I. Introduction: two predominant types of lava
   A. Lava derived from magma: less dissolved gas, because it is released when pressure drops upon extrusion
   B. Basaltic magma at oceanic ridges or hotspots: Iceland, Kilauea
   C. Granitic magma at convergent boundaries: Mt. St. Helens, Fujiyama
   D. Terms:
      1. viscosity: resistance to flow—function of
         a. temperature
         b. dissolved gas content
      2. pyroclastic: particles shattered by volcanic eruption

II. Volcanic eruptions
   A. Factors that determine the violence of an eruption
      1. Composition of the magma
      2. Temperature of the magma
      3. Dissolved gases in the magma
   B. Viscosity of magma viscos=sticky
      1. Viscosity is a measure of a material's resistance to flow
      2. Factors affecting viscosity: temp., silica content, dissolved gas
         a. Temperature (hotter magmas are less viscous) e.g. honey: cool vs. hot
         b. Composition (silica content) e.g. honey vs. syrup
            1) High silica = high viscosity (e.g. felsic lava)
               a) 70% or more
               b) silica tetrahedral link into mats
            2) Low silica = more fluid (e.g., mafic lava)
               a) about 50%
               b) hotter
         c. Dissolved gases
            1) water vapor, carbon dioxide
            2) Gas content affects magma mobility
               a) Low silica allows gases to escape easily
               b) High silica traps gases within lava
            3) Gases expand near the surface and extrude lava: lava fountains
            4) Violence of an eruption is related to how easily gases escape from magma
               a) Fluid basaltic lavas are generally quiescent -- pressure released
               b) Highly viscous magmas produce explosive eruptions – pressure builds

III. Materials extruded during an eruption
  A. Lava flows
    1. Basaltic lavas are more fluid
      a. hot: thin sheets, 10-300 meters per hour
      b. Types of basaltic lava
        1) Pahoehoe lava (resembles braids in ropes)
        2) Aa lava (rough, jagged blocks) cooler than pahoehoe lava: broken crusts
    2. rhyolite lava: cooler, more silica, flows very slowly
  B. Pyroclastic materials: pulverized rock, molten lava
    1. "Fire fragments"
    2. Types of pyroclastic material
      a. Solids classified by size
        1) Ash and dust - fine, glassy fragments
        2) Cinders - "pea-sized"
        3) Lapilli - "walnut" size
        4) Pumice - from "frothy" lava—many cinders and lapilli are pumiceous
        5) Particles larger than lapilli: Blocks - hardened lava
      b. Bombs –
        1) ejected as hot lava—
        2) cool on the fly into fusiform shapes
  C. Gases
    1. One to 6 percent of magma by weight
    2. pressure reduction at surface allows to escape the magma
    3. composition
      a. Mainly water vapor (70%) and carbon dioxide (15%)
      b. About 5% each nitrogen, sulfur
      c. Lesser amounts of chlorine, hydrogen, argon

IV. Volcanoes:
  A. Types of volcanoes
    1. Shield volcano
      a. characteristics
        1) Broad, slightly domed
        2) Primarily made of basaltic (fluid) lava
        3) Generally large
        4) Generally produce a large volume of lava
      b. mature shield volcanoes have steep middle slopes, with rift zone vents
      c. common for system of lava tubes to drain lava to distant flanks
      d. e.g. Mauna Loa in Hawaii

2.Composite cone (or stratovolcano)—
   a. Most are adjacent to the Pacific Ocean (e.g., Fujiyama, Mt. Shasta) “Ring of Fire” around Pacific stretches from Aleutians to New Zealand
   b. Large size, symmetric shape
   c. Interbedded lavas and pyroclastics—andesitic magma
      1) fluid lavas early
      2) pyroclastics build steep upper slopes of coarse material, finer widespread
      3) lavas stabilize this area—short central vent flows
   d. Most violent type of activity (e.g. Vesuvius)
   e. Often produce nuée ardente
      1) Fiery pyroclastic flow of hot gases infused with ash
      2) Flows down sides of a volcano at speeds up to 200 km per hour
   f. May produce a lahar, a type of volcanic mudflow
      1) stratovolcanoes are high—have snow and glaciers that melt
      2) unconsolidated pyroclastic debris can also fail due to heavy rainfall or other (than eruption) sudden snowmelt
      3) dangerous lahar areas—
         a) Mt. Rainier is very dangerous
            i. high population density
            ii. large amount of unconsolidated debris, and snow and ice
            iii. many residential areas upon lahar deposits
         b) Nevado del Ruiz--1985
            i. Andes Mountains Columbia
            ii. 100 km/hr down three major rivers
            iii. 25,000 killed in overnight lahar

3.Cinder cone
   a. Built from ejected lava fragments
   b. Steep slope angle—30-40 ^{o}
   c. Rather small size-
   d. short eruptive phase
   e. Frequently occur in groups—many times as parasitic cones on larger volcano—Vesuvius has many

B. General features—
1. starts as a fissure that ejects magma
2. intermittent eruptive phases over decades, centuries, millennia
3. Vent (connected to the magma chamber via a pipe)
4. Opening at summit
    a. Crater (steep-walled depression at the summit)—constructive feature
    b. Caldera
        1) a summit depression greater than 1 km diameter
        2) collapse feature: evacuation of magma from central vent area
            a) by eruption, or
            b) by draining to flanks

V. Other volcanic landforms
A. Calderas
1. Steep walled depression at the summit
2. Size exceeds one kilometer in diameter
3. Types of calderas
    a. Crater Lake-type—cone summit evacuated of magma by eruption
    b. Hawaiian-type—cone summit evacuated of magma by draining
    c. Yellowstone-type—widespread area of uplift, huge pyroclastic eruption, ring fracture collapse, welded tuff formation

B. Fissure eruptions and lava plateaus
1. Fluid basaltic lava extruded from crustal fractures called fissures
2. Produces flood basalts
3. e.g., Columbia Plateau, Deccan Plateau

C. Volcanic pipes and necks
1. Pipes are short conduits that connect a magma chamber to the surface
2. Volcanic necks (e.g., Ship Rock, New Mexico) are resistant vents left standing after erosion has removed the volcanic cone