EGU General Assembly 2020

GI5.2: Innovative instrumentations, techniques, geophysical and remote sensing methods, material characterization, models and ICT tools for the smart and resilient cities of the future

Deep geophysical investigation in urban area: Ferrara city example

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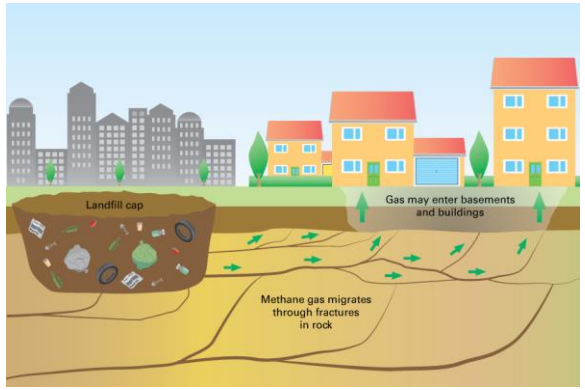
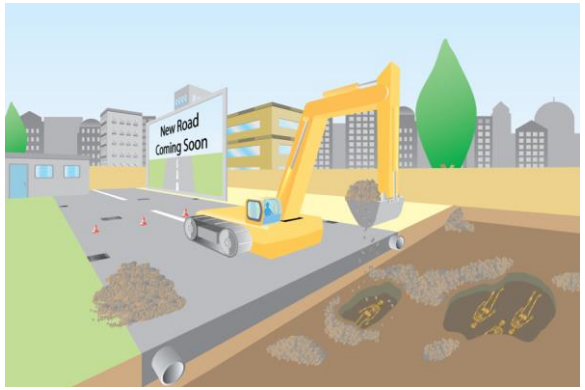
Introduction

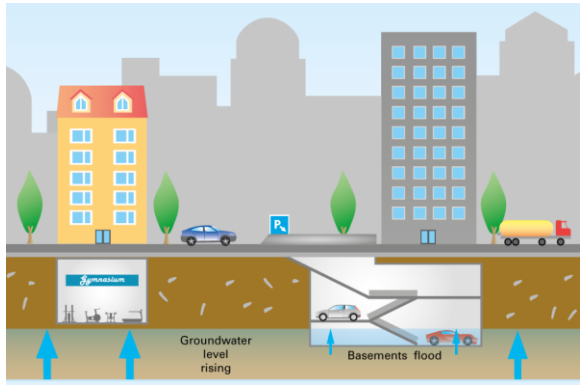
More than one half of the world population lives in urban area. The new process of urbanization strongly requires the adoption of new strategies and programs for urban planning to make the cities resilient to natural disasters and to increase their energy and environmental sustainability.

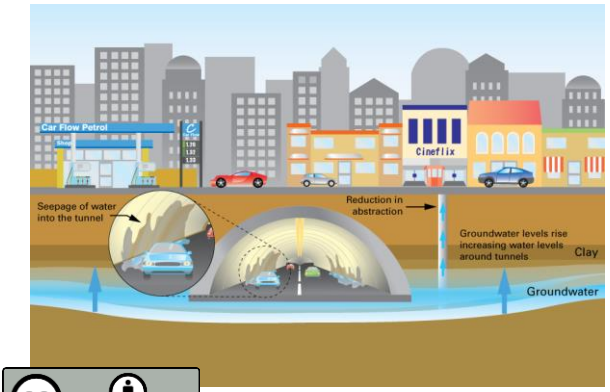
In this scenario, a detailed knowledge of the geological subsoil and its iteration with urban infrastructures became a fundamental issue for urban planning of view.

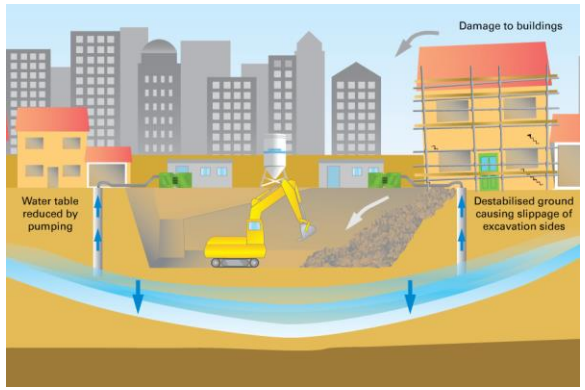
Urban Geophysics









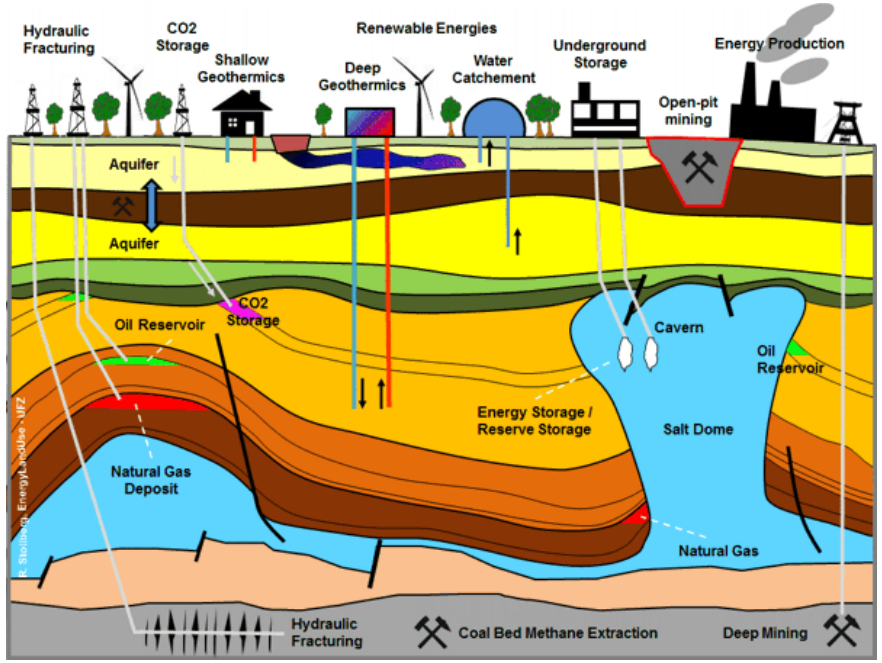


The role of **applied geophysics** for the new scenario of the increasing global urbanization is going to grow day by day.

