

Optional GEOL 103 Writing Assignment KEY: Earth Interior

1) Seismologists refer to a rock's "velocity." What does this mean? How do differing velocities allow seismologists to study the Earth's interior? (See Fig. 21.5) What kinds of boundaries does the air-water interface in Fig. 21.1 correspond to within the Earth?

**A rock's velocity refers to the velocity that energy waves from earthquakes or explosions pass through it; this property depends largely on density. When adjacent rocks have different velocities, an energy interface exists between the rocks. Energy waves can be either reflected or refracted (similarly to Fig 21.1, where instead of rocks having different velocity, the air and water have different velocities) at particular angles at such an interface, allowing us to use seismic methods to indirectly sample these changes in rock type. Changes in velocities with depth also tell us about density and compositional changes in rocks with depth.**

2) What does the P-wave shadow zone tell us about the Earth's core, and why? What does the S-wave shadow zone tell us about the Earth's core, and why? (See Fig. 21.2)

**The P-wave shadow zone develops because the core-mantle boundary is an interface that causes refraction, resulting in a shadow zone causing a subset of P-waves that originate at one point near the Earth's surface to refract. P-waves can also refract at the inner/outer core boundary. This in turn causes P-waves not to reach the surface over a range of angles.**

**The S-wave shadow zone develops because S-waves cannot travel through the liquid outer core, thus S-waves from one point near the Earth's surface cannot be observed over an even broader range of angles than P-waves.**

3) What is isostasy, and what does it have to do with the fact that continental crust is usually thicker than oceanic crust? Why can continental mountains stick up so high into the air?

**Isostasy is the concept that lower density crustal rocks "float" upon the mantle. When the crustal load is high (due to rocks or to glacial ice), the mantle is depressed, but it can "spring back" slowly as the load is removed by erosion or ice melting. The continental crust is thus thicker than oceanic crust because of its lower density. Mountains can have deep roots, and can also stick up into the air due to this phenomenon.**

4) What happens to continents as they are stripped of sediment due to erosion or as glacial ice is melted from them? **As mountains weather, the crustal load is lightened, causing uplift due to isostatic rebound. The uplift causes further erosion. This rebound and erosion is one reason that the igneous and metamorphic roots of old continents can be found near the Earth's surface: much of the relatively flat interior of Canada is composed of the very weathered igneous and metamorphic remnants of very old mountain ranges. Removal of large continental glaciers also caused isostatic rebound.**

5) In Figure 21.5, there is a change in P- and S-wave velocity between the lithosphere and the asthenosphere, but there's no change in density. Why, and how does this relate to plate tectonics? There is a change in P- and S-wave velocity and density at the base of the asthenosphere. What does this tell us about the nature of the rocks above and below this boundary? **The decrease in P- and S-wave velocity at about 100 km with no density change marks the lithosphere and the asthenosphere boundary; this behavior is part of our evidence that this boundary is between rocks of the same chemical composition, but the "slower" rocks in the asthenosphere are more plastic than the lithospheric rocks.**

**Velocity AND density change at the base of the asthenosphere at about 400 km. This is interpreted to mean that the atoms in minerals become closer packed, and there is no partial melting, so the rocks are no longer plastic. Another transition to even closer packing occurs at about 650 km.**

6) What does Figure 21.10 tell us about the nature of the mantle? Is the mantle nearly homogeneous, or are there significant variations in the physical properties (heat, density) within the mantle? **The seismic tomography data suggest that the mantle is quite heterogeneous; its heat is not evenly distributed, and the density of the rocks varies a good bit (but not as much as, e.g., the difference between continental crust and oceanic crust).**