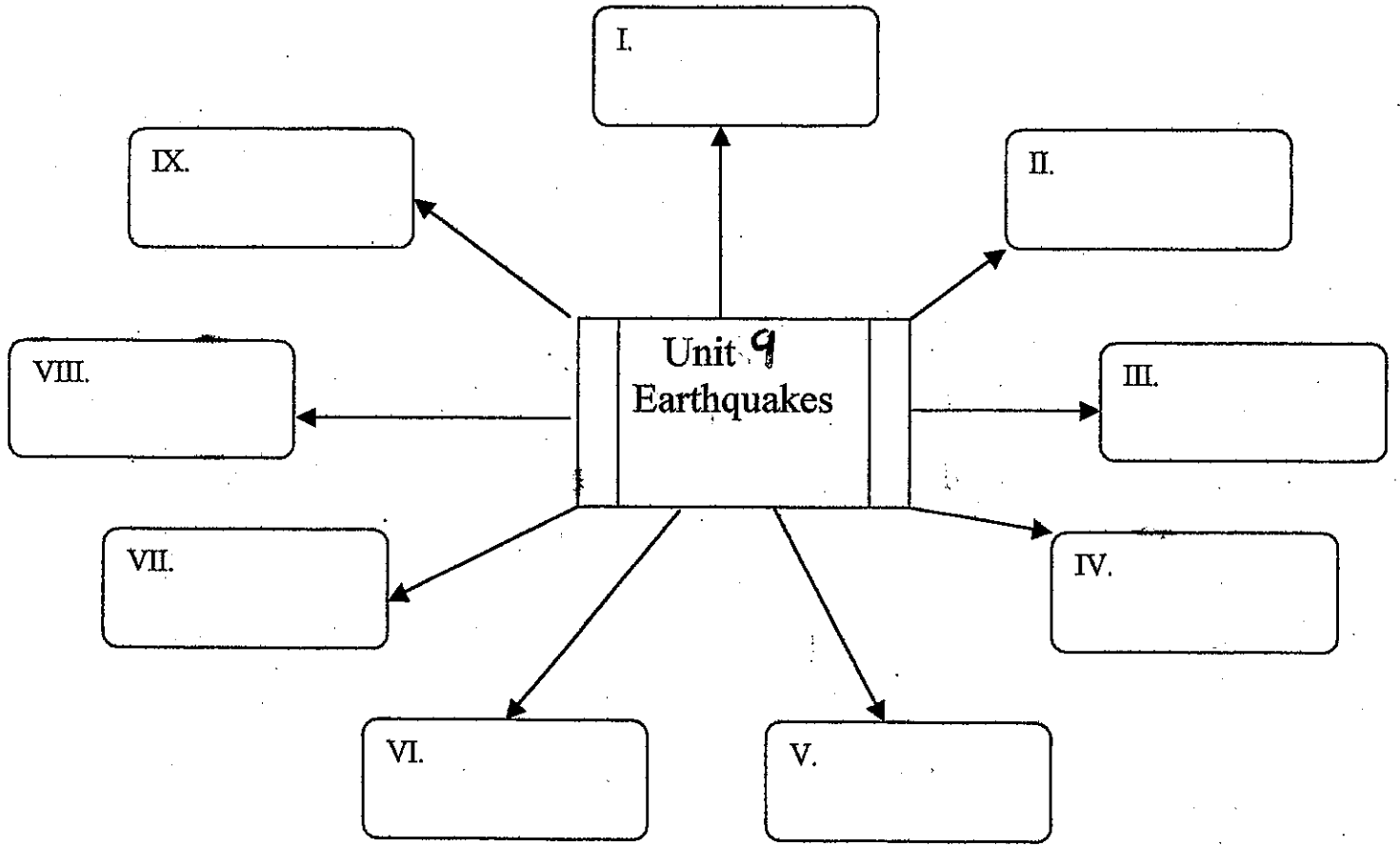
Name _____
Date _____
Period ____

Unit 9
Earthquakes
E. Science – Mrs. Weiler



# I. Earthquakes

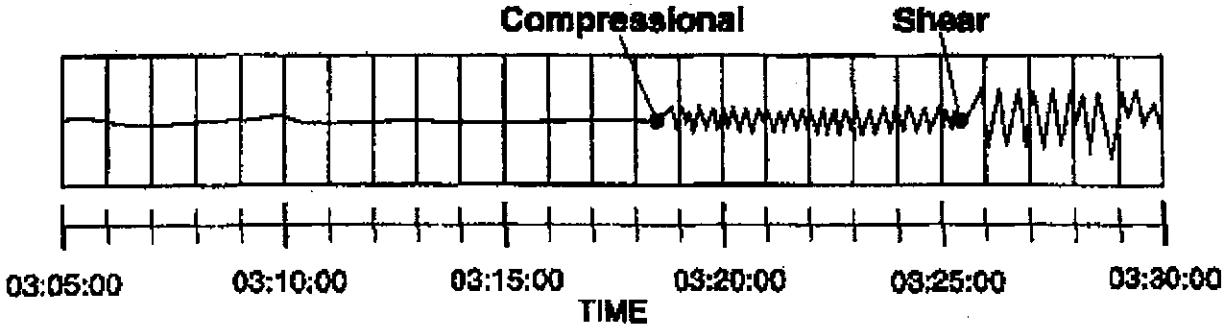
- Are the sudden trembling/movement of the ground
- There are over 1 million each year = 1 per second
- A major cause of earthquakes is because of faulting.
  - _____ - sudden movement of rock along planes of weakness in the earth's crust
  - _____ - planes of weakness in the Earth's crust.
  - Rock is stressed to the breaking point and the two halves have an elastic rebound.
  - Great masses of rock suddenly scrape past one another.
- _____ - the point where the rock breaks.
- _____ - the point on the Earth's surface directly above the focus.
  - Analysis of seismic waves allows the determination of the location of epicenters.

# II. Earthquake waves

- When faulting occurs, vibrations called _____ spread out in all directions from the focus.
- _____ - a device that detects measures, and records the motions of the earth associated with seismic waves.