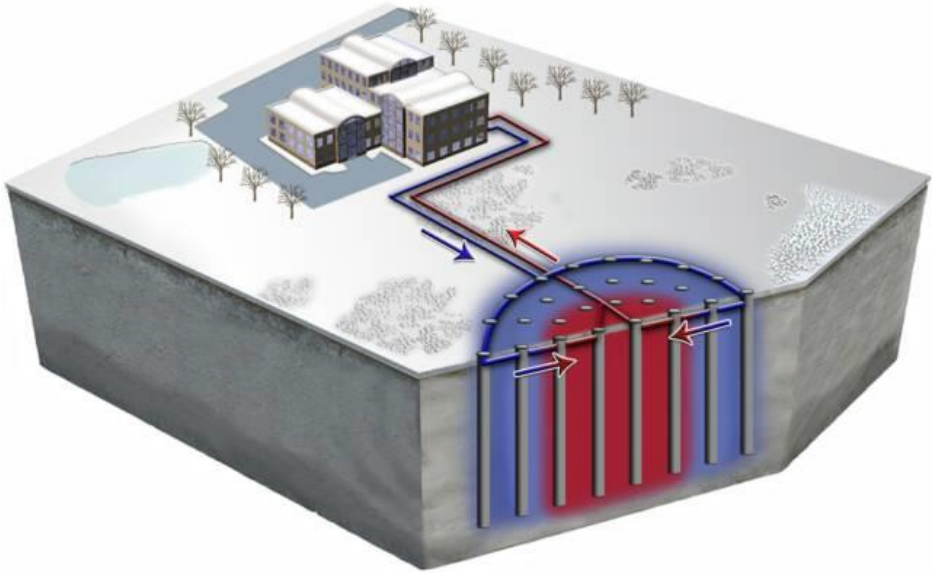
A novel sub-discipline, called Urban Geophysics, has recently been developing in the field of geophysics for analyzing limits and potentialities of well-known geophysical techniques in urban and industrialized areas.

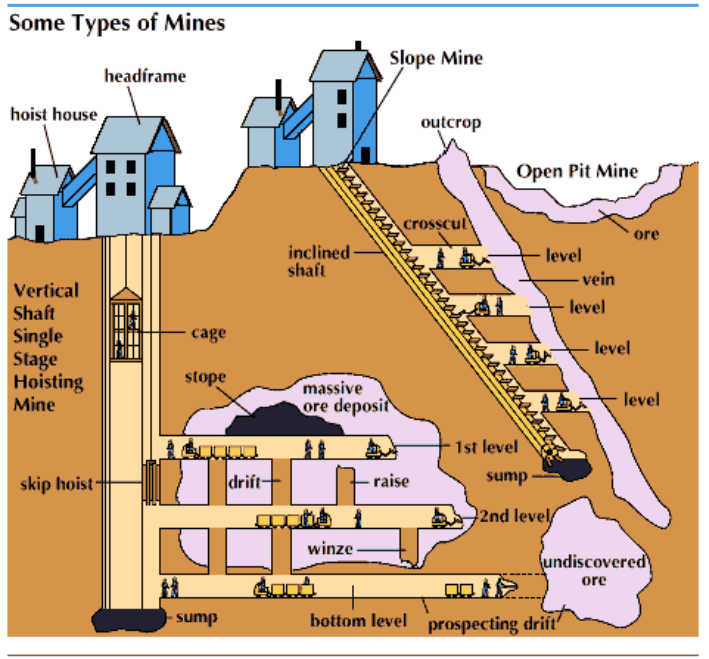
Their remote-sensing ability offers several advantages compared with invasive methods. The most appropriate methods are:
ground penetrating radar, electrical, electromagnetic, seismic and micro-gravity techniques.

Urban Geophysics

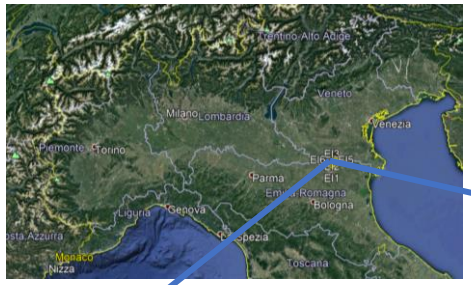


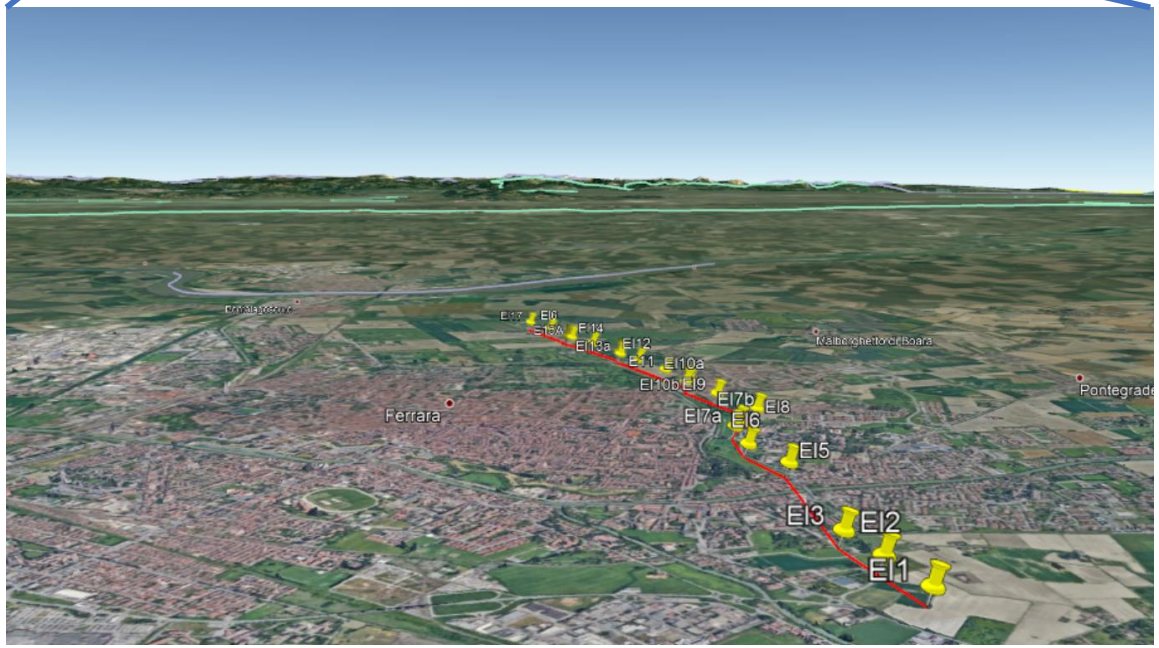
The application of some geophysical methods allows the recognition of deep geological structures from near surface down to more several hundred meters.
The urban environment, characterized by a difficult logistic and a high level of noise, has a strong impact on the applicability of the geophysical prospecting methods and on the data quality.





