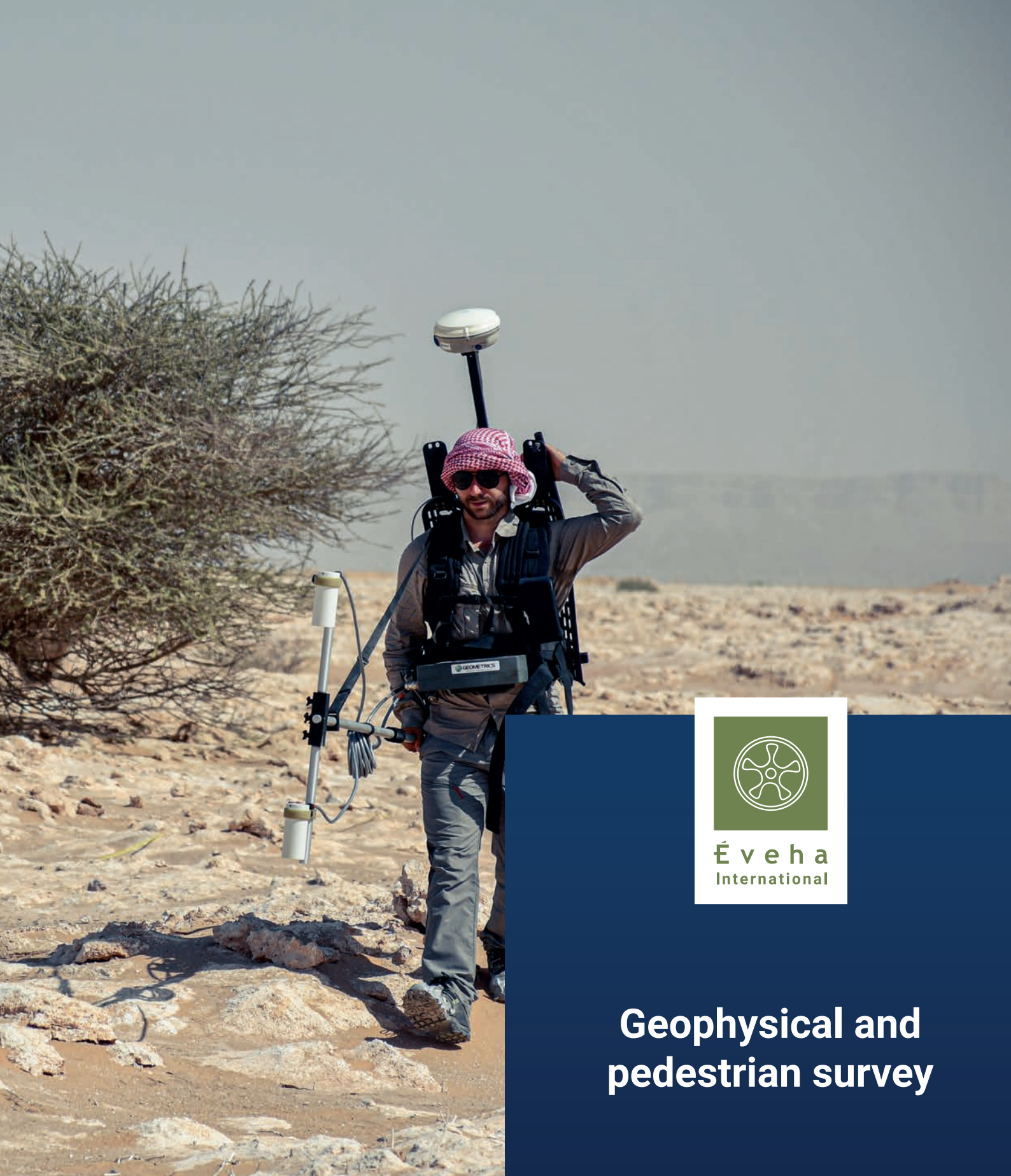




Eveha
International

Geophysical and pedestrian survey

One of Eveha International's most important strengths lies in its ability to conduct large-scale geophysical and pedestrian surveys.





DEFINITION

Geophysical Prospection

Geophysical prospection refers to a set of measurement methods used to map the physical properties of the subsurface based on measurements taken at the surface.

