

Types of Volcanic Eruptions

Volcanology Geo 421

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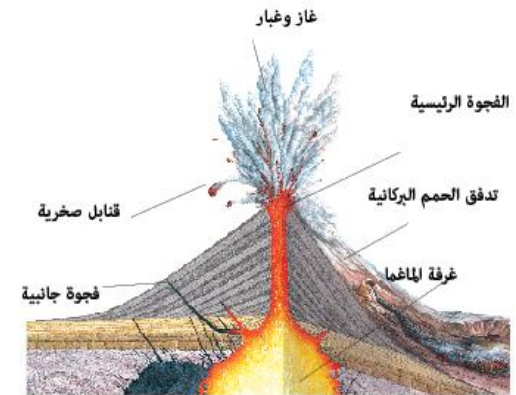
3.2.1 Antarctica eruption

IV. Phreatic eruptions

1. Eruption Mechanisms

- ✓ A graduate increase of temperature with increasing depth at the rate of one Degree Celsius for every 32 minutes.
- ✓ Gases and Vapour are formed due to the heat of water, during the ascent time of magma forced due to a vast volume of pressure that accelerate due to gases and water vapour.
- ✓ When there is enough pressure as the gases increase in their volume size up to 4 to 5 thousands times pull and blows off the top of volcano to erupt
- ✓ Finally, the magma comes out through vent or fissures, sometime quickly and sometimes slowly..

• هناك ما يزيد عن 800 بركان نشط في العالم، والدولة التي يحدث فيها معظم البراكين هي أندونيسيا، إذ يثور فيها نحو 200 بركان.



أكبر الانفجارات البركانية يزودها بالطاقة مزيج من البخار وغاز ثاني أكسيد الكربون الذي يبقى مذاباً في الحمم داخل البركان بسبب الضغط الهائل. ولكن حين يقلت صمام تلك الحمم يتحرر الضغط بشكل مفاجئ ويسبب انفجاراً ضخماً يكفي لأن يرسل كتلاً من الصخر بحجم المنازل إلى مسافة آلاف الأمتار عالياً في الهواء.

II - Type of magmatic Eruptions:

2-1 Hawaiian eruptions

- A Hawaiian eruption is a type of volcanic eruption where lava flows from the vent in a relatively gentle,
- Typically they are effusive eruption, with basaltic magmas of low viscosity (low content of gases, and high temperature) at the vent.
- Such as eruption in Kilauea Crater of [Kilauea](#) Volcano, [Hawaii](#) on 1959

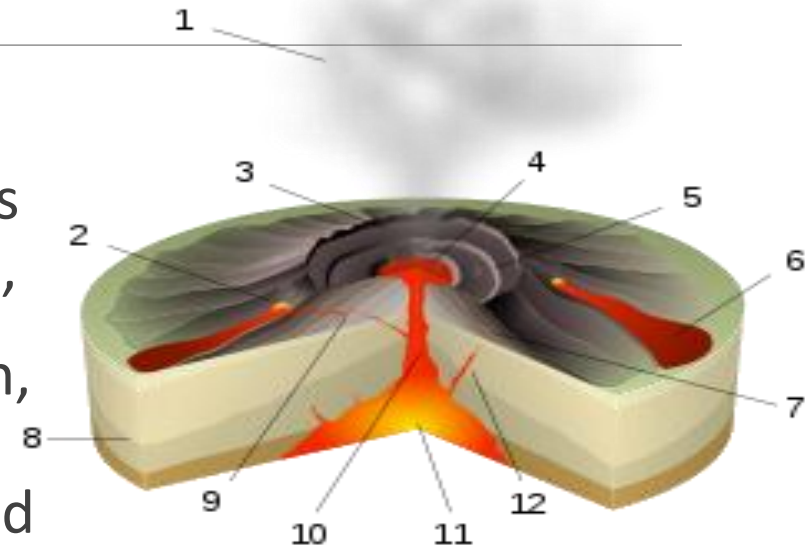


Fig. Hawaiian eruption:
1: Ash plume, 2: Lava fountain,
3: Crater, 4: Lava lake, 5:
Fumaroles, 6: Lava flow, 7
Layers of lava and ash, 8:
Stratum, 9: Sill, 10: Magma
conduit, 11: Magma chamber,
12: Dike

➤ **Hawaiian magmatic eruption may occur & erupty :**

1. **along fissure, such as the eruption of Mauna Loa Volcano in 1950,**
2. or erupted **at a central vent**, such as the eruption in Kīlauea Iki occurred on and during the 1959

Notice that

- In ***fissure-type volcanic eruptions, lava spurts (jets) to a height of 300 meters or more (heights of 1600 meters*** were reported for the 1986 eruption of Mount Mihara on Izu Ōshima, Japan), ***from a fissure at the volcano's rift zone and feeds lava streams that flow downslope on either side.***



➤ Hawaiian eruptions characteristics:

✓ It is usually

1. Start by formation of a crack in the ground (surface)
from which a curtain of radiant (glowing متوهجة
وحمراء) magma
2. Or starts via several closely spaced magma
fountains.



