



# Volcanic supersites as cross-disciplinary laboratories

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**Guided tour to the talk**

**1) Volcanic risk projects**

**2) Geosphere-biosphere studies  
in Protected Areas: ECO-POTENTIAL**

**1 + 2) Volcanic supersites as  
cross-disciplinary laboratories:  
The case of Mt. Etna**



# MEDiterranean SUPersite Volcanoes MED-SUV



## VOLCANIC HAZARDS:

**VOLCANES PRESENT POTENTIAL THREATS TO PEOPLE AND PROPERTY.**

→ **Lava flows** are extremely hot and can burn everything in their path. Even after lava cools in massive rock, the land covered by the flow cannot be used for years. If you see a lava flow, do not go near it! It may flow slowly and regularly but it is hot, releases dangerous gases and can explode. After the eruption has ended, do not walk on lava flows; they remain hot for years.

→ **Volcanic gases:** in addition to lava, volcanoes may release gases into the atmosphere. These gases can be dangerous to your health, even if you cannot smell anything.

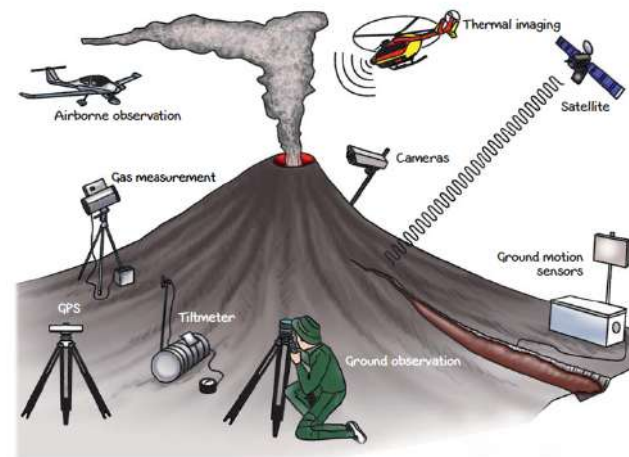
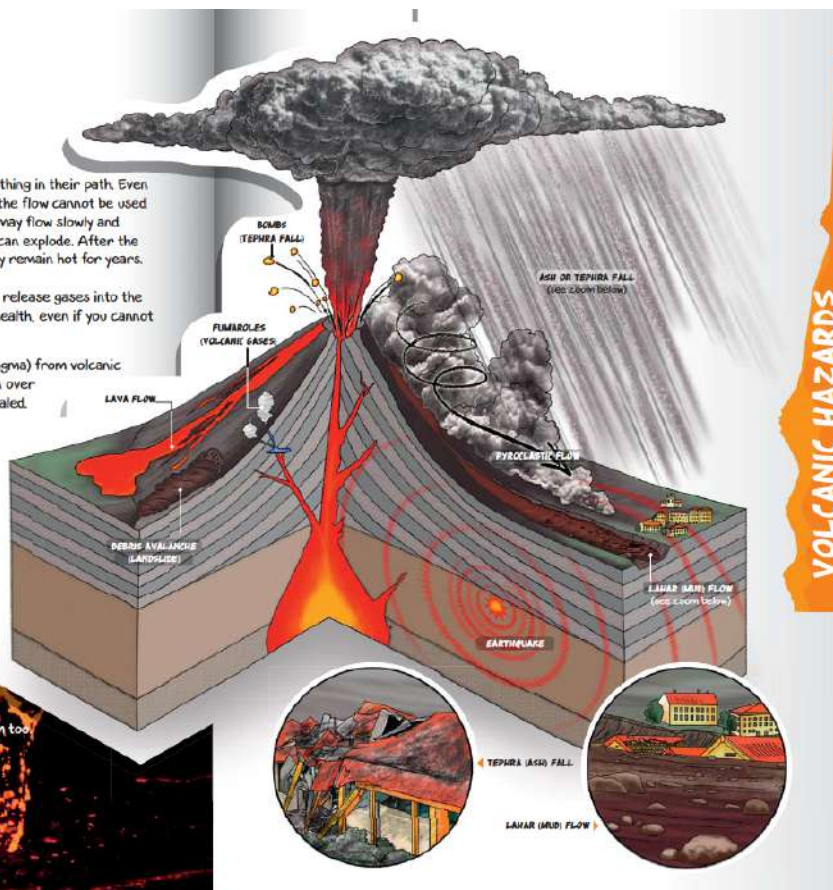
→ **Ash or tephra fall:** small fragments (pieces of magma) from volcanic eruptions are projected into the air and drop like rain over large areas. Fine ash can cause health problems if inhaled. Heavy ash falls may also cause roofs to collapse.

