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Short Report

Magnetic Prospecting of Diachronic Structures (Antiquity to First World War) on the Site of the Sanctuary of Ribemont-sur-Ancre (Somme, France)

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ABSTRACT The site of the sanctuary of Ribemont-sur-Ancre (Somme, France) is of major scientific interest for the knowledge of the Celtic civilization in Europe. It also presents other peculiarities: two clearly identifiable periods of occupation – the first one as early as third century BC- to the second century AD and the second one from 1914–1918. In the area disrupted through military operations, the remains of several epochs are intermingled. In order to obtain a precise knowledge of the space time organisation of each occupation, a magnetic survey was carried out. The comparison of geophysical results with the aerial photographs shot during the war allows an exact determination of the origin of the anomalies. It becomes possible to separate the magnetic anomalies which are contemporary, anterior or probably posterior to the conflict of 1914–1918. The range of magnitude and the sign of polarity of anomalies appear as a means to facilitate the identification of the features of each period. Among the anomalies detected, some of them, such as the elliptic enclosure, have been identified by the excavations as unknown archaeological remains. Generally speaking, the ability of the magnetic method for surveying any structure in such a disrupted environment suggests a more frequent use in prospecting of the sites which were battlefields in Historic periods.C

Key words: magnetic prospecting; aerial photograph; Celtic period; Gallo-Roman period; sanctuary; First World War

Introduction

Nowadays, archaeological surveys take into account several types of information, the origin

of which is not directly archaeological. Thus the notion of site has become wider, including different data about the environmental conditions and the ancient landscape at any given time, and extending the study of human occupation of sites to recent periods.

Geophysical prospecting appears as a means to obtain a broader description of the archaeological

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landscape. Indeed, all the buried structures that are potentially detectable will be detected, whatever their nature and age.

Numerous diachronic structures are located at the site of the sanctuary of Ribemont-sur-Ancre (Somme, France). This site is of major scientific interest for knowledge of the Celtic civilization in Europe. It also presents other peculiarities: two clearly identifiable periods of occupation —the first one as early as third century BC to the second century AD and the second one from 1914 to 1918. The landscape of the region is strongly marked by the First World War. During the last years of the war, the British Army settled its lines of defences on the hillside. In this area the remains of several epochs are intermingled. As a consequence aerial reconnaissance does not always supply a clear enough vision of the distribution of archaeological remains, especially in the plots of land concerned by the present study.

In order to obtain a precise knowledge of the space–time organization of each occupation, a magnetic survey was carried out. With such a method, data acquisition is quick but its high sensitivity to ferrous objects makes its application *a priori* non-pertinent on a battlefield for the detection of faint magnetic anomalies. However it seemed interesting to experiment with the capacities of the method to detect archaeological structures in such a magnetically polluted environment.

Geographical and geological setting

The village of Ribemont-sur-Ancre is located in the region of Picardie, in the Somme area, 20 km from Amiens. The archaeological site occupies the top and the southern side of a natural hill. The downhill slope varies from an altitude of 80 m at the top of the hill to an altitude of 40 m in the Ancre River plain. On the top of the hill, a layer of loess (thickness of 2–3 m) covers the flint clay (thickness of 1m) resulting from the dissolution of the Cretaceous White Chalk. On the edge of the hill, flint clay crops-out; at the bottom of the hill, colluvium hides the Chalk bedrock.

Archaeological setting

From the top of the hill (known locally as ‘Boeuf d’Or’ —The Golden Ox), the sanctuary of Ribemont-sur-Ancre looks down upon a vast landscape between the Roman road of Amiens-Bavay and the River Ancre. The archaeological remains extend over an area of 200 ha. Since its discovery in 1960, the site has been investigated by many aerial reconnaissances (Agache, 1978) and several excavations (Cadoux and Massy, 1970; Cadoux, 1984; Brunaux, 1998; Brunaux *et al.*, in press).

Studied for a long time as an ancient Celtic place of worship, the site is now reinterpreted as a genuine Celtic monument from the second half of the third century BC (Brunaux, 1998). On this primitive occupation a pre-Augustean sanctuary was established (Brunaux *et al.*, in press). The last state of the monumental urban complex dates back to the second century AD. It is composed of a temple, followed down the slope by three courtyards of increasing size, lined by two groups of buildings. A theatre and *thermae* stand on the axis of the temple. The three major monuments and the residences fall into line along a distance of 800 m.

The layout of archaeological features (Figure 1) obtained by data processing of aerial photographs shows a space devoid of remains halfway down the hill (Ferroq du Leslay, 1996). This area was disrupted through military operations during the First World War and the necessary earthworks performed after the conflict as a preliminary to cultivation (Figure 2).

Recent historical setting

The chronology of the events of 1918 gives information about the circumstances in which the archaeological site was disrupted by the military occupation (Livesey, 1996).

