Volcanoes classification

- >1300 volcanoes known to have erupted in Holocene (last 10 000 years)
- ~500 classified as 'active' (i.e. known to have erupted in recorded history)
- Remainder classified as 'dormant' (may become active again) or 'extinct' (not expected to erupt again), but Vesuvius was thought to be extinct before AD 79!

Paricutin (Michoacan, Mexico) shown erupting in 1943 (graphic by Diego Rivera)

Volcanoes and eruptive style

Eruptive style and hazard depends on:

- Tectonic setting
- Depth of magma formation
- Rate of magma movement to the surface
- Percent and type of volatiles (gases)

How and why do volcanoes erupt?

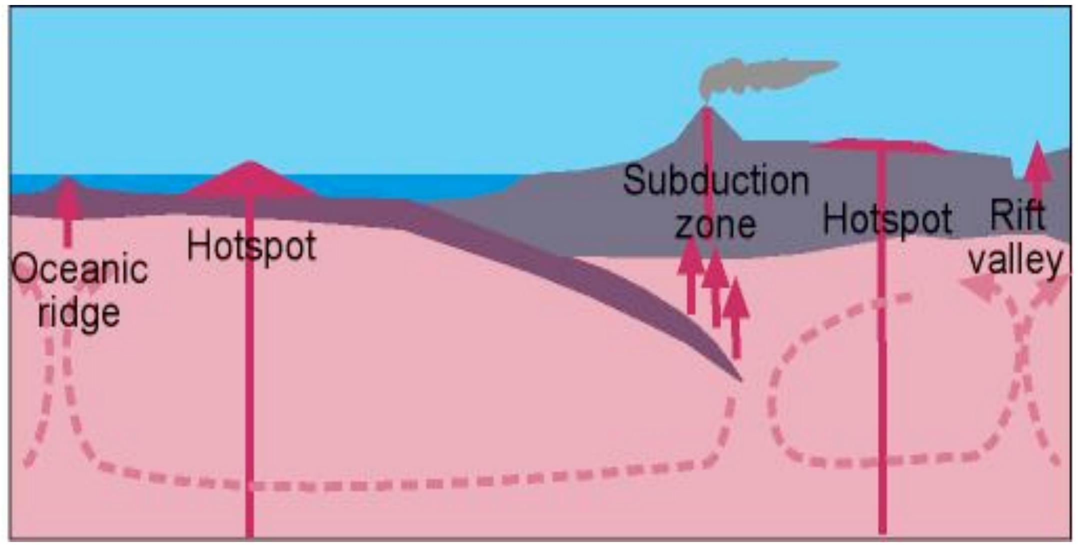
- Hot, molten rock (magma) is buoyant (has a lower density than the surrounding rocks) and will rise up through the crust to erupt on the surface.
- When magma reaches the surface it depends on how easily it flows (viscosity) and the amount of gas (H_2O, CO_2, S) it has in it as to how it erupts.
- Large amounts of gas and a high viscosity (sticky) magma will form an explosive eruption.

  Think about shaking a carbonated drink and then releasing the cap

- Small amounts of gas and (or) low viscosity (runny) magma will form an effusive eruption.

  Where the magma just trickles out of the volcano (lava flow)

Volcanoes - tectonic settings



Oceanic ridges, hotspots	Subduction zones
Basic/Mafic volcanics	Acidic/Felsic volcanics
Low SiO_2	High SiO_2
Fluid lava (10 m/s)	Viscous lava (3 m/s)
Low gas pressure (little explosive activity)	High gas pressure (explosive activity)

Classification of volcanic eruptions

Low Hazard

High hazard

		Gas Pressure		
		Low	Medium	High
Lava Type	Fluid	Icelandic Hawaiian	Strombolian	Vesuvian
	Inter.	-	Vulcanian	Perretian
	Viscous	Merapian	Vicentian	Peléean

