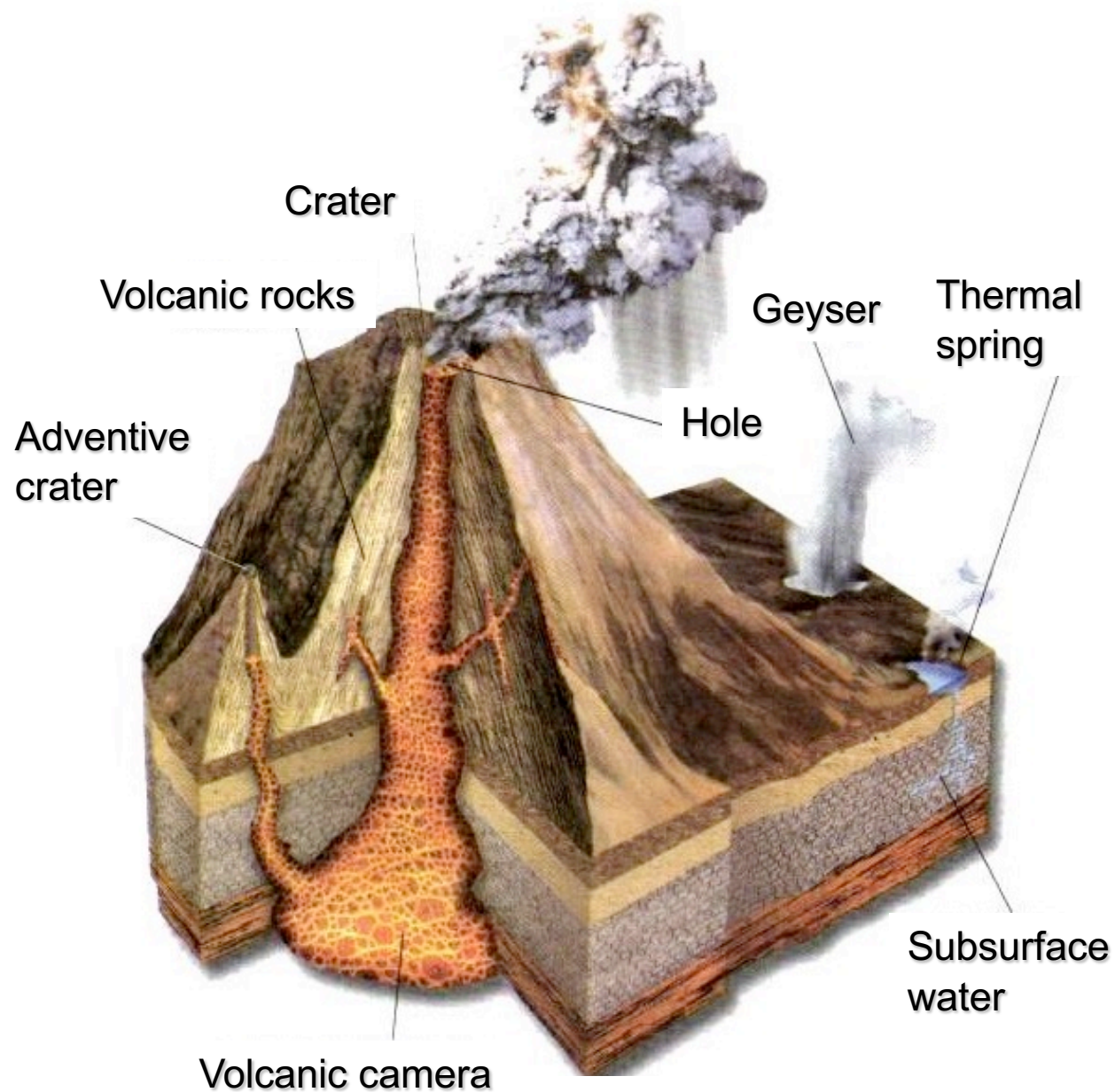


# **Genetic features of volcanic glasses of different composition**

**Vladislav Petrov**

**vlad243@mail.ru**

**Joint ICTP-IAEA International School on Nuclear Waste Vitrification**  
Abdus Salam International Centre for Theoretical Physics (ICTP)  
Trieste, Italy  
**23 - 27 September 2019**



**VOLCANISM** - volcanic eruption and magma outflow on the Earth's surface

Products of volcanism:

