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Saudi Society for Geosciences

Al-Amri's Encyclopedia of Earth Sciences

28

موسوعة العمري في علوم الأرض

380 Q & A سؤال ؟ جواب

In

Geologic Hazards

المخاطـــــــر الجيولوجيـــــة

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﴿ وَفِي ٱلْأَرْضِ ءَايَٰتٌ لِّلْمُوقِنِينَ ﴾

[سورة الذاريات : آية 20]

﴿And on the Earth are Signs for
Those Whose Faith is Certain﴾


موسوعة
العلوم الأساسية

Preface

Praise and thanks to Allah who helped me accomplish this modest effort associated with writing the Scientific Encyclopedia. The comprehensive scientific encyclopedia in earth, environment and energy sciences aims to provide and serve researchers, school and university students and groups of society, due to the suffering of those interested in the problems of the scarcity of Arab references in this field. The encyclopedia is one of the largest in the world includes 30 scientific and cultural books documented and supported by pictures and simplified illustrations in approximately 6000 pages, covering five main parts:

The First Part consists of six books that discuss the age of the Earth, its shape, movements, internal structure, minerals and mining ores, gravity and its relationship to tides:

- Estimating Age of the Earth
- Earth's Shape & Movements
- Earth's Gravity & its Applications
- The Internal Structure of the Earth
- Minerals & Mining
- Tides

As for the Second Part of the encyclopedia, it included six books that link the Earth's relationship with the solar system, especially the moon, and the atmosphere, water, and vitality surrounding the Earth. As well as the role of earthquakes, explosions, volcanoes and tsunamis in affecting the structure of the earth and how to reduce its risks:

- Tsunami Waves
- Earthquakes & Explosions
- Seismic Hazard Assessment
- Volcanoes & Ways to Confront Them
- Geology of the Moon
- Spheres Surrounding the Earth

The Third Part consists of six books related to everything related to environmental problems and disasters and their solutions, climatic changes, the importance of afforestation and the treatment of global warming:

- Environmental Problems & Their Solutions
- Afforestation: Challenges & Solutions
- Climate Change & Global Warming
- Slips, Landslides & Floods
- Desertification & Drought
- Torrents & Water Dams

The Fourth Part of the encyclopedia consists of six books that discuss the relationship of Earth sciences with other sciences nuclear, and medically, as well as the role of clean, sustainable energy, economically and environmentally:

- Geothermal Energy
- Is the Age of Oil Over?
- Nuclear Geophysics
- Medical Geology
- The Future of Energy in our World
- Guide to Writing Theses & Scientific Publication

As for the Fifth Part, it consists of six books that contain 2020 Questions and Answers (Q & A) to help university students and researchers and prepare them for comprehensive and qualifying exams for postgraduate studies and practice the profession.

- 321 Questions & Answers in the Evolution of the Earth
- 358 Questions & Answers in Petrology, Geochemistry, Remote Sensing and GIS
- 358 Questions & Answers on Natural Resources
- 380 Questions & Answers in Geological Hazards
- 303 Questions & Answers in Seismology and Engineering Seismology
- 300 Questions & Answers in Applied Geophysics

Volcanology

Introduction

Volcano is one of the most formidable and magnificent creations of nature. Volcanos can be either creators or destroyers. They can be mountains or hills, with a crater or vent where lava, melt on rock, hot vapor, and gas erupt from within the earth. Volcanic eruptions sow everywhere fear, death and destruction. But people continue to live near volcanoes trying to understand and predict their behavior. Volcanic activity is widespread over the earth, but tends to be concentrated in specific locations. Volcanoes are most likely to occur along the margins of tectonic plates, especially in subduction zones where oceanic plates dive under continental plates. As the oceanic plate subducts beneath the surface, intense heat and pressure melts the rock. Molten rock material, magma, can then ooze its way toward the surface where it accumulates at the surface to create a volcano. Volcanic activity can be found along the Mid-ocean ridge system as well. It is also thought that a «hot spot» lies beneath the island that contributes to volcanism.

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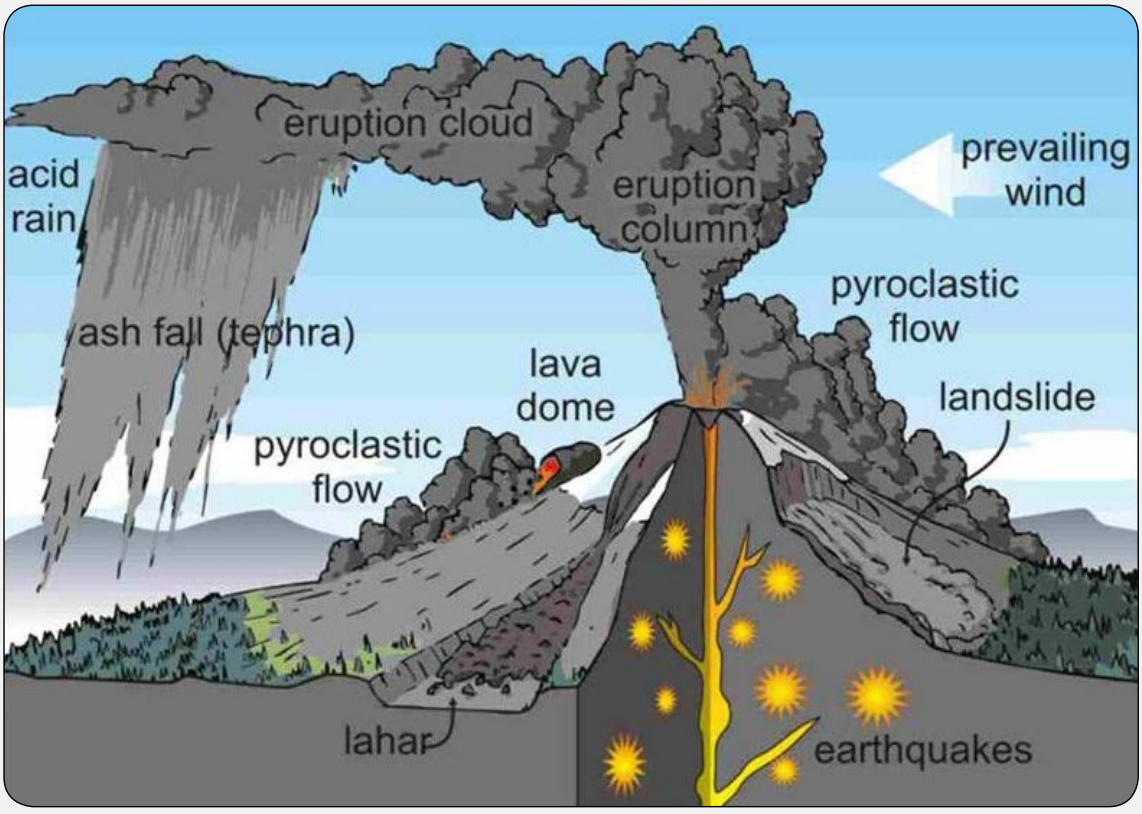
Questions & Answers in Volcanology



Volcanology

1 What is Volcanology?

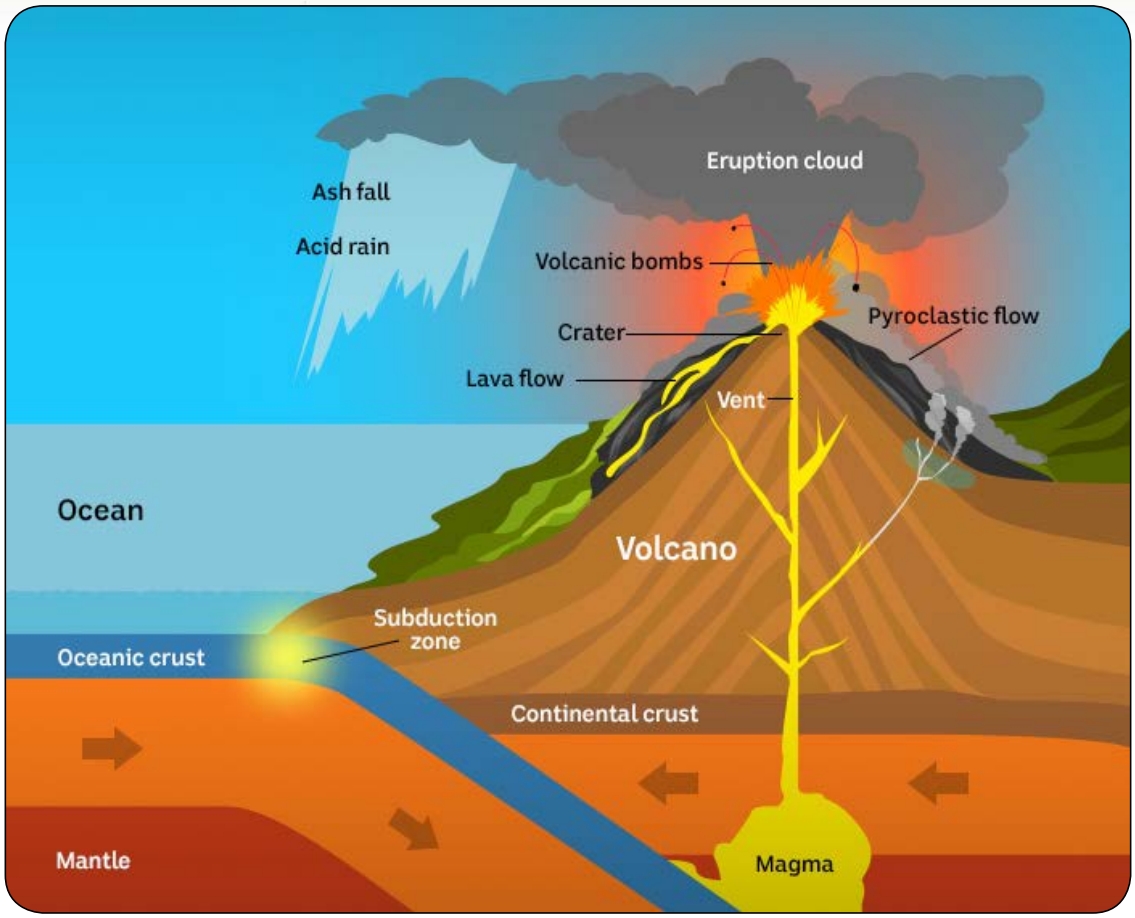
Volcanology (also spelled vulcanology) is the study of the generation and movement of molten rock on Earth and other planetary bodies, primarily through volcanoes and volcanic eruptions. This encompasses the generation of magma, its geochemistry and movement through the Earth's crust, the physics of volcanic eruptions and hazards including ash clouds and pyroclastic flows Can you explain the concept of volcanoes? A volcanologist is a geologist who studies the eruptive activity and formation of volcanoes, and their current and historic eruptions.

2 What is A volcano?

A volcano is an opening, or rupture, in a planet's surface or crust. A volcano is the vent through which magma and gases are discharged. Magma that reaches the surface is called "lava." Volcanos are named for Vulcan — the Roman god of fire.

3 Where are volcanoes usually found?

Volcanoes are found all over the world but the most common location for active volcanoes is at the boundaries of tectonic plates where plates are converging. One plate pushes under another (a process known as subduction) and as it sinks it melts and generates an explosive type of magma that is vented through volcanoes on the upper plate. These kinds of volcanoes are common along the so-called Ring of Fire — a horseshoe-shaped area around the Pacific Ocean.
Volcanoes also occur in the middle of oceans where tectonic plates are pulling apart or diverging. This mainly occurs underwater, where it can also lead to hydrothermal vents on the deep sea floor that harbor extreme forms of life. Volcanic activity in Iceland also comes from diverging tectonic plates. Some volcanoes occur in the middle of tectonic plates, and are created as the plate moves over a hot part of the Earth's interior. As the plate continues to move across the "hot spot", a chain of volcanoes, like those seen in the islands of Hawaii, are created.



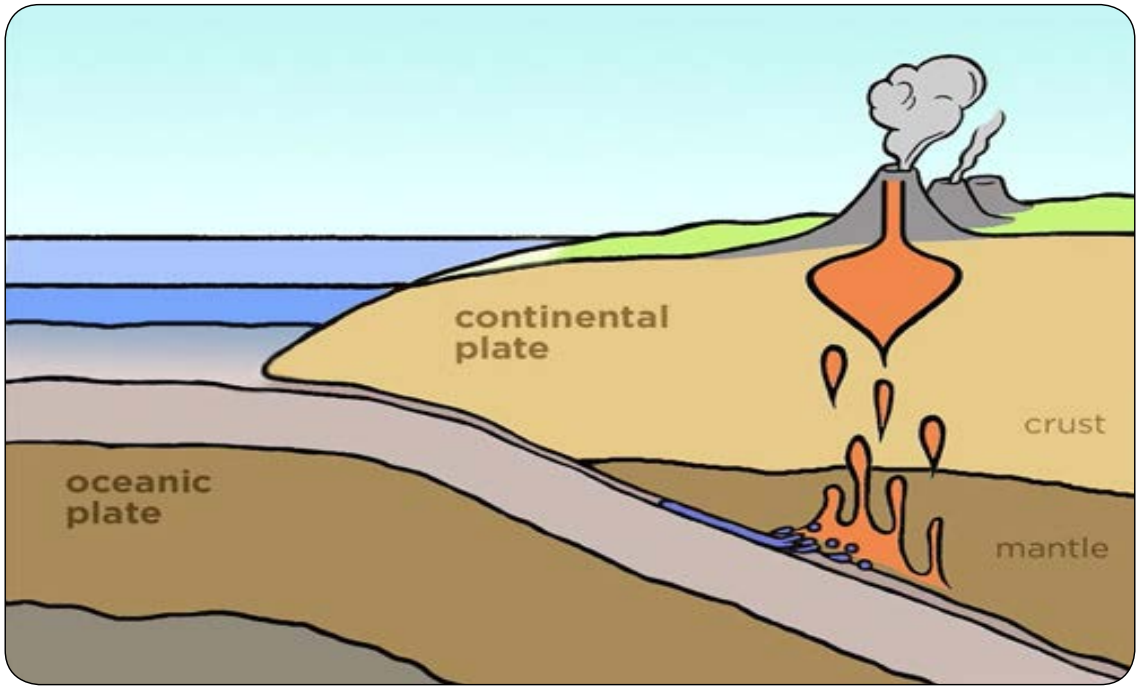
4 What is the sequence of events before, during, and after a volcanic eruption

The eruption of a volcano is a process. First of all a volcano is a way for magma from within the Earth to escape. When pressure from gases gets too great a volcano will erupt so that the built up magma under pressure has somewhere to go. After the volcano erupts the magma becomes lava and it begins to cool down once it has reached the surface. Lava and volcanic ash can have a profound effect on the area around the volcano and it can destroy people's homes as well. When the lava all cools down and everything is returned to normal the process will start all over again with gases building up that will eventually lead to another eruption.

5 How often do volcanoes erupt?

Some small volcanoes only erupt once in their lives, while other volcanoes erupt multiple times. Kilaeua volcano in Hawaii, which has been erupting continuously since 1983, is the world's most active volcano. While some volcanoes erupt at regular intervals, there are always exceptions to the rule. A. Timing: If a volcano has erupted at reasonably regular intervals then this could help suggest when it might erupt again.

The longer the period between eruptions and the larger the last eruption, the bigger the predicted eruption. And even if a volcano behaves as expected — not a given — a recent inventory suggests we can only use this method on around 1,200 of the 3,500 active volcanoes around the world, for which there is an eruption history. B. Earthquake activity: Increased earthquake activity can indicate a volcano is about to erupt, but not always. C. Change of volcano shape: When magma rises it can cause measurable changes to the summit and slopes of the volcano. D. Warming water: As magma rises it can also cause detectable heating of groundwater and surface lakes. E. Gas emissions: Changes in the amount and composition of gas emitted from volcanoes can tell scientists about how magma is moving



6 What does this picture show. How does this lead to volcanic eruptions?

This picture shows a volcano forming at a subduction zone. When an oceanic plate collides with a continental plate, it sinks into the mantle below. As the oceanic plate sinks, fluid (shown in purple) is squeezed out of it. The fluid flows up into the mantle rock above and changes its chemistry, causing it to melt. This forms magma (molten rock – shown in orange). The magma rises and collects in chambers within the crust. As magma fills the chamber, pressure grows. If the pressure gets high enough, the magma can break through the crust and spew out in a volcanic eruption.

7 What happens as magma forces its way up through weak spots of the crust?

Magma is the term that is used to call molten rocks that resides deep within the earth. It is composed of crystals, particles of rock, liquids and different types of gas. The reason that magma rises to the earth is that its weight is lesser than the hard rocks that surround it and also the extreme temperature underneath the earth forces it to rise upward. When magma is forced to rise due to the reasons mentioned above, it exerts pressure on the weak spots of the crust. It fills up the cracks that were produced by the shifting of the earth's crust and when the pressure has risen too much, it will force itself upwards and erupt as lava.

8 How does lava get enough pressure to break through the crust?

The pressure to break the crust comes from two sources: gas and buoyancy. The gas pressure builds as the molten rock approaches and eventually may crack the crust. The buoyancy of molten rock is related to the temperature and composition of the rock. It is hot and less dense then the surrounding rock so it can, with a little help from gas, fracture rock.

9 What kinds of rocks do volcanoes make?

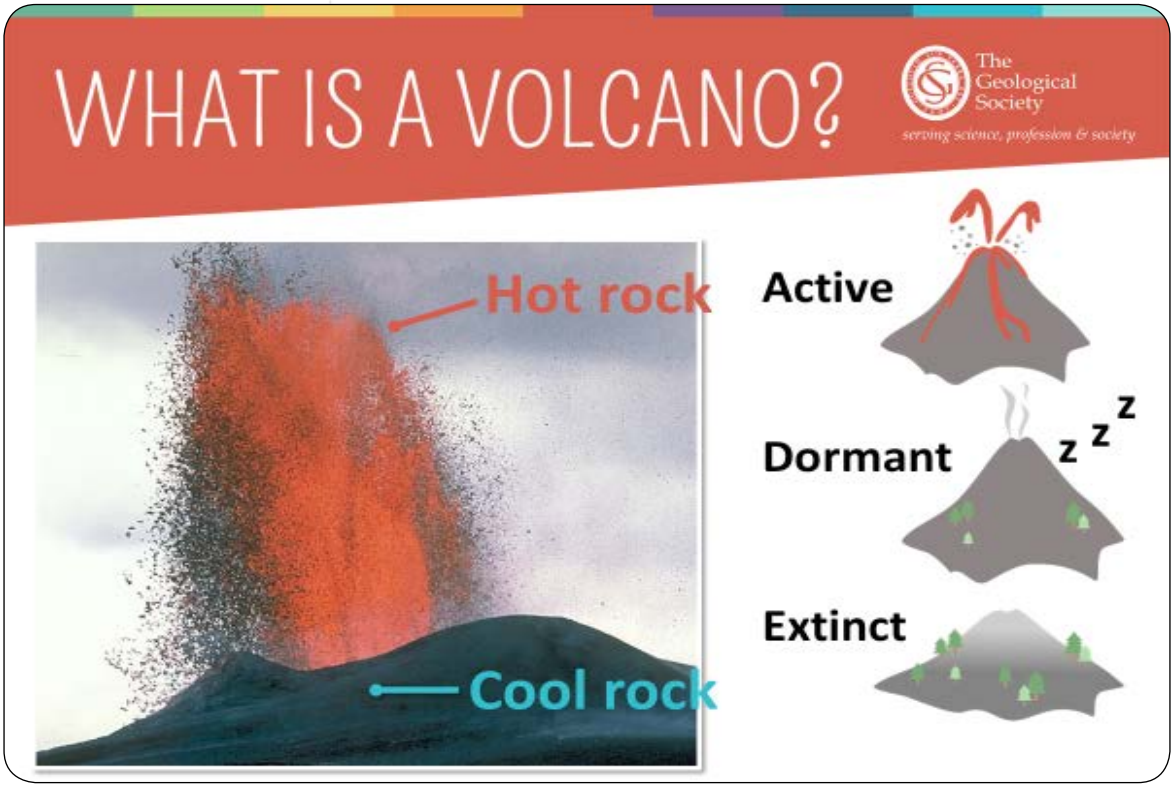
Volcanoes make many different types of rocks. For example, black shiny rocks with only a few crystals are usually basalt. The opposite — white shiny rock with many crystals and often many bubble holes inside the rock is rhyolite. In between are andesites, which are light gray and usually have large box-shaped crystals called plagioclase.

10 What gases do volcanoes emit?

Inside the crater of a volcano there is nothing alive and many small fumaroles (holes) release nasty gases. There are many colorful minerals being deposited from the gases as they cool. The most important gas is water, and then carbon dioxide. These two important gases are not poisonous. Sulfur dioxide, hydrogen chloride, and hydrogen fluoride are emitted, as well. They are strong poisons and cause pollution problems.

11 What is the difference between an active, erupting, dormant and extinct volcano?

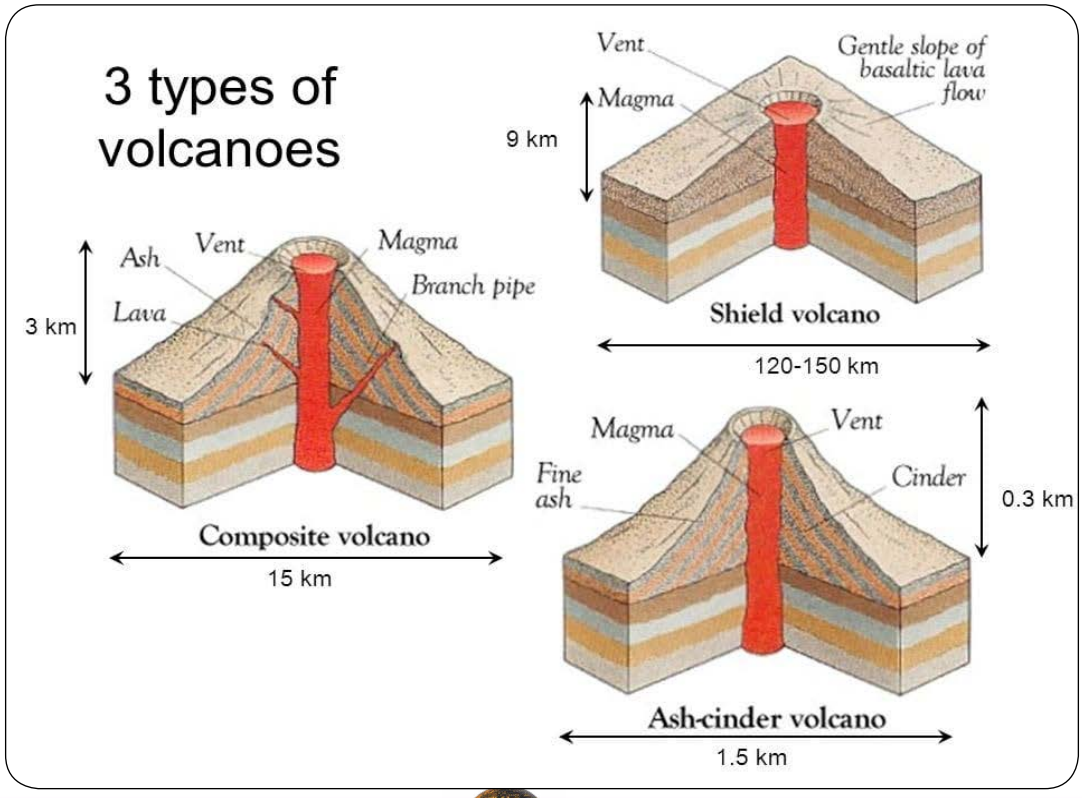
Active volcano is a volcano that has had at least one eruption during the past 10,000 years. An active volcano might be erupting or dormant.
Erupting volcano is an active volcano that is having an eruption.
Dormant volcano is an active volcano that is not erupting, but supposed to erupt again. Extinct volcano has not had an eruption for at least 10,000 years and is not expected to erupt again in a comparable time scale of the future.



12	**What's the most common type of volcano?**	
	A. Stratovolcanoes B. Shield Volcanoes C. Cinder Cone Volcanoes	

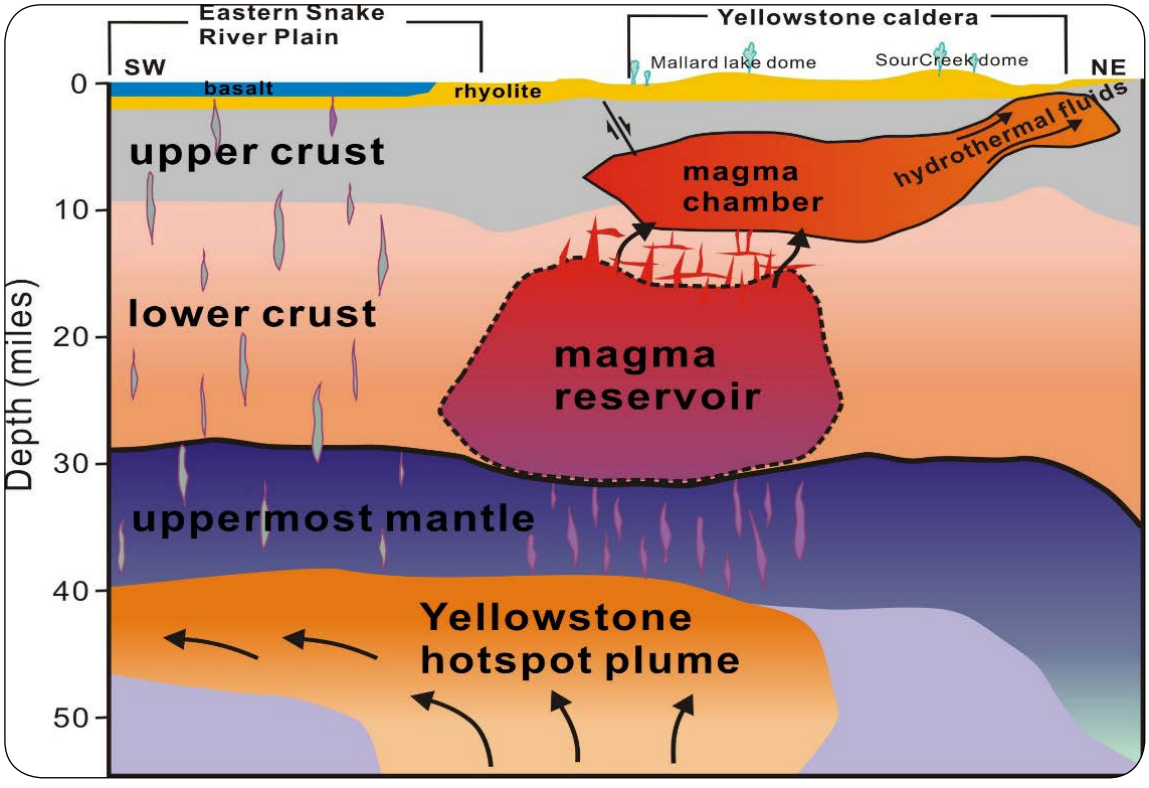
13 How to recognize types of volcanoes?

A Shield volcanoes are recognized by its broad, gently sloping form, made of once fluid lavas. Mauna Loa is the type example. B. Cinder cones volcanoes, by steep sided (25-33 degrees), made of fragments of lava that were spit out of the volcano. Most of these cones are small (100's of meter across, although some get large, several kms). Mauna Kea has some of these cones as does Waianae. Diamond Head is a special type of cinder cone because it was formed very explosively. He has a very large crater compared to the rim size. This type of volcano is called a tuff cone. Koko crater is another example of this type of volcano. C. Composite or Stratovolcanoes are composed of once pasty lavas and layers of lava fragments (from explosive eruptions). It has gentle to moderate slopes on flanks and is steep near the summit. Usually smaller than shields but larger than cinder cones. Some of these volcanoes, like Crater Lake volcano, have cinder cones on it.



14 What is a Supervolcano?

The term "**Supervolcano**" implies a volcanic center that has had an eruption of magnitude 8 on the Volcano Explosivity Index (VEI), meaning the measured deposits for that eruption is greater than 1,000 cubic kilometers (240 cubic miles). The VEI scale was created as a general measurement of the explosivity of an eruption. There are multiple characteristics used to give an eruption its VEI allowing for the classification of current and historic eruptions. The most common criteria are volume of ejecta (ash, pumice, lava) and column height. All VEI 8 eruptions occurred tens of thousands to millions of years ago making the volume of ejecta or deposits the best method for classification.



