# Ch 4 Volcanoes Notes

Volcano - a vent through which magma, fragments of rock and ash, and gases erupt, or the structure built around the vent by such eruption.

Vary depending on magma composition and plate-tectonic setting

magma generated: (magma sources)
1) divergent plate boundaries
2) subduction zones
3) hot spots. (intra plate volcanism)

1) divergent plate boundaries
- mostly spreading seafloor ridges (rifts)
- magma from partial melting of mantle
- melt maybe due to reduction in pressure ~~of~~ from plates that are spreading above
- upper mantle ultramafic so magma is mafic, basalt forms sea floor
- continental rifts less common
  - mafic magma may melt granitic crust to make magma more silicic
  - mafic volcanism more prevelant though
  - East Africa rift (Mt. Kilimanjaro)

only using a part of mantle that part is mafic.

2) subduction zones
- magma more basalt/mafic if oceanic plate subduc.
- magma more silicic (still mafic too) if continental plate subducted.
- dewatering - subducted plate contains water, it is released and rises into spot between overriding and subducted plates, $H_2O$ reduces melting temp of mantle material & ∴ induces magma formation magma is andesitic to basaltic (depending on extent of

- commonly volcanoes on continental edges above subduction zones are andesitic since granitic crustal rocks are assimilated by mafic magma producing intermediate-comp.

3) Hot Spots
- mantle plumes - columns of warm material rising in the upper mantle; if overlying plate is weak enough magma breaks through
- comp: mafic magma from mantle melting
  mafic sea floor = mafic (basaltic) eruption
  ! if mafic magma goes through continental crust, granite may be assim. so more silicic
- plumes caused by ?
  ? high concentrations of radioactive elements
  ? anomalous regions of outer core
- Hawaii formed by hot spot. → Sheild

* fissure eruption - the outpouring of magma forming volcanic rocks at rifts on the sea floor (magma from a long crack rather than a single pipe or vent)
  - example on continent: Columbia Plateau, US. (50,000 km² WA, OR, ID)
  - India, Brazil - 750,000 km²

flood basalts

most volcanoes over subduction zones
Ring of Fire - volcanoes rimming Pacific Ocean

## Vocanic Structures

* shield volcano - very flat & low in relation to diameter
  - basaltic lavas (low in silica, high in magnesium & iron) are fluid so flow freely & far. (thin flows, <1 m thick)
  - hot spot volcanoes are often sheild volcanoes (Hawaii)

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* pahoehoe - from fluid lavas (basaltic) that form a smooth quenched, hardened skin as they cool develop a ropy appearance as they flow

* aa - from lavas that flow less readily (still basaltic though) and produce jumbled, blocky flows (hurt to walk on)

* pillow lava - when lavas are extruded under water, rapid quenching of hot flow surface leads to bulbous flow forms resembling pillows
  - glassy exterior; course-grained, slowly cooled interior

* columnar jointing - lava contracts as it cools, can fracture the flow into a mass of polygonal columns
  - common in basaltic flows (because start at higher temp ∴ more contraction?)

* volcanic dome - compact, steep-sided
  - more silicic lavas, andesitic & rhyolitic, are more viscous, flow less readily; ooze out of tube & pile up close to vent (like tooth paste tube) (Mt. St. Helens)

Some volcanoes erupt violently due to water & gas trapped in the magma under pressure

pyroclastics - bits of violently erupted volcanic material
  - "fire", "broken"

most energetic pyroclastic erup. more typical of andesitic or rhyolitic lava because thicker lavas tend to trap more gasses

pyroclasts vary in size:
flourlike dust
coarser, gritty volcanic ash & cinders (up to golf ball size)
largest chunks, volcanic blocks can be size of house!
bombs - block sized blobs of still molten lava thrown from a volcano
- develop streamlined shape as deform in flight

* cinder cone - when coarser pyroclasts fall close to the vent & pile up into a very symmetric cone-shaped heap. (even found in Hawaii when plume rises up, crystallizes, falls back as cinders. Also Sunset - phreatomagmatic (water eruption))

rocks:
tuff - rock formed from ash-sized pyroclastic fragments
volcanic breccia - coarser rock containing large angular blocks

* stratovolcanoes or composite volcanoes - built up in layers made up of some lava, then pyroclasts, then lava, then ..., etc.
- most volcanoes along subduction zones
- typically stiff, gas-charged lavas that erupt explosively with a rain of pyroclastic material
- combo of pyroclastics & viscous lavas tends to produce steep-sided, symmetric cones

caldera - magma chamber empty, rocks unsupported, if weak may collapse into the hole → become much larger than original summit
- also may be formed by violent explosion (Mt. St. Helens)
- "Crater Lake" is a caldera (misnamed) (not a crater, is a caldera)
(collapsed kind)
deepest fresh water lake in U.S. (600m)

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## Hazards related to volcanoes

1) Lava - usually advances slowly (few km/hr), can evade, flows down hill; predictable
- destroys property >500°C - 1400°C

protection against:
- Iceland fought lava flow by cooling it with water to slow/stop its progression into the harbour
- another method is to divert the flow
- moves at a rate of ~ 10m/s

2) Pyroclastics - often more dangerous than lava flows
- erupt suddenly, explosively, spread faster, farther
- large blocks & volcanic bombs dangerous due to size
- volume of finer ash & dust cause severe problems (coats/covers everything, can't breath)
- Pompeii buried by ash (Vesuvius)
- * - nuée ardente - deadly, denser-than-air flow of mixed hot gases and fine ash "glowing cloud" >1000°C, rushes down slopes of volcano >100km/hr, chars everything in path, usually andesitic volcanoes, not first thing out of volcano though so if andesitic becomes active, leave area!

ash flow

- lahar - mudflow of meltwater & volcanic ash from snow-capped volcano where snow is melted

3) Toxic Gases - non-toxic - $H_2O$ vapour, $CO_2$
- toxic - CO, S gases, HCl & HF acids
- killed before aware
- best defense → get away

4) Steam Explosions - island volcanoes - water may seep in, become steam & blow up the volcano, this is a phreatic eruption
- strength 100 million tons of dynamite, heard 3000 km away, dust 80 km up

5) Secondary: Climate - one eruption can have global effect
- dust high in atm, years to settle, measurable cooling