Between March and April, 1918, the German offensives of Ludendorff took place on the Western Front line. They were aimed at separating the British Army from the French Army. The first offensive, called ‘Michael Operation’, occurred in Somme between Arras and La Fère. The British troops were attacked on 21 March along a 90 km

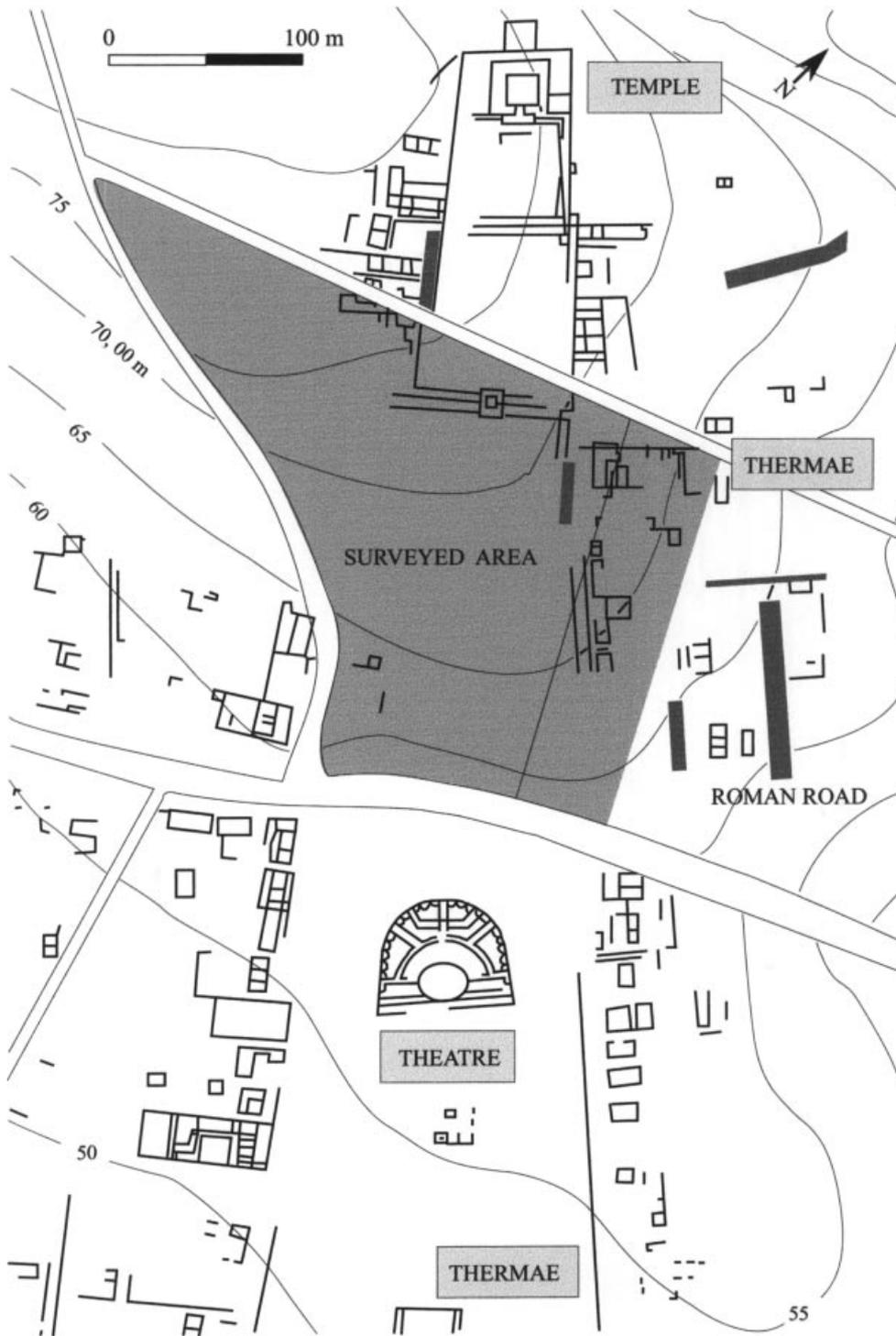


Figure 1. Ribemont-sur-Ancre (Somme). Plan of archaeological features obtained by data processing of aerial photographs (Ferroq du Lesley, 1996). Reproduced by permission of Centre Archéologique Départemental de Ribemont-sur-Ancre.

