Inrap and geophysics: towards a sustainable approach

Guillaume Hulin, François-Xavier Simon

INRAP AND GEOPHYSICS: TOWARDS A SUSTAINABLE APPROACH

Guillaume Hulin, François-Xavier **Simon**
Inrap. Guillaume.hulin@inrap.fr.

Samenvatting

Het beleid rond preventieve archeologie in Frankrijk is reeds vele jaren goed ingeburgerd. Als veldpraktijk wordt hierbij, net als in Vlaanderen, voornamelijk ingezet op proefsleuven om projectzones archeologisch te evalueren. Binnen de preventieve archeologie is het nationaal instituut voor erfgoedonderzoek (INRAP) met 2000 archeologische studies per jaar (ca. 1800 evaluaties en 200 opgravingen) de absolute koploper. De integratie van geofysische technieken bij zulk evaluatieonderzoek blijft, ondanks een lange traditie van (experimentele) toepassingen in de Franse archeologie, beperkt. Sinds kort brengt een meer systematische toepassing van geofysische methodes bij INRAP daarin verandering. Door vergelijkingen met proefsleuvenonderzoek, en het gebruik van geofysische prospectie voor en tijdens opgravingscampagnes, streeft INRAP naar een meer duurzame en beredeneerde implementatie van deze technieken. De voornaamste toepassingen zijn te groeperen in: de detectie van archeologische sporen; de prospectie en reconstructie van begraven landschappen; en de karakterisering van archeologische lagen in opgegraven oppervlakken. Hierbij staat telkens de combinatie van een kostenefficiënte en wetenschappelijk meer robuuste archeologische methodologie voorop. Om dit mogelijk te maken, werd recent bij INRAP een geofysisch team opgericht dat, met het oog op verdere uitbreiding, deze evolutie in goede banen leidt.

Summary

The policy and practice of preventive archaeology is well established in France. By far the main methodology applied is trial trenching surveying, both for prospection and evaluation. Within this preventive archaeology process in France most of the fieldwork is done by Inrap, the National Institute for Preventive Archaeology. The integration of geophysical prospection within this preventive process remains rather limited up to date, despite a fairly large number of experiments with these techniques. However, within the last few years Inrap is systematically applying geophysical surveys, although always with specific goals and research frameworks. The main goals within these survey projects are: the detection of archaeological features; palaeolandscape reconstructions; and the mapping and characterization of archaeological layers during excavations. A durable approach, regarding cost-efficiency and scientific robustness of the applied methods, is of high importance within this approach. To allow this, Inrap recently established a team for geophysical prospection.

INTRODUCTION

The policy concerning preventive archaeology is currently well established in France. Archaeological evaluation is at the heart of the French process and the practice of trial trenching is by far the most applied methodology. With about 2000 archaeological studies carried out each year (approx. 1800 evaluations and 200 excavations), Inrap is the most renowned institute in France for preventive archaeology. In this context, the use of geophysics has been very contentious. Some attempts to carry out geophysics have been tried, especially for archaeological evaluation, but most of them ended up in failure and created tension and misunderstanding between geophysicists and archaeologists. However, Inrap decided to overcome the adversity towards geophysical survey, and is currently

practicing a well thought out strategy and methodology to implement archaeological geophysics in a sustainable way.

A SPECIFIC POLICY FOR PREVENTIVE ARCHAEOLOGY

In France, the process for preventive archaeology is divided into five different stages:

