Hunter College - CUNY
Dept. of Geography & Environmental Science
GEOG 101 Lecture Presentation Summary
Spring 2020

***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. This presentation usually takes 1.5 periods (or 1 hr. 45 min.).

- The geologic environment forms the basis of people's interaction with and use of the features found on earth's surface. That will be the focus of the next presentation, Lecture 15. The factors listed on **Slide 4** are part of just a short list of 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.

- Be able to differentiate the terms on **Slide 5**. Especially important to geographers is topography which is 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 and the reality that similar landforms in different climates will be evaluated and used differently by people.

- **Slide 6**: 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.

- As seen in **Slide 7**, the continents have not been in the same place over geologic time. The oldest map estimates continental positions 225 million years ago. 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.

- **Slide 8** addresses the *Plate Tectonic Theory* which seeks to explain the shifting position of the continents over geologic time. **VIEW THE 6 MINUTE VIDEO**. On the world map note the colored areas called plates. Note 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; see that each side has a different type of boundary.

- **Slide 9** names, defines and illustrates the three major boundary zones. Be able to distinguish them. **(a) New crust is created** at the divergent or spreading zone 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 convergent or subduction zone where it is melted; trenches are formed where the plates converge and volcanic activity marks the melting zones on the surface. **(c)** When the edges of two **plates rub against each other**, a transform or horizontal-sliding zone is created; fault lines are formed and earthquakes occur (this situation caused the recent earthquakes in Puerto Rico).

  The inset map 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 10:** 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.

- **Slides 11-12** present a view of the four major ocean basins: Atlantic, Indian, Pacific and Arctic. Note numerous unique features on the ocean floor. The yellow arrows and circles point out areas with key examples.

- **Slide 11** shows the Mid-Atlantic Ridge which extends 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.

- **Slide 12** 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. The Pacific Ocean Basin has the greatest number of features: these include 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 as 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 13-17** illustrate terms associated with ocean basin topography. These simply diagrams illustrate the location of ocean basin features. Know the characteristics of each.

- **Slide 14: The continental shelf and continental slope** mark the underwater extension (or flooded portion) of the continent. 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 global warming. During times of global cooling (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 15: The ocean floor is called the** "**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 thermal vents on the ocean floor. 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!

- **Slide 16: Trenches, deeps and troughs** 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. 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 17** shows the trench's location and compares it to surface features. An upside-down Mt. Everest can easily fit into it!

- **Slides 18-19: Hot spots** are areas away from plate boundaries, 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 19 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 19 left map).

- **Slides 20-21:** 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. **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. The following four slides show how Slide 21 was constructed and the generalized sequence as indicated by the arrows.

- **Slide 22:** 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 23:** 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 metamorphic rock*. (C) The sedimentary rock may be dragged deep into the earth's interior and melted to become part of *magma* (liquid rock).

- **Slide 24:** 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 25:** 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 *igneous rock* 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 **magma** cools. An **extrusive igneous rock** is created **on** the surface as **lava** 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 26:** This one repeats Slide 21.

- **Slides 27 and 28** summarize sedimentary, igneous and metamorphic rocks. Because sedimentary rocks comprise about 75% of all surface rock and are always deposits in parallel layers, we can study changes to the surface using the rock cycle and forces shaping landforms.

- *In class the first part of Lecture 14 ends here.*

- With **Slide 29** 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 30:** The **three tectonic/building** forces are **folding, faulting, and volcanism** and they provide the mechanism for building mountains and elevating other surface features. The **three gradational/reducing forces** are **weathering, mass**

wasting and erosion and they provide the mechanism for wearing down a surface and producing sediment.

- **Slides 31-34** focus on tectonic forces. Pay attention to the arrows on the diagrams; 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 32)** 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 33**) 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 34**) 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 35-42** focus on gradational forces. These are the forces that **wear away** the surface: weathering, mass wasting and erosion.

- **Slide 36.** BTW, weathering has nothing 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.

- **Slide 37. Soils** are a wonderful example of the results of 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. In this course you don't have to know the details of each layer.

- **Slide 38. Mass wasting** is an umbrella term for numerous types of land movement under the force of gravity. It affects slope stability. Avalanches are included here.

- **Slides 39-46** focus on **erosion** with its sequence of forces shaping the earth's surface: ***take-move-place***. Of the five agents of erosion listed, running water is by far the chief shaper of the earth's surface, 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).