CHAPTER 19

Study Guide

STUDY TO GO

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BIG Idea Earthquakes are natural vibrations of the ground, some of which are caused by movement along fractures in Earth's crust.

Section 19.1 Forces Within Earth

Vocabulary

- elastic deformation (p. 529)
- epicenter (p. 533)
- fault (p. 530)
- focus (p. 533)
- plastic deformation (p. 529)
- primary wave (p. 532)
- secondary wave (p. 532)
- seismic wave (p. 532)
- strain (p. 528)
- stress (p. 528)

Key Concepts

MAIN Idea Faults form when the forces acting on rock exceed the rock's strength.

- Stress is force per unit of area that acts on a material and strain is the deformation of a material in response to stress.
- Reverse, normal, and strike-slip are the major types of faults.
- The three types of seismic waves are P-waves, S-waves, and surface waves.

Section 19.2 Seismic Waves and Earth's Interior

Vocabulary

- seismogram (p. 534)
- seismometer (p. 534)

Key Concepts

MAIN Idea Seismic waves can be used to make images of the internal structure of Earth.

- Seismometers are devices that record seismic wave activity on a seismogram.
- Travel times for P-waves and S-waves enable scientists to pinpoint the epicenters of earthquakes.
- P-waves and S-waves change speed and direction when they encounter different materials.
- Analysis of seismic waves provides a detailed picture of the composition of Earth's interior.

Section 19.3 Measuring and Locating Earthquakes

Vocabulary

- amplitude (p. 539)
- magnitude (p. 539)
- modified Mercalli scale (p. 540)
- moment magnitude scale (p. 540)
- Richter scale (p. 539)

Key Concepts

MAIN Idea Scientists measure the strength and chart the location of earthquakes using seismic waves.

- Earthquake magnitude is a measure of the energy released during an earthquake and can be measured on the Richter scale.
- Intensity is a measure of the damage caused by an earthquake and is measured with the modified Mercalli scale.
- Data from at least three seismic stations are needed to locate an earthquake's epicenter.
- Most earthquakes occur in seismic belts, which are areas associated with plate boundaries.

Section 19.4 Earthquakes and Society

Vocabulary

- seismic gap (p. 550)
- soil liquefaction (p. 547)
- tsunami (p. 548)

Key Concepts

MAIN Idea The probability of an earthquake's occurrence is determined from the history of earthquakes and knowing where and how quickly strain accumulates.

- Earthquake forecasting is based on seismic history and measurements of accumulated strain.
- Earthquakes cause damage by creating vibrations that can shake Earth.
- Earthquakes can cause structural collapse, landslides, soil liquefaction, and tsunamis.
- Seismic gaps are sections along an active fault that have not experienced significant earthquakes for a long period of time.

CHAPTER 19

Assessment

Vocabulary Review

Complete the sentences below with the correct vocabulary term from the Study Guide.

1. _____ is the deformation caused by stress.
2. _____ deformation causes a material to bend and stretch.
3. The amount of energy released and the amplitude of seismic waves are measured by the scale known as the _____.
4. _____ happens when seismic vibrations cause subsurface materials to liquefy and behave like quicksand.
5. A travel-time curve shows the relationship between the travel time of a given type of wave and _____.
6. The type of seismic wave that does not pass through the outer core is called a(n) _____.

The sentences below are incorrect. Make each sentence correct by replacing the italicized word with a vocabulary term from the Study Guide.

7. A *fault plane* is a region where earthquakes are expected but none has occurred for a long time.
8. The damage caused by earthquakes is described by the *moment magnitude* scale.
9. An underwater earthquake causes the movement of a column of water, resulting in a *seismic wave.*
10. The recording made by a seismometer is called a *stress-strain curve.*

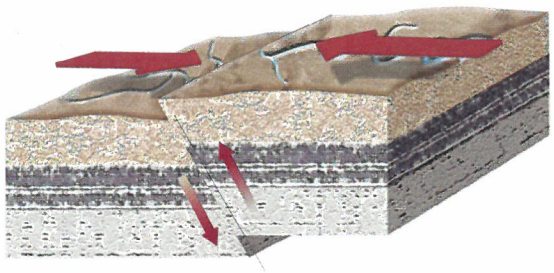
Distinguish between the vocabulary terms in each pair.

11. epicenter, focus
12. stress, strain
13. plastic deformation, elastic deformation
14. secondary wave, surface wave
15. Richter scale, moment magnitude scale
16. amplitude, magnitude

Understand Key Concepts

17. What is stress?
    - **A.** speed seismic waves travel
    - **B.** point at which rocks fail and generate an earthquake
    - **C.** force per unit area
    - **D.** measure of the deformation of rocks

Use the diagram below to answer Questions 18–20.



18. Which type of fault is shown?
    - **A.** reverse
    - **B.** normal
    - **C.** shear
    - **D.** strike-slip

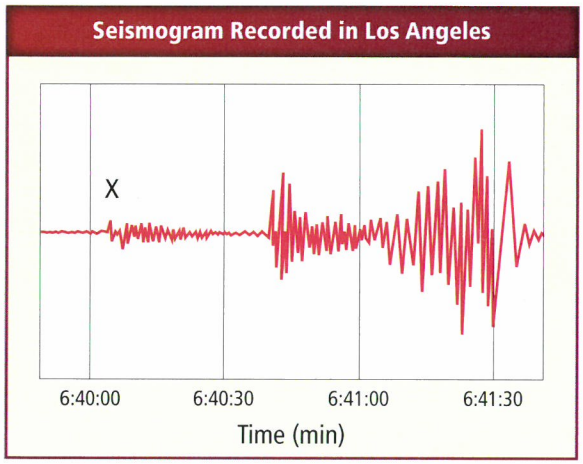
19. Which type of force caused this fault to form?
    - **A.** compression
    - **B.** tension
    - **C.** shear
    - **D.** divergent

20. In which direction is the movement in this type of fault?
    - **A.** horizontal
    - **B.** horizontal and vertical
    - **C.** side-to-side
    - **D.** vertical

21. What happens to a rock that undergoes elastic deformation once the stress is removed?
    - **A.** It returns to its original shape.
    - **B.** It breaks to generate an earthquake.
    - **C.** It undergoes plastic deformation.
    - **D.** It does not change shape.

