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THE INTRAMURAL CHARIOT RACING STONE BARRIER AT CARTEIA (SPAIN): GEOPHYSICAL SURVEY AND VERIFICATION BY ARCHAEOLOGICAL TEST EXCAVATION

Manuel Jaén-Candón[2], Alejandro Jiménez-Hernández[1], Inmaculada Carrasco-Gómez[1], José Peña-Ruano[3], Teresa Teixidó-Ullod[3]

[1]University Pablo de Olavide. Seville, Spain
[2]Gibraltar National Museum
[3]Instituto Andaluz de Geofísica, University of Granada, Spain

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**Corresponding author: Alejandro Jiménez-Hernández (ajharqu@gmail.com)*

ABSTRACT

The aim of this research is to deepen the knowledge of the urban plan of the Roman city of Carteia, in particular its central sector. The origin of this settlement dates back to the 4th century B.C and in 171 B.C became the first Latin colony outside Italy, getting the name of *Colonia Libertinorum Carteia*.
In 2005, exhaustive three-dimensional cartography at scales 1:1000 and 1:500 and a high resolution orthophotography surveis carried out on the site. The analysis of the paleo-relief provided by the previous images suggested the possible location of a Roman chariot racing *circus* inside the walls of the city. In order to prove it, in 2016 a geophysical exploration was done over this geomorphological anomaly. We used georadar (GPR), electrical resistivity tomography (ERT) and magnetic survey to contrast the results. The resulting anomalies were tested on 2017 with the archaeological tranches that allowed us to confirm the existence of an intramural *circus*.

KEYWORDS: Ground penetrating radar GPR, electrical resistivity tomography (ERT), geomagnetic survey, DEM, meta secunda, spina, cavea, podium

1. INTRODUCTION

The site of Carteia is located at the bottom of the Algeciras bay (Figure 1), in the municipality of San Roque (Cádiz). It has been the object of numerous investigations focused on the different chronological milestones that mark its long history, from its foundation in the Carthaginian era to its depopulation during the Late Antiquity.

Figure 1. Location of the Carteia archaeological site

The first relevant excavations were carried out by Martínez Santa-Olalla in the 50s and 60s of the last century, identify Carteia with the Tartessos of classical sources such as Strabo, Pomponius Mela, Silius Italicus or Pliny the Elder (Mederos 2008). Within these walls, Prof Pellicer (Pellicer et al, 1977) define its topographical and temporal limits, precise the layout of its walls and locate the necropolis outside the walls. The William L. Bryant Foundation in principle was also financing the search and location of the mythical Tartessos, but after (1965) a set of archaeological digs focused on the *forum*, the temple and the termal bath (Woods *et al.* 1967).

In the campaign developed by the Bryant Foundation in 1965, published two years later, a total of 18 trenches are excavated and documented. These digs are placed in different points of the urban plot within the colony walls. The stratigraphy revealed in three of them has been taken into account in this research.

During the execution of the IX trench, a powerful structure was documented (Figure 2 and Figure 3). It is 9 m wide and a length of more than 90 m in N-S direction, buttresses on its western side. The inner structure is formed by compartments 5 m wide, except one of 1.5 m wide. During the cleaning of one of these compartments, various materials were recovered, ranging from ceramics from Campania, Iberia, Arretine and South Gaulish samian. In first instance these structures were interpreted as "a retaining wall of land, of a water reservoir with buttresses, or a part of an enclosure of markets or shops". Although, as we shall see, they really correspond to the foundation of the western grandstand of the *circus*, in an area where the land was filled in to achieve the horizontal of the runway; hence the character of a retaining wall observed by the excavators (Woods et al. 1967, 53-54).

Figure 2. Picture of the western grandstand foundations and podium.

Trench X was located where a geophysical survey carried out by Professor Aitken (University of Oxford) had detected anomalies with his proton-magnetometer. It is situated in a flat area, which would correspond to the western *circus* runway, situated at a height of 21.1 m above sea level. The cut 4 m long was N-S oriented. The remains of a room in a Roman dwelling were documented, consisting of a wall 5.2 m long, 55 cm wide and 30 cm high that had been preserved, with a NE-SW orientation; with which they blocked two perpendicular walls at the trench limits. The pavement, in which a small fragment of marble remained, was documented at a depth of 72 cm. In the middle of this room was located an oval pit reinforced with adobes that reached a depth of 2 m from the ground. The bottom was formed by a layer of charcoal and cast iron which led them to interpret it as a smelting furnace. Along with older materials such as patera, Campanian pottery and Iberian ceramics, fragments of a varied repertoire of imperial ceramics were extracted, including terra sigillata of the shapes Drag. 26, 37 and 44 (Woods et al. 1967, 55-56).

The XI trench was located a few meters from the X and 21 m above sea level, also it was oriented in a cardinal direction, with a square shape of 5 m on each side. Practically on the surface, on the western side of the archaeological cut, a powerful cobbled structure appeared following N-S direction, with a maximum dimension of 2.57 m. Its eastern limit was detected and the excavators interpreted as a possible street pavement. They respected the structure and continued excavating in the remaining half of the cut up 70 cm depth in which the natural substratum began to emerge. In these layers they documented, among other objects: common pottery sherds and South Gaulish samian ware (Woods et al. 1967, 56-58).

With this background, we designed a research strategy to verify the existence of the *circus* (Jaén et al. 2017). First, we reviewed the stratigraphies and analyzed the graphical and cartographical information of the site, especially the series of aerial photographs, the Series A of the 1945-46 American Flight and the Series B taken between 1956-57. These images show us an unmistakable way the silhouette of a *circus* that remains framed in the terrain. In a second step, a geophysical prospection was planned in 2016, whose methods and results are presented in following sections.