- ▶ Lava
- ▶ Volcanic gases
- ▶ Ash
- ▶ Volcanic bombs
- ▶ Pyroclastic masses

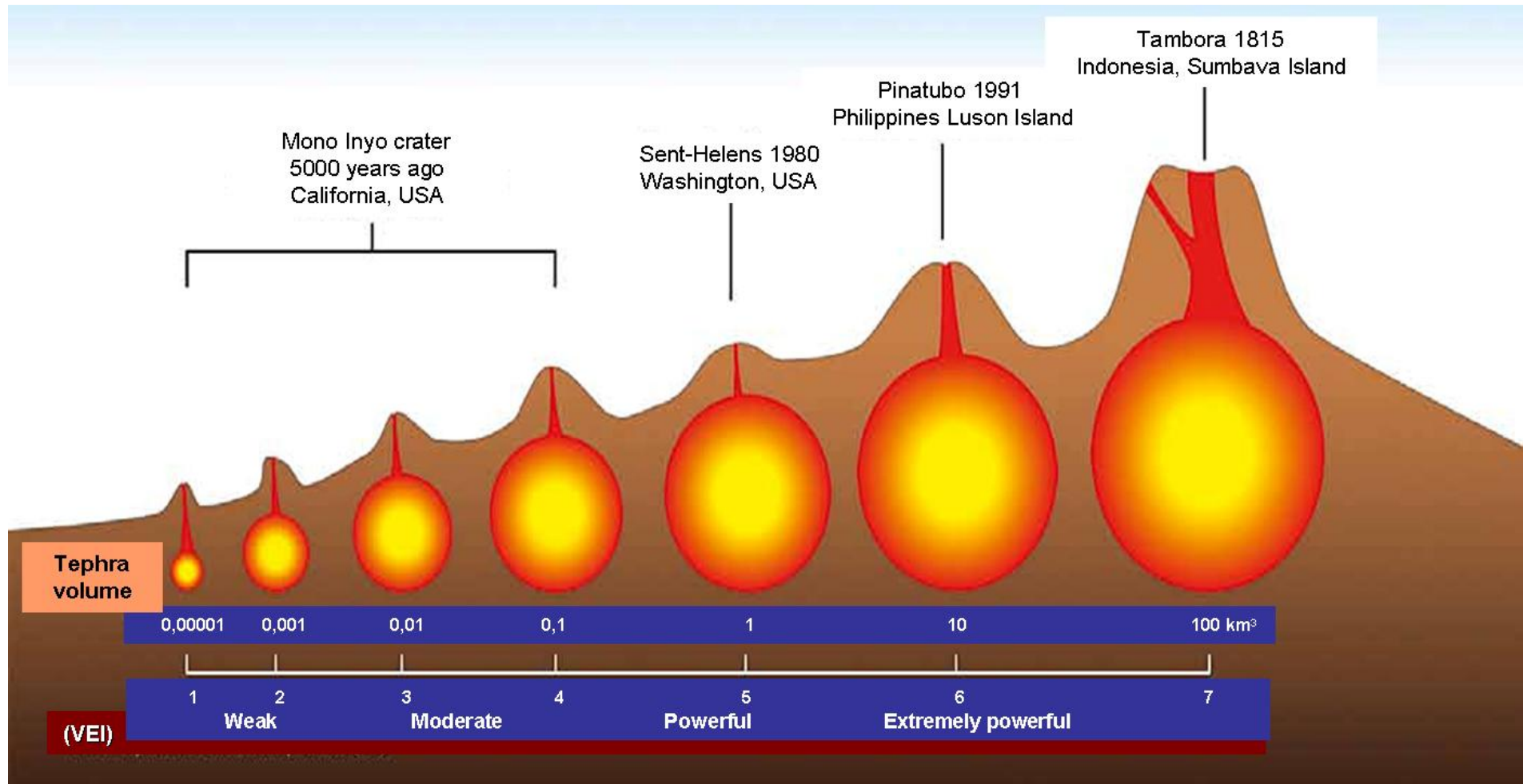
## Negative aspects of volcanism

| Number of deaths | Volcano                   | Year | Reason of death          | VEI |
|------------------|---------------------------|------|--------------------------|-----|
| 92,000           | Tambora, Indonesia        | 1815 | Hunger                   | 7   |
| 36,000           | Krakatoa, Indonesia       | 1883 | Tsunami                  | 6   |
| 29,000           | Mount Pelee, Mauritius    | 1902 | Pyroclastic flow         | 4   |
| 25,000           | Nevado del Ruiz, Colombia | 1985 | Mudflow                  | 3   |
| 14,300           | UeDzen, Japan             | 1792 | Tsunami                  | ?   |
| 9,350            | Laki, Iceland             | 1783 | Hunger                   | 6   |
| 5,110            | Kelud, Indonesia          | 1919 | Pyroclastic flow         | ?   |
| 4,011            | Galunggung, Indonesia     | 1882 | Mudflow                  | 5   |
| 3,500            | Vesuvio, Italy            | 1631 | Mud and Pyroclastic flow | ?   |
| 3,500            | Vesuvio, Italy            | 79   | Pyroclastic flow         | 5   |