15 Describe the magma in Shield volcano ?

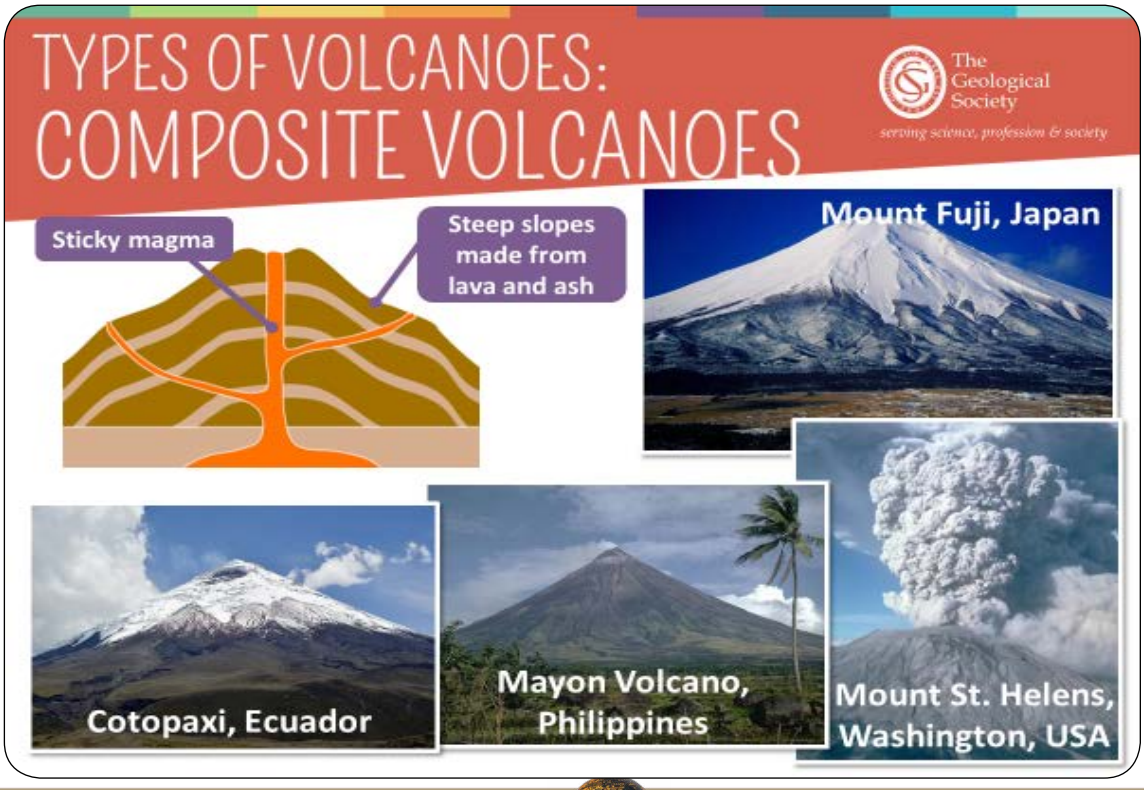
Shield volcanoes are the largest volcanoes on Earth that actually look like volcanoes. The Hawaiian shield volcanoes are the most famous examples. Shield volcanoes have the following characteristics:

- Basaltic magma, which is high in temperature, very low on silica and with low gas content. This type of magma produces fluid lava with very little explosive activity.
- Basic lava, which is non-acidic and very runny.
- Gentle sides as the lava flows for long distances before it solidifies.
- No layers, as the volcano just consists of lava.
- Less violent eruptions.
- Shorter periods between eruptions.
- Examples of shield volcanoes are Kilauea and Mauna Loa, Fernandina, Karthala

16 Describe the magma in Stratovolcano?

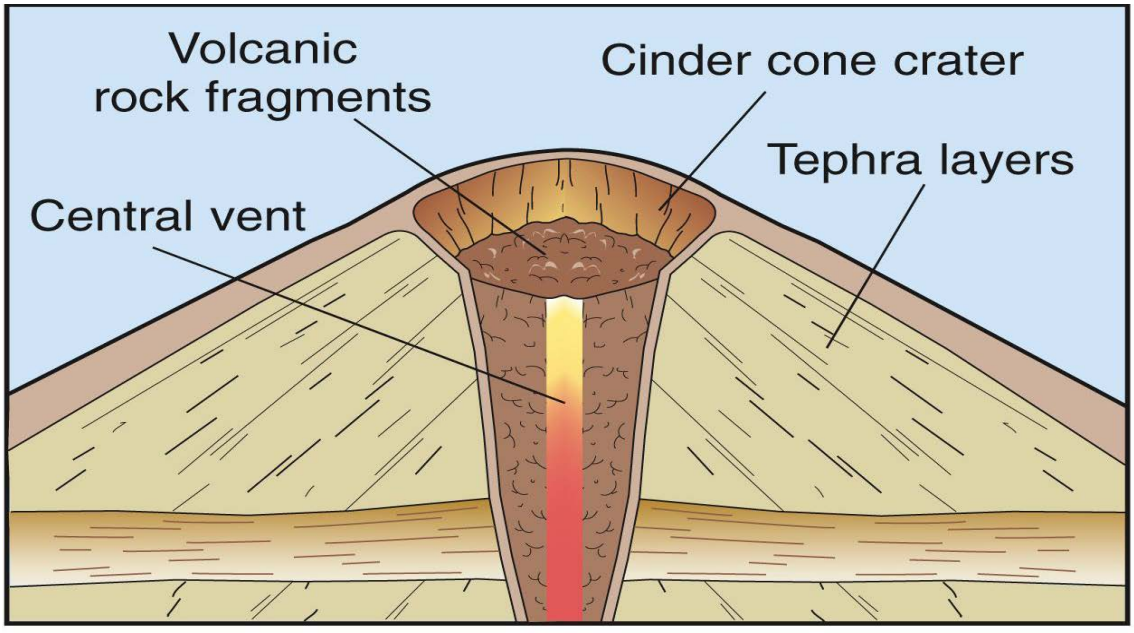
Stratovolcanoes comprise the largest percentage (~60%) of the Earth's individual volcanoes. and have the following characteristics:

- Andesitic magma, which is lower in temperature, has more silica and a lot of dissolved gases and is more likely to explode when it reaches the surface.
- Acidic lava, which is very viscous (sticky).
- Steep sides as the lava doesn't flow very far before it solidifies.
- Alternate layers of ash and lava. For this reason, they're also known as stratovolcanoes. Strato means layers.
- Violent eruptions.
- Longer periods between eruptions.
- Strato volcanoes are usually about half-half lava and pyroclastic material, and the layering of these products gives them their other common name of composite volcanoes.



17 What are Cinder cone Volcanoes?

Cinder cone, also called ash cone, deposit around a volcanic vent, are circular to oval volcanic cone structures, which are composed exclusively or predominantly of pyroclastic ejecta dominated by cinder. They therefore form the simplest type of volcanoes. Cinders are glassy rock fragments which contain numerous gas bubbles "frozen" as magma exploded into the air and then cooled quickly. These fragments accumulate around and downwind from a vent. Spheroidal and spindle-shaped bombs are common at cinder cones. Unlike the violently explosive eruptions that create large stratovolcanoes, cinder cones form when low-viscosity lava with lots of gas erupts, often as liquid fountains. Lava may be spewed hundreds of feet through the air. These volcanoes seldom exceed 500 m in height and form steep slopes of up 30 to 40º with a very wide summit crater. Once this type of volcano has become dormant, a cinder cone normally never erupts again. Most of them are "single-shot" eruptive features. The next outburst will build a new cinder cone somewhere nearby.



(b)

18 What is a pyroclastic flow?

A pyroclastic flow is a fluidized mixture of solid to semi-solid fragments and hot, expanding gases that flows down the sides of a volcano. These awesome features are heavier-than-air emulsions that move much like a snow avalanche, except that they are fiercely hot, contain toxic gases, and move at phenomenal, hurricane-force speeds. They are the most deadly of all volcanic phenomena.

19 What is lahar?

A lahar is a type of mudflow or debris flow composed of pyroclastic material, rocky debris, and water. The material flows down from a volcano, typically along a river valley. It is very dangerous because it's consistency and the way it acts is very much like cement. It is liquid when it's moving, but when it stops, it solidifies. This can cause just as much devastation as lava itself

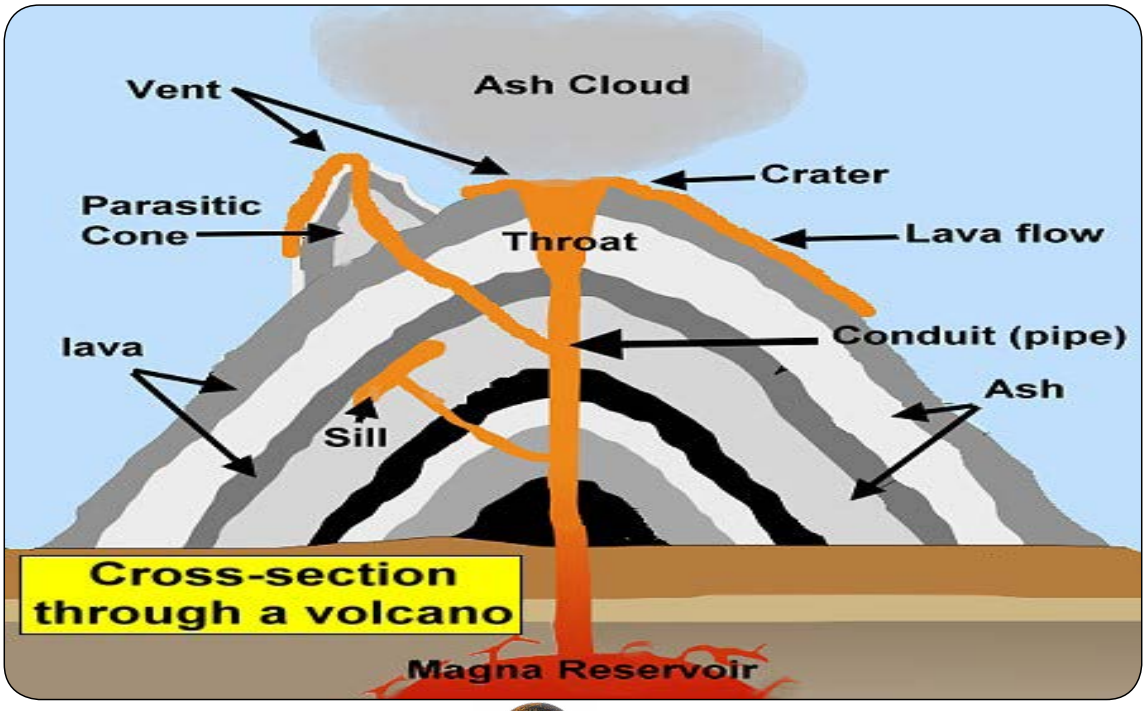
20 What is a mud volcano?

In volcanic regions, mud volcanoes are usually small volcano-shaped cones of mud. They are built as mud erupts from a vent, either as a flowing liquid or ejected into the air. The mud is formed as acid gases rise through the crust, react with rock and turn it into clay. The mud is a mixture of clay and groundwater. The mud volcanoes erupt following pressurization from geothermal steam and gases.

21 Draw a cross- section showing major elements of a volcano?

Volcanoes are not just holes in the surface of the Earth, if we slice into a volcano we can see what an average volcano structure might be.When molten rock is below the surface of the Earth it is known as magma but when it erupts it is called lava.

Ash steam and gas – material erupted from a volcano
Lava- erupted magma
Magma chamber- pool of magma below the volcano
Conduit- channel which magma travels through
Main vent- main opening in the ground surface
Crater- created when an eruption blows the top off a volcano
Sills- flat sheets of igneous rock formed underground rather than erupting from a volcano
Dykes – vertical columns of igneous rock formed from magma cooling below the surface
Geysers- vent that shoots steam and boiling water into the air
Volcanic bombs- lumps of rock and blobs of lava ejected by the volcano



22 What is meant by Tephra?

Tephra is a general term for fragments of volcanic rock and lava that are blasted into the air by explosions or carried upward by hot gases in eruption columns or lava fountains. Tephra includes large, dense blocks and bombs, and small, light rock debris such as scoria, pumice, reticulite, and ash.

23 What are Fumaroles ?

Fumaroles are vents from which volcanic gas escapes into the atmosphere. Fumaroles may occur along tiny cracks or long fissures, in chaotic clusters or fields, and on the surfaces of lava flows and thick deposits of pyroclastic flows. They may persist for decades or centuries if they are above a persistent heat source (active Magma chamber) or disappear within weeks to months if they occur atop a fresh volcanic deposit that quickly cools.

24 Why is a chain of extinct volcanoes often found trailing away from a hotspot?

Hot spots cause mantle to melt. The magma rises up and breaks through the overlying plate. The hotspot stays in one place, but the tectonic plate above it moves. As the plate moves, so does the volcano. The volcano that moved away from the hot spot becomes extinct, and another one forms right above the hot spot. This process continues, forming a line of extinct volcanoes.

25 How old is Aconcagua?

Aconcagua is a very old volcano that is no longer active. No one knows exactly how old the Aconcagua is, however, the last time that the volcano was active was almost ten million years ago. During Aconcagua's active time the volcano was able to reach a height of around twenty-two thousand feet. Aconcagua is apart of the Andes mountain range in Mendoza Province, Argentina.

26 What is the difference between Scoria and Pumice?

Scoria is a dark-colored igneous rock with abundant round bubble-like cavities known as vesicles. It ranges in color from black or dark gray to deep reddish brown. Scoria usually has a composition similar to basalt, but it can also have a composition similar to andesite. Scoria forms when magma containing abundant dissolved gas flows from a volcano or is blown out during an eruption. As the molten rock emerges from the Earth, the pressure upon it is reduced and the dissolved gas starts to escape in the form of bubbles. If the molten rock solidifies before the gas has escaped, the bubbles become small rounded or elongated cavities in the rock. This dark-colored igneous rock with the trapped bubbles is known as scoria. Small particles of scoria that litter the landscape around the volcano are known as "lapilli" if they are between 2 millimeters and 64 millimeters in size. Larger particles are known as "blocks."

Pumice is a vesicular igneous rock that is very similar to scoria. There are a few differences that can be used to distinguish them. First is their color. Scoria is almost always black or dark gray to reddish brown, while pumice is almost always white to light gray to light tan. This color difference is a result of their composition. Scoria forms from basaltic magmas, while pumice forms from rhyolitic magmas - which usually contain more gas. Pumice has a much higher concentration of trapped bubbles - so many that the walls between them are very thin. The vesicles in pumice contain enough air that the rock will float on water. The thick walls of scoria make it heavy enough to sink.

obsidian

pumice

rhyolite

granite

scoria

basalt

27 What is the different between Pahoehoe and Aa?

Pahoehoe (Pa-Hoy-Hoy) lava flows are very hot, thin and runny. When it cools is has a smooth to ropey texture because of the low silica content which makes it cool quickly. Pahoehoe flows creep along generally at less than 3 feet per minute but some flows have been measured at over 20 miles per hour. The terms pahoehoe and Aa are from the native Hawaiian language and are now used by geologists the world over.

Aa lava flows are formed when the lava is produced in a manner that allows it to cool quickly. When a fire fountain shoots the lava high into the air it cools somewhat before it can flow after landing on the surface. Aa lava also forms when there is a huge amount of lava produced or a steep slope moves the lava at high speeds. These high speeds put the lava in greater contact with the air, which makes it cool more quickly.

When volcanoes do produce lava flows they are classified as either Pahoehoe or Aa. The lava is identical in both pahoehoe and aa lava flows, the difference comes from the amount of lava erupted and the speed of cooling. Pahoehoe lava flows are produced from a small amount of lava that moves slowly, while Aa flows usually are associated with a large volume of lava that moves swiftly. Aa flows are generally 6-15 feet thick and pahoehoe flows are usually 1-3 feet thick.


LAVA TYPES
The Geological Society
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Pahoehoe lava, Hawaii
´A´a lava, Guatemala
Photo: Librex/CC-By-2.0
Columnar joints, Isle of Mull
Pillow lava, Cornwall
CSM - Exeter University

28 What does tuff mean?

Tuff is a type of rock made of volcanic ash ejected from a vent during a volcanic eruption. Following ejection and deposition, the ash is compacted into a solid rock in a process called consolidation. Tuff is sometimes erroneously called "tufa", particularly when used as construction material, but geologically tufa is a limestone precipitated from groundwater. Rock that contains greater than 50% tuff is considered tuffaceous. Tuff is a relatively soft rock, so it has been used for construction since ancient times. Since it is common in Italy, the Romans used it often for construction. Tuff can be classified as either sedimentary or igneous rock.

29 What is pillow lava?

Pillow lava One of the most common types of submarine lava is called pillow lava because it consists of roughly spherical or rounded pillow-shaped forms. Pillow lava forms not only in the deep sea, but also when on-land lava flows into the sea, rivers, or lakes. Pillow lava has been observed forming in shallow water off the coast of Hawaii, where lava from Kilauea volcano enters the sea and continues to flow underwater. The glassy surfaces of pillows are not smooth but have cracks, corrugations, and linear grooves, many of which intersect at right angles. The outer crust of pillows forms adjacent to spreading cracks, which act like tiny versions of mid-ocean ridges.

30 What is volcanic ash?

Volcanic ash is a mixture of rock, mineral, and glass particles expelled from a volcano during a volcanic eruption. The particles are very small—less than 2 millimeters in diameter. They tend to be pitted and full of holes, which gives them a low density. Along with water vapor and other hot gases, volcanic ash is part of the dark ash column that rises above a volcano when it erupts. Due to their tiny size and low density, the particles that make up volcanic ash can travel long distances, carried by winds. When an ash column is moved about by wind, it is called an ash plume. Eventually the ash in the sky falls to the ground. It may create a thick layer of dust-like material on surfaces for miles around the original eruption.

31 How do scientists forecast eruptions?

Scientists use a wide variety of techniques to monitor volcanoes, including seismographic detection of the earthquakes and tremor that almost always precede eruptions, precise measurements of ground deformation that often accompanies the rise of magma, changes in volcanic gas emissions, and changes in gravity and magnetic fields. Although not diagnostic individually, these techniques, when used in combination at well-monitored volcanoes, have resulted in successful predictions. At Pinatubo volcano (Philippines) in 1991, a successful forecast saved thousands of lives.

32 Name a difference between an island chain and an island arc.

An island chain occurs on a lithospheric plate. An island arc is a string of volcanic islands that forms close to a plate boundary.

33 Give some Key facts about volcanoes?

- A volcano is formed by eruptions of lava and ash.
- Volcanoes are usually cone shaped mountains or hills.
- When magma reaches the Earth's surface it is called lava. When the lava cools, it forms rock.
- Volcanic eruptions can happen at destructive and constructive boundaries, but not at conservative boundaries.
- Some volcanoes happen underwater, along the seabed or ocean floor.

34 How are underwater volcanoes different from volcanoes that are above sea level?

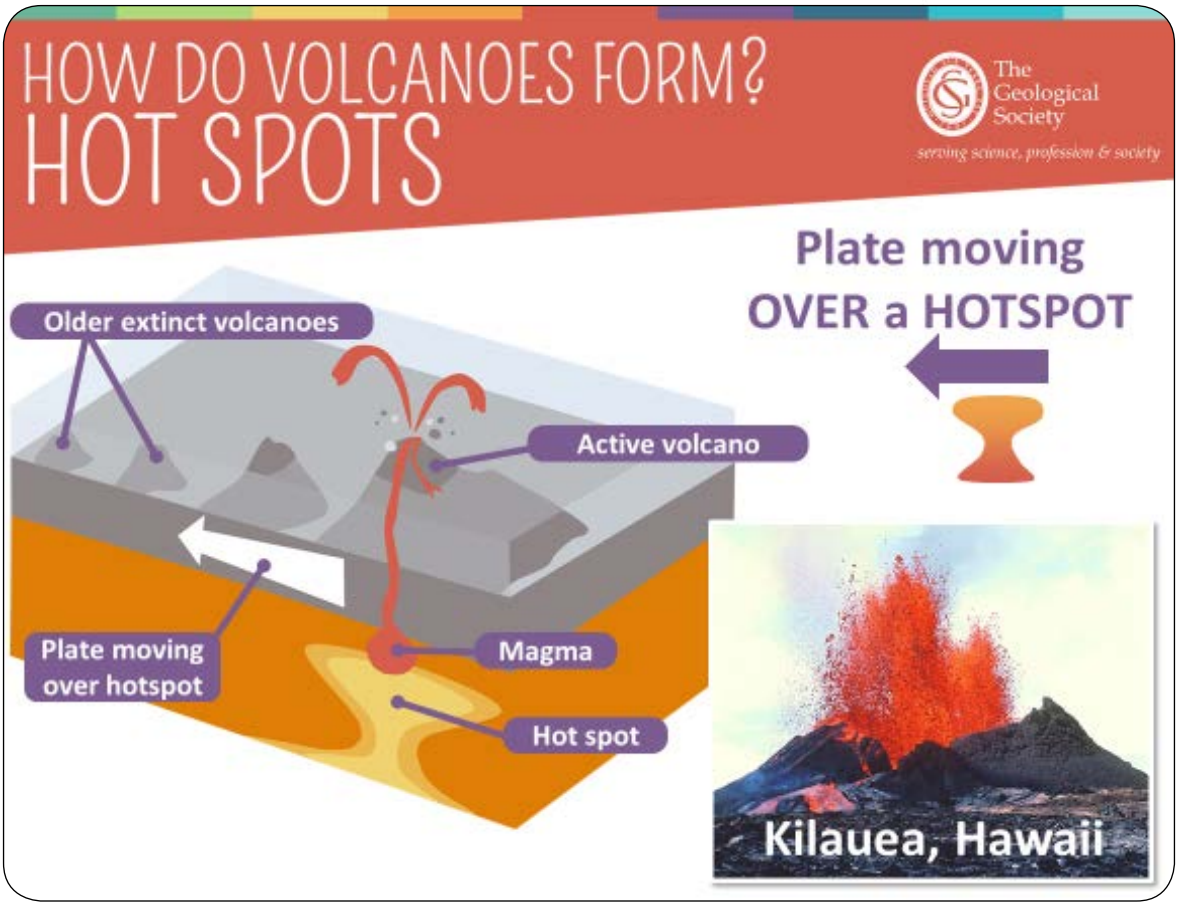
Submarine volcanoes are very different from the volcanoes that are above sea level. Water has a higher pressure than air. This higher pressure can cause an underwater, explosive volcanic eruption. One famous example of an underwater explosive eruption is Surtsey, a new volcano off the south shore of Iceland. When Surtsey erupted it punched through the sea and became an island.

35 One such hazard is that volcanic ash can be a threat to what?

Aircraft, in particular those with jet engines where ash particles can be melted by the high operating temperature; the melted particles then adhere to the turbine blades and alter their shape, disrupting the operation of the turbine.

36 What are hotspot volcano?

Hotspots are volcanic areas believed to be formed by mantle plumes, which are hypothesized to be columns of hot material rising from the core-mantle boundary in a fixed space that causes large-volume melting. In other words Upwelling diapirs with magma from the core–mantle boundary. Plumes rise buoyantly in a lava lamp, plumes of hot mantle rock are theorized to rise buoyantly from the deep mantle. When a plume rises to the shallow mantle, it partially melts and the melt upwells to the surface, erupting as a hotspot volcano. Hotspot volcanism is unique because it does not occur at the boundaries of Earth's tectonic plates, where other volcanism occurs. The mantle plumes that form hotspots are thought to be relatively stationary, while tectonic plates are not. As a plate continues to move away from the lava stream, it carries built up volcanoes with it; as these volcanoes cool and subside, they can produce lines of islands, atolls, and seamounts known as hotspot tracks. Hawaii is the most well-known example of a hotspot volcano.



37 **How old is the oldest volcano?**

The oldest volcano is probably Etna and that is about 350,000 years old. Most of the active volcanoes that we know about seem to be less than 100,000 years old. Volcanoes grow because lava or ash accumulates on the volcano, adding layers and height.

38 Which country has the most active volcanoes?

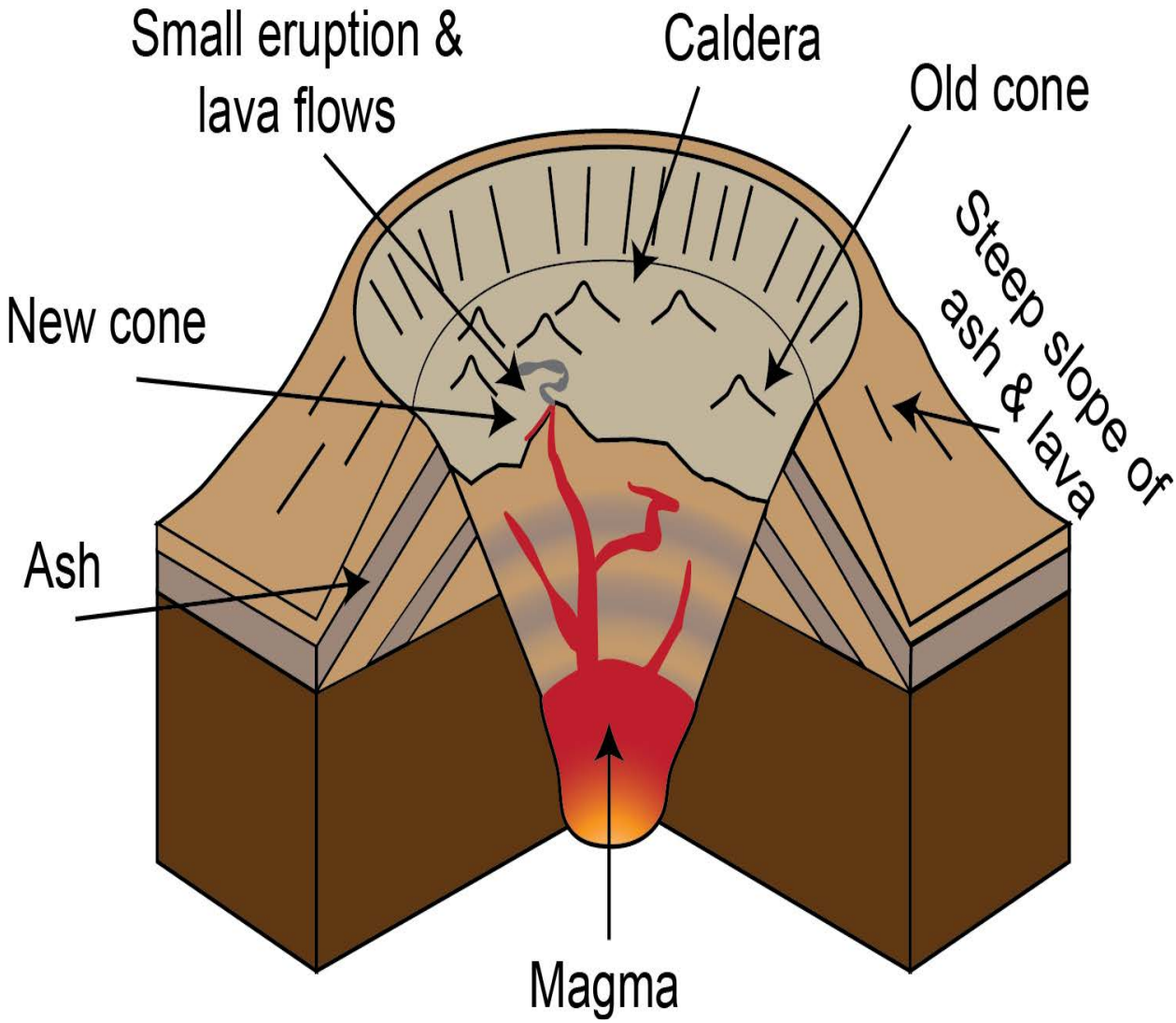
Indonesia is the country with the most active volcanoes. There are over 76 active volcanoes in Indonesia. This country has the maximum active volcanoes on earth. There are overall 147 volcanoes in Indonesia. Indonesia is one of the countries located in the "Ring of Fire". Other countries with high numbers of active volcanoes are the United States, Russia, Japan, Philippines and Australia.

39 What is meant by Calderas and Craters?

Caldera volcano has the coolest and stickiest magma. It tends to erupt so violently its top collapses and leaves a large basin shape in its place. Most calderas—large circular or oval depressions more than 1 km in diameter—have been formed by inward collapse of landforms after large amounts of magma have been expelled from underground. Many are surrounded by steep cliffs, and some are filled with lakes.

The terms **crater** and caldera are often used synonymously, but calderas are larger than craters. A crater can occur inside a caldera, as at Taal Lake in the Philippines, but not the reverse. Calderas are often associated with large eruptions (those producing volumes of 10 cubic km or more of dacitic or rhyolitic magma that form pyroclastic plateaus. Calderas also occur on shield volcanoes. These calderas are thought to form when large rift eruptions or lateral intrusions remove tremendous quantities of magma from the shallow magma chambers beneath the summit, leaving the ground above the chambers with no support. The collapse and refilling of calderas on active Hawaiian volcanoes probably recur many times during a volcano's lifetime.

Caldera Volcano



40 What are the chemical characteristics of volcanic magmas?

Basaltic Magma. Usually forms from rock in the upper mantle, Less than 50% silica, low viscosity, Gases escape easily, Quiet eruptions.
Andesitic Magma. 50-60% silica, Found along oceanic-continental subduction zones, Forms from oceanic crust or oceanic sediments, Intermediate viscosity, Intermediate explosivity. Rhyolitic Magma. Molten material that rises and is mixed with continental crust (rich in water and silica), More than 60% silica, High viscosity, Large amount of trapped gases, Very explosive.