Urban area: Ferrara city - Italy



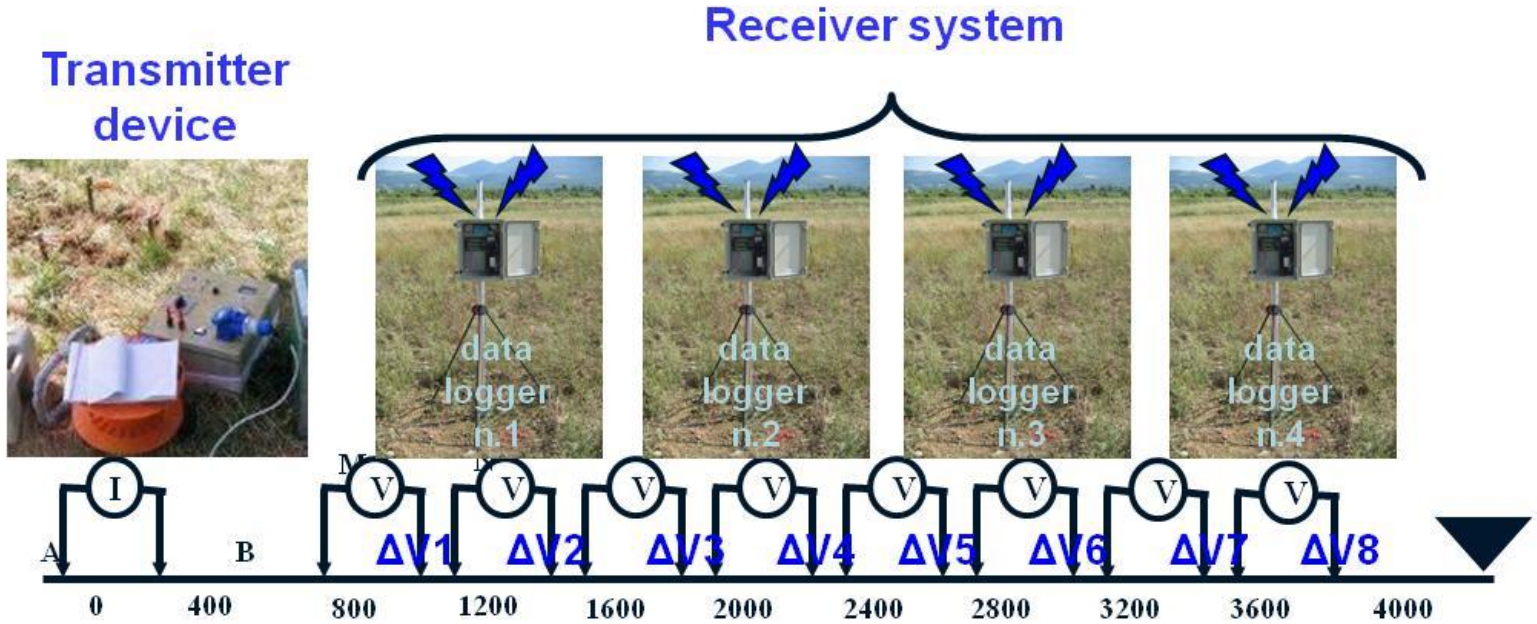


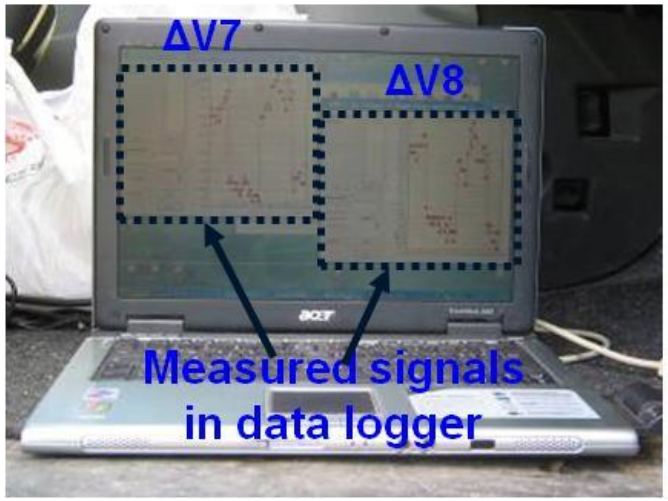
This work presents the results obtained by**Deep Electrical Resistivity Tomography (DERT)** and **P-wave Seismic Reflection** surveys performed in the city of Ferrara, which is interested in the management of geothermal resources and in the mitigation of seismic risk (CLARA-“Cloud Platform and smart underground imaging for natural risk assessment” Project funded by Italian MIUR). Along the eastern flank of the city walls, DERT and Reflection Seismic profiles were carried out in order to improve the geological information of the urban context.

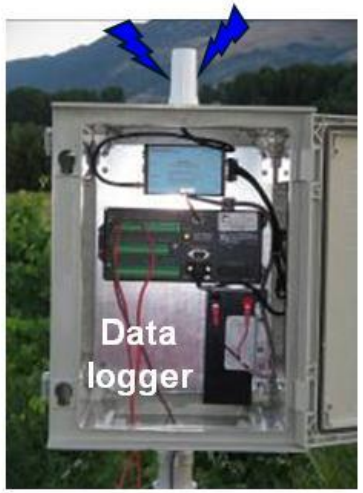
Deep Electrical Resistivity Method - DERT

The acquisition system is a prototype instrument built in the Hydrogeosite Laboratory of CNR-IMAA:

1) a transmitting stations which injects the current (max 15 Ampere)
2) multichannel receive devices which records the generated voltage signals (mV). It is composed by 5 remote multichannel data loggers (max 8 drop of potentials) connected with a radio communication system to a personal computer.

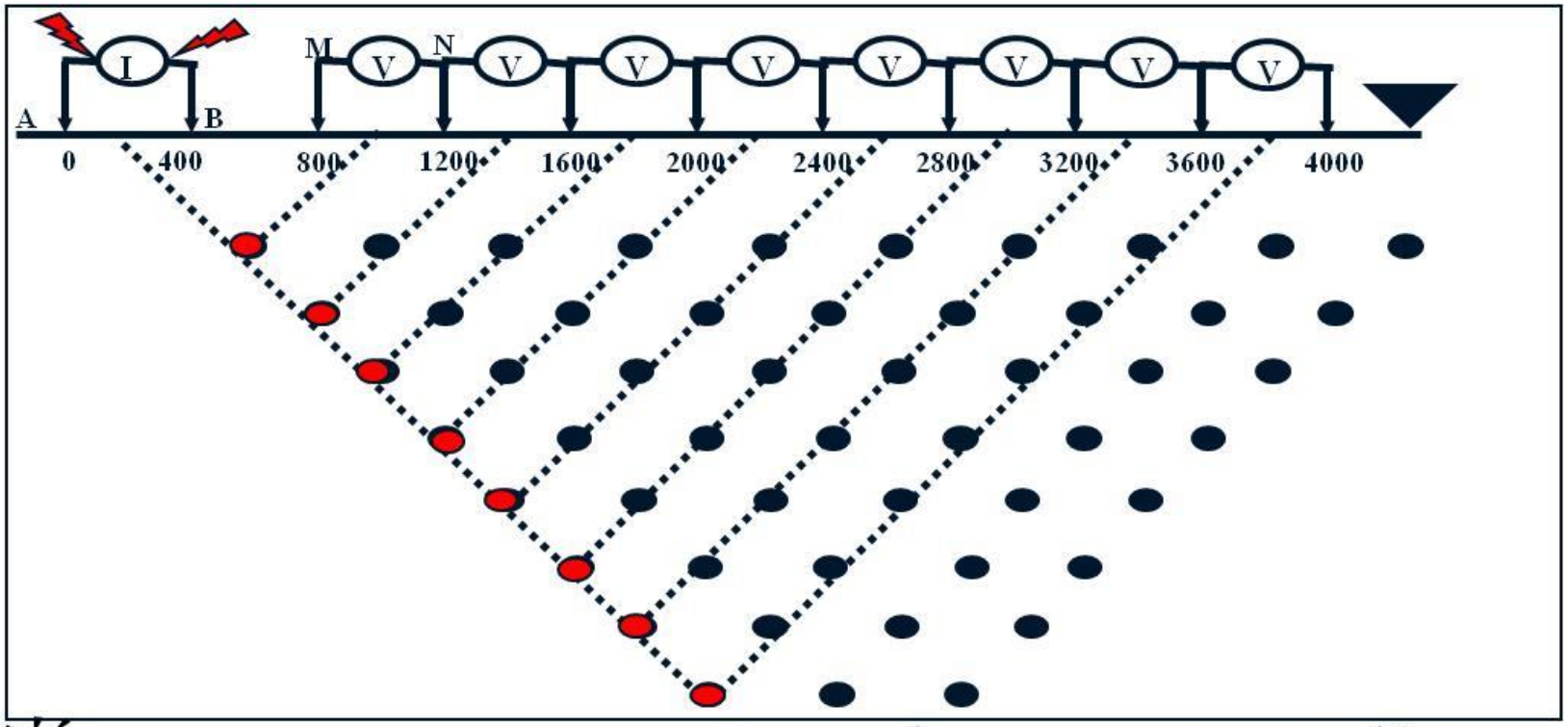




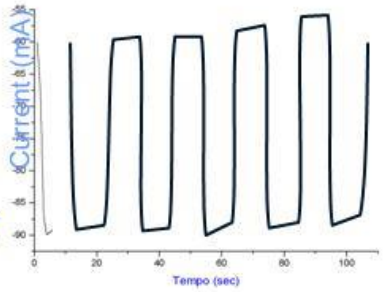


Deep Electrical Resistivity Method - DERT

At the same time 8 voltage recording from 5 to 20 min were acquired for each current injection related to different positions of the electrodes along the profile.

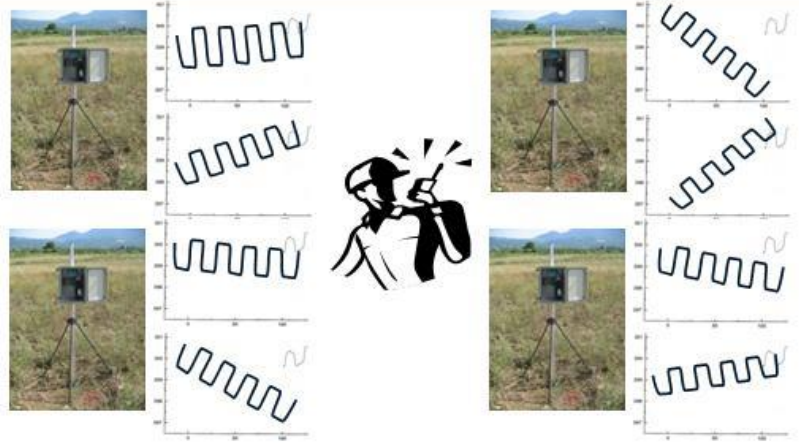


Transmitter device



~15-20 minutes

Receiver system

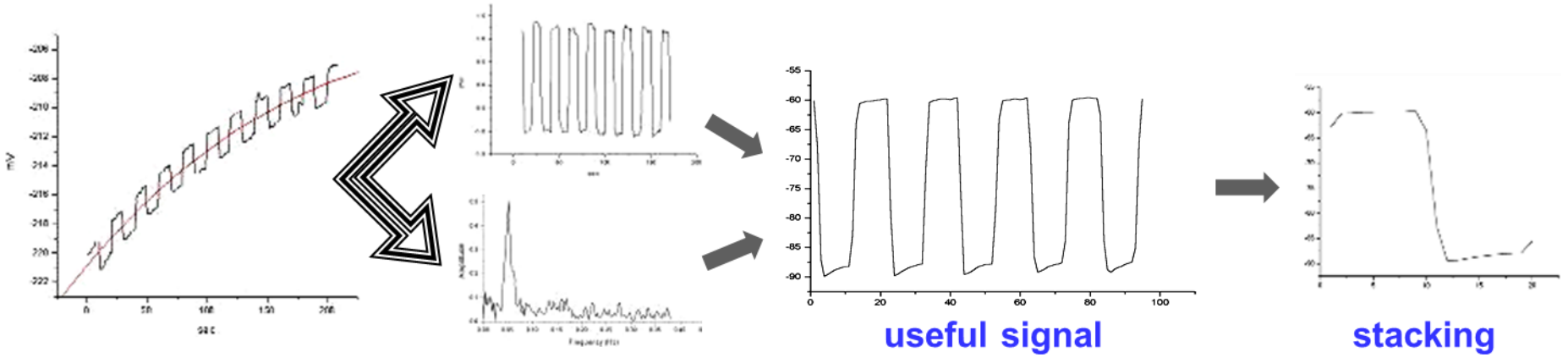


Deep Electrical Resistivity Method - DERT

Data Analysis

identification of useful signal in voltage recordings with very low s/n ratio

Bad data removal, Detrending, FFT, Stacking

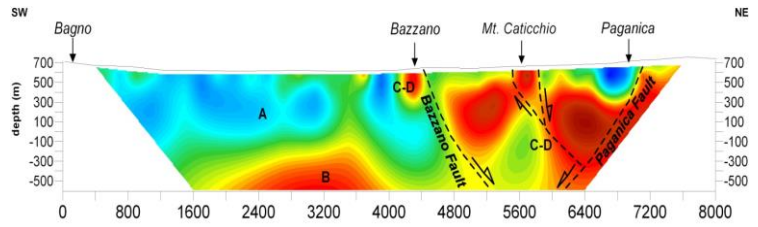


$$\rho_a = [\pi a n(n+1)(n+2)](\Delta V / I)$$

(Hannenson, 1990)

ΔV: potential drop between MN electrodes
I: current intensity
a: basic distance between two contiguous electrodes
n: integer number times the basic distance

Inversion Data



DERT in FERRARA CITY

The mains characteristic of the acquisition procedure are:

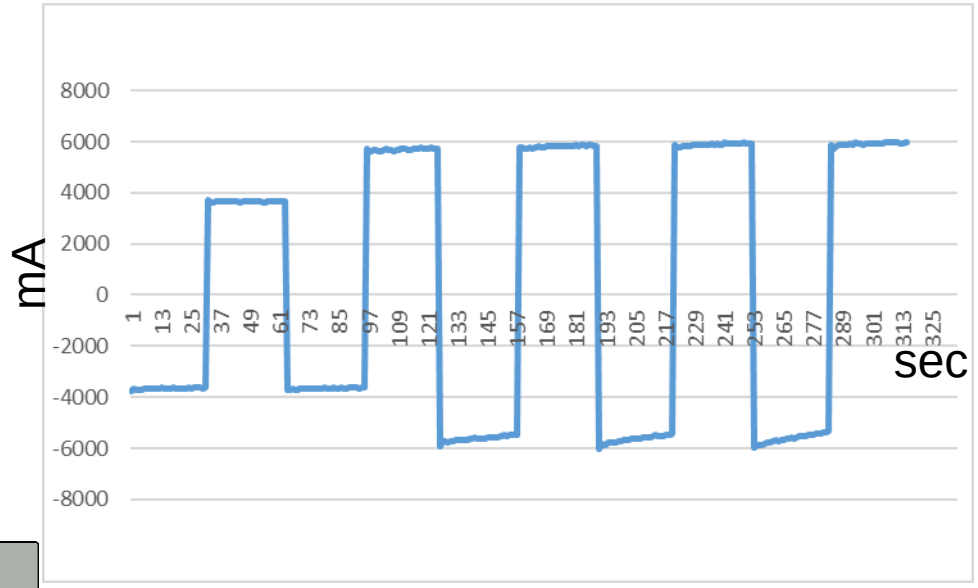
- n. electrodes: 19
- electrode distance (ED): from 300m to 900m
- n. energizations: 35
- n. drop of potential: 240
- Max. injected current: 14.000 mA
- Min. injected current: 3.000 mA

DERT in FERRARA CITY

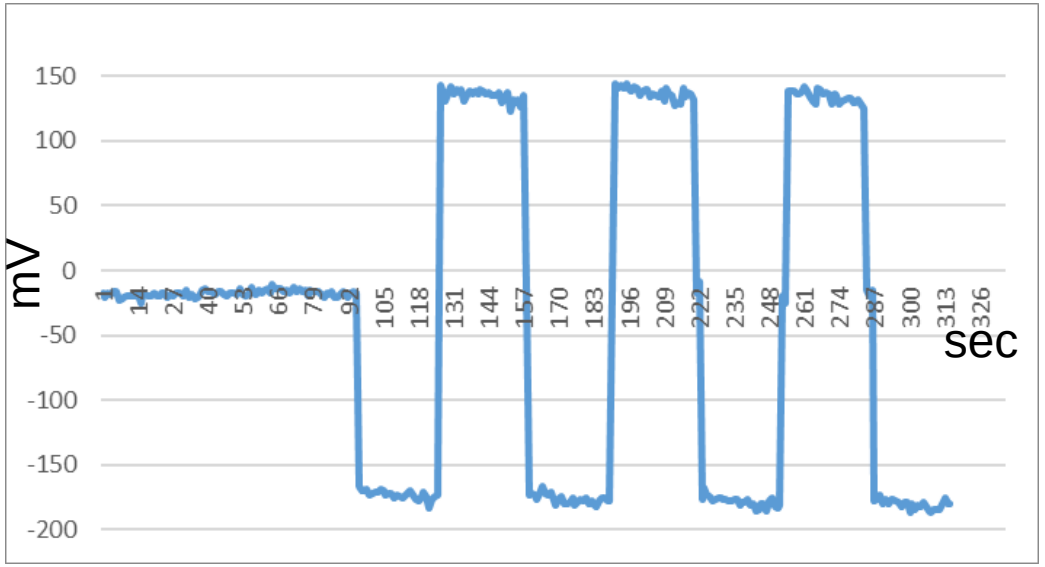
New energization system: Transmitter, power supply, datalogger, steel electrodes

