Received: 18 November 2020 | Revised: 11 April 2021 | Accepted: 24 May 2021

DOI: 10.1002/arp.1832

RESEARCH ARTICLE

WILEY

Magnetic prospection at Aistra (Álava) and Peña Amaya (Burgos): Towards a new diagnostic paradigm for early mediaeval Iberia

Juan Antonio Quirós[1] | Stefano Campana[2] | Ken Saito[3]

[1]Department of Geography, Prehistory and Archeology, University of the Basque Country, Leioa, Spain

[2]Department of History and Cultural Heritage, University of Siena, Siena, Italy

[3]PhD School of Classical Studies and Archaeology, Department of Philology and Linguistics, University of Pisa, Pisa, Italy

Correspondence
Stefano Campana, Department of History and Cultural Heritage, University of Siena, Siena, Italy.
Email: campana@unisi.it

Funding information
Rural Studies Group (Unidad Asociada UPV/EHU-CSIC); Research Group on Heritage and Cultural Landscapes of the Government of the Basque Country, Grant/Award Number: IT931-16; Spanish Ministry of Economy, Industry and Competitiveness, Grant/Award Number: EI/FEDER UE HAR2016-76094-C4-2R

Abstract

This article discusses the application and implications of magnetic prospection within two complex early mediaeval sites of the 5th–10th centuries BCE in northern Spain, at Aistra and Peña Amaya in the Upper Ebro Valley. In this period most sites displaying domestic and other forms of occupation present multifaceted and challenging problems due to the poor preservation of stratigraphic relationships in rural contexts and rarity and poor visibility of early mediaeval horizons in multi-period urban sites. It is now widely acknowledged that extensive magnetic prospection, both in rural areas and in abandoned townscapes, can on a variety of sites facilitate the identification of domestic settlements, productive areas and monumental structures as well as the patterns of former roads, trackways and field boundaries. The two sites described here were selected to test this approach in the particular environment of the Ebro Valley and to draw any resulting conclusions about early mediaeval settlement in the area.

KEYWORDS
longhouse, *longue durée*, magnetometry, perishable evidence, road system

1 | BACKDROP

The initial identification of early mediaeval sites in the Mediterranean area, especially in the open countryside, has always been difficult. Recently, however, this critical stage in the investigative process has been studied systematically and in depth, demonstrating both the widespread presence of evidence relating to this period and the ineffectiveness of traditional methods for the primary identification and characterization of archaeological contexts. Although reasonably effective for the detection of evidence relating to the comparatively robust material culture of some historical periods (Renfrew & Bahn, 2020), long-trusted methods have proved decidedly less successful in dealing with the more fragile material remains of the early mediaeval period, subject to decay and erosion by normal taphonomic processes over the passage of time (Campana, 2009; Ghisleni et al., 2011; Hamerow, 2005; Liebeschuetz, 2007; Vaccaro et al., 2013). Archaeological research in the last two decades has shown very clearly that across a large part of southern Europe the domestic and other buildings of the early mediaeval period relied largely on the use of readily decaying materials such as timber, clay and straw. As a result, the stratigraphic remains mainly consist of 'negative' features such as postholes and foundation trenches, the timbers themselves having been removed for re-use elsewhere or the whole or part of the building having fallen into decay and progressive deterioration in situ over the passage of time (Quirós Castillo, 2012a).

In the wider social and historical perspective, the dissolution of the Roman Empire tax system led to the wholesale collapse and regionalization of the economy and of production systems throughout the Mediterranean world (Wickham, 2005). The resulting reorganization and simplification of the hand-crafted systems and processes meant that domestic, public and 'industrial' construction work was now in most cases carried out at a local scale, with low levels of specialization and standardization. Indeed, buildings, other structures and urban layouts of the early mediaeval period rarely present consistent and regular geometric patterns in terms of dimensions and proportions, creating further difficulty in the recognition and dating of structures, particularly for the earlier parts of the Middle Ages.

A second issue arises from the nature of the occupation deposits within which the structures are found. In general terms two main cases can be distinguished. In urban centres or in long-lasting settlements the perishable early mediaeval structures usually occupy an intermediate position in the stratigraphic sequence, between two phases dominated by masonry and other hard materials, those of the Roman period and the later Middle Age. Moreover, early mediaeval domestic buildings often employed reused materials, making them quite difficult to distinguish as a recognizable building phase. Finally, the early mediaeval structures often occur within multiperiod and complex stratified sites in which the recognition of domestic buildings in the absence of extensive excavation is extremely complex and difficult to achieve (Carver, 2003). Taken together, these factors have a seriously negative effect on the investigator's capacity to recognize early mediaeval structures in their own right. In rural areas, and particularly in abandoned sites and landscapes, archaeologists are often faced by the difficulties, leading Carver to characterize them as 'poorly stratified sites' (Carver, 2009). The stratigraphic elements consist mainly of posthole structures alongside sunken-floor buildings where multi-period debris has been allowed to accumulate, the genuinely contemporary material remains of the early mediaeval structures and occupation deposits having been spread over a wide area after decades of mechanized and intensive agriculture. Cumulatively, all of these peculiarities combine to explain why field-walking survey usually fails to identify clear evidence of early mediaeval occupation sites. In the last two decades, however, pioneering work, both in northern Europe and in the Mediterranean area, have shown that their recognition is possible through the adoption of alternative diagnostic methods, mainly high-resolution geophysical prospection implemented systematically and as far as possible contiguously (without gaps) over large areas (Campana, 2017; Gaffney et al., 2018; Neubauer et al., 2014; Powlesland, 2009).

In the case of Spain a large part of the geophysical prospection work done so far has been focused on Roman or protohistoric sites characterized by the use of dense and long-lasting building materials, as noted in a recent overview on the use of non-destructive techniques in the evaluation of archaeological sites (Mayoral Herrera, 2016). Despite this the list of sites investigated by non-invasive methods has increased substantially in recent years, in particular with regard to 'central places' belonging to Iron Age, Roman period and Late Mediaeval Ages (e.g., Álvarez Martínez et al., 2016; Carreras Monfort, 2016; Fernández-Álvarez et al., 2017; García-García et al., 2017; Novo et al., 2016; Ruiz Zapatero et al., 2012; Soto Cañamares, 2016; Torres-Martínez et al., 2016). However, very few multiperiod sites potentially involving mediaeval occupations have been studied in this way (but see Fernández-Álvarez et al., 2017; Henning et al., 2019) and there are as yet no examples of similar diagnostic work and analyses having been carried out on single-period early mediaeval or later-prehistoric sites, both characterized by weak structural and material evidence.

This paper presents the outcome of research work on two former settlements involving structures and other material evidence from the Middle Ages, implementing extensive and contiguous magnetic survey to better define the overall content and interpretation of the remains. The sites were chosen, after wide-ranging preliminary discussion, so as to address two major site types: long-lasting and complex multi-layered sites, and poorly stratified rural settlements.

2 | ENVIRONMENTAL SETTING AND ARCHAEOLOGICAL CONTEXT

The two sites that are the focus of this discussion are located along the Upper Ebro Valley in northern Spain (Figure 1). In this area an intense archaeological research programme has been in progress in recent years, aiming at the analysis of early mediaeval societies and based on the integration of diagnostic methods including, intensive terrestrial survey as well as aerial prospection, extensive stratigraphic excavation and sample test-pitting (e.g., Didierjean & Quirós Castillo, 2016; Quirós Castillo, 2012b, 2019). Magnetic surveys were undertaken at both sites at various points in the research, the interpreted results being shown in combination with those from aerial survey, for instance in Figures 6–8 relating to Peña Amaya. In the case of the urban or proto-urban site of Peña Amaya the geophysical work was carried out within a site that was known solely through excavation, whereas in the polynuclear village of Aistra extensive geophysical

FIGURE 1 Location of the Peña Amaya and Aistra sites [Colour figure can be viewed at wileyonlinelibrary.com]

prospection took place within the framework of a structured programme of archaeological excavations carried out over several years.

