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NEW GLOBAL PERSPECTIVES ON ARCHAEOLOGICAL PROSPECTION

13TH INTERNATIONAL CONFERENCE ON ARCHAEOLOGICAL PROSPECTION
28 AUGUST - 1 SEPTEMBER 2019
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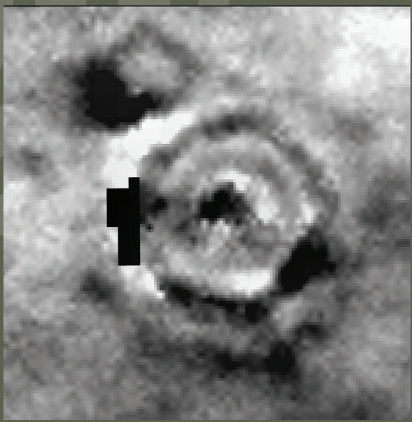

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Cover images:

Top Left:	Earth resistance data from a circular ditched monument SL014-209041-, Carrowmore Megalithic Cemetery, Co. Sligo.
Top right:	Electromagnetic induction survey of a fulacht fia, monument SL008-205----, Coney Island, Co. Sligo. Photograph: Ciarán Davis
Bottom left:	Megalithic Passage Tomb, monument SL014-209006-, Carrowmore Megalithic Cemetery, Co. Sligo
Bottom right:	Court Tomb, monument SL015-050----, Deerpark, Co. Sligo

Contents

Magnetic signal prospecting in a former Achaemenid 'palace': the example of Gumbati (Georgia)

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The Gumbati site

The archaeological site of Gumbati is located on the right bank of the Alazani River in the Kakheti region, Georgia. Excavations in the 1990s (Knauß 2000: 119-130) revealed parts of a rectangular building made with mudbrick walls of 2m width on average. Its southern extension is almost 40m in length. Stone column bases, typical of an Achaemenid royal style well-known from ancient Persia, were found around the building. Because of its architectural characteristics, it was interpreted as the remains of one of the administrative complexes controlling the Transcaucasus, the northernmost province of the Achaemenid Empire (mid-6th/mid-4th century BC).

Project framework and purposes

In July 2018, archaeological investigations were resumed at Gumbati within the frame of a German-French joint project named "Paradise" and funded from 2017 to 2020 by the *Deutsche Forschungsgemeinschaft* (DFG) and the *Agence National de la Recherche* (ANR). Its main goal is to produce comparable datasets regarding the spatial organization of several Achaemenid centers of power located in central Iran and in the Caucasus. As these sites were created within planned landscapes, covering dozens of hectares and encompassing spacious gardens, residences and administrative buildings, an improved understanding of their layout depends on complementary surveys. Consequently, one of the main tasks implemented is to develop suitable geophysical approaches for these sites. Since they are of a complex archaeological nature, combining mudbrick architectural remains and lighter garden infrastructures such as flow channels, we focus on combined magnetic and electromagnetic methods. Also, since all sites are located in intensively farmed regions, we aim to evaluate whether a deeper study of the soil magnetic properties would enable us to map the different sectors of the site, e.g. gardened and inhabited areas, despite surveying within landscapes of destruction.

Implementing geophysics at Gumbati

Devices used
In order to comprehensively evaluate the magnetic signal of soils of the surroundings, we used magnetometry and EMI prospecting.

The magnetic anomaly map was obtained by using and processing data from three devices made available by the Munich University Geophysics Department:

- Förster Ferex Gradiometer in the so-called "quadro-sensor" configuration (Foerster Ferex 4.032 Datalogger with four CON650 probes). The probes were mounted on a frame and carried in zigzag mode, 40cm above the ground.
- Scintrex Smartmag Sm4G-special Cesium-magnetometer applied as total field magnetometer, in a so-called "duo-sensor" configuration.
- Geometrics G-858 MagMapper Cesium-magnetometer applied as total field magnetometer, in a so-called "duo-sensor" configuration.

The EMI maps were produced using a GF Instruments CMD-Mini Explorer made available by the University Lyon 2/CNRS Archéorient lab. Measurements were recorded in both horizontal coplanar/vertical dipole (HCP/VD) and vertical coplanar mode/horizontal dipole (VCP/HD) configurations. It provides in-phase and apparent electrical conductivity maps for three different transmitter-receiver (Tx-Rx) distances of 0.32m, 0.71m and 1.18 m.

Survey strategy

The main target of the first 2018 geophysical prospection campaign at Gumbati was to obtain more information on archaeological remains in the vicinity of the partially excavated building. The trenches that brought to light architectural features were located in cultivated fields southwest of a large farmstead built in Soviet times. Consequently we mainly focused the magnetic survey on that area. A grid of 40m by 40m squares was staked out on the field over an area of about 5.5ha. The southern part covered the refilled trenches of the former excavation. The prospection was accomplished using all three magnetometer instruments for different parts in order to evaluate their efficiency in that particular context. The Ferex gradiometer was used for the two eastern and southern 40m rows. The two cesium magnetometers were alternatively used on the northwestern part.