41 What is the difference between magma and lava?

Magma is composed of molten rock and is stored in the Earth's crust. **Lava** is magma that reaches the surface of our planet through a volcano vent. Lava is hot for two reasons: 1. It's hot deep in the Earth (about 100 km down) where rocks melt to make magma. 2. The rock around the magma is a good insulator, so the magma doesn't lose much heat on the way to the surface.
Magma is a complex mixture of molten rock (or part molten). Aside from the minerals, magma can also contain suspended crystals, water, carbon monoxide or other gas bubbles. Magma forms tens of kilometers beneath the surface, in the mantle or deep in the surface. magma generally sits in hot chambers, and when it reaches the surface and becomes lava, it quickly solidifies due to the much lower temperatures. Technically, lava is any molten rock expelled by a volcano in any way.

42 What is the difference between a conduit and a vent on a volcano?

Magma leaves the magma chamber, moves up the conduit, and leaves the conduit at the vent.

43 How do you know when a volcano cannot erupt anymore?

When there are no signs of an active magma chamber beneath the volcano (no unusual seismic activity, no volcanic gasses escaping etc.), and when there hasn't been any activity for a long time span (at least 10,000 years).

44 Are there health effects from volcanic ash?

Ash may include fine particulates that can be inhaled deeply in the lungs. Short-term exposure to ash can cause eye, nose and throat irritation. It is not known what kinds of long-term health effects breathing in ash can have on people. People with asthma, emphysema and other respiratory conditions are more prone to the adverse effects of volcanic ash fall that may include: Runny nose, Sore throat , Worsening of pre-existing respiratory conditions, Difficulty breathing, Eye and skin irritation.

45 If the Pacific Plate is moving at 9 cm per year, calculate:

A. How long will it take for this plate to travel 4.5 meters?
4.5m x 100 = 450 centimeters; 450 cm / 9 cm/yr = 50 years

B. How far will the plate have travelled in meters after 3 years?
9 cm x 3 yrs = 27 cm or .27 m

46 How many volcanoes can erupt at once?

There is no limit on the number of volcanoes that could erupt at once other than the number of active volcanoes themselves: while it is thus theoretically thinkable, that all 600 volcanoes (on land) known to have had eruptions during recorded history erupt at once, this is so unlikely that it can be excluded. At any given time, about 10-20 volcanoes are erupting on average, and it could be imagined that this number sometimes peaks to about 30-50 erupting volcanoes (on land).

47 What are "megaplumes"?

In 1986, a large plume of hot, particle laden water approximately one million cubic meters in volume was discovered over the North Cleft segment of the Juan de Fuca Ridge. This plume was unique in its shape (horizontally and vertically symmetric), size (100 km^3) and rise height (~1km), indicating that an enormous volume of hot water had been released in a relatively short period of time. Later it was discovered this giant plume was associated with a volcanic eruption on the seafloor. Since then megaplumes (or "event plumes") have been discovered at many other undersea eruption sites.

48 Can eruption of one volcano lead to the eruption of others in this or nearby countries?

There is no known mechanism for an eruption at one volcano to set off an eruption at another volcano. Their magma plumbing systems are not directly connected, despite adjacent volcanoes being fed from the same source. The same really powerful earthquake might trigger two very close volcanoes, but that is about it. This is a slow process, with magma taking thousands of years (or longer) to migrate to the surface. A particular volcano will not erupt until there is enough magma and associated gas collected in its shallow magma chamber.

49 Which kind of volcano is being described below? Use one of these terms: active, dormant, or extinct.

A. No longer erupting (**extinct**)
B. Could be described as "sleeping" (**dormant**)
C. May erupt in the future but is not erupting at present or recently (**dormant**)
D. Erupting on a regular basis (**active**)
E. The volcano is eroding and a volcanic rock is exposed (**extinct**)

50 What causes the lightning in the ash cloud?

Lightning is a common phenomenon in volcanic eruption clouds. In an explosive eruption, rock is fragmented into tiny pieces, referred to as “ash” - though not a product of combustion like the ash from a fire. Those particles can carry electrical charges, while frictional collisions between grains can also build up charge. If the positively-charged ash particles become separated from the negatively-charged particles in sufficient quantity, and the two oppositely charged regions become temporarily linked, this is a lightning bolt.

51 What are the relationships between volcanoes and geysers?

Both volcanoes and geysers depend on a strong heat source in the underground, but they have completely different mechanisms. A geyser is a phenomenon on the surface, where ground water beneath the shallow surface is heated up until it explodes into boiling water and steam and then refills its plumbing system with fresh water, so that a new cycle can start. Geysers don’t need to be at a volcano, but almost always occur in volcanic regions close to a volcano. A volcano does not need to have geysers around.

52 What evidence is there of volcanism on other planets?

Moon: has small volcanos, fissures (breaks in the crust), and extensive flows of basalt, a fine-grained dark volcanic rock. The large dark basins that you can see on the Moon are the maria — areas of these lava flows. However, all these volcanic features are old. There are no active volcanic features on the Moon. Most of the volcanic activity took place early in the Moon›s history, before about 3 billion years ago. The most recent lava flow occurred about 1 billion years ago. Saturn, Neptune and Uranus are gas planets and have no solid surface. Therefore, they do not have volcanoes. Some of their moons may have ice volcanoes. Pluto is an icy planet and although we do not have sufficient images of its surface to say for sure, it is unlikely that it has volcanoes because it is too cold. Mars has volcanic features that are similar in shape to those on Earth, although much larger. Venus has more than 1700 volcanic features and many of these look fresh — unweathered.

53 Why don't we find active volcanos on all planets and moons?

Active volcanos occur on planets that are still hot. In general, the larger the planet, the slower it cools. Small planets or moons, like Mercury and our Moon, have cooled to the point that they are no longer hot enough to melt rock. Larger planets, like Earth and Venus, are still hot and still have active volcanism.

54 How can you tell a volcanic crater from an impact crater?

Volcanic craters may have a cone or flanks associated with the crater. There may also be flows present. Impact craters may have central peaks, ejecta, raised rims and floors that are lower in elevation than the surrounding terrain that can distinguish them from volcanic craters. During an impact event, the rocks that are impacted are shocked.

55 How can volcanoes work if there is no atmosphere?

Without an atmosphere, lava can still be forced out through a volcano and flow onto the surface – controlled by gravity. However, without an atmosphere to insulate the lava, it would cool very quickly on the surface.

56 Are volcanoes only extrusive or can they be intrusive?

The definition of a volcano is an opening in the earth through which magma, ash and gas can escape from the interior. By that definition, volcanoes are only extrusive. However, sometimes magma associated with a volcano can cool inside the volcano and create a volcanic neck, a dike or a sill. These features are intrusive.

57 How dangerous are volcanoes?

Volcanoes are usually less dangerous than other natural hazards such as earthquakes, tsunamis and hurricanes. Volcanoes have a serious of hazards (e.g. lava flows, ash fall, pyroclastic flows, climate changes on a global scale) that relate into different dangers or risks. The risks when visiting an active volcano depend on which risk zones of the volcano are visited and for how long.

58 How many volcanic eruptions occur every year?

On average, there are about 50-70 volcanoes that erupt every year. Some of them erupt multiple times, while others only have one eruption. The typical number of individual eruptions per year is more in the range of about 60-80.

59 What is meant by Eruptive phases vs eruptions?

In many cases, it is not easy to define the start and end of an eruption and whether long-lasting eruptions should be considered in such statistics or not. Generally, volcanologist prefer to talk about eruptive phases of a volcano that belong to one single eruption: two or several eruptive events separated by a pause in activity, which can span hours to even weeks. However, it is often impossible to give a final answer to whether two eruptive events at the same volcano should be considered two eruptions or two phases of the same eruption.

Volcanology

60 Which was the world's biggest eruption?

On 10 April 1815, Tambora produced the largest eruption known on the planet during the past 10,000 years. The volcano erupted more than 50 cubic kilometers of magma and collapsed afterwards to form a 6 km wide and 1250 m deep caldera. The eruption produced global climatic effects and killed more than 100,000 people, directly and indirectly. Minor lava domes and flows have been extruded on the caldera floor at Tambora during the 19th and 20th centuries.

61 Which is the world's largest volcano?

The largest volcano on earth is Mauna Loa on Hawai'i Big Island. It is a massive shield volcano constructed by countless lava flows. When measured from the base to the top, the pile of lavas measures more than 17,000 m ! When measured from the sea floor, Mauna Loa's height is still more than 9,000 m, thus it is also the highest mountain on earth. Mauna Loa in fact is so heavy, that its weight has bent the oceanic crust under the volcano several kilometers downwards into the mantle. Mauna Loa is one of the Earth's most active volcanoes, with 33 well-documented eruptions in historic times since 1843. Its last eruption was in 1984 and since 2004, Mauna Loa is showing increasing signs of a possible awakening in a not-too-distant future.

62 Is there a relationship between large earthquakes (>M6) that occur along major fault zones and nearby volcanic eruptions?

Sometimes, yes. A few historic large regional earthquakes (>M 6) are considered by scientists to be related to a subsequent eruption or to some type of unrest at a nearby volcano. The exact triggering mechanism for these historic examples is not well understood, but the volcanic activity probably occurs in response to a change in the local pressure surrounding the magma reservoir system as a consequence of (1) severe ground shaking caused by the earthquake; or (2) a change in the "strain" or pressure in the Earth's crust in the region surrounding where the earthquake occurred

63 What kinds of hazards are associated with volcanic eruptions?

Debris flows, or lahars, are slurries of muddy debris and water caused by mixing of solid debris with water, melted snow, or ice. Lahars at Nevado del Ruiz volcano, Colombia, in 1985, killed more than 23,000 people. Lahars can travel many tens of miles in a period of hours, destroying everything in their paths. Tephra (ash and coarser debris) is composed of fragments of magma or rock blown apart by gas expansion. Tephra can cause roofs to collapse, endanger people with respiratory problems, and damage machinery. Tephra can clog machinery, severely damage aircraft, cause respiratory problems, and short out power lines up to hundreds of miles downwind of eruptions. gas . Pyroclastic flows and surges can travel more than a hundred miles per hour and incinerate or crush most objects in their path. Though most extend only a few miles, a pyroclastic surge at Mount St. Helens in 1980 extended 18 miles (28 km) and killed 57 people.

Lava flows erupted at explosive stratovolcanoes like those in the Pacific Northwest and Alaska are typically slow-moving, thick, viscous flows. Kilauea volcano on the Island of Hawaii has produced thin, fluid lava flows throughout its history, and almost continuously since 1983.

64 Can volcanoes be dangerous even when they don't erupt?

Yes. Many stratovolcanoes have a plumbing system of hot acid water that progressively breaks down hard rock to soft, clay-rich material. The volcano is gradually weakened, and large parts may suddenly fail. Resulting water-rich landslides are especially dangerous because they can occur without any volcanic or seismic warning. The risk of mudflows formed this way is especially high along rivers downstream from Mount Rainier, because of the large population on floodplains, the huge weakened edifice of the volcano, and a long history of large flows that occurred when the volcano was otherwise dormant

65 How many active volcanoes are there on Earth?

Sometimes, yes. A few historic large regional earthquakes (>M 6) are considered by scientists to be related to a subsequent eruption or to some type of unrest at a nearby volcano. The exact triggering mechanism for these historic examples is not well understood, but the volcanic activity probably occurs in response to a change in the local pressure surrounding the magma reservoir system as a consequence of (1) severe ground shaking caused by the earthquake; or (2) a change in the "strain" or pressure in the Earth's crust in the region surrounding where the earthquake occurred

66 What is the role of Volatiles?

Role of Volatiles– water lowers the melting temperatures. At a Subduction Zone, the oceanic plate descends into the mantle, water is driven from the plate and lowers the melting temperature, creating melt

67 How can you determine the age of eruptions?

The age of lava flows can be determined using a variety of techniques, but four common ways include examination of surface features, carbon 14 dating, $^{40}Ar/^{39}Ar$ dating, and ^{36}Cl surface exposure dating. Three of these four methods rely on "radioactive clocks," where an unstable element decays to a stable element over time. Surface features—the relative age of a lava flow, particularly basalt flows, can be determined by examining features preserved on the surface of the flow. Fresh pahoehoe flows have a ropey, glassy surface. As time goes by, the glass will degrade, but the ropey features will still be present. Eventually the ropey features erode away, leaving a flatter, smoother surface on the top of a flow.

68 Does faulting cause volcanoes to erupt?

No clear relationship between faulting and volcanic eruptions has been established. Many volcanoes form in areas with no faulting and most faults are not filled with igneous intrusions. In some cases, igneous rocks in the form of dikes do follow fault planes, but the igneous rock appears to be taking advantage of this path of pre-existing weakness. Also, in many volcanic fields, volcanic vents may be aligned along zones of crustal weakness (e.g., Chain of Craters in the Zuni-Bandera volcanic field), taking advantage of pre-existing flaws in the Earth's crust. Rarely, large magnitude earthquakes along major fault zones appear to trigger volcanic activity in nearby volcanoes.

69 How are volcanic gases measured?

Monitoring volcanic gases can be helpful in predicting eruptions. For example, an increase in CO_2 and SO_2 concentrations emitted from fumaroles may indicate increasing magmatic activity beneath the volcano. The composition and relative volumes of these volatiles can be measured in a variety of ways:

· **Direct measurements** -- Gases escaping from fumaroles can be collected in evacuated flasks and analyzed in geochemical laboratories. Although much useful data has been assembled in this way, the technique can be dangerous and there is great difficulty in collecting samples that are uncontaminated by atmospheric air.

· **Cospec measurements** -- Another technique involves the remote sensing of some gases by a correlation spectrometer, a devise originally developed in the 1970s to monitor SO_2 and other gases from factory smokestacks.

· **Toms measurements** -- On a more regional scale, the distribution and amount of sulfur dioxide released into the stratosphere by volcanic eruptions can be measured by the total ozone mapping spectrometer (TOMS).

70 How do you know when a volcano is going to erupt?

Prior to an eruption, magma (molten rock) migrates into a magma chamber, or reservoir, beneath a volcano. As magma moves toward the surface, it (1) releases gases such as sulfur dioxide and carbon dioxide, (2) produces small earthquakes, and (3) causes subtle swelling of the flanks of the volcano. Scientists can watch for these warning signs by monitoring gases emitted by the volcano, determining the size and frequency of small earthquakes under the volcano by using seismographs, and measuring changes on the slopes of the volcano using tiltmeters.

71 How do volcanoes affect climate?

Sulfur-rich volcanic eruptions that eject material into the stratosphere can have significant effects upon climate. These effects generally consist of tropospheric cooling and stratospheric warming. Volcanic aerosols have a lifetime of 1–3 yrs, so tropospheric cooling will occur over this time frame. Volcanic aerosols injected into the stratosphere can provide surfaces for ozone-destroying reactions. Therefore, large, sulfur-rich eruptions (e.g. Mount Pinatubo) may result in decreased ozone concentration. Abundance of ozone may affect ultraviolet and longwave radiative fluxes, although no clear relationship between ozone abundance and global temperature has been established. Over the course of weeks to years, ongoing production of ash from volcanoes may locally change climate by modifying the “dustiness” of the local atmosphere. Recent work suggests that large eruptions may trigger El Nino climate events.

72 What are the benefits of volcanoes?

The main good effect that volcanoes have on the environment is to provide nutrients to the surrounding soil. Volcanic ash often contains minerals that are beneficial to plants, and if it is very fine ash it is able to break down quickly and get mixed into the soil. Another benefit might be the fact that volcanic slopes are often rather inaccessible, especially if they are steep. Thus they can provide refuges for rare plants and animals from the ravages of humans and livestock. Finally, on a very fundamental scale, volcanic gases are the source of all the water (and most of the atmosphere) that we have today. Volcanic emissions have produced the atmosphere and the water of the oceans. Volcanoes make islands and add to the continents. Volcanic deposits are also used as building materials. Most of the basalt and diabase is used for crushed stone: concrete aggregate, road metal, railroad ballast, roofing granules, and riprap. High-denisity basalt and diabase aggregate is used in the concrete shields of nuclear reactors. Some diabase is used for dimension stone ("black granite").Pumice, volcanic ash, and perlite are mined in the west. Pumice and volcanic ash are used as abrasives, mostly in hand soaps and household cleaners. The finest grades are used to finish

73 Which are the world's most dangerous volcanoes?

Volcanoes can pose immediate risk to local inhabitants and it tends to be large explosive eruptions, lahars and tsunamis which cause the greatest loss of life from the immediate effects of a volcanic eruption. Tambora in 1815 is thought to have directly killed 92,000 people. Some of the most dangerous volcanoes due to their explosive history and proximity to large population centers are :

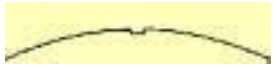
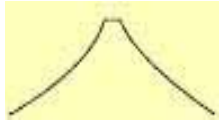
- Mount Tambora (Indonesia) in 1815
- Krakatoa (Indonesia) in 1883
- Mount Pelée (Martinique) in 1902
- Mount St Helens (Washington, USA) in 1980
- Mount Pinatubo (Philippines) in 1991
- Eyjafjallajokull (Iceland) in 2010

74 What is a geothermal field?

Geothermal fields or systems are areas of hot springs and steam vents, which form when rainwater seeps into the ground. The water is then heated by hot rock that has itself been heated by underlying magma (molten rock). They do not necessarily represent the vent of a volcano. It is rather unlikely that geothermal exploration can trigger an eruption. However, geothermal energy extraction can modify the surroundings of the exploration sites (e.g., ground subsidence). While these changes will tend to be relatively shallow (compared with the deep roots of a volcano), exploration must be carefully monitored when located close to an active volcano.

75 What are the different types of volcanoes?

Although every volcano has a unique eruptive history, most can be grouped into three main types based largely on their eruptive patterns and their general forms. The form and composition of the three main volcano types are summarized here:

VOLCANO TYPE	VOLCANO SHAPE	COMPOSITION	ERUPTION TYPE
SCORIA CONE	Straight sides with steep slopes; large summit crater	Basalt tephra; occasionally andesitic	Strombolian
SHIELD VOLCANO	 Very gentle slopes; convex upward	Basalt lava flows	Hawaiian
A STRATOVOLCANO	 Gentle lower slopes, but steep upper slopes; concave upward; small summit crater	Highly variable; alternating basaltic to rhyolitic lavas and tephra with an overall andesite composition	Plinian

76 Can earthquakes trigger volcanic eruptions?

Earthquakes are not necessarily linked to volcanic activity. Some earthquakes are due to tectonic activity (plates shifting), hence not related to volcanoes, while some others are due to magma trying to find its way up a volcano (volcanic earthquakes). Volcanic earthquake are generally indicative of an increase of volcanic activity but don' necessarily lead to an eruption. Tectonic earthquakes can "shake" a volcano and can potentially help triggering an eruption. However, they can also potentially stop an eruption. No direct links between tectonic earthquake activity and eruptions in have been found so far.

77 What are hydrothermal vents?

Hot springs on the ocean floor are called hydrothermal vents. The heat source for these springs is the magma (molten rock) beneath submarine volcanoes. Circulating seawater deep in the ocean crust gets very hot because of the high pressure and can dissolve many chemicals from the rocks. When the hot fluids exit the seafloor and mix with cold seawater, the dissolved chemicals precipitate instantly into tiny mineral particles, forming the plumes that we see at black smokers. Another form of hydrothermal venting is diffuse venting, where lower temperature fluids come out as shimmering water which generally do not contain enough dissolved metal and sulfide to form “smoke”, but may support dense communities of vent animals.

78 What are positive Effects of volcanoes?

Volcanoes have a large effect on their locality. They produce ash, lava, volcanic bombs, pyroclastic flows and lahars. Ash from large volcanoes has been known to affect global climates. The effects of volcanoes can be both positive and negative.

Positive effects are 1. Geothermal energy is where heat from within the Earth is used to generate electricity. 2. Geothermal energy can be generated in areas where magma lies close to the surface. This is good for increasing renewable energy use. 3. Ash ejected by the volcano acts as a good fertilizer for soils 4. Volcanoes attract many tourists, who enjoy the dramatic scenery that they produce 5. Rising magma brings valuable minerals to the surface, creating mining opportunities.

79 What are negative effects of volcanoes?

Negative effects are :

1. Volcanoes are dangerous. They can kill people and damage property.
2. Economic activity can suffer as it is hard for businesses to operate after an eruption
3. Habitats and landscapes are damaged by lava flows.

80 What determines how violently volcanoes erupt?

The chemical composition of magma, water content, internal pressure and other characteristics can influence how violently a volcano erupts. Chemical signatures in cooled lava can also describe the composition of Earth's interior at the time of an eruption that can help geologists understand Earth's inner workings and distant past.

81 What is laze?

When molten lava flows into the ocean, it reacts vigorously with sea water to create large steam plumes laden with hydrochloric acid. These acidic 'laze' plumes mainly create a local hazard for people visiting the coastal entry. Inhaling or contacting acid gases and liquids can irritate the skin, eyes and respiratory tract, and may cause breathing difficulties, particularly for people with pre-existing respiratory diseases

82 What is Vog?

The term **'vog'** refers to the hazy air pollution caused by the volcanic emissions from Kīlauea Volcano, which are primarily water vapor (H2O), carbon dioxide (CO2), and sulfur dioxide (SO2) gas. As SO2 is released from the summit and east rift eruptive vents, it reacts in the atmosphere with oxygen, sunlight, moisture, and other gases and particles and, within hours to days, converts to fine particles, which scatter sunlight, causing the visible haze that is observed downwind of Kīlauea.

83 How are volcanic eruptions monitored?

Volcanic eruptions are unpredictable - however, scientists can monitor volcanoes to estimate when they are likely to erupt. Scientists can use a variety of techniques to do this, such as:

- seismometers - used to measure earthquakes occurring near an eruption. Volcanic eruptions are measured by Volcanic Explosivity Index (VEI).
- tiltmeters and GPS satellites- these devices monitor any changes in landscape - volcanoes tend to swell near an eruption
- monitoring gases escaping from a volcano using robots called Spiders-- often there is an increased release of sulphur dioxide near an eruption, as the magma gets closer to the surface
- measuring temperature - volcanoes become hotter when magma starts to rise through the main vent
- looking at the past history of eruptions - scientists can identify patterns of activity

84 Are gases in the Moon's magma the same as Earth's magma?

Geologic evidence for volcanism, from the study of lunar photos, indicate that the amount to gas dissolved in lunar magmas was very small, even less than Hawaiian lavas. The gases are long gone – escaped into space billions of years ago- likely water and carbon dioxide. Both of these compounds are abundant in the materials out of which the terrestrial planets – including the Moon – were made, and so they are the most likely candidates.

85 What is meant by Effusive Eruptions?

Effusive or Non explosive eruptions are favored by low gas content and low viscosity magmas (basaltic to andesitic magmas).

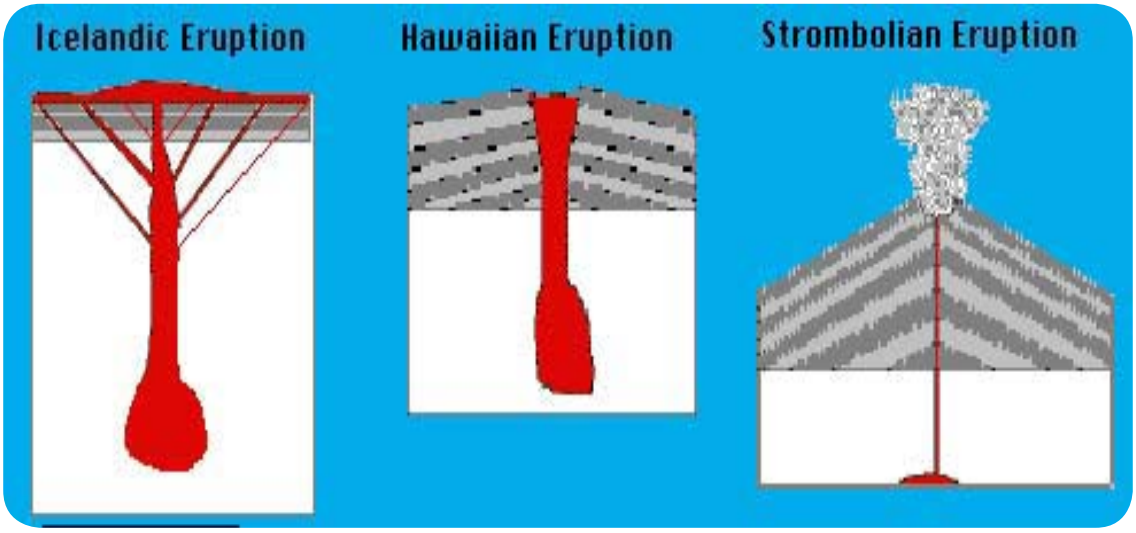
- If the viscosity is low, non-explosive eruptions usually begin with fire fountains due to release of dissolved gases.
- Lava flows are produced on the surface, and these run like liquids down slope, along the lowest areas they can find.
- If the magma emerges along a fracture, it results in a fissure eruption, often called a "curtain of fire"
- Lava flows produced by eruptions under water are called pillow lavas.
- If the viscosity is high, but the gas content is low, then the lava will pile up over the vent to produce a lava dome or volcanic dome.

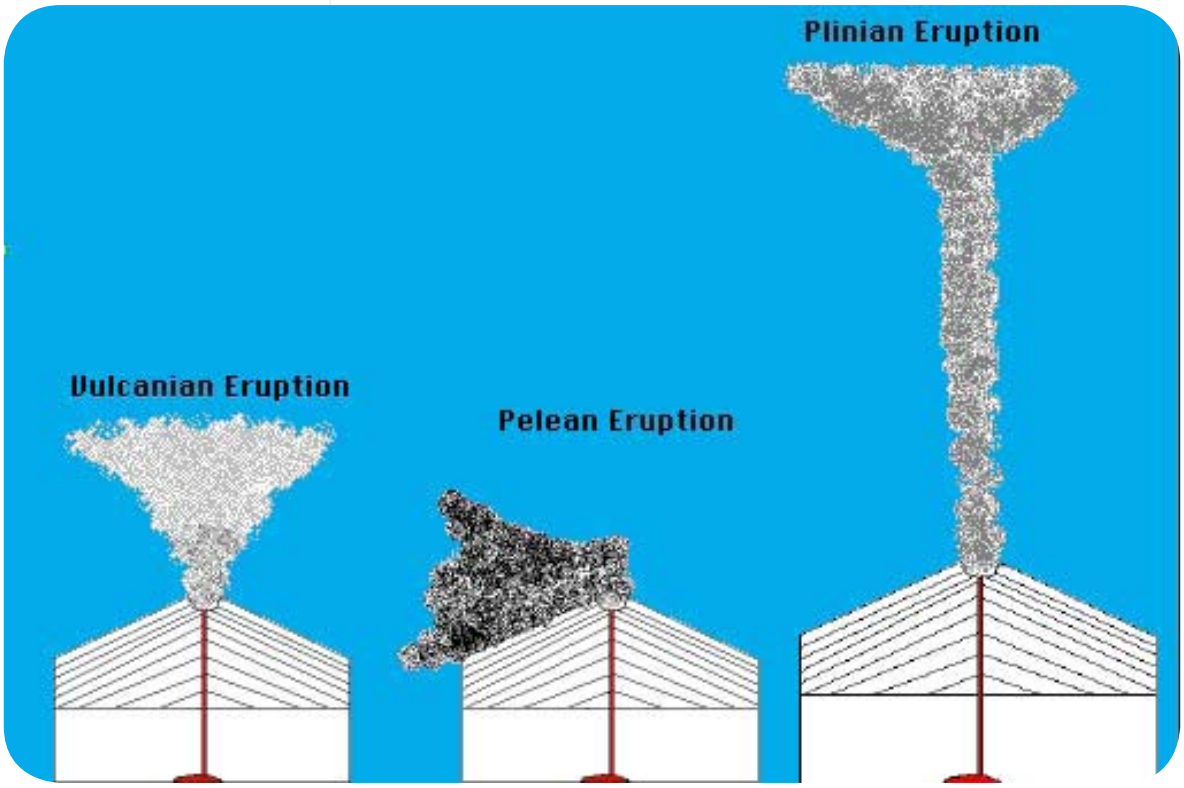
86 What are a hot spot and a mantle plume?

About 95% of the world's volcanoes are located near the boundaries of tectonic plates. The other 5% are thought to be associated with mantle plumes and hot spots. Mantle plumes are areas where heat and/or rocks in the mantle are rising towards the surface. A hot spot is the surface expression of the mantle plume.

87 Classify Volcanoes according to their eruption types and cone shapes?

There are six eruption types and three basic cone shapes. The six eruption types are in order from least explosive to the most explosive; Icelandic, Hawaiian, Strombolian, Vulcanian, Pelean, and Plinian.
There are three basic cone shapes : cinder cones, shield cones, and composite cones or stratovolcanoes.





Notice how, as the eruptions become more violent, the cone shapes become more steeply constructed.