→ **Pyroclastic flows:** these are mixtures of hot gases and volcanic material (ash and rocks) that move downhill very fast. It is a very dangerous phenomenon!

→ **Lahars:** this Javanese word refers to a mixture of water and volcanic material. Lahars usually occur near a river or when it is raining a lot. These mudflows can bury large areas under meters of debris.

→ **Debris avalanches or volcanic landslides:** during an eruption, part of the volcano may collapse and cause landslides.

→ **Earthquakes:** earthquakes often accompany volcanic activity. People need to be prepared for them too.



# Main Hazards posed by Mt. Etna

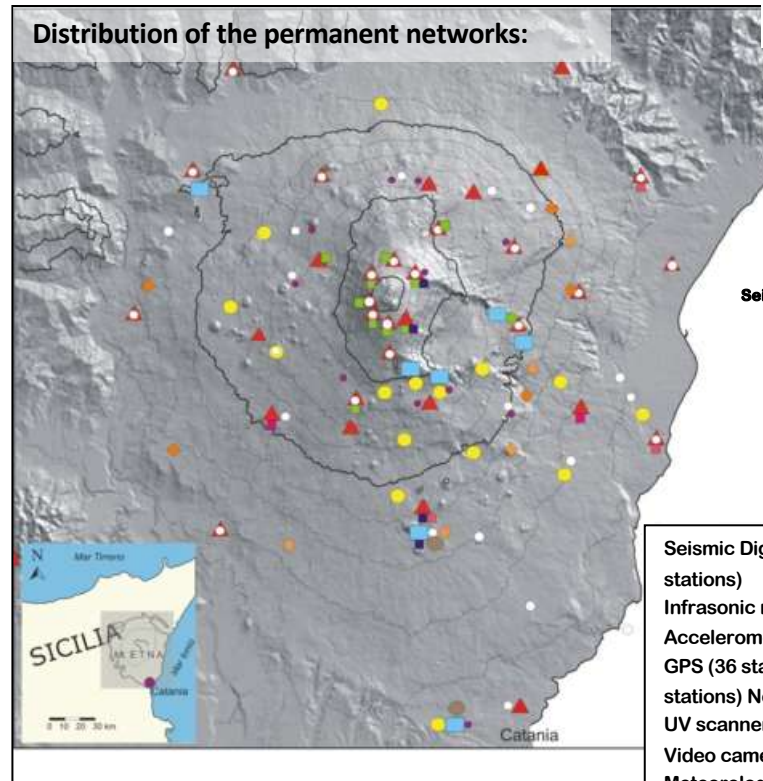
- 1) ash column dispersal and fallout
- 2) lava flow invasion
- 3) persistent degassing

- 4) collapses and landslides
- 5) opening of fractures
- 6) earthquakes

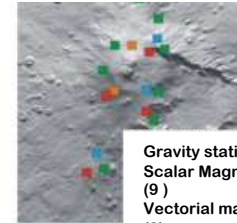


# In-situ Operating Ground-based Monitoring Systems & EO Observations on Mt. Etna

**Mt. Etna monitoring system includes networks of permanent stations, instrumentation for periodic measurements, analytical laboratories, and continuous analysis of EO data**

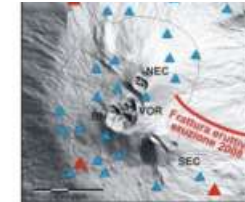


## Gravity & Magnetic Networks



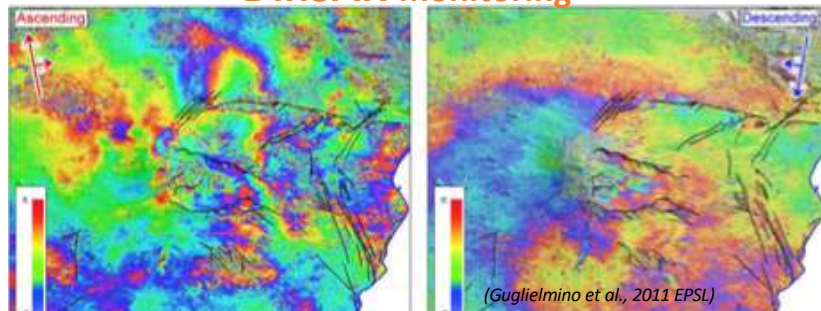
Gravity stations (4)  
Scalar Magnetic stations (9)  
Vectorial magnetic stat, ...