1. Review of the development work project by the Ministry of Culture (local agencies - *Services Régionaux de l'Archéologie*), on which basis it is decided whether or not an archaeological evaluation is required.
2. Execution of the evaluation by Inrap or a licensed local authority archaeological service (no private companies). This evaluation consists of trial trenching of 5 to 10% of the project surface area. In addition to the detection of archaeological sites, the evaluation has to characterize the remains by providing information on their nature, function, date and state of preservation[31]. Concerning the funding for preventive archaeological evaluation each development project is subjected to a tax (5300 euros per ha in 2016), even if no archaeological evaluation is required. This tax provides the means for archaeological evaluations at the national scale, a third of it is used for subsidizing 'meagre' developers (e.g. social housing constructions or private houses). In doing so, archaeology in France is seen as a public service. The amount allocated for the evaluation is based on the surface area of the land planning project and the complexity of the evaluation, as defined by the ministerial decree of 2 November 2016 for local authority services. In rural situations, this amount is 3600 euros per ha for areas larger than 15 ha and up to 9720 euros per ha for areas smaller than 3 ha. In urban contexts, for deeply stratified sites (more than 1.3 m of archaeological stratification) the amount can reach 19440 euros per ha.
3. After the evaluation, a report is submitted to the Ministry of Culture and reviewed by a scientific independent commission (*CTRA - Commission Territoriale de la Recherche Archéologique*). Based on these results, the prefect may decide that the site requires an excavation.
4. Excavations have to be funded by the developer following the 'polluter pays' principle. These can be undertaken by Inrap, by a licensed local authority archaeological service or by a licensed private company.
5. An excavation report is submitted to the Ministry of Culture and reviewed by the *CTRA* to evaluate its scientific content.

TRIAL TRENCHING: A FRENCH SPECIALITY?

The practice of systematic trial trenching is the result of a long struggle conducted by French archaeologists since the 1980's. This approach, also resulting in a number of large area excavations, led to a significant increase of the archaeological knowledge in France in the last decades[32].

At the same time, some attempts to introduce geophysics in the French preventive archaeological system were made, more specifically in the evaluation phase, with the more or less confessed goal to

[31] CNRA, 2009.

[32] Demoule, 2004.

reduce or even substitute trial trenching. These attempts generated a lot of tension within the archaeological community, which feared geophysics as an unwarranted substitution for the trial trenching methodology. This friction concerned mainly three different aspects: scientific reliability, time and cost effectiveness of geophysics. These points are largely declaimed as benefits of geophysics, but are they truly realistic?

IS GEOPHYSICS A BETTER EVALUATION TECHNIQUE?

The limitations of geophysical surveys were clearly demonstrated during the large area evaluations of the 'CSNE project'[33]. Within this project, a 60 ha test area with soil conditions (luvisols) and typology of archaeological remains (pits, ditches, post-holes) typical of northern France was surveyed. The geophysical surveys (magnetic and resistivity methods) were, within this project, able to detect only ca. 25 % of archaeological sites found during the evaluation (trial trenching of 10% of the project surcae area). These results can be considered as representative for a large part of North of France, but also for similar soil conditions in Belgium, Germany and the Netherlands.

For French archaeologists, such a low detection rate constitutes the main argument to consider geophysics as an inefficient technique for evaluation, compared to results obtained with trial trenching. Consequently, if geophysics is seen as a step forward in countries where trial trenching is not implemented or only with a low surface area ratio (<5%), in France, it is seen as a step backwards concerning the evaluation phase for development-led archaeology. Moreover, even though geophysics is, in some cases and in some soil contexts, a useful tool for site detection, it remains unable to characterize archaeological features. Thus, it is an insufficient mean to fill all the requirements concerning date, function and state of preservation[34].

As it is the case in other countries as well[35], comparisons between geophysics and trial trenching are very limited in France. Feedback on the results from these two evaluation techniques have to be explored further, to assess the true 'success rate' of archaeological geophysics, on a wide variety of soil types and archaeological sites.

IS GEOPHYSICS FASTER?

In France, the average duration of the whole process for the archaeological evaluation is approximately one year, from the application of the Ministry of Culture to the final report. This can be considered as a long time, but it is in fact relatively short and as a result, it can be difficult to introduce geophysics into the process. In the case of large development projects, such as linear land planning projects (e.g. rail- or motorways) multifarious areas have to be surveyed. If it is relatively straightforward to use a mechanical digger at any time and on all of the fields, the same does not apply to geophysics due to practical limitations on ploughed fields or fields with crops for example. That generally involves a kind of patchwork survey, necessitating prior organization and multiple interventions. For ploughed fields, some preparation of the ground surface may be required. Weather conditions (frost, drought…) can also have a negative effect on the quality of a survey which requires flexible intervention. All these aspects can make the application of geophysical survey time- and money-consuming.

