Hunter College - CUNY
Dept. of Geography & Environmental Science
GEOG 101 Lecture Presentation Summary
Spring 2021

***NOTE**: In the absence of face-to-face lecturing and explanation of the material presented in the lecture slides, I will summarize the content of each lecture presentation stressing the concepts and interrelationships that are essential to an introductory geography course.*

If, after viewing the lecture presentation, the imbedded short videos and hot links to articles, and after reading this summary, you have any questions, would like to contribute a comment or two, need clarification by other examples or would like additional information on the topic, please do not hesitate to email me at agrande@hunter.cuny.edu.

LECTURE 14: Lithosphere 1

- The purpose of this lecture is to introduce you to geologic processes and the forces that shape the earth's surface. *Lecture 15: Lithosphere 2 will look at land surface development.*
- **Slide 4: Geologic Influences.** The geologic environment forms the basis of people's interaction with and use of the features found on earth's surface. The factors listed on the slide are just some of the variables that influence people living on the surface of the Earth. Each one can be divided into many subcategories. *This will come into play again during Part III of the course.*
- **Slide 5: Definitions.** Be able to differentiate these terms. Especially important to geographers is **topography:** *the study of surface features*. People are influenced most directly by topographic characteristics (Lecture 15). Unique features influence human activity within regions. And, we can **never forget climate** for the role it plays in shaping landforms. In reality, similar landforms in different climates will be evaluated and used differently by people.
- **Slide 6: Geologic Cycle.** The three parts of the geologic cycle are (a) continental drift and plate tectonics, (b) rock and mineral formation, and (c) building and gradational processes. We will go over all three. Be able to distinguish each.
- **Slide 7: Continental Drift**. The continents have not been in the same position over geologic time and they are still moving. The oldest map estimates continental positions 225 million years ago. ***(View the 1.5 min video of the Earth's plates over the past billion years.)*** The shift in position (or *drift*) is a result of forces at work within the earth's interior as illustrated by the diagram at lower right corner. This is an important diagram. ***(View the 1 min video illustrating the convection cells.)***
- **Slide 8: Evidence of Continental Drift.** Despite centuries of musings about the "jigsaw puzzle fit" of the continents *(first put forward with the world maps of the 16th century),* it was not until the early 1900s that it was formally proposed by Alfred Wegener and not until the late 1900s that enough hard evidence was gathered from around the world to legitimize the concept: *Similar rock formations in Africa and South America, fossils of land-based plants and animals on separate continents that could not have crossed an ocean, and such paleoclimate oddities as glacial striations in the Sahara and tropical coral in the Arctic.* GPS-linked LIDAR measures present-day movements.

- **Slide 9**: **Plate Tectonics.** The *Theory of Plate Tectonics* seeks to explain the shifting position of the continents over geologic time. **VIEW THE 6 MINUTE VIDEO**. On the map, take notice of the colored areas called <u>plates</u>. Observe the types of plate boundaries (each has a name) and the symbols used (see the key) to represent what is happening. Also note the directional arrows on the plates; this tells us which way the plate is moving. When the arrows face each other, that means that the plates are colliding. The diagram at the lower right is a cross-section across the Nazca Plate *(Points 1-2 on map and diagram match locations)*; see that each side has a different type of boundary.

- **Slide 10: Plate Boundaries.** The three major boundary zones are named, defined and illustrated. ***Be able to distinguish them***.
  - **(a) New crust is created** at the <u>divergent or spreading zone</u>, where molten rock from earth's interior comes to the surface; ridges are formed by volcanic activity. Rift zones form where the crust is pulled apart, as the East Africa Rift Valley (land) and Greenland Rift Basin (ocean).
  - **(b) Old crust is drawn back** into the earth's interior at the <u>convergent or subduction zone</u> where it is melted; trenches are formed where the plates converge and are dragged deep beneath the sea floor; volcanic activity marks the melting zones on the earth's crust.
  - **(c) When the edges of two plates rub against each other**, a <u>transform or horizontal-sliding zone</u> is created; fault lines are formed and earthquakes occur (this situation caused the earthquakes in Puerto Rico).