## Seismic Network during the 2008 eruption

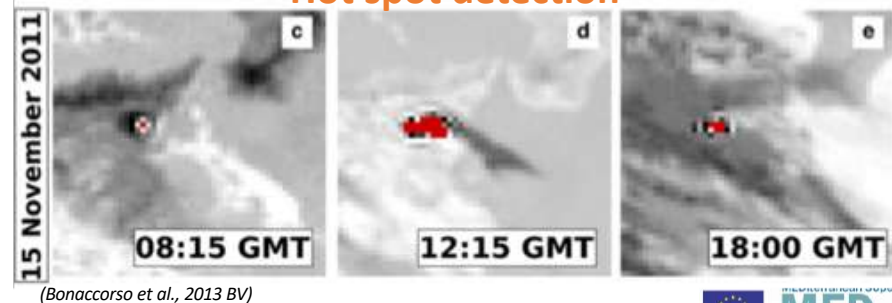


- Seismic Digital (23 stations) & Analogic Network (16 stations)
- Infrasonic network (11 stations)
- Accelerometric network (4 stations)
- GPS (36 stations), Tilt (11 stations) & Extensometer (4 stations) Networks
- UV scanner network (9 stations)
- Video cameras (7 stations)
- Meteorological stations (2)
- Ash fallout network (2 stations)

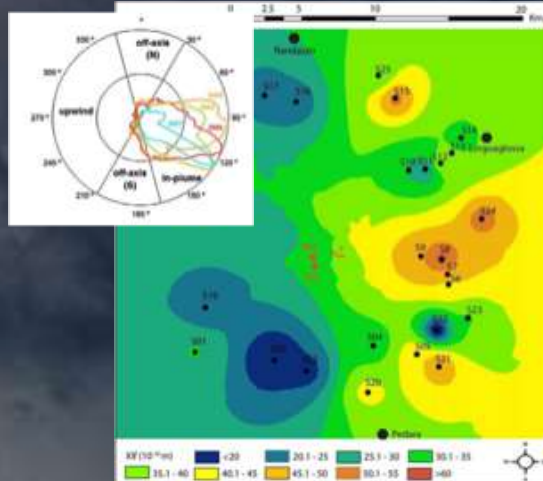
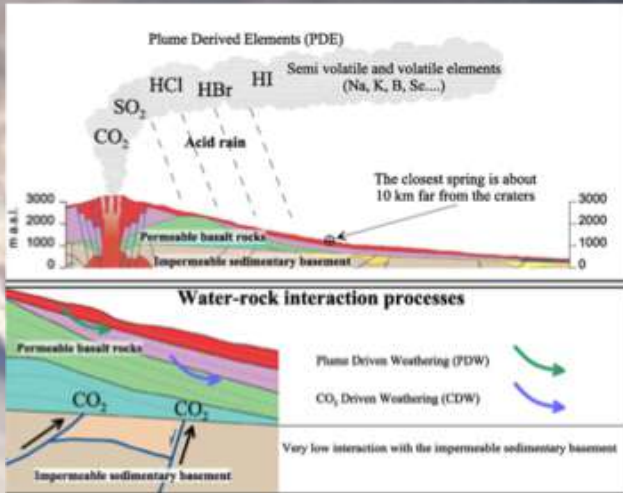
## DinSAR monitoring



## Hot spot detection



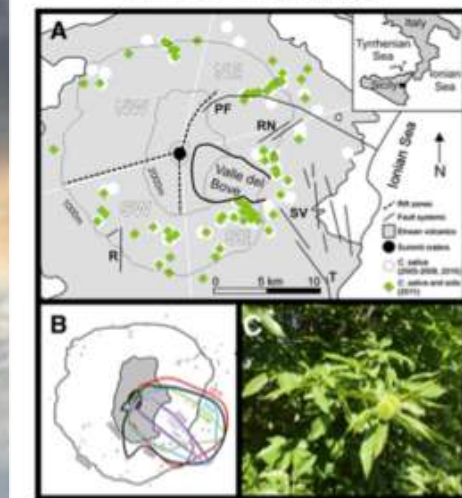
# Volcanoes create a special environment



