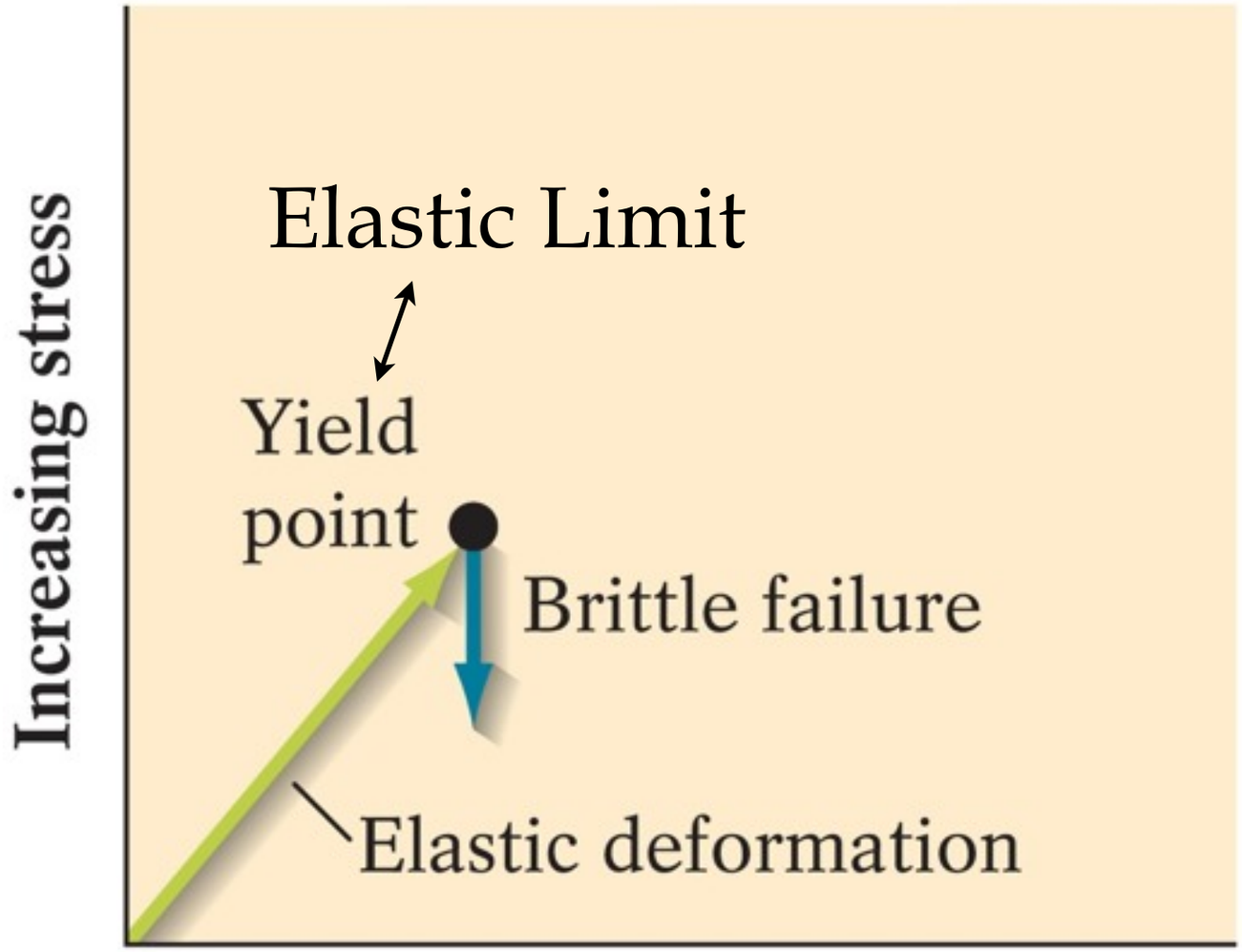


(a) Elastic deformation

Brittle Strain (non-recoverable)

