VOLCANOES!!!

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Earth Science

THE NATURE OF VOLCANIC ERUPTIONS

- Factors that determine the violence of an eruption:
  - Composition of the magma
  - Temperature of the magma
  - Dissolved gases in the magma
- Viscosity
  - The measure of a material's resistance to flow

VISCOSITY

- Factors affecting viscosity
  - Temperature (hotter magmas are less viscous)
  - Composition (silica content)
    - High silica– high viscosity (rhyolitic lava)
    - Low silica- more fluid (basaltic lava)

DISSOLVED GASES

- Also affect eruptions
- Mainly water vapor and carbon dioxide
- Gases expand near the surface
- A **vent** is an opening in the surface of Earth through which molten rock and gases are released.
- Provide the force to extrude lava

MORE ON DISSOLVED GASES

- Violence of an eruption is related to how easily gases escape from magma
  - Gases escape easily from fluid magma
  - Viscous magma produces a more violent eruption

MAGMA COMPOSITION

Table 1 Magma Composition					
Composition	**Silica Content**	**Viscosity**	**Gas Content**	**Tendency to Form Pyroclastics (ejected rock fragments)**	**Volcanic Landform**
Basaltic	Least (~50%)	Least	Least (1–2%)	Least	Shield Volcanoes Basalt Plateaus Cinder Cones
Andesitic	Intermediate (~60%)	Intermediate	Intermediate (3–4%)	Intermediate	Composite Cones
Rhyolitic	Most (~70%)	Greatest	Most (4–6%)	Greatest	Pyroclastic Flows Volcanic Domes

VOLCANIC MATERIAL

- Two Types of basaltic lava
  - Pahoehoe lava (resembles braids in ropes)
  - Aa lava (rough, jagged blocks)

PAHOEHOE (ROPY) LAVA FLOW

SLOW-MOVING AA FLOW

PYROCLASTIC MATERIAL

- **Pyroclastic materials** is the name given to particles produced in volcanic eruptions
- The fragments ejected during eruptions range in size from very fine dust and volcanic ash to pieces that weigh several tons

