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INGV | PROMUD DEFINITION OF A MULTIDISCIPLINARY MONITORING PROTOCOL FOR MUD VOLCANOES

GMPV8.3–EGU25-9144 Preliminary results from the INGV-PROMUD Project: seismic and hydromorphological monitoring of "Maccalube di Aragona" Mud Volcano (Sicily, Italy).

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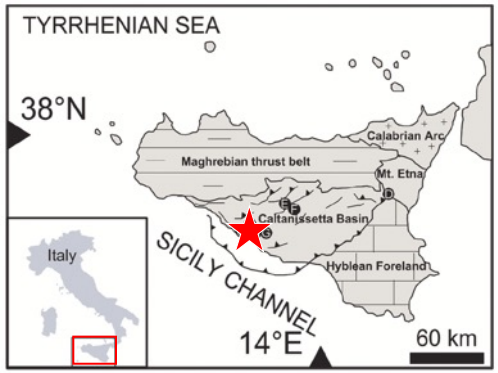
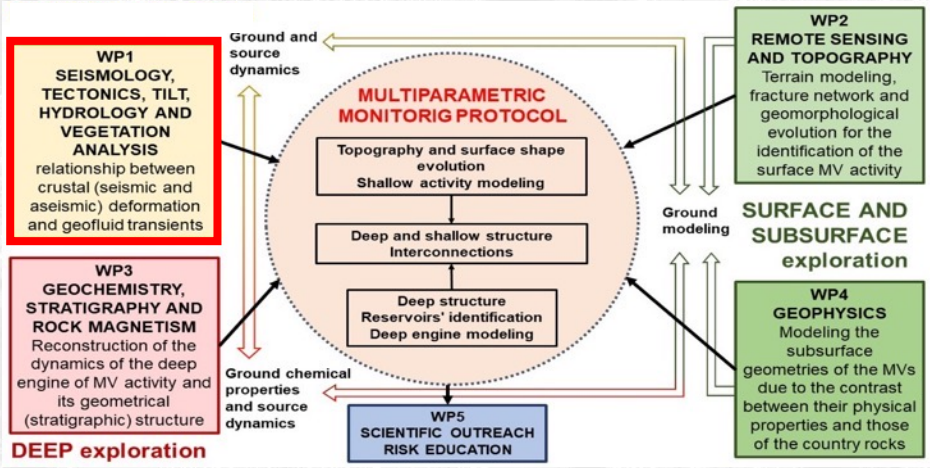
The **INGV-PROMUD project** *(https://progetti.ingv.it/it/promud)* is aimed to individuate ***proxies of MVs activity***, with the ultimate goal of developing a ***possible monitoring protocol***. It is a 3-years (2023-2025) multidisciplinary project, based on data acquired by both permanent networks and spot surveys in two main study sites in Italy: the Salse di Nirano (Northern Apennines) and the ***Maccalube di Aragona*** (Sicily), both managed as nature reserves by the regional governments.





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Ordinary

MV activity @ Aragona


Credits: https://www.ansa.it


Credits: https://www.gds.it

27/09/2014: 2 children killed by a paroxysm

Extraordinary

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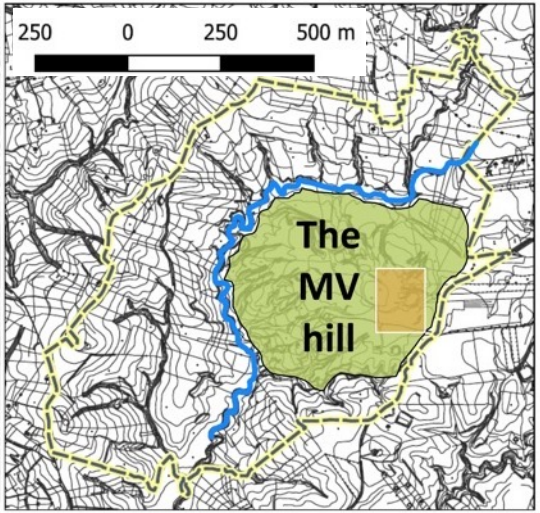
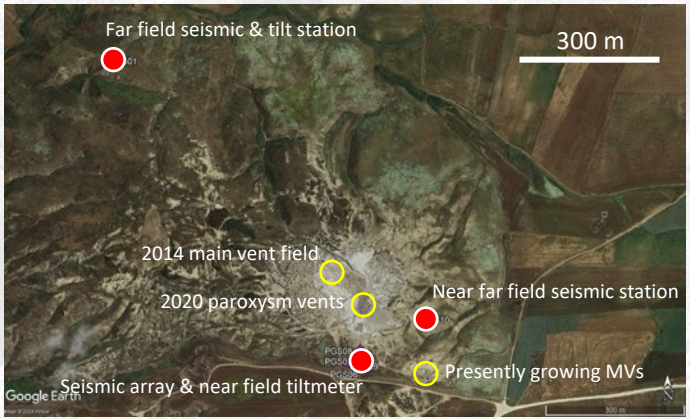
Real time & near real time network

