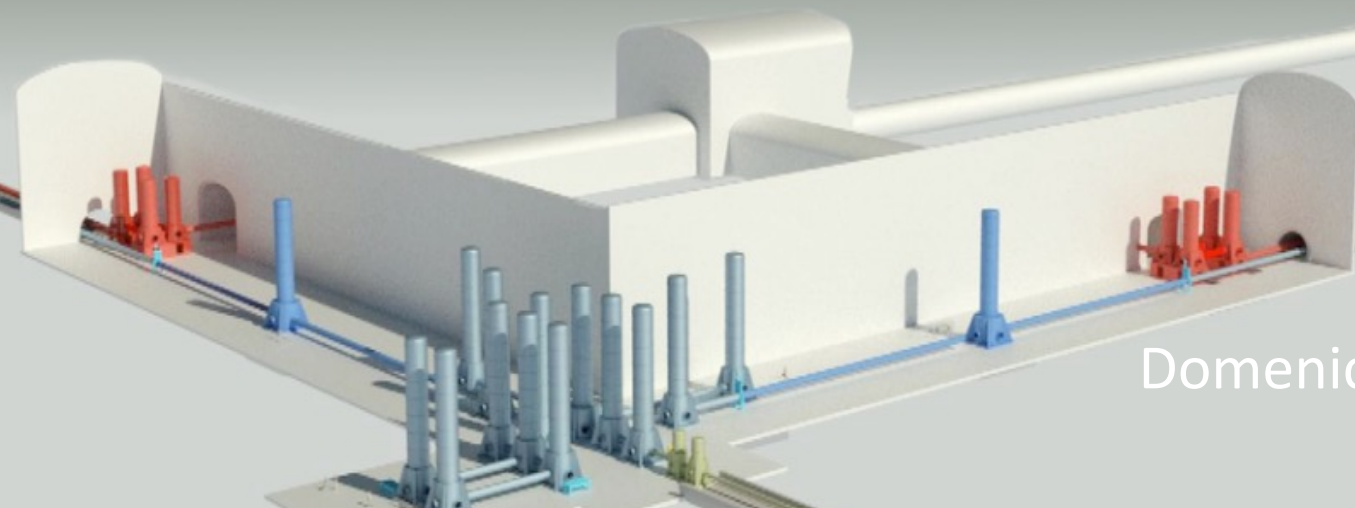


Site Characterization & Preparation Board contribution to Civil Eng.



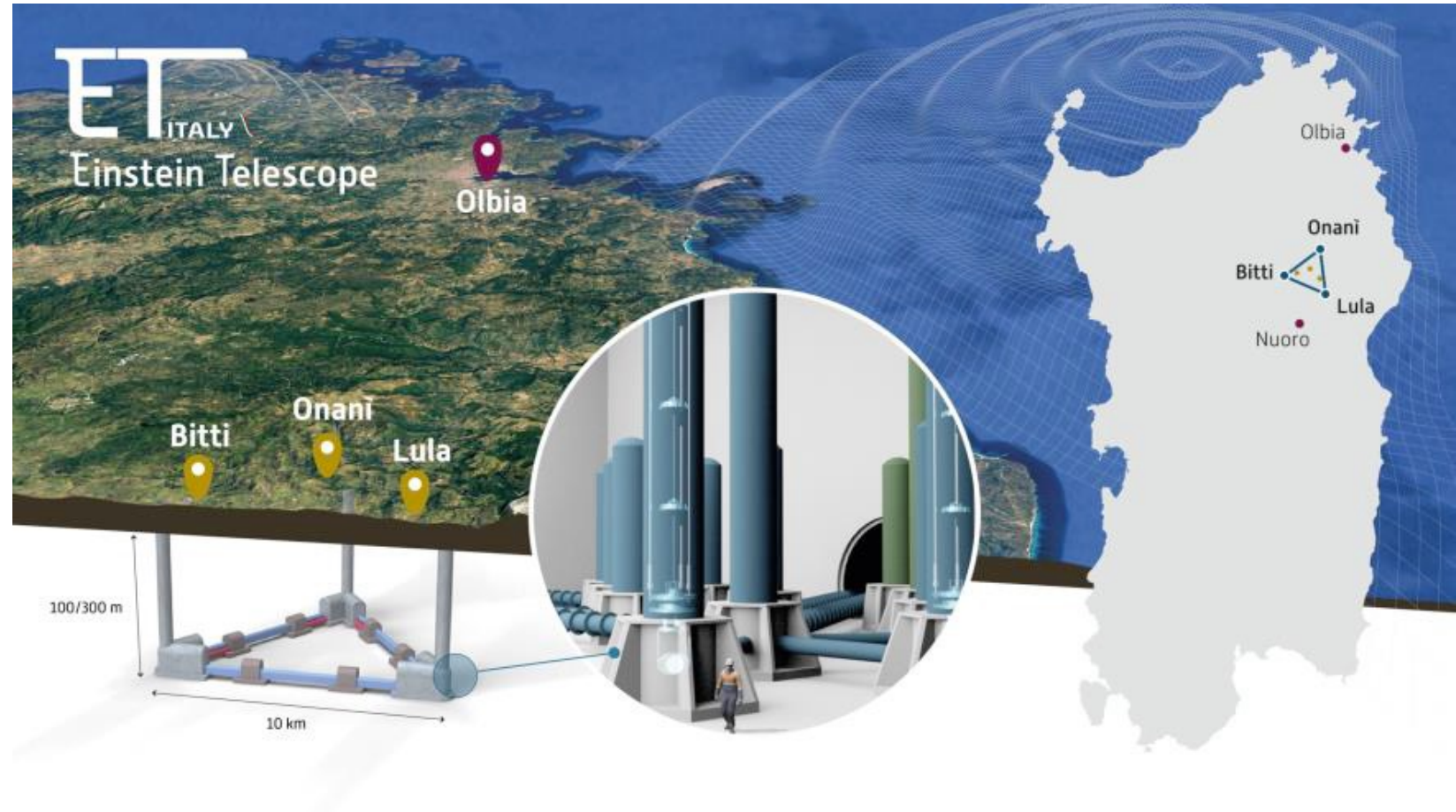
Domenico D'Urso

Sardinia

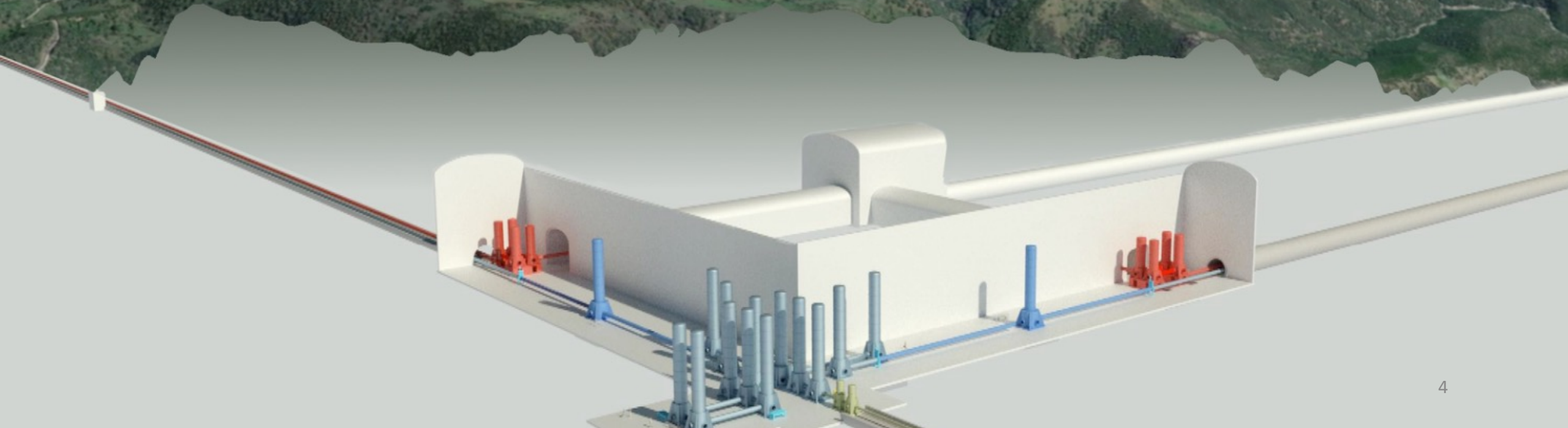


The Italian Site – Sos Enattos area

- Sos Enattos: former mine with underground access guaranteed through tunnels and shaft
- In the area of the mine, the SARGRAV laboratory, a seed of ET, aims to host underground experiments, cryogenic payloads, low frequency and cryogenic sensor development that need low seismic and anthropogenic noise

