Magnetic and EMI prospection in a disturbed environment: the case of the Saint Brice/ Ecouen (Val d'Oise, France) pottery workshop

Michel Dabas, Rémi Guadagnin, Danièle Lambert, Alain Tabbagh, Julien Thiesson

Magnetic and EMI prospection in a disturbed environment: the case of the Saint Brice/ Ecouen (Val d'Oise, France) pottery workshop.

Michel Dabas[*1], Rémi Guadagnin[2], Danièle Lambert[2] Alain Tabbagh[3], Julien Thiesson[3]

[1] AOROC-CNRS-ENS-PSL 45 rue d'Ulm, F-75230 Paris cedex 05, michel.dabas@ens.psl.eu

[2] JPGF, 62 rue de la République, 95400 Villiers-le-Bel, jpgf@hotmail.fr

[3] Sorbonne-Université, UMR 7619 METIS, case 105, Faculté des Sciences et d'ingénierie de Sorbonne Université 4 place Jussieu 75005 Paris, alain.tabbagh@upmc.fr, julien.thiesson@upmc.fr

(*= corresponding author)

Topic: Case studies and archaeological feedback

Type of presentation: oral

Key-words: Archaeological feedback, magnetic and EM disturbances, Magnetic susceptibility, Pottery workshop, Remanent Magnetization.

Highlights: Detection of kilns within pottery workshops. Comparison of EM and magnetic results. Detection with EM disturbances.

1. Introduction

The first observation of remains of possible pottery workshops has been made during the construction of the Epinay-sur-Seine-Le Tréport railway line in 1874. This site was then completely forgotten but, one century later, systematic field-walking observations achieved by the JPGF association in the 'Pays de France' at the North of Paris, in the Rosne and Ysieux river valleys, have demonstrated the presence of a continuous pottery production from, at least, the Gallo-Roman period to the Medieval period. In 2009, as part of a research program on the local production of ceramics, an in-depth study of the material resulting from systematic surface prospecting carried out since, made it possible to highlight the in situ production of common pottery and *terra sigillata* (Samian ware) of the Argonne type during the Lower Roman Empire. The existence of this specialized artisanal activity being clearly established, it remained to locate the workshop(s) with precision: the presence of characteristic debris more or less

concentrated in the plowing horizon on several plots (baking supports, pipes, rashed silt nodules with a vitrified face, etc.) allowed the archaeologists to define four zones probably corresponding to production units with one or more kilns, distributed on each side of the ancient road from Paris (*Lutecia*) to Amiens (*Samarobriva*) at the limit between the territories of Ecouen to the east and Saint-Brice to the west, 17 km North of Paris.

2. Archaeological feedback

Following magnetic and EMI prospections in 2013 winter, the first archaeological excavation was carried out in Saint-Brice in summer 2013, in the western sector of "La Plaine du Moulin" (Guadagnin, 2016) where the existence of a Lower Empire workshop was expected due to the observation of surface remains; leveled kiln, small dump and layers of occupation containing many witnesses of the production of Samian ware pottery can be assumed dating back to the second half of the 4th century, with a *terminus post quem* provided by a coin issued in Amiens in 353. A production of common ceramics from the 3rd century AD can be expected, that of Samian ware in the 4th and at the beginning of the 5th; and again common pottery until to the 6th / 7th centuries.

After a second series of geophysical surveys (2014), other diagnostic excavations were carried out in 2014 and 2016 in the eastern sector of the site, "Les Reserves de Chauffour" (*Calfur = Calcis furnus)* in Ecouen (Guadagnin, 2016); two other production units existed at the border of a marsh, at the east of the ancient road. They made it possible to study two Samian ware kilns of ‘Argonne’ type (Chenet, 1941), well preserved under thick colluviums.

3. Geophysics in a difficult environment: feedback of 3 geophysical surveys

Geophysical surveys were carried out in 2013, 2014 and 2021 on both sectors (Ecouen and Saint-Brice) to detect traces of pottery workshops and more specifically possible kilns. Magnetic and EMI surveys were first used in 2013 and 2014. Several anomalies which could correspond to kilns were found: four in the eastern part of the site at Ecouen, between the road and the course of the river (Rosne), and two in the western part at Saint-Brice (Tabbagh & Thiesson, 2015). From these anomalies, only two of the eastern ones were found in excavation to correspond with kilns. The last survey (2021) has not been field-proofed yet.

