

SCINTREX

SARIS Case History #1



SARIS

Scintrex Automated Resistivity Imaging System



Archeological targets at Garchy

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ABSTRACT

Two lateral pole-pole (PPL) profiles were performed over a buried wall and over a deep limestone reef structure, in order to demonstrate the practicality of using the PPL array. Both the buried and the reef structure were well delineated with the PPL array. In addition a Wenner array was used to investigate the buried wall. Results of the PPL and Wenner arrays proved that the PPL was more advantageous as compared to the Wenner array.

INTRODUCTION

Two lateral pole-pole profiles and multiple Wenner spaced profiles were performed over a buried wall and over a deep limestone reef structure at the French government CNRS test site at Garchy (fig. 1).



Figure 1.: Location of the Garchy test site



Description of the Garchy Test site

The Garchy site was designed by the French Centre National de la Recherche Scientifique (CNRS) in 1953. The site was designed for simultaneous seismological, magnetic, gravity and ionospheric observations as well as to serve as an easily accessible site for testing and calibration purposes. Furthermore, the Garchy site was also designed to serve as a training ground for graduate and undergraduate students as well as visiting geoscientists.

The location of the site was thoroughly researched. The site had to be sufficiently far away from any noise source; far enough from the seashore to eliminate seismic noise, far enough from cities and industrial centres to eliminate seismic and electrical noise and far enough from DC-powered railway tracks to eliminate magnetic noise. The terrain had to be flat, to avoid parasitic reflections in ionospheric soundings, as well as being stable in a seismically quiet area and with a firm bedrock to ensure good mechanical properties for seismic investigations. Furthermore, the site had to be sufficiently far away from other existing European observatories.

The site is located in the Parisian Basin, on Jurassic limestone, 200 km SE of Paris and 10 km east of the Loire river in the Nièvre Department; one of the least populated in France (the largest town, Nevers is located some 40 km away and has a population of 50000 inhabitants), and is 400 km from the seashore. The site covers 100 hectares, including 40 hectares of wooded terrain.

The apparent resistivity of the first few metres is quite variable since these are represented by a reef structure, this is adequate for electrical and EM methods. From a depth of 5 to 6 m, a resistive limestone is encountered and at a depth of 300 m and beyond the Lias clay formation is encountered.



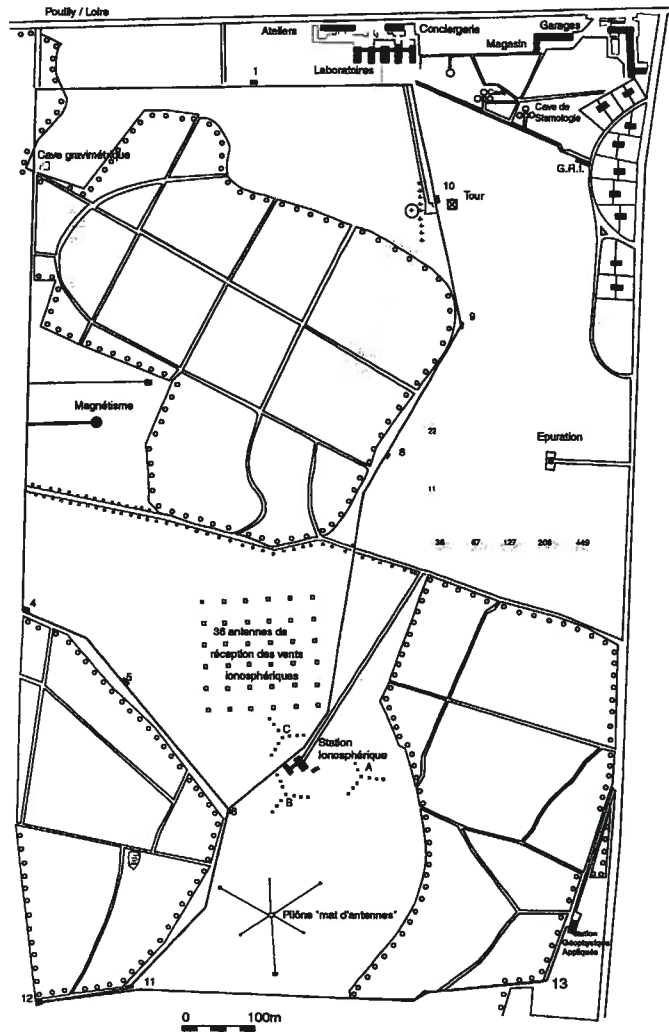


Figure 2.: The Garchy test site



The Lateral Pole-pole (PPL) array

The lateral pole-pole array (PPL) is not as well known as other arrays. It is simply a pole-pole array perpendicular to the direction of the survey lines. Figure 3 illustrates the in-line pole-pole, gradient and lateral pole-pole arrays.