88 **What are main causes of volcanic eruption?**

Volcanoes will erupt for two reasons :

1. The magma deep under the crust is less dense than the surrounding rock causing it to rise.
2. As the magma approaches the surface of the Earth the gas that is in the magma will come bubbling out because the pressure surrounding the magma will decrease nearer the surface.

89 What are Strombolian and Vulcanian eruptions?

Strombolian eruptions are named for the volcanic island off of the coast of Italy. Stromboli has erupted over many centuries almost constantly. Stromboli has been named the "Lighthouse of the Mediterranean" because it erupts every 20 minutes or so. Strombolian eruptions are short lived explosive eruptions that shoot very thick and pasty lava into the air along with bursts of steam and gas. Strombolian eruptions usually produce little or no lava. Because of this the cones that are produced by this type of eruption is a very steep sided cone called a cinder cone.

Vulcanian eruptions are named after the island of Vulcano off the coast of Italy. This is the same island that gave us the name "Volcano". Vulcanian eruptions contain high dark clouds of steam, ash, and gas. The ash plume builds a cauliflower shaped head and a thinner more tree trunk-like base. When the volcano quits erupting ash and gases it then ejects thick pasty lava. Vulcanian eruptions usually build a steep sided cone that is more symmetrical than a cinder cone. This more symmetrical cone is called a strovolcano. Vulcanian eruptions will send an ash plume to a height of 2-9 miles.

Strombolian and Vulcanian eruptions are more explosive than Icelandic and Hawaiian eruptions. Vulcanian eruptions are more violent and explosive than strombolian eruptions.

90 What are Pelean and Plinian eruptions?

Pelean eruptions are named for the catastrophic eruption on the island of Martinique in the Carribean Sea in 1902. The eruption and the pyroclastic flow that followed killed 29,000 people almost instantly. «Glowing clouds» of gas and ash flew down the mountain at over 70 miles per hour. The cloud was so full of ash that it was heavier than air and hugged the ground as it approached the coast.

A Plinian eruption is the most explosive of the eruption types. Mt. St. Helens eruption was a plinian eruption. Plinian eruptions are characterized by a very high ash cloud that rise upwards to 50,000 feet (almost 10 miles) high. Very deadly pyroclastic flows are also part of plinian eruptions. Pelean and Plinian eruptions are the most dangerous and explosive of the eruption types.

91 How is a volcano formed?

1. Magma rises through cracks or weaknesses in the Earth's crust.
2. Pressure builds up inside the Earth.
3. When this pressure is released, eg as a result of plate movement, magma explodes to the surface causing a volcanic eruption.
4. The lava from the eruption cools to form new crust.
5. Over time, after several eruptions, the rock builds up and a volcano forms.

92 Where is runny lava and Lave dome found?

This type of lava is found at mid-ocean ridges or hot spots. If the lava is very hot and has a low viscosity (runny with a low gas and silica content). Lava domes are rounded, steep-sided mounds built by magma that is highly resistant to flow, usually either dacite or rhyolite. Such magmas are typically too viscous to move far from the vent before cooling and crystallizing. Domes may consist of one or more individual lava flows.

93 Which was the world's biggest eruption?

On 10 April 1815, Tambora produced the largest eruption known on the planet during the past 10,000 years. The volcano erupted more than 50 cubic kilometers of magma and collapsed afterwards to form a 6 km wide and 1250 m deep caldera. The eruption produced global climatic effects and killed more than 100,000 people, directly and indirectly. Minor lava domes and flows have been extruded on the caldera floor at Tambora during the 19th and 20th centuries.

94 Which is the biggest volcano?

The biggest volcano in the world is probably Mauna Loa, in Hawaii. It rises off of the seafloor to 13,000 feet above sea level or about 29,000 feet above the seafloor. Another huge volcano is Mt. Etna on the island of Sicily, in Italy.

95 How Magmas Evolve?

1.A single volcano may extrude lavas that vary in composition 2. Bowen's reaction series •Minerals crystallize in a systematic fashion based on their melting points. •As minerals crystallize, the composition of the liquid portion of the magma continually changes •The minerals rich in iron (Fe) and magnesium (Mg) (ferromagnesians) crystallize first. •The melt becomes enriched in Na, K, Al, and SiO_2.

96 What two ingredients in magma affect the type of explosion and shape of a volcano?

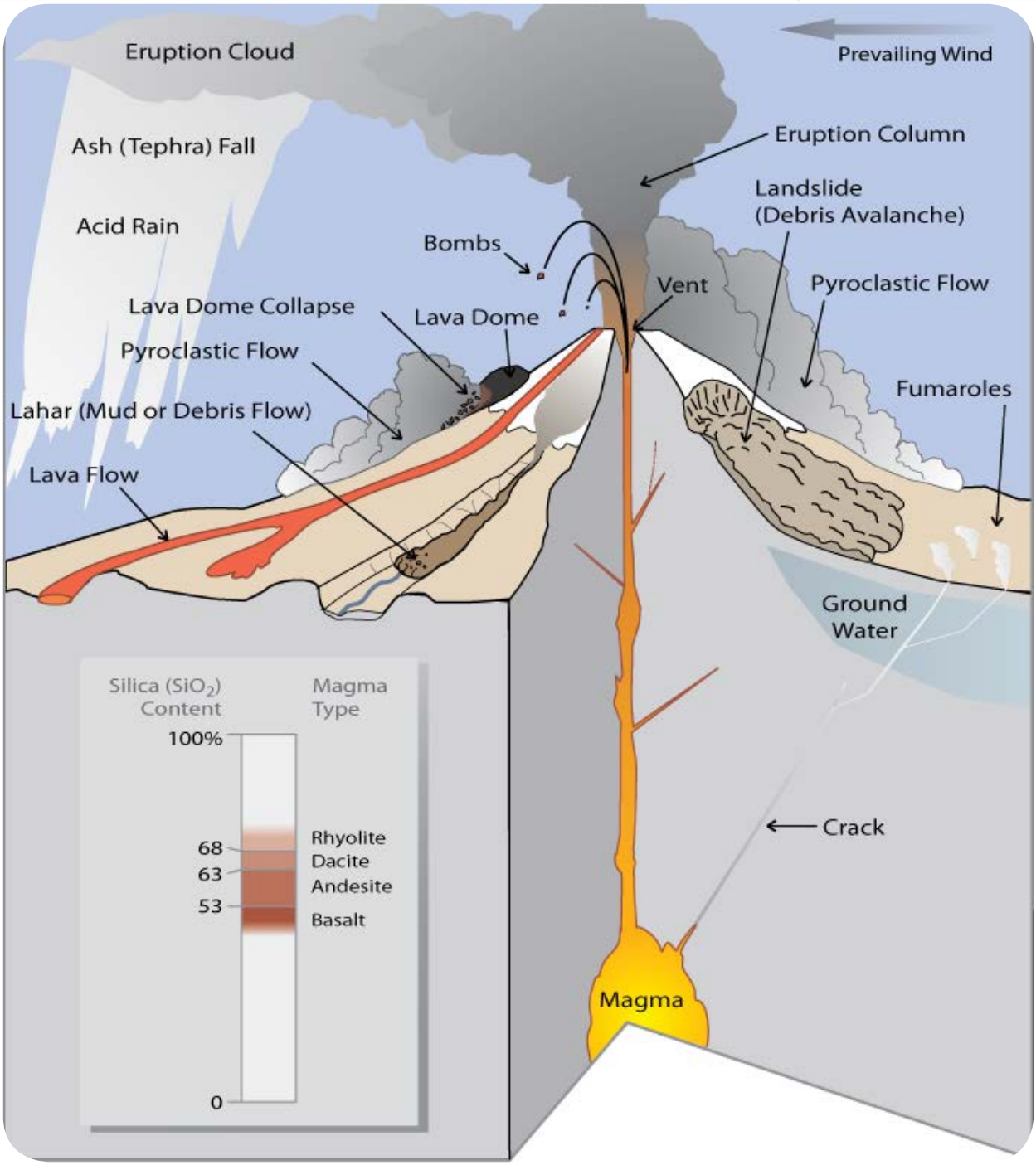
Silica and dissolved gas in magma affect the type of explosion and shape of a volcano.

97 What is Volcanic Explosivity Index?

The volcanic explosivity index (VEI) ranks eruptions based on combined intensity and magnitude. The higher the VEI, the more explosive the eruption. Height of the eruption plume, volume of explosively ejected material, and duration of eruption are the criteria for assessing VEI.

98 What are Volcanic hazards?

Volcanic hazards include explosions, lava flows, bombs or ballistics, ash or tephra, pyroclastic flows, pyroclastic surges, mudflows or lahars, landslides, earthquakes, ground deformation, tsunami, air shocks, lightning, poisonous gas and glacial outburst flooding. Each hazard has a different consequence, although not all occur in all eruptions or in association with all volcanoes. Volcanic eruptions are measured using a simple descriptive index known as the Volcano Explosivity Index (VEI) which ranges from zero (non-explosive) to eight (catastrophically explosive). The index combines the amount of material ejected (by volume) with the height of the eruption column and the duration of the eruption.


Eruption Cloud
Prevailing Wind
Ash (Tephra) Fall
Eruption Column
Landslide
(Debris Avalanche)
Acid Rain
Bombs
Vent
Pyroclastic Flow
Lava Dome Collapse
Lava Dome
Pyroclastic Flow
Fumaroles
Lahar (Mud or Debris Flow)
Lava Flow
Ground
Water
Silica (SiO_2)
Content
Magma
Type
100%
Rhyolite
68
Dacite
63
Andesite
53
Basalt
0
Crack
Magma

99 What are precautionary measures for Volcano?

BEFORE A VOLCANO: Have a disaster plan and know whether or not you are at risk for danger. Be prepared for mudslides, flash floods, earthquakes, ash falling, acid rain and tsunamis. Prepare a disaster supplies kit for your home and car. Include a first aid kit, canned food and a can opener, bottled water, battery-operated radio, flashlight, protective clothing, dust mask, goggles and sturdy shoes. Don't forget, know all of your evacuation routes. **DURING A VOLCANO:** Follow the evacuation order issued by authorities. Avoid areas downwind and river valleys downstream of the volcano. If your caught indoors, close all windows and doors, put machinery inside a barn, and bring animals inside. If you're trapped outdoors, seek shelter indoors. If you're caught in falling rocks, roll into a ball and protect your head. If you're caught near a stream, be aware of mudflows and move to higher ground. Protect yourself when ash falls by wearing long-sleeved shirts and long pants. Use goggles to protect your eyes. Wear a dust mask and keep car engines off. **AFTER A VOLCANO:** Cover you mouth and nose. Volcanic ash can irritate your respiratory system. Wear goggles and protect your eyes. Keep your skin covered. Clear roofs of ash, because the ash is very heavy and can cause the building to collapse.

100 Why Volcanic eruptions are more violent at converging boundaries than at divergent boundaries?

Convergent plate margin eruptions are more violent because the magma is more viscous from lower temperatures and it has more volatiles (mostly water).

Volcanology

101	**Is it true that there are volcanoes in the ocean?**

On the surface of the earth, we know of at least 1,500 active volcanoes. The ocean contains 10,000 volcanoes! We just don't have much chance to see them because they are hidden away!

102	**Volcanoes can also form where there is stretching and thinning of what?**

The crust's plates, e.g., in the East African Rift and the Wells Gray-Clearwater volcanic field and Rio Grande Rift in North America.

103	**Why Study Volcanism?**

1. Volcanic eruptions affect the atmosphere, hydrosphere, and biosphere locally and sometimes globally.
2. Volcanism is a major geologic hazard to a significant portion of Earth's inhabitants.
3. Volcanism is responsible for much of Earth's most spectacular scenery

104 How many active volcanoes and likely to explode again?

About 1,900 volcanoes on Earth are considered active, likely to explode again. Most of the world's active volcanoes are found on the "Ring of Fire", a 40,000 km horseshoe shaped area of the Pacific Ocean.

105 Where was the loudest sound volcano?

The loudest sound in recorded history was made by a volcano called Krakatau. Found in Southeast Asia, when Krakatau erupted in 1883 it released 200 megatons of energy – that's the equivalent of 15,000 nuclear bombs.

106 What is the viscosity in terms of volcanic magmas?

Viscosity is a physical property that describes a material's resistance to flow.

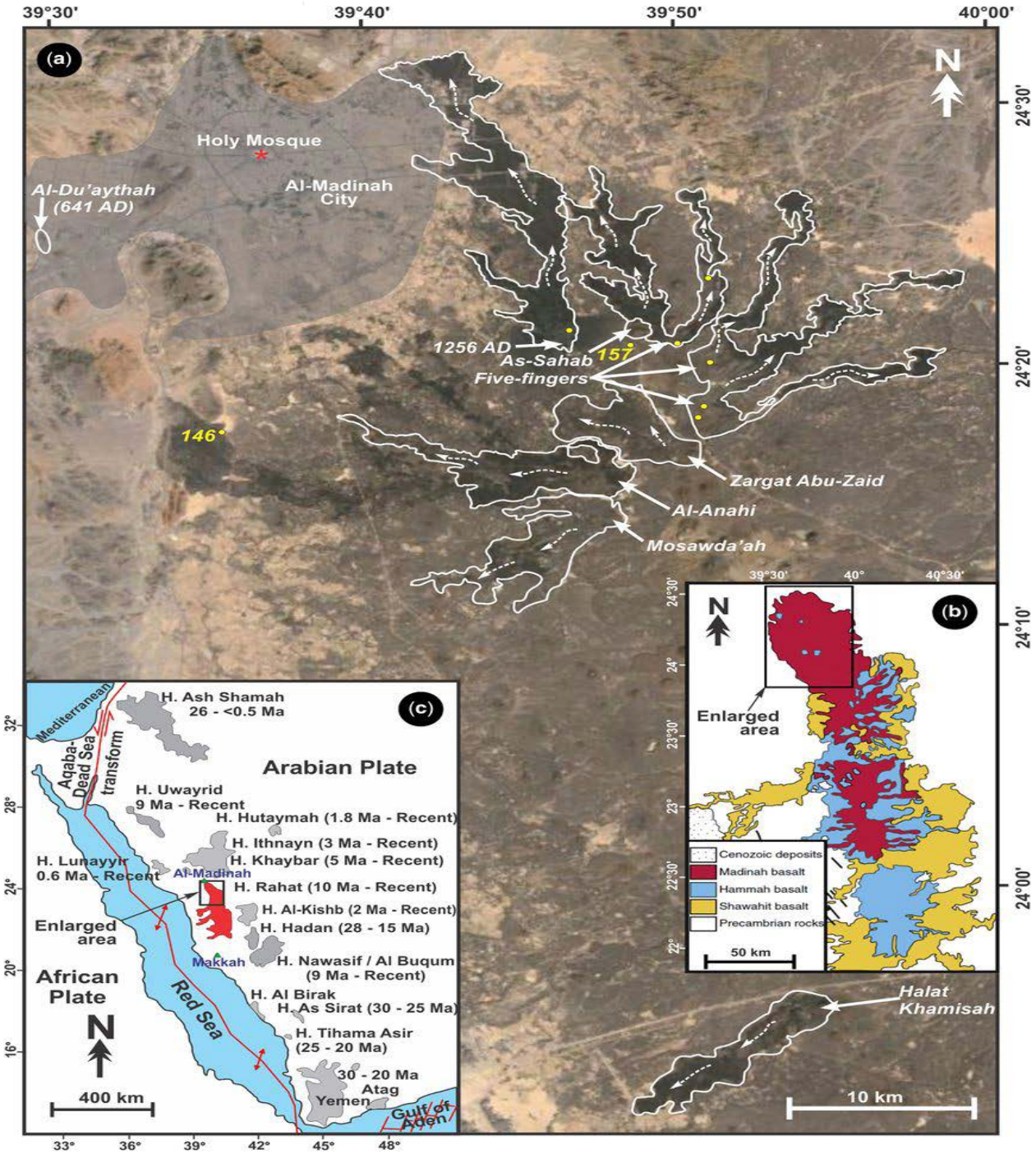
1. Cooler magma = higher viscosity.
2. High silica = higher viscosity .
3. Higher viscosity tends to trap gases and produces explosive eruptions.

107 Discuss briefly the most recent volcanic eruptions in Harrat Rahat?

Saudi Arabia has active volcanoes in the west and northwest of the country. Volcanic activity is related to hot spot activity on the Arabian Plate which was uplifted on the eastern side of the Red Sea rift. The basaltic lava fields in the western part of the country are called harrats. They cover about 180,000 square km and extend from Turkey to Yemen in the south.

Harrat Rahat is the northernmost of a series of young basaltic volcanic fields in western Saudi Arabia arranged parallel to the Red Sea (<10 Ma), is one of the largest volcanic fields on western Arabia. In the north of the field, some of the youngest volcanic centers have pyroclastic cones, lapilli fall deposits and/or lava flows associated with them. The products reflect dominantly Hawaiian eruptions, and only one center experienced phreatic magmatism. Results from new ^{3}He surface-exposure dating provide constraints on stratigraphy of the youngest (<0.3 Ma) products. Harrat Al Madinah (''harrat'' in Arabic means lava field) is among many intraplate basaltic volcanic fields that are located in the western margin of the Arabian Peninsula forming a broad zone sub-parallel to the Red Sea Rift , which has been active over the last 30 Ma. These harrat fields are relatively thin (typically\300 m) but cover vast areas, the largest of which is *60,000 km^2.

The 1256 AD eruption site is located near to the culturally significant Al Madinah city, it has been selected to demonstrate the diversity of volcanic phenomena associated with intraplate volcanism of the Al Madinah Volcanic Field. Hawaiian to Strombolian type eruptions created lava spatter and scoria cones. The historically documented eruption lasted for 52 days and formed a *2.25 km long chain of NW–SE-aligned scoria and lava spatter cones , producing alkali-olivine basalt (*0.5 km^3) a'a and pahoehoe lava flows . At least seven cones have been identified.


39°30'
39°40'
39°50'
40°00'
24°30'
24°20'
24°10'
24°00'
(a)
N
Holy Mosque
Al-Madinah City
Al-Du'aythah (641 AD)
1256 AD
As-Sahab
Five-fingers
157
146
Zargat Abu-Zaid
Al-Anahi
Mosawda'ah
(b)
Enlarged area
Cenozoic deposits
Madinah basalt
Hammah basalt
Shawahit basalt
Precambrian rocks
50 km
Halat Khamisah
10 km
(c)
Mediterranean
Aqaba-Dead Sea transform
H. Ash Shamah 26 - <0.5 Ma
Arabian Plate
H. Uwayrid 9 Ma - Recent
H. Hutaymah (1.8 Ma - Recent)
H. Ithnayn (3 Ma - Recent)
H. Khaybar (5 Ma - Recent)
H. Lunayyir 0.6 Ma - Recent
Al-Madinah
H. Rahat (10 Ma - Recent)
H. Al-Kishb (2 Ma - Recent)
H. Hadan (28 - 15 Ma)
Enlarged area
Makkah
H. Nawasif / Al Buqum (9 Ma - Recent)
African Plate
H. Al Birak
H. As Sirat (30 - 25 Ma)
Red Sea
H. Tihama Asir (25 - 20 Ma)
30 - 20 Ma Atag
Yemen
Gulf of Aden
400 km
32°
28°
24°
20°
16°
33°
36°
39°
42°
45°
48°

108 There are several volcanic areas in the world considered to be super volcanoes. Which of the following is a super volcano ?

A.	Mount St. Helens	C.	Banff National Park
B.	Lake Superio	D.	Yellowstone National Park

109 Historically, the largest known volcanic explosion is which of the following ?

A.	Krakatoa (Indonesia, 1883	C.	Katmai (Alaska USA, 1912
B.	Mt. Tarawera (New Zealand, 1886	D.	Tambora (Indonesia, 1815)

110 This is the scale used to measure the size of volcanic eruptions.

A.	Richter Scale	C.	Vulcan Index
B.	Volcano Eruptivity Scale	D.	Volcanic Explosivity Index

111 Which of the following is NOT a benefit of volcanic activity ?

A.	Geothermal power	C.	Soil fertilization
B.	Valuable metal deposits	D.	Glacier melting

112 **Which one has examples of volcanoes caused by 'convergent tectonic plate, coming together?**

A.	Mid Atlantic ridge	C.	Pacific ring of fire
B.	Both (a) and (b)	D.	None of these

113 **Volcanoes can also form where there is stretching of the earth's _____ and where the _ ---------- goes thin.**

A.	Surface, crust	C.	Plate, surface
B.	Crust, crust	D.	Plate, crust

114 **Volcano forms by the stretching earth's crust and the crust goes this this phenomenon is called:**

A.	Interaplate volcanism	C.	Non-hot interpolate
B.	Hot spot intraplate	D.	None of these

115 **Volcanoes are generally found where _____ pull apart or are coming together:**

A.	Intraplates	C.	Tectonic plates
B.	Earth's crust	D.	None of these

116 **Which ridge has examples of volcanoes caused by "divergent tectonic plates" pulling a part?**

A.	Pacific ring of fire	C.	Mid Atlantic Ridge
B.	Both (a) and (b)	D.	None of these

117 **Volcanoes can be caused by _____ so called 'hot spots'.**

A.	Mantle plumes	C.	Ash
B.	Gases	D.	None of these

118 **When the lava is horn by expending gases into fluid hot clots ranging in size from 1 cm to 50 cm across is called:**

A.	Spatter	C.	Cones
B.	Shield	D.	None of these

119 **Volcanic Mt. Etna is located in:**

A.	Sicily	C.	Germany
B.	England	D.	None of these

120 **The magma not able to reach the surface crystallizes to form:**

A.	Sedimentary Rocks	C.	Volcanic Rocks
B.	Plutonic Rocks	D.	None of these

121 **An active volcano Mauna Loa is located in:**

A.	Hawaii U.S.A.	C.	Brazil
B.	Figi	D.	None of these

122 **The magma not able to reach the surface crystallizes to form:**

A.	Volcanic Rocks	C.	Plutonic Rocks
B.	Both (a) and (b)	D.	None of these

123 **The hot molten material erupted from a volcano is called:**

A.	Magma	C.	Lava
B.	Pyro-clast	D.	None of these

124 **Hotspot volcanoes can be found on the islands like:**

A.	Malaysian	C.	Indonesian
B.	Hawaiian	D.	None of these

125 **Hotspot volcano is also found elsewhere is the solar system especially on:**

A.	Sun and moons	C.	Rocky planets and moons
B.	Both (a) and (b)	D.	None of these

126 **Volcanoes are usually located on:**

A.	Divergent plate boundaries	C.	Convergent plate boundaries
B.	Hotspots	D.	All of them

127 **The erupted material of volcano consists of:**

A.	Lava texture	C.	Lava composition
B.	Pumice	D.	None of these

128 **Divergent plate boundaries after volcanic activity form:**

A.	Volcanic islands	C.	Continental zone
B.	Mantle plumes	D.	None of these

129 **A place where two plates usually an oceanic plate and a continental plate collides is called:**

A.	Continental zone	C.	Volcanic zone
B.	Subduction zone	D.	None of these

130 **Magma contains the contents of:**

A.	Silica	C.	Aluminum
B.	Magnesium	D.	None of these

131 **Volcanic erupted material when inside the hill/earth/mountain it is called _____ and after it coming out it is called _____.**

A.	Lava, magma	C.	Magma, lava
B.	Scoria, Pumice	D.	None of these

132 **The type of volcano on Jupiter, Saturn, and Neptune is known as:**

A.	Shields	C.	Cinder cone
B.	Cryovolcano (ice volcano)	D.	None of these

133 **The volcanoes formed by the alternating layers of lava and rock fragments are called:**

A.	Cinder cones	C.	Spatter cones
B.	Compostite volcanoes	D.	Shields

134 **Composite volcanoes are also known as:**

A.	Stratovolcanoes	C.	Shields
B.	Compound volcanoes	D.	None of these

135 **Stratovolcano forms impressive, snow-capped peak which is often exceeding _____ in height, _____ in area and _____ in volume:**

A.	2500 m, 1000 sq. km. 400 km8	C.	1900 m, 800 sq. km, 200 km8
B.	2000 m, 800 sq. km, 200 km	D.	None of these

136 **Stratovolcanoes are constructed along subduction zones e.g:**

A.	Divergence Zones	C.	Trans form Zones
B.	Obduction Zones	D.	Subduction Zones

137 **Shield volcanoes are _____ in size:**

A.	Small	C.	Medium
B.	Long	D.	Huge

138 **Types of volcanoes are:**

A.	Cinder cones	C.	Spatter cones
B.	Composite Volcanoes	D.	All of them

139 **Shield volcanoes are built by many layers of lava, gently formed a sloping cones caused by the fluid called:**

A.	Runny Lava	C.	Basaltic Lava
B.	Gases	D.	None of these

140 **Example of shield volcanoes is:**

A.	Kilavea	C.	Mauna Loa
B.	Mount Fugi	D.	None of these

141 **Cinder cones are chiefly formed by:**

A.	Explosion	C.	Strombolian Euroption
B.	Both (a) and (b)	D.	None of these

142 **Cinder cones are built from lava fragments called:**

A.	Mantle plumes	C.	Ash
B.	Cinders	D.	None of these

143 **Cinder cones' example is:**

A.	Mount Hood	C.	Hekla on Iceland
B.	Paricufin in Mexico	D.	None of these

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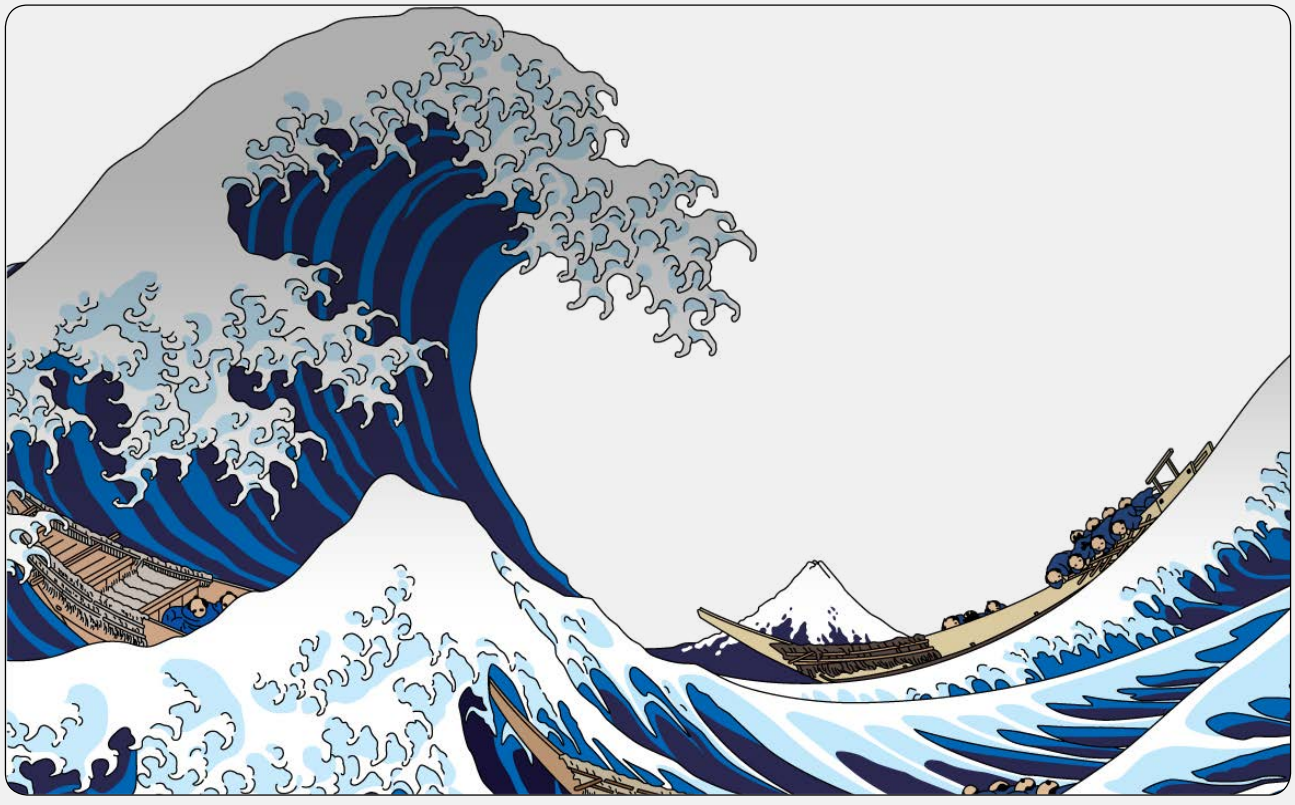
104

Questions & Answers in Tsunami



Tsunami

Intruduction

A **tsunami** is a series of waves or surges most commonly caused by an earthquake beneath the sea floor. Tsunamis can cause great loss of life and property damage in coastal areas. Very large tsunamis can cause damage to coastal regions thousands of miles away from the earthquake that caused them. There are two ways to find out if a tsunami may be coming. These natural and official warnings are equally important. Respond to whichever comes first. Assessment of tsunami hazard and risk is required to support preparedness measures and effective disaster reduction. In most coastal locations, highly destructive tsunami events are not well represented in historical records, which tend to be short compared to the return period of large tsunamis. In this way, tsunamis are different from more frequent hazards (such as floods or cyclones) for which historical records often provide a more useful reference for understanding the hazard and its impact.

