

Design and construction of two boreholes for seismometers installation in support of ET seismic characterization in Sardinia

Speaker

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CIVILE EDILE E AMBIENTALE



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INFN - CT

G. Schillaci



INFN

Physics department, Sapienza University of Rome

F. Ricci, P. Rapagnani, L. Naticchioni



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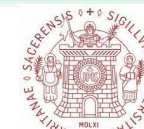


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CONTENT

- GENERAL OVERVIEW (location, geological settings, access, etc.)
- SENSORS REQUIREMENTS
- BOREHOLE CHARACTERISTICS AND CONSTRUCTION PHASE
- VERTICALITY CHECK
- SURFACE INFRASTRUCTURES LAYOUT
- TIME AND COST
- COST SENSITIVITY ANALYSIS

GENERAL

CONTRACTING STATION: **INFN**

DESIGNER: **prof. ing. Q. Napoleoni (A&G)**

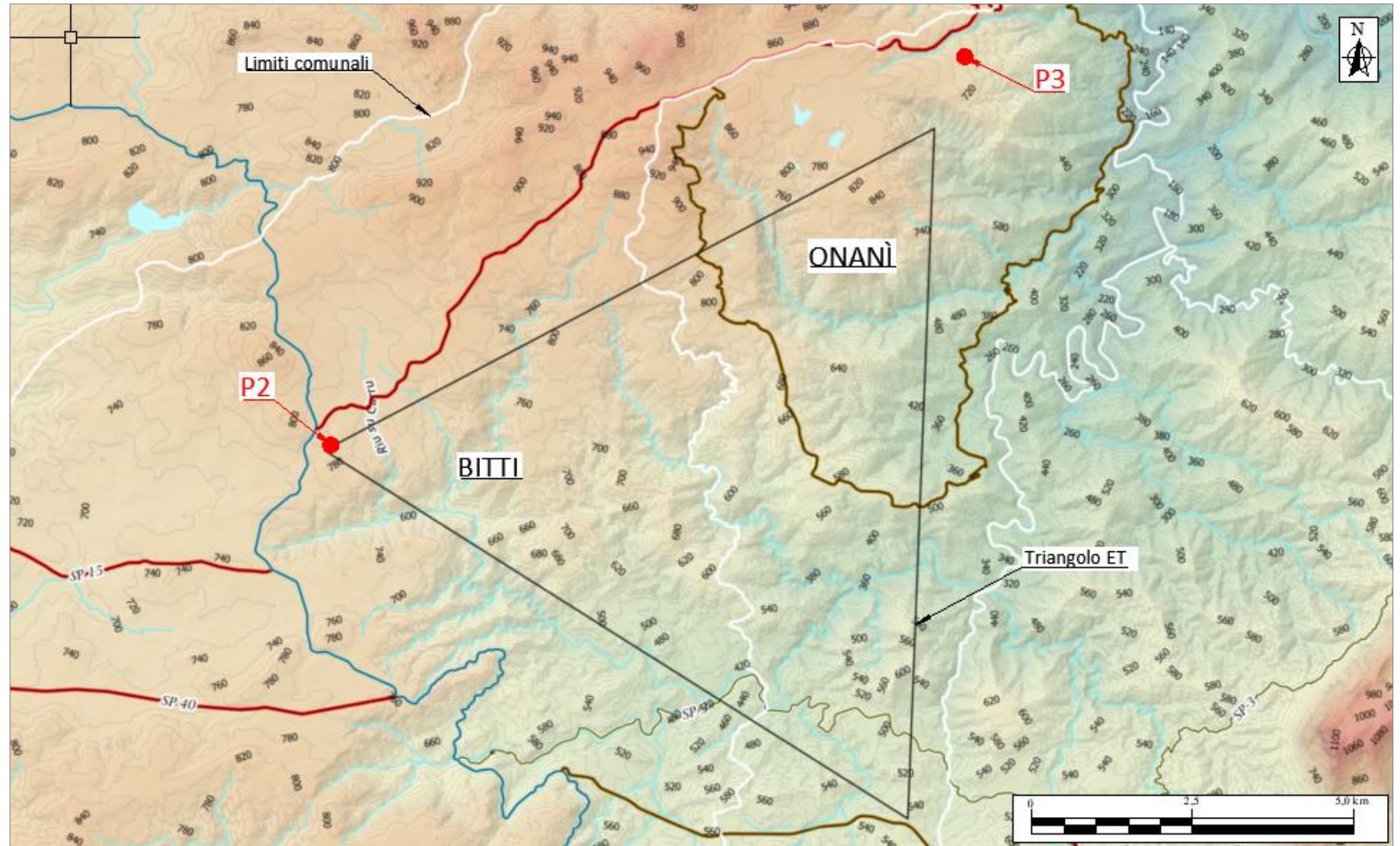
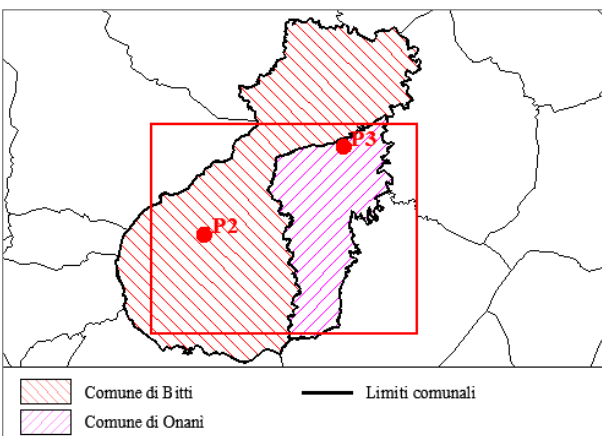
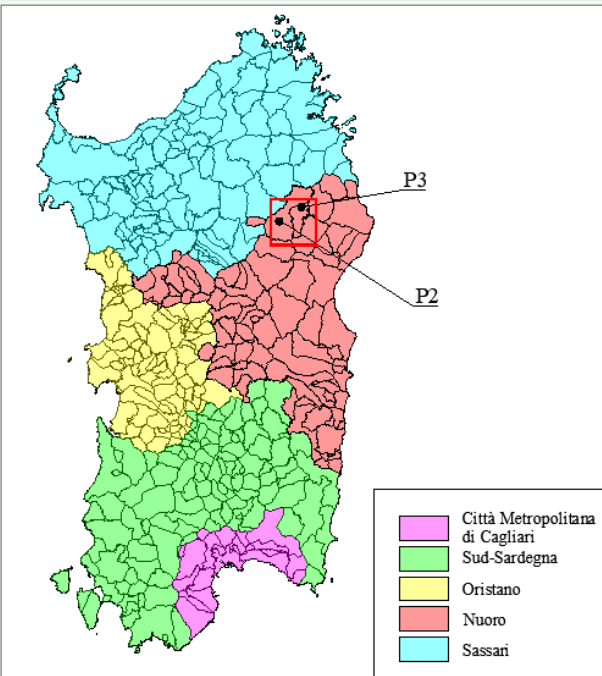
RUP: **ing. Gaetano Schillaci**

CONSTRUCTION MANAGER: **dott. geol. Davide Boneddu**

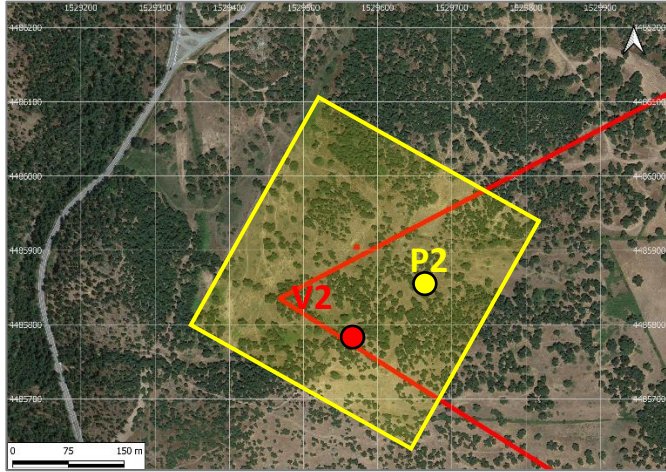
CONSTRUCTOR: **SAMMINIATESE POZZI S.r.l.**