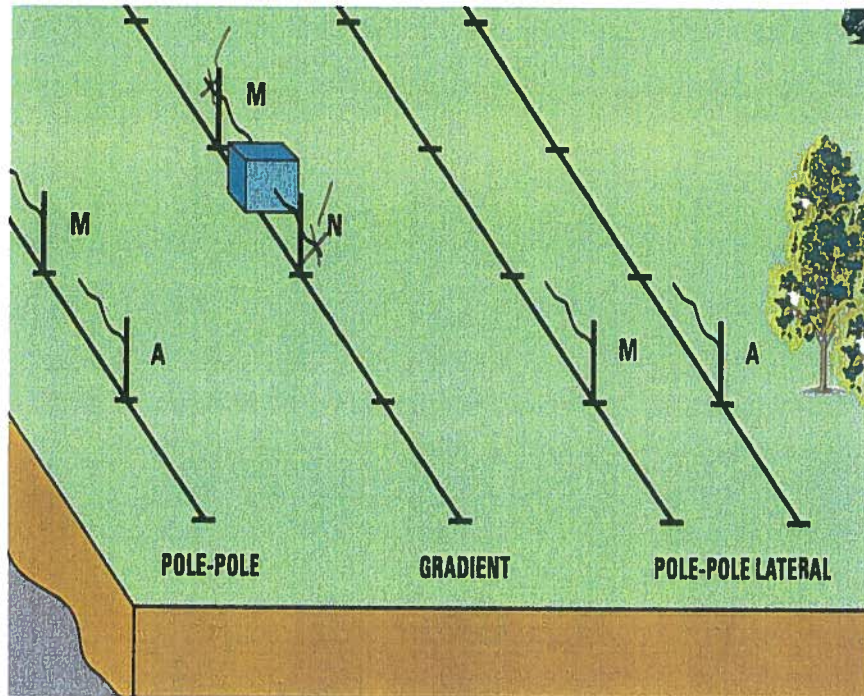


Figure 3: The in-line pole-pole, gradient and lateral pole-pole arrays.

In practice, the moving current and potential electrodes are usually set on two adjacent survey lines. Furthermore, there is considerable economic incentive in using the PPL array: a PPL survey is three to five times less expensive than a dipole-dipole survey.



FIELD RESULTS

Buried Wall

Dr. Robert Bazinet of Scintrex performed the two profiles in September 1999, using a Scintrex SARIS resistivity meter.

The PPL profile was performed over a buried wall, typical of what one would find at archeological sites. The buried wall was approximately 25 cm wide, resistive and shallowly buried in quite conductive soil overlying conductive chalk formations. The resistivities of both the soil and the underlying rock were of the order of 50 to 100 ohms-metres.

The PPL profile using an a spacing of 1m is illustrated in figure 4.

The profile shows a single well defined narrow peak over the wall. The target is obviously thin. The width of this peak, at its half height is 2.25 m.

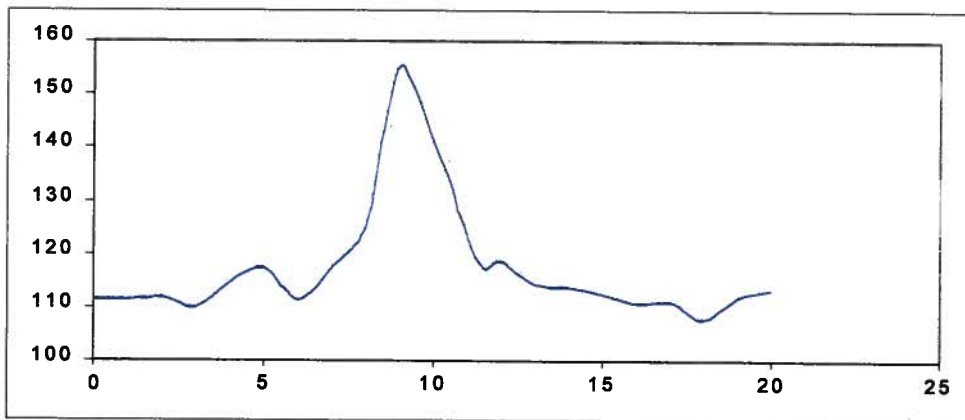


Figure 4.: PPL profile over the buried wall.



Figure 5 presents the same results from a set of Wenner profiles over the wall. We used $a = 1$ to 4 meters and, admittedly, the data at wider spacings is sparse. To maintain some measure of efficiency, we used a station step equal to the “a” spacing.