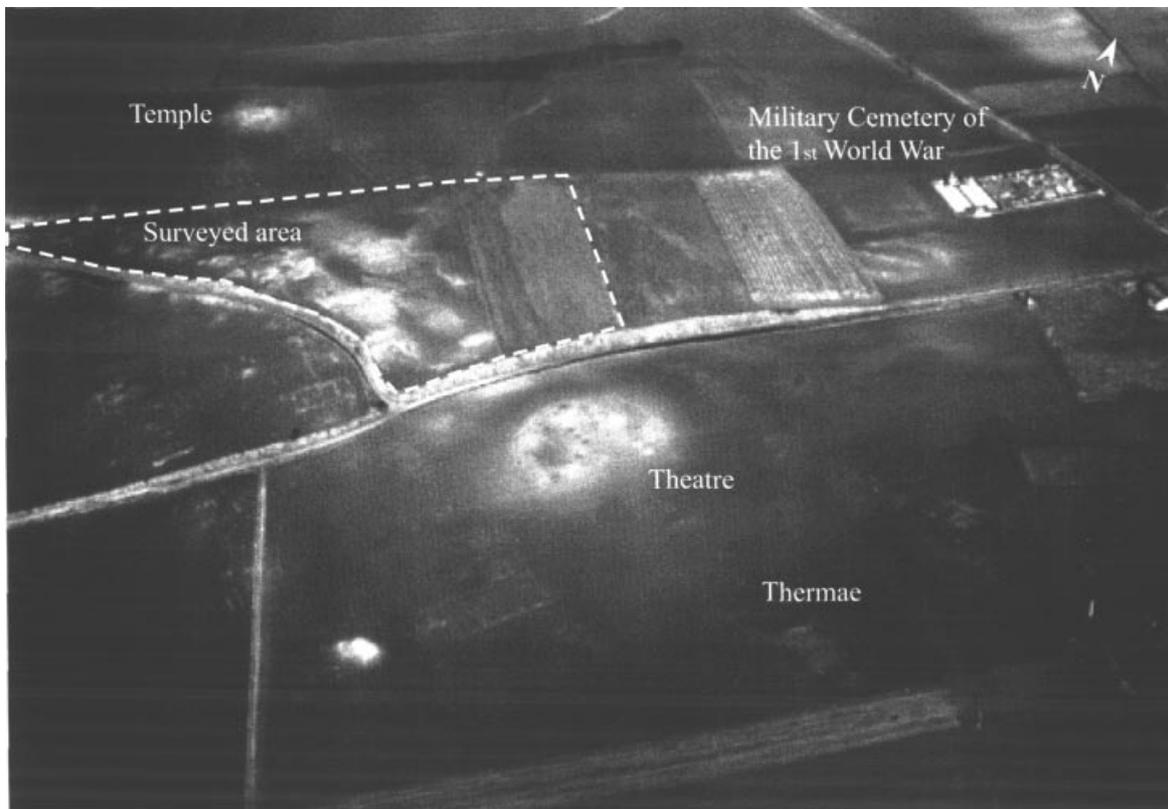


Figure 2. Ribermont-sur-ancre (Somme). Aerial photograph showing the three major monuments and the residences of Gallo-Roman period (Agache, 1978). The dotted line marks one of the areas disrupted through military operations during the First World War. Reproduced by permission of R. Agache, Ministère de la Culture.

battle front. After gaining 60 km, the advance of the German troops was stopped near Amiens (26 March to 4 April). The stabilized front line ran through Montdidier and Albert, including the village of Ribemont-sur-Ancre.

Three months later, 8–25 August, an Allies counter offensive beat back the German lines by 20 km to the east, definitely excluding the village from the fighting areas.

Our enquiry at the Imperial War Museum of London allowed us to find several vertical aerial reconnaissance photographs taken by the Royal Air Force between 6 April and 1 July 1918. These photographs show the whole system of the lines of defence, such as the trace of trenches and the zigzag communication trenches. The chalky circular traces mark the numerous points of shell impacts (Figure 3).

So, this rich documentation can be used in order to improve the interpretation of the geophysical results.

Equipment and measurement process

For the magnetic survey, the instrument used was the G-858 Magmapper magnetometer from GeoMetrics. In the gradiometer mode, this equipment uses two sensors, and from measurements of the absolute value of the total magnetic field at each sensor, it provides the difference between two levels of the Earth's magnetic field.

Thus prospecting is carried out in the vertical gradiometer mode, both sensors being fixed to a vertical staff. The bottom sensor is at a height of 65 cm, and the spacing between sensors is fixed to 1 m. The difference in intensity divided by the distance between sensors is considered as a good approximation of the vertical magnetic gradient, measured at the middle point between sensors. The vertical gradient has several interesting proprieties in exploration (Breiner, 1973; Scollar *et al*, 1990). It can filter the regional magnetic

