

## Test Two Study Guide

### **Earthquakes**

#### **Earthquake hazards**

- Effect of Ground Shaking: Buildings can be damaged, Subsidence may occur (ground is at different level than before earthquake), *Liquefaction*-the mixing of sand, soil, and groundwater could cause buildings to sink into the ground, buildings may be damaged by surface waves making the ground heave and lurch
- Ground Displacement: ground movement along a fault could rip apart a structure that is built across a fault
- Flooding: an earthquake can break dams or levees along rivers; thus, flooding the area and sweeping away/drowning people, Tsunamis and seiches (small tsunamis) can also cause a lot of similar damage
- Fire: Fires can be caused by broken gas lines and power lines, or tipped over wood or coal stoves, if the water lines are also broken this could cause serious problem. Ex. Great San Francisco Earthquake 1906

#### **Earthquake Prediction**

- Decrease of crustal seismic velocities in an area days to months prior
- Swelling in the local volume of crustal rocks producing a bulging or doming of the area
- Ground tilting associated with the above
- Increased emission of radon from the crust
- Changes in the water level in wells and in the activity of geysers (where they are present)
- Anomalous electrical and radio frequency signals
- Unusual behavior of certain types of animals

#### **Magnitude**

The *magnitude* of an earthquake refers to the amount of energy released. It is commonly referred to a numerical scale 2 to 10. The difference between whole numbers is approximately a factor of 30X.

The tectonic plates are in lithosphere contently moving rigid rock. The sudden release of pressure at its boundary only causing to create earthquake

A *seismograph* records earthquake waves. When an earthquake occurs, three types of waves are generated. The first two, the P and S waves, are propagated within the Earth, while the third, consisting of Love and Rayleigh waves, is propagated along the planet's surface. The P wave travels about 3.5 miles (5.6 kilometers) per second and is the first wave to reach the surface. The S wave travels at a velocity of a little more than half of the P waves. If the velocities of the different modes of wave propagation are known, the distance between the earthquake and an observation station may be deduced by measuring the time interval between the arrival of the faster and slower waves.

Some seismic waves travel trough the Earth's interior. These are body waves. There are two forms of body waves. These are referred to as P waves and S waves. P stands for Primary: this is the first wave recorded by seismographs, since it travels

faster than the S or Secondary waves.

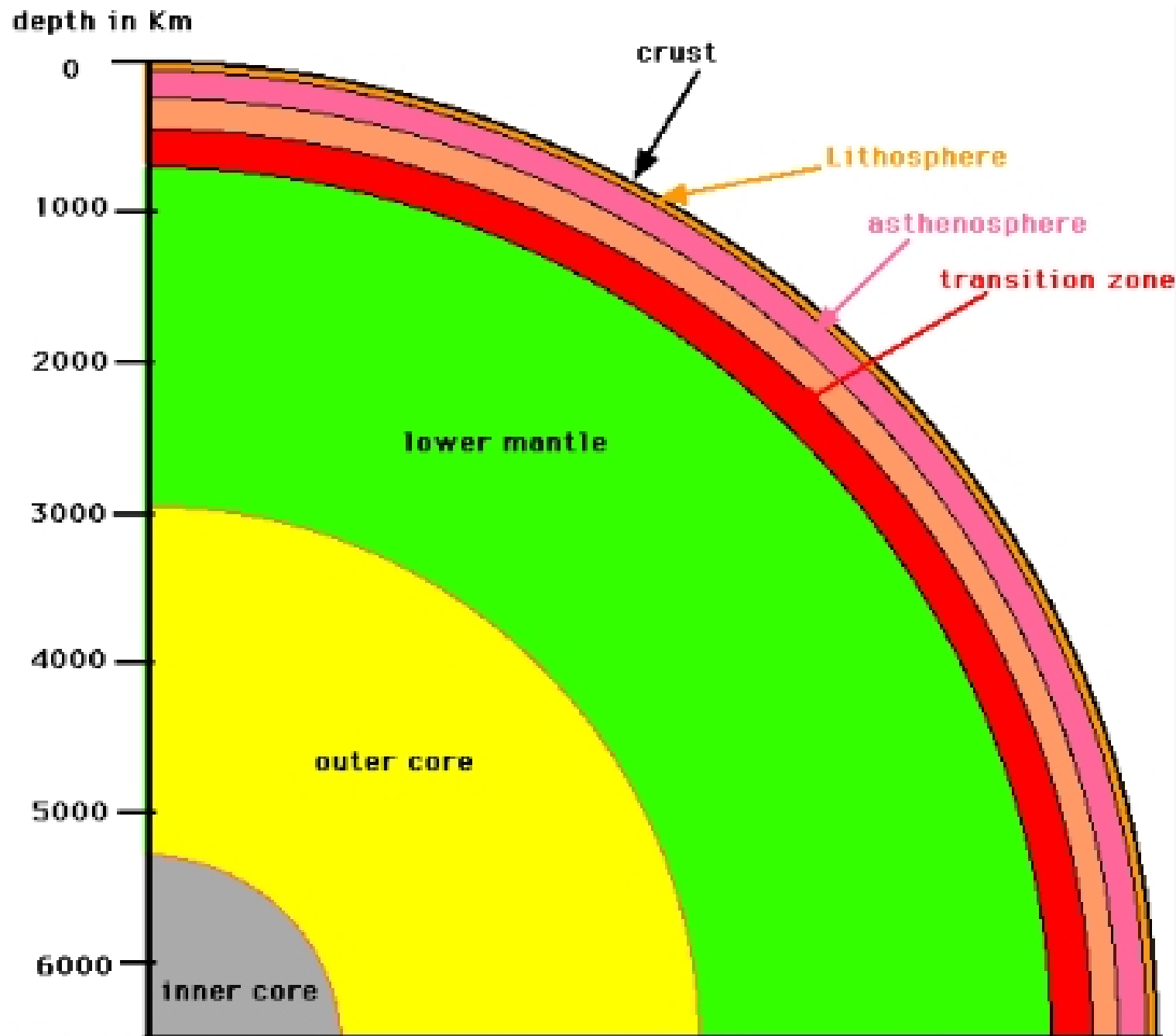
*P waves* (also known as longitudinal waves):

