

Volcanism and Igneous Processes

I. Introduction

- A. Volcanism- process by which magma, gas, and water are released from the interior of the earth. Volcanic processes and eruptions often result in the spewing and build up of volcanic material about a volcanic center, constructing a volcanic edifice commonly referred to as a volcano.
- B. Volcanism a product of tectonic process
 - 1. heat transfer from interior to exterior of earth

II. Nature of Volcanic Activity

- A. Style of volcanism;
 - 1. Explosive vs. Quiescent is determined by the composition of the magma, its temperature, and amount of dissolved gases contained within. All of which influence the magmas viscosity, or resistance to flow.
 - a. > viscosity, > violent nature of the eruption
 - b. < viscosity, < explosive nature of the eruption
 - 2. Factors affecting viscosity
 - a. temperature: the higher the temperature the lower the viscosity, i.e. the more kinetically active the magma is at atomic level, the less resistance to flow it possesses.
 - b. chemical composition: the SiO₂ or silica content of the magma also influences the viscosity.
 - (1) Granitic magma = 70% silica, intermediate magma = 60% silica, basaltic magma = 50% silica.
 - (2) > silica content, > viscosity of magma, believed to result from tendency of complex silica anions to form long chains of molecules before crystallization begins.
 - c. Gas content: dissolved gasses tend to <viscosity of magma, gasses also exert pressure on magma resulting in explosive eruption of magma from vent, as magma rises towards surface, confining pressure decreases, and temperature slightly decrease resulting in expansion of gasses and POW!

III. PRODUCTS OF VOLCANIC ERUPTIONS

- A. Lava Flows- lava may be produced from any composition magma, but in general flowing or molten lava is commonly associated with low silica, basaltic composition magmas (e.g. Hawaii)

1. Hawaiian-type lavas- basaltic composition (60% silica), slowly flow down slopes, cooling to form basalt.
 - a. Pahoehoe flows-lava flows with a smooth congealed skin, a whipped or ropy appearance.
 - b. aa flows- more blocky in appearance, flows are rough jagged blocks with angular edges. These are generally lower temperature lavas than Pahoehoe flows, thus tend to be cool, blocky, and thick.

B. Escaping Gases from Lava- Magmas hold dissolved gases within them, as these magmas are extruded as lava, gases begin to escape.

1. Gases estimated to compose 1-5% of total wt. of lava, most of which is
 - a. water vapor (70%),
 - b. carbon dioxide (15%),
 - c. sulfur oxide and nitrogen oxides (<5%)
 - d. hydrogen, chlorine, and argon.

C. Pyroclastic Materials - fragments of pulverized rock and lava ejected from a Volcano. These ejecta range in size from very fine dust or ash to sand sized volcanic ash, to house-sized volcanic bombs and blocks. Pyroclastic eruptions are associated with highly viscous magmas with high-pressure buildup of gases.

1. fine ash- result of gas-filled frothy magma, gases expand and blast semi-cohesive lava into tiny pieces to form ash..
 - a. Tuff- deposits of ash
 - (1) welded tuffs- glass shards in ash heat-fuse after deposition.
2. Pumice- sand to gravel sized fragments of cooled lava with many air voids.
3. Lapilli- walnut sized pyroclastic ejecta.
4. Cinders- pea-sized basaltic particles
5. Blocks and bombs- pyroclastic fragments larger than lapilli, blocks = comprised of ejected hardened lava, bombs=ejected as molten lava.

IV. Volcanic Edifices and Volcanic Eruptions

A. Volcanoes-mountainous accumulations of volcanic material

B. Anatomy of Volcano

1. Crater- steep-walled depression at summit of volcano
2. Calderas - large craters > 1 km.
3. Magma Chamber - magma center located beneath Volcano, source of magma/lava.
4. Central vent or pipe- conduit leading from magma chamber to crater or opening of Volcano
5. Flank Eruption- eruption of volcanic materials from side of Volcano, not through central vent.

- a. parasitic cone- smaller secondary volcanic buildup on side of Volcano, via flank eruptions

C. Volcano Types (based on morphology of Volcano)

1. Shield Volcano- broad, shield shape, gentle slopes, associated with basaltic lavas (low viscosity lavas).
2. Cinder cones- composed of ejected lava fragments or pyroclastic material, steeper sides to Volcano than shield type.
3. Composite cones or Strato Volcano- Volcanos comprised of a mixture or alternating layers of lava and pyroclastic material, generally form large Volcanos, often associated with violent eruptions (e.g. MT. St. Helens) and andesitic magmas (sl. more siliceous than basalt).
 - a. Composite cones produce:
 - (1) nuee ardents - glowing clouds of hot volcanic ash.
 - (2) lahar - mudflows formed of water saturated volcanic debris.
4. Caldera Collapse- e.g. Crater Lake in Oregon - occurrence when Volcano collapses in on itself, results from strata above magma chamber becoming very thin, volcano can't support itself, mountain collapses into magma chamber.

V. Intrusive Activity and Phenomenon

A. Intrusive- refers to injection and cooling of magma beneath the earth's surface

1. Dikes - planar bodies of igneous intrusive rock that resulted from the injection of magma across strata or layers of rock, i.e. discordant sheet-like intrusive bodies.
2. Sills - planar bodies of igneous intrusive rock that resulted from the injection of magma parallel to strata or layers of rock, i.e. concordant sheet-like intrusive bodies.
3. Laccoliths - inverted lense-shaped igneous intrusive bodies (convex side up), analogous to a sill, but much larger and result in upwarping pre-existing strata or rock layers (e.g. Black Hills of South Dakota).
4. Batholiths- large intrusive bodies of igneous rock that are > 40,000 square km in diameter, in reality magma chambers that have cooled and solidified beneath the earth's surface (e.g. Sierra Nevada Mountains of California)
 - a. Stocks - smaller scale versions of solidified magma chambers (<10 km)
5. Volcanic Necks - congealed volcanic pipe or vent (e.g. Shiprock, NM)