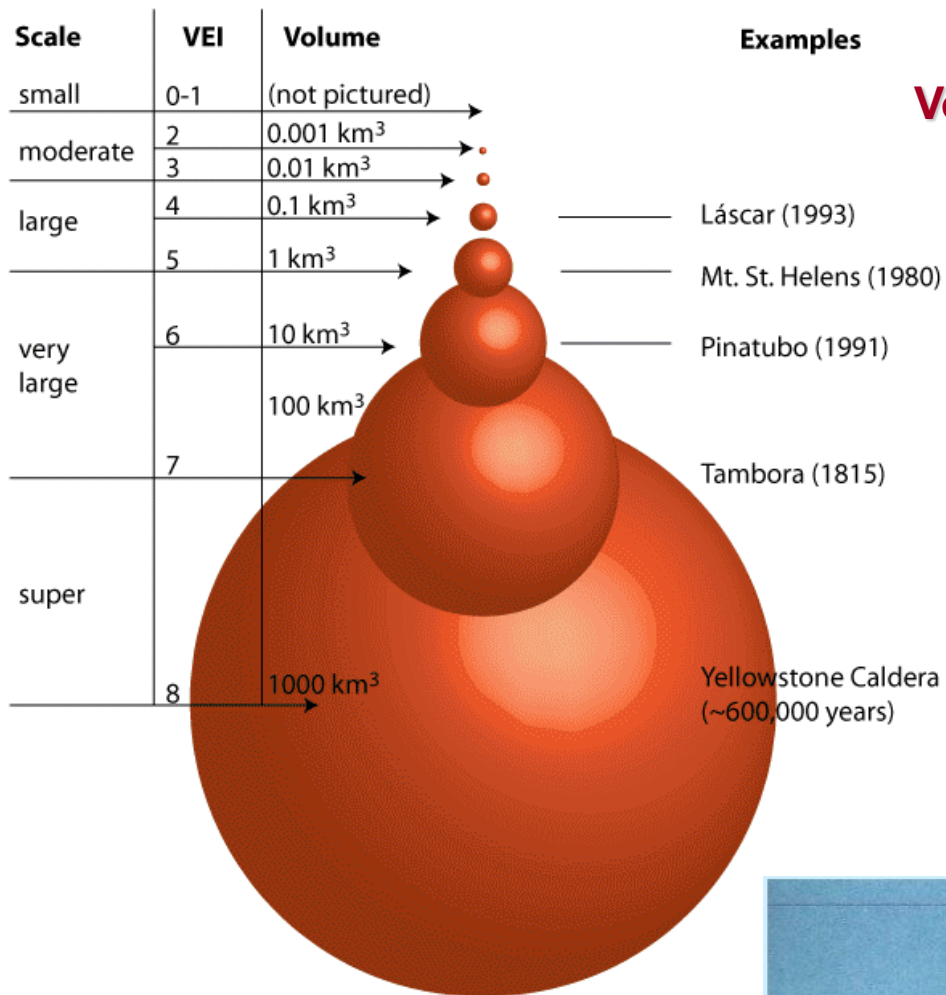


## Volcanic Explosivity Index (VEI)

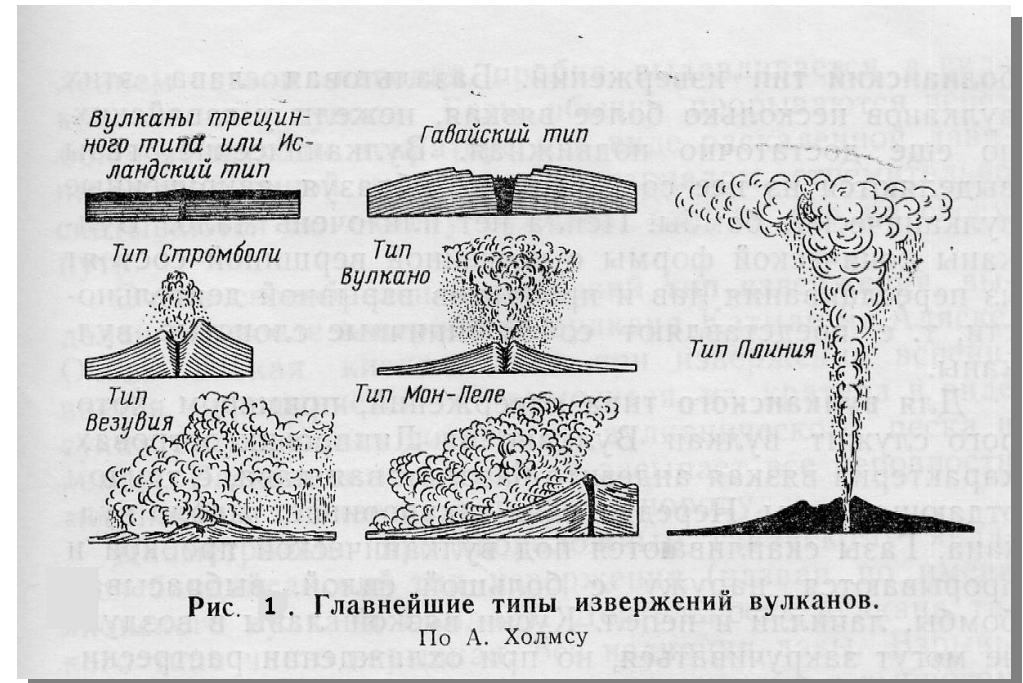


VEI is based on the volume of erupted products (tephra) and the height of the column of ash. Proposed by C.A. Newhall and S. Self (1982) to assess the impact of eruptions on the earth's atmosphere.