1 What is a tsunami?

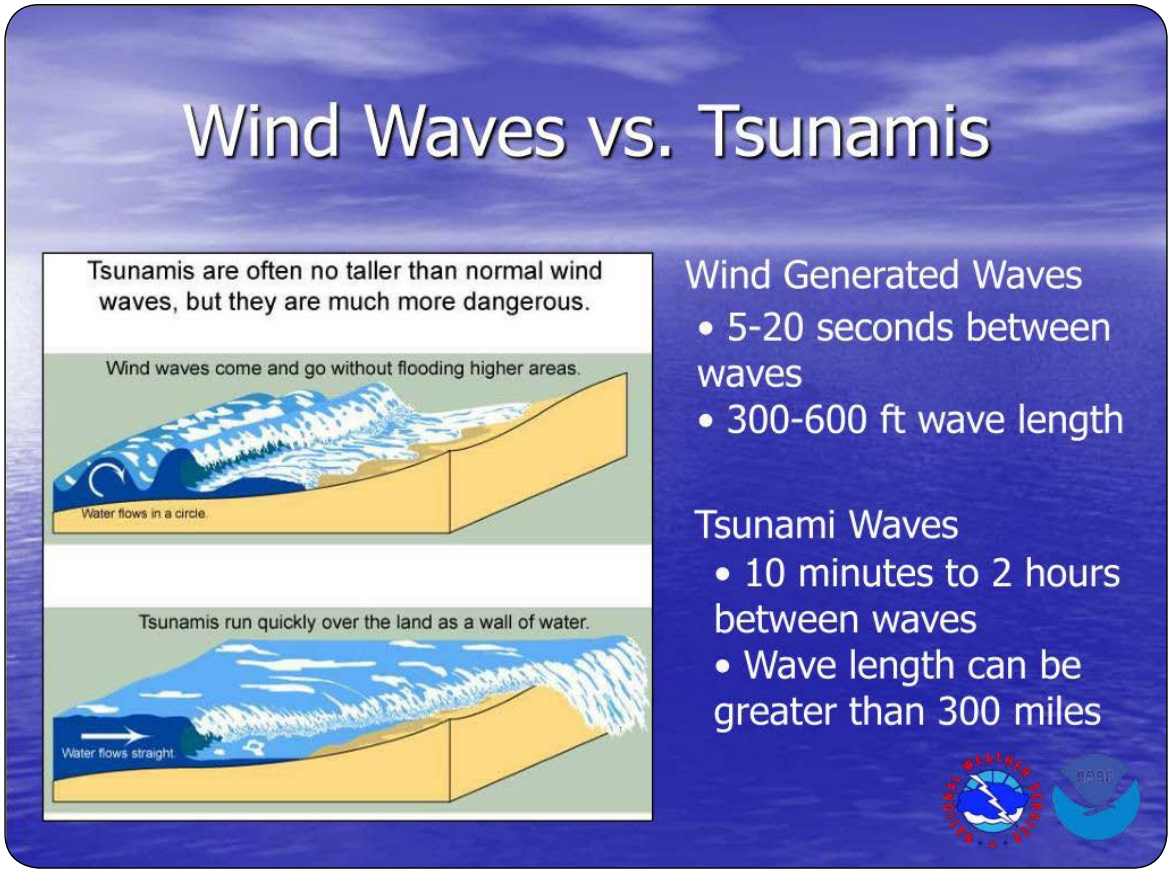
The name **Tsunami** (soo-NAH-mee), from the Japanese words tsu meaning harbour and nami meaning wave, is now used internationally to describe a series of waves travelling across the ocean. These waves have extremely long wavelengths, up to hundreds of kilometers between wave crests in the deep ocean. It is caused by a sudden disturbance of the ocean floor that displaces a large amount of water. Tsunamis are caused generally by earthquakes, less commonly by submarine landslides, infrequently by submarine volcanic eruptions and very rarely by large meteorite impacts in the ocean. In the past, tsunamis have been referred to as 'tidal waves' or 'seismic sea waves'. Both are misleading.

2 How are tsunamis different from normal ocean waves?

- **Ocean waves** are related to changes in the atmosphere by the gravitational attraction of the sun and moon and can be predicted many years in advance, just by knowing orbital positions and local site conditions. while tsunamis are related to changes within the Earth.
- **Tsunami waves** are distinguished from ordinary ocean waves by their long wavelengths (distance between two crests or highest point of the wave), often exceeding 100 kilometers in the deep ocean and by the long amount of time between the arrivals of these crests, ranging from five minutes to an hour.
- **Most tsunami** waves do not break like normal surf waves at the beach that curl over as they approach shore rather they come in much like a very strong and very fast wall of water. Those that do break often form vertical walls of turbulent water called bores.

Tsunami

	Tsunami	Wind Wave
Source	Earthquakes, landslides, volcanic activity, certain types of weather, near earth objects	Winds that blow across the surface of the ocean
Location of energy	Entire water column, from the ocean surface to the ocean floor	Ocean surface
Wavelength	60-300 miles	300-600 feet
Wave Period	5 minutes – 2 hours	5-20 seconds
Wave Speed	500-600 miles per hour (in deep water) 20-30 miles per hour (near shore)	5-60 miles per hour



3	How do tsunami occur?

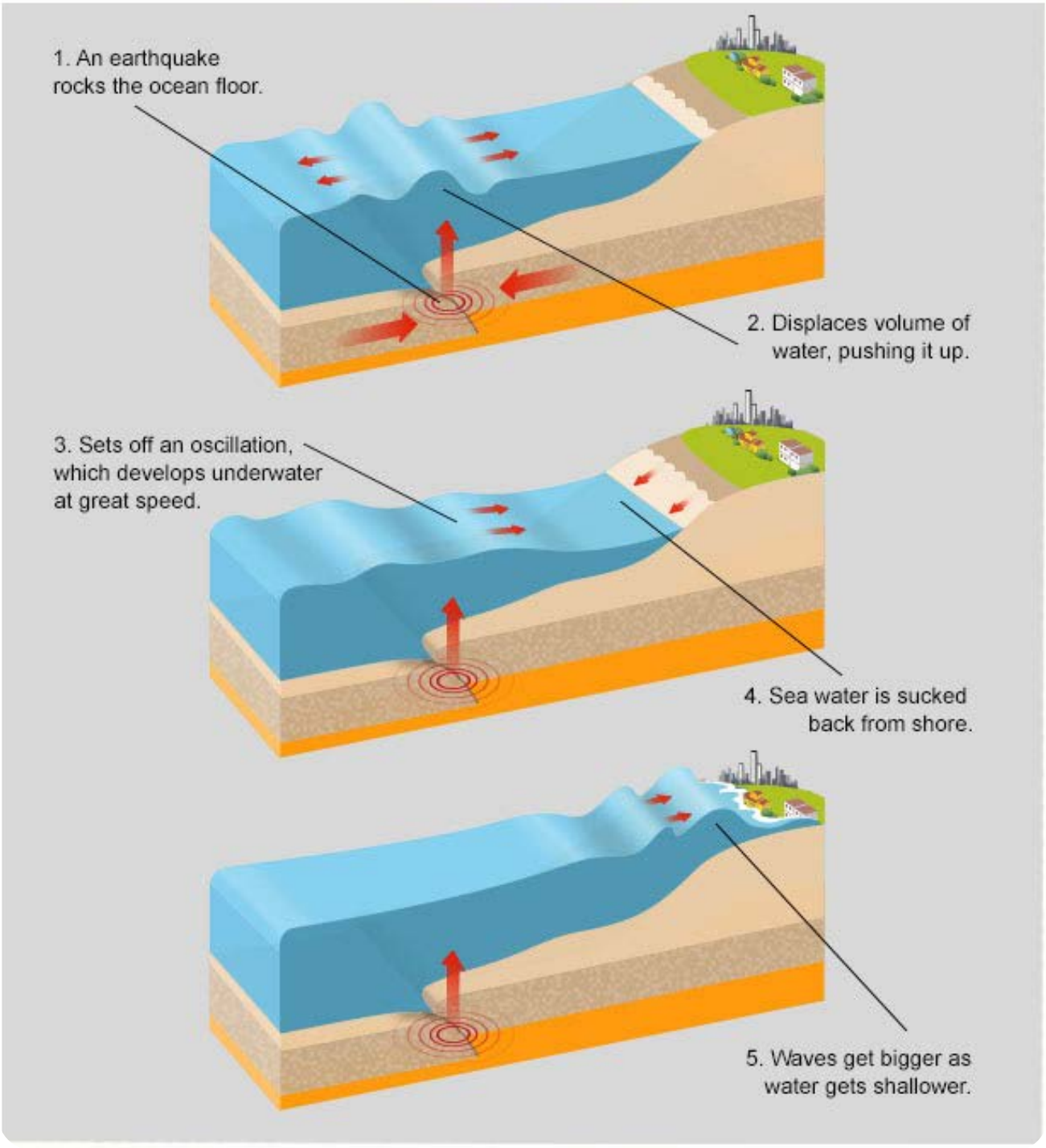
Tsunami are actually waves caused by sudden movement of the ocean due to earthquakes, landslides on the sea floor, land slumping into the ocean, major volcanic eruptions or large meteorite impacts. 1. Most tsunami are caused by large earthquakes at the seafloor, when large slabs of rock are forced to move past each other suddenly causing the overlying water to move. The resulting wave moves outwards and away from this event 2. Underwater landslides can cause tsunami, and so can land which slumps into the ocean. Landslides happen when slopes become too steep to withstand gravity 3. Less common are tsunami initiated by volcanic eruptions. These occur in several ways:

- if an underwater volcano erupts, the hot lava may heat the surrounding water quickly and explosively.
- massive flows of volcanic debris such as ash can travel down the side of a volcano and into the ocean, pushing water outwards.
- the top of an underwater volcano may collapse downwards, so that the overlying water also drops.

Large meteorite impacts that occur at sea can also trigger tsunami.

Tsunami

Anatomy of a tsunami



4 Can a tsunami occur anywhere in the world?

Yes, all oceanic regions of the world can experience tsunamis, but in the Pacific Ocean large, destructive tsunamis occur much more frequently because of the many large earthquakes occurring in the margins of the Pacific Ocean.

5 Do all earthquakes cause tsunamis?

No, all earthquakes do not cause tsunamis. There are four conditions necessary for an earthquake to cause a tsunami:

(1) The earthquake must occur beneath the ocean or cause material to slide in the ocean

(2) The earthquake must be strong, at least magnitude 6.5.

(3) The earthquake must rupture the Earth's surface and it must occur at shallow depth – less than 70 km below the surface of the Earth (4) The earthquake must cause vertical movement of the sea floor (up to several meters).

6 What is run-up and inundation?

When a tsunami approaches a coastline, the wave begins to slow down and increase in height, depending on the topography of the sea floor. Often the first signs of a tsunami are a receding water level caused by the trough of the wave. In some instances though, a small rise in the water level just before the recession, has been observed. Regardless, the incoming wave approaches much like the incoming tide though on a much faster scale. The maximum vertical height to which the water is observed with reference to sea level is referred to as run-up.

The maximum horizontal distance that is reached by a tsunami is referred to as inundation.

Tsunami

7 How do volcanic eruptions cause tsunamis?

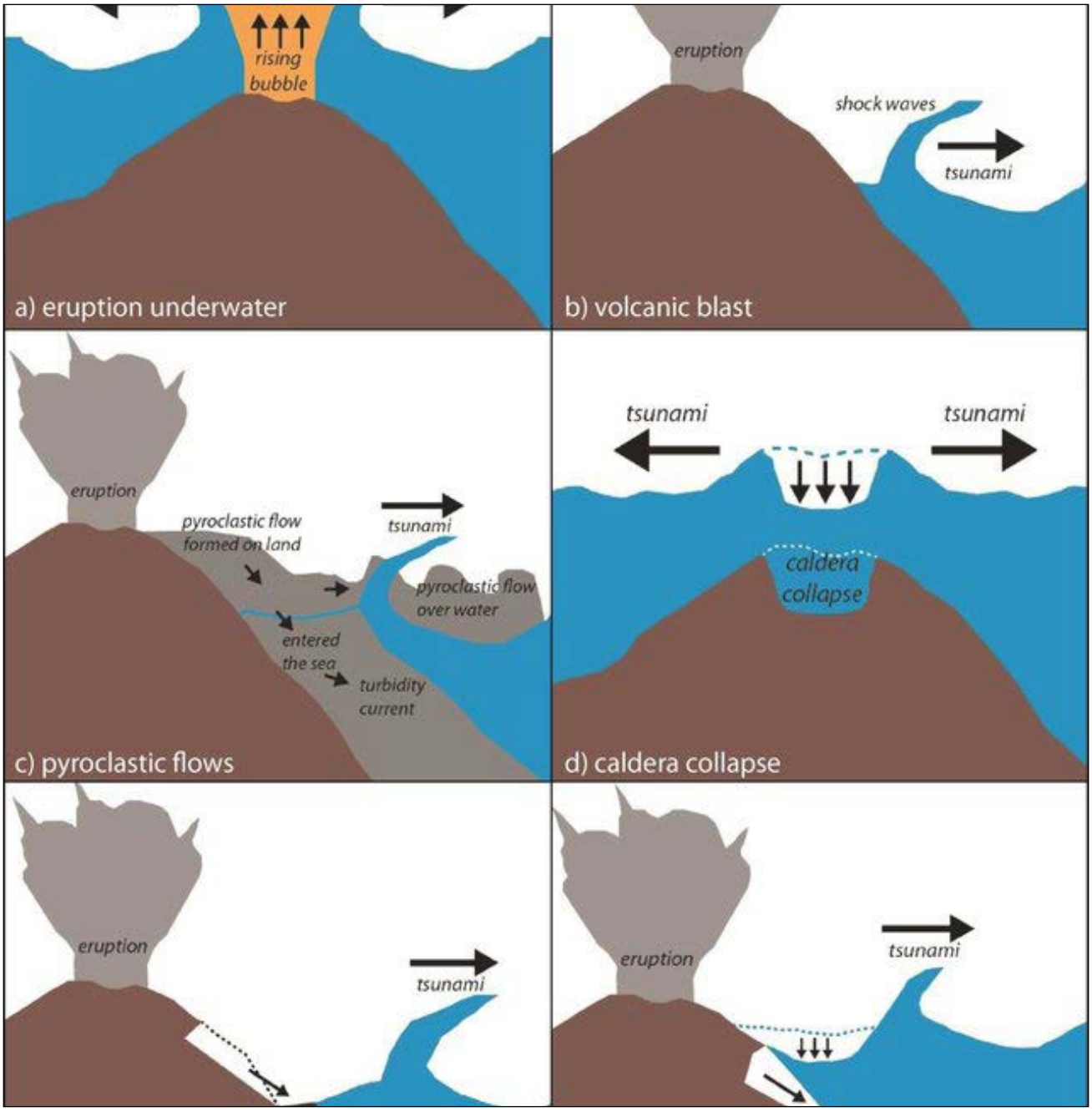
Although relatively infrequent, violent volcanic eruptions can displace a great volume of water and generate extremely destructive tsunami waves in the immediate source area. According to this mechanism, waves may be generated by the sudden displacement of water caused by a volcanic explosion, by a volcano's slope failure, or more likely by a phreatomagmatic explosion and collapse/engulfment of the volcanic magmatic chambers.

8 How do volcanoes generate tsunamis?

Tsunamis generated by volcanoes, both above and below water, are infrequent, but several types of volcanic activity can displace enough water to generate destructive tsunamis. These include:

· Pyroclastic flows (flowing mixtures of rock fragments, gas, and ash)
· Submarine explosions relatively near the ocean surface
· Caldera formation (volcanic collapse)
· Landslides (e.g., flank collapse, debris flows)
· Lateral blasts (sideways eruptions)

Like other nonseismic tsunamis, such as those generated by landslides, volcanic tsunamis usually lose energy quickly and rarely affect distant coastlines.


rising bubble
a) eruption underwater
eruption
shock waves
tsunami
b) volcanic blast
eruption
pyroclastic flow formed on land
tsunami
pyroclastic flow over water
entered the sea
turbidity current
c) pyroclastic flows
tsunami
tsunami
caldera collapse
d) caldera collapse
eruption
tsunami
eruption
tsunami

Tsunami

9 How are tsunami wave heights measured?

The wave height of a tsunami can be highly variable in a local area depending on the underwater topography, orientation to the oncoming wave, the tidal level and the magnitude of the tsunami. A common method for determining tsunami wave height is by measuring the runup, the highest vertical point reached by the wave. Runup heights are measured by looking at the distance and extent of salt-killed vegetation, and the debris left once the wave has receded. This distance is referenced to a datum level. Tide gauges, found in most harbors, are the other tool for measuring tsunami wave height and period (wavelength).

10 What's the height of tsunami?

The largest recorded tsunami was in 1958 in Alaska. An earthquake generated an enormous landslide which crashed into the ocean creating a wave that destroyed vegetation over 500 meters above sea level. In New Zealand, the 1931 Hawke's Bay earthquake triggered a landslip at Waikare which in turn caused a localized 15.3 meter tsunami. At Napier there was a tsunami of about 3 meters. Otherwise the largest recorded tsunami in NZ was in Gisborne in 1947 and it was 10 meters. In the case of the earthquake of 26 December 2004, the wave reached the coast at heights ranging from 3 to 35 meters in the area of Banda Aceh. In Thailand, they measured waves up to 10 meters high in the area of Khao Lak, and from 4 to 8 meters in the region of Phuket.

11 Do all oceans have tsunamis?

Yes. Tsunamis have been recorded in all the major oceans of the world. However, this phenomenon is mainly seen in the Pacific and the Indian oceans. The Pacific basin is an area surrounded by volcanic island arcs, mountain chains and subduction zones earning the nickname the "ring of fire" and is the most geologically active area on the planet. The east side of the Indian ocean is also a very active seismic region. The Atlantic and other oceans and seas are far less geologically active, with some exceptions and therefore the occurrence of tsunamis is rare.

12 If a tsunami is detected how much time to warn the public?

Warning time for a tsunami can be anywhere from 15 minutes to several hours depending on how close your island is to the earthquake that triggered the tsunami.

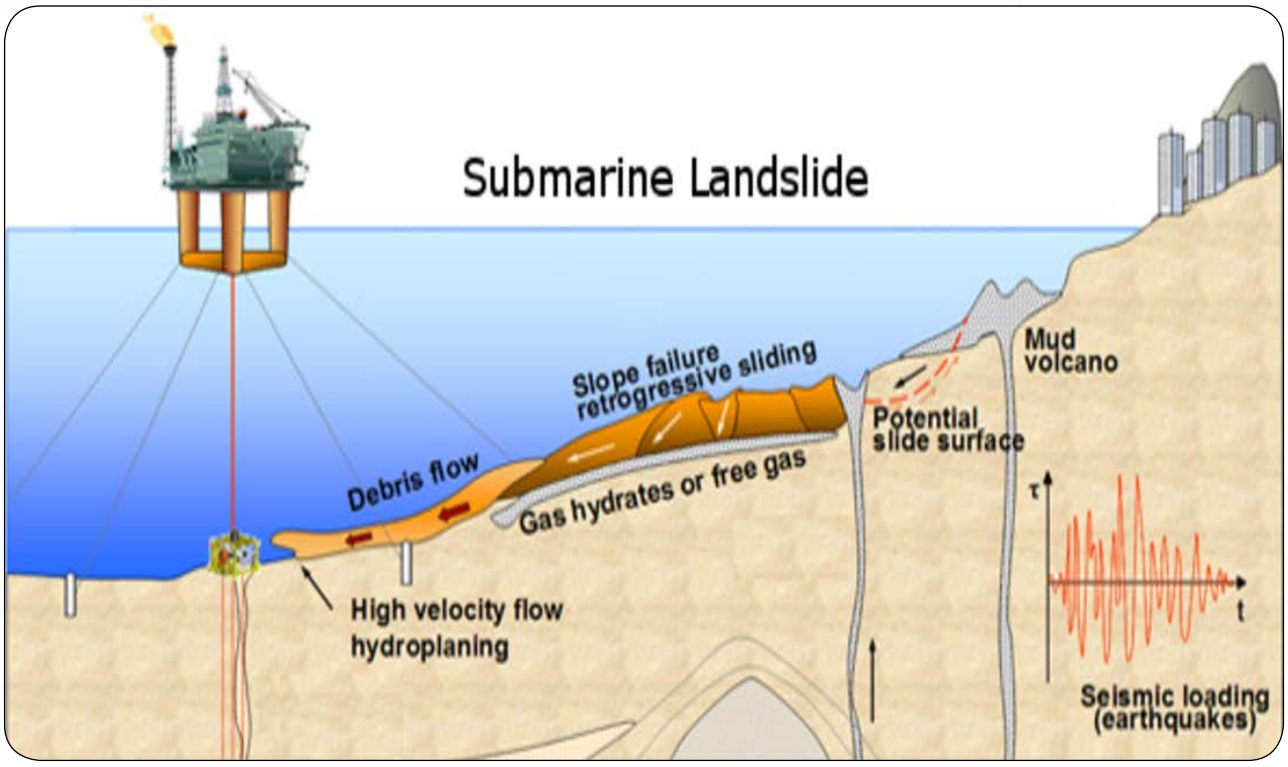
13 Where do tsunamis happen?

Tsunamis can be generated in all of the world's oceans, inland seas, and in any large body of water. Of the 754 confirmed events between 1900 and 2015, about 78% occurred in the Pacific Ocean (around the geologically active "Ring of Fire"), 8% in the Atlantic Ocean and Caribbean Sea, 6% in the Mediterranean Sea, 5% in the Indian Ocean, and 1% in other seas. Since 1900, the highest percentage of tsunamis was generated off Japan (21%) followed by Russia (8%) and Indonesia (8%). The most significant distant tsunamis since 1900 originated off Alaska, Chile, Japan, Indonesia, Pakistan, and Russia.

14 How do landslides generate tsunamis?

Landslide is a general term that incorporates rock falls, slope failures, debris flows, slumps, ice falls/avalanches, and glacial calving . Tsunamis can be generated when a landslide enters the water and displaces it from above (subaerial) or when water is displaced ahead of and behind an underwater (submarine) landslide. Tsunami generation depends on the amount of landslide material that displaces the water, the speed it is moving, and the depth it moves to. Landslide-generated tsunamis may be larger than seismic tsunamis near their source and can impact coastlines within minutes with little to no warning, but they usually lose energy quickly and rarely affect distant coastlines. Most landslides that generate tsunamis are caused by earthquakes, but other forces (like gravity, wind, and increased precipitation) can cause overly steep and otherwise unstable slopes to suddenly fail. Earthquakes that are not large enough to directly generate a tsunami may be large enough to cause a landslide that in turn can generate a tsunami.

Tsunami

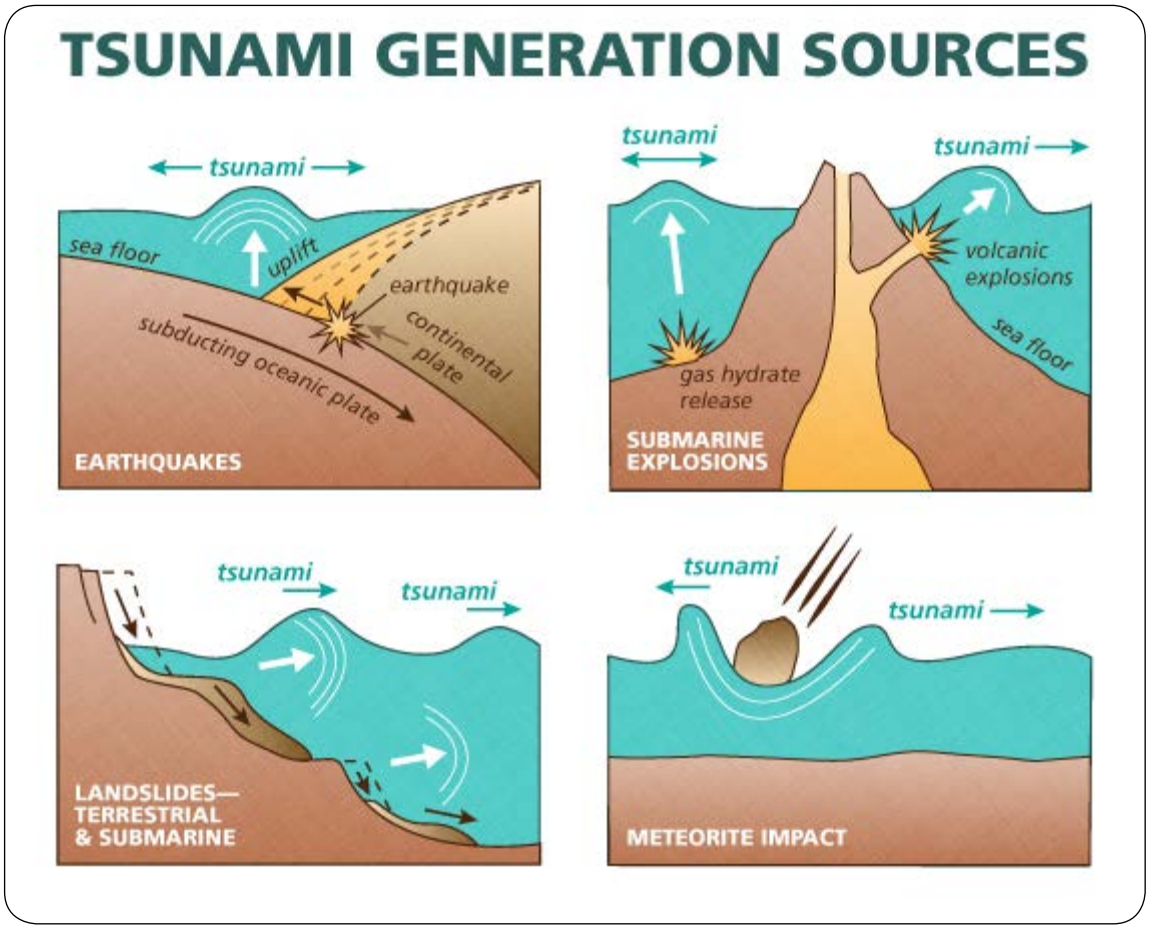


15 Why are tsunami so destructive?

As the tsunami enters the shoaling water near the coast, its velocity decreases and its height increases. It is in these shallow waters that tsunamis become a threat to life and property, for they can crest to heights of more than 30-50 meters and strike with devastating force. Finally, terminal height or run-up of the tsunami at the point of impact will depend on how the energy is focused, the travel path of the waves, the coastal configuration, and the offshore topography. Most tsunami damage and destruction is caused by flooding, wave impacts, strong currents, erosion, and debris. The water can be just as dangerous as it returns to the sea, taking debris and people with it. Tsunamis are among the most terrifying natural hazards known to man. They have been responsible for tremendous loss of life and property throughout history.

16 Why are tsunamis so dangerous?

Tsunamis cause the water level and currents to rise rapidly, sometimes high enough to drown or injury people who have not escaped away from the shore to high ground. Dangerous waves can follow the first tsunami wave, trapping people who returned to the danger area because they thought the tsunami was over. Also, people can be caught unaware if they don't know the natural tsunami signs (earthquake shaking, water receding rapidly from the beach, a loud noise like a freight train coming from the ocean) or they are places where there are no tsunami warning systems. Strong tsunamis damage ports and harbors, as well as tourist areas, thereby damaging relief efforts and the economy of the communities.



Tsunami

17 Where is the most destructive Tsunamis?

The most destructive tsunamis are the Great 1960 Chilean tsunami and 1883 after the explosion and collapse of the volcano of Krakatoa (Krakatau), in Indonesia. Generally, some of the most damaging tsunamis are in Japan 2011 generated in the Pacific Ocean. Asia: Asian tsunami in 2004 generated in the Indian Ocean. Alaska: Major tsunamis were generated along the Alaskan coast in 1946, 1957, 1958, 1964, and 1965. US/Canada West Coast: Tsunamis were generated locally in 1812, 1873, 1878, 1927, 1930, 1946 and 1949. The west coast was also impacted by tsunamis generated in other regions in 1877, 1946, 1952, 1957, 1960, 1964, 1975, 2006, and 2010. US/Canada Atlantic Coast: Tsunamis were recorded in 1755, 1884, 1886, and 1929. Puerto Rico and the Virgin Islands experienced damaging tsunamis in 1867 and 1918.

18 What does a tsunami look like when it reaches the coast?

When a tsunami reaches the coast, it may look like a fast-rising flood, or a wall of water (bore). Its appearance may differ at different points along a coast. It will not look like a normal wind wave. Tsunamis rarely become great towering breaking waves. Sometimes, before the water rushes on land, it will suddenly recede, showing the ocean floor, reefs, and fish like a very low, low tide.