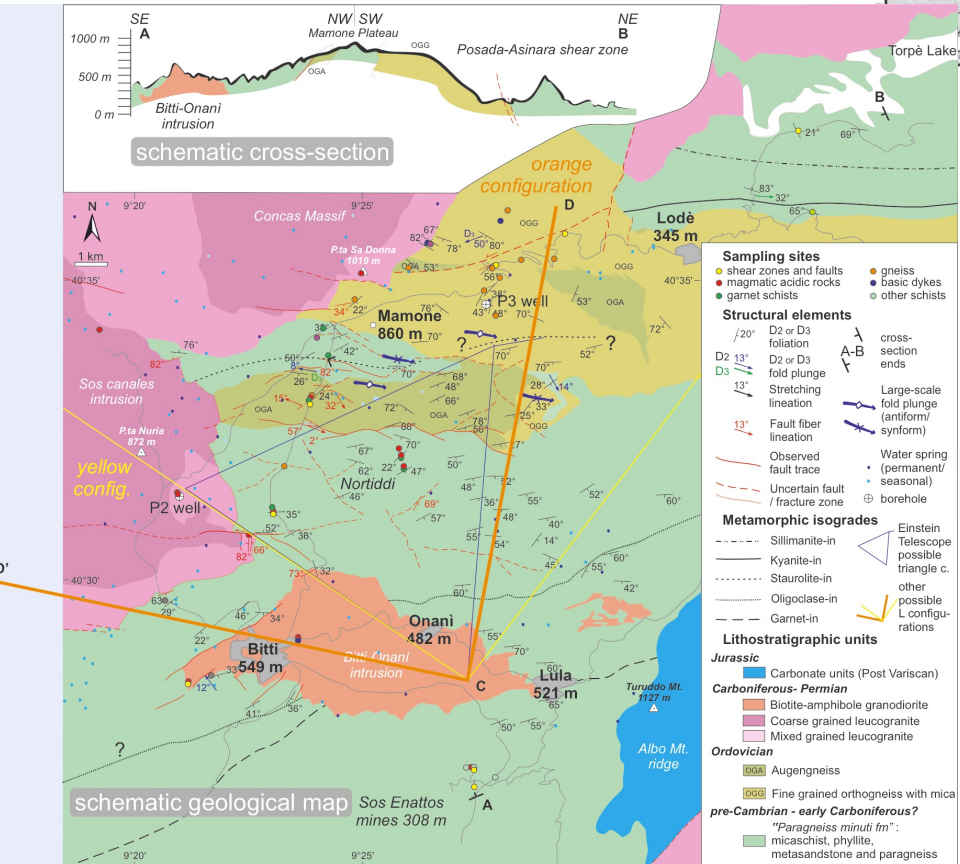
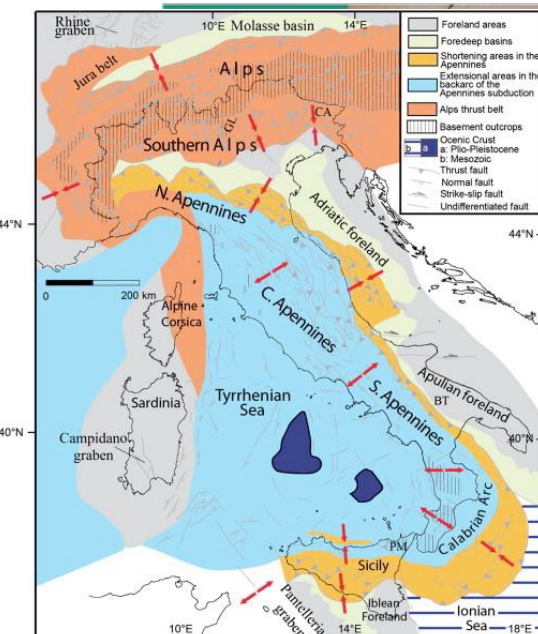
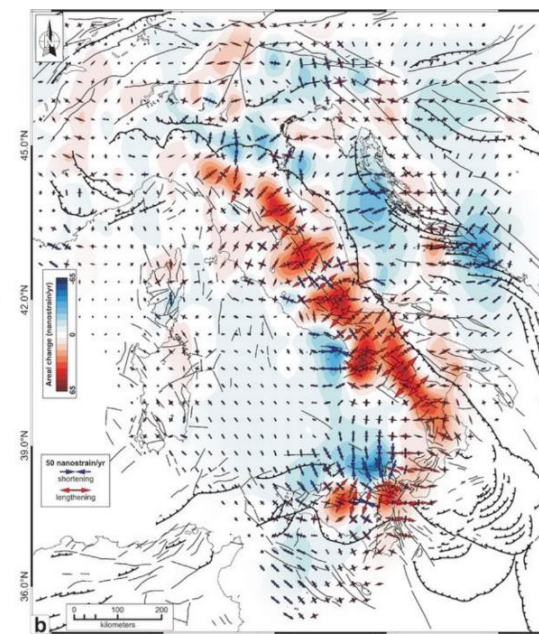
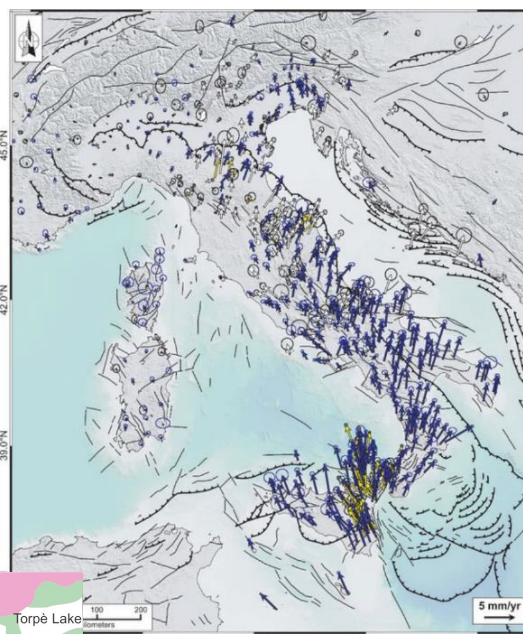


Input from site characterization: Geological framework

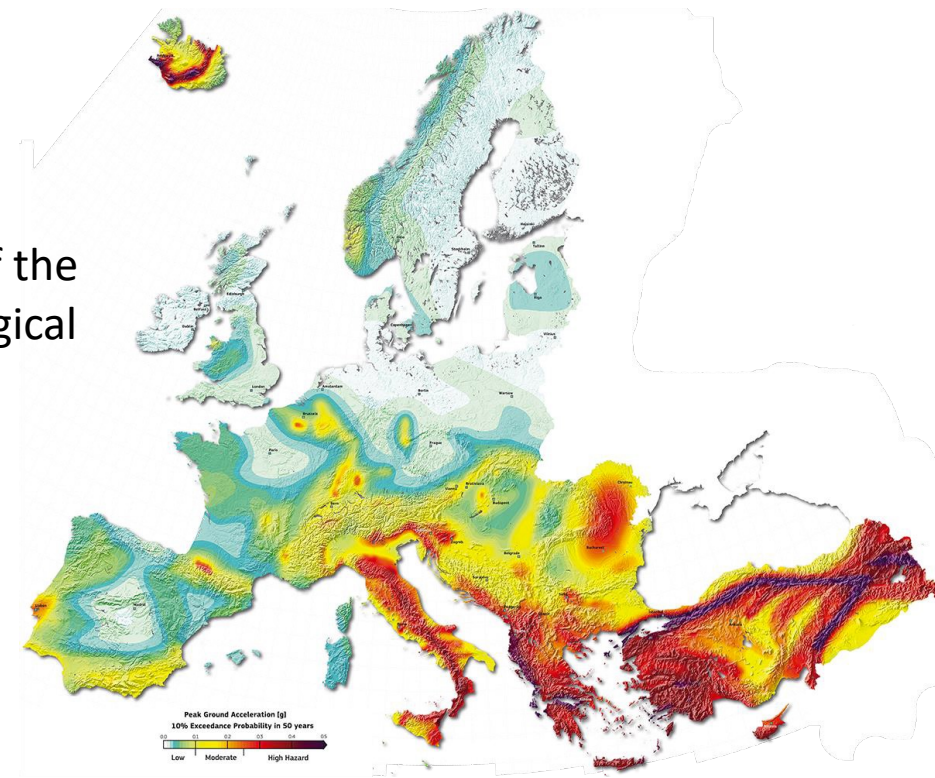


Geological framework

- Corsica-Sardinia microplate is very stable → low crustal deformation
- No significant seismic activity



- Lithologies: Orthogneiss, granitoids, micaschists.
- On going geological survey of the area and review of the geological maps.



