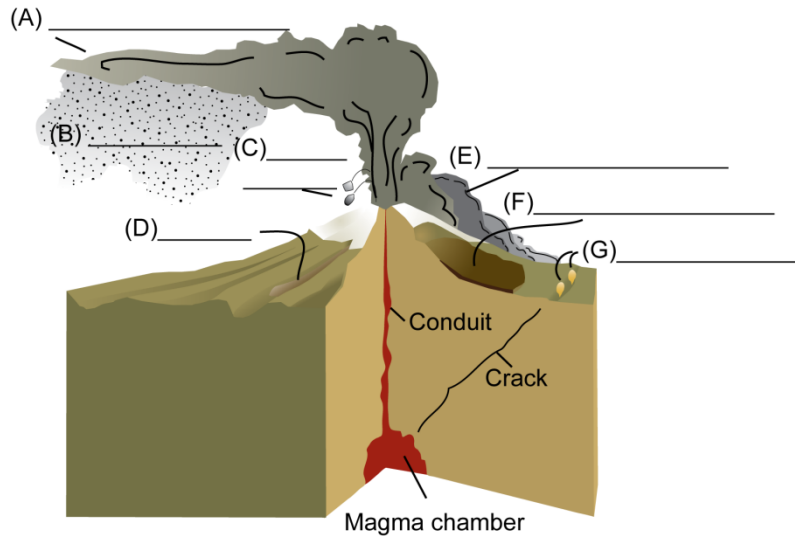


## Chapter 3 – Volcanic Hazards

### Practice Exam and Study Guide

1. In the following illustration please fill in the labels for the indicated volcanic hazards.



Note: Volcanic summits are commonly covered with snow & glaciers as depicted in this scene.

2. What are fumaroles?
3. Select from the following list potentially dangerous gases emitted from fumaroles.
- H<sub>2</sub>O
  - O<sub>2</sub>
  - CO<sub>2</sub>
  - SO<sub>2</sub>
  - H<sub>2</sub>S
4. Acid rain is produced when SO<sub>2</sub> is mixed with water vapor. What is the name of the acid that is produced by this reaction?
- Carbonic acid
  - Hydrochloric acid
  - Sulfuric acid
  - Hydrofluoric acid
  - Nitric acid
5. If you are hiking up the side of a volcano, and encounter a hollow (a low lying depression) should you walk through such an area? If not, then why not?

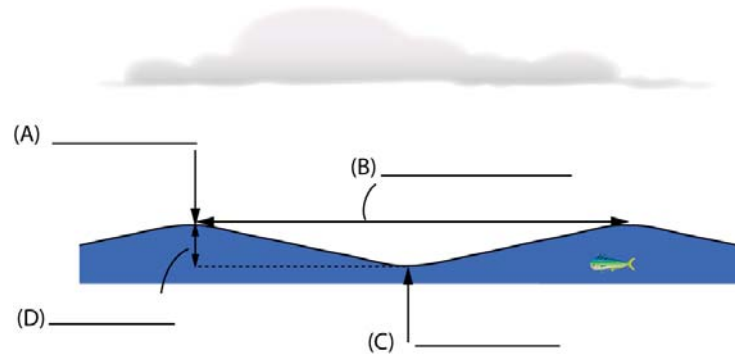
6. Carbon dioxide (CO<sub>2</sub>) is an odorless and colorless gas that can suffocate people. On October 21, 1986 a CO<sub>2</sub> cloud was released from Lake Nyos. It asphyxiated ~1700-1800 sleeping villagers. Where is Lake Nyos?
- Nigeria
  - Chad
  - Central Republic of Africa
  - Cameroon
  - Republic of the Congo
7. What is the name of the process that results in the emission of CO<sub>2</sub> from lakes overlying subvolcanic magma chambers?
8. What are the essential conditions that must exist prior to a limnic eruption?
9. In a *deep tranquil* lake saturated with CO<sub>2</sub>, will this gas phase remain in solution or will it exsolve in the deeper waters of the lake?
10. If a deep tranquil lake saturated with CO<sub>2</sub> is disturbed such that bottom waters rise to the lake surface, then what will happen to the CO<sub>2</sub>?
11. Given two lava flows, one effusing from Mt. Nyiragongo, Democratic Republic of the Congo and the other from Kilauea, Hawaii how will they differ in terms of their potential danger to an observer?
12. If you are lucky enough to witness an eruption of Mount Etna, Sicily, then should you be concerned if you are closer than about 805 meter (0.5 mile) from the volcano's summit? If so, then why?
13. Lightning is an electrostatic discharge between variously charged areas of the eruption column or between charged areas of the column and the ground. What process produces the positive and negative electrostatic charges within the eruption column?
14. Should airplanes attempt to fly through ash clouds? If not, then why?