Once the magnetograms were edited, we selected an area where we implemented the EMI survey. This area shows remarkably discrete features combined with more continuous soil magnetic property variations. By surveying it with the EMI device, we aimed to test the capability of this method to describe accurately both types of anomalies (geometries and/or magnetic properties). The whole area was surveyed twice with the EMI, at first in HCP mode, then in VCP mode, collecting 12 datasets in all. The probe was held as close as possible to the surface. Regular measurements were taken on a reference point in order to correct the drift.

Results

Here, for brevity, we focus principally on the magnetic signal of the site, rather than a large treatise on the entire set of 12 EMI apparent properties maps.

Magnetic map

The magnetogram (Fig. 1) shows that the site is poorly preserved. The excavators had already stressed the impact of repeated ploughings on the architectural remains. In the northern part, a number of roundish dark anomalies can be interpreted as signatures of pits. The linear features, pointing to the existence of mudbrick walls, are only just visible in the center of the image. These faint lines, oriented approximately at a 45° angle from north, may belong to building remains such as the ones excavated. However this direction is also parallel to the actual ploughing and field limits. Further analysis is therefore needed to ascertain the interpretation. In the southern part of the surveyed area, the magnetogram shows blurry features possibly caused by the filling of the old trenches.

EMI and transformed magnetic anomaly map

The magnetic signal can be described as the whole set of parameters which could be measured in prospecting. It includes the magnetic field anomaly (total or gradient), the magnetic susceptibility (measured by EMI devices) and ideally the magnetic viscosity. Presently, only the first two parameters were measured. The magnetic map (Fig. 2a), and its conversion as a susceptibility layer (Desvignes and Tabbagh 1995: 122-132) (Fig. 2b), may be compared to apparent magnetic properties using EMI (Fig. 2c). The general trends are the same. However, since the EMI is characterized by a less spatially resolved sampling interval than the magnetometry, some discrepancies appear. We cannot evaluate if these discrepancies are linked to the spatial sampling, measurement errors or the difference between the total and the induced magnetization. The next step will be to use the processing described by Benech *et al.* (2016: 103-112) for inverting the data to a magnetic susceptibility model to be transformed in to a magnetic anomaly. If the discrepancies are confirmed, some sampling and trench testing could be useful to understand its origins.