A NEW STRUCTURAL MAP

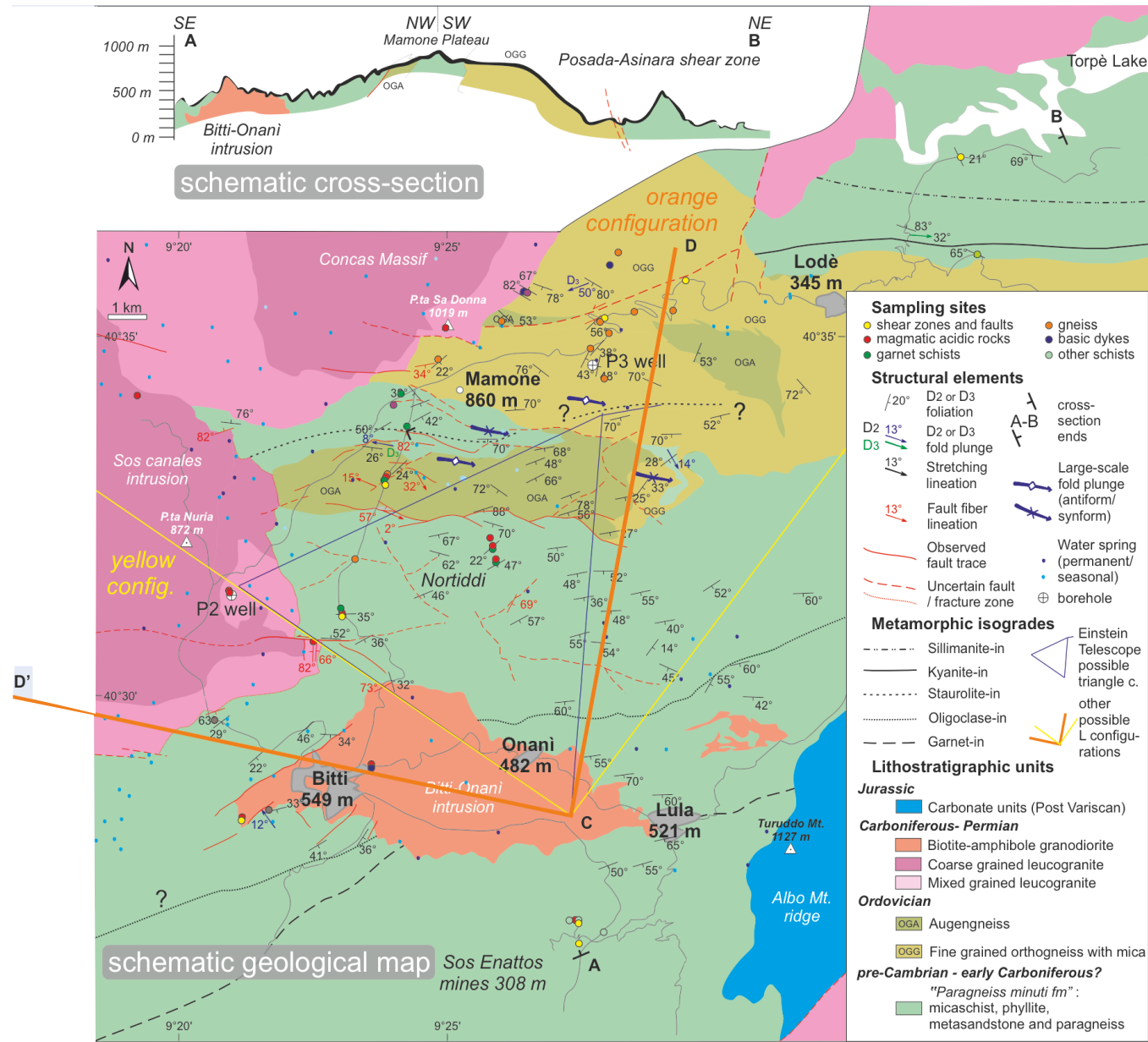
We have

- merged the lithologic information from published maps
- retraced limits also using satellite info
- added new data

Faults often overprint main lithological boundaries of **late orogenic** fold structures.

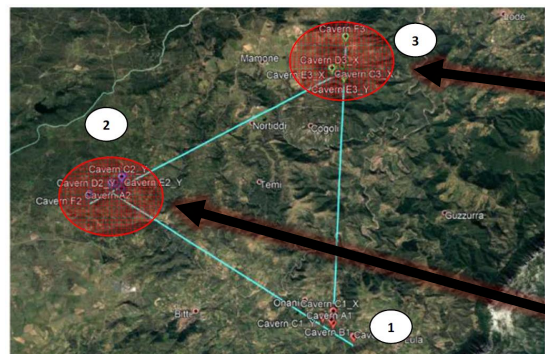
Faults are locally associated in orientation and composition to the edges of main **post-orogenic** intrusive bodies.

Credits to L. Cardello

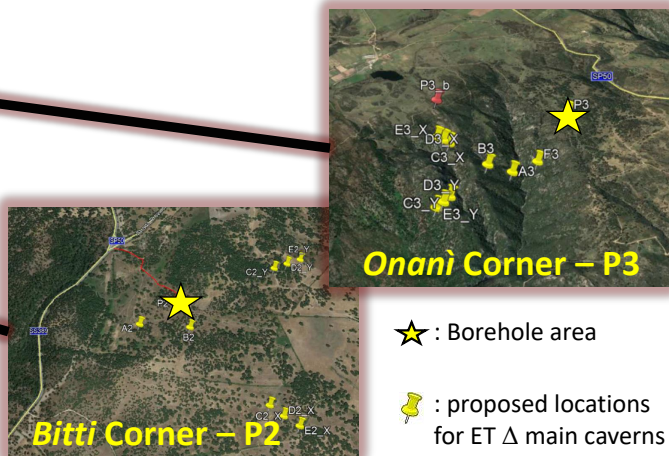


P2 and P3 sites

In July 2021 we started the surface and underground seismic, geophysical and environmental measurements at the other two corners (named after the local municipalities of *Bitti* and *Onani*).



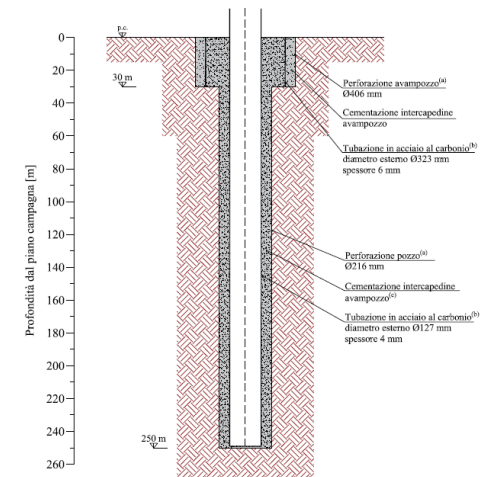
P1 - Lula Corner – Sos Enattos



★ : Borehole area
📌 : proposed locations for ET Δ main caverns

Borehole preparation

- Excavation of two boreholes at the corner points P2 (-270m) and P3 (-260m). The drilling and consolidation of the boreholes has been started in April 2021 and completed in July 2021.
- A steel pipe was inserted into the borehole and cemented to the surrounding rocks. An optical fiber strainmeter was fixed inside the concrete (see A. Rietbrock's talk).
- Final inner diameter: 119mm.
- Pressure test passed in both cases.



*see C. Rossini's talk

Geophysical logs

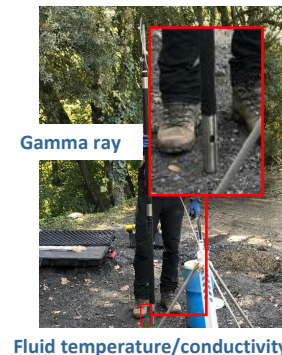
Logs were made right after the drilling and before the consolidation of the borehole with the steel pipes.

Probes:

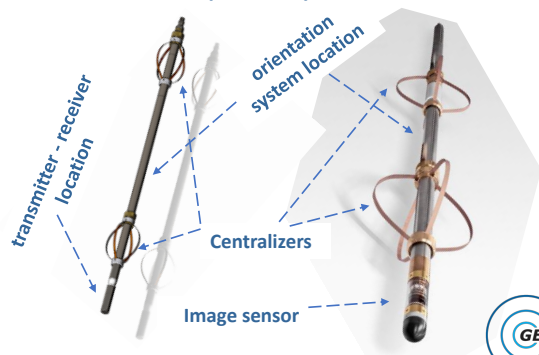
QL40 Caliper



QL40 Gamma and FTC stacked



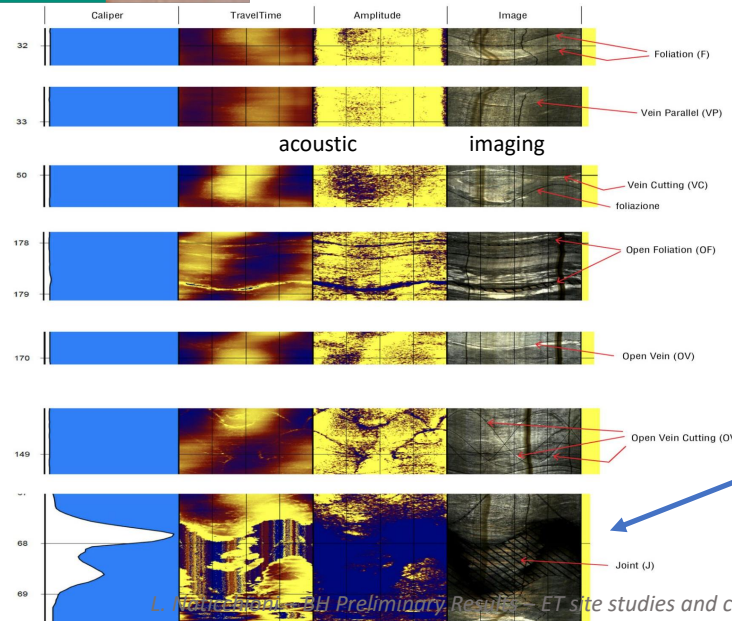
QL40 ABI 2G (acoustic)



QL40 OBI 2G (image)



