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THE ROMAN ARMY IN CENTRAL PORTUGAL: REASSESSING THE ARCHAEOLOGICAL EVIDENCE OF TWO POSSIBLE MILITARY SITES

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Resumo: Following a complementary non-invasive analysis including satellite and aerial imagery, as well as UAV-based photogrammetric and LiDAR surveys, this paper presents and

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discusses the Roman military evidence identified at Alto do Golado (São Pedro do Sul) and Modedufe (Lamego). Though the archaeological remains of these sites have been partly noticed before, undetected relevant aspects resulted in misinterpretations, which are now reassessed in this study. Constituting the first known evidence of the Roman army in the region located between the Vouga and Douro rivers, further analysis of computed GIS models resulted in some hypotheses regarding mobility, visibility and territorial control. Ultimately, this paper also stresses the importance and the need for additional, invasive archaeological research to validate these hypotheses and, consequently, contribute to a better understanding not only of the sites here discussed but also of the Roman military presence in Western Iberia.

Palavras-chave: Roman camp; Airborne LiDAR; UAV Photogrammetry; GIS; Viseu region.

Abstract: Seguindo uma metodologia complementar não-invasiva que analisou imagens aéreas e satélitais, bem como dados de levantamentos de aerofotogrametria e LiDAR, o presente artigo explora os vestígios de elementos militares romanos recentemente identificados nos sítios do Alto do Golado (São Pedro do Sul) e Montedufe (Lamego). Embora estes sítios fossem já parcialmente conhecidos, alguns elementos relevantes passaram despercebidos, resultando em interpretações relativamente genéricas e erróneas, algo que o presente texto reavalia. Recorrendo a modelos gerados com recurso a ferramentas SIG, discutem-se ainda algumas análises espaciais de mobilidade, visibilidade e de subsequente possível controlo territorial. Por fim, este artigo reforça ainda a necessidade de se realizarem trabalhos arqueológicos invasivos, cruciais para corroborar as hipóteses apresentadas e, por conseguinte, compreender melhor estes sítios e o contexto da presença militar romana nesta região do ocidente peninsular.

Keywords: Acampamento romano; LiDAR aéreo; Aerofotogrametria; Região de Viseu.

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Introduction

The Roman conquest of the Iberian Peninsula was a gradual and lengthy process, lasting approximately two centuries, and was characterised by successive wars and several retaliatory expeditions (e.g. Morillo *et al*., 2020). This military activity resulted in the often extensive movement of a large number of Roman troops across the territory and, consequently, in the construction of the necessary supporting infrastructure. Overall, Roman military sites can be distinguished into two major typologies based on the nature of their temporal occupation, namely whether it is a permanent base, often referred to as a fort, where there is a settled, long-lasting occupation, or a temporary camp. Although there is a recurring lack of agreement on terminology in the classification of Roman camps, these were often used for short-term periods and were constructed, for instance, while campaigning, for night stops while marching or besieging enemy positions (Jones, 2017). Identifying and analysing this type of site can sometimes be a difficult task as they can present distinct sizes, shapes and functions (Costa-García, Fonte and Gago, 2019), and, given their temporary occupation, frequently lack any associated material culture (Peralta Labrador, 2002). In recent years, there have nonetheless been relevant developments in the study of Roman camps, mostly deriving from greater availability of remote sensing data, resulting in the identification of an increasing number of new sites and, consequently, significantly adding to a better understanding of the military undertakings occurred in this part of the Roman world (e.g. Costa-García, Fonte and Gago, 2019; Menendez Blanco *et al*., 2020; Martín Hernández *et al*., 2020; Morillo *et al*., 2021).

This knowledge of Roman military sites in the Iberian Peninsula is, however, currently characterised by a strong dichotomy, roughly corresponding to the modern-day border between Portugal and Spain, as the volume of research produced is strikingly distinct, despite both countries having a relatively early surge on interest in this topic. Whereas in Spain there has been a greater academic interest and a sizable amount of publicly available remote sensing data, in the Portuguese context the interest has been relatively reduced and certainly limited by the lack or uneasy access to remote sensing data. Indeed, until recently the only archaeological evidence available was limited to a couple of cases (e.g. VV.AA., 1958; Nunes, Fabião and Guerra, 1988). Nevertheless, this panorama has now slowly been changing and the Roman military presence has lately been attested in a growing number of archaeological sites, mostly located near the northern Portuguese border and the Tagus Valley (e.g. Fonte *et al*., 2020; Pimenta, 2022; Fonte *et al*., 2023).

This paper will instead focus on the area corresponding to the central region of Portugal (Fig. 1), particularly the area situated between the Vouga and Douro rivers, where Roman military evidence had not yet been detected. Following a complementary non-invasive methodology which includes satellite and aerial imagery, both historic and recent, as well as UAV-based photogrammetric and LiDAR surveys, this paper presents and discusses the Roman military evidence identified at Alto do Golado (São Pedro do Sul, Viseu) and Modedufe (Lamego, Viseu). Though these sites were previously known, various relevant aspects have not thus far been perceived, misleading prior interpretations. Additionally, GIS-based spatial analysis also provided interesting results, allowing to put forward some hypotheses regarding the contextual framework of these Roman military sites.

1. The Roman army in Western *Hispania*: literary evidence and archaeological data

The Roman conquest of Western Iberia was a lengthy and non-continuous process, often assuming a punitive and, consequently, impulsive character (Fonte, 2022), contrasting therefore with the organised undertakings documented elsewhere in the Roman world (Fabião, 2006). Although the origins of this process can be traced to the context of the Second Punic War (218-201 BC), Roman military actions extended