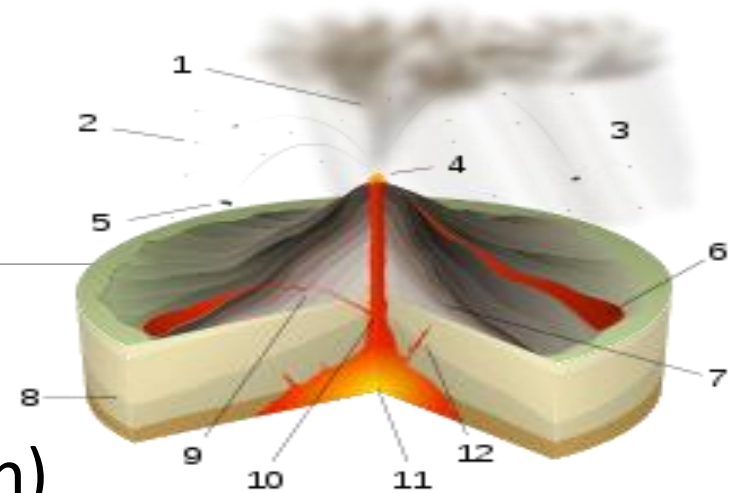
Thus

- ✓ The lava can overflow aside of fissure and form 'A'ā or pāhoehoe style of flows.
 - ✓ Eruptions ejected via central cone can form small a little sloped of shield volcanoes,
- Hawaiian volcanic eruption is a basaltic magmas with low viscosity, low content of gases, and high temperature at the vent.
- **Very little** amount of volcanic ash is produced.
- This type of eruption occurs most often as a hotspot volcanoes such as Kīlauea, though it can occur near subduction zones (e.g. Medicine Lake Volcano in California, United States.)

2. 2: Strombolian eruption

Strombolian eruptions are relatively :

1. named after the Italian volcano Stromboli,
2. low-level Volcanic eruptions,
3. The eruptions products (ejection) consist of:
 - a) Glowing cinder,
 - b) lapilli
 - c) and lava bombsto altitudes of tens to hundreds of meters.
4. They are small to medium in volume.



1 Ash plume, 2 Lapilli, 3 Lava fountain, 4 Volcanic ash rain, 5 Volcanic bomb, 6 Lava flow, 7 Layers of lava and ash, 8 Stratum, 9 Sill, 10 Magma conduit, 11 Magma chamber, 12 Dike

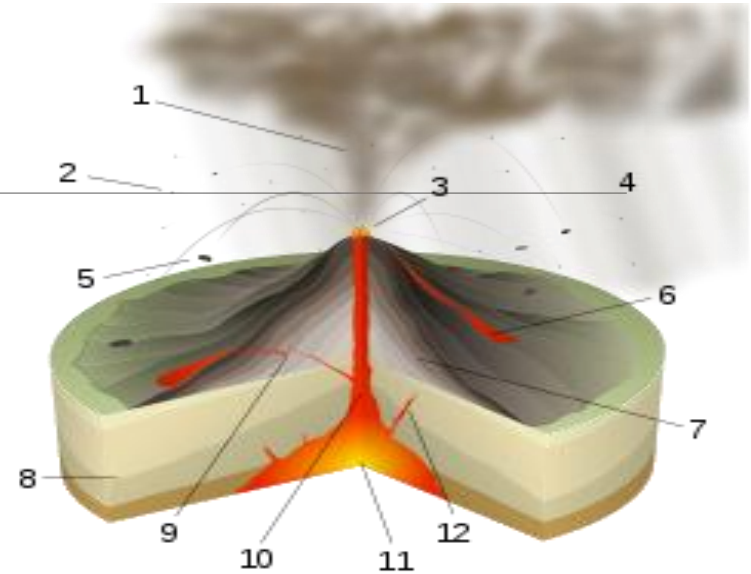


Strombolian volcanoes are characterized:

1. with a huge clots combine molten LAVA bursting stream down the slope from the Summit crater to form glowing arcs through the sky.
2. Its Explosions are driven by bursts of gas slugs that rise faster than surrounding magma.
3. Tephra typically glows red when leaving the vent, but its surface cools and assumes a dark to black color and may significantly solidify before impact.
5. The tephra accumulates around the vent, forming a cinder cone
6. Cinder is the most common product, the amount of volcanic ash is typically rather minor.
7. The lava flows are more viscous, and therefore **shorter and thicker**, compared with Hawaiiin Eruption.
8. It may or may not be accompanied by production of Pyroclastic rock.