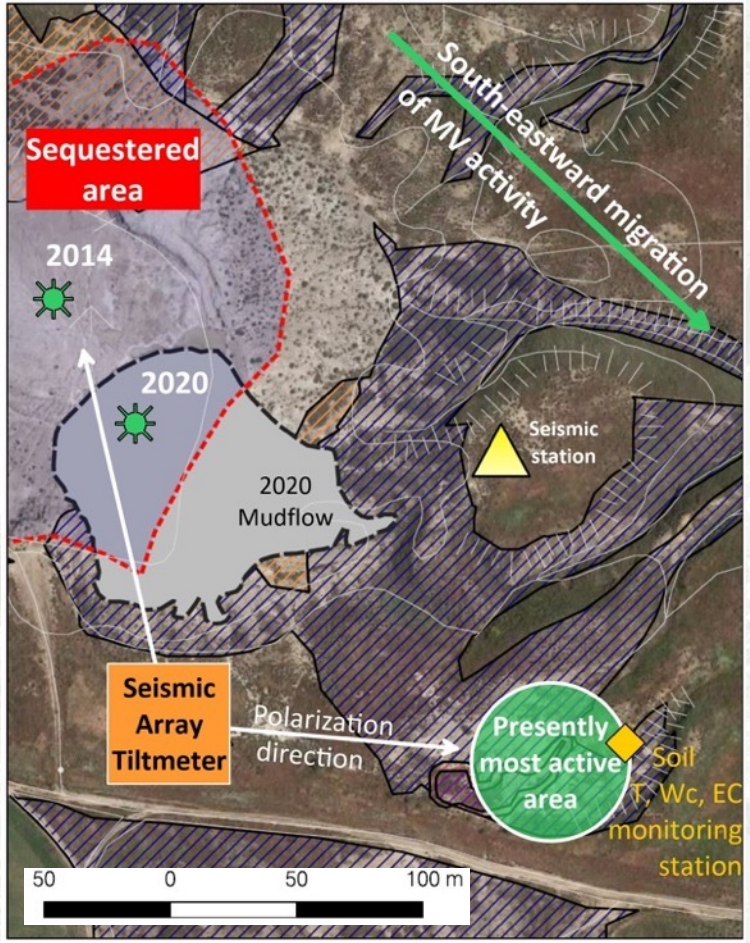
- Seismic array (4 stations) + 1 near far & 1 far field stations
- 2 Tiltmeters (1 near & 1 far field)
- Meteorological (rain, air T & Rh, wind speed, atmospheric pressure) & soil (T, apparent volumetric water content, electric conductivity) station



Discrete surveys (monthly)

- GNSS positioning of mud emitting vents
- Apparent soil volumetric water content





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Preliminary results (1/6): technical problems

Problem: Plastic shafts deformed by soil thrust, damaging buried instrumentation

Solution: Only over ground installations in MVs areas.