15. Should you seek shelter from an ash fall in a building with a thin corrugated tin roof? If not, then why?
16. Lahar is an Indonesian term for a hot or cold mixture of water and volcanic rock fragments flowing down the slopes of a volcano or river valley. Fragments in such mixtures can vary from less than  $\sim 0.004$  mm to over meters in diameter. What type of volcano is most often associated with the development of a lahar?
17. Mount Rainier lies near the beautiful cities of Tacoma and Seattle, Washington. It possesses two characteristics that are commonly associated with the generation of a lahar. What are those two characteristics?
18. Over the last several thousand years how often have lahars initiated on Mount Rainier reached the Puget Sound lowland?
- 2000 to 3000 years
  - 4000 years
  - 500 to 1000 years
  - 100 – 200 years
19. If large lahars continue to occur at rates similar to those of the past, then what is the change of a lahar reaching the Puget Sound lowland during an average human lifespan?
- 5-in-10 (50%)
  - 3-in-10 (30%)
  - 1-in-10 (10%)
  - 7-in-10 (70%)
20. According to the United States Geological Survey what are the two common processes that initiate lahars on stratovolcanoes?
21. Mount Rainier is described as being composed of large volumes of hydrothermally altered volcanic materials. In terms of the generation of lahars, why is the presence of such material a significant concern?

22. How are most lahars on Mount Rainier initiated?
23. Geologists have mapped two prominent lahars that were derived from Mount Rainier. One occurred about 500 years ago and then other about 5600 years ago. What is the name of the lahar that originated 500 years ago?
24. What is the name of the lahar that originated on Mount Rainier about 5600 years ago?
25. There have been 55 lahars that have originated from Mount Rainier over the last 10,000 years. In the past 5,600 years, 6 and possibly 13 have occurred. Geologists use these data to calculate a recurrence interval for lahars derived from Mount Rainier. That recurrence interval is 500 to 1000 years. Given your answer to questions 20 and 21, when is the next lahar expected?
26. Select from the following list *all* of the characteristics of a debris avalanche.
- Gravitationally induced
  - Flows or slides
  - Is incoherent and chaotic
  - Can be a wet or dry mixture of soil and rock debris
  - Moves at high speeds
27. Deposits derived from a debris avalanche are commonly thick and have a chaotic hummocky surface. True or False
28. Select from the following list *all* of the characteristics of a cold debris avalanche.
- Occurs along a steep gravitationally unstable slope
  - Occurs along a shallowly inclined water-saturated slope
  - Occurs as a direct result of earthquakes produced by magma movement
  - Occurs as a result of the high level injection of magma
  - None of the above
29. Select from the following list *all* of the characteristics of a hot debris avalanche.
- Occurs along a steep gravitationally unstable slope
  - Occurs along a shallowly inclined water-saturated slope
  - Occurs as a direct result of earthquakes produced by magma movement
  - Occurs as a result of the high level injection of magma
  - None of the above

30. Were the initial events that created the Osceola and Electron lahars on Mount Rainier a cold or hot debris avalanche?
31. How is the initial event leading up to the penultimate eruption at Mount Saint Helens in 1980 classified?
32. Choose from the following list all of the processes that might produce a tsunami.
- Earthquakes
  - Volcanic eruptions
  - Landslides
  - Meteorite impacts
  - Undersea slumps
33. A tsunami is a set of ocean waves caused by any large, abrupt disturbance of the \_\_\_\_\_.
34. The magnitude of an earthquake is a relative measure of its energy, while the focus is the location of the earthquake within the Earth's interior. Most tsunamis are produced by
- Large (>5) magnitude, shallow focus (<5 km) earthquakes
  - Small (<7) magnitude, deep focus (>30 km) earthquakes
  - Large (>7) magnitude, shallow focus (<30 km) earthquakes
  - Small (<7) magnitude, deep focus (< 50 km) earthquakes
  - None of the above
35. Are tsunamis wind driven or tidal waves? Yes or no
36. What do you call the series of waves radiating outward from a central area where a large mass of material was suddenly displaced into a large body of water due to a volcanic eruption, pyroclastic flow, or debris avalanche?