Bioremediation of volcanic dispersion and deposition - Quayle et al., 2010; Martin et al., 2012

Plume fingerprinting in the critical zone  
Liotta et al., 2016

**A persistent volcanic plume supplies volcanogenic elements through rainfall and dry deposition with implication on water, soil, and vegetation**

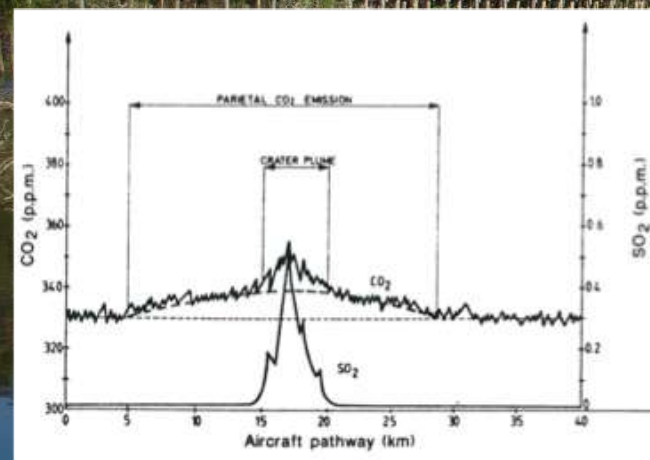


# The volcanic environment:

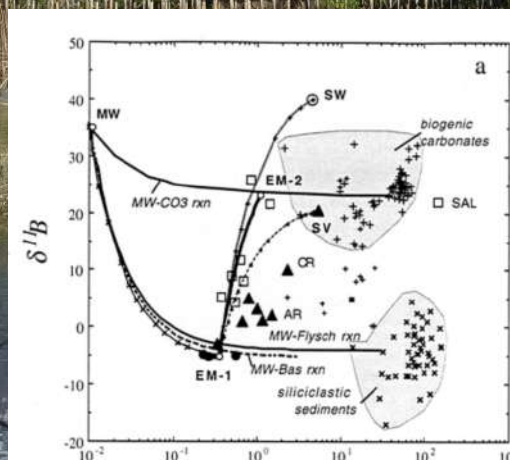
## Chemical weathering

## Interface reactions between rock-derived chemicals and biota

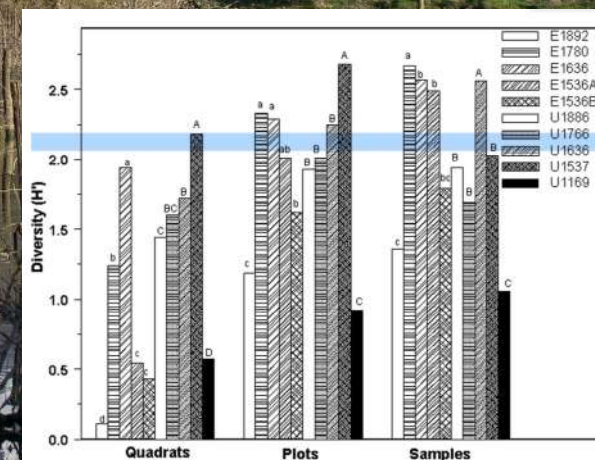
## Diffuse emission of magmatic and biogenic carbon dioxide