Initiated in the early 1910s for mineral exploration purposes, the discipline quickly diversified into the fields of oil and gas exploration, geology, environmental studies, civil engineering, and archaeology.

Éveha offers services in this field, with expertise in a wide range of geophysical methods that provide a better understanding of a site's archaeological and geomorphological context.

▲ Equipment used during a survey (magnetic survey): this type of instrument requires clear and relatively even terrain.

▼ Equipment used during a survey (GPR / Ground-Penetrating Radar survey): this type of instrument requires clear terrain.



WHY?

Why use geophysics?

Through rapid and non-destructive subsurface analysis, geophysics serves as a strategic planning tool for complex excavation projects by characterizing different excavation zones. This allows for the optimization of resources and means to be deployed.

This discipline also makes it possible to survey the areas surrounding the excavation zone to provide better contextualization.

Furthermore, geophysics contributes to soil studies, particularly the geomorphological study of the site.

Fields of application for geophysics:

- Archaeology
- Soil studies
- Decontamination / Pyrotechnics
- Utility mapping
- Structural health monitoring



Addressing constraints beforehand

Carrying out geophysical surveys involves several technical and organizational constraints. Most of these constraints are related to site accessibility for the instruments, weather conditions (soil being too dry or water-saturated), and the presence of «noise» or interference on-site that may affect measurements (high-voltage lines, buried utilities, metal fences, buried waste, etc.).

This implies:

- Ensuring in advance that the **surface conditions are compatible** with the surveys (brush clearing/ mowing, removal of obstacles);
- **Defining survey methods adapted** to the nature of the remains and the subsurface;
- Establishing an intervention schedule **that can be adjusted based on weather conditions**.



Objectives

Geophysical prospection addresses several objectives and challenges in archaeological research:

- **Identify the presence of remains on unassessed land.**
- **Characterize the spatial extent of a site or a building.**
- **Verify the continuity of structures beyond the excavation limits.**
- **Detect activity zones related to heating or iron metallurgy during excavation (survey on stripped surfaces).**
- **Assist in characterizing features that are barely visible to the naked eye during excavation (survey on stripped surfaces).**
- **Support the geomorphological characterization of a site (continuity of stratigraphic units).**

Ultimately, geophysical prospection provides extensive information on the nature of buried remains. It contributes fully to a better understanding of the potential of archaeological sites.

In this regard, geophysical prospection provides valuable information for developing development projects and defining excavation strategies (areas to avoid, preferred locations for trial trenches or archaeological excavations, etc.).

Results are presented as subsurface maps or cross-sections accompanied by technical commentary. The numerous documents produced are developed in collaboration with the various stakeholders involved in the study to provide the most relevant information possible.

REFERENCES

They trust us :





METHODS

To carry out geophysical surveys, we can implement five data acquisition methods.

The choice depends on the nature of the terrain and/or the surface area to be surveyed. It is sometimes useful to test different methods in the field to determine which one will yield the best results.

Workflow

The duration of an operation is often determined by the size of the area to be surveyed. In most cases, the fieldwork phases are short, ranging from one day to a maximum of about two weeks. The time required for data processing and report writing is generally equivalent to the time spent in the field. Whenever possible, the report is delivered within two months following the completion of the fieldwork.



◀ Excerpt from the magnetic map of Dura-Europos (Syria) (Credit: Chr. Benech).

MAGNETIC SURVEY

Output: ~1 ha/day
Investigation depth: ~2 m
Deliverables: Maps of the local magnetic field.

Requirements: For the surveys to proceed smoothly, the plots must be clear of obstacles and vegetation that could hinder the survey operations.

▼ Multi-probe magnetic survey equipment.