westwards, in a more systematic way, during the second century BC, mostly as a result of several conflicts with the Lusitanians, an ethnic group traditionally allocated to the western part of the peninsula, with the earlier references dating to the beginning of this century (Liv. 35.1.5-12; 35.7.6; 37.46.7 and 37.57.5). These conflicts and their subsequent military movements intensified in the following decades, ultimately leading to the outbreak of the so-called Lusitanian Wars (155-139 BC) (App. Iber., 56-61, 70; Oros. Hist. IV.21.10), during which Roman control seems to have permanently extended to the Tagus valley. Indeed, the first Roman military incursions north of this river occurred in the aftermath of this war, when the governor of Hispania Ulterior, *Decimus Iunius Brutus*, led a punitive campaign against the allies of the Lusitanians in 138 BC, the *Callaici* (App., Iber., 71-73) (Fonte, 2022). Having the Tagus Valley as a base of operations (Strab., Geog., III.3.1), this Roman general advanced north following a route roughly parallel to the coastline, crossed the Douro River and reached the Minho River. This action did not, however, result in Rome's direct, permanent control of this region, as suggested not only by the archaeological record (Fonte, 2022) but also by further literary evidence, as there are references to another series of successive military campaigns against the Lusitanians within two decades of this expedition (Plut. Mar. 6; App. Iber. 99-100; Eutr. Brev. IV.27 and V.1). A greater impetus for the factual integration of these territories occurred with the unfolding of the Sertorian Wars (Plut. Sert., Sal, Hist. II.59, Oros. Hist., V.23.1-15), between 80 and 72 BC, as this conflict had a greater geographical scope and led to a greater and more concerted investment by the Roman Senate in *Hispania*. The integrative process of this region seems to have endured solely in the aftermath of the military campaigns undertaken by *Iulius Caesar* (Armada, García-Vuelta and Seoane-Novo, 2018), during his tenure as *propraetor* of *Hispania Ulterior* between 61 and 60 BC, which culminated with a naval expedition that reached *Brigantium,* modern-day A Coruña, in the far north of the western coast (App. Iber. 73-75, App. BC. 2, 8, 26-27; Plut. Caes. 11-12; Dio Cass., 37.52-53). Ultimately, the conquest of *Hispania* would only be completed in the course of the *Bellum Cantabricum et Asturicum* (Flor. Epit. XXXIII; Oros., Hist., VI.21.1-11), partly commanded by *Augustus* in the late 1st century BC and during which significant Roman military contingents were scattered across the northwest (e.g. González-Álvarez *et al*., 2019; Peralta Labrador, Camino Mayor and Torres-Martínez, 2019; Morillo *et al*., 2020; Menéndez-Blan-

co *et al*., 2020). Concluded the conquest, there was an administrative reorganisation of the territory that, for this region, chiefly resulted in the division of *Hispania Ulterior*, creating the province of Lusitania south of the Douro (Pliny, NH IV, 21), where the study area of this paper lies.

Following the flow and the temporal framework of this conquering process, the literary sources available were produced by several authors over a long period. Though frequently lacking geographical context and mentioning place names that have not endured, these sources have for a long time been the principal asset for academic research on this topic (Fabião, 2006). As mentioned earlier, the oldest literary texts referring to possible Roman military movements in this geographical context can be dated back to the beginning of the 2nd century BC and are provided by Livy (35.1.5-12; 35.7.6; 37.46.7 and 37.57.5). The most relevant source for this context is, however, Appian (Iber. 56-61, 70-75, 99-100 and BC 2, 8, 26-27), as this author offers the most detailed account of the various moments of the Lusitanian Wars (155-139 BC) and the multiple expeditions undertaken afterwards, as well as for the campaigns of Julius Caesar occurred between 61 and 60 BC, for which it is also possible to draw on data provided by Plutarch and Cassius Dio (Plut. Caes.; Dio Cass. 37.52-53). The Sertorian Wars (80-72 BC) constituted a pivotal moment for the expansion of Roman influence in the whole region and detailed information about this conflict is provided by Plutarch (Plut. Sert.) and Salust (Hist. II.59). Additionally, the works of the Late Roman authors Eutropius and Orosius (Brev., IV.27 and V.1; Hist. IV.21.10. V.23.1-15, VI.21.1-11) also add some information on these military undertakings.

Despite all the references to the movement of troops and even sieges provided by the various sources, the only direct reference to the Roman military sites associated with these activities is provided by Strabo, as was already noted by Fabião (2006). While describing the Tagus valley, this author (Geog., III.3.1) mentions the fortification of *Olisipo* (Lisbon) and the use of Moron as a base of operations by *Decimus Iunius Brutus,* then governor of *Hispania Ulterior* (Fonte, 2022), in the scope of his campaign undertaken in c. 138-136 BC and which resulted in the first Roman incursion northwards (App. Iber., 71-73). There is, however, some indirect literary evidence in other sources, mostly of geographic nature, referring to Roman military sites, such as the *Castra Servilia* and *Castra Caecilia* mentioned by Pliny (NH IV.22.117), the latter also given as a road station in the Antonine Itinerary (*Iter XXIV*

Item ab Emerita Caesaraugusta) and often associated with the roman camp of Cáceres el Viejo, Spain (Knapp, 1977; Pereira and Pereira, 2018). As these military sites bear the name of the commanding officer who allegedly promoted their foundation, some authors (e.g. Knapp, 1977; Alarcão, 2004) have suggested other similarly named places like *Caepiona*, mentioned by Ptolemy (2.5.6), and *Caeciliana*, a road station between *Olisipo* and *Salacia* (*Iter XII Item ab Olisippone Emeritam*), could, despite lacking the substantive *Castra*, have a putative military origin, though this was not thus far possible to corroborate as even the location of both sites remains undetermined (Fabião, 2006). A similar occurrence of a place name suggesting a military structure can be found in the case of *Aritium Praetorium* (Knapp, 1977; Fabião, 2014), also referred to as a road station in the Antonine Itinerary (*Iter XIV Alio Itinere ab Olisippone Emeritam*), but the archaeological evidence for this site is still lacking as well.

Although inexistent for the earliest periods of Roman expansion, epigraphic finds can also constitute an important indirect source to grasp the presence of Roman military contingents in present-day central Portugal. The inscriptions made by serving army members could be of particular interest as they often mention their respective military units. In some cases, it is not possible to determine the full name of the military unit, as can be observed in an inscription allegedly discovered in the Castro de Pinho (São Pedro do Sul) (Vaz, 1997: 200-202), commissioned by a certain *Tiberius Claudius Modestinus*, and which partly refers an unspecified cohort, or the inscription mentioning military personnel who served elsewhere in the Roman world (e.g. Encarnação, 2002). In other cases, however, it is possible to frame the inscription within the chronological and geographical scope of activity of the referred military unit, such as the inscription of *L. Lavius Tuscus* of the *Legio X Gemina*, dating from the reign of *Claudius* (r. AD 41-54), that was found at Castelo de Gaia (Vila Nova de Gaia) (Carvalho, 2003). Concomitantly, a different set of inscriptions can provide more direct evidence for the presence of the Roman army in a particular area, as observed in a Roman tile discovered at Manigoto (Pinhel), which bears a stamp with the letters LIIII MA (or MD) and, therefore, plausibly denotes it was produced by the *Legio IV Macedonica*, possibly having a detachment in this region (Alarcão, 2006). Indeed, both this Legion and the X Gemina were active in northwestern Iberia during the Cantabrian Wars and both were part of the *exercitus hispanicus*

that remained in the peninsula until the middle of the 1st century AD (Rodríguez Gonzaléz, 1998).