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Preliminary results (2/6): Polarization of seismic noise

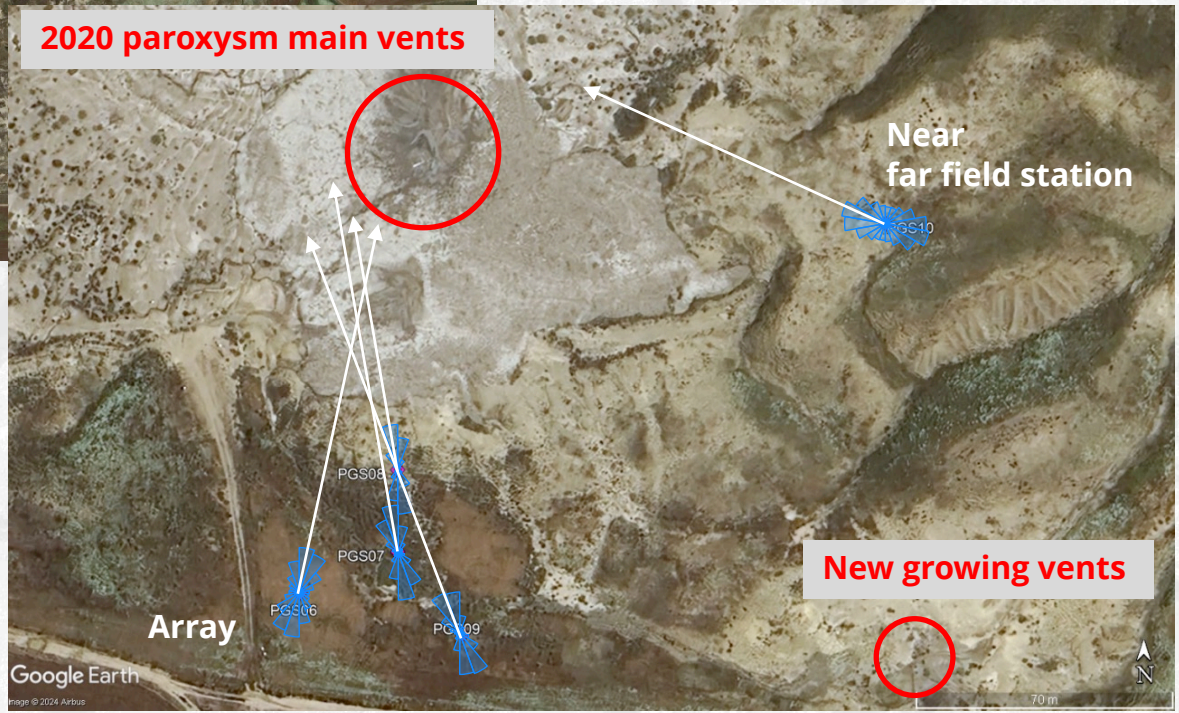
0.2-1 Hz frequency band

No preferential azimuthal directions out of the vent field

Azimuth in the vent field is well collimated to a common source.

Result

Polarization direction of seismic noise useful for individuating positions (migration) of fluid venting sources.