3- *Vulcanian eruptions*

- It is named after Vulcano, eruptions. Another example was the eruption of Parícutin in 1947.
- Vulcanian Eruptions are characterized by:
 1. a dense cloud of ash-laden gas exploding from the crater and rising high above the peak.
 2. hot ash forms a pale white cloud near the upper level of the cone.



1 Ash plume, 2 Lapilli, 3 Lava fountain, 4 Volcanic ash rain, 5 Volcanic bomb, 6 Lava flow, 7 Layers of lava and ash, 8 Stratum, 9 Sill, 10 Magma conduit, 11 Magma chamber,

3. The eruption column is dirty to black ,
4. Old rocks blast out of the vent , as the vent clear.

5. Further Ash becomes white to creamy in color with a density ash as Pillion eruption ,
6. The tephra is dispersed over a wider areas than that from Strombolian eruptions.
7. The pyroclastic rock and the base poured deposits form an ash volcanic cone, while the ash covers a large surrounding area.

8. The Vulcanian end with a flow of viscous lava.

9. The eruption throw large meter-size of blocks several hundered meters up to several kilometer in air

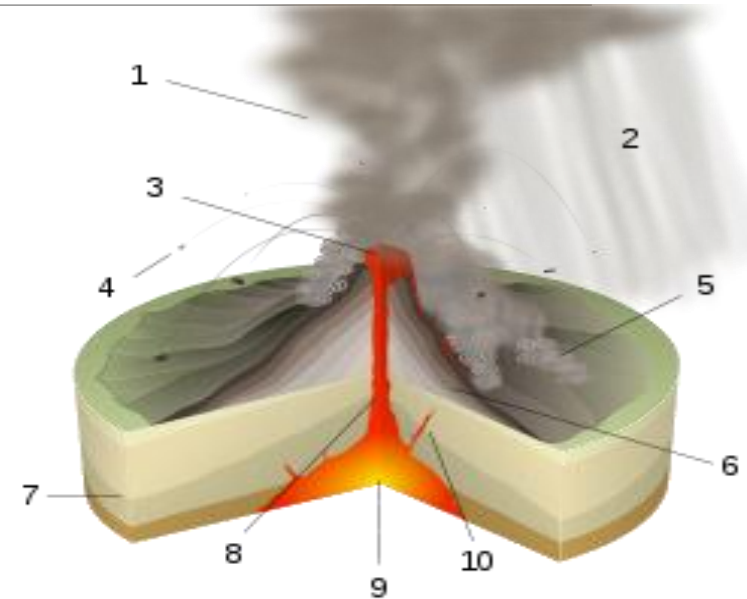
10. Vulcanian eruptions are dangerous to persons within several hundred metres of the vent.

11. One feature of this type of eruption is the "Volcanic bomb." These can be blocks often 2-3 m in dimensions.



4 - Peléan Eruption

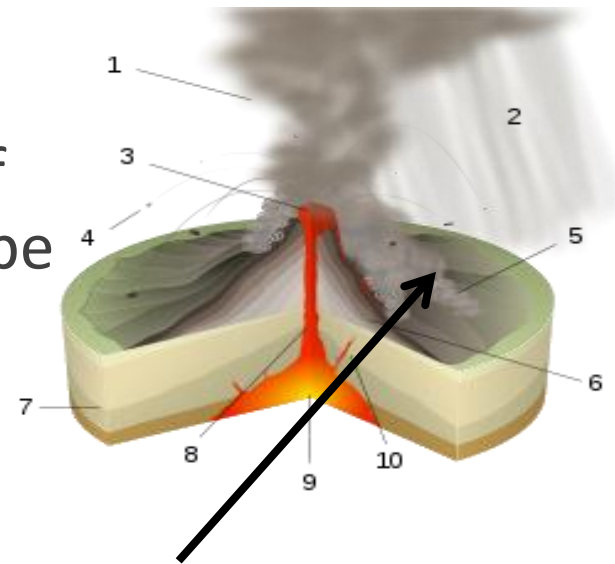
➤ ***Peléan eruption*** or nuée ardente (glowing cloud) eruption, such the one occurred on the Mayon Volcano in the Philippines in 1968,



Peléan eruption: 1 Ash plume, 2 Volcanic ash rain, 3 Lava dome, 4 Volcanic bomb, 5 Pyroclastic flow, 6 Layers of lava and ash, 7 Strata, 8 Magma conduit, 9 Magma chamber, 10 Dike

Peléan Eruptions Occurrence:

1. They can occur when viscous magma, typically of rhyolitic or andesitic type, is involved, and share some similarities with Vulcanian eruptions.
2. Formation of lava domes is another characteristic feature. Short flows of ash or creation of pumice cones may be observed as well.
3. The most important characteristics of a Peléan eruption is the presence of a glowing avalanche of hot volcanic ash, or a pyroclastic flow.