Portuguese academic research in Roman military archaeology experienced a relatively early outbreak in the middle of the twentieth century, interestingly associated with one of the first uses of aerial photography for archaeological research in this country, and which resulted in a set of relevant studies on the site of Mata Velha de Antanhol (Coimbra), while also referring other possible Roman camps, such as Chões do Alpompé (Santarém) or Valado de Santa Quitéria (Arganil) (Girão and Oleiro, 1953; VV.AA., 1958). Since then, however, the research on this topic has relied, almost exclusively, on the data provided by classical sources (Fabião, 2006), resulting in a significant number of studies presenting putative locations for the previously mentioned places of *Caeciliana*, *Caepiona* and, particularly, *Moron* (Fabião, 2014). According to Fabião (2004), the archaeological investigation undertaken at Lomba do Canho (Arganil) was the exception, as there was no literary evidence for a Roman site in the area and the materials exhumed at the site suggested a military context dating from the Late Republican period (Nunes, Fabião and Guerra, 1988). A renewed interest in this research topic surged in recent decades, especially in the Tagus valley, where archaeological investigations not only at the site of Chões de Alpompé, which has traditionally been associated with the *Moron* of the literary sources and where the evidence analysed thus far seems not only to support this hypothesis but also suggests possible subsequent military occupations (Arruda *et al*., 2018; Fonte *et al*., 2020), but also at Alto do Castelo (Alpiarça) (Pimenta, 2022) and Alto dos Cacos (Almeirim) (Pimenta, Mendes and Henriques, 2014) revealed possible Roman military settlements. Additionally, evidence from excavations undertaken at Monte dos Castelinhos (Vila Franca de Xira) (Pimenta, 2022), Santarém (Arruda and Viegas, 2014) and even Lisbon (Pimenta, 2014), also suggests some degree of military activity, particularly for the latter where a ditch possibly related to a military installation dated from the 2nd century BC was identified (Pimenta, 2022), seemingly corroborating the literary evidence mentioned earlier (Strab. Geo. III.3.1.). Indeed, the evidence uncovered in most of these sites has been chronologically framed into this period of early Roman expansion (Pimenta, 2022), being therefore fittingly related to the moment in which the sources document military activity around the Tagus area, particularly to the campaigns of *Decimus Iunius Brutus* in

the second half of the 2nd century BC (Gomes, 2022). The previously mentioned camp of Antanhol has also traditionally been associated with this military incursion (VV.AA., 1958), however, the lack of any archaeological work undertaken there thus far does not allow to corroborate this hypothesis. Recent research has, nevertheless, put forth new data that can arguably support an early Roman military occupation at Antanhol, namely the identification and subsequent study of the possible shipwreck of Arruelas (Figueira da Foz), located in an area that would have been an ancient estuary of the Mondego, which was loaded with a set of ceramic materials dating between 140 and 130 BC (Imperial, 2022). Similar materials were also identified at Santa Olaia (Silva *et al*., 2021), a relevant hillfort settlement located in relative proximity to this shipwreck and which would have been the main port in this area. Given this overall picture, most of the evidence for the Roman military presence known thus far appears particularly concentrated in the Tagus and Mondego valleys (Fonte *et al*., 2020; Pimenta, 2022). Nevertheless, the advent of remote detection techniques and the increasing availability of data has, however, recently been improving this panorama of the Roman military presence in what is now Portuguese territory (e.g. Costa García *et al*., 2019; Fonte *et al*., 2023; Fonte *et al*., 2024).

2. Remote sensing and Roman military archaeology in Western Iberia

The use of aerial photography can provide valuable information for archaeological research. Interpreting, documenting and mapping any visible features in oblique or vertical aerial photographs (e.g. Ceraudo, 2013), namely crop, soil or shadow marks, it is possible to identify sites, or features of a site, which are frequently difficult or even impossible to perceive from a ground-level perspective. Considering a broader perspective, these datasets can be used to study past landscapes and the changes that occurred from the second half of the twentieth century onwards. The increasing use of these techniques resulted in significant advances in Roman military archaeology (Menéndez-Blanco *et al*., 2013) and, indeed, aerial photography already has a long tradition of use in this research topic, particularly in the Spanish context, where aerial imagery was already used in the identification of the Roman camps of Cáceres el Viejo (Almagro Basch, 1943) and Numantia early in the 20th century (González Reyero, 2007: 239), while several

other sites have also been identified using mostly aerial orthophotography from the so-called Vuelo Americano, an aerial photographic survey undertaken by the United States Air Force in the 1950s (e.g. Loewinsohn, 1965; Sánchez-Palencia, 1986).

Contrastingly, the use of these techniques has, until recently, been limited in Portugal (Fumadó Ortega and Sánchez Pardo, 2013). Although the first documented use of aerial photography for archaeological investigation can be traced to 1934[2] and it was even documented in the study of the possible Roman camp of Mata Velha de Antanhol during the 1950s (VV.AA., 1958), this technique has been generally neglected by Portuguese archaeologists (Fumadó Ortega and Sánchez Pardo, 2013) until the turning of the millennium (e.g. Lopes, 2003; Mantas, 2003). Nevertheless, there has recently been a renewed interest in this technique (Blanco-Rotea *et al*., 2016; Costa-García, Fonte and Gago, 2019) and thus the panorama has been changing, particularly given the increasing availability and ease of use of unmanned aerial vehicles (UAV), as well as the increasing accessibility to historical and recent aerial photographs and satellite imagery.

In the last two decades, other remote sensing techniques have been developing and some have revealed great potential for archaeological research. Perhaps the best known of these is the Light Detection and Ranging (LiDAR) technology, which can be carried on an aerial platform to survey large areas. This active remote sensing technique uses a sensor that emits high-frequency near-infrared laser pulses that generate one or more returns upon contact with any physical object and which are then received back by a sensor. Being transported on an aerial platform, it is possible to repeat this process over a trajectory and, given the very high scanning frequency of the sensor, acquire large quantities of high-precision data in a relatively short period of time (Historic England, 2018), subsequently creating three-dimensional point clouds. These points clouds can thereafter be processed, classified and interpolated to generate digital surface models (DSM), when the first returns are considered, or digital terrain models (DTM), obtained through the interpolation of the ground classified points, therefore effectively "removing" vegetation canopies (Devereux *et al*., 2005). As the result of this interpolation is usually a relatively precise model of the surface,

[2] Produced in the context of the archaeological excavations at Silveirona, directed by Manuel Heleno, then director of what is now the National Museum of Archaeology. Currently held in the Museum's archives.

the DTM are particularly useful for archaeological research, as either by themselves or enhanced with various visualisation techniques, they can reveal small topographic features of archaeological interest that frequently were otherwise imperceptible.

