ERTH 456 / GEOL 556
Volcanology

– Lecture 09: Conduits cont'd, Magma Chemistry–

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hours: M 4-5PM, R 3-4PM or appt.

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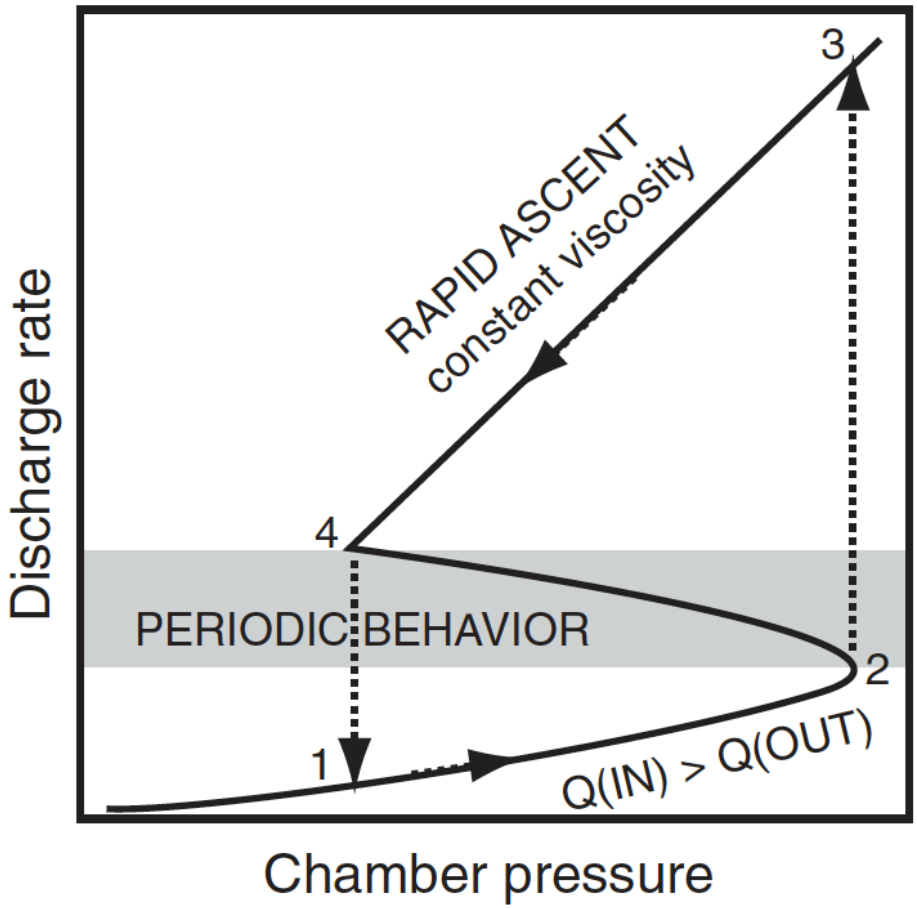
Conduit Flow

- numerous interacting factors = variety in volcanic behavior
- Figure: general steady-state solution of feedbacks: magma input, overpressure, output
- small decompression related changes in magma viscosity: 1-2-3-4
- periodic behavior when input in shaded region



Cashman & Sparks, 2013

Gas during Ascent

- after mobilization magma ascents due to volatile exsolution
- bubble velocity: drift velocity
- magma velocity: ascent velocity
- ascent modulated by vesiculation & gas escape, which depends on viscosity
- low viscosity (basalt): bubbles separate from ascending magma when bubbles rise faster than melt