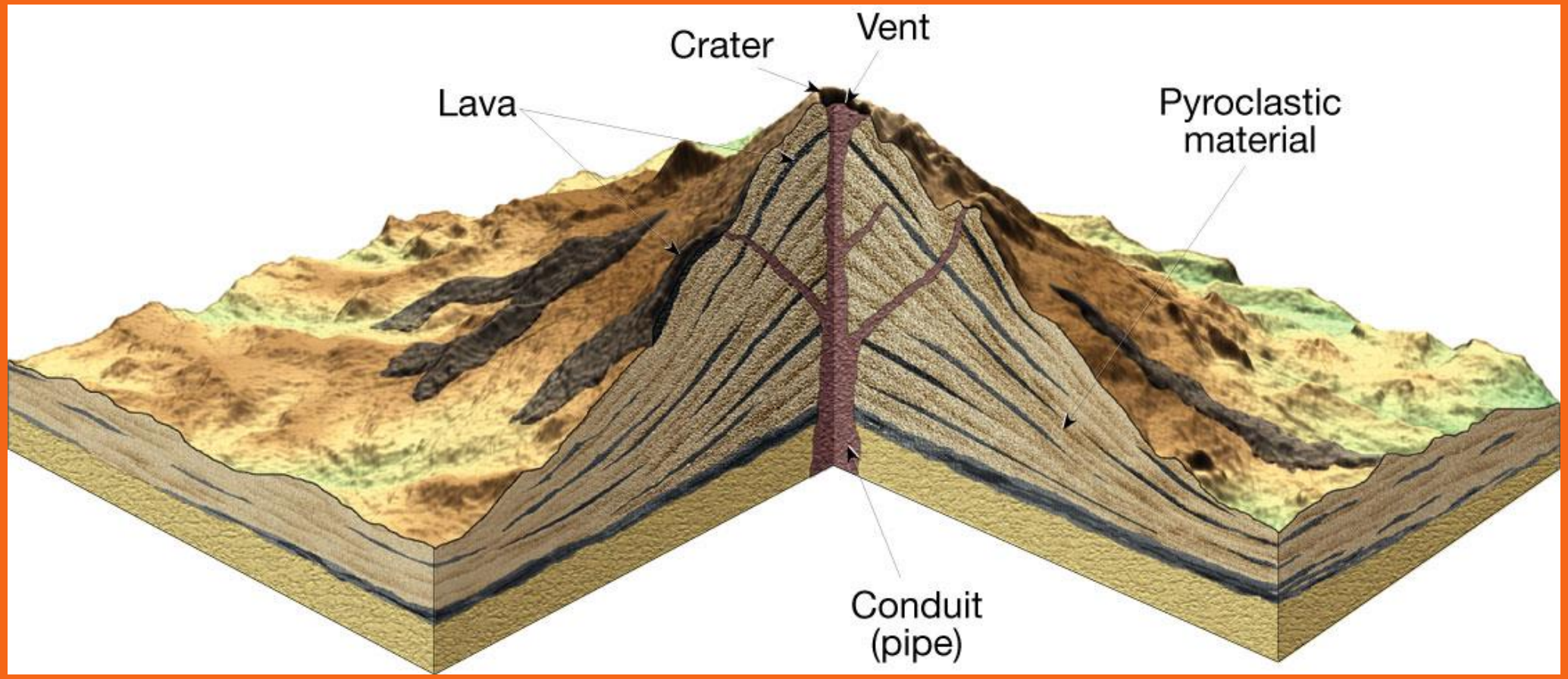
MORE FOR PYROCLASTIC MATERIALS

- Types of pyroclastic material
  - Ash and dust—fine, glassy fragments
  - Pumice—frothy, air-filled lava
  - Lapilli—walnut-sized particles
  - Cinders—pea-sized particles
- Particles larger than lapilli
  - Blocks—hardened lava
  - Bombs—Globs of lava ejected from volcano

ANATOMY OF VOLCANOES

- Anatomy of a volcano
  - A **volcano** is a mountain formed of lava and/ or pyroclastic material
  - A **vent** is an opening exposed on the earth's surface where volcanic material is emitted
  - A conduit, or pipe, carries gas-rich magma to the surface