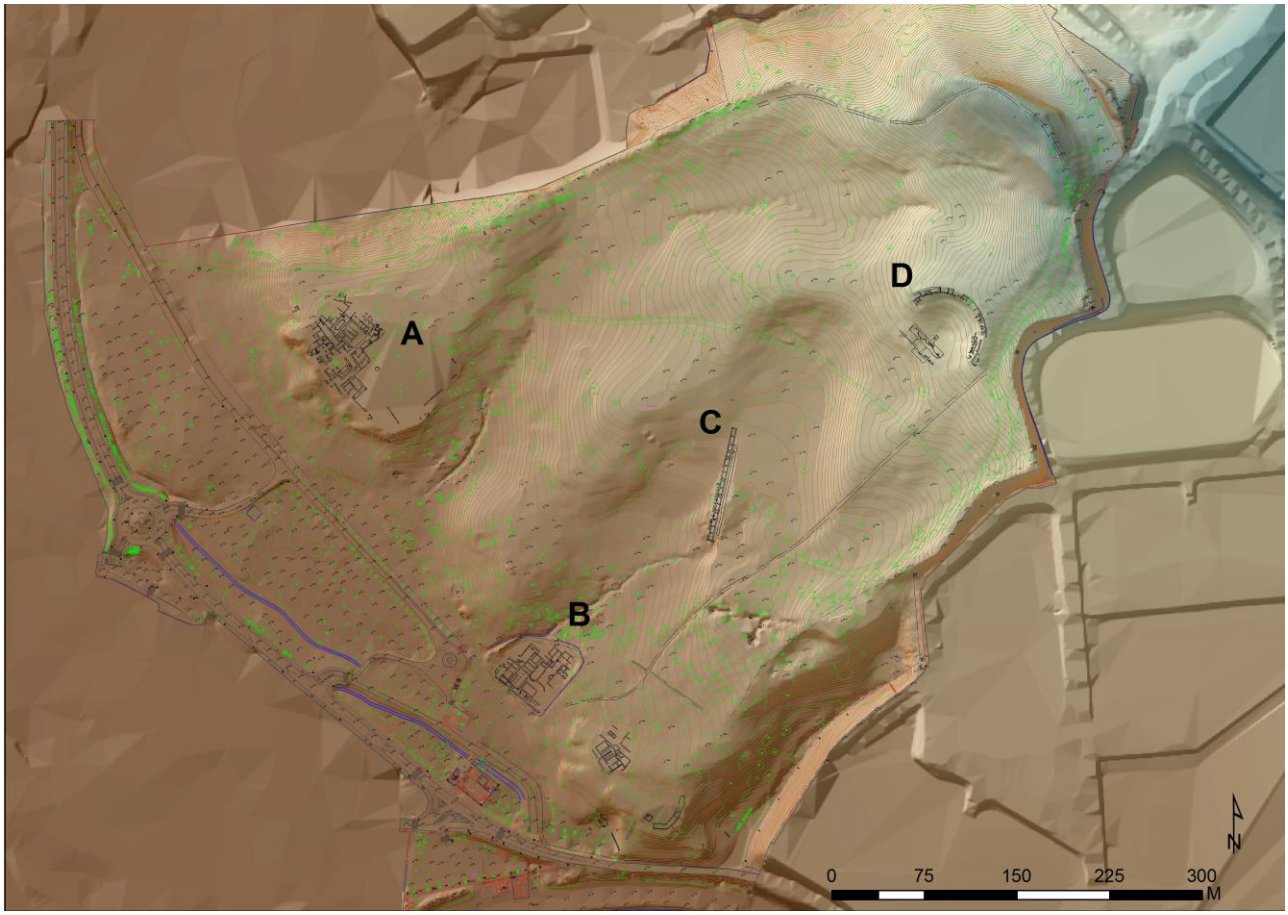

Figure 3. Plan and Digital Elevation Model of the archaeological site of Carteia. [A] Forum, [B Thermal Bath, [C] Circus, [D] Theatre.

Finally, to confirm the geophysical models, a specific archaeological excavation was carried out in 2017. We planned a series of trenches to locate the barrier of the *circus* and the second turning post. The archaeological results show the existence of structures that could be related to the chariot racing *circus*, the most notable finding is the appearance of the *meta secunda* (second turning post).

2. MATERIALS AND METHODS

2.1. Surface images

This study was based on the exhaustive topographical, planimetrical and photographical surveys of the site carried out in 2005, with the aim of having surface information for planning all future archaeological bugs and conservation activities on the site. The products derived from this work include three-dimensional cartography at scales of 1:1000 and 1:500 for detail. A high-resolution orthophotography and the installation of a geodetic reference points network were also made in the site. The digital terrain model (DTM) obtained showed a depression in the central area of the city, near the theatre, forming a large elongated plain flanked to the north and south by an orographic accident that suggested the shape of a *circus* (Figure 3).

The graphic superimposition of aerial photographs of other known circuses on the DTM (Figure 3), made coincide the zone corresponding to the seating sections, on the structure excavated by the Bryant Foundation (Bryant XI in Figure 7). Taking this into account, we superimposed similar structures over overlapping similar structures over this "supposed anthropic modification" in the DMT. In this context, the aerial photographs of American flight 1946-47 shows the geoarchaeological substratum and allowed the development of an intervention strategy to approach the study of the building.

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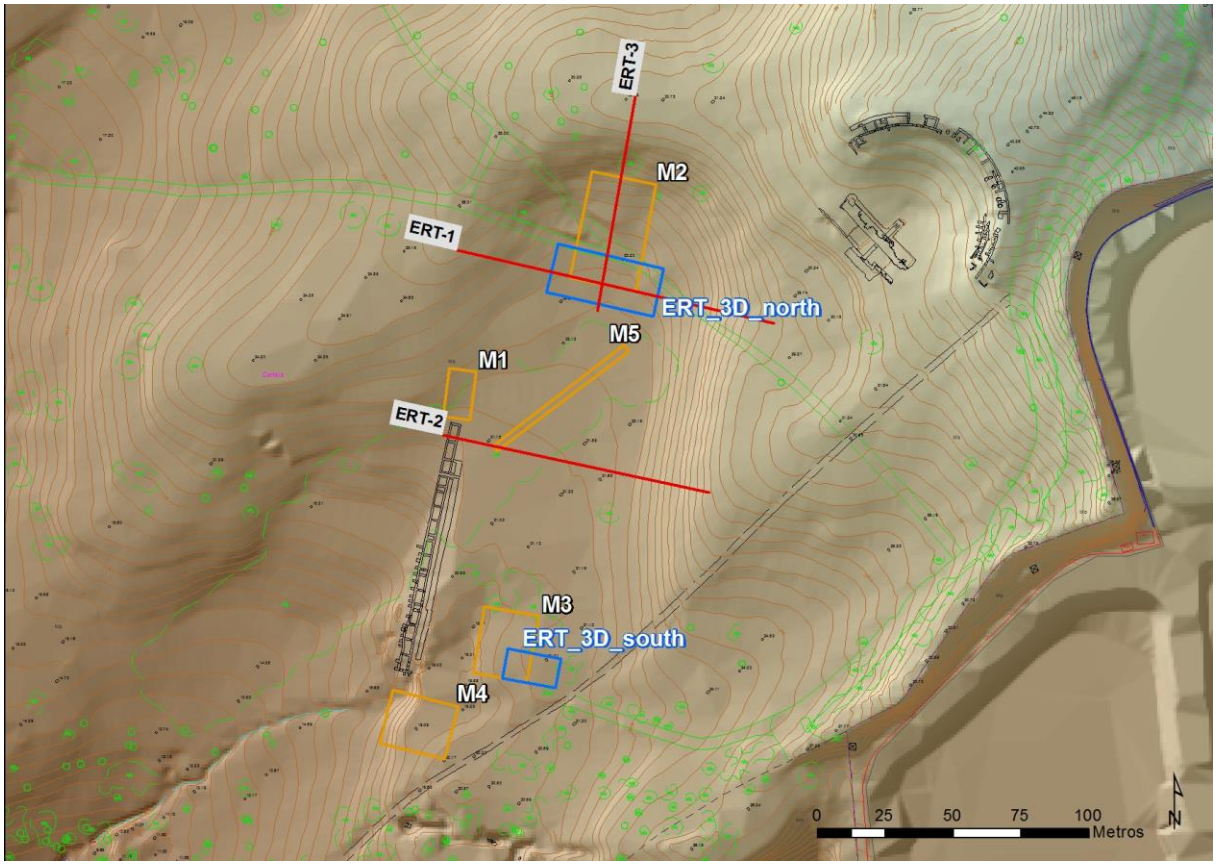

Figure 4. Location of the geophysical surveys. Magnetic and georadar survey (M); Electrical Resistivity Tomography (ERT). Electrical Resistivity Tomography 3D (ERT 3D).

2.2. *Geophysical methods*

Geophysical methods are non-destructive techniques that use remote sensors to explore the subsurface. Suffice it to cite the experiences in Carnuntun (Austria) (Neubauer et al. 2014) or those closest to Contributa Iulia (Pizzo et al. 2016), Osuna (Jiménez et al. 2016), Torreparedones (Monterroso 2017), applications of GPR, ERT byAngelis et al., (2017), Tsokas et al., (2009) or Kastrouli project (Levy et al. 2018). Three different and complementary systems were used to contrast the results: ground penetrating radar (GPR), electrical resistivity tomography (ERT) and vertical gradient magnetic anomalies map.

The 3D-GPR method was used in the areas indicated in Figure 4. GSSI equipment with 400 MHz antenna is used and the data were acquired by sweeping the sectors with parallel profiles 0.5 m spaced, eventually individual contrast profiles were made. For each sector the parallel profiles were combined to obtain a volume of data that, suitably treated, allowed the obtaining of vertical cuts by chosen places, 3D images and plants of the structures at different depths.

ERT was used to validate the 3D-GPR images, to contextualize geoarchaeologically the deposit and determine with precision the morphology of the basal part of the structures. ABEM Terrameter SAS 1000 equipment is used. The electrodes have been placed every 1 m; under these conditions the total length of the device is 40 m, so that the system has been transferred successively (technically called roll allong) until the desired distance is covered in each case. Electrical tomography profiles have been treated with the Res2dinv program (Geotomo, Software Inc.), which solves the inverse problem by reticulating the terrain (mesh units). Topographical correction has been added as the relief is considerable. The iterative inversion process has been fixed for a maximum of 10 iterations or an error of less than 2%.

In order to contrast the initial hypothesis, a set of actions was designed, the first results of which offered an even more complex reality than we had anticipated as the initial instrumental hypothesis. For which we proceeded to carry out two sectors of 3D-ERT combined 3D-GPR at the ends of the barrier.