22. Which type of geologic material is most prone to liquefaction?
    - **A.** granite
    - **B.** metamorphic rock
    - **C.** soil and loose sediment
    - **D.** lava flows

Use the figure below to answer Questions 23–25.



23. Which type of wave is labeled "X"?
    - **A.** P-wave
    - **B.** S-wave
    - **C.** surface wave
    - **D.** shear wave

24. At what time did the surface waves arrive at this station?
    - **A.** 6:40:00
    - **B.** 6:40:05
    - **C.** 6:40:33
    - **D.** 6:41:10

25. What can the difference in travel times between P- and S-waves be used to determine?
    - **A.** how far away the epicenter was
    - **B.** the type of fault
    - **C.** the depth of the earthquake
    - **D.** whether the core is liquid

26. Which seismic hazard is a form of structural failure?
    - **A.** tsunami
    - **B.** pancaking
    - **C.** soil liquefaction
    - **D.** seismic gap

Constructed Response

Use the figure below to answer Questions 27–29.

Some Earthquakes in Recent History

Location	Year	Richter Magnitude
Chile	1960	8.5
California	1906	7.9
Alaska	1964	8.6
Colombia	1994	6.8
Taiwan	1999	7.6

27. **Calculate** How much more energy was released by the Chilean earthquake than the Taiwan earthquake?

28. **Approximate** How much larger was the amplitude of the waves generated by the Alaskan earthquake than the Taiwan earthquake?

29. **Classify** the earthquake locations with the type of plate boundary, and suggest how the tectonic processes were probably related.

30. **Name** five states with high seismic risk.

31. **Compare and contrast** a tsunami and a surface wave.

32. **Explain** why scientists need measurements from more than two seismometers to determine the exact location of an earthquake. Make a diagram similar to **Figure 19.17** to support your answer.

33. **Describe** three different ways earthquakes can cause damage or cause harm to people.

Think Critically

34. **Summarize** the factors considered when assessing seismic risk.

35. **Evaluate** how earthquake intensity is related to the type of fault.

36. **Draw** the basic components of a seismometer.

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Use the figure below to answer Questions 37 and 38.

37. **Appraise** the specific type of earthquake damage shown, and propose the possible causes.

38. **Infer** the intensity of the earthquake that caused this damage, using the modified Mercalli scale.

39. **Explain** why there are three different ways to measure the size of earthquakes.

40. **Critique** this statement: If a certain area has not had an earthquake for over a hundred years, it is not likely to ever occur.

41. **Design** a house that would be structurally sound in an earthquake. Label the features, and explain how they would help prevent earthquake damage.

42. **Suggest** cost-effective ways of saving lives in an earthquake in the United States. How might your strategy be different in California and Florida?

Concept Mapping

43. Use the following terms to complete the concept map: *reverse faults, tension, types of stress, strike-slip faults, compression, shear, causes,* and *normal faults.*

Challenge Question

44. **Explain** why most earthquakes are shallow. Use the concept of plastic deformation and brittle failure and your knowledge about the temperature of Earth's interior.

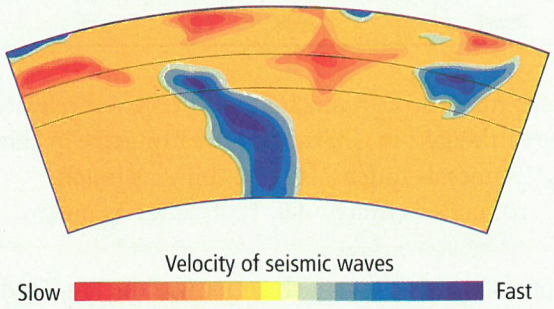
Additional Assessment

45. WRITING in Earth Science Imagine you live along an active fault. Write a disaster plan for your school, giving guidelines on what to do before, during, and after an earthquake. Include a list of disaster kit supplies.

DBQ Document-Based Questions

Data obtained from: Fukao Y., S. Widiyantoro, and M. Obayashi. 2001. Stagnant slabs in the upper and lower mantle transition region. *Reviews of Geophysics* 39 (3): 291–323.

The figure below shows a cross section of Earth extending from the surface to the boundary between the core and the mantle. The colors show how the speed of seismic waves differs from the expected value for waves at that depth. This cross section is taken across the subduction zone off the west coast of South America. West is left, and east is right.



46. What properties of subsurface material could cause seismic waves to move quickly through the blue areas and more slowly through the red areas?

47. Thinking about plate tectonics, what portion of the diagram could represent a subducting plate with molten rock rising from the subduction zone to form volcanoes?

Cumulative Review

48. What is the most common extrusive igneous rock? **(Chapter 5)**

49. Describe three processes that affect the salinity of the oceans. **(Chapter 15)**