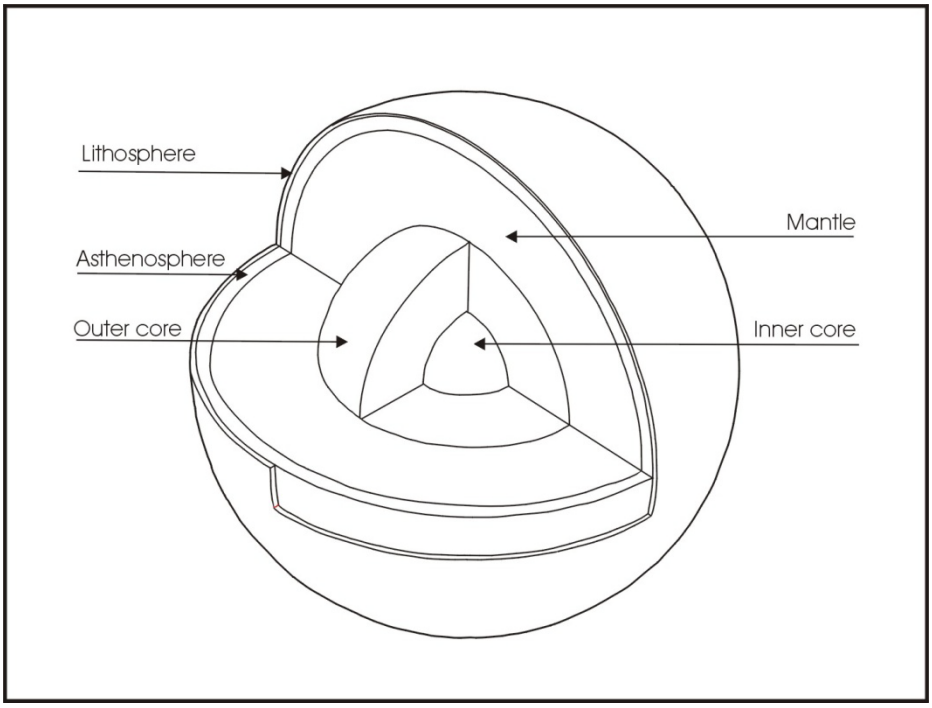
Answer Key

Answers to Study Questions

1. The four components that constitute the Earth system:
   a. atmosphere: the gaseous envelope surrounding the Earth.
   b. hydrosphere: the water on or close to the surface of the Earth.
   c. biosphere: the organic components.
   d. geosphere: the inorganic components that include rock and other materials.

2. In physical geology we concentrate on the geosphere. Nonetheless, we will also examine how the other components (or spheres) interact with the geosphere to explain processes that occur on and inside Earth.

3. The inner core is solid; the outer core is liquid; the mantle and the asthenosphere are both solid and plastic; and the lithosphere is solid and rigid.



4. The two types of crust are oceanic crust and continental crust. Oceanic crust is denser and thinner than continental crust.

5. a. lithosphere: the relatively rigid crust and the uppermost part of the mantle

   b. asthenosphere: the part of the upper mantle that behaves plastically; the asthenosphere underlies the solid lithosphere

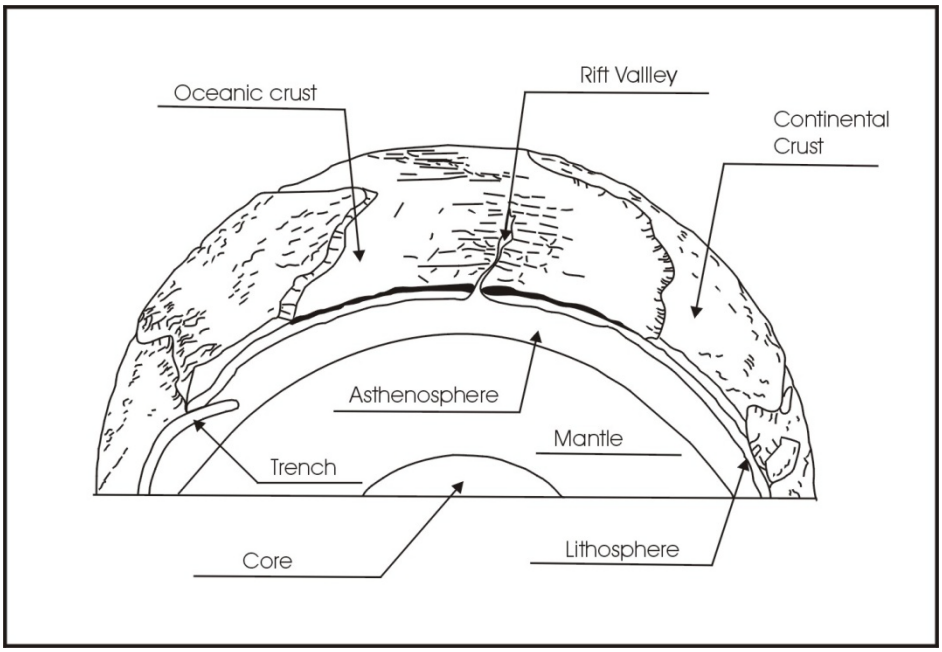
   c. atmosphere: the gaseous component of the Earth's surface fluids—air