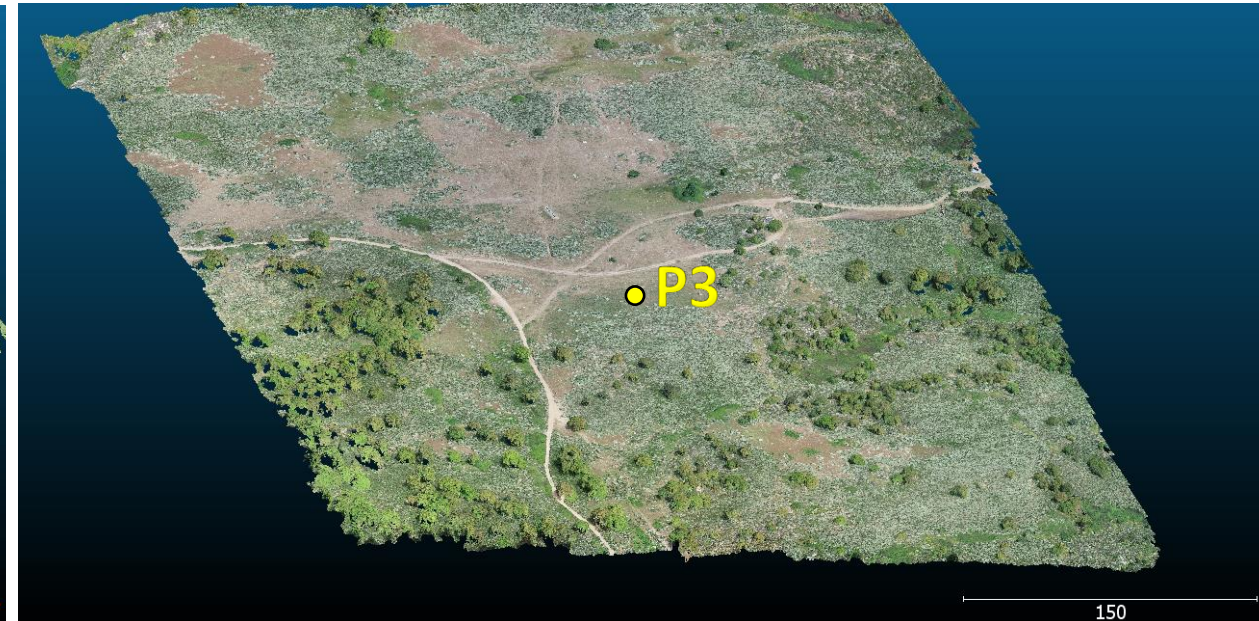
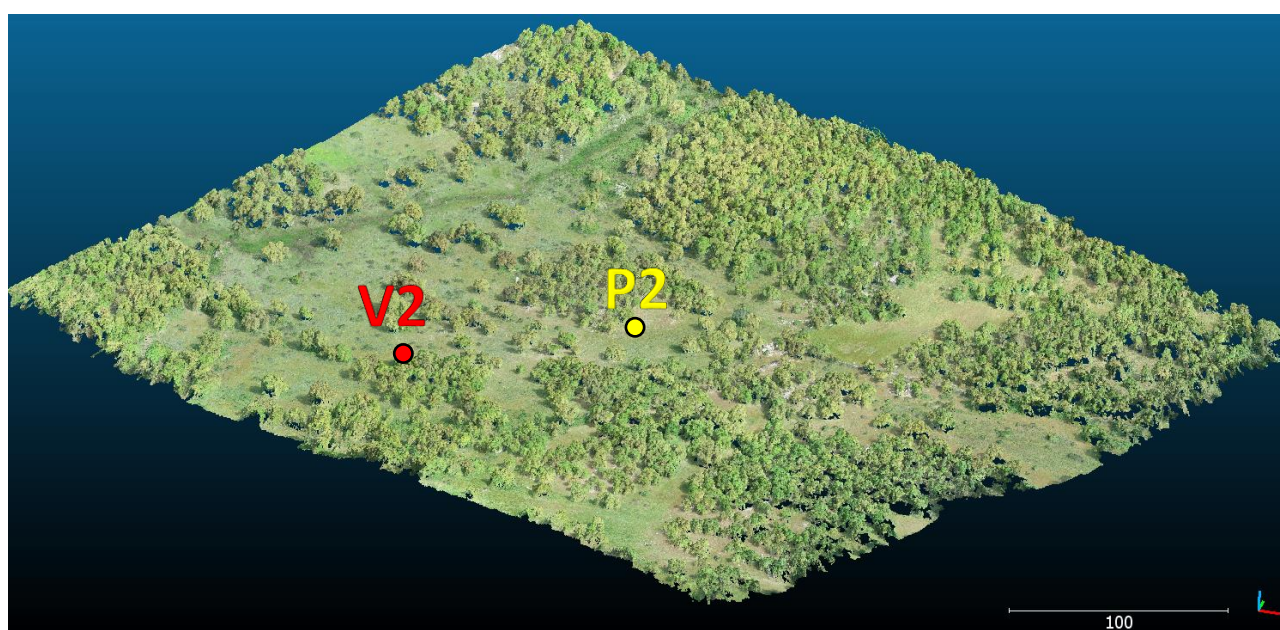
BOREHOLES LOCATION



BOREHOLES LOCATION

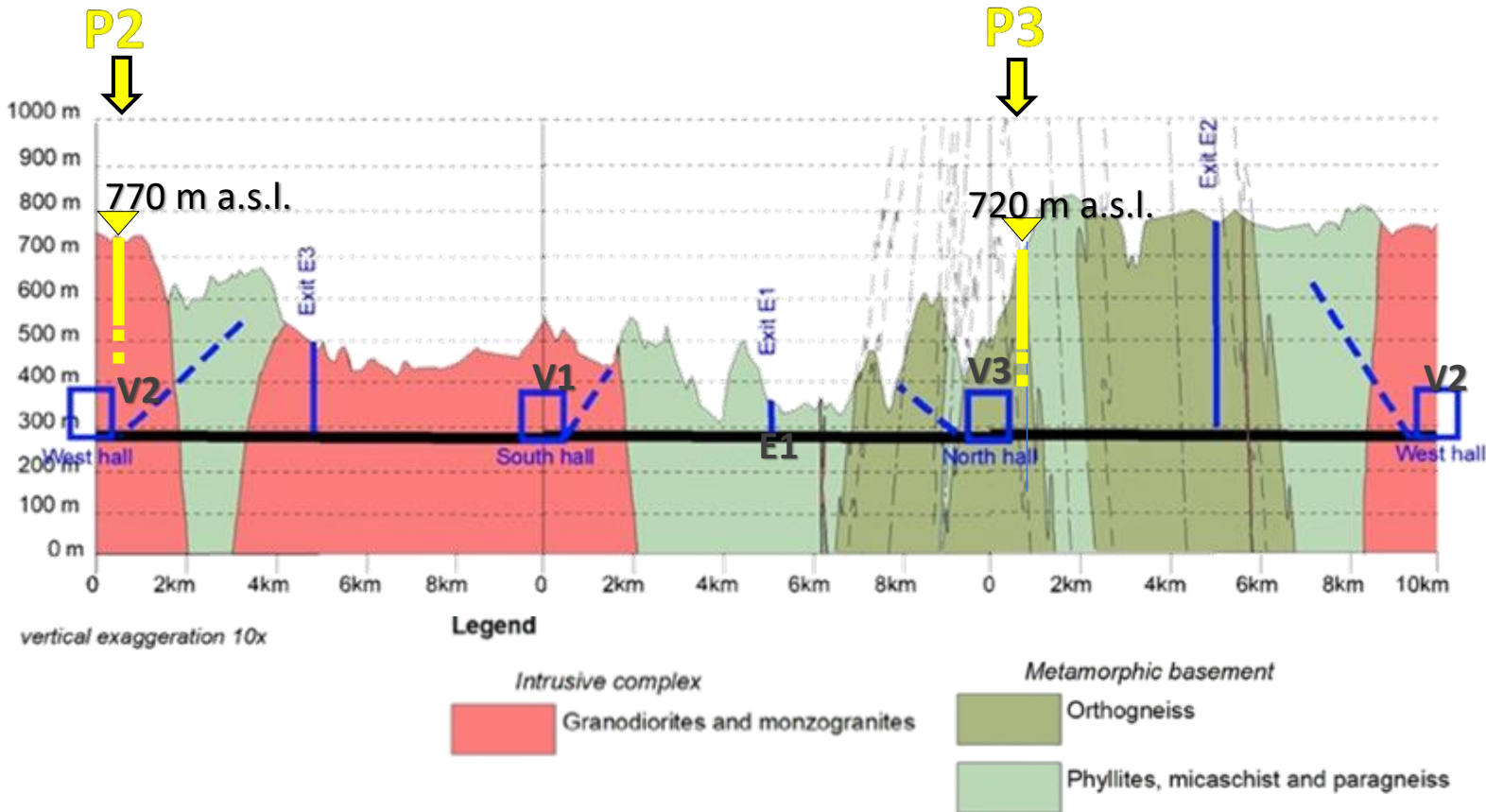
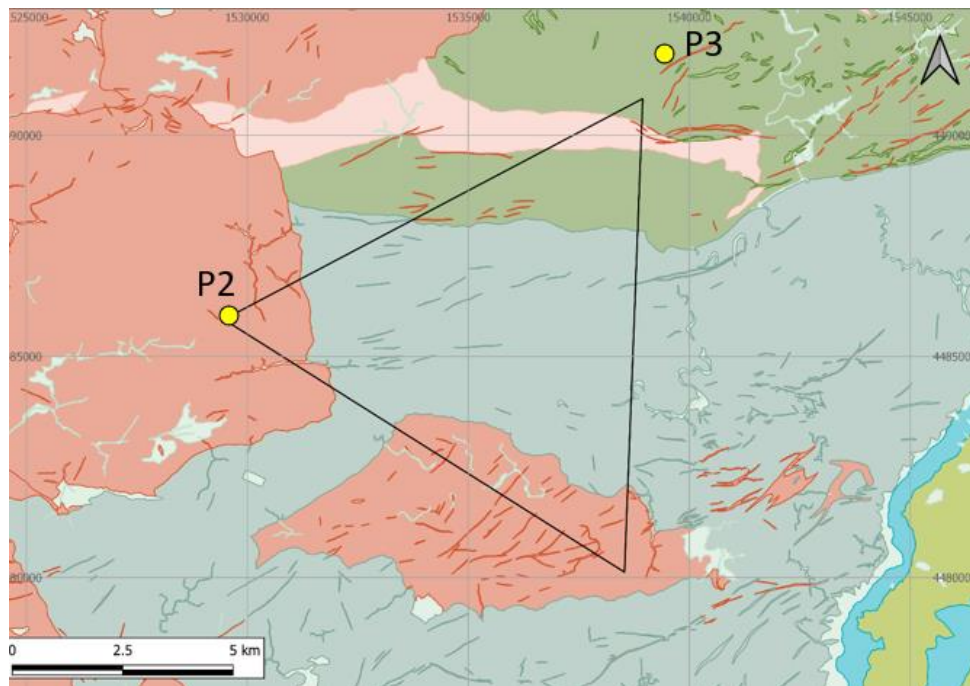


Drone survey (June 2020) on the area surrounding the boreholes.