- _____ - the line that was recorded on paper by a seismograph
- _____ - the total energy released by an earthquake

1

A seismogram recorded at a seismic station is shown below.




Which information can be determined by using this seismogram?

(1) the depth of the earthquake's focus
(2) the direction to the earthquake's focus
(3) the location of the earthquake's epicenter
(4) the distance to the earthquake's epicenter

1

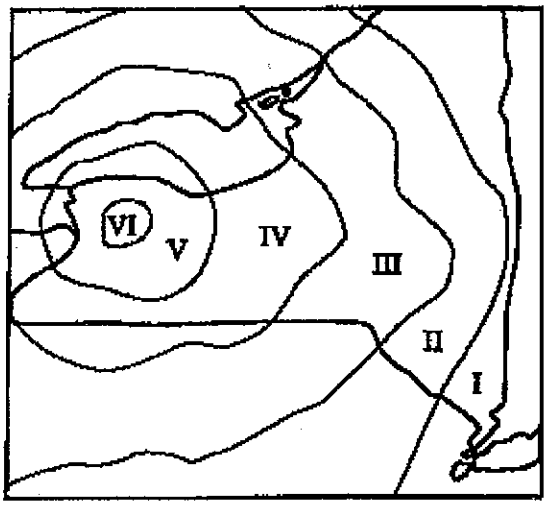
# III. Measuring Earthquakes

- _____ -based on the energy released, used scientific instruments, measures the magnitude
- _____-based on descriptions of earthquake damage on structures made by humans

#2

. The map below shows the intensity values (Earth-shaking effects observed by people) during an earthquake that occurred in New York State. The numbered areas on the map were determined from the Modified Mercalli Scale shown at the right. The scale is used to group locations according to the observed effects of an earthquake.