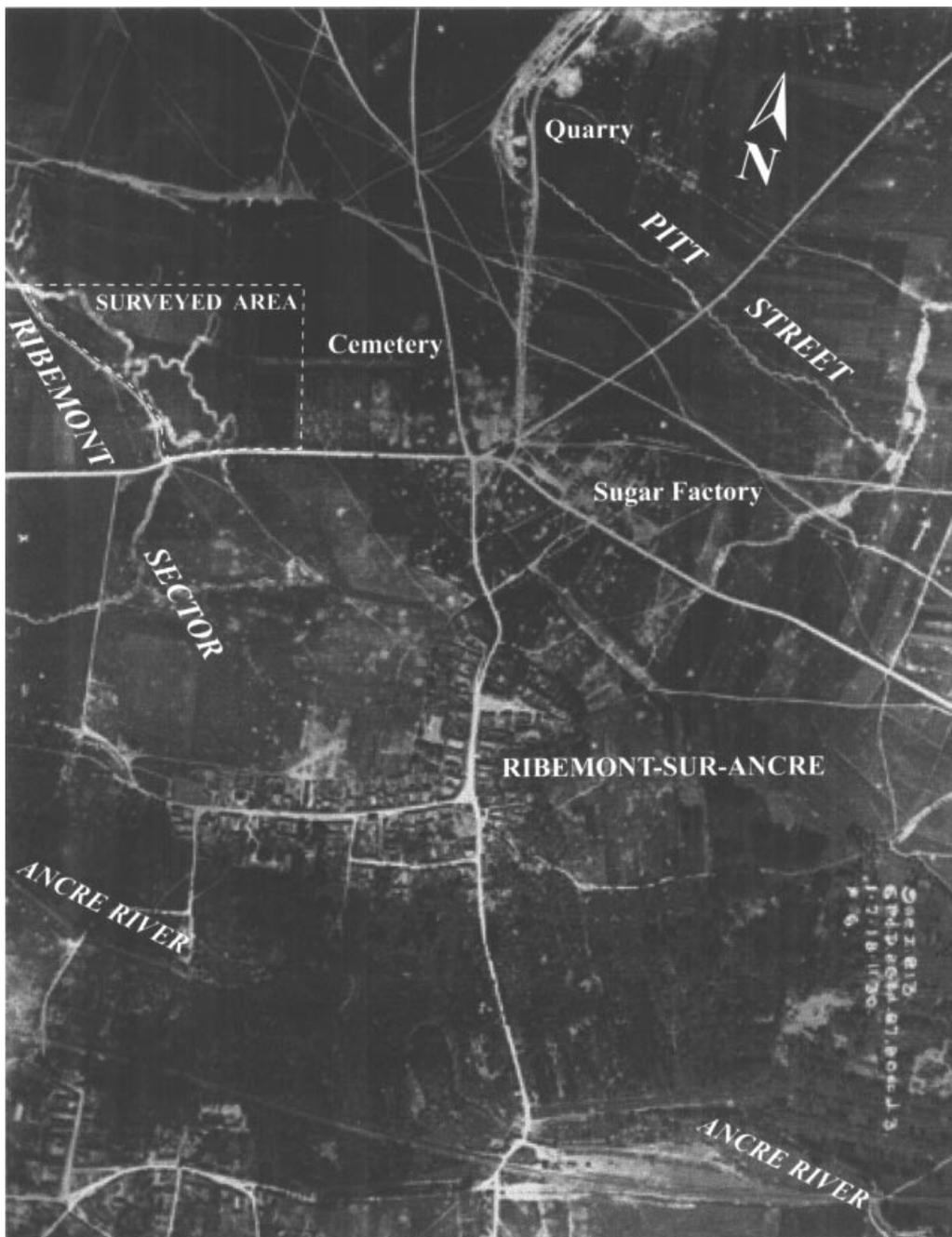


Figure 3. Ribemont-sur-Ancre (Somme). Vertical aerial reconnaissance photograph taken by the Royal Air Force on 1 July 1918. (Imperial War Museum, London, No. 1069/1918/213). Reproduced by permission of the Imperial War Museum.

anomaly, better define the shallower anomalies assumed to be of interest, and effectively remove magnetic time variations.

The speed of measurement determines both the extent of the area surveyed and the size of the

sampling mesh, which are the main influences on interpretation. In our case, measurements were made every 0.1 s with a sensitivity of 0.01 nT. The surveyed area (2.75 ha, 50 m grid) was covered by neighbouring lines in opposite direction with

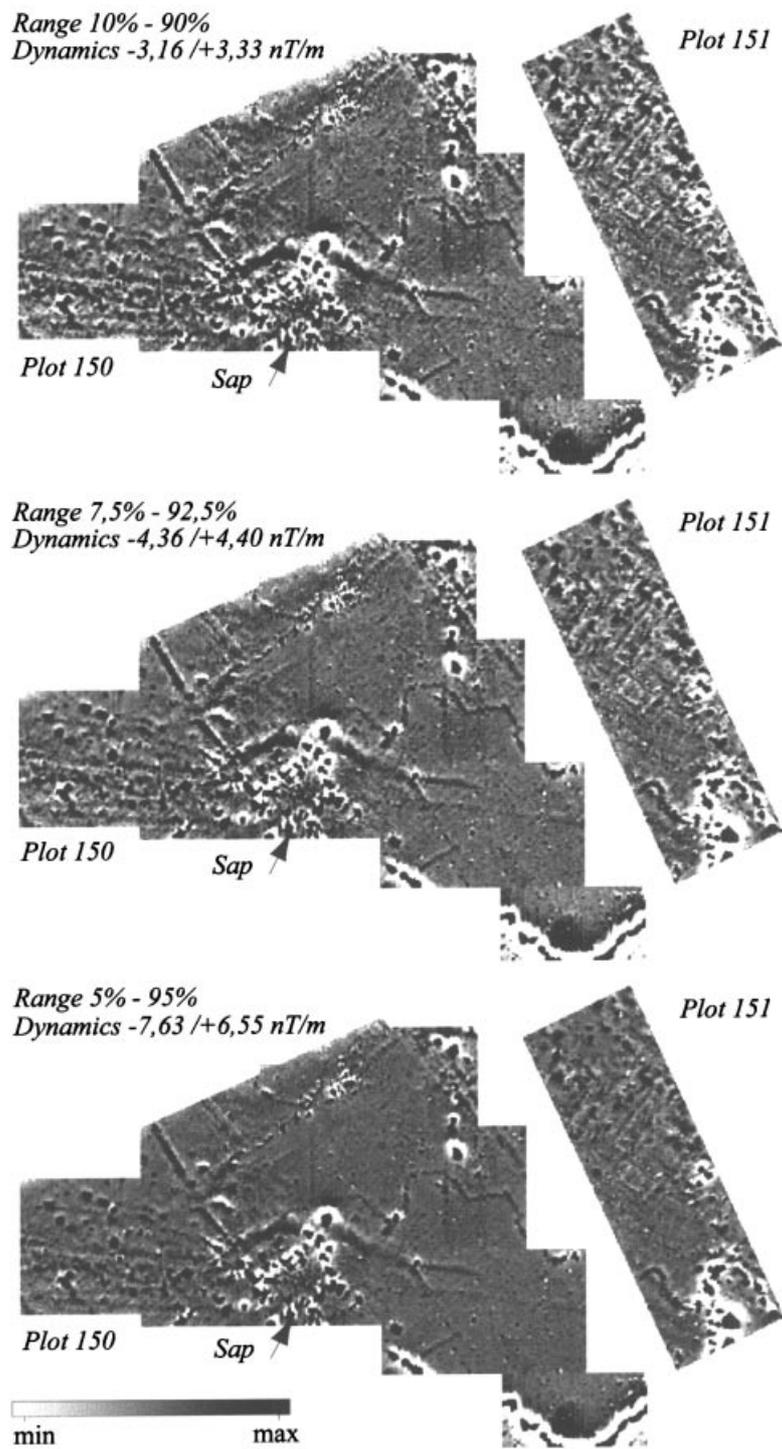


Figure 4. Ribemont-sur-Ancre (Somme, France). Magnetograms of the plots 150 and 151 in accordance with the dynamics of the vertical gradient measurements.

a 1 m separation. Specific processing includes removal of line effects, correction of herringbone effects, and reinterpolation of processed data on a 0.5 m square mesh.

Two plots have been surveyed, separated by a metallic fence. The western plot (plot 150) is a ploughed field, whereas the eastern plot (plot 151) is a pasture.

No metal detector prospecting was carried out prior to the magnetic survey; usually, the cleaning of the ferrous shallower objects, which can hide the response due to the deeper or fainter anomalies may be valuable. Such an

operation was not feasible, owing both to the complexity of the task and to problems linked to safety conditions. The existence of unexploded ordnance, still live after 80 years, is more than likely.

Results

The results of magnetic prospecting are shown in grey-scale image. Different levels of saturation are useful to complete the interpretation of magnetic data (Figure 4). For instance, a sap (military