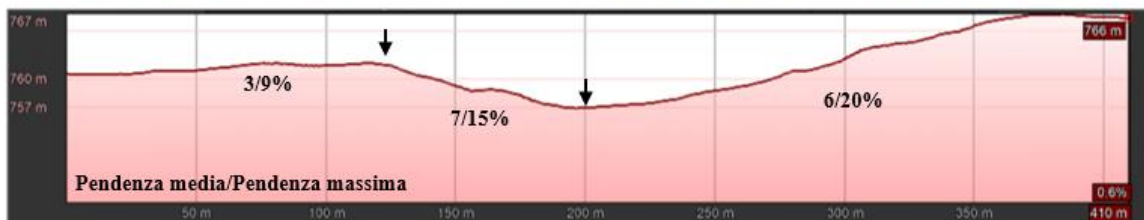
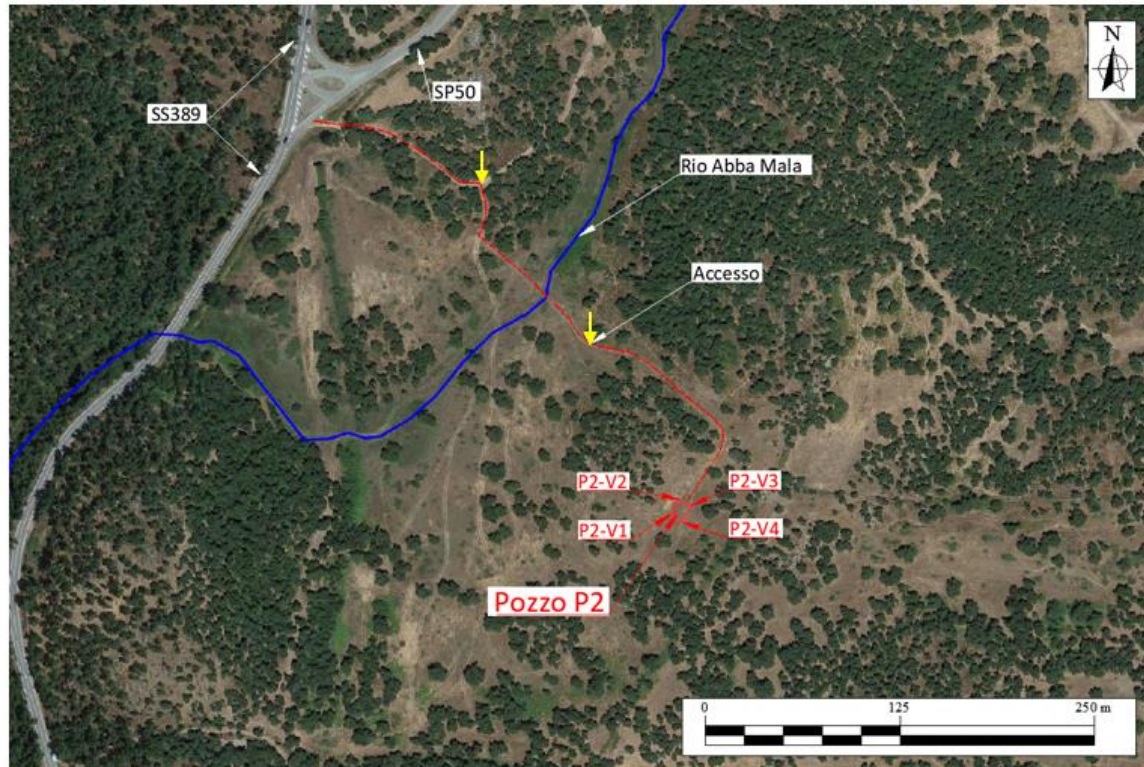
GEOLOGICAL SETTINGS

