



Meccanismi e dinamiche eruttive

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- Una eruzione puo' essere vista come una successione di processi:
 - Risalita del magma
 - Dispersione in atmosfera e sulla superficie
 - Deposizione

Questi processi sono fortemente correlati

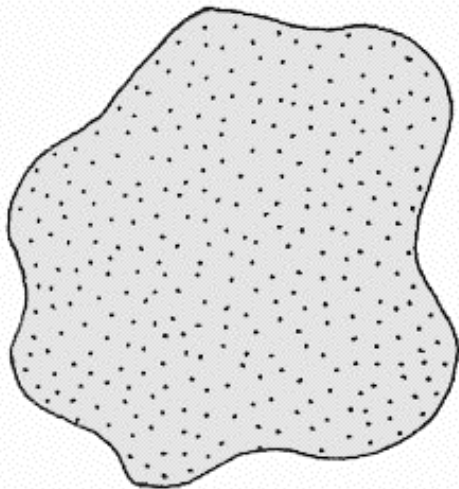
Controllo importante di composizione, reologia e contenuto in volatili

Il magma

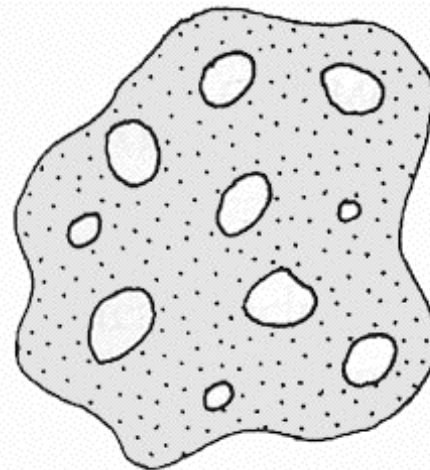
- Liquido multifase, multicomponente
- Composizione variabile
- Costituenti principali
 - (Si, O, Al, Ca, Mg, Fe, Na, K, Ti, P, espressi in ossidi)
- Componenti volatili (H₂O, CO₂, S, Cl, F)

I volatili magmatici

- Concetti chiave:
 - I volatili possono essere disciolti (in soluzione) nel fuso magmatico
 - I volatili possono essere presenti come fase essolta dal fuso (sotto forma di bolle)



Single-phase system
Melt only that
generally contains
dissolved volatiles



Two-phase system
Melt plus bubbles
of volatile fluid

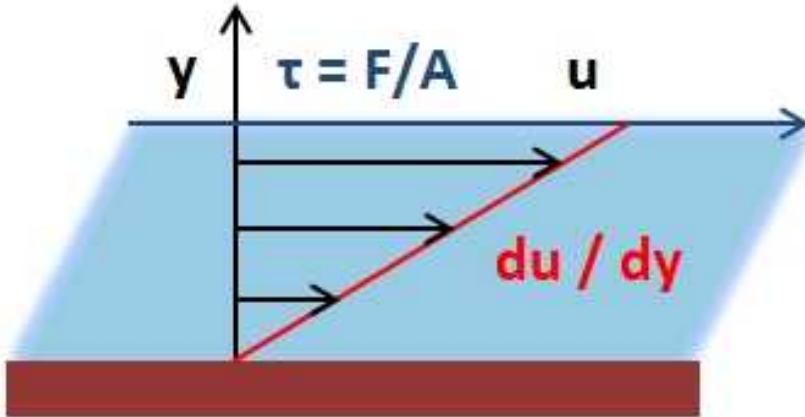
I parametri fondamentali

- Viscosita'
 - Resistenza di un fluido a deformarsi

Dipende da:

- Composizione
- Volatili
- Temperatura
- Contenuo in bolle e cristalli

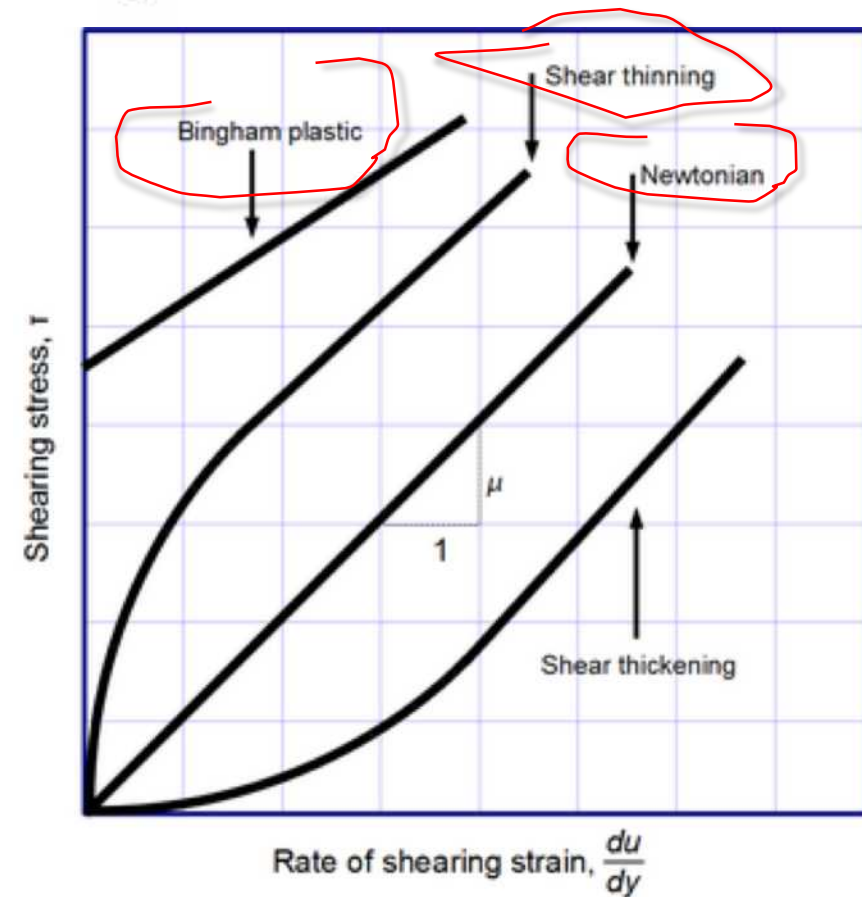
Viscosita' (tangenziale) η



$$\frac{F}{A} = \tau = \eta \frac{du}{dy}$$

Resistenza di una sostanza a deformarsi sotto l'azione di uno stress di taglio

Tipi di fluido



Valori tipici di viscosita' (Pa s)

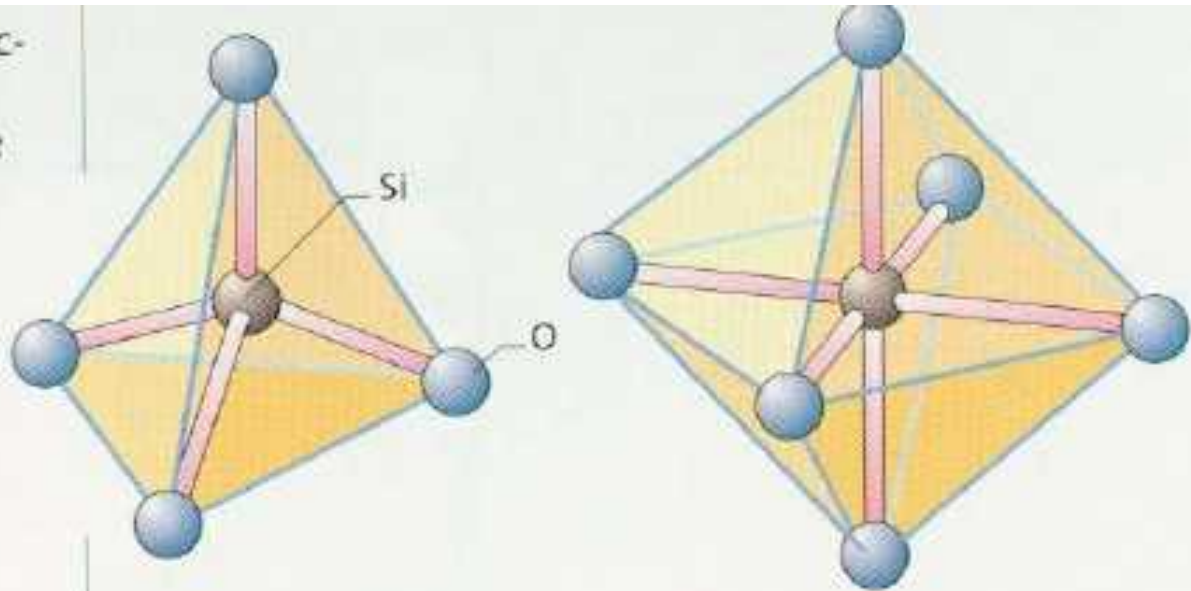
Aria	10^{-5}
Acqua	0.01
Olio/miele	1
basalto	100
andesite	10^4
Riolite (5% H ₂ O)	10^5
Riolite (anidra, 800°C)	10^{11}
Mantello astenosf.	10^{18}

Viscosita' dei magmi

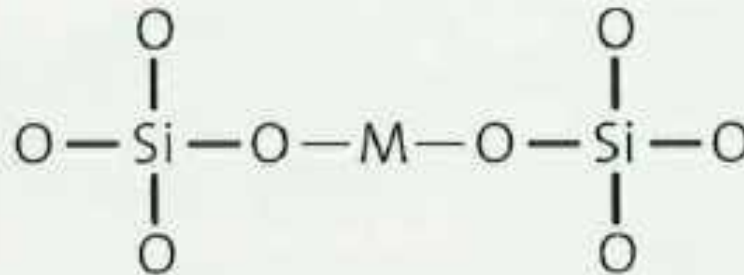
- La viscosita' di una magma e' funzione di:
 - Composizione
 - Temperatura
 - Contenuto in volatili
 - Contenuto in cristalli
 - Contenuto in bolle
 - Pressione