The availability of LiDAR data and its subsequent use for archaeological research in the Iberian Peninsula is marked by a striking dichotomy, corresponding to the modern border between Portugal and Spain and the different policies followed thus far by each country. Whereas in Spain there are already data from several national coverages and the use of LiDAR data for archaeological research has been steadily increasing in recent years, in Portugal the panorama is rather different, as airborne LiDAR data is still scarce and mostly with restricted accessibility. Indeed, until recently, the only data available for the Portuguese territory was limited to a low-resolution strip corresponding to the oceanic shoreline, publicly available solely as a DTM and through a Web Map Service (WMS). This picture has, nonetheless, been slowly changing, firstly with a LiDAR survey covering the northern district of Viana do Castelo (approx. 2400 km²), commissioned by the local Comunidade Intermunicipal do Alto Minho (CIM Alto Minho), and thereafter with several surveys undertaken by the Instituto de Conservação da Floresta e Natureza (ICNF) in the framework of their áGil Project. Though this project chiefly sought to test the potential of airborne LiDAR to monitor densely forested areas of high wildfire risk, surveying seven test areas across central and northern Portugal as case studies, the data produced was made publicly available in a classified point-cloud format and can therefore be used for archaeological research (Vilarinho, 2021). Concomitantly, there have also recently been several private, small-scale surveys undertaken with UAV-installed LiDAR sensors, mostly in the framework of the Odyssey Sensing Project (Soares *et al*., 2023; Serra *et al*., 2023a; Serra *et al*., 2023b).

Coincidently with data availability, the use of airborne LiDAR data in the context of Portuguese archaeological research is still forcibly limited, mostly using the data from the Viana do Castelo district or the Spanish datasets (e.g. Costa-García, Fonte and Gago, 2019; Fonte *et al*., 2021), that provide some coverage of frontier areas. Though limited, the analysis of this data has nonetheless revealed several previously unknown Roman camps in northern Portugal (Blanco-Rotea *et al*., 2016; Costa-García, Fonte and Gago, 2019; Fonte *et al*., 2023; Fonte *et al*., 2024). Additionally, recent research projects using UAV-LiDAR have also detected a possible military site at Mina da Presa

(Sánchez-Palencia and Currás, 2015; Currás and Sánchez-Palencia, 2021) and even revealed previously unknown features at Chões de Alpompé (Fonte *et al*., 2020), a site that, as mentioned earlier, has been subject to considerable prior academic interest. This panorama will hopefully soon improve, as the first national LiDAR survey of the territory is currently underway, and this will certainly provide a significant leap forward in the use of remote sensing in Portuguese archaeology.

3. Material and methods

The archaeological evidence presented and discussed for each site was first identified while analysing aerial photographs, both historical and modern. Therefore, the preliminary approach of this study followed a non-invasive methodology, constituted by an integrative acquisition, processing and analysis of remote sensing data. Firstly, the satellite imagery datasets provided by commercial platforms, such as Google Earth and Microsoft Bing, were extensively inspected, followed afterwards by a thorough analysis of the available collections of vertical aerial photos, historic and recent, particularly the earlier extant examples from the 1945 SPLAL (Sociedade Portuguesa de Levantamentos Aéreos, Lda) flight and the 1995, 2004-2006, 2018 and 2021 aerial coverages provided by Direcção-Geral do Território (DGT). Subsequent steps included UAV-based photogrammetric surveys, aiming to produce detailed and high-resolution tridimensional topographical and morphological models at both sites. Additionally, a UAV-based LiDAR survey was also conducted at Montedufe, where the overall conditions of terrain and archaeological remains seemed adequate and advantageous to employ this technique. The interpretative process undertaken during the analysis of the different datasets was, naturally, a subjective undertaking, mostly based on previous knowledge of the particular characteristics of Roman military sites and, indeed, the archaeology of this region.

The initial approach to each site followed a similar methodology, as mentioned above. After analysing the satellite data available, the 1945 SPLAL flight (1:15,000 scale) stereoscopic aerial photos were acquired from the Portuguese Army, through their Centro de Informação Geoespacial do Exército (CIGeoE) (Redweik *et al*., 2010). The orthorectification of these historical aerial photos followed a similar

approach of photogrammetric structure-from-motion (SfM) and multi-view stereo (MVS) as published elsewhere (Blanco-Rotea *et al*., 2016; Gonçalves, 2016; Fonte and Costa-García, 2016; Fonte *et al*., 2017; Fonte *et al*., 2020; Fonte *et al*., 2021). These images were subsequently processed using Agisoft Metashape Pro, where the various images were aligned and thereafter several ground control points (GCP) were introduced for accurate georeferencing processing. This procedure was followed by the processing of the dense point cloud, which was then used to generate DSM and orthomosaics, with a spatial resolution of 0.30 m.

Although airborne LiDAR has been yielding excellent results in archaeological research, primarily because it enables the acquisition of high-resolution DTMs even in densely vegetated areas, allowing for topographical readings that would otherwise be unattainable through photointerpretation of aerial or satellite imagery, Portugal still lacks a full national LiDAR coverage. Consequently, a cost-effective alternative was considered to provide detailed digital models of the sites under analysis. In this case, low-altitude aerial photogrammetric surveys were undertaken using UAVs. The resulting data was subsequently processed following the same SfM-MVS approach mentioned earlier and using the Agisoft Metashape Professional, a well-known software commonly used for three-dimensional modelling through the generation of point clouds, which are unclassified by default. Therefore, to obtain a DTM, a rather relevant step is the classification of the point clouds. Indeed, this software offers four distinct point classification tools. The first, which is nearly entirely automatic, is the Classify Points (CP) tool, where the user only needs to adjust one parameter, which, when set to 0.00, results in an automatic classification. The second tool, Classify Ground Points (CGP), is also highly automated but requires the user to manipulate four geometric parameters (max. angle, max distance, cell size, erosion radius) "which are used to distinguish points representing the bare earth from those representing other features based on the angle and slope from adjacent points. This tool uses a TIN-based algorithm" (Howland *et al.*, 2022: 5). The third option is Select Points by Colour (SPC) and it allows for a classification based on colour values. In cases where there is a lower colour variation, displaying for instance similar vegetation and soil points, this tool yields better results. In this case, the proceeding is not, however, fully automated and requires a greater interaction from the user, particularly concerning colour choices and

tolerance settings. Finally, the Assign Class (AC) tool is a completely manual process where the user must select and classify the various points, an often time-consuming task with results depending heavily on the field-acquisition data parameters.

