**AP Environmental Science-** *EXAM 1 STUDY GUIDE* **Ms. Taylor**

**Unit 1- Earth Systems and Resources:** *Earth science concepts*taylor@whsad.org

**Topic 1- *Geological Time Scale:***

* **Stratigraphy** is a branch of geology that studies rock layers (strata)
* Rules of rock stratification:
	+ Strata are laid down in succession, with each layer representing a “slice” of time.
	+ **Principle of superposition**- any give rock layer is older than the layers above, and younger than the layers below
		- Some rock layers have not been preserved because of erosion or natural disasters

The fossil record of life on earth has been captured **chronologically** in the rock strata of Earth. The fossil record is our greatest source of evidence for the *evolution of life*. Using fossil evidence and the rules of stratification, *Earth’s history has been organized* into various units according to major biological and geological events that took place throughout history.

* **Biological Events-** Scientists examine fossil evidence to determine which species were present at any given time period. Scientists determine evolutionary relationships between organisms by comparing anatomical characteristics.
* **Geological Events**- Scientists can find evidence in rock layers about the occurrences of floods, droughts, earthquakes, volcanic eruptions, asteroid strikes, tsunamis, glaciers, etc.

Earth’s history has been organized into a **Geological Timescale**

* Earth’s history is organized into **4 major Eras** (*Cenozoic, Mesozoic, Paleozoic, and Precambrian*)
* Eras are further categorized into **periods**

**TODAY:**

* We are in the **Quaternary Period** of the **Cenozoic Era.**
* **Cenozoic Era-** Earth has been in the Cenozoic Era for the last **65 million years.** This era is characterized by the *diversification of mammals.* (Since dinos no longer ruled the land! They went extinct at the end of the Mesozoic Era, in the cretaceous period)
* **Quaternary Period-** We entered this **1.8 mya.** Mammals have been diversifying throughout the entire Cenozoic Era, but the *evolution of Man* took place in the last 1.8 million year. ALSO, major *ice ages* took place.

**QUESTION A NON AP PERSON MIGHT ASK**: *How did we quantify the Geological Timescale?!? I know that we can examine rock layers to determine a chronological series of events, but how did we get the actual dates of each event?*

**Relative Dating:** We used the rules of *stratification* to develop a chronological series of events

**Absolute Dating:** We used *radiometric dating* to quantify (measure) the years that have passed since each event

* **Radiometric dating-** certain radioactive elements have defined half-lives- the amount of time it takes for this element to decay by one half (can be in the thousands, millions, or billions of years). We can test the elements present in certain rocks and fossils, determine how much of the element remains, and therefore determine how many years ago that this element began to decay.

**Topic 2: *Earth’s Composition:***

Earth is divided into 3 major layers:

**Crust**

* Outermost layer, **solid**
* 2 types- continental crust and oceanic crust
* **Continental** crust is thicker, but less dense.
* **Oceanic** is thinner, but *more dense*

**Mantle**

* Second layer, mostly solid
* Portions in the upper-mantle have a more “*plastic-like*” consistency, allow some motion
* Composed of iron, magnesium, aluminum, and **SILICATES**
	+ The silicates in the mantle allow for the plastic-like consistency!

Be able to label this diagram with: *oceanic crust, continental crust, ocean, lithosphere, uppermost mantle, upper mantle, lower mantle, asthenosphere.* Know which one should be labeled *“plastic-like”*

**Core**

* Center of earth
* Outer core is *liquid iron*
* Inner core is *solid iron*, because it is under so much pressure

**Lithosphere:**

* The solid, outer portion of earth is called the lithosphere. The lithosphere is basically the crust, but also consists of the *uppermost* portions of the mantle that are *solid.*

**Asthenosphere:**

* The upper portion of the mantle has a “plastic-like” consistency with some mobility. This area is known as the asthenosphere and is directly below the lithosphere.

