Ge 151
Endogenic Processes: Volcanism

I. Introduction

Form on Earth
- ∝ Si/Fe ratio – Fig 4.11 (144)
- ∝ volatile abundancies
- ∝ rate
- ∝ new geometry

II. Silicic Volcanism – 60% or more SiO_2

A. Obsidian & rhyolite – 4.12 (145) Mt. Lassen, etc.

B. Volatile – 4.13 (146)

Fuji, Vesuvius, St. Helens – stratovolcanoes

C. Ash flows – ignimbrite – Katmai

D. Plate tectonic setting of silicic volcanism

4.7 (139)

Generally tied into "recycled" crust

E. Other planets? No, generally

No stratovolcanoes

Ignimbrite – without stratovolcanoes?

No plate tectonics on Mars, Venus, or Mercury

III. Basaltic Volcanism

A. Major Types (F4.17)

1. Mid-Ocean ridges

Only terrestrial

2. Flood basalts = Plateau basalts = Maria

Sheets of basalt covering $<10^5$ km^2 to a depth of km's. No vents visible, but terrestrial examples have fissure sources. Rare tubes and flow fronts. Found on all the terrestrial planets. High effusion rates?? Massive climate change?? (2.1, 4.1, 8.2, 4.23, 4.25, 7.12)

3. Plains basalts

A region ~10^4 km^2 dotted with small cones and lava flows. Flows fed by fissures, cones, and tubes. Need high resolution images but hints on all but Mercury.

4. Patera = Coronas = Low shields

Very shallow slopes. Alba Patera the only huge example on Mars (1600 km diameter). 100 km scale Coronas common on Venus. Terrestrial low shields only a few km in size. Made of long, skinny flows. (4.12, 7.14)

5. Shield volcanoes

2°-12°; ~5° slopes, often have caulderas.Both point and fissure sources. Low rates, frequent, vent control. Common on Earth, Mars, Venus. Few km to few 100's of km in scale. (4.27, 4.30, 4.34, 7.13, 4.24)

B. Smaller Basaltic Landforms

Vent area:	Lava flows:
Caulderas (4.29, 4.32, 4.35)	a'a' vs. pahoehoe
Cinder cones (P5)	flow tubes (4.3, 4.16)
Fissures (4.36, 4.21, 4.22, 4.33)	tubes (4.2)
Spatter ramparts	channels (4.19. 4.20. 4.31)
Lava lakes/ponds	inflation features

C. Comparative Planetary Physical Volcanology

1. Ascent of magma
    i) Driving force
    ii) Crack formation
    iii) Flow of magma
    iv) Cooling
2. Eruption dynamics/ pyroclastic deposits
    i) Volatile exsolution
    ii) Plume height
    iii) Pyroclastic deposits
3. Lava flows
    i) Rheology – composition – Bingham plastic model
    ii) Lengths of lava flows
        a) viscosity
        b) effusion rate
        c) cooling

Suggested References

Pyroclastic deposits:
Cas and Wright, 1987. Volcanic Sucessions, 528 pp.

Basaltic eruptions:
Wilson and Head, 1983, "A comparison of volcanic eruption processes on Earth, Moon, Mars, Io, and Venus", *Nature*, vol. 302, pp. 663-669.

Bingham Plastic Model:
Moore et al., 1978; "Yield strengths of flows on the Earth, Mars, and Moon", *Proceedings of the 9th Lunar and Planetary Science Conference*, pp. 3351-3378.

Moon:
Wilhelms, 1987, The Geologic History of the Moon, USGS Prof. Paper 1348, 320pp.

Mars:
Mouginis-Mark, Wilson, and Zuber, 1992, The physical volcanology of Mars, *Ch. 13 in* Kieffer *et al*., Mars, Univ. Arizona Press.

Venus:
Head et al, 1991, "Venus volcanism: initial analysis from Magellan data", *Science*, vol. 252, pp.276-288.

Mercury:
1987 Mercury, Univ. Arizona Press.