

12.001 Lecture Notes: Volcanoes
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Show picture of an explosive volcanic eruption and ask why are some fun to watch whereas for others it is better to be far away.

Terminology:

Magma=> molten rock

Lava => molten rock on the earth surfaces

Volcanic rocks

Massif e.g. lava flow chemistry + texture

Explosive: pyroclastic classification dependent on fragment content and size.

Bomb >64 mm

Lapillus 64-2 mm

Ash < 2mm

Classified based on texture and - importantly - chemistry, which in the field is more or less determined by color.

Chemical classification of volcanic rocks (explain that this is based only on chemistry)

Rock type	SiO ₂	Eruption T	NBO/T	viscosity				
Basalt	48-52	~1200	0.6-0.9	10 ¹⁻²				
Andesite	52-63		0.5					
Dacite	63-68		0.3					
Rhyolite	68-77	850	0.002-0.2	10 ⁶⁻⁸				

How composition influences viscosity:

Melts have internal structure (but no long-range order like crystals)

Similar to minerals, a silicate melt structure is formed by SiO₄ tetrahedra and, depending on composition, these tetrahedra form specific networks.

So for the melt structure we distinguish network formers (Si⁴⁺, Al³⁺, Fe³⁺) and network modifiers (Na⁺, K⁺, Ca²⁺, OH⁻)

Draw a picture of the network including network modifiers etc.

The longer range the network is, the higher the viscosity (if T, volatiles etc are all the same)

Important is the value of NBO/T

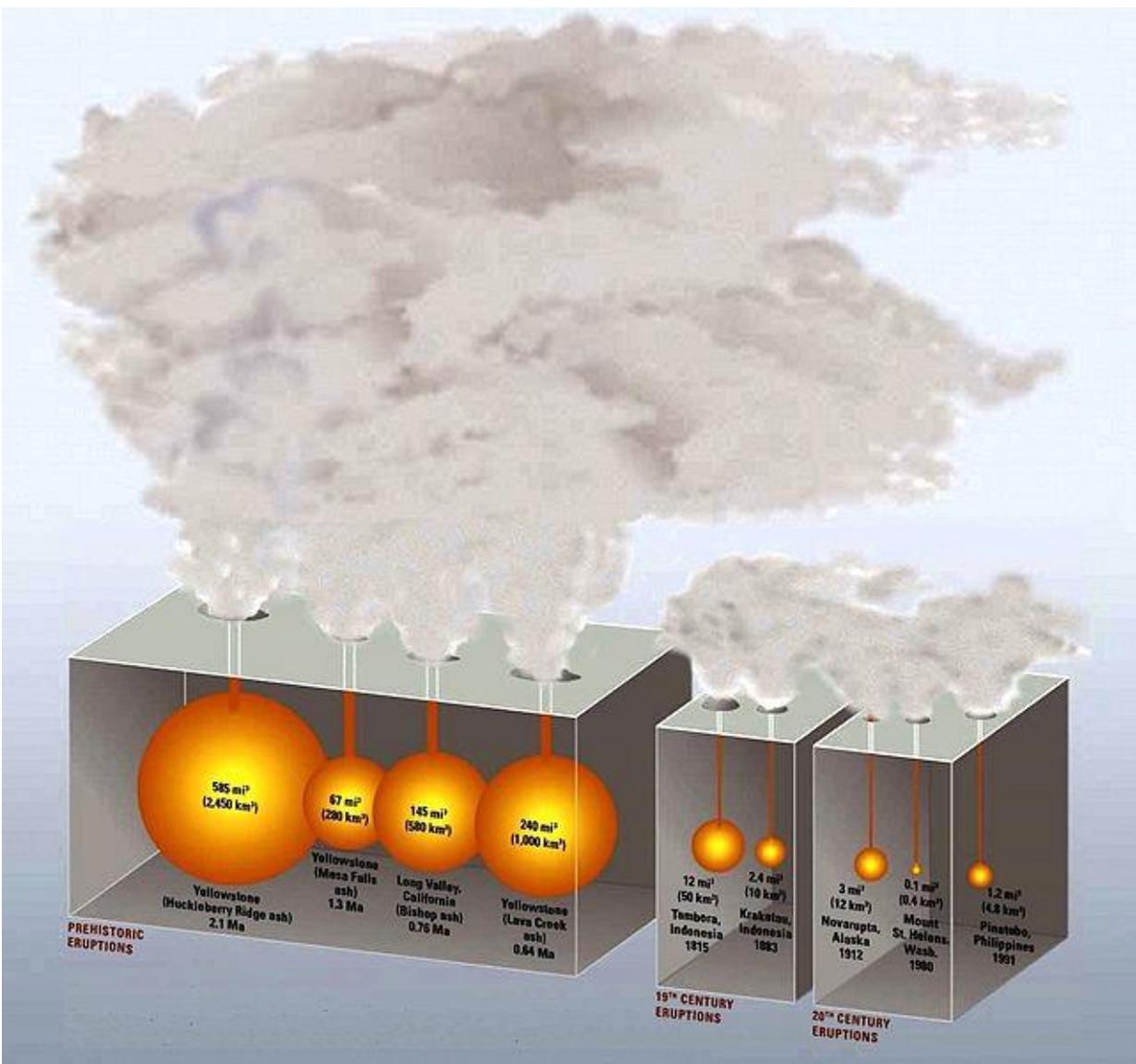
=0	-> 3-D network	viscosity high
=1	layers	
=2	chain	
=3	diamers	
=4	monomers	viscosity low

Show plot of volatiles, viscosity against SiO₂, and volatiles for a basalt against pressure.

