

Extra Credit for Exam II

**Extra Credit Atlas Exercise
for EXAM II focuses on climate
and climate controls.**

**It is available on the course home page
and BlackBoard.**

**Submit answers via email to
agrande@hunter.cuny.edu
no later than
Tuesday, March 31, 2020**

GEOG 101 Part II
People and their
Physical Environment

14: The Lithosphere
Geologic Processes
and
Forces Shaping the Earth
Chapter 3

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Hunter College Geography



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PART II: People and their Physical Environment

- ✓ I. Introduction to the Physical Environment
- ✓ II. Earth-Sun Relationship
- III. **Earth Systems**
 - ✓ A. The Hydrosphere: Oceans
 - ✓ B. The Atmosphere: Weather and Climate
 - C. The Lithosphere: Geologic Influences and
Landscape Development
- IV. Earth Habitat
 - A. Biosphere
 - B. Natural Controls and Cycles
 - C. Human Impact
 - D. Natural Hazards
 - E. Earth Resources

Geologic Influences



- ❖ **Geologic environment influences how people live and survive on the earth's surface.**
- The pattern of human activity is related to what is on and below the surface.



Human use factors include:

- ✓ geologic processes
- ✓ type of rock
- ✓ slope angle
- ✓ soil fertility
- ✓ water supply
- ✓ mineral resources
- + climate variables effect
- erosion and deposition rates:
- landform development

Definitions

- ❖ **GEOLOGY**: scientific study of the earth: origin, structure and processes.
- ❖ **GEOMORPHOLOGY**: study of landforms: origin, characteristics, processes, evolution
- ❖ **TOPOGRAPHY**: study of surface features

All used by geographers to evaluate location.

GEOLOGIC CYCLE

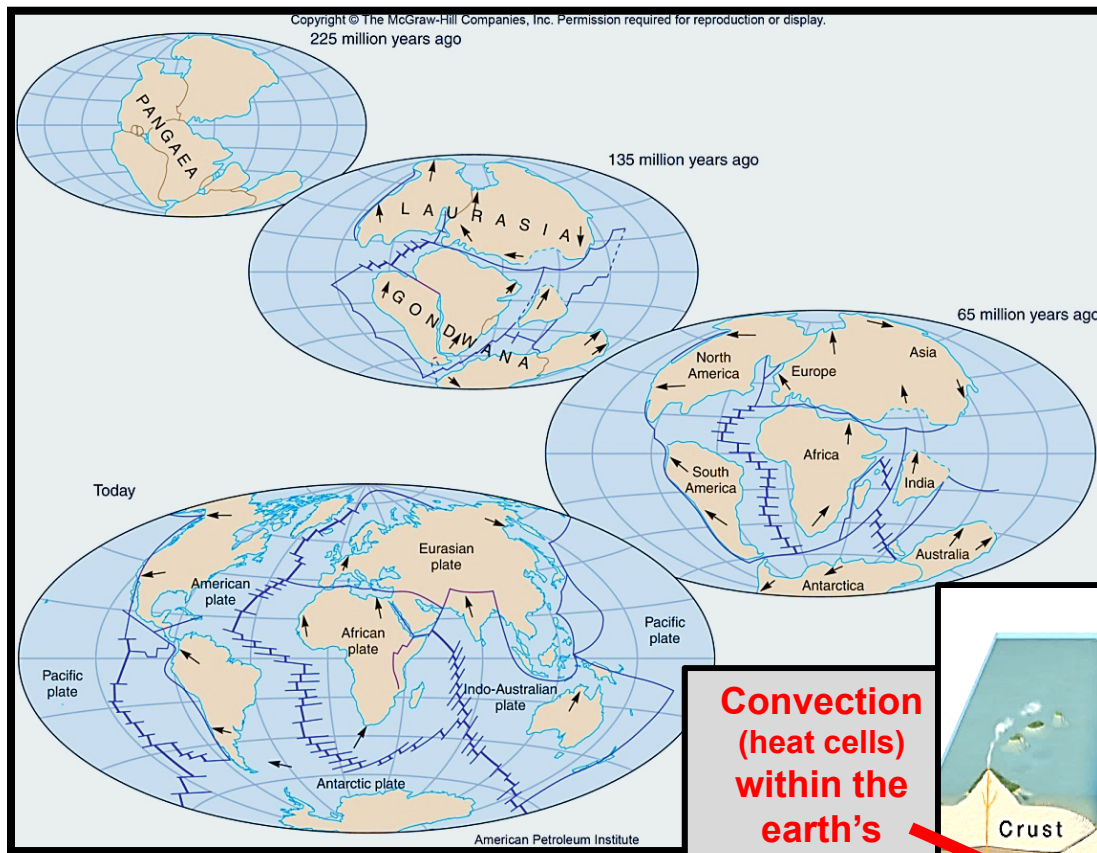
There are 3 parts to the geologic cycle:

- 1. Continental Drift:** *Plate Tectonic Theory*
- 2. Rocks and Minerals:** *Creation of earth materials*
- 3. Building and Gradational Processes:** *Creation and shaping of surface landform features*

Continental Drift

The earth's crust **shifts position** in response to forces within its interior.

The theory explaining this is called **Plate Tectonics**.



**Convection
(heat cells)
within the
earth's
interior.**

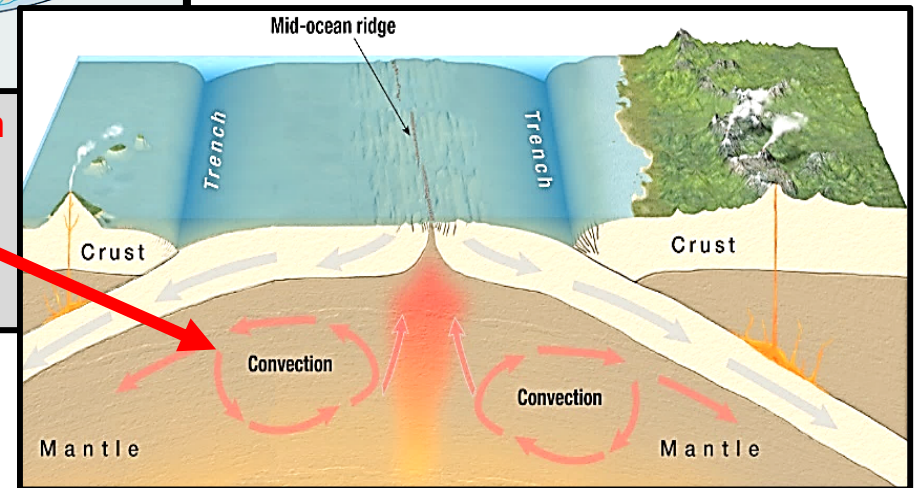


Plate Tectonics Theory

This says that the continents and the ocean floor are on **lithospheric plates** that “float” on the upper mantle.

They **collide and scrape** against each other as they slowly shift position (“drift”) in response to convective forces within the earth.

https://www.youtube.com/watch?v=0mWQs1_L3fA 6 min

Plate Tectonics

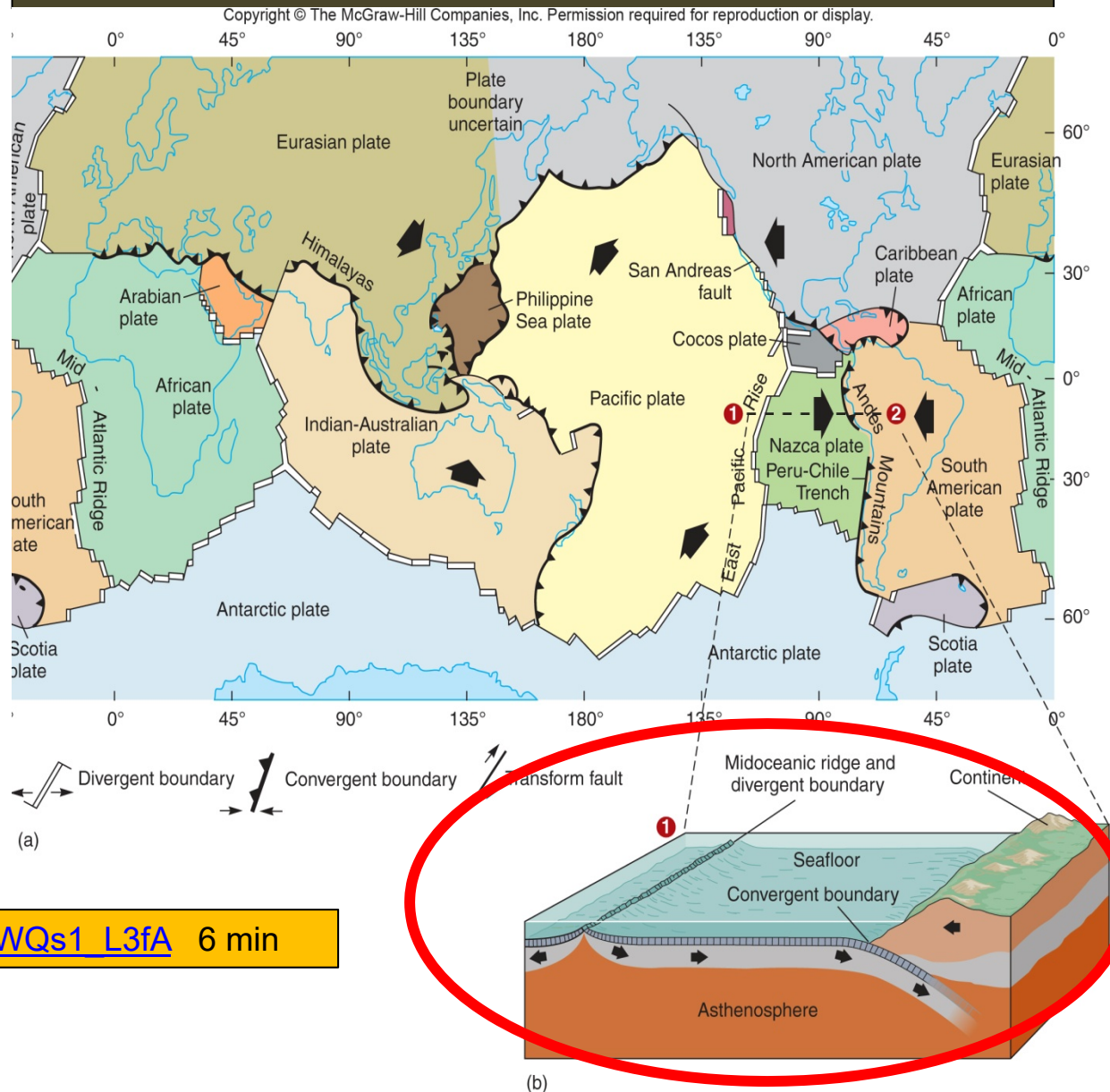
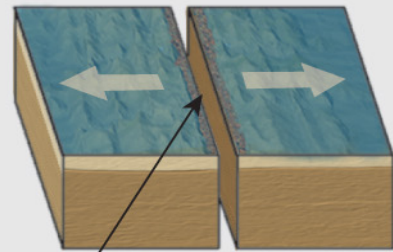


Plate Boundaries

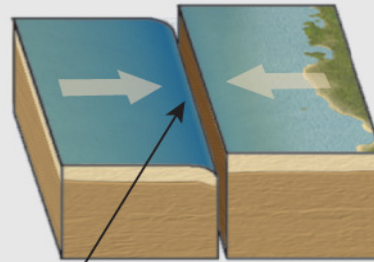
Divergent plate boundary



Spreading ocean ridge

(a)

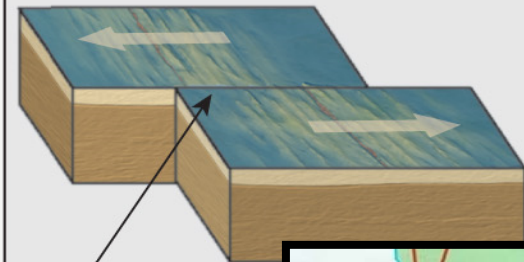
Convergent plate boundary



Trench

(b)

Transform plate boundary



Fault line

(c)

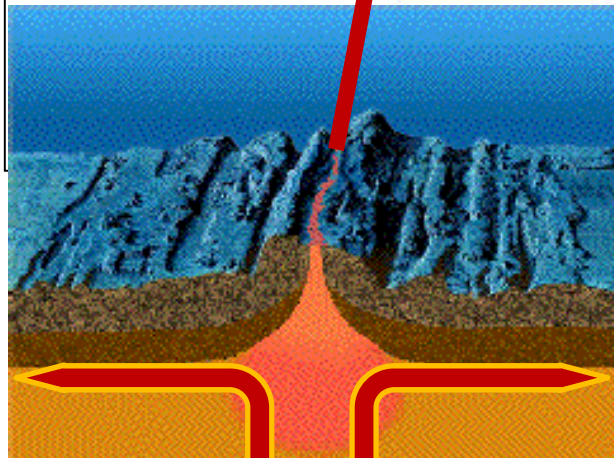
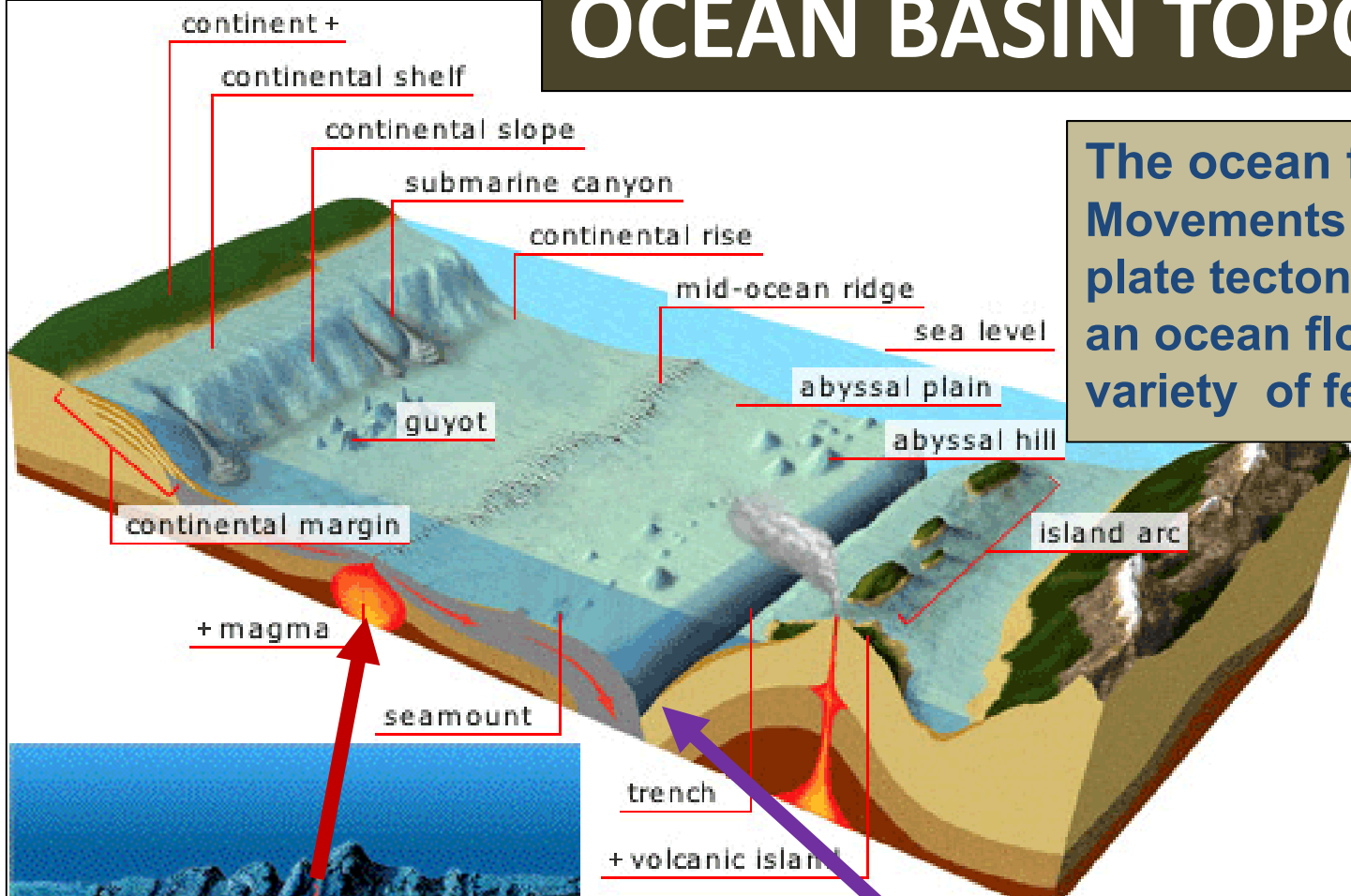
Three types of boundary zones:

- a) **Divergent or Spreading:** new crust is formed from molten material (ridges formed).
- b) **Convergent or Subduction:** old crust is drawn back into the interior to be melted (trenches formed).
- c) **Transform or horizontal-sliding:** plates rub against each other (fault lines with earthquakes).



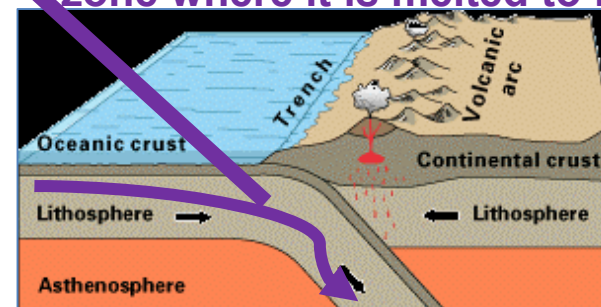
OCEAN BASIN TOPOGRAPHY

The ocean floor is not flat!
Movements associated with plate tectonics have created an ocean floor with a great variety of features.



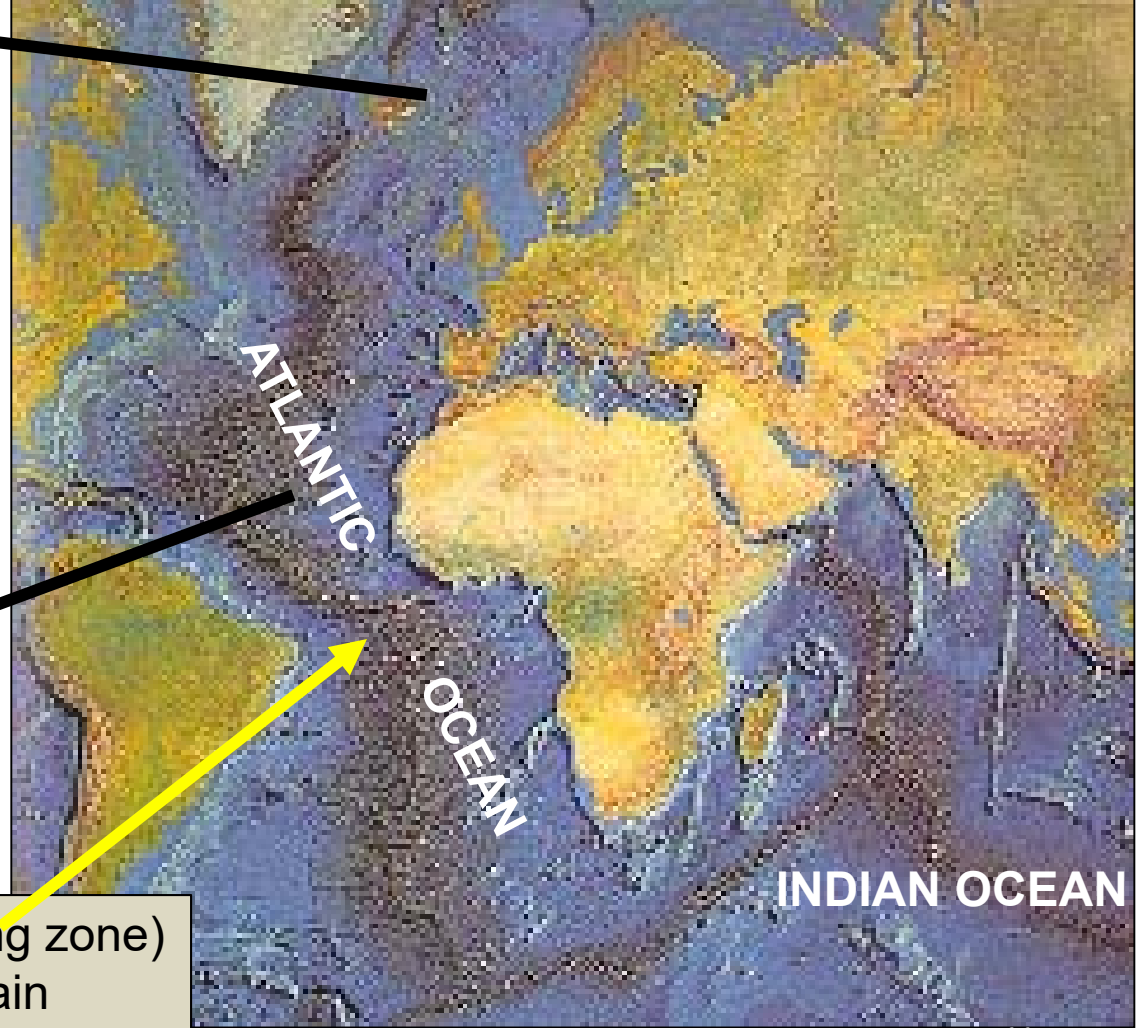
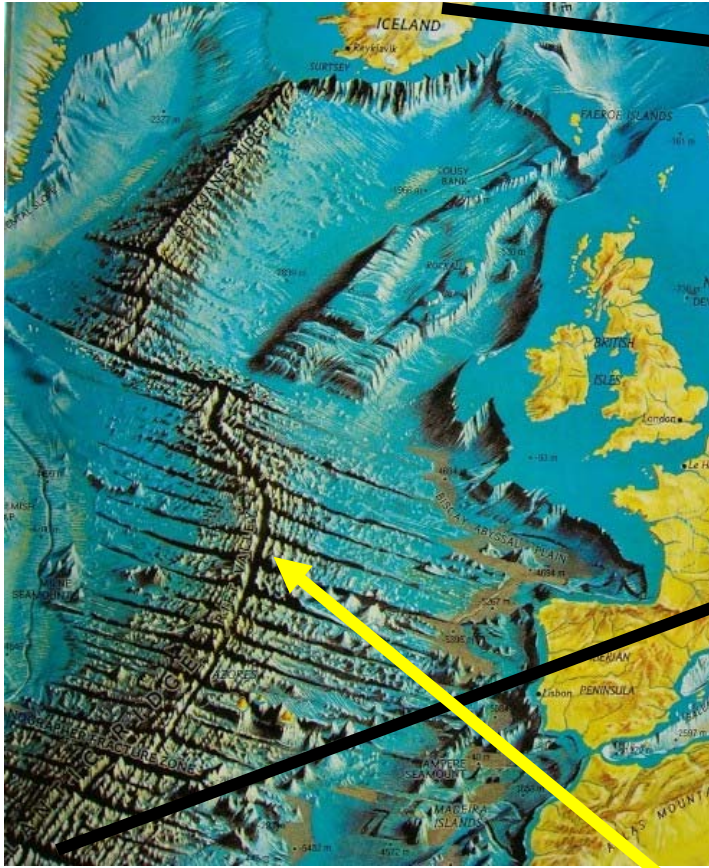
New crust is created in the spreading zone as magma rises and cools.

Old crust is destroyed in the subduction zone where it is melted to form magma.



<https://www.youtube.com/watch?v=UjHeS3PnUFw> 35 sec.

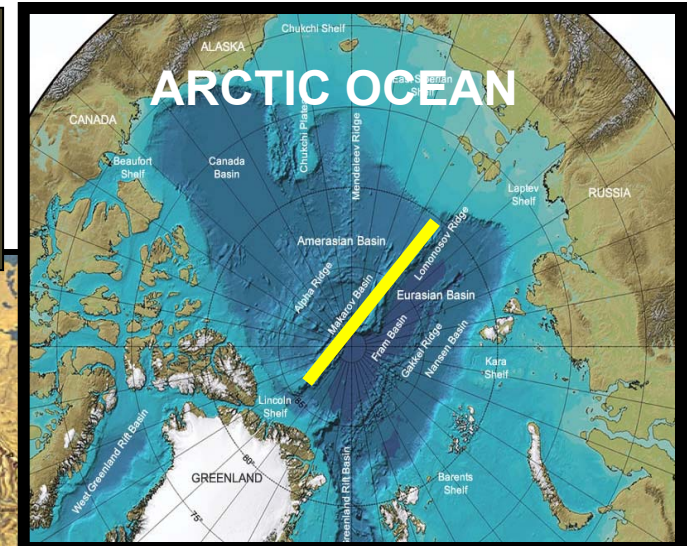
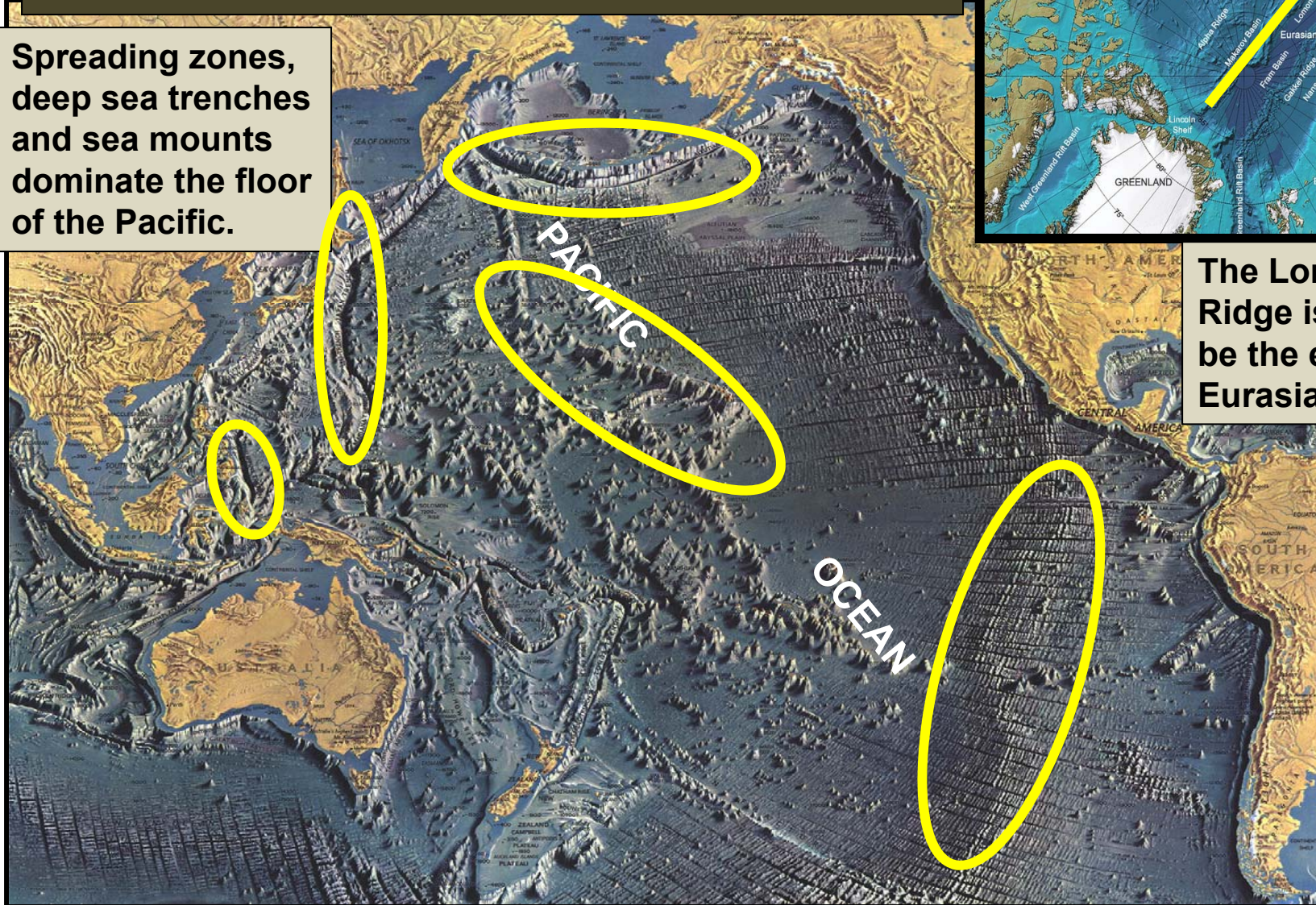
Atlantic and Indian Ocean Basin Topography