**Topic 3- *Plate Tectonics:***

Earth’s lithosphere is divided into many large “pieces” known as tectonic plates. These plates are slowly moving 2-5 cm per year. The plates are able to glide because of the plastic-like asthenosphere. The plates are pushed along by **convection currents** in the Earth’s mantle.

**Convection currents:** Heat from Earth’s core **rises** through the mantle. As it reaches the upper mantle, it is **cools** and begins to fall. As it reaches the core, it heats up again and begins to rise. (This is all happening VERY slowly). This rotation of heat creates a slowwww churning motion of the material in the asthenosphere, which then, slowly moves the lithospheric plates that are “floating” on top.

The idea that Earth was composed of moving plates arose from two theories (from two totally different scientists)

* **The theory of continental drift-** Idea that all the continents were once connected as a super-continent known as “**Pangaea,”** which began to split **200 mya.** It was observed that the continents fit like puzzle pieces, and that on isolated continents the same fossils and geological characteristics were found.
* **The theory of sea-floor spreading:** there were underwater mountain ranges, and the new seafloor was being generated at these mountains.

**BACK TO THE PLATES…**

Convection currents cause plates to move in different directions. Plates interact with other plates at their boundaries.

**There are 3 types of plate boundaries:**

1. *Divergent boundaries*
2. *Convergent boundaries*
3. *Transform boundaries*

**Divergent Boundaries:** *Two plates slide apart from each other*

* When 2 oceanic plates diverge, magma from the mantle rises, solidifies, and *forms new oceanic crust*.
	+ “sea-floor spreading”
* When 2 oceanic plates diverge, a **mid-ocean ridge** forms (BASICALLY, an underwater mountain range)
	+ **EXAMPLE**- *Mid-Atlantic Ridge*
* When 2 continental plates diverge, a **rift valley** is formed.
	+ **EXAMPLE**- *East African Rift Valley*

**Convergent Boundaries:** *Two plates slide into each other*



**CONTINENTAL-CONTINENTAL**

* When 2 continental plates slide into each other, a **mountain range** forms.
	+ **EXAMPLE:** The *Himalayan Mountains* were formed at a convergent boundary between the Indian plate and the Eurasian plate

**OCEANIC-CONTINENTAL:**

* When an oceanic and a continental plate converge, the oceanic plate is **subducted** under the continental plate.
	+ This is because the oceanic plate is MORE DENSE.
* When the plates collide, the continental plate is “crunched up” to form a **volcanic mountain range**.
* The mountain range is volcanic, because the subducted oceanic plate enters the mantle and melts into magma, which eventually can escape through the continental crust above.
* **EXAMPLE:** *Andes Mountain Range (South America)*

**OCEANIC-OCEANIC:**

* When two oceanic plates converge, subduction still occurs, because the oceanic crust on the continental side is less dense, while the oceanic crust on the ocean side is more dense.
* While one oceanic crust is subducting, the other oceanic crust is crunching up. This appears to the surface as an **arc of volcanic islands.**
* As the subducting plate moves under, it creates a **deep ocean trench.**
* **EXAMPLE:** *Japan, Philippines, Aleutian Islands*

**Transform Boundaries:** *plates slide past each other*

* No volcanic activity, but earthquakes are often associated with these boundaries
* **EXAMPLE:** San Andreas Fault (California)

**Topic 4- *Volcanoes, Earthquakes, and Tsunamis***

**Volcanoes:**

* 95% of volcanoes occurs at subduction zones and oceanic divergent boundaries
* Subduction zone- subducting plate melts into magma, which then rises to surface
* Ocean Divergence- oceanic plates move apart, magma rises, cools, and creates new ocean floor

**Ring of Fire**

* Zone in the Pacific with high volcanic / earthquake activity as a result of several plates being subducted

**Hotspots:**

* 5% of volcanoes occur above hotspots
* Hot spots are areas in the mantle with usually high heat flow (reason is unknown, it has something to do with the convection currents).
* The hot spot is in the mantle, so it does not move. The plates on top of the mantle move over the hotspot