Acquisition system: Multichannel datalogger

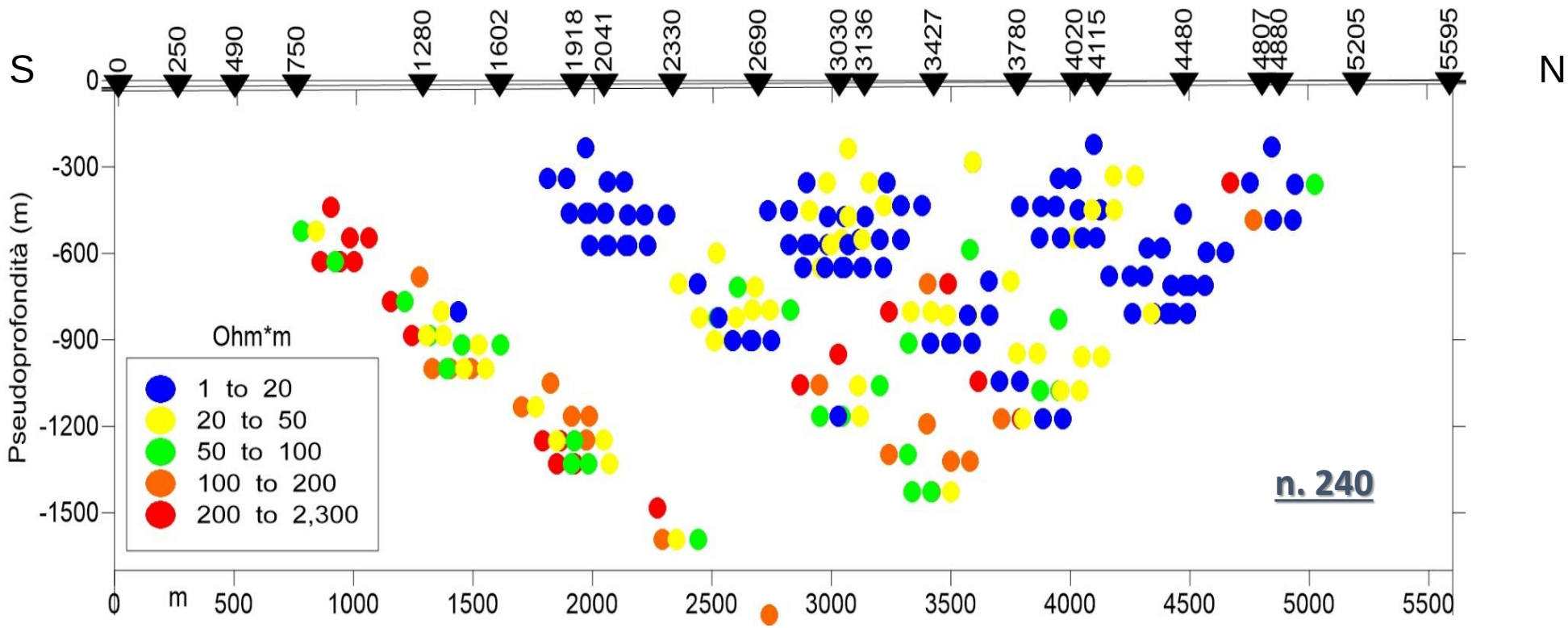
Injected current



Elaborated drop of potential

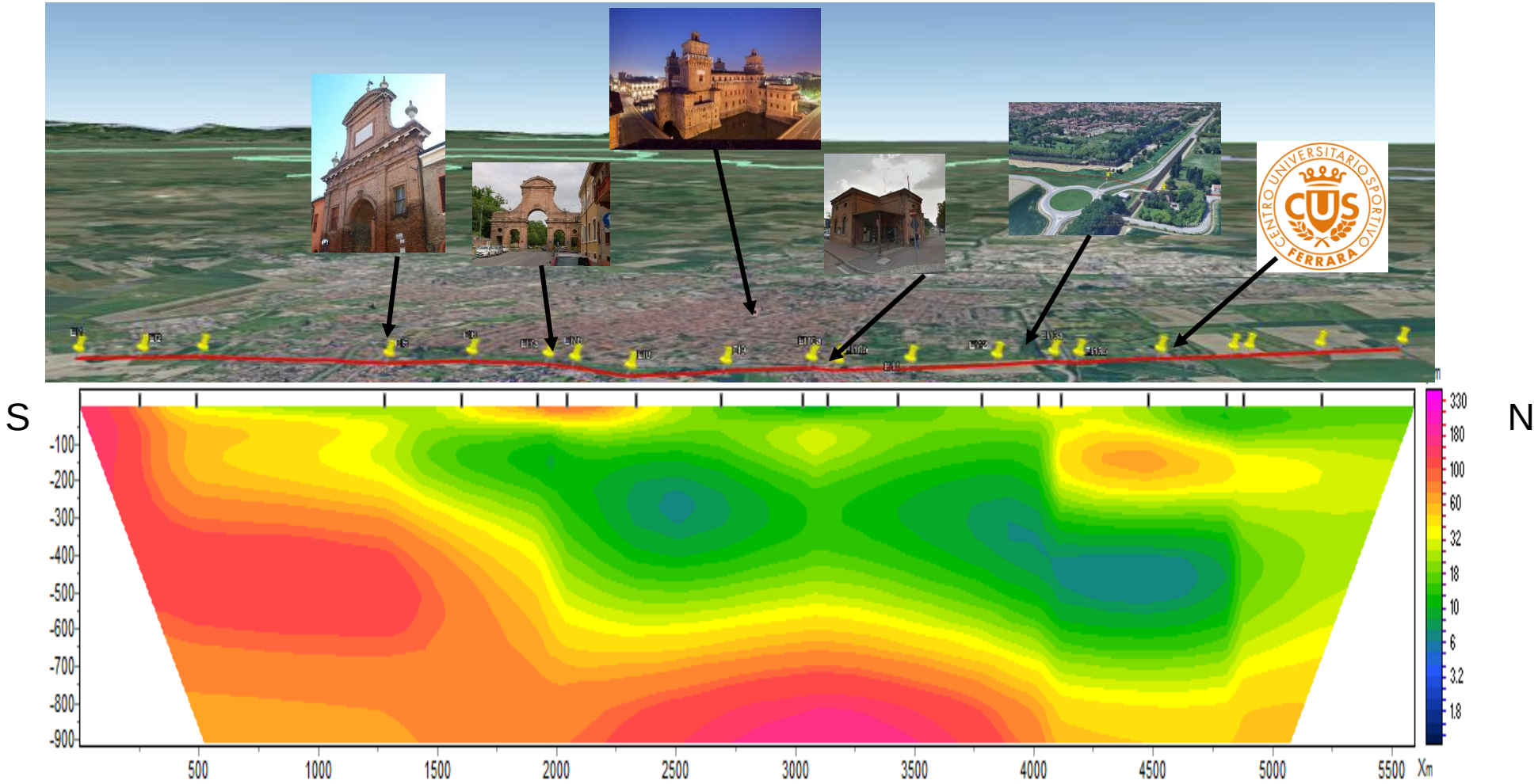


DERT in FERRARA CITY



Distribution of the apparent electrical resistivity values obtained from the elaborated acquired data

DERT in FERRARA CITY



Electrical resistivity Tomography after the inversion procedure with the ZondRes2D software

Seismic Reflection in FERRARA CITY

Seismic reflection investigations offer a powerful non-invasive tool suitable for mapping the subsurface geological framework from the very near-surface to hundreds of metres below surface.

Seismic Reflection in FERRARA CITY

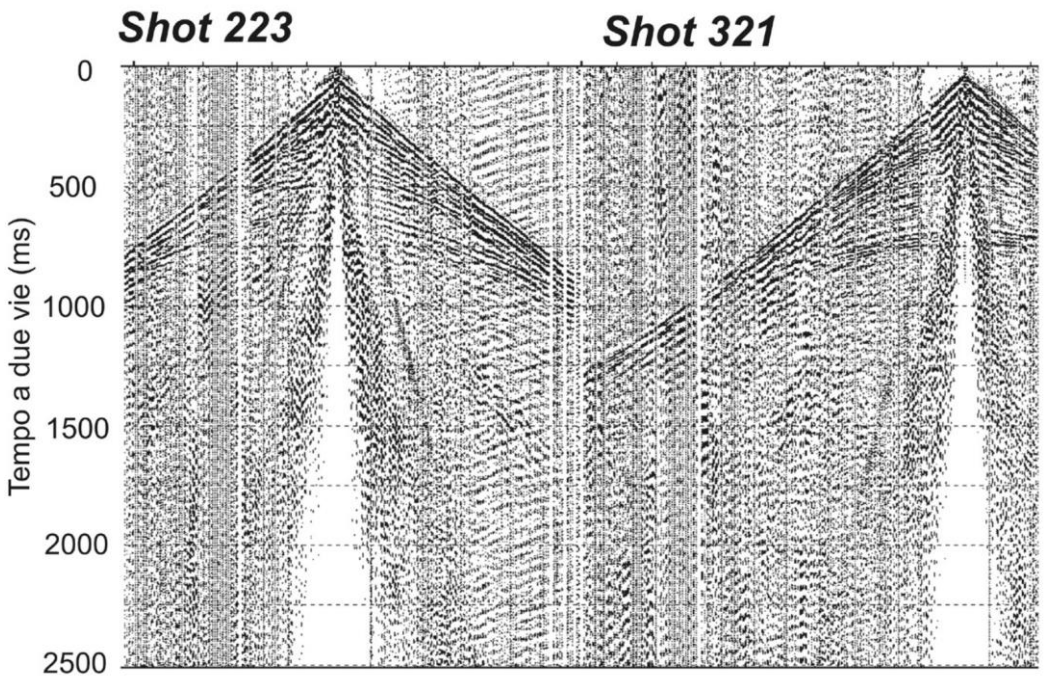
Recently several seismic surveys was performed in urban environment by using frequency-controlled vibroseis sources both in P- and SH-wave.

In this case, a 2.5-km seismic line was acquired by a vibroseis MiniVib T-2500 source in P-wave configuration.

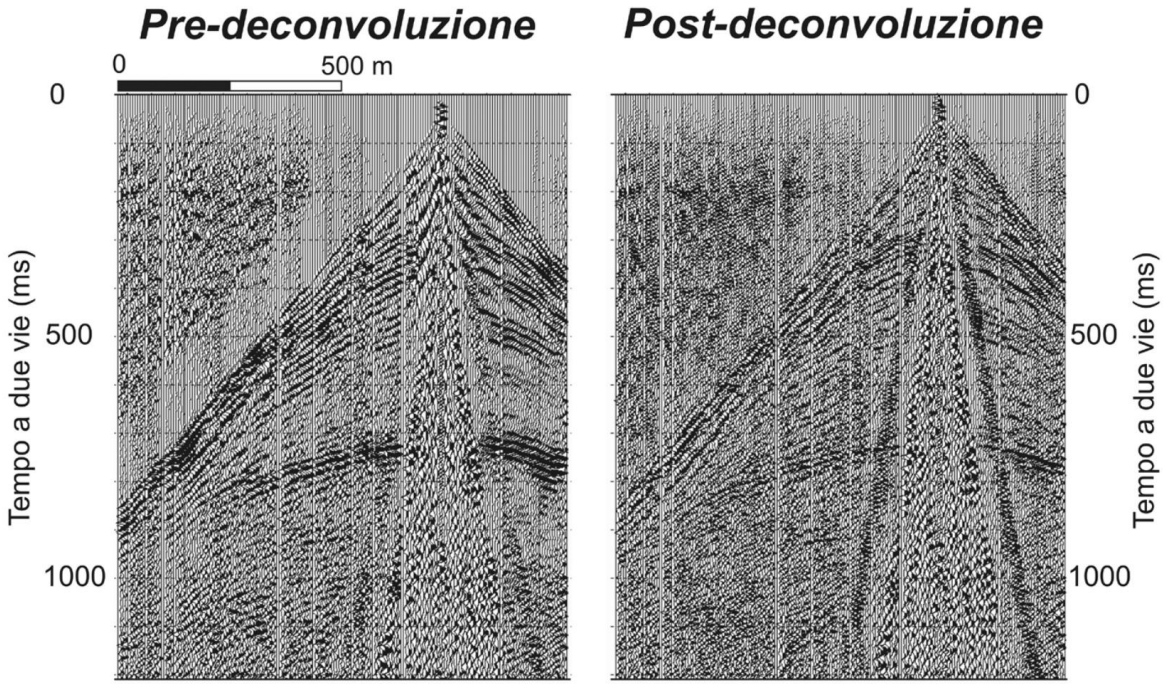
The reflection seismic line was acquired with a DMT telemetric recording system Summit II/IIplus with 24-bit A/D converter. As receivers, linear patterns of 6 geophones at 10 Hz with a distance between groups of 10 m were used.

