Multidimensional electrical resistivity survey for bedrock detection at the Rieti Plain (Central Italy)

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Electrical Resistivity Tomography (ERT)

Electrical resistivity is an intrinsic property that quantifies how strong a given material opposes the flow of electric current

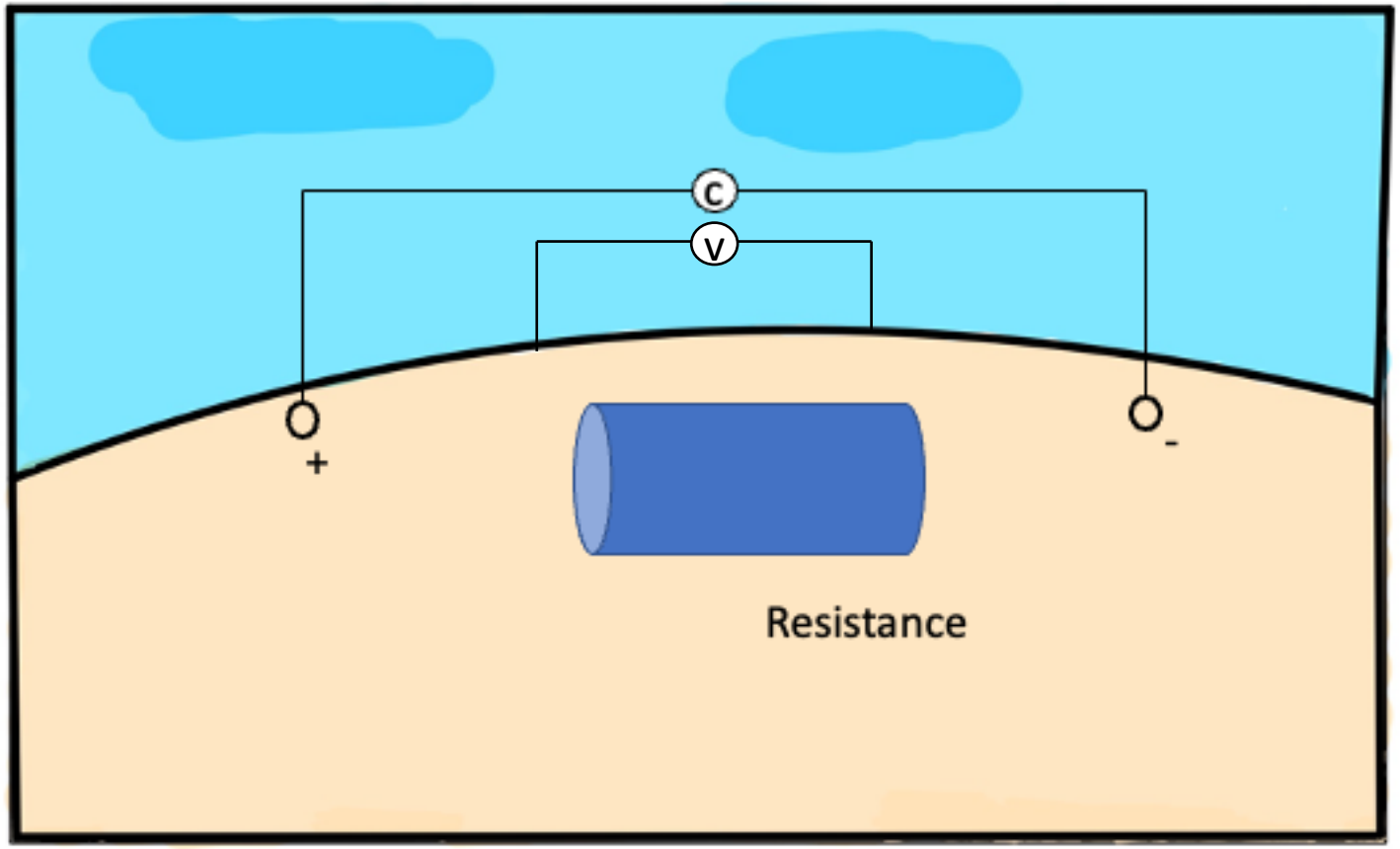
supply a current into the earth

↓

A material is conductive
if it contains free carriers (current flow)

↓

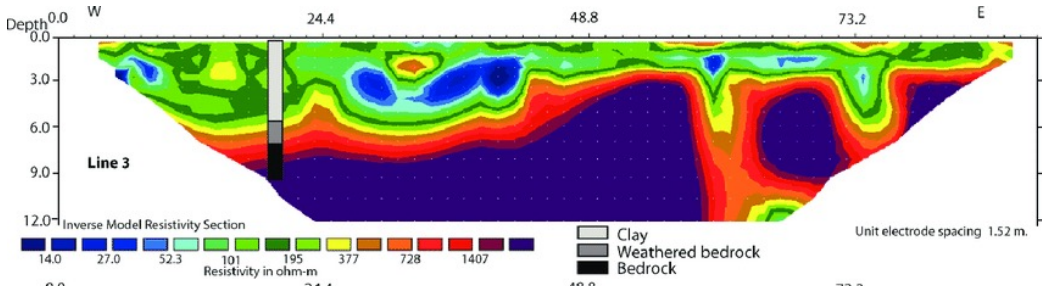
Resistance occurs in the ground,
electrical potential differences can be measured



(c) current electrodes

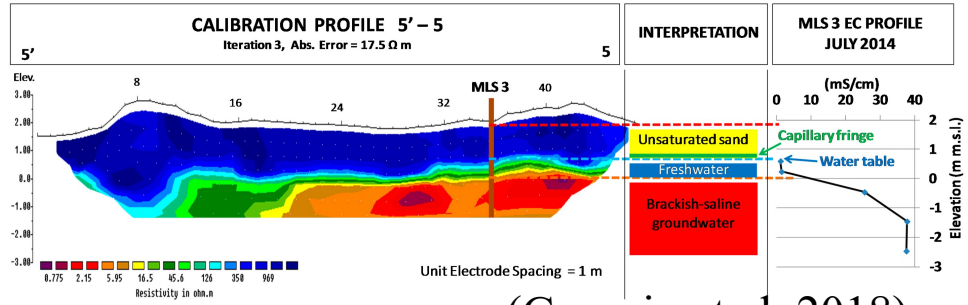
(v) potensial electrodes

Estimate Bedrock



(Ismail & Anderson, 2012)

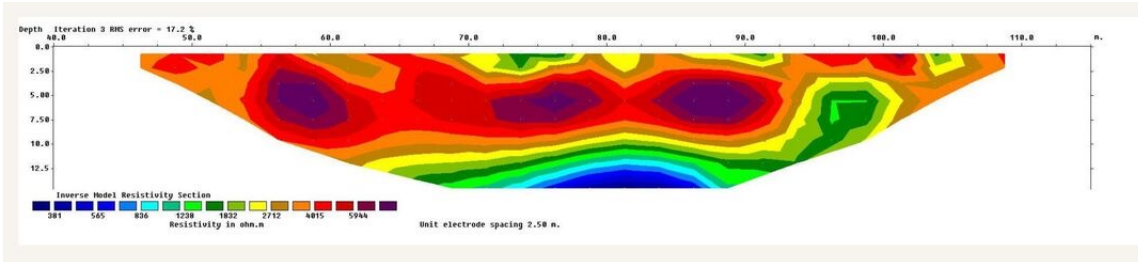
Groundwater



(Greggio et al, 2018)

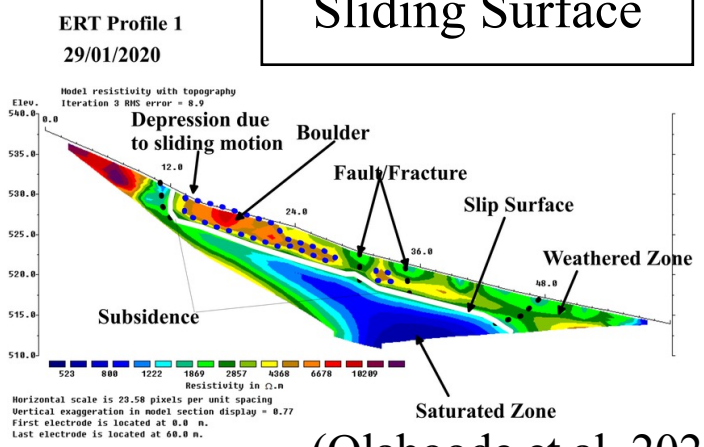
ERT
(Electrical Resistivity Tomography)

Identify archaeological features



(Nelson, 2021)

