CORNELL NOTES
Directions: You must create a minimum of **5 questions** in this column **per page** (average). Use these to study your notes and prepare for tests and quizzes. Notes will be turned in to your teacher at the end of the Unit for scoring.

UNIT 4: Earth Science
Chapter 12: Earth's Internal Processes (pages 352-387)

I. Evolution of Earth's Crust

A. Continental Drift

1. Early 19th century there was no single theory of how Earth's processes _____.

2. In 1915, Alfred Wegener proposed hypothesis that suggested Earth's continents once were part of **large super-**_____

a. Called it _____

b. Broke apart into pieces _____**million years ago**

c. Pieces _____ over surface of Earth like rafts on water

d. Idea originally met with great resistance (unable to identify _____ necessary)

3. Matching Continents- If use your imagination you can see how pieces "_____ together"

a. Coastline of northwestern Africa fits with eastern _____ _____

b. South America and southern tip of _____ fit nicely together

c. Wegener argued you could match up _____ **types**, _____, **erosion features**, and **mountain ranges**

d. Years later, oceanographers were able to show, using _____, **edges of continental shelves** matched

4. Matching Fossils- used fossils of large land animals that preceded _____

5. Matching **Rocks** and **Mountains**-

a. Wegener showed that **mountain ranges** to be _____ mountain range originally

b. Also showed they shared unique _____ and _____

B. Seafloor Spreading Hypothesis

1. After World War II, Dr. Harry Hess used **sonar** to detect and map the _____

a. Detected that a **mid-ocean ridge system** (**MOR**) was continuous and wrapped around the _____

b. Proposed **hypothesis of seafloor spreading** or _____

c. Proposed that _____ from the Earth's **mantle** is forced upwards because of its low density

d. This caused the _____ to crack (**fault**) and move apart

e. **Faulting** causes two mountain ranges with a down-dropped _____ **valley** between

f. Continuous process allows **new rock** to form as _____ fills in from below

2. Ages of Sediment and Rocks

a. In early 1960's massive programs for **drilling** into the _____ began

b. Discovered that **continental rocks** were billions of years old and **seafloor rocks** less than 200 _____ years old

c. Concluded that rocks of **oceanic crust** increase in age as their location _____ from **MOR**, and at _____ they are new

3. Magnetic Polarity of Rocks

a. Discovered that Earth's _____ **field** repeatedly reverses itself over time

b. Discovered **bands of reversed polarity** in seafloor rocks with polarity of Earth at time they _____

C. Theory of Plate Tectonics

1. Originated in the _____

2. Identified about a dozen **major B**_____ and minor ones

3. Plates composed of a _____ **layer** of uppermost mantle and a layer of either **oceanic** or **continental** _____ above

4. Some only oceanic crust, and some _____ oceanic and continental

5. Three main kinds of **plate** _____

a. **Move** _____

b. **Move** _____

c. _____ **past one another**

6. **Divergent Plate Boundaries**

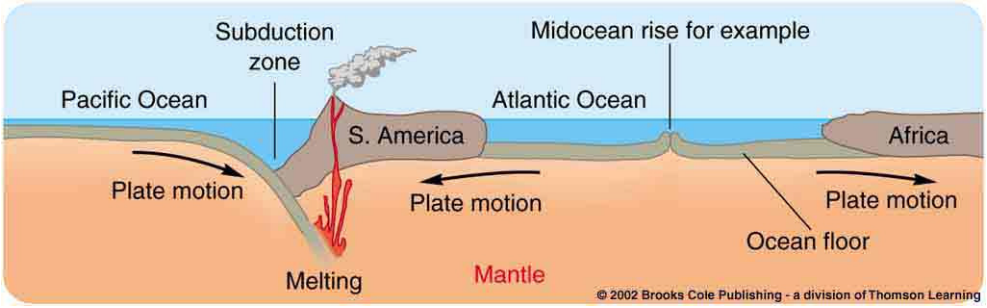
a. Occurs at **MOR** when magma rises along faulted rift valley, _____, **cools** to **form new oceanic crust**

b. Resulted in production of **ocean** _____

7. **Convergent Plate Boundaries**

a. Occurs where **plates** _____

b. _____- **oceanic** slab bends under **continental** slap



c. _____ along subduction zone partially melts rock and produces **magma** which rises towards _____

d. **Magma** feeds _____ **arc** that parallels this zone

e. Region of collision also has a **deep-sea** _____ that parallels the zone

f. **Convergent plate boundaries** also exist between two slabs of **oceanic** _____

