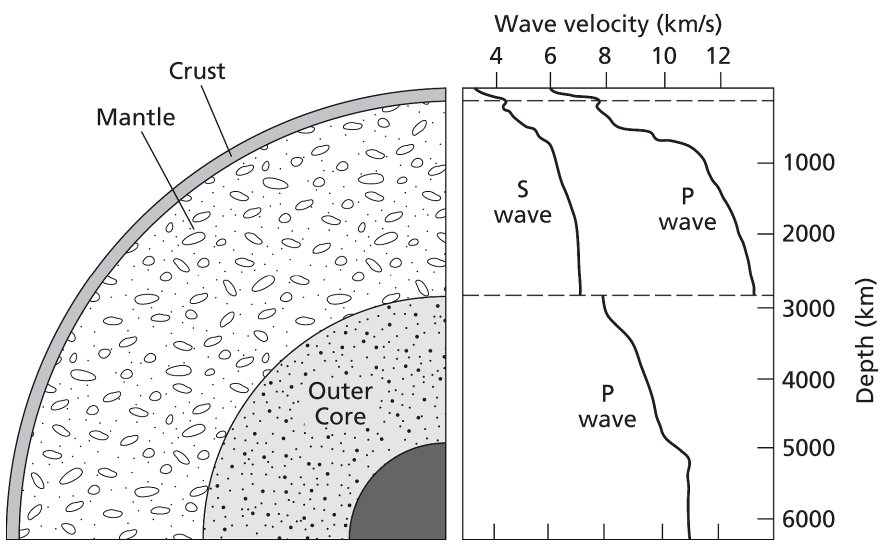
Date ______________ Period ______________ Name Mr. Sudbury - Key

CHAPTER 14 ENRICHMENT

EARTHQUAKE WAVE VELOCITIES

Earthquakes produce both longitudinal waves, known as P waves, and transverse waves, known as S waves. Geologists have used properties of these waves to predict the composition of Earth's interior. They think that Earth consists of three main zones: the crust, the mantle, and the core. They think the core consists of a liquid outer core and a solid inner core.

P waves and S waves travel through various rock materials at different velocities. S waves cannot pass through molten (liquid) rock. If Earth's composition were that of a uniform solid, the velocities of P and S waves would increase steadily with depth, because increasing pressure beneath the surface increases the elastic properties of the rock, which in turn increases wave velocities. However, the interior rock composition is not uniform; it changes with depth, so earthquake wave velocity does not increase smoothly, as shown in the graph below.



1. How fast do P waves move in the crust?

   Approx 6 - 7 km/s. which is 6,000 - 7,000 m/s

2. How fast do S waves move in the crust?

   Approx 3 - 4 km/s. which is 3,000 - 4,000 m/s

3. What happens to S waves approximately 2900 km below Earth's surface? Why?

   S-waves do not travel deeper than 2,900 km below the surface because S waves can only travel through solid rock (the crust). The outer core of the earth is composed of molten rock, and thus S-waves are prevented from traveling in or through the outer core. This is shown on the graph because the S-wave only travels through the crust and mantle and stops at the depth of the outer core.

4. Using only data on P waves, how could you determine the depth of the boundary between the mantle and the outer core?

P-waves move significantly more slowly in molten rock than through solid rock. The graph shows a distinct decrease in P-wave speed (velocity) approx. 2900 km below the surface where P-waves slow by about 6 km/s. This sharp decrease in speed indicates a sudden transition from solid rock to molten rock.

5. How does P-wave speed indicate that the inner core is composed of solid rock?

Approx. 5000 km below the surface, there is a sharp increase in the speed of P-waves, which indicated a compositional transition to a medium through which P-waves move faster. P-waves move faster in solid rock, and thus it is thought the inner core is solid.

6. S waves can travel through solid rock, and the inner core is solid. Why then are no S waves found in the inner core?

In order to reach the inner core, S-waves would have to travel through the outer core, which is composed of molten rock. S-waves cannot travel through molten rock and this cannot reach the inner core.

7. Which is likely to be a more distinct transition—from the mantle to the outer core or from the outer core to the inner core? Why?

The transition from the mantle to the outer core is probably more distinct than the transition from the outer core to the inner core. This is because there is a large and distinct break in the P-wave velocities at the boundary between the mantle and the outer core. There is no break in P-wave velocities at the boundary between the outer and inner core, only a steep increase in wave velocity.

EARTHQUAKE WAVE VELOCITIES

All numerical answers have been rounded to the correct number of significant figures.

1. approximately 6 to 7 km/s
2. 3 to 4 km/s
3. S waves do not travel deeper than 2900 km below the surface because S waves can only travel through solid rock. The outer core is composed of molten rock, and thus S waves are prevented from traveling into the outer core.
4. P waves move significantly more slowly in molten rock than in solid rock. The graph shows a distinct decrease in P-wave speed approximately 2900 feet below the surface where P-waves slow by about 6 km/s. This sharp decrease in speed indicates a sudden transition from solid rock to molten rock.
5. Approximately 5000 km below the surface, there is a sharp increase in the speed of P waves, which indicates a compositional transition to a medium through which P waves move faster. P waves move faster in solid rock, and thus it is thought that the inner core is solid.
6. In order to reach the inner core, S waves would have to travel through the outer core, which is composed of molten rock. S waves can not travel through molten rock, and thus they cannot reach the inner core.
7. The transition from the mantle to the outer core is probably more distinct than the transition from the outer core to the inner core. This is because there is a large and distinct break in P-wave velocities at the boundary between the mantle and the outer core. There is no break in P-wave velocities at the boundary between the outer and inner core, only a steep increase in wave velocity.