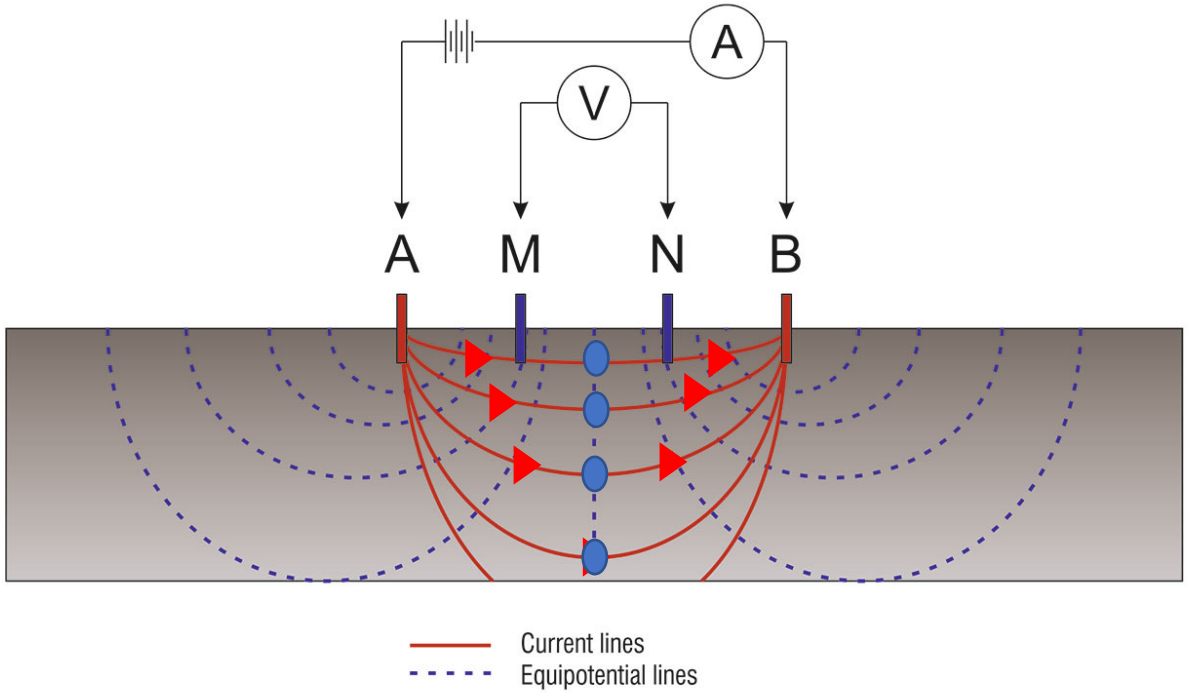
Sliding Surface



(Olaboode et al, 2022)

VES(Vertical electrical soundings)

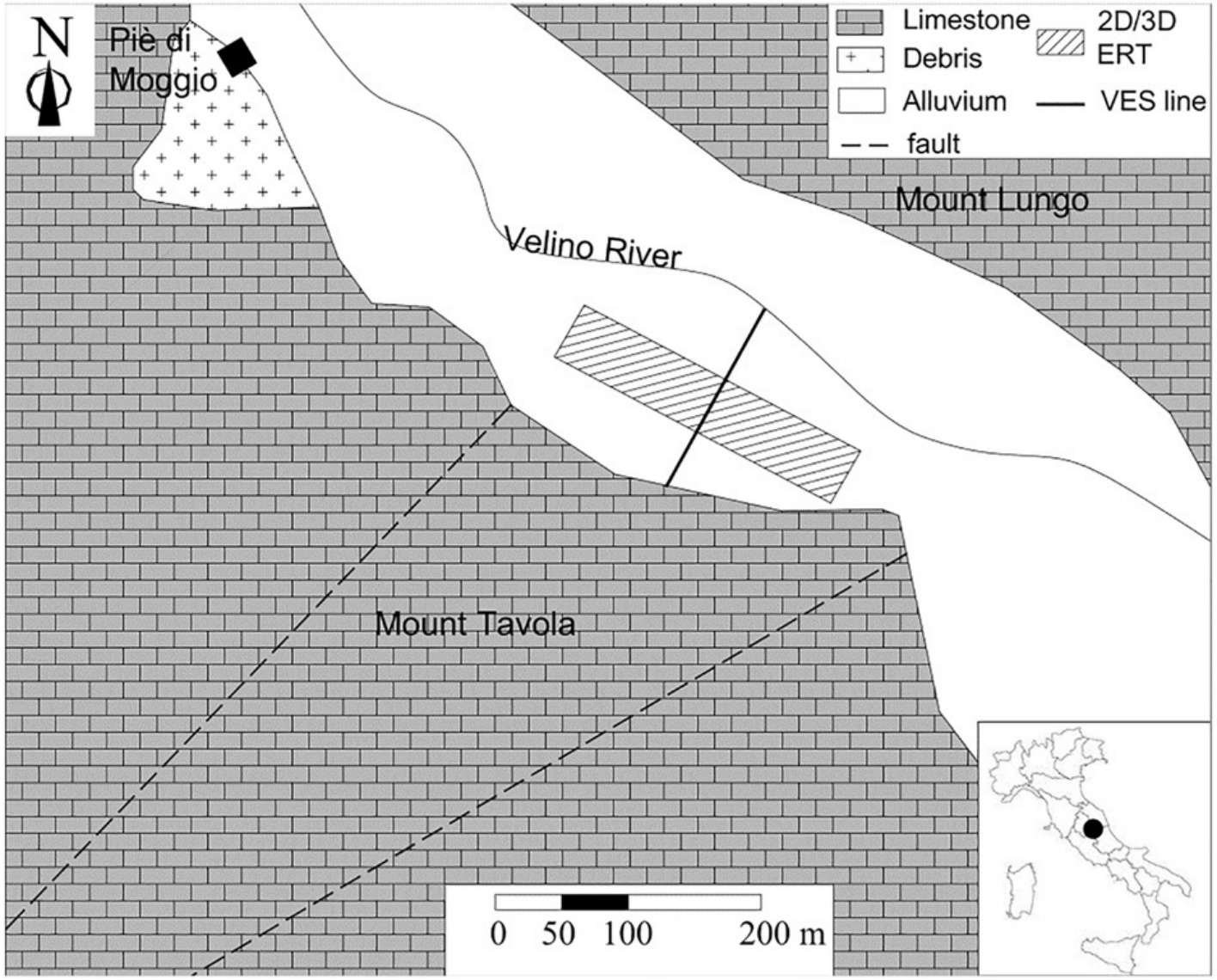
VES's basic mechanism is sending an electric current into the ground through an electrode and then measuring the voltage generated on another electrode located at a certain distance. Nevertheless, this method can reconstruct only a one dimensional model



Current Electrodes | Potential electrodes

Study Area

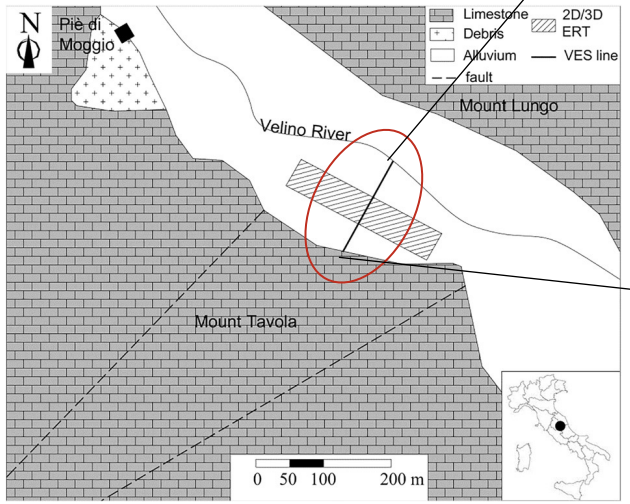
The study site is located at the north-western part of the Rieti Plain (Central Italy, near the town of Rieti, around 80 km northern of Rome), along the low Velino River Valley

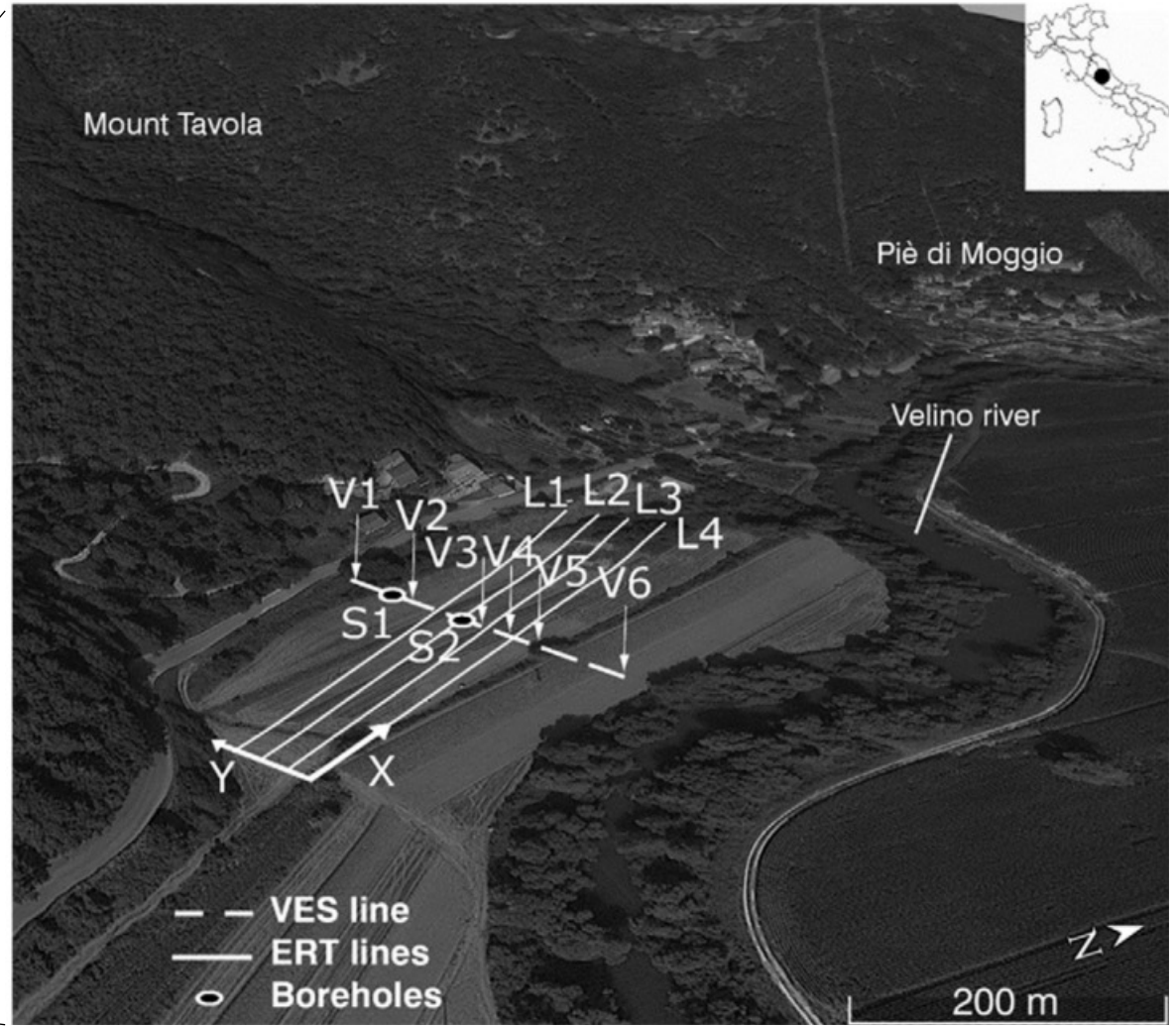


Investigated Area

The 3D aerial reconstruction of the surveyed area

- V= VES (V1–V6)
- L= ERT lines (L1–L4)
- S= two boreholes (S1 and S2)

