

Exam covers Oceans, The Seafloor, Beaches/Coasts, Plate Tectonics, Volcanoes, Earthquakes.

**\*\*The History of how the theory of plate tectonics came to be:**

Early Theory: Pre continental drift (Alfred Wegener continents stationary, ocean floor is all very old .All continents seem to fit together like a jigsaw

Plate Tectonic theory resulted from post WW2 Era

**Two important Data Sets As a result of WW2 :**

1. Global Mapping - most EQ's occur in distinct zones and many occur on the seafloor. Ocean floor EQ's occur in areas with distinct features
2. Record of Earth Magnetic Field: Paleomagnetism

**The Three types of plate boundaries:**

1. **Divergent** : Ocean - Ocean Divergence MORs **or** Continent - Continent divergence rift zone (rift zones, many volcanoes in the area (Basaltic = Mild Eruptions, Area of Killer Lakes)

2. **Convergent** : Continent - Ocean Collision : Ocean crust subducts underneath continental crust because friction causes partial melting, rising magma creates volcanoes as part of the magmatic arc - *Trenches and volcanic belts*

Continent - Continent Collision: The end result of an entire ocean plate being subducted.

Continental crust **will not follow into the subduction zone**= the two pieces of continental crust will become welded together in a suture zone (old site of subduction) -*Mountain Building Ex.*

*The Himalayas*

Ocean - Ocean Collision: One oceanic plate moves underneath another. Partial melting at depth causes magma to rise and creates island arcs- a string of islands that runs parallel to the trench. Angle of subjecting plate determines distance from islands to trench. -*Trenches and Volcanic Island Arc Ex: The Aleutian Islands, Alaska*

3. **Transform** : Plates move past each other, aren't moving towards or away from each other. Conservative; crust isn't created or destroyed. Commonly connect large divergent/ convergent features; create a zig zag pattern.

**\*\*\*\*Geologic Features you would find at each plate boundary, and why those features exist**

**Divergent Boundaries:** MORs (plates created), shallow EQs, rifting, new oceans form, volcanoes, seafloor spreading

**Convergent Boundaries:** trenches (plate destroyed via subduction), volcanic belts/arcs, subduction zone, deep EQ's, accretionary prism, volcanoes, mt. building

**Transform Boundaries:** MORs, EQs, conservative (not gaining or losing)

Where do you find deep EQ's/ Shallow EQ's?

Mid ocean Ridge (MOR) EQ's occur at shallow depths ( <10km )= *caused by rocks pulling apart*

Trench EQ's occur at shallow -> deep depths ; deepest depths at farther distances from trench= *caused by rocks coming together*

EQ's in linear features, cutting across MOR's occur at shallow depths= *caused by rocks moving past each other*

**Difference between hot spot Volcanoes and volcanoes formed at plate boundaries:**

**-Hot Spots:** a mantle plume that causes volcanism in a stationary location, regardless of plate movement. Hotspot leaves a line of volcanoes on the crust as the plate moves above the hotspot. Volcanoes created by the hotspots can be dated, and rate and direction of plate movement determined. Oceanic Hotspots- Ex: emperor seamount- Hawaiian island chain. Continental Hotspot - Ex: yellowstone

**Volcanoes created at Ocean-Ocean Convergent Boundaries:** Partial melting at depth causes magma to rise and creates island arc.

**Volcanoes created at Continent-Ocean Convergent Boundaries:** Friction caused partial melting and the arising magma creates volcanoes as part of the magmatic arc.

**Sea Floor Spreading:** occurs at MORs as the plates diverge, hot molten rock comes up to the surface to make new crust. Sea floor is expanding but the size of the crust is not because of the subduction zone (crust get sucked back down towards the mantle).

**Viscosity- how it effects lava composition and how explosive of an eruption you get**

**Viscosity:** resistance to flow, Higher viscosity= slow (peanut butter) Lower Viscosity= faster (water)

Low Viscosity: Lava easily releases gases and rarely pyroclastic, higher lava temperature (basaltic) quiet eruptions

High Viscosity: Lava clogs gas and forms vesicles, usually pyroclastic and explosive, higher silica content (more so felsic rocks), higher amount of gas dissolved in magma (andesitic) explosive eruptions

**What determines different properties of Lava:** how much quartz is in it, temperature, gases and viscosity

**Different Volcanic Products:**

Lava: molten rock outside of Earth, primarily of basaltic composition

Gases: water vapor most common gas released, expanding gases propel pyroclastic material high into atmosphere (column rising from volcano), more gas = more pyroclastic material

Pyroclastic Flows: mixture of gas and pyroclastic debris violently expelled from a volcano during an eruption, common in andesitic-type eruptions

Lahars: a mud or debris flow slurry of pyroclastic material, water, and rock

Plateau Basalts: very large stretches of land or ocean floor of basaltic lava resulting from "quiet" eruptions, least violent eruptions (crack in the earth)

Columnar Jointing: series of polygonal columns usually 5 or 6 sided and forms due to the contraction of lava during cooling. Also commonly due to water quenching

Pillow Basalts: extruded basalt on the seafloor that cools into semi spherical pillows. As hot lava contacts cool water it quenches and then extends further again and again. This is common as oceanic hotspots and MORs

**Characteristics of different types of volcanoes:**

1. **Composite Volcano** : (Stratovolcano) alternating layers of pyroclastic and lava flows, andesitic in composition, steepness increased by pyroclast, flattened by lava flows. Lava flows protect loose pyroclast = less erosion. Short eruptions
2. **Cinder Cone Volcano** : Constructed of pyroclastic material ejected from central vent, no lava flows, typically mafic or intermediate pyroclasts, much smaller than shield volcanoes, short life span because the gases burn out and because it has loose pyroclasts = rapid erosion.
3. **Shield Volcano** : broad gently sloping (flat dome/shield), low viscosity lava, frequent daily eruptions, ex: Hawaiian Islands. Activity is predictable = low risk, commonly have (spatter cones - small steep cones surrounding a vent), caused by belching small amounts of gas

**\*\*High quartz= violent eruption (volcanoes, andesitic volcanoes)\*\***

### **Volcanic Eruptions:**

Mt. Tambora- caused the year without a summer

Krakatoa- blew apart an island, lowered global temperatures

Mt. St Helens- composite volcano, explosive history, more quartz

Mt. Vesuvius- buried cities of Pompeii and Herculaneum, two day eruption, happened long time ago

Icelandic Volcano: put a ton of ash in the air and stopped air travel in Europe for five days

### **Tsunami:**

Boxing day: Indian Ocean, 1500X more powerful than a nuclear bomb, did not have tsunami warning systems

Japanese: walls were not high enough and people thought they had moved to high enough grounds, debris is still in the ocean today, effected nuclear power plant

**Earthquakes:** Elastic rebound theory- sudden release of built up energy in the form of strain causing movement . Faulting occurs in the

Haiti-2010: leveled entire island

L'Aquila-2009: deadliest EQ to hit Italy, scientist were convicted of manslaughter

Nepal-2015: triggered an avalanche, caused by the convergence of India to Asia

Strain- object changing shape in response to stress

Stress- force applied to an object

Brittle behavior: rocks break

Ductile behavior: rocks able to deform without losing its strength

### **The different type of seismic waves**

#### **Body Waves**

**P Waves**: primary waves- compressional (slinky) both solid and liquid phases of matter can move via compression, travel through the outer core, s waves do not

**S Waves**: secondary waves- transverse wave (ropey) propagate through solid rocks, do not move through liquids because of shear strength, the zone where no s waves are recorded is called the S-Wave shadow zone