Low

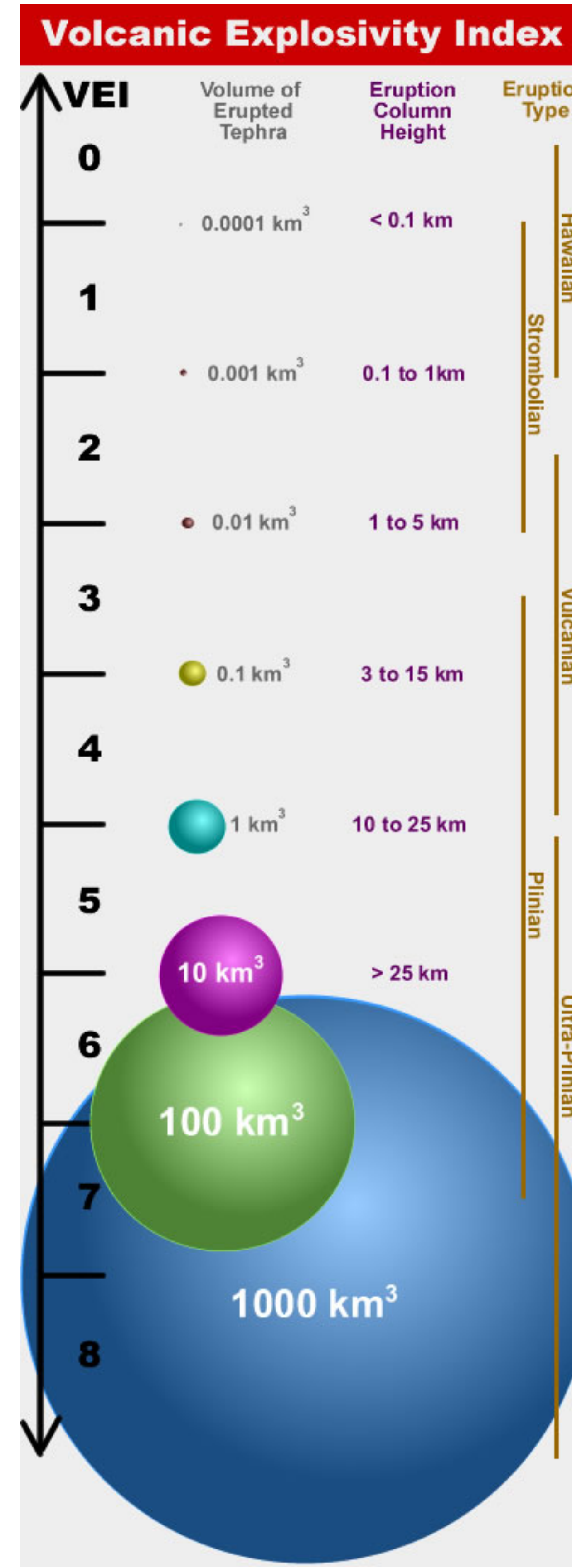
High

Oceanic ridge
Hotspots

Subduction zone

VEI (Volcanic Explosivity Index)

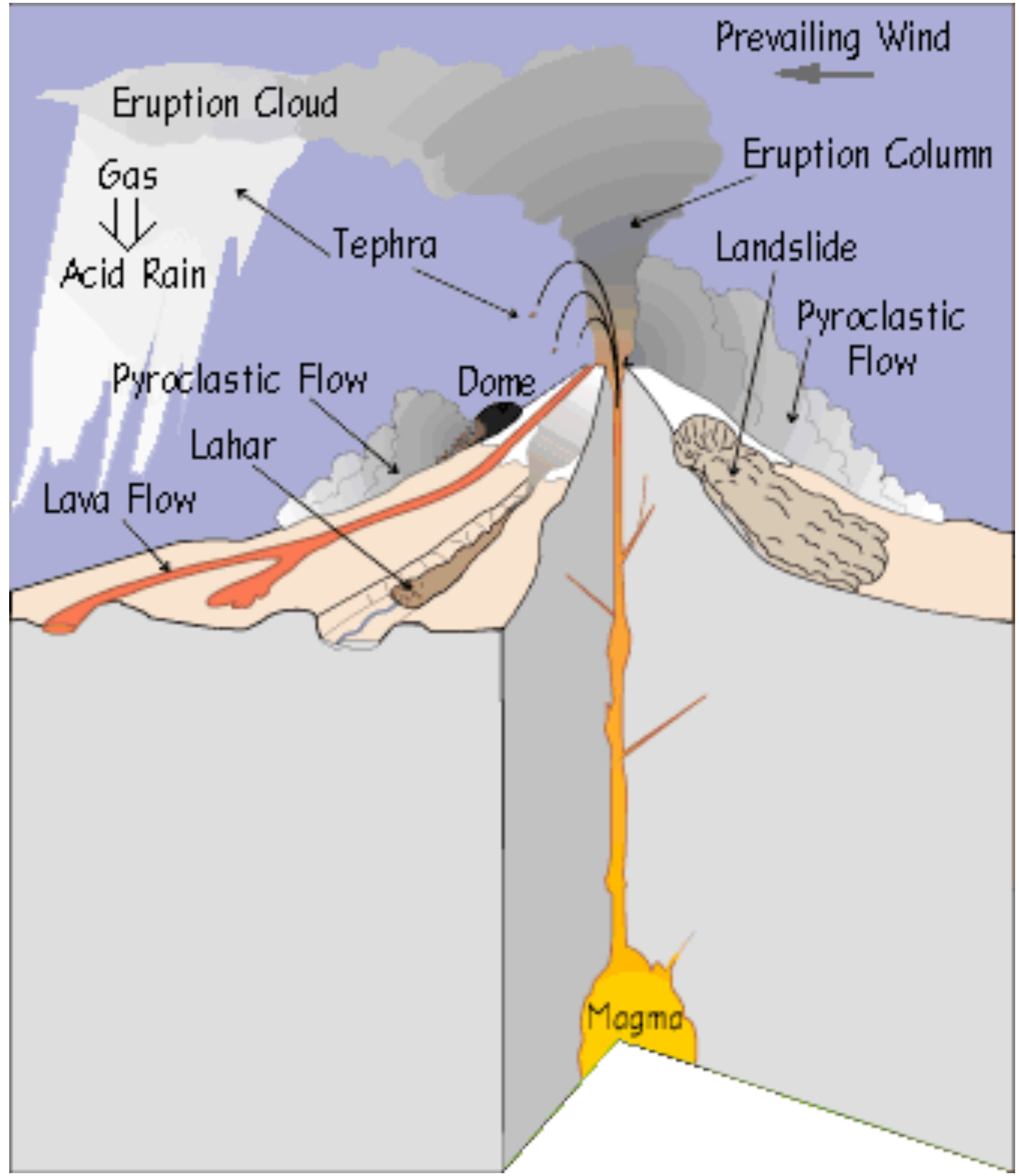
VEI	0	1	2	3	4	5	6	7	8
General Description	Non-Explosive	Small	Moderate	Moderate-Large	Large	Very Large			
Volumn of Tephra (m^3)	$1x10^4$	$1x10^6$	$1x10^7$	$1x10^8$	$1x10^9$	$1x10^{10}$	$1x10^{11}$	$1x10^{12}$	
Cloud Column Height (km) Above crater / Above sea level	<0.1	0.1-1	1-5	3-15	10-25	>25 ⟶			
Qualitative Description	"Gentle,"	"Effusive"	⟵ "Explosive" ⟶		⟵ "Cataclysmic," "paroxysmal," "colossal" ⟶				
				⟵ "Severe," "violent," "terrific" ⟶					
Eruption Type (see fig. 7)		⟵ Strombolian ⟶		⟵ Plinian ⟶					
	⟵ Hawaiian ⟶		⟵ Vulcanian ⟶		⟵ Ultra-Plinian ⟶				
Duration (continuous blast)	⟵ <1 hr ⟶			⟵ >12 hrs ⟶					
			⟵ 1-6 hrs ⟶						
				⟵ 6-12 hrs ⟶					
Maximum explosivity	Lava flow	⟵ Explosion or Nuée ardente ⟶							
		⟵ Phreatic ⟶							
	Dome or mudflow								
Tropospheric Injection	Negligible	Minor	Moderate	Substantial ⟶					
Stratospheric Injection	None	None	None	Possible	Definite	Significant ⟶			
Eruptions	976	1239	3808	1083	412	168	50	6	0