Viscosita' dei fusi silicatici

► Fig. 4.8. The basic structure of a silicate melt (magma) and that of the most common silicate minerals in the Earth's crust and Earth's mantle are the SiO_4 tetrahedron and the SiO_6 octahedron

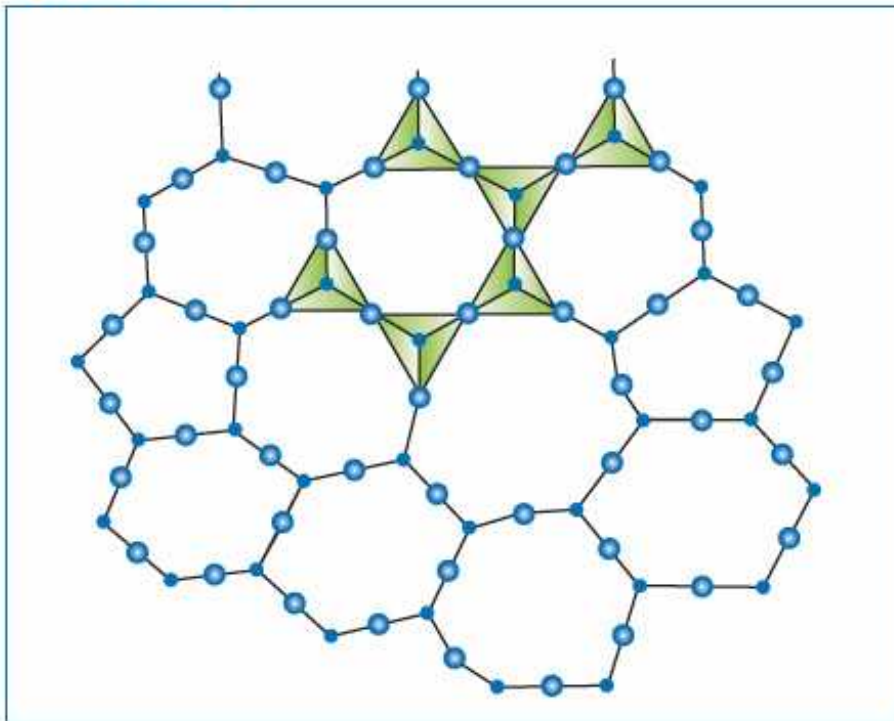


► Fig. 4.9. The viscosity of a silicate melt is largely determined by the contrast between the strong covalent Si-O bonds and the weaker ionic O-M bonds