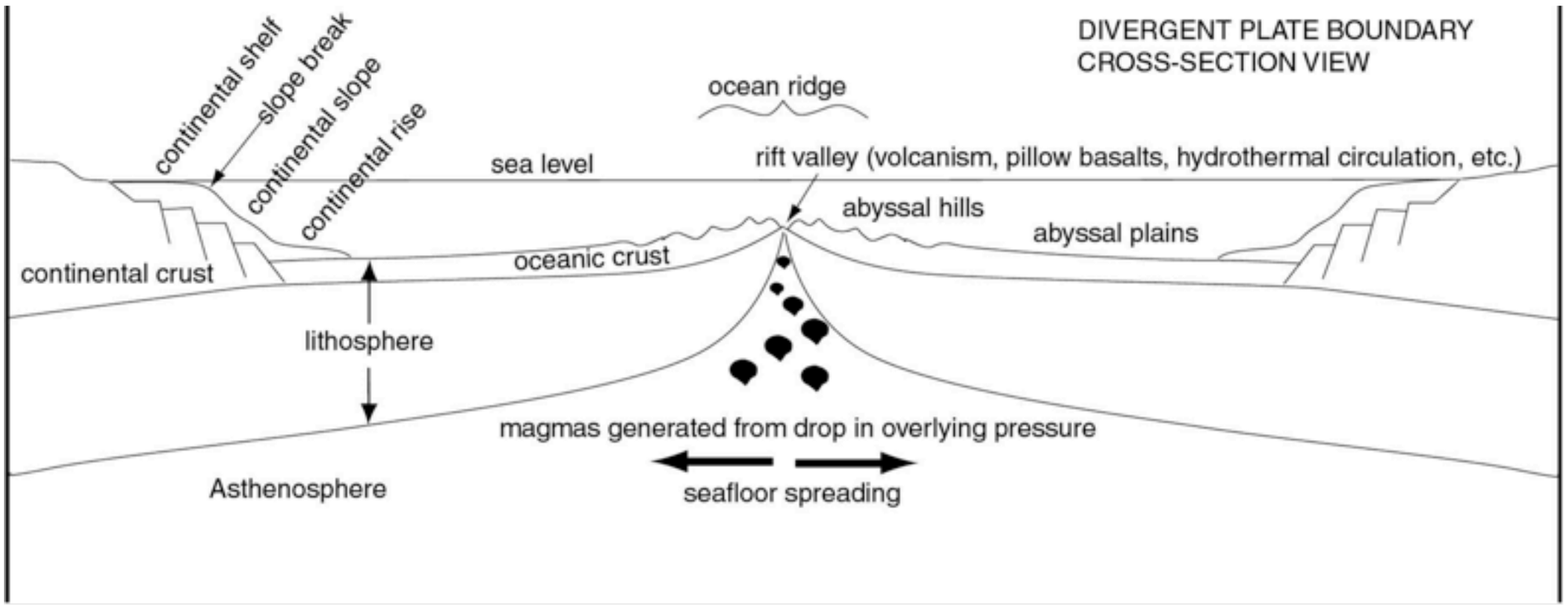


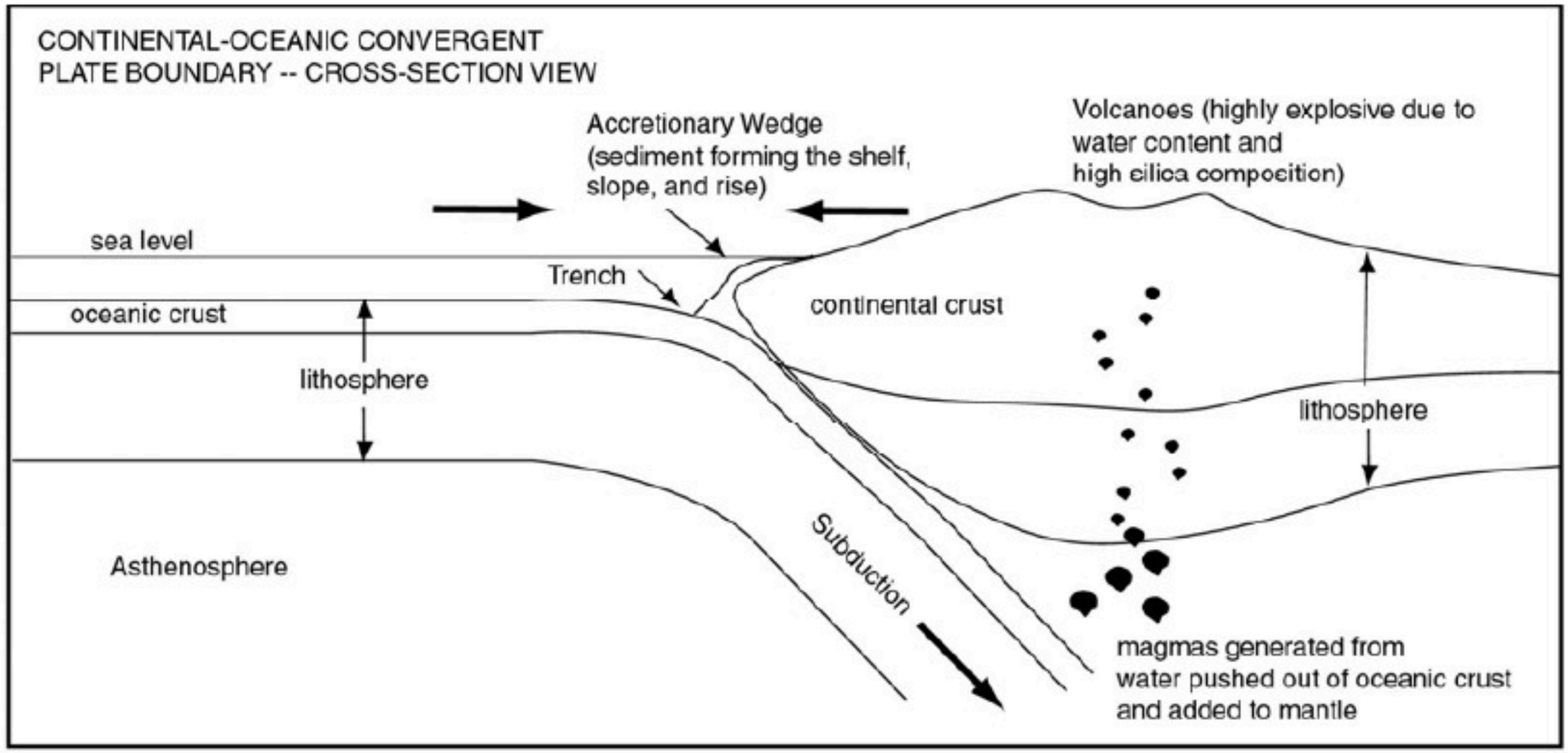
(a) Elastic deformation



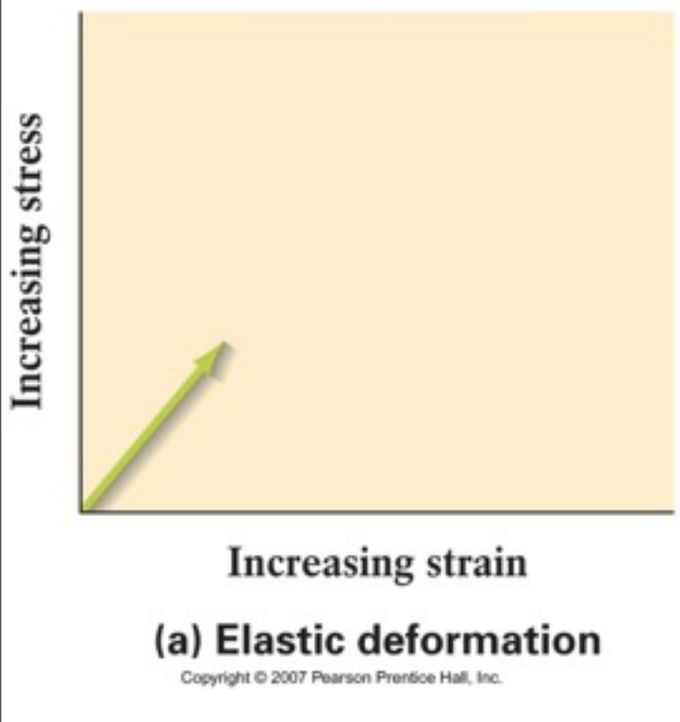
Increasing strain

(b) Brittle failure

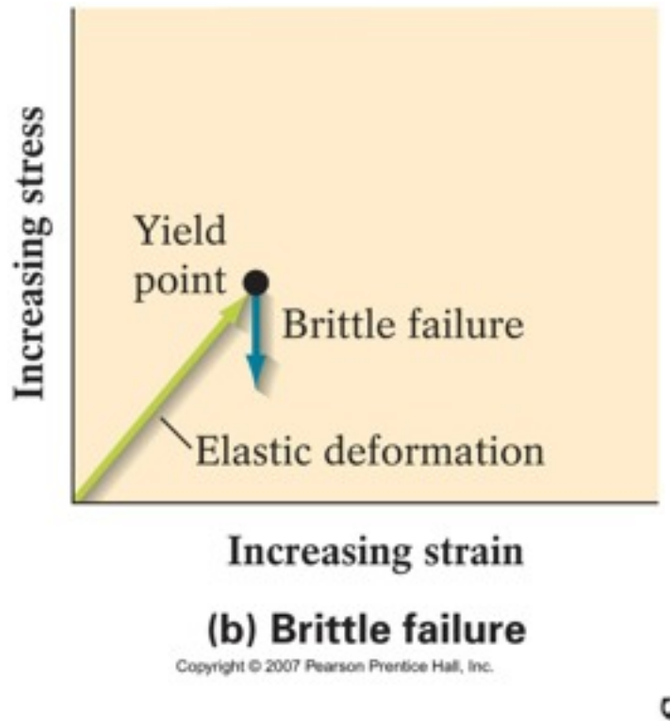

DIVERGENT PLATE BOUNDARY
CROSS-SECTION VIEW
continental shelf
slope break
continental slope
continental rise
ocean ridge
sea level
rift valley (volcanism, pillow basalts, hydrothermal circulation, etc.)
abyssal hills
abyssal plains
continental crust
oceanic crust
lithosphere
magmas generated from drop in overlying pressure
Asthenosphere
seafloor spreading