Peña Amaya (Sotresgudo, Burgos) lies 50 km NW of Burgos, one of the main cities in the Castile-Leon region. The site lies at the far eastern end of a plateau over 3 km in length and more than 200 m in width, close to the adjacent plains of the Duero Valley and therefore widely visible from a considerable distance (Figure 2). The geology is characterized by limestone and dolomitic deposits of the Upper Cretaceous period, resulting in karst morphologies. There are also several natural pools and other sources of water. The altitude of the site creates a severe micro-climate, the ground surfaces being largely barren apart from sporadic tree vegetation. The local communities have exploited these challenging environmental conditions mainly for pastoral purposes and today the site is mostly covered by hard-leaved sclerophyll vegetation. The site extends over more than 40 ha, with evidence of occupation extending from the Copper Age to the late Middle Ages (so from the 3rd millennium BCE to the 14th century CE). Internally the site is divided into two distinct parts, at altitudes of 1200 and 1370 m above sea level. The availability of a large number of 6th–14th century documentary sources referring to the site, along with the role attributed to it by several historians (Quintana López, 2017) as the capital of a Visigothic dukedom, made Peña Amaya the object of archaeological research from at least the 19th century onwards. Nonetheless, after an initial intervention conducted in the last decade of that century by R. Moro (Cisneros et al., 2005) which led to the identification of a mediaeval quarter, no archaeological investigation of any decent size has been carried out subsequently.

FIGURE 2 Peña Amaya, from above: Oblique aerial photograph of the mediaeval area excavated by R. Moro in the 19th century; enclosure wall; walled terrace in the area of the castle of Peña Amaya [Colour figure can be viewed at wileyonlinelibrary.com]

Abundant artefactual material, found on the surface or collected through metal detecting over the decades, is preserved in nearby museums but it was only in the early years of the present century that an evaluation survey was undertaken through a programme of 24 test excavations covering a total area of about 214 m^2 (Figure 2). The results of this fieldwork and the evidence of the museum collections and documentary sources have recently been brought together in a monograph that summarizes most of the previously collected information and speculations about the site (Quintana López, 2017).

Previous historical and archaeological studies have established the long lasting history of the site which was first a prehistoric hillfort, then a city, a *vicus* or something similar in Roman times, then again a city in the Visigothic period when according to some authors it served as the seat of a bishopric; it finally became a castle in mediaeval times (Quintana López, 2017). This complex and continuous series of transformations in the size and purposes of the site exacerbated the complexity of sub-surface taphonomic processes, enhancing the difficulty in accurately distinguishing shapes, sizes, borders and material cultures within the site and, in a more general sense, its transformations across time. Analyses based on the test excavations and survey work show that the earliest structural evidence can be traced back to the Roman period though artefacts collected from secondary situations and/or conserved in nearby museums and other collections give witness to the existence of more ancient signs of occupation dating back as far as the Chalcolithic period. The limited extent of the excavated areas, and the limitations of the written evidence in the documentation, leave open several interpretative issues in terms of representativeness, gaps and inconsistencies between the written sources and the archaeological evidence.

As usual, the most recent phases are more visible and readily definable than the earlier ones, which are generally characterized by an absence or shortage of artefacts. Specifically, the fortifications of the castle, the walls visible in various parts of the site, the three detected cemeteries and the still-visible surface traces of the district investigated in the 19th century have been attributed to the Middle Ages (8th–14th centuries). In addition, a 'dispersed urban layout' or '*Città ad isole*' (Brogiolo & Gelichi, 2006) has been proposed to explain the nature of the site in mediaeval times, based on the existence of at least three inhabited units or alternate neighbourhoods with empty spaces in between, articulated around churches and parish cemeteries distributed both on the plain of La Peña and in the castle area (Quintana López, 2017).

Regarding the Visigothic period in the 6th–8th centuries there is a strong contrast between the role played by Amaya as portrayed in the written sources (Quintana López, 2017), as against the relative absence of material evidence for its existence. The site was reputedly conquered by King Leovigildo in the year 574 in response to its role as a cornerstone in the post-Roman political order, opposed to the Visigoth kingdom. According to some authors Amaya had become the capital of the Visigoth duchy of Cantabria. In 712 the site was also occupied by Tarik in one of the few attested military actions that Muslims carried out during the conquest of the Visigothic kingdom. In addition to some finds of ceramic and metal artefacts the only structures assigned to the 6th–8th centuries are some fugitive deposits, negative features and very indistinct indications of possible structures found in various parts of the site (Quintana López, 2017). It is interesting to note that even in the Roman period (1st century BCE to 5th century CE) no evidence of substantial masonry constructions had been found so far (Quintana López, 2017). For the previous phases the characterization of the site is even more complex; there is some evidence to show that there was a significant occupation during the Cantabrian age (ca. 5th-1st centuries BCE) but the site was probably not occupied during the first phase of the Iron Age (ca. 10th–5th centuries BCE). Finally, the assumed occupations of the Bronze and Copper Ages are defined only on the basis of material finds recovered out of context.

In summary, Peña Amaya is undoubtedly a complex and multi-period site, characterized by a long-lasting continuity, of which, however, only a very limited part has yet been verified from fieldwork or artefactual evidence. Moreover, the site poses important challenges to the identification and characterization of the early mediaeval occupation, despite written sources pointing to the importance of this area during this period.

San Julián de Aistra, the second focus of the present study, is a deserted site located on the Álava plain between the towns of Zalduondo and Araia, about 27 km east of the city of Vitoria-Gasteiz, the current capital of the Basque Country. The site is articulated around two central places known individually as San Julián and Aistra. San Julián takes the form of an elevated plateau at 680 m above sea level, overlooking the surrounding landscape; it has a small church dedicated to San Julián and Santa Basilisa, dating from the mid-10th century (Figures 3, 10 and 12). At the foot of the plateau there is a second nucleus, Aistra, known from cropmarks and earthworks on aerial photographs but not yet tested by archaeological excavation (Figure 3). Like the rest of the Álava plain, the lithology of San Julián is based on limestone and dolomitic deposits of the Cretaceous period, easy to extract and process for construction work. In reality, however, hard sandstone blocks were brought from the nearby mountains of Elgea for use in construction of the church. The geological and topographical nature of the San Julián plateau has meant that the preserved soils are relatively thin and therefore the posthole features and ruined structures are poorly preserved and relatively difficult to define on the ground. Excavations have been conducted in recent years as part of a project carried out in collaboration with Andrew Reynolds of University College London. A 1600 m^2 area has been excavated and a variety of test pits make it clear that the early mediaeval occupation has been located (Figure 3).

The early mediaeval settlement is located next to a previously unidentified Roman settlement revealed by numerous residual artefacts, including some funerary inscriptions. The first evidence of early mediaeval occupation, on the northwestern slopes of the site (Figure 10), is represented by five agrarian terraces 120 m in length, dating by C14 from between the 5th and 6th centuries. Structures linked to this first mediaeval period (a series of irregular features dug directly into the rock, some of them linked to grain silos) have been greatly affected by later disturbance.