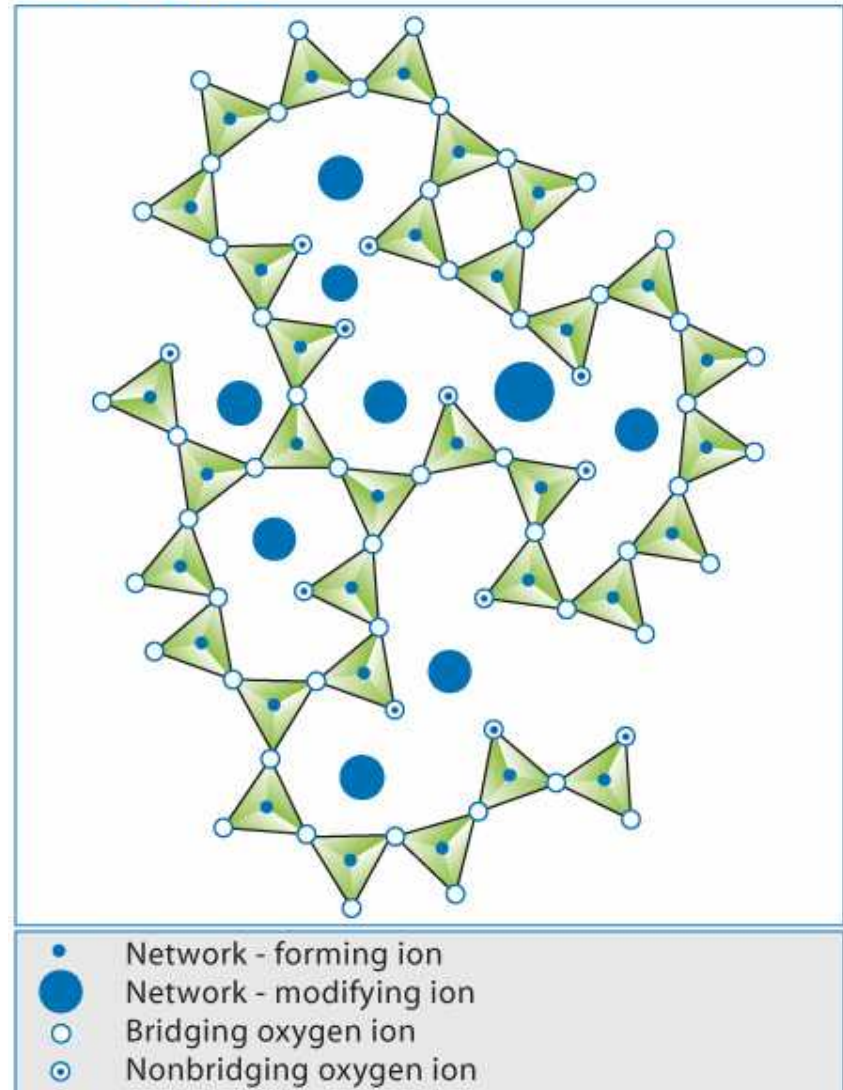


Viscosita' dei fusi silicatici

PURE SILICA

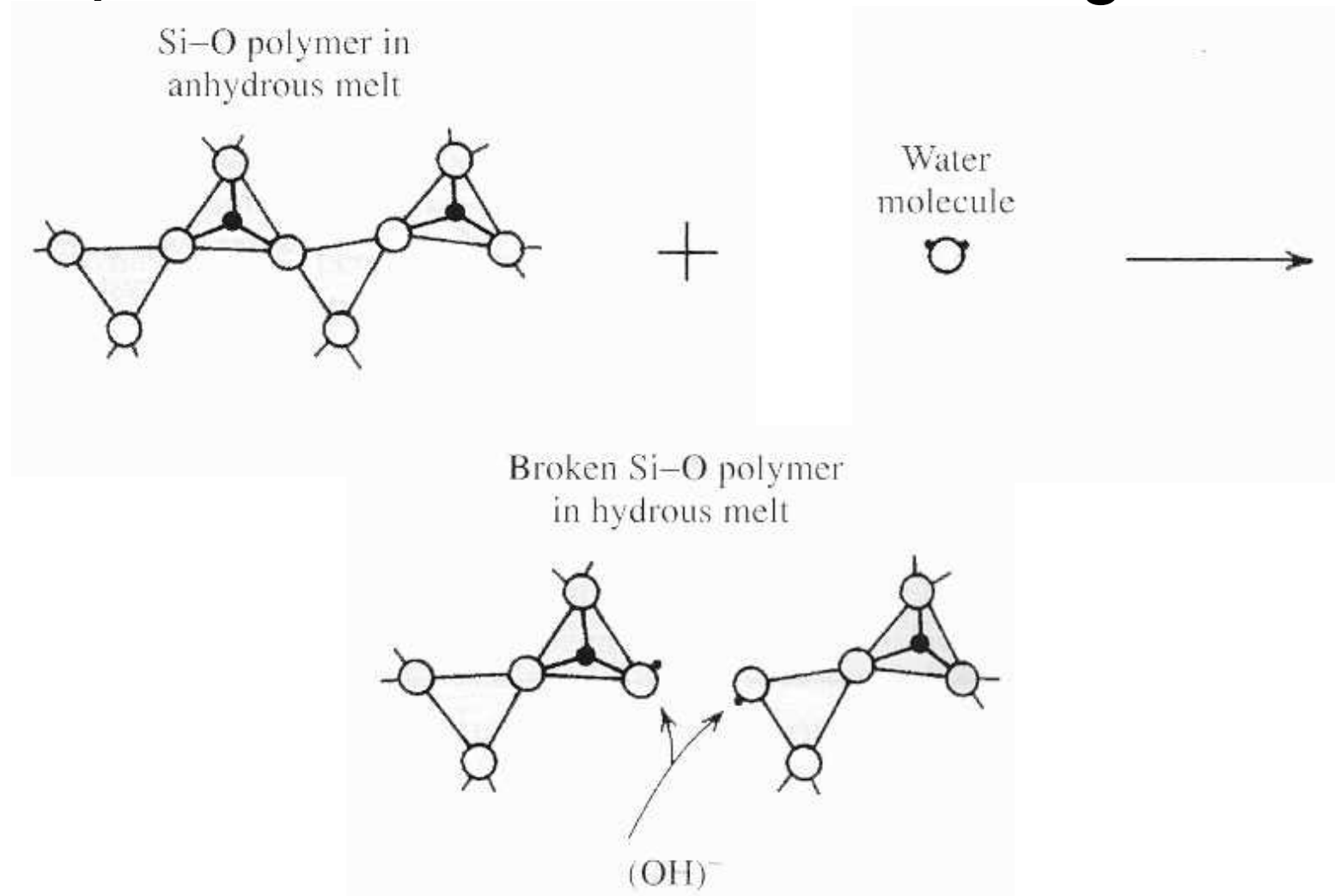


SILICATE MELT

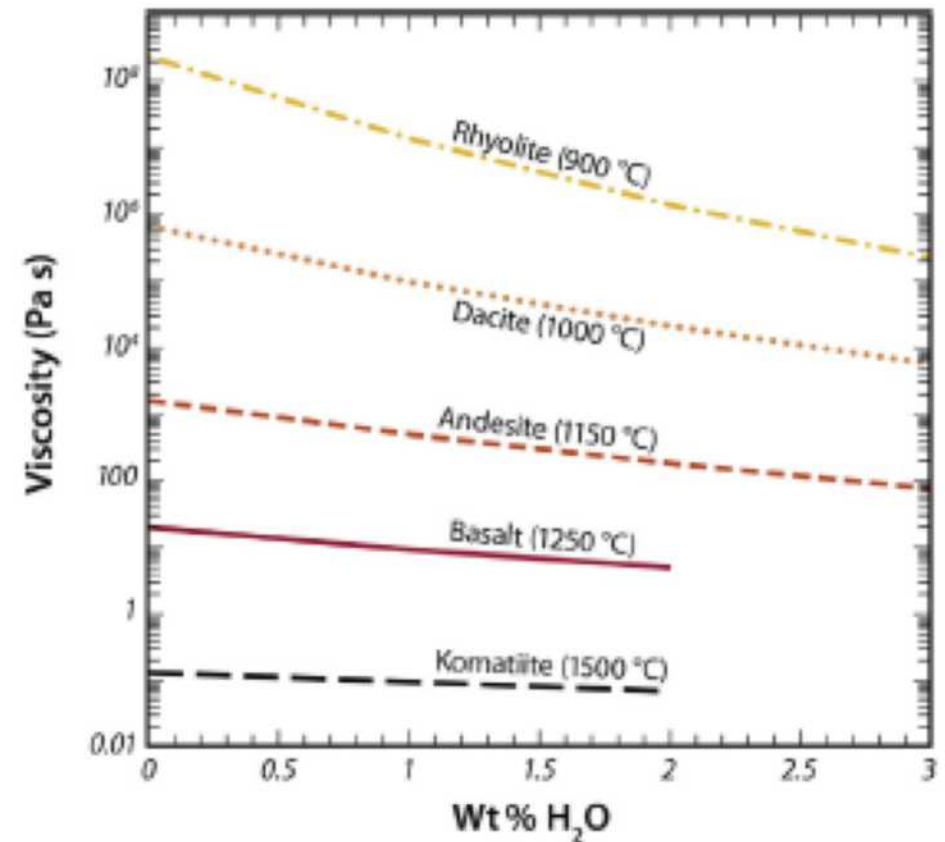
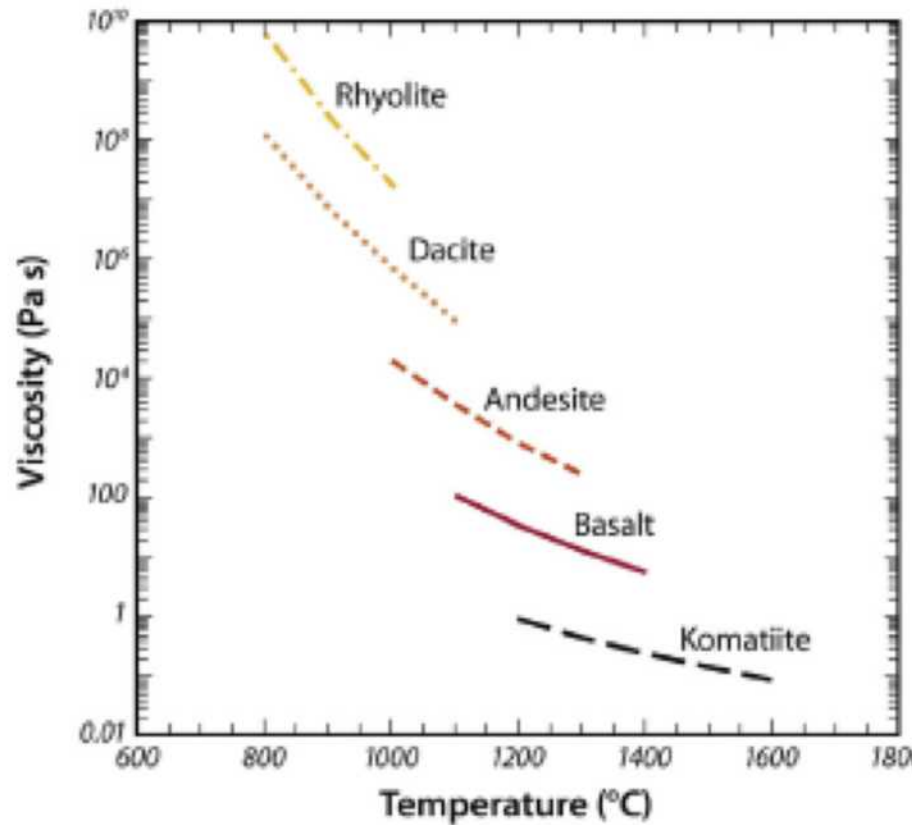


Viscosita' : ruolo dei volatili

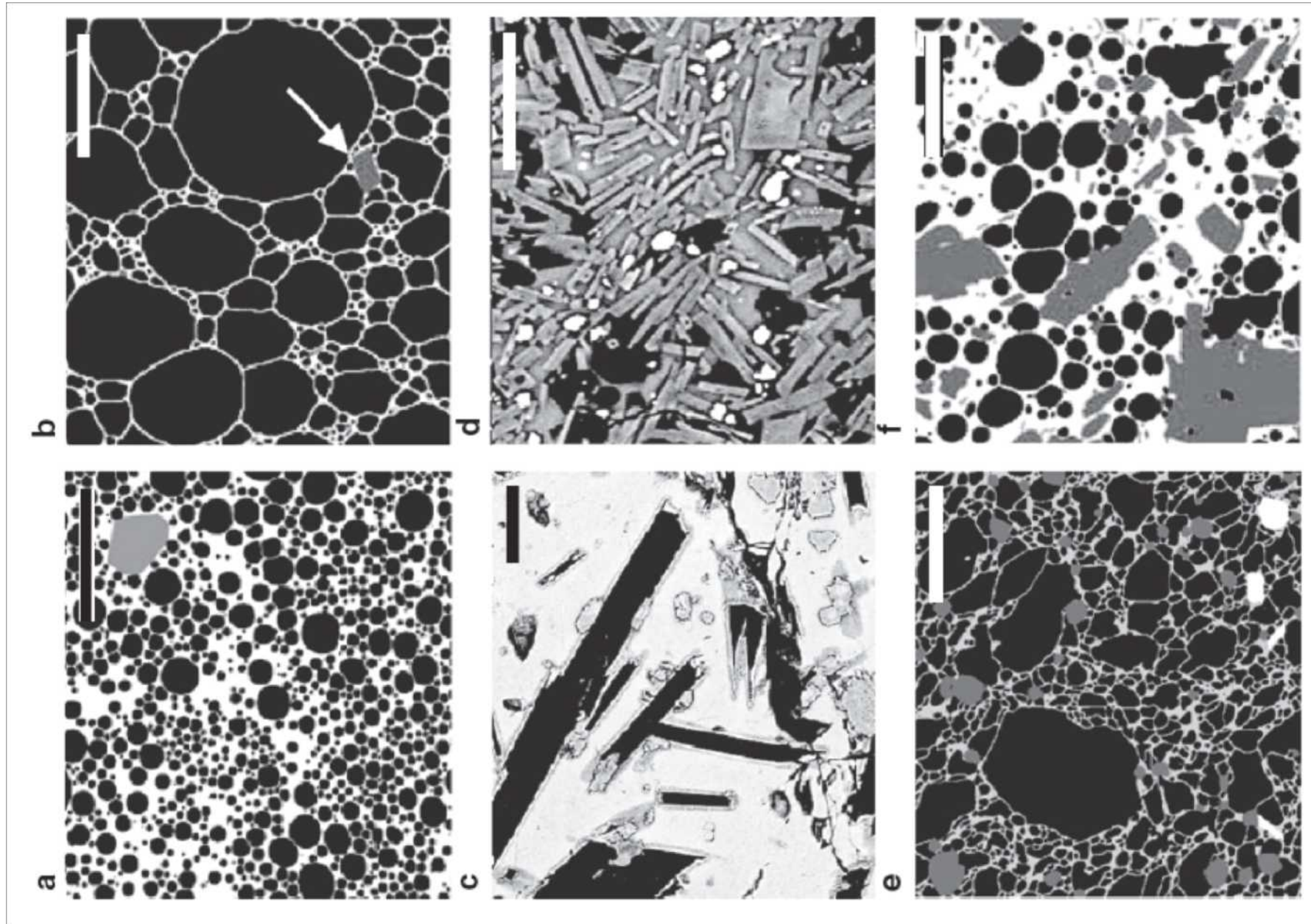
- Depolimerizzazione del fuso magmatico



- Effetto di temperatura e contenuto in H₂O sulla viscosita' di un fuso magmatico