As for the sites analysed in this study, the more promising results were obtained using two distinct tools. Whereas for Montedufe it was the CGP tool that produced the best results, for Alto do Golado it was the SPC instead. This can largely be attributed to the different types of vegetation canopies presently covering each site, considering that in Montedufe the vegetation is mostly characterised by pine trees and deforested areas, while at Alto do Golado there is a high density of low shrubs and occasional rocky outcrops. After processing and analysing this digital data, the initial mapping results were subject to an extensive ground-truthing procedure and then subsequently adjusted. This validation on the field cannot at any rate be discarded or overlooked, as it is essential to corroborate, or not, these desk-based assessments and frequently adequately perceive the contextual framework of the previously observed features.

The following methodological step in this research consisted of an integrated analysis of the data resulting from prior assessments and fieldwork. In order to further characterise the contextual framework and eventual settlement patterns for both sites, GIS (Geographic Information System) spatial analysis tools were then explored to compute visibility and mobility-related models, namely viewsheds, time isochrones and MADO (*Modelo de Acumulación del Desplazamiento Óptim*o) (Fábrega-Álvarez, 2006; Fábrega-Álvarez and Parcero-Oubiña, 2007; Llobera, Fábrega-Álvarez and Parcero-Oubiña, 2011). The MADO employs relatively complex calculations and processing to produce an accumulative model of optimal routes between or radiating from several points based on the principle that certain physical factors influence human movement. Computing algorithms assume that slopes and waterways restrain spatial movement (friction/cost) and calculate the routes providing superior cost-efficiency, where cost is measured through an energy expenditure formula, considering walking time based on slope and waterway conditions, which can remain relatively constant over time. This computing model aims to achieve a minimum cumulative cost (García Sanjuán *et al*., 2009: 176; Osório, 2014: 13), resulting therefore in optimal Distance-Cost pathways.

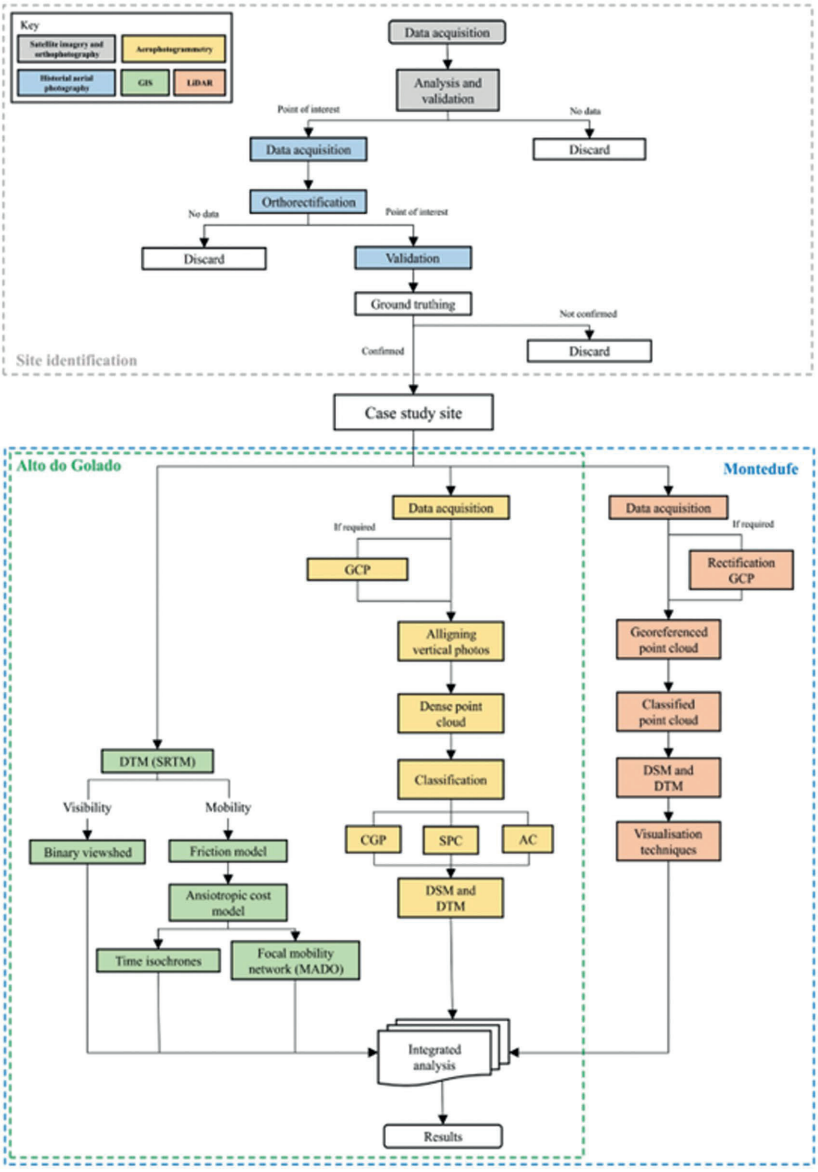

DIAGRAM 1 - *Schematic methodological flowchart*

In the case study of Montedufe, a MADO produced earlier in the context of the 'Fortified and Monumentalized Landscapes of the Beira-Douro Project' was used. This model was computed from a friction surface of 128kmx100km, based on the DEM (Digital Elevation Model) from the Shuttle Radar Topography Mission (STRM) with a 30m spatial resolution. Subsequently, sixty-four cost-weighted surfaces were created, from which accumulated flows originating from the central point (with no determined destination) of each cost surface were obtained. A QGIS-integrated GRASS tool (r.flow) was then employed to eliminate accumulated flows with a value below 70,000 per cell (Canha, 2022: 259-265). The MADO used for the case study of Alto do Golado was created while analysing potential movement flows in the area of Lafões (Redentor and Canha, 2023) and, for this model, 29 cost-weighted surfaces were established, eliminating accumulated flows with 30,000 per cell value.

To calculate the isochrone lines, it was assumed that walking on a flat surface without obstacles covers approximately 5000m in an hour (Vita-Finzi and Higgs, 1970: 7) and the computing was undertaken using the same friction surfaces mentioned earlier. The resulting Cost surfaces were generated through the GRASS r.walk.points tool with the respective points of origin located at the centre of the Montedufe and Alto do Golado enclosures. A maximum cumulative cost of 10,000m (2h) was considered for this analysis, displaying 15-minute isochrone lines based on the processed cost surfaces.

As for the visibility analysis, binary potential viewshed models were produced for each site (Kennedy, 2009: 509-510), using the same SRTM 30 DEM as the base map for terrain elevation. Seeking to strengthen this analysis and particularly considering the uneven topography of Alto do Golado and Montedufe, a set of points was carefully selected along the perimeter walls and interior areas of both sites. These were, in turn, used as the viewpoints, with an observer height of 1.7m, to compute a 10,000m radius accumulated viewshed that was subsequently converted into a binary display of 0 (not visible) and 1 (visible).