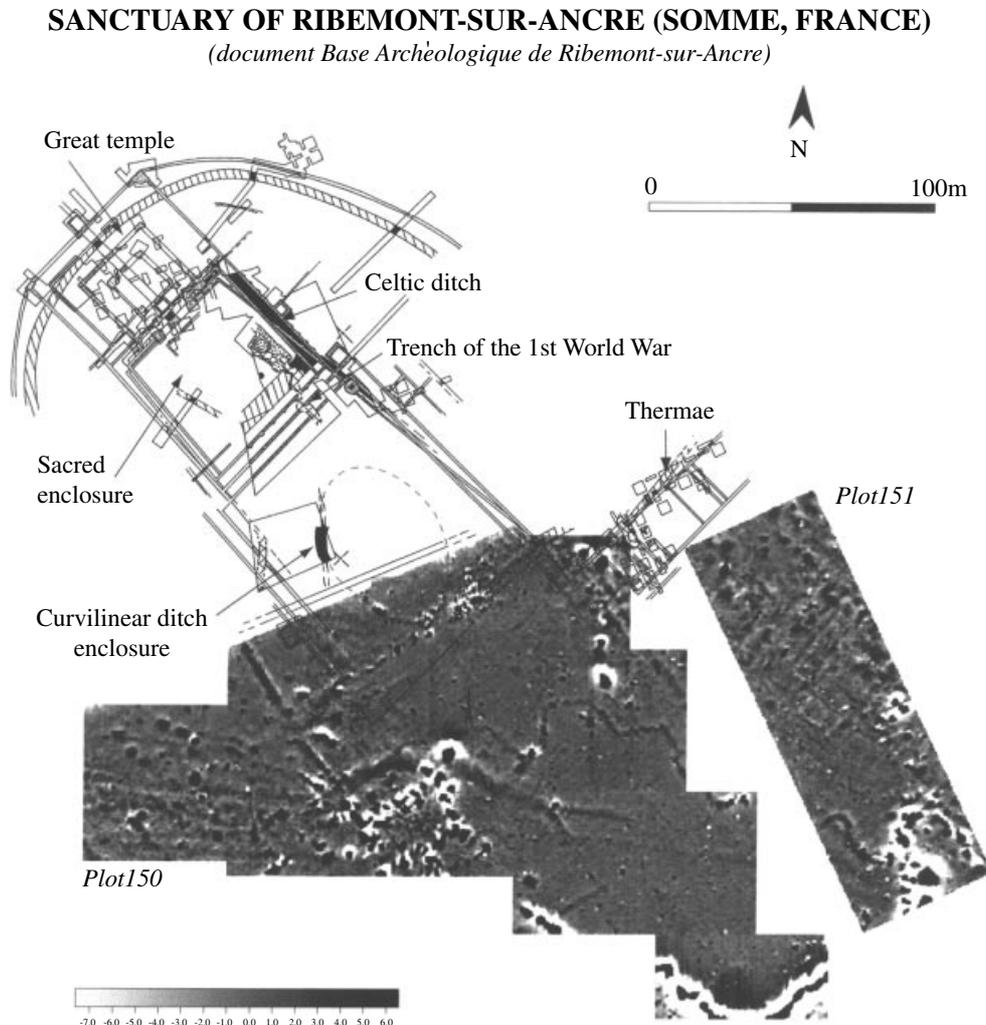
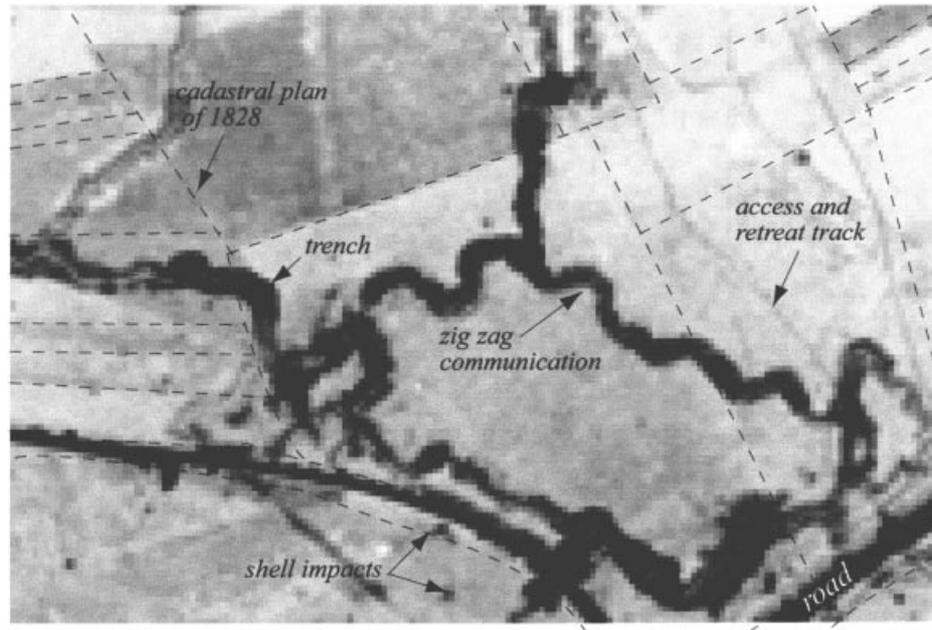