[33] Hulin *et al*., 2018.

[34] CNRA, 2009.

[35] Orbons, this volume.

IS GEOPHYSICS CHEAPER?

Archaeological evaluation within preventive archaeology involves considerable expenses[36]. In France the current funding policy cannot extend to include both geophysics and trial trenching (considering the current standard). Combining both methods would be ideal, but would result in an increase in the costs of archaeological evaluations (3600 euros per ha for areas larger than 15 ha for the complete study), especially where there is no prior knowledge on the archaeological and soil conditions. In such cases, at least two geophysical techniques should be used in order to deliver reliable results, raising the costs between 2000 and 3000 euros per hectare. Considering the robustness and reliability of both techniques, geophysics is then very expensive compared to the established trial trenching method.

FROM A BLIND TO A SUSTAINABLE APPROACH

For all the reasons detailed above, the use of geophysics in the French preventive archaeology process has not been straightforward. The main problem is that almost all the initial attempts were carried out during the evaluation phase and without any (or with poor) knowledge on the expected type of archaeological structures and soil conditions. Such a blind approach is generally synonymous with failure and is not cost-efficient. To be fully efficient, geophysics has to answer precisely defined questions, with robust *a priori* information on what one is looking for and in what conditions. This is by definition in contradiction with the exploratory nature of the evaluation phase.

Consequently, Inrap does not recommend using geophysics on large areas if very little a priori knowledge is available, but promotes a different approach. Geophysics has to be implemented only on very specific cases where the applied technique is expected to be efficient (according to the type of archaeological remains and soil conditions), or in cases where trial trenching is difficult to implement (for example in urban contexts). In these cases geophysics can be implemented with the right method and sensor configuration. Thus, it becomes more reliable and the global evaluation would be more cost effective.

Moreover, geophysics does not have to be considered only for the archaeological evaluation. Although more limited in number, geophysical studies can also be implemented during the excavation phase with very good results[37].

From 2002 to 2017, Inrap performed 174 geophysical surveys, more than half of them have been performed since 2015. All of them followed the principles of the above outlined sustainable approach and can be divided into three different topics:

- Detection of archaeological structures:

The detection of archaeological structures is the main and the most common application. 61 % of the geophysical studies carried out by Inrap were done with this goal. These surveys were undertaken in several phases within the process: in the evaluation phase, between trial trenching and excavation, or even after excavation, to extend the interpretation and mapping of the site outside the confines of the excavation area.

- Landscape analysis:

[36] Depaepe *et al*., 2016.

[37] Hulin and Simon, 2012; Hulin et al., 2014.

The integration of archaeological knowledge within the wider landscape is crucial to understand human occupation patterns. Geophysics (especially electromagnetic induction) can in this respect offer important information on the geomorphology and pedology of the (past) landscape. This approach is really efficient and represents 12 % of our geophysical surveying activity.

- Characterization of archaeological layers and features on stripped areas:

On a different scale, geophysics can be also used directly on stripped areas, during the excavation phase[38]. In this case, the aim is not to detect but to characterize archaeological layers. This characterization is mainly based on magnetic parameters such as susceptibility or viscosity but can also be achieved with multispectral analysis or resistivity measurements. In combination with soil and geochemical analyses this can reveal important additional information about the past human occupation. The range of possible archaeological features that can be surveyed with these techniques is very wide: from heated zones to smithies, manure deposits or dark earth, etc. This approach represents 27 % of the geophysical studies carried out by Inrap.