3.1. Montedufe

The photogrammetric survey of Montedufe was undertaken using a DJI Mavic Pro with a camera featuring a 1/2.3" (CMOS) sensor and 12 megapixels of effective pixels. Using an aiding software to conduct an automated and systematic survey, the flight plan was preemptively

prepared and the different parameters were defined as well. Indeed, the nadir flight was set at an altitude of 50 metres with an 80% overlap and an estimated ground sampling distance (GSD) of 1.64 cm/pixel. Given the rather sizable area of this site, the photogrammetric survey had to consequently cover an extensive area (430m x 610m) of approximately 26 hectares and was therefore accomplished in the course of 5 missions, resulting in a set of 1071 photographs. In this case, the resulting data was not georeferenced through Ground Control Points (GCP) as the GPS system from this UAV model was deemed accurate enough.

After the survey on site was concluded, the data was then processed using Agisoft Metashape Pro, following a multi-stage procedure that started with the alignment of all the vertical photos obtained and continued afterwards with the processing of a dense point cloud. As the major objective of this photogrammetric survey was to produce a detailed DTM, the classification of the point cloud was then undertaken using the previously mentioned CGP tool and considering the following parameters: max. angle (deg): 15; max distance (m): 0.05; cell size (m): 10; erosion radius (m): 0. These parameters have already revealed great potential in case studies analysed elsewhere (Howland *et al*., 2022) and proved effective for Montedufe as well. Subsequently, a DTM with a resolution of 9.35 cm/pixel was interpolated using solely the ground points, resulting, naturally, in a significant improvement from earlier DSMs. Lastly, an orthomosaic was also generated, having a resolution of 2.34 cm/pixel.

Though the DTMs obtained through SfM-MVS photogrammetry can reveal interesting results and might sometimes suffice for some archaeological investigations, a DTM interpolated from airborne LiDAR-derived data can nonetheless constitute a significant improvement, particularly considering this remote sensing technique has the capacity to penetrate vegetation canopies and, consequently, provide high precision elevation data even in densely forested areas. Contrastingly, SfM-MVS photogrammetry relies on images captured from the air, and its accuracy heavily depends on several factors, such as image resolution, camera quality or the ability to accurately classify ground and non-ground points. This technique can consequently be severely limited in areas presenting a dense vegetation canopy or a complex topography, as the resulting images lack the necessary detail to create an accurate DTM. Therefore, whereas SfM-MVS photogrammetry can have superior cost-effectiveness and be an accessible method for terrain modelling, the outcome will hardly be able to match the precision

and topographic detail of DTMs generated from airborne LiDAR data, especially in challenging environmental conditions. Given that Montedufe is partly covered by a dense forest of pine trees, a LiDAR survey was deemed particularly relevant to improve the previous assessment and grasp a better understanding of this site.

The UAV-based LiDAR survey of Montedufe was undertaken using a Microdrones md4-1000 drone, equipped with the mdLiDAR 1000 HR, integrated with a Velodyne Puck VLP-16 LiDAR sensor, owned by Era-Arqueologia. The data acquisition flight was undertaken at an altitude of 70 metres, with a speed of 7 metres per second and a lateral overlap of 50 % between scans. An area of roughly 20 ha was surveyed, resulting in a LAS format point cloud with a density of approximately 100 points per square metre. Trimble's Applanix POSPac UAV software was used for the rectification of the trajectory of the drone and GNSS data from the Rede Nacional de Estações Permanentes (ReNEP), provided by DGT for PPK (Post Processed Kinematic) positioning. Concluded the rectification, the generated file was further processed using Microdrones' mdInfinity software, originating a georeferenced point cloud.

This point cloud was then post-processed using the LAStools and planlauf/TERRAIN software. Firstly, the point cloud was classified with LAStools, allowing the identification of the ground points. Thereafter, a DSM and a DTM were interpolated using planlauf/TERRAIN, both displaying a 0.20 m spatial resolution. Aiming to accentuate archaeological microtopographies, various visualisation techniques were then applied to the DSM and DTM, namely the local relief model (Hesse, 2010), positive openness (Doneus, 2013) and sky-view factor techniques (Zakšek, Oštir and Kokalj, 2011).

3.2. Alto do Golado

For this site, a low-altitude aerial survey was conducted using a Yuneec H520E UAV equipped with an E90X camera featuring a 1" (CMOS) sensor and 20 megapixels of effective pixels. Also making use of specialised software to conduct an automated and systematic survey, the nadir flight plan set a constant altitude of 50 metres with a 70% overlap and an estimated GSD of 1.5 cm/pixel. This survey was undertaken in a single mission, covering an area of approximately 280m x 285m, roughly corresponding to 8 hectares, and resulting in 112 photographs. Additionally, this survey was georeferenced using five Ground

Control Points (GCP) obtained through a centimetre-precision GPS/GNSS, specifically the Emlid Reach+, connected to the Rede Nacional de Estações Permanentes (ReNEP) provided by the DGT.

The following processing of the acquired data started, once again, with the point cloud classification procedure. Given the dense low vegetation cover, mainly composed of small shrubs, the CGP tool proved ineffective, not only when using the parameters employed for Montedufe but also while testing different approaches. As the area exhibited a mostly green/grey bichromatic picture (vegetation/rock outcrops), the SPC tool was then employed and, firstly, rocks and visible soil were classified as terrain using the colour parameter #98a0ab, a tolerance of 30 and channel Hue. The broad range of greys did, however, compromise the results obtained. Contrastingly, the range of greens seemingly presented a greater uniformity, therefore leading to a change in this approach and the low vegetation was instead selected, using the colour parameter #787e6e with a tolerance of 30 and channel Hue. By inverting the selected points it was then possible to adequately muster all the points not corresponding to vegetation, hence being either soil or stone, which were subsequently classified as terrain points. In this case, the classification focused solely on distinguishing between these two classes, and although classifying paths were not considered, these would have been processed with relative ease given the distinctive colouration. After the classification of the point cloud was concluded, the interpolation of a DSM and DTMs ensued, the latter being generated using the parameters mentioned earlier for Montedufe and having a 3.08 cm/pixel resolution. Finally, the orthomosaic produced for Alto do Golado had a resolution of 1.54 cm/pixel.

Comparing the results obtained for Montedufe and Alto do Golado, it is possible to ascertain that SfM-MVS photogrammetry can yield interesting results when the processing and point-cloud classification tools are tailored to the constraints imposed by the various variables registered during the data acquisition procedure in the field.