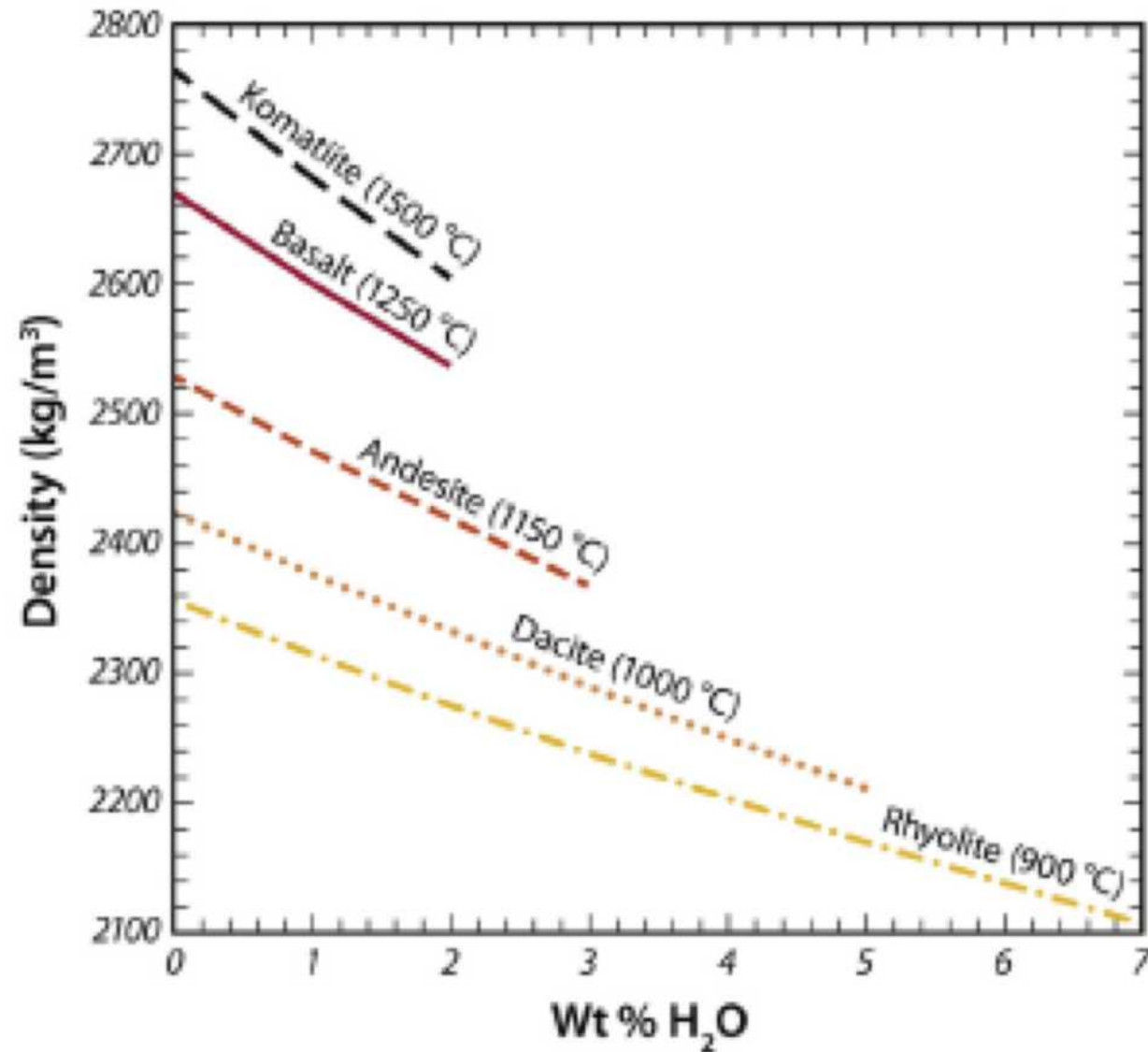


Effetto di cristalli e bolle sulla viscosita' di un fuso magmatico



Altri parametri

- Densita'



I volatili magmatici: solubilità

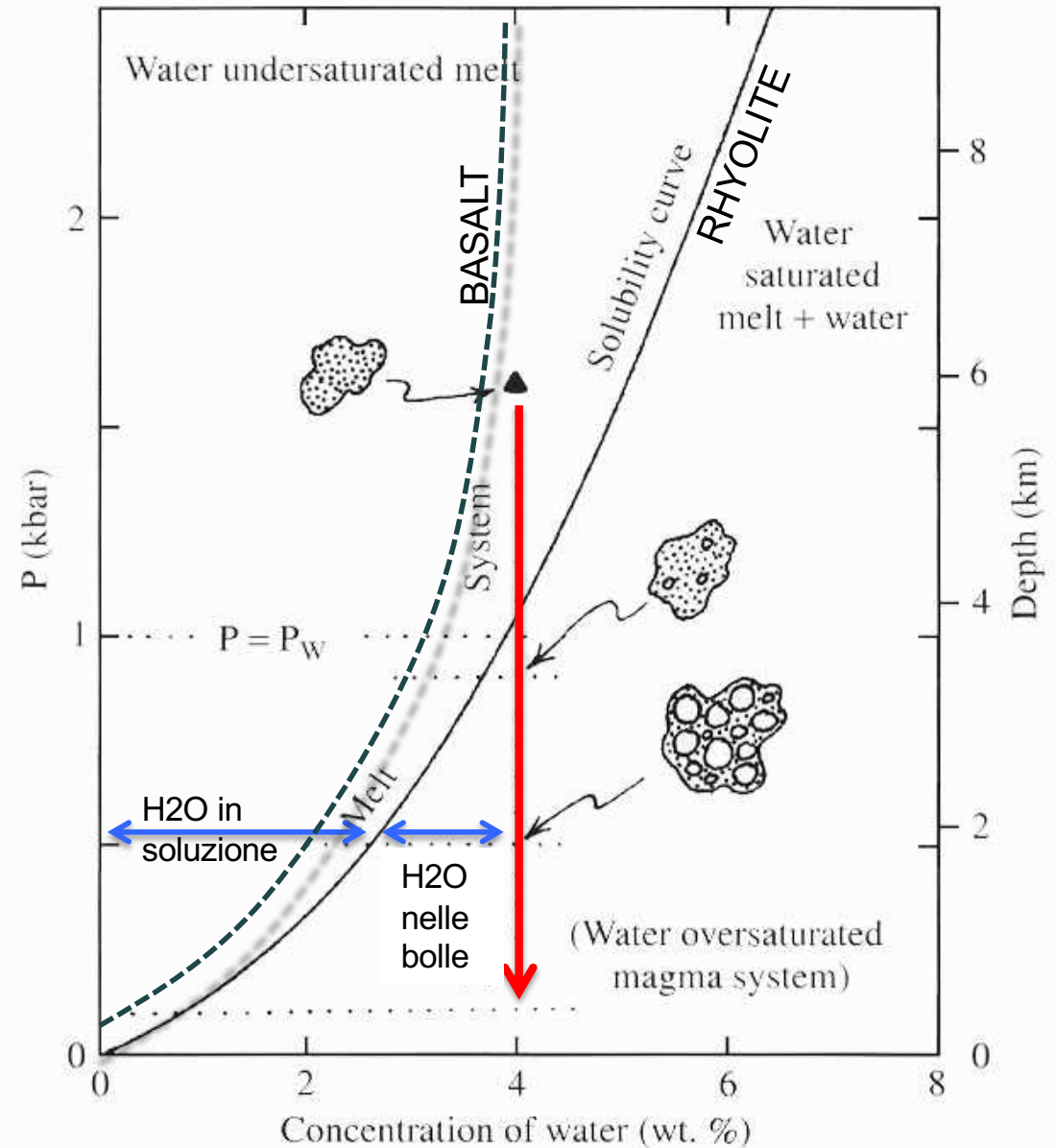
La ***solubilità*** di un componente volatile in un magma rappresenta la massima quantità di quel componente che può essere mantenuta in soluzione nel magma a quelle condizioni di P e T

La solubilità è funzione di:

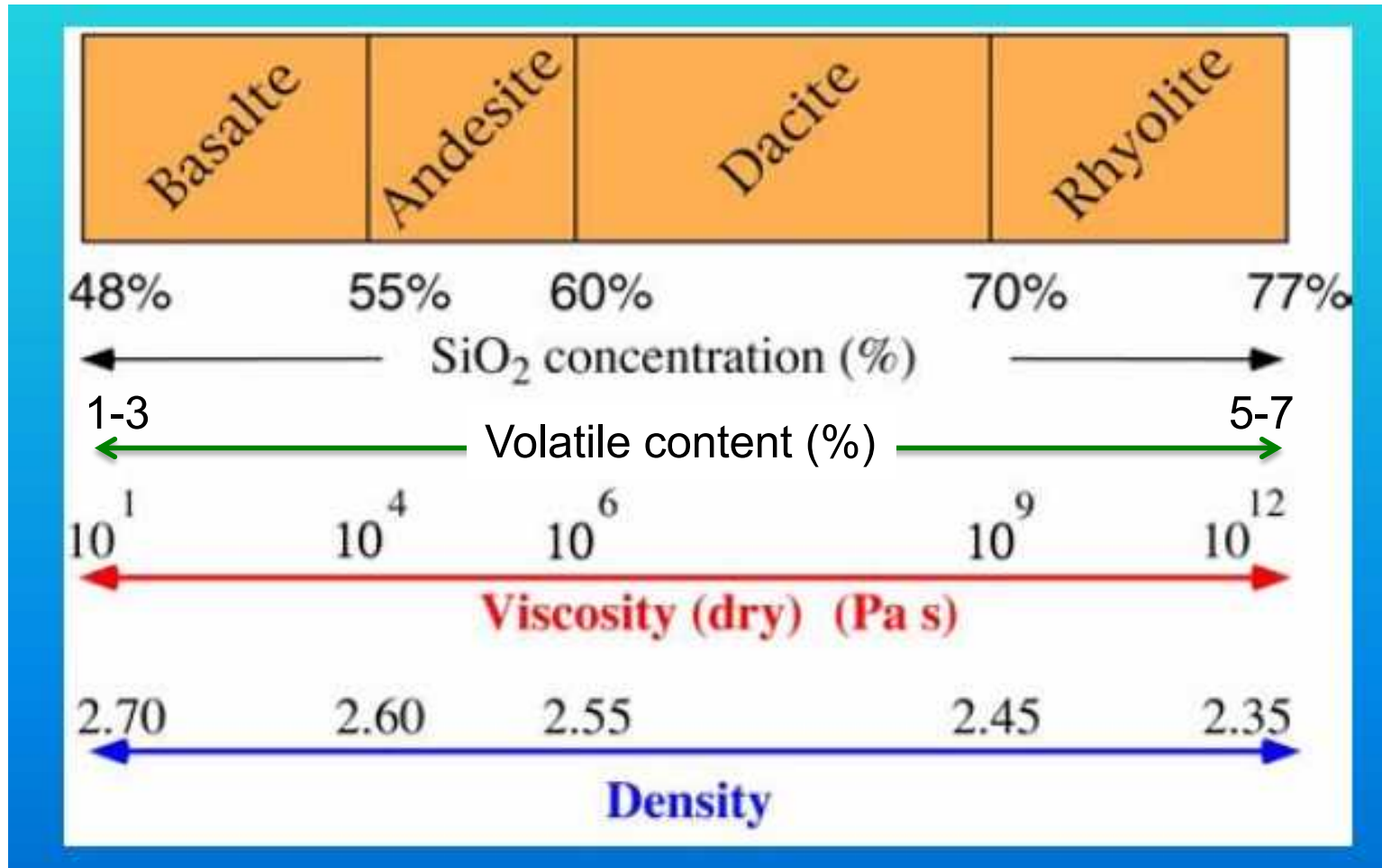
- Tipo del componente volatile (H₂O, CO₂, S, Cl, F)
- Presenza di vari componenti volatili
- Pressione
- Temperatura
- Composizione del magma

