

LECTURE FOURTEEN: Volcanoes and Volcanic Rocks 1

IN THIS LECTURE

- Monogenetic and Polygenetic volcanoes
- Volcanoes and Plate Tectonics
- Volcanic Products
- Classification of Volcanic Rocks
- Eruption Styles
- Structure of a Volcano
- Shield Volcanoes
- Scoria Cones

MONOGENETIC VS POLYGENETIC VOLCANOES

Monogenetic

- Volcano built up by the products of one eruption or eruptive phase
- Simple magma conduit system used during only one eruption or one prolonged eruptive phase
- Example - Surtsey and Heimey

Polygenetic

- Volcano resulting from many eruptions, separated by relatively long periods and often involving different magmas.
- Complex "plumbing systems" with intricate complicated conduit systems used many times during different eruptive phases.
- Example - Hawaii

PRODUCTS OF VOLCANIC ERUPTIONS

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

Pumice - light, porous volcanic rock that forms during explosive eruptions, consisting of a network of gas bubbles frozen amidst fragile volcanic glass and minerals. All types of magma (basalt to rhyolite) will form pumice.

Scoria - a vesicular glassy lava rock of basaltic to andesitic composition ejected from a vent during explosive eruption.

Tuff - the general name for consolidated ash. May be composed of (a) crystals ejected from the volcano; (b) small fragments (<4mm) of lava or other rock types; (c) lapilli and (d) fragments of a glassy nature. Tuffs often show sedimentary features such as bedding and grading

Ignimbrites - welded tuffs that form when the layers of tuff material were so hot when they were deposited that that the edges of the fragments weld together.

Volcanic ash - consists of rock, mineral, and volcanic glass fragments smaller than 2 mm (0.1 inch) in diameter, which is slightly larger than the size of a pinhead.

Lapilli - Rock fragments or tephra between 2 and 64 mm (0.08-2.5 in) in diameter that were ejected from a volcano during an explosive eruption are called lapilli.

Accretionary Lapilli - Rounded tephra balls between 2 and 64 mm in diameter are called accretionary lapilli if they consist of tiny ash particles.

Volcanic block - a solid rock fragment greater than 64 mm in diameter that was ejected from a volcano during an explosive eruption.

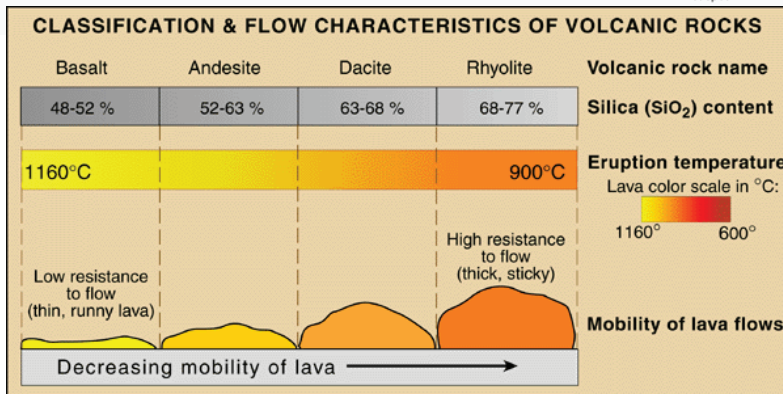
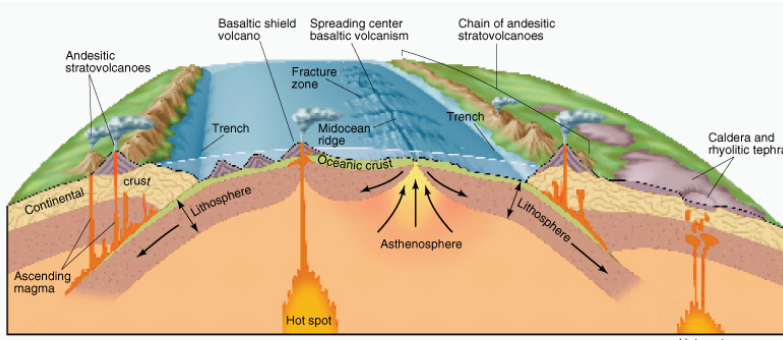
Volcanic bombs - lava fragments that were ejected while viscous (partially molten) and larger than 64 mm in diameter.

Pyroclastic flow - a ground-hugging avalanche of hot ash, pumice, rock fragments, and volcanic gas that rushes down the side of a volcano as fast as 100 km/hour or more. The temperature within a pyroclastic flow may be greater than 500° C, sufficient to burn and carbonize wood.

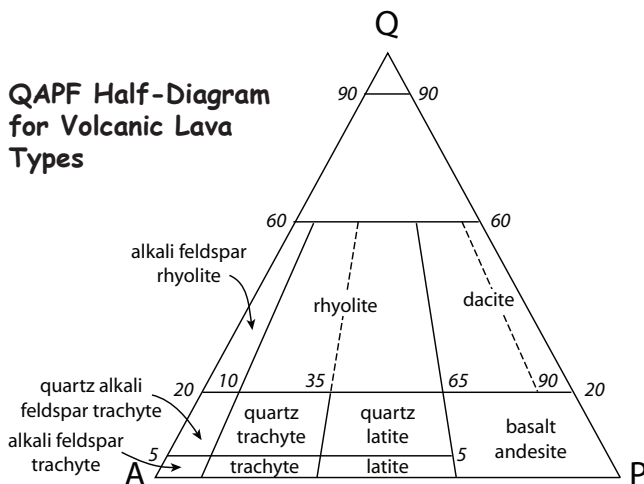
Caldera - a large, usually circular depression at the summit of a volcano formed when magma is withdrawn or erupted from a shallow underground magma reservoir. The removal of large volumes of magma may result in loss of structural support for the overlying rock, thereby leading to collapse of the ground and formation of a large depression. Calderas are different from craters, which are smaller, circular depressions created primarily by explosive excavation of rock during eruptions.

A`a lava - (pronounced "ah-ah") a Hawaiian term for lava flows that have a rough rubbly surface composed of broken lava blocks called clinkers.

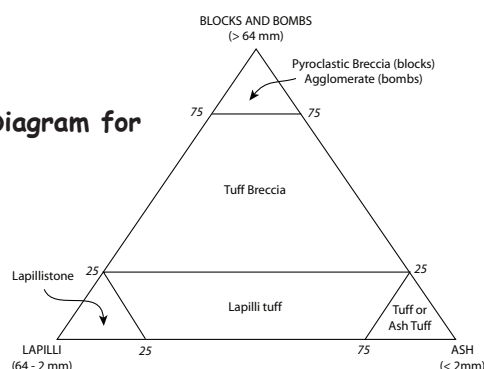
Pahoehoe - a Hawaiian term for basaltic lava that has a smooth, hummocky, orropy surface.



QAPF Half-Diagram for Volcanic Lava Types



IUGS Classification Diagram for Pyroclastic Deposits



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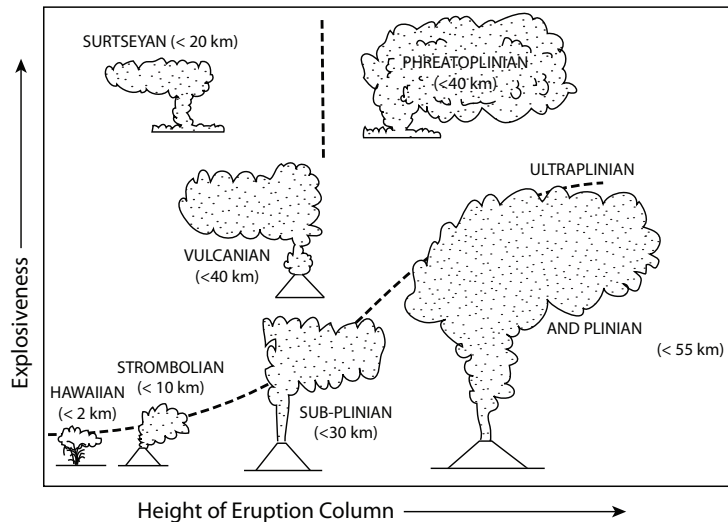
ERUPTION STYLES

Plinian eruptions are large explosive events that form enormous dark columns of tephra and gas high into the stratosphere (>11 km).

Phreatic eruptions are steam-driven explosions that occur when water beneath the ground or on the surface is heated by magma, lava, hot rocks, or new volcanic deposits.

Strombolian eruptions are characterized by the intermittent explosion or fountaining of basaltic lava from a single vent or crater.

A vulcanian eruption is a type of explosive eruption that ejects new lava fragments that do not take on a rounded shape during their flight through the air.



GENERIC STRUCTURE OF A VOLCANO

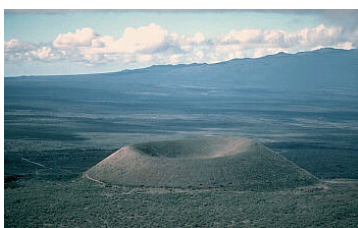
- A volcanic vent is an opening exposed on the earth's surface where volcanic material is emitted.
- All volcanoes contain a central vent underlying the summit crater of the volcano.
- The volcano's cone-shaped structure, or edifice, is built by the more-or-less symmetrical accumulation of lava and/or pyroclastic material around this central vent system.
- The central vent is connected at depth to a magma chamber, which is the main storage area for the eruptive material.
- Because volcano flanks are inherently unstable, they often contain fractures that descend downward toward the central vent, or toward a shallow-level magma chamber.
- Such fractures may occasionally tap the magma source and act as conduits for flank eruptions along the sides of the volcanic edifice.
- These eruptions can generate cone-shaped accumulations of volcanic material, called parasitic cones.
- Fractures can also act as conduits for escaping volcanic gases, which are released at the surface through vent openings called fumaroles.

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 can be summarized as follows.

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
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 andesitic composition	Plinian

SCORIA CONES

- Most common type of volcanic centre.
- Small volcanic landforms built typically during strombolian eruptions of basaltic and basaltic andesite magmas
- Usually circular in plan view owing to formation from a point source
- Elongate forms develop when eruptions continue along a large part of a fissure which does not localise to a single point source vent
- Usually have central bowl shaped craters
- Basal diameter is up to 2.5 km and slopes of around 33°
- Many layers in scoria cones are made up of scoria or cinder as well as mass-flow deposits related to avalanching of material down the steep slopes but can also include bombs of lava spatter
- Often scoria cones have accompanying lava flows of fairly small volumes
- Gas content of the magma associated with scoria cones increases towards the end of the eruption and so the lava spatter ejected normally increases leaving a collar of material on the cone.
- Eruptions range in duration from a few days to a few years with 95 % of scoria cone eruptions stopping within one year.
- Scoria cones are very susceptible to weathering.



Scoria Cone
Mauna Kea Hawaii



Shield Volcano
Mauna Loa Hawaii

SHIELD VOLCANOES

Basic characteristics of shield volcanoes

- Symmetrical and circular to elliptical in shape
- Convex-up piles of basaltic lava with slopes < 10°
- Built up by fluidal eruptions of basaltic lavas from central vents and/or flank eruptions
- Shield basal diameter (Ws) varies between a few kilometers to over 100kms
- Shield heights (Hs) are on average 1/20 Ws
- Composed almost entirely of lava flows but also may contain < 1% pyroclastic deposits including scoria fall
- Deposits from phreatomagmatic and phreatic explosions
- Some oxidised soil horizons and epiclastic sediments
- Divided into two types
 - Large or Hawaiian Shields
 - Small or Icelandic Shields