



# MAGNETIC SURVEYS ON THE ARCHAEOLOGICAL SITES OF GIRDI QALA AND LOGARDAN

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**F**rom September 25<sup>th</sup> to October 14<sup>th</sup>, a second campaign of geophysical survey has been carried out in the frame of the French archaeological mission of Girdi Qala and Logardan in Iraki Kurdistan, directed by Régis Vallet (CNRS). The goal was to complete the results of the 2015 campaign: at Girdi Qala, only the main tell and its immediate vicinity was covered and according to the observations of the pedestrian survey, it appeared particularly interesting to extend the survey to the northwest to another eminence limited to the North by an abrupt slope. In the case of Logardan, the first purpose was to link the two magnetic maps of 2015 to follow the layout of the structures detected on the southern slope. An extension of the survey was also carried out to the southeast to check if there is –or not- an extension of the settlement in this direction.

## METHODOLOGY

The geophysical survey was carried on by using the magnetic method that proved its speed and efficiency in this archaeological and environmental context. The principle of the magnetic method is to measure the local variations<sup>1</sup> of the Earth magnetic field due to the presence of iron oxides in the soils and in the archaeological structures. The magnetic survey has been carried out with a cesium gradiometer G858 (Geometrics Inc) with a mesh grid of 1 m x 0.10 m interpolated at 0.50 m.

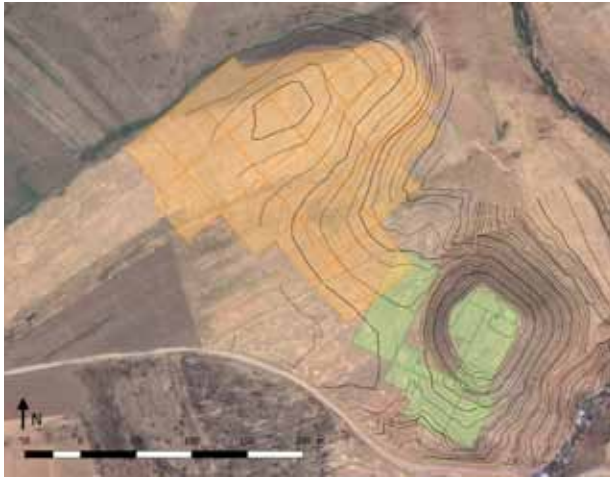
## RESULTS OF THE MAGNETIC SURVEY

### GIRDI QALA (FIGURES 1A-E)

In 2016, a surface of 4 ha has been covered by magnetic survey at the north of the main tell (figure 1a). The magnetic map (figure 1b) shows a very clear image of the archaeological settlements rarely disturbed by modern activities or erosion layouts.

Three areas with different kinds of magnetic anomalies can be identified (Figure 1d):

- ▶ Area with a high density of magnetic anomalies, possibly showing an organized settlement, well delimited on 3 sides (1<sup>st</sup> area, red outline).
- ▶ Area with punctual anomalies of different sizes and high amplitude (2<sup>nd</sup> area, pink outline).
- ▶ Less dense area characterized by some linear anomalies excepted in the southern part marked by a set of small punctual anomalies (3<sup>rd</sup> area, blue outline).



**Fig. 1a** - Magnetic survey implantation on the site of Girdi Qala in 2015 (green) and 2016 (orange).



**Fig. 1b** - Magnetic survey results on the site of Girdi Qala (-5nT(White)/+5nT(Black)).



**Fig. 1c** - Location of non-Archaeological anomalies in the site of Girdi Qala North.



**Fig. 1d** - Location of interesting magnetics anomalies on the site of Girdi Qala North.



**Fig. 1e** - Magnetic map of Girdi Qala and location (in red) of the Trench D.

Some magnetic anomalies (figure 1c) can be interpreted as channels (light green lines) for field's irrigation, road tracks (yellow lines), ploughing (blue lines) and modern fences (orange lines). The erosion of the site due to water runoff is also visible on the magnetic map (dark green lines) to the northern eminence.