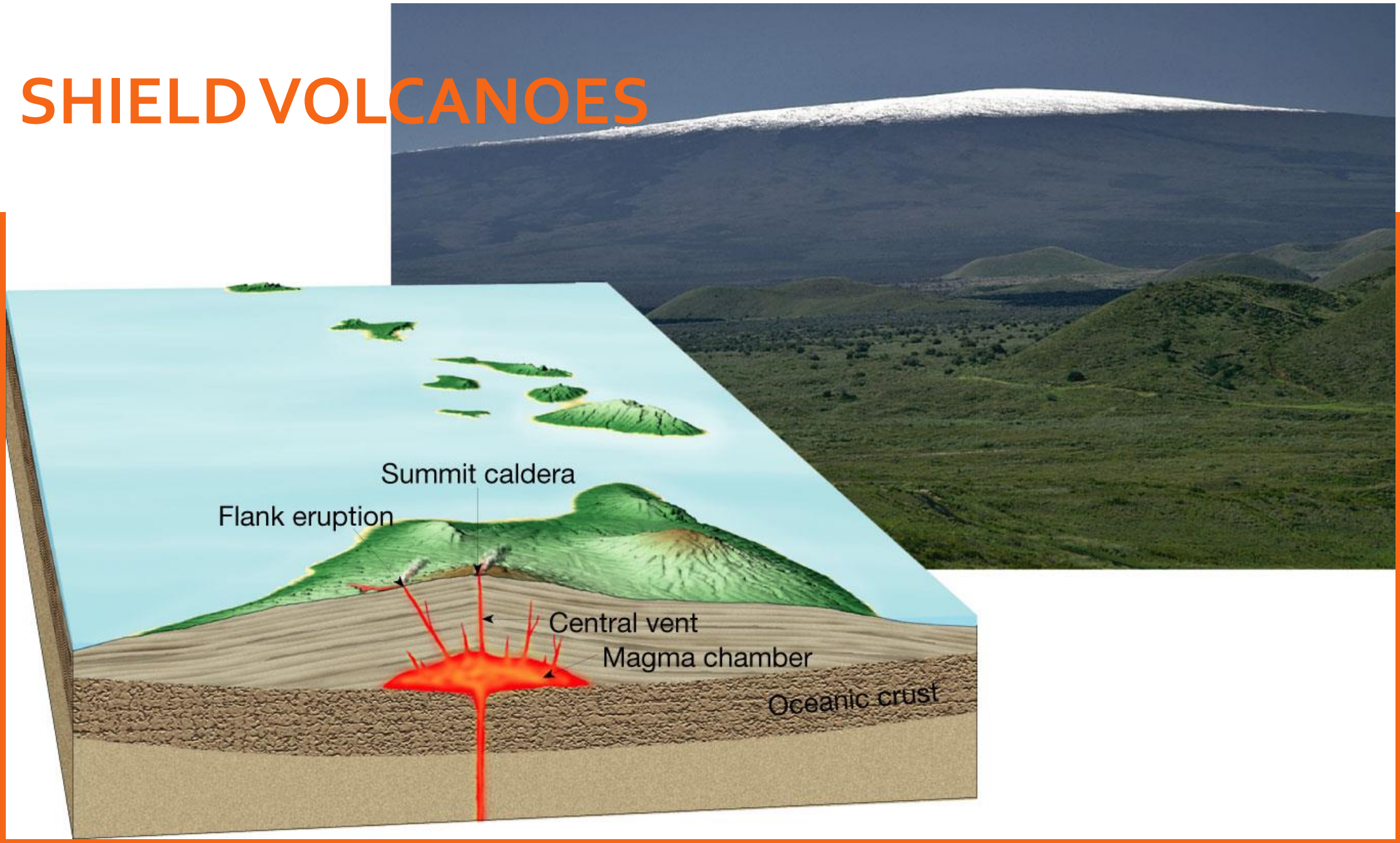
ANATOMY OF A "TYPICAL" VOCANO



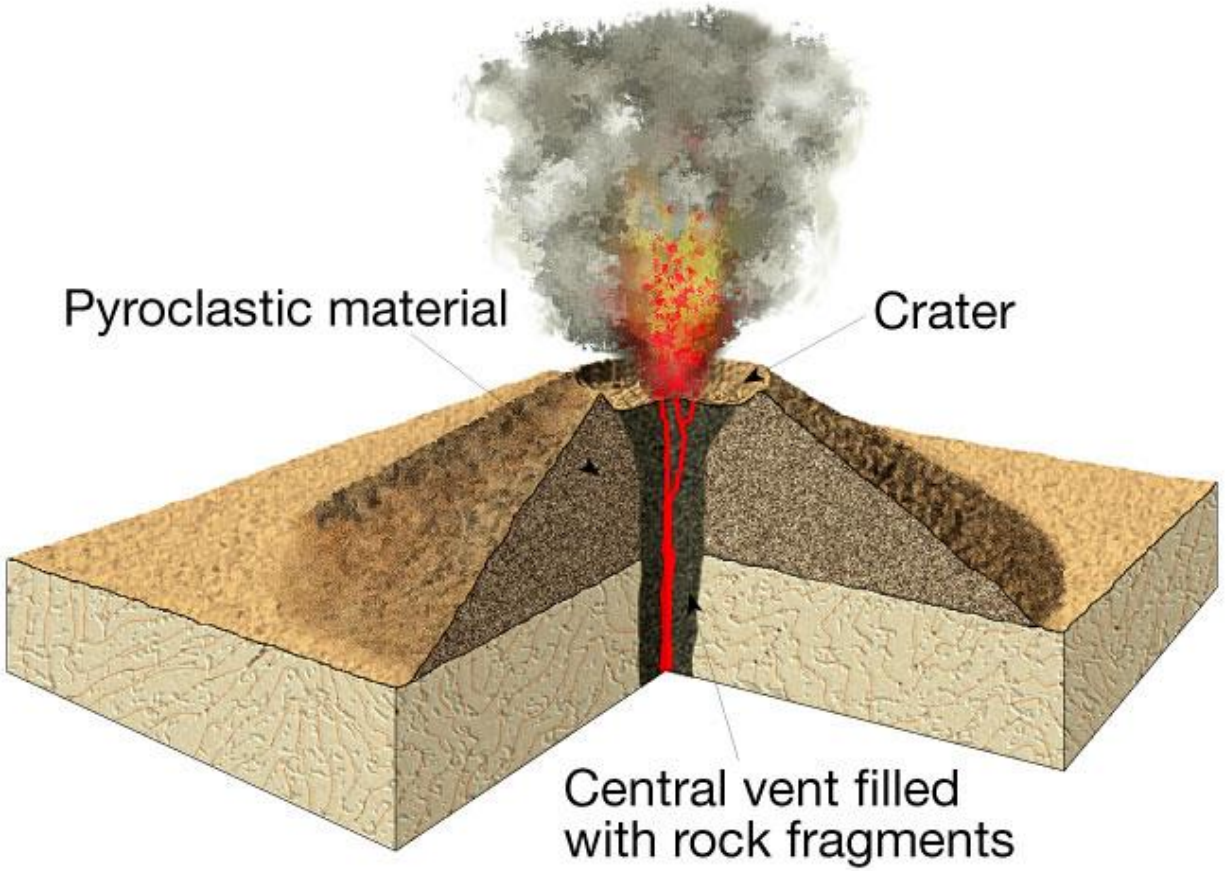
TYPES OF VOLCANOES

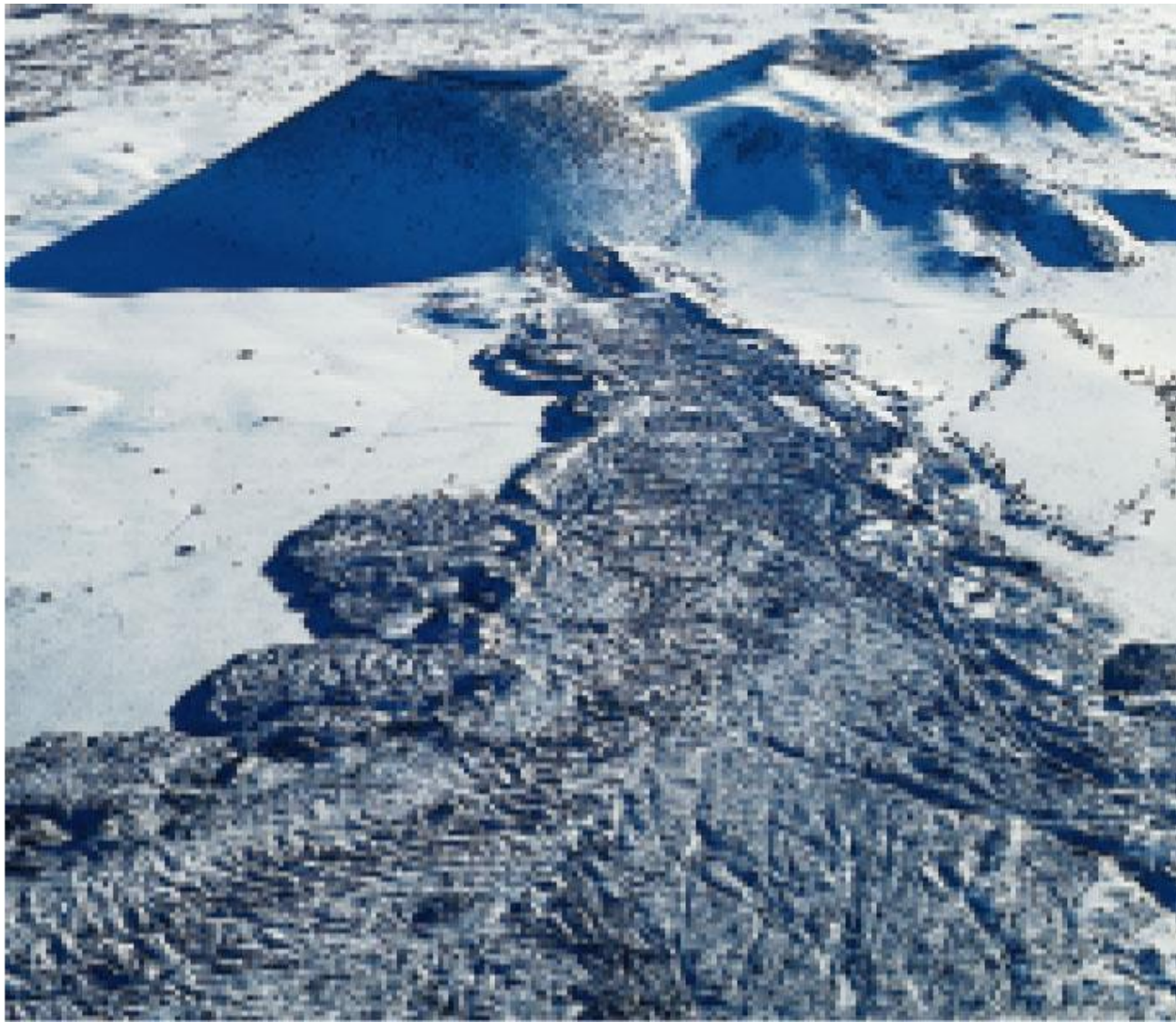
- Shield volcanoes
  - Broad, gently sloping volcanoes built from fluid basaltic lavas.
- Cinder cones
  - Small volcanoes built primarily of pyroclastic material ejected from a single vent.
    - Steep slope angle
    - Rather small in size
    - Frequently occur in groups