Gas during Ascent – Bubbly to Annular Flow

https://www.youtube.com/watch?v=YV_BlnpJvao

Gas during Ascent – Slug Flow

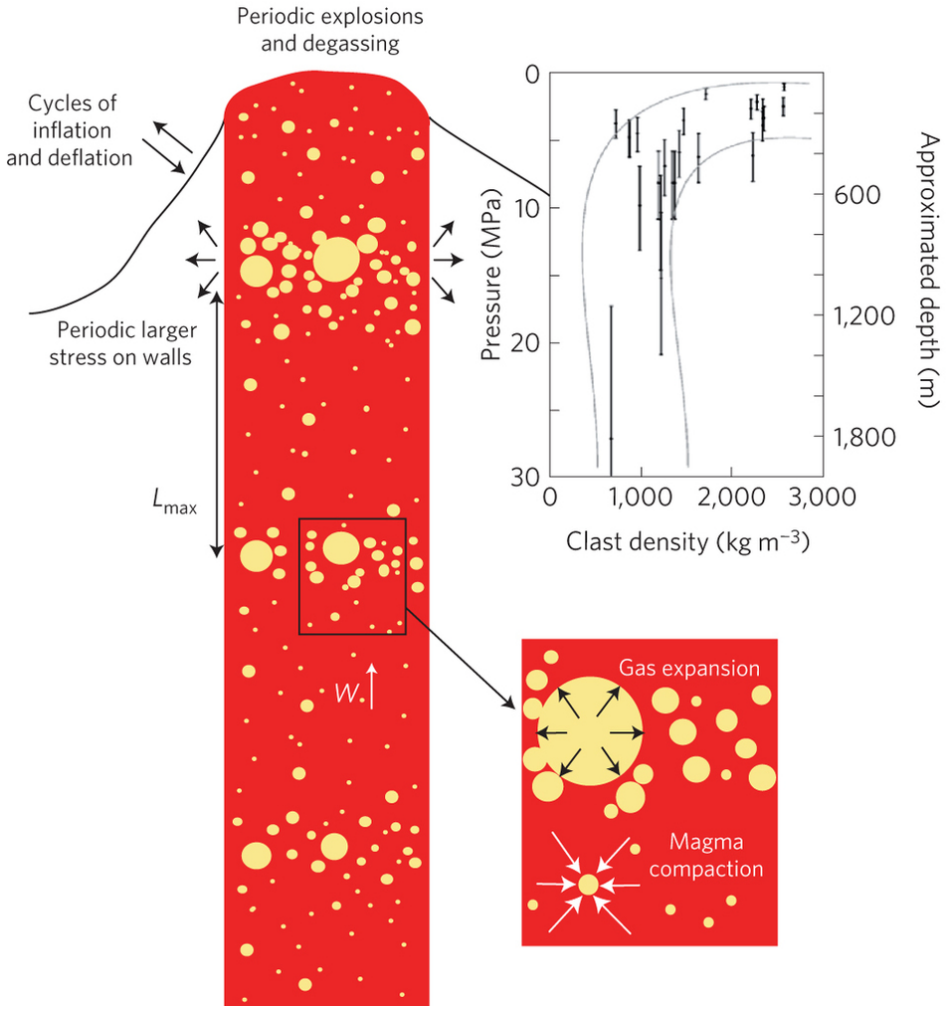
https://www.youtube.com/watch?v=_K1jkp9uCz4

