Study Guide Questions – Earth Structure and Plate Tectonics

What evidence did Alfred Wegener present in 1912 to support the idea of "continental drift"?

Why did most geologists at the time dismiss Wegener's ideas?

What mechanism did Wegener propose to move the continents?

What was the contemporary understanding of the structural relationship between the continents and the Earth's interior?

At the most fundamental level, *WHY* is the interior of the Earth layered?

What events in the early evolution of the planet produced the primary layers?

Density is mass per unit volume. In the metric system: grams (mass) per cubic centimeter (volume).

How can we calculate the average density of the Earth?

This question becomes two separate questions:

How to calculate the **volume** of the Earth? (relatively easy)

How to calculate the **mass** of the Earth? (much harder – think *gravity*)

How can we infer what is inside the Earth?

<u>Important Concepts</u>

Seismic waves

What produces enough energy to travel through the body of the planet?

P and S waves

How do they differ? What media can each move through?

What path does a seismic wave take moving through the planet?

Spherical expansion of the wave front

Ray path – a line perpendicular to the wave front that traces the movement of the wave

Reflection – off boundaries between layers

Refraction – wave bends toward slower material

Relationship between:

Temperature and density of the medium

Pressure and density of the medium

Phase of the medium [idea of partially molten rock]

Velocity of seismic waves and density of the rock [as related to all of the above]

<u>What's inside the Earth?</u>

How can we infer that there ARE different layers inside the Earth?

How can we infer changes of composition?

How can we infer phase changes?

Two different types of seismic shadow zones:

P-wave shadow – because of refraction

S-wave shadow – can't move through liquid

What was the original classification of the layers of the Earth's interior?

[Based on seismic velocities and inferred density and composition]

What are representative densities of the crust, mantle, and core?

[Given in the textbook]

Moving Toward a Unified Theory of Plate Tectonics

<u>Key Pieces of New Information: 1930s – 1950s</u>

Improved seismographs and an expanded seismograph network revealed structures and processes of the Earth's interior

What important, fundamental, insight did Kiyoo Wadati and Hugo Benioff have about deep earthquakes around the rim of the Pacific Basin?

Remote sensing of the seafloor – from ships – revealed seafloor features, such as seamounts and the mid-ocean ridge, and the thickness of sediments and structure of bedrock *below* the seafloor

Broader application of radiometric dating revealed some really old (billions of years) pieces of continents, but the ocean basins were no older than about 200 million years

The expanding field of paleomagnetics showed that the continents had moved independently of each other through time. And paleomagnetics would soon yield critical evidence for seafloor spreading

Although the idea of mantle convection was proposed in 1916, solid supporting evidence of the process was not produced until the late 1940s and early 1950s. This mechanism provided a force powerful enough to move continents

<u>The Pieces Fall into Place: Late 1950s and early 1960s</u>

Important processes:

Creation of new crust – demonstrated to occur at mid-ocean ridges

Destruction (recycling) of old [oceanic] crust – subduction shown to occur at trench systems

Power to move continents and plates – move evidence for processes of mantle convection

What is the geometry of earthquake foci at a trench?

The Wadati-Benioff zone

In an east-west transect across the North Atlantic Ocean, where is the sediment that covers the basaltic bedrock the thickest? Where is it thinnest?

If the background rate of sediment deposition is approximately uniform across the ocean basin, what do these thick and thin areas of sediment suggest about the relative age of the seafloor?

Distinguish between these related, but specifically different, concepts:

Continental drift

Seafloor spreading

Plate tectonics

On the scale of the planet, what drives plate tectonics?

What forces on the actual plate drive plate movement?

Structure and Composition – And How These Relate to Processes

What are the two basic types of crust? Which is thicker? Which is denser? Which is older (generally)?

Why can lithospheric plates float on the asthenosphere?

Lithosphere

Can a lithospheric plate contain more than one type of crust?

How can that happen without the plate breaking apart?

What is the fundamental difference between *crust* and *lithosphere*?

Compare the thickness of lithosphere beneath a continent and beneath an ocean.

Where, specifically, is the thinnest lithosphere?

Where, specifically, is the thickest (or deepest) lithosphere?

Asthenosphere

What is the single most important physical property of the asthenosphere? [as it allows for the movement of lithospheric plates]

What are the relative densities of the lithosphere and asthenosphere? Does it matter whether oceanic lithosphere is young or old? How about continental lithosphere?

What three things can the asthenosphere "do" that are important for plate movement? [that is, when force is applied or other physical changes occur, how does the asthenosphere respond?]

{ these answers are not explicitly stated in the textbook, so I'll give them to you }

(1) Flows when unequal pressure is applied [because it is partially molten]

(2) Provides a "slippery" surface for the lithospheric plates to move across

(3) Can produce melt (magma) by a reduction in pressure (at a MOR) or injection of volatiles (at a trench)

*** IMPORTANT ***

Your textbook provides a concise summary of plate tectonics { which you should read and understand }

Page 76 in the 7th Edition

Paragraph starts with:

" In 1965, the ideas of continental drift and seafloor spreading were integrated into the overriding concept of **plate tectonics** (tekton, "builder") …

What is Archimedes Principle? { if you don't know, look it up }

How does it apply to a boat? To an iceberg?

To a piece of double-thick continental crust associated with a mountain range?

What happens when 1 km of the surface of the mountain range is eroded and removed?

Plate Boundaries

Are earthquakes randomly distributed across the Earth surface?

Could you locate all the major plate boundaries on a map that shows only earthquake epicenters?

What is the geometry and depth of earthquakes at a mid-ocean ridge? At a submarine trench?

Sketch a single plate on the surface of a sphere.

Move the plate in one direction.

What are the three fundamental types of plate boundaries that result?

Convergent Plate Boundaries

The two types of crust – oceanic and continental – can interact in three convergent combinations:

Oceanic – Oceanic

Oceanic – Continental

Continental – Continental

What features on the Earth surface represent each of these types of convergent boundary?

Which piece of lithosphere will be subducted in each case?

Analogies – What is the important point?

A thick block of pine and a thin block of oak floating on water

Two Styrofoam kickboards

A towel on the slope of a lectern

A towel moving off the edge of a table

The Wilson Cycle – What Plate Tectonics Theory Explains About the History of Ocean Basins

In the mid 1960s, Tuzo Wilson applied the developing concepts of plate tectonics in a synthesis of how ocean basins formed, evolved, and closed. This is summarized toward the end of Chapter 3.

Review, and understand, Figure 3.37, which shows the stages in evolution of an ocean basin.

Apply these processes to the breakup of Pangaea, which began about 250 million years ago, to produce the present configuration of ocean basins and continents.

Relate each step of ocean evolution to a modern feature on the Earth.

What will the Pacific Ocean look like about 100 million years in the future if the continents continue moving in the directions they are today?