19 Can near earth objects generate tsunamis?

It is very rare for a near earth object like an asteroid or comet to reach the earth, and there is still a lot of uncertainty about their potential to generate tsunamis and the size and reach of those tsunamis if they do. Scientists believe there are two ways near earth objects could generate a tsunami. Large objects (approximately 1,000 meters, 0.62 mile, or more in diameter) that make it through Earth's atmosphere without burning up could hit the ocean, displacing water and generating an "impact" tsunami. Smaller objects tend to burn up in the atmosphere, exploding before they reach the Earth's surface. If this happens above the ocean, the explosion could release energy into the ocean and generate an "airburst" tsunami.

20 How do I recognize a tsunami?

It is almost impossible to recognize an approaching tsunami. Tsunamis arrive completely unexpectedly causing huge damage in their path. Briefly before a tsunami, the sea retreats revealing the sea bottom. If you see this happen it is usually already too late. A tsunami is on its way and will arrive within seconds.

21 How are tsunamis forecast?

The first sign of a potential tsunami is an earthquake. Seismic waves travel about 100 times faster than tsunamis, so information about an earthquake is available before information about any tsunami it may have generated. Three key pieces of information about an earthquake help the Tsunami Warning Centers determine if it was capable of generating a tsunami: location, depth, and magnitude. The warning centers use this preliminary seismic information to decide if they should issue a tsunami message and at what alert level(s). Once a message is issued, the warning centers conduct additional seismic analysis and run tsunami forecast models using information from the seismic and water-level networks as it becomes available. It is more difficult to forecast non-seismic tsunamis (like landslide and volcanic tsunamis and meteotsunamis), which can arrive with little to no warning.

22 Could Nuclear testing create a tsunami?

Nuclear testing at and near Pacific islands, with ample wave detection equipment included, showed that such explosions do not propagate hazardous tsunami waves.

Tsunami

23 Can you surf on a tsunami wave?

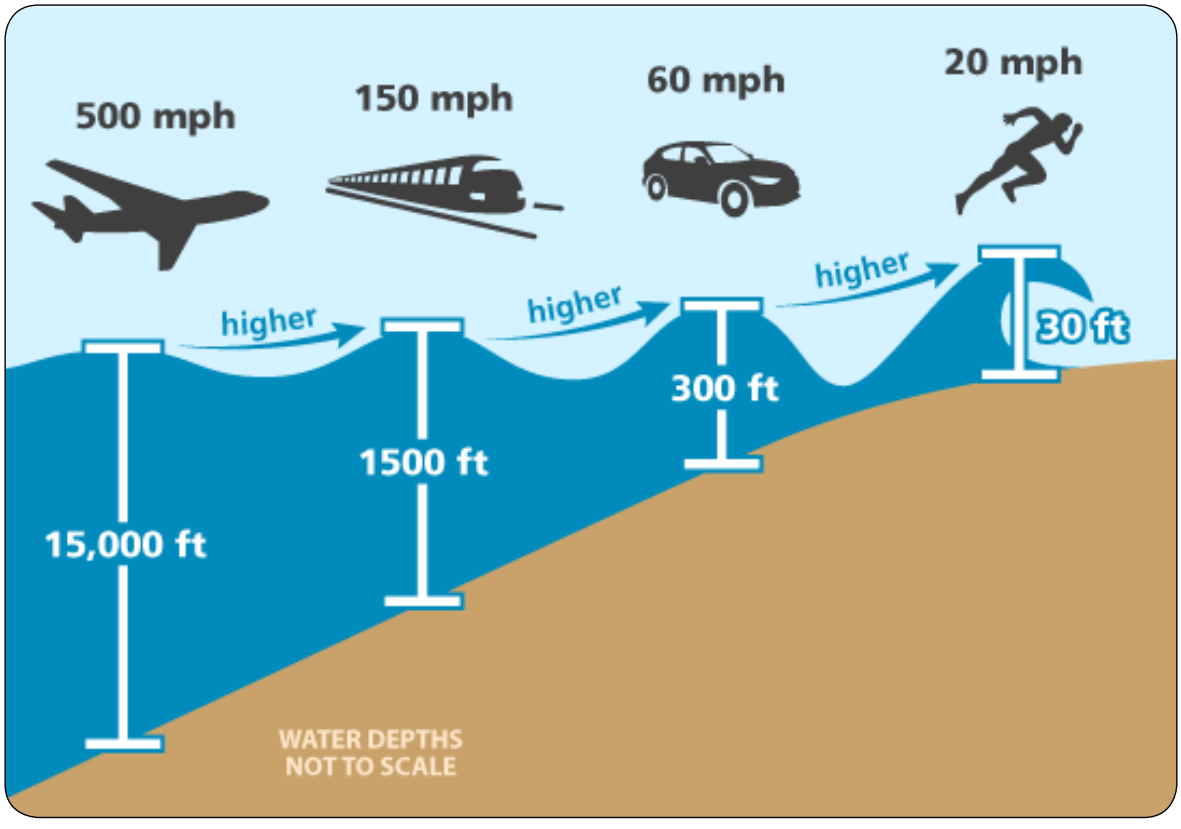
Absolutely not! Tsunami waves cannot be surfed. Tsunamis are an extremely dangerous phenomenon that should be avoided at all times. Aside from a tsunami's tremendous destructive power, there is a large amount of seafloor material (mud and sediment) in a tsunami unlike normal ocean waves comprised mostly of water. This makes them very dangerous for surfing.

24 What are the characteristics of a tsunami?

- Tsunamis are different from normal waves
- Tsunamis have long wavelengths. In the deep ocean tsunami waves have extremely long wavelengths. In comparison to wind-driven waves, tsunami waves may have wavelengths up to hundreds of kilometers between wave crests. Tsunamis are therefore much more destructive than normal waves because the huge flooding body of water can continue to rush onto land for an extended period of time.
- As a tsunami approaches land, the size increases. The speed and size of a tsunami is controlled by water depth. In the deep ocean tsunami waves may be unnoticed by ships or from the air. As the wave approaches land it reaches shallow water and slows down.
- Tsunamis are fast. In the deep ocean, a tsunami can travel at more than 900 kilometers per hour, close to the speed of a jumbo jet, and in shallow water, it can be described as roughly the speed of a fast cyclist.
- Tsunamis retain their energy. As well as travelling at high speeds, tsunamis can also travel large distances with limited energy losses. Tsunamis can therefore have sufficient energy to travel across entire oceans.
- Tsunami waves move outwards, away from their source. The path of a tsunami is never symmetrical and is determined by a number of factors including the bathymetry of the sea floor. Tsunamis move outwards at right angles to the subduction trench where the earthquake has occurred. A tsunami travels faster through deep water and
- A tsunami is a 'series' of waves. A tsunami generally consists of a series of waves. The amount of time between successive waves is known as the wave period. Waves can be a few minutes or over two hours apart.

25 How fast do tsunamis travel?

The speed of a tsunami depends on the depth of the water it is traveling through. The deeper the water; the faster the tsunami. In the deep ocean, tsunamis can move as fast as a jet plane, over 500 mph, In the very deepest parts of the oceans, the speed can be over 700 mph and can cross entire oceans in less than a day. As the waves enter shallow water near land, they slow to the speed of a car, approximately 20 or 30 mph. Tsunami speed can be computed by taking the square root of the product of the water depth and the acceleration of gravity (32.2 feet per second squared). In 15,000 feet of water, this works out to about 475 miles per hour.



Tsunami

26 How are tectonic plates associated with tsunamis?

When one tectonic plate subducts under another, it does so in a series of sharp events that often cause earthquakes. One result of this movement is that the ocean bottom is very quickly moves upward in some locations and downward in other nearby locations. This happens so rapidly that the water surface is also up or down by the same amount; this wave pattern is then the initial waveform of the newly created tsunami that then propagates away from the source area. The earthquakes can also trigger submarine landslides that either generate tsunamis on their own or enhance the tsunami generated by the tectonic bottom movement.

27 Where do tsunamis most often occur in the world?

Tsunamis occur most often in the Pacific Ocean and Indonesia because the Pacific Rim bordering the Ocean has a large number of active submarine earthquake zones. However, tsunamis have also occurred recently in the Mediterranean Sea region and are expected in the Caribbean Sea as well.

28 Can strike-slip (horizontal motion) earthquakes trigger tsunamis?

Yes, approximately 10-15% of damaging tsunamis are triggered by strike-slip earthquakes. This type of earthquake is less likely to trigger a tsunami than one with vertical motion. The waves are likely generated by associated landslides or motion of a sloping bathymetric feature. Tsunamis generated by strike-slip earthquakes normally affect regions near the source only.

29 Is the wavelength of a tsunami in the deep ocean greater or smaller than the typical wavelength of a wind-generated wave?

Wavelengths of tsunami are significantly greater than those of common everyday wind-generated waves. For example, the wavelengths of tsunami vary from 100 m to over 500 km while everyday wind-generated waves have wavelengths that vary from around 100 to 200 m.

30 How many tsunamis have there been?

For the Pacific Ocean alone, this site lists over 1490 tsunami events that date back to as early as 47 B.C. For the years 1904- 2004, the catalog lists about 640 events. This averages out to 6 or 7 tsunami-causing events a year. Not all of these events generated large amounts of damage but most had at least some local effects.

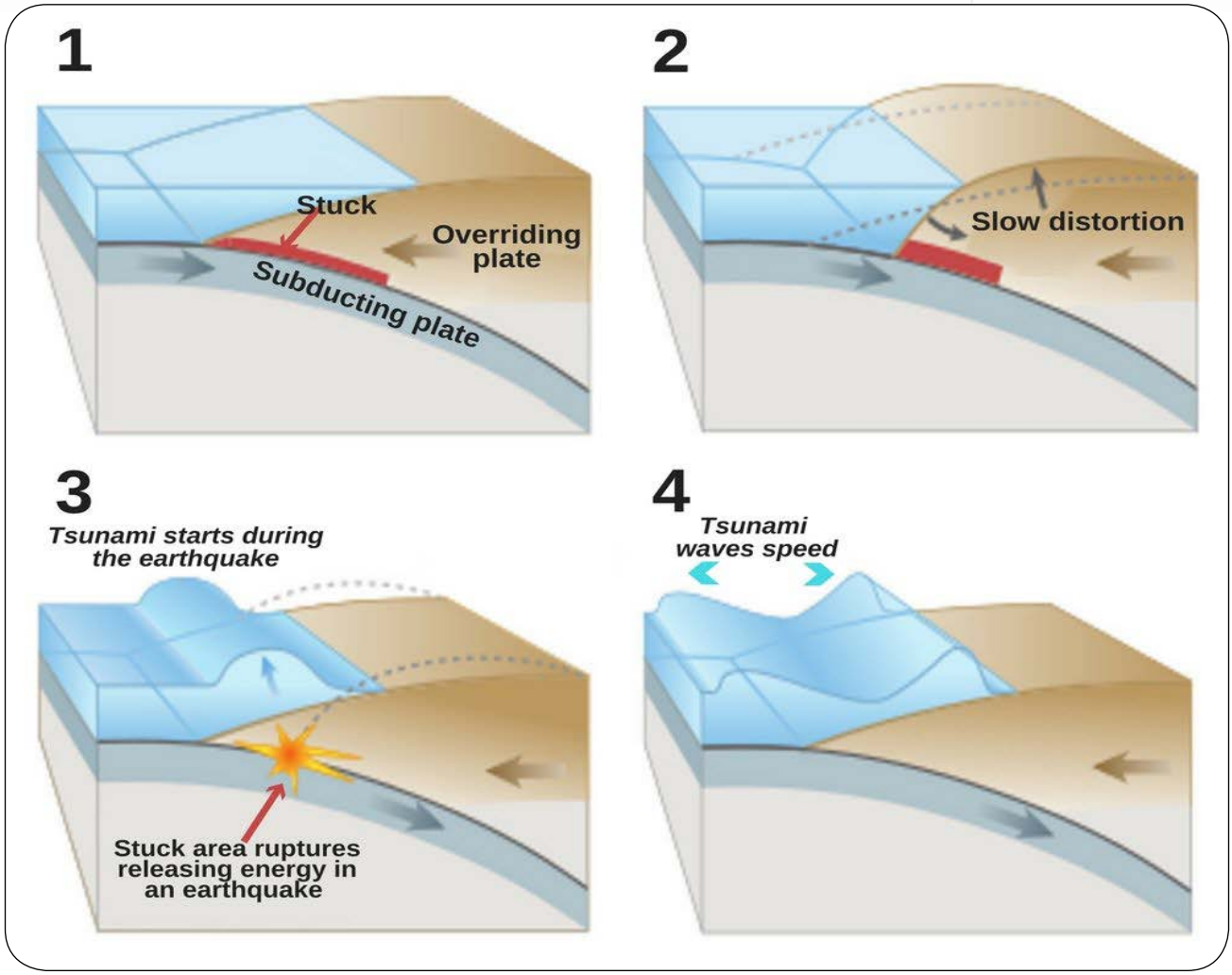
31 What was the biggest tsunami?

The biggest Tsunami Magnitude in the last century was probably the 1960 Chile tsunami . The tsunami magnitude refers to the amount of energy released during generation and corresponds roughly to the largest amount of water moved. The tsunami wave with the highest runup (biggest splash) in the last century was probably at 1958 Lituya Bay, The tsunami that caused the most damage and human casualties in the last century is the recent 2004 Sumatra tsunami.

32 How do earthquakes generate tsunamis?

Tsunamis can be generated when the sea floor abruptly deforms and vertically displaces the overlying water. Tectonic earthquakes are a particular kind of earthquake that are associated with the earth's crustal deformation; when these earthquakes occur beneath the sea, the water above the deformed area is displaced from its equilibrium position. Waves are formed as the displaced water mass, which acts under the influence of gravity, attempts to regain its equilibrium. When large areas of the sea floor elevate or subside, a tsunami can be created. Large vertical movements of the earth's crust can occur at plate boundaries. Plates interact along these boundaries called faults. Around the margins of the Pacific Ocean, for example, denser oceanic plates slip under continental plates in a process known as subduction. Subduction earthquakes are particularly effective in generating tsunamis.

Tsunami



33 Can tsunamis be predicted?

Currently, scientists cannot say when and where an earthquake might occur and so they cannot predict when an earthquake-generated tsunami might occur. Tsunamis that are triggered by volcanic activity – like submarine volcanic eruptions or pyroclastic flows- can be forecasted if the volcano is carefully monitored as is the case with volcanoes

34 What is a tide station?

A tide station has one or more calibrated instruments, called tide gauges, which have the ability to measure long and short term changes in sea level from astronomical tides or long period waves such as tsunami waves of surges. Tide stations in the ITWS telemeter their data via satellite to PTWC and other regional warning centers.The International Tsunami Warning System makes use of an extensive seismic and tide gauge network. However, it makes primary use of 31 seismic stations, and more than sixty tide stations which have the ability to transmit their data immediately and in real time to the headquarters at the Pacific Tsunami Warning Center in Hawaii.

35 Can tsunami come from more than one direction?

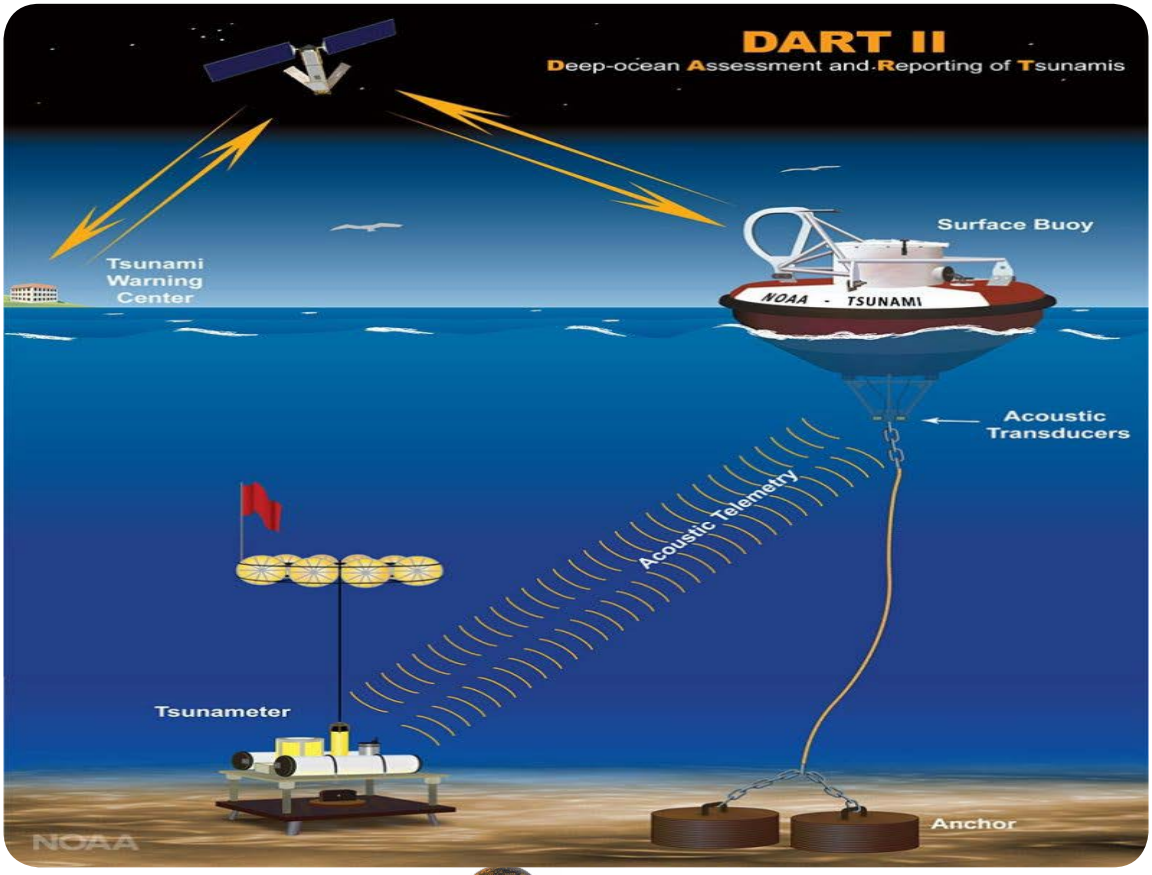
Tsunami travel away from the source of the tsunami in all directions. However when they hit the East Coast, they are coming from the east – most likely from either the Hikurangi Trench, the Kermadec Trench, or Chile.

36 How far inland can tsunami go?

That depends on how high the tsunami wave is and how high above sea level the land is. If you are 35 metres (about 70 steps) above sea level or 2 kms (about 20 minutes walking) in land you should be safe, even if it was a very big tsunami.

37 What is a DART system?

DART (Deep-ocean Assessment and Reporting of Tsunami) systems were developed by NOAA for the early detection, measurement, and real-time reporting of tsunamis in the open ocean. The NWS's National Data Buoy Center operates and maintains the U.S. network of DART systems, which is part of a larger international network. The U.S. network is composed of 39 systems (as of 2016) strategically located throughout the Pacific and Atlantic Oceans, the Gulf of Mexico, and the Caribbean Sea. Each system consists of a bottom pressure recorder (BPR) anchored on the ocean floor and a separately moored companion surface buoy. When a tsunami passes over a BPR, the instrument detects and records the changes in the overlying water pressure. An acoustic link transmits information from the BPR to the surface buoy, which then relays it via satellite to the warning centers.



38 What is the International Tsunami Warning System (ITWS)? What is the International Tsunami Information Centre (ITIC)?

The International Tsunami Warning System in the Pacific (ITWS) and the International Tsunami Information Centre (ITIC) is one of the most successful international scientific programs in disaster reduction. With support from the United States and other Member Nations and with the continuous sponsorship and coordination by the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the program has been in operation for more than 30 years.

39 How are Tsunami detected?

The Tsunami Warning Centers depend on an observation system that includes seismic and water-level networks from around the world to help them determine when and where to issue tsunami messages. These networks are critical to the warning centers' ability to provide timely and accurate messages:

- Seismic Networks—When an earthquake occurs, seismic networks provide information about an earthquake's location, depth, magnitude, and other source characteristics. The warning centers analyze this information to determine if the earthquake could have generated a tsunami and if a tsunami message is necessary.
- Water-Level Networks—If an earthquake meets certain criteria, the warning centers turn to water-level information, looking for changes in water-level height that could indicate the existence and size of a tsunami. The primary sources of information about water-level change are a network of Deep-ocean Assessment and Reporting of Tsunami (DART) systems and an extensive array of coastal water-level stations.

40 How long does a tsunami last?

Large tsunamis may continue for days in some locations, reaching their peak often a couple of hours after arrival and gradually tapering off after that. The time between tsunami crests (the tsunami's period) ranges from approximately five minutes to two hours. Dangerous tsunami currents can last for days.

Tsunami

41 What is the difference between a local and a distant tsunami?

Tsunamis are often referred to as local or distant. The type of tsunami depends on the location of the source of the tsunami and where it may strike land. The source of a local tsunami is close to the coast and may arrive in less than one hour. The danger is greatest for local tsunamis because warning time is limited. A distant tsunami is generated far away from a coast, so there is more time to issue and respond to warnings.

42 How does weather generate tsunamis?

Air pressure disturbances often associated with fast moving weather systems, like squall lines, can generate tsunamis. These "meteotsunamis" are similar to tsunamis generated by earthquakes. Their development depends on the intensity, direction, and speed of the air pressure disturbance as it travels over the ocean as well as the ocean's depth. Meteotsunamis are regional, and certain parts of the world are prone to them due to a combination of factors such as local weather patterns and the shape and features of the surface of the Earth, both above and below the ocean.

43 How big is a tsunami?

In the deep ocean, the wavelength of a tsunami may be hundreds of miles, but its waves may be barely noticeable and are rarely more than three feet high. Mariners at sea will not normally notice tsunamis as they pass beneath their hulls. As the waves enter shallow water near land and slow down, their wavelengths decrease, they grow in height, and currents intensify. When they strike land, most tsunamis are less than 10 feet high, but in extreme cases, can exceed 100 feet when they strike near their source. The first wave may not be the last or the largest. A large tsunami can flood low-lying coastal areas more than a mile inland.

Reefs, bays, entrances to rivers, undersea features, and the slope of the beach can all influence the size, appearance, and impact of tsunamis when they strike the coast. A small nondestructive tsunami in one place may be very large and violent a few miles away.

44	What should I do if I notice the warning signs?

If you are at the beach, immediately move inland or to higher ground.

- If your boat is in deep water and offshore, maintain your position.
- If your boat is berthed or in shallow water, secure your vessel and move inland or to higher ground.
- If you are on the coast and cannot move inland, seek shelter in the upper levels of a stable building.
- Do not return to the coast until you receive official clearance.
- Continue to follow emergency services instructions.

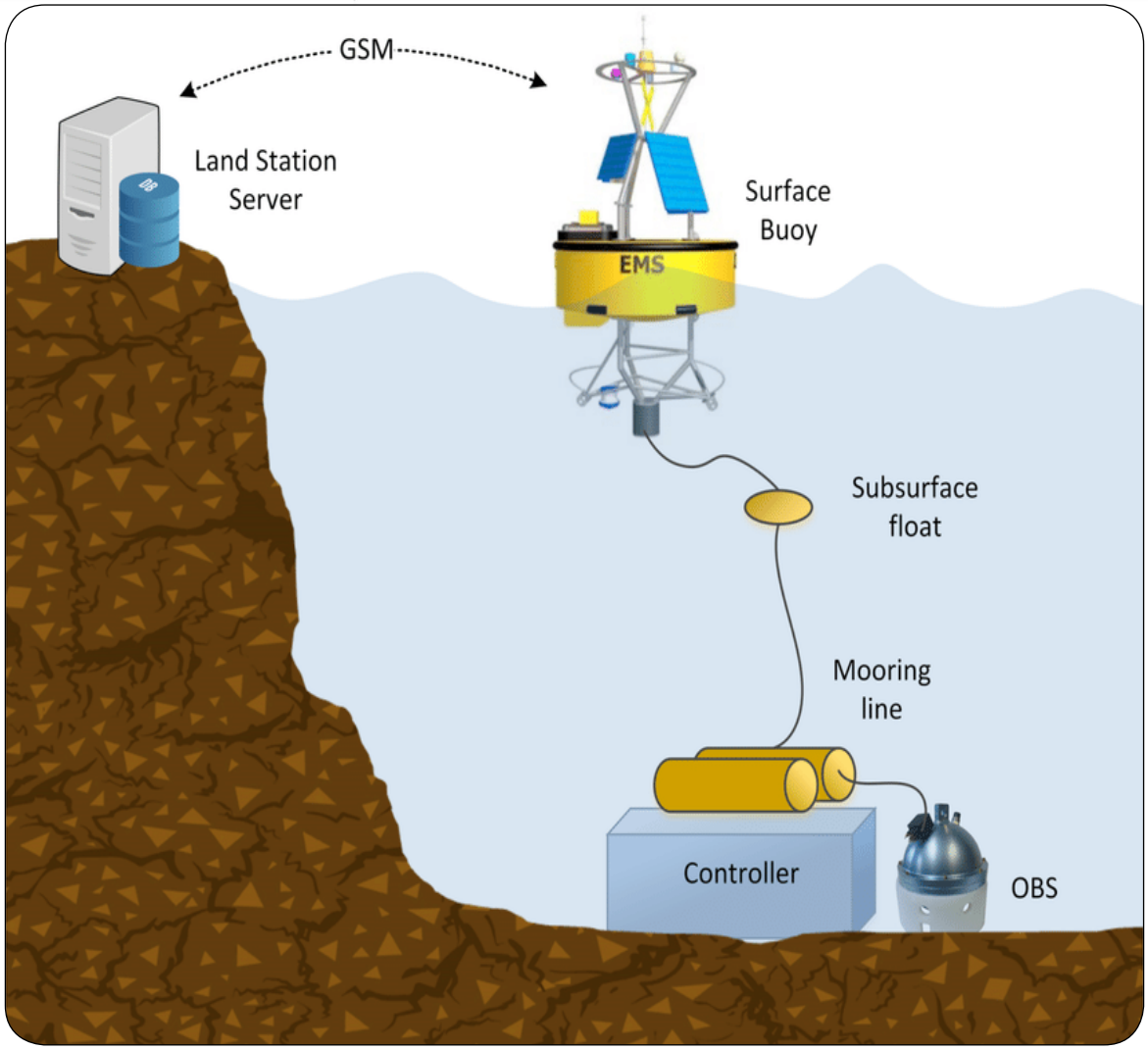
Tsunami

45 What types of earthquakes generate tsunamis?

Most of the earthquakes that generate tsunamis occur on thrust or reverse faults. These earthquakes originate mainly where tectonic plates move toward each other in subduction zones. But, 10-15 percent of damaging tsunamis are generated by strike-slip earthquakes, where the movement of the earth is horizontal. These tsunamis are likely generated by associated landslides, movement of a sloping ocean floor, or the presence of seamounts, which are underwater mountains (that can act like paddles and push the water horizontally). Tsunamis generated by strike-slip earthquakes normally affect regions near the source only.

46 What is OBS?

Ocean bottom seismometers (OBS) are devices that contain a 3C seismometer and a hydrophone to record long offset seismic or seismological data. They are not permanent devices located on the sea floor, and are typically designed to work down to 6000 m water depths for a maximum operational period of approximately 3 months. The OBS system is buoyant in the water and is attached onto an iron frame or anchor. It is recovered with an acoustic release system: On completion of the survey, the device is separated from the anchor by an acoustic release and ascends to the surface by sending a coded acoustic signal emitted by the ship›s transducer to the transponder of the OBS. The instrument also has a radio beacon to be detected by the ship›s radar, as well as a flash light and a flag for an easy detection and retrieval onboard.