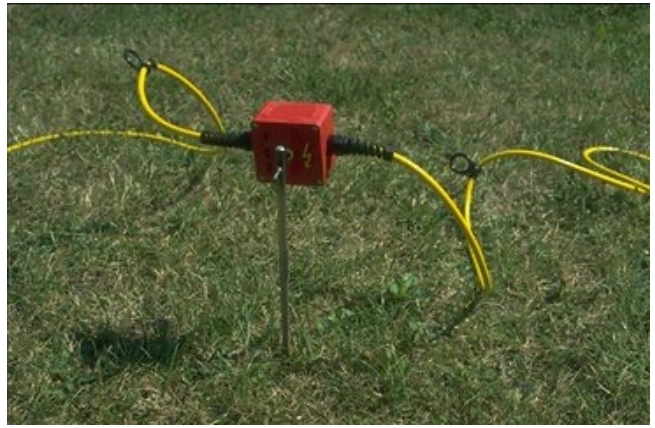




Acquisition data

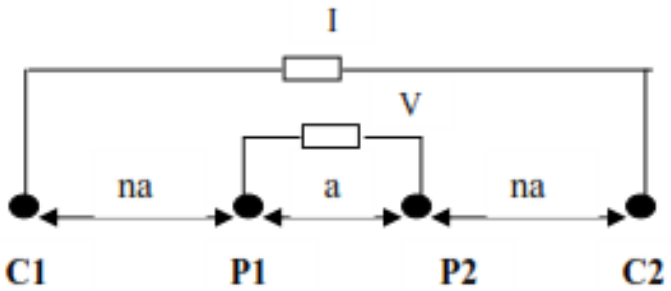
Equipment: SyscalPro imaging system

48 steel electrodes

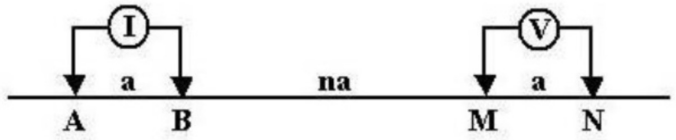


Configurations

VES



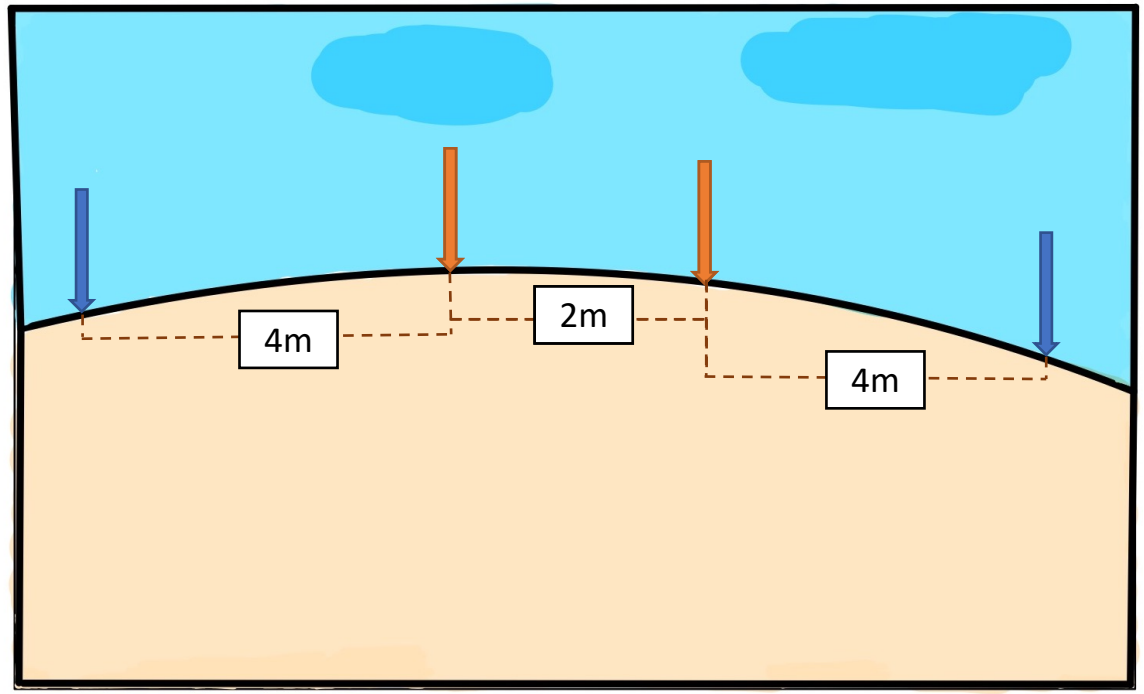
Dipole-Dipole Array



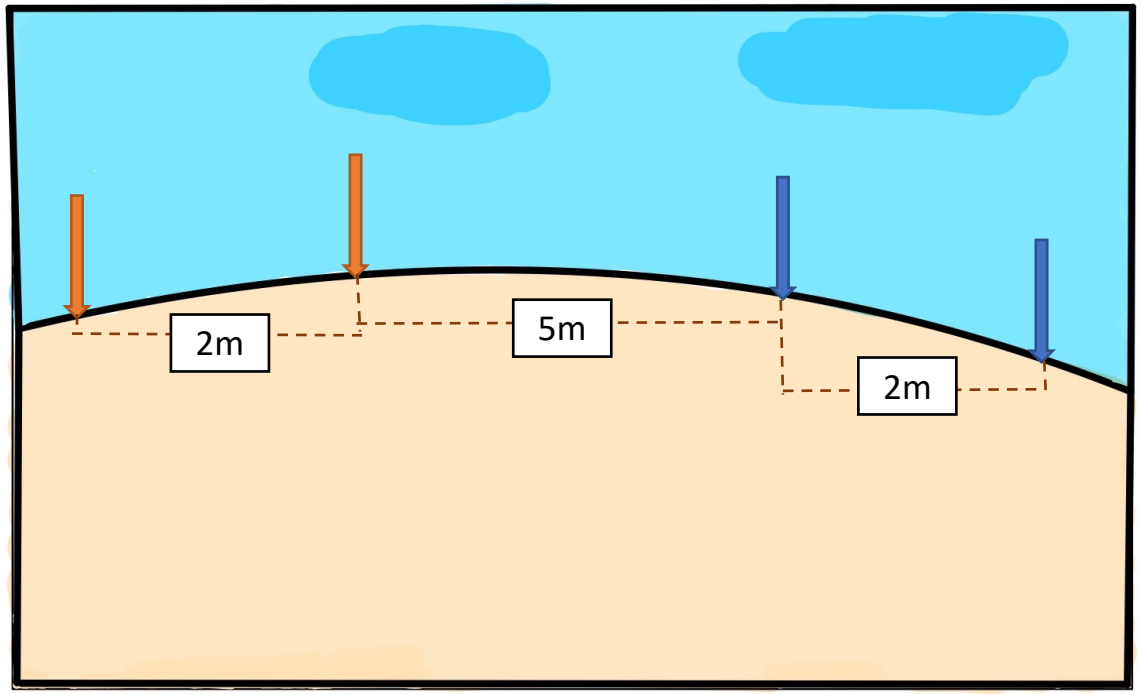
Spacing electrode = 5m
profile length= 200 m