37. For the following illustration of the key characteristics of a tsunami please fill in the missing labels.



38. What is the period of a tsunami?

39. In the deep oceans, the wave height of a tsunami is often no more than

- a. 5 m high
- b. 3 m high
- c. 2 m high
- d. 1 m high
- e. 10 m high

40. Wavelengths for tsunami typically range from \_\_\_\_\_ of meters to over \_\_\_\_\_ kilometers.

41. Periods for tsunami range from \_\_\_\_\_ minutes to \_\_\_\_\_ hours.

42. In the deep oceans what are the maximum speeds documented for a tsunami?

- a. 100 kilometers/hour
- b. 200 kilometers/hour
- c. >966 kilometers/hour
- d. 500 kilometers/hour
- e. 450 kilometers/hour

43. When a tsunami approaches shore sea level appears to recede. What is this phenomenon called?

44. Tsunamis often come ashore as a wall of water resembling a tidal bore. The maximum vertical height above normal high tide reached by the tsunami as it travels over the land surface is referred to as \_\_\_\_\_.

45. Where is the Alika 2 landslide located?
46. What caused the Alika 2 landslide?
47. What was the runup for the Alika 2 landslide?
48. Are the residents living on Mauna Loa, Hawaii safe from a tsunami?
49. In 1883, a volcano lying within the Sunda Strait between Java and Sumatra violently erupted. In the surrounding coastal communities it produced a series of tsunamis that ultimately killed about 36,000 people. What is the name of this volcano?
50. What happened on the French Caribbean island of Martinique in the Lesser Antilles in 1902?
51. Select from the list below all of the processes that preceded the main eruption of Mount Pelée?
- a. Fumarole activity and eruption of sulfuric gases
  - b. Minor volcanic eruptions and formation of small pyroclastic flows
  - c. Formation of a crater lake
  - d. Lahar development
  - e. None of the above
52. Did the citizens of St. Pierre heed the early warning signs of an impending eruption of Mount Pelée?
53. What was the maximum speed reached by the pyroclastic flow that engulfed St. Pierre and what is its estimated maximum temperature?
- a. 50 mph 500°F
  - b. 75 mph 750°F
  - c. 100 mph 1000°F
  - d. 100 mph 1100°F
  - e. 100 mph 1300°F

54. How many people lived in St. Pierre prior to the May 8, 1902 pyroclastic flow?
- 25,000
  - 26,000
  - 27,990
  - 29,000
  - 28,998
55. How many people living in St. Pierre survived the May 8, 1902 pyroclastic flow?
- 1
  - 2
  - 3
  - 20
  - 122
56. Were the citizens of Martinique safe following the May 8, 1902 main eruption of Mt. Pelée?
57. What happened to the community of Morne-Rouge, Martinique, on May 30, 1902?
58. Large sustained volcanic eruptions eject into the atmosphere large quantities of ash and SO<sub>2</sub> gas. Molecules of SO<sub>2</sub> combine with water vapor to form droplets of sulfuric acid. These tiny droplets along with volcanic dust form an aerosol. How does the resulting aerosol affect the temperature of the Earth's surface?
59. The eruption of Mount Krakatoa in the Sunda Strait between Indonesia and Java in 1883 is classified as a VEI \_\_\_\_\_ eruption.
60. How high did the 1883 eruption column of Krakatoa reach?
- 10 – 12 km
  - 15 – 20 km
  - 25 – 36 km
  - 5 – 10 km
  - 50 – 60 km



61. The 1883 eruption was so violent that it literally tore the volcano apart. It was so loud that it was heard as far away as Rodriguez Island in the Indian Ocean. This is a distance of about
- 3000 kilometers
  - 3500 kilometers
  - 4000 kilometers
  - 4500 kilometers
  - 5000 kilometers
62. The cloud of sulfuric acid droplets and volcanic dust formed a stratospheric aerosol that was distributed by the wind around the globe. During the year following the eruption it is estimated that global temperatures dropped by
- 5.0°C
  - 4.0°C
  - 1.5°C
  - 0.5°C
  - 2°C
63. Following the eruption of Krakatoa global weather patterns remained chaotic years and the global climate did not return to normal until
- 1884
  - 1885
  - 1886
  - 1887
  - 1888
64. Due to aerosols produced during volcanic eruptions the colors of sunrises and sunsets are greatly modified from their normal colors. How are the sunsets and sunrises following the 1883 eruption at Krakatoa and the June 15, 1991 eruption of Mt. Pinatubo in the Philippines described?