FIGURE 3 The san Julián plateau in Aistra, from above: Oblique aerial photograph of the site; oblique aerial photograph of the open area excavation; early mediaeval negative features of the excavated structures [Colour figure can be viewed at wileyonlinelibrary.com]

In the 7th century the site was greatly modified. The excavations revealed a series of grain silos associated with a sunken-floored building and a longhouse (E6), the latter only partially excavated at its western end but measuring 20 m in length and 6 m in width, dimensions previously unknown within domestic architecture of this period in Spain. The western end is delimited by a series of postholes and the southern side has a curving perimeter, suggesting a boat-shaped structure. An entrance on the south side is flanked by a reinforced posthole indicating where the door was hinged. Lines of postholes show that the interior had been divided into at least two different spaces. All floor surfaces or other primary deposits had been removed by later destruction, hindering a full understanding of the structure; however, a lily-shaped buckle and other personal ornaments securely dated to the 7th century were found in the post-occupation contexts.

During the 8th century the site was reorganized. The structures of the previous phases were abandoned, a new funerary area was established, a longhouse was erected at a different orientation and other structures were built around a central courtyard. As with the previous phases, floors and primary contexts were missing so it is not possible to describe or analyse the architecture in any detail. The new longhouse (E5) presents characteristics similar to the building of the previous period, with upright timbers on the long sides, access from the curving eastern end and two linear spaces in the interior, the whole structure having a floor area of about 250 m^2, being 25 m in length by 10 m in width. The neighbouring buildings were relatively complex. Building E3, for instance, covered an area of 80 m^2, divided into two clearly separate spaces, each with its own access.

Radiocarbon dating indicates that this later longhouse was in occupation until the 10th century. An associated cemetery, containing some 60 graves, was in use during the 8th–10th centuries. Consumption patterns, domestic architecture and the overall nature of the remains led to the interpretation of the San Julián focus as a manor or domanial centre (Quirós Castillo, 2017).

In the first half of the 10th century the small church of San Julián and Santa Basilisa was built, and the previous longhouse was dismantled using very sophisticated techniques. From the 11th century onwards only some of the identified structures remained in use. The Aistra site was apparently deserted by the 14th century.

3 | MAGNETIC SURVEY AND INTERPRETATION METHODS

Although this paper is for the most part focused on the outcomes of magnetic survey work at Peña Amaya and Aistra, it is important to emphasize that a substantial amount of information towards a better understanding of the sites was also contributed by field-walking survey and artefact collection, aerial photography, open-area excavation and targeted small-scale test-pitting (Figures 2 and 3).

Both sites were surveyed using a FEREX® fluxgate gradiometer which has four sensors with a resolution of 0.1 nT mounted in parallel on a fibreglass trolley or handcart. Notwithstanding the bumpy and uneven morphology of both sites (Figure 4) the instrument achieved relatively rapid data acquisition through the use of GNSS technology which allowed the survey work to be carried out without any need for physical reference systems on the ground for recording the positioning of the measurements and controlling the direction and spacing of the traverses. Ground resolution in both surveys was 5 cm along profiles 50 cm apart.

The Peña Amaya survey was carried out during the summer of 2015, between 22 June and 6 July. The total coverage in 15 days of fieldwork was about 20 ha. The hilltop location meant that the survey work was generally done in conditions of strong wind and bright sunlight. The fieldwork work at Aistra was executed during the late spring of 2016, from 2 to 7 June. The total surveyed area was about 8.5 ha. Around half of the surveyed fields were entirely suitable for the acquisition of good-quality measurements but the other half were characterized by more uneven surfaces. Across the whole of the surveyed area the measurements encountered a large amount of magnetic 'noise', mainly caused by fragments of wire-mesh fences of the kind that now border the majority of the fields. Some parts of the surveyed areas had already been excavated in the past.

FIGURE 4 Ken Saito during the collection of magnetic data at Peña Amaya [Colour figure can be viewed at wileyonlinelibrary.com]

The collected datasets were processed by GISys and mapped by QGIS. The interpretation workflow proceeding through vector drawing and documentation of the magnetic anomalies, followed by interpretation to international GIS-based standards through the regular practices developed by Stefano Campana at the University of Siena and at the University of Cambridge (Campana, 2018). From the technical point of view the drawing work was facilitated by the use of an interactive touchscreen display, giving an economical overall working time while also providing a high resolution of display and final output.

Within this process the vector drawing of the magnetic anomalies and interpreted archaeological or contextual features (geology, hydrology or present-day agricultural activity etc) is based on the principle that any piece of potentially meaningful evidence that could be identified as such in the interpretation process must be defined and documented in terms of its spatial dimensions (width, length, shape etc) and then mapped in the form of a closed polygon. The process of interpretation and mapping, however, inevitably involves a degree of uncertainty in the identification and interpretation of some of the raw data. The mapping is therefore recorded through two separate but spatially overlapping digital 'layers'—an 'Interpretation' layer and a 'Hypothesis' layer.

The Interpretation layer is aimed at depicting the most clearly defined magnetic anomalies and interpreted archaeological and/or contextual features through polygonal geometry. This represents the most reliable level of potentially archaeological or contextual evidence. What cannot be drawn through polygon geometry (because, for instance, it lacks some aspect in its spatial dimensions or clarity of outline) can alternatively be mapped on the Hypothesis layer. In such cases the raw data tends on occasions to lose some of its potential value through not falling into a distinct category of feature identification.

Over nearly two decades of interpretation and mapping work in the University of Siena this 'twin-layer' approach has shown itself to be an excellent stratagem, a kind of filter or discriminant that makes it possible to frame a clear distinction between firm attributions to a particular feature type whether archaeological or contextual in the Interpretation layer as against more generalized indications at a lower level of interpretative precision and reliability in the Hypothesis layer, through which very narrow, indistinct or imprecise forms of evidence in the magnetic data can nevertheless be represented by line geometry for proper incorporation into the process of identification and interpretation. The Hypothesis layer thus represents a second level of feature extraction and interpretation, though necessarily less precise and trustworthy compared with that shown on the Interpretation layer.

In addition, a third layer, aimed at the recording of discernible or suspected 'patterns' in the raw or interpreted data, is specifically devoted to the documentation of apparently meaningful aggregations of potentially archaeological and/or contextual data. This Patterns layer uses line geometry to record the outlines of identifiable 'clusters' of evidence, whether magnetic anomalies or interpreted archaeological (or contextual) features, characterized by any kind of regular or repeating pattern. This third level of feature extraction and interpretation is inevitably less precise and trustworthy compared with the Hypothesis layer.

In the associated tables of attributes it has been a consistent policy to minimize the number of fields and therefore possible ambiguities in the description of the magnetic anomalies and interpreted archaeological and/or contextual features, reducing the number of options and providing a descriptive guide of the different values through fields such as definition, interpretation, reliability, risk, origin, history, ground control, comparisons, and size (area, width and length).

4 | DISCUSSION OF THE GEOPHYSICAL RESULTS

The overall results of the Peña Amaya magnetic survey can with good reason be rated as successful, a large number of magnetic anomalies being identified across all parts of the surveyed area (Figure 5). These are represented by 791 features on the Interpretation layer, 220 on the Hypothesis layer and 1523 on the Patterns layer.

In response to the size and the complexity of the collected data it was decided to organize the interpretation process by progressive steps, the first stage involving analysis of the magnetic data to identify different generic types of potential archaeological and contextual features. The classification of the resulting features was based on some or all of the following characteristics: shape, size, topography, orientation and intensity of the magnetic signal. The main functional categories identified during this process were: compound (cluster of buildings and/or structures), generic structure, bank/ditch, road, ditch, pit (subdivided into generic pit, posthole etc), terracing, thermo-remanent magnetization (TRM), generic dipole and not identified. Within these categories it was possible to suggest a further sub-grouping mainly based on the spatial distribution and consistency of the features within the category as a whole. This approach then made it possible to identify a number of potentially significant 'clusters' for recording on the Patterns layer.