The magnetic exploration was applied in vertical pseudogradient mode using a GSMP-40 V6.0 potassium vapour magnetometer (GEM Systems, Inc.); with is 0.1 nT of absolute precision. The system consists of two sensors that normally works in the same vertical with 1 m separation. It has a capacity to take up to 20 readings per second, which allows a remarkable sampling density while walking.

2.3. *Archaeological trenches*

Once the results obtained through geophysical prospecting had been analysed, the need arose to confirm the findings by carrying out a series of trenches in areas previously selected on the basis of the data available to us. We then started from the re-excavation of trench XI (Bryant Foundation, 1965) since the linear structure, interpreted by them as the pavement of a road, could be the barrier of the *circus*. From the location of the trench, we raised a series of trenches immediately south of cut XI, until we located the second turning point.

The limits of the working area as well as the perimeter of the localized structures were documented by means of classical topography with a total station referring to the topographic network of the site for correct georeferencing.

During the excavation process and once they were completed, an extensive photographic report was made, both of the excavation process and of the elements of archaeological interest.

The resulting archaeological interpretation of the structures, layers and profiles were drawn using sketches made on graph paper. However, for the precise and three-dimensional documentation of the exhumed archaeological remains, Close Range Photogrammetry was used using the VisualSFM programs, combined with Meshlab and Blender. These programs allowed us to obtain a dense point cloud of the geometry of the structures while serving as a basis for the creation of meshes to which to apply photorealistic textures (Georgopoulos 2016).

All the graphic and alphanumeric information was exploited in the GIS platform created for the Archaeological Site of Carteia.

3. GEOPHYSICAL SURVEY

The proposed geophysical prospecting combined, on the one hand, the most appropriate methods according to the objectives set and, on the other, the location of these tasks in the most sensitive places, given the impossibility of using in a massive way all the techniques in the entire surface occupied by the area to be prospected.

3.1. *M-1. GPR and Magnetic Sector.*

This sector covers an area about 600 m² (M1 in Figure 5), sought to know the continuity of the *cavea* (grandstand) currently exhumed to the north and confirm the existence of one of the main doors to the building as suggested by the mobility models tested through GIS analysis. This sector was complemented by a more restricted area of 180 m² of the space delimited by GPR.

The magnetic anomalies map was not as defining as we would have wished. The GPR, however, showed how the grandstand continues northwards with the same dimensions as the one already exhumed, leaving free a space about 4 m wide that corresponds to a large access door to the arena.

3.2. *M-2. GPR and Magnetic Sector.*

The M-2 sector (Figure 5) has a surface around 970 m² and the works in this area were designed with the aim of locating the barrier, the first turning post, the track at the height of the hemicycle and the podium of the *circus*. It was carried out by means of a magnetic survey complemented with georadar in specific sectors of the area.

The results were unsatisfactory because as the magnetic contrast between the substrate, the structures and the debris was not sufficient to delimit the structures clearly. Nevertheless, the curve of the podium of the hemicycle is observed.

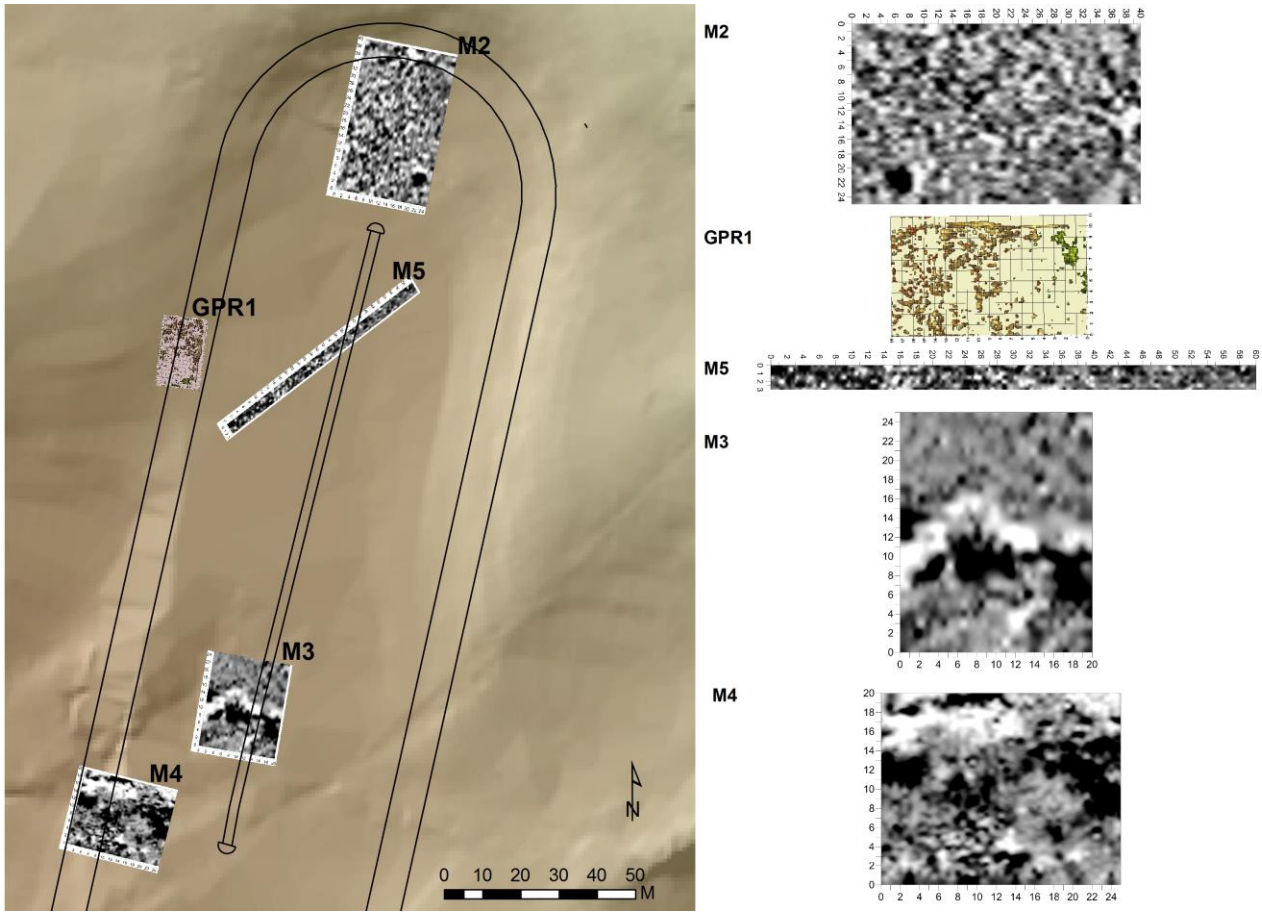

Figure 5. Magnetic anomalies maps and GPR sectors.

3.3. M-3. GPR and Magnetic Sector.

The M-3 sector (Figure 5) has an area of 500 m² and its purpose was to detect the barrier and the second turning point to know the total length of the spina. A magnetic survey was carried out complemented with GPR in specific sectors of the delimited area.

The magnetic result did not allow, as in the rest of the sectors, to determine the specific nature of the anomalies detected. In this case, the strongest anomalies coincided with the depression in the terrain caused by surface water runoff that had a special impact on this sector, which led us to wonder whether these alterations correspond to a natural channel or to the hydraulic infrastructure work that would evacuate the waters of the building's almost 2.5 ha of surface area.

With less sharpness, a linear structure was also observed with a width of about 6 m that could correspond to the barrier of the *circus* at its southern end. This sector was also explored with GPR and 3D ERT, methods through which it was confirmed that this alignment would correspond to the barrier of the *circus*.

3.4. M-4. GPR and Magnetic Sector.

The M-4 sector (Figure 5) is the largest of all those designed with a surface area of 494 m² and destined to define the encounter between the western *cavea* and the starting gates (*carceres)* and part of them to determine the overall dimensions of the *circus*.

The results showed a large number of magnetic anomalies which, although difficult to interpret, confirmed the initial hypothesis. In the northern zone, the anomalies coincide, as in the case of M3, with the important linear incision caused by the evacuation of the waters of this sector, with a difference in heights of up to 3 meters. On the western side, a series of north-south alignments were observed, coinciding with the structures of the exhumed grandstand and with lateral appendages on the western side that could well correspond to buttresses such as those observed in the existing grandstand.