I volatili magmatici

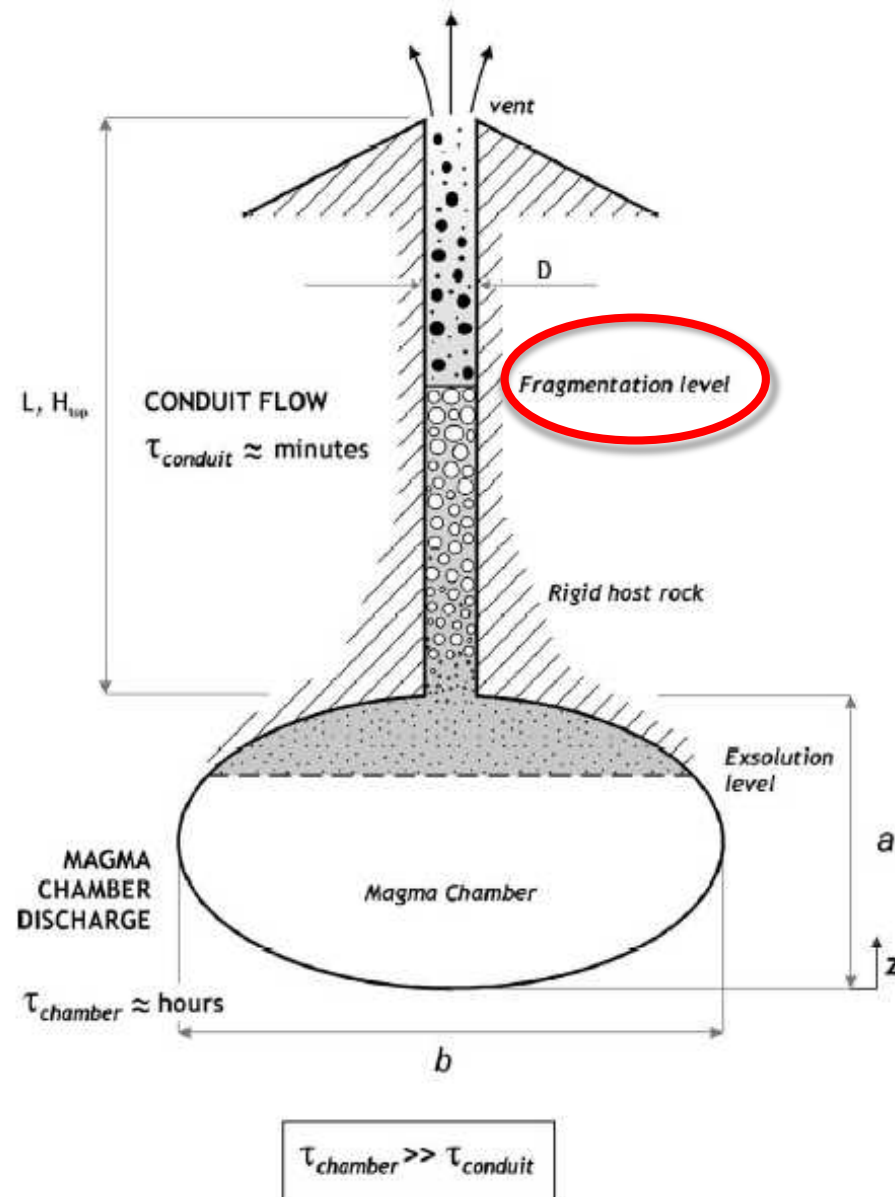
- Decompressione (risalita) di un magma ricco in volatili



I parametri fondamentali



Flusso in condotti



Vulcanismo esplosivo

- Lo stile di attivita' e' fortemente correlato a:
 - reologia (composizione, temperatura, cristalli, bolle)
 - portata di massa dell'eruzione
 - grado di frammentazione

Bubbles drive explosive eruptions

If bubbles grow fast enough, the fluid breaks into fragments or drops

Acceleration of fluid to the surface

Volume increase

Bubble nucleation and growth

Pressure decrease



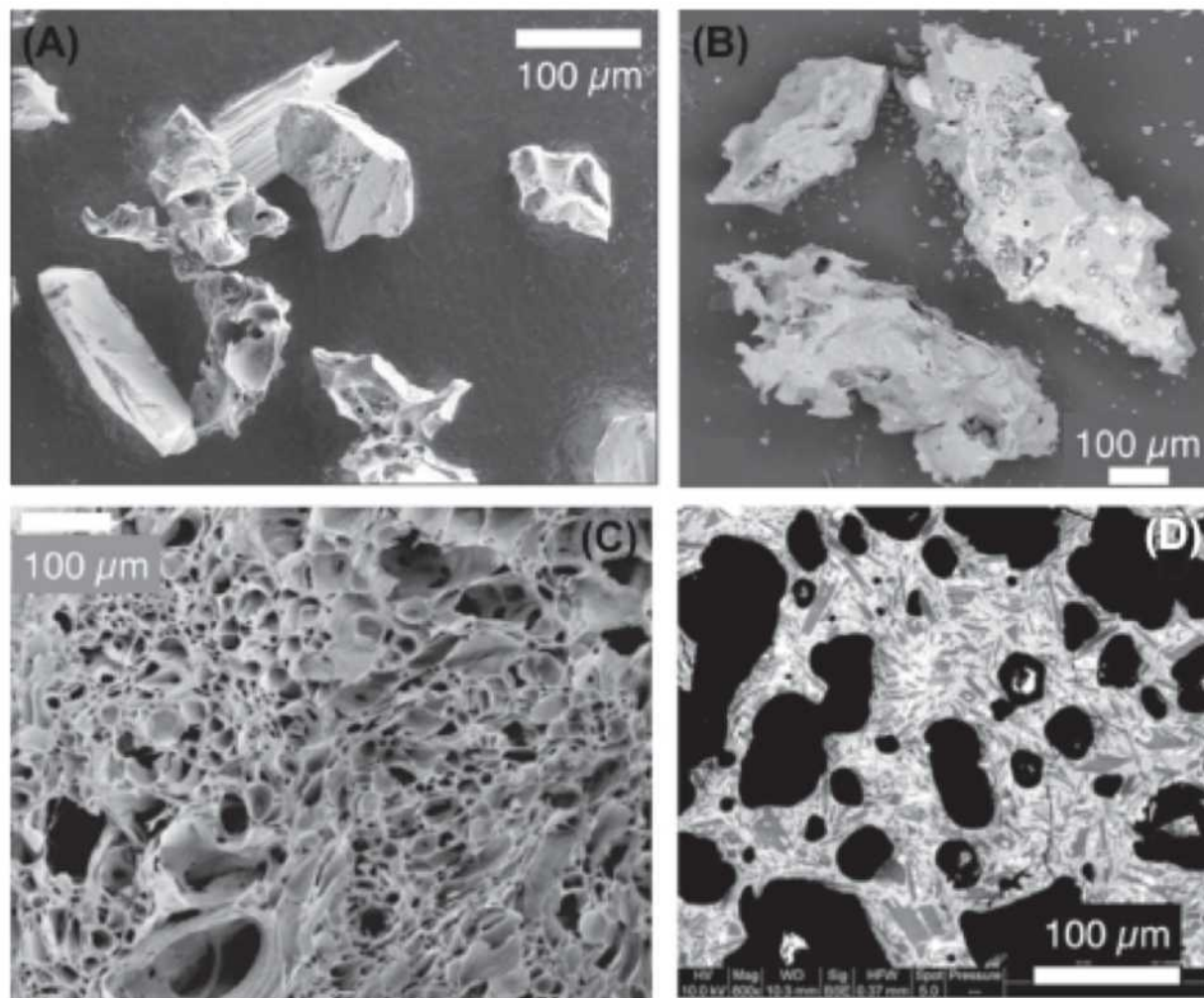
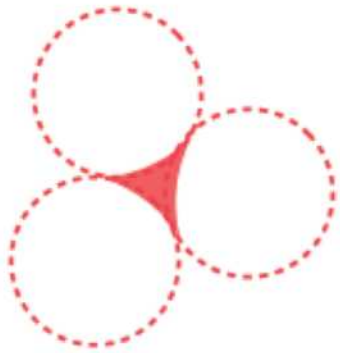


FIGURE 25.10 Electron microscope images of pyroclast textures; images in ((A)–(C)) are created using secondary electrons; image in (D) created using backscattered electrons. (A) Crystals (dense, with cleavage) and micropumice in ash fall from Mount St Helens, 1980; (B) experimentally generated pyroclasts from a sample of Unzen dacite with 36% connected porosity that was fragmented at 850 °C. The clasts are elongated and angular, showing clear evidence of brittle fragmentation (Photo courtesy of U. Kueppers, LMU); (C) “spherical” pumice clast interior from Mount St Helens, 1980; (D) scoria from 1974 eruption of Fuego, Guatemala; note low vesicularity and irregular shape of vesicles (black) and numerous plagioclase crystals (dark gray) in quenched glass (light gray).