Geophysical logs



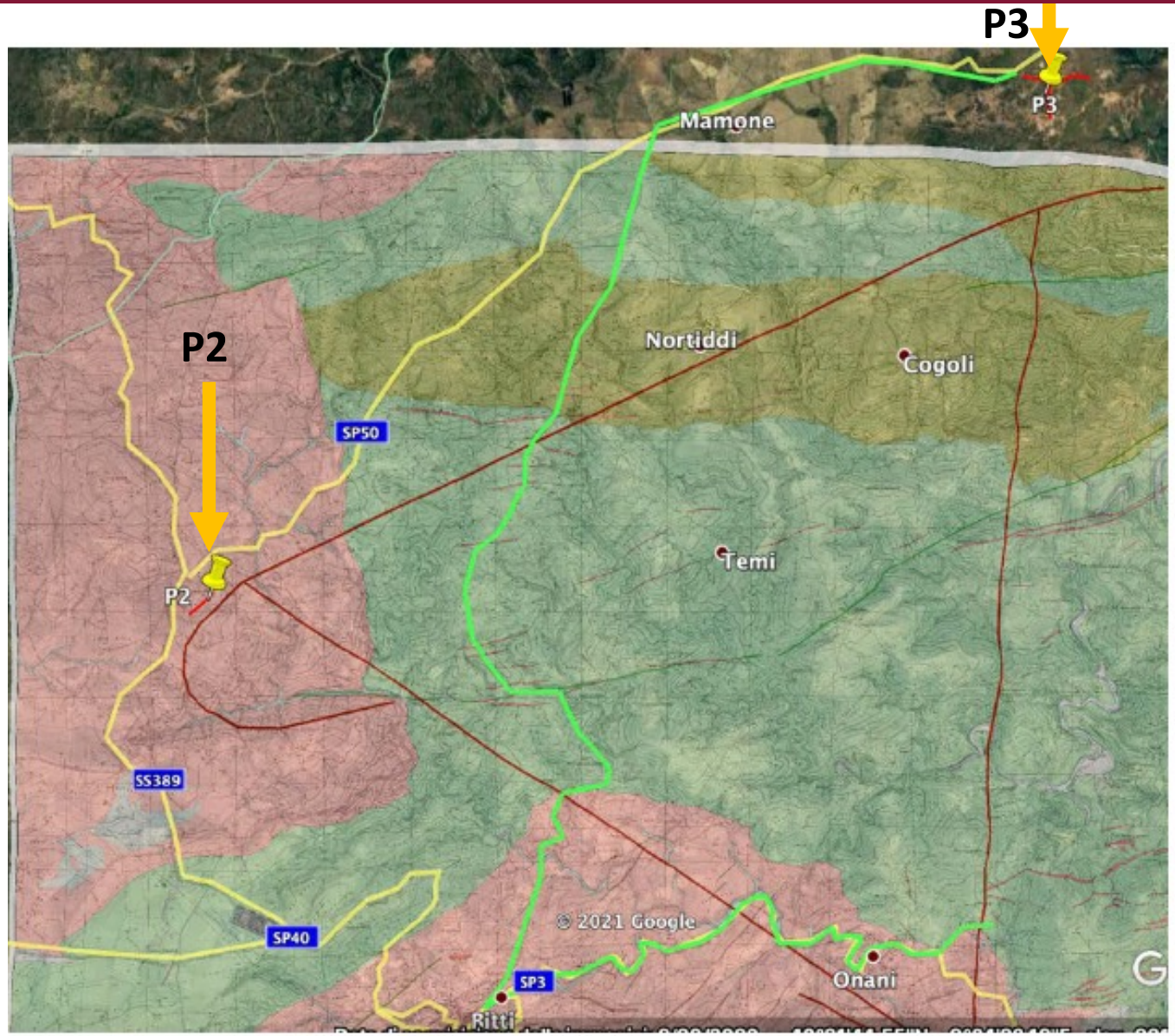
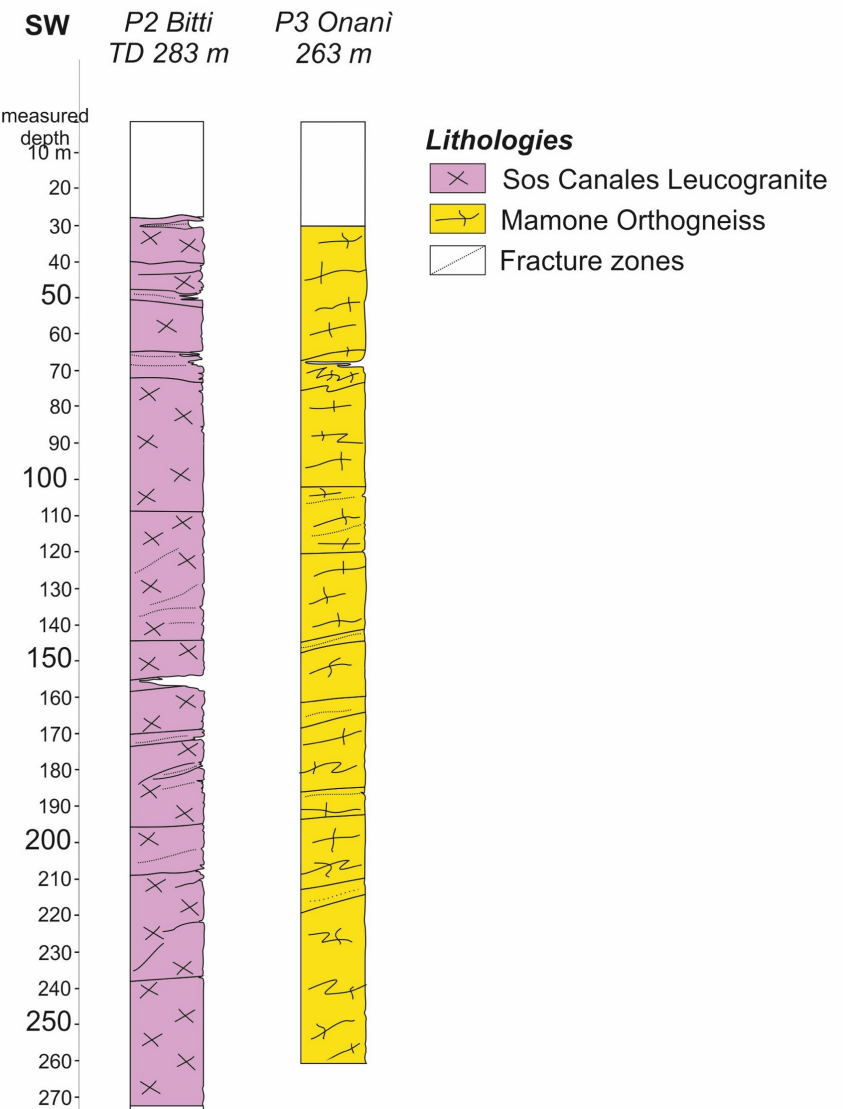
Example of discontinuities encountered in the P3 borehole and interpretation:

- Small-aperture discontinuities
- Large-aperture discontinuities



BOREHOLES

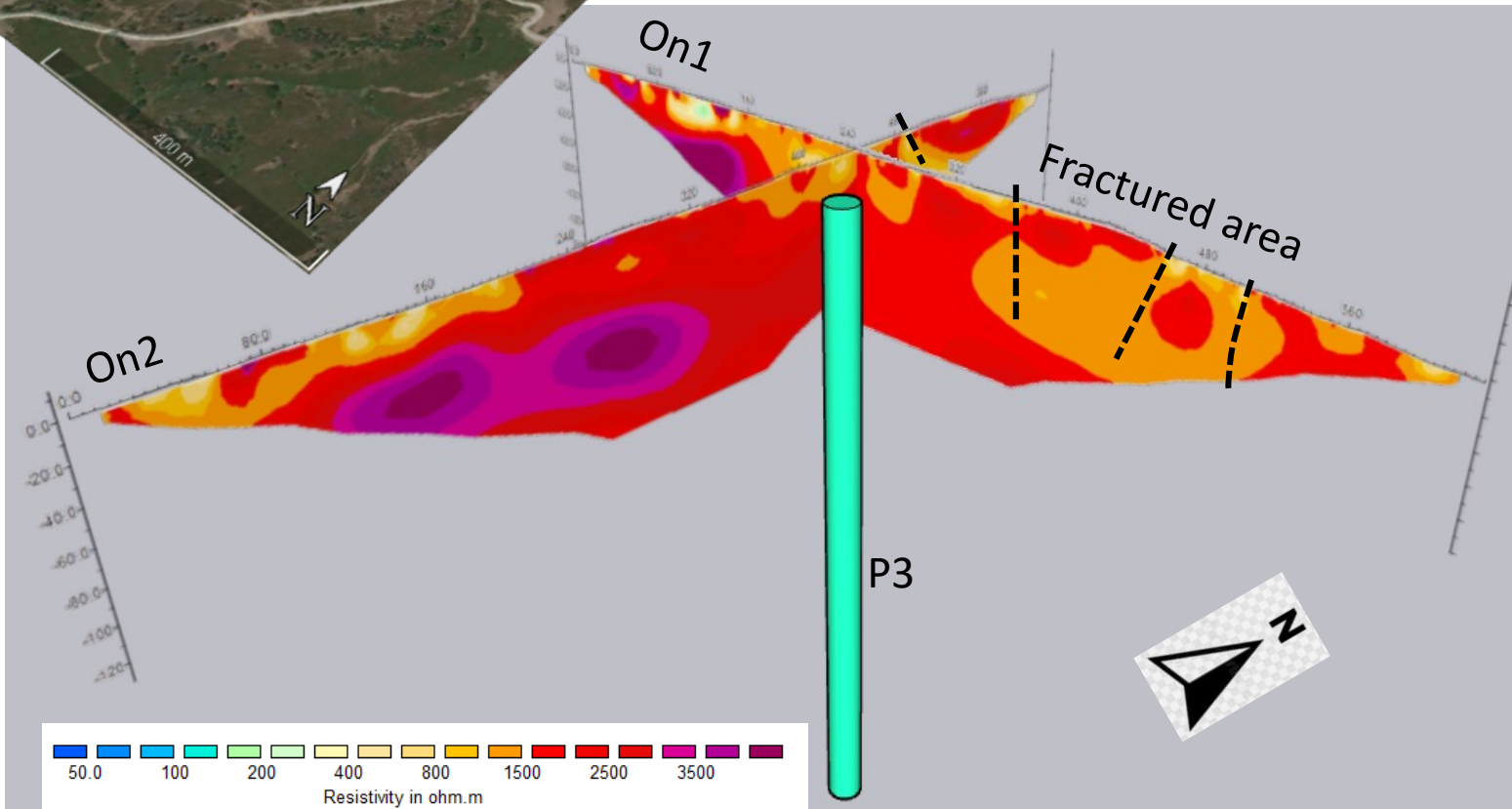
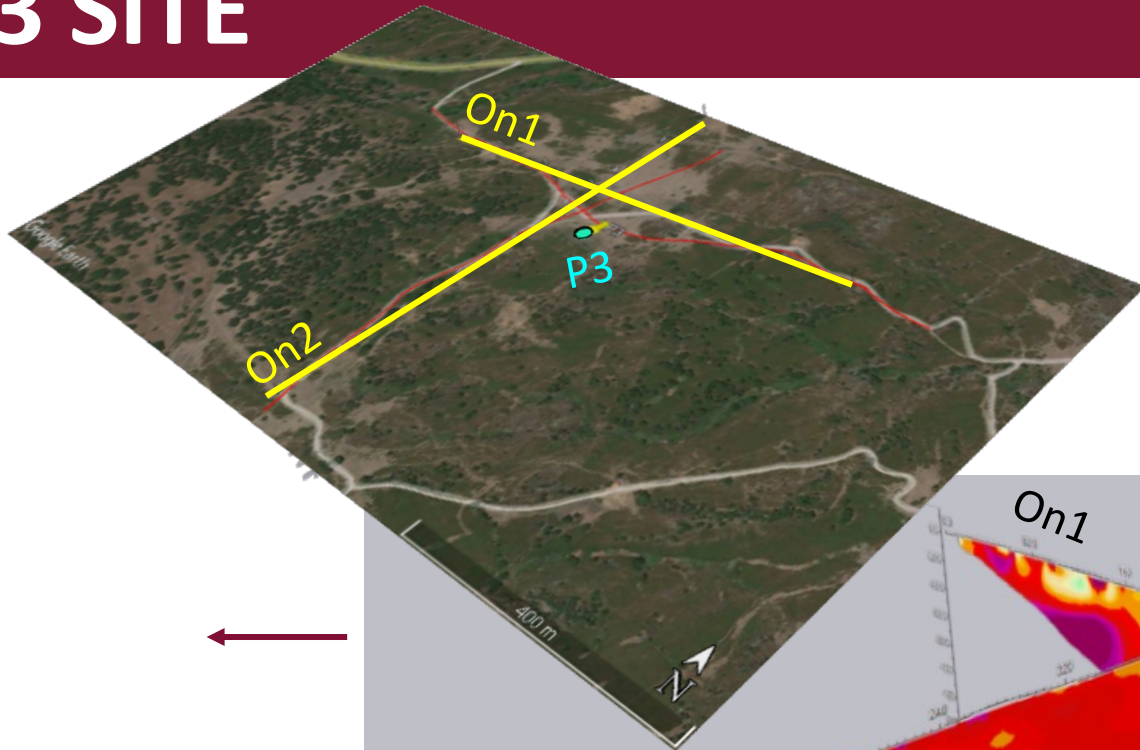
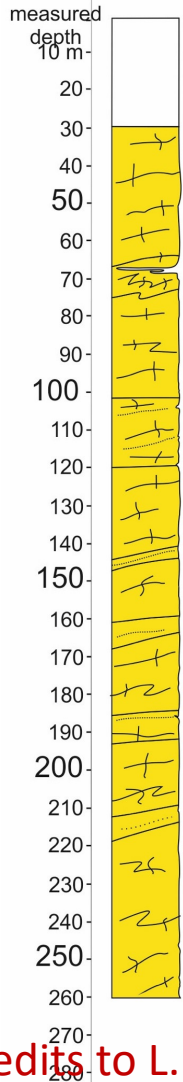
Borehole composition at P2 and P3 sites



ERT P3 SITE

the geometry of fault and fracture systems is of limited extension and interconnectivity

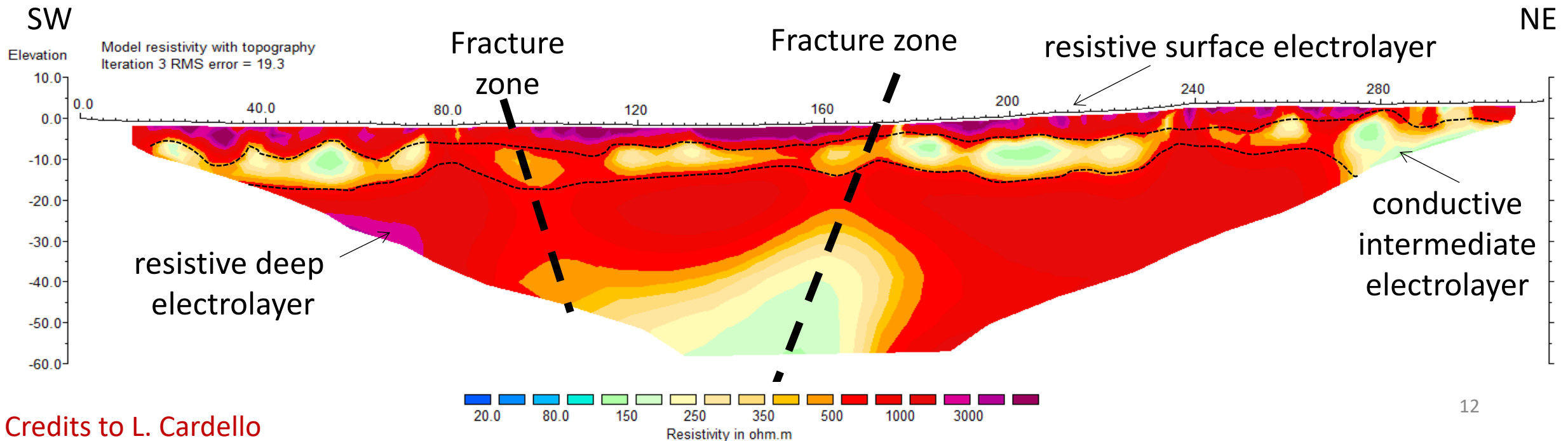
SW 3 Onani
263 m



ERT P2 SITE

The tomography of the Bitti vertex shows a stratified resistivity array composed of:

- i) a near-surface resistive electrolayer
- ii) an intermediate conductive layer
- iii) a resistive deep electrolayer, which is characterized by a large deep conductive anomaly that is bounded by suddenly graded fault-related resistivity drop



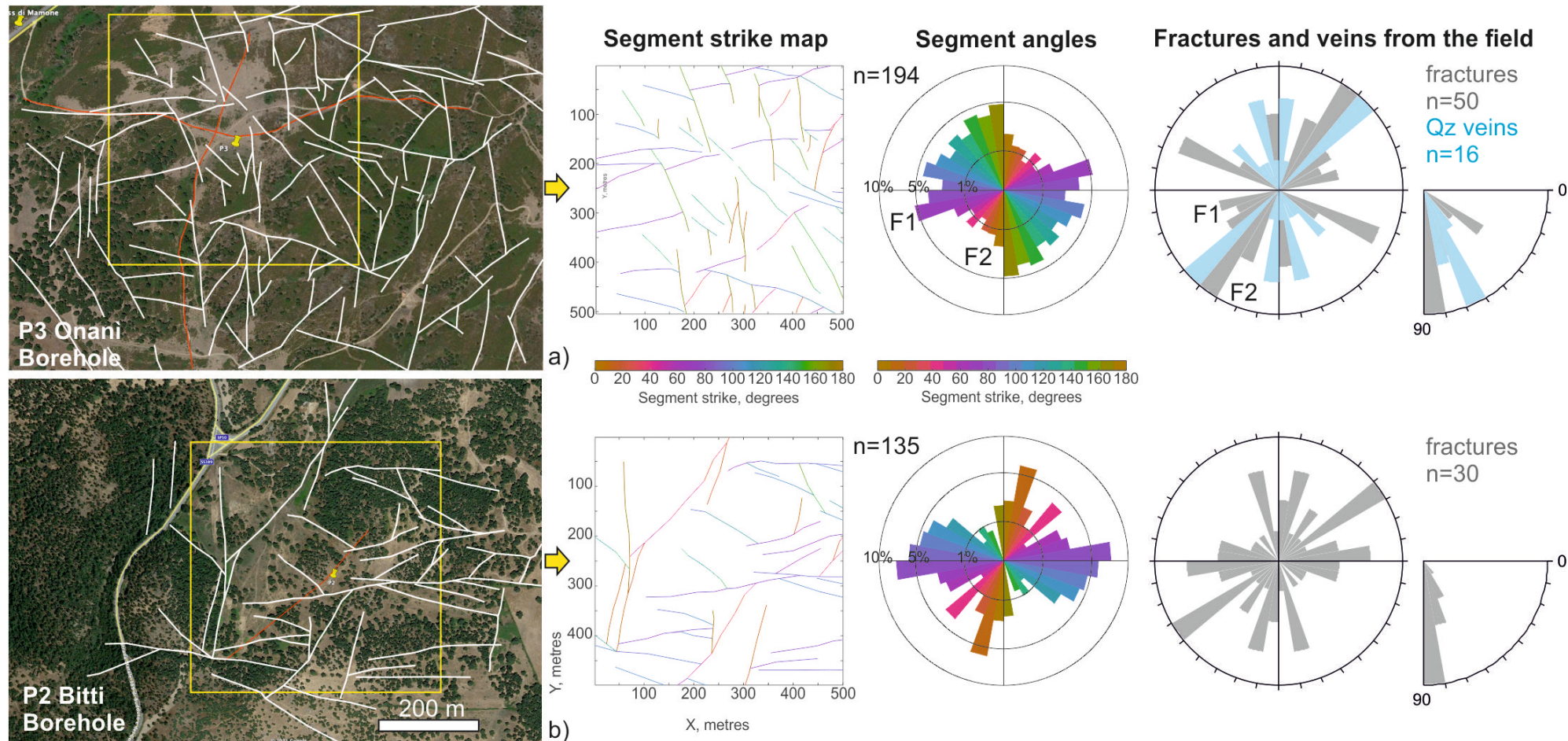
FAULT CONTACTS and ARENIZED PERMEABLE GRANITS

*Arenized cataclasite along
high-angle faults
40° 32'56"N; 9° 23'58" E.*



MORPHOSTRUCTURES AND STRUCTURES

Morpho-structural segment trace maps at P3 and P2 boreholes were created after interpretation of satellite images, used to estimate fault segment orientation using FracPaQ. On the right, comparison of stereographic projects of both interpreted segments and measured fractures in the field.

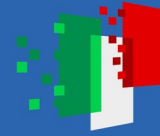




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ET sustainable design

- Modeling and Layouts
- Preliminary cost estimate (excavation)
- Evaluation of TBM configuration and tunnel monitoring
- Preliminary indications on the management of excavated lands and rocks
- Preliminary strategy on the management of excavated soil and rock
- Tender of the PNRR ETIC project for the preliminary feasibility study for ET in Sardinia (14 Million of euro , to be assigned by dec. 2023 and delivered by dec. 25)
- Assumptions: ET located in the area of Sos Enattos (NU, Italy), considering both triangular (six interferometers inserted in a system of tunnels and caverns with an equilateral triangle layout on a side about 11 km) and L shape (two interferometers inserted in a system of tunnels and caverns with an 'L' layout on a side about 16 km) configurations.

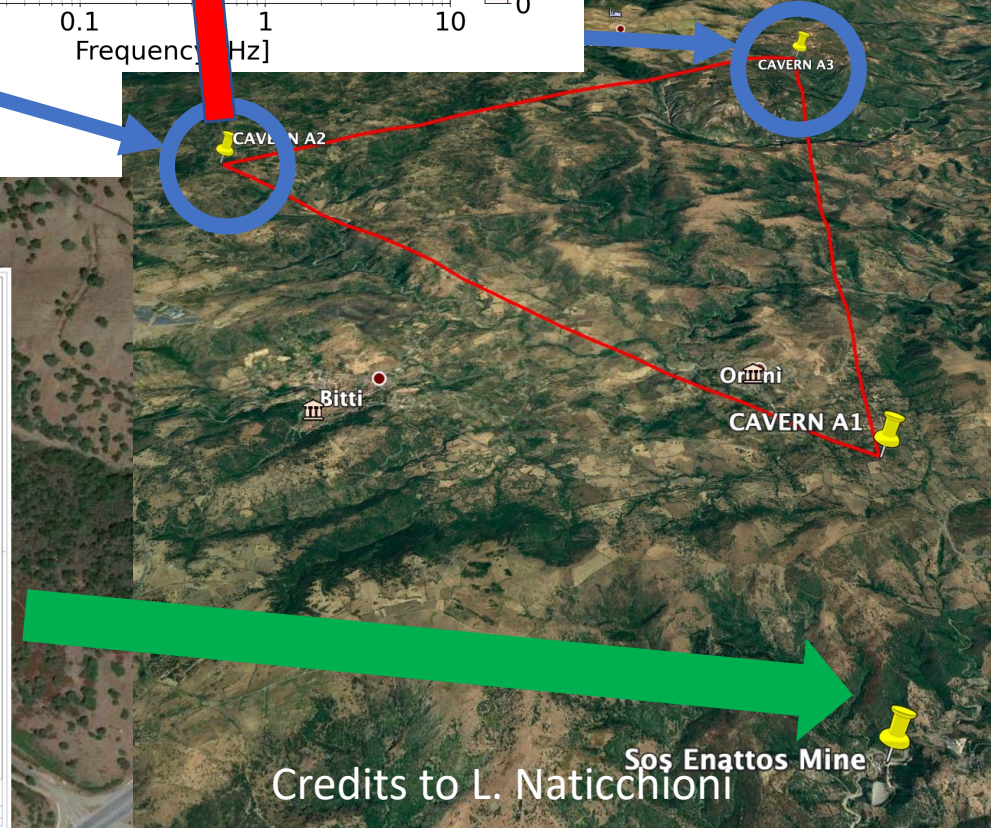
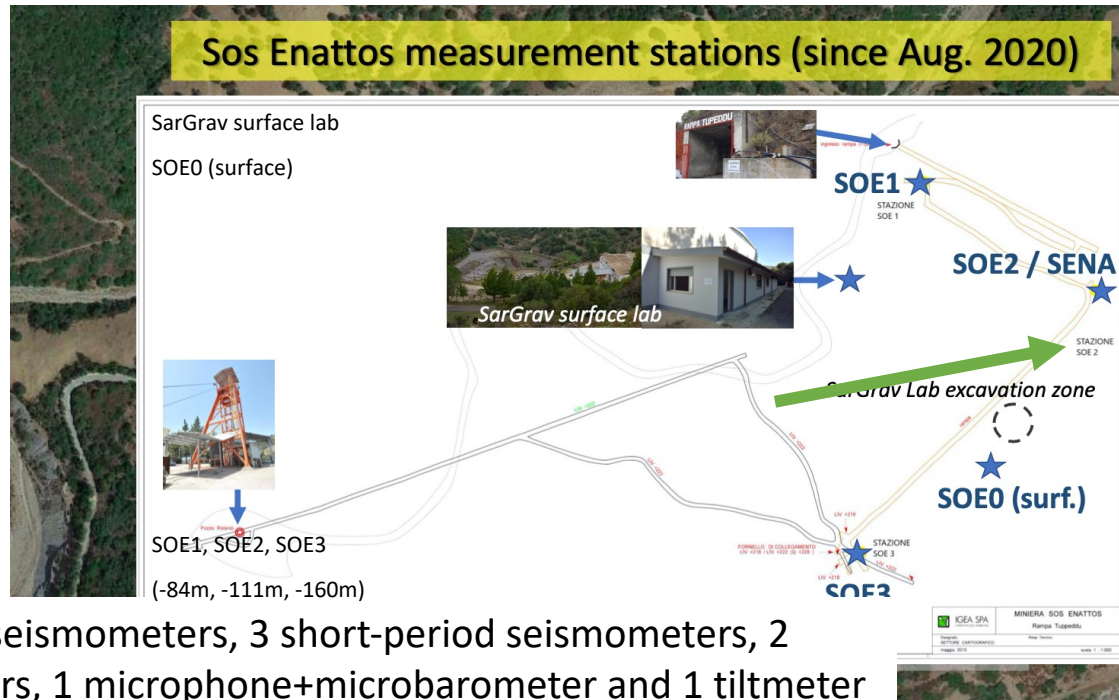
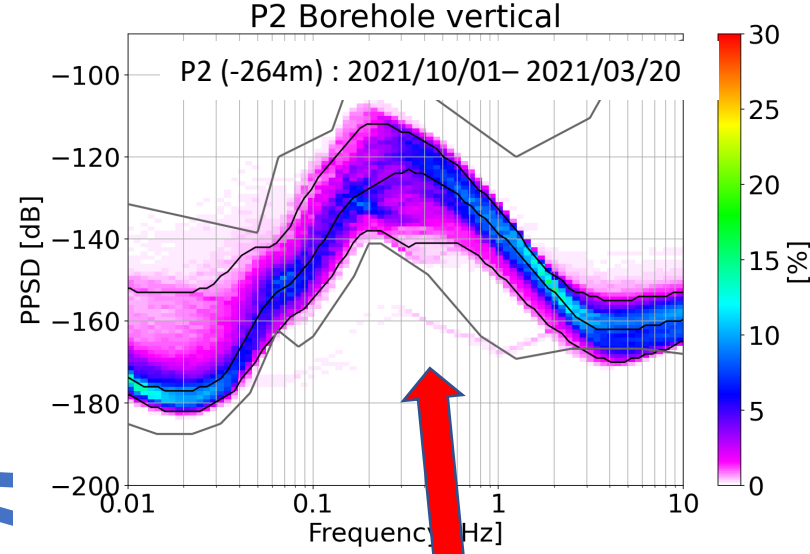
**Input from site characterization:
Constraints on detector localization &
potential local source noise and
mitigation needs**