**New York State**




**Modified Mercalli Scale**

| Intensity Value | Observed Effects |
|---|---|
| I | Usually detected only by instruments |
| II | Felt by a few persons at rest, especially on upper floors |
| III | Hanging objects swing; vibration like a passing truck; noticeable indoors |
| IV | Felt indoors by many, outdoors by few; a sensation like a heavy truck striking a building; parked automobiles rock |
| V | Felt by nearly all; sleepers awakened; liquids disturbed; unstable objects overturned; some dishes and windows broken |
| VI | Felt by all; many frightened and run outdoors; some heavy furniture moved; glassware broken; books fall off shelves; damage slight |
| VII | Difficult to stand; noticed in moving automobiles; damage to some masonry; weak chimneys broken at roofline |
| VIII | Partial collapse of masonry; chimneys, factory stacks, columns fall; heavy furniture overturned; frame houses moved on foundations |

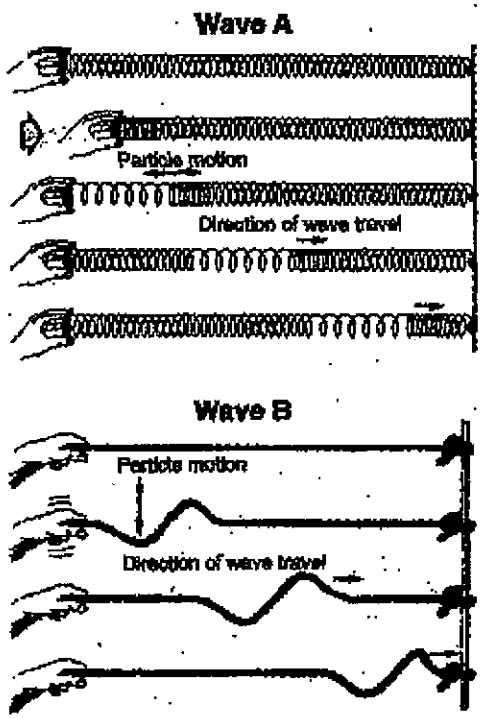
At which location in New York State could everyone feel the vibrations caused by this earthquake?
(1) 43°30' N, 75°30' W (2) 43°00' N, 78°30' W (3) 41°00' N, 74°00' W (4) 42°45' N, 74°00' W

# IV. Types of Earthquake Waves

- **P-Wave (Primary)**
  - can travel through solids, liquids, and gases
  - the higher the density of the material it moves through, the_____ the wave travels.
  - The greatest of the earthquake waves, usually the_____ to arrive.

- **S-Wave (Secondary)**
  - can only travel through *solids*
  - usually the *second* type of wave to arrive
- **R-Wave** travel along the surface, this type causes the most damage to buildings and people.

The diagrams below show demonstrations that represent the behavior of two seismic waves, *A* and *B*.




Which statement concerning the demonstrated waves is correct?

(1) Wave *A* represents a compressional wave, and wave *B* represents a shear wave.
(2) Wave *A* represents a shear wave, and wave *B* represents a compressional wave.
(3) Wave *A* represents compressional waves in the crust, and wave *B* represents compressional waves in the mantle.
(4) Wave *A* represents shear waves in the crust, and wave *B* represents shear waves in the mantle.

A characteristic of compressional waves and shear waves is that they both

(1) travel at the same speed
(2) travel faster through more dense solid materials
(3) travel through liquid and solid materials
(4) cause rock particles to vibrate in the same direction

Which difference between gabbro bedrock and granite bedrock causes seismic waves to travel faster in gabbro than in granite?

(1) Gabbro is more dense than granite.
(2) Gabbro has greater permeability than granite.
(3) Gabbro has a darker color than granite.
(4) Gabbro is made of smaller mineral grains than granite.