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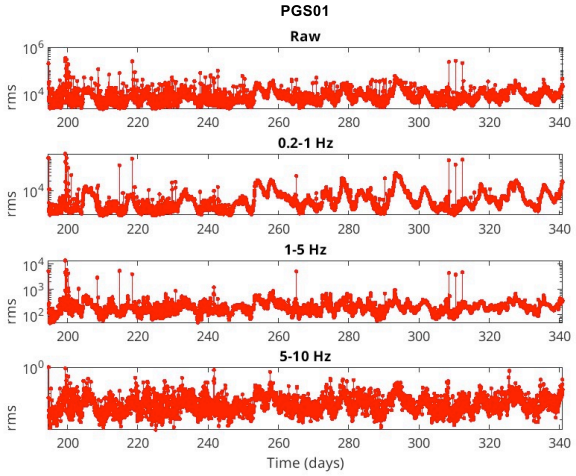
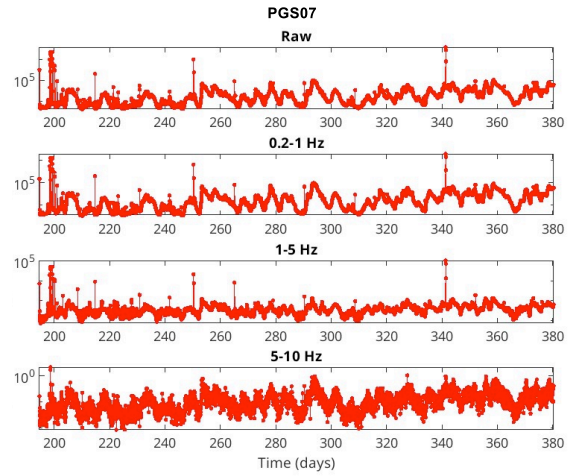
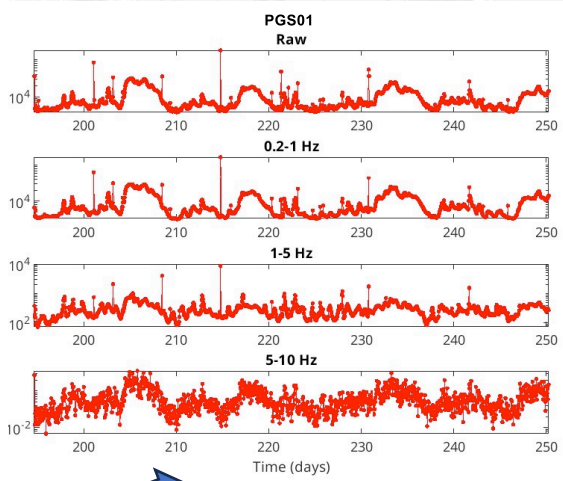
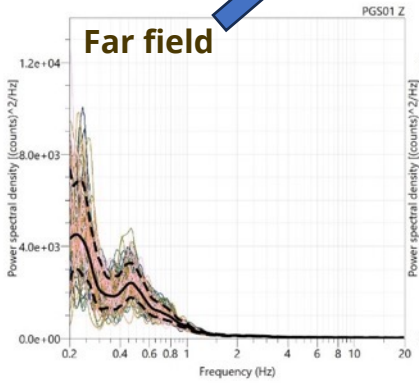
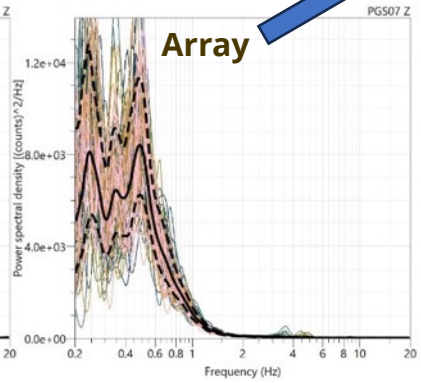
Preliminary results (3/6): Seismic noise spectra