4. Results

4.1. Montedufe

This site is located on the eastern end of a small ridge displaying a roughly northwest-to-southeast orientation, presenting a maximum

elevation of 976 metres above sea level. Administratively, Montedufe is situated in the southernmost area of Vila Nova de Souto D'El-Rei parish, part of the municipality of Lamego. The single previously known reference to an archaeological site at Montedufe was provided by the Endovélico, the official database of the governmental entity for cultural heritage. There, the site (CNS 3538) has been registered as an Iron Age fortified settlement, seemingly resulting from a 1981 investigation named "Maps of Places of Archaeological Interest in the Oporto District" developed by a Northern Archaeological Research Group. Analysing the sparse available for this project has nonetheless revealed it might have solely resulted in the mapping of possible archaeological sites, without any further information. Indeed, the database entrance for Montedufe does not contain any description whatsoever.

Recent archaeological research undertaken on this site occurred mostly in the course of the "Fortified and Monumentalized Landscapes of the 'Beira-Douro' between the 3rd and 1st millennia BC - Architectures, Scenarios, and Symbolism" project (Canha, 2022). After a previous desk-based assessment, an initial visit to the site occurred in early 2019, followed by subsequent ground-truthing fieldwork aiming not only to document archaeological features but, particularly, to analyse the different phases of vegetation coverage as well. This undertaking revealed the northern sector was primarily covered by heather and other low shrubs, while the southern sector presented a relatively dense forested area of mature pine trees. During a subsequent reforestation process, the vegetation on the northern sector was cleared and, despite fortunately having no sizable impacts on the soil, the opening of a new trackway partly damaged the northern side of the inner enclosure. This reduction of the vegetation canopy has also resulted in the seemingly favourable situation to undertake a UAV-based photogrammetric survey. Nevertheless, the southern forested area was still somewhat difficult to read and, therefore, a UAV-based LiDAR survey was also conducted, in collaboration with the Odyssey Remote Sensing project.

The following analysis of all the evidence from the previous desk-based assessment, the aerial surveys and the various ground-truthing procedures revealed entirely atypical features for an Iron Age hillfort in this region, particularly considering size, morphology and structural features. Contrasting with other known hillforts, the defensive perimeter observed at Montedufe is not defined by a wall but by a low earthen embankment instead. Furthermore, it was possible to confirm

it consists of two concentric embankments, as already suggested while analysing historical aerial photography from the 1945 SPLAL flight (Fig. 2). The innermost enclosure displays a sub-oval configuration, presenting a maximum length of approximately 265 metres and a maximum width of roughly 106 metres, covering an area of 2.22 hectares (Fig. 3), and is delimited by an earthen rampart, currently measuring between 0.6 and 1 metre in height and presenting a base section gauging approximately 5 metres (Fig. 4). As mentioned earlier, this structure is intersected at the eastern and western ends by a recent trackway that crosses the entire ridge. The second enclosure displays an irregular sub-elliptical configuration, measuring roughly 450 x 270 metres and encompassing an area of 9 hectares (Fig. 3). Being located on the slope and having been subject to various forestry and subsequent ground levelling undertakings, this enclosure is harder to perceive on the terrain, frequently consisting of a discrete bump a few centimetres above the ground. Nevertheless, it was still possible to observe a small relatively well-preserved section of this rampart on the east-southeast side of the site, identical in all respects to the smaller enclosure (Fig. 4), suggesting a similar context for both structures.

Identifying extant entrance points on site has proven a rather difficult task using recent data, mainly because existing traces could have been located in areas where agricultural and forestry ground impact was greater. Therefore, the interpretation provided for possible entrances relies primarily on historical aerial photos and partially on the models resulting from the aerial surveys. Despite these limitations, a thorough analysis of these data suggests the smaller enclosure might have had a single entrance, possibly located along the southeastern longitudinal axis. Regarding the outer perimeter, the results obtained revealed particularly relevant features suggesting a possible "chicane" entrance on the eastern side. This type of entrance is formed by the parallel arrangement of two lengths of rampart forming a corridor. Similar entrances have been documented in the Roman military sites of O Penedo dos Lobos (Galicia) (Fonte, Costa-García and Gago, 2022), El L.laurienzu (Asturias) (Costa-García *et al*., 2016: 54-55; Martín Hernández, 2015: 244-245) and El Juncal (Cantabria) (Vicente García, 2020), all three possibly contemporary with the Cantabrian and Asturian Wars (29-19 BC) (Fig. 5).

The similar morphological and constructive characteristics observed for both structures can easily suggest a coeval period of occupation and, perhaps, even construction, although other hypotheses cannot

be fully discarded. Considering the building technique, it is possible to suggest it was intended for rapid constructive undertakings. The embankment of the relatively better-preserved inner enclosure also appears to constitute a small levelled area, perhaps having soil removed from the interior to build the ramparts, therefore forming a relatively flattened platform. This apparent swiftness in construction, combined with the steep topography of the site, particularly on the northern side where there is a pronounced slope between the ridge and the second perimeter line, strongly suggests this site was not intended for long-term occupation.

A possible parallel to Montedufe can be found in the Roman camp of Sierracastro (Cantabria), also related to the Cantabrian Wars (Fernández Acebo and Martínez Velasco, 2010: 441-444) (Fig. 5 A). This military site is located on the summit of a hill, having therefore good visual control over the surrounding landscape. Morphologically, it displays an oval-shaped enclosure defined by a double agger (though a third one is apparent to the north), encompassing an area of roughly 5 hectares. The inner enclosure is rather similar in size to the one observed at Montedufe, covering approximately 3 hectares. The morphological adaptation to the topography can also be similarly noticed in other Roman military enclosures documented throughout Northwestern Iberia, particularly the main singing camp of La Loma (Peralta Labrador, 2015; Peralta Labrador, Torres-Martínez and Domínguez Solera, 2022) (Fig. 5 C) or the castellum of A Recacha (Menéndez-Blanco *et al.*, 2011; Pérez-Díaz *et al*., 2021) (Fig. 5 D). Albeit these sites display rather irregular layouts, contrasting therefore with the more easily recognisable playing-card-shaped morphology, there nonetheless is an attested general tendency to use rounded corners and straight lines.