An abrupt change in the speed of seismic waves is an indication that the

(1) seismic waves are colliding
(2) shear wave has overtaken the compressional wave
(3) waves are going into a material with different properties
(4) waves are passing through material of the same density

The study of how seismic waves change as they travel through Earth has revealed that

(1) *P*-waves travel more slowly than *S*-waves through Earth's crust
(2) seismic waves travel more slowly through the mantle because it is very dense
(3) Earth's outer core is solid because *P*-waves are not transmitted through this layer
(4) Earth's outer core is liquid because *S*-waves are not transmitted through this layer

# V. Subtracting Time

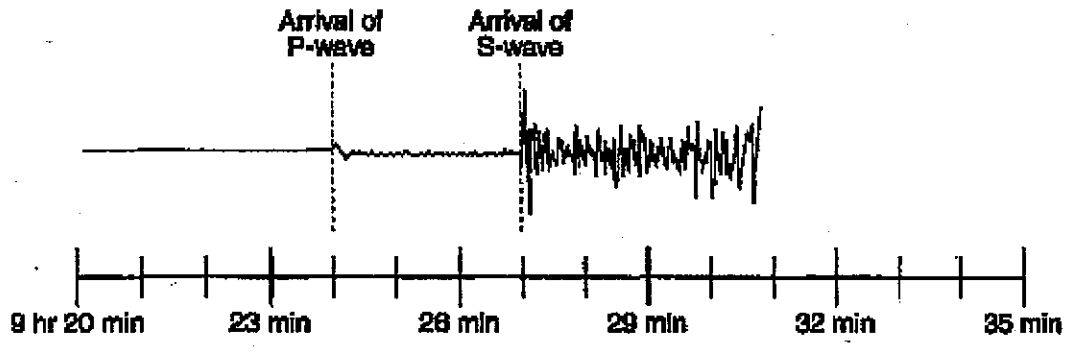
11:08:20
- 3:40

1. You can not subtract 40 from 20.
2. You must borrow one minute.
3. Cross out the 8 and change it to 7.
4. 1 minute = 60 seconds
5. You must add 60 seconds to the 20 you started with
6. You can now subtract normally.

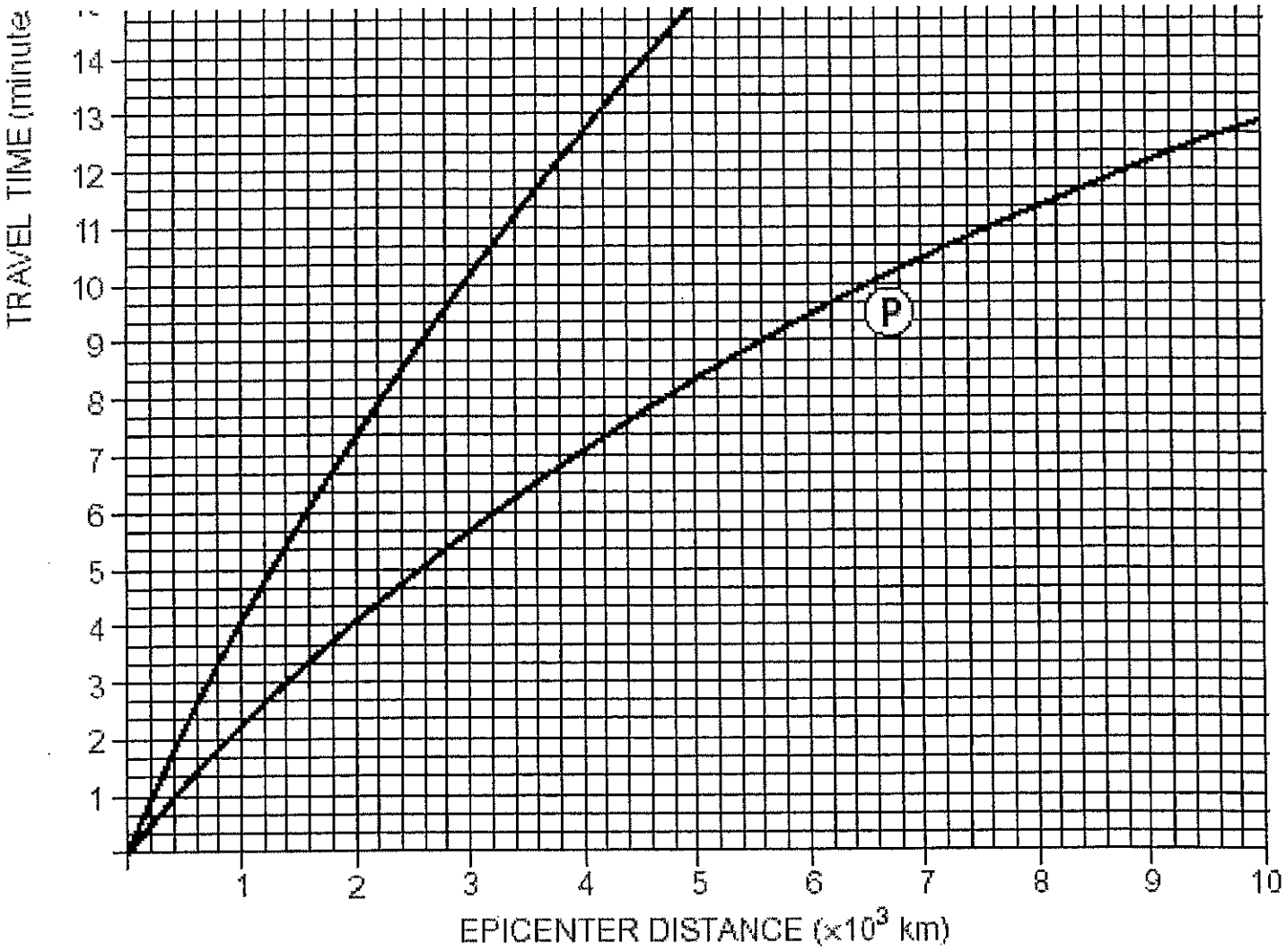
| | | |
|---|---|---|
| 1:24:36<br>- 35:14 | 4:15:56<br>- 28:13 | 7:50:15<br>- 3:45 |
| 1:15:30<br>- 14:35 | 6:41:10<br>- 2:10 | 1:01:01<br>- :15 |