Coming back to the first experiment in 2013 on the Plaine du Moulin/Saint-Brice, the survey was done manually over an area of 47 x 80 m using two cesium magnetometer sensors in vertical gradient mode (Geometrics G858) and an EMI prototype (CS150, perpendicular configuration, 1.5 m inter-coil spacing)). We found that it was difficult to use the data coming from the bottom magnetic sensor (h=0.3m): the signal is too disturbed by anomalies produced by a lot of small superficial ferrous objects (iron litters) probably as a result of the spreading of urban sludge (coming from the nearby Paris city) during the 19th and 20th centuries. Also several seconds long temporal variations exist when trains pass on the nearby railway. Some strong EM interference coming from the nearby airport beacons could also explain the linear stripes along the profiles seen on the map (Fig. 1). Fortunately, the EMI surveys (f= 8 kHz) does not seem to be impacted by the interferences and show up a clear anomaly. This anomaly exhibits a significant magnetic signal as well as a higher electrical resistivity value. It was selected as a potential pottery workshop. A small excavation above this anomaly has found a pile of Gallo-roman *tegulae* and mortar, but no kiln. In a second excavation 15 m to the North based on the position of a well-defined magnetic anomaly (from a reprocessed magnetic map -upwards continuation-) but with no corresponding susceptibility anomaly, has found no noticeable remains. In this area, EMI gave the most reliable results.

In April 2014, were conducted a second survey to the East of the ancient road (Ecouen) over an area of 27 x 100 m (G858) and 27 x 50 m (CS60 EMI prototype, 0.6 m inter-coil spacing, vertical coplanar configuration) with a lower depth of investigation than the previously used CS150.

Four anomalies were identified as being able to correspond to structures of the workshop, 2 (A and B in Figure 2) to the north of the zone and 2 (C and D in Fig. 2) in the central part where in electromagnetic prospecting the apparent magnetic susceptibility reached very high values near 300 10^{-5} uSI. Anomalies A and B, in the area not covered by the EMI survey, corresponded to existing kilns which were excavated during the summer of 2014. But nothing visible was observed at points C and D during the trial trenches. The samples taken during the excavations made it possible to observe that heated subsoil (reddish) had a magnetic susceptibility which remains low, significantly lower than that of the surface layer, and that it is the remanent magnetization which made it possible to detect the kilns. In this area, magnetics was more reliable for locating the kilns.

Finally, in 2021, we conducted an EMI survey using a CMD-Mini-Explorer 6L (GF Instruments, Brno) with an RTK GPS in order to resurvey Saint-Brice area but over a wider area, the archaeologists being sure that other kilns may exist. 1.8 ha was surveyed (1 m interval between profiles, 7 cm in line spacing). The output of this instrument are 6 apparent electrical conductivity data corresponding to increasing depths of investigation (inter-coil separation = 0.2; 0.33; 0.5; 0.72; 1.03 and 1.5 m) and 6 apparent susceptibility data. Data were calibrated using a manual zero offset calibration and converted into apparent conductivities and susceptibilities. For inter-coil separation shorter than 0.5 m conductivity maps show no particular anomalies except the ones related to agricultural practice (heavy workload of tractors). For deeper levels, clear resistive elongated anomalies that can be interpreted as

masonry walls were found and the trace of 2013 excavations (Fig. 3). Unfortunately, the apparent susceptibilities maps are also heavily distorted by the agricultural practices but surprisingly not the most superficial levels. This instrument shows the high vertical variability of the magnetic susceptibility, which makes a difficult parameter to use for the detection of kilns or of dumps in this situation.

As a conclusion, even in a very difficult situation like this one (Railway interference, sludge), magnetic field measurements, if correctly processed, have a good potential of detection for kilns because they are sensitive to the remanent magnetisation in situations where the magnetic susceptibility of heated features remains low.

Figure Captions

Figure1 : Saint-Brice-La Plaine du Moulin. Map of Earth Magnetic Field (Geometrics G858, h=0,85m, local trends), Apparent Magnetic Susceptibility and Electrical Resistivity (CS150).