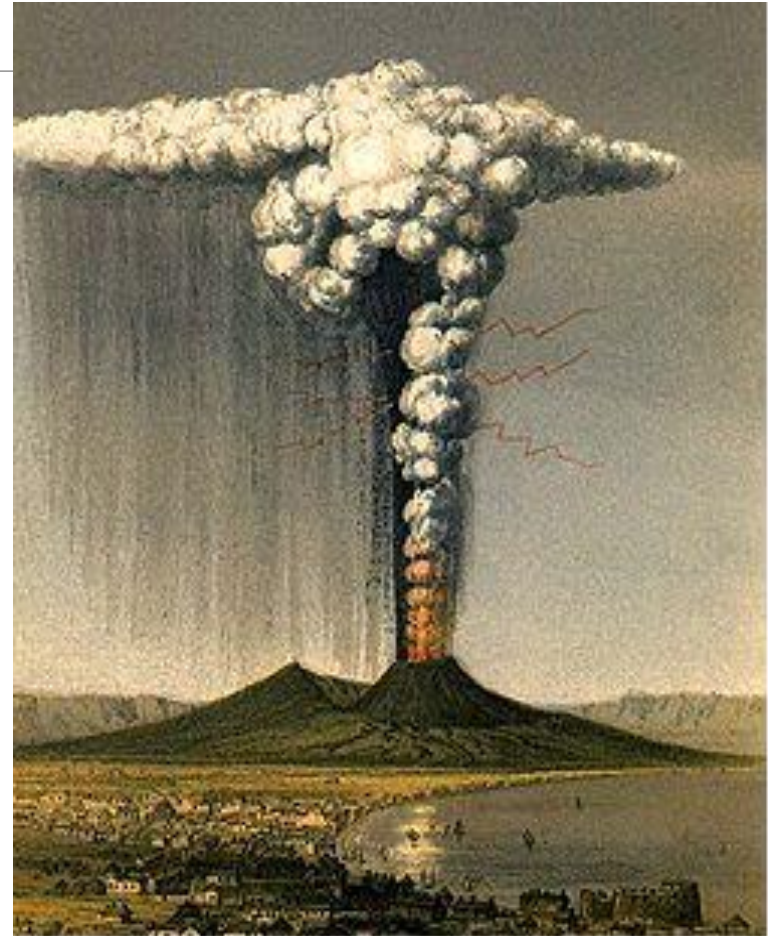
Pele'an Eruptions are characterized by:

1. Releasing a large amount of gas, dust, ash,
2. and lava fragments are blown out of a central crater, fall back,
3. and form **avalanches** that move Down slope at speeds as great as 160 km per hour. Such eruptive activity cause a great destruction and loss of life if it occurs in populated areas.
4. The initial phases of eruption are characterized by pyroclastic flows.
5. The tephra deposits have lower volume and range than the corresponding Plinian type described below.

6. The viscous magma then forms a steep-sided dome or volcanic spine in the volcano's vent.
-
7. The dome may later collapse, resulting in flows of ash and hot blocks.
 8. The eruption cycle is usually completed in few years, but in some cases may continue for decades

5- Plinian eruption

- **Plinian eruptions** are marked by columns of gas and volcanic ash extending high into the stratosphere, a high layer of the atmosphere.
- ✓ Plinian Eruption characteristics by the ejection of:
 1. a huge amount of pumice and emitting a powerful continuous gas causing blasting eruptions.



2. usually the most powerful volcanic eruption, and involve the explosive ejection of relatively viscous lava.
3. Large plinian eruptions—such as Mount St. Helens during 18 May 1980, and during 15 June 1991 at Pinatubo in the Philippines.
4. ***Throwing and ejecting ashes and volcanic gas to hundreds and many kilometers height into the atmosphere above the earth surface.***
5. The resulting due to the falling ash can affect large areas hundreds of miles downwind.
6. ***Fast-moving pyroclastic surges and pyroclastic flows together with nuées ardentes, are often associated with Plinian eruptions.***
7. These volcanoes can destroy all of the plants around the blast zone, and can kill many if people do not evacuate.