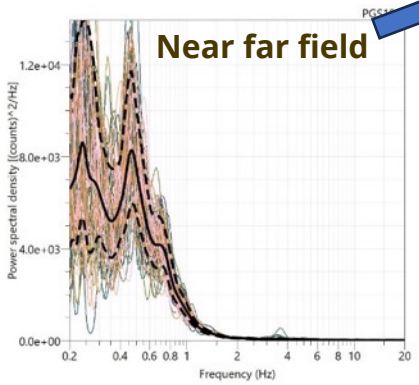






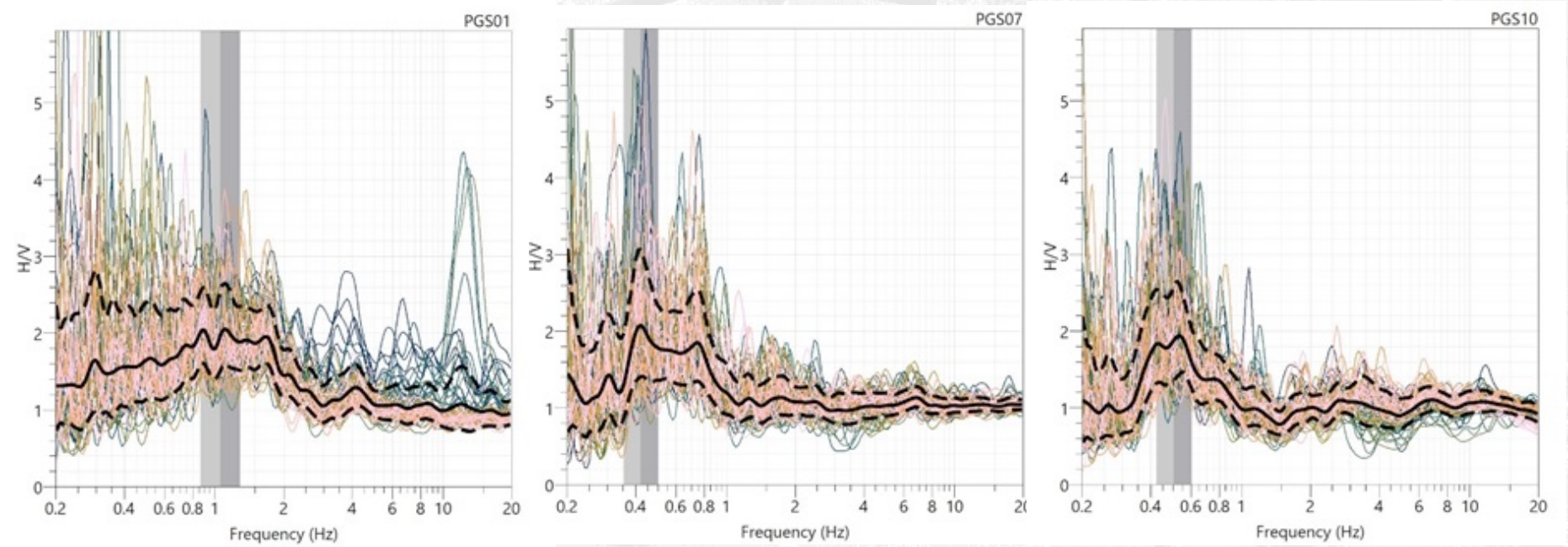






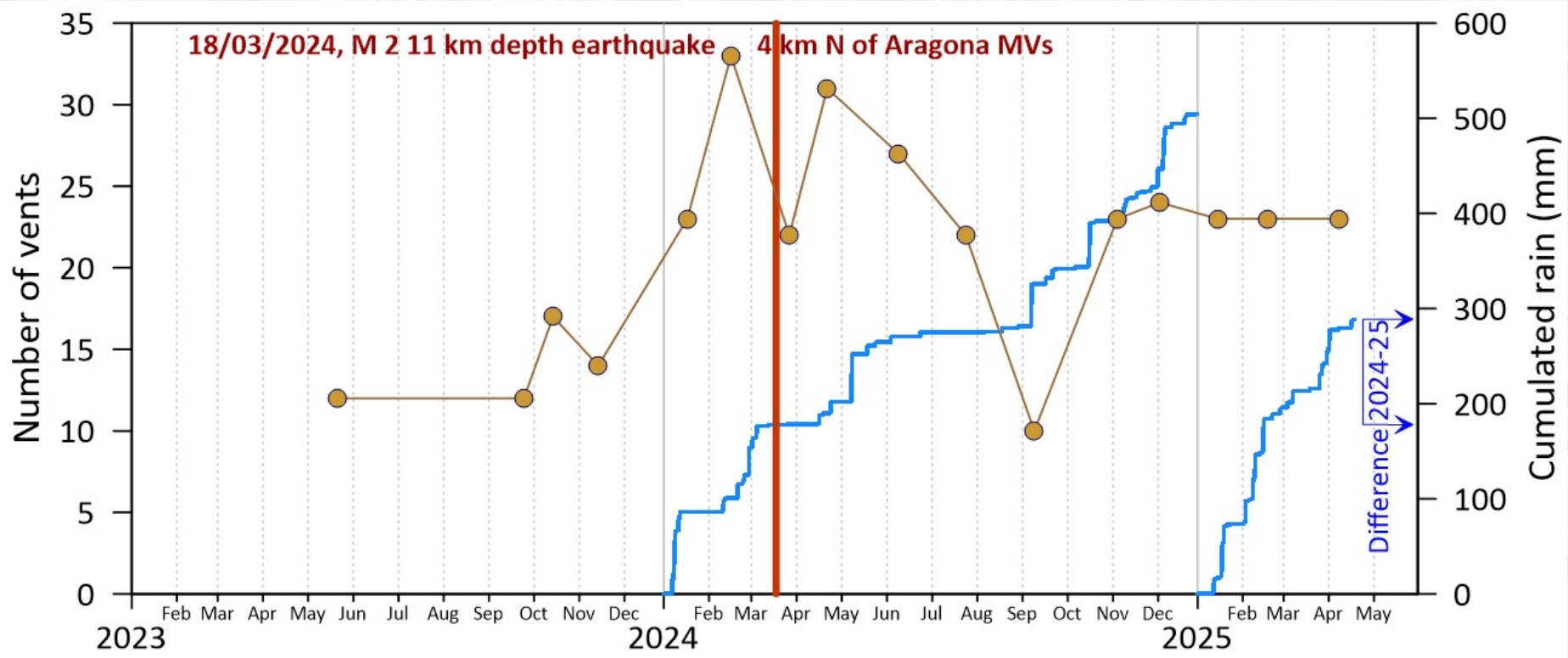
- Spectral amplitude higher closer to the vent field
- Periodicities on daily, weekly and fortnightly time scales to be investigated