The Mid-Atlantic Ridge (a spreading zone) is the world's longest mountain chain

Pacific and Arctic Ocean Basin Topography

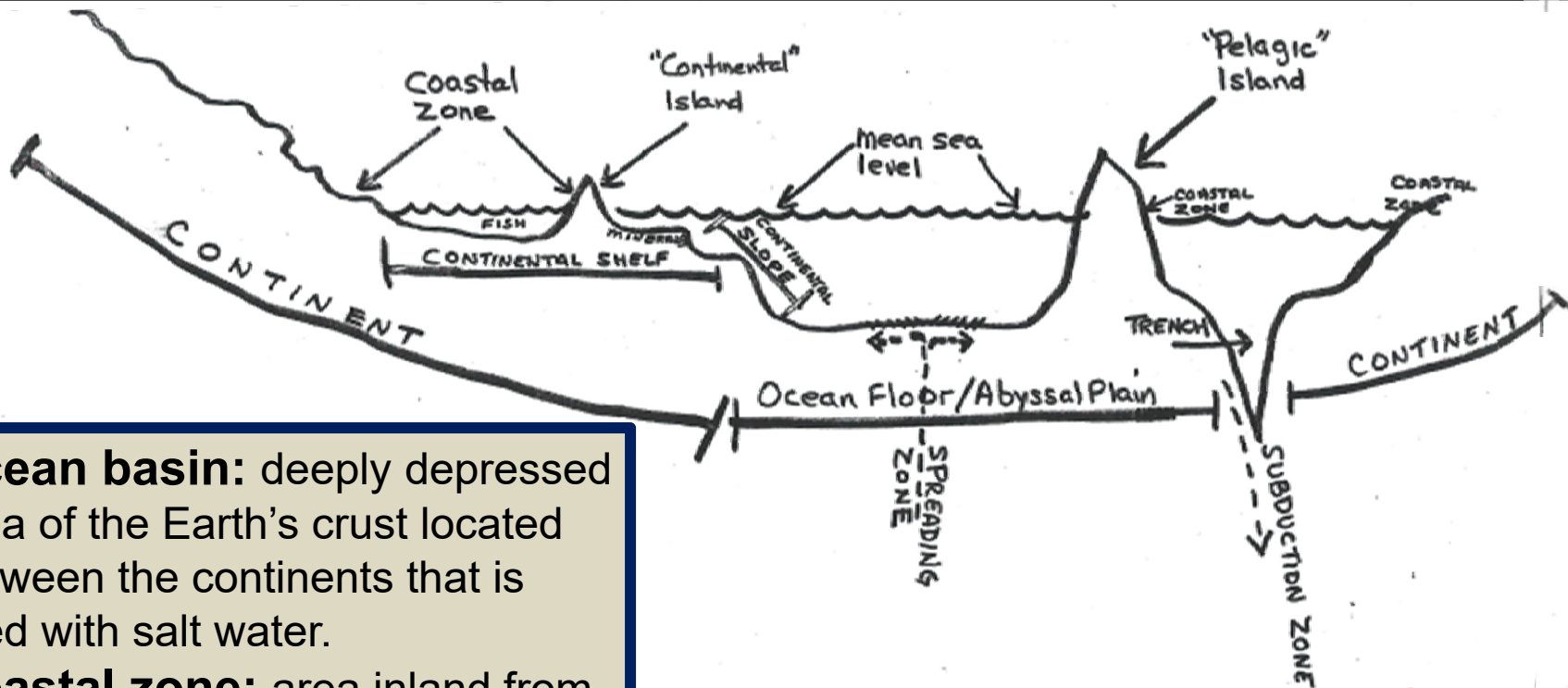
Spreading zones, deep sea trenches and sea mounts dominate the floor of the Pacific.



The Lomonosov Ridge is believed to be the edge of the Eurasian Plate

Generalized Ocean Basin Topography

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Section of course
home page.

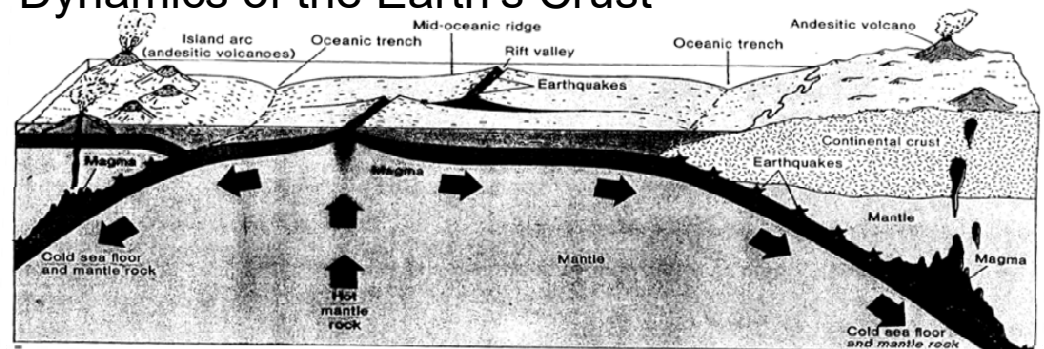


Ocean basin: deeply depressed area of the Earth's crust located between the continents that is filled with salt water.

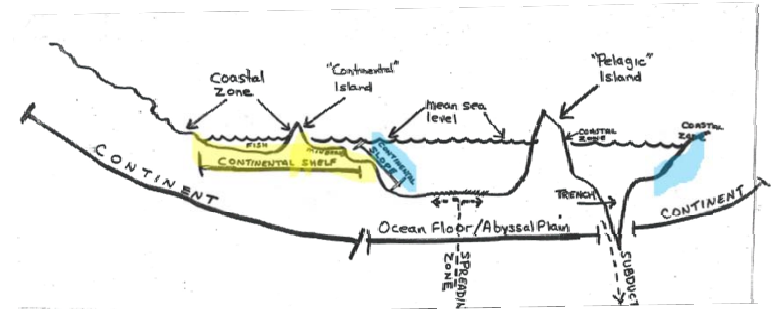
Coastal zone: area inland from the shore that has ocean-related features.

Mean sea level: the height of the oceans calculated by averaging all high and low tides.

Dynamics of the Earth's Crust

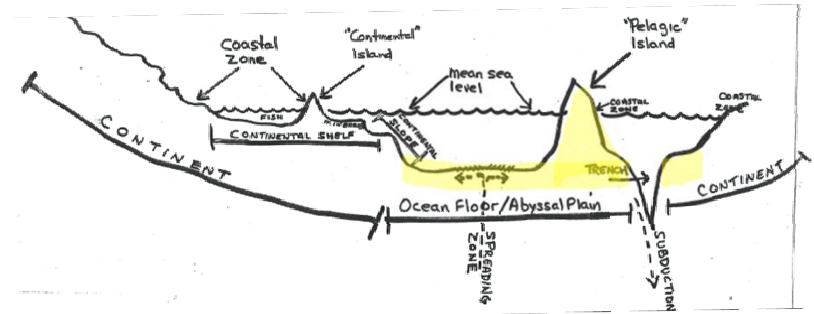


OCEAN BASIN TOPOGRAPHY



- ❖ **Continental Shelf** is the **underwater extension** of the continent that flooded when sea level rose.
 - It is fairly **shallow** (0-600 ft. deep); **sunlight penetrates** to it
 - **"Continental" islands** rise from the shelf (mountain tops).
Examples: Long Island, Bahamas, British Isles, Indonesia
 - It is the site of the **"fishing banks."**
 - It is the site of off shore **mineral deposits.**
- ❖ **Continental Slope** is the edge of the continent that steeply descends to the ocean floor (c.600 -12,000 ft deep)

OCEAN BASIN TOPOGRAPHY



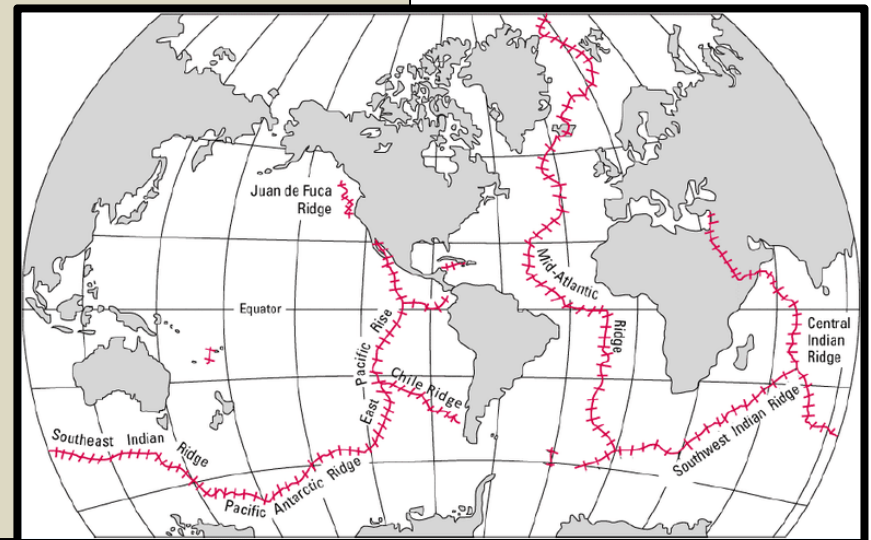
❖ Ocean Floor or Abyssal Plain.

- About **12,000-18,000 ft** below the surface.
- It is **very cold** and **very dark**. Sunlight does not penetrate to these depths.
- **Few fish** and bottom dwelling creatures live here, except near the thermal vents.
- Has the **potential** as a supplier of minerals

➤ **"Pelagic" islands, seamounts and ridges rise from the floor.**

Ex.: Bermuda, Iceland, Mid-Atlantic Ridge, Hawaii, islands of the South Pacific.

**Location of
the Mid-
Ocean Ridges**

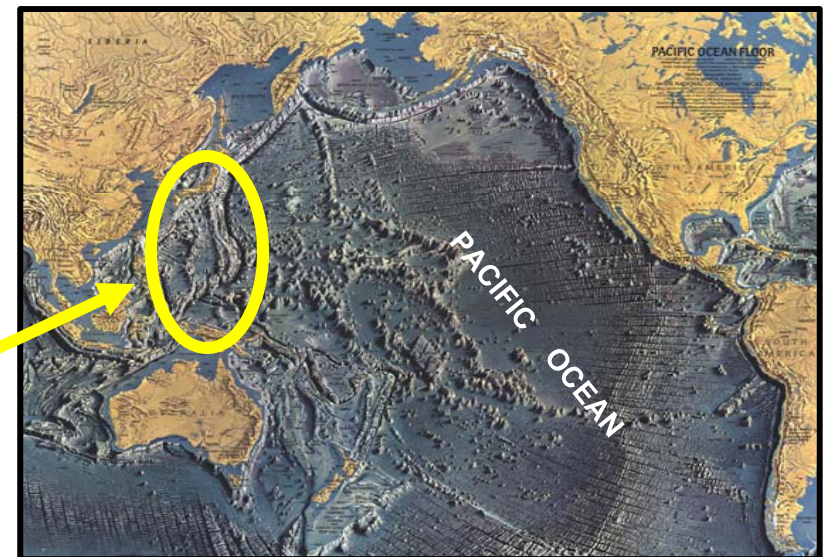
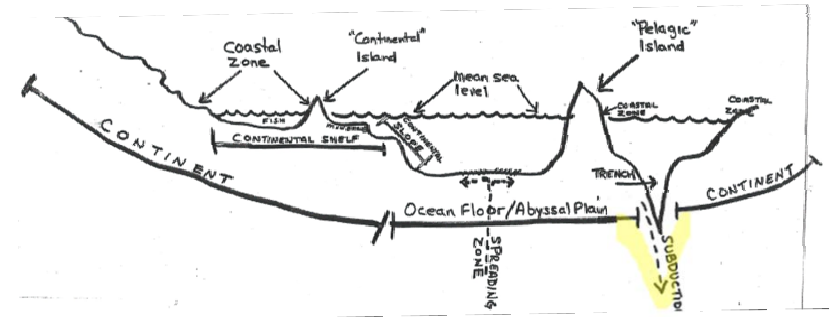


OCEAN BASIN TOPOGRAPHY

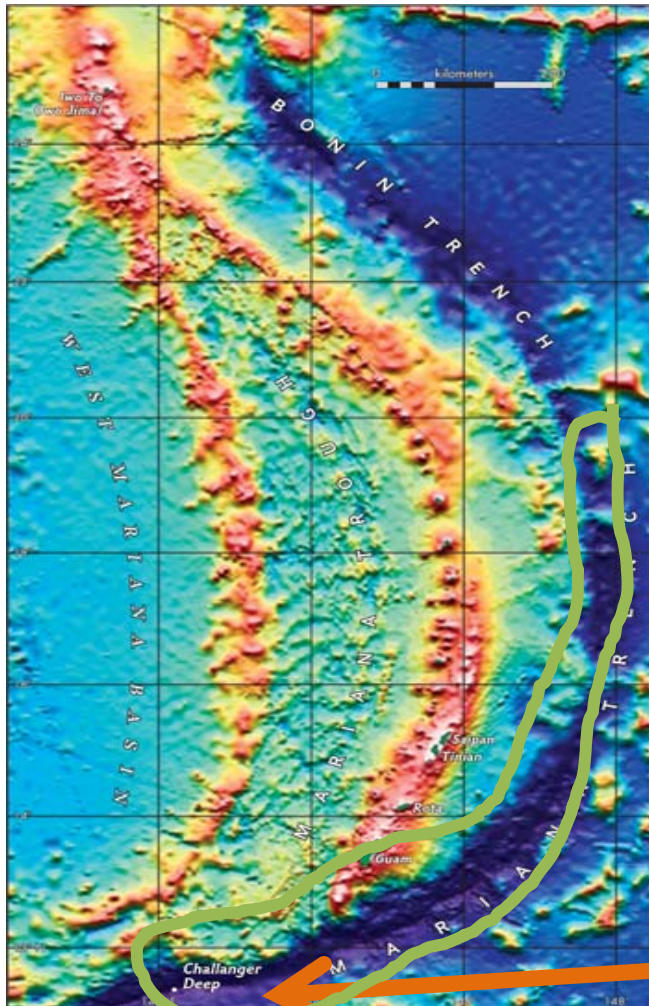
❖ Trenches, deeps, troughs.

- These are the **deepest points** on the ocean floor extending **below 18,000 ft.**
- Here the **crust is dragged back into the interior** of the planet and is remelted.