# VI. Seismographs

#2. The seismogram below shows the arrival times of an earthquake's *P*-wave and *S*-wave recorded at a seismic station in Portland, Oregon.




What was the distance from Portland to the earthquake's epicenter?
(1) 1800 km (2) 2500 km (3) 3200 km (4) 4100 km




1. Find the difference in arrival times.
2. Bring edge of paper to the left side of the graph.
3. Mark off the difference in arrival times.
4. Hold the paper straight up and down.
5. Move the paper so that the top mark touches the S line and the bottom line touches the P line
6. Look straight down to find the epicenter distance.

#9 A seismograph station records a difference in arrival time between the *S*- and *P*-wave of 4 minutes. About how far away is the earthquake epicenter? (Refer to the *Earth Science Reference Tables*.)

(1) 1,000 km (3) 2,600 km
(2) 1,900 km (4) 5,200 km

#10 A seismic station receives a *P*-wave at 12:07 a.m. and an *S*-wave at 12:12 a.m. The station's distance from the epicenter is approximately

(1) 2,600 km (3) 4,000 km
(2) 3,400 km (4) 8,800 km

#11 The epicenter of an earthquake is located 2,800 kilometers from a seismic station. Approximately how long did the *S*-wave take to travel from the epicenter to the station?

(1) 11 min 15 sec (3) 5 min 20 sec
(2) 9 min 35 sec (4) 4 min 20 sec

#12 A seismic station is 2,000 kilometers from an earthquake epicenter. According to the *Earth Science Reference Tables*, how long does it take an *S*-wave to travel from the epicenter to the station?

(1) 7 minutes 20 seconds (3) 3 minutes 20 seconds
(2) 5 minutes 10 seconds (4) 4 minutes 10 seconds

#13

An earthquake's P-wave traveled 4,800 kilometers and arrived at a seismic station at 5:10 p.m. At approximately what time did the earthquake occur?

(1) 5:02 p.m. (3) 5:10 p.m.
(2) 5:08p.m. (4) 5:18 p.m.