47 **What can cause a tsunami?**

A.	Landslide	**C.**	Underwater earthquake
B.	Volcanic eruption	**D.**	All of the above

Tsunami

48 **Do all undersea earthquakes trigger a tsunami?**

A.	Yes	**B.**	<u>No</u>

49 **What does the word "tsunami" mean in Japanese?**

A.	Tidal wave	**C.**	Killer wave
B.	<u>Harbor wave</u>	**D.**	Century wave

50 **Witnesses have said that an approaching tsunami sounds like what?**

A.	Firecrackers exploding	**C.**	Ice cracking
B.	<u>A freight train</u>	**D.**	Nothing—there is absolute silence

51 **What is the most active tsunami area?**

A.	<u>Pacific Ocean</u>	**C.**	Caribbean Sea
B.	Indian Ocean	**D.**	North Atlantic Ocean

52 **What is the deadliest tsunami ever recorded?**

a. The 1782 South China Sea tsunami
b. The 1868 northern Chile tsunami
c. The 1883 South Java Sea tsunami
d. The 2004 Indian Ocean tsunami

53 **How fast can a tsunami travel?**

a. Up to 100 miles an hour (160 kilometers an hour)
b. Up to 200 miles an hour (320 kilometers an hour)
c. Up to 500 miles an hour (800 kilometers an hour)
d. Up to 1,000 miles an hour (1,600 kilometers an hour)

54 **Can you detect a tsunami in the open ocean?**

A. Yes **B.** No

Tsunami

55 **Where was the largest tsunami in history recorded?**

A.	India	C.	Chile
B.	Philippines	D.	Japan

56 **What is frequently a warning sign of an impending tsunami?**

a. Winds suddenly change direction
b. The sky suddenly clears
c. Seawater suddenly retreats from the shore
d. All of the above

57 **Most major tsunamis are produced by earthquakes with magnitudes greater than**

A.	6	C.	8
B.	7	D.	9

58 **Most major tsunamis are produced by earthquakes with hypocenters less than**

A.	5 km	**C.**	20 km
B.	10 km	**D.**	30 km

59 **Most major tsunamis are generated by earthquakes along**

A.	Divergent margins	**C.**	Transform margins
B.	Convergent margins	**D.**	Intraplate

60 **If the seafloor is suddenly displaced upward, then what happens to the sea surface?**

A.	It will subside	**C.**	It will momentarily rise
B.	It will remain unchanged	**D.**	None

Tsunami

61 **During a tsunami a series of waves radiating outward from a central disturbance of the sea floor is called a ?**

A.	Ocean storm	**C.**	Wave train
B.	Wind-generated disturbance	**D.**	Wavelets

62 **Just prior to a tsunami coming ashore, sea level appears to fall quickly. This phenomenon is called ?**

A.	Sea level drop	**C.**	Drawdown
B.	Draw fall	**D.**	Dip in sea level

63 **Does the period of a tsunami range from seconds to minutes or from minutes to up to 2 hours?**

The periods of tsunami range from minutes up to 2 hours

64 **Does the speed of a tsunami increase or slow down as it enters the shallow water adjacent to a landmass lying in its path?**

The speed of a tsunami slows as it enters shallow water

65 **In the open ocean a tsunami can travel at speeds of**

A.	50 m/hour	**C.**	966 km/hour
B.	100 m/hour	**D.**	20 m/hour

66 **The speeds of tsunami in open oceans can reach up to 966 km/hour. As a tsunami approaches shallow water which of the following set of transformations occur?**

a. Wavelength increases, wave period decreases, and wave height stays the same
b. Wavelength decreases, wave period decreases, and wave height increases
c. Wavelength decreases, wave period increases, and wave height increases
d. Wavelength decreases, waver period stays the same, and wave height increases

67 **If the average depth of the oceans is 3500 meters, then what would the speed of a tsunami be in such open ocean conditions?**

A.	300 km/hour	**C.**	667 km/hour
B.	400 km/hour	**D.**	500 km/hour

Tsunami

68 **In the following formula what is g and d? Speed = (g * d)1/2**

g is the acceleration due to gravity (9.81 m/sec) while d is the depth to the seafloor

69 **The wave height of a tsunami is typically less than**

A.	0.1 m	**C.**	1 m
B.	0.2 m	**D.**	0.5 m

70 **Where did the Good Friday earthquake occur?**

A.	Chile	**C.**	California
B.	Sumatra	**D.**	Alaska

71 **What factors can determine the strength of a tsunami?**

a) The amount of seafloor displacement
b) The length of the rupture zone.
c) The depth of the water above the seafloor displacement

72 **Why do tsunamis in deep water tend to make stronger tsunamis?**

a) More water is lifted or dropped
b) More potential energy is created

73 **What determines whether the sea initially advances or retreats when a tsunami arrives?**

a) Whether the nearby seafloor has a steep or shallow slope
b) Whether the earthquake takes place in deep or shallow water
c) Whether the seafloor near the coast is uplifted or dropped down
d) Whether the coast is in the northern or southern hemisphere

74 **Which is the most dangerous location for a tsunami hazard?**

a. a straight stretch of coast directly exposed to the open sea
b. a rocky point protruding into the ocean in deep water
c. a bay with a nice sandy beach at its end
d. a small boat in the deep ocean

75 **Both earthquakes ruptured the subduction zone 30 km beneath the sea floor. Based only on this information, which of the two do you think produced the bigger tsunami?**

A.	Earthquake A
B.	Earthquake B
C.	Neither / Cannot be Determined

Tsunami

76 **The maximum uplift and subsidence of Earthquake A was 5 m, while for Earthquake B it was 1 m. Based only on this information, which of the two do you think produced the bigger tsunami?**

A.	Earthquake A
B.	Earthquake B
C.	Neither / Cannot be Determined

77 **The ocean depth in the vicinity of Earthquake A is 500-1000 meters. The ocean depth in the vicinity of Earthquake B is 0-200 meters. Based only on this information, which of the two do you think produced the bigger tsunami?**

A.	Earthquake A
B.	Earthquake B
C.	Neither/Cannot be Determined

78 **The magnitude of Earthquake A is 9.1. The magnitude of Earthquake B is 8.7. Based only on this information, which tsunami would you expect to be bigger?**

a. a straight stretch of coast directly exposed to the open sea
b. a rocky point protruding into the ocean in deep water
c. a bay with a nice sandy beach at its end
d. a small boat in the deep ocean

79 **How much uplift occurred during the Good Friday earthquake?**

A.	5 m
B.	10 m
C.	15 m
D.	25 m

80 **What is a tsunami?**

A.	a type of fish	C.	a kind of volcano
B.	a series of huge waves	D.	Earthquake

81 **The term Tsunami is coined from?**

A.	Chinese term	C.	German term
B.	Indian term	D.	Japanese term

82 **Tsunamis are waves generated by ?**

A.	Earthquakes	C.	Underwater landslides
B.	Volcanic eruptions	D.	All the above

83 **Tsunami can occur only during?**

A.	Morning	C.	Evening
B.	Noon	D.	Any time of day or nights

Tsunami

84 **International Tsunami Information Centre is in?**

A.	Honolalu	C.	Jakartha
B.	Goa	D.	Pondicherry

85 **What is the speed of tsunami waves?**

A.	40 meters/hour	C.	9000 km/hour
B.	100 kms/hour	D.	800 km/hour

86 **If you were at the beach, how would you know there may be a tsunami?**

A.	There may be a warning	C.	There is a drop in the level of the ocean
B.	An alert comes over the radio	D.	all of the above

87 **What would you do if you heard a warning?**

a) Surf on the big waves
b) Get out of the water quickly and move to higher ground
c) Wait until you have finished your swim
d) phone your friend

88 **Tsunamis are most commonly found in which ocean?**

A.	Pacific Ocean	C.	Artic Ocean
B.	Atlantic Ocean	D.	Indian Ocean

89 **What is the cause of tidal waves?**

a) wind
b) gravitational force of the moon on the sea
c) gravitational force of the sun on the sea
d) gravitational force of the earth on the sea

90 **Tsunami is classified as**

A.	Water Hazard	C.	Biological hazard
B.	Environmental hazard	D.	Geological hazard

91 **Just prior to a tsunami coming ashore, sea level appears to fall quickly. This phenomenon is called**

A.	Sea level drop	C.	Drawdown
B.	Draw fall	D.	Dip in sea level

Tsunami

92 **Most major tsunamis are produced by earthquakes with magnitudes greater than**

A.	6	**C.**	8
B.	7	**D.**	9

93 **Major tsunamis are produced by earthquakes with hypocenters less than**

A.	5 km	**C.**	20 km
B.	10 km	**D.**	30 km

94 **Major tsunamis are generated by earthquakes along**

A.	Divergent margins	**C.**	Transform margin
B.	Convergent margins	**D.**	None of the above

95 **During a tsunami a series of waves radiating out ward from a central disturbance of the sea floor is called a**

A.	Ocean storm	**C.**	Wave train
B.	Wind-generated disturbance	**D.**	Wavelets

96 **When the stress exceeds the resistance to shearing along the locked interface between two converging plates, what will happen?**

a. The seafloor will suddenly subside
b. The seafloor will suddenly be driven upward
c. The seafloor will slide passively in a lateral direction parallel to the strike of the interface
d. Nothing will happen

97 **If the seafloor is suddenly displaced upward, then what happens to the sea surface?**

A.	It will subside	**C.**	It will momentarily rise
B.	It will remain unchanged	**D.**	Nothing will happen

98 **Just prior to a tsunami coming ashore, sea level appears to fall quickly. This phenomenon is called**

A.	Sea level drop	**C.**	Drawdown
B.	Draw fall	**D.**	Dip in sea level

Tsunami

99 **As a tsunami approaches shallow water which of the following set of transformations occur?**

a. Wavelength increases, wave period decreases, and wave height stays the same
b. Wavelength decreases, wave period decreases, and wave height increases
c. Wavelength decreases, wave period increases, and wave height increases
d. Wavelength decreases, waver period stays the same, and wave height increases

100 **The wave height of a tsunami is typically less than**

A.	0.1 m	**C.**	1 m
B.	0.2 m	**D.**	0.5 m

101 **What does "tsunami" mean in Japanese?**

A.	severe earthquake	**C.**	Harbor wave
B.	Huge wind	**D.**	Terrible storm

102 **What are the three phases of disaster management planning?**

a. Preparation, Response and Recovery
b. Preparation, Planning and Perception
c. Evacuating, Rebuilding and Re-branding
d. Planning, Evacuating and Recovery

103 **What are the technologies involved in the detection of Tsunami?**

a. Satellites to provide warning of tsunamigenic earthquakes
b. Coastal tidal gauges
c. Tsunami detectors linked to land by submarine cables
d. All of the above

104 **The number of tsunami waves generated by one earthquake is generally:**

A.	one	**C.**	about 50
B.	10 or 12	**D.**	about 100-120

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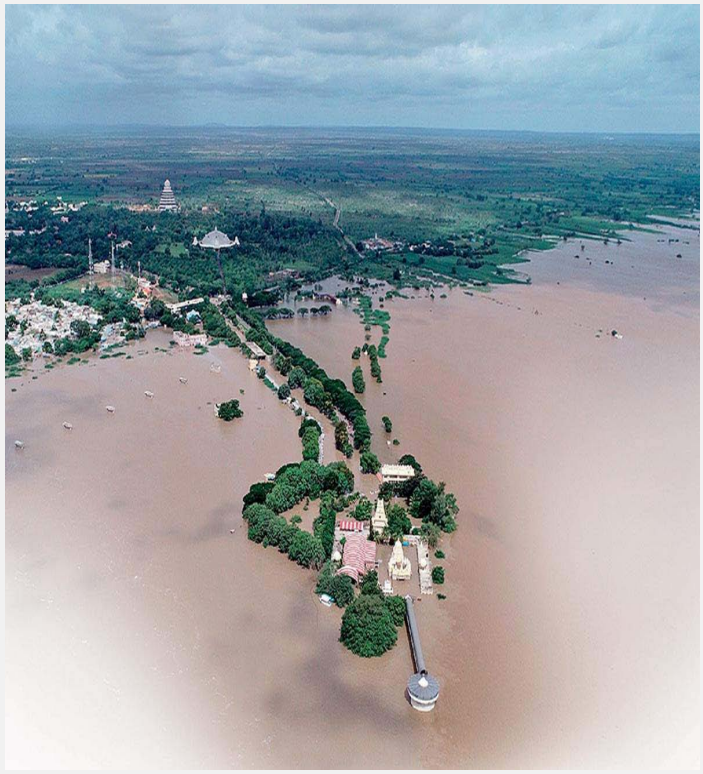
133

Questions & Answers
in
Landslides & Floods



Landslides & Floods

Intruduction

Natural hazards like Floods and Landslides can lead to major disasters which hamper the development of the nations and affect many areas in the World. Landslides are dominantly considered as a local soil threat in mountainous regions and on slopes. Hazards posed by landslides are accidental and dynamic. The driving forces/pressures for flooding and landslides are of natural, social, economic, and ecological origins which interact in complex ways. Most of countries around the world, especially Asian and African countries, do not have adequate methodology of estimation of losses due to the occurrence of natural disasters. The information about loss estimation caused by floods of different magnitudes and the loss return period are crucial to develop policies for rational flood and landslide alleviation, based on cost effective measures. With the availability of satellite rainfall analyses at fine time and space resolution, it has also become possible to mitigate such hazards on a near-global basis.

Landslides & Floods

1 What is a landslide ?

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope due to gravity. The materials may move by falling, toppling, sliding, spreading, or flowing.

2 What are slope movements of landslides?

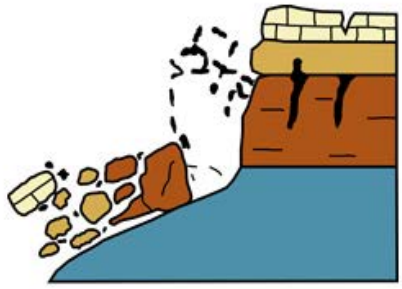
The term "**landslide**" encompasses five modes of slope movement: falls, topples, slides, spreads, and flows. These are further subdivided by the type of geologic material (bedrock, debris, or earth). Debris flows (commonly referred to as mudflows or mudslides) and rock falls are examples of common landslide types.

3 What causes landslides?

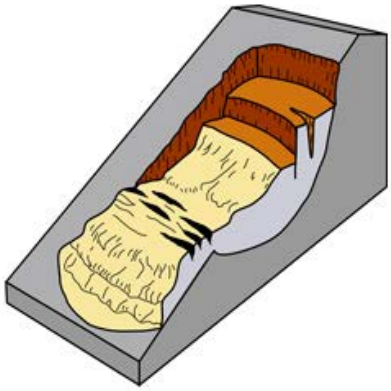
It occurs when the consequence of a complex field of forces (stress is a force per unit area) active on a mass of rock or soil on the slope. It happens due to geological causes, morphological causes, physical causes and human causes. There are two parameters that determine the landslides are as follows:

- Increase of shear stress: It happen due to the removal of lateral and underlying support; increase of lateral forces as well as load; transitory stresses like blasting, earthquakes etc.; and geological movement.
- Decrease of material strength: It happens due to the weathering, pore water pressure and changes in structure.

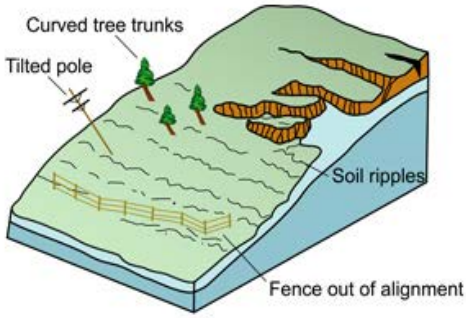
Lateral spread



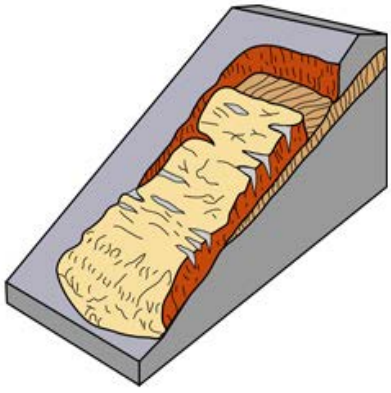
Topple



Rotational Landslide



Creep



Translational Landslide

Rockfall

4 Do human activities cause landslides?

Yes, in some cases human activities can be a contributing factor in causing landslides. Many human-caused landslides can be avoided or mitigated. They are commonly a result of building roads and structures without adequate grading of slopes, poorly planned alteration of drainage patterns, and disturbing old landslides.

5 How landslides can mitigate?

A. By restricting or even removing population from landslides prone areas.
B. By restricting certain types of land use where slopes are vulnerable.
C. By installing early warning systems based on the monitoring of ground conditions such as strain in rocks and soils, slope displacement, and groundwater levels.

6 What branches of geologic hazards?

Geologic Hazards include: Earthquakes, Volcanic Eruptions, Tsunami, Landslides, Floods, Subsidence, Impacts with space objects

7 How do pyrite and pyrrhotite damage building foundations?

Pyrite and pyrrhotite are minerals known as iron sulfides. When iron sulfides are exposed to water and oxygen, a series of chemical reactions breaks down the iron sulfides and forms new minerals called sulfates. These sulfates take up more space than the original iron sulfides. As they grow, the new sulfate minerals push against the surrounding rock, causing it to swell and crack.

8 What are submarine landslides?

Earthquake shaking and other factors can also induce landslides underwater. These landslides are called submarine landslides. Submarine landslides sometimes cause tsunamis that damage coastal areas.

9 How to manage Natural Hazards?

The best most efficacious way of managing natural hazards is to build a comprehensive historical, and whenever possible, prehistorical (e.g., trenching active faults to document thousands of years of activity), record of hazard events. Civil authorities, land managers, and the emergency management community can leverage that record to stage and deploy meaningful land management and emergency preparedness at the community level. Hazard preparedness at the family-, business-, and community-level is critical to building a resilient community capable of mitigating the worst of natural hazards events.

NATURAL DISASTERS


tornado


volcano


earthquake


tsunami


drought

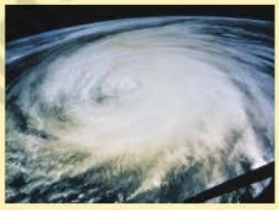

avalanche


dust storm


forest fire


thunderstorm


snowstorm


hurricane


windstorm


hailstorm


flood


sandstorm


sinkhole

www.eslforums.com

10 How to deal with geologic hazards?

Coping with geologic hazards is :

1. avoid the areas where known hazards exist. Such areas can be converted into parks, for instance.
2. Evaluate the potential risk of a hazard, if activated.
3. Minimize the effect of the hazards by engineering design and appropriate zoning.
4. Develop a network of insurance and contingency plans to cover potential loss or damage from hazards.

11 What are similarities and dissimilarities between natural and geologic hazards?

A natural hazard can be described as the threat of a potentially damaging process or phenomenon that occurs, or has the potential to occur, in our physical environment. The hazard exists whether or not an event has happened. A natural hazard becomes a natural disaster when an event occurs that causes injuries and damages beyond society's ability to cope.

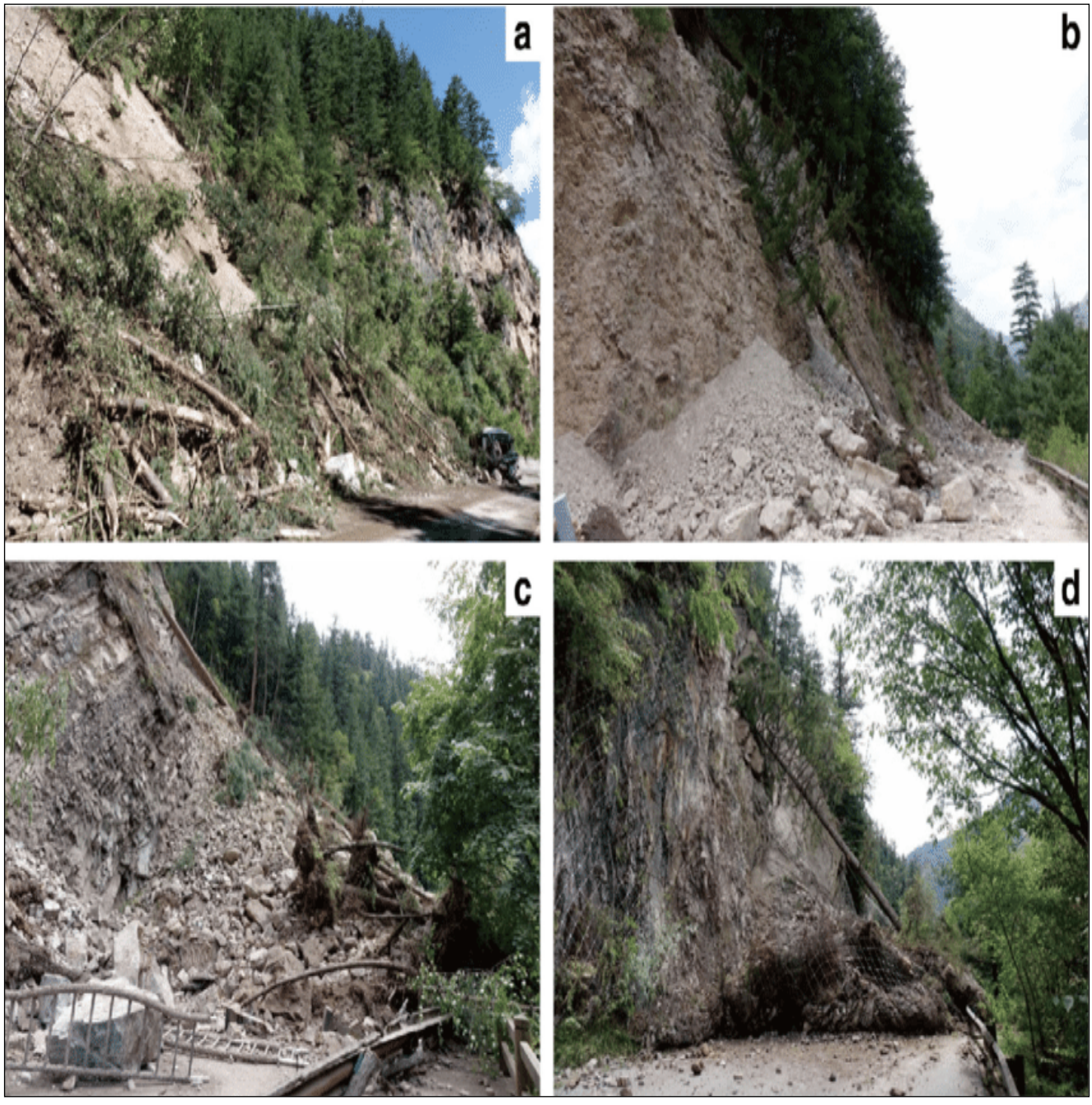
A geological hazard is a natural hazard that has a geological or physiographic cause, trigger or effect. Geological hazards can rarely be stopped, but careful land-use planning, robust building codes, engineered mitigation structures, and personal preparedness can reduce the risk of loss.

12 How fast do landslide travel?

Landslides can move slowly, (millimeters per year) or can move quickly and disastrously, as is the case with debris flows. Debris flows can travel down a hillside at speeds up to 200 miles per hour (more commonly, 30 – 50 miles per hour), depending on the slope angle, water content, volume of debris, and type of earth and debris in the flow. These flows are initiated by heavy periods of rainfall, but sometimes can happen as a result of short bursts of concentrated rainfall or other factors in susceptible areas. Burned areas charred by wildfires are particularly susceptible to debris flows, given certain soil characteristics and slope conditions.

13 Who is most at risk for landslides?

As people move into new areas of hilly or mountainous terrain, it is important to understand the nature of their potential exposure to landslide hazards, and how cities, towns, and counties can plan for land-use, engineering of new construction and infrastructure, and other measures which will reduce the costs of living with landslides. Although the physical causes of many landslides cannot be removed, geologic investigations, good engineering practices, and effective enforcement of land-use management regulations can reduce landslide hazards


a
b
c
d

14 How do landslides cause tsunamis?

Tsunamis are large, potentially deadly and destructive sea waves, most of which are formed as a result of submarine earthquakes. They may also result from the eruption or collapse of island or coastal volcanoes and the formation of giant landslides on marine margins. These landslides, in turn, are often triggered by earthquakes. Tsunamis can be generated on impact as a rapidly moving landslide mass enters the water or as water displaces behind and ahead of a rapidly moving underwater landslide.

15 What are Remedial steps for landslides?

- Modification of Slope Geometry: In order to improve the stability of the unstable or potentially unstable slopes, the profile of the slope is sometimes changed by excavation or by filling at the toe of the slope.
- Drainage Control: The presence of water in joints or in soil slope has a fundamental influence on the slope stability.
- Internal Slope Reinforcement Systems: The aim of rock slope stabilization with structural elements is to help the rock mass to support itself by applying external structures which are not part of the rock mass but support it externally.
- Retaining Walls: Construction of wall along the problematic slopes area.

16 What are some examples of landslides that have caused tsunamis?

The 1964 Alaska earthquake caused 115 deaths in Alaska alone, with 106 of those due to tsunamis generated by tectonic uplift of the sea floor, and by localized subareal and submarine landslides. The earthquake shaking caused at least 5 local slide-generated tsunamis within minutes after the shaking began. An eyewitness account of the tsunami caused by the movement and landslides of the 1964 Alaska earthquake.

17 What is the difference between a sinkhole and a pothole?

A sinkhole is a closed natural depression in the ground surface caused by removal of material below the ground and either collapse or gradual subsidence of the surface into the resulting void.
A pothole is usually a fairly small feature caused by failure of paving materials, usually associated with roads, parking lots, and airports. In the colder parts of the country, potholes become more abundant in late winter and spring be cause of freeze-thaw damage to pavements.

18 How do you know if the area is vulnerable to landslides?

There are two things that you should know if you are vulnerable. First, check if there is enough vegetation to hold the soil hard. Second, check if the soil is strong enough.

19 How will I know if a landslide will happen?

After heavy rain and/or prolonged rain or tremors and shakes. After these, a landslide might occur. Do not panic, it is the worst mistake that you will do, stay calm, plan an evacuation plan. If you are inside a building, do not go out unless it is safe to do so. If you are at a river, prepare to evacuate the area. If you are driving, look out for debris

20 What debris flows are?

Debris flows, also known as mudslides, are a common type of fast-moving landslide that tends to flow in channels.es and debris Landslides are caused by disturbances in the natural stability of a slope. They can accompany heavy rains or follow droughts, earthquakes, or volcanic eruptions. Mudslides develop when water rapidly accumulates in the ground and results in a surge of water-saturated rock, earth, and debris. Mudslides usually start on steep slopes and can be activated by natural disasters.

21 What areas are at risk?

A. Areas where wildfires or human modification of the land have destroyed vegetation;
B. Areas where landslides have occurred before;
C. Steep slopes and areas at the bottom of slopes or canyons;
D. Slopes that have been altered for construction of buildings and roads;
E. Channels along a stream or river; and F. Areas where surface runoff is directed.

22 What you can do to protect yourself?

Before intense storms and rainfall :

A. Assume that steep slopes and areas burned by wildfires are vulnerable to landslides and debris flows.
B. Learn whether landslides or debris flows have occurred previously in your area by contacting local authorities, a county geologist or the county planning department, state geological surveys or departments of natural resources, or university departments of geology.
C. Contact local authorities about emergency and evacuation plans. D. Develop emergency and evacuation plans for your family and business.
E. Develop an emergency communication plan in case family members are separated. F. If you live in an area vulnerable to landslides, consider leaving it.

23 What is Subsidence?

Subsidence is defined as sinking or settling of the ground in almost vertically downward direction which may occur because of the removal of natural support from the underground or due to compaction of the weaker rocks under the load from overlying mass.

Types of subsidence

Subsidence is the sinking of the Earth's surface in response to a geologic or man-made process. It occurs when loose, water saturated sediment begins to compact causing the ground surface to collapse.

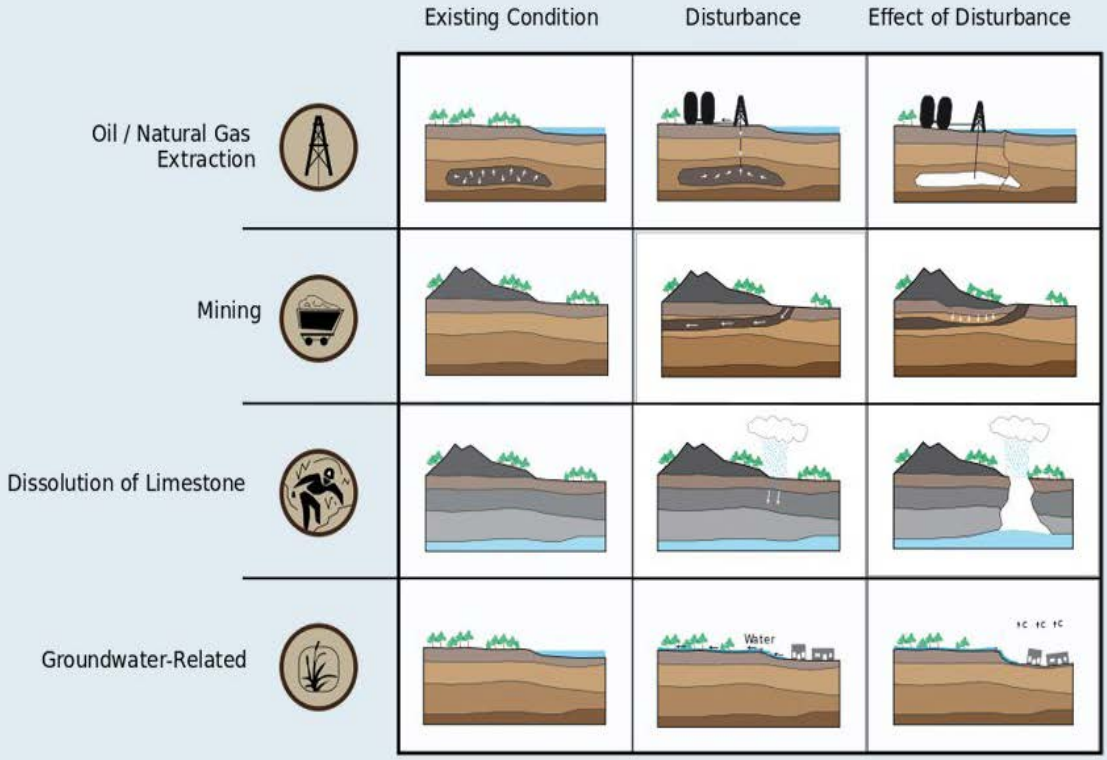


Image courtesy of Mpetty1

24 **Define Denudation?**

It is general term used when the surface of the earth is worn away by chemical as well as mechanical actions of physical agents and the lower layers are exposed. This happens when the rocks were exposed for a sufficient length of time to the attacks of physical agents.

25 **What is regolith?**

Regolith is all of the materials lying between unweathered bedrock below and the Earth's surface above.

26 **What are rock falls?**

The term rock fall represents both a process and the resulting deposit. The process involves the falling for some distance through the air, or the bouncing and rolling down slope of solid material or soil on a steep slope. The typically broken and shattered material resulting from this process is also called a rock fall.

27 **What are topples?**

A topple is a rock fall that involved the forward rotation of a detached block above a pivotal point located in the lower part of the detached material. When the block detaches from the substrate it appears to pitch and rotate forward.

28 A mudflow differs from a debris flow in what way?

It is composed of finer grained material. For example, a mudflow is composed of 80% or more particles less than 0.06 mm in size, while a debris flow is composed of 20% to 80% particles larger than 2 mm in size.

29 What is the difference between Creep and Rapid flow?

Creep is a slow movement of soil in the range of a few cm a year. This phenomenon occurs either seasonally or continuously. As shown in the picture, it can be identified by tilted fence, or trees with curved trunks. Creep can buckle walls, but not life threatening. The process can be slowed down by planting trees.
Rapid flow is similar to the creep, but differ in terms of speed and depth. It is faster. Creep is involved up to shallow depth (app. 1-2 m), whereas the rapid flow is involved to greater depth (app. Up to 5 m or more).

30 What is Earthflows and Solifuction?

Earthflows are down slope, viscous flows of saturated, fine-grained materials, which move at any speed from slow to fast.
Solifuction is a downward movement of wet soil along the slopes under the influence of gravity.

31 What is Slump?

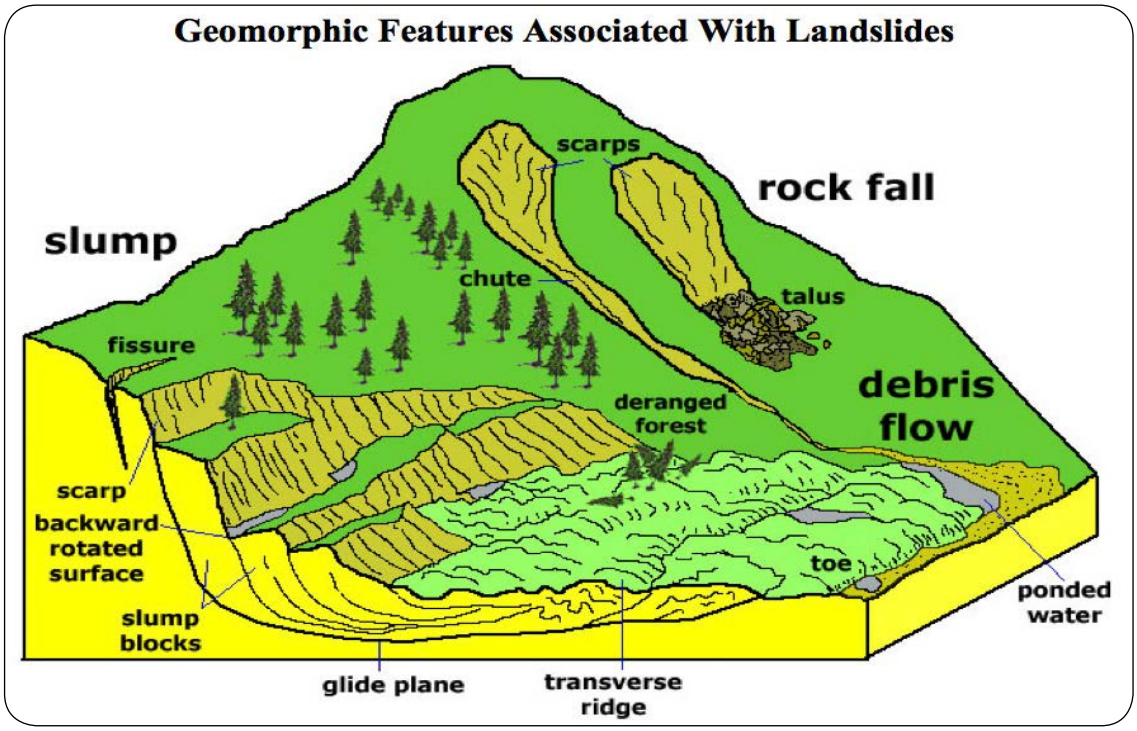
Slump or debris slide: Soil mass moving at a speed of few tens of meters to a few hundred meters per hour is known as slump. It is identified by rotational arc scars. Generally, it is not hazardous to life, but is threat to natural property.

32 What is Plastic outflow?

Plastic outflow: It may occur when a plastic layer like clay bed is squeezed outward due to overlying heavy load. ØCollapse: It occur due to extensive pull out of large volume of underground water or due to subsurface solution activity in limestone terrain.

33 List Factors which can be used in landslides classification?

The following factors can be used to classify landslides: Material: Rock, Soil Lithology , structure, Geotechnical properties Geomorphic attributes: Weathering, Slope form Landslide geometry: Depth, Length, Height etc. Type of movement: Fall, Slide, Flow etc Climate: Tropical, Peri-glacial etc. Water: Dry, wet, saturated Speed of movement: Very slow, slow etc. Triggering mechanism: Earthquake, rainfall etc.



34 What is a flood and causes?

A flood is an excess of water (or mud) on land that's normally dry and is a SITUATION wherein the inundation is caused by high flow, or overflow of water in an established watercourse, such as a river, stream, or drainage ditch; or ponding of water at or near the point where the rain fell. This is a unpredictable - duration type-natural and inevitable event.

There are two types of reasons that cause flood, i.e .

1 - Natural and 2- Man-made.

Natural causes of flood- Intense rainfall for a long period of time, Snowmelt or melting down of glacier, Rise in water level of rivers due to various reasons, Volcanic eruptions, Land slide etc.

Man-Made Causes of Flood-, Pollution and climate change, which ultimately result into either lack of rainfall or over dripping, Limitless urbanization., Poor construction and management of dams., improper water flow management and negligence in handling water expulsion. Etc. Reasons for floods varies with Landform as well.

It is generally thought, that unusually frequent cases of severe flooding in recent years can be attributed to climate change due to global warning caused by excessive manmade emission of greenhouse gasses originating from the burning of fossil fuel. Another reason for flooding of low areas is that the water level in the oceans is slowly rising because of the melting of the polar ice caps also caused by global warming.

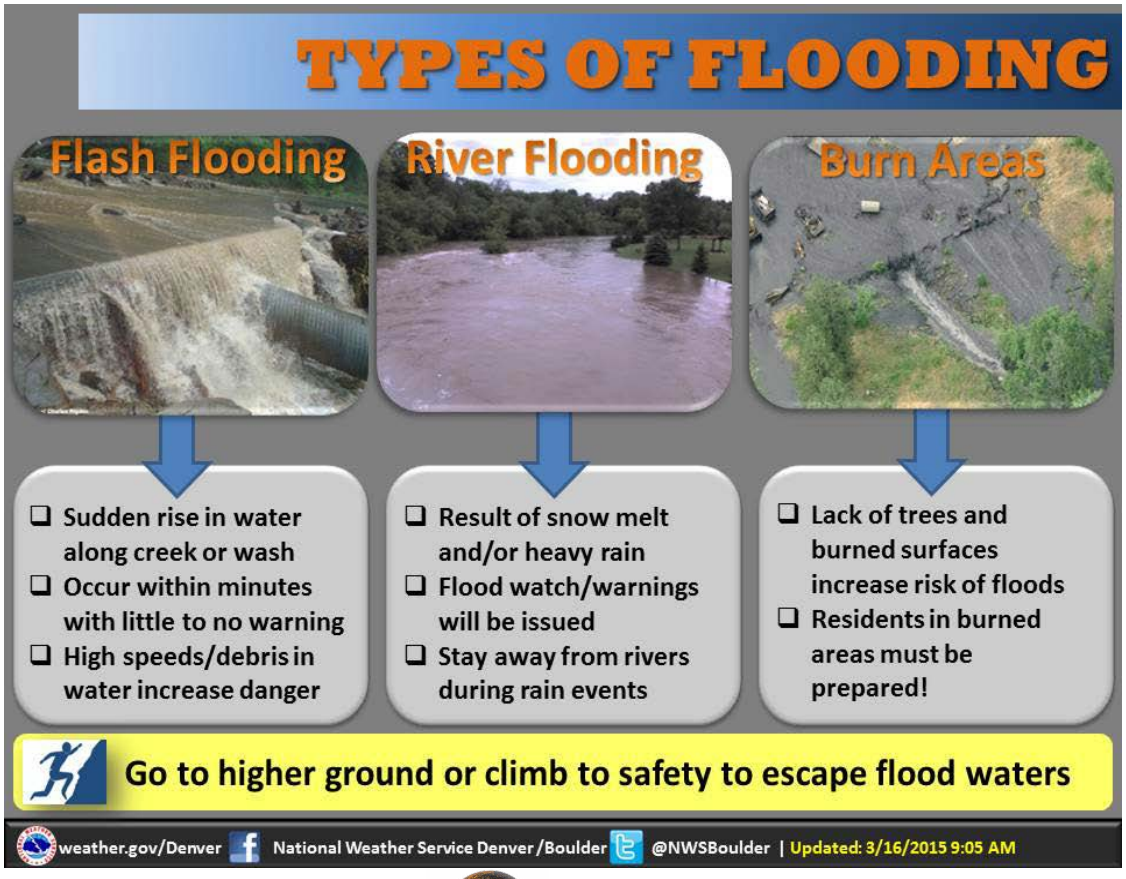
35 What types of floods?

According to Duration : Slow-Onset Flooding Rapid-Onset Flooding Flash Flooding and According to Location : Coastal Flooding Storm surge Arroyos/ Mud Flooding River Flooding Urban Flooding.

36 Can floods be predicted?

Flood predictions require several types of data:

1. The amount of rainfall occurring on a real time basis.
2. The rate of change in river stage on a real time basis, which can help indicate the severity and immediacy of the threat.
3. Knowledge about the type of storm producing the moisture, such as duration, intensity and areal extent, which can be valuable for determining possible severity of the flooding.
4. Knowledge about the characteristics of a river's drainage basin, such as soil-moisture conditions, ground temperature, snowpack, topography, vegetation cover, and impermeable land area, which can help to predict how extensive and damaging a flood might become.



37 What are major factors which control flooding?

There are several factors that can cause floods. River flooding usually happens when there has been a great deal of rainfall higher up in the river course which then travels down and overflows the riverbanks. In higher or colder regions, melting snow or ice have the same affect and cause the river level to rise above its banks and flood. Coastal flooding usually happens during a tropical storm. It is caused by storm surges and large waves moving towards the drier and usually low level land. These surges travel overland, cause coastal areas to be flooded and can devastate the impacted areas. Other factors which can contribute to flooding include:

· volume, spatial distribution, intensity and duration of rainfall over a catchment
· the capacity of the watercourse or stream network to carry runoff
· catchment and weather conditions before rainfall
· ground cover
· topography
· tidal influences

38 How are dams responsible for causing floods?

When the water behind a dam reaches the capacity of the dam, water must be released the prevent damage to the dam. Sometimes extremely large amounts of water needs to be released during large rain events. These large releases of water can sometimes cause flooding downstream. A dam is designed within engineering parameters. These include factors of safety for the earthworks or concrete arch which their construction effectiveness relies on. There are very careful calculations done during the design, to allow for all sorts of eventualities in the catchment area (the places where the upstream water is collected from), also the historical flood events, the 25 year flood, the 50 year flood, the 100 year flood etc. If the reservoir above the dam is susceptible to rockfall, engineers even allow for the effects of waves overtopping the dam.

Landslides & Floods

39 What is Flash Floods?

Flash floods occur within 6 hours of a rain event, or after a dam or levee failure, or following a sudden release of water held by an ice or debris jam, and flash floods can catch people unprepared. You will not always have a warning that these deadly, sudden floods are coming. So if you live in areas prone to flash floods, plan now to protect your family and property.

40 What are causes of Storm Surge?

Storm surge is an abnormal rise in water level in coastal areas over and above the regular astronomical tide. Storm surge is always a result meteorological storms that cause higher than normal tides on the coast. There are three parts of a storm that create this surge. They are: Wind, Waves, Low atmospheric pressure.

41 How does an avalanche differ from a landslide?

Avalanche, The rapid downslope movement of snow and ice in steep mountain areas. The influence of gravity on the accumulated weight of newly fallen uncompacted snow or on thawing older snow leads to avalanches which may be triggered in a variety of ways including earthquakes, gun shots and the movements of animals or skiers. Avalanches are most common during winter or spring but glacier movements may cause ice avalanches during summer. Avalanches may cause considerable loss of life and can destroy settlements, roads, railways and forests. In many areas, regular avalanche tracks can be identified and precautions taken to minimize damage, such as the prevention of development in these areas, the construction of avalanche sheds over existing roads and railways and the use of tunnels for new road and rail links. Avalanches present the greatest threat in areas where their path cannot be predicted and may cause a major hazard for skiers and mountaineers. The term is also sometimes used for the movement of rock debris on steep mountain slopes.

42 How does deforestation bring flood?

Deforestation on a grand scale is visually dramatic and brings with it many environmental changes, some of which are immediate and detrimental, but other changes that are incremental and not immediately obvious. It should be noted, however, that the removal of individual trees and ever small blocks of trees in planned clear-cuts does not constitute deforestation. If a forested area is regenerated through management techniques that include selective cutting and block cutting, that area is expected to revert to the full stocking that existed before tree removal.

43 What is the difference between cyclones and hurricanes?

A. In the northern hemisphere, extreme low pressure systems are called hurricanes and rotate counter-clockwise.
B. In the southern hemisphere, extreme low pressure systems are called cyclones and rotate clockwise.

44 What is the difference between soil erosion and flooding?

Soil erosion is the result of flooding. Soil erosion can also be caused by the wind. Flooding is the above normal flow of water thru any channel or over land not normally carrying water. Flooding cause soil erosion but soil erosion does not cause flooding.

45 What is the characteristic of the mass above and below a landslide respectively?

A.	Both stable	C.	Unstable and stable
B.	Both unstable	D.	Stable and unstable

46 What type of landslide may undergo landslide?

A.	Rock fragments	C.	Whole blocks
B.	Loose soil	D.	Any type of mass

47 What is the character of the surface of shear in hard, brittle and coherent mass?

A.	Curved	C.	Circular
B.	Planar	D.	Undulated

48 What is the character of the surface of shear in loose, inherently weak rocks?

A.	Curved	C.	Circular
B.	Planar	D.	Undulated

49 **Type of landslide where surface of failure is planar is**

A.	Translational	C.	Rock toppling
B.	Rotational	D.	Longitudinal

50 **What is the characteristic sloping surface in rotational slides?**

A.	Curved	C.	Circular
B.	Planar	D.	Undulated

51 **Type in which falls are involved rather than sliding is**

A.	Translational sliding	C.	Rock toppling and falls
B.	Rotational sliding	D.	Subsidence

52 **Sinking or settling of the ground in almost vertical direction naturally is called _____**

A.	Flowage	C.	Avalanche
B.	Sliding	D.	Subsidence

53 **What movements is observed in all cases of subsidence?**

A.	Horizontal	**C.**	Vertical
B.	Shearing	**D.**	Inclined movement

54 **In which type of slide, weather conditions play a very important role?**

A.	Translational sliding	**C.**	Rock toppling and falls
B.	Rotational sliding	**D.**	Subsidence

55 **Translational sliding is quite common in slopes made up of**

A.	Rocks	**C.**	Rocks and non-cohesive soils
B.	Cohesive soils	**D.**	Rocks and cohesive soils

56 **Which of the following is not part of geological disaster?**

A.	Volcanoes	**C.**	Tsunami
B.	Earthquakes	**D.**	Sea Surge

57 **Mass wasting is the _____ movement of Earth material such as regolith or solid rock under the influence of gravity.**

A.	Down slope	C.	Loose soil
B.	whole blocks	D.	Slope

58 **Gravity acting across a sloped or inclined surface can be broken into a Normal and a _____ component.**

A.	Tangential	C.	Planner
B.	Vertical	D.	Perpendicular

59 **.....is defined as the downward and outward movement of slope-forming materials.**

A.	Flood	C.	Landslides
B.	subsidence	D.	Avalanche

60 **Rock is defined as any intact, _____, and firm mass that existed in its natural place prior to a landslide.**

A.	Hard	C.	loose
B.	soft	D.	wet

61 **Soil is an aggregate of _____ and rock fragments ± organic material that formed from the in situ weathering**

A.	Minerals	**C.**	soils
B.	Rocks	**D.**	all of them

62 **What might fill the voids and spaces between mineral or rock fragments in a soil?**

A.	gas and water	**C.**	loose sand
B.	air	**D.**	water only

63 **Material defined as earth is composed of**

a. 80% or more particles smaller than 0.06 mm
b. 20% to 80% particles larger than 2 mm
c. 80% or more particles smaller than 2 mm
d. 50% or more particles smaller than 2 mm

64 **Material defined as mud is composed of**

a. 80% or more particles smaller than 0.06 mm
b. 20% to 80% particles larger than 2 mm
c. 80% or more particles smaller than 2 mm
d. 50% or more particles smaller than 2 mm

65 **Material defined as debris is composed of**

a. 80% or more particles smaller than 0.06 mm
b. 20% to 80% particles larger than 2 mm
c. 80% or more particles smaller than 2 mm
d. 50% or more particles smaller than 2 mm

66 **Material in an earthflow is composed of**

a. 80% or more particles smaller than 0.06 mm
b. 20% to 80% particles larger than 2 mm
c. 80% or more particles smaller than 2 mm
d. 50% or more particles smaller than 2 mm

67 **Material in a debris flow is composed of**

a. 80% or more particles smaller than 0.06 mm
b. 20% to 80% particles larger than 2 mm
c. 80% or more particles smaller than 2 mm

68 **Debris flows can reach speeds of**

A.	26 km/hour	**C.**	50 km/hour
B.	36 km/hour	**D.**	56 km/hour

69 **A flash flood is a flood that Flood**

a. is caused by heavy rain rather than from the flooding of a river
b. occurs in urban areas
c. occurs suddenly and unexpectedly and for a short duration
d. is caused by the blocking of drains.

70 **A flood can vary in:**

A.	size	**C.**	duration
B.	speed of water flow	**D.**	all of the above

71 **When a river's water level reaches 10 meters, this means that:**

a. the water level is 10 meters above an arbitrary 'zero' level
b. the water level is 10 meters above mean sea level
c. the water level is 10 metres above mean sea level or an arbitrary 'zero' level
d. it will flood.

72 **The size of a flood is measured by:**

a. the rate of flow of water in a waterway or river
b. the level of water in a waterway or river
c. a river gauging station
d. all of the above.

73 **Which of the following is associated with a La Niña event?**

a. the Southern Oscillation Index (SOI) is strongly negative
b. the ocean surface off the coast of South America is warmer than usual
c. there is an increased chance of above average rainfall in eastern Australia
d. all of the above.

74 **Which of the following potentially affects the size of a flood?**

a. bridges and other structures in waterways
b. the size and windiness of a river
c. vegetation in and around a river
d. all of the above

75 **Which of the following is an environmental consequence of floods?**

a. dispersal of weed species
b. erosion of soil
c. release of pollutants into waterways
d. all of the above.

76 **Which of the following is used to estimate which areas will be inundated during a flood, based on river height information?**

a. satellite and radar images
b. flood maps / floodplain hydraulic models
c. river gauging stations
d. all of the above.

77 **Which of the following statements is false?**

a. weather forecasts for a small region are more accurate than those for a large region
b. weather forecasts are more accurate in Melbourne than in Darwin
c. forecasts of temperature are more accurate than forecasts of rainfall
d. all of the above

78 **Which of the following is true? Flood warnings:**

a. should not be released until the information is certain
b. should indicate what the threat is, what action should be taken, by whom and when
c. are best if they come from a single source
d. all of the above.

79 **Flood risk refers to:**

a. the chance of a flood occurring
b. the number of people and properties exposed to floodwaters if a flood occurs
c. the vulnerability of people and properties that are exposed to floodwaters
d. all of the above.

80 **Which of the following can reduce the risk of flooding?**

a. zonings and building regulations for new developments
b. dams, detention basins and levees
c. flood awareness and education programs
d. all of the above.

81 **The Probable Maximum Flood is:**

a. an estimation of the largest possible flood that could occur at a particular location
b. the maximum flood experienced in the last 100 years
c. the maximum flood experienced in the last 200 years
d. the maximum flood experienced since flood records have existed.

82 **For good land use planning, buildings should be built:**

a. above the 1 in 100 year flood level
b. above the level of the Probable Maximum Flood
c. based on the chance and consequences of a flood for that particular building
d. above the level of the largest historical flood.

83 **In the future, which of the following is expected to increase the risk of flooding?**

A.	population growth	**C.**	climate change
B.	urbanization	**D.**	all of the above.

84 **In the future, which of the following is unlikely?**

a. there will be an increased chance of flash flooding and coastal inundation
b. flood risk will increase due to population growth and urbanization
c. improvements in flood forecasting and warning technologies will reduce the impacts of floods
d. we will be able to eliminate the risk of flooding.

85 The change in elevation of a stream per unit length is called .

A.	base level	C.	velocity
B.	gradient	D.	discharge

86 The lowest level to which a stream may erode is called .

A.	base level	C.	velocity
B.	gradient	D.	discharge

87 As the discharge in a stream increases, load usually .

A.	increases	C.	stays the same
B.	decreases	D.	none of the above

88 A stream with too much bed load will usually have what type of channel pattern?

A.	straight	C.	braided
B.	meandering	D.	dendritic

89 **Which of the following is not a characteristic of a braided stream?**

A.	branching channels	C.	abundant bed load
B.	high gradient	D.	constant discharge

90 **Usually the largest floods in a stream occur?**

a. very frequently, several times in one year
b. frequently, every few years
c. rarely, about every ten years
d. rarely, or once every few 100 years

91 **If a dam is removed, then upstream from the former dam the river responds by**

a. downcutting (lowering its bed)
b. raising its bed
c. avulsion d. becoming a braided stream
e. decreasing its discharge f. making no change

92 **Which of the following measurements is not needed to estimate stream discharge?**

A.	stream velocity	C.	bed load of stream
B.	width of stream	D.	depth of stream

93 **Which is not a characteristic of a regional flood?**

a. An extended rise of river elevation for weeks to months.
b. Large storm systems or an extended period of rainfall.
c. A small drainage basin.
d. Floodplains covered with floodwaters.

94 **The process of avulsion causes?**

a. downcutting of the riverbed
b. wider floodplains for the river
c. slow shifting of the river's channel
d. formation of a new course for the river channel

95 **The process of avulsion is caused by?**

a. erosion of the river channel
b. buildup of sediment in the river channel
c. widening of the channel
d. destruction of natural levees

96 **Urbanization usually results in an increase in flood frequency because?**

a. less water is able to runoff in streams
b. less water is able to infiltrate into the ground, so instead is discharged rapidly into streams
c. more water is used by humans and then discharged to streams
d. rainfall is greater in urban areas than in rural areas

97 **Channelization of streams is designed to reduce flooding by?**

a. speeding the passage of floodwaters
b. reducing bank erosion
c. slowing down river velocity so as to reduce damage
d. increase the meandering of streams

98 **Dams are designed to reduce flooding by?**

a. protecting river banks from erosion
b. providing storage for flood water
c. increasing the downstream velocity of flood water
d. trapping sediment behind the dam so it can't be deposited downstream

99 **Flood can not occur due to**

A.	Cyclone	**C.**	Heavy rain
B.	Tsunami	**D.**	Biological disaster

100 **The largest floods in prehistoric times were probably the result of .**

A.	very heavy rainfall	C.	ice dam failures
B.	hurricanes	**D.**	meteorite impacts

Landslides & Floods

101 **Flash floods are often caused?**

a. by thunderstorms
b. dikes and dams that are too high
c. by rainfall over many days
d. by river beds that are too high

102 **When forests are cut or burned down?**

a. water can flow away very quickly and cause mudslides
b. nutrients are washed deep into the soil
c. water stands in fields and cannot flow away
d. rainfall can get into the ground more quickly

103 **A flood can be caused by:**

A.	Rising rivers	**C.**	Heavy rain in a small area
B.	High tides	**D.**	All of the above

104 **Which of the following should you do in a flood?**

A.	Go sight-seeing	**C.**	Put valuables high up
B.	Drink the water	**D.**	Water the garden

105 **What is a flash flood?**

a. A sophisticated flood
b. Power lines fallen in flood waters
c. A deep flood
d. A flood that happens fast with little warning

106 **Which of these problems can be caused by floods?**

A.	Landslips	C.	Destroyed crops
B.	Sewage contamination	D.	All of the above

107 **How many inches of fast-moving flood water can knock you off your feet?**

A.	6 inches	C.	10 inches
B.	8 inches	D.	15 inches

108 **What factors contribute to flooding?**

a. Rainfall intensity.
b. Rainfall duration.
c. BOTH of the above; rainfall intensity and rainfall duration.
d. down Slope

109 **What causes most flash flooding?**

a. Tornadoes.
b. Slow-moving thunderstorms, thunderstorms repeatedly moving over the same area, or heavy rains from hurricanes and tropical storms.
c. Hailstorms.
d. earthquakes

110 **How many feet of fast-moving flood water can sweep a vehicle away?**

A.	3 feet	**C.**	4 feet
B.	2 feet	**D.**	20 feet

111 **What is the downgrade movement of mass along no definite surface called?**

A.	Flowage	**C.**	Subsidence
B.	Sliding	**D.**	Earthquake

112 **In which type of flowage, failure is not easily perceptible?**

A.	Rapid failure	**C.**	Slow failure
B.	Quick failure	**D.**	Moderate failure

113 **In which type of flowage, failure is easily visible?**

A.	Rapid failure	**C.**	Slow failure
B.	Quick failure	**D.**	Moderate failure

114 **What is a type of mass failure in which a superficial mass fails by moving as a whole along a definite surface of failure called?**

A.	Flowage	**C.**	Subsidence
B.	Sliding	**D.**	Earthquake

115 **A complex landslide commonly involves two or more of the classes**

_____, _____, _____, or _____.

fall, slide, spread, flow

116 **What is a common term that is synonymous with slide?**

Slump

117	**A slide forms when a coherent mass of regolith or bedrock breaks free and then slides down slope along either a _____ or _____surface.**
	Planar, curved
118	**What are the two major types of landslides that fall under the heading of slide?**
	Translational and rotational
119	**Is the surface of failure for a translational slide planar or curved?**
	Planar
120	**Is the surface of failure for a rotational slide planar or curved?**
	Curved
121	**How does a translational slide differ from a block slide?**
	A block slide is a special type of translational slide. It involves material that is hard and

122	**Liquefaction is the process by which water saturated, loose, cohesion-less sediments are transformed from a _____ into a _____ state.**
	Solid, liquid-like
123	**On what type of a slope would a lateral spread likely occur on: gentle or steep?**
	Gentle
124	**Failure during a lateral spread is caused by what?**
	Liquefaction which typically occurs as a result of ground shaking during an earthquake
125	**Water-saturated fine-grained slope material that liquefies and then runs out, leaving a bowl-shaped depression on the sloping land surface are called_____.**
	Earthflow
126	**Are earthflows generally faster or slower than mudflows?**
	Slower

127	**A debris flow is commonly described as having the consistency of what common**
	Wet cement
128	**Can debris flows carry particles as large as a house?**
	Yes
129	**The imperceptible slow and steady down slope movement of the regolith is called _____.**
	Creep
130	**List below at least 4 lines of evidence for creep.**
	Bent trees, roads, railroad tracks, retaining walls, and the down slope tilting of layered rocks
131	**Permafrost is soil that must remain frozen for at least _____ consecutive years.**
	2 years

132	**What happens to the topmost or surface portion of permafrost during the summer?**	
	It melts	

133	**The slow imperceptible down slope motion of the topmost or surface portion of permafrost is called _____.**	
	Solifluction	

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Projects	❖ Completed **40** local projects, **16** international projects and **74** technical reports.
Conferences	❖ Participated in more than **125** local and international conferences & **75** specialized seminars and workshops
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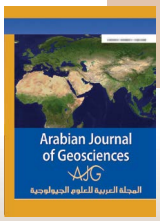

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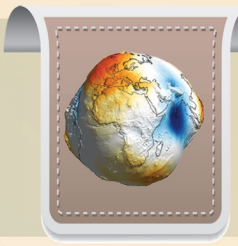

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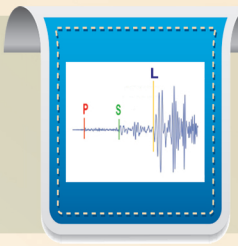

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