- V2 and P2 in Granodiorites
- V3 and P3 in Orthogneiss

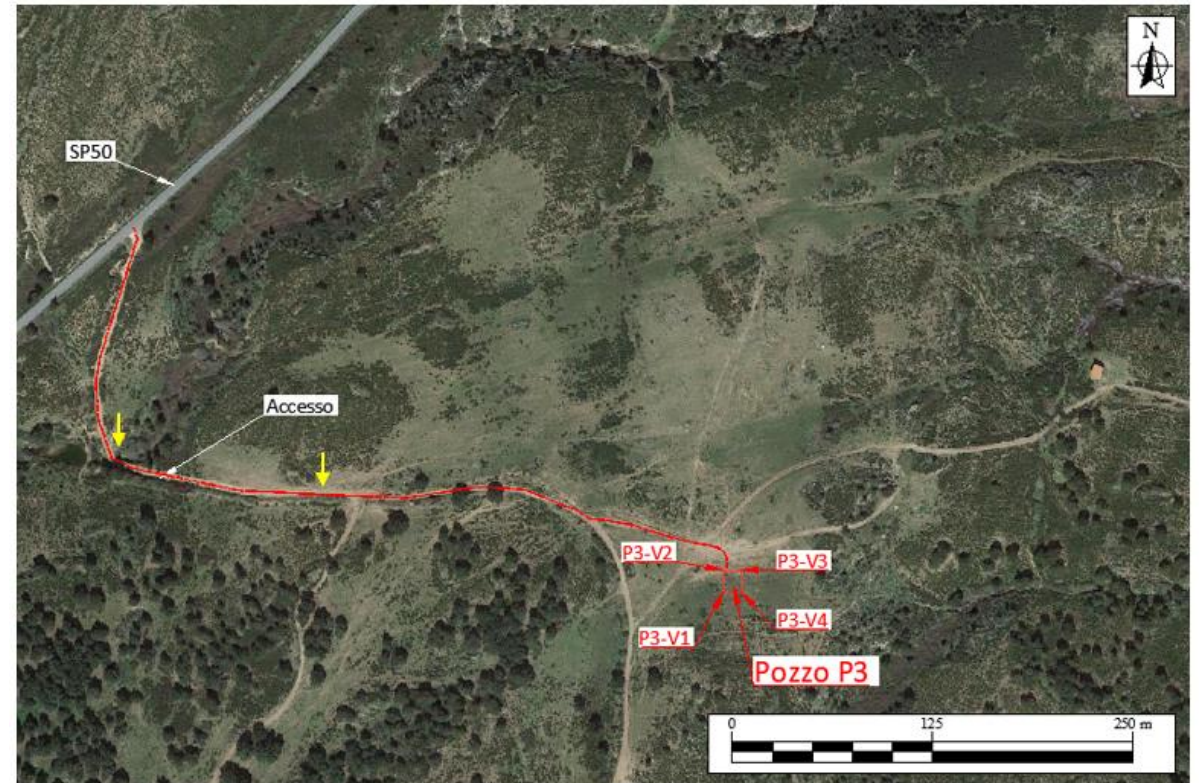


ACCESS

BOREHOLE P2

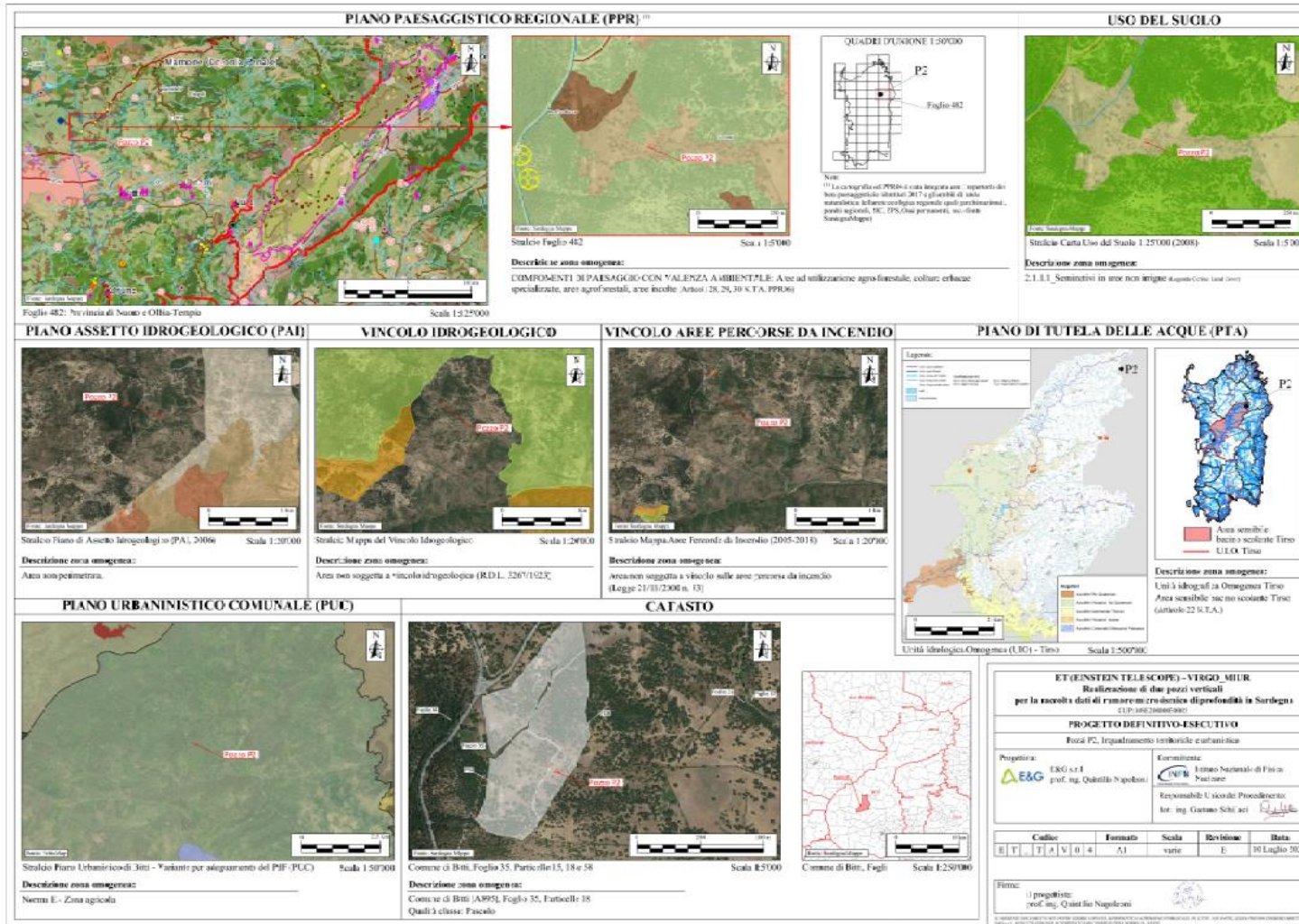


BOREHOLE P3



ENVIRONMENTAL ISSUES AND LOCAL PERMITS

BOREHOLE P2

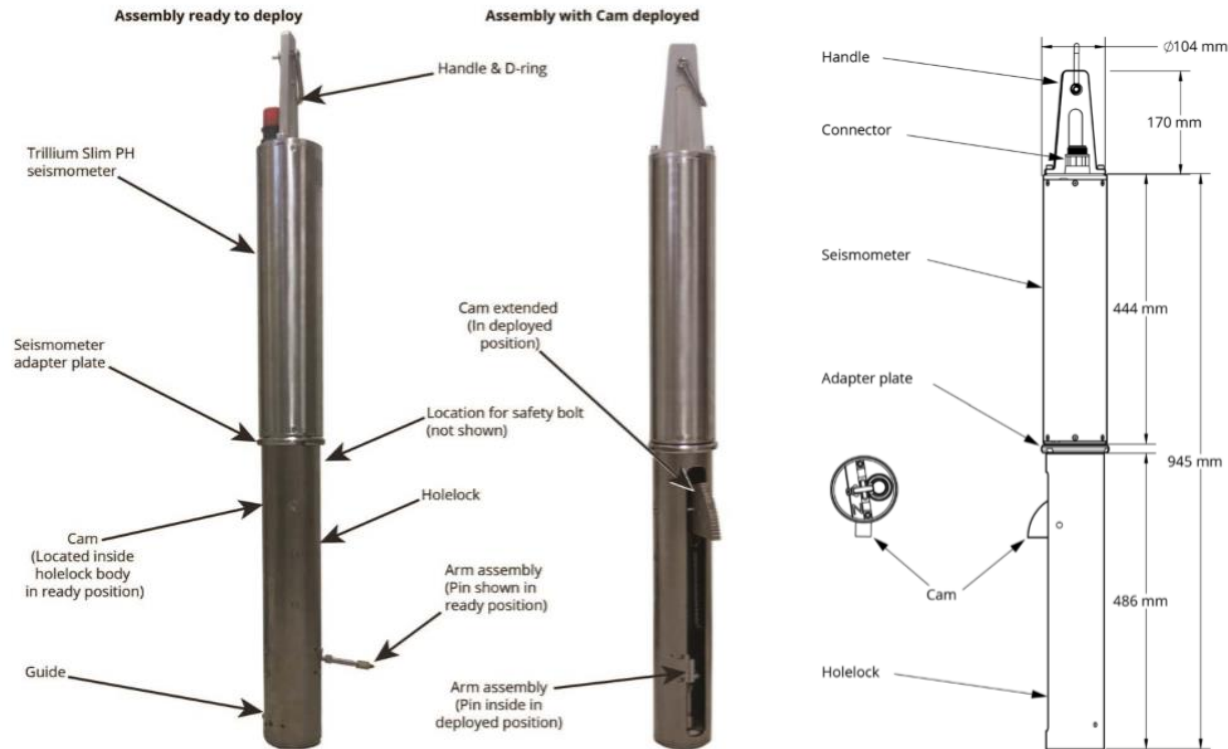


- environmental constraints
- landscape constraints
- administrative constraints
- surface and groundwater management
- land registry

SENSORS REQUIREMENTS

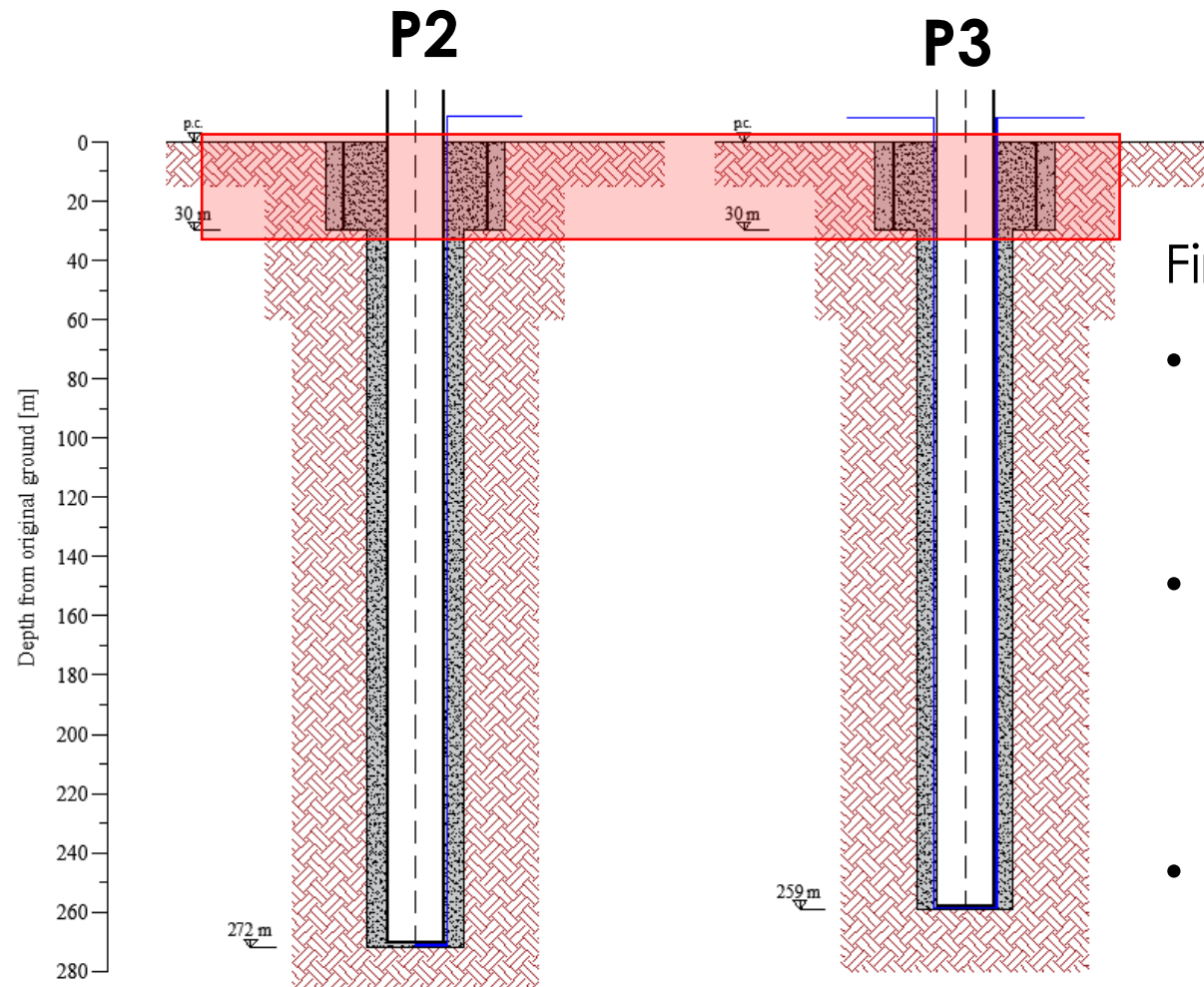
Trillium120-SPH2

Broadband triaxial seismometer



- Steel lining internal diameter: **114-129 mm**
- Maximum tilt: **3°**
- **Good mechanical contact** between borehole lining and surrounding rock mass
- **Waterproof** lining

BOREHOLE CHARACTERISTICS AND CONSTRUCTION PHASE

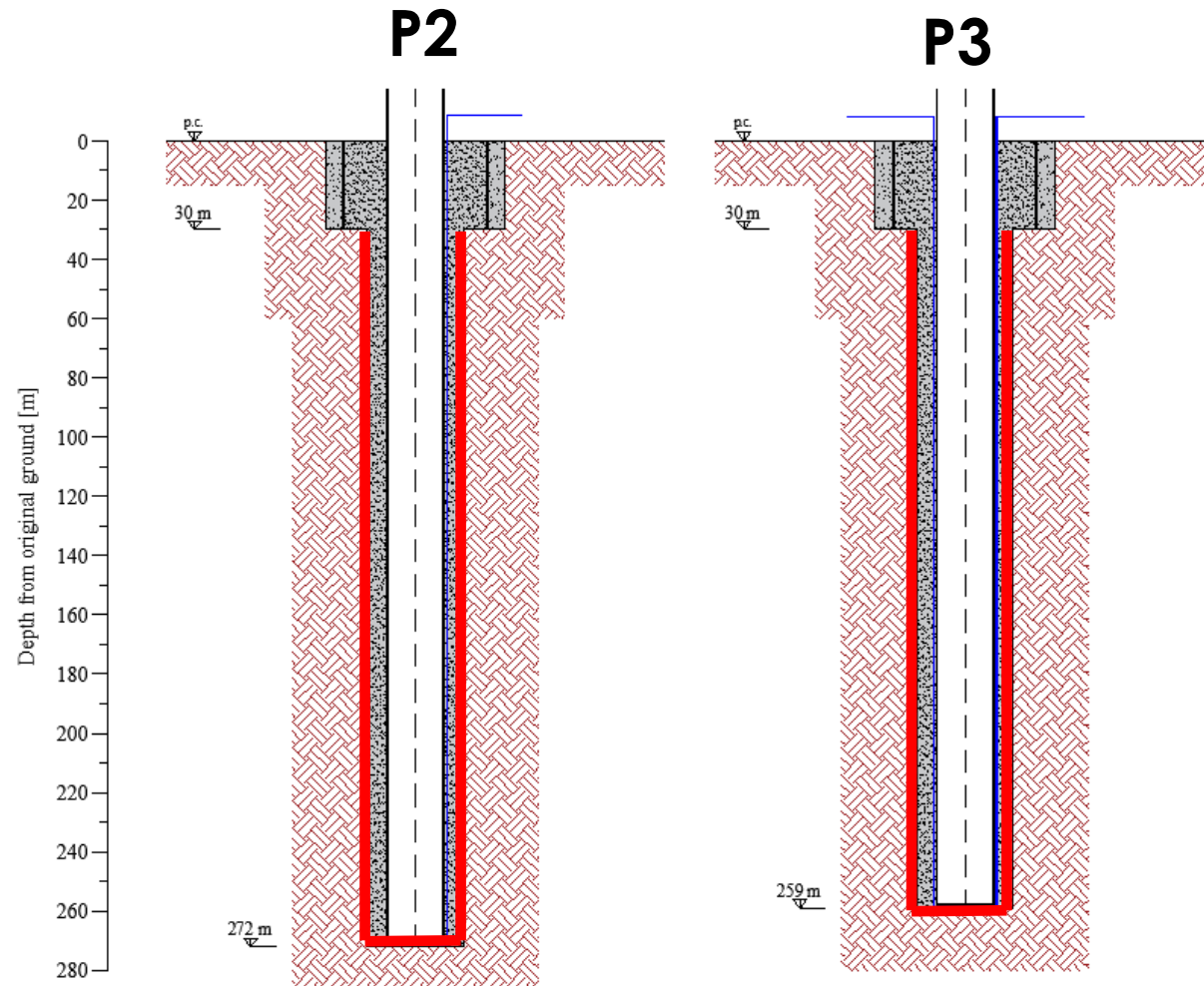


First phase drilling:

- Drilling (core destruction) up to **30 m** with a diameter of **406 mm**
- Steel casing installation: diameter **323 mm**, thickness **6 mm** (**312 mm** internal)
- Cementation of the interspace between casing and surrounding rock mass