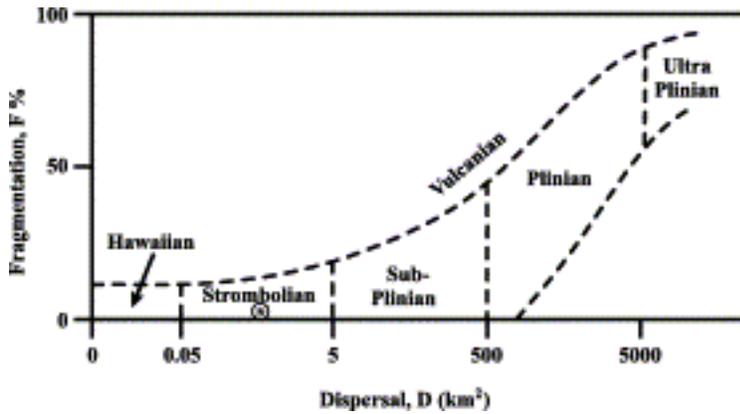
Then show the two pictures again and ask for reasons of the different eruption style... point

out the importance of volatiles for volcanic eruptions and explain that volatiles are considered the key factor for volcanic eruptions in general - show a pumice. Show principal make-up of a volcano: vent, magma chamber, feeder system Explain the important internal and external forcing mechanisms that trigger eruption (Schminke book Fig 4.31)

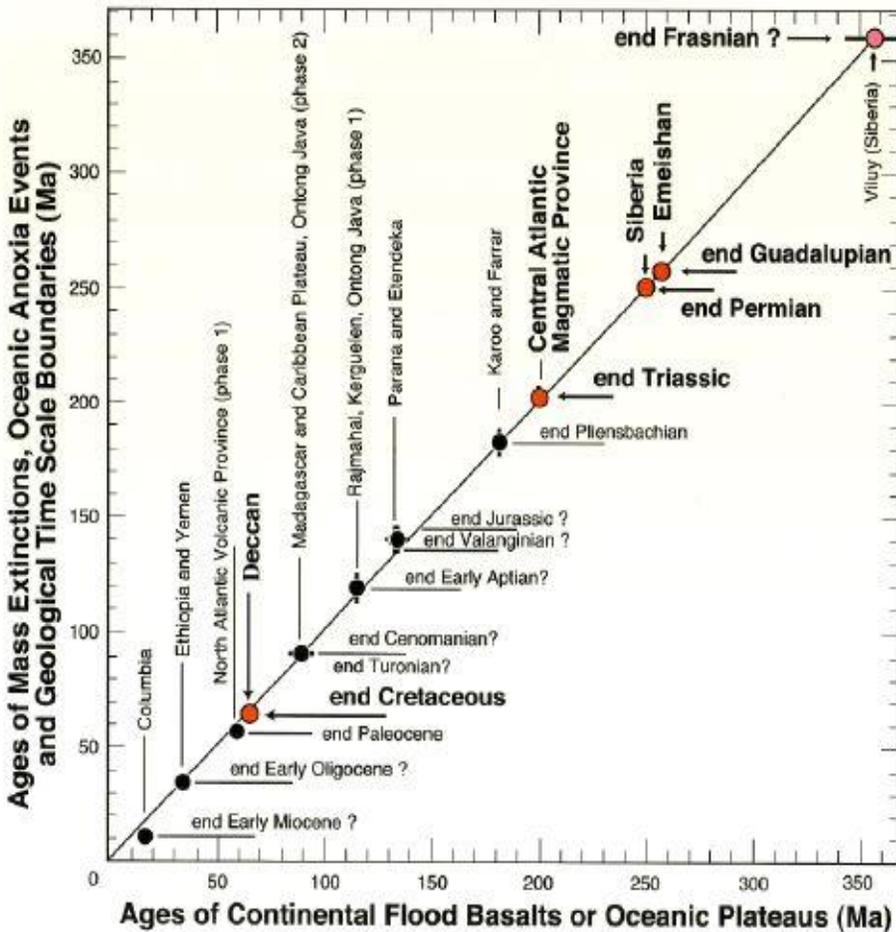
Explain calderas and the size of volcanic eruptions; Long Valley caldera and Yellowstone. Mention flood basalts and the Siberian Traps with 1-4 million km³ of lava.