https://www.wired.com/2013/07/revamping-the-volcanic-explosivity-index-or-tiny-eruptions-need-love-too/

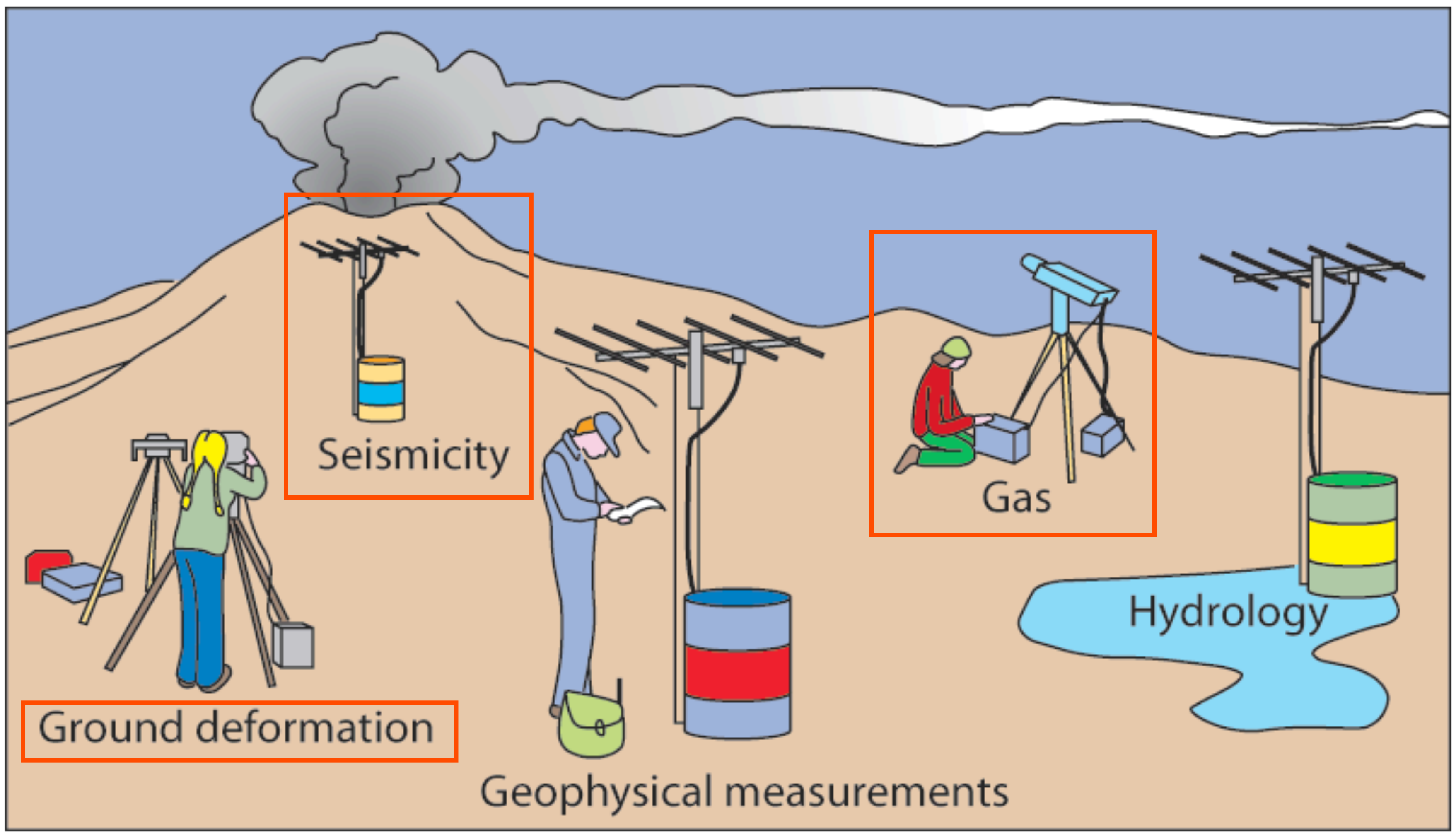
Volcanic Hazards

- Pyroclastic flow
- Lahars/Mud flows
- Pyroclastic fall
- Lava flow
- Noxious Gas
- Earthquakes



http://volcanoes.usgs.gov/Hazards/What/hazards.html

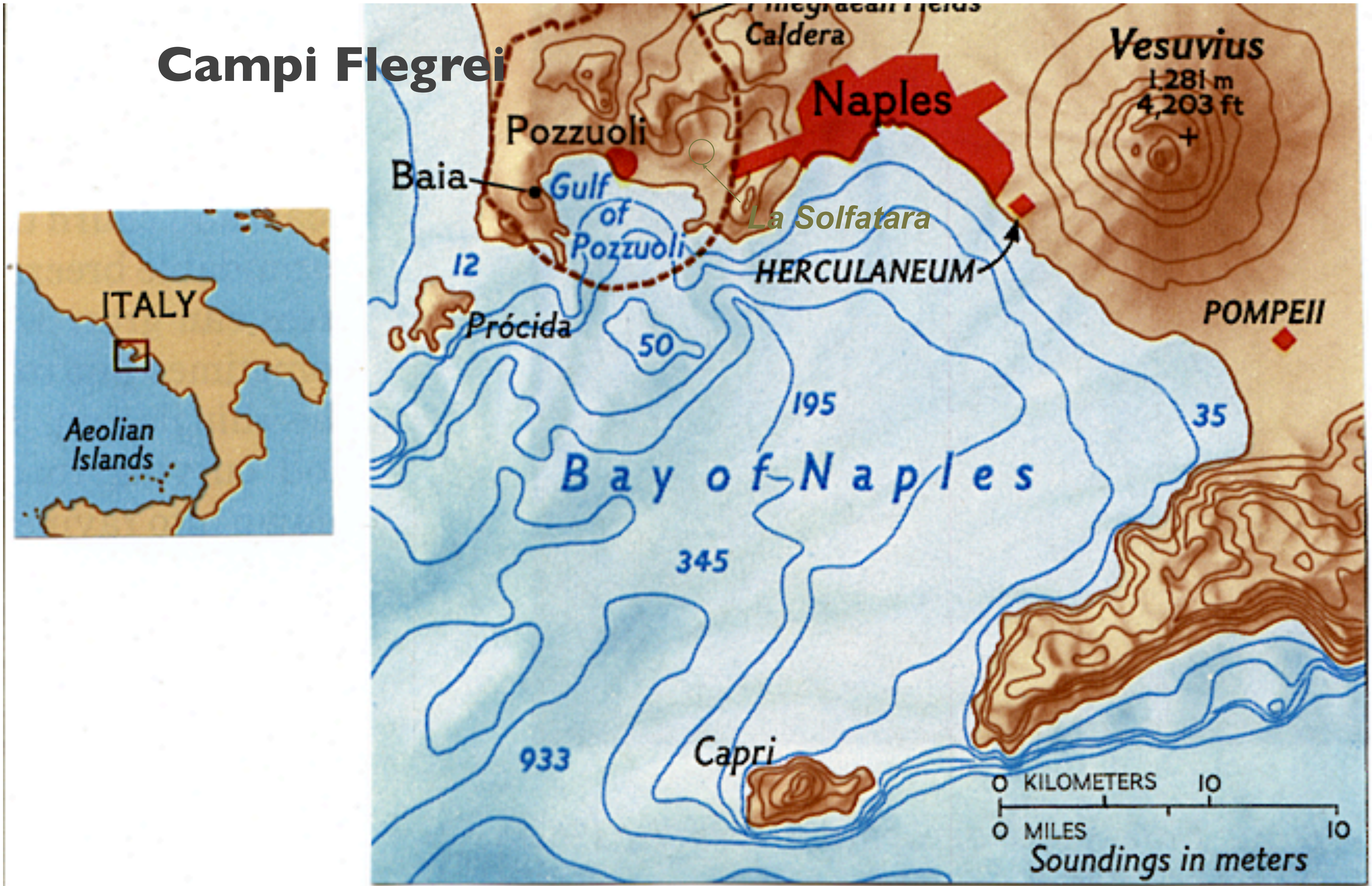
Volcano Monitoring



- Seismicity
- Deformation
- Gas Output
    - (on volcano and remote sensing techniques)

These three things are the most important precursors to an eruption.

Volcanic hazards in the Naples region



http://www.ov.ingv.it/ov/doc/vulcani_napoletani_HQ.pdf

Mount Vesuvius: recent major eruptions

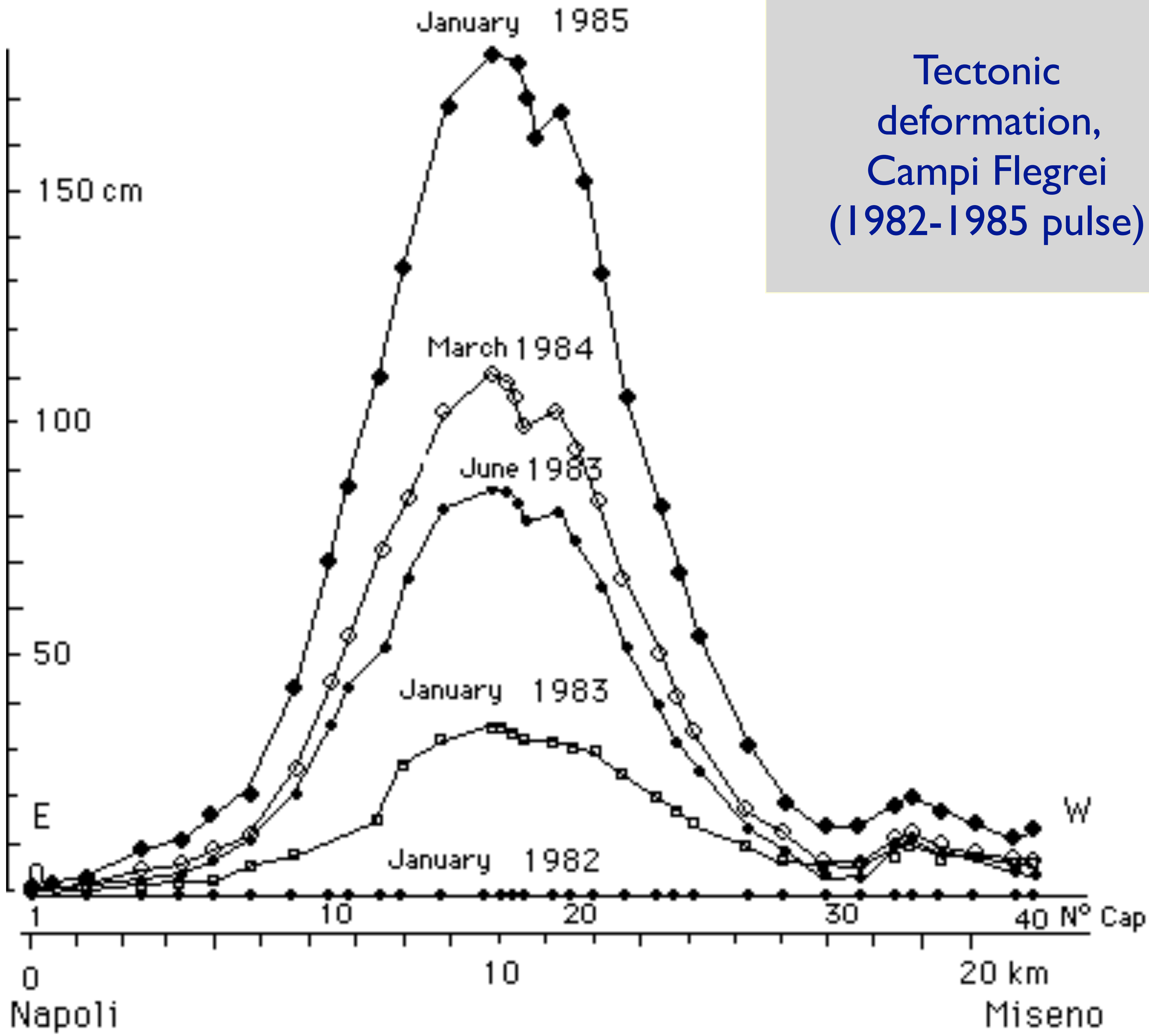
- A.D. 79: destruction of Pompeii and Herculaneum;
- 80 eruptions since then -
  most violently in 1631 and 1906;
  quiet since 1944

