Forces in Earth's Crust

Understanding Main Ideas
Use the diagrams below to answer items 1–3.

1. Diagram A
   a. Type of Fault: ______________________
   b. Stress Force: ______________________
   c. Movement Along Fault: hanging wall moves __________

2. Diagram B
   a. Type of Fault: ______________________
   b. Stress Force: ______________________
   c. Movement Along Fault: hanging wall moves __________

3. Diagram C
   a. Type of Fault: ______________________
   b. Stress Force: ______________________
   c. Movement Along Fault: Rock slips _______ each other with little _______ motion (vertical)

Building Vocabulary
Write a definition for each of these words. Use the back of this sheet if you need more space.

4. shearing **stress that moves rock in ________ past each other**
5. hanging wall **block of rock which lies _______ the fault**
6. syncline **rock folds with arch _______. Looks like:**
7. footwall **block of rock which lies _______ the fault**
8. stress **that acts on rock to change its shape** or V
9. anticline **rock folds with arch _______. Looks like:**
10. plateau **a large _______ of land elevated above ________________**

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Evidence of Movement Along Faults

Each picture below shows how an earthquake changed the land surface at a fault. Examine the pictures carefully. Decide what kind of fault is shown in each. Then explain how movement along the fault caused the changes you see. Write your answers in the spaces provided.

* Determine which way the hanging wall moved.

Fault 1

Fault 2

Fault 3

Word bank: compression →← normal fault
            reverse fault
            convergent strike slip fault
            tension
            divergent
            transform

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Earthquakes

I. **Defined:** An Earthquake is the shaking of earth's ___ caused by a release of ___. The result is the ______ of the Lithospheric plates. Earthquakes occur along the edges of ______ plates.

A great deal of ______ inside Earth is released as a result of an ________ on the rocks underground. Pressure is defined as the force or ______ acting on each unit of area. Forces applied to rocks can cause them to fold or stretch without ______ change, but only up to a point. The rocks will remain folded or ________ once their ______ limit is passed. When rocks break, they produce _______ that travel throughout Earth. These vibrations are called _____________. The shape and position of rock layers indicate the pressure the rock has experienced.

6-2 Earthquakes Everywhere!

An earthquake may occur anywhere on Earth, but most happen in areas of crustal movement associated with mountain-building processes.

The Pacific Coast region provides a shake or two for its inhabitants, especially in California along the San Andreas Fault—a great rift which extends for hundreds of miles along the western border of California.

Earthquakes occur in patterns known as seismic belts. These are well-defined fault zones. Many earthquakes originate in the circumpacific belt made up of young mountain ranges and chains of volcanic mountains.

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PART 1

Use the copy of the world map provided here and a red or blue colored pencil. Place an # on the world map indicating the approximate location of the following cities or countries:

1. Algeria (northern tip)
2. Anchorage, Alaska
3. Bogotá, Colombia (South America)
4. Costa Rica
5. Eureka, California
6. Guatemala, Central America
7. Iran
8. Japan
9. Kamchatka
10. Lisbon, Portugal
11. Los Angeles, California
12. Madrid, Spain
13. Mexico City, Mexico
14. New Guinea
15. New Zealand
16. Philippines
17. Quito, Ecuador (South America)
18. Santiago, Chile (South America)
19. Singapore
20. Tibet
Earthquakes and Seismic Waves

Understanding Main Ideas

Answer the following questions in the spaces provided.

1. What are seismic waves?
   
   created by ___________.
   
   The travel through ___________ carrying ___________.

2. In what order do the three types of seismic waves arrive at a seismograph?
   
   First to arrive ___________ waves, followed by ___________ waves.
   
   Last to arrive are ___________ waves.

3. Which type of seismic wave produces the most severe ground movements?
   
   ___________ waves because ___________.

4. Describe the moment magnitude scale, and explain why it is useful in measuring earthquakes.
   
   M.M. scale estimates total ___________ released.
   
   It’s useful because it rates EQ of all ___________ and ___________.