On the northern part (1<sup>st</sup> area), a set of aggregated magnetic anomalies might be related to a settlement from the Uruk period, according to the analysis of the ceramics collected during the pedestrian survey and the first archaeological sounding above the largest magnetic anomaly (diam. 10m and magnetic amplitude around 8nT)<sup>1</sup>(figure 1e). It is very difficult to identify an organization through this set of anomalies, probably due to the erosion of the site, but they look also partly aligned. The observation was already done last year concerning the magnetic anomalies from the top of the tell corresponding to poorly preserved structures<sup>2</sup>.

Nevertheless, these anomalies are also well delimited in a specific area even if a fence or a ditch does not mark this delimitation. Cautious must be taken in the interpretation of the alignments of this area: they are indeed partly due to modern ploughing.

Immediately to the South of this probable settlement, there is an area with numerous punctual anomalies always apart from each other at least from few meters: here again, they are delimited inside a specific area even if this delimitation is characterized by a specific structure. These anomalies are rather similar in terms of size and magnetic amplitude (diam. 4m and magnetic amplitude around 15-20nT). These characteristics are also very close to the anomalies detected at the bottom of the tell: according to the archaeological sounding opened during the last campaign in this area<sup>2</sup>, close to the surveyed one, these magnetic anomalies could match to fireplaces. These anomalies are in the same size than fireplaces identified last year<sup>2</sup> (diam.3-4m and magnetic amplitude around 6nT), but with a stronger magnetic amplitude. This area could be therefore identified as artisanal area whose exact function is still hypothesis according to the magnetic results. Between these anomalies, we can also observe some linear negative anomalies which might correspond to walls of houses.

A long magnetic anomaly (blue line) (length: 60m, thickness: 4m, and magnetic amplitude around 20nT) could perhaps indicates the location a ramp. Its shape and magnetic amplitude is therefore similar to the one identified on the southern slope of the tell.

To the East, in the 3<sup>rd</sup> area, small punctual anomalies similar to those observed in the previous area (even if a little bit smaller) are visible but they don't appear as belonging to a coherent and well delimited group. There is also a big anomaly (extension around 10m, and magnetic amplitude around 5-10nT) whose shape is particularly irregular and does not help for its identification: it could be a ruined building as well as a waste deposit of magnetic material from any historical period.

To the South, a set of linear and more punctual anomalies seem to delimitate two enclosures. The first one, to the East, has a semicircular shape opened on its oriental side. The positive and rather thick anomaly might indicate the presence of a ditch. The western limit is more surprising with a set of small anomalies but also very clear. The interior of the enclo-

1. About the results, see in this report the chapter "Archaeological Survey of Girdi Qala North Mound" pxx-yy.

2. About the results, see Vallet (ed.) 2015, pp. 48-52.

sure is also scattered by some small and positive anomalies (pits?). The other enclosure, to the West, looks widest even if its western limit is beyond the surveyed area. The southern limit appears very clearly with a linear anomaly whereas the other sides are marked by more punctual anomalies: it could possibly be traces of an eroded ditch. Nevertheless, there is no evidence to propose a date for these both structures.

To the southeast of this last enclosure, several small anomalies (diam.1m and magnetic amplitude around 5nT) could be pits: there are also located in a well delimited area, at the bottom of the eastern slope of the tell (blue outline, south part).

### **LOGARDAN (FIGURES 2A C)**

Last year, in 2015, a geophysical survey (figure 2a) contributed to retrieve some information about the organization of the site and help to choose the location of the first archaeological soundings. During this campaign, the goal of the geophysical survey was to complete the results by linking the two parts of the magnetic map for a more homogeneous vision and to check if there was –or not- an extension of the settlement to the East.

The results of the magnetic survey during both campaigns are displayed on figure 2b. Concerning the results of 2016, four specific areas can be identified (figure 2c):

- ▶ Area with a lot of small anomalies (diam.0.5 to 1m, magnetic amplitude around 3 or 4nT) which could be rubbishes or magnetic material (1<sup>st</sup> Area, green outline).
- ▶ Area with the prolongation of the water runoff (2<sup>nd</sup> Area, red outline).
- ▶ Area with several circular anomalies (diam.3m, magnetic amplitude around 10-20nT) which could be fireplaces (3<sup>rd</sup> Area, blue outline).
- ▶ Area without specific anomalies which probably confirms the southeastern limit of the settlement (4<sup>th</sup> Area, yellow outline).