Preliminary results (4/6): Nakamura (H/V) spectral ratio

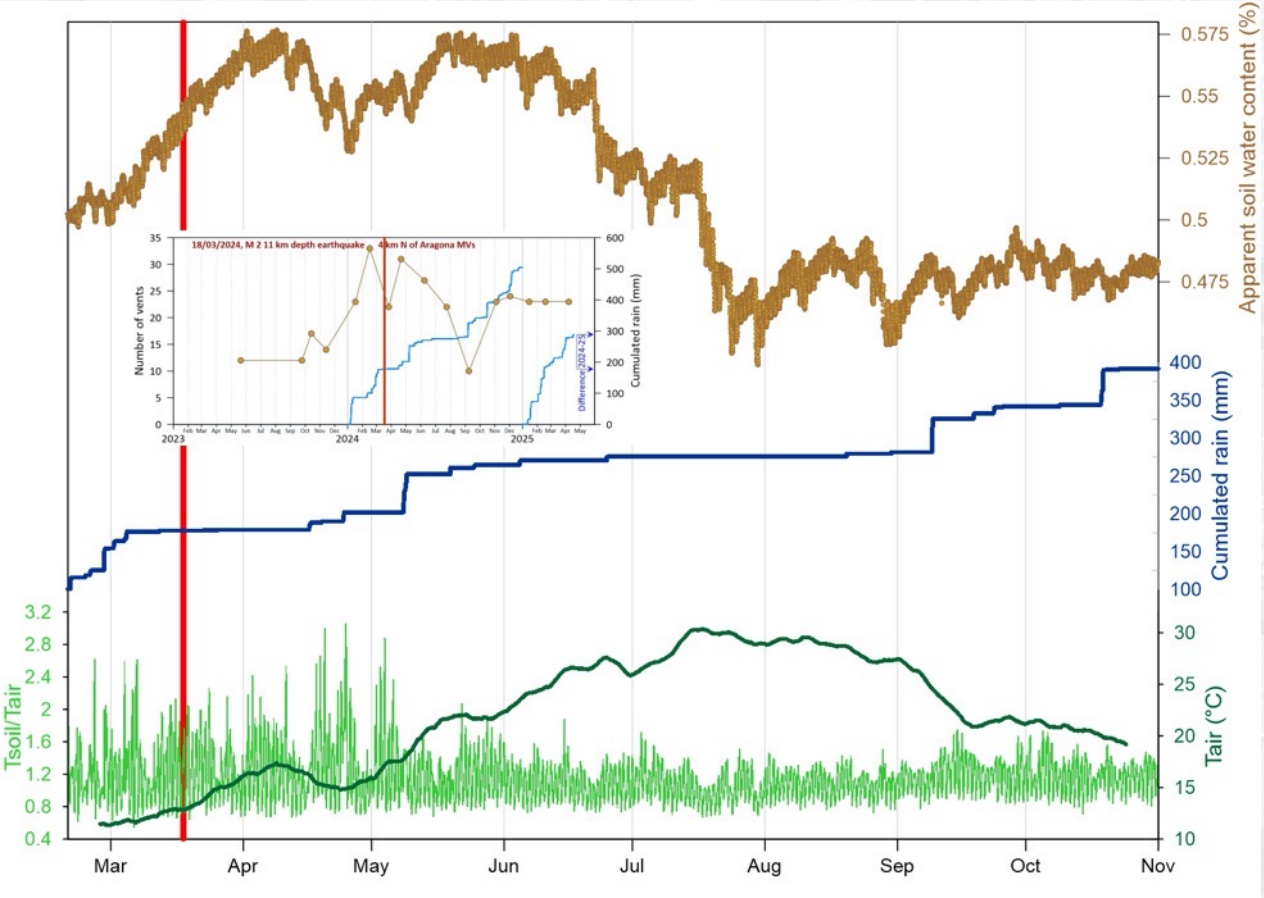


No evident amplification in & out the vent field

Preliminary results (5/6): Discrete surveys - Number of vents



Preliminary results (6/6): Near real time monitoring



- Two different styles, independent of the hydrological regime, at the time of the earthquake and in the following months.
- Apparent soil water volumetric content as a proxy of vent number and, in turn, of mud flux