Sardinia Site

Long-term measurements

Characterization of the Bitti and Onanì corners:
Surface and underground seismic and environmental measurements



Credits to L. Naticchioni

4 broadband seismometers, 3 short-period seismometers, 2 magnetometers, 1 microphone+microbarometer and 1 tiltmeter distributed over underground and surface stations

Potential noise sources

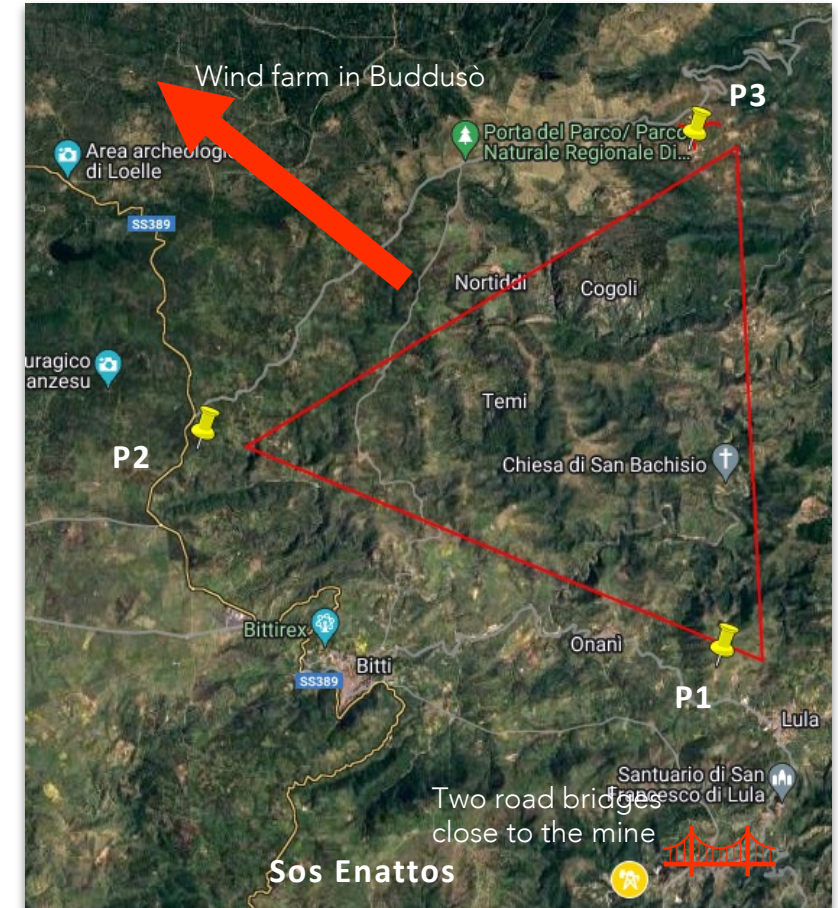
We identified some potential noise sources, both of natural and anthropic origin. Some of them have been clearly identified and characterized. Other are still being investigated to assess their contribution to the overall background noise in Sos Enattos.

➤ Natural:

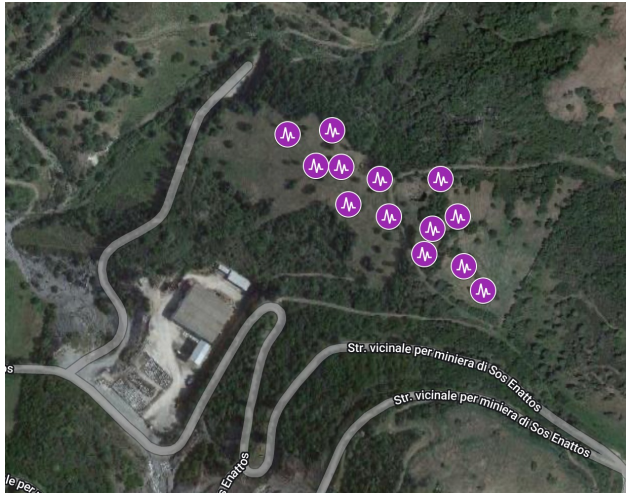
- microseisms;
- wind;

➤ Anthropic:

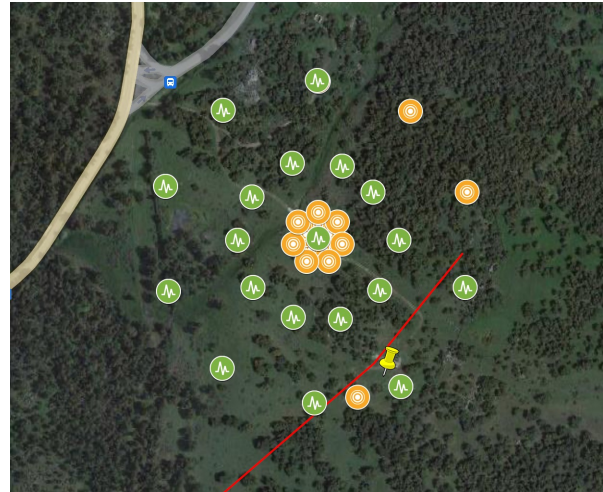
- day/night cycle from human activities (mainly farming activities);
- two road bridges in the neighborhood of the mine;
- wind farms;
- no other relevant infrastructures in the area.



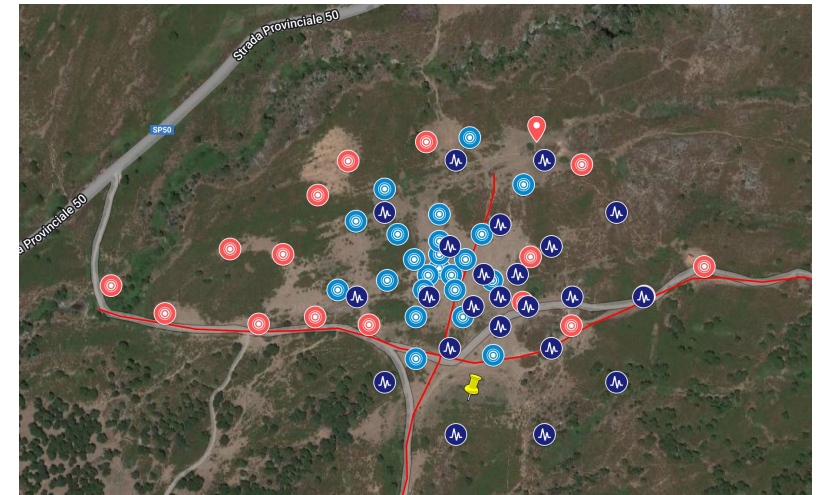
Temporary Deployments



Sos Enattos - Broadband array (January 2021)

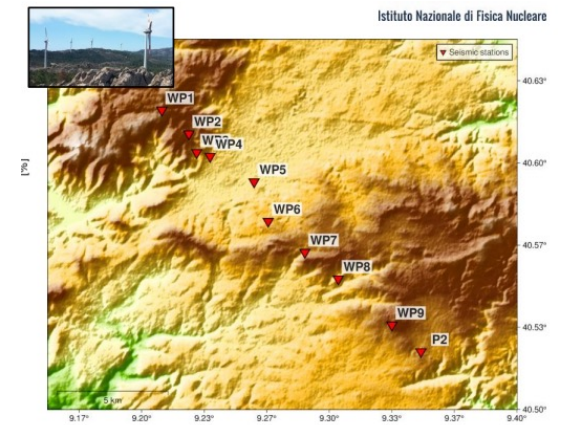


P2 broadband array + geophones (September 2021)



P3 broadband array + geophones (July & Oct 2021)