FOAM DISINTEGRATION

Simple Model:

Magma decompression causes bubble to nucleate and grow



Bubbles expand until they interfere with each other; continued expansion will then cause bubble walls to rupture to produce volcanic ash



Vesiculation/acceleration

**Mount St. Helens,
WA**

brittle fragmentation



Tipo di attivita'

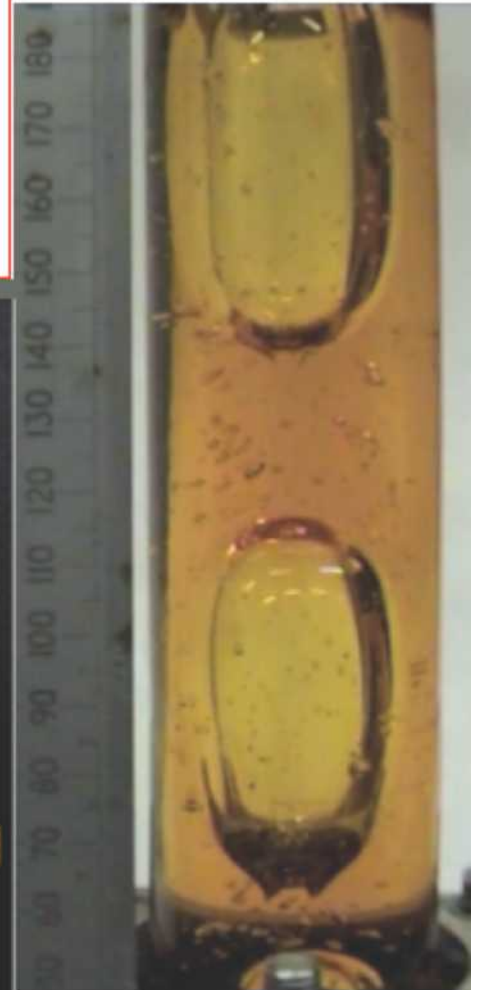
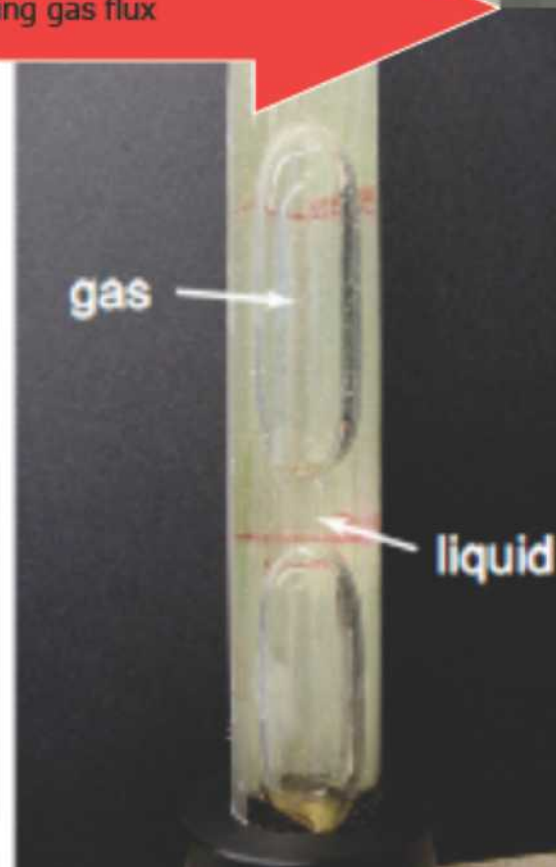
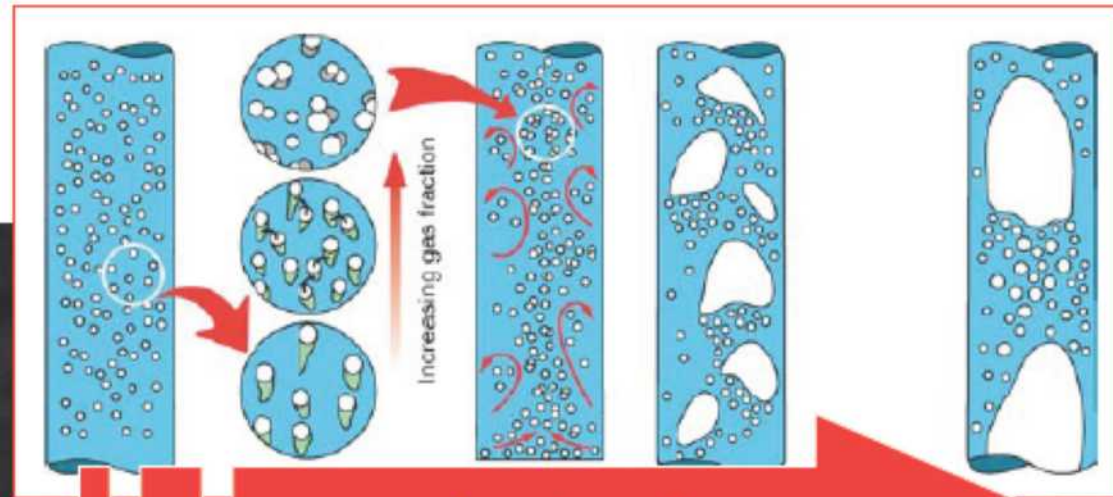
- Vulcanismo esplosivo vs. vulcanismo esplosivo
 - *SEPARAZIONE FASE GASSOSA DAL MAGMA*



1. Gas can move relative to magma

Bubbly

Slug



VULCANISMO EFFUSIVO

GENERALMENTE ASSOCIATE ATTIVITA' EFFUSIVA ED
ESPLOSIVA DI BASSA INTENSITA'



La colonna eruttiva

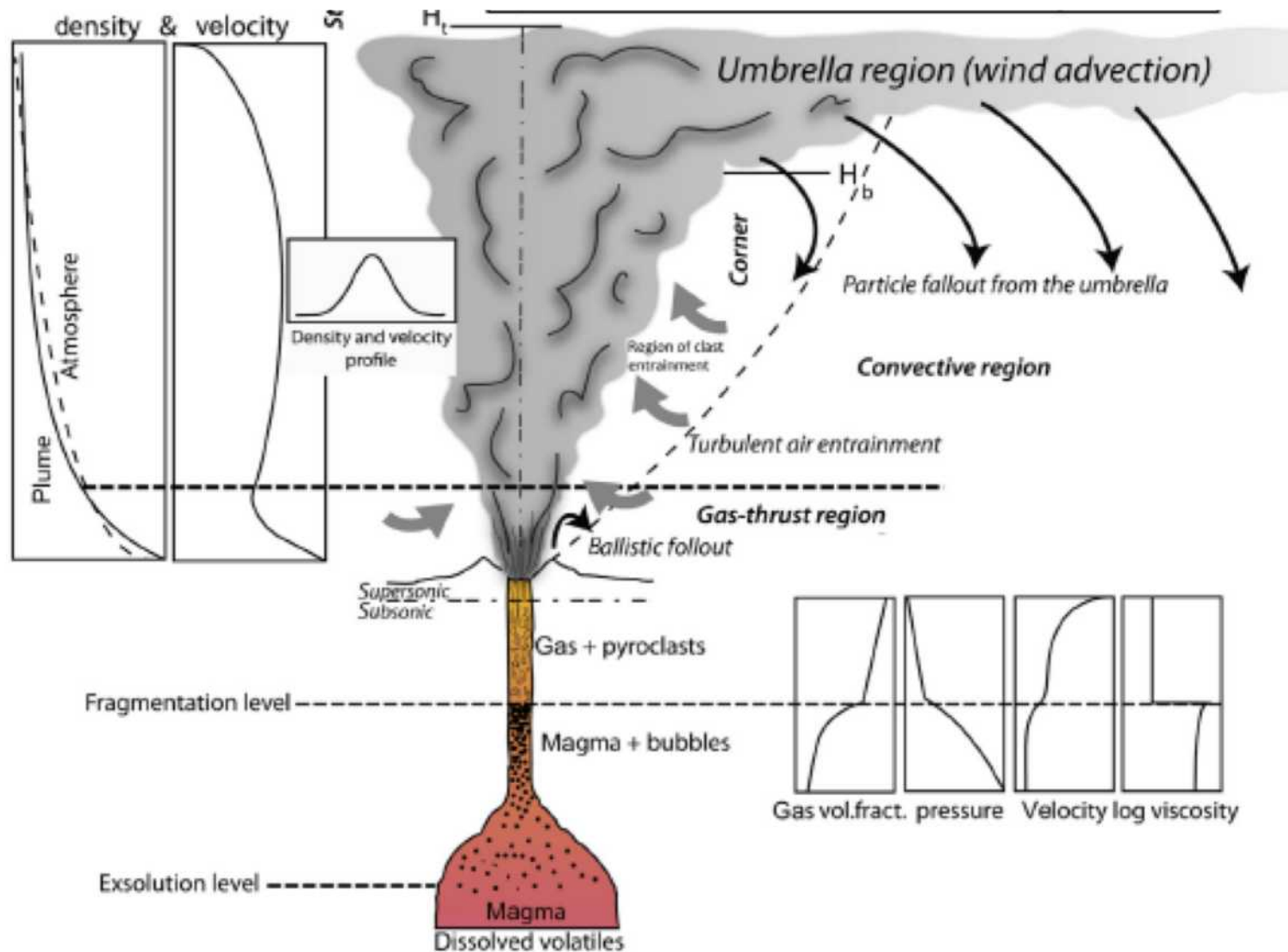
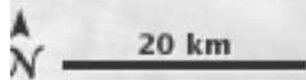


FIGURE 29.2 General scheme of eruptive regimes for a strong plume, and variation of physical parameters during plinian eruptions.

