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► **To cite this version:**

Regis Vallet, Lionel Darras. Magnetic signatures of urban structures: case study from Larsa (Iraq, 6th-1st millennium BC). *Archeosciences, revue d'Archéométrie*, 2021. hal-03505219

**HAL Id: hal-03505219**

**<https://hal.science/hal-03505219>**

Submitted on 31 Dec 2021

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## MAGNETIC SIGNATURES OF URBAN STRUCTURES: CASE STUDY FROM LARSA (IRAQ, 6<sup>TH</sup>-1<sup>ST</sup> MILLENNIUM BC)

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Presses universitaires de Rennes | « [ArcheoSciences](#) »

2021/1 n° 45-1 | pages 51 à 54

ISSN 1960-1360

ISBN 9782753585874

DOI 10.4000/archeosciences.8378

Article disponible en ligne à l'adresse :

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<https://www.cairn.info/revue-archeosciences-2021-1-page-51.htm>  
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**ArcheoSciences**

Revue d'archéométrie

45-1 | 2021

14th International Conference of Archaeological  
Prospection

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### Electronic version

URL: <https://journals.openedition.org/archeosciences/8378>

DOI: 10.4000/archeosciences.8378

ISSN: 2104-3728

### Publisher

Presses universitaires de Rennes

### Printed version

Date of publication: 16 August 2021

Number of pages: 51-54

ISBN: 978-2-7535-8587-4

ISSN: 1960-1360

Electronic distribution by Cairn



CHERCHER, REPÉRER, AVANCER.

### Electronic reference

Lionel Darras and Régis Vallet, "Magnetic Signatures of Urban Structures: Case Study from Larsa (Iraq, 6<sup>th</sup>-1<sup>st</sup> millennium BC)", *ArcheoSciences* [Online], 45-1 | 2021, Online since 16 August 2021, connection on 30 August 2021. URL: <http://journals.openedition.org/archeosciences/8378> ; DOI: <https://doi.org/10.4000/archeosciences.8378>

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# Magnetic Signatures of Urban Structures: Case Study from Larsa (Iraq, 6<sup>th</sup>–1<sup>st</sup> millennium BC)

Lionel DARRAS<sup>a</sup> and Régis VALLET<sup>b</sup>

## Highlights:

- *Magnetic signatures of urban structures.*
- *Understand water distribution in a megalopolis thanks to geophysics prospecting.*

**Keywords:** magnetic survey, megalopolis, urban structures, water-distribution, case study.

## INTRODUCTION

Mesopotamia was a great centre of civilization, the oldest of all and certainly one to which the West owes much of its cultural heritage (Margueron, 2013). From the beginning of the 4<sup>th</sup> millennium BC southern Iraq was full of cities, some of which reached several hundred hectares in area. Larsa was one of them, the capital of a city-state before its capture by Hammurabi of Babylon in 1763 BC. The site covers 200 hectares, more or less the size of Paris under Philippe Auguste at the beginning of the 13<sup>th</sup> century, then among the largest cities in Europe.

## PREVIOUS PROSPECTION AND PLANS

A French mission has been exploring the site of Larsa since 1933. In the 1980s, around 50 buildings were spotted on the surface and mapped on the plan of the time (Huot *et al.*, 1989; Huot, 2014; Huot & Suire, 2019). Surveys north-west of a 27-m-high tell near the centre of the site, the E-Babbar temple of the sun-god Shamash, patron deity of the city (Fig. 1), detected architectural clusters of interest: B48 and B49 marked by a few walls observed on the ground surface and B50, a small but high tell (Fig. 1, location A and

B respectively). Based on surface finds from archaeological fieldwalking, all structures had been dated to the paleo-Babylonian period, the great era of Larsa at the beginning of the 2<sup>nd</sup> millennium BC.

North of the town, several buildings were spotted around what was interpreted as streets (Fig. 1, location E), but they were not well identified and characterized. South of the town (Fig. 1, location F), a couple of urban structures had been located in conjunction with the end of a supposed “street” but without determining any details.

After a 30-year hiatus due to geopolitical events that do not need to be described here, the Larsa team resumed field activities in 2019 (Vallet, 2020). Two geophysical prospecting campaigns, two weeks each, were carried out in the spring and in the fall. After Uruk (Van Hess & Fassbinder, 2019), Larsa is thus the second major site in southern Iraq to be the subject of such a program.

## GEOPHYSICAL SURVEYS

Geophysical prospecting was carried out using the magnetic method, which has already proven its speed and efficiency for general recognition of archaeological sites, applicable in modern archaeological and environmental contexts.

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Figure 1. Plan of Larsa before the 2019 campaigns (Huot, 2014).

Magnetic prospecting was carried out with a caesium vapour gradiometer G858 (Geometrics Inc.) with a grid of  $1\text{ m} \times 0.10\text{ m}$  interpolated at  $0.50\text{ m}$ . The results were processed with WuMapPy open-source software (Marty *et al.*, 2015), and overlaid on an aerial drone view (Fig. 2).