Along with these structures aligned and consistent with the exhumed structures belonging to the foundation of the *cavea*, other divergent alignments were also observed in the arena of the *circus* whose orientations coincided with those of the architectural structures conserved in the

surroundings and which demonstrate, as we will see below, that the *circus* was inserted into the urban framework once it was consolidated.

3.5. M-5. GPR and Magnetic Sector.

Sector M5 (Figure 5) used the existing road be-between the eucalyptus grove to make an oblique section to the arena and with the intention of detecting the barrier. It was 60 m long by 3 m wide with a total area of 180 m².

The limited surface area and the presence of eucalyptus roots made it impossible to clearly discern the boundaries of the barrier. However, a difference was observed in the magnetic response of the sectors more to the NE than those of the SO. Thus, from meter 0 to 26 the remains have a negative rather than positive magnetic response, and the opposite occurs from meter 26 to 60. The interpretation that we give to this fact, explains the implantation of the *circus* on the ground, of which we will speak carefully, that forced to carve the rock of the substrate in all the north and east zone and to fill with rubble all the depression of the ground to the south and west to level the track.

3.6. ETR-1. Electrical Resistivity Tomography profile.

This profile (Figure 6) is located transversally to the direction of the *circus* at 54 m from the head and with a length of 120 m. It was raised to know the situation and state of conservation of the structures of the *cavea*, locate the barrier and its dimensions, define the surface level of the arena and quantify the amount of debris that exists in this sector on it.

The ERT1 profile proved to be an exceptional tool to delimit the structures and obtain clear sections of the *circus*. In this case, it was possible to define that the height of the *arena* was between 21 and 22 m above sea level and to delimit the eastern *cavea* with total dimensions between 9 and 10 m wide, very similar to those of the exhumed *cavea*. The preserved podium can be distinguished up to a height of more than 2 m.

Between the 50 and 60 meters of the profile a powerful anomaly (red color) was documented that certifies the existence of the barrier, with dimensions between 10 and 6 meters. At 67 m a powerful anomaly was observed, detected in other sectors, which may correspond to a channeling of the arena drainage system.

Between meters 5 and 17, strong anomalies were detected corresponding to the western bleachers and the podium with a conserved height of more than 2 m.

3.7. ETR-2. Electrical Resistivity Tomography profile.

The second profile (Figure 6) had the same objectives as the first one, 121 m from the headboard and 100 m long. It also sought to define the deviation angle that *circus* barriers usually have in order to increase the size of the mouth of the right track with respect to the left, which marks the direction of the race.

In this sector the arena seems to be above 21 m over sea level which means that almost the entire section of the building at this point would be below the surface level.

Between meters 84 and 92 the eastern *cavea* was detected with a podium preserved at a height of 1.5 meters. At meter 56, a powerful anomaly was detected that could correspond to a channel such as the one previously detected in the ERT-1. Between meters 41 and 52, a strong resistivity was observed in a structure that must correspond to the barrier of the *circus* as it is in the expected place. Finally, between meters 5 and 12, the response of the foundations of the western cavea excavated today is observed.

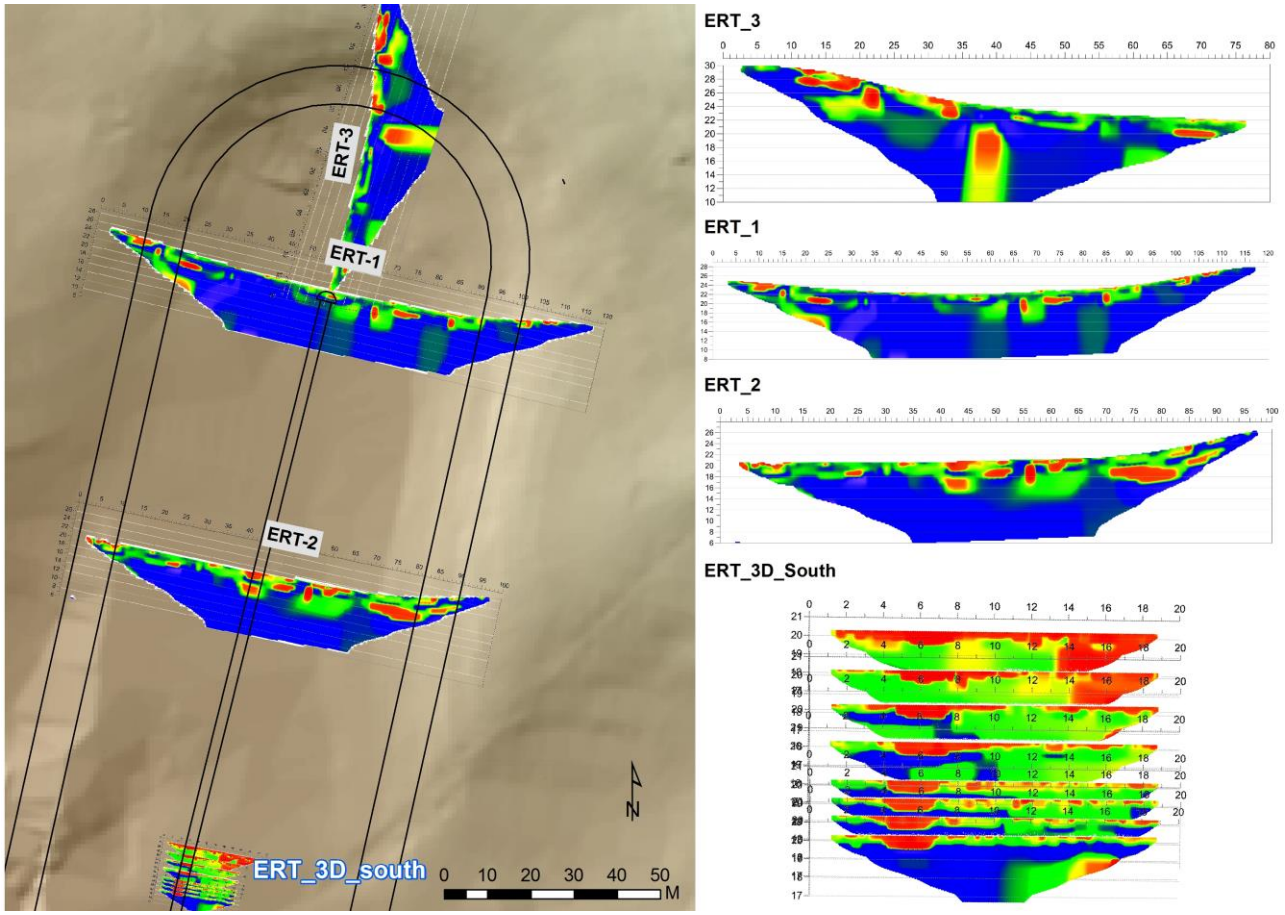

Figure 6. ERT profiles over the DEM of Carteia archaeological site

3.8. *ETR-3. Electrical Resistivity Tomography profile.*

The last profile (Figure 6) was planned with a length of 80 m and was designed to define the structure of the tiers of the hemicycle and its state of conservation, as well as the level of use in Roman times outside the building at this point.

According to this ERT, the outer level of the *circus* in the hemicycle must have been 29 m, one meter below the current surface, and the level of the arena would have been around 22 meters. The northern tier, corresponding to the *circus* hemicycle, develops between meters 15 and 34, with a total width close to 20 m, i.e. twice as wide as the western and eastern tiers. The podium would have a conserved height greater than 2.5 m and before it accumulates a large mass of debris that decreases its thickness to remain at the height of the arena at 70 m of the profile.

Between 37 and 40 m a powerful resistivity is observed that could correspond to a channel of evacuation of superficial waters. At 66 m begins a powerful signal that must correspond to the barrier that was expected just at that precise point and that would be at a level of foundation since the height of the surface is what would correspond to the arena of the *circus*.

3.9. *ERT_3D_north*

To define the northern end of the barrier and the prime target, 7 parallel profiles equidistant 3 m were made to create, by interpolation, a three-dimensional model of the anomalies detected. These profiles had a length of 40 m, covering a total area of 722 m². This rectangle was located to the south of the magnetic sector M2.

This sequence of tomography profiles showed what was already detected in profiles ERT_1 and ERT_3. In the 5 consecutive profiles from the south, it is observed the powerful anomaly caused by the barrier between meters 17 and 25 that is no longer observed in the last two profiles, showing the limit of the spine, which coincides with the ERT_3.