#14

A seismograph station $3 \times 10^3$ kilometers from an epicenter received *P*-waves at 3:33:00 in the afternoon. What was the origin time of the earthquake? [Refer to the *Earth Science Reference Tables*.]

(1) 3:03:00 p.m. (3) 3:28:40 p.m.
(2) 3:27:20 p.m. (4) 3:38:40 p.m.

#15

An earthquake *P*-wave arrived at a seismograph station at 01 hour 21 minutes 40 seconds. The distance from the station to the epicenter is 3,000 kilometers. The earthquake's origin time was

(1) 01 h 11 min 40 sec (3) 01 h 20 min 20 sec
(2) 01 h 16 min 00 sec (4) 01 h 27 min 20 sec

#16

How far from an earthquake epicenter is a city where the difference between the *P*-wave and *S*-wave arrival times is 6 minutes and 20 seconds?

(1) $1.7 \times 10^3$ km (3) $3.5 \times 10^3$ km
(2) $9.9 \times 10^3$ km (4) $4.7 \times 10^3$ km

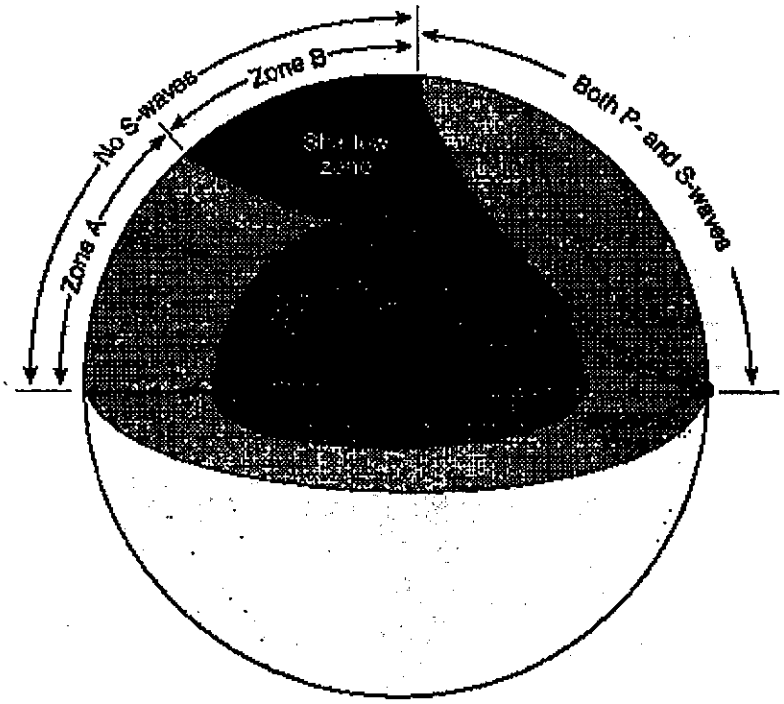
#17

What is the average velocity of an earthquake's S-wave in its first 4 minutes of travel?

(1) 1 km/min (3) 500 km/min
(2) 250 km/min (4) 4 km/min

#18

. The cross section below shows the distribution of earthquake waves as they travel through Earth's interior. The arrows within Earth's interior represent the pathways followed by some earthquake waves.




Which types of earthquake waves will most probably be detected in zones *A* and *B*?

(1) zone *A*: *P*-waves, only; zone *B*: *S*-waves, only (3) zone *A*: *S*-waves, only; zone *B*: *P*-waves, only
(2) zone *A*: *P*-waves, only; zone *B*: no *P*- or *S*-waves (4) zone *A*: *S*-waves, only; zone *B*: no *P*- or *S*-waves

# VII. Earthquake Prediction

- Earthquakes can cause damage, injury and death.
- Most injuries and fatalities are by buildings falling of people and related events.
- Scientists can make long-term predictions for certain areas of crustal activity.
- Planning for earthquakes is important since earthquakes cannot be accurately predicted.
    - "Drop, cover and hold."
    - Drop down under a strong desk or table.
    - Turn away from the windows.
    - Cover your eyes with one hand and hold on to the tale with the other.
    - Communities can have earthquake drills at home, work and school.
    - Construct new buildings on solid rock.