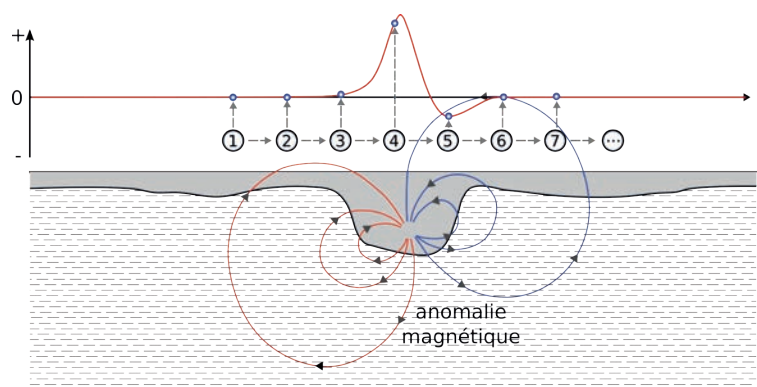


Magnetic survey is a geophysical prospection method particularly well-suited for detecting pits, heating zones (industrial areas, kilns/ovens), metallic elements, fired bricks, and more.

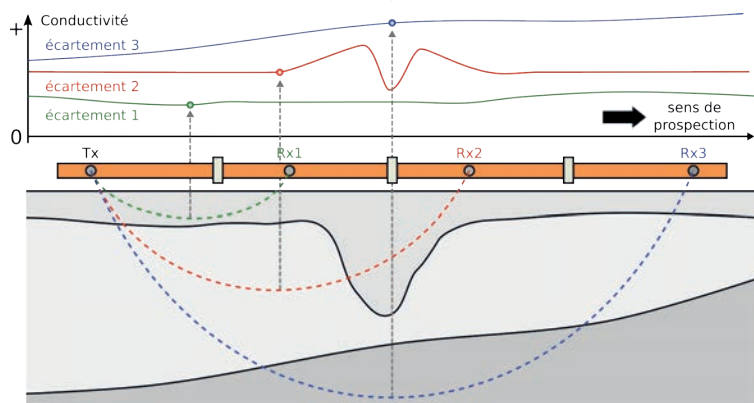
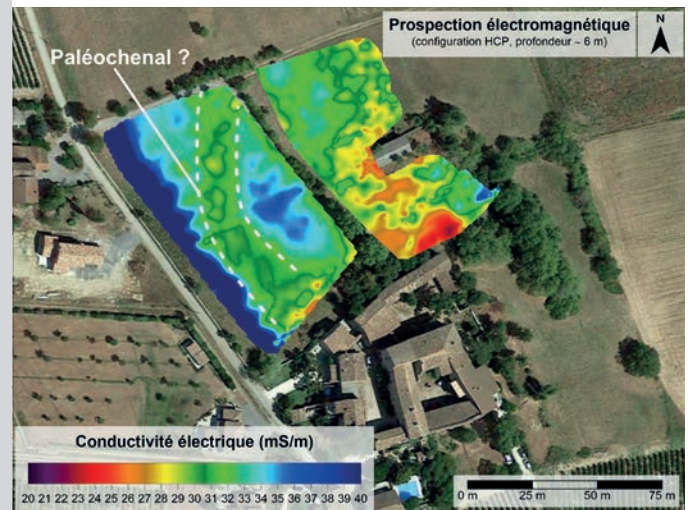
Principle: Magnetic survey is based on measuring spatial variations in the Earth's magnetic field (Aspinall et al. 2008). Differences in the magnetic properties of natural materials (rocks, sediments, etc.) or anthropogenic materials (bricks, ceramics, etc.) present in the subsurface produce local variations (anomalies) in the magnetic field, which can be observed during a magnetic mapping survey. The measurement typically taken in the field is the gradient of the vertical component of the Earth's magnetic field. The recorded variations may be of anthropogenic origin (presence of walls, ditches, heating zones) or natural origin (geological or pedological variations).

Limitations: This method is disrupted by surrounding magnetic fields produced by elements such as high-voltage lines, metal stakes, fences, and metal pipes, etc. It does not allow for the distinction of objects that are too close together (adjacent or superimposed).

Reference: Aspinall, A., Gaffney, C.F., Schmidt, A., 2008. Magnetometry for Archaeologists, Geophysical Methods for Archaeology. AltaMira Press, Lanham, Maryland.



ELECTROMAGNETIC SURVEY



Electromagnetic survey is a geophysical prospection method that allows for the simultaneous measurement of electrical conductivity and magnetic susceptibility. It is suitable for detecting «positive» structures (masonry, walls, stonework), «negative» structures (pits, ditches), heating zones (industrial areas, kilns), or even metallic elements.