## Volcanic Explosivity Index and Explosion Types

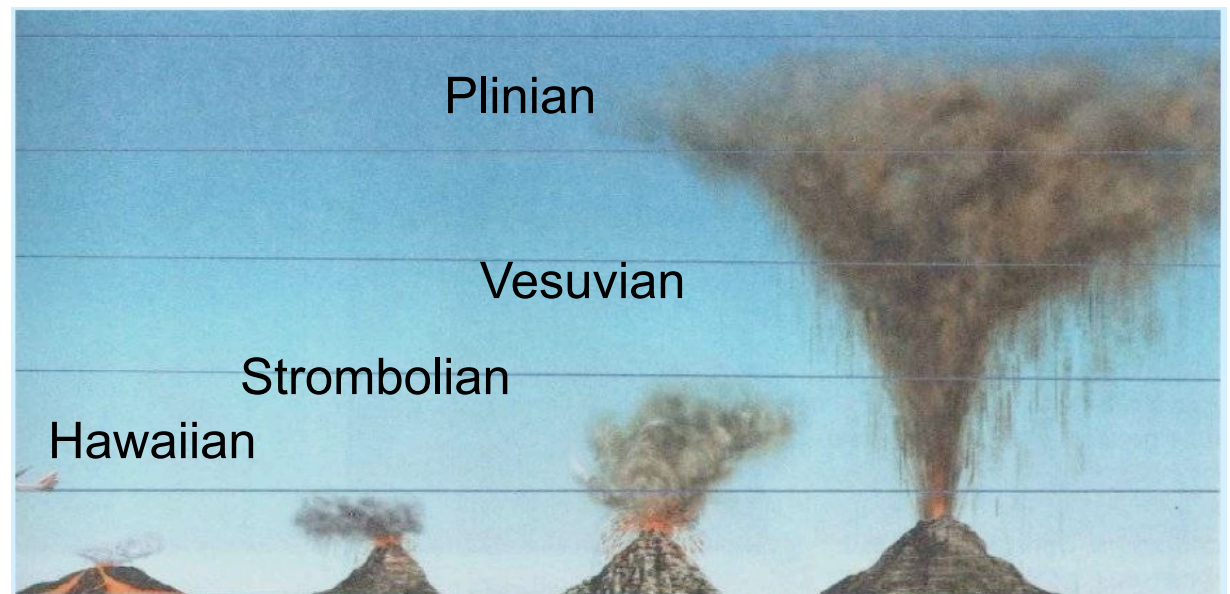


**Hawaiian** – calm outflow of lava

**Vesuvian** (vulcanic) – explosive eruption

**Plinian** – powerful explosive eruption of lava with huge volume of ash

**Peleian** – obelisk of viscous lava in the crater



# Volcano Explosivity Index

©Rob Gamesby  
<http://www.coolgeography.co.uk>

2

3

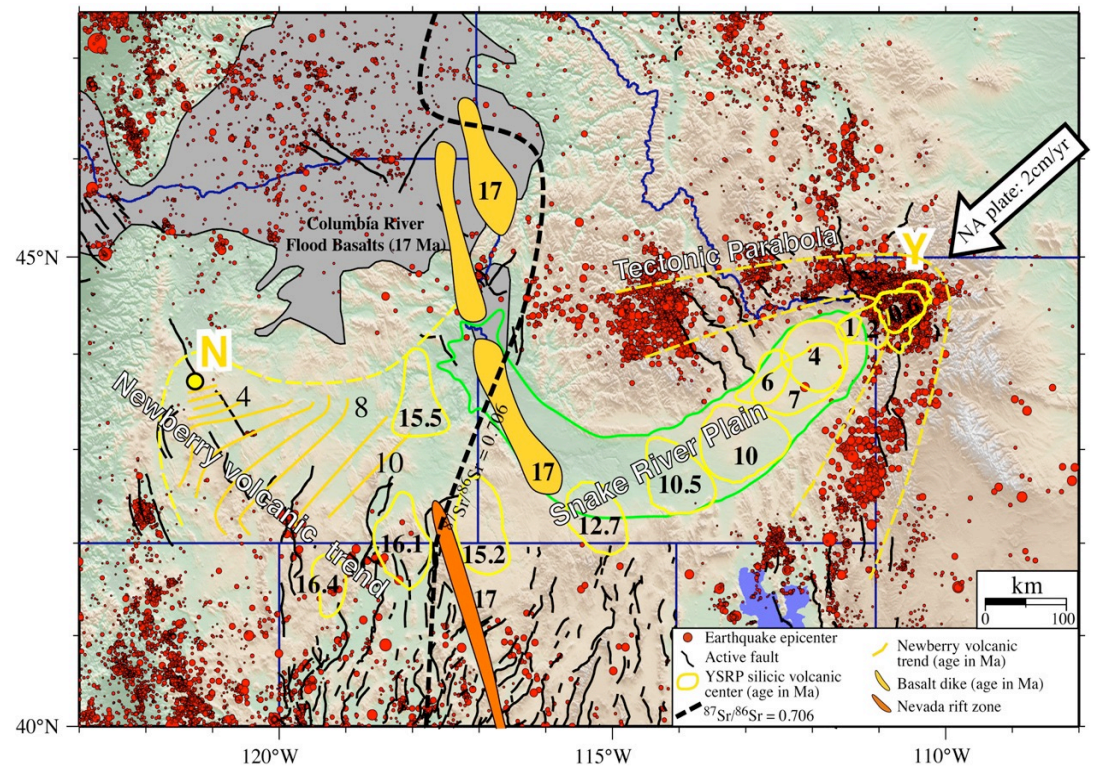
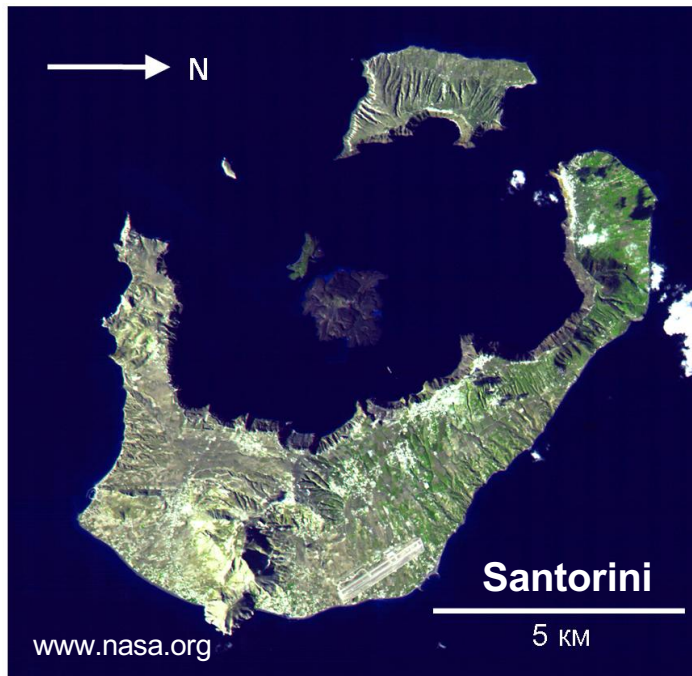
VEI 4