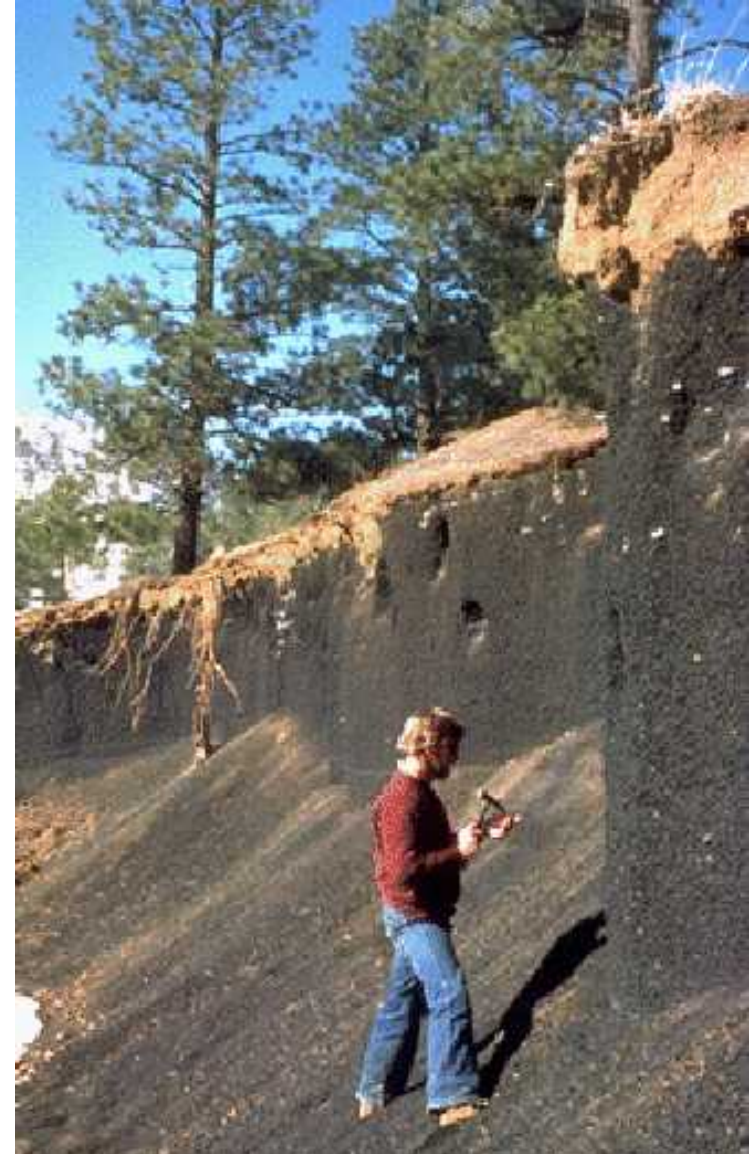




Puyehue-Cordón Caulle



Depositi di caduta



Il collasso della colonna eruttiva

Directed blast



Dome collapse



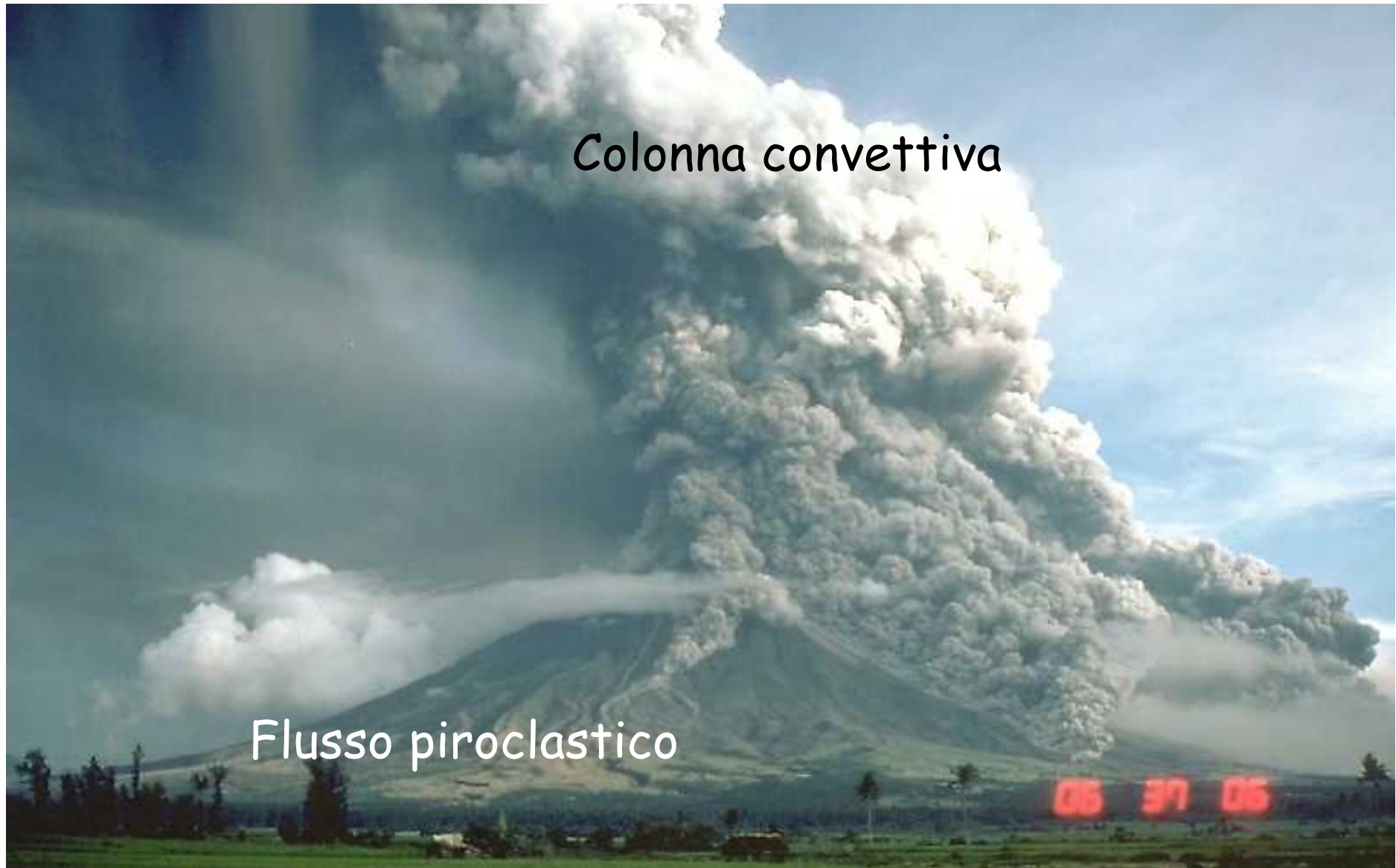
Boiling-over



Column or fountain collapse



Il collasso della colonna eruttiva

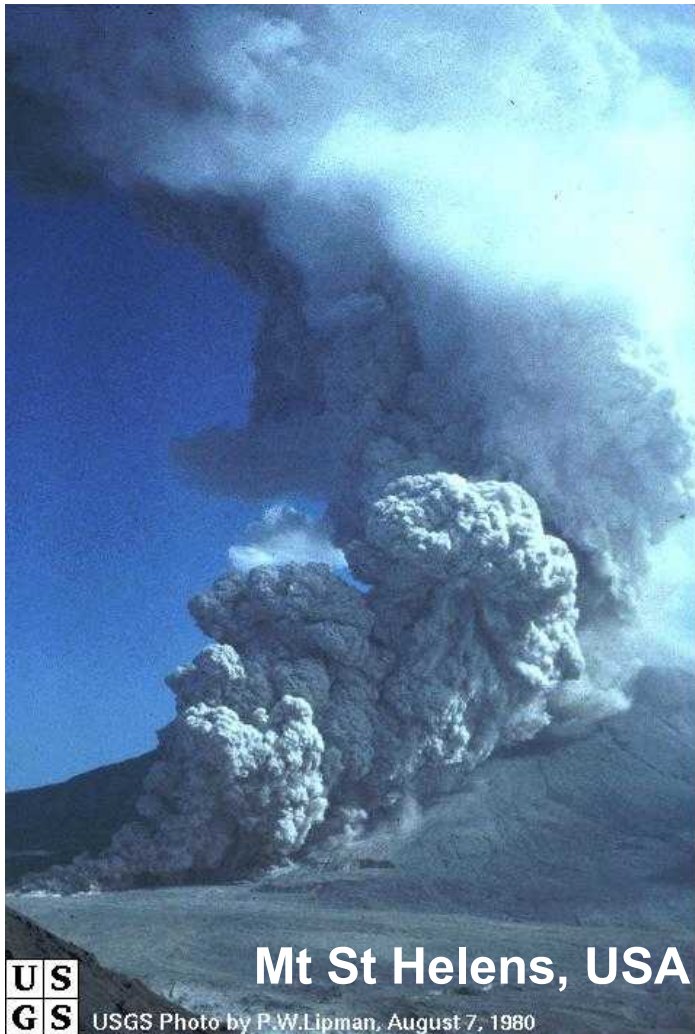


Colonna convettiva

Flusso piroclastico

Mayon (Filippine)