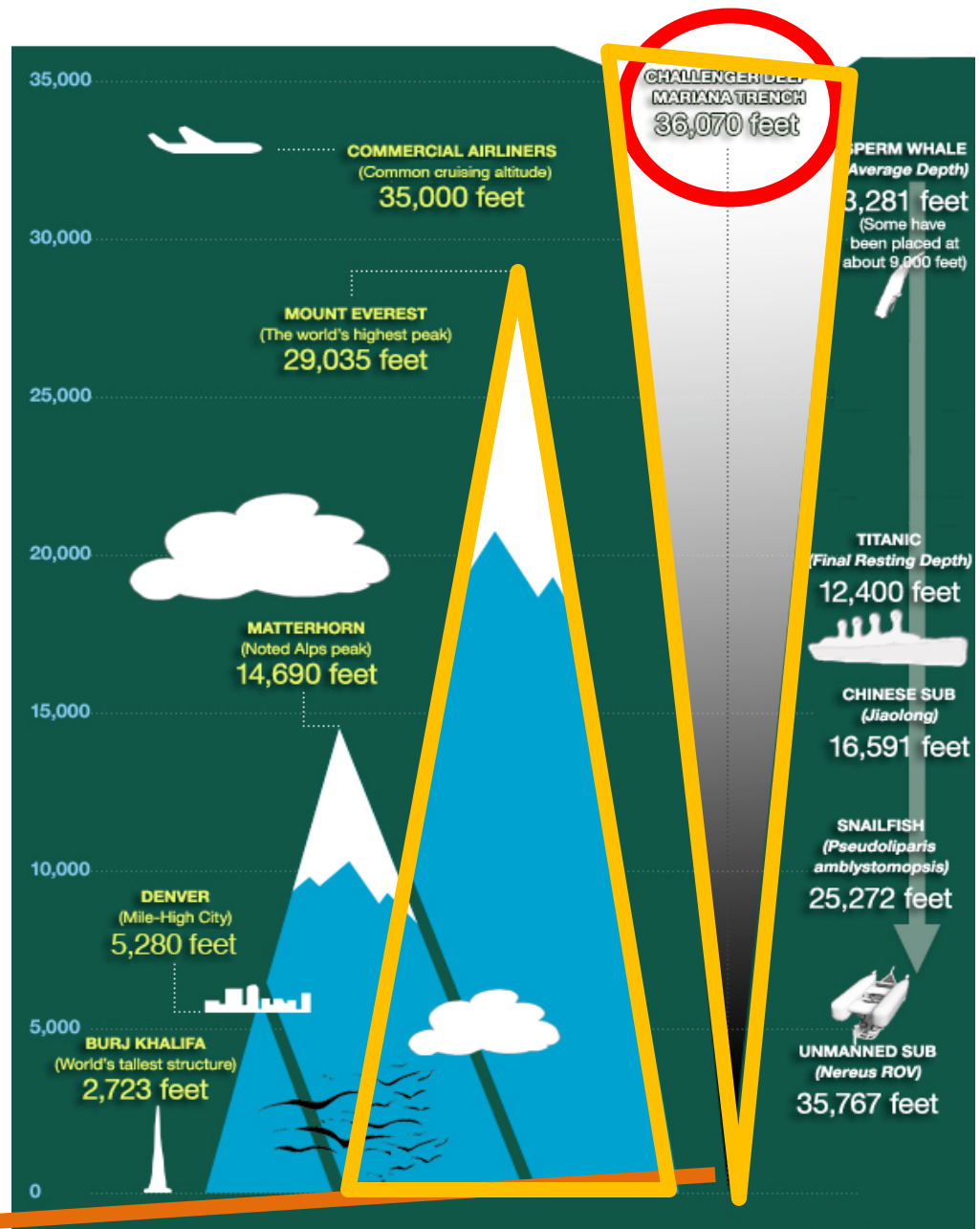
➤ **Mariana Trench**, contains the deepest point on Earth: the bottom of the **Challenger Deep** is 36,070 ft (6.8 mi) below mean sea level.



Marianna Trench



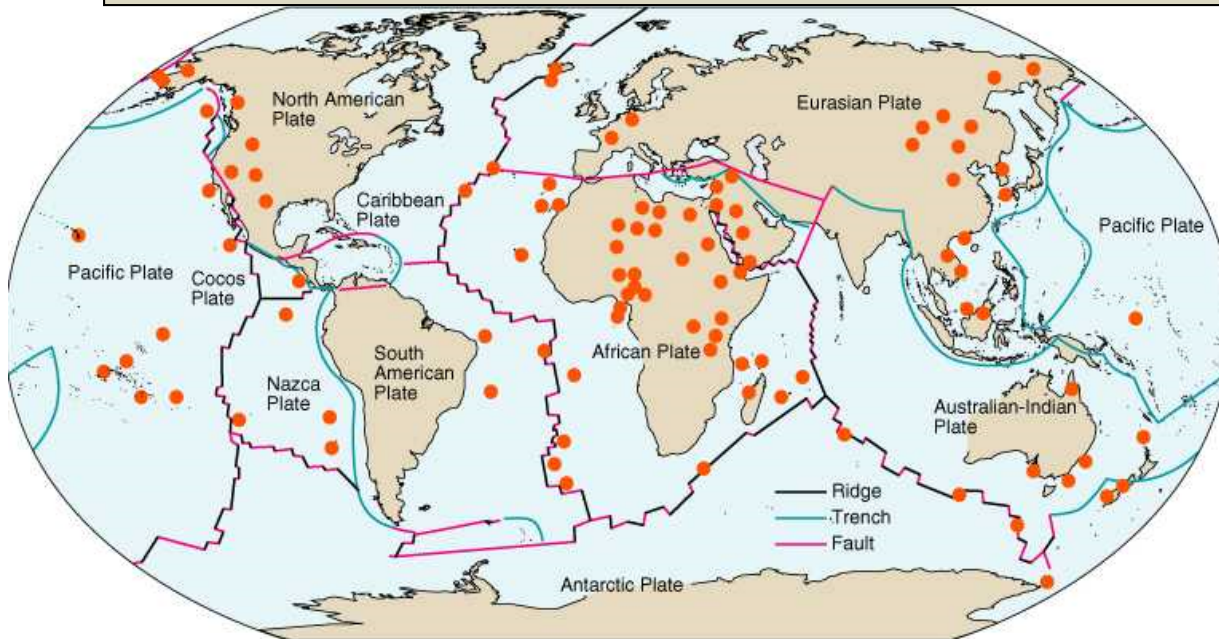
Challenger Deep -36,070 ft



National Geographic Expedition 2013

Geologic Hot Spots

❖ **Hot spot:** Zone of weakness in the earth's crust (ocean and continental) that allow molten material to breach the crust away from plate boundaries.



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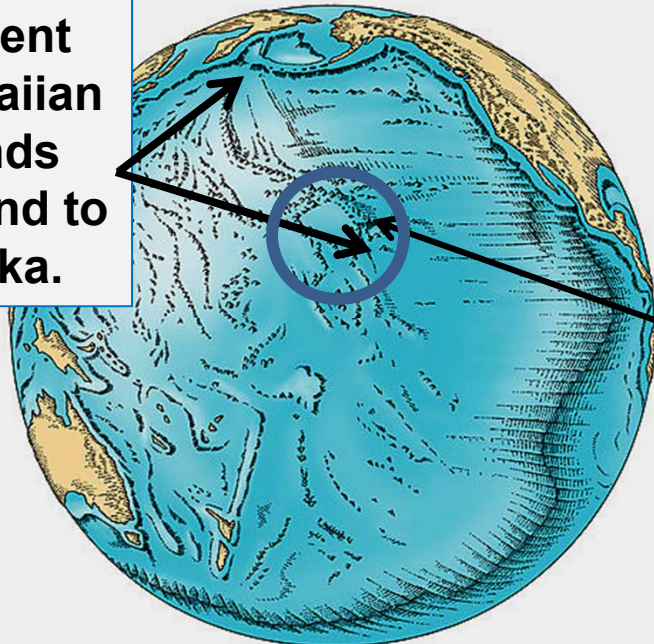
Volcano chains trail away from mid-ocean hotspots, with the oldest volcanoes (now long extinct) now lying far from the hotspot.

➤ These hotspot tracks are aligned along the direction of motion of the overlying plate.

The Hawaiian Island Chain is an example of this.

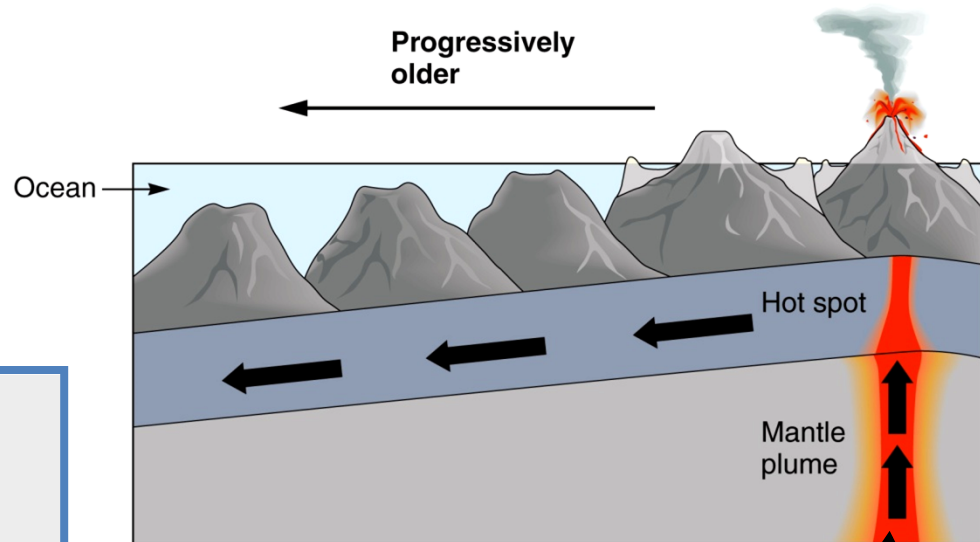
“Hot Spot” under Hawaii

Ancient
Hawaiian
islands
extend to
Alaska.

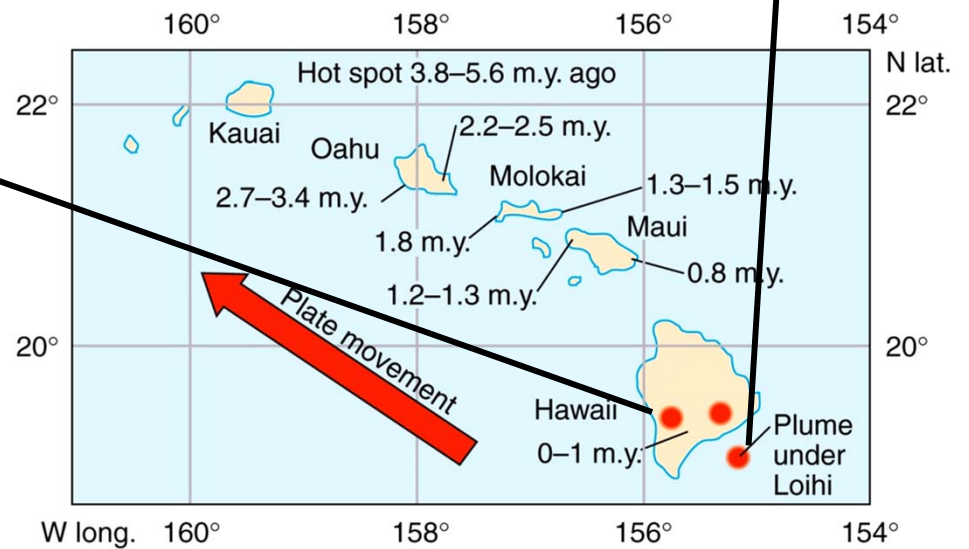


SCIENCEPHOTOLIBRARY

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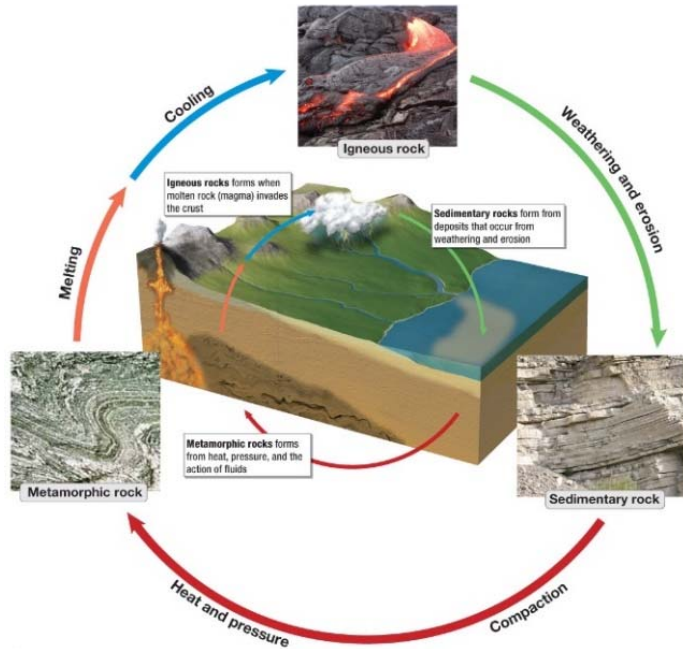


(a)

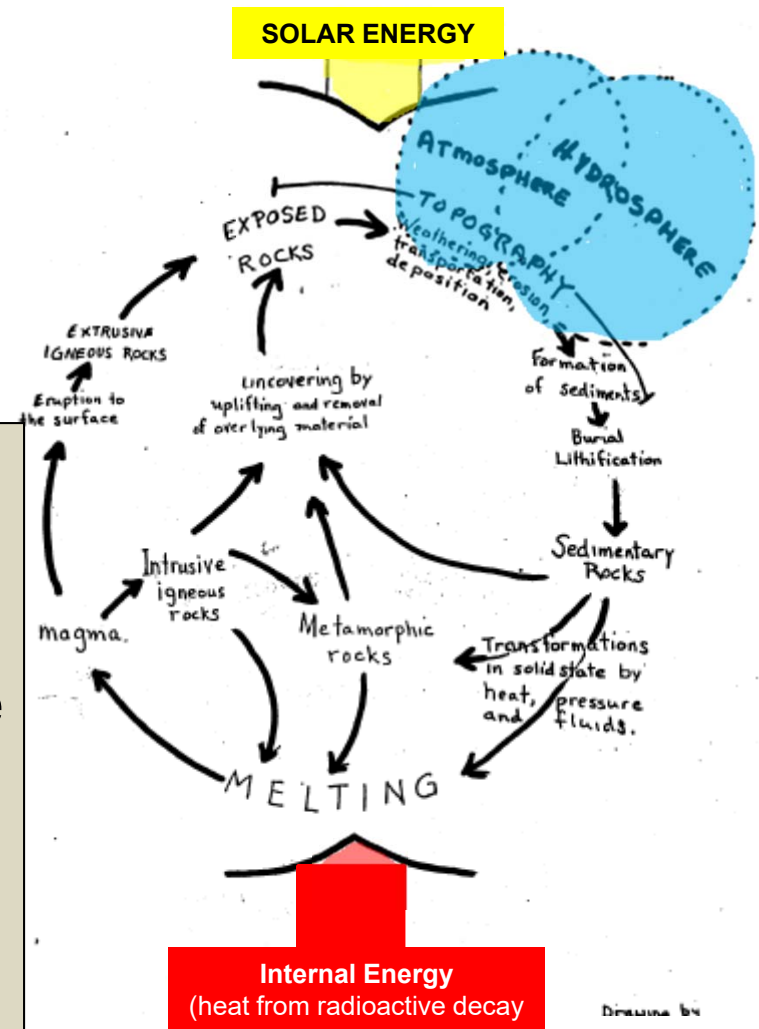


(b)