Figure 2 : Ecouen-Les Réserves de Chaufour. Position of maps Fig.1 and 2; 3D model of the kiln found for B anomaly; Map of Earth Magnetic Field (Geometrics G858, h=0.85m), Apparent Magnetic Susceptibility and Electrical Resistivity (CS60).

Figure 3 : Saint-Brice – La Plaine du Moulin. CMD-Miniexplorer-6L maps (mesh 0.5 x0.5m) for apparent electrical conductivity and magnetic susceptibility

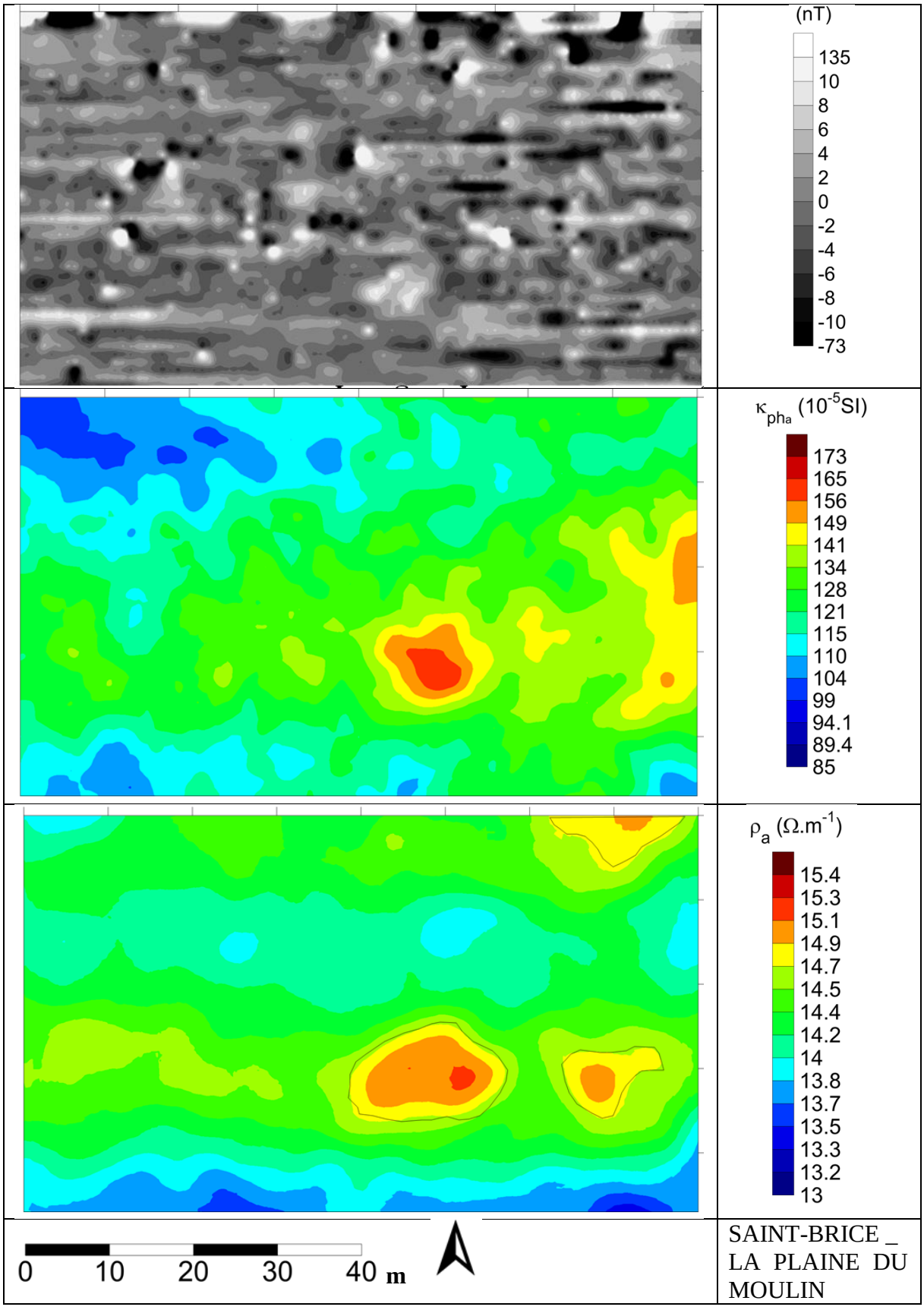
References

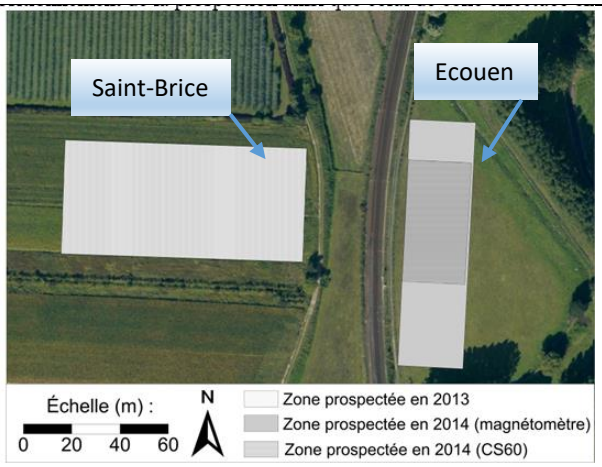
Guadagnin, R., 2016. Ecouen/Saint-Brice (site 10.4/28.1) Val-d'Oise. Les officines de potiers gallo-romains de la