3.10. *ERT_3D_south.*

To the south of the barrier (Figure 6), where we assumed the second turning post, the closest to the starting gates, should be found, another sector was located with a series of 8 resistivity tomography profiles with a length of 40 m and equidistant to 2 m, covering a total surface of 219 m².

The results corroborated that the remains excavated by the Bryan Foundation correspond to the barrier of the *circus*. They also confirm that the anomaly detected in the sector by the magnetic prospection at its southern end corresponds to the same spine.

It was also found that the barrier deviated somewhat more than initially planned and that it was longer than the dimensions proposed in our initial hypothesis, thus extending the total length of the building.

4. ARCHAEOLOGICAL TRENCHES

From the results of the geophysical survey we proceeded to the location and cleaning of the XI trench of the Bryant F. that was going to serve us as guide in our activity. By means of aerial photography we detected and placed, in a provisional way, the location of the cut that was marked in the ground by a soft subsidence. The structure is about 10-15 cm from the surface, made of masonry and 2.47 m wide.

Its documentation allowed us to contrast that the anomalies detected by geophysics in this sector corresponded to a structure that, due to its location and orientation was compatible with that of the *circus* and divergent with respect to the alignments of the rest of the surrounding buildings, forming part of the *spina* of the show building. With this background, we plan to carry out a series of archaeological cuts to detect the barrier and the second turning post of Carteia's *circus* (Figure 7).

4.1. *Trench C1*

The next question was whether the width of the barrier was that of the documented foundation or, as was more common in known chariot racing buildings, it was wider. We proposed to carry out a trench to verify this end and the prolongation of the barrier towards the south. This trench, called C1, was located about 4 meters south of cut XI of the Bryant F. and was oriented with the alignment of the barrier with dimensions of 7.4 m long and 1.3 m wide. Its excavation detected the presence of the structure and certified that it did not extend to the east, which indicated that the total width of the barrier was 2.47 m documented.

4.2. *Trench C2*

With the results obtained in C1, we reformulated the strategy to direct it to the detection and documentation of the southern end of the barrier and the second turning post that would be a good indication of the total length of the *circus*, one of the great unknowns of this building. Taking into account the topography, we assumed that this *circus* should be very short, less than 300 m. Since the beginning of the barrier is usually a third of the total length, the turning point (*meta)* had to be very close to C1. For this reason, we proposed the tranche C2 at 5 m south of C1 and with dimensions of 5 x 2 m oriented perpendicular to C1. It was quickly detected that the barrier continued towards the south, surpassing the dimensions that we had initially foreseen.

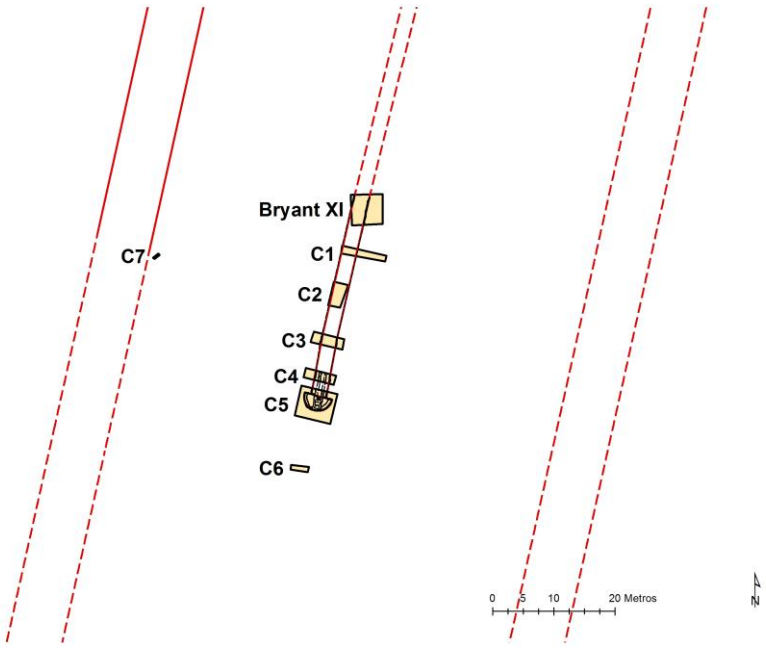

Figure 7. Location of the archaeological trenches to document the Carteia circus barrier

4.3. *Trench C3*

C3 was located 5 m south of C2, with dimensions of 5 x 1.7 m, in such a way that it could detect the limits of the barrier and the substrate on which it was excavated. Between 10 and 20 cm from the surface, the presence of the spina foundation was observed.

4.4. *Trench C4*

It was raised south of the C3 survey. The proximity to the road that connected with the theatre was a limitation when deciding the location of the new trenches, so C4 was located 4.3 m south of C3 so as not to cut this road. Its dimensions were 5 x 1.5 m and the same orientation and objectives as C3. Immediately, about 20 cm from the surface, the foundation was detected with the same alignment and without changes suggesting the end of the structure. It was also noted the presence of a sewer that ran through its interior, which appeared with its cover collapsed and filled with debris and that had to change direction at a point between the two cuts.

4.5. *Trench C5*

At 1.4 m south of C4, excavation of the C5 cut began, just on the transit route of the visit to the site. At a depth of only 15 cm, the remains of a semicircular structure 4.6 m in diameter were identified, which determined the end of the barrier to the south, at a distance of 34 m from the northern limit of trench XI of the Bryant Foundation.

The turning post was 10 Roman cubits (4.4 m) wide and was excavated over layers of debris that had previously leveled the ground for the construction of the *circus*. In its middle there was a sewer that had to collect the water from a sump that had to be located right in the centre of the curve of the finish line as it seemed to indicate a slight re-sinking in the terrain and a darker coloration of the matrix of the surface documented in this point, although this end could not be verified. The sewer followed the middle of the barrier to a point where it had to connect with another sewer or turn west, looking for the natural point of water evacuation that the topography indicates.

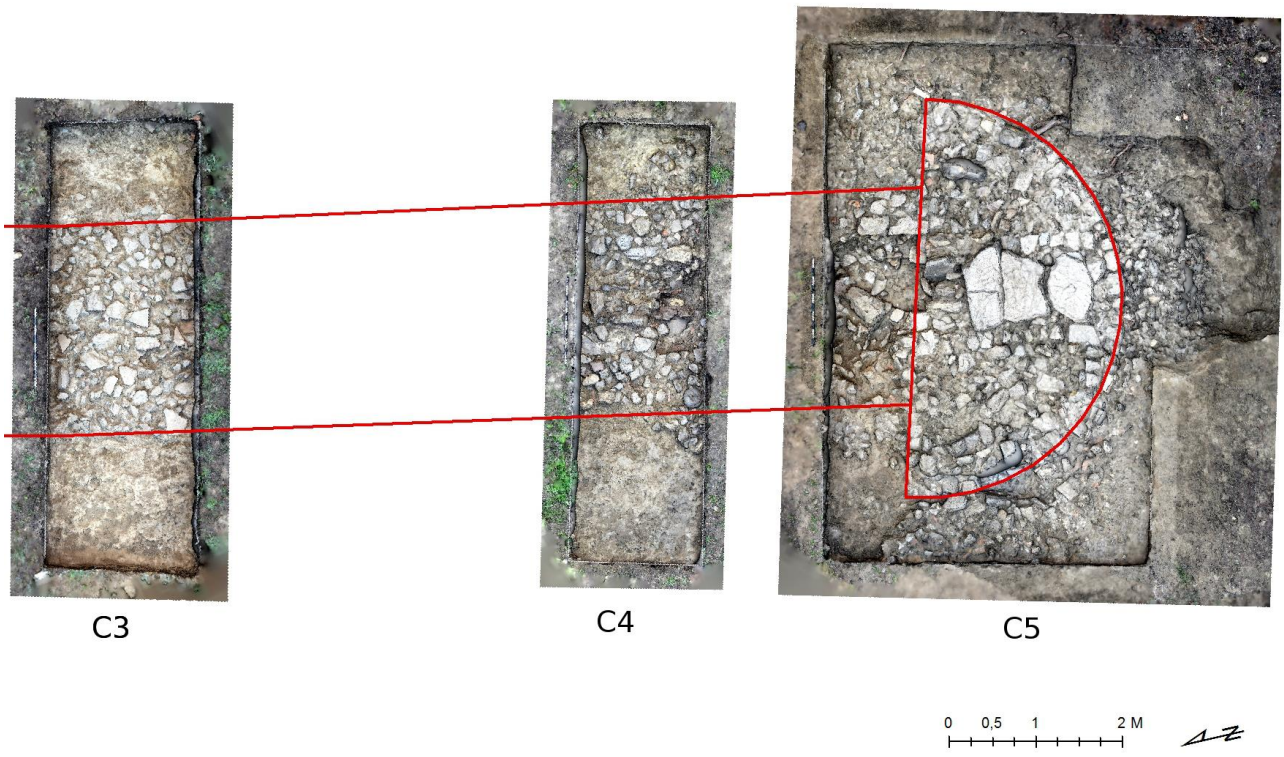

Figure 8. Map of archaeological trenches 3, 4 and 5 showing the foundations of the barrier and the meta secunda of the Carteia's circus. Orthoimage obtained by photogrammetry