ROCK CYCLE

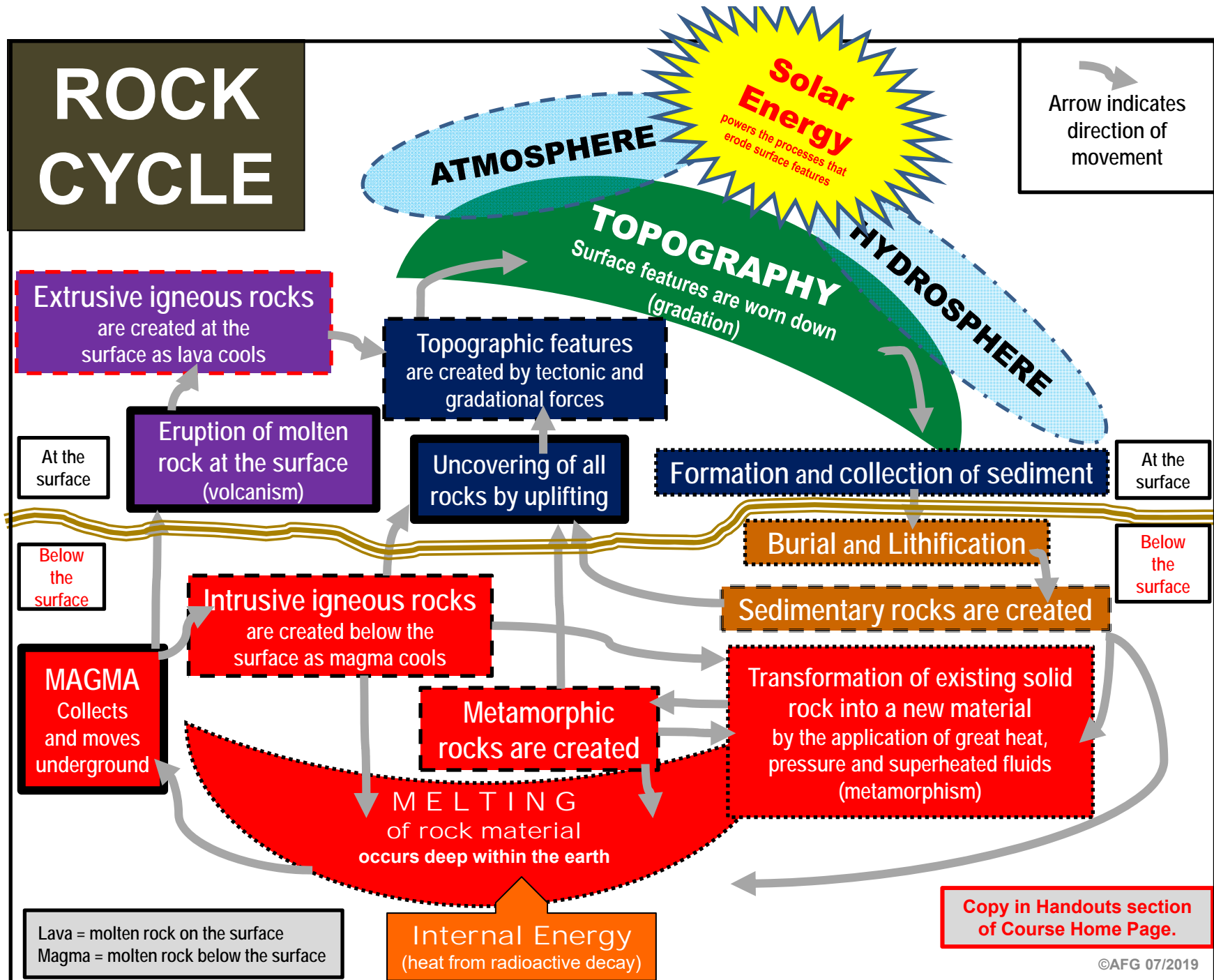


- ❖ **ROCK CYCLE:** illustrates how earth materials (rocks and minerals) are created and how they are inter-related to surface landforms and the internal processes of the earth.
- ✓ It is driven by the earth's internal heat engine and influenced by solar powered atmospheric processes.

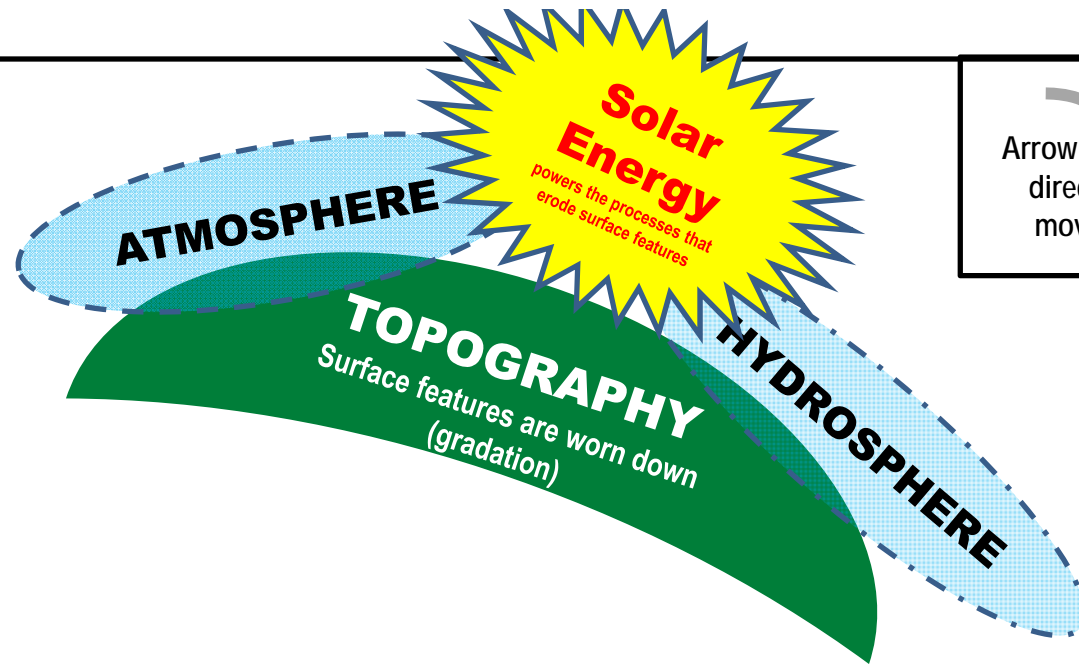


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ROCK CYCLE



ROCK CYCLE



At the surface

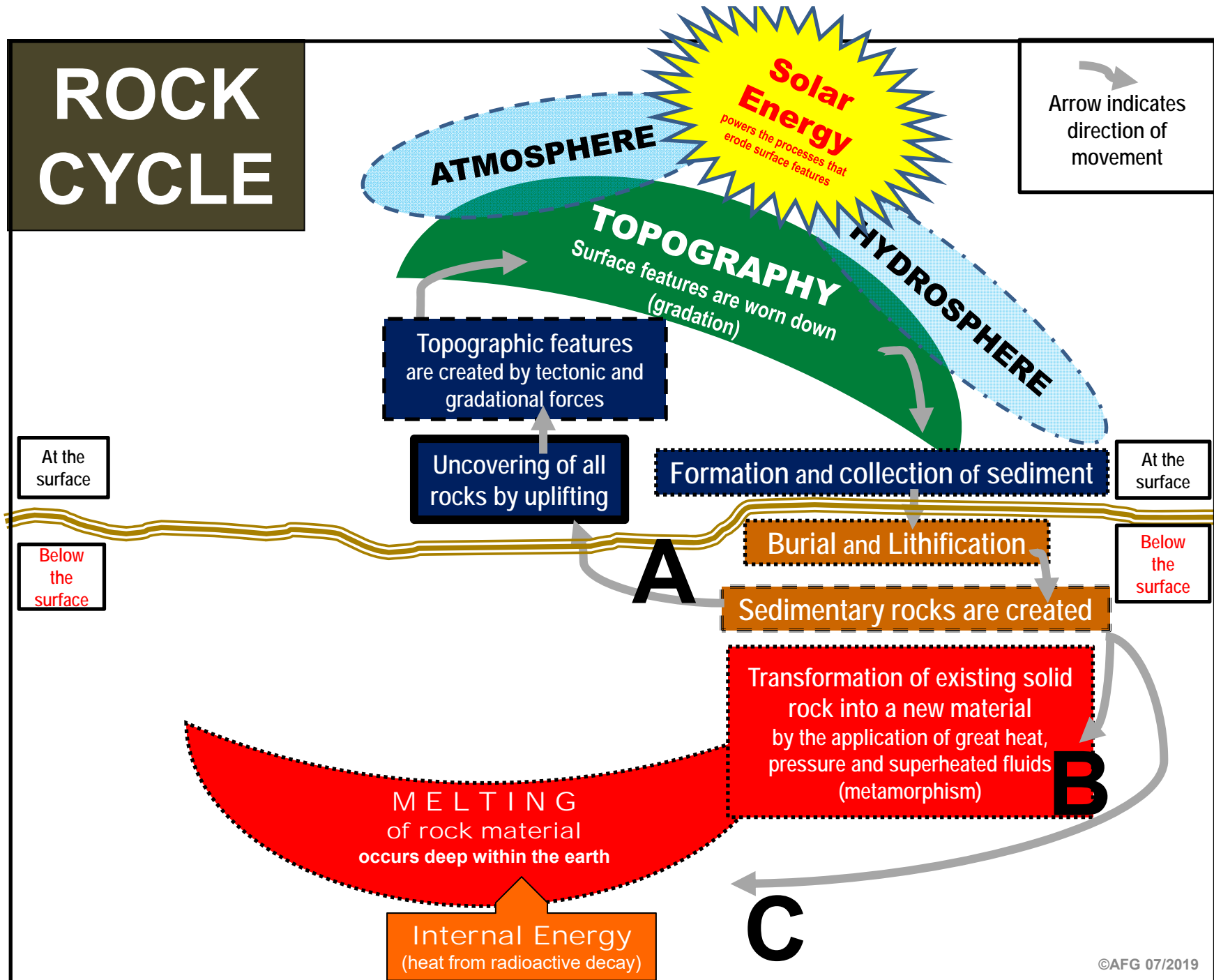
At the surface

Below the surface

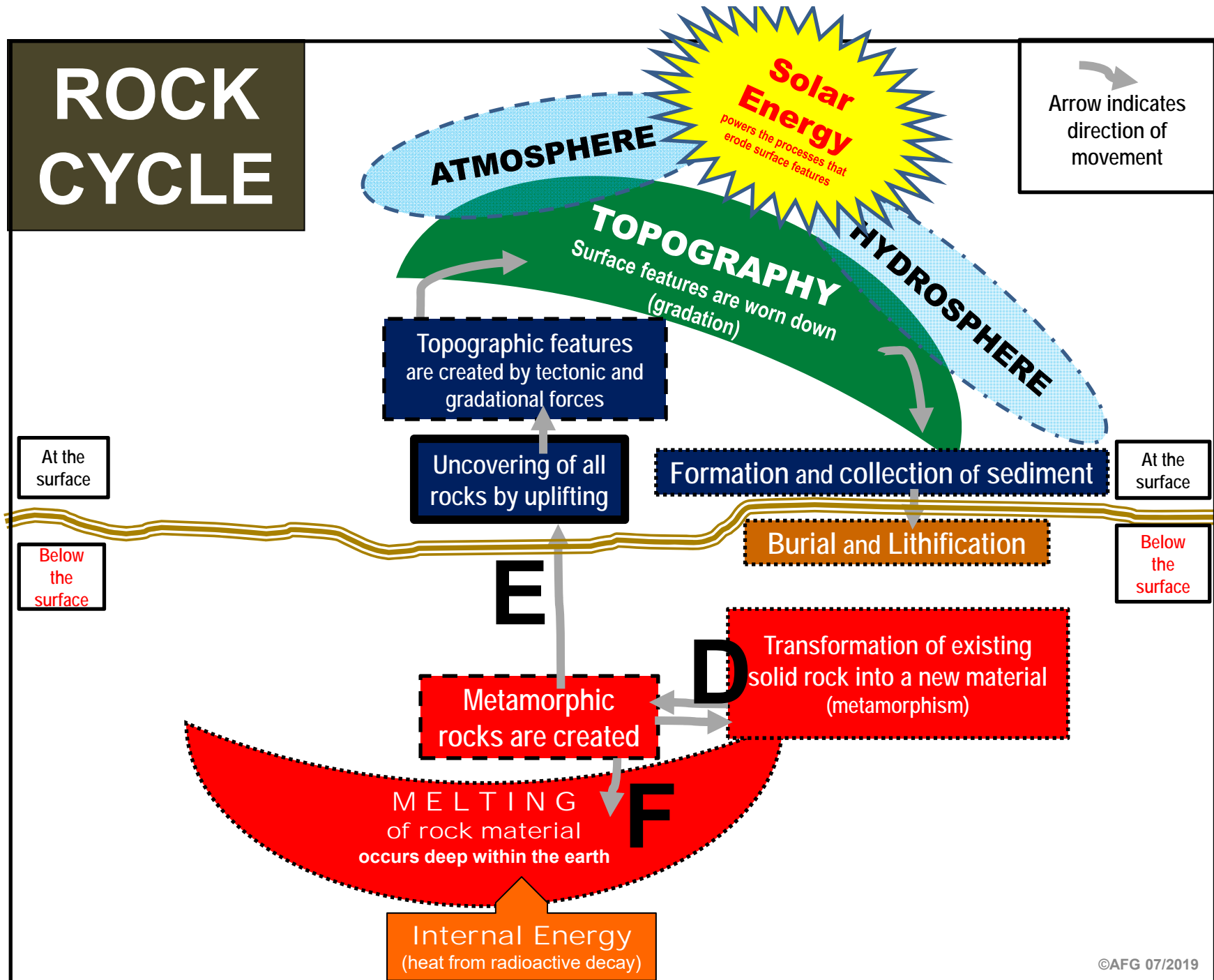
Below the surface

Internal Energy
(heat from radioactive decay)

ROCK CYCLE



ROCK CYCLE



ROCK CYCLE

Solar Energy
powers the processes that erode surface features

ATMOSPHERE

TOPOGRAPHY
Surface features are worn down (gradation)

HYDROSPHERE

Arrow indicates direction of movement

Extrusive igneous rocks
are created at the surface as lava cools

Topographic features
are created by tectonic and gradational forces

Uncovering of all rocks by uplifting

Formation and collection of sediment

Burial and Lithification

Intrusive igneous rocks
are created below the surface as magma cools

Transformation into a new material (metamorphism)