SHIELD VOLCANOES



CINDER CONES



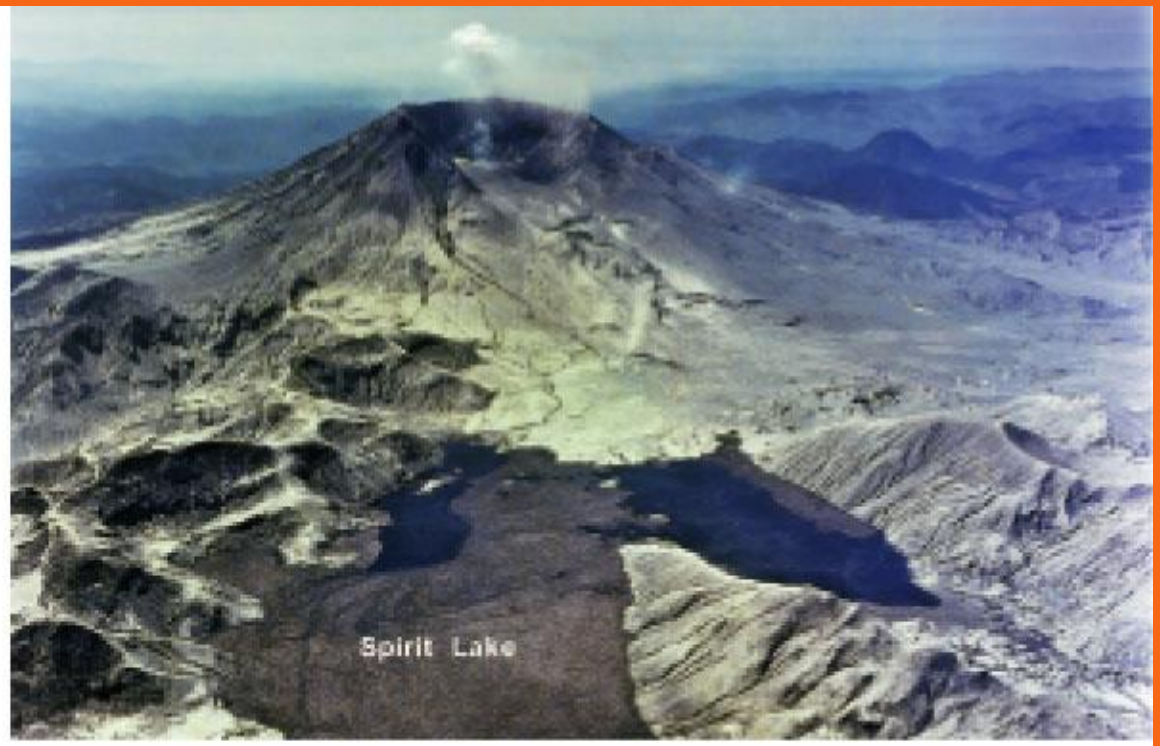


ONE MORE

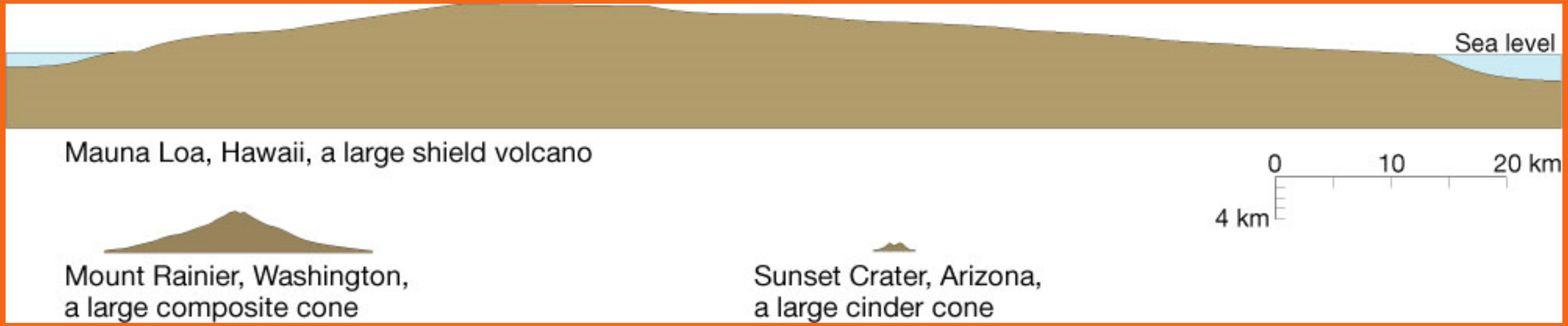
- Composite Cones
  - Volcanoes composed of both lava flows and pyroclastic material
    - Most are adjacent to the pacific ocean (ie. Mt. Rainier)
    - Large Size
    - Interbedded lavas and pyroclastics
    - Most violent type of activity