The results from the GIS spatial analysis revealed interesting details for a better understanding and contextualisation of this site in the wider landscape, particularly regarding the topographic setting and the inherent visual dominion over the surrounding area. Additionally, the theoretical movement flow lines obtained through the computed MADO offered interesting perspectives on the overall mobility across this territory. These elements will be analysed and discussed in detail in the following chapter

4.2. Alto do Golado

Alto do Golado is located on a remote high ridge of Serra da Arada, São Pedro do Sul, and was documented during an analysis of the aerial imagery resources available for this region. Surveying the satel-

lite data available on Google Earth and Microsoft Bing, as well as the various orthophotos from DGT available for this region, it was possible to identify extant positive remains of a large playing-card-shaped enclosure covering approximately 1,6 hectares in area. A more detailed observation also revealed a distinctive type of construction that seemed to be an entrance to the enclosure, situated on the southwestern side, and which clearly resembled a *clavicula*, a standard type of protected entrance for Roman temporary military camps (Fig. 7 and 8). In addition, the subsequent analysis of historical aerial photography, namely from the 1945 SPLAL flight, resulted in the detection of other two entrances on the southeastern and northeastern sides of the enclosure, both showing traces of *claviculae*. Further study of this dataset also made it possible to ascertain that, since then, a trackway surged across the enclosure. This trackway was therefore post 1940 and, despite of crude construction, it damaged the possible remains of the northwestern entrance, consequently explaining why these are not easily perceptible nowadays. A smaller enclosure with a similar constructive technique (Fig. 7 and 8) can be observed perpendicularly attached to the southwestern side and, based on evidence for similar sites found elsewhere (e.g. Jones, 2012), it can be interpreted as an annexe to the larger, main enclosure.

The area where the site is located has recently undergone the construction of a wind farm and, as such undertakings require preventive archaeological investigations, the subsequent research on the reports available revealed that the enclosure had already been noted during the prior surveys of this area (Caninas and Henriques, 2000; Henriques and Caninas, 2019). Notwithstanding, it was interpreted as an ethnographic feature, thus post-medieval or even contemporary in chronology, and though an interpretation for the functionality of this enclosure is never provided, there is an underlying hypothesis that it might be related to animal husbandry. The report also does not provide any information on the playing-card morphology and the protected entrances, features that were therefore only identified in the course of this research. These particular features, as well as the location of the site, have clear parallels with other Roman military sites that have been recently discovered throughout northwestern Spain and Portugal, namely Alto da Pedrada (Arcos de Valdevez, Viana do Castelo) (Costa-Garcia, Fonte and Gago, 2019: 25-27) (Fig. 10), O Penedo dos Lobos (Manzaneda, Ourense) (Costa-García *et al*., 2016: 48-50; Fonte, Costa-García and Gago, 2022) (Fig. 11), Alto da Raia (Montalegre, Vila Real and

Calvos de Randín, Ourense) (Fonte *et al*., 2024) and, to some extent, also Alto da Cepeira (Guitiriz, Lugo) (Currás *et al.*, 2021: 2-7).

The subsequent ground-truthing process was particularly thorough and permitted the confirmation of the hypotheses put forward for the various features in the previous interpretive process. Despite a shallow vegetation canopy covering most of the area where the site lies, visible positive remains were observed for the whole perimeter of the enclosure, as suggested by the previous assessment, constructed using dry local stone and sometimes taking advantage of rock outcrops (Fig. 9). The remains of the *claviculae* are also perceptible on the ground, the southwestern and northeastern being the best preserved. Nevertheless, features suggesting a fourth entrance with *clavicula* were also observed on the northwestern entrance, though this was, as mentioned above, greatly affected by the trackway. The various pedestrian surveys undertaken in the interior of the enclosure did not provide a single artefact. This lack of material culture has, however, also been observed in temporary camps documented elsewhere, for instance in the case of Alto da Pedrada (Corta-Garcia, Fonte and Gago, 2019: 25-27) and has often been considered a common feature of this type of site. A significant exception can be found at the already mentioned Roman camp of O Penedo dos Lobos, where a survey methodology using metal detectors revealed a rather interesting set of archaeological materials that not only confirm the Roman military nature of the site but also its possible occupation in the context of the Cantabrian Wars, attested by coins minted by Augustus*'* legate *Publius Carisius* (25-22 BC) (Fonte, Costa-García and Gago, 2022). This can be particularly relevant for the case study of Alto do Golado given the typological proximity between the two sites and considering it was not yet possible to undertake a similar methodological approach. Although the annexe is a unique feature without any parallel known thus far in Western Iberia, analysing all this evidence and considering the close typological parallels with several other sites, partly resulting from the relative standardisation of Roman military sites, it seems plausibly safe to assume Alto do Golado could be a small *castra aestiva,* that is a Roman military temporary camp, dating to the late 1st century BC or the 1st century AD.

The computed GIS models provided significant insights for a comprehensive analysis of this site within the wider landscape, namely considering the visibility and mobility aspects. Indeed, the optimal movement routes computed by the MADO suggested that, though

somewhat isolated, Alto do Golado might have controlled a significant mountain route intersection. A thorough analysis and subsequent discussion of these aspects will ensue ahead.

5. Discussion

The interpretative process of the archaeological evidence detected at Montedufe was somewhat conditioned by the considerable impact various agro-forestry undertakings had, over the course of several decades, in some sectors of the archaeological site. Prior to the investigation undertaken in the course of the "Fortified and Monumentalized Landscapes of the Beira-Douro'' project (Canha, 2022), the knowledge on this site was rather limited and solely a portion of what has been described as interior enclosure had been detected. The analysis of aerial imagery, historical and recent, and LiDAR data, permitted not only the observation and mapping of the visible remains of this inner feature but also resulted in the identification of an exterior enclosure. Subsequent analysis revealed the architecture and construction techniques of these enclosures present some distinctive features dissonant with the architecture of the indigenous settlements of the region, particularly a possible defended entrance in "chicane", an architectural solution commonly used in Roman camps. Although not displaying a playing-card-shaped layout as Alto do Golado, the morphology and constructive technique of Montedufe revealed also some interesting close parallels in Roman military sites detected throughout the northwestern Iberian Peninsula, for instance, the sites of Sierracastro (Fernández Acebo and Martínez Velasco, 2010), A Recacha (Menendéz Blanco *et al*., 2011; Pérez-Díaz *et al*., 2021) and La Loma 1 (Peralta Labrador, 2015; Peralta Labrador *et al*., 2022). Recent research undertaken at these sites revealed they were constructed in the context of the Cantabrian Wars and perhaps a similar relative chronological framework can tentatively be advanced for Montedufe. Nonetheless, lacking a more invasive approach at this site, other hypotheses must not be excluded, starting the possibility the two enclosures could result from two distinct construction periods, albeit identical construction techniques suggest similar origins, or even that the site can be from a distinct period altogether. Hopefully, further archaeological research will shed new light on this issue.

If the Roman military occupation of Montedufe is confirmed, this site can then likely be considered a castra aestiva, as it displays a close similarity to the aforementioned sites.

These Roman camps display, however, distