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Do magnetic and electric survey results correlate with archaeological evidence? Case studies

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When a geophysical survey is performed before an archaeological excavation anomalies are interpreted jointly by archaeologists and geophysicists and assumptions are made. But excavation results are seldom discussed afterwards with geophysicists to compare the initial hypotheses with the subsequent discoveries. This paper discusses the case of geophysical survey data in a number of research programs where hypotheses are based on geophysical anomalies that were sometimes confirmed by excavation, and sometimes not. Occasionally, there was a clear explanation for the discrepancy between the hypothesis and the excavation results.

SETTLEMENT STUDY

The small Roman town of Vendeuvre-du-Poitou (Vienne, France) was surveyed by the electric method on 40 ha and by the magnetic method on 3.5 ha; a surface area of 0.3 ha was excavated (by Johan Durand, PhD student, University of Poitiers). The excavated zone was previously surveyed by both electric and magnetic means. The excavation showed that streets and walls built of stones with mortar bonding induced easily discernible anomalies of high resistivity. However, the structures composed of walls that were made of mud, even when resting on stone flashing, did not generate anomalies strong enough to be properly identified on the resisitivity map before excavation. This has significant repercussions on the interpretation of the results of the electric survey for the entire town. It in fact shows anomaly-free zones inside some blocks or at the edges of an area that may not be empty of buildings, especially at its northern outskirts, where the ground was fairly covered with ceramics.

The use of the magnetic method is not straightforward for drawing the overall layout of Vendeuvre-du-Poitou, even if on the whole the streets are clearly perceptible as are the blocks. Nonetheless, the interpretation of the magnetic anomalies is less easy to translate into types of remains expected during the excavation. Some fairly limited strong anomalies were, as could be expected, caused by the presence of a domestic hearth made of tiles, but the discovery could not be anticipated, owing to the relatively large number of such anomalies on the magnetic map.

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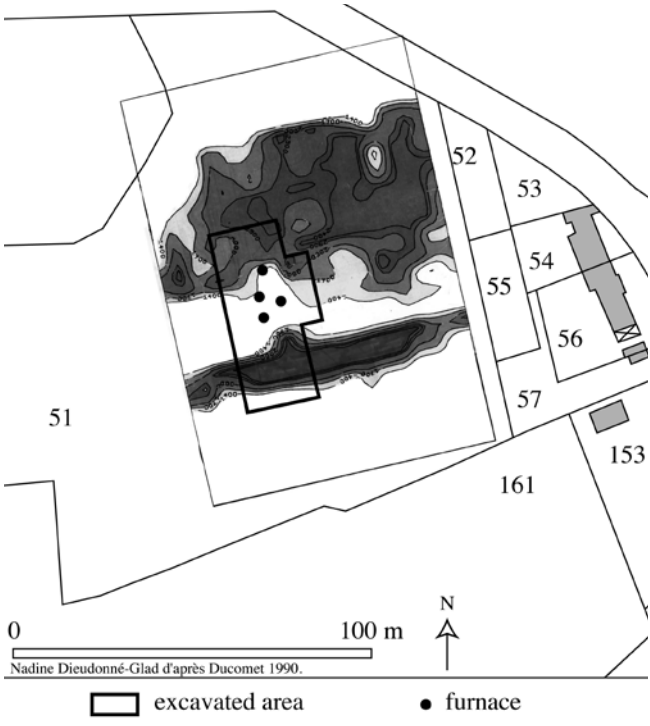

Fig. 1. Electromagnetic survey of the Oulches iron smelting site. Black dots: location of the workshop furnaces. Grey: high magnetic susceptibility areas (Surveyed by G. Ducomet)

Fig. 2. One of the furnaces discovered at the Oulches smelting site. Its external diameter is around 2 m. It was filled with burned clay (Photo N. Dieudonné-Glad)

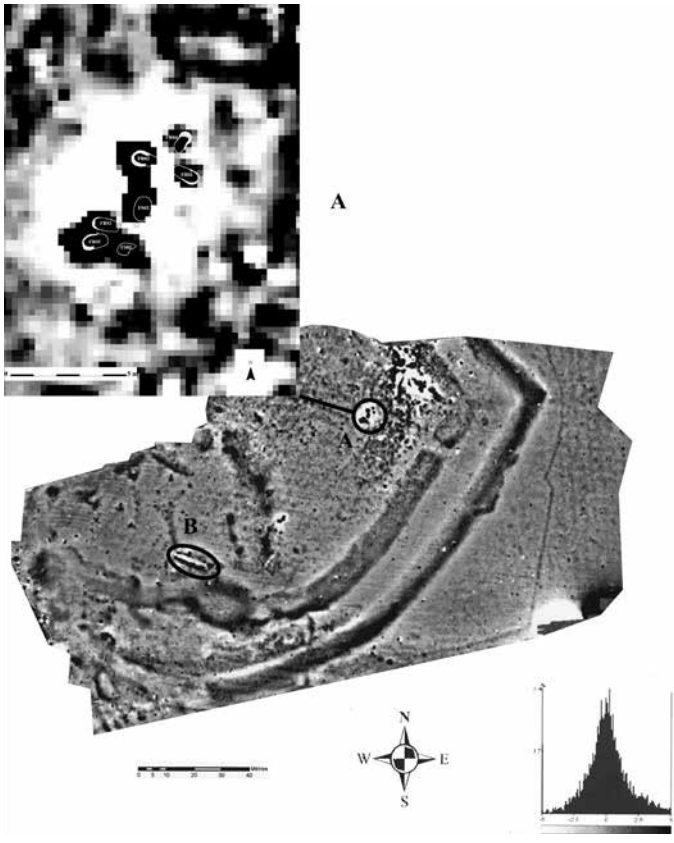

Fig. 3. Magnetic survey of a Gallic farm dated to the 2nd–1st century BC and of iron metallurgy workshops dated from the mid 6th–mid 5th century BC (Meunet-Planches, Indre, France). A. Workshop structures in white, B. *Murus gallicus* magnetic anomalies (Surveyed by Géocarta)

IRON METALLURGY WORKSHOPS STUDIES

Waste from iron metallurgy workshops is highly magnetic: it consists of iron ore residues, slag, metal fragments. It induces magnetic anomalies that can be higher at ground level than the anomalies created by the baked clay of buried furnace structures. For example, at Oulches (4th century AD smelting workshop, Indre, France), anomalies recorded during the electromagnetic and magnetic survey highlighted the presence of waste, but failed to disclose the location of four furnaces, arround 2 m in diameter, buried between the iron ore disposal in the southern part of the site and the slag disposal in the northern part (Figs 1 and 2).

In other cases, when slag was trapped in the furnaces and slag waste around the furnaces was scarce, the magnetic anomalies showed very precisely the location of the furnaces (Fig. 3: A),

e.g., Meunet-Planches (mid 6th – mid 5th century BC smelting and smithing workshop, Indre, France). On that site, a ditched celtic farm surrounded by a *murus gallicus*-type wall later replaced the iron metallurgy workshops. A set of highly magnetic anomalies was interpreted at first as evidence of another iron workshop, but with a different layout (Fig. 3: B). The excavation revealed only the presence of the *murus gallicus*, from which five typical iron nails were retrieved. It is still not clear why the magnetic anomaly created by these five nails weighing less than 200 g each was almost similar to that of tens of kilos of slag waste.

Another case of misinterpreted magnetic anomalies was understood after the excavation. The magnetic survey inside a Roman military fort at El Deir (Kharga Oasis, Egypt) showed a particularly high magnetic rectangular anomaly (15 nT) in one of the buried barracks of the site (magnetic survey by Tomasz Herbich, Oasis Project directed by Gaëlle Tallet, University of Limoges). The hypothesis was that the room housed the smithy of the fort. The excavation revealed a 2 m-thick ash layer with very thin fragments of baked clay from fireplace trash containing ceramics. It filled the unit up to the ceiling. It seems, therefore, that a 2 m-thick layer of that kind can create a magnetic anomaly as significant as a 10 or 20 cm-thick layer of metallurgical waste. This explanation is consistent with the theory of magnetic survey, but has rarely been verified to that extent in the field. This experience has led us to reconsider the interpretation of the magnetic survey as a whole and has shed new light on the inside layout of the fort.