8. Short eruptions can end in less than a day, but longer events can take several days to months.
9. The longer eruptions begin with production of clouds of volcanic ash, sometimes with pyroclastic flows. Fine ash can deposit over large areas.
- 10. Plinian eruptions** are often accompanied by loud noises, such as those generated in Krakatoa.
11. The lava is usually rhyolitic and rich in silicates. Basaltic lavas are unusual for Plinian eruptions;
12. the most recent example is the 1886 eruption of Mount Tarawera.
- 13. The amount of magma erupted can be so large that the top of the volcano may collapse, resulting in a caldera.**

5- Pliny's Eruptions (*Vesuvian eruptions*)

A Stony Pine is a type of tree called Pliny used to describe the eruption or also known as *Vesuvian eruptions*, are volcanic eruption marked by their similarity to the “Eruption of Mount Vesuvius in AD 79”

➤ Pliny's eruptions characteristics by:

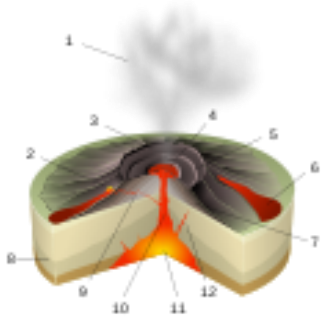
1. are marked by columns of gas and volcanic ash extending high into the stratosphere, the second layer of Earth's atmosphere.
2. Its ejection shows large amount of pumice and very powerful continuous gas blast into air.
3. The eruption ejection shows large amount of pumice and very powerful continuous gas blast into air.



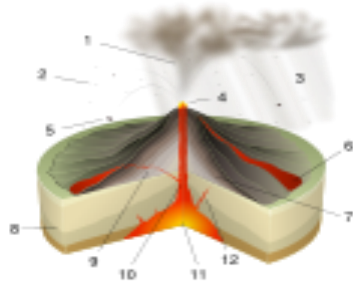
4. Short eruptions can end within less than a day, but longer eruptions can take several days to months.
 - ✓ The longer eruptions begin with production of **clouds** of volcanic ash,
 - ✓ sometimes with **pyroclastic flows**.
5. The amount of magma erupted can be so large that the top of the volcano may collapse, resulting in a **caldera**.
6. Fine ash can cover a large areas.
7. Plinian eruptions are often accompanied by loud noises, such as those generated by **Krakatoa**.
8. The lava is usually **rhyolitic** and rich in **silicates**.
9. **Basaltic** lavas are unusual for Plinian eruptions.



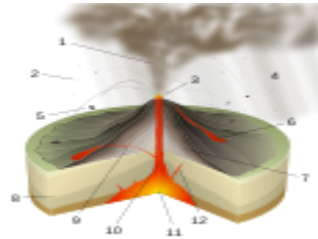
Diagrams showing magmatic volcanoes eruption types



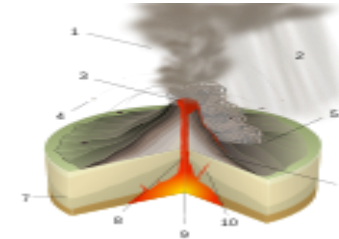
Hawaiian eruption



Strombolian eruption



Vulcanian eruption



Pelean eruption



Pliny's Eruptions



Low eruption

Violent Eruption, very destroying

Classifying Volcanoes & Eruptions based on Magmatic Properties

Viscosity	Gas	Volcanic Structure	Resulting Type of Eruption
High	High	Stratovolcano	Plinian Eruption: Very explosive and violent eruption that shoots rock and ash 10's of miles into the atmosphere. It features Lahars, Debris, Pyroclastic Flows, Lava Flows, Land Slides, Plumes & Ash.
High	Low	Dome on Stratovolcano	Slow Eruption: Dry hot rock oozes out and forms a dome, which may later form a Pyroclastic Flow
Med High	High	Stratovolcano	Vulcanian Eruption: Explosively similar to a Plinian Eruption with cannon like bursts, but much smaller eruption. It forms a: Plume, Ash, Debris, Lava Flows, but not a Lahar, or pyroclastic flow.
Med High	Low	Dome on Stratovolcano	Minor Eruption: A Dome is formed and may ooze out hot dry rock.
Med Low	High	Cinder Cone	Strombolian Eruption: Hot lava is ejected out of the volcano's vent in spurts as gasses violently push out marble to boulder sized rock – it looks very similar to a Hawaiian fountain, but not as a fluid, but rather as chunks of rock.
Med Low	Low	Cinder Cone	Building Eruption: A minor eruption with small amounts of lava spray and not nearly as spectacular.
Low	High	Shield Volcano	Hawaiian Fire Fountain: Large amounts of fluid lava are ejected out – which looks much like a geyser that consists of liquid rock. Fire Fountain, Lava Flows, Lava Tubes
Low	Low	Shield Volcano	Effusive Eruption: Lava oozes out of the top of the volcano as Lava Tubes or Lava Flows

Volcanoes of Magmatic eruptions product

➤ *Volcanoes Magmatic eruptions product are called :*

1. Juvenile or Ejecta, and

✓ Ejecta mean:

material that is forced or thrown out of a Volcanic vent **through the air or under water, and fell back on the ground surface or on the ocean floor, especially as a result of volcanic eruption.**

2. Clasts:

➤ **Clastics (Particles)formed during explosive due to decompression and gas expansion when or from gas release.**

Ejecta or Juvenile can consist of:

1. **Juvenile particles** - (fragmented magma and free crystals).
2. **Similar or accessory particles** - older volcanic rocks from the same volcano.
3. **Accidental particles** - derived from the rocks under the volcano.

2) Clastic Metamorphic and Igneous Rocks, divided into:

1. Clastic metamorphic rocks:

- include breccias formed by faults, as well as some protomylonite and pseudotachylite.
- Occasionally, metamorphic rocks can be brecciated via hydrothermal fluids, forming a hydrofracture breccia.

2. Clastic Igneous Rocks:

- ✓ Pyroclastic of volcanic rocks such as tuff, agglomerate and intrusive breccias, and some marginal pyroclastics, such as:
 - Eutaxitic (the compaction and flattening of glass remains and pumice fragments around undeformed crystals), and
 - Taxitic (volcanic rock of clastic or schlieric appearance due to the aggregation of flows of different colors, textures, granularity, or mineral composition)intrusive morphologies.

- ✓ Igneous clastic rocks are broken by flow, injection or explosive disruption of solid or semi-solid igneous rocks or lavas

Volcanic Phreatomagmatic eruption

are defined as juvenile forming eruptions as a result of interaction between water and magma.

They are different from magmatic

unlike



- Phreatic eruptions are the result of interaction between **magma and water** unlike magmatic eruptions.
- It is very common for a large explosive eruption to have magmatic and phreatomagmatic components.
- The products of phreatomagmatic eruptions contain juvenile clasts.

III- Phreatomagmatic eruption Mechanisms

➤ The Phreatomagmatic eruption:

is the most common thermal explosive of volcanic products or volcanic supplied materials caused **by the reduction of its hot particles/ particles under rapid cooling** when came across or contacted with water Resources. (thus, the Phreatomagmatic eruption occurred under water or in touch with water).

✓ *The water Resources are originate either by:*

1. a water lake or by Caldera-lake, Or by Sea Water,
2. or by ground water where the phreatomagmatic material eruption commenced **due its contact with water.**

Volcanic (Materials) formed by Phreatomagmatic Eruption Mechanisms.

1. Cinder cones is believed to due the interaction **between magma and ground water** to form in many cases.
2. The rapid cooling is leading to explosively and producing magma fragments; are causing:
 - ✓ The circulating stress waves and
 - ✓ Thermal contraction widening cracks in magma fragment.
3. **Ash** is formed by the same mechanisms of magmatic volcanoes eruptions with a wide range of basic to acidic compositions.

Phreatomagmatic eruption materials

4. **Blocky and associate** Class with low vesicularities are formed.
5. **Fine grained than those of deposits of magmatic eruption** and well sorted. *These deposits are:*

1. Hyaloclastite (non-explosive)

- Hyaloclastite is glass found with pillow basalts that were produced by non-explosive quenching and fracturing of basaltic glass.
- These are still classed as phreatomagmatic materials eruptions, as produced as a juvenile clasts due to the interaction of water and magma.
- They can be formed at water at depths of >500 m,^lwhere hydrostatic pressure is high enough to inhibit vesiculation in basaltic magma.

Phreatomagmatic eruption materials

2. Hyalotuff:

- **Hyalotuff** is a type of rock formed by the explosive **fragmentation of glass** during phreatomagmatic eruptions at shallow water depths (or within aquifers).
- The deposits are much finer grained than the deposits of magmatic eruptions, due to the much higher fragmentation of the type of eruption.
- It is known as an accretionary lapilli formed as a result of the **cohesive properties** of **wet ash, causing the particles to bind**.
- They have a **circular structure when viewed in hand specimen** and under the optical microscope.

Phreatomagmatic eruption

Deposits Surface features (Landforms)

- There are two types of vent landforms formed due to the explosive and interaction of magma with ground or surface water:
 - 1) *Tuff Cones*
 - 2) *Tuff Rings.*
- Both their landforms are associated with monogenetic volcanoes (often Lava flow volcanoes) and polygenetic volcanoes (lithological discontinuities due to major changes in magma chemistry, volcanotectonic events).
- In the case of polygenetic volcanoes they are often inter bedded with lavas, ignimbrites and ash- and lapilli-fall deposits.

1- Tuffa Rings:



- ✓ Tuff rings have a low profile of unaltered ,
- ✓ thinly bedded tephra ,it is considered to be an ignimbrite or pyroclastic products surrounding by a wide crater (called a maar crater);
- ✓ It is generally lower than the surrounding topography.

2- Tuff Cones

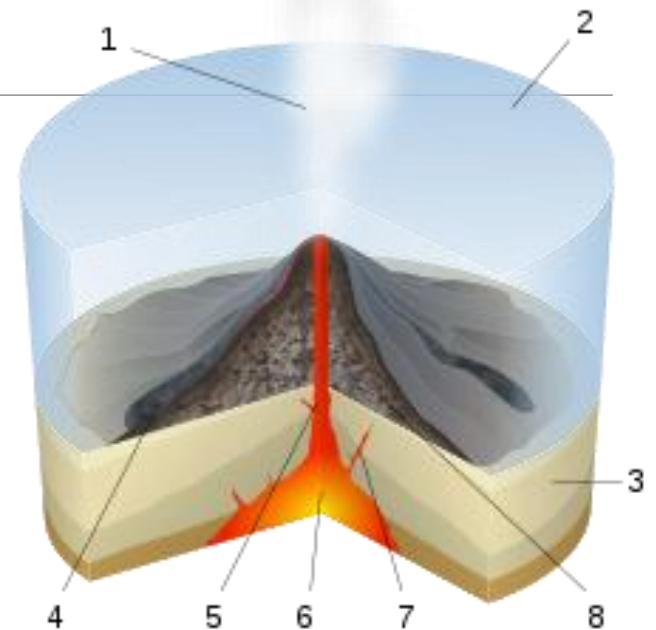


- ✓ Tuff Cones are steep sloped and cone shaped.
- ✓ They have wide craters and are formed of highly altered, thickly bedded tephra.

Types of Phreatomagmatic eruption

1. Submarine

- is a type of volcanic eruption where lava erupts under an ocean.
- Most of submarine eruptions occur at mid-ocean ridges, and near hotspots.



Submarine eruption:

1. Water vapor cloud
2. Water
3. Stratum
4. Lava flow
5. Magma conduit
6. Magma chamber
7. Dike
8. Pillow lava

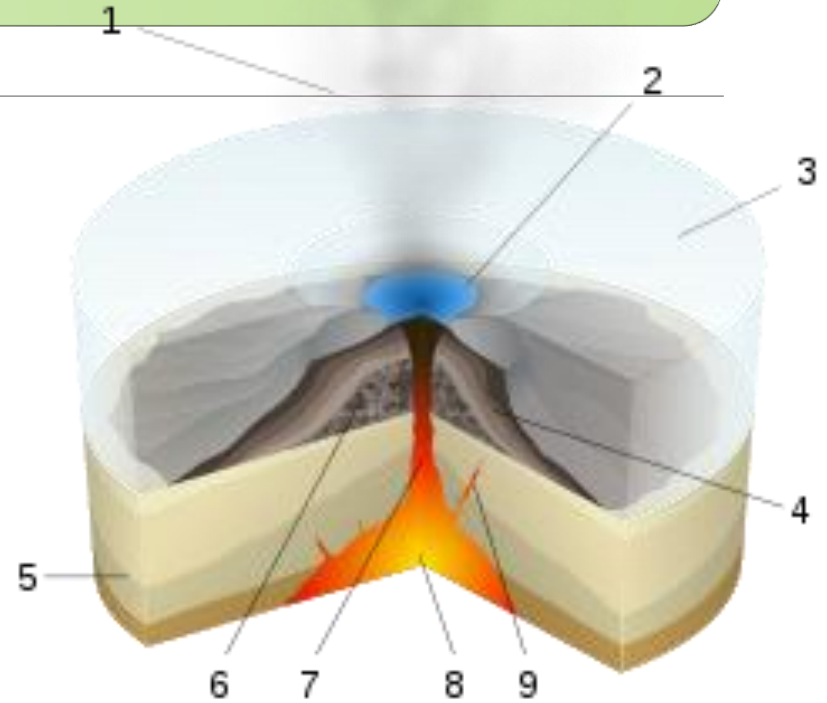
Cont.: Types of Phreatomagmatic eruption

2. Subglacial eruption

are **named because of its activity under ice**, or under a glacier.

They can **cause dangerous floods, lahars, and create hyaloclastite and pillow lava.**

- Only five of these types of eruptions have occurred in the present day.



1 water vapor cloud, 2 lake, 3 ice, 4 layers of lava and ash, 5 strata, 6 pillow lava, 7 magma conduit, 8 magma chamber, 9 dike

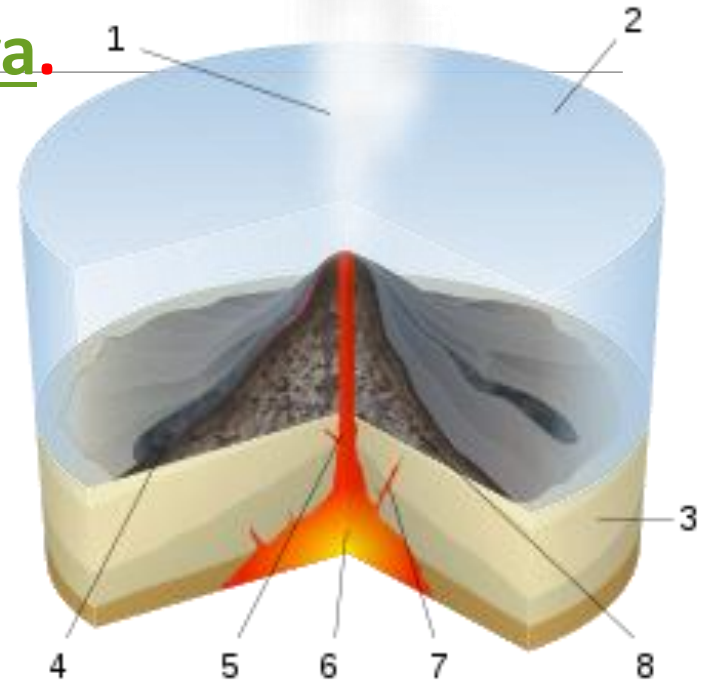
Cont.: Sub-glacial eruptions

- **Sub-glacial eruptions called a tuya.**

- A tuya may be recognized by its stratigraphy, which typically consists of a:

- 1) basal (bottom) layer of pillow basalts

- 2) overlain by hyaloclastitic breccia, tuff, and capped off by a lava flow.



1 water vapor cloud, 2 lake, 3 ice, 4 layers of lava and ash, 5 strata, 6 pillow lava, 7 magma conduit, 8 magma chamber, 9 dike

Cont.: Sub-glacial eruptions

➤ In the subaqueous eruptions in glacial, **pillow lavas**

formed first as a result of melt water:

- Once the ***Volcano's vent reaches shallower water, eruptions become Phreatomagmatic***, forming and depositing the hyaloclastitic breccia.
- Once the **volcano arises through the ice, it erupts lava, forming the flat capping layer of a **tuya**.**

Cont.: Phreatic eruption

- **Phreatic eruptions** is typically a steam **eruption** and rock fragments; the inclusion of lava is unusual (i.e. without lava ejection).
- **They** are a common precursor of volcanic activity. The **eruptions** are caused by groundwater flashing to steam as it is heated by magma.
- The temperature of the fragments can range from cold to **glowing**.
 - The extreme temperature of the magma ranges from 600 to 1,170 °C causes near-instantaneous evaporation to **steam** resulting in an explosion of steam, water, ash, rock, and **volcanic bombs**.



Phreatic eruption

- It is also called a **phreatic explosion** or **ultravulcanian eruption**.
 - It occurs when rising magma meet and contact with ground or surface water.



Phreatic eruptions

Note: If the molten materials formed in the steam, the term phreato-magmatic may be applied.

- **Phreatic eruptions are** occasionally create broad, with low-relief craters called maars.
- Its explosions can be accompanied with carbon dioxide or hydrogen sulfide gas emissions..
- The former can suffocate at sufficient concentration; the latter I(H₂S) a broad spectrum poison.
- In 1979 phreatic eruption on the island of Java killed 149 people were overcome by poisonous gases.

WHEN IS A VOLCANO CONSIDERED ACTIVE, DORMANT, OR EXTINCT?

➤ *Volcanoes Classified, as :*

1. active,
2. dormant,
3. or extinct is a subjective and incorrect exercise.

➤ A **volcano** is generally **considered active** if it has **erupted in historic time**. This definition, however, is rather ambiguous.

➤ **Volcano active if it is currently erupting**, or exhibiting unrest through earthquakes, uplift, and/or new gas emissions.

WHEN IS A VOLCANO CONSIDERED ACTIVE, DORMANT, OR EXTINCT?

- There are **529 volcanoes** that have not erupted in historic times, but
- Exhibit clear **evidence of eruption in the past 10,000 years.**
 - ✓ These *latter volcanoes* are probably best **considered "dormant,"** since they have the potential to erupt again.
- ❖ **The Volcanoes are not inactive, it is considered truly extinct, or just dormant, depends on the average relaxation (Not active Period of Time), time interval between successive eruptions.**

What are volcanoes signs and behaviour appear before eruption?

It will signs:

- 1. A very small earthquakes beneath the volcano, slight inflation,**
- 2. or swelling, of the volcano and**
- 3. increased emission of heat and gas from vents on the volcano,**