MELTING
of rock material occurs deep within the earth

Internal Energy
(heat from radioactive decay)

MAGMA
Collects and moves underground

Eruption of molten rock at the surface (volcanism)

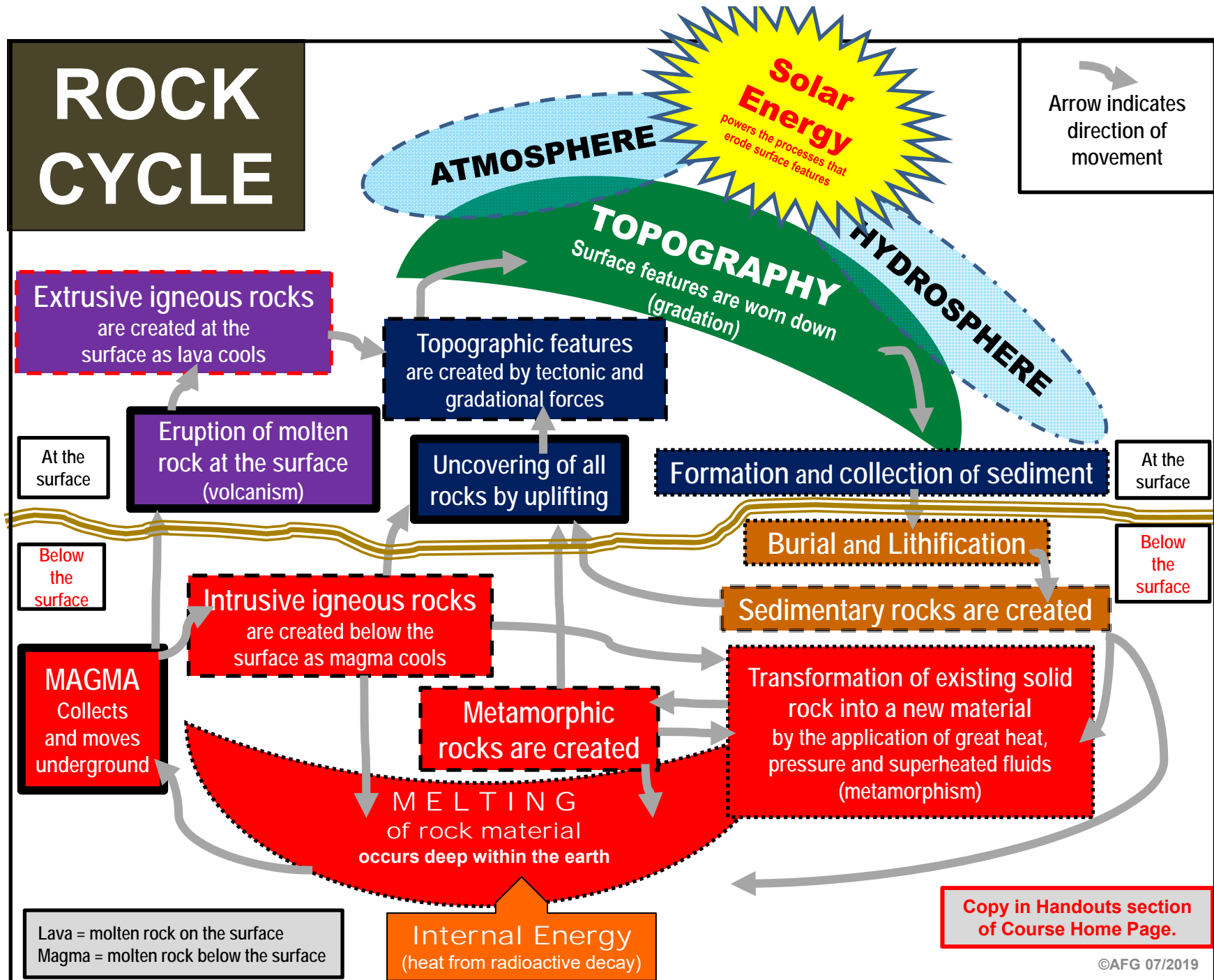
At the surface

Below the surface

LAVA = molten rock on the surface
MAGMA = molten rock below the surface

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ROCK CYCLE



ROCK CYCLE

There are three main categories of rock:

- sedimentary
- igneous
- metamorphic

❖ Sedimentary Rocks

Formed by the **compaction** and **cementation** of rock fragments by a process called ***lithification***.

- They are deposited in parallel horizontal layers.



- ✓ They make up about 75% of the earth's surface.



Lava flow
cooling
to become
igneous
rock

ROCK CYCLE



❖ Igneous Rocks

Formed from the **cooling** of molten (liquid) rock.

- The molten rock is a **“soup” of minerals.**
- The **rate of cooling** determines the **crystallization of minerals** and their appearance.

❖ Metamorphic Rocks

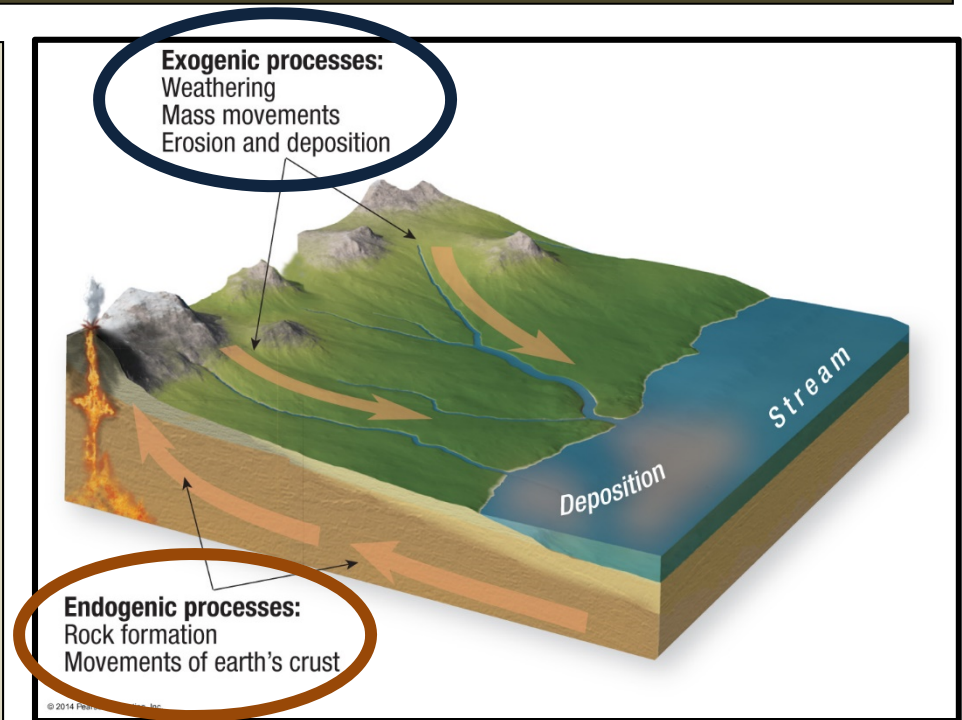
Created as **great heat and pressure is applied** to existing rocks (sedimentary, igneous and other metamorphic rocks).

- They are “baked.”
- This **changes their physical composition** and creates a new material.

Forces Creating and Shaping Surface Landforms

There are two opposing forces always at work:

- ❖ **ENDOGENIC: tectonic or building forces**
- ❖ **EXOGENIC: gradational or reducing forces**
 - ✓ They are part of dynamic earth, including the rock cycle, and interact with both atmospheric and hydrologic processes.



- **These forces are usually present together.** Can't have just one process working. However, one may be dominant.

Building Forces that Create and Shape Surface Landforms

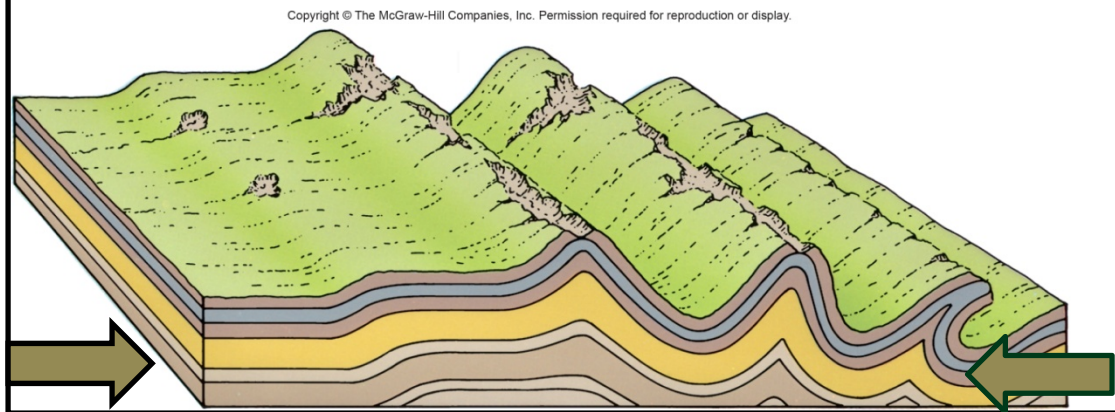
The three **TECTONIC** or building forces are:

- a) **FOLDING**: compression, bending, breaking
- b) **FAULTING**: movement, tension, breaking
- c) **VOLCANISM**: melting, movement of molten material, release of pressure (eruption/explosion)

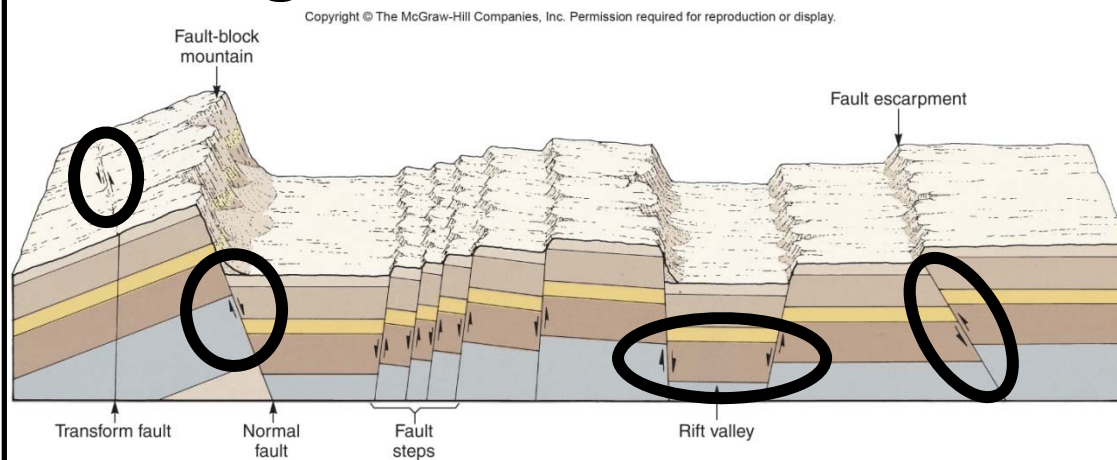
Tectonic Forces:

Folding, Faulting and Volcanism

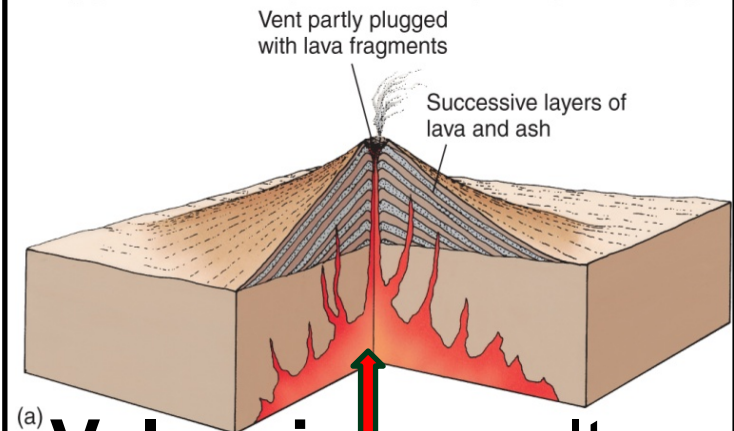
Folding: compression



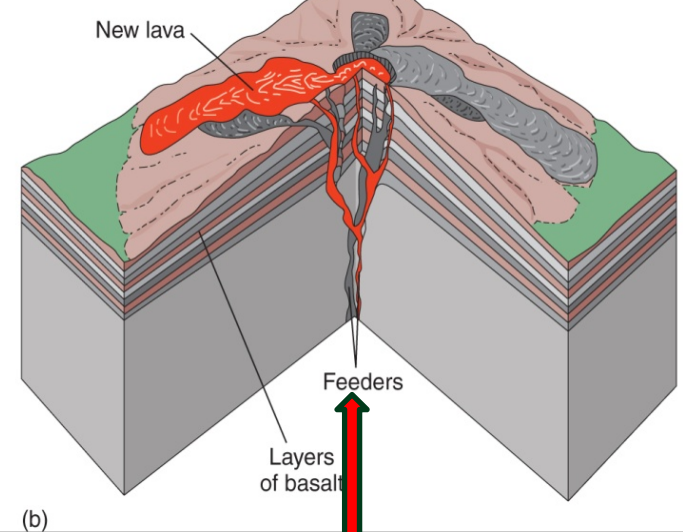
Faulting: fracture, stress



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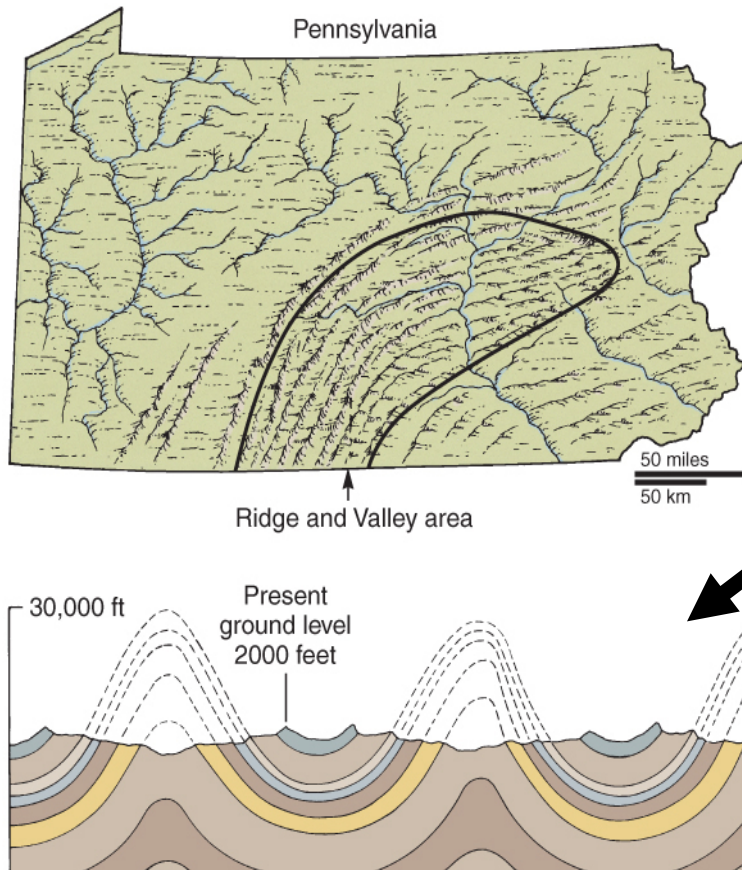
(a) **Volcanism: molten material to surface**



FOLDING

These were once horizontal layers of rock that have been warped over time.