Diffuse Carbon degassing – Allard et al., 2001



Water-Rock interaction  
Pennisi et al., 2000



Lava flow – Vegetation interaction  
Del Moral and Poli Marchese, 2010



# *The H2020 project **ECOPOTENTIAL**: Improving future ecosystem benefits through Earth Observations*

**2015 - 2019, 47 partners**

**Coordinator: Antonello Provenzale**

**Co-Coordinator: Carl Beierkuhnlein**

**Project Manager: Carmela Marangi**

**External Communication Officer: Mariasilvia Giamberini**



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# ECOPOTENTIAL



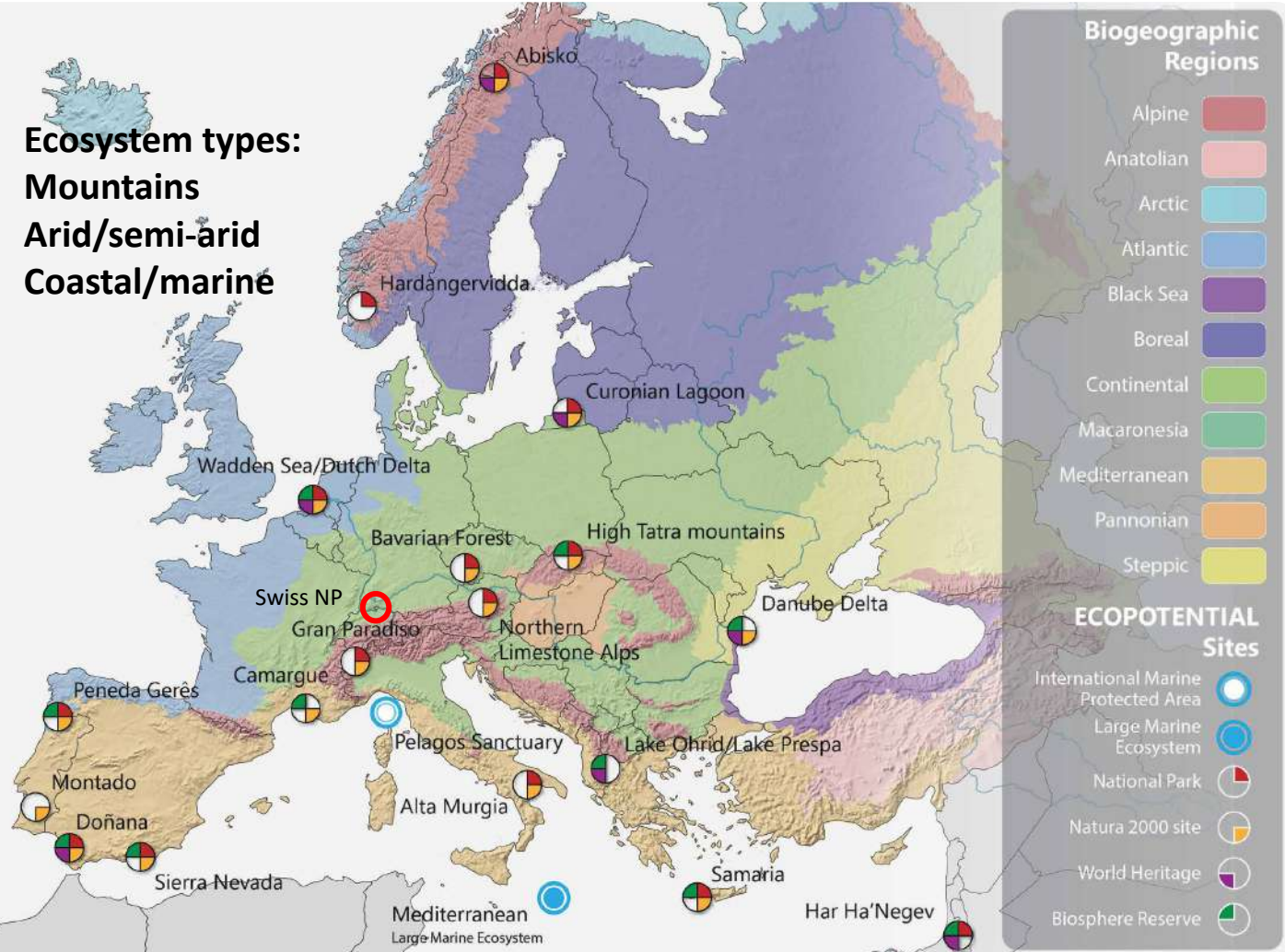
This project is funded by the European Union

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 641762. Copyright by Ecopotential Consortium.

## Working in partnership with 23 Protected Areas in Europe and beyond



**Ecosystem types:**  
Mountains  
Arid/semi-arid  
Coastal/marine



### Biogeographic Regions

- Alpine
- Anatolian
- Arctic
- Atlantic
- Black Sea
- Boreal
- Continental
- Macaronesia
- Mediterranean
- Pannonian
- Steppic

### ECOPOTENTIAL Sites

- International Marine Protected Area
- Large Marine Ecosystem
- National Park
- Natura 2000 site
- World Heritage
- Biosphere Reserve



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# ***What do we study in the ECOPOTENTIAL Protected Areas:***