Linear features close to the break of slope along the northwestern and southwestern edges of the plateau (Figure 6: green solid and shaded-filled polygons, violet and green dashed lines). Linear features sharing a similar width and magnetic intensity near the centre of the plateau seem from their overall shape to indicate an enclosure of some kind up to 80 m or so across. At this stage of analysis the most likely explanation would seem to be that these features represent banks and/or ditches for enclosure or defence but as yet there is no evidence as to their possible dating.

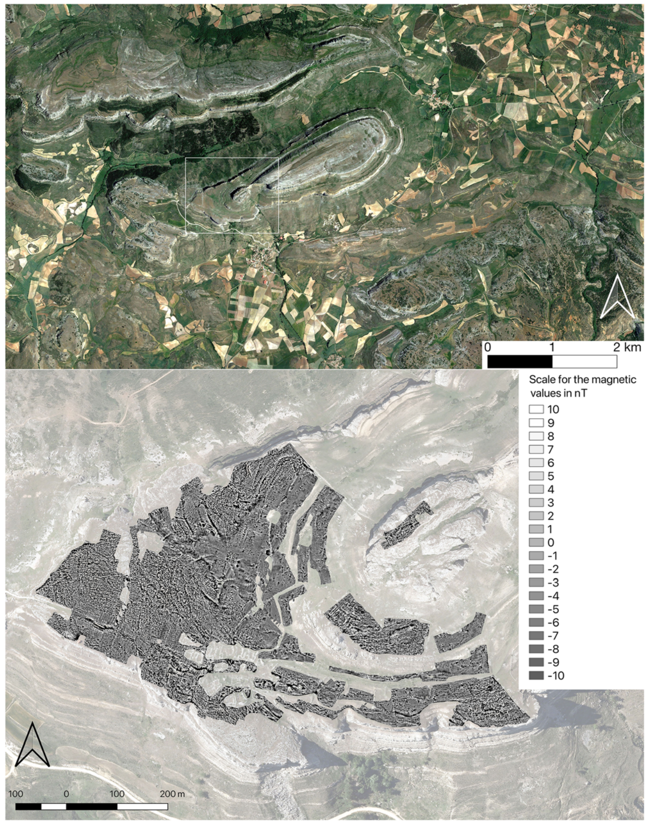

FIGURE 5 Peña Amaya. Top: Air photo of the site and its surrounding in a mountainous area with many steep slopes and a ground surface dominated by scrub and small trees. The rectangular outline shows the area covered by the lower part of the figure. Bottom: Closer view showing the areas covered by the geophysical survey (scale for the magnetic values: +10 nT white; −10 nT black) [Colour figure can be viewed at wileyonlinelibrary.com]

Rectangular clusters of features with an overall size range, on average, between 50 and 100 m^2, the majority fairly regularly oriented from northwest to southeast (Figure 6: violet, red and orange polygons). A particular interesting cluster is concentrated in the southwestern part of the surveyed area (Figures 6 and 7: brown lines, violet and orange polygons). However, this is one of the most complicated parts of the plateau, most of the individual magnetic anomalies being very difficult to interpret. Indeed, there remain legitimate doubts about the true origin of the anomalies and hence of the archaeological features that they are tentatively assumed to represent—some might indeed be geological rather than archaeological in origin. The final word will only come through the implementation of targeted test excavation aimed at clarifying the subsoil nature of the evidence.

In the northern part of the surveyed area and along the central part of the plateau the magnetic data showed a large number of small dipoles, most of them displaying similar characteristics of size and shape. Moreover, their spatial distribution seems to follow regular patterns or 'clusters'. At present, having considered the intrinsic characteristics of these clusters in terms of size, shape and consistency of orientation, it seems reasonable to interpret at least some of the

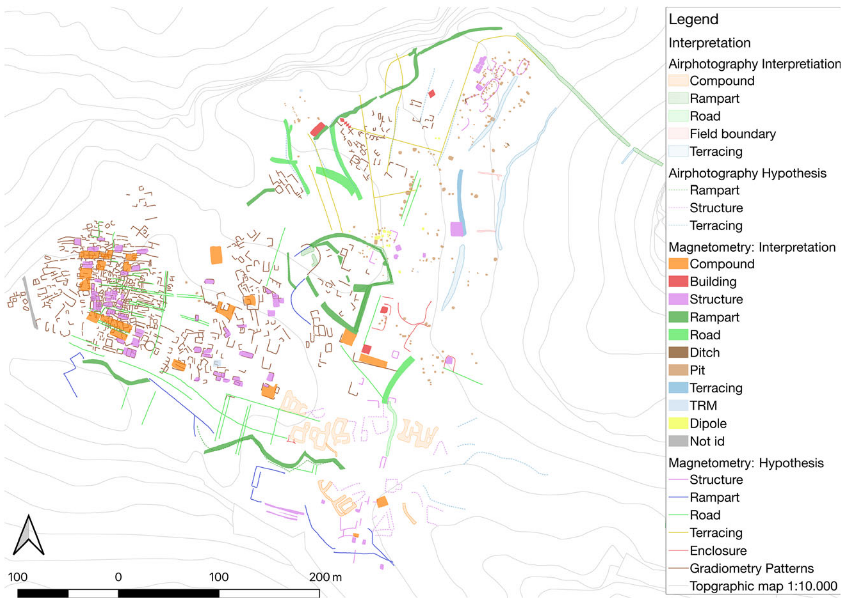

FIGURE 6 Peña Amaya. Archaeological interpretation of the magnetic anomalies, clearly showing the high density of mapped features [Colour figure can be viewed at wileyonlinelibrary.com]

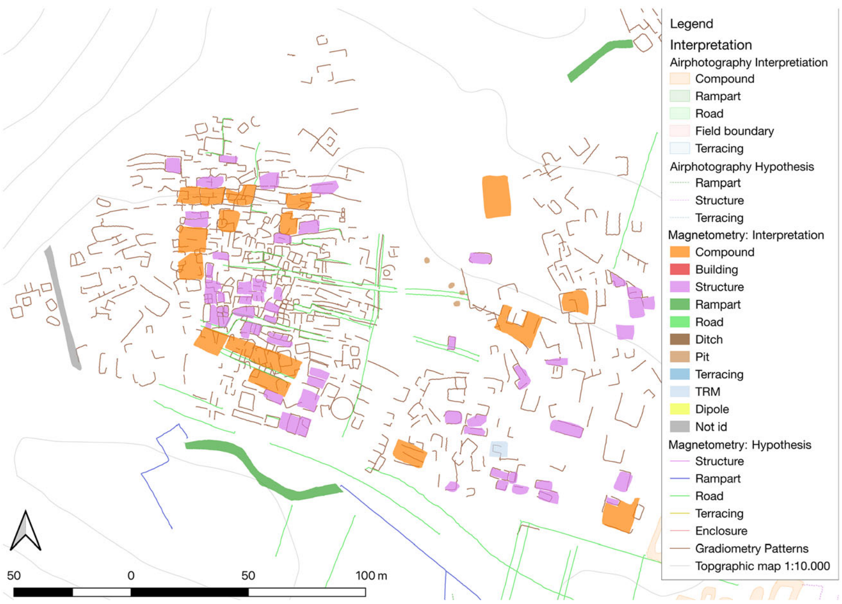

FIGURE 7 Peña Amaya: Archaeological interpretation of the southwestern part of the surveyed area [Colour figure can be viewed at wileyonlinelibrary.com]

features as the individual postholes of possible longhouses (Figure 8, in the northern part of the figure—small brown circular polygons joined by violet lines). Some of the other clusters in this area might be interpreted as pits or as an indication of subsoil features involving some form of thermo-remanent magnetism. Once again, the true nature and dating of any of these features could only be revealed by targeted excavation. In the northern and central part of the area (light green lines in Figure 7) represent what are taken to be roadways.