  The <u>inset map</u> on slide 10 shows the *San Andreas Fault Zone*, a transform plate boundary, where the Pacific Plate rubs against the North American Plate. At one time the peninsula of Baja California hugged the west coast of Mexico (see double-headed arrow). Some day (+/-115 million from now!) the tip of Baja will be next to Southern California. However, LA will be a suburb of SF in only +/-50 million years because they are closer to each other.

- **Slide 11: Ocean Basin Topography.** Ocean basins get their unique characteristics, in part, from plate tectonics. Ocean basin topography is very complex. We will focus on features pertinent to this course. The animation at the left shows the spreading zone creating new crust. Click on the link to the diagram on the right to see subduction as the crust is drawn back into the earth.

- **Slides 12-13: Ocean Floor Topography.** The four major ocean basins: Atlantic, Indian, Pacific and Arctic, are presented. Note numerous unique features on the ocean floor. The yellow arrows and circles point out areas with examples of important features.
  - **Slide 12** shows the Mid-Atlantic Ridge *(a spreading zone)* extending into the Indian Ocean Basin. The left inset is an enlargement of the area in the North Atlantic (between the black lines). The ridge has the youngest rocks in the basin. A convergent zone ***(circled in red)*** marks the boundary of the Caribbean Plate.
  - **Slide 13** shows features of the basins of Pacific and Arctic oceans. The **Arctic Ocean Basin** is the most difficult to explore because of the polar ice cap. Underwater features as the Lomonosov Ridge are increasingly being used as geopolitical and geoeconomic markers. The **Pacific Ocean Basin** has

the greatest number of features, as spreading zones, deep sea trenches, seamounts and guyots, volcanic islands and hot spots. (FYI: hots spots are **not** located at plate boundaries; we'll look at them later.) ***"Ring of Fire"*** refers to the existence of active volcanoes along the perimeter of the Pacific Plate, a result of subduction along convergent boundaries. Note the circled spreading zone west of South America; the trench along the Aleutian Islands of Alaska where the Pacific Plate disappears under the North America Plate; the seamounts and guyots northwest of the Hawaiian Hot Spot; and the deep-sea trenches near the volcanic islands of Japan, Philippines and Indonesia.

- **Slides 14-18: Ocean Basin Topography.** Terms associated with ocean basin topography are shown. These simple diagrams illustrate the location of ocean basin features. ***Know the characteristics of each.***

- **Slide 15: The Continental Shelf and Continental Slope** mark the underwater extension (or flooded portion) of the continent. The area designated as continental shelf depends on sea level.
  - As sea level rises, the continental shelf expands as more land is flooded by sea water; hills and other highland areas become islands and are called *"continental islands."* This happens during times of <u>global warming</u>.
  - During times of <u>global cooling</u> (as an Ice Age), more of the continental shelf is exposed because sea water levels are lower; as areas dry up, islands become joined to each other and to the mainland creating <u>land bridges</u>.
  - The shallow waters of the continental shelf contain most of the world's fish populations; minerals deposits that are found on land can be mined at shallow depths. World states tend to claim and protect this area of water *(sea surface and underwater boundaries and other economic and geopolitical considerations).*

- **Slide 16: The Ocean Floor or** "**Abyssal Plain."** This deep-sea area is cold and dark and contains only specialized life forms at the greatest depths. With technology, there is potential to harvest pure minerals from the areas near the *<u>hydrothermal vents</u>* *(cracks on the ocean floor from which superheated, mineral infused water is discharged into the ocean).* Volcanoes that rise from the ocean floor and break the surface are called *"pelagic islands",* as are the tops of the undersea ridges that break the surface. Note the inset map that shows the location of the global mid-ocean ridge system on the abyssal plain. It looks like the seams on a baseball!

- **Slides 17-18: Trenches, Deeps and Troughs.** These are the deepest parts of the ocean basin, extending well below the abyssal plain. Here is where the earth's crust is subsumed, melted and returns to the magma pool of the earth's interior. The deepest trench on earth is the Marianna Trench, which is nearly 7 miles below sea surface and 3.4 miles below the abyssal plain. **Slide 18** shows Marianna Trench's location and compares it to surface features. An upside-down Mt. Everest can easily fit into it!

- **Slides 19-20: Geologic Hot Spots.** A hot spot is an area located <u>away</u> from a plate boundary (either on land or under water), where points of weakness allow a plume of molten material to come to the surface. Because the tectonic plates move slowly over these hot spots, a trail of volcanic activity is created with the youngest, most active volcanoes over the hot spot and the oldest, inactive and extinct volcanoes furthest away. The Big Island of Hawaii, a composite of three active volcanoes, is slowly moving away from the hot spot. A new island, named Loihi, is being formed on the ocean floor southeast of Hawaii (see **Slide 20** lower right map). We can trace the ancient Hawaiian Islands all the way to the Aleutian Trench (Alaska) where they disappear into the earth's interior (see **Slide 20** left map). *Yellowstone National Park* is located over a hot spot and the volcanic features to its west are ancient remnants of North America's movement over it. ***On Slide 19 click on the <u>Yellowstone Hotspot</u> link and look at the maps and pictures (but do not worry about the details.)***

- **Slides 21-27: The Rock Cycle.** The Rock Cycle explains the formation of sedimentary, igneous and metamorphic rocks. It also illustrates rock formations' relationship to the creation of landform features on the earth's surface.
    - **Slides 21-22: Review the three diagrams** which show the same thing in different ways. <u>Follow the arrows.</u> Note that the cycle is affected by BOTH the earth's internal engine and solar-powered atmospheric processes. *NOTE: The Slides 22-25 show how Slide 21 was constructed and the generalized sequence as indicated by the arrows and colored text boxes.*
    - **Slide 23:** This is the **base diagram** showing earth's surface affected by solar energy-influenced atmospheric and hydrosphere processes and by internal energy generated from radioactive decay. (We will address *topographic gradation* separately.)
    - **Slide 24:** This slide shows the **sequence of sedimentary rock formation**. **(A)** Sediments from eroded surface material are collected at the surface, eventually buried and lithified (turned to rock). Over geologic time, they may return to the surface and be part of new topographic features. The cycle begins anew.
    - The sedimentary rock can follow two other paths. **(B)** It can be subjected to tremendous heat and pressure and transformed (metamorphosed) into a new material: *a <u>metamorphic rock</u>*. **(C)** The sedimentary rock may be dragged deep into the earth's interior and melted to become part of *<u>magma</u>* (liquid rock).
    - **Slide 25:** Once created, a **metamorphic rock** can **(D)** be transformed again *(note double arrow*), **(E)** be uplifted to the surface to be part of new topographic features or **(F)** be melted. The cycle begins anew.
    - **Slide 26: Molten (liquid) rock** is like a "soup" of minerals. It collects and moves underground. Molten rock is called "**magma"** when it is underground and "**lava"** when it comes to the surface. *(IMPORTANT: magma and lava are the same thing but occur in different places.)*
    - An **<u>igneous rock</u> is created after the magma/lava cools and hardens.** The type of igneous rock created depends on the mixture of minerals and the rate of cooling. An **intrusive igneous rock** is created **below** the surface as **<u>magma</u>** cools. An **extrusive igneous rock** is created **on** the surface as **<u>lava</u>** cools. Once created, an igneous rock can **(G)** be metamorphosed, (**H)** be uplifted to the surface to be part of new topographic features or **(I)** be melted again. The cycle begins anew.

- **Slide 27:** This one repeats Slide 22.

- **Slides 28-29: Rock Cycle Recap.** The three categories of rock (sedimentary, igneous and metamorphic) are summarized. ***Know the difference between the three types of rocks.*** *Preview to next lecture: Because sedimentary rocks comprise about 75% of all surface rock and are always deposited in parallel layers, we can study changes to the surface by using the rock cycle and forces shaping landforms as clues.*

- **Slide 30: Forces Creating and Shaping Surface Landforms.** With Slide 30 we change gears and look at how surface landforms are created. Forces shaping the surface landforms are termed **endogenic** (tectonic/building) and **exogenic** (gradational/reducing). These forces are usually present together, but one may not have as strong a presence. Both forces are needed in order to have a varied landscape, otherwise the earth would either have no flat land or be as smooth as a bowling ball. *Review the examples from the textbook.*

- **Slide 31: Tectonic Forces.** The **three tectonic/building** forces are **folding, faulting, and volcanism** and they provide the mechanism for building mountains and elevating other surface features.