Courtesy of the [U.S. Geological Survey](https://www.usgs.gov/). Image in the public domain.



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Courtesy of Elsevier, Inc., <http://www.sciencedirect.com>. Used with permission. Source: Courtillot, Vincent E., and Paul R. Renne. "On the Ages of Flood Basalt Events." *Comptes Rendus Geoscience* 335, no. 1 (2003): 113-40.

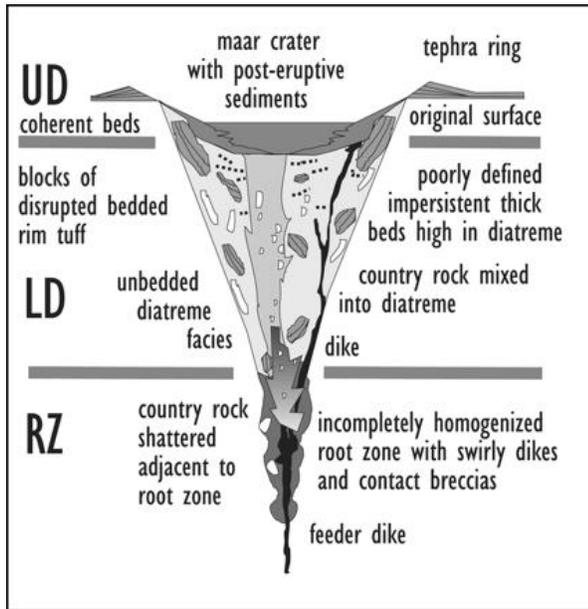
Eruption style and volcano shape

Shield volcanoes, e.g. Hawaii. Large areal extent.

Stratovolcano: Mt St Helens - mix of explosive eruptions and lava flows.

Cones: small eruptions usually of relative high viscosity magma

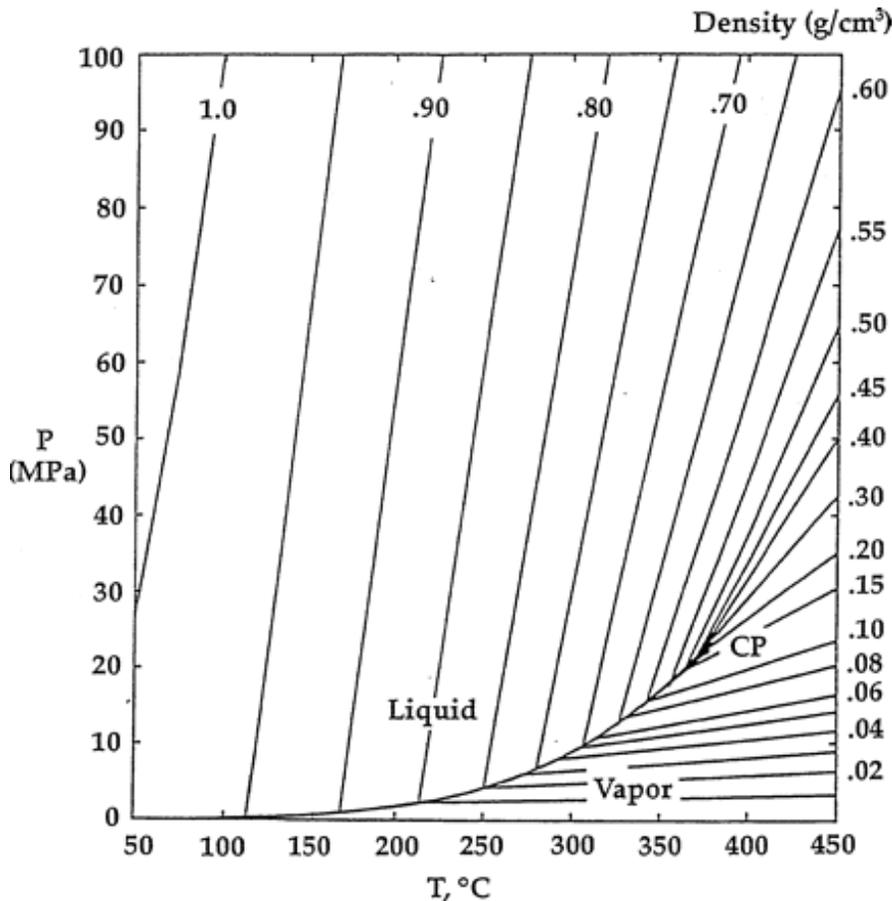
Special type of eruption: Phreatomagmatic



Courtesy of Geological Society of America. Used with permission.

Source: White, J. D. L., and M. K. McClintock. "Immense Vent Complex Marks Flood-basalt Eruption in a Wet, Failed Rift: Coombs Hills, Antarctica." *Geology* 29, no. 10 (2001): 935-8.

Food for thought: since interaction with water triggers explosive eruption why don't we generally see explosive eruptions along the oceanic ridges?



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