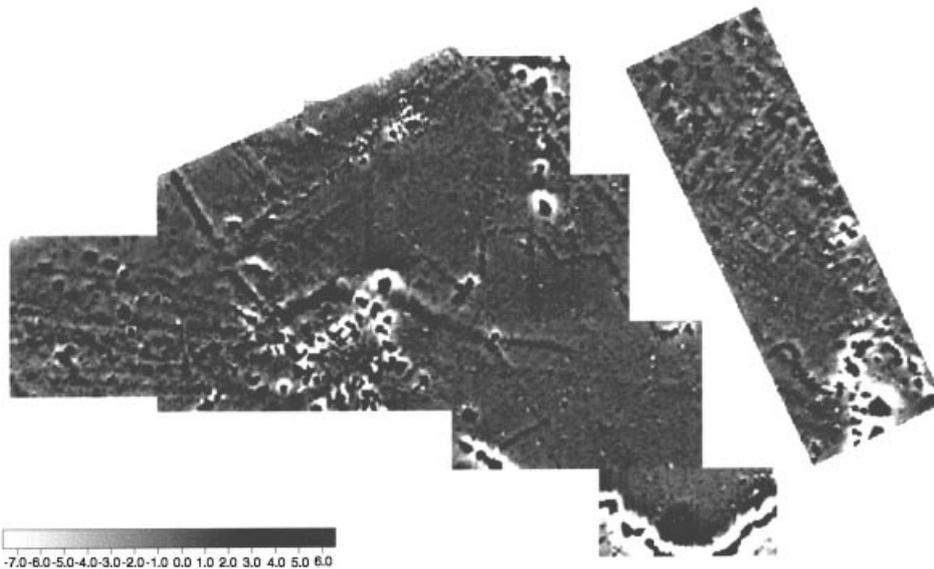
Figure 5. Plan of the sanctuary of Ribemont-sur-Ancre and magnetogram of the plots 150 and 151. Caesium magnetometry using GeoMetrics G-858 in vertical gradiometer mode. Sensitivity 0.01 nT at 0.1 s cycle rate (10 measurements per second). Dynamics $-7.63/+6.55$ nT in 256 grey-scale (White/black), 50 m grid. Reproduced by permission of centre Archéologique Départemental de Ribemont-sur-Ancre.

expression \simeq trench subterranean (in french: "sape")) appears clearly defined as a quadrangular structure on the less saturated map, whereas on the more saturated maps the similar anomaly

is strongly noisy. Although minimum and maximum values are very high, approximately 80 per cent of the vertical gradient measurements lie in the range of -3 to $+3$ nT m. Schematically,



(a)



(b)

Figure 6. (a) Enlargement, inverse video and contrast enhancement of the vertical aerial photograph from 1 July 1918. (Imperial War Museum, London, No. 1069/1918/213. (b) Magnetogram of the plots 150 and 151. Caesium magnetometry using GeoMetrics G-858 in vertical gradiometer mode. Sensitivity 0.01 nT, dynamics $-7.63/+6.55$ nT. Reproduced by permission of the Imperial War Museum.

two types of anomalies are generated by the archaeological structures (Figures 5 and 7a) and the remains of the First World War (Figures 6b and 7b).

All of the stronger anomalies can be ascribed to excavated structures with high magnetic filling. The origin of a great number of them can be identified by comparing with the aerial photographs,

especially those of 1 July 1918 (Figure 6a). In plots 150 and 151, these anomalies delimit the trace of the trenches, the zigzag communication trenches, the shell impacts and the impression of a bunker (Figure 7b). The high magnitude of anomalies is probably due to the reinforced concrete bunker. At the end of the war, the trenches were filled with material cleared from the parapets, which

