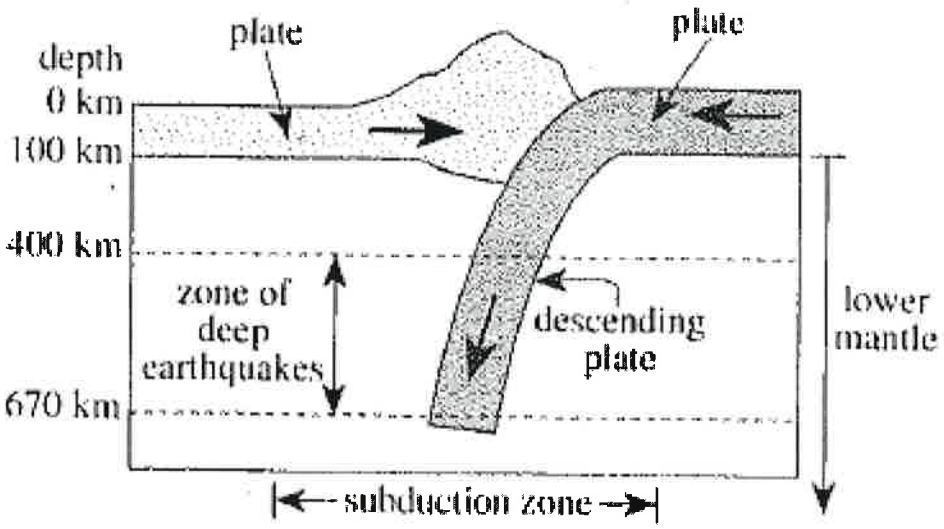
# Titan Learning Center
# Science ACT Prep
# Week 5

Earthquakes occur when rocks under stress suddenly fracture and fault, releasing seismic energy from the *focus* (the location of the rocks' initial fracture). In *subduction zones* (see figure below), where 2 plates (composed of crust and upper mantle) collide and the edge of 1 plate is forced down into the lower mantle below, some earthquake foci are located at depths of 400 km to 670 km (*deep earthquakes).*




Scientists have wondered what causes deep earthquakes. Below 400 km depth, rocks are under high pressure and at temperatures greater than 1,500 ° C, so they should bend in response to stress rather than break, as they do above 400 km depth. Two scientists discuss possible causes of deep earthquakes.

*Scientist 1*
Common minerals in plate rocks, such as *serpentine,* contain water. As the edge of the plate descends into the lower mantle and is heated, these minerals dehydrate. This makes the rocks brittle and easier to fracture. The released water also helps lubricate existing fractures, allowing them to move. Dehydration usually occurs at depths shallower than 400 km. Howerver, when the edge of a plate is force down into the lower mantle, it may descend so rapidly that it remains much cooler than the surrounding mantle. In that descending plate, minerals retain water in their crystal structure to much greater depths. When they are heated to a point where they dehydrate, somewhere between 400 km and 670 km depth, the rocks become brittle and fracture, releasing seismic energy.

*Scientist 2*
Another common mineral in plate rocks, called *olivine,* changes to a denser mineral called *spinel* when subjected to the high temperatures in the lower mantle. This process usually occurs at mantle depths shallower than 400 km. However, when the edge of a plate is forced down into the lower mantle, it may descend so rapidly that it remains much cooler than the surrounding mantle. This allows olivine to exist well below the depths where it is normally found. At some depth below 400 km, the plate reaches a temperature that allows olivine in the rocks to suddenly change to spinel. This changes causes a rapid compaction and fracturing of the rocks, releasing seismic energy.

**1.** Which of the following pairs of statements best explains the cause of the rock fracturing responsible for deep earthquakes according to the viewpoints of the 2 scientists.

| | Scientist 1 | Scientist 2 |
|---|---|---|
| 1. | | |
| **A.** | Change of olivine to spinel | Dehydration of serpentine |
| **B.** | Change of serpentine to spinel | Dehydration of olivine |
| **C.** | Dehydration of serpentine | Change of olivine to spinel |
| **D.** | Dehydration of olivine | Change of serpentine to spinel |

**2.** According to the information provided, the *maximum* depth reached by descending plates in subduction zones is closest to which of the following?

**F.** 100 km
**G.** 250 km
**H.** 400 km
**J.** 670 km

**3.** Which of the following statements about serpentine is most consistent with the information in Scientist 1's viewpoint?

**A.** Serpentine is only 1 of the minerals in plate rocks that contain water.
**B.** Serpentine is the only mineral in plate rocks that contains water.
**C.** Serpentine can change its crystal structure to a denser, more compact form.
**D.** Serpentine is found only in the lower mantle.

**4.** Which of the following hypotheses about minerals would be most consistent with both of the scientists' viewpoints? Under temperatures and pressures similar to those in Earth's lower mantle:

**F.** olivine dehydrates to form spinel.
**G.** spinel dehydrates to form olivine.
**H.** spinel dehydrates to form serpentine.
**J.** olivine dehydrates to form serpentine.

**5.** According to the information provided, which of the following is the most direct cause of the rock fractures that cause earthquakes?

**A.** Movement of rocks in Earth's core
**B.** Stress on rocks
**C.** Cooling of rocks
**D.** Radioactive decay of elements in Earth's mantle

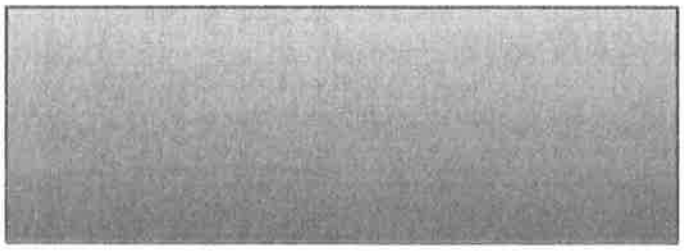
**6.** If it were discovered that plates, as they descend, instantly rise to the same temperature as the surrounding mantle, how would this discovery affect the viewpoints, if at all?

**F.** It would only strengthen the viewpoint of Scientist 1 only.
**G.** It would weaken the viewpoint of Scientist 2 only.
**H.** It would strengthen the viewpoints of both scientists.
**J.** It would weaken the viewpoints of both scientists.

**7.** In a lab, the masses of 2 mineral samples, one of olivine and one of spinel, of the same size and shape were determined. Which of the following statements about the samples is most consistent with the information in Scientist 2's viewpoint? The mass of the olivine sample would be:

**A.** greater than the mass of the spinel sample because spinel is more dense than olivine.
**B.** less than the mass of the spinel sample because spinel is more dense than olivine
**C.** greater than the mass of the spinel sample because olivine is more dense than spinel.
**D.** Less than the mass of the spinel sample because olivine is more dense than spinel.

TLC Stamp



Be sure to fill out your name on a raffle ticket.