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(a)



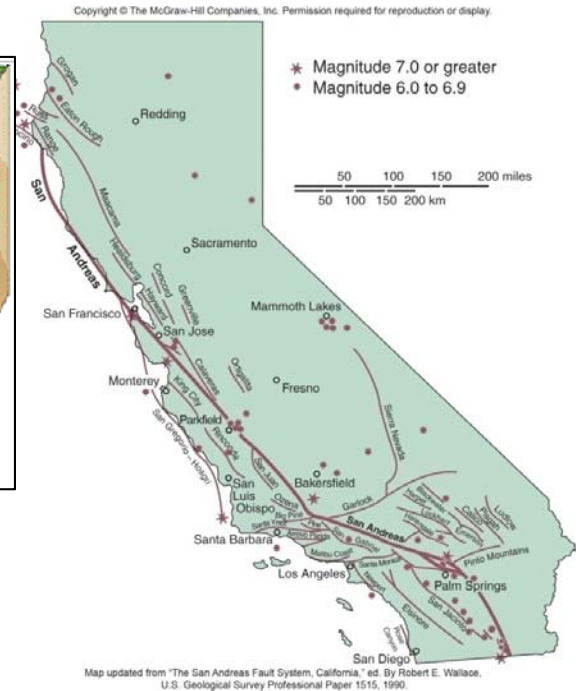
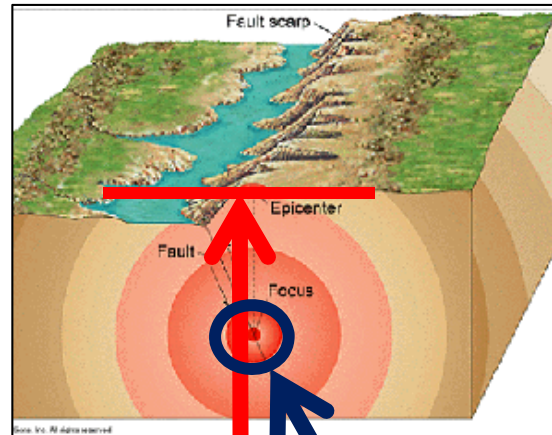
(b)

(b) © Mark C. Burnett/Photo Researchers

FAULTING and FAULT ZONES

The **San Andreas Fault** is an example of a primary fault zone with hundreds of other faults associated with it.

- **Earthquakes occur when built-up stress is relieved along a section of the fault.**
 - The shaking (quaking) of the ground is a result of stress release.



- ❖ The **FOCUS** of an earthquake is where the stress is released along the fault (the break).
- ❖ The **EPICENTER** of an earthquake is the **geographic coordinates at the surface directly above** the “focus”.

VOLCANISM



(a) **MT ST HELENS**



(b) **Explosive**



(c)

(alt): U.S. Geological Survey



HAWAII VOLCANO NP

Gentle



COLUMBIA PLATEAU (ancient)



(left): © McGraw-Hill Companies, Inc.



Gradational Forces

❖ **Gradational** or reducing **forces wear away the land surface.**

There are 3 major categories:

1. **Weathering:** changes in place.
2. **Mass Wasting:** loosening and movement under the force of gravity.
3. **Erosion:** friction, movement and deposition (occurring concurrently) create new shapes.

Gradational Forces

❖ **WEATHERING:** a change in place in reaction to exposure to air, water and temperature.

Happens in 2 ways:

1. Mechanical weathering = disintegration

- crumbling and fragmentation
- frost action, crystallization, root action

2. Chemical weathering = decomposition

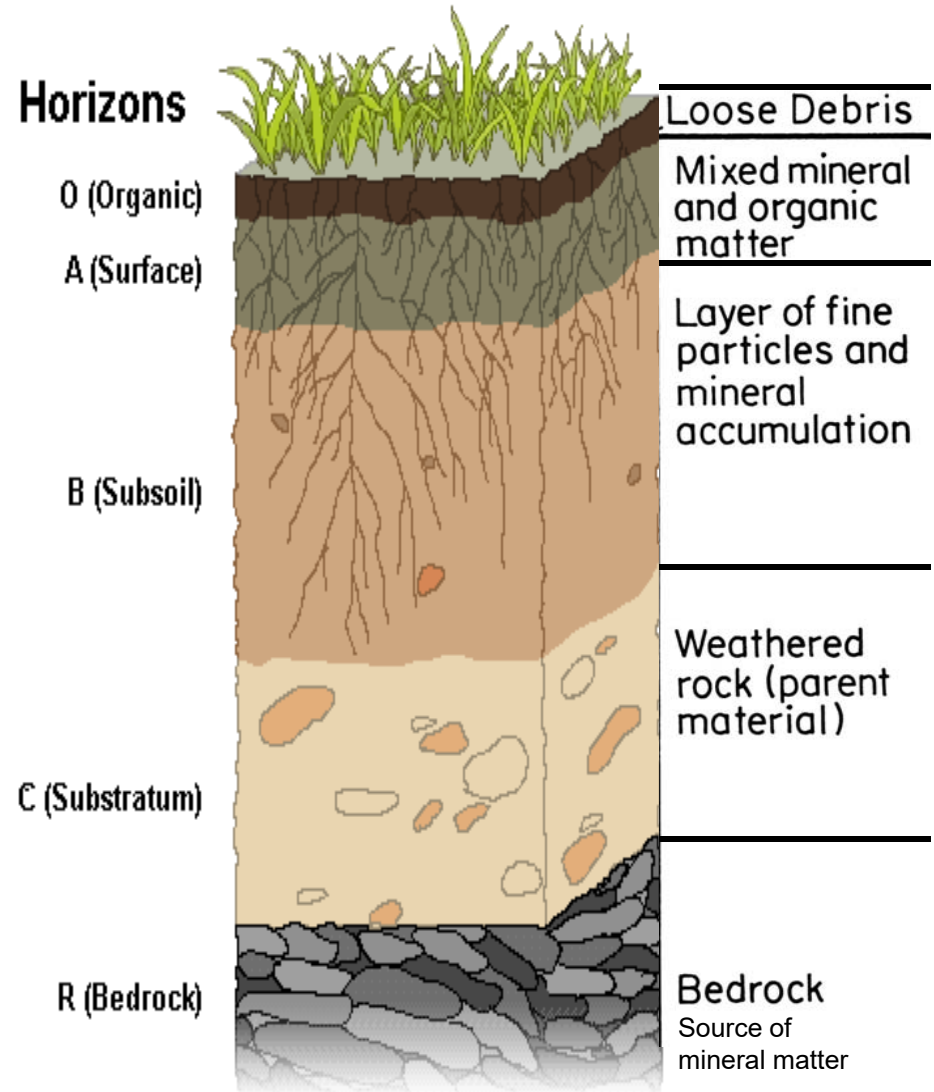
- decay and separation of parts
- oxidation, hydrolysis, carbonization

Soils

❖ **Soil Formation:**
Result of a very long period of mechanical and chemical weathering.

- Air, water and heat break down bedrock and organic material and release nutrients (climate related).
- Soil development is slope dependent.

❖ **Soil Horizons:** the layers of the soil were certain conditions prevail.

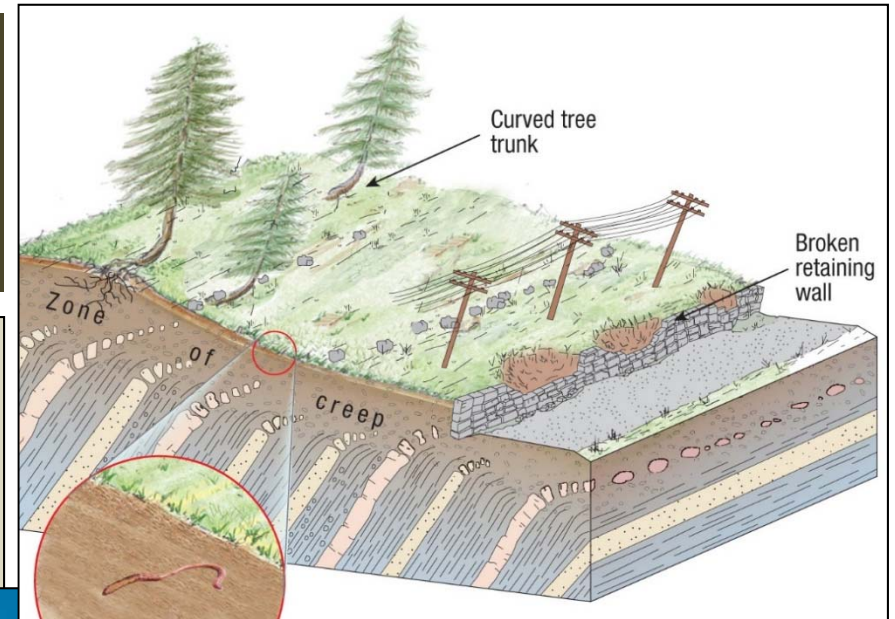


There are tens of thousands of different combinations creating unique soils around the world.

Gradational Forces

❖ **MASS WASTING:** loosening and movement down slope under the force of gravity.

- landslides
- rock slides
- mud flows
- soil creep
- slump



➤ Stability of slopes can be affected by natural events and by human actions.



Gradational Forces

❖ **EROSION:** The combination of friction, movement and deposition occurring at the same time that creates new shapes: *“Take-Move-Place”*

- **Agents of erosion are:**
- running water
 - moving ice
 - wind
 - waves
 - currents



“Take-Move-Place”

Running Water and Valley Shapes

V-shape Valley

Downward cutting by fast-flowing water is greater than lateral cutting: the valley **deepens**.

U-shape Valley

When the water flow is weak, it cannot cut downward. Looping rivers **cut laterally** (side to side): the valley **widens**.

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(a)

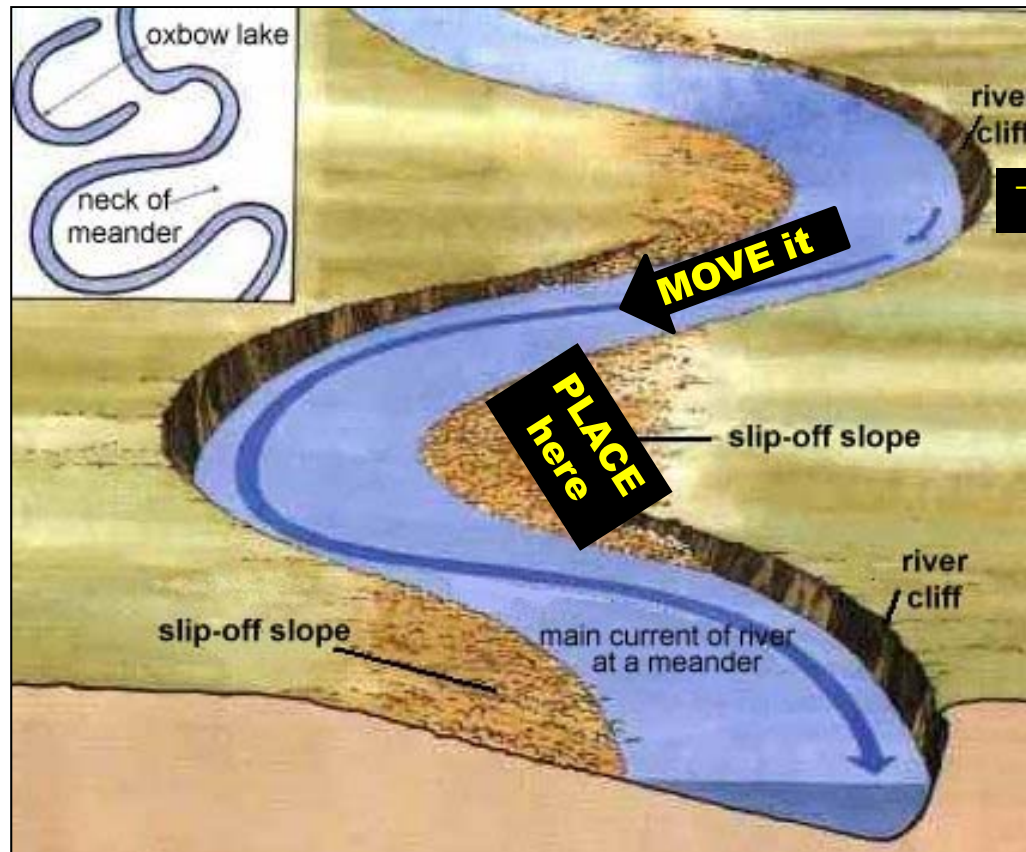


(b)

(a) © Robert N. Wallen; (b) U.S. Geological Survey

River Meander Diagram

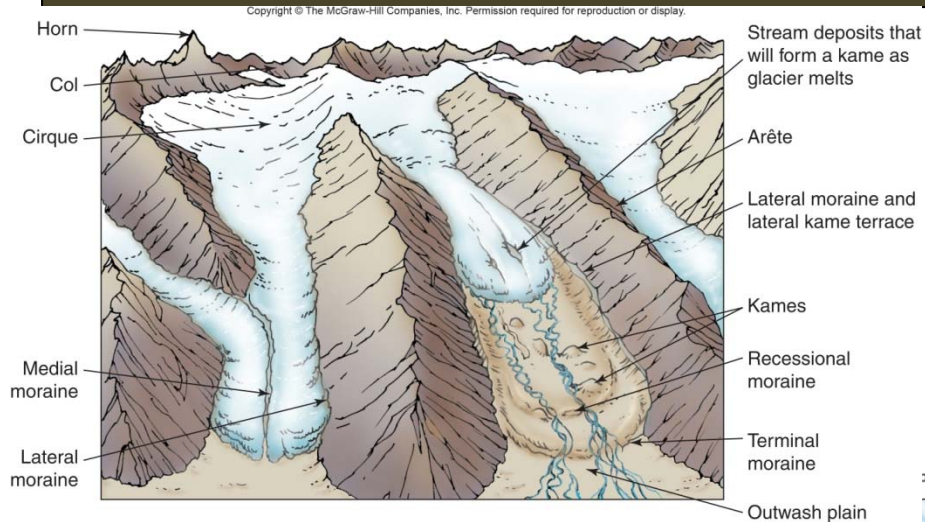
<https://www.youtube.com/watch?v=8a3r-cG8Wic>
3 min