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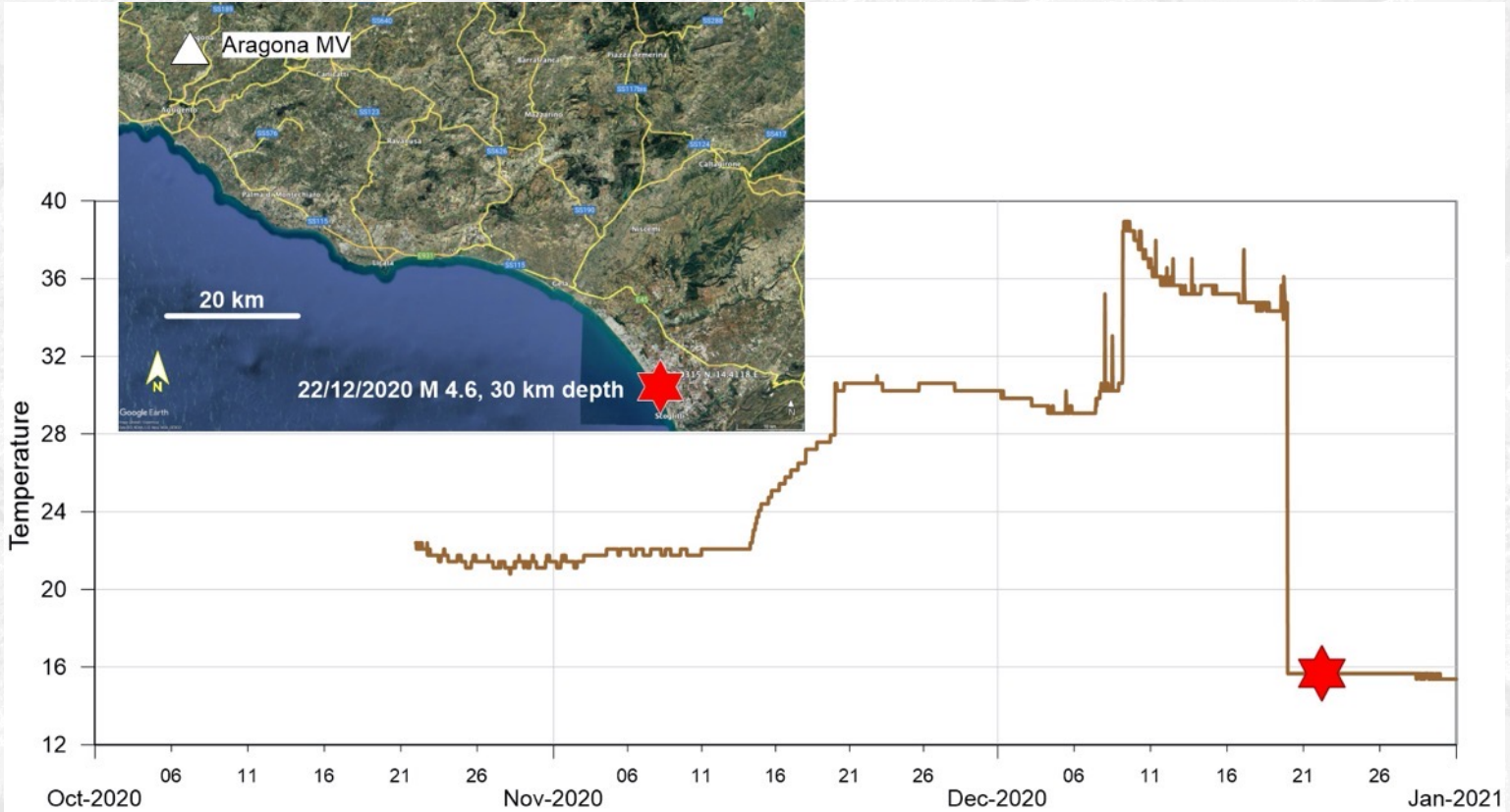
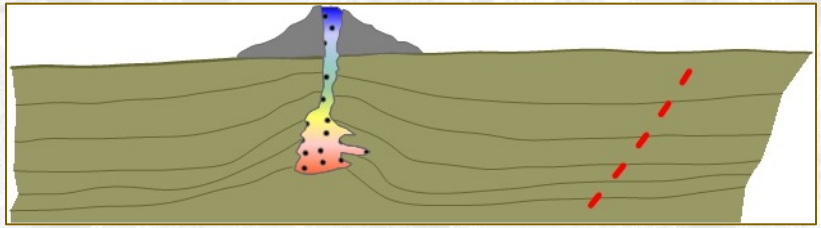
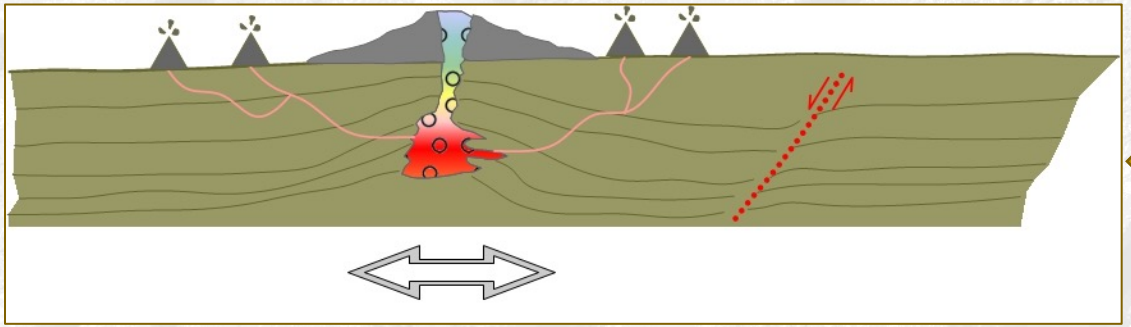
A previous case: the December 2020 M 4.6 earthquake



