

Extra Credit for Exam II

Extra Credit Atlas Exercise for EXAM II focuses on climate and climate controls.
 It is available on BlackBoard and the Course Home Page.
 Submit answers via email to agrande@hunter.cuny.edu no later than 10 PM Thursday, April 8, 2021

1

GEOG 101 Part II
 People and their Physical Environment

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

Prof. Anthony Grande
 Hunter College Geography



Lecture design, content and presentation ©AGG 1021
 Individual images and illustrations may be subject to prior copyright.

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

3

Geologic Influences

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

❖ **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.

4

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.

5

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*

6

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.

The evolution of Earth's tectonic plates over the past billion years - YouTube 1.5 min

convection currents Planet Earth - YouTube 1 min

Evidence of Continental Drift

Rock Composition Evidence

Glacial Evidence: markings and deposits

Fossil Evidence: land-based plants and animals

Plate Tectonics

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=0mWQs1L3fA> 6 min

Plate Boundaries

Divergent plate boundary

(a) Spreading ocean ridge

Convergent plate boundary

(b) Trench

Transform plate boundary

(c) Fault line

Three types of boundary zones:

- Divergent or Spreading:** new crust is formed from molten material (ridges formed).
- Convergent or Subduction:** old crust is drawn back into the interior to be melted (trenches formed).
- 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.

continent + continental shelf, continental slope, submarine canyon, continental rise, mid-ocean ridge, sea level, abyssal plain, abyssal hill, continental margin, guyot, island arc, trench, volcanic island, seamount, + magma, + magma

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

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

<https://www.youtube.com/watch?v=0mWQs1L3fA> 35 sec

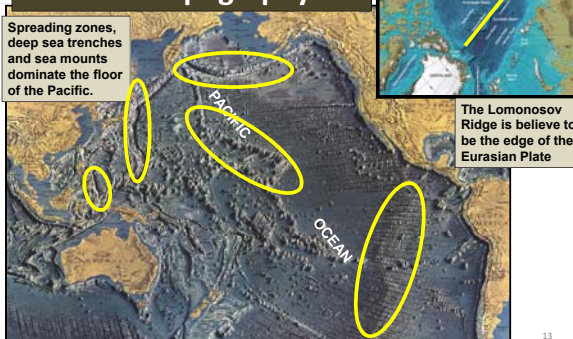
Atlantic and Indian Ocean Basin Topography


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

Subduction zones exist around the Caribbean Basin and also in the South Atlantic, E of Tierra del Fuego and N of Antarctica (red ovals).

Pacific and Arctic Ocean Basin Topography

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



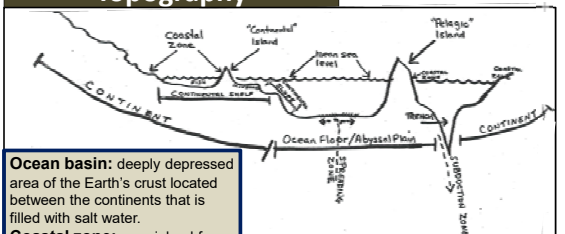


The Lomonosov Ridge is believed to be the edge of the Eurasian Plate

13

Generalized Ocean Basin Topography

Copy in Handouts 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)




15

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 hydrothermal 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



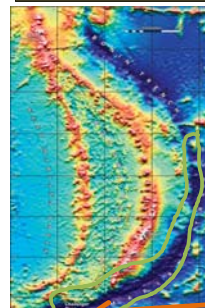
OCEAN BASIN TOPOGRAPHY

- ❖ **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.

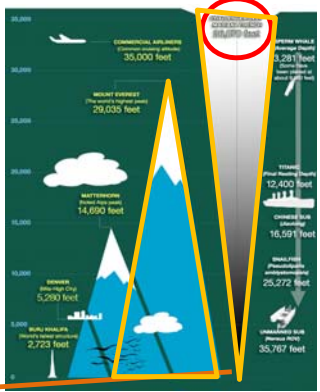



17

Marianna Trench



Challenger Deep -36,070 ft



National Geographic Expedition 2013

18

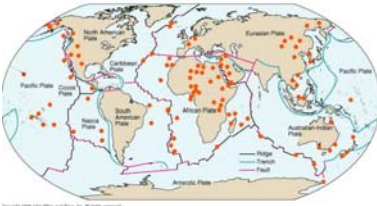
Geologic Hot Spots

❖ **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.

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.

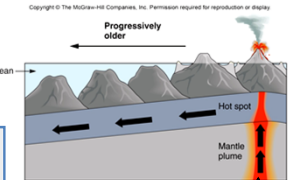
The Hawaiian Island Chain is an example of this. So is Yellowstone National Park on the N. American Plate.



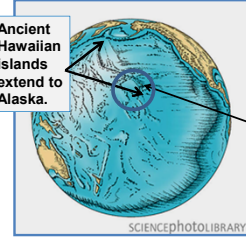
<https://www.nps.gov/subjects/geology/plate-tectonics-continental-hotspots.htm> Tracking the Yellowstone Hotspot

"Hot Spot" under Hawaii

Progressively older

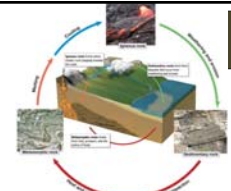


Ancient Hawaiian islands extend to Alaska.



Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

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.

Copy in Handouts section of course home page.

ROCK CYCLE

ATMOSPHERE: Solar Energy (heat from electromagnetic radiation)

TOPOGRAPHY: Surface features are worn down (gradation)

HYDROSPHERE

At the surface: Extrusive igneous rocks are created as lava cools; Eruption of molten rock at the surface (volcanism); Uncovering of all rocks by uplifting; Formation and collection of sediment.

Below the surface: Intrusive igneous rocks are created below the surface as magma cools; Burial and Lithification; Sedimentary rocks are created; Transformation of existing solid rock into a new material by the application of great heat, pressure and superheated fluids (metamorphism); Metamorphic rocks are created.

MELTING of rock material occurs deep within the earth.

Internal Energy (heat from radioactive decay)

MAGMA: Collects and moves underground.

Lava = molten rock on the surface; Magma = molten rock below the surface.

Copy in Handouts section of Course Home Page.

ROCK CYCLE

ATMOSPHERE: Solar Energy (heat from electromagnetic radiation)

TOPOGRAPHY: Surface features are worn down (gradation)

HYDROSPHERE

At the surface: Uncovering of all rocks by uplifting; Formation and collection of sediment.

Below the surface: Burial and Lithification; Sedimentary rocks are created; Transformation of existing solid rock into a new material by the application of great heat, pressure and superheated fluids (metamorphism); Metamorphic rocks are created.

MELTING of rock material occurs deep within the earth.

Internal Energy (heat from radioactive decay)

ROCK CYCLE

ATMOSPHERE: Solar Energy (heat from electromagnetic radiation)

TOPOGRAPHY: Surface features are worn down (gradation)

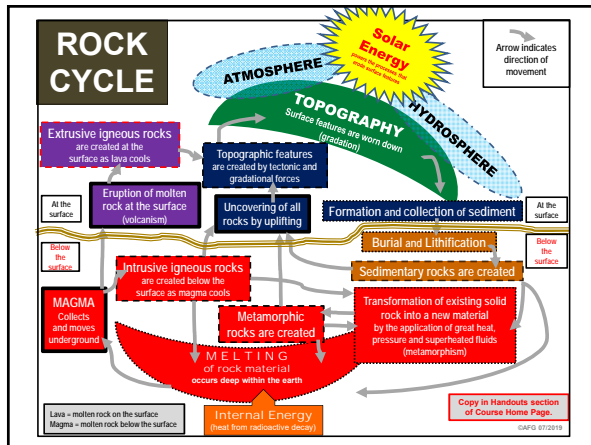
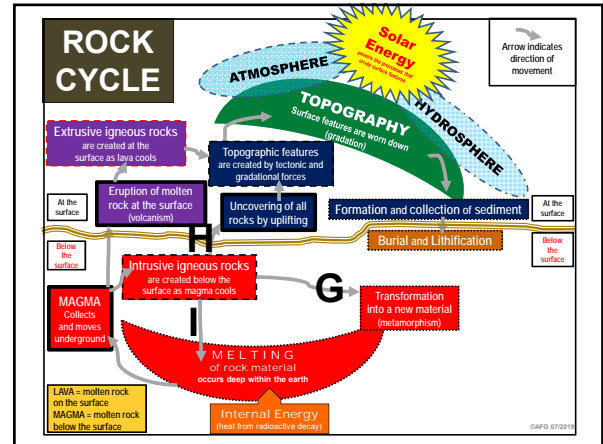
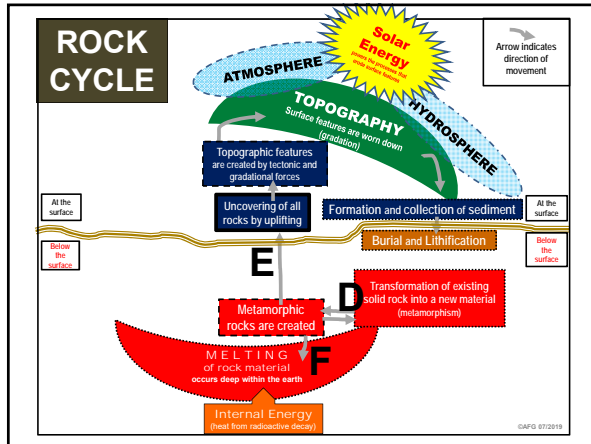
HYDROSPHERE

At the surface: Uncovering of all rocks by uplifting; Formation and collection of sediment.

Below the surface: Burial and Lithification; Sedimentary rocks are created; Transformation of existing solid rock into a new material by the application of great heat, pressure and superheated fluids (metamorphism); Metamorphic rocks are created.

MELTING of rock material occurs deep within the earth.

Internal Energy (heat from radioactive decay)



ROCK CYCLE

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

There are three main categories of rock:

- sedimentary
- igneous
- metamorphic

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

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.