The magnetic map of the area around the B48–B49 and B50 buildings (Figs. 2A and 2B) revealed the full extent of these structures. Later excavations confirmed the Hellenistic date of these structures in the surface levels, that is, 1300 years later than envisaged. To the north, geomagnetic prospecting revealed most of the layout of the structures, later confirmed by excavation. B48 and B49 (Fig. 2A) turned out to be large, sumptuary residences built on a rectangular plan ( $650\text{ m}^2$ ), obviously part of planned urban development. To the south, the small tell B50 turned

out to be the central feature of a large rectangular complex,  $110 \times 60\text{ m}$  or  $6600\text{ m}^2$  (Fig. 2B), with a facade projecting to the south, toward the E-Babbar. The architecture revealed by the geophysical data invited the interpretation of this complex as one of the major temples of the city. Excavations confirmed this preliminary identification, revealing two superimposed temples, an Hellenistic overlying an Paleo-Babylonian one. While the excavations have yet to take on speed, it was possible based on the magnetic map to distinguish some courtyards and rooms of the monumental Paleo-Babylonian temple (walls up to  $5.6\text{ m}$  wide, preserved up to the first floor at a height of  $4.5\text{ m}$  in places).

In an aerial view of the site, a long track crossing from north to south, to the ziggurat in the centre, is visible. Its nature, either street or canal, was discussed for decades

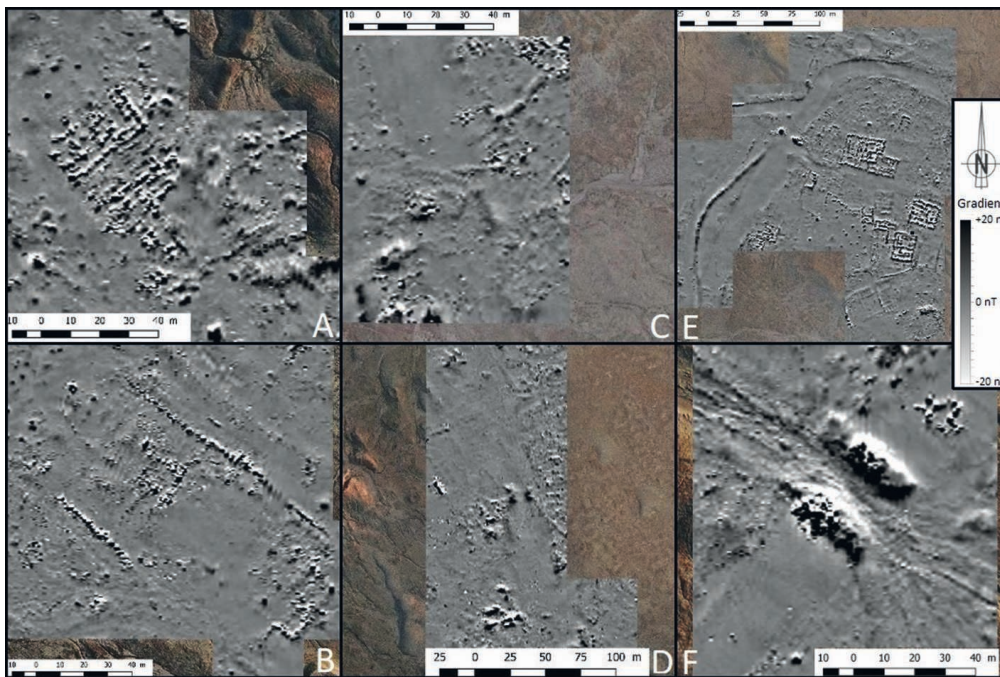


Figure 2. Magnetic maps around urban structures at the site of Larsa (Darras, 2019).

(Huot *et al.*, 1989: 34, Margueron, 2013: 140-146), without decisive evidence one way or another. The issue was ultimately resolved thanks to magnetic prospecting in two strategic locations: a place where recent fieldwalking had detected a large quantity of ceramics mixed with freshwater shells (Fig. 1, location C) and another place where the trace of this feature seemed to disappear from the aerial view (Fig. 1, location D). The canal hypothesis with associated urban structures was confirmed. Structures related to what will be called from now on the Grand Canal of Larsa, located in the first of the two areas (Fig. 2C), could correspond to a canal navigation control post, with a military building and towers or bridge pillars on either side. In the second location (Fig. 2D), the Grand Canal apparently runs between buildings, under a bridge with pillars clearly visible on either side, before deviating to the south-east, where it becomes much narrower.

In the northern part of the city, the magnetic map (Fig. 2E) shows the Grand Canal joining surprisingly another major canal running around the perimeter of the city. This canal appears to continue at least along the entire north-eastern quarter of the city (it was observed before, but was interpreted as a street), while to the west, it empties into a very large basin, perhaps a port or a reservoir, bounded on the north and east by enormous mud-brick dikes. East of the northern end of the Grand Canal, before it joins the other canal, there are several houses (B26, B27 and B59) flanking a wide street that runs over a bridge crossing the Grand Canal (B25). The surprise was to discover that the

Grand Canal was directly linked to another one, of equal importance, surrounding the city. This last channel was followed towards the west, where it empties into a very large basin, perhaps a port or a reservoir, bounded to the north and east by enormous mud-brick dikes, and towards the east (where it had been seen before but interpreted a street), where it continues at least all along the northeaster quarter of the city.

At the south, the magnetic map around the structures noted around B17 (Fig. 2F) articulates two urban structures of a different nature, probably another important canal intersecting the rampart, protected by two strong rectangular towers. The magnetic prospection also added many streets, bridges and buildings to the city map, making it very different from what it was before this fieldwork was carried out (Fig. 3).

## CONCLUSION

The geophysical data from the surveys carried out at Larsa in 2019 provide a better identification and characterization of urban structures so far only identified as buildings without many details. A list of magnetic signatures was initiated for each urban structure (house, temple, bridge, canal, rampart, dikes, etc.). The geophysics program begun in 2019 has already changed and substantially improved our understanding of the city of Larsa, revealing in particular the crucial importance of its inner water-distribution network.



Figure 3. Plan of Larsa after the 2019 campaigns (Vallet, 2020).

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