1). **Magma** erupted here produces chains of **volcanic** _____ **arcs**

2). As plates converge, _____ builds, which could be released as **tsunami-causing earthquakes**

g. Along some convergent plates, **two slabs** of <u>low density</u> collide and buckle upward forming folded _____

8. **Transform Plate Boundaries**

a. Some boundaries among plates exist as large _____, or **cracks**

b. Mostly _____ **motion** takes place

c. Important when cut <u>perpendicular</u> to **MOR**. They allow movement _____ from ridge crests to occur

D. What drives the plates?

1. Driven by combination of _____

a. _____ **push** at the MOR

b. **Plate** _____ where subducts back into Earth (_____ helps)

c. _____ between a plate and the mantle material below the plate

2. Thermal Energy-**Internal convection of mantle** material is the driving _____ for all mechanisms of plate motion

a. Comes from **decay of** _____ **elements** in Earth

b. Increased temperature due to _____ and _____ **heating**

c. Conversion of secondary **earthquake** waves in outer core another source of _____

II. Earthquakes

A. Global Earthquake Distribution

1. **Earthquakes** are not distributed randomly, but occur in **well-defined** _____

a. Zones coincide with edges of _____

b. **Seismic data** from earthquakes helped to decipher structure of _____ floor

2. Depth of Focus

a. _____ faulting creates **narrow band of numerous, shallow earthquakes**

b. _____ boundaries have **broad zone** of earthquakes

B. Causes of Earthquakes

1. **Earthquake**- any seismic _____ of Earth caused by the rapid release of _____

2. Deformation

a. Earth's crust composed of rigid, _____ material

b. When stress applied to brittle material it shows <u>little sign</u> of strain (_____) until it suddenly <u>breaks</u>

c. _____ can be of <u>4 types</u>

1). _____ **stress**- mass is squeezed or shortened

2). _____ **stress**- mass is stretched or lengthened

3). _____ **stress**- different parts of mass are moved in opposite direction along a plane

4). _____ **stress**- mass is subject to twisting

3. _____ **Deformation**- when material deforms as stress is applied, but snaps back to its original shape when stress removed

4. **Energy Release**- strain energy builds up along cracks in Earth's crust in response to _____

a. _____- crack along which movement has taken place

b. _____ **rebound**- sudden energy release that goes with fault movement. Causes _____

C. Earthquake Waves

1. **Earthquake waves** _____ out in all directions

a. _____- point of origin

b. _____- Point on Earth's surface directly above the focus

2. **Earthquake waves** can be sorted into two major types

a. _____ **Waves**- Travel through Earth

b. _____ **Waves**- travel across Earth's surface

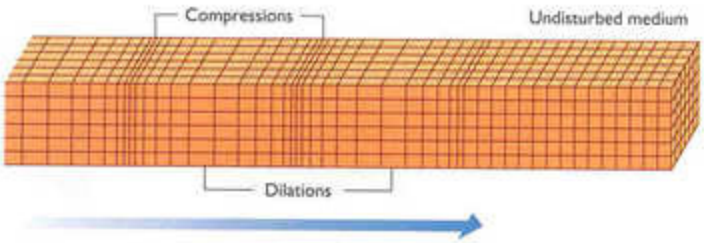
3. **Body Waves**

a. _____ **wave** (P-waves)- push-pull motion

1). Matter bumps into each other and transmits energy like sound wave

2). Travel through all kinds of matter

P wave



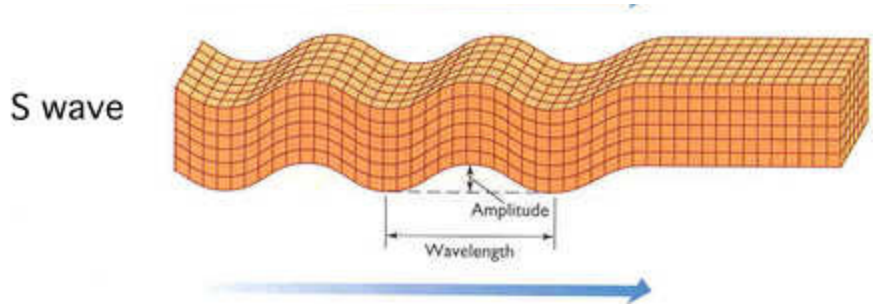
b. **Secondary wave** (S-waves)