Such an approach to consider geophysical properties of soils as anthropogenic proxies for past human activity is clearly underused by the geophysical community and is moreover mostly unknown in the archaeological community. However, that can considerably change our perception of a site and could help archaeologists during the excavation by highlighting, in a very short time, some places of interest that are possibly invisible to the human eye.

CONCLUSIONS: HOW TO RECONSIDER GEOPHYSICS IN ARCHAEOLOGY?

The popular way to consider geophysics as an easy and robust tool is based on hundreds of geophysical surveys performed on well-preserved sites and published in archaeological or geophysical scientific journals. These cases are often presented to the public, politicians and developers as a 'new technology' vision providing an ideal survey method. However, besides these 'ideal' examples, preventive archaeology in France shows that the bulk of archaeological sites deliver far less obvious geophysical survey results.

In France, preventive archaeology has taught us that most of archaeological sites leave very slight marks in the soil. These sites are the main purpose of the archaeologist's daily work and their study completely changed our knowledge about the past human activity. These sites have to be considered at their own value and most of the time, trial trenching is the only way to detect them efficiently.

Nonetheless, the current policy at Inrap does integrate geophysical survey in its toolkit. Compared to most countries that use geophysics mainly for archaeological evaluation (often on large areas and without any prior information), Inrap promotes a rational use of geophysics on very specific case studies with very clear scientific and/or technical issues. In most cases, Inrap implements geophysics after trial trenching or as a complementary tool within the excavation phase. Consequently much archaeological and pedological information has already been gathered, which leads to a greatly improved geophysics efficiency.

Using this 'sustainable' approach, 86 geophysical surveys were carried out from 2015 to 2017 (41 in 2017), and all prospects indicate an increase in geophysical surveys in the near future. Currently, a team of 2 geophysicists with 18 technicians specialised in data acquisition is fully operational at Inrap.

[38] Simon et al, 2012; Hulin and Jagou, 2014.

Integration of a geophysical team inside an archaeological institute completely changes the perception of archaeologists for remote sensing techniques. After decades of conflicts in France, geophysics seems to be well accepted as a complementary tool for preventive archaeology.

BIBLIOGRAPHY

CONSEIL NATIONAL DE LA RECHERCHE ARCHÉOLOGIQUE 2009: *Le diagnostic d'archéologie préventive*, CNRA 2008-2012, Avis n°1, 4 décembre 2009.

DEMOULE J.-P. (eds.) 2004: *La France archéologique : vingt ans d'aménagements et de découvertes, Paris*, Paris.

DEPAEPE P., KEROUANTON I., PRILAUX G, TALON M. 2016: *Management of large archaeological projects in a competitive environment: The French case. Recent developments in preventive archaeology in Europe*, in NOVAKOVIĆ P., HORŇÁK M., GUERMANDI M.-P., STÄUBLE H., DEPAEPE P., DEMOULE J.-P. (eds.), Proceedings of the 22nd EAA Meeting in Vilnius, sept. 2016. Ljubljana University Press: 123-135.

HULIN G, SIMON F-X. 2012: Geophysics and preventive archaeology in France: new interdisciplinary issues, *First Break* 30, 67-71.

HULIN G., JAGOU B. 2014: Reconnaître et caractériser les zones de forge sur surface décapée : apport de la géophysique à l'étude paléométallurgique, *Archéopages* 39, 90-99.

HULIN G., PRILAUX G., TALON M. 2014: Intégration de la géophysique à un projet archéologique d'envergure : l'exemple du projet canal Seine-Nord Europe, *Revue Archéologique de Picardie* 1/2: 245-260.

HULIN G., BAYARD D., DEPAEPE P., KOEHLER A., PRILAUX G., TALON M. 2018: Geophysics and preventive archaeology: comparison with trial trenching on the CSNE project (France), *Archaeological Prospection* 25, 2, 1-12.

SIMON F-X., KOZIOL A, THIESSON J. 2012: Investigating magnetic ghosts on an Early Middle Age settlement: comparison of data from stripped and non-stripped areas, *Archaeological Prospection* 19, 3, 191-200.