For more details send an email to *lpetronio@inogs.it*

Seismic Reflection in FERRARA CITY



Example of two energizations after ground force correlation. Note on shot 223, the periodic noise induced by the passage of cars at the end of the line (right), which does not, however, mask the strong reflection at TWT at 750 s. Shot 321 records only random noise.



Example of a shot where a deconvolution has been applied. On the right you can see the considerable increase in the vertical resolution of the reflections produced by the algorithm.

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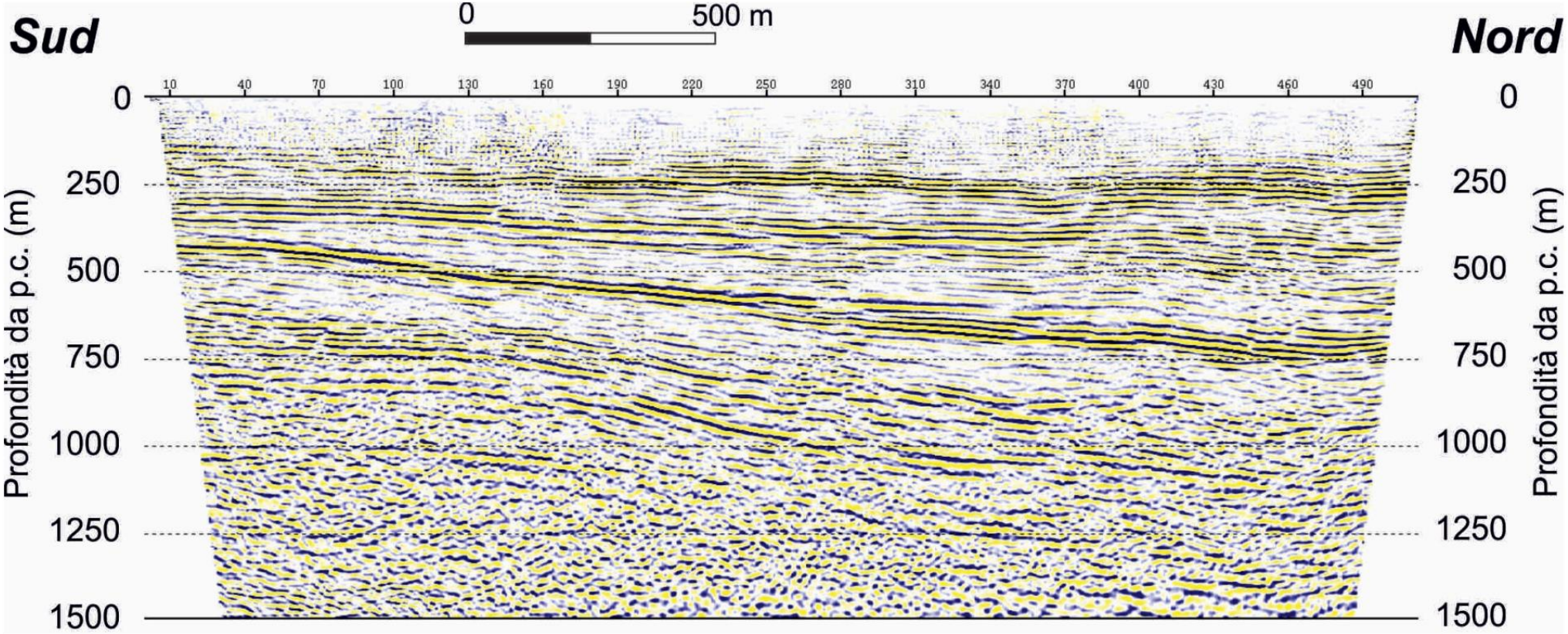
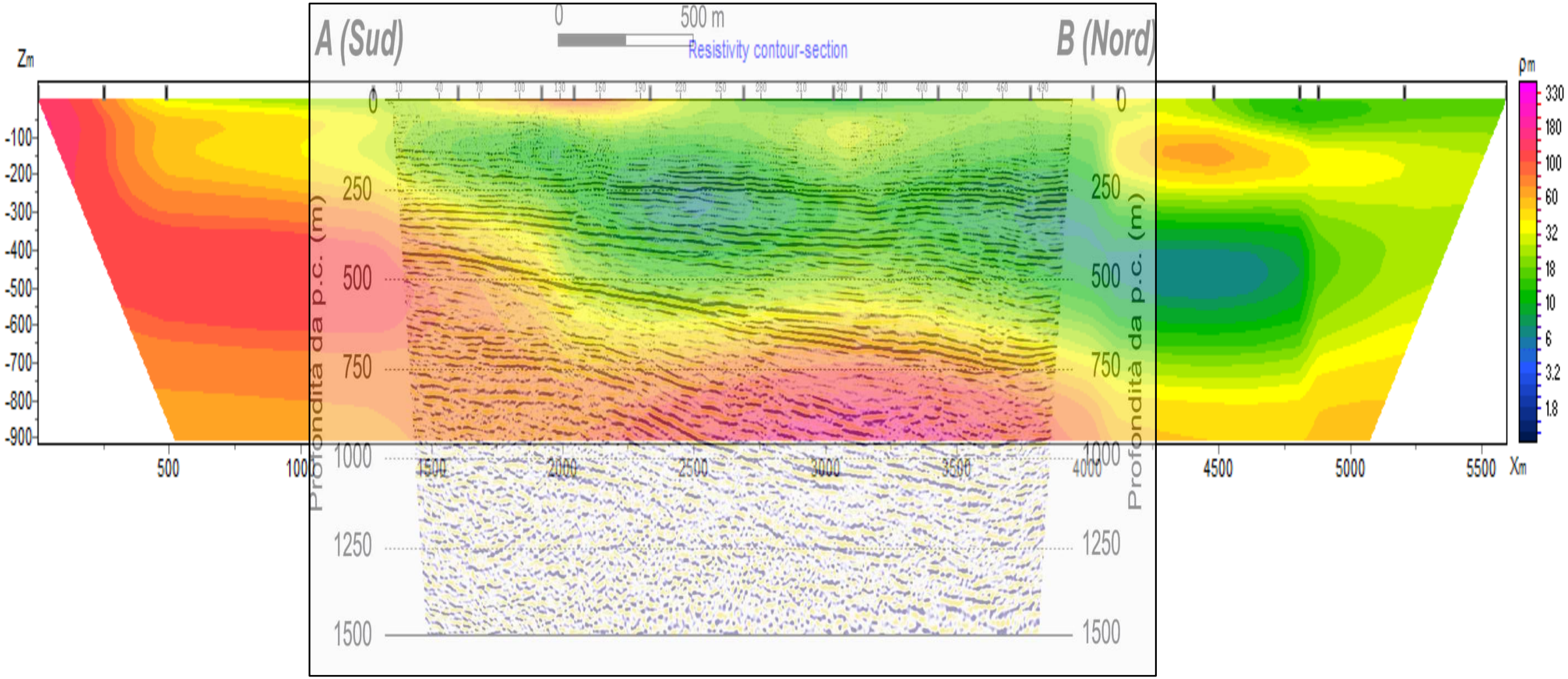
Seismic Reflection in FERRARA CITY