VEI 5

Boxes not proportional – just a visual indication that ejecta volume goes up by the power of 10 for each level of the VEI

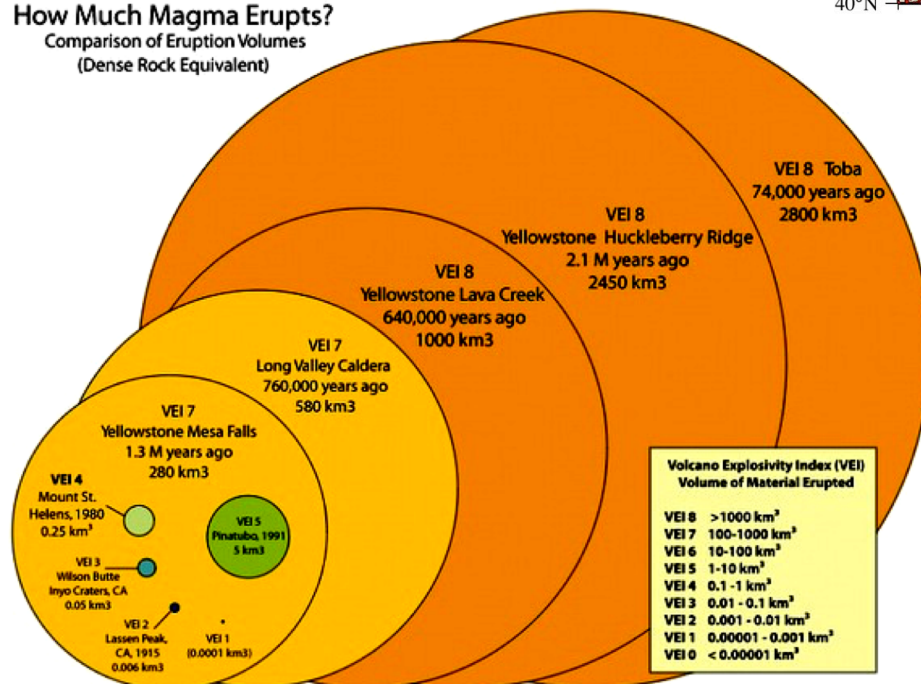
| VEI | Ejecta volume             | Classification          | Description    | Plume      | Frequency    | Tropospheric injection | Examples                                       |
|-----|---------------------------|-------------------------|----------------|------------|--------------|------------------------|--|
| 0   | < 0.00001 km <sup>3</sup> | Hawaiian                | effusive       | < 100 m    | constant     | negligible             | Kīlauea  |
| 1   | > 0.001 km <sup>3</sup>   | Hawaiian / Strombolian  | gentle         | 100–1000 m | daily        | minor                  | Nyiragongo (2002)                              |
| 2   | > 0.001km <sup>3</sup>    | Strombolian / Vulcanian | explosive      | 1–5 km     | weekly       | moderate               | Mount Sinabung (2010)                          |
| 3   | >0.01 km <sup>3</sup>     | Vulcanian / Peléan      | severe         | 3–15 km    | few months   | substantial            | Nevado del Ruiz (1985), Soufrière Hills (1995) |
| 4   | > 0.1 km <sup>3</sup>     | Peléan / Plinian        | cataclysmic    | 10–25 km   | ≥ 1 yr       | substantial            | Mount Pelée (1902), Eyjafjallajökull (2010)    |
| 5   | > 1 km <sup>3</sup>       | Plinian                 | paroxysmal     | 20–35 km   | ≥ 10 yrs     | substantial            | Mount St. Helens (1980)                        |
| 6   | > 10 km <sup>3</sup>      | Plinian / Ultra-Plinian | colossal       | > 30 km    | ≥ 100 yrs    | substantial            | Krakatoa (1883), Mount Pinatubo (1991)         |
| 7   | > 100 km <sup>3</sup>     | Ultra-Plinian           | super-colossal | > 40 km    | ≥ 1,000 yrs  | substantial            | Tambora (1815)                                 |
| 8   | > 1,000 km <sup>3</sup>   | Supervolcanic           | mega-colossal  | > 50 km    | ≥ 10,000 yrs | substantial            | Yellowstone (640,000 BP), Toba (74,000 BP)     |





### How Much Magma Erupts?

Comparison of Eruption Volumes  
(Dense Rock Equivalent)