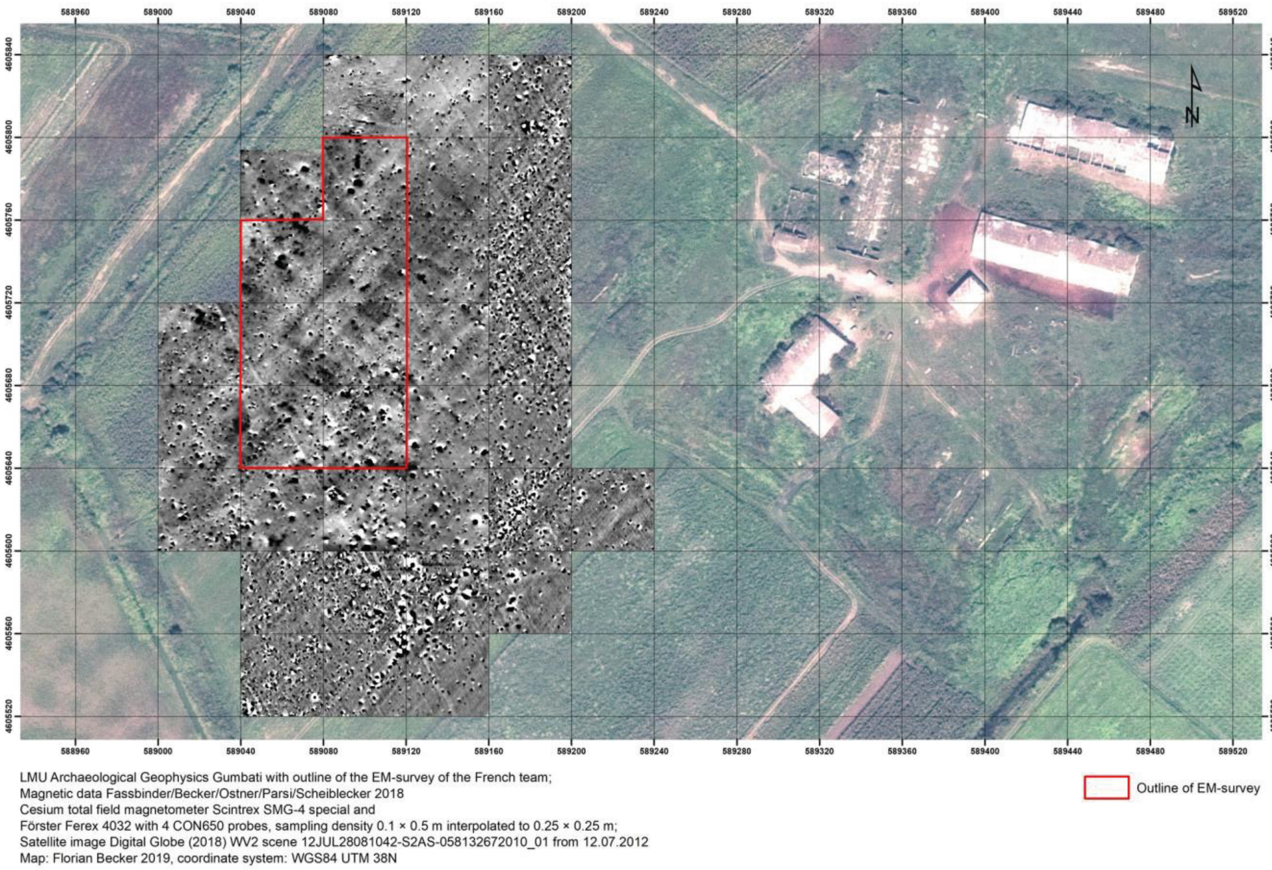

Fig. 1. Results of the magnetic prospection on Gumbati (scale: white/-10nT to black/+10nT).

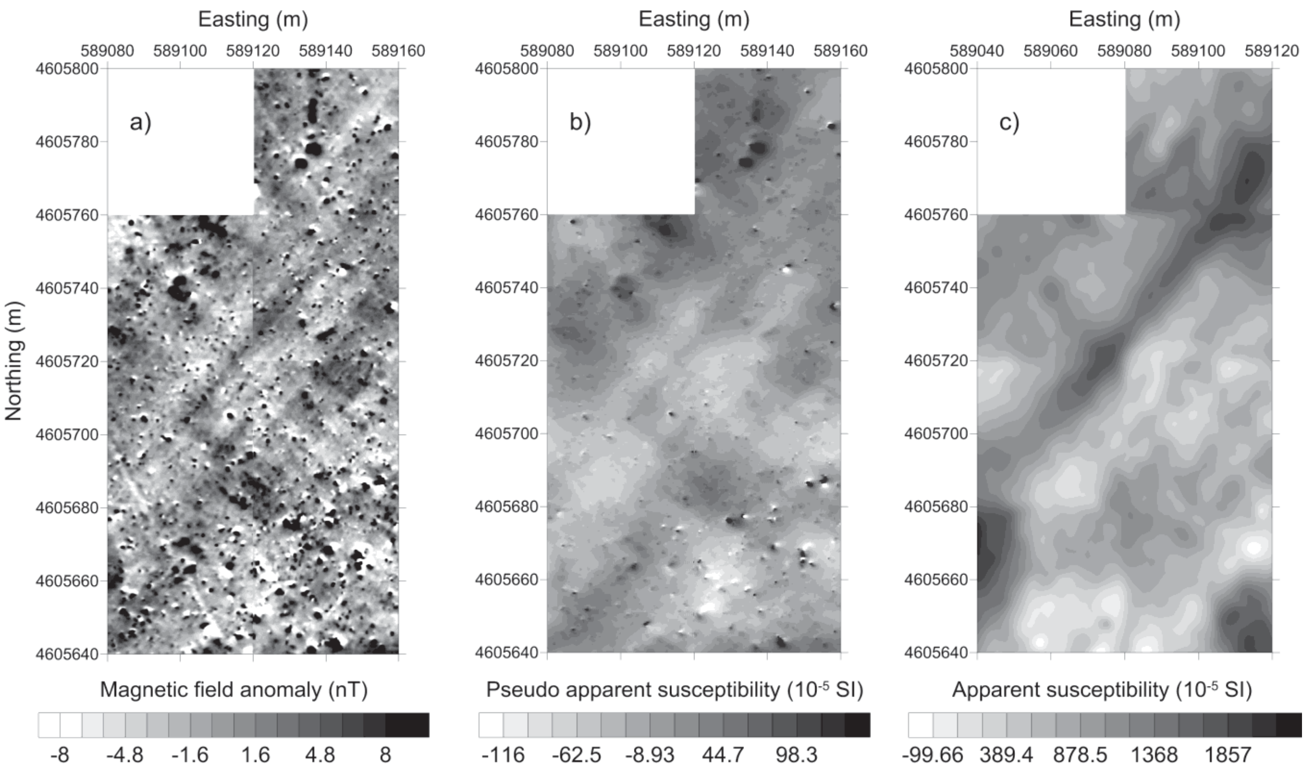

Fig. 2. (a) Extract of the magnetic anomaly map, (b) map of the pseudo-apparent magnetic susceptibility map computed from the magnetic anomaly map, (c) the apparent magnetic susceptibility map obtained from the in-phase measurement of the VCP Tx-Rx =1.18m channel.

Conclusion

The magnetic signal of the archaeological remains at the site of Gumbati was investigated. Magnetic and EMI survey results are generally in good accordance. The discrepancies between the pseudo-susceptibility map and the apparent susceptibility map could evidence the presence of material bearing remnant magnetization. However, the uncertainties linked to the EMI map lead us to process the data further and we will compute an inverted susceptibility model. If differences are confirmed, then it might be worthwhile to combine the survey with a complete magnetic description of soil samples that would help us to clarify their origins.

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