COMPOSITE CONES

MOUNT ST. HELENS BEFORE AND AFTER MAY 18, 1980, ERUPTION



PROFILES OF VOLCANIC LANDFORMS



OTHER VOLCANIC LANDFORMS

- Calderas
  - Large depressions in volcanoes
  - Nearly circular
  - Formed by collapse
  - Size exceeds one kilometer in diameter

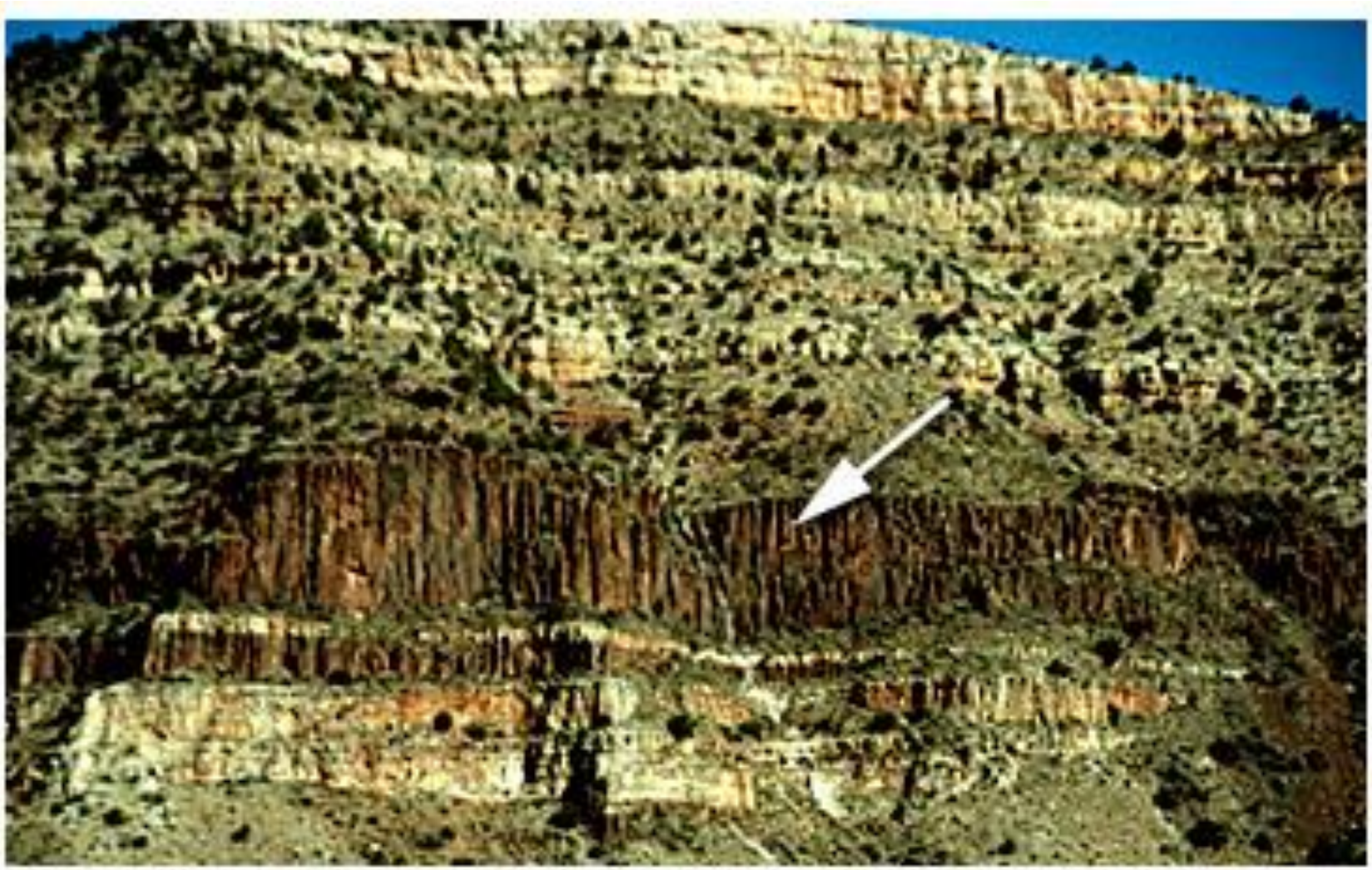
- Lava Plateaus
  - Fluid basaltic lava extruded form crustal fractures called fissures.