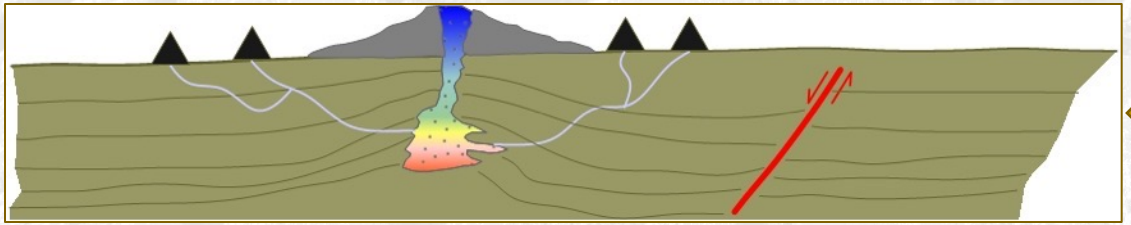
Changes in the stress field, MV & seismic activity



Phase A
Background MV activity and dormant normal fault



Phase B
- Tensile stress field
- Increment of permeability/fracturing
- Increment of mud flux & T
- Formation of new vents
- Aseismic deformation along the fault



Phase C
- Strain release & seismic rupture
- Decrement of mud flux & T
- Deactivation of new vents

Crustal Transient Theory (Bernard, 2000)
During Phase C seismic rupture & changes in MV activity may occur in any possible relative timing.

Summary of preliminary results

- Technical remark: better avoiding buried instrumentation due to soil thrust.
- Polarization of seismic noise useful for individuating changes in spatial distribution of MV activity. Usefulness of discrete surveys, integrating fixed seismic networks, using Tromino®
- Apparent soil water content and number of vents give similar information as proxies of MV activity
- Near real time monitoring of soil water content and temperature, integrated by discrete surveys of number of vents, useful for evaluating the state of activity of MVs
- **New way to look at the relationship between seismic & MV activities: not only seismic triggering of MVs, but both expressions of wider (space, time) scale processes, as changes in the sub-regional stress field.**

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Thank you for your attention

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