Principle: Electromagnetic survey is based on the emission of an alternating electromagnetic field into the ground, the variations of which are then translated into electrical conductivity and magnetic susceptibility values. Depending on their nature and structure (composition, rock types, water content, porosity, etc.), natural or anthropogenic materials possess different levels of electrical conductivity and magnetic susceptibility. These differences in properties produce local variations (anomalies) that can be observed during mapping and reflect changes in the nature of the subsurface. The investigation depth of the method is proportional to the coil spacing of the instrument and can be adapted, depending on the equipment, for either an archaeological or geomorphological study..

Limitations: The investigation depth is limited for magnetic susceptibility (≤ 1 m). The soil must be sufficiently electrically conductive to obtain high-quality measurements.

Output: ~ 1 ha/day or ~ 4 ha/day

Investigation depth: ~ 1.5 m or ~ 6 m

Deliverables: Electrical conductivity and magnetic susceptibility maps.

Requirements: For the surveys to proceed smoothly, the plots must be clear of obstacles and vegetation that could hinder the survey operations.

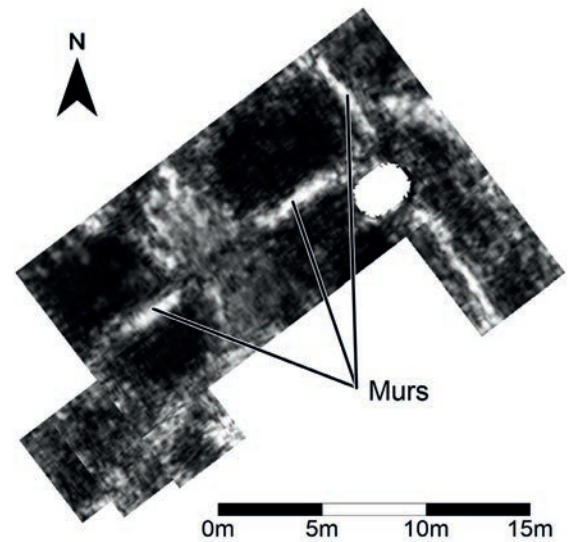


GROUND- PENETRATING RADAR SURVEY (OR GPR SURVEY)



This method produces horizontal «time-slices» (or plan-view maps) of the ground at various depths. It is suitable for use in urban environments as it is relatively insensitive to electrical and electromagnetic interference. This method enables the detection of «positive» structures (masonry, walls, stonework), «negative» structures (pits, ditches), and voids.

Principle: Ground-penetrating radar survey is based on the emission of an electromagnetic wave into the ground to reveal changes in its composition (Conyers 2013). The emitted wave either propagates deeper or reflects back to the surface depending on changes in the soil's electrical properties. By performing numerous measurement profiles side-by-side and sufficiently close together, it is possible to create maps of these changes relative to depth. These changes can be of natural origin (changes in rock or sediment type) or anthropogenic (such as the presence of walls, cavities, or fill). The investigation depth of this method depends on the nature of the soil and the nominal frequency of the antennas used. The frequency range commonly used in archaeological contexts spans from 200 MHz to 600 MHz, which in practice corresponds to an investigation depth of approximately 2 to 3 meters maximum.



Limitations: The investigation depth is very limited in highly attenuating environments (clayey, salty, or water-saturated soils) or highly diffractive environments (graded aggregate or heterogenous fill).

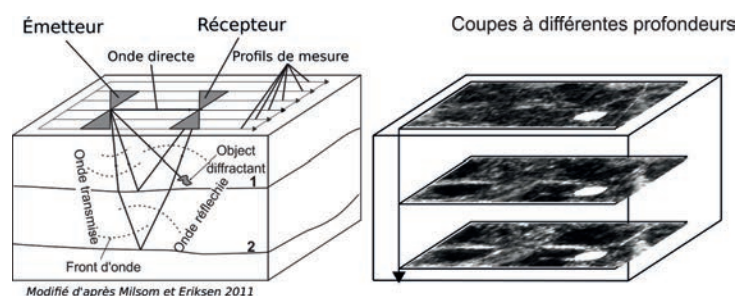
Reference: Conyers, L. B., 2013. Ground Penetrating Radar for Archaeology, Geophysical Methods for Archaeology. AltaMira Press, Lanham, Maryland.

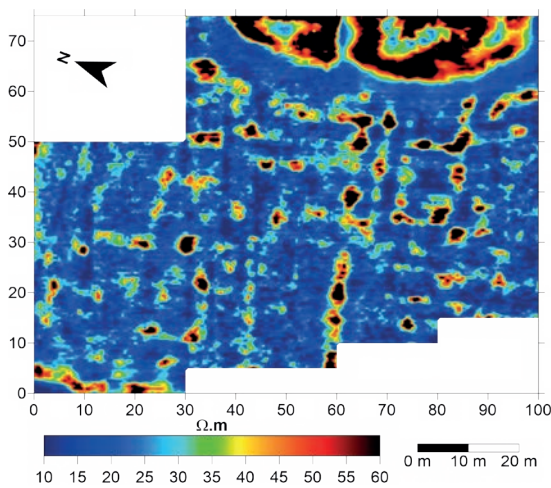
Output: ~1 ha/day

Investigation depth: ~2 m

Deliverables: Radar reflectivity maps.

Requirements: For the surveys to proceed smoothly, the plots must be clear of obstacles and vegetation that could hinder the survey operations.





ELECTRICAL RESISTIVITY SURVEY

Electrical resistivity survey is a geophysical prospection method particularly well-suited for detecting «positive» structures (masonry, walls, stonework) and «negative» structures (pits, ditches).

Principle: Electrical resistivity survey is based on measuring spatial variations in the soil's electrical resistivity (Schmidt 2013). Depending on their nature and structure (composition, rock types, water content, porosity, etc.), natural or anthropogenic materials possess different electrical resistivities, primarily due to their varying water content. These differences in electrical properties produce local variations (anomalies) that can be observed during electrical resistivity mapping. The recorded variations can be of anthropogenic origin (presence of walls or ditches) or natural origin (geological or pedological variations).

Limitations: This method requires soil that is sufficiently loose and moist to insert electrodes, ensure proper current transmission, and achieve sufficient contrast between structures.

Reference: Schmidt, A., 2013. Earth Resistance for Archaeologists, Geophysical Methods for Archaeology. AltaMira Press, Lanham, Maryland.

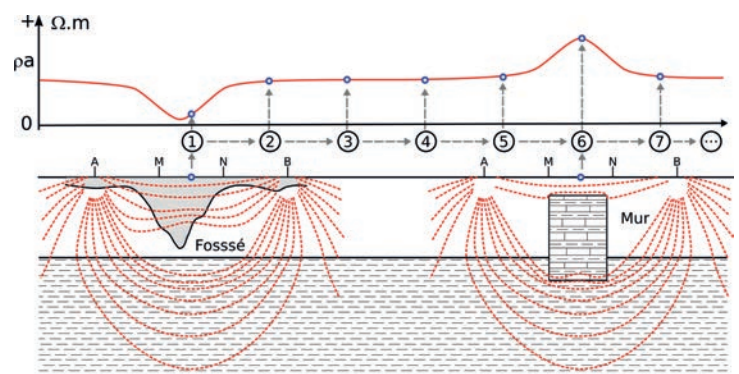


Output: ~0.25 ha/day

Investigation depth: ~ 0.5, 1, and 1.5 m

Deliverables: Electrical resistivity maps at various investigation depths.

Requirements: For the surveys to proceed smoothly, the plots must be clear of obstacles and vegetation that could hinder the survey operations. The soil must allow for electrode insertion.



ELECTRICAL RESISTIVITY TOMOGRAPHY (ERT)

Output: ~ 150 m/day
Investigation depth: ~ 15 m
Deliverables: 2D electrical resistivity model.

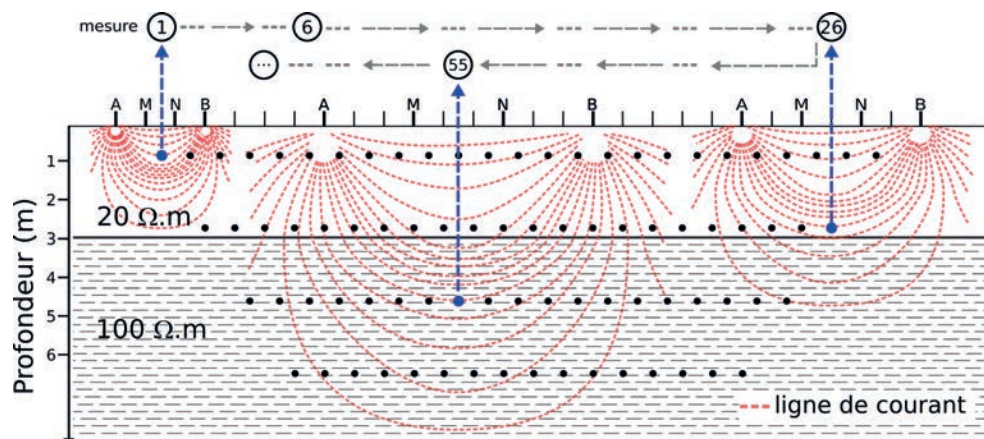
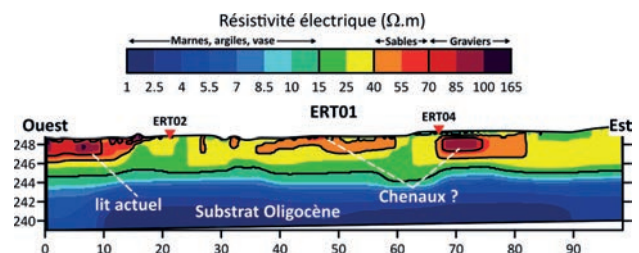
Requirements: For the surveys to proceed smoothly, the plots must be clear of obstacles and vegetation. The soil must allow for electrode insertion.

Electrical Resistivity Tomography (ERT) is used to reconstruct subsurface variations at significant depths. It is particularly relevant for geomorphological studies or for detecting large-scale structures.

Principle: Electrical resistivity tomography is based on measuring the vertical variations of the soil's electrical resistivity (Schmidt 2013). The penetration depth of the current injected into the ground is proportional to the spacing between the electrodes used. A profile of regularly spaced electrodes is set up on the ground; as the acquisition progresses, increasingly wider electrode spacings are used. This allows the injected current to flow deeper and deeper into the subsurface. These resistivity variations at depth reflect changes in the nature of the subsurface (composition, rock types, water content, porosity, etc.).

Limitations: This method requires soil that is sufficiently loose and moist to insert electrodes, ensure proper current transmission, and achieve sufficient contrast between structures.

Reference: Schmidt, A., 2013. Earth Resistance for Archaeologists, Geophysical Methods for Archaeology. AltaMira Press, Lanham, Maryland.



Deliverables



A report is submitted at the end of each survey. It covers the acquisition characteristics and the data interpretation. **First, the survey method is presented and the rationale for the choice is explained.** The document is illustrated with maps showing the surveyed areas and the primary results. These maps are presented in various forms:

- **A «raw» document** – which has undergone initial data processing – displaying the main anomalies identified during the survey;
- **Interpreted documents** where the most significant features are highlighted.

Comments specify the suspected nature of the remains (walls, ditches, pits, graves, geological anomalies, etc.). In some cases, information regarding the burial depth of the remains can also be provided. Following discussions with other project stakeholders, preliminary interpretive hypotheses may also be proposed.

▼ Interpreted survey map (Archaeological Department of the Ardèche and Alba Museum).



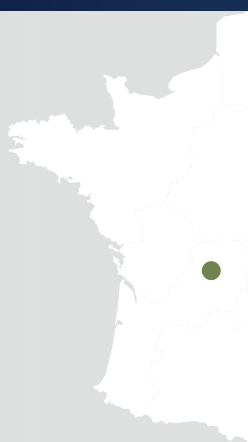
In the interest of long-term data archiving, Èveha prioritizes open, cross-platform, and free file formats, even though some raw data is kept in proprietary formats. This raw data can be provided to the client upon request.



**Our Research
Laboratory Affiliations**



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