**Volcanic Plumes**

Reading:

*Encyclopedia of Volcanology*, pp. 477-494; 513-526; 555-570

*Volcanic Successions*, Ch. 5:93-104

Sparks et al., *Volcanic Plumes*, 1997

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**Mount St. Helens Umbrella**

- 10 minutes for full umbrella to develop
- Reached 25 km high in 7 minutes
- Diameter: 20 km (base) to 70 km (top)
- Vertical rise of ~110 m/s
- Horizontal spread of ~55 m/s
Column Collapse

- Buoyant
  - Linear
- Super-buoyant
  - Non-linear
- Collapsed
  - Too little air mixture

Cause of Collapse

- Buoyancy is caused by mixing of hot volcanic gas and particles with air
- If too little air is mixed into the column it collapses
- This could be due to low mass eruption rate
- Or due to a very large diameter vent

Shape of Eruption Columns

Height of the columns
\[ H = \sim 1.6 \ Q^{0.25} \]

Wind shear deforms the rising plume
Effect is complex, depending on altitude

Mt. Mayon, Philippines

Mt. Asama, Japan
**Plume Location**

- Upwind stagnation point (usp)
- Horizontal displacement of plume axis (hdp)
- Ratio < 1 for small plumes, strong wind
- Ratio > 1 for huge plumes, weak wind

**Tephra Transport**

- If $v_t < \text{convective rise}$ then particles lift
- If $v_t > \text{convective rise}$ then particles fall
- Stagnation point locates balance
- Stratospheric transport of Plinian plumes by Jet Stream