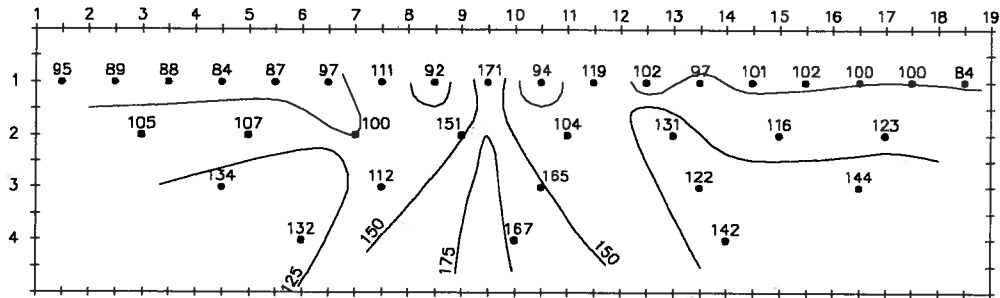


Figure 5.: Wenner profiles over the buried wall.

Unfortunately, with this density of data points, even the contouring is subject to interpretation. Figure 5 has been hand contoured and shows a typical Wenner response over a plate. It is complex but still understandable.

It is obvious from this example, that the lateral pole-pole results are easier to use than the raw Wenner resistivity results. Furthermore the pole-pole data were acquired much faster than the Wenner data set. The pole-pole survey needed only half the resistivity measurements taken in the Wenner survey, even considering that we did use the absolute minimum of Wenner readings. We should have taken more resistivity readings at the larger spacings to eliminate all ambiguity but this would have meant even more time to complete the Wenner survey.



Reef structure

This survey has been performed over a deeper limestone reef structure that intercepts the local chalky formations of the area. An A-M electrode spacing of 5 m was used and readings were taken every 5 m. Figure 6 illustrates the results of this PPL profile.

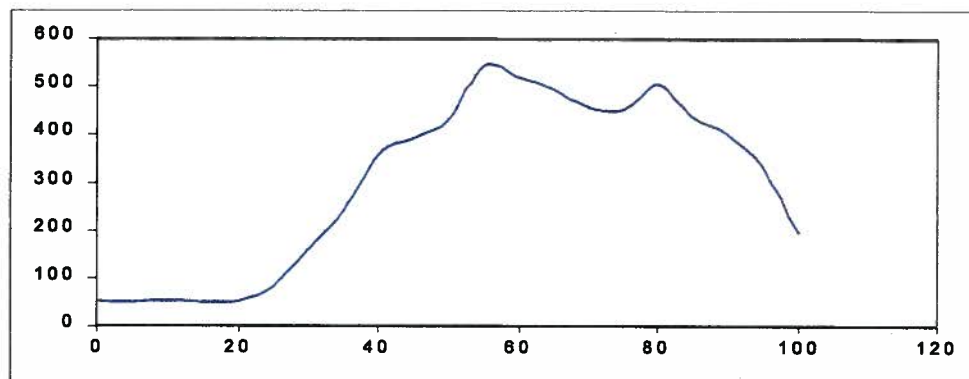


Figure 6: PPL profile over the reef structure.

The reef is obvious from this profile. The high resistivity limestone is represented by the 500 or so ohm-meter peak in the much more conductive (50 Ω -m) chalk. The reef edges are approximately at mid-slope, that is at 40 m and at 100 m. The 100 m contact is not as certain because fences and buildings prevented us from continuing the profile.



CONCLUSION

Two electrode arrays, and particularly the lateral pole-pole array, should be used more often in resistivity profiling. They are not a universal solution but, where the conditions are right, as it is often the case, they offer a considerable reduction in survey costs, in comparison to four electrode arrays. The fact that one can interpret results from a survey using a single electrode spacing is responsible for a considerable increase of productivity. One can even acquire two lateral pole-pole lines at once, if a two channel receiver is available, by having an "M" electrode on each side of the moving current electrode. All in all, a lateral pole-pole survey is easily 5 or 6 times faster than an equivalent Wenner survey. Some time is lost in the installation of the "infinity" electrodes but there is still considerable savings. Survey costs can be reduced by a factor of three or more.

Furthermore, the single-spacing lateral pole-pole profiles are much easier to interpret than the multiple spacing four electrode pseudo-sections and tend to offer better lateral resolution. This is very interesting when one is looking for lateral variations in resistivity.

Finally, the fact that the pole-pole configuration is associated with a strong signal on power ratio makes it particularly well adapted to use with small portable resistivity meters.



ACKNOWLEDGMENTS

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Mr. D. Doucet (Oissel, France) provided us with the 3-D resistivity simulations.

Various members of Scintrex personnel contributed to this work. Nadia Daby Seesaram participated in the field work at Garchy, Richard Lachapelle helped to process the data, and Enid Chow prepared some of the figures.