INTRUSIVE IGNEOUS ACTIVITY

- Plutons
  - Intrusive structures that result from the cooling and hardening of magma beneath the surface of earth.
    - Intrusive igneous bodies, or plutons, are generally classified according to their shape, size, and relationship to the surrounding rock layers.

- Sills and laccoliths
  - Sill and laccoliths are plutons that form when magma is intruded close to the surface
    - **Sills** resemble buried lava flows and exhibit columnar joints
    - **Laccoliths** are lens-shaped masses that arch underlying strata upward

SILLS

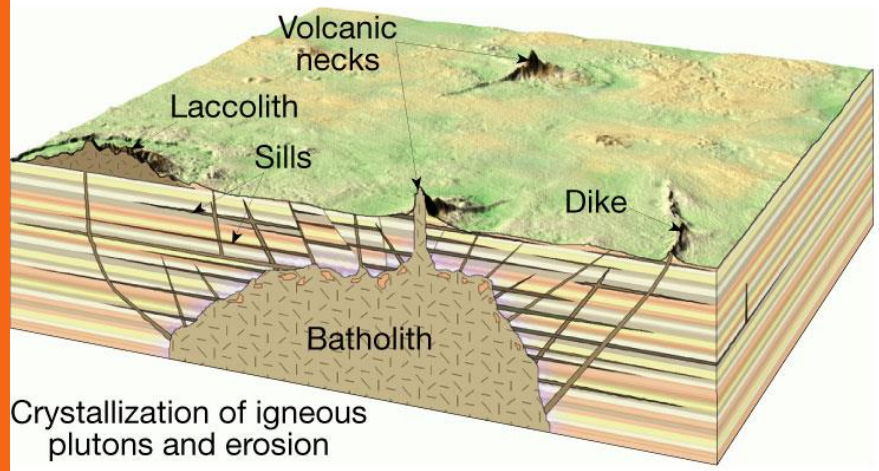


- Dike
  - Tubular-shaped intrusive igneous features that cut across preexisting rock layers.
  - Many dikes form when magma from a large magma chamber invades fractures in the surrounding rocks.

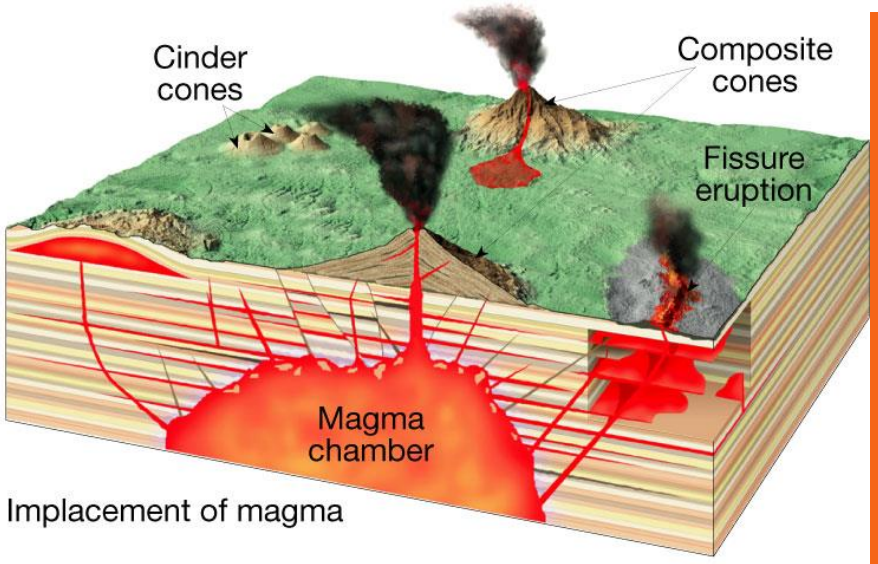
- Batholiths
  - Large masses of igneous rock that formed when magma intruded at depth, became crystallized, and subsequently was exposed by erosion.
  - An intrusive igneous body must have a surface exposure greater than 100 square kilometers to be considered a batholith