Lava flow cooling to become igneous rock

Metamorphic Rock

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)

31

Tectonic Forces: Folding, Faulting and Volcanism

Folding: compression

Volcanism: molten material to surface

Faulting: fracture, stress

FOLDING

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

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Ridge and Valley area

30,000 ft

Present ground level

2000 feet

(A) (B)

© © Mark C. Barrett/Photo Researchers

33

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".

34

VOLCANISM

MT ST HELENS

Explosive

HAWAII VOLCANO NP

Gentle

COLUMBIA PLATEAU (ancient)

35

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.

36

Gradational Forces

❖ **WEATHERING:** a change in place in reaction to exposure to air, water and temperature.
Happens in 2 ways:

- Mechanical weathering = disintegration**
 - crumbling and fragmentation
 - frost action, crystallization, root action
- Chemical weathering = decomposition**
 - decay and separation of parts
 - oxidation, hydrolysis, carbonization

37

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.**

The diagram shows soil horizons from top to bottom: O (Organic), A (Surface), B (Subsoil), C (Substratum), and R (Bedrock). To the right, a vertical column lists: Loose Debris, Mixed mineral and organic matter, Layer of fine particles and mineral accumulation, Weathered rock (parent material), and Bedrock (Source of mineral matter).

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

38

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.

39

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”

40

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

41

River Meander Diagram

The diagram shows a river meandering. On the outer bank (point bar), it says 'slip-off slope' and 'river cliff'. On the inner bank (cut bank), it says 'slip-off slope' and 'river cliff'. A 'main current of flow at a meander' is shown. Labels include 'exbow lake', 'neck of meander', 'slip-off slope', and 'river cliff'. Arrows indicate 'TAKE from here' and 'PLACE here'. A box in the top right corner contains the URL: <https://www.youtube.com/watch?v=6a3r-cGRWIs> 3 min.

TAKE --- MOVE --- PLACE
EROSION --- TRAVEL --- DEPOSITION

42

Moving Ice and Glacial Landscapes




Mountain deposits that will form a large ice glacier melt.

Labels include: Cirque, Arête, Hanging valley, U-shaped glacial trough, Horn, Col, Glacier erratic, and Hanging waterfall.

<<<<mountain glacier and its features

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

TAKE --- MOVE --- PLACE

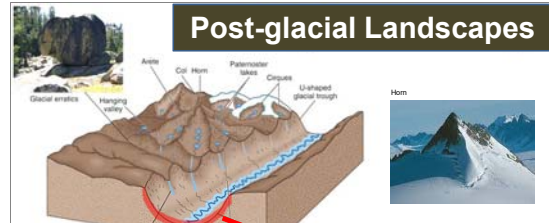


continental glacier and its features. >>>>

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

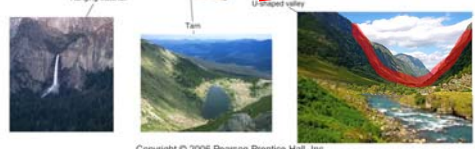
<https://www.youtube.com/watch?v=21UjgDyP28wQ> 4 min NatGeo Glaciers and Climate Warming

Post-glacial Landscapes



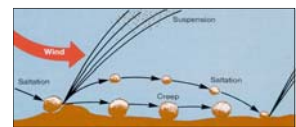
Labels include: Arête, Col, Horn, Paternoster lakes, Cirques, U-shaped glacial trough, Horn, Hanging valley, Hanging waterfall, Tarn, and U-shaped valley.

(c) Postglacial




Copyright © 2006 Pearson Prentice Hall, Inc.

Wind Formed Landscapes




Labels include: Wind, Suspension, Saltation, and Creep.



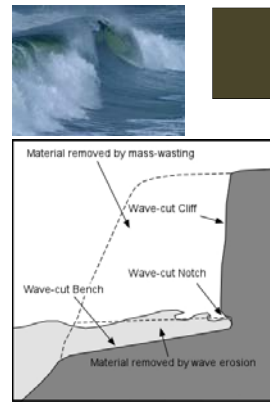
Colorado, 1930s

Take-Move-Place


Wind is also a sandblaster!



Wave Action Landscapes



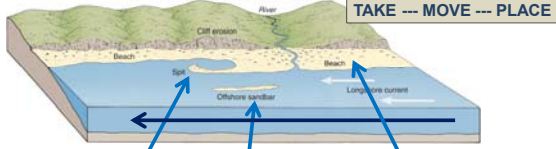
Labels include: Material removed by mass-wasting, Wave-cut Cliff, Wave-cut Notch, Wave-cut Bench, and Material removed by wave erosion.



<https://www.youtube.com/watch?v=3Adm0M47-A>


46

Longshore Currents



Labels include: River, Cliff erosion, Beach, Spit, Offshore sandbar, and Longshore current.

TAKE --- MOVE --- PLACE



Coastal landscapes created by longshore currents.

47

N E X T

LANDFORM DEVELOPMENT and LAND USE

48