**How Hotspots Work:**

* As the usually high heat circulates through the mantle, it begins to melt into magma and decrease in density as it begins to rise. Gases that were once dissolved under pressure begin to bubble, and the bubbles continue to bring the magma to the surface. The resulting eruptions overtime create a landmass as the cooled lava builds up.
* As the plate continues to move, the volcanic island will eventually be cut off from the magma source, and it will no longer be an active volcano. This volcano is extinct. A new volcanic island will form at the lithosphere that is currently over the plate.
* Overtime, a linear series of volcanic islands will form

**EXAMPLE-** Hawaiian Islands

The only Hawaiian Islands that have active volcanoes are those that are currently over the hot spot. They will go extinct as the plate slowly moves on.

**Volcanic Eruptions:**

* Depending on the height of the volcano and the pressure of the explosion, volcanoes can shoot materials into the stratosphere of Earth
* Most common gases released:
	+ Steam
	+ CO2
	+ **Sulfur Dioxide**
		- If sulfur dioxide enters the atmosphere, it interacts with atmospheric gases and forms sulfate ions, which block solar radiation and can **decrease global temperatures**
		- The eruption of **Mt. Pinatubo** released a significant amount of sulfur dioxide into the atmosphere, and results in a 2**°** decrease in global temperatures the following year.

**Earthquakes:**

* Earthquakes happen after there is a **SUDDEN/ABRUPT** movement in the Earth
* Convection currents push plates, but **friction** causes plates to get “stuck”
* Immense buildup of energy is eventually released as the plates “unlock”
	+ This occurs at TRANSFORM and SUBDUCTION (convergent) boundaries

**The severity (how damaging) the earthquake is depends on…**

* The amount of energy that has been stored (how long since last movement?)
* The distance the rocks move in the jolt
* How far below the surface the jolt was
	+ SHALLOW focus earthquakes cause the MOST damage
	+ **Focus=** area in earth where movement occurred
	+ **Epicenter**= on land directly above the focus

Energy is released from the focus in all directions as **seismic waves**

* Body waves travel through the Earth
	+ **P waves**= primary waves- travel fast and reach seismograph first
	+ **S waves**= secondary waves- reach the seismograph second
* **Surface waves** travel along the surface and cause the most damage to infrastructure. They are the last to reach the seismograph.

**Richter Scale**

* Information from the seismograph is used to determine the magnitude (strength) of an earthquake according the Richter scale
* The scale is logarithmic- each number increment is exponentially stronger
* Earthquakes with a magnitude of 7 or higher can cause moderate to severe damage.
* The highest earthquake ever recorded was a 9.5 in Chile

**Tsunamis:**

* Along subduction zones, there is an abrupt **vertical** movement
* The plate that is subducting is also pulling the other plate down, which eventually *snaps back up*
* The plate that snaps up causes a **vertical displacement of water**
* Seismic waves carry the displaced water at incredible speeds, creating a swell upon shore.
* Tsunami waves destroy everything in site

**How to reduce primary/secondary effects of earthquakes:**

* Mapping of fault lines (where are earthquakes likely to happen?)
* Preparing computer models and simulations (how big will the tsunami be and where could it hit?)
* Strengthening building codes (earth quake proof architecture)
* Communication technology (warning systems, alerts, evacuation plans)

**Topic 5: *Latitude, Solar Intensity, and Seasons:***

* Earth **rotates** around an “axis” that is tilted at **23.5°.**  1 rotation = 1 day (24 hours)
* Earth **revolves** around the sun 1 revolution = 1 year (365.25 days)
* Zero degrees latitude is the **equator**, which receives the most direct sunlight
* As latitude increases north or south, the sun hits the earth at a *less direct angle*
* During one quarter of the revolution, the northern hemisphere is tilted towards the sun. The northern hemisphere is in **summer** while they are *tilted towards the sun* (for about 3 months)
* At the same time, the southern hemisphere is *tilted away from the sun*. The southern hemisphere is in **winter** while the northern hemisphere is in summer.
* Hemispheres that are tilted towards the sun receive solar radiation at a stronger angle.