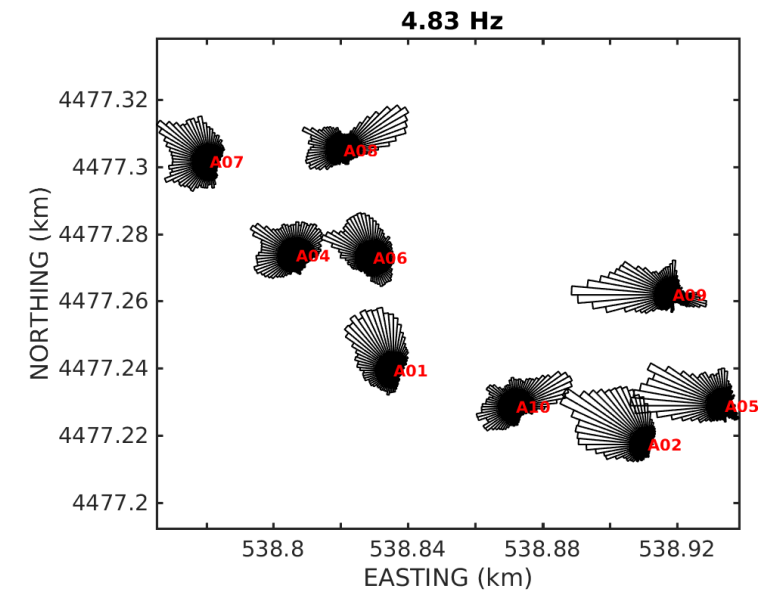
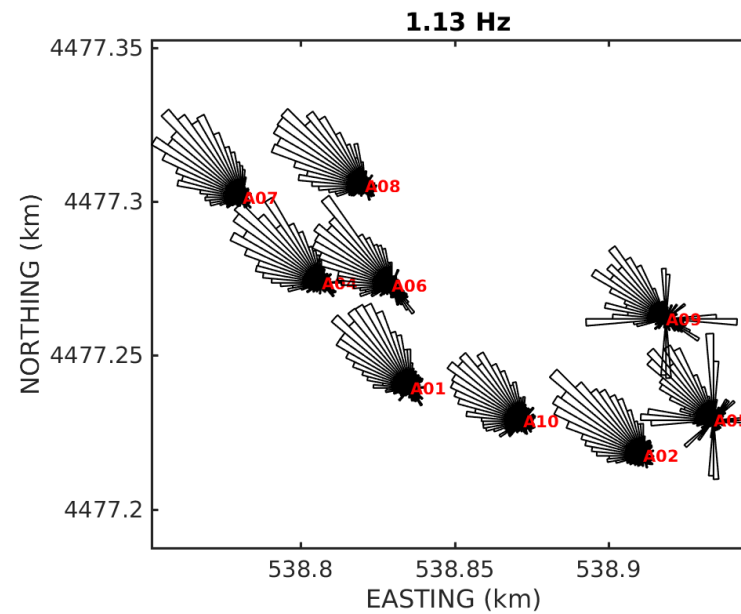
Aimed at characterization of the corners for seismic noise properties and NN purposes (correlation analysis).



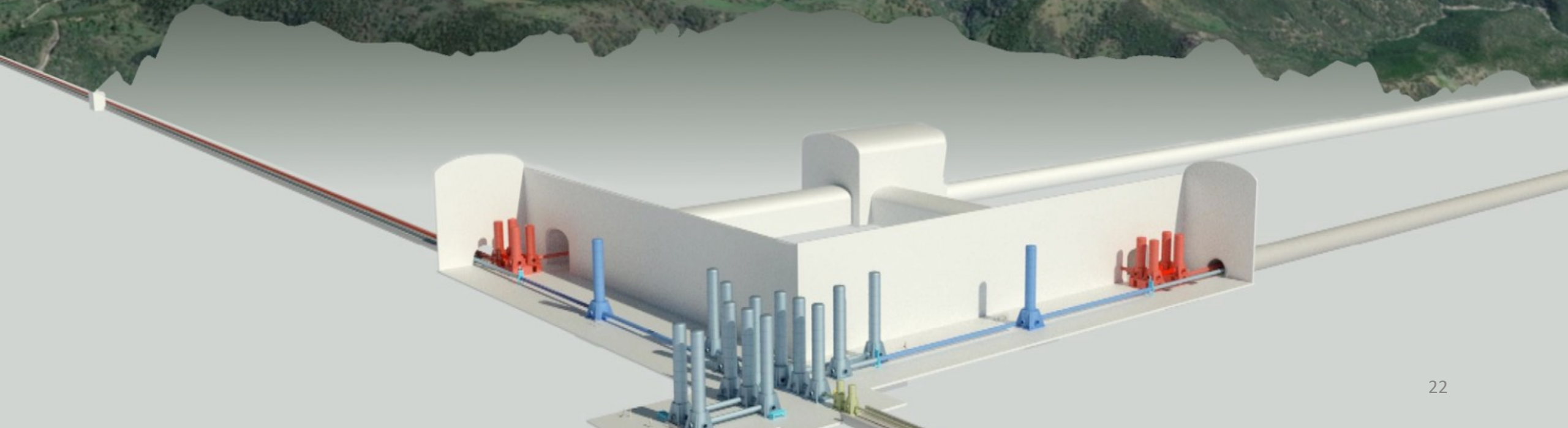
Broadband array (early 2023)

Ambient noise (natural sources)

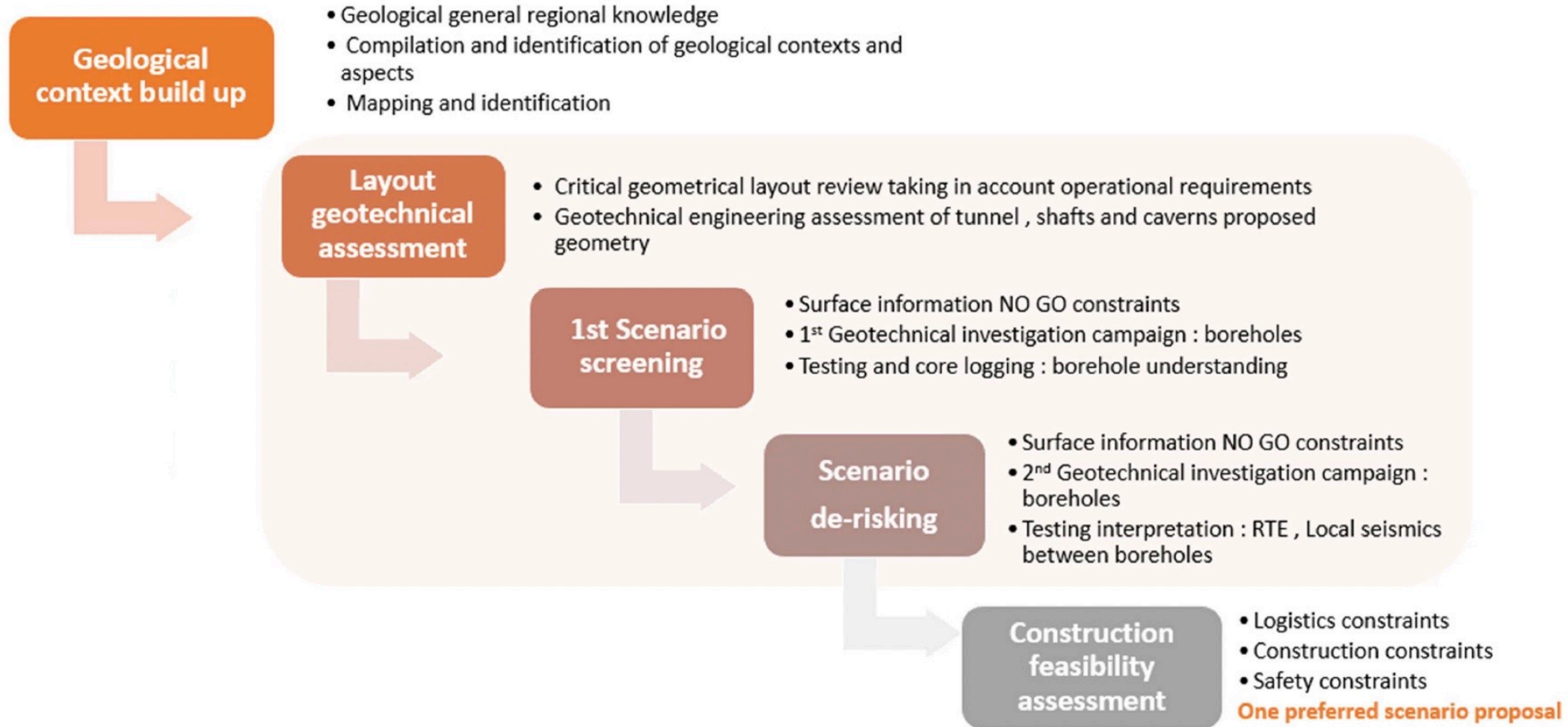
Array analysis confirms the direction of microseismic noise at low frequencies. At higher frequencies, the variability of polarization directions throughout the array deployment indicates a strong influence of topography.



EMR



Synoptic stepwise approach



SCB / SPB Presentations

Wednesday 15 Nov, afternoon – Salle 101, IJCLab & online

14:00

EMR General overview and Organization

Wim Walk

200/1-101 - Salle 101, IJCLab

14:10 - 14:30

Completed, Ongoing & Upcoming Geo-studies EMR

Bjorn Vink

200/1-101 - Salle 101, IJCLab

14:30 - 14:50

EMR Noise Measurements, Active & Passive Seismic. Results and recommendations

Michael Kiehn

200/1-101 - Salle 101, IJCLab

14:50 - 15:10

15:00

Civil Engineering approach for EMR region

Patricia Lamas

200/1-101 - Salle 101, IJCLab

15:10 - 15:30

Discussions and Conclusions (Site Characterization strategy, Workshop, ...)

Domenico D'Urso et al.

200/1-101 - Salle 101, IJCLab

15:30 - 15:55