TAKE --- MOVE --- PLACE

EROSION --- TRAVEL --- DEPOSITION

Moving Ice and Glacial Landscapes



<<<<mountain glacier
and its features

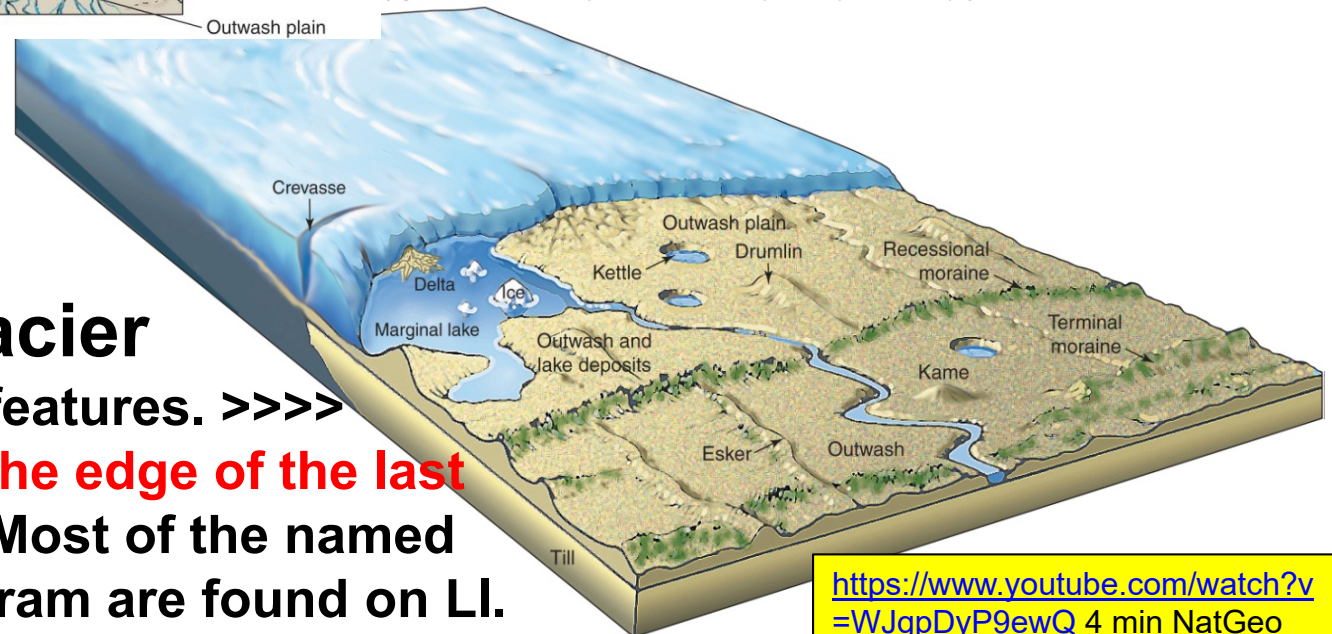
<https://www.youtube.com/watch?v=SROTOaENeHs>

TAKE --- MOVE --- PLACE

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continental glacier
and its features. >>>>

Long Island was at the edge of the last
continental glacier. Most of the named
features on the diagram are found on LI.

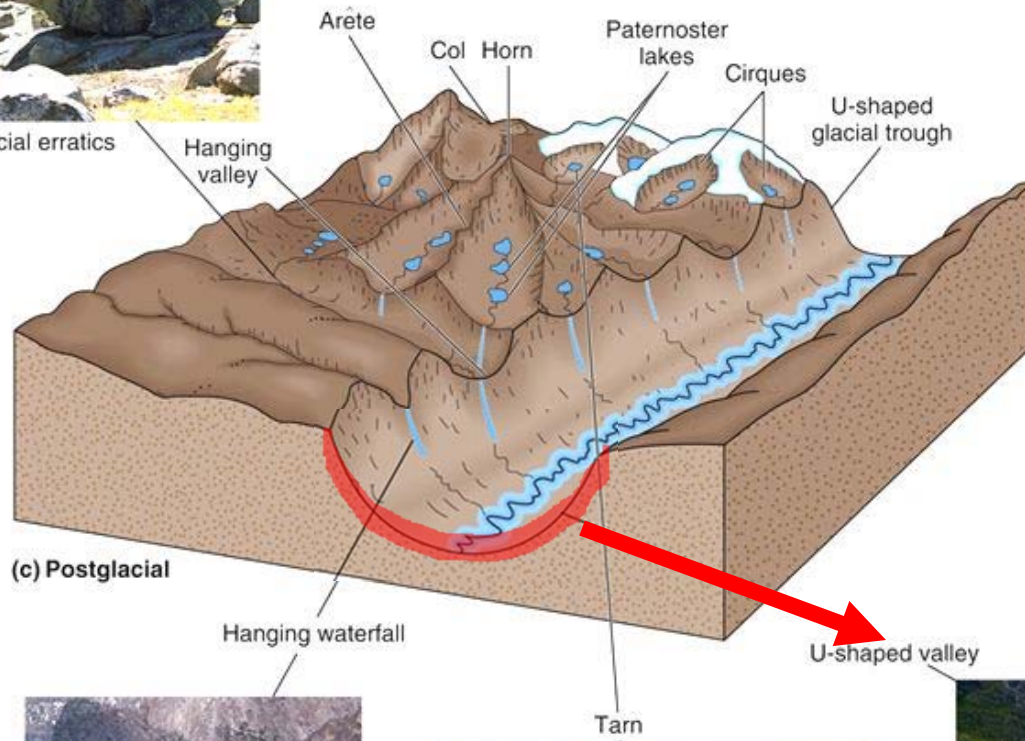


<https://www.youtube.com/watch?v=WJgpDyP9ewQ> 4 min NatGeo
Glaciers and Climate Warming

Post-glacial Landscapes



Glacial erratics



(c) Postglacial

Hanging waterfall

Tarn

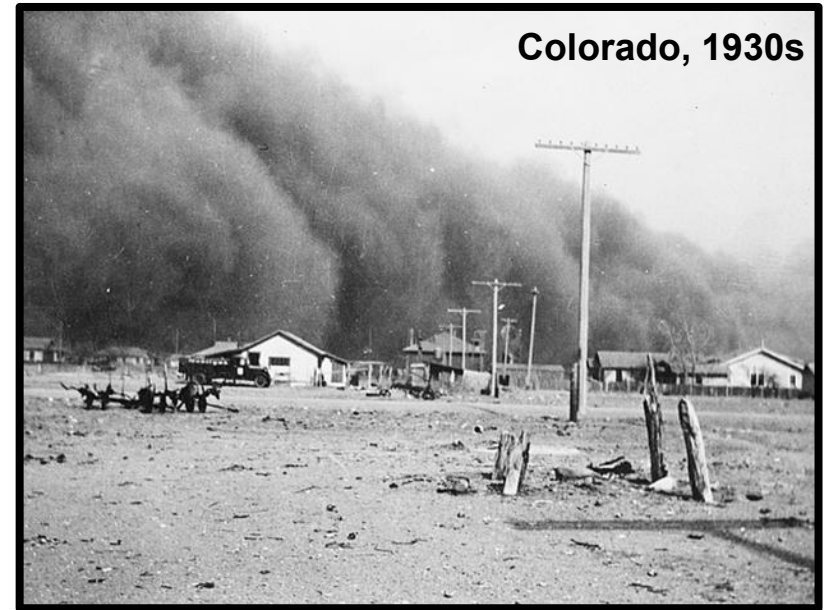
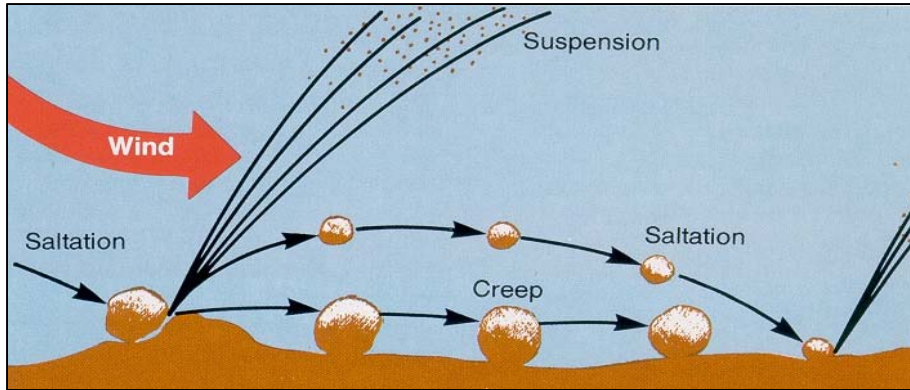
U-shaped valley



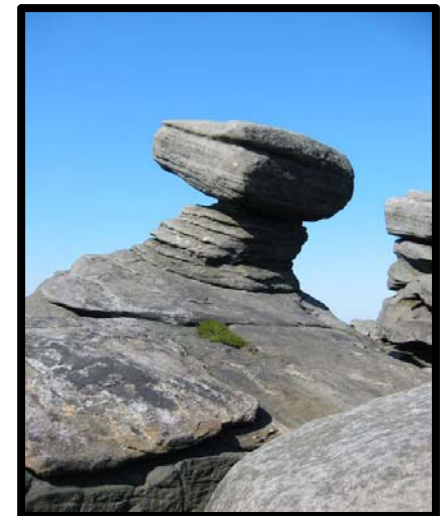
Horn



Wind Formed Landscapes

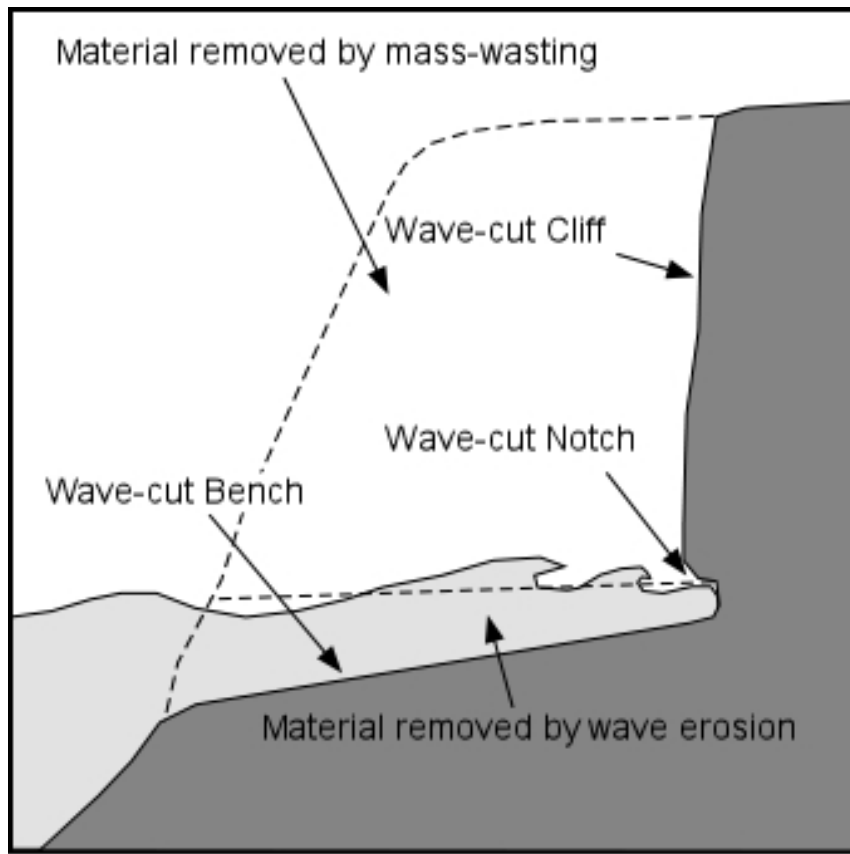


Take-Move-Place
Wind is also a sandblaster!





Wave Action Landscapes

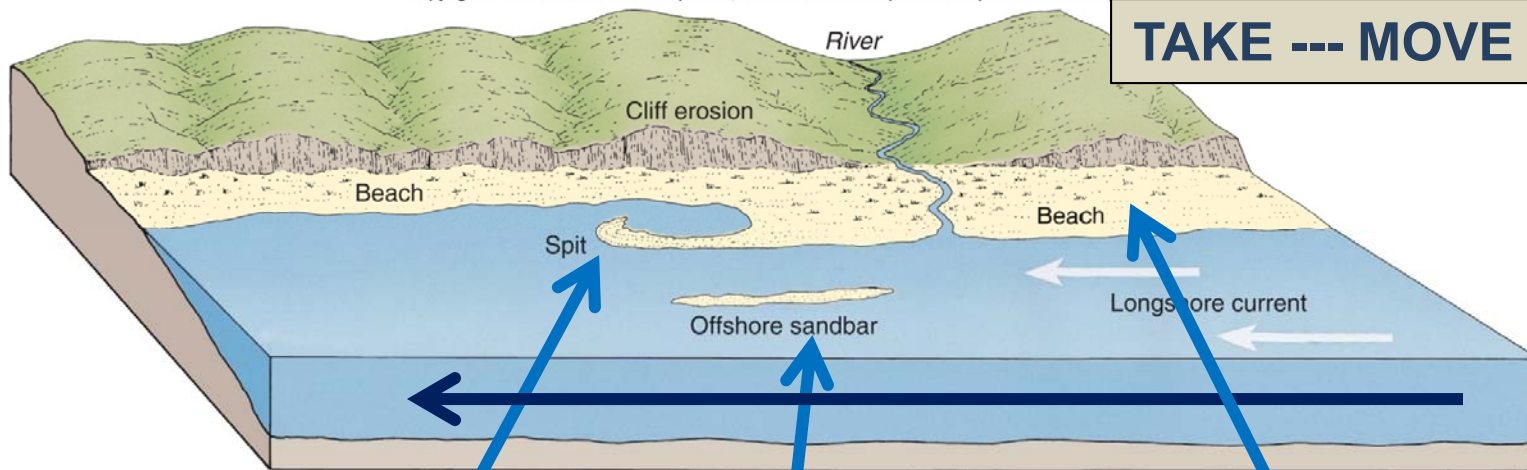


<https://www.youtube.com/watch?v=3iAdm0Md7-A>

Longshore Currents

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TAKE --- MOVE --- PLACE



Coastal landscapes created by longshore currents.

N E X T

**LANDFORM
DEVELOPMENT
and
LAND USE**