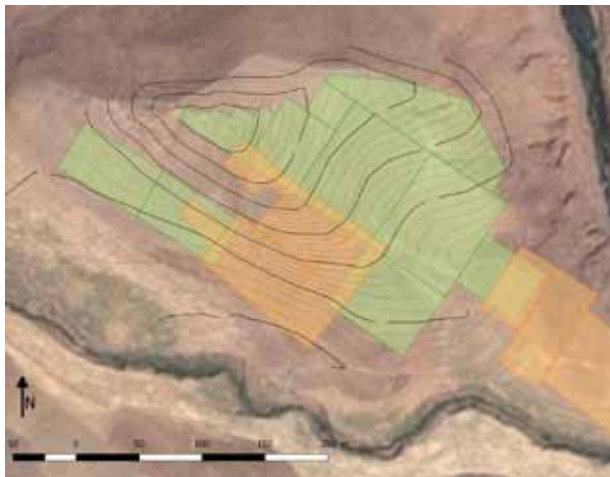
### **CONCLUSION**

The magnetic map reveals the presence of different types of structures, although it is not sure at the moment that they all date from the Uruk period. Only the northern part, where an archaeological survey has been carried out, is for the moment well-documented. This sector is characterized by a high density of magnetic anomalies but does not however allow a detailed view of the organization of the constructions. Contiguous to this sector, a series of strong magnetic anomalies seems to signal the presence of a series of furnaces, close in dimensions to those excavated in 2015 at the foot of the tell. Further to the south, two well-defined forms could correspond to enclosures, without being sure that they are not more recent. They are adjoined to the south by a set of point anomalies, less magnetic than those described above, which could therefore rather correspond to pits.



On Lugardan, the magnetic survey achieved the exploration with no more significant information. In the southern part, a set of small anomalies could correspond to backfills. On the eastern side, there is no specific sign of an extension excepted only isolated anomalies.

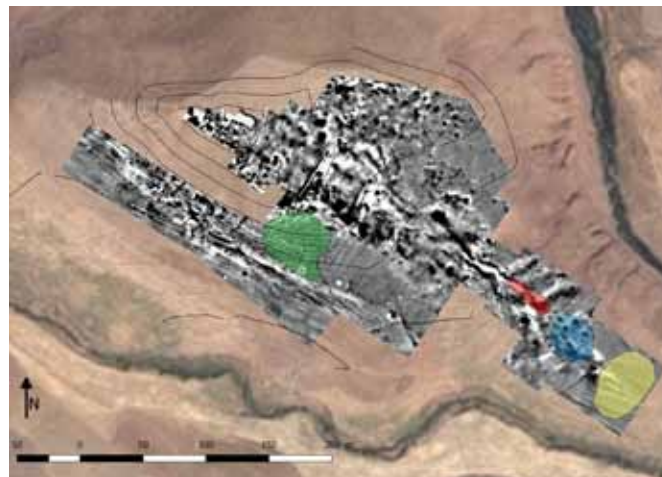
This campaign achieves the magnetic survey as planned in the program of the archaeological mission. Next step will be a more detailed interpretation of the results by the joint analysis of geophysical data and the results of current and forthcoming archaeological soundings: it will make possible a better characterization of the origin of the magnetic anomalies and extrapolate the extension and the organisation of the excavated structures.



**Fig. 2a** - Magnetic survey implantation on the site of Logardan in 2015 (green) and 2016 (orange).



**Fig. 2b** - Magnetic survey results on the site of Logardan (-5nT(White)/+5nT(Black)), and location of the Trenches D & E (in red) excavated during this campaign.



**Fig. 2c** - Interpretation of magnetic survey result on the site of Logardan.