Configurations

VES



Dipole-Dipole

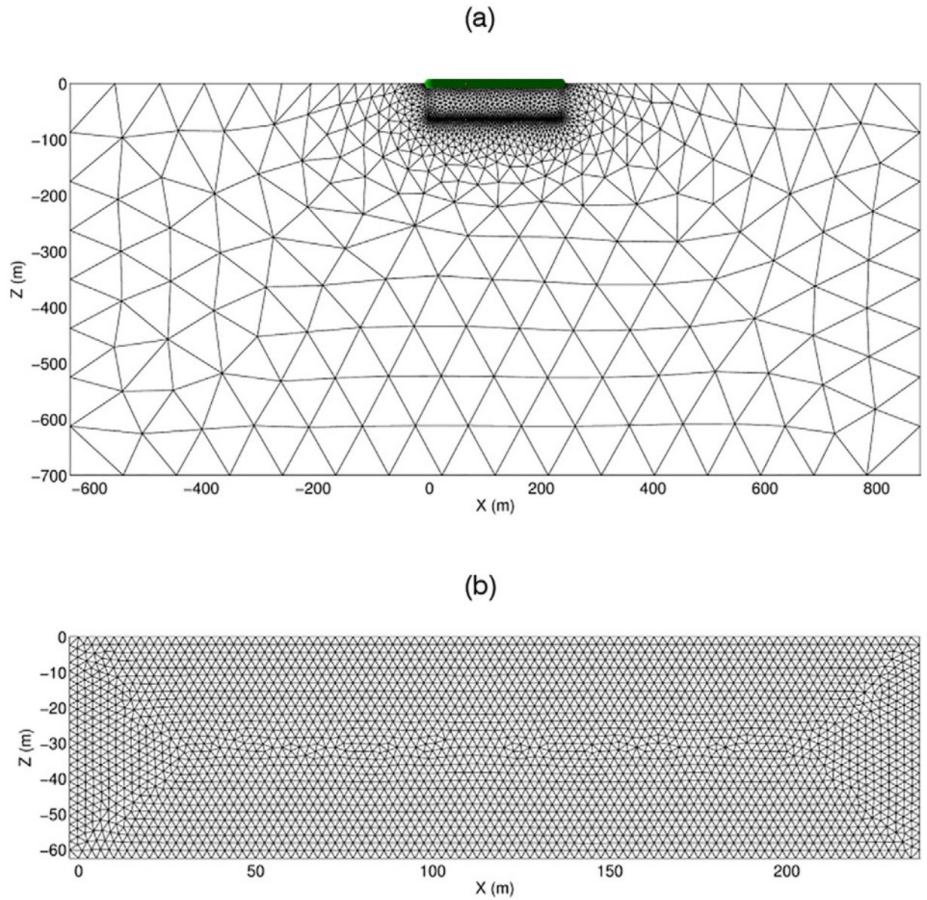


Current Electrodes

Potential electrodes

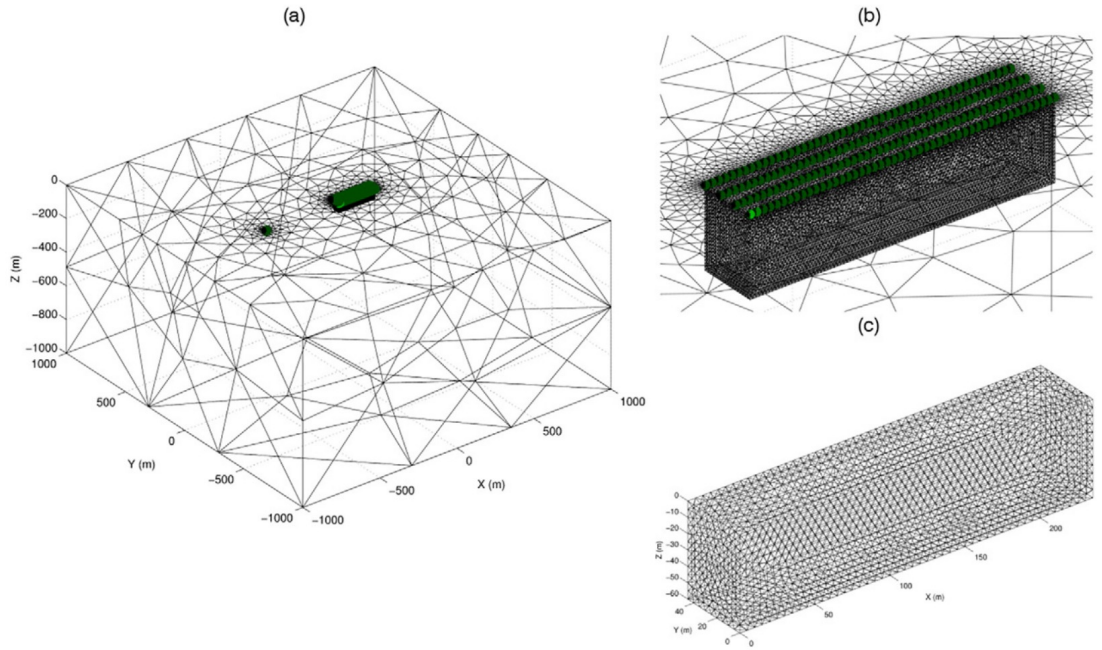
Finite Element

2D ERT



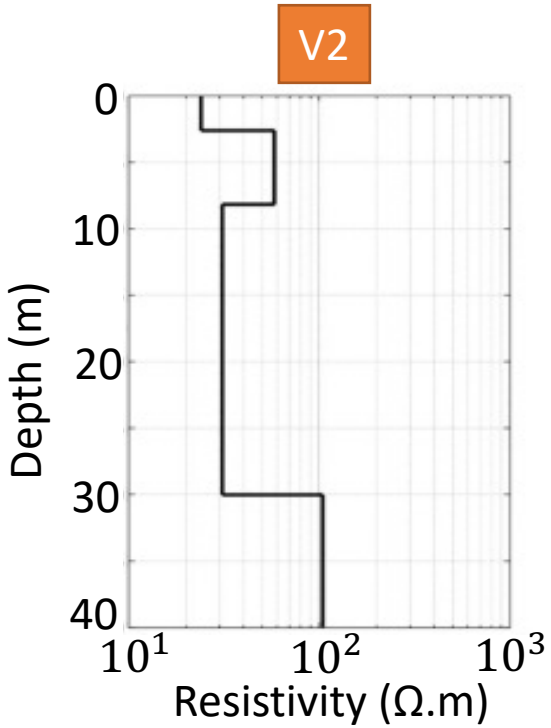
3228 elements

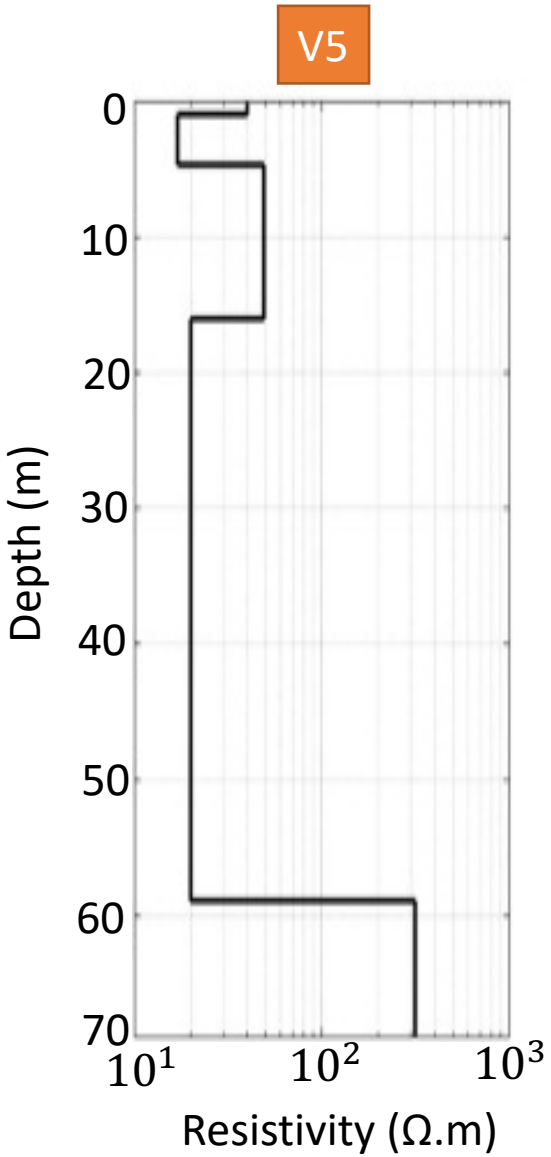
3D ERT

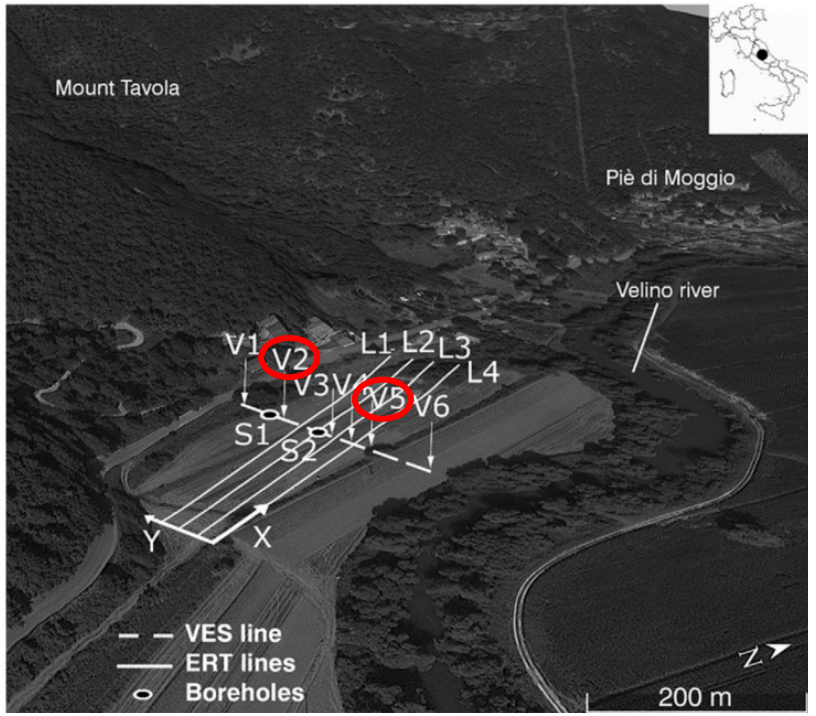


301641 elements

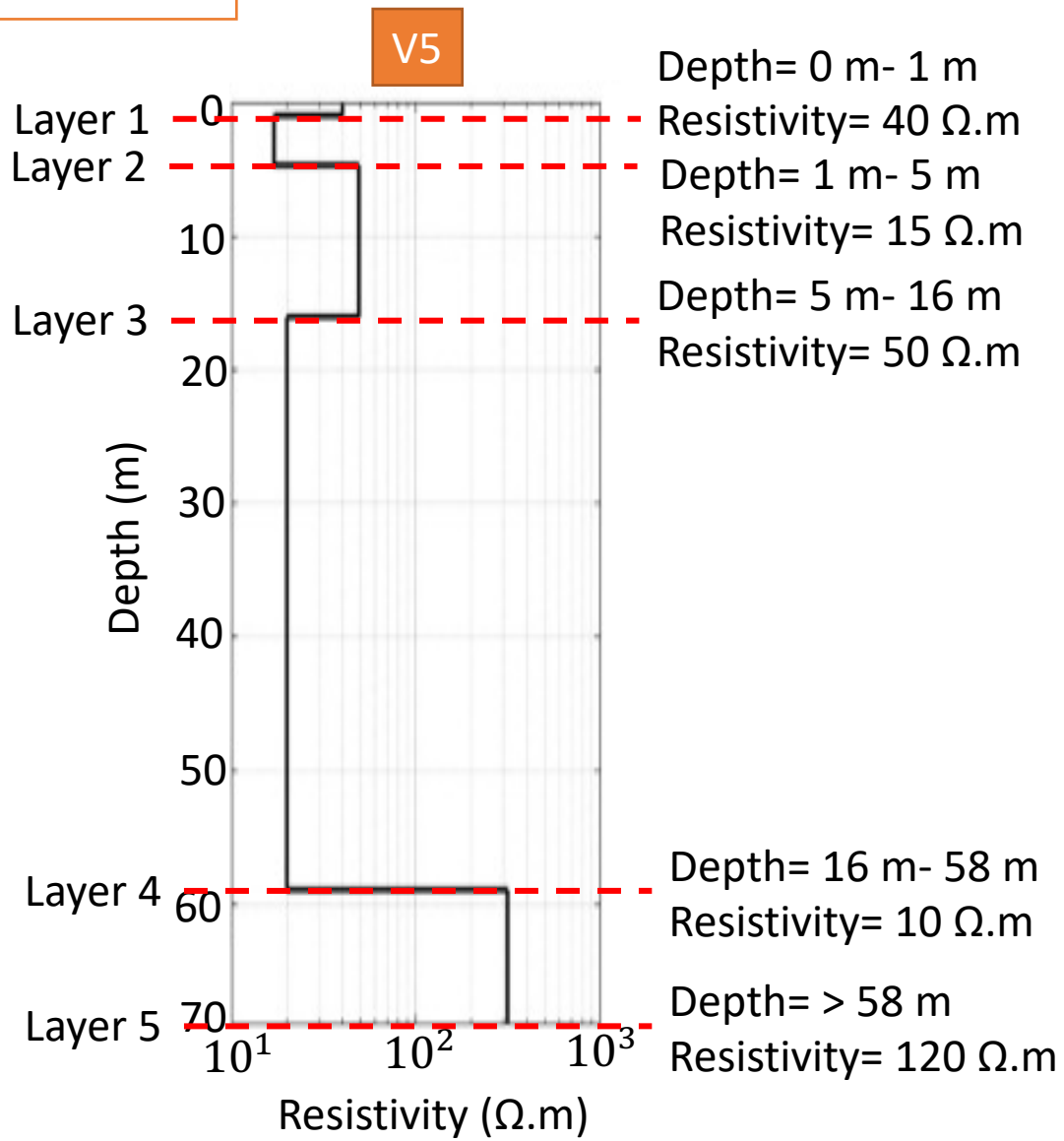
Field results (VES)



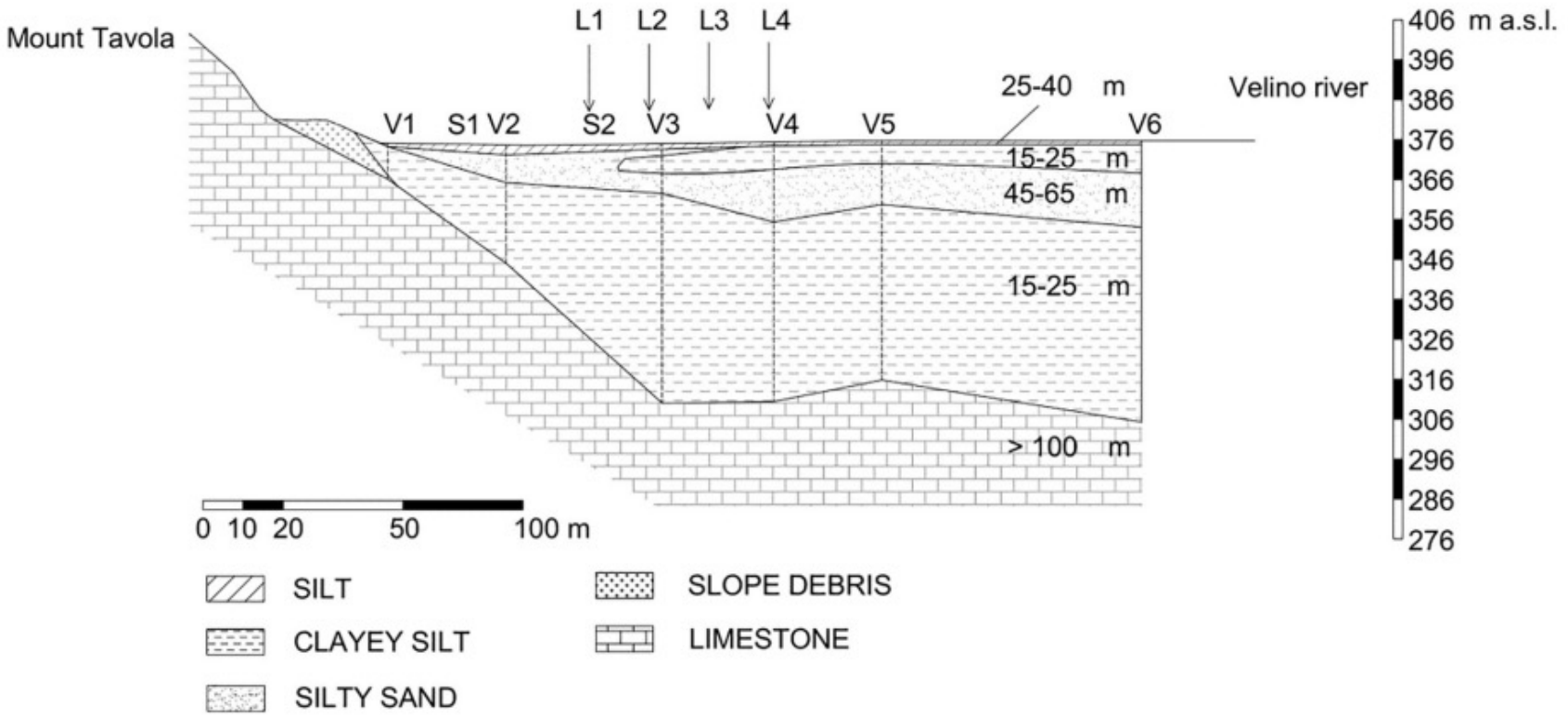


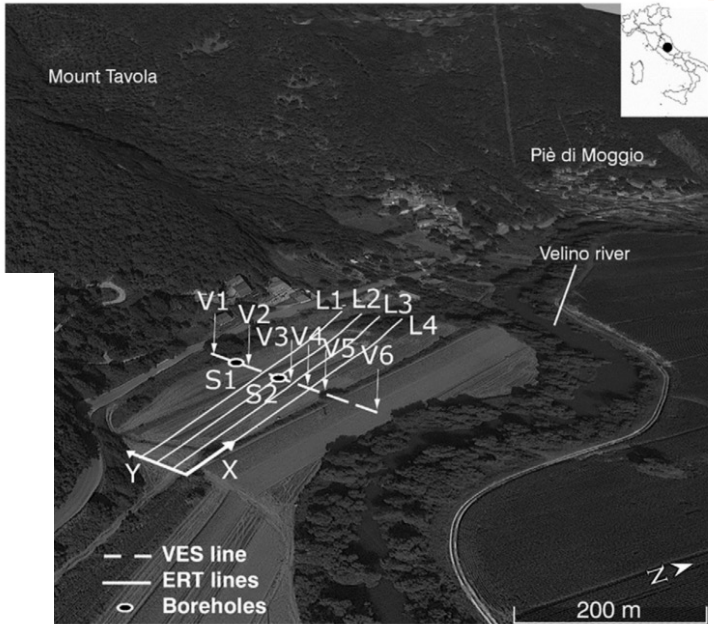


How to read the fields result of VES?



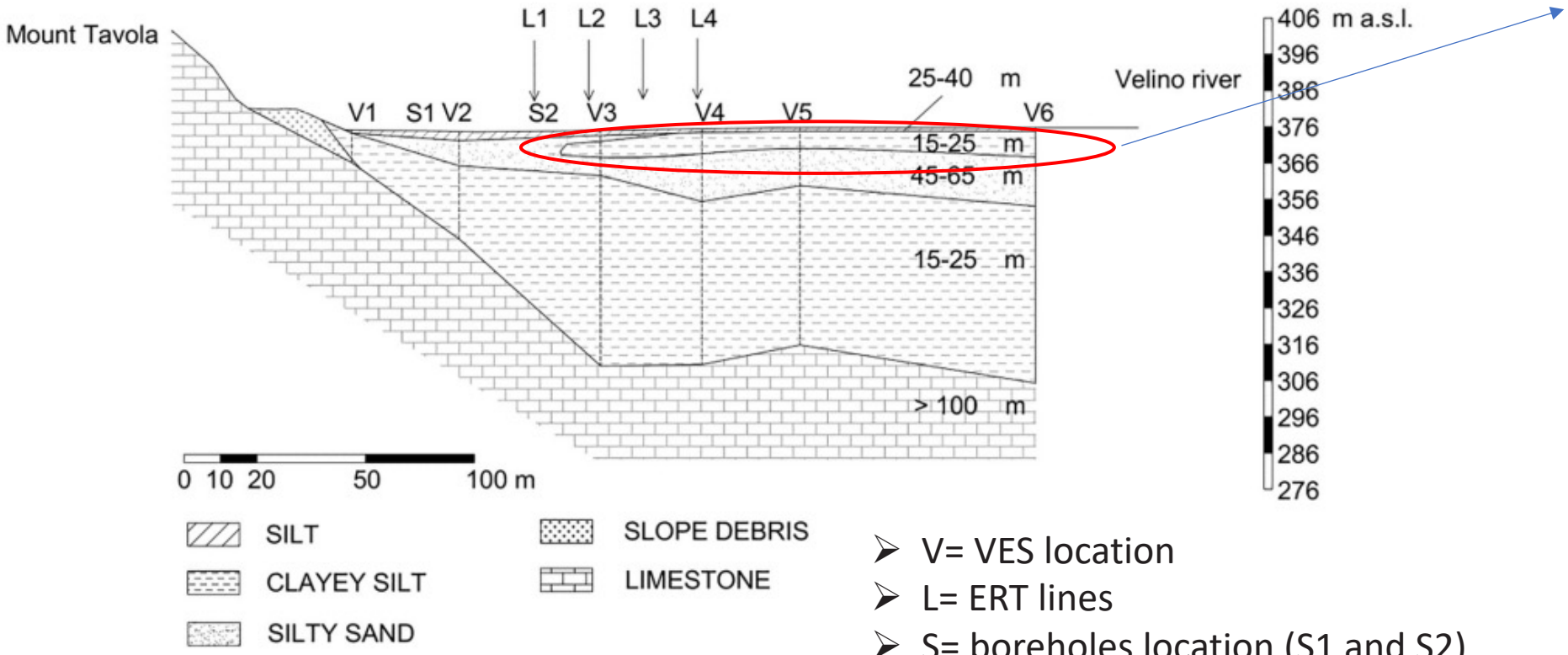
Reconstructed VES with borehole data





- V= VES location
- L= ERT lines
- S= boreholes location (S1 and S2)

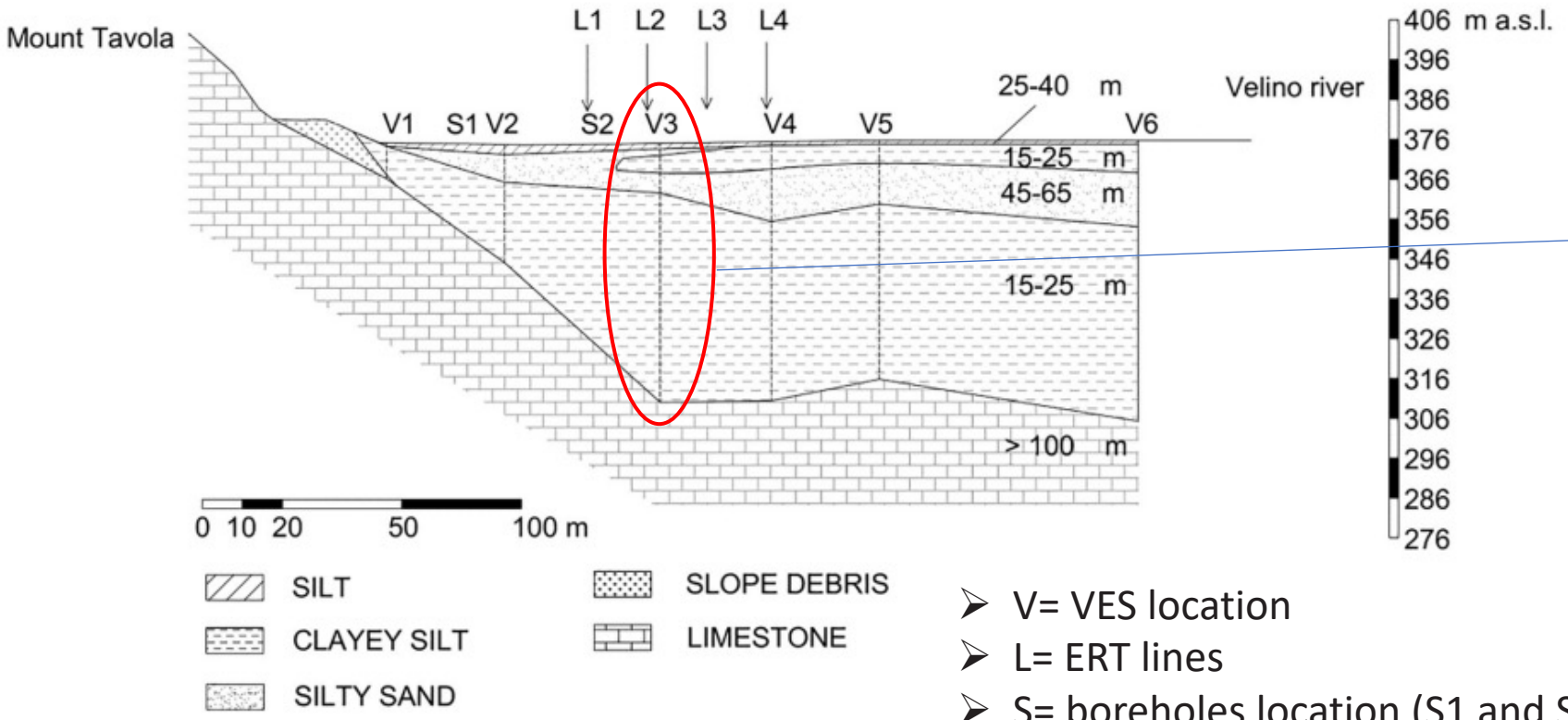
Reconstructed VES with borehole data



The clayey silt founded in the V3, V4, and V5.

- V= VES location
- L= ERT lines
- S= boreholes location (S1 and S2)

Reconstructed VES with borehole data

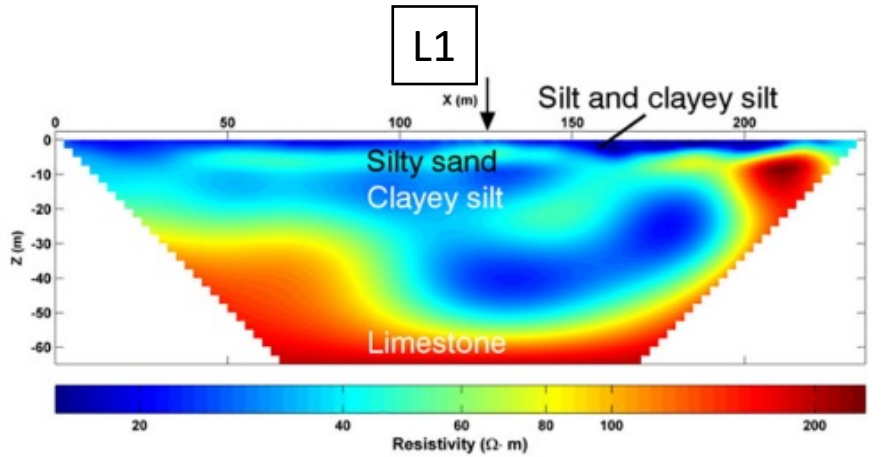


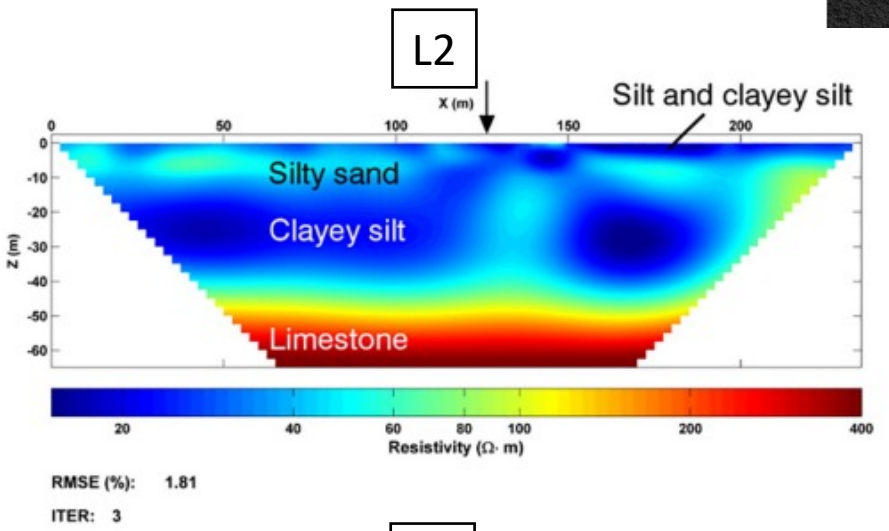
The bedrock depth reaches its maximum (about 65 m from surface) in correspondence to V3