BATHOLITHS

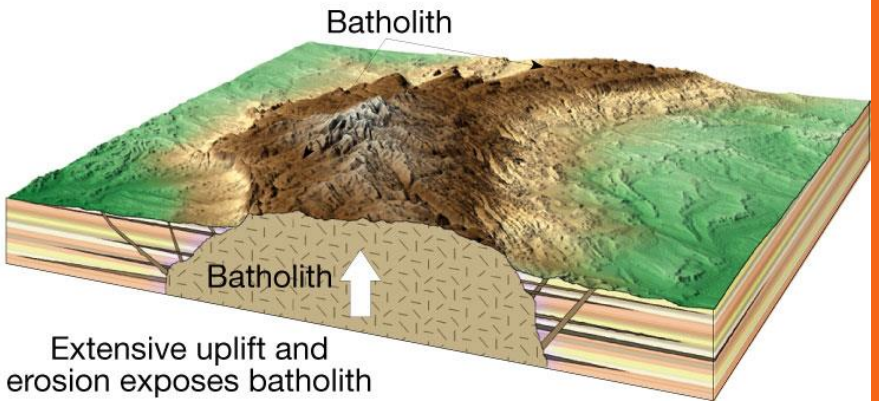
TYPES OF IGNEOUS PLUTONS



Crystallization of igneous plutons and erosion



Implacement of magma



Extensive uplift and erosion exposes batholith

ROLE OF HEAT

- The **geothermal gradient**– earth's natural temperature increases with depth but is not hot enough to melt rock in the lower crust and upper mantle
  - Additional heat is generated by
    - Friction in subduction zones
    - Crustal rocks heated during subduction
    - Rising, hot mantle rocks

ROLE OF WATER

- Causes rock to melt at a lower temperature
- Plays an important role in subduction ocean plates

BASALTIC MAGMA AT THE SURFACE

PLATE TECTONICS AND IGNEOUS ACTIVITY

- Convergent plate boundaries
  - The basic connection between plate tectonics and volcanism is that plate motions provide the mechanisms by which mantle rocks melt to generate magma
  - Ocean- Ocean
    - Rising magma can form volcanic island arcs in an ocean (Aleutian Islands)
  - Ocean- Continent
    - Rising magma can form continental volcanic arcs (Andes Mountains)

CONVERGENT BOUNDARY VOLCANO

DIVERGENT PLATE BOUNDARIES

- The greated volume of volcanic rock is produced along the oceanic ridge system
  - Lithosphere pulls apart
  - Less pressure on underlying rocks
  - Partial melting occurs
  - Large quantities of fluid basaltic magma are produced

INTRAPLATE IGNEOUS ACTIVITY

- Intraplate volcanism is igneous activity that occurs within a tectonic plate away from plate boundaries.
  - Most intraplate volcanism occurs where a mass of hotter than normal mantle material called a mantle plume rises toward the surface.
  - The activity forms localized volcanic regions called hot spots.
  - Examples include the Hawaiian Islands and the Columbia Plateau.

EFFECTS OF VOLCANIC ERUPTIONS

- Volcanic gases are spewed into the atmosphere.
  - Mostly water vapor (harmless)
  - Others Carbon Dioxide, Sulfur Dioxide, Hydrochloric Acid, Hydrofluoric Acid, and Ash (Can all be harmful).

MORE ABOUT GASES

- Sulfur dioxide can turn into an aerosol in the stratosphere which increases the amount of sunlight (heat) reflected back into space. This can cause a drop in the average temperature of the earth and results in death due to famine in many cases.
  - Russian Famine of 1601-1602 caused by volcanic eruption in Peru. (1/3 of population killed (2 million people)

MORE EFFECTS

- Acid Rain
  - Hydrochloric acid and hydrofluoric acid are in droplets of water vapor in the ash cloud and quickly fall to the ground as acid rain.
    - Ash in the stratosphere settles and will be removed within several days to a few weeks.

OTHER HAZARDS

- Ash thrown into the air can damage aircraft and cause failure.
- Gases and acid rain can cause crop failure which leads to famine and can cause widespread death.

CLASSIFICATION OF VOLCANIC ACTIVITY

- Frequency of eruption leads to three categories
  - Time is somewhat relative.

1. Active– erupting or likely to erupt (shows signs of unrest such as earthquakes and gas emission)
   - Has erupted in the last 10,000 years.

VOLCANIC ACTIVITY LEVEL

2. Dormant or inactive– volcanoes that have erupted in the past, but are presently quiet.

Many volcanoes are unknown as they can have really, really long regharge periods.

Example: Yellowstone has about a 700,000 year cycle

3. Extinct– volcanoes that no longer have a supply of magma.

Example: islands formed from hotspots