## Answers

- (A) Umbrella region, (B) Ash fall, (C) Bombs and Blocks, (D) Lahar, (E) Pyroclastic flow, (F) Debris avalanche, (G) Fumaroles
- Small vents or cracks in an around a volcano that emit steam and gas
- c. CO<sub>2</sub>, d. SO<sub>2</sub>, e. H<sub>2</sub>S
- c. Sulfuric acid (H<sub>2</sub>SO<sub>4</sub>)
- No, these are areas where gases might accumulate
- d. Cameroon

7. limnic eruptions
8. There must be a lake that lies above a sub-volcanic magma chamber. CO<sub>2</sub> emitted from the magma chamber enters the lake from below. The cold bottom waters of the lake become saturated with CO<sub>2</sub>.
9. CO<sub>2</sub> will remain in solution.
10. As the cold deep water moves upward it becomes warmer, and as a result, the CO<sub>2</sub> will exsolve. A cloud of poisonous CO<sub>2</sub> gas may escape the lake and travel down the slopes of the volcano.
11. Mafic lava from Mt. Nyiragongo is very fluid and travels at significantly greater speeds than do lavas from Kilauea, Hawaii. Hence, an observer should take great care in observing lava effusing from Mt. Nyiragongo and make sure that they are well out of its path. In contrast, though lava effusing from Kilauea is slower than at Mt. Nyiragongo, it is relentless. Thus, though an observer may be a safe distance from the flow one day that may not be true the following day.
12. No, tourists have been struck and killed by falling bombs and blocks ejected from Mount Etna within this distance. In addition, lightning strikes near the summit have killed at least 4 tourists since 2000.
13. Within the eruption column tephra tumbles and bumps into each other building up an electrostatic charge.
14. No, the temperatures inside jet engines are hot enough to melt volcanic ash. The melt is then swept into the cooler interior portions of the engine where it causes it to completely shut down, i.e., flame out.
15. No, when ash is wet its density increases significantly. As a result, a 10-cm-thick layer of such material is sufficiently dense to collapse most shelters made of such weak material.
16. Stratovolcanoes
17. It is a stratovolcano with glaciers and snowfields at its summit
18. c. 500 to 1000 years
19. c. 1-in-10 or 10%
20. In melt-water generated lahars, pyroclastic flows travel over and erode glacier ice and snow thereby generating a mixture of water, ice, pumice, and rock fragments. In landslide-generated lahars, landslides are initiated by magma rising into the volcano and destabilizing it by producing steep gravitationally unstable slopes and/or by concomitant earthquakes. In addition, landslide-generated lahars are also produced in steep to over steepened volcanic terrains underlain by weak hydrothermally altered volcanic rocks.
21. Hydrothermally altered volcanic rocks are very weak and thus are highly susceptible to landslide development in steep to over steepened volcanic terrains.
22. Most lahars on Mount Rainier are initiated by cold debris avalanches and are thus landslide-generated lahars.
23. The Electron mudflow or lahar
24. The Osceola mudflow or lahar
25. As the Electron lahar occurred 500 years ago, a recurrence interval of 500 to 1000 years, suggests that another lahar originating from Mount Rainier could occur at any time.
26. a. through e. are all characteristics of debris avalanches

27. True
28. a. Occurs along a steep gravitationally unstable slope
29. c. Occurs as direct result of earthquakes produced by magma movement and/or d. Occurs as a result of the high level injection of magma
30. Cold debris avalanche
31. Hot debris avalanche
32. a. through e. all could produce a tsunami
33. sea surface
34. b. large (>7) magnitude, shallow focus (<30 km) earthquakes
35. No, they are created by neither of these processes
36. A tsunami
37. (A) crest, (B) wavelength, (C) trough, (D) wave height
38. The time it takes successive crests or troughs to pass a stationary point.
39. d. 1 meter high
40. hundreds, 500
41. 10, 2 hours
42. c., >966 kilometers/hour
43. drawdown
44. runup
45. Off the SW coast of Mauna Loa, Hawaii
46. A large piece of Mauna Loa gave way and slide into the adjacent Pacific Ocean
47. More than 400 meters (1312 feet)
48. Absolutely not. The volcano continues to grow and thus portions remain highly susceptible to gravitational collapse.
49. Krakatoa or Krakatau
50. Mount Pelée erupted.
51. a. through d. occurred prior to the main eruption.
52. No, they did not.
53. e. 100 miles per hour with temperatures reaching 1300°F.
54. d. 29,000
55. b. 2
56. No, volcanic activity continued for many days following the main eruption.
57. A pyroclastic flow struck the community and killed 2,000.
58. They reflect the Sun's rays and thus cause a cooling of the Earth's surface.
59. 6
60. c. 25-36 km
61. d. 4,500 km
62. d. 0.5°C
63. e. 1888
64. They are often described as "vividly red and orange".