**Current state of Protected Areas  
from Remote Sensing**

**Ongoing changes in the ecosystems and environment  
of the ECOPOTENTIAL Protected Areas**

**Future projections on the state of the ecosystem  
in the ECOPOTENTIAL Protected Areas**

**Narratives related to Protected Area needs:  
The Storylines**

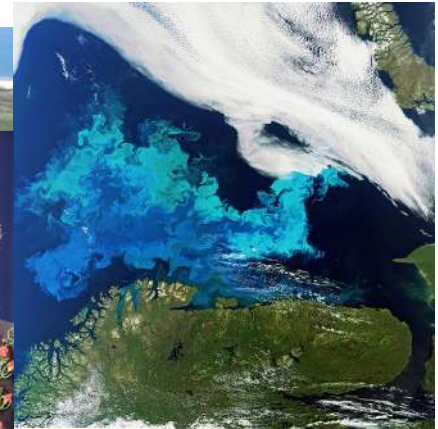
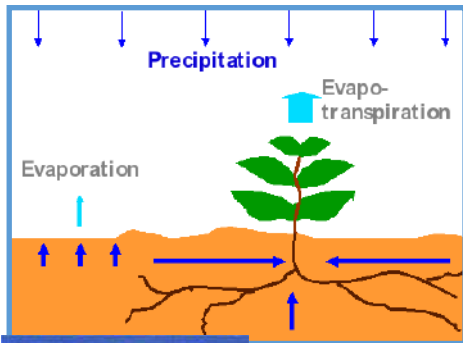




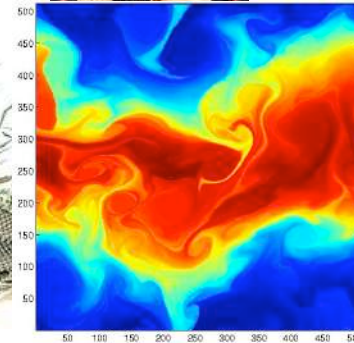
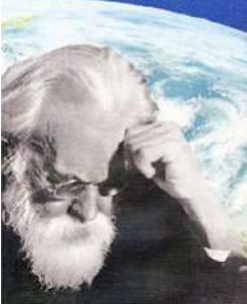
# Geo-bio-hydro interaction: “back to the future”



Ecosystems are seen as “one physical system” with their environment, with cross-scale geosphere-biosphere-hydrosphere interactions

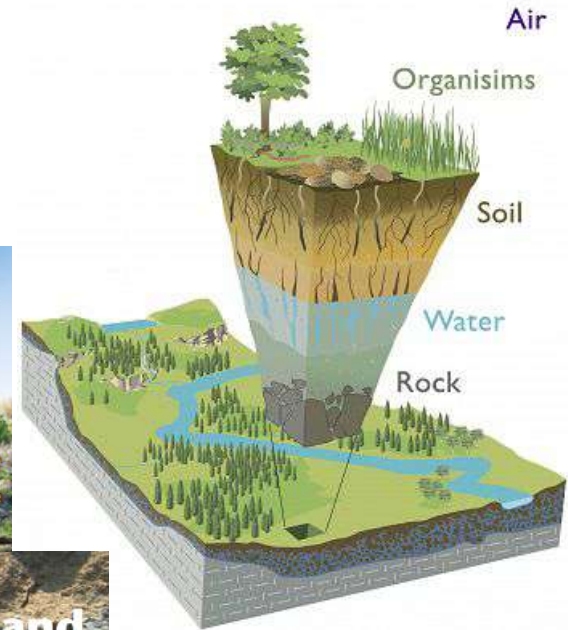
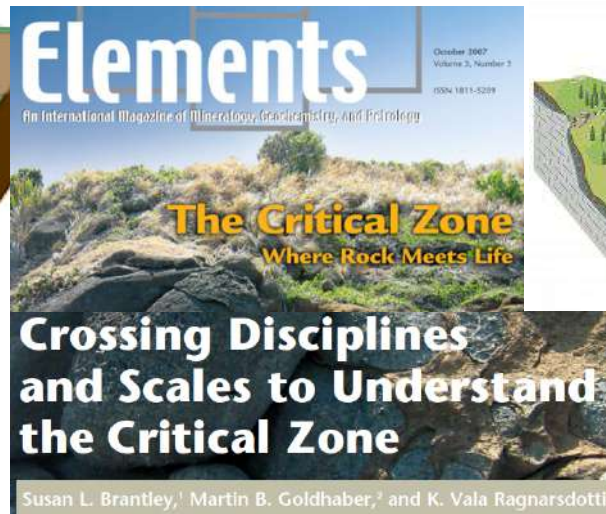
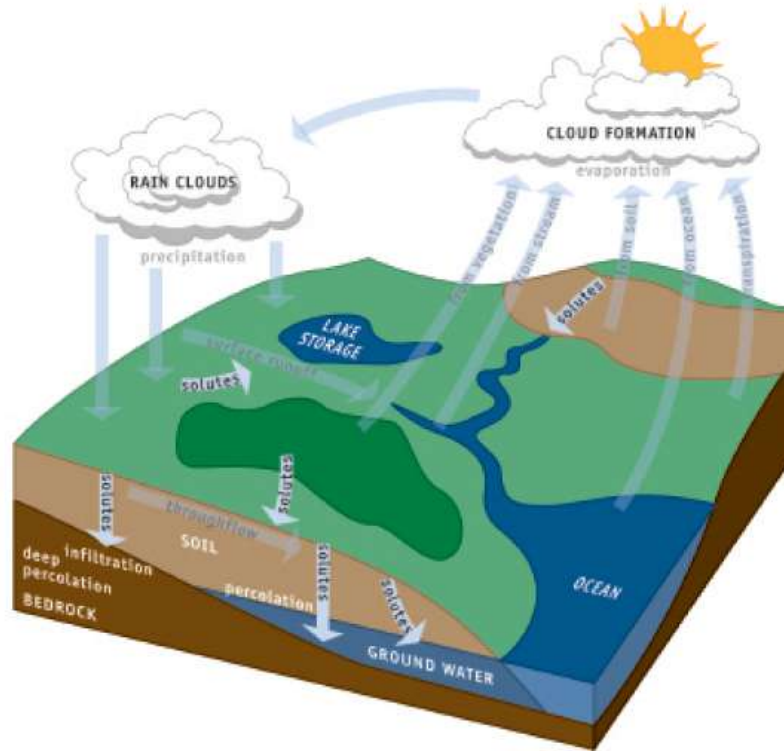