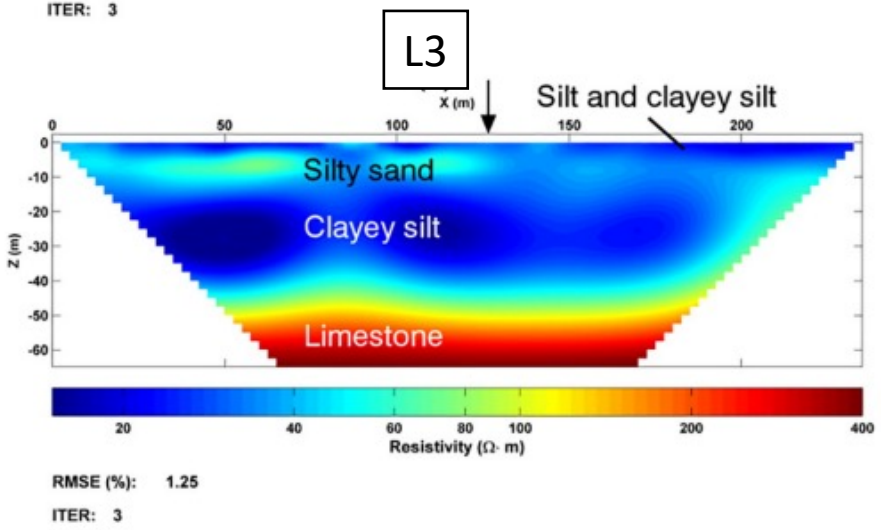
- V= VES location
- L= ERT lines
- S= boreholes location (S1 and S2)

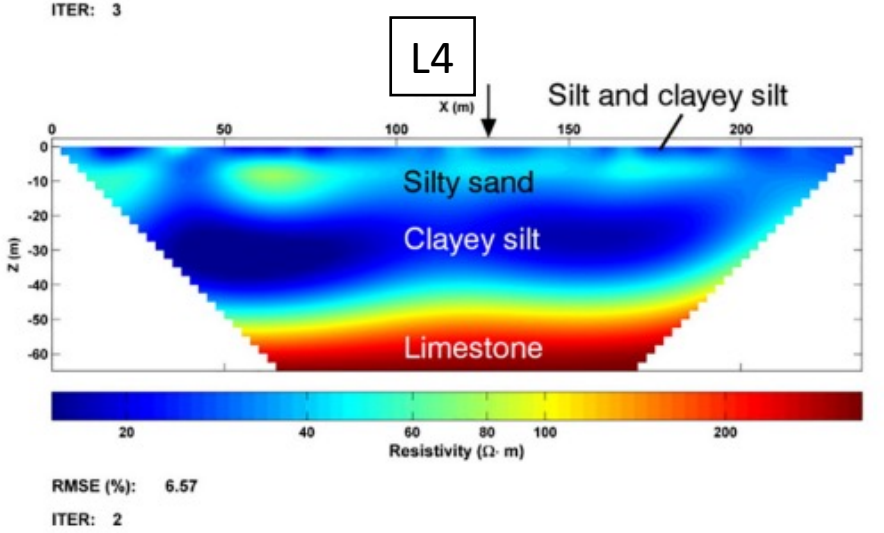
Bedrock was detected at depth 20 to 65 m from surface

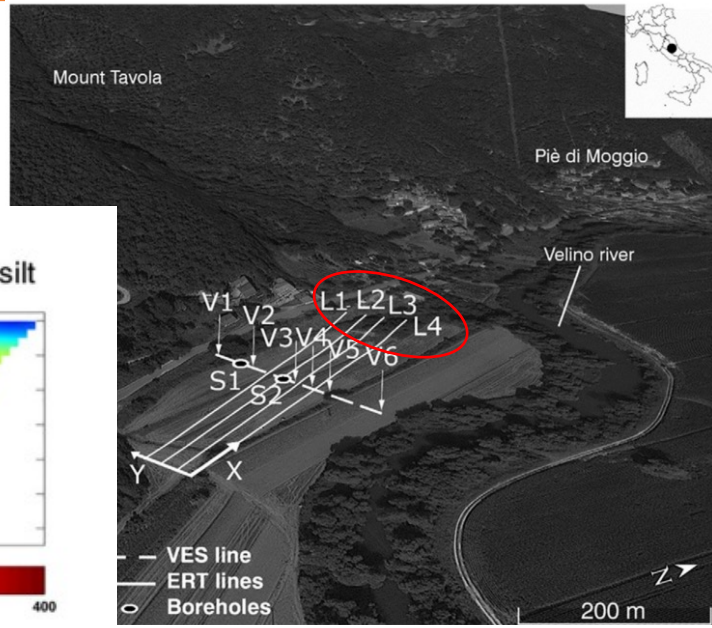
Field results (2D ERT)



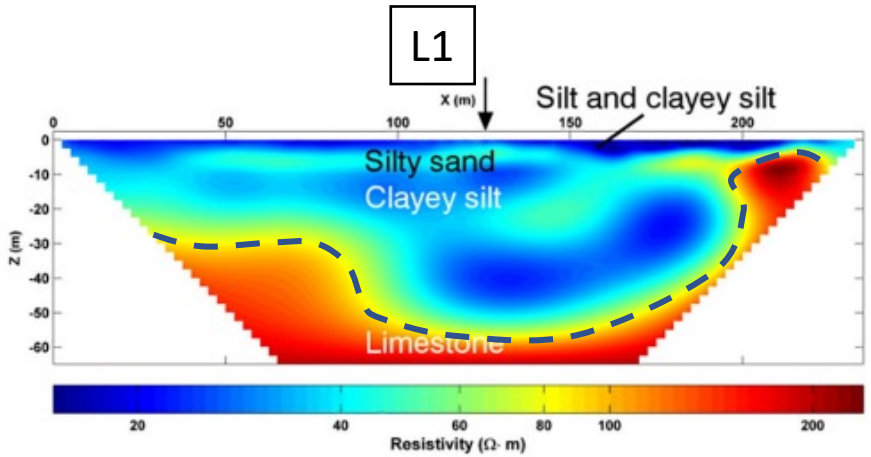


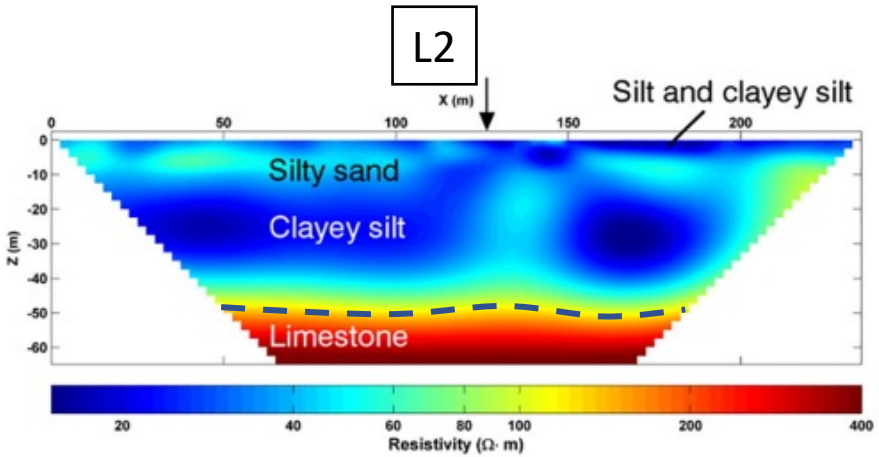


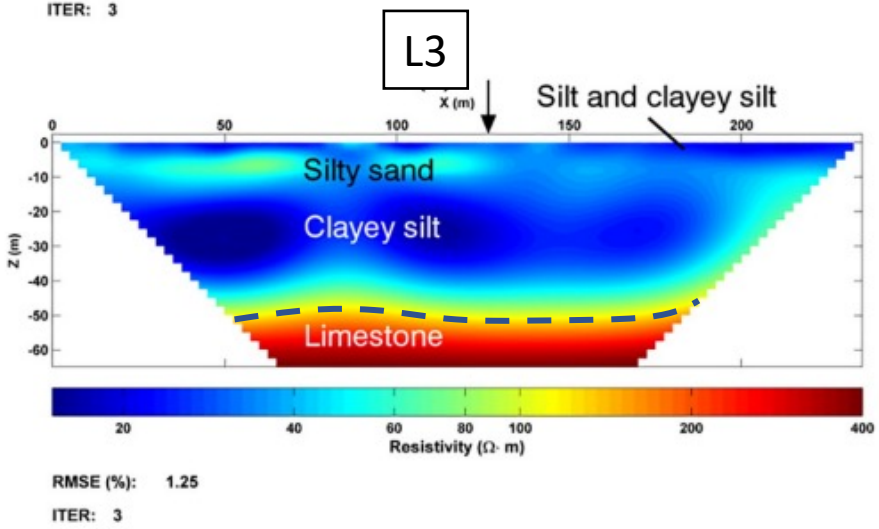


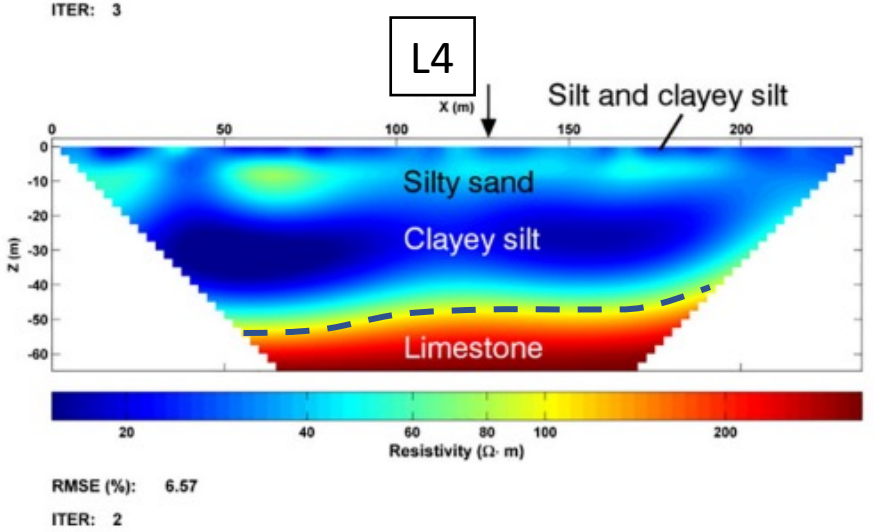


Field results (2D ERT)