4.6. Trench C6

It was opened next to the road and was conceived with reduced dimensions of 3 x 0.8 m, to intercept the theoretical prolongation of the barrier structure. Immediately, about 20 cm from the surface, the sandstone, that forms the geological substratum of the site, was documented.

4.7. Trench C7

The last of the objectives proposed during the execution of the project was to date the construction of the *circus*. In the pits made, we just removed the layers over the remains up to the interfacies of destruction of the structures without excavating the stratification units belonging to the construction, use and abandonment of the *circus*, for which it would have been necessary greater deadlines and budgets. Bearing in mind that the *circus* was a horizontal platform about 300 m long in a context with an undulating orography and a remarkable slope, and that this forced the builders to excavate the substrate in much of the building and fill with layers of debris throughout the south and southwest sector to level the runway, we decided to make a small pit in an area where surface water runoff had left visible a profile showing the contribution of debris. This trench, the C7, had a length of 1 m and advanced in the profile about 30 cm to a depth of 70 cm. We were able to document at least three successive layers of compacted rubble, probably resulting from the demolition of the existing structures on the 3 hectares occupied by the *circus*, which provided an interesting repertoire of archaeological material in which abundant ceramic fragments of containers of different types stand out, together with the remains of seashells and fragments of *tegulae* (Roman tiles) and hydraulic cladding that confirm, in a first assessment, the idea that the *circus* should have been built as early at the end of I. A.D. or in the II A.D.

4.8. Stratigraphic Synthesis

For a proper understanding of the stratigraphic process documented in the different cuts from the individualisation of the stratification units (Table *1*), these are classified in an order determined by the stratigraphic relations with the neighbouring units. In addition, they are ascribed to the successive phases that we extract from the archaeological analysis with a specific historical period. The units are also included in stratigraphic groups established according to the characteristics of the units and their position in the stratigraphic sequence that determine that they form part of the same event. The 44 stratification units, defined in the different trenches carried out, have been unified in the following 8 stratigraphic groups:

Table 1. Stratigraphic groups.

N	Type	Description	Date	Phase	Period
1	Destruction	Destruction of *circus* structures and use to date		I	Contemporary
2	Disuse	Sewer clogging after falling into disuse		II	Roman
3	Building	Sewer construction	I-II a.D.	III	Roman High Empire
4	Building	*Circus* barrier construction	I-II a.D.	III	Roman High Empire
5	Building	Construction of the second turning post of the *circus*	I-II a.D.	III	Roman High Empire
6	Building	Base for the *circus* track.	I-II a.D.	III	Roman High Empire
7	Building	Levelling layers for *circus* construction	I-II a.D.	IV	Roman High Empire
8	Building	Trenches for meta, barrier and sewer foundation	I-II a.D.	III	Roman High Empire

In summary, the stratigraphic sequence documented in this archaeological activity begins with works to level the ground for the construction of the structures that make up the *circus* and its tracks. This event, which must have occurred at the end of the 1st century A.D. or later in the 2nd century A.D., is reflected in group 7, in phase IV of the sequence. Prior to the compaction of these layers, the constructions that occupied the place chosen for the *circus* had to be destroyed. Remains of these demolished constructions are visible along these three hectares, especially to the south and west of the *circus*, some with a significant elevation, which are characterized by having a very different alignment to that of the *circus*. However, this event has not been detected in our cuts.

Once the terrain has been levelled, the trenches are opened for the construction of the barrier and the finish line, and also for the sewer in the stretch that passed through the barrier. This event is represented in group 8.

Afterwards, the sewer, group 3, is built as part of the drainage system that is essential for the proper functioning of the *circus*. The one detected must correspond to a small sample of a much denser and more complex network to keep a 290 x 74 m surface dry.

The next event, corresponding to group 5, would be the construction of the *meta* (turning post) that is carried out, as well as the sewer, in a more careful way than the barrier will be done, taking the stones with lime mortar.

After the turning post, the barrier is built with a less careful foundation since it had to receive much less weight than the foundation of the turning point. These units are included in group 4. These three groups are integrated into the stratigraphic sequence in phase III.

Phase II occurs at an indeterminate chronological moment, presumably when the *circus* ceases to be in use and ceases to be maintained, which would lead to clogging of the cloaca. It is represented by group 2.

Phase I indicates the destruction of the *circus* and is represented by group I. It contains the stratification units that show the destruction, erosive and depositional processes produced from the abandonment of the *circus* to the present day. These units have been formed in recent times, especially due to the agricultural work carried out until the 1960's, which eroded the remains of the barrier and the turning post to below the level of the *circus*'s surface area.

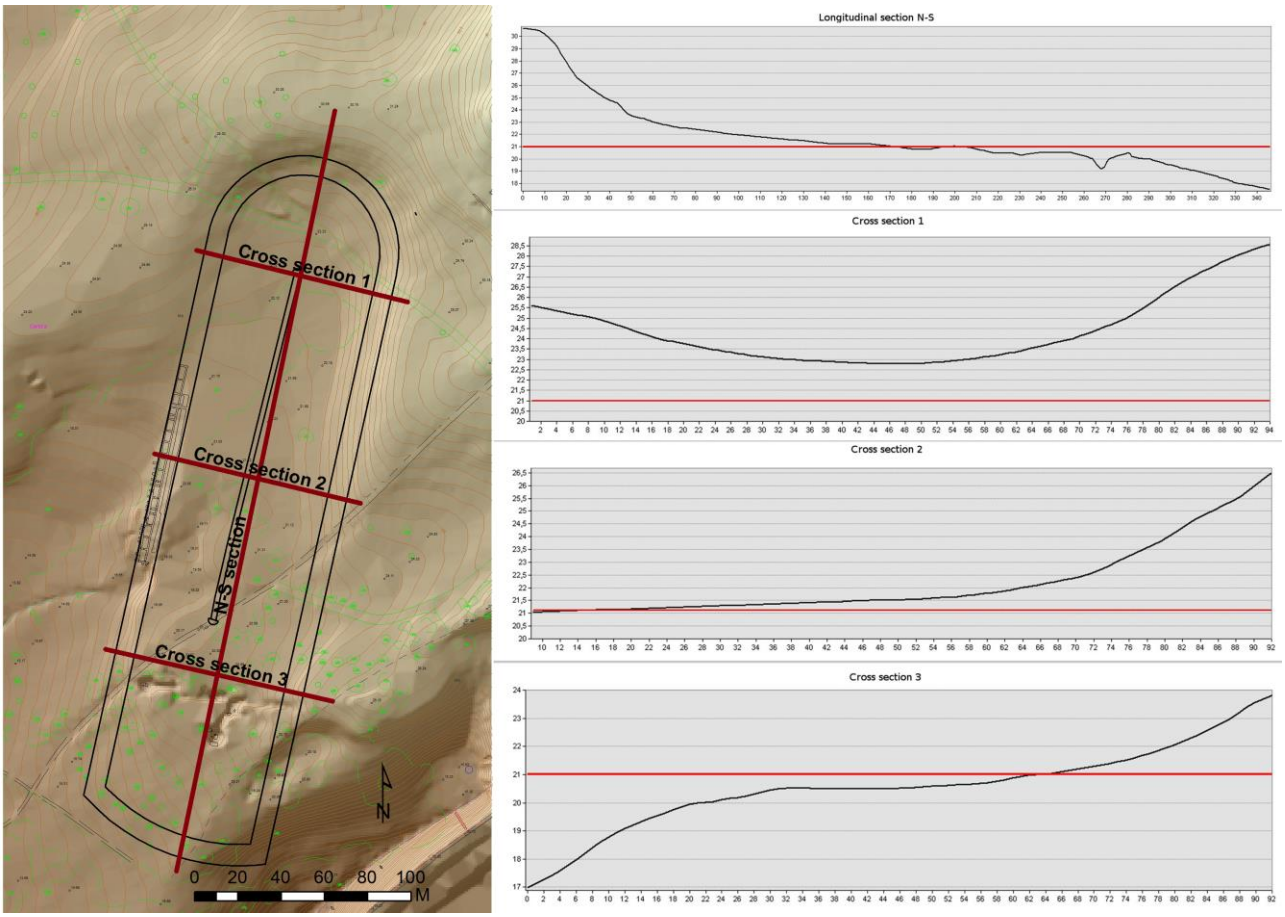

Figure 9. Sections (black line) of the ground in the circus of Carteia and indication of arena level (red line).

5. DISCUSSION

The results of the different archaeological actions carried out in the area provided important information to define the formal characteristics of the *circus* of Carteia, the shape and size of the barrier, locate the *meta secunda* which, in turn allowed us to know the length of the turn in the race and hypothesize with greater foundation about the total length of the *circus*. We also probed the layers that level the runway and obtained valuable archaeological material that allowed us to get closer to the date of construction of the building.

The 2005 planimetric survey clearly showed the characteristic shape of a *circus*. When we linked this survey to the exhumed remains of what was once interpreted as the *tabernae* of a *macellum*, it was clear that it was actually the foundation of a *circus* stands, as can be deduced from the comparison with the stands of other *circi* throughout the Roman Empire. With a width of around 9 m and a length of close to 93 m, it is made up of the base of a powerful wall, 2 m wide, which on its eastern side has a series of rectangular boxes of about 5 x 3 m of interior light separated by a corridor by 1.6 m from the previous wall. These boxes are grouped in series of 2, 3 or 4

separated by a smaller box, 1.3 m wide by 3 in length. In the southern half, the ensemble is reinforced by buttresses built in a rhythmic manner to reinforce the part most exposed by the topography. The closest parallels can be found in the stands of circuses such as Toledo (Sánchez-Palencia and Sáinz 2001), Mérida (Nogales 2008, fig. 16) or Segóbriga (Ruiz de Arbulo et al. 2009, fig. 11, 12a and 12b).

Finally, the structure detected in cut XI of the Bryant F. E interpreted as a way or road, in the absence of a precise location at the time, made us think, with much justification as has been demonstrated, that it should be part of the *circus* barrier.

The methodology in common use today for the study of Roman show buildings is based on the joint use of multispectral and geophysical remote sensing techniques because the extensive excavation of buildings of this size is very costly and not very advisable if these tasks are not complemented with the conservation and consolidation of the exhumed structures. Therefore, the geophysical survey scheduled for 2016 was intended to define the size of the *circus* and to detect the remains of the bleachers on its north and east sides, while at the same time verifying the existence of the barrier. The results confirmed a large part of we had originally expected, but we could not clearly detect either of the two turning posts nor be completely sure of its width, since it seemed to be narrower than usual, as confirmed in the end.

Today we already know, thanks to the execution of a series of verification trenches, that the barrier had a width of 2.5 m while the turning point reached 4.4 m. The distance between the podium of the hemicycle and the limit of the second turning post is 212 m which could be indicative, if the distance between the starting gates and the *meta secunda* is 1/3 of the total length, that the track could reach 316 m in length. At the height of the second finish line, the western track would be 29.8 m wide (100 Roman feet) while on the eastern side it would be 37 to 39 m wider depending on the total width of the track between 72 and 74 m. At the finish line, the tracks would have the same width of 33.5 m or 34.5 m. In the hemicycle, the track had to be wider, about 44.5 m (100 Roman cubits) because the electric 3D north did not seem to detect the barrier or the *meta* clearly so it is possible that something was to the south of the space sampled, something also habitual.

The shape of the terrain, together with the structures mentioned, seem to indicate that the building could have been about 90-92 meters wide which, once subtracted the space of 9 m dedicated to each bleachers, must have had an arena of 72-74 m. The total length can be deduced from several factors. Firstly, the space available up to the wall; secondly, the fact that in chariot racing stadium (*circi)* such as Mérida the distance between the facade of the starting gates and the beginning of the barrier is one third of the total length and given that the barrier of the *circus* of Carteia is higher than the documented section (Humphrey 1986, 21). In the rest of the complete chariot racing buildings analysed this distance may be slightly higher or lower than this figure but always around it. With all this, the total length of the *circus* could oscillate between 300 m, as the topography seems to indicate, or reach 336 m if we take into account the proportion of 1/3 of the starting gates and the second turning post.

The terrain within the walls has a rugged topography, with a series of elevations and valleys with a downward trend from NE to SW, with a maximum height of 59 meters and a minimum of 2.5 meters over sea level. In the surroundings of the *circus* the heights oscillate between 30 m, to the north and east of it, and 15 meters on the southwest side. However, the space corresponding to the arena is maintained somewhat above 21 m on average, so that to the north and east the structure is excavated in the substrate of sandstone while to the southwest the land was filled with debris to maintain the horizontal.

The longitudinal section (Figure 9) shows how the structure creates a virtually horizontal surface around a height of 21 meters above sea level. Towards the north we can see how the stands of the hemicycle were excavated in the substrate and how thick rubble has accumulated between 1.5 m and 3 m on the surface of the *arena* which indicates that in this sector the structures can be well preserved.

The cross sections also show the topography of the terrain and how there seems to be a horizontal elevation located at 21 m. The first section located 50 m from the head shows how the steps were excavated in the substrate and in the arena there has been an accumulation of debris close to 2 m, which makes it possible that the structures could be in good condition.

The second section was drawn 165 m from the head. This profile is substantially different, as it shows a horizontal surface at elevation 21 and how the eastern grandstand is excavated in the sandstone of the site and there has been a significant accumulation of debris where the *podium* wall would be. On the contrary, the eastern side and its grandstand in this sector has been eroded to the level of the foundations, as can be seen in the grandstand structures excavated and visible today.

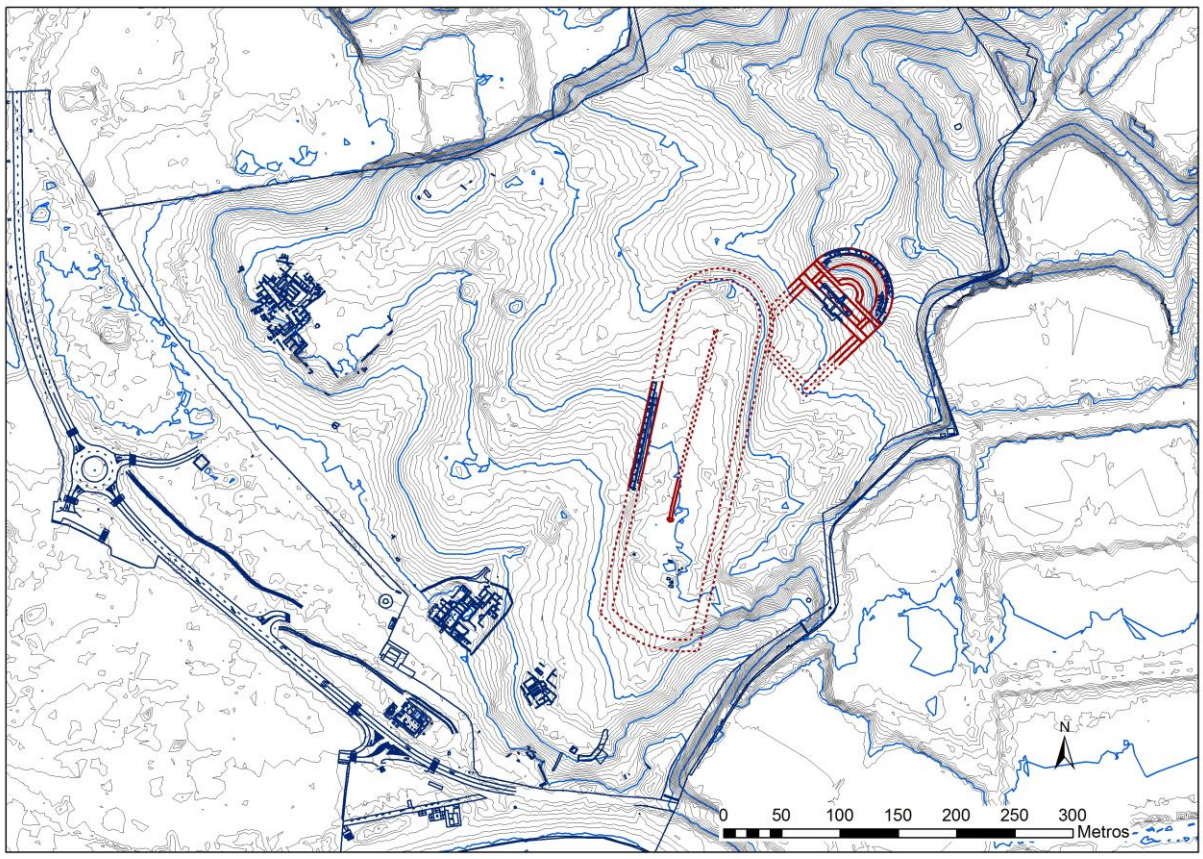

Figure 10. Reconstruction of the circus and theatre at the archaeological site of Carteia

The last section was made at the foot of the building, 245 m from the head and follows the trend shown by the previous section. The eastern tier is still supported against the topography of the terrain. Much of the arena would still be excavated in the substrate while the western area would be filled with debris to reach a height of 21 m. It is precisely in this sector where a greater erosion of the surface and of the remaining structures of the building up to a height greater than one meter is observed, where the structures would be worse conserved.

We have estimated that the total width of the building would be about 90-92 meters to which subtracting the width of the respective grandstand (cavea), 18 m, leaves a arena of 72-74 m. Bearing in mind that the minimum width detected in the starting gates in Bovillae is 2.95 m, the width of the runs to align 12 chariots had to be around 35.4 m in such a way that the dimensions calculated for the *circus* of Carteia adjust to these measures. The estimated length of the Carteia *circus*, between 300 and 336 m, is a short figure between the circuses known in Hispania and the rest of the Empire although there are exceptions such as Gerasa (Humphrey 1986, 495-504) (Fauquet 2002, 141-45) that with a length of 244 m would move in an interval lower than that of Carteia or Tarragona both cases, as we are dealing with Carteia, conditioned by topographical issues. This may be the reason for its length since there was not enough space within the walls for a larger building, although it is not far from the dimensions of circuses such as Tarragona (Dupré 2004) or Valencia (Ribera 2001). It is also true that most of the circuses, given their dimensions, were located outside the walls but we have cases where the builders included the building within the walls where its monumentality was a symbolic reference, such as the paradigmatic case of Tarragona.

As for the date of construction, we know that the *circus* is built after the August urbanization of the city (Roldán and Blánquez 2013, 389-93), amortizing domestic constructions. On the other hand, the construction technique of most of the bleachers is compatible with high-imperial moments with the use of a very characteristic *opus vittatum*. In the sector of exhumed bleachers a remodelling of an important section of foundation is observed. All this suggests a construction at the end of the 1st century A.D. or at the beginning of the 2nd century A.D. as the ceramic remains recovered in the C7 survey seem to confirm. Of the useful life of the *circus*, we are told by the subsequent reform detected in the section that is visible today.

By analysing the trenches carried out by the Bryant Foundation, we can adjust these appreciations a little more. The X cut was made on a

height of something more than 21 m above sea level, that is, the approximate height we have established for the arena. Therefore, all the documented structures were below the *circus* level and, therefore, were amortized by the construction of the *circus*. Although the published stratigraphic record does not allow for greater precision, the exhumed constructions were accompanied by material from the Republican or Late Republican period among the pieces reviewed by the authors and, as more modern material, terra sigillata of forms that could be dated to the second half of the 1st century A.D. or even as early as the 2nd century A.D. We can state with these data that the area was occupied in the republican period or Early Empire and that it was destroyed to build the *circus* as early as the middle of the 1st century AD.

Trench XI reflects a similar situation. The barrier was built on layers that leveled the ground to the level of the arena. Among the material recovered in these layers, the authors highlight the presence of South Gaulish sigillata, which again indicates the range of probable dates for the construction of the building from the middle of the 1st century AD.

Among the materials recovered in cut C7 of this intervention, in stratification units 4, 5 and 6 that correspond to levelling layers for the construction of the *circus* track, a wide repertoire of high-imperial forms stand out among which we can highlight the existence of Hispanic terra sigillata in the form Drag. 37 and Drag. 18, whose chronology focuses on the second half of the 1st century AD, reaching the 2nd century AD. The presence of a fragment of the border of African terra sigillata variant A, in the shape of Lamb. 4/36B, extends the chronology and, although the sample is small and insufficient to specify the date of construction of the *circus*, it seems clear that it must have been already in the second century AD.

The *circus* is a functional building, destined to the accomplishment of races of chariots, with some very specific rules. It is also possible that it combined its functions as a *circus* with those of a stadium, a function that has been insinuated for circuses whose barriers have not been located, despite the efforts and that nobody doubts its character as a building for shows, such as Tarragona or Segóbriga. It is a place of concentration for many people, some 15,000 spectators, who had to have easy access to the seats assigned and whose evacuation had to be also agile.

The ceremonial of the races entailed the previous parade and the triumphal exit of the winners. The starting gates would have to have a wide space for the access of the carriages and there would have to be a triumphal door that, of habitual way, is placed in the center of the hemicycle. However, the topography of the *circus* that occupies us would force the door to have too steep a slope, if it had been located there, or it would have been obliged to be subterranean and in a bend towards the west. Another option would be for it to be located, contrary to the usual, on the western side of the *circus*.

6. CONCLUSIONS

In this study we applied many non-destructive techniques to characterize the Roman *circus* of Carteia city. Firstly, the historic and aerial ortophotomaps show us the superficial footprint of the *circus*. Secondly, the MDT detailed map ratifies the hypothesis and provides a first estimation of the remains size. Thirdly, the combined geophysical methods have provided information on the potential of buried structures and their functionalities. In this context, the ERT method has been the best due to the low magnetic and dielectric contrast of the structures with the fitting medium. Finally the archeological digs confirmed the previous indirect models.

As a historical-archaeological contribution, the implications of the construction of a *circus* in Carteia go far beyond the erection of a new show building. Its construction of more than 300 m long, inside the walls (Figure 10), forced to take advantage of all available space, reaching the city wall, as also happened in Tarragona, the other intramuros *circus* known to date in Hispania. This would undoubtedly lead to a global urban reform that would force the acquisition and demolition of some 3 hectares of urban constructions, the reordering of streets and infrastructures, and the fitting out of passages under the *circus* itself to connect the entire eastern sector with the western sector interrupted by the *circus* runway, as happened with the construction of a cryptoportico in the aforementioned Tarragona. Perhaps we are facing a global urban program of the city of Carteia that included the reform or construction of other buildings next to the *circus*.

It is clear that the most striking aspect of the Carteia *circus* is its intramural character alongside the theatre and other public buildings, a fact that we find in some provincial capitals, such as Mérida, with an amphitheatre and theatre annexes within its walls, or Tarragona, with the theatre, in the civic forum, the *circus* in the provincial, both intramuros, and, as there is not enough space within the walls, the amphitheatre was attached to them from the outside. The construction of these entertainment buildings within the city obeys propaganda objectives that are understandable in large administrative centers but, in the case of Carteia, it is necessary to reflect on the prestige and symbolism of the city as the first Latin colony outside the Italic

Peninsula. It is even more surprising that, when computing the space destined for large public buildings, theater, *circus*, forum, thermal baths, etc., the resulting functional space is really scarce, so perhaps the entire walled space of Carteia could have had a more propagandistic than purely functional. This would imply that the bulk of the population and industries along with other uses had to be located outside the walls.

In short, the methodology employed has allowed us to know the dimensions of the building, its state of conservation, form and the materials that compose it, essential information for a meditated programme of future actions on a site that is currently open to the public.

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