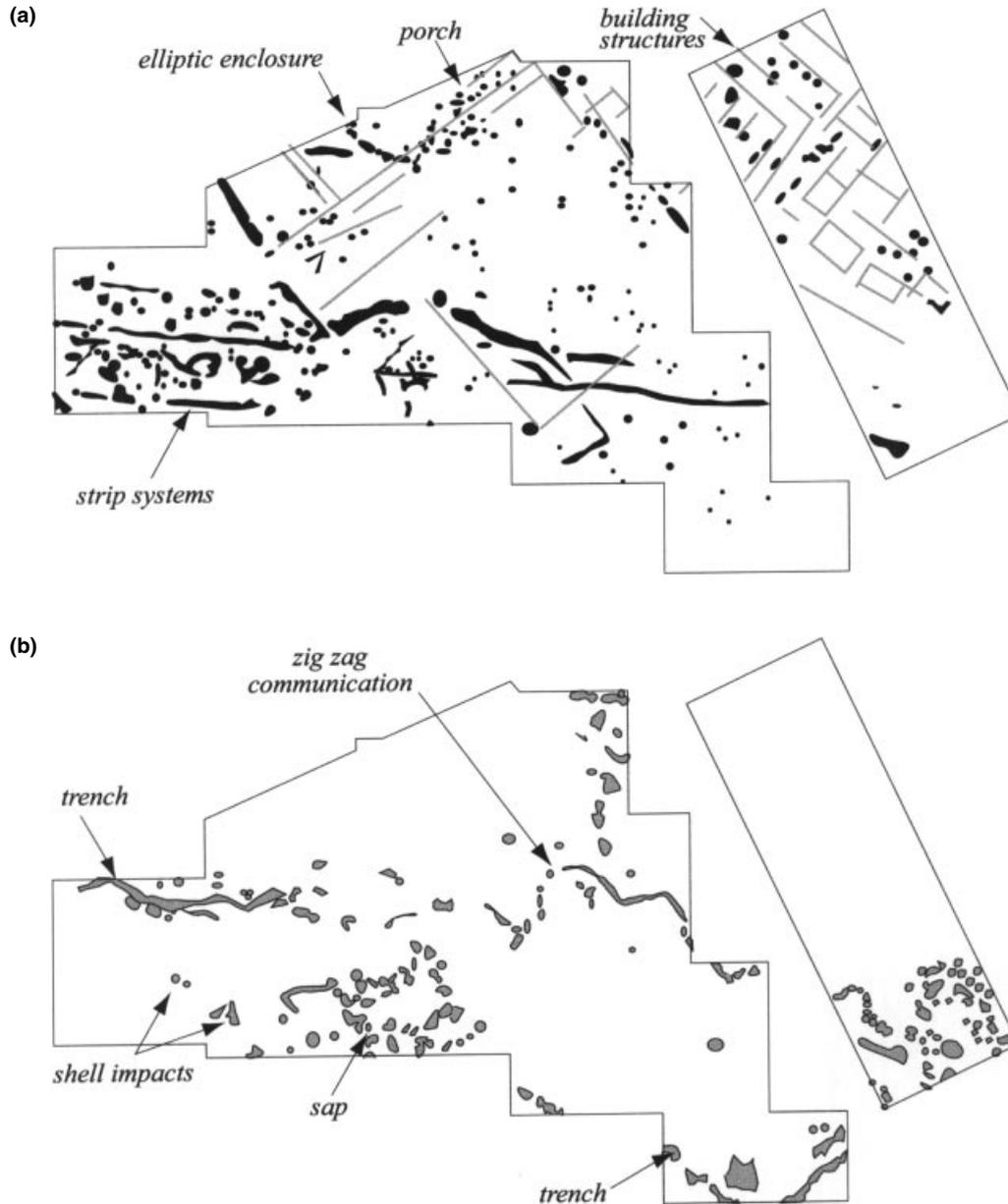


Figure 7. (a) Magnetic anomalies of structures not related to the conflict. (b) Magnetic anomalies of structures contemporary with the conflict.

included metallic objects such as barbed wire entanglement, metallic stakes and shrapnel splinters. Former excavations along the Celtic ditch have shown that some ammunition dumps have been buried by the filling in of the trenches. In the western part of the surveyed zone, the linear abnormalities can be superimposed on the ancient boundaries of the strip systems, which are visible on the cadastral map of 1828 (Figure 6a).

At the south of the sanctuary, recent excavations made on the extension of a curvilinear magnetic anomaly, allow us to identify it as a Celtic ditch enclosure, probably of elliptic shape. This archaeological structure, located at the entry of the porch, was unknown until now. The other magnetic anomalies near the porch, are unidentified on the aerial photograph of 1 July 1918; they could mark the presence of Celtic metallic objects coincident with the courtyard entrance of the Gallo-Roman temple.

Numerous faint anomalies are of linear thin shape. They seem to correspond principally to the ancient building structures (Figure 5 and 7a). For example, on the front of the sanctuary, the walls of the porch are well detected. These walls, made of chalky stones, appear as anomalies of low magnitude, with negative polarity. The association of various magnitudes and polarities of the anomalies is a great advantage because it readily facilitates the identification of most of the features. Down the slope of the hill, weak linear anomalies could mark the existence of walls at the south of plot 150. In plot 151, down to the *thermae*, the magnetic rectangular anomalies mark the remains of the constructions (*insulae*) lining the vast courtyard on the east side.

Conclusions

Before this study, only Celtic and Gallo-Roman periods seemed of interest at Ribemont-sur-Ancre. The occupation of the site during the First World War and the following earthworks add new layers—apparently the most recent—of remains and signatures of human activity. Thanks to the magnetic survey, it is now possible to separate with high accuracy the different archaeological levels.

The comparison of geophysical results with the aerial photographs shot during the war allows an exact determination of the origin of the anomalies. It becomes possible to separate the magnetic anomalies that are contemporary, anterior or probably posterior to the conflict of 1914–1918. The range of magnitude and the sign of polarity of anomalies appear as a means to facilitate the identification of the features of each period.

Among the former anomalies detected, some of them, such as the elliptic enclosure, have been identified by the excavations as unknown archaeological remains. In this case the magnetic survey advantageously completes the aerial reconnaissance.

Generally speaking, the ability of the magnetic method for surveying any structure in such a disrupted environment suggests a more frequent use in prospecting of the sites that were battle fields in historic periods. Magnetic feature detection could also permit the investigation of these sites in conditions of maximum safety.

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