1). Travel more slowly

2). Movement of particles **perpendicular** to direction wave

3). Lag time between P-wave and S-waves used to locate **epicenter**

4). Only travels through solids

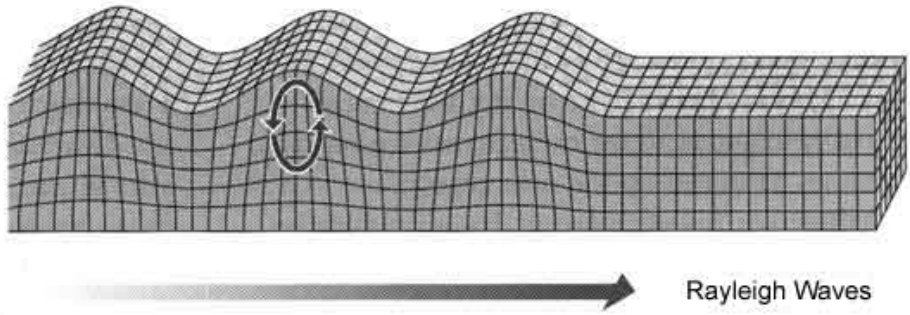


4. Surface Waves

a. Move in more **complex** manner

b. Cause rolling motion like **ocean wave**

c. Exhibit **rolling** motion and **side-to-side** motion



D. Earthquake Measurement

1. _____ measurement schemes have been used

a. **Modified Mercalli intensity scale**- ranks earthquakes in a range from I-XII, XII being the worst. Based _____ observations

b. _____ **Magnitude scale**- uses amplitude of the largest earthquake wave giving measure of _____ release

1). Called _____ **Scale** for short

2). Measurements made with a _____

2. Levels of destruction is extremely variable

a. **Poor** _____ **materials** are largest contributor

b. Some damage is secondary- caused by _____, **fires**, and _____

3. Earthquake proofing- scientists and _____ finding ways to reduce damage

III. Earth's Interiors

A. What's Inside?

1. _____ **waves** have been used to infer images of Earth's interior (like ultrasound to see inside human body)

2. Discovered that Earth is _____ uniform

B. Earthquake Observation

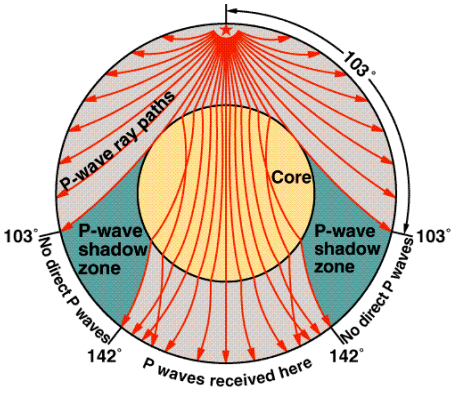
1. Discovered **waves** bend as they encounter sharp changes in _____

a. Boundary that marks density change between layers called _____

b. **Mohorovicic discontinuity** (**Moho**) separates _____ from uppermost mantle

2. _____ **Zones**- a "dead zone" between **105** and **140 degrees** from epicenter as S-waves travels through Earth

a. Scientist think layer of Earth is _____ them



b. Suggest **outer core** is _____ state

c. Used to infer what is in Earth's interior like _____ in human body

3. **Solid Inner Core**- The way P-waves pass through core shows inner core is _____ than outer core and **solid**

a. State of particular material depends on both _____ (weight) of overlying material and _____

b. When **pressure** dominates, in _____ **state**

C. Composition of Earth's Layers

1. Layers become denser with depth

a. _____- crust and uppermost mantle made of rocky material

b. _____- weaker, plastic-like layer upon which lithospheric plates move

c. _____- made of mostly metallic material such as iron and nickel

2. Astronomers hypothesize that early Earth may have formed from meteorite-like material forced together by _____ and _____ to melting

IV. Volcanoes

A. Origin of Magma

1. **Molten rock** has lower _____than solid counterpart

a. **Buoyant force** acts on magma making it _____

b. **Rising magma** may reach _____ if rock has **conduits** through which it can flow

c. Magma reaches _____ as **volcanic eruption**

2. Magma on the Surface- most _____ found near boundaries that separate **tectonic plates**, above **mantle plumes** or **hot spots on continents** or in the **ocean basins**

