Answer Key

Answers to Study Questions

1. *Stress* is a force that acts on a body and tends to change its size or shape. *Strain* is the change of the body in size or shape, in response to stress.

2. Stress diagrams:

   compressive stress → ←

   tensional stress ← →

   shear stress →
   ←

3. Types of strain and deformation:

   - *plastic strain*—a body is molded or bent under stress and does not return to its original shape.
   - *elastic strain*—a deformed body recovers its original shape after the stress is released.
   - *fracturing*—a body under stress cracks or breaks.

4. Whereas a ductile rock folds, brittle rock fractures.

5. Sedimentary rocks deform plastically in two ways. If stress is applied very slowly, rock near the surface may deform plastically, and a rock that is a deformed under considerable confining pressure may deform plastically.

6. A *fault* is a fracture in bedrock along which movement has taken place.

7. At Hollister, California, the San Andreas Fault is moving at a rate of about one centimetre per year.

8. The principle of original horizontality states that layers of sedimentary rock began as horizontal beds or strata.

9. A geologic map often allows for clearer understanding of an area than does a fly-over, because soil and vegetation often conceal most of the bedrock from view. Maps combine information derived from observations from a number of individual outcrops, and inferences

about regional structure can be made by examining the patterns of these data.

10. *Strike* is the compass direction of a line formed by the intersection of an inclined plane with a horizontal plane. The *dip* of a bedding plane has a direction perpendicular to the strike and an *angle* that is measured downward from the horizontal plane to the bedding plane.

11. No. A horizontal bedding plane has neither strike nor dip.

12. A geologic cross section is a vertical representation of a portion of the Earth.

13. Compare your diagram to Figures 15.11 and 15.12 in the textbook. In map view, the oldest rocks are along the hinge line of axis of the anticline.

14. A plunging fold is a fold in which the hinge lines are not horizontal. Compare your diagram to Figure 15.13 in the textbook.

15. The oldest rocks are exposed at the centre of a structural dome.

16. Isoclinal folds are produced by more intense compressive forces than are open folds.

17. In overturned folds, limbs dip in the same direction, while the limbs of recumbent are essentially horizontal.

18. A *joint* is a fracture or crack in bedrock along which no displacement occurs; a *fault* is a fracture or crack in bedrock along which displacement occurs.

19. Compare your diagrams to Figures 15.23, 15.25, and 15.28 in the textbook.

    Vertical compressive stress or horizontal tensional stress can produce normal faults. A *horst* is a block that has been uplifted along normal faults. Horizontal compressive stress produces reverse faults.

20. A *graben* is a valley or rift created by the dropping of a block bounded by normal faults. A *horst* is a block that has been uplifted along normal faults.

21. An *unconformity* is a surface or contact that represents a break in geologic record, with the rock immediately above the contact being considerably younger than the rock beneath. In a *disconformity*, the contact representing missing rock strata is parallel to beds above and below it. In an *angular unconformity*, the contact representing missing rock strata lies on tilted or folded rock and is overlain by younger strata. A *nonconformity* is a contact in which an erosion surface on plutonic or metamorphic rock has been covered by

younger sedimentary or volcanic rock. Compare your drawings to Figures 8.13-8.15 in the textbook.

22. The elastic rebound hypothesis of earthquake development theorizes that rocks are strained by movement along a fault until they rupture, causing the blocks on either side to "snap back" into an unstrained position. The rupture of strained rocks produces seismic waves.

23. The *focus* is the point within the Earth where seismic waves originate, while the epicentre is the point on the Earth's surface directly above the point where seismic waves originated.

24. *P wave:* a compressional wave that vibrates (very quickly) parallel to the direction of wave propagation.

    S wave: a transverse wave that vibrates (more slowly than a P wave) perpendicular to the direction of wave propagation.

    surface waves: the slowest waves set off by earthquakes, which travel on the Earth's surface away from the epicentre.

25. The distance from the recording station to the earthquake is determined from the arrival times of the P, S, and surface waves. A circle can be drawn on a globe with the centre being the recording station and the radius being the distance from the recording station to the earthquake. Distance to the earthquake from at least two other recording stations are calculated, and circles centred around each of these stations are drawn (the radii equal the distance to the earthquake). The earthquake epicentre is located at the intersection of the three circles. The depth of the earthquake can also be determined by analysis of seismograms.

26. The Richter scale measures the amount of energy released at an earthquake's focus. Damage begins at a magnitude of 4.5 on the Richter scale.

27. Intensity of an earthquake depends on the total amount of energy released, the distance of the location from the earthquake's epicentre, the type of rock, and the rock's degree of consolidation.

28. At the surface of the Earth, earthquakes cause ground motion, fire, landslides, and permanent displacement of land surfaces.

29. *Tsunamis* are very large sea waves, usually caused by great earthquakes that disturb the sea floor, but also resulting from submarine landslides or volcanic explosions. The rise of the sea floor causes all the water over the floor to be lifted or dropped. As the water returns to sea level it sets up a long, low wave that spreads rapidly across the ocean.

30. A *Benioff zone* is an earthquake zone that begins at an ocean trench and slopes landwards and downward into the Earth at an angle of 30° to 60°.

31. At divergent plate boundaries, earthquakes are associated with normal faults. Such earthquakes are shallow and restricted to a narrow band.

32. At transform boundaries earthquakes are shallow and are usually aligned along a narrow band along one fault. They may form a broader zone if plate motion is taken up by movement along a system of parallel faults.

33. As ocean floor is subducted under a continent, earthquakes are associated with

    - normal faults as a result of tension as the plate stretches on an outer wall of the trench.
    - shallow angle thrust faults, for some distance below the trench, where the plate is in contact with the overlying plate.
    - compression or tension within the descending lithosphere at depth.