Mt. Vesuvius

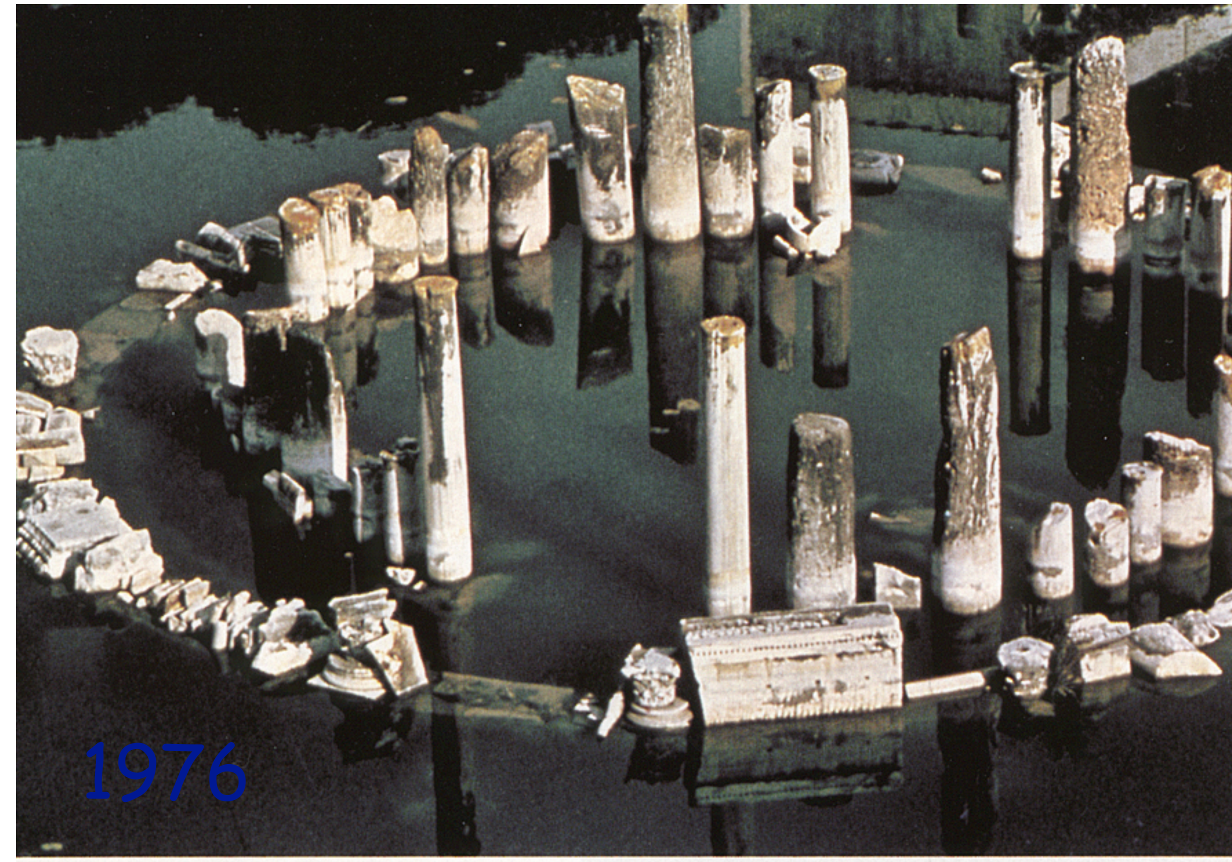
modern Herculaneum

excavated area of Roman Herculaneum (20 m below modern city)

Tectonic deformation, Campi Flegrei (1982-1985 pulse)



Ruins of Roman market, Pozzuoli; inundated by sea, uplifted by 2m in <10 years as a result of volcano-tectonic forces beneath Campi Flegrei caldera