- **Slides 32-35** focus on <u>tectonic forces</u>. Pay attention to the arrows on the diagrams because they show movement.
  - **Folding** is a result of the compression of horizontal layers of rock from extreme pressure, say from a continental collision. The rolling landscape of Central Pennsylvania **(slide 33)** is a result of the collision of Africa with North America which created the folded Appalachian Mountains.
  - **Faulting** creates fractures in the earth's crust from the great stress exerted on brittle rocks. **Fault zones (slide 34**) are cracks in the earth's surface caused by stress. When the accumulated stress reaches its containment point, energy is released in the form of shaking and sudden movements: we call this an ***earthquake***. *Know the difference between an earthquake's "focus" and "epicenter."* The focus is the point along the fault where pressure is released (the snap occurs), while the epicenter is the latitude/ longitude coordinates on the surface directly above the focus.
  - **Volcanism (slide 35**) is the process by which molten rock comes to the surface. Volcanic activity can be explosive (when pressure is stored, then suddenly released) or gentle (flowing out of fissures). It depends on the circumstances in the area.

- **Slides 36-47** focus on <u>gradational forces</u>. The **three gradational/reducing forces** are **weathering, mass wasting and erosion** and they provide the mechanism for wearing down a surface and producing sediment. These are the forces that **wear away** the surface.

- **Slide 37: Weathering.** **BTW, weathering has <u>nothing</u> to do with the weather.** In this context it means that something **undergoes an alteration (change) in place,** as an iron fence rusting, a pothole forming in the street in springtime, or a tombstone becoming hard to read. **Note the two types of weathering**: <u>mechanical weathering</u> which is disintegration and <u>chemical weathering</u> which is decomposition.

- **Slide 38: Soils.** Soil formation is a wonderful example of the results of combining chemical and mechanical weathering. Know that soils have layers called **"horizons."** The top horizon is highly organic, being composed of rotting material while the lowest level is solid rock (inorganic material) called "bedrock". In between are combinations of organic and rock material distributed by water. Organic and inorganic material provide the nutrients for plants. For this course, you do not have to know the details of each layer.
- **Slide 39: Mass Wasting.** This is an umbrella term for numerous types of land movement under the <u>force of gravity</u>. It affects slope stability. Avalanches are included in this category.
- **Slides 40-47. Erosion.** The key to understanding **erosion** is the sequence of forces shaping the earth's surface: ***take-move-place***. Of the five agents of erosion listed on slide 39, <u>running water is by far the chief shaper of the earth's surface</u>, even in desert areas. When looking over the slides and **watching the three videos** note that there is always the same sequence: material is taken from a place (source), it is transported by a conveyance (water/wind/ice/wave action/longshore current), and then dropped someplace else when the conveyance can no longer carry it (slow moving water/light winds/melted ice/calm seashore/weak current).
- **Slides 41-42: Running Water.** Moving water is the chief shaper of the landscape. It has great power to erode. When it stops moving, it deposits the material it has carried. Take-Move-Place.
- **Slides 43-44: Moving Ice.** A glacier is a mass of ice that moves slowly but powerfully over land. Think of it as a giant bulldozer pushing away everything in its place. There are two types of glaciers: mountain and continental. When glacial ice melts it releases meltwater which further erodes the landscape but also deposits material that was carried in the ice, as soil, boulders, vegetation, etc. They create unique landscapes that are very recognizable. Take-Move-Place.
- **Slide 45: Wind.** Wind is an erosional agent through the movement of tiny grains of rock material. When the grains strike an object, they act as an abrasive. When wind slows or stops blowing, it drops particles. The heaviest fall out first, then the fine dust. Take-Move-Place.
- **Slide 46: Wave Action.** Waves batter coastal areas and shorelines of lakes and rivers. Normal wave action constantly creates new material and moves around old material. Storm driven waves are extremely destructive. Take-Move-Place.
- **Slide 47: Longshore Currents.** Along a coastline, hand-in-hand with wave active, longshore currents erode soft sediments and move them along. As the fringe areas of the currents slow, sediment is dropped and sandy formations are created. Take-Move-Place.
- **Slide 48: Next – Landscape Development**