Flussi piroclastici

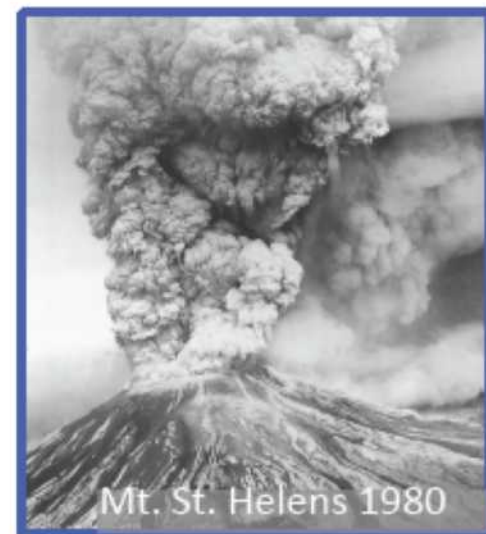


Depositi di flusso piroclastico

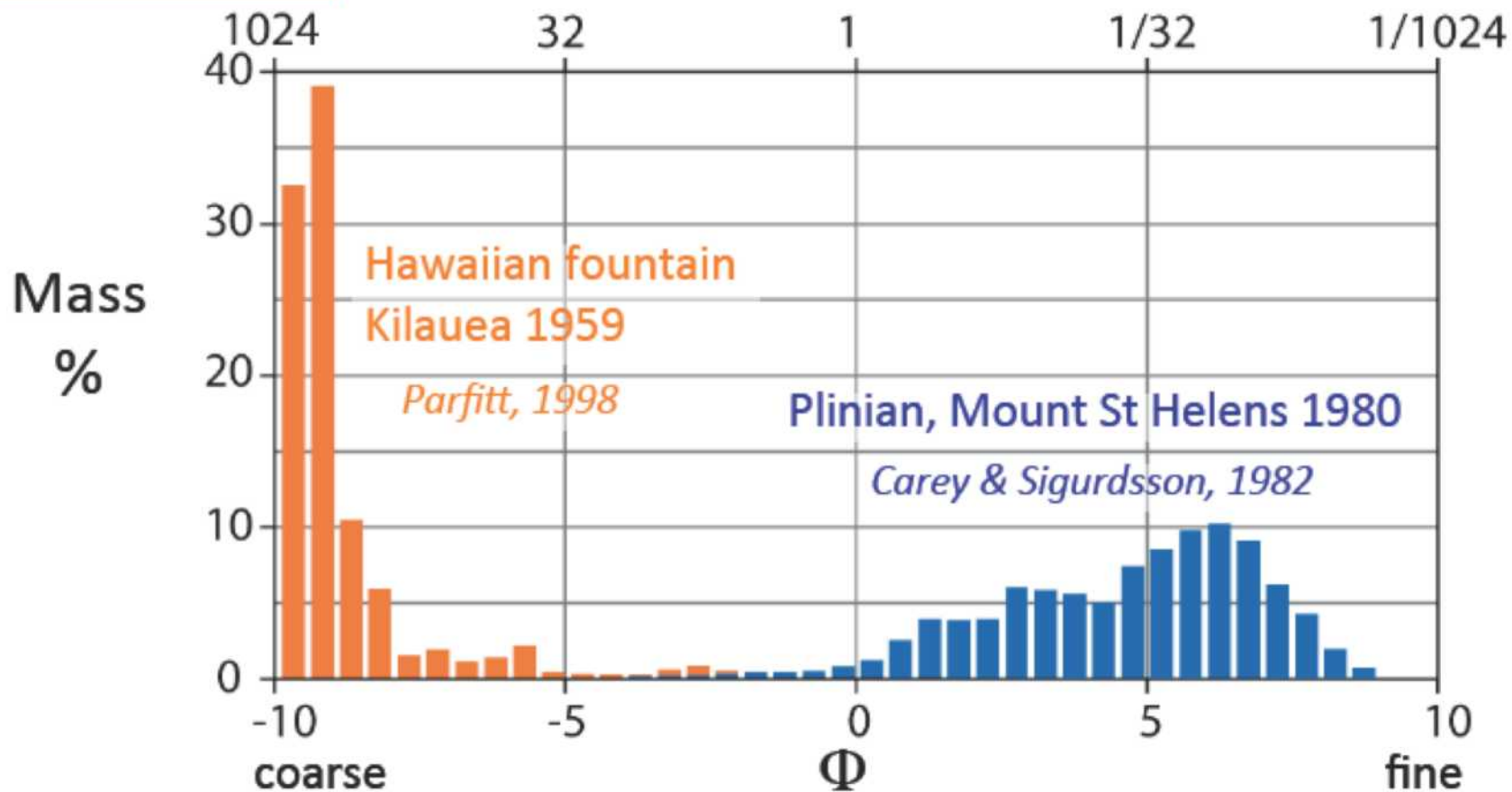




Fragmentation mechanism reflected in the total deposit grain size distribution

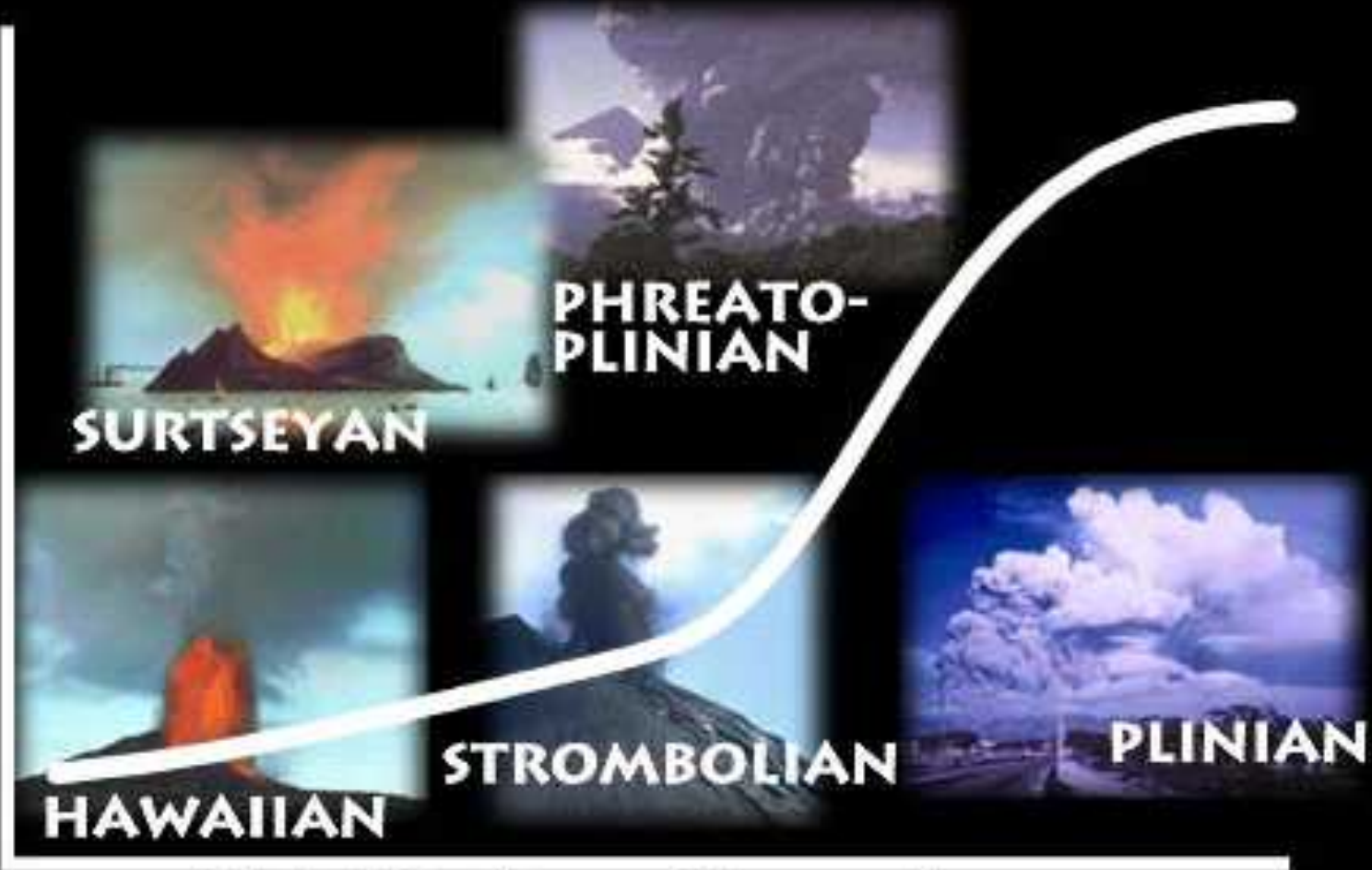


Diameter in mm = $2^{-\Phi}$



FRAMMENTAZIONE DEI PRODOTTI

Explosiveness ↑



Height of eruption column →

DISPERSIONE DEI PRODOTTI

Mafic

Violent
Strombolian



Vulcanian



Silicic



Hawaiian



Strombolian



Subplinian



Plinian

Eruzioni Hawaiane



- Etna, Italia, 2001



- Pu' u O' o, Hawaii, 1984

Eruzioni Stromboliane



- Stromboli, Italia, 2006

Eruzioni Stromboliane



- Stromboli, Italia, 2000

Eruzioni subPliniane



- Chaiten, Cile, 2008

Eruzioni Pliniane



- Lascar, Cile, 1993

Eruzioni Surtseyane



- Tonga, 2009

Eruzioni Vulcaniane



- Montserrat, West Indies, 2002

Eruzioni Vulcaniane



- Montserrat, West Indies, 2002

Eruzioni Freatiche



- Iwo Jima, Giappone, 2001