5. How do geologists locate the epicenter of an earthquake?
   
   1. measure the difference in ___________ time of P & S waves = ___________ time at ___________ stations
   
   2. determine ___________ to epicenter + plot on map by drawing ___________ circles.
   
   3. Where the circles ___________ = epicenter

Building Vocabulary

Match each term with its definition by writing the letter of the correct definition in the right column on the line beside the term in the left column.

6. focus

7. epicenter

8. surface waves

9. seismograph

10. magnitude

a. records ground movements caused by seismic waves as they move through the Earth

b. slowest seismic waves that produce the most severe ground movements

c. the point beneath Earth’s surface at which rock under stress breaks and triggers an earthquake

d. a measurement of earthquake strength

e. the point on the surface directly above the point at which an earthquake occurs
Comparing the Richter and Moment Magnitude Scales

The Richter scale rates earthquakes based on the size of their seismic waves, as measured by seismographs. The moment magnitude scale rates earthquakes based on the total amount of energy they release. To determine the moment magnitude rating, seismologists measure the surface area of the ruptured fault and how far the land moved along the fault. An earthquake's Richter rating and moment magnitude rating are not always the same. The table below shows the ratings on both scales for some famous earthquakes.

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Richter scale</th>
<th>Moment magnitude scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1811-1812</td>
<td>New Madrid, midwestern US</td>
<td>8.7</td>
<td>8.1</td>
</tr>
<tr>
<td>1906</td>
<td>San Francisco, California</td>
<td>8.3</td>
<td>7.7</td>
</tr>
<tr>
<td>1960</td>
<td>Arauco, Chile</td>
<td>8.5</td>
<td>9.5</td>
</tr>
<tr>
<td>1964</td>
<td>Anchorage, Alaska</td>
<td>8.4</td>
<td>9.2</td>
</tr>
<tr>
<td>1971</td>
<td>San Fernando, California</td>
<td>6.4</td>
<td>6.7</td>
</tr>
<tr>
<td>1985</td>
<td>Mexico City, Mexico</td>
<td>8.1</td>
<td>8.1</td>
</tr>
<tr>
<td>1989</td>
<td>San Francisco, California</td>
<td>7.1</td>
<td>7.2</td>
</tr>
<tr>
<td>1994</td>
<td>Northridge, California</td>
<td>6.4</td>
<td>6.7</td>
</tr>
<tr>
<td>1995</td>
<td>Kobe, Japan</td>
<td>6.8</td>
<td>6.9</td>
</tr>
</tbody>
</table>

1. Which earthquake was strongest according to the Richter scale? Which was strongest according to the moment magnitude scale?

2. Which earthquakes had the same or close to the same ratings on both scales?

3. Which earthquakes were rated more than 0.5 points stronger on the moment magnitude scale than they were rated on the Richter scale?

4. Which earthquakes were rated more than 0.5 points stronger on the Richter scale than they were rated on the moment magnitude scale?

5. Why can the same earthquake have different ratings on the two scales?
Interpreting and Applying

13–17. Figure 15.1 illustrates the paths taken by seismic waves set in motion by an earthquake. The locations of five seismograph stations are indicated by the letters A, B, C, D, and E. Figure 15.2 shows seismograph readings for the five stations. In the space beside each seismogram, write the letter of the station that would record that pattern of seismic waves.

**USE:**

1. **Location of seismograph to Focus**
2. What material the seismic wave is travelling through

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13. [Diagram of increasing time of arrival]
14. [Seismogram A]
15. [Seismogram B]
16. [Seismogram C]
17. [Seismogram D]

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18–22. Column A below lists descriptions of certain effects. The items in Column B are causes. In the space provided beside each effect, write the letter of the cause that brought about that effect.

**Effect**

18. S waves stop moving when they reach the boundary between the mantle and the core.
19. Although an earthquake occurs, a seismograph station receives no seismic waves.
20. As they travel through Earth's interior, seismic waves do not follow straight paths.
21. P waves and S waves arrive almost simultaneously at a seismograph station.
22. The velocity of seismic waves increases as the waves cross the Moho.