Gas during Ascent – Slug / Annular Flow

https://www.youtube.com/watch?v=g0eXnEutiaU

Two-phase Flow

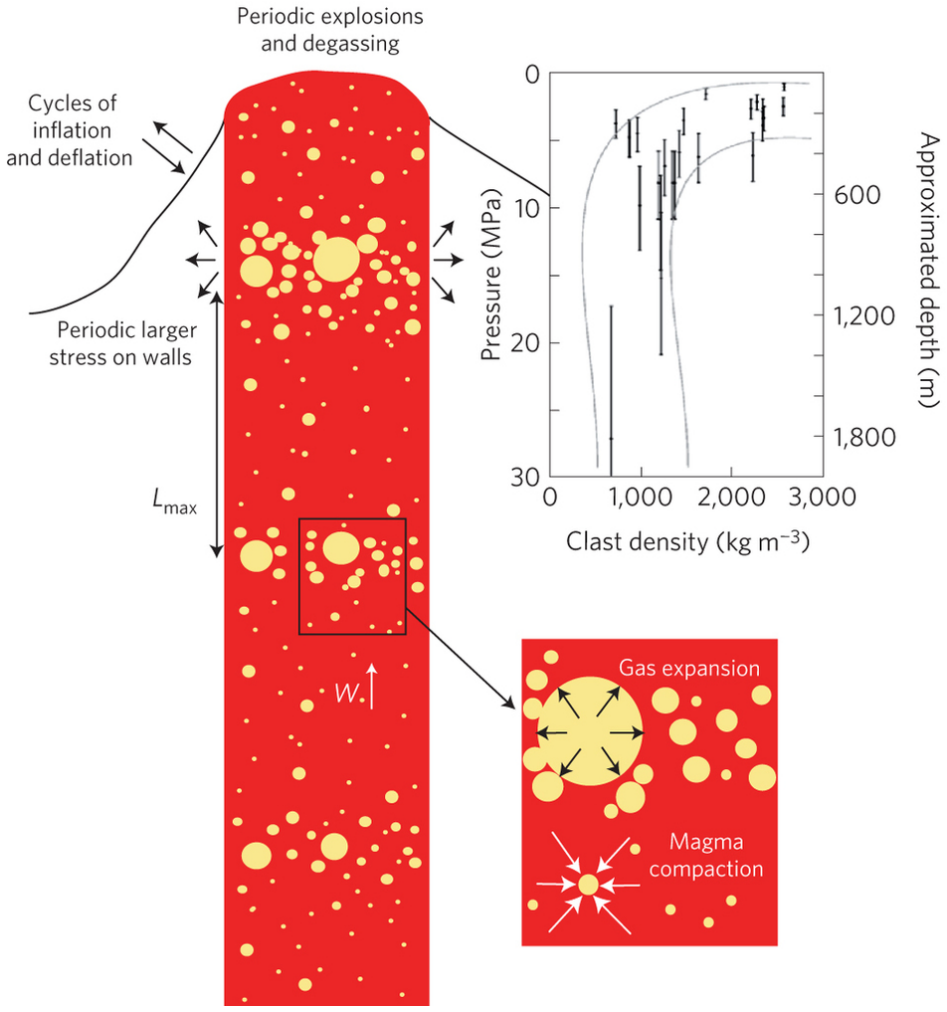
- recent development to move toward numerical models that examine gas-magma flow in large conduits with viscous fluid
- high-viscosity fluids enhance bubble coalescence due to drift velocity decrease



Michaut et al., 2013

Two-phase Flow

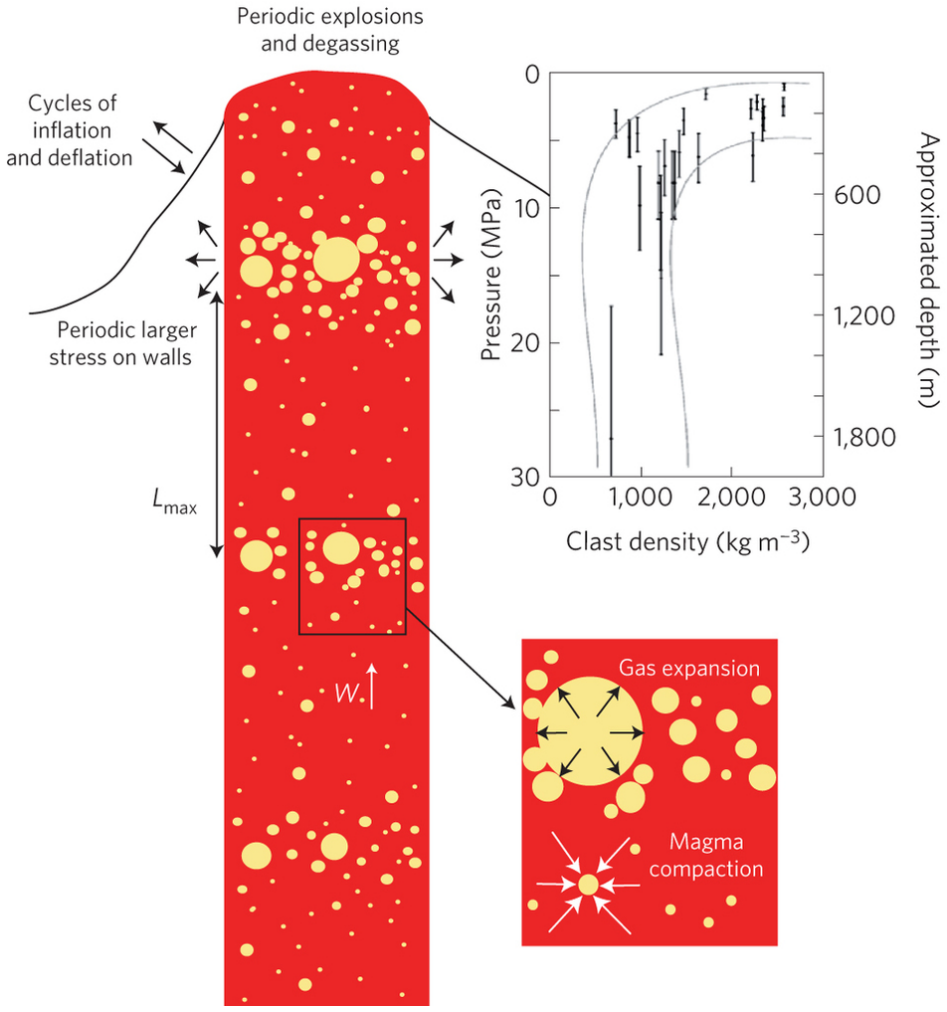
- large, conduit filling bubbles may be dynamically unstable during buoyancy-driven ascent
- cyclic patterns in bubbly magmas may explain pulsing in Hawaiian, Strombolian eruptions