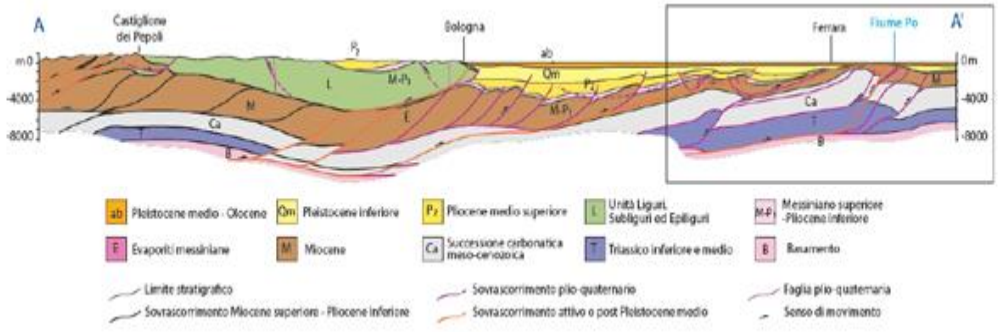
Final section migrated in time and then converted in depth

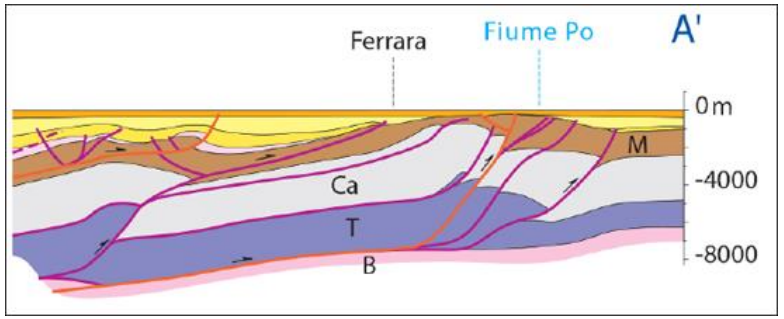
For more details send an email to *lpetronio@inogs.it*

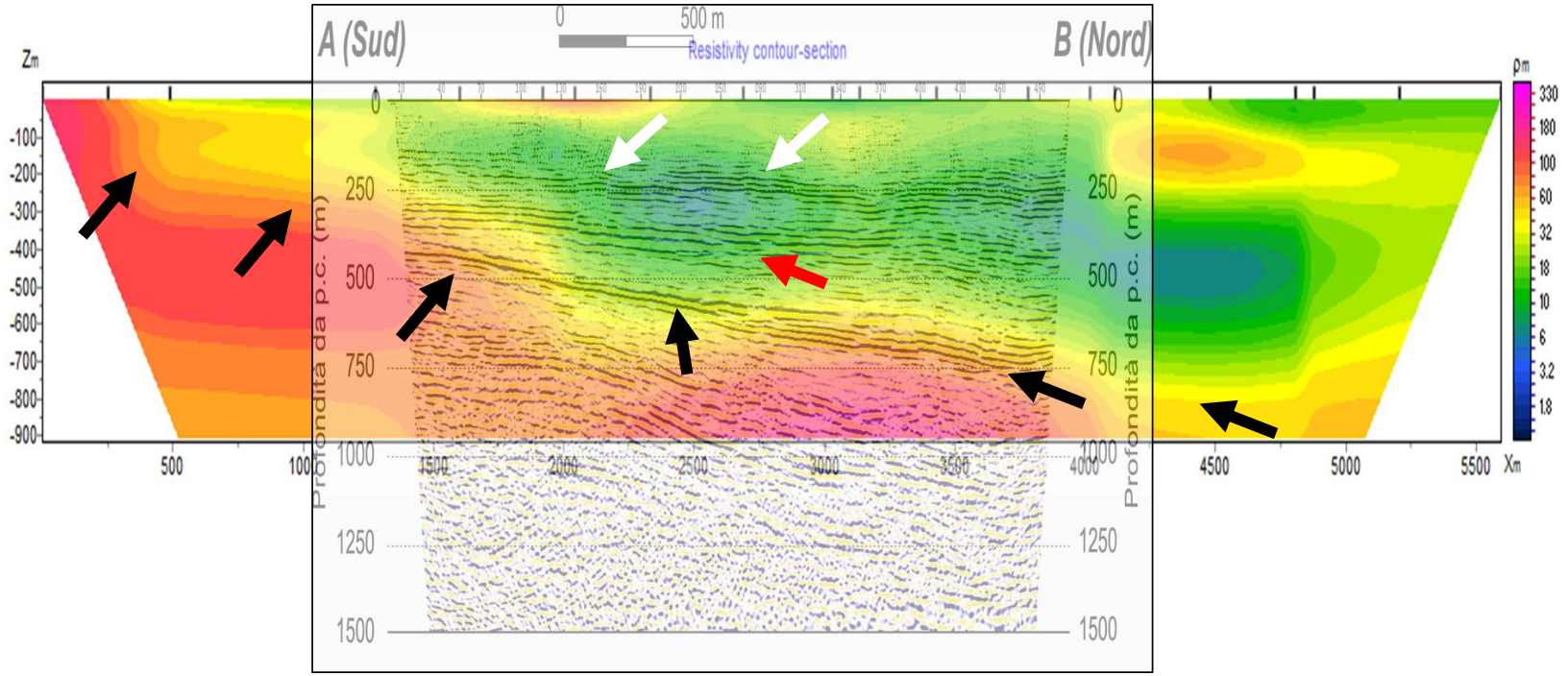
Joint phase: DERT and Seismic Reflection



Interpretation







The joint interpretation of DERT and seismic data allowed to reconstruct the 'local' stratigraphic-depositional evolution until a depth of about 1 km, and to highlight the occurrence of a sin-depositional Quaternary tectonic tilting associated to the growth of a fault-propagation fold.

…in progress

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Thanks for your attention

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