#19 .Base your answer to the following question on the passage and map below. The passage provides some information about the sediments under Portland, Oregon, and the map shows where Portland is located.

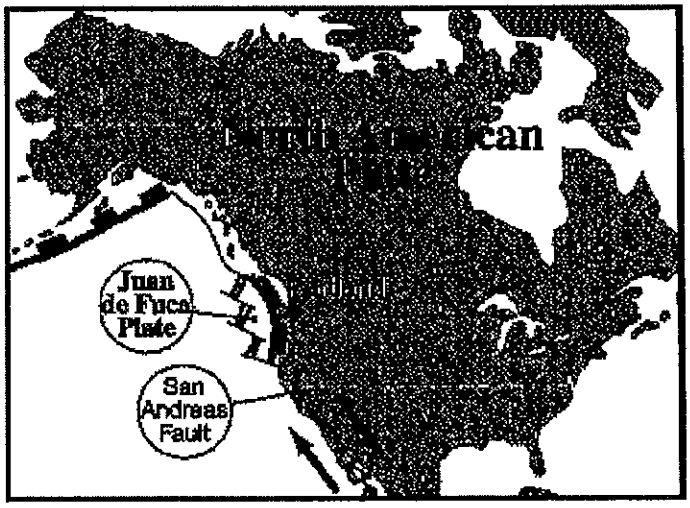
**Bad seismic combination under Portland: Earthquake faults and jiggly sediment**

Using a technique called seismic profiling, researchers have found evidence of ancient earthquake faults under Portland, Oregon. The faults may still be active, a USGS [United States Geological Survey] seismologist will announce tomorrow.

The research also turned up a 250-foot deep layer of silt and mud, deep under the city, which may have been caused by a catastrophic ice dam break some 15,000 years ago.

The two findings could together mean bad news, as soft sediment is known to amplify ground shaking during strong earthquakes. In the 1989 San Francisco earthquake, much the damage to buildings was caused by liquefaction, a shaking and sinking of sandy, watersaturated soil along waterways....

— Robert Roy Britt
excerpted from
"Bad sesimic combination under Portland:
Earthquake faults and jiggly sediment"
explorezone.com 05/03/99




Describe one precaution that can be taken to prevent or reduce property damage in preparation for a future earthquake in Portland.

(18)

# VIII. Tsunami

- _____ (sue-na-me) a large wavelength ocean wave produced by a disruption on the ocean bottom.
- Disruptions: faulting, volcanic eruptions and landslides.
- A tsunami can lead to huge waves hitting the shoreline, building damage, injury and death.

#20

When the seafloor moves as a result of an underwater earthquake and a large tsunami develops, what will most likely occur?

(1) Deep-ocean sediments will be transported over great distances.
(2) No destruction will occur near the origin of the earthquake.
(3) The direction of the tsunami will be determined by the magnitude of the earthquake.
(4) Severe destruction will occur in coastal areas.

#21

Tsunamis are caused by

(1) Earth's rotation
(2) dynamic equilibrium
(3) hurricane winds
(4) earthquakes

# IX. Volcanoes

- _____ – a mountain composed of extrusive igneous rocks.
- A volcanic eruption is the giving off of gases, lava, and/or lava rock onto Earth's surface through the opening of a volcano.
- Volcanoes are considered to be natural hazards because building can be destroyed and people can be injured or killed from something caused by nature.
  - _____ – falling rock from an eruption.
  - Lava can reach 1000 degrees Celsius.
  - Ash lands on glaciers, _____ the ice and causing mudslides.
  - Gases emitted by volcanoes can cause immediate death.
  - Can cool the earth's surface temperature.
- Because magma moves upward before an eruption, the eruption can be predicted by monitoring:
  - The temperature
  - The degree of the mountains slope
  - The width of a volcano
- Volcanoes occur in areas of _____ boundaries where the land is pushing up/down (this causes frictions and heat). (Also occur in "Hot Spots")
- Planning for volcanic eruptions: evacuation routes