Michaut et al., 2013

Two-phase Flow

- crystals may hinder gas migration if bubbles are trapped
- . . . or help degassing if bubbles coalesce in melt pathways



Michaut et al., 2013

Magma Fragmentation

Fragmentation: transition from melt with included bubbles to continuous gas phase with suspended droplets / particles (Cashman & Sparks, 2013)

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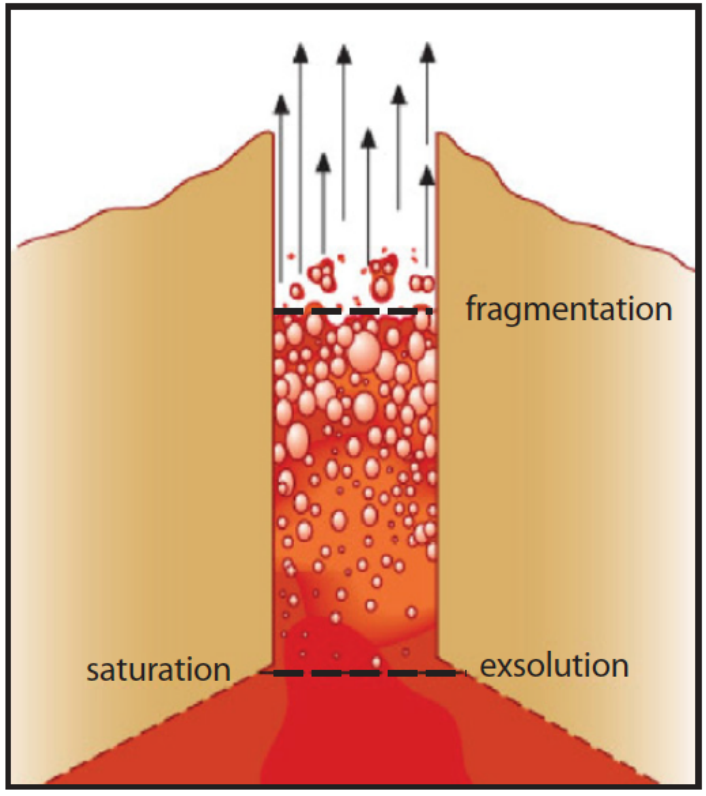
- can be ductile (low-viscosity, basaltic melts) or brittle (high-viscosity, silicic melts)
- **ductile fragmentation:** instabilities in accelerating liquid phase
- **brittle fragmentation:** magma exceeds critical vesicularity, volatile phase critical overpressure, expanding melt exceeds critical strain rate



Cashman & Sparks, 2013

Conduit Examples - Dike, Reykjanes, Iceland

R. Grapenthin

Conduit Examples - Dike, Kamen, Kamchatka

Conduit Examples - Conduit Zimina, Kamchatka