**Cause**

A
a. The station is located at or near the epicenter of the earthquake.
b. Earth's outer core is liquid.
c. The nature and density of the materials that make up Earth's interior vary considerably with depth.
d. The station is in the shadow zone.
e. The materials that make up the mantle are denser than those that make up the crust.

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6-3 Earthquake Word Search

Locate and circle the 18 terms associated with earthquakes commonly found in earth science textbooks. The terms are listed below the puzzle. They may be found backward, forward, vertically, horizontally, and diagonally.

A E K C O H S R E T F A J B S
S T R A I N Y C N U M G I E E
F H R C I M S I E S Z T C P I
Q L D R S C X B R K A O I I S
K O I P O W V J G F N M B C M
N L S E I M T I Y D A V W E O
S H P G E O E D A N K E X N G
Y O L K Q I J R U I F E W T R
T O A N I L Y S T A M R A E A
I H C P E W T C U F A U B R T
S U E R A B Y L A C I T R E V
N T M V F C T A I E A C S G E
E F E P R I M A R Y W A V E T
T I N A S E I S M O G R A P H
N R T S U R C T E S W F O E Z
I Z M L AT N O Z I R O H A I

- aftershock
- crust
- displacement
- energy
- epicenter
- fault
- fracture
- horizontal
- intensity
- primary wave
- secondary wave
- seismic
- seismograph
- shake
- strain
- tremor
- tsunami
- vertical
Monitoring Faults

Understanding Main Ideas

Answer the following questions on a separate sheet of paper.

1. How might monitoring faults help geologists predict an earthquake?
2. What two factors help geologists determine earthquake risk?

3. a. Name three cities shown on the map above that have a major risk of earthquake damage.
   b. Name three cities that have a moderate risk of earthquake damage.
   c. Name three cities that have a minor risk of earthquake damage.

Building Vocabulary

Answer each item below. Write your answers on a separate sheet of paper.

4. Name four instruments that are used to detect movement along faults.
5. Briefly describe how each instrument works.
   - **What it uses**: vert/horizontal
Earthquake Probability

This combined map and bar graph shows the probability of earthquakes in different areas along the San Andreas fault. Probability is a measure of how likely it is that some event will happen in a given time. A probability near 100 percent means that an event is very likely to happen. A probability near zero percent means an event is very unlikely to happen.

Earthquake Probability Along the San Andreas Fault

Use the figure above to answer the following questions. Write your answers on a separate sheet of paper.

1. Which area on the fault has the highest probability of an earthquake?

2. What is the probability of an earthquake in the North Coast area?

3. The fault section between the Santa Cruz Mountains and Parkfield has a very low probability. Geologists know that this area has experienced very little damaging seismic activity in the past. They also found that the blocks of rock in this section move slowly and continually. Why would slow, continual movement lead geologists to give the section a low probability?

4. What can you infer about why the probability of an earthquake is so high in the Parkfield area?

5. How do you think geologists learn about how the blocks of rock along a fault move?
Earthquakes • Key Terms

Key Terms

Read the clues below, and then find the key terms from the chapter that are hidden in the puzzle. The hidden terms may occur vertically, horizontally, or diagonally.

Clues

1. The shaking and trembling of Earth's crust
2. A fold in rock that bends downward
3. A stress force that squeezes rock
4. A large area of elevated flat land
5. A force that changes a rock's shape or volume
6. An earthquake that occurs after a larger earthquake in the same area

7. Large wave caused by earthquakes on the ocean floor
8. Stress that pushes rock in opposite directions
9. A fold in rock that bends upward
10. Occurs when an earthquake turns soil into liquid mud
11. The half of a fault that lies below
12. An instrument that records ground movements caused by seismic waves

stionscoddlnpm
faearthquakev1
waftershockndi
ytoneequercaftq
dupcoshearingu
swnofsazseptwe
egompiorvadtf
inmpfgtpulacma
sodrsynclinepc
mwcemuaqvbc
tovesjmwucktibi
glnsottrumbbeyo
ratikovooxlean
awooplyimsahu
pufnttsunamiss
haletanticline

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