$^{87}\text{Sr}/^{86}\text{Sr}$  value of 0.706 is interpreted as border between continental (east) and oceanic (west) lithosphere. YSRP - Yellowstone-Snake River Plain system of volcanoes of acidic composition.  $V_{\text{mean}} \sim 4.5$  cm/year during 15 Ma (Smith et al., 2009)





## Morphology of Volcanoes



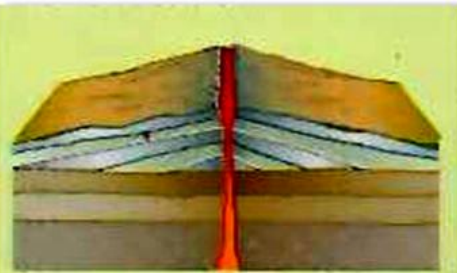
caldera



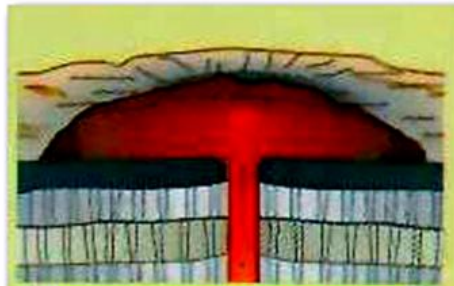
cinder cone



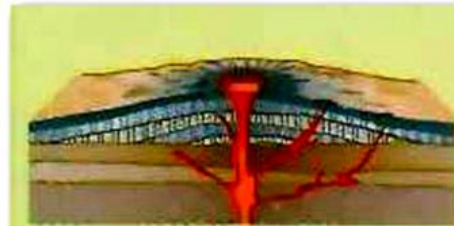
complex volcano



mouth fracture



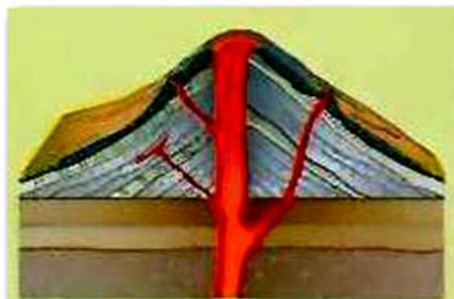
lava cupola



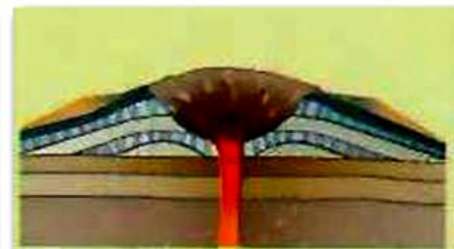
shield volcano



somma



stratovolcano



ash cone

## Products of eruption:

**Solid (Tephra), Liquid (Lava), Gaseous**

*The solid products of eruption:*



**Volcanic bombs**



**Lapillies**



**Volcanic ash**



Kariak volcano (view from Avacha volcano)



Apocalypse in Mexico: [www.pixanews.com](http://www.pixanews.com)



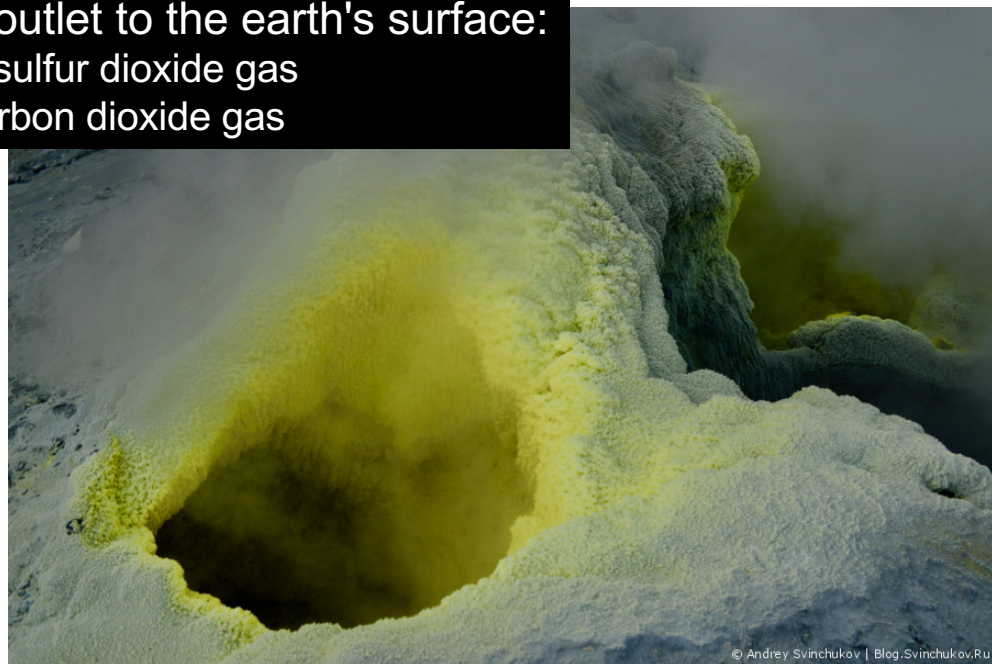


***The gaseous products of eruption:***

- Water vapor
- Sulfur dioxide gas
- Carbon dioxide gas

Fumarole - volcanic gas outlet to the earth's surface:

- a. Solfatara = fumarole with sulfur dioxide gas  
b. Mofeta = fumarole with carbon dioxide gas





## Liquid products of eruption:



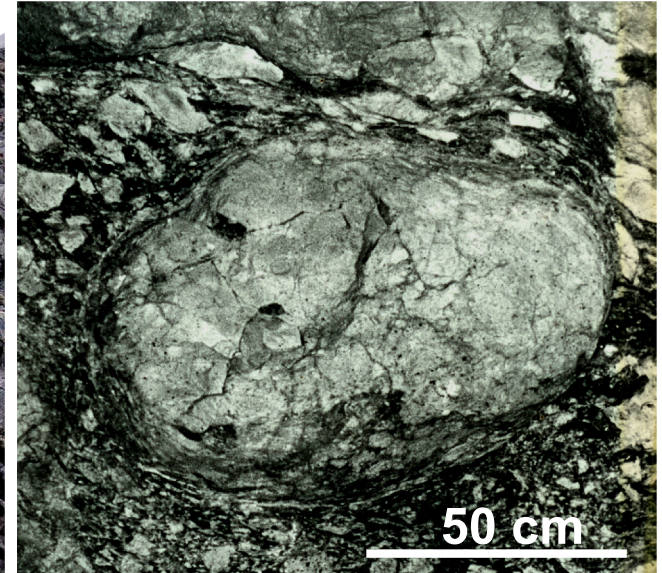
**Pahoehoe**  
*molten lava*



**Aa**  
*viscous lava*



**Pillow**  
*molten lava in water*





1\_2013\_Tolbachik\_05-49.mp4  
2\_2013\_Lava and Snow\_07-13.mp4  
3\_2011-2013\_TimelapseCamera\_05-19.mp4  
4\_2012-13\_Tolbackic\_Chaplygin Ilya\_11-56.mp4  
5\_TVC\_21-50.mp4



A CRASY VOLCANOLOGIST PRODUCTION



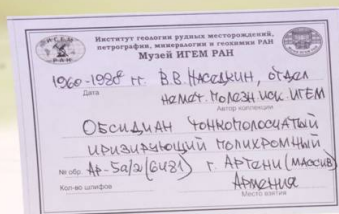
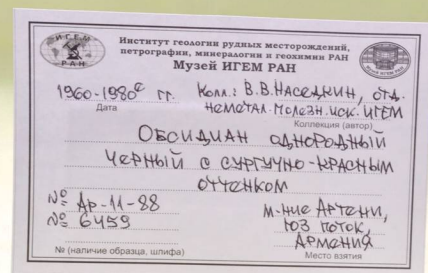
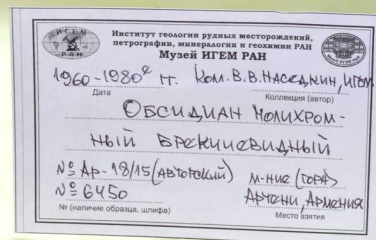
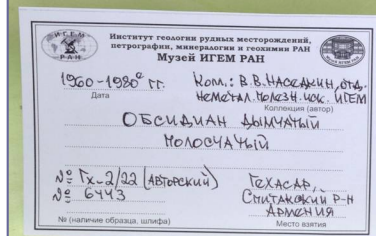
# GLASS



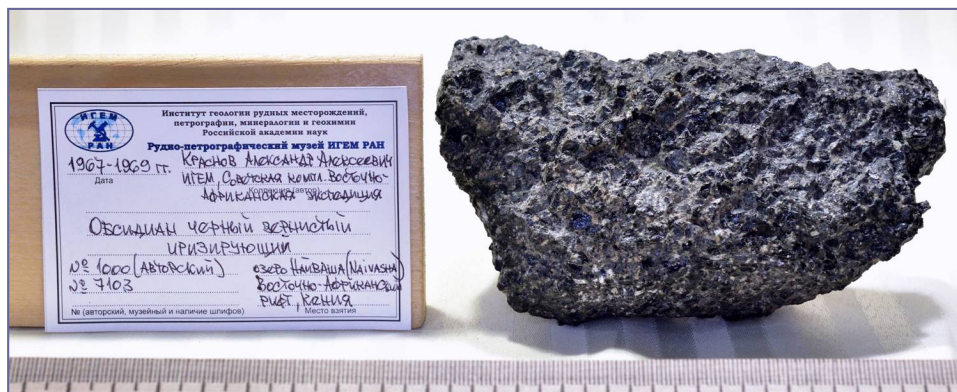
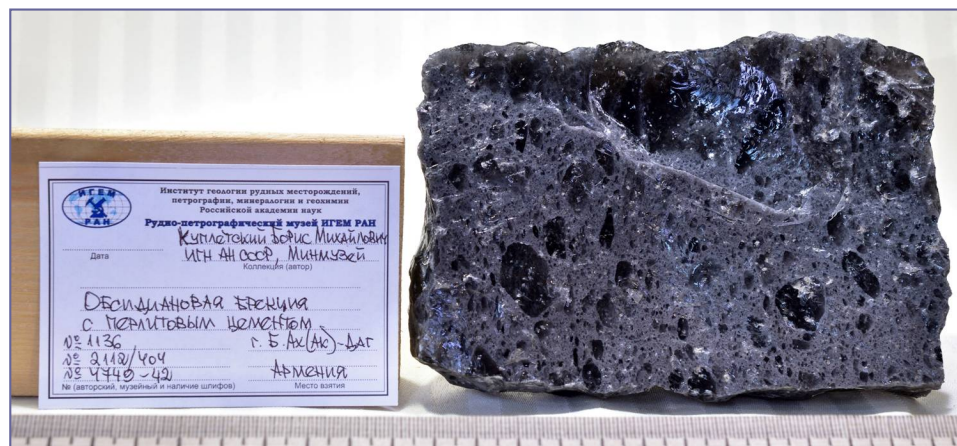
*Dale Chihuly*