CONTINENTAL-OCEANIC CONVERGENT
PLATE BOUNDARY -- CROSS-SECTION VIEW
Accretionary Wedge
(sediment forming the shelf,
slope, and rise)
Volcanoes (highly explosive due to
water content and
high silica composition)
sea level
Trench
oceanic crust
continental crust
lithosphere
lithosphere
Asthenosphere
Subduction
magmas generated from
water pushed out of oceanic crust
and added to mantle

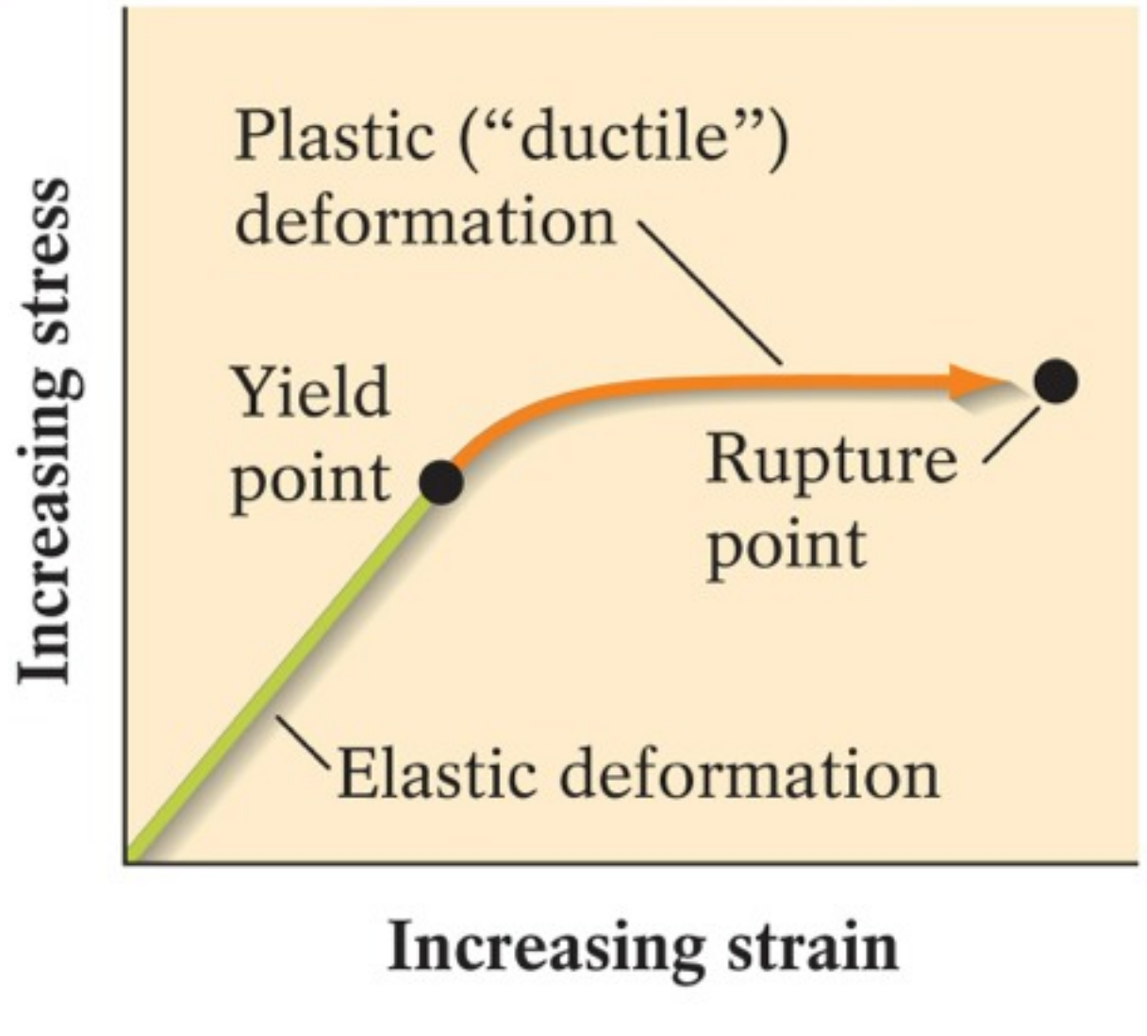
Ductile/plastic strain (non-recoverable)



(a) Elastic deformation



(b) Brittle failure



(c) Plastic deformation