Vallée du Rosne : bilan des fouilles programmées en 2013, 2014 et 2016. Bulletin J.P.G.F. (1), 1.

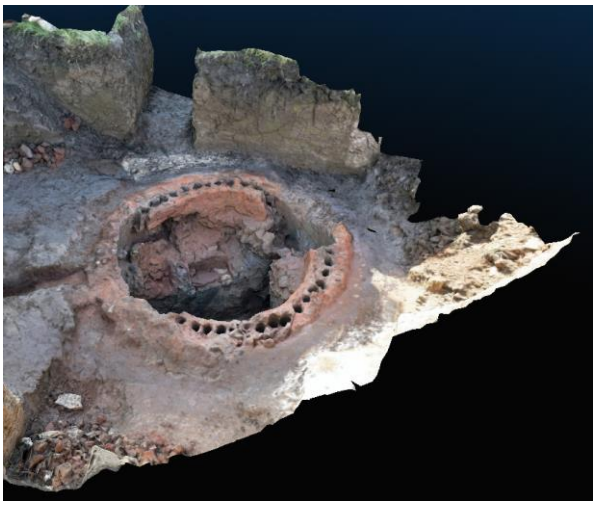
Guadagnin, R., 2017. Ecouen/Saint-Brice. Les officines de potiers gallo-romains de la vallée du Rosne. In Catalogue de l'exposition "Potiers antiques et médiévaux du Pays de France"; musée Archéa, Louvres, p. 49 à 64.

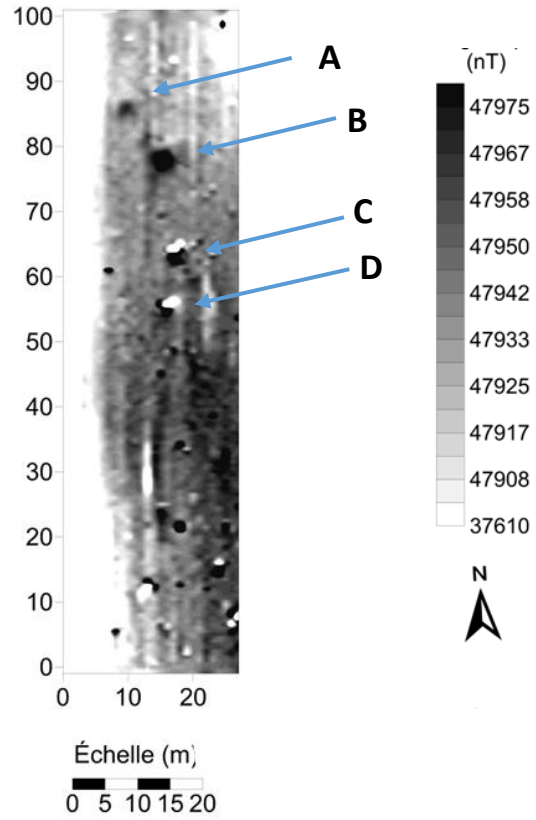
Tabbagh, A., Thiesson, J., 2015. Rapports de prospections géophysiques réalisées à Saint-Brice et à Ecouen (Val-d'Oise), SISYPHE, Université Paris VI - Jussieu, janvier 2013, avril 2014, et 12 septembre 2015.