БИОСФЕРА  
В.И.Вернадский





# The Earth Living Skin (aka the Earth Critical Zone)



[www.czen.org](http://www.czen.org) , <http://criticalzone.org/national/>

The layer between the top of vegetation canopy and the “rocky matrix”, where physics, chemistry, hydrology, eco-hydrology, geology and biology closely interact



**Establish a coordinated effort to monitor  
climate, atmosphere, hydrology, ecosystems,  
soil dynamics and environmental changes  
at volcanic supersites**

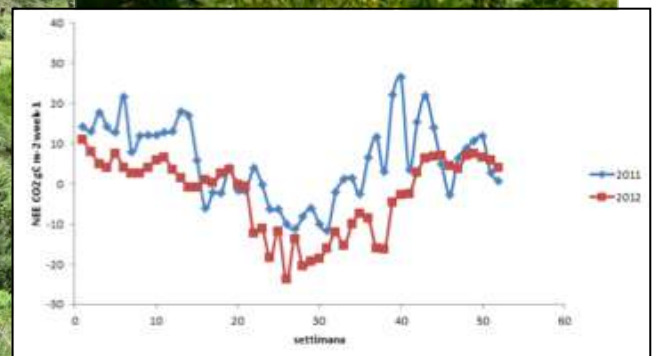
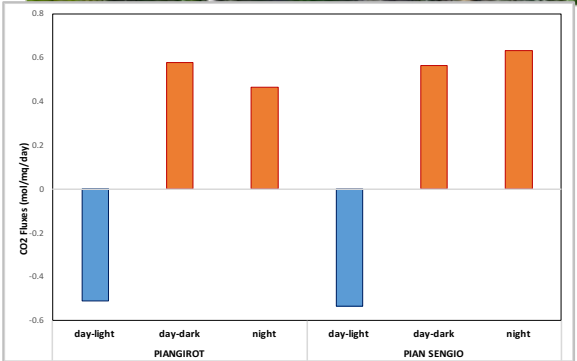
**Establish Earth Critical Zone sites  
at (active) volcanic areas**