B. Eruptive Products- Volcanoes expel wide variety of materials

1. Solids- all solids collectively called _____

a. _____ often ejected into atmosphere as globules that cool and solidify as fall to Earth

b. Smallest particles form **volcanic** _____

c. The larger the size of **pyroclastic** particle, the _____ it will fall to the volcano

2. _____- volcanoes release broad variety of superheated gases.

a. Most common is _____ **vapor**

b. **Carbon** _____ and _____ compounds expelled high into **atmosphere**

c. Volcanoes major contributor to _____ **gases** that affect climate long after eruption

3. **Liquids**-Magma may remain as liquid initially and flow across Earth's surface as _____

a. _____- measure of U of a fluid to flow

b. _____ of molten rock material influences its viscosity

c. _____ **content** and **composition** also affect viscosity

d. **Low-viscosity lavas** are generally **basaltic** in composition and tend to _____ easily and form huge volcanic forms

C. Eruptive Styles- Volcanoes can erupt in many different ways depending on _____

1. **High viscosity** (thick, sticky magmas) tend not to erupt, causing internal _____ within a volcano to rise

a. Pressure can cause **violent** _____ eruption

b. Characterized by abundant _____

2. **Low viscosity**- erupt easily and produce quiet eruptions of freely flowing _____

3. **Eruptive style** strongly linked to _____ and **composition** (factors hard to measure until after eruption)

4. Plate Boundary Setting- Most of Earth's volcanoes located along the _____ **of Fire**

a. Rims the _____ **Ocean**

b. Lie in _____ zones

c. Location of large **earthquakes** and **violent** _____ **eruptions**

5. _____ **Spots**- volcanically active sites that arise in places where large quantities of magma move to the surface in large, column-like plumes

a. **Hot Spots** do not move, but _____ move over them

b. Forms **volcanic island chains** like _____

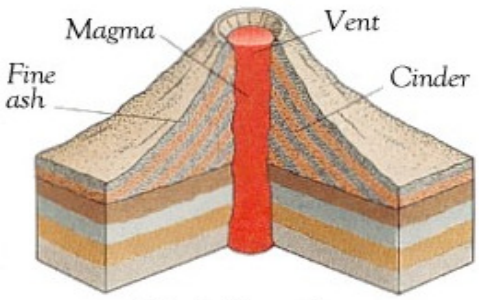
c. **Yellowstone National Park** is example of hot spot over _____ **plate**

D. Types of Volcanoes

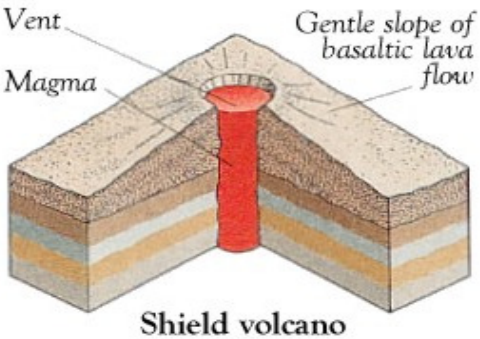
1. **Cinder Cone Volcanoes**-when primary eruptive products are **large fragments** of solid material that pile up near the _____ **hole**

a. Tend to be _____

b. Most range in _____ of meters



Ash-cinder volcano



Shield volcano

2. _____ **Volcanoes**- Form from **high-temperature**, **fluid**, **basaltic lava**

a. Abundant **lava flows** that can move _____ over Earth's surface

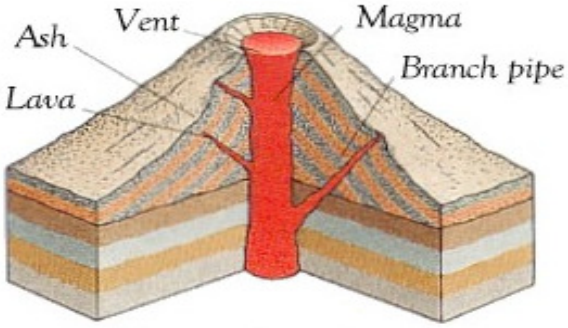
b. **Broad**, **flat** structures made up of layer upon layer of _____

c. _____ volcanoes are examples

3. _____ **Volcanoes**- occur along **convergent** plate boundaries

a. Produce volcanoes formed from alternating _____ events that produce **pyroclastic** materials, and **lava flows**

b. Often _____ (hundreds of meters high and tens of kilometers across at base)



Composite volcano