Earthquake damage,
Church of Purgatory,
Pozzuoli
1982

GIANNI TORTOLI

La Solfatara,
one of several small active craters in the Campi Flegrei

Volcanic Risk in Italy

- Rischio Vulcanico

  https://rischi.protezionecivile.gov.it/it/vulcanico

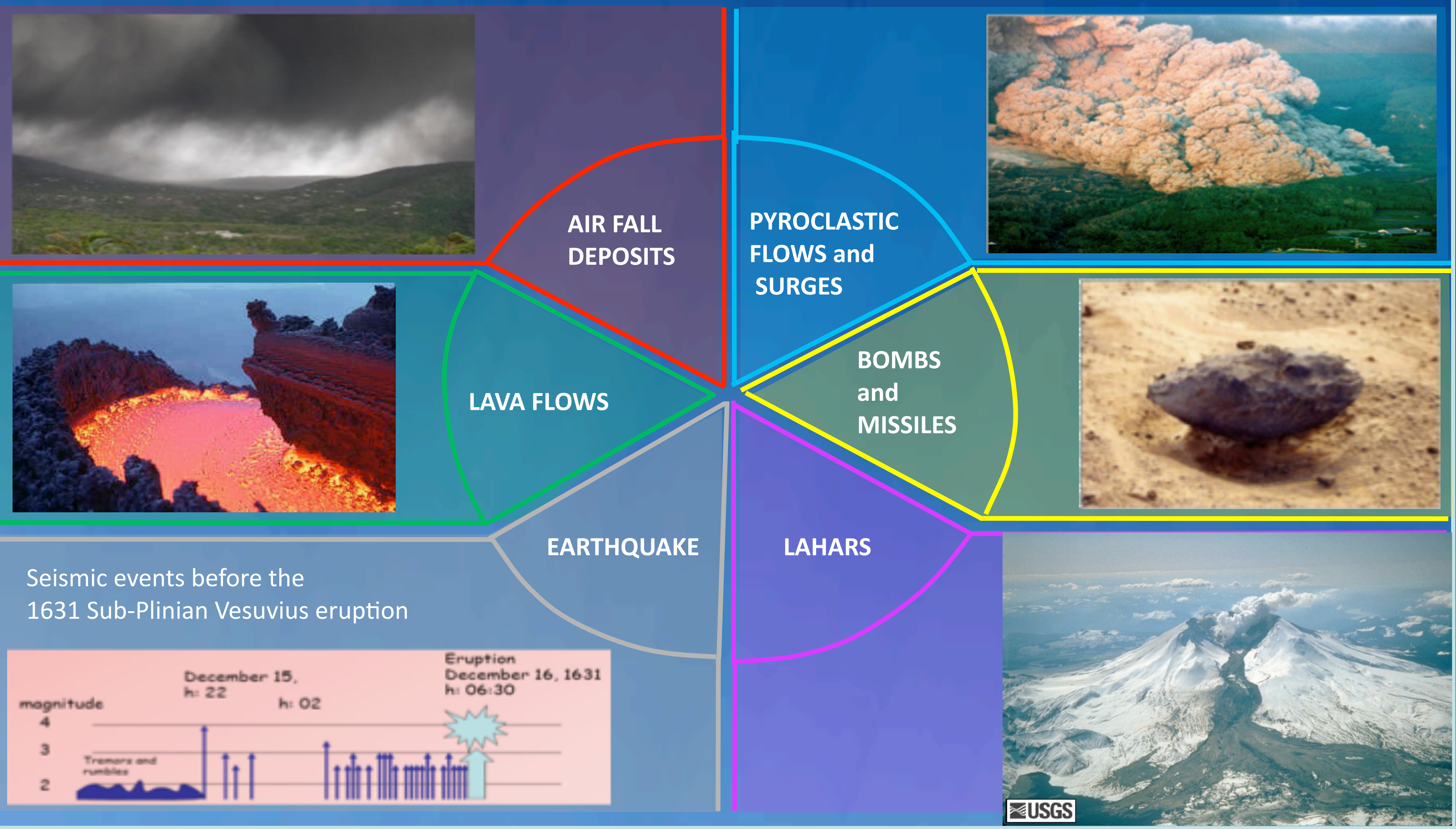
  - Previsione
  - Livelli di allerta
  - Pianificazione
  - Piano Vesuvio

    https://www.protezionecivile.gov.it/it/approfondimento/aggiornamento-del-piano-nazionale-di-protezione-civile-il-vesuvio

The effect of VOLCANIC ACTIONS

DESCRIPTION

ACTIONS



DESIGN METHODOLOGY FOR TECHNICAL RETROFIT

Cumulative effects given by a complex eruptive scenario (SpeeD and EXPLORIS projects for Vesuvian area)

The effect of VOLCANIC ACTIONS

MITIGATION ACTIONS

1. WATER
2. SNOW
3. WIND
4. LANDSLIDES
5. **VOLCANIC ACTIONS**
6. VOLCANIC RISK

EARTHQUAKE:

SEISMIC REINFORCEMENT: iron chains in masonry building, insertion of infill panels or resistant elements in soft floors of reinforced concrete buildings

ASH FALL DEPOSITS

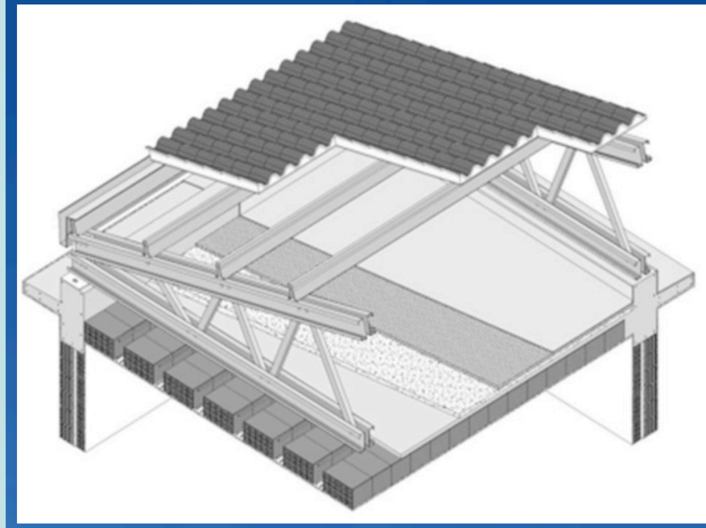
Vuln.	Roofing type	Load [kPa]	Collapse prob. [%]
A	Weak pitched wooden roof	2,0	50
B	Standard wooden flat roof; Flat floor with steel beams and brick vaults; Sap floors	3,0	50
C1	Flat floor with steel beams and hollow bricks ; R.C flat slab (more than 20 year old)	5,0	60
C2	R.C flat slab (less than 20 year old); Last generation R.C. flat slab	7,0	51
D	Last generation R.R. pitched slab ; Last generation steel pitched roof	12,0	50