**Mt. Etna can be the first example**

# Study the Earth Critical Zone as it was at the beginning of time

*Thank you for your attention*





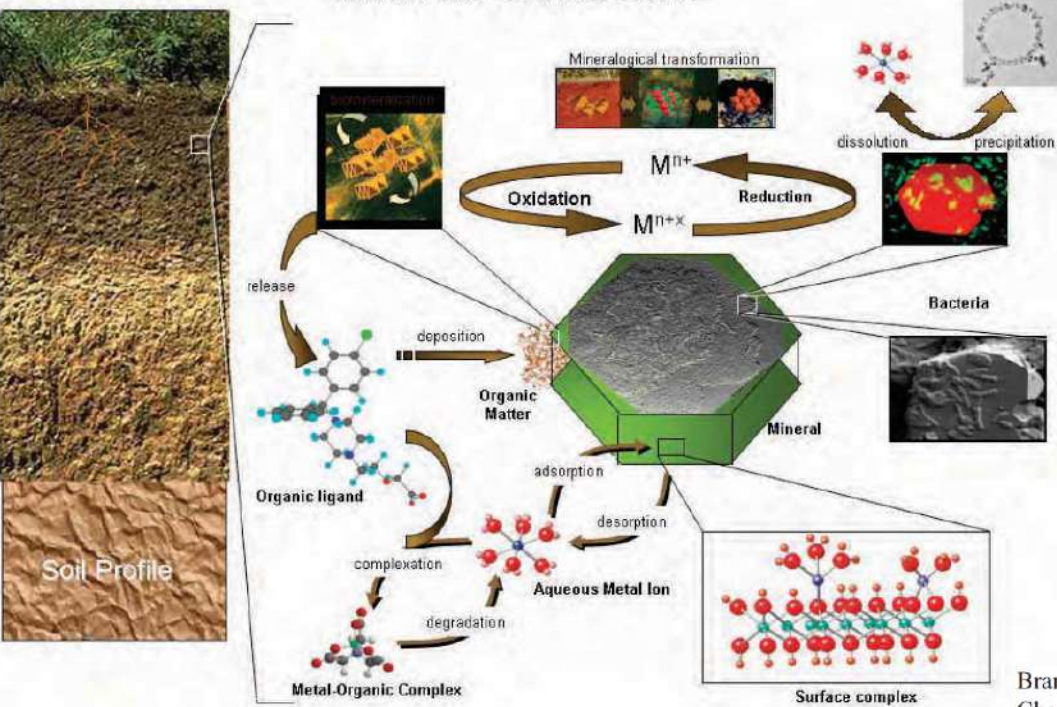
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# The Earth Living Skin (aka the Earth Critical Zone)

Intergrated Processes Controlling Elemental Cycling  
within the Critical Zone



Text Box 1. The economic goods and services of Earth's Critical Zone.

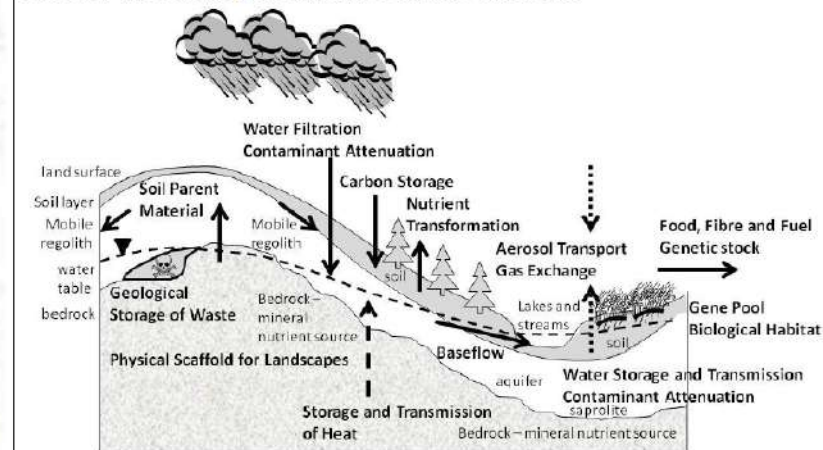


Figure 1. Flows of material and energy in Earth's Critical Zone.

## Sustaining Earth's Critical Zone

Brantley, S.L., White, T.S., White, A.F., Sparks, D., Richter, D., Pregitzer, K., Derry, L., Chorover, J., Chadwick, O., April, R., Anderson, S., Amundson, R., 2006, *Frontiers in Exploration of the Critical Zone: Report of a workshop sponsored by the National Science Foundation (NSF), October 24-26, 2005, Newark, DE, 30p.*

**Biogeochemical cycling**  
**Hydrological cycle**  
**Weathering**