Landscape Forms

References:
Encyclopedia of Volcanoes. pp 643-662; 663-682; 683-696

Topics
- Small monogenetic volcanoes
- Large polygenetic volcanoes
- Effects of erosion
- Volcanic topography

Small Volcanoes (Generally Monogenetic)
- Domes
- Scoria cones
- Maars
- Tuff rings
- Tuff cones
- Diatremes

Dome Features
- Spines
- Rough top surface
- Steep flanks
- Marginal breccia
- Inverted cup form

Mono Domes, CA
Submarine Rhyolite Domes

- Hyaloclastite pile
- Brecciated rhyolite
- Dikes, vitric selvage
- Hydrothermal zones
- Palagonitization

Scoria Cones

- Simplest and commonest volcanic form
- Characterized by three parameters
  - Height, width, crater width
- Standard initial slope of 30°
- Conical shape
- Occur in several environments
- McGetchin model of cone growth
- Erosion is systematic
Basaltic Monogenetic Fields

- 10s to 1000s of cones
- General elliptical shape
- Aspect ratio of 2:1 to 5:1
- 10 to 70 km in length
- Areas of extensional tectonics
- Elongate perpendicular to tension
- Widespread in western USA
- Pinacate example

North rim of Grand Canyon
Scoria cones aligned along fault planes

Maars

- Result from hydromagmatic explosions
- Simple circular water-filled depression
- Low rims of ejecta (tuff ring)
- Vertical crater walls
- Pre-eruption rocks exposed in walls
- Abundant pre-volcanic boulders
- Typical diameter of 1 km
- ~ 100 m deep

Tuff Cones

- Massive deposits
- Thickly bedded
- Palagonitized
- Bedding up to 30°
- Wet surges
**Tuff Rings**

- Thinly-bedded
- Poorly-indurated
- Beds less than 12°
- Sandwave beds
- Dry surges

**Diatremes**

- Breccia pipes
- Kimberlite
- Contains diamonds
- Ultramafic magmas
- Mixture of rocks
- Driven by deep CO₂

**Subglacial Volcanoes**

- Pillow lavas
- Pillow breccias
- Hyaloclastites
- Dikes
- Flat top with lava
Sub-glacial

Sequence of intrusion
Pillow lava, pillow breccia, stratified hyaloclastite, lava
Final form is a table mountain

Subglacial volcano, Iceland

Large Volcanoes
- Generally polygenetic
- Simple cones
- Composite cones
- Compound volcanoes
- Volcano complexes

Simple Cones
- Single summit vent
- Small crater (<200 m diameter)
- Radial symmetry
- Slopes > 40° near summit
- Concave profiles
- Height of a volcano is limited
- May grow to 3000 m
- Mass eruption rate is a control

Simple Cones

Popocatepetl, Mexico
Volume of the Cone

For a geometric cone:  \( V = \frac{4}{3} \pi r^2 h \)
where \( r \) is the radius and \( h \) the height

For common volcanic cones: \( V = B e^{M/h} \)
where \( B \) and \( M \) are constants and volume determined by integration

Composite Cones
- More than one stage in their evolution
- Somma type (Vesuvius)
- Debris avalanches commonly interrupt growth
- Average height is 2000 m

Compound Volcanoes
- Massif formed of several volcanoes
- Volcanic complexes
- They have no defined center
Shield Volcanoes

- Convex upward profiles
- Hawaiian shields
- Galapagos shields
- Icelandic shields

Hawaiian Shields

- 2 - 3° slopes near base and summit
- 10° slope in mid-range
- Shallow summit calderas > 200 m
- Composed of thin lava flows
- Rift zones due to lateral weakness
- Tube-fed pahoehoe lavas common

Icelandic Shields

- Moderate size
- Extremely symmetrical
- Small size >800 m high
- Uniform slope ~ 8°
- Tube-fed pahoehoe lavas

Galapagos Shields

- Profile like over-turned soup plate
- Steeper mid-flank slopes > 10°
- Very deep summit calderas > 800 m
- Very symmetrical volcanoes
- Circumferential fissures

Erosion of Volcanic Deposits

- Erosion of cones
- Erosion of lavas
- Erosion of tuffs
- Volcanic topography
**Erosion of Cones**

- Parasol ribbing
- Development of “flat irons”
- Rounded hills
- Necks and dikes

**Erosion of Lavas**

- Stepped topography due to layering
- Sapping produces steep canyons
- Columnar jointing exposed
- Inverted topography

**Erosion of Tuffs**

- Dendritic erosion
- Deep gully cutting
- Flat-topped plateaus
- Box canyons
- Castle ramparts
- Yardangs (wind eroded ridges)
- Wigwams, teepees, yahoos, etc.
Volcanic Caused Topography

- Lava dams
- Debris avalanches

Eroded Dikes

- Wall-like form
- Orientation
- Textures
- Cooling joints