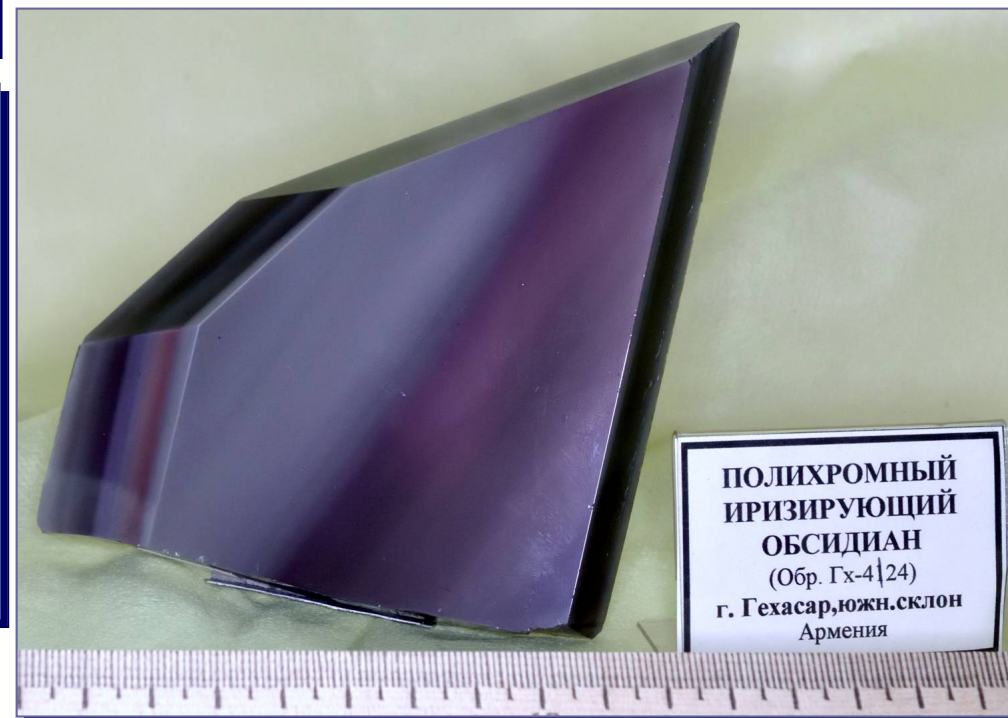
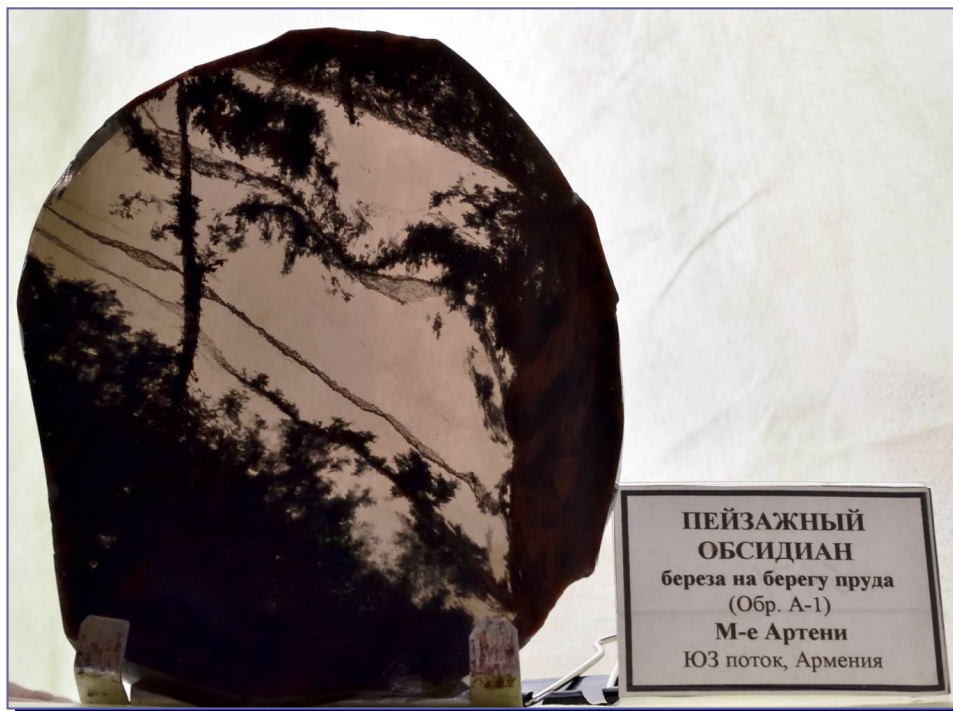
















**Thank you for attention!**