- Are compression waves
- Vibrate in the same direction they travel
- Velocity of P waves depends on the elastic moduli and density of the transmitting medium

*S waves* (also known as transverse waves):

- Shear waves
- Vibrate in a direction transverse or perpendicular to the direction of travel
- Velocity of S waves depends on the shear modulus and the density of the transmitting medium

## Earth's Interior



Crust - in the figure above, the outermost black line represents the crust of the Earth. The base of the crust is recognized by a sharp increase in the velocity of seismic waves. This is the Mohorovicic discontinuity (or M-discontinuity); it separates the crust from the mantle. In the ocean basins, crust is thinner, averaging

5-7 km thick. On continents, the M-discontinuity occurs at a depth of 25-30 km on average, and even deeper beneath mountain belts. The maximum thickness of continental crust, nearly 70 km, is reached in the Tibet Plateau of the Himalayan Mountains.

Oceanic crust - In a generalized fashion, oceanic crust can be described as consisting of three layers

- At the top is a thin layer of oceanic sediments. These are primarily very fine clays and siliceous materials secreted by microscopic organisms
- The second layer is made of basalts, characteristically pillow basalts
- The third layer is largely gabbro

Continental crust - Continental crust is far more heterogeneous than is that of the ocean basins. Compositionally the continental crust is more felsic (perhaps chemically like a diorite). It is also less dense than the mafic oceanic crust (which is why the continental crust stands high on the surface of the Earth, while oceanic crust is lower).

Mantle- Between the M-discontinuity and the very strong 2900 km discontinuity (see the velocity vs depth graph above), is the Earth's mantle. The upper mantle extends from the base of the crust to a depth of approximately 450 km. Between 450 km and about 700 km is the transition zone, and from 700 km to the 2900 discontinuity, lays the lower mantle.

Upper Mantle - samples of the upper mantle are occasionally brought to the surface of the Earth as rock fragments carried by erupting magmas. These are predominantly pieces of peridotite, a rock composed primarily of Mg-rich olivines and pyroxenes. The occurrence of diamonds in kimberlites indicates that they came from depths greater than 200 km. The major rock type of kimberlites is peridotite. Magmas erupting in the ocean basins, such as along the oceanic ridges are basaltic in composition. Even taking a geothermal gradient as high as 40 degrees C/km and an extreme crustal thickness of 10 km, it becomes obvious that temperatures high enough to produce basaltic magmas cannot be reached in the crust. Thus the magmas erupting in the ocean basins must come from the mantle. Laboratory experiments have shown that liquids of basaltic compositions can be produced by partially melting peridotite.

Within the upper mantle, between 100 and 200 (there is some variation in these exact depths, from place to place) is a zone where seismic velocities are actually lower than they are at slightly shallower depths. From the decrease in the S-wave velocities in this region, it can be inferred that the peridotite has lost some of its rigidity, that it is more ductile, and likely close to its melting point (perhaps a small fraction has melted - but the bulk of it is still solid). This region is referred to as the asthenosphere. That more brittle part of the upper mantle above the asthenosphere along with the crust is the lithosphere. The boundary between the lithosphere and