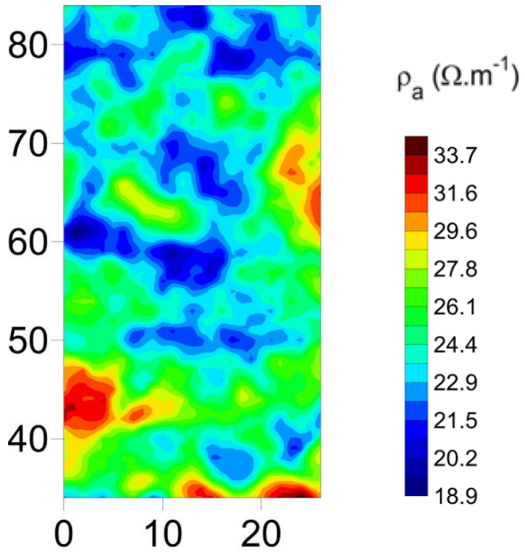
Chenet, G., 1941. La céramique gallo-romaine d'Argonne du IV^{è} siècle et la terre sigillée décorée à la molette, Mâcon 1941.

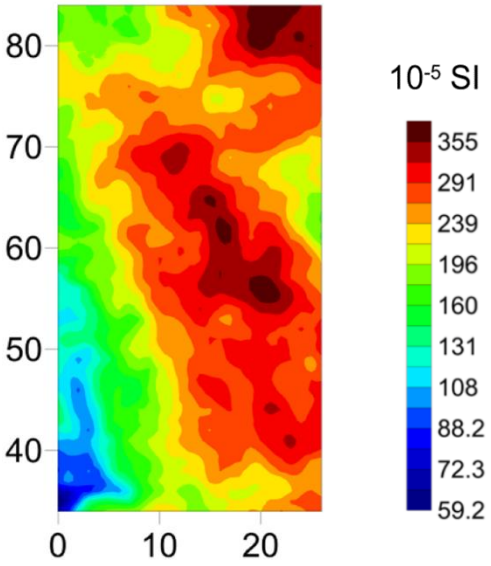

(nT)
135
10
8
6
4
2
0
-2
-4
-6
-8
-10
-73
κpha (10-5SI)
173
165
156
149
141
134
128
121
115
110
104
99
94.1
89.4
85
ρa (Ω.m-1)
15.4
15.3
15.1
14.9
14.7
14.5
14.4
14.2
14
13.8
13.7
13.5
13.3
13.2
13
0
10
20
30
40 m
SAINT-BRICE _ LA PLAINE DU MOULIN