1. **pitched roofs by overlapping light structures (CFS, Cold Formed Steel; UHPC, Ultra High Performance Concrete)**

2. **the reinforcement of the roof slab:**

   - FRP, Fiber Reinfor... (physical and mechani... degrade in range above 60-80°C)

   - FRCM (Fiber Reinforced Cementitious Matrix)



The effect of VOLCANIC ACTIONS

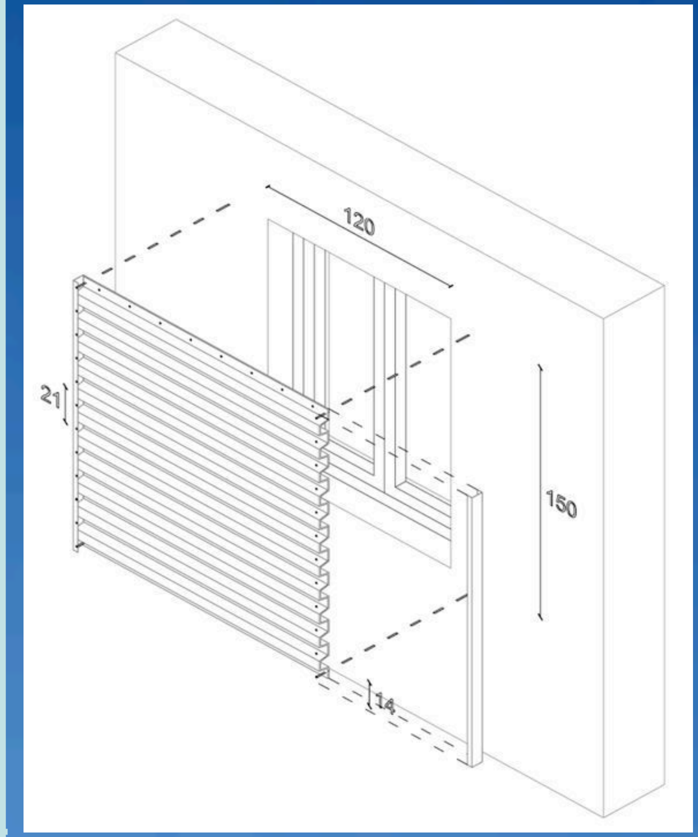
MITIGATION ACTIONS

PYROCLASTIC FLOWS

RESISTANCE TO LATERAL PRESSURE OF STRUCTURAL ELEMENTS FOR BUILDING TYPE.	
TECHNICAL ELEMENT	**CRITICAL PRESSURE [kPa]**
Wooden seasonal structures	3,5
3-4 floors weak masonry buildings with deformable floors	3,5 - 5
4+ floors weak or strong masonry building	
6+ floors r.c. buildings	4 - 5
Weak tuff walls (thickness ≤40cm, span>4m)	4 - 7,5
4-6 floors r.c. buildings	4,5 - 6
Non aseismic weak r.c. buildings	4,5 - 8
1-3 floors r.c. buildings	6,5 - 9
Medium strength tufo walls (thickness ≥40cm, span>4m)	7 - 9
Non aseismic strong r.c. buildings	
1-2 floors weak masonry buildings with deformable floors	11 - 18
3-4 floors masonry buildings with rigid floors	
1-2 floors masonry buildings with rigid floors	14 - 19

PROTECTION OF OPENINGS :

- **Overlay steel anchored along the external perimeter**
- **Fire safety shutters of steel or alluminium**
- **Special protective films on glass surfaces**



LAHARS PYROCLASTIC FLOWS and LANDSLIDES

The effect of VOLCANIC ACTIONS

MITIGATION ACTIONS

CHOICE OF THE TECHNICAL OPTIONS

To assess the effectiveness of mitigation actions, it is necessary a comprehensive analysis of technological options.

A qualitative judgment can be expressed by six key indicators:

1. **Quick installation**
2. **Storability**
3. **Lightness**
4. **Cost;**
5. **Preservation of constructive and architectural features;**
6. **Multifunctionality (ability of the technical solution to respond to different phenomena).**

Through four categories:

SE – Interventions on elevation structures
SV – Interventions on vertical surfaces
SO – Interventions on horizontal structures
AP – Interventions on openings

VOLCANIC RISK

SECURE COHABITATION WITH THE VOLCANO

MAIN OBJECTIVES
(Vesuvian area):

- **Development of accurate volcanic models (physical and mathematical), assessing future eruption scenarios and their consequences on the surrounding territory.**
- **Assessment of the global vulnerability and potential damage induced by the volcano on the entire system (population, built environment, infrastructure, etc.).**
- **Production of volcanic risk-reduction guidelines for communities and local/ national governments.**
- **Promotion of a socio-cultural methodology enhancing consciousness and auto-regulation of the territory.**
- **Identification of alternative people settlements and the reorganization of the entire infrastructural network in the whole region, relieving the current situation to more manageable scenarios.**