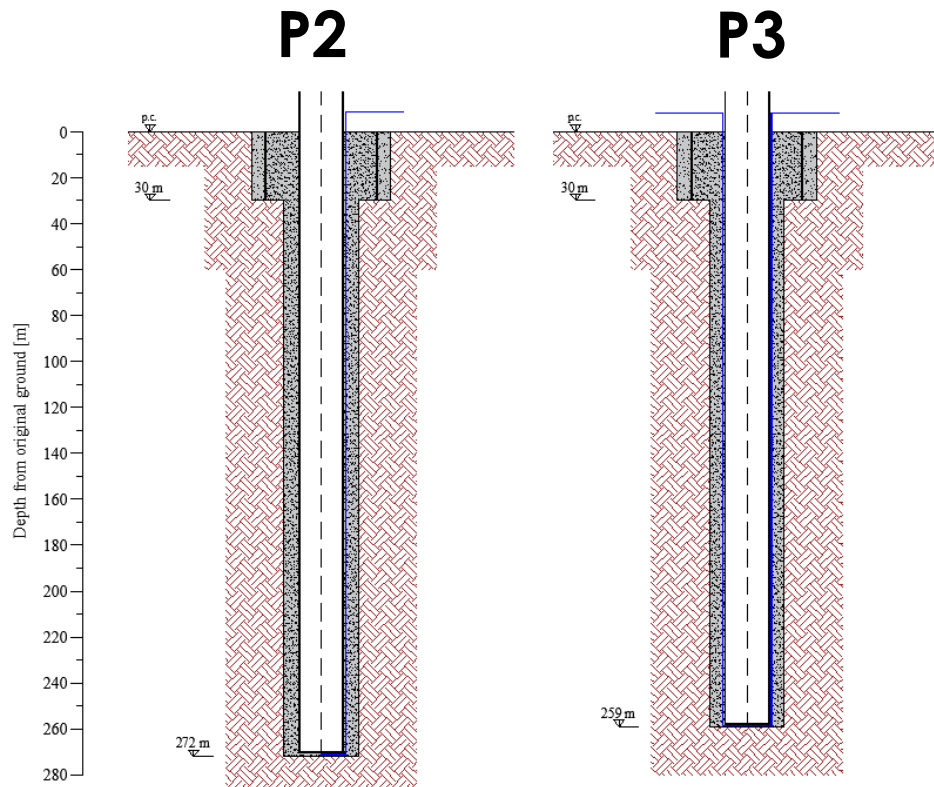
BOREHOLE CHARACTERISTICS AND CONSTRUCTION PHASE



Second phase drilling:

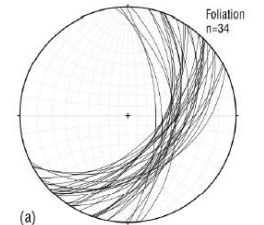
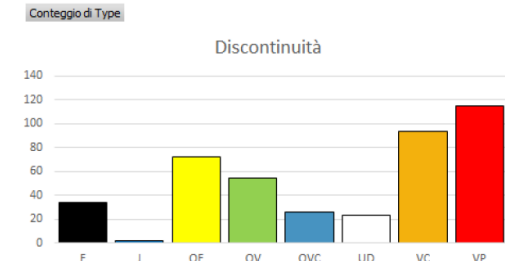
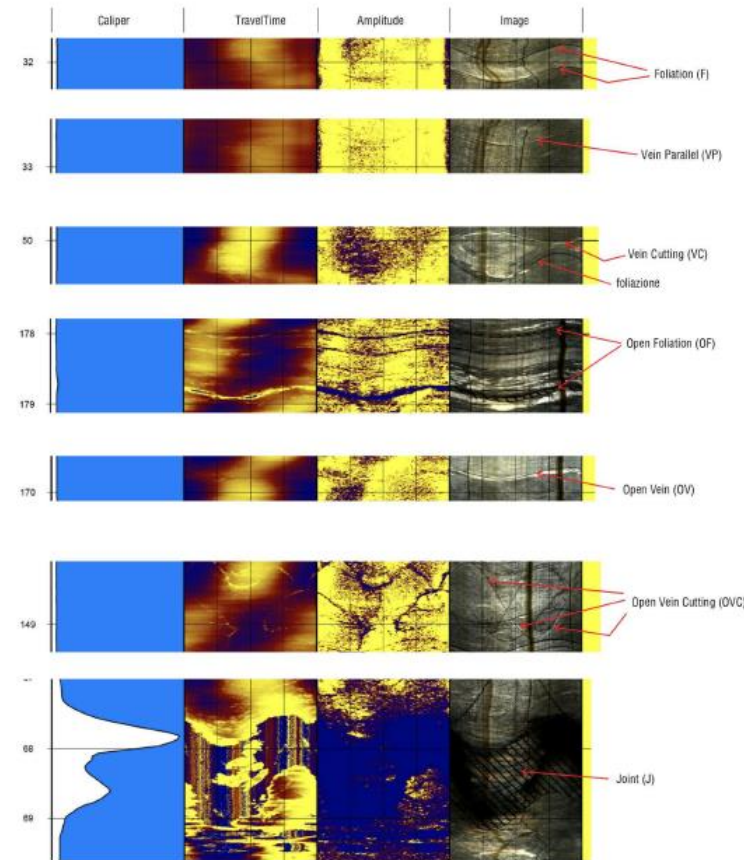
- **216 mm** core destruction drilling up to **272 m** for P2 and **259 m** for P3 (design depth 250 m)
- Collection of cutting every 5 m for laboratory analysis
- Verticality check every 15 m

BOREHOLE CHARACTERISTICS AND CONSTRUCTION PHASE



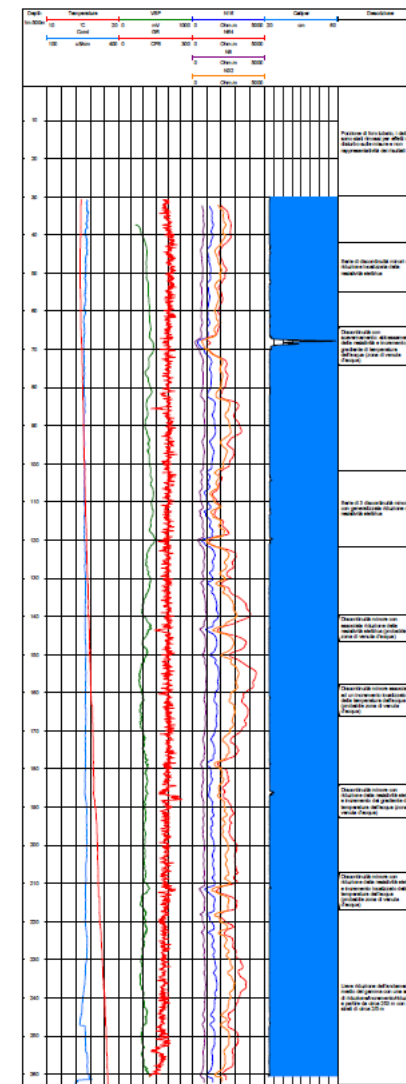
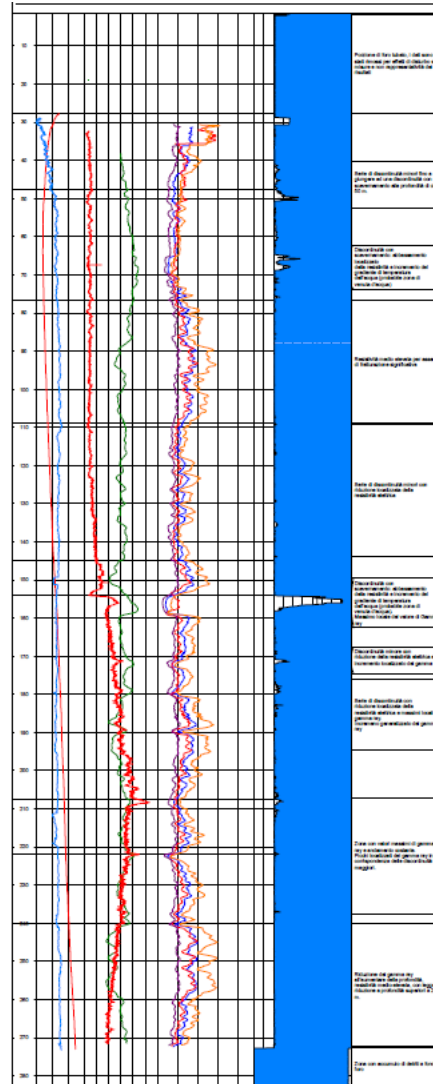
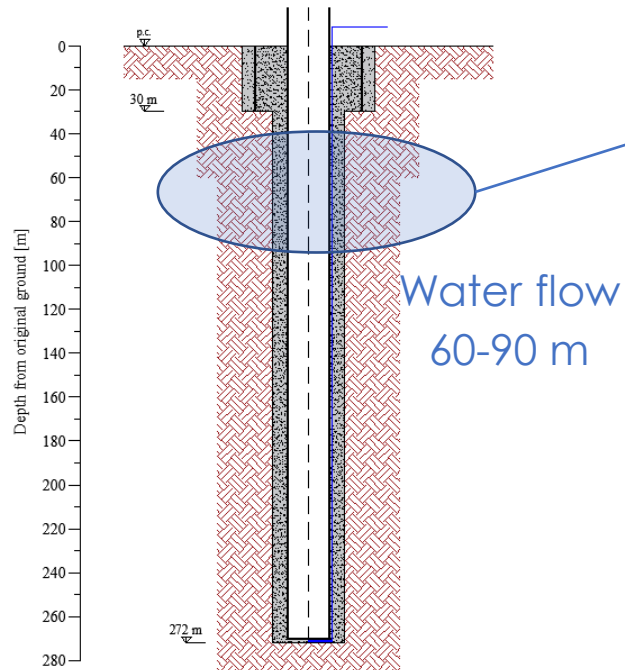
Geophysical Logs	
Temperature & Conductivity	Incoming water flow; Geothermal gradient
Self-potential	Lithological local variation; Incoming water flow with different salinity
Natural Gamma Ray	Clay content variation
Normal Resistivity	Lithology and water content variation
Caliper	Well diameter; Discontinuities mapping
Structural Logs	
Acoustic	Discontinuities in water: orientation, spacing, frequency, aperture
Optical	RGB image of the well; Discontinuities in dry or clean water: orientation, spacing, frequency, aperture

- At the end of drilling, 2 days stop for the execution of **logs**: temperature and conductivity, resistivity and self potentials Caliper, Gamma ray, acoustic, optical

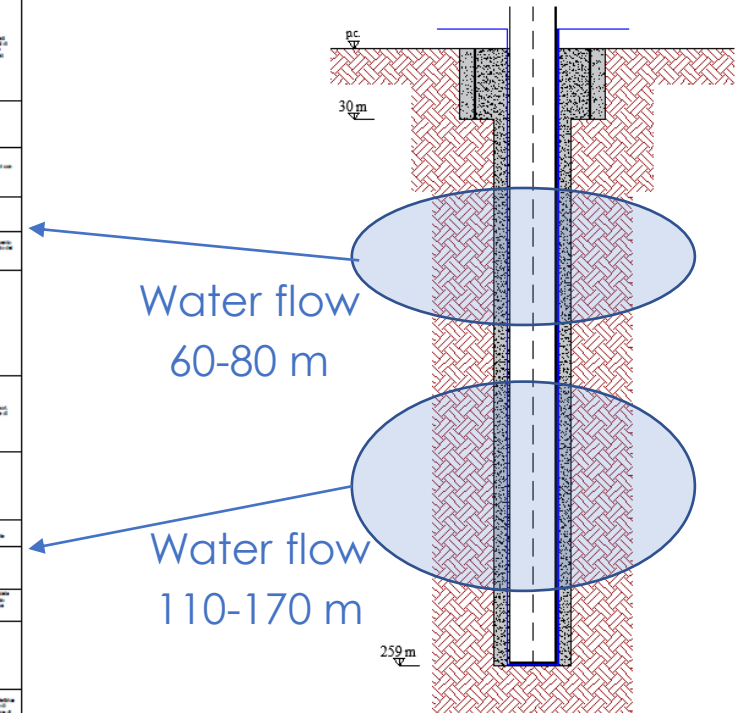


BOREHOLE CHARACTERISTICS AND CONSTRUCTION PHASE

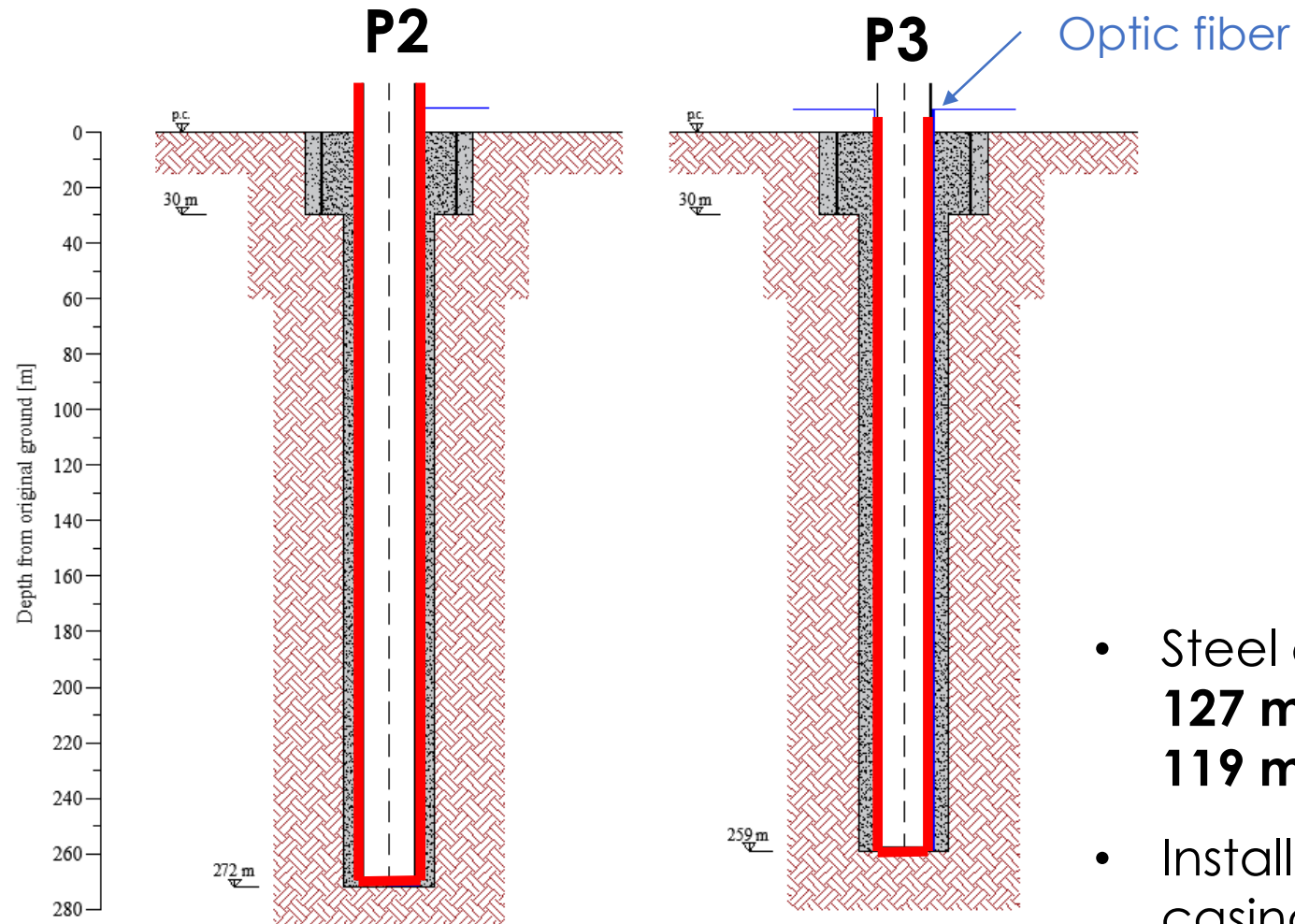
P2



P3

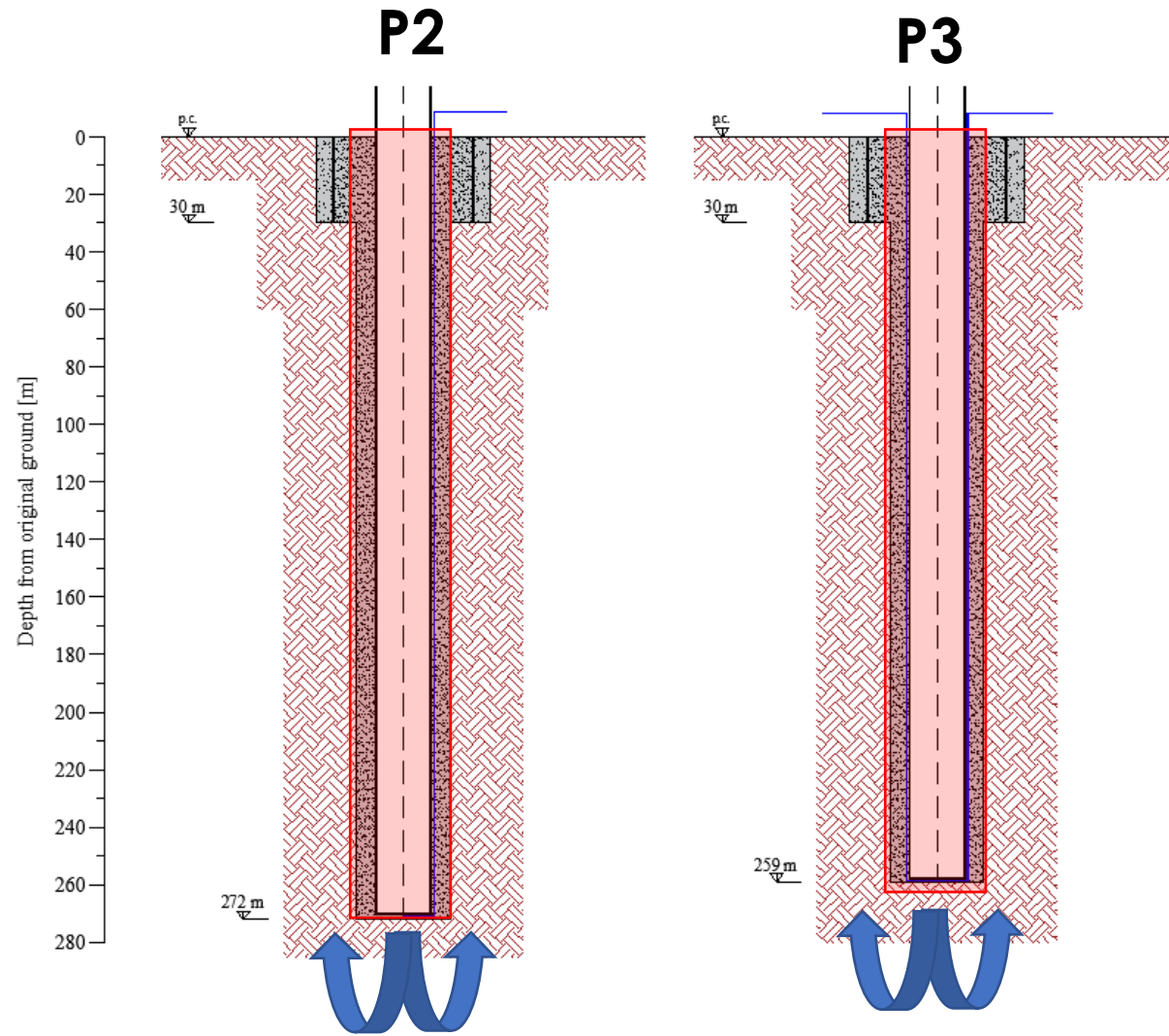


BOREHOLE CHARACTERISTICS AND CONSTRUCTION PHASE



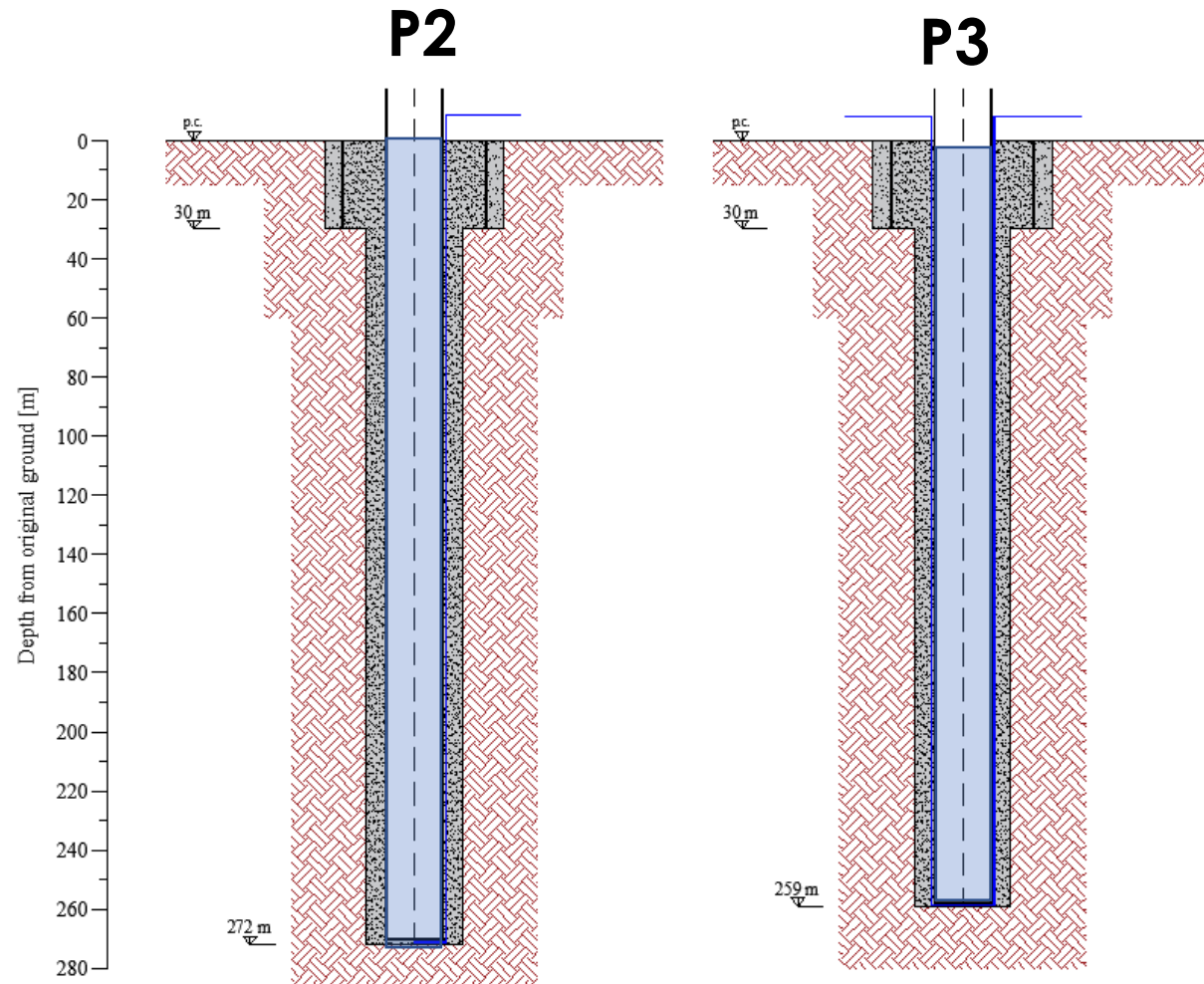
- Steel casing installation: external diameter **127 mm**, thickness **4 mm**, internal diameter **119 mm** (required range: 114-129 mm)
- Installation of fiber optics connected to the casing (single line for P2, loop for P3)

BOREHOLE CHARACTERISTICS AND CONSTRUCTION PHASE



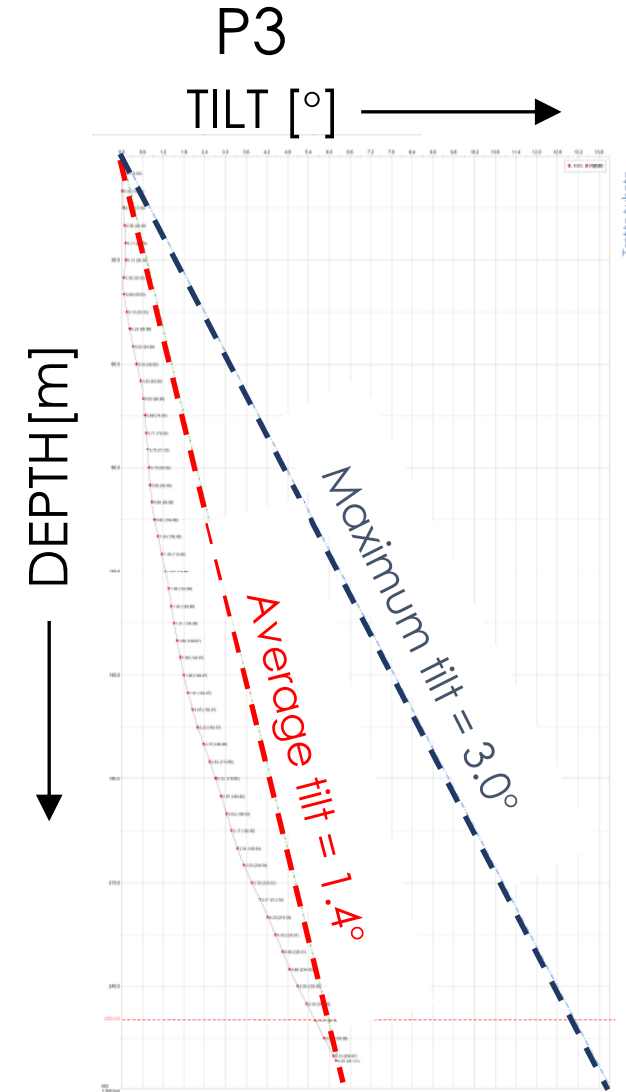
- Cementation from bottom to top of the interspace between casing and surrounding rock mass
- cement grout (cement, water, additives) with a minimum density of 1,85 ton/mc

BOREHOLE LEAK TEST

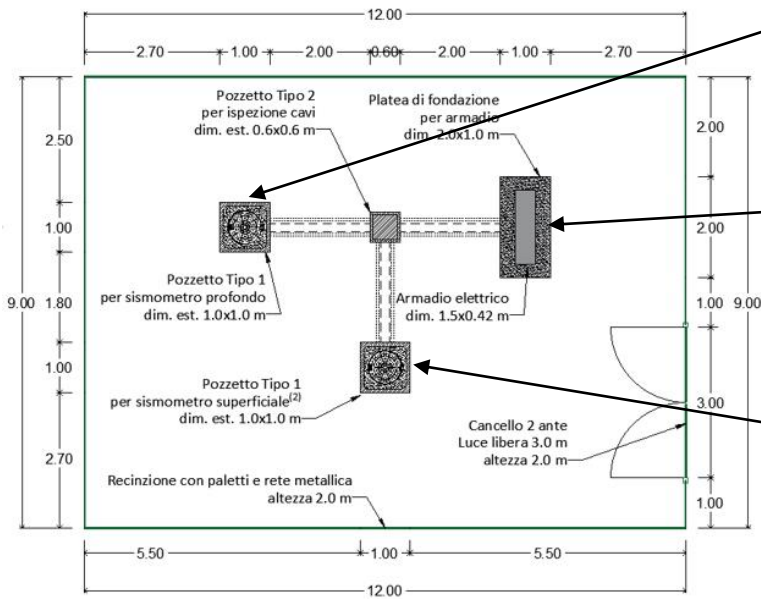


- A. 24 hours stop after cementation
- B. Filling the borehole to the top with water
- C. Pressurize the borehole to 4 Mpa
- D. Pressurization time 24 hrs
- E. Check pressure decrease $< 10 \%$