Among other types of evidence, a clear and unambiguous pattern can be recognized in the central part of the survey area (Figures 7 and 8). Well-defined lines and shapes, all of them consistently oriented from northnortheast to southsouthwest seems to show a regular pattern that might well represent part of an 'urban complex' involving roads and building along them.

The results of the smaller-scale magnetic survey at San Julián de Aistra (Figures 9–12) were similarly positive though in this case there were many orthogonally-arranged 'background' anomalies undoubtedly reflecting present-day or recent agricultural patterns within the surveyed fields (on the lower part of Figure 9). As at Peña Amaya significant numbers of magnetic anomalies were identified across the whole of the surveyed area, in this case involving 489 potentially archaeological features on the Interpretation layer and 15 on the Hypothesis layer but none on the 'Patterns layer.

Among the most evident features there stand out a series of macro-elements indicated in light green and yellow in the southeastern part of Figure 8, respectively interpreted as recent field boundaries and traces of other human activities, some of them connected

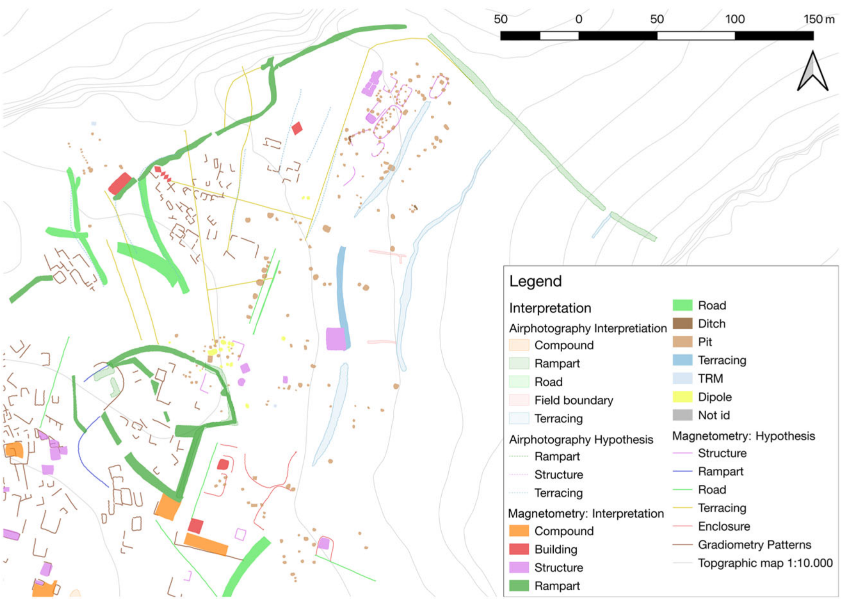

FIGURE 8 Peña Amaya. Archaeological interpretation of the central and northern parts of the surveyed area. Near the top of the figure violet lines show the conjectured outlines of possible timber-built structures, with individual postholes in brown [Colour figure can be viewed at wileyonlinelibrary.com]

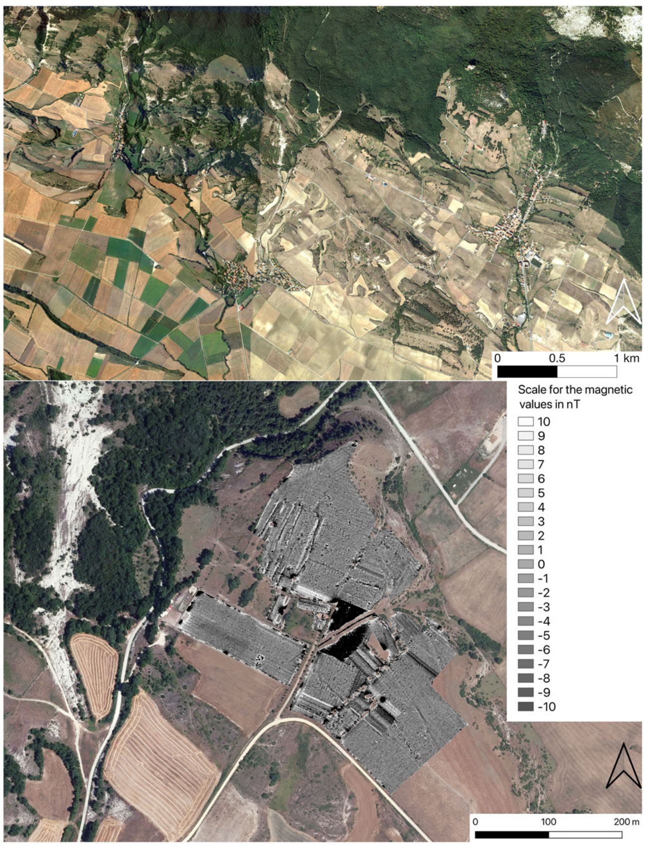

FIGURE 9 Aistra. Top: Aerial view of the site in its landscape setting. Below: Closer view overprinted with the magnetic data for the surveyed areas (scale for the magnetic values: +10 nT white; −10 nT black) [Colour figure can be viewed at wileyonlinelibrary.com]

with the use of wire-mesh fences. Marked in blue further to the northwest there is a pattern of what appear to be parallel terraces, of unknown date though again perhaps of relatively recent origin.

On the highest part of the hill, towards the north of the surveyed area, there emerged a group of anomalies that were very similar to one another in their size and signal intensity (Figure 11, in red). On the basis of these criteria, along with their spatial patterning in relation to one another these can with reasonable certainty be interpreted as postholes belonging to a number of timber-built houses and/or related structures. Four of them share a consistent northeasterly orientation, whereas three others, less well-defined, trend towards the northwest. In the case of the largest structure, measuring 12 × 10 m across, it even seems possible to identify internal subdivisions dividing the building into between up to three or more different spaces. In the same area there are what appear to be traces of at least four *grubenhäuser* (Figures 10 and 11, orange features). They all share the typical characteristics of this type of building: sub-rectangular in shape and measuring about 3–4 × 2–3 m in length and width. The orientation of the buildings, including the largest longhouse and the *grubenhäuser*, closely matches that of the church which lies about 100 m to the south (stippled grey in the right-hand part of Figure 11), suggesting that the church and at least some of the conjectured buildings were coeval throughout at least part of their lives.

Further features of particular interest have also emerged, including an apparent 'cluster' in fairly close proximity to the church, especially on its northern side (Figure 12). In the majority of cases the anomalies are dipoles between 1.5 and 2 m across, of circular or elliptical shape. There are also two dipoles of similar shape and signal-intensity but of much larger dimensions, situated slightly further away from the church, one to the west and the other to the south; apart from their location, however, there is nothing to suggest any meaningful relationship with the church. At this stage of interpretation it seems plausible to identify the smaller dipoles as inhumation burials whereas the larger features presumably represent pits of some as yet unknown function.

Close to the steeply sloping western edge of the hill, approximately 100 m southwest of the church and 200 m from the

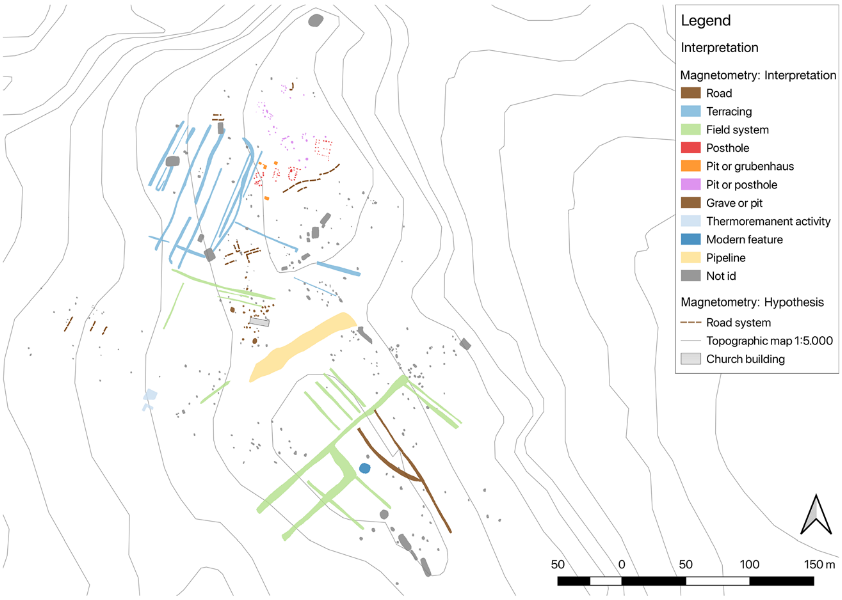

FIGURE 10 Aistra. Contour lines in grey and GIS-based interpretation of the magnetic measurements [Colour figure can be viewed at wileyonlinelibrary.com]

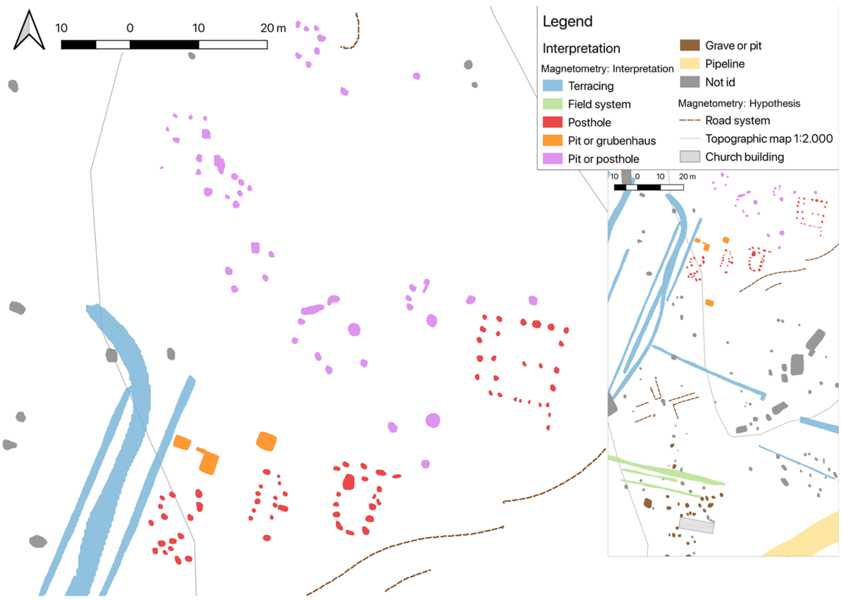

FIGURE 11 Aistra. Closer view showing interpreted archaeological features in the northern part of the surveyed area, including three possible grubenhäuser and a large number of individual small dipoles probably representing the postholes of timber-built longhouses and related structures [Colour figure can be viewed at wileyonlinelibrary.com]

conjectured post-built structures and possible *grubenhäuser* further to the north, there is a large anomaly in the magnetic data, significant for its size, intensity and irregularly quadrilateral shape (Figure 10, light blue). The characteristics of this dipole, which measures up to 8 × 8 m across, suggest the presence in this area of some potentially important thermo-remanent deposit or activity, perhaps related to a furnace and accompanying waste products; the position of this unusual feature, well clear of the church and other apparent buildings on the site but close to steep slopes that would have created favourable up-draughts, entirely consistent with this hypothesis.

Between the church and the conjectured furnace there are numerous small dipoles probably associated with anthropic activity but with no relevant characteristics or clear interrelationships to suggest what those activities might have been. In some cases the anomalies could perhaps represent postholes of domestic or service structures (for storage or various types of productive activity); in others they might indicate somewhat larger pits for food storage, the disposal of waste material or for other functions.

All in all, both Peña Amaya and Aistra, on the basis of the magnetic results, present rich and complex contexts exhibiting clear or inferential evidence of multiple phases of occupation, providing a clear incentive for further research in the field. These first surveys have produced information of great importance in the identification of a large variety of potentially archaeological features (terraces, banks and/or ditches, pits, longhouses, *grubenhäuser*, other apparent buildings or service structures, burials, furnace activity, road systems

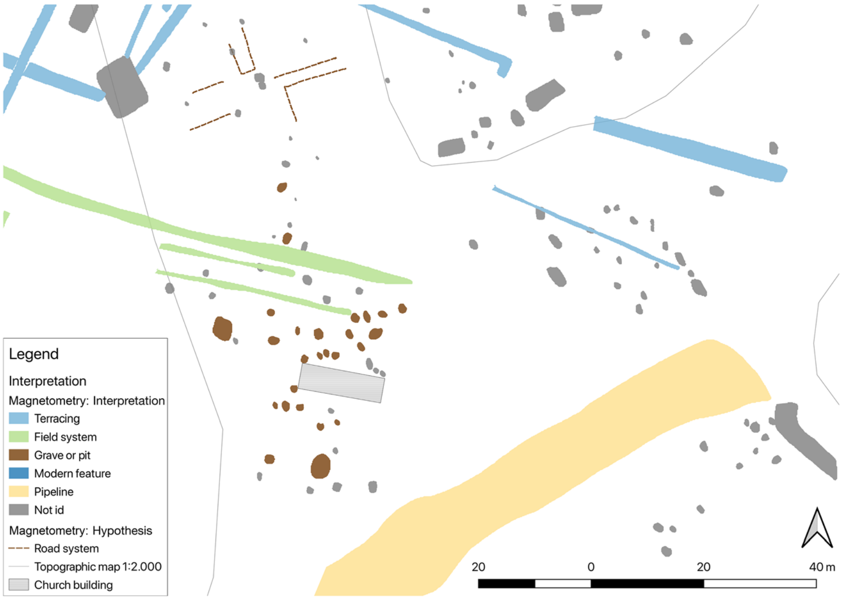

FIGURE 12 Aistra. Close-up of the central part of the surveyed area, close to the church, showing brown dipoles probably representing pits or more likely inhumation graves associated with the church [Colour figure can be viewed at wileyonlinelibrary.com]

and terracing works etc). As a next stage in the research it would be important to implement a series of carefully targeted excavations, ranging from test-pits to small but tightly-focused stratigraphic excavations aimed at recovering more information on the characteristics of the subsurface features and deposits, and above all perhaps on their relative dating. Equally important would be a continuation of non-destructive investigations, possibly using different geophysical methods, complementary to magnetometry (such as electric resistivity tomography and/or ground penetrating radar). It would also be useful to develop a programme of drone-based photogrammetry so as to obtain high resolution digital terrain models for both of the sites.

5 | CONCLUSIONS

The two case studies described above allow us to frame a series of considerations on the settlement history of the sites involved and more generally on the interpretation, evaluation and conservation of early mediaeval settlements and landscapes in this part of Spain.

On the basis of these two examples, what kind of information can we hope or expect to gain from magnetic prospection in the study of early mediaeval occupations? For a start we must of course recognize the complexity of the evidence and the difficulty of identifying the early mediaeval features and deposits in long-lasting and multi-layered sites like Peña Amaya as well as in poorly stratified or poorly preserved rural settlements such as Aistra. As a first conclusion from the results illustrated above, we need to take for granted the quantity and complexity of the information now potentially available to us. Information emerging from magnetic prospection and from other non-invasive survey methods will clearly challenge our capacity to perceive and understand in detail the extent and nature of the accumulated archaeological evidence. But there are nevertheless many positive aspects. It is first of all essential to understand that the result of this kind of survey work is not just a quantitative increase in the body of information that can be added to the pre-existing framework of observation and ideas arising from the earlier excavations and fieldwork studies. Rather, the information recovered through geophysical survey has created significant problems in accepting some of the apparent 'certainties' in previous interpretations, both in terms of the extent of the inhabited areas and (necessarily) in evaluation of the representativeness of the results obtained in the past. In the case of Peña Amaya, for instance, it seems highly probable that interpretations based on the limited programme of earlier excavations and test-pitting failed to grasp the inherent complexity of the site, not only as regards the early mediaeval phases. To avoid misunderstanding, it is necessary to stress that limited test excavations are always problematic and potentially misleading as regards what is or is not present within the investigated areas. Indeed, the only way to make small-scale sampling effective and representative is to implement high-quality diagnostics as a first step in the investigative process so as to provide a preliminary interpretative framework that will then allow carefully targeted intrusive interventions. Without a reliable diagnostic baseline of this kind we will continue to be at the mercy of chance, the only way to achieve credible results lying in the kind of extensive open-area excavation which demands amounts of time and financial support that seem progressively less likely to be available—and sustainable—in the straightened economic realities of the coming years.

Although the disjunction between the written sources and the material evidence in the field is particularly problematic, the spatial patterns identified in these two case studies also pose a significant problem as regard the degree of conscious 'urban' planning in the pre-mediaeval period and in its continuation into and during the early Middle Ages. In particular the magnetic results at Amaya might well question the 'island city' model that has been proposed so far. In the case of Aistra the model based on two main poles (Aistra at the bottom of the hill and of San Julián towards the top) appears now to be blurred in favour of a polyfocal system that extends over a larger area, suggesting the need to review the functioning of the domanial centre and the mechanisms for withdrawing income.

Another aspect of interest in relation to extensive geophysical prospection consists not only in the identification and better characterization of the site under examination but also in the proposition of a new diagnostic paradigm, at least in the Spanish context and for the early Middle Ages with their impermanent building materials, poorly defined stratification and fragile material culture. In the last decades, in fact, the systematic implementation of large-scale prospection in Europe and more recently and occasionally in the Mediterranean has shown that it can respond much more effectively to the needs of archaeological and landscape evaluations than a 'traditional' technique relying principally on field-walking survey, aerial photography and written sources. It has reached the stage where we must reconsider the research protocols in a modular perspective, placing geophysical prospection at the first stage in the investigative process. In other words, it is necessary to develop in Spain, and perhaps more generally within the Mediterranean area, a new diagnostic procedure for evaluation of the cultural resource and archaeological record. This must clearly be more flexible, more responsive and more capable of combining a variety of differing but mutually supportive methods of investigation in an original way.

At the same time it is only realistic to suspect that this enhanced role for geophysical prospection (especially where deployed on a large scale) might generate a degree of friction within the archaeological community, as has been the case with many other scientific techniques when they appear to conflict with the sensibilities of the purists of the humanities: the theoretical conflict and distrust of the 'two cultures' that make up the reality of the archaeological discipline has already been called into question by authors such as Lidén and Eriksson (2013) and others including Martinón-Torres and Killick (2015), Moro Abadía (2017), Sørensen (2017) and Martiñón-Torres (2018). Whereas some authors consider the growing diffusion of scientific methods to form the basis for a new archaeological paradigm (Kristiansen, 2014), others reject what they see as the excessive relevance assigned to procedures and hard science, claiming greater weight for the humanist and theoretical dimensions of the discipline (González Ruibal, 2014).

Looking beyond these possible schisms the post-Covid context presents us with a very real challenge. How, for instance, can we build new protocols and procedures for the evaluation of the archaeological resource when we are fully aware of the limitations of traditional approaches but also of the extraordinary progress achieved by non-destructive diagnostic methods in recent years? How can we reconcile these factors but at the same time face the political and economic realities of the coming years as regards the sustainability of preventive archaeology based on extensive stratigraphic excavation? Ultimately, the economic, social and intellectual crisis emphasized by the Covid pandemic might in fact present us with the 'golden ticket' to rethink preventive archaeology in an open, fair-minded and ambitious way, making greater use of methodological approaches that are already fully developed and available to us, albeit all too often applied in a very limited way in various fields of archaeological investigation and research.

ACKNOWLEDGEMENTS

This research work described here has been supported by the project 'Peasant agency and social complexity in north-western Iberia in the mediaeval period' of the Spanish Ministry of Economy, Industry and Competitiveness (EI/FEDER UE HAR2016-76094-C4-2R) as well as by the Research Group on Heritage and Cultural Landscapes of the Government of the Basque Country (IT931-16) and the Rural Studies Group (Unidad Asociada UPV/EHU-CSIC). The authors are also grateful to Chris Musson who patiently and willingly revised the final text, improving the English language and enhancing the overall readability.

ORCID

Stefano Campana https://orcid.org/0000-0002-3936-3242

REFERENCES

Álvarez Martínez, J. M., Iglesias Gil, J. M., Jiménez Chaparro, J. I., & Teichner, F. (2016). Prospección geofísicas en Regina Turdulorum (Casas de Reina, Badajoz). Aplicación al conocimiento al conocimiento de su territorio urbano. In V. Mayoral (Ed.), *La revalorización de zonas arqueológicas mediante el empleo de técnicas no destructivas* (pp. 245–262). Madrid: Consejo Superior de Investigaciones Científicas, Instituto de Arqueología.

Brogiolo, G. P., & Gelichi, S. (2006). *La città nell'alto Medioevo italiano*. Laterza: Bari.

Campana, S. (2009). Archaeological site detection and mapping: Some thoughts on differing scales of detail and archaeological 'non-visibility'. In S. Campana & S. Piro (Eds.), *Seeing the unseen* (pp. 5–26). London: Taylor & Francis.

Campana, S. (2017). Emptyscapes: Filling an 'empty' Mediterranean landscape at Rusellae, Italy. *Antiquity*, *91*(359), 1223–1240. https://doi.org/10.15184/aqy.2017.139

Campana, S. (2018). *Mapping the archaeological continuum. Filling 'empty' Mediterranean landscapes*. New York: Springer.

Carreras Monfort, C. (2016). Geofísica adaptada a diferentes entornos: Experiencias del equipo ICAC-UAB. In V. Mayoral (Ed.), *La revalorización de zonas arqueológicas mediante el empleo de técnicas no destructivas* (pp. 133–148). Madrid: Consejo Superior de Investigaciones Científicas, Instituto de Arqueología.

Carver, M. (2003). Archaeological value and evaluation. SAP—Manuali per l'Archeologia, no. 2, Società Archeologica.

Carver, M. (2009). *Archaeological investigation*. Routledge.

Cisneros, M., Quintana, J., & Ramírez, J. L. (2005). Peña Amaya y Peña Ulaña: Toponimia y arqueología prerromana. *Palaeohispanica*, *5*, 566–570.

Didierjean, F., & Quirós Castillo, J. A. (2016). Invisible medieval villages: Aerial research in Alava (Basque Country, Spain), AARGnews. *The Newsletter of the Aerial Archaeology Research Group*, *52*, 52–59.

Fernández-Álvarez, J. P., Rubio-Melendi, D., Quirós Castillo, J. A., González-Quirós, A., & Cimadevilla-Fuente, D. (2017). Combined GPR and ERT exploratory geophysical survey of the medieval village of Pancorbo castle (Burgos, Spain). *Journal of Applied Geophysics*, *144*, 86–93. https://doi.org/10.1016/j.jappgeo.2017.07.002

Gaffney, V., Neubauer, W., Garwood, P., Gaffney, C., Löcker, K., Bates, R., de Smedt, P., Baldwin, E., Chapman, H., Hinterleitner, A., Wallner, M., Nau, E., Filzwieser, R., Kainz, J., Trausmuth, T., Schneidhofer, P., Zotti, G., Lugmayr, A., Trinks, I., & Corkum, A. (2018). Durrington walls and the Stonehenge hidden landscape project 2010–2016. *Archaeological Prospection*, *25*(3), 255–269. https://doi.org/10.1002/arp.1707

García-García, E., Andrews, J., Iriarte, E., Sala, R., Aranburu, A., Hill, J., & Agirre-Mauleon, J. (2017). Geoarchaeological core prospection as a tool to validate archaeological interpretation based on geophysical data at the Roman settlement of Auritz/Burguete and Aurizberri/Espinal (Navarre), 7, 4. *Geosciences*, *7*, 104. https://doi.org/10.3390/geosciences7040104

Ghisleni, M., Vaccaro, E., Bowes, K., Arnoldus, A., MacKinnon, M., & Marani, F. (2011). Excavating the Roman peasant I: Excavations at Pievina (GR). *Papers of the British School at Rome*, *79*, 95–145. https://doi.org/10.1017/S0068246211000067

González Ruibal, A. (2014). *An archaeology of resistance: Materiality and time in an African borderland*. Rowman & Littlefield Pub Inc.

Hamerow, H. (2005). *Anglo-Saxon settlements in a post-roman landscape, in Dopo la fine delle ville: le champagne dal VI al IX secolo, proceedings of the workshop (Gavi, 8–11 may 2004)* (pp. 327–334). Mantova: SAP Società Archeologica s.r.l.

Henning, J., McCormick, M., Enciso, L., Rassmann, K., & Eyub, E. (2019). Reccopolis revealed: The first geomagnetic mapping of the early medieval Visigothic royal town. *Antiquity*, *93*(369), 735–751. https://doi.org/10.15184/aqy.2019.66

Kristiansen, K. (2014). Towards a new paradigm? The third science revolution and its possible consequences in archaeology. *Current Swedish Archaeology*, *22*, 11–34.

Lidén, K., & Eriksson, G. (2013). Archaeology vs. archaeological science do we have a case?, current Swedish. *Archaeology*, *21*(2013), 11–20.

Liebeschuetz, W. (2007). L'aristocrazia in occidente tra il 400 e il 700, in I Longobardi. Dalla caduta dell'impero all'alba dell'Italia (catalogue of the exibition), Milan.

Martinón-Torres, M., & Killick, D. (2015). Archaeological theories and archaeological sciences. In A. Gardner, M. Lake, & U. Sommer (Eds.), *The Oxford handbook of archaeological theory*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199567942.013.004

Martiñón-Torres, M. (2018). Mobility, minds and metals: The end of archaeological science? In X.-L. Armada, M. Murillo-Barroso, & M. Charlton (Eds.), *Metals, minds and mobility integrating scientific data with archaeological theory* (pp. 161–169). Oxford: Oxbow Books Ltd.

Mayoral Herrera, V. (Ed.) (2016). *La revalorización de zonas arqueológicas mediante el empleo de técnicas no destructivas*, *Anejos de Archivo Español de Arqueología*. Madrid: CSIC.

Moro Abadía, O. (2017). Bridging the gap in archaeological theory: An alternative account of scientific 'progress' in archaeology. *World Archaeology*, *49*, 271–280. https://doi.org/10.1080/00438243.2016.1264883

Neubauer, W., Gugl, C., Scholz, M., Verhoeven, G., Trinks, I., Löcker, K., Doneus, M., van Meirvenne, M., & Saey, T. (2014). The discovery of the school of gladiators at Carnuntum, Austria. *Antiquity*, *88*, 173–190. https://doi.org/10.1017/S0003598X00050298

Novo, A., Vallés, J., Chapa, T., Cabrera, A., & Pereira, J. (2016). Detección de estructuras a diferentes profundidades mediante Georradar 3D multicanal en el yacimiento de la Edad del Hierro del Cerro de La Mesa (Alcolea de Tajo, Toledo). In V. Mayoral (Ed.), *La revalorización de zonas arqueológicas mediante el empleo de técnicas no destructivas* (pp. 125–132). Madrid: Consejo Superior de Investigaciones Científicas, Instituto de Arqueología.

Powlesland, D. (2009). Why bother? Large scale geomagnetic survey and the quest for 'real archaeology'. In S. Campana & S. Piro (Eds.), *Seeing the unseen. Geophysics and landscape archaeology* (pp. 167–182). The Netherlands: Taylor & Francis.

Quintana López, J. (2017). El Castro de Peña Amaya (Amaya, Burgos): del nacimiento de Cantabria al de Castilla, Santander.

Quirós Castillo, J. A. (2012a). Arqueología de la Arquitectura y Arquitectura doméstica en la Alta Edad media Europea. *Arqueología de la Arquitectura*, *9*, 131–265.

Quirós Castillo, J. A. dir. (2012b). Arqueología del campesinado medieval: La aldea de Zaballa, Bilbao.

Quirós Castillo, J. A. (2017). Longhouses, biografía de la casa y complejidad social en el noroeste peninsular en la Alta edad media. *Arqueología de la Arquitectura*, *14*, e059.

Quirós Castillo, J. A. dir, (2019). Arqueología de una comunidad campesina medieval: Zornoztegi (Álava), Bilbao.

Renfrew, C., & Bahn, P. (2020). *Archaeology theories, methods and practice*. London: Thames & Hudson.

Ruiz Zapatero, G., Märtens, G., Contreras, M., & Baquedano, E. (2012). *Los últimos carpetanos. El oppidum de El llano de la Horca (Santorcaz, Madrid)*. Madrid: Museo Arqueológico Regional.

Sørensen, T. F. (2017). The two cultures and a world apart: Archaeology and science at a new crossroads. *Norwegian Archaeological Review*, *50*(2), 101–115. https://doi.org/10.1080/00293652.2017.1367031

Soto Cañamares, P. (2016). Métodos geofísicos en el marco del proyecto RITECA II. Trabajos realizados por el Instituto de Arqueología de Mérida (CSIC-GOBEX), in V. Mayoral, La revalorización de zonas arqueológicas mediante el empleo de técnicas no destructivas, Madrid, p. 79–98

Torres-Martínez, J. M., Teichner, F., Fernández-Götz, M., & Vallés, I. J. (2016). Resultados de las prospecciones geomagnéticas desarrolladas en el oppidum de Monte Bernorio (Pomar de Valdivia, Palencia). *Trabajos de Prehistoria*, *73*(2), 365–376.

Vaccaro, E., Ghisleni, M., Arnoldus-Huyzendveld, A., Grey, C., Bowes, K., MacKinnon, M., & Rinaldi, R. (2013). Excavating the Roman peasant II: Excavations at case Nuove, Cinigiano (GR). *Papers of the British School at Rome*, *81*, 129–179. https://doi.org/10.1017/S006824621300007X

Wickham, C. (2005). *Farming in the early middle ages: Europe and the Mediterranean, 400–800*. Oxford: OUP Oxford. https://doi.org/10.1093/acprof:oso/9780199264490.001.0001

How to cite this article: Quirós, J. A., Campana, S., & Saito, K. (2021). Magnetic prospection at Aistra (Álava) and Peña Amaya (Burgos): Towards a new diagnostic paradigm for early mediaeval Iberia. *Archaeological Prospection*, 1–12. https://doi.org/10.1002/arp.1832