   d. hydrosphere: the water component of the Earth's surface fluids

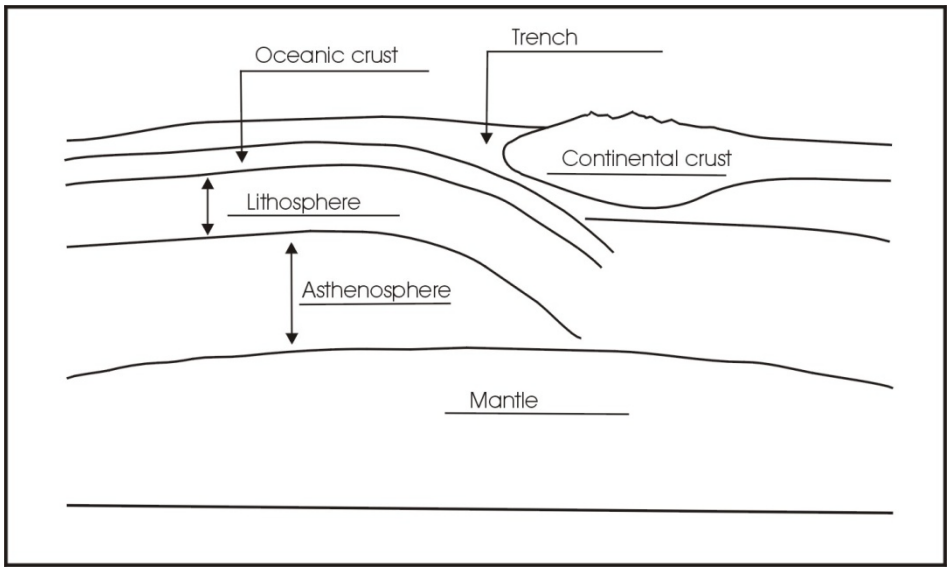
6. The three major types of plate boundaries are

   - divergent: the plates are separating.
   - convergent: plates are moving together.
   - transform: plates are sliding past one another.

7.



8. The figure below illustrates a subduction boundary. Volcanoes would be found on the thickened portion of the continental crust, which lies directly above the sinking segment of the oceanic crust.



9. Compare your diagram to Figure 1.9 in the textbook.

10. The two processes by which water returns to the atmosphere are evaporation and transpiration. The two mechanisms by which water precipitated on land can return to the sea are by surface runoff in streams and by percolation of groundwater. Compare the diagram you have drawn to Figure 10.1 in the textbook.

11. Three surficial processes by which rock that was originally elevated by Earth internal processes wears down are flowing streams, waves, and glaciers. Other processes include landslides and wind erosion.

12. A mineral that formed deep below the Earth's surface is not at equilibrium at the low pressure and temperature conditions at the Earth's surface. The mineral is unstable at the Earth's surface and will have the tendency to break down to form other, more stable, minerals.

13. *Weathering* is the "in place" disintegration and decomposition of unstable material at the Earth's surface; *erosion* is the loosening and removal of material.

14. A *cemented* rock has a material (cement) that has been *added* between the grains to bind them together. A *lithified* rock is any rock in which the grains do not easily separate. A rock may be lithified by cementation, compaction, or recrystallization.

15. a. The Earth is estimated to be about 4500 million (4.5 billion) years old.

    b. The first dinosaurs are thought to have come into existence about 230 million years ago, and dinosaurs are thought to have become extinct about 65 million years ago.

    c. The first humans are thought to have appeared about three million years ago.

16. The last century represents about 0.0000022% of estimated geologic time.

17. The principle of uniformitarianism is that the geological processes operating now are the same as those that operated in the past; that is, the present is key to the past. An example of this principle is illustrated by rocks found at the summit of the Canadian Rocky Mountains. We can see that some of the rocks are sedimentary units that contain marine fossils. If the present is the key to the past, we should be able to conclude that these rocks were formed below sea level just as rocks form today through the deposition of sediments in a marine basin. The current elevation of the rocks must be a product of tectonic forces similar to those that operate today at convergent plate boundaries. Thus, by observing and understanding processes that are in operation today, we are able to explain phenomena that operated in the past.

18. Compare your answer to Table 1.2 in the textbook.