VERTICALITY CHECK



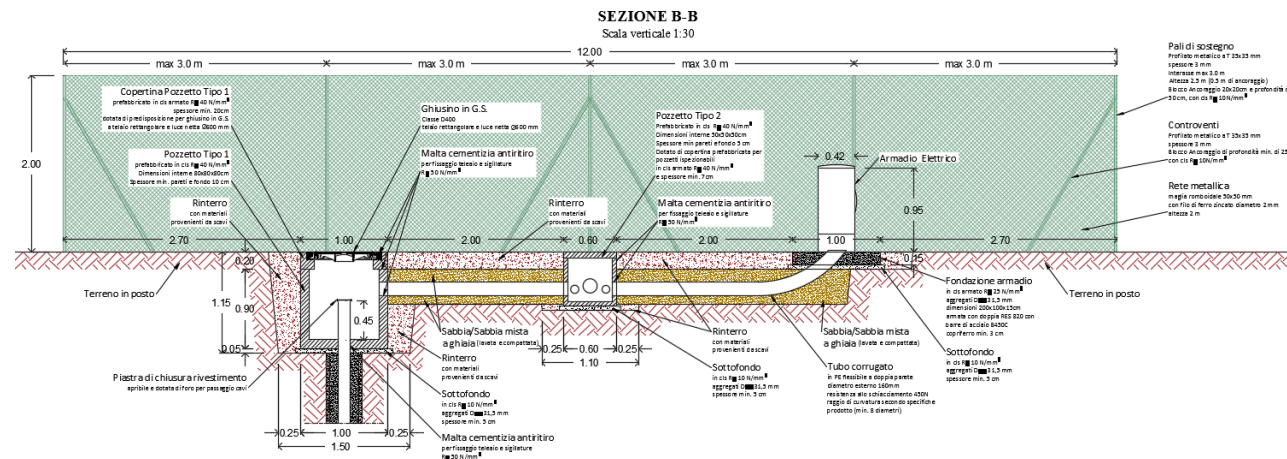
SURFACE INFRASTRUCTURES LAYOUT



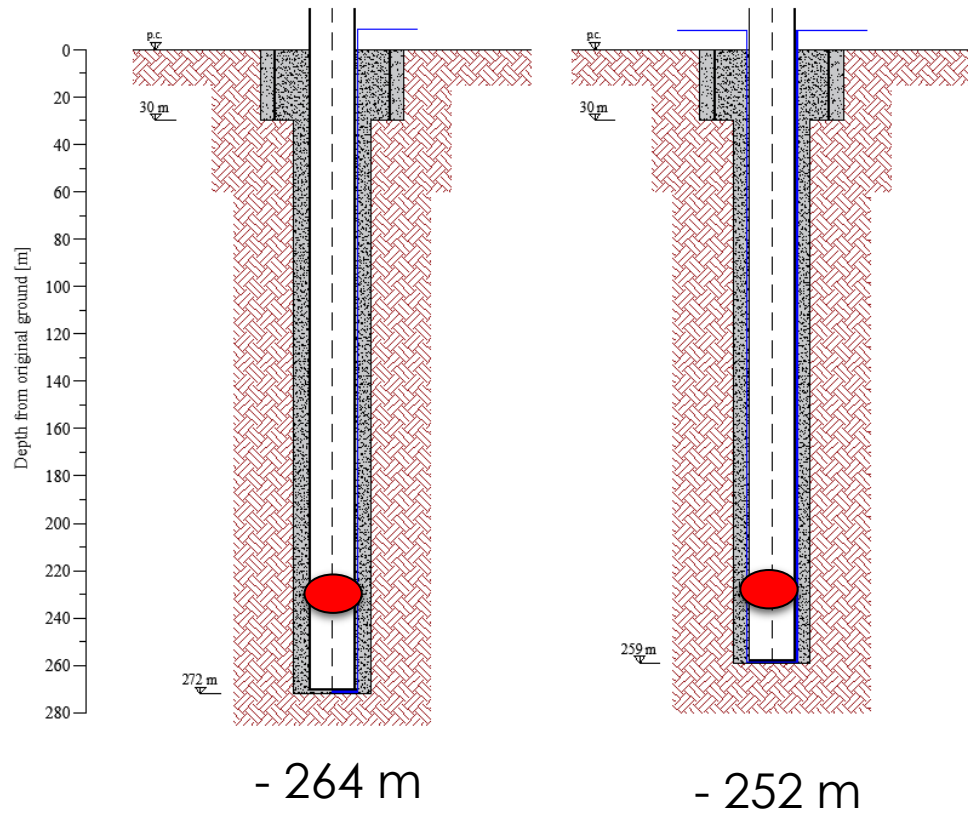
Inspection pit for borehole sismometer

electronic box

Inspection pit for borehole sismometer



SENSORS INSTALLATION



TIME AND COST

Design construction time schedule for one borehole

ID	ACTIVITY	MONTH/WEEK											
		1				2				3			
		1	2	3	4	5	6	7	8	9	10	11	12
1.1	SITE INSTALLATION												
1.2	DRILLING, LOGS												
1.3	BOREHOLE COMPLETION												
1.4	LEAK TEST												
1.5	DRILLING PLANT DECOMMISSIONING												
1.6	SURFACE WORKS												
1.7	SITE INSTALLATION DECOMMISSIONING												

Total cost: **263'000 euro**

(taxes and other fees not included)

- Construction substantially in line with the design construction program: total time (two boreholes) about 5 months (from April to August 2021)
- Average drilling production: 10-30 m/day

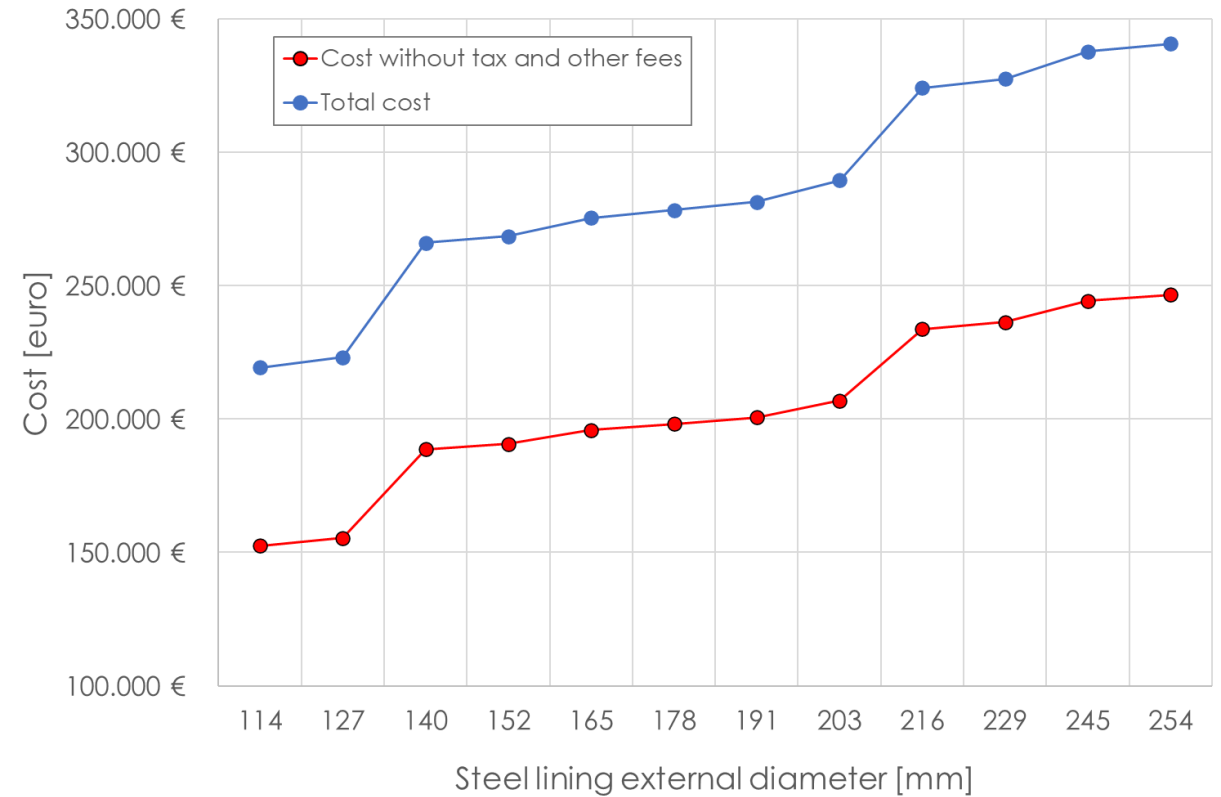
COST SENSITIVITY ANALYSIS

A cost sensitivity analysis is carried out as a support for the feasibility study of the sensor network for the ET infrastructure.

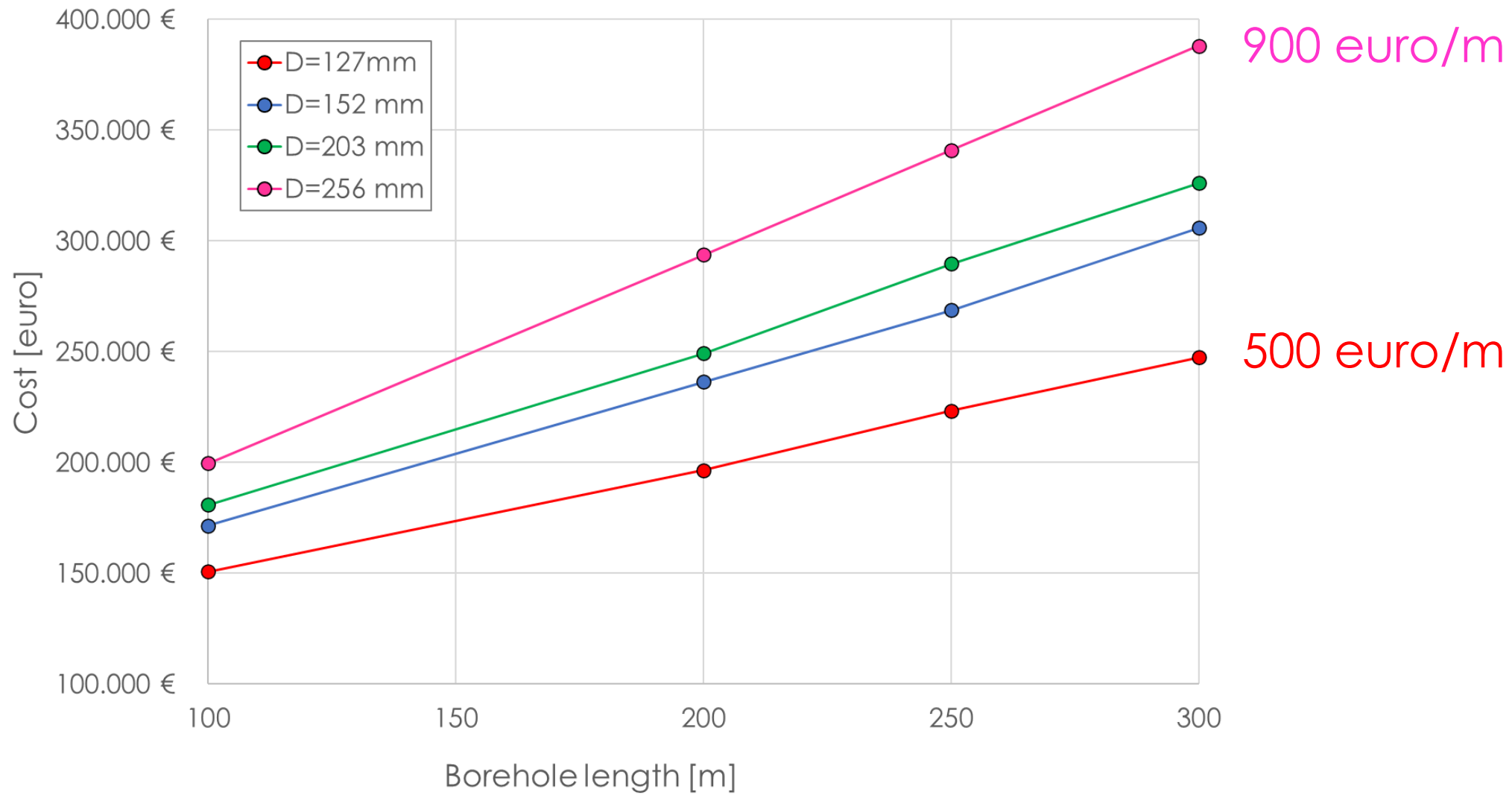
Main assumptions:

- Steel lining external diameter: from 114,3 mm (4.5 inches) to 254 mm (10 inches)
- Boreholes depth: 100, 200, 250, 300 m
- unit prices from the regional or national reference price list
- Included in the cost: site installation, borehole drilling and completion, surface infrastructures, safety
- Not included in the cost: instrumentation and sensors, solar panels, electrical equipment

COST SENSITIVITY ANALYSIS



COST SENSITIVITY ANALYSIS



THANK YOU FOR THE ATTENTION