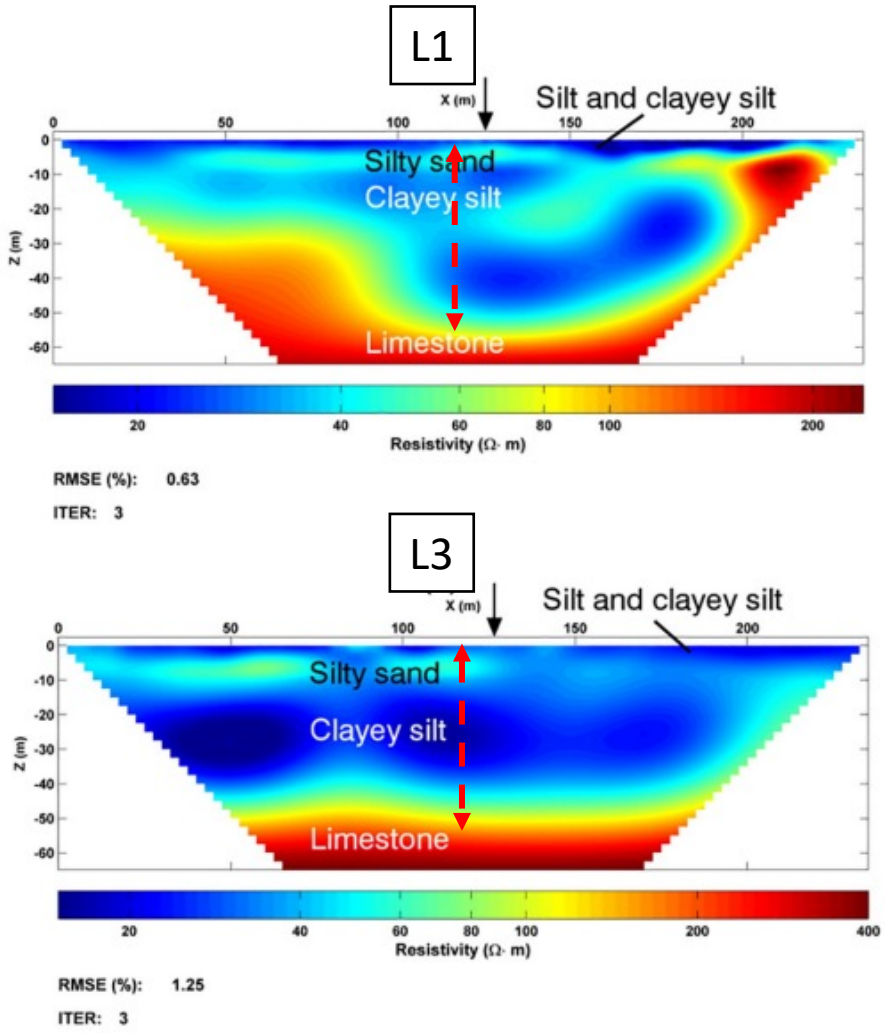






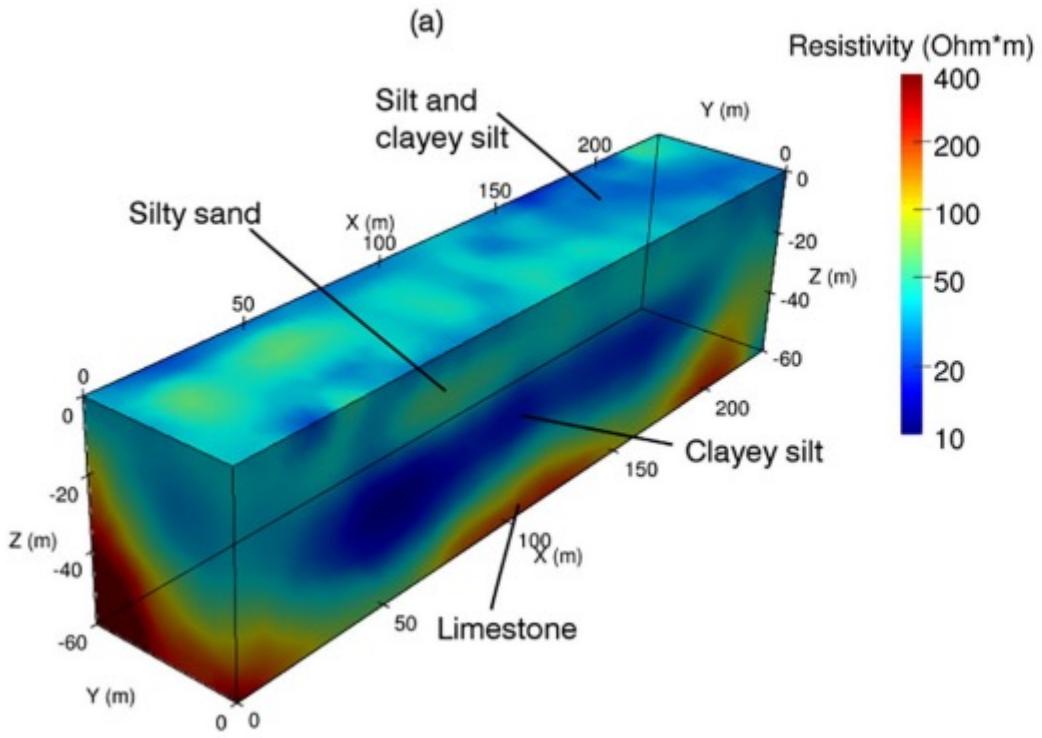
the bedrock is visible at shallower depths on the L1 line (Fig. 9a) executed close to the Mts. Tavola

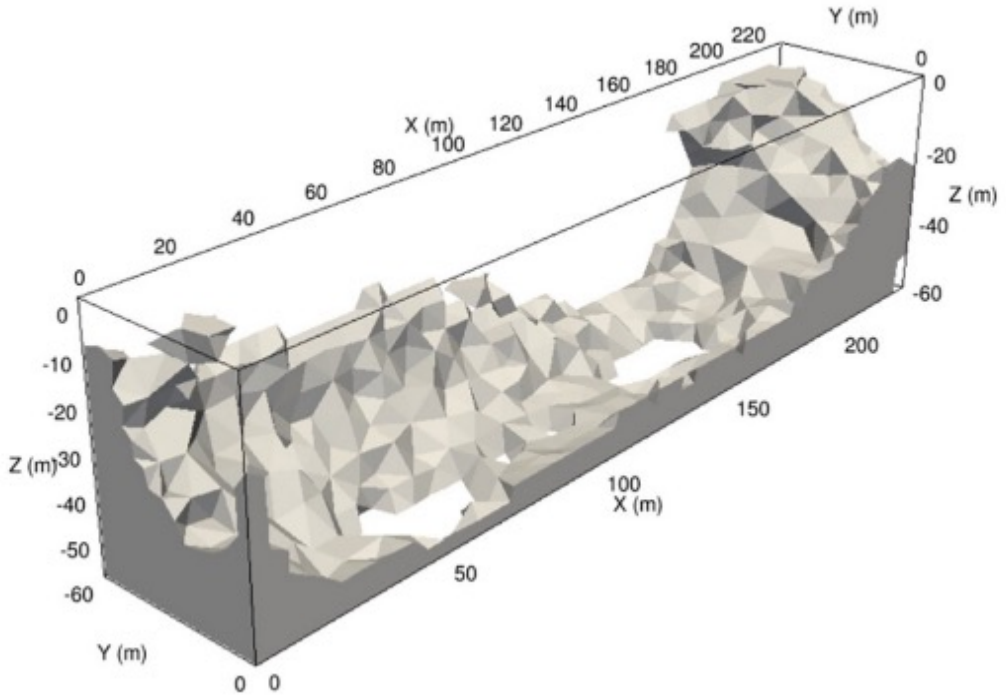
Field results (2D ERT)



The bedrock depth in the middle part of the basin, early inferred for VES investigation, is confirmed by ERT, even though it is slightly lower (around 50 m from surface)

The pseudo-3D inversion of the 4 ERT lines on the 235 × 45 × 65 m





Bedrock was detected at depth 20 to 65 m from surface (300-500 Ωm)

1. Rapid screening performed with VES surveys, operating under the hypothesis of homogeneous subsoil in both x- and y directions, provides a preliminary geophysical reconstruction of the basin. bedrock was detected at increasing depths (20 to 65 m from surface) moving towards the Velino River.
2. The 2D resistivity models enhance the high degree of variability of the silty sand formation in the study area, even though bedrock is recovered at shallower depth with respect to the VES line (50 m).
3. A pseudo-3D inversion of the ERT lines allows us to reconstruct a volumetric image of the bedrock at the study site

1D VES survey may be applied where a rapid low-budget screening is requested, while 2D and 3D ERT can be focused on specific areas to confirm the VES results. Drilling boreholes is required to confirm the results of the inversion processes