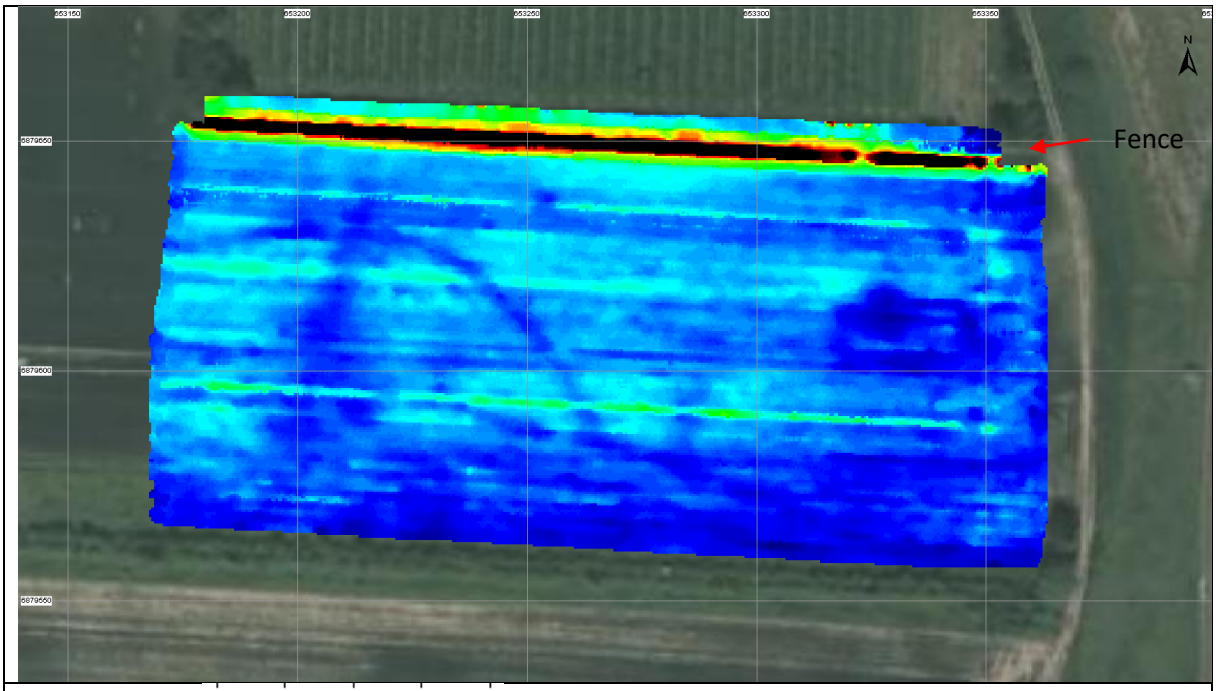




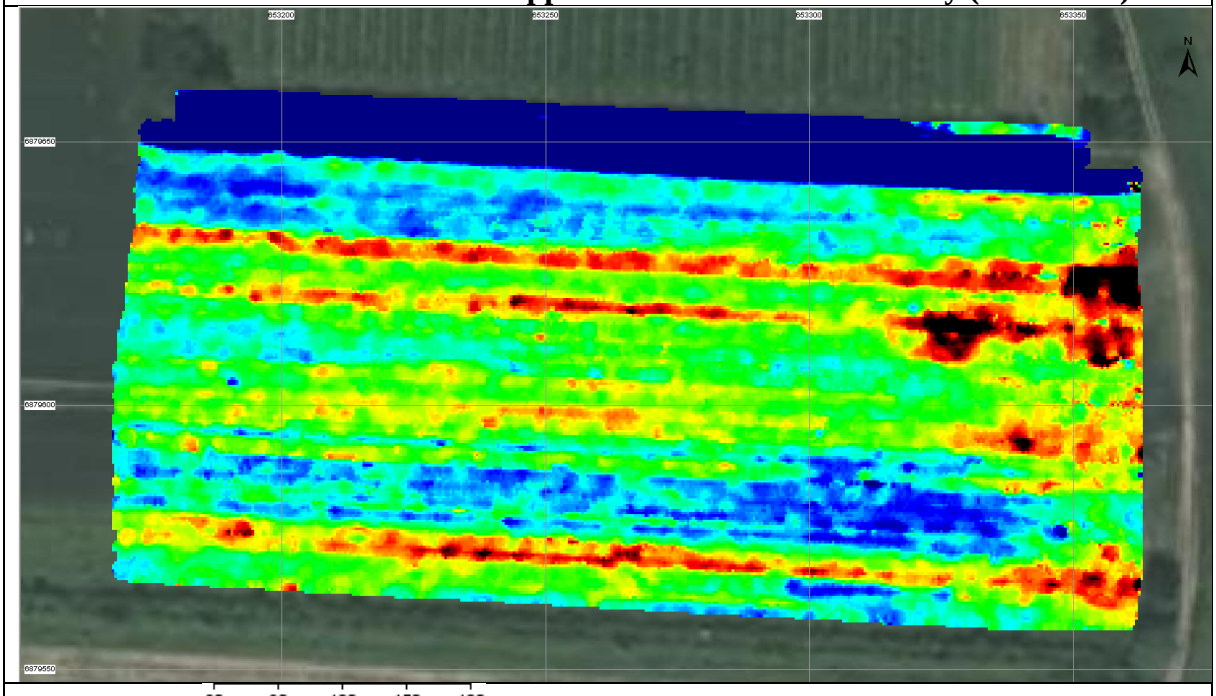




ECOUEN - Les Réserves de Chauffour



L = 150 cm **Apparent Electrical Conductivity (milliS.m^{-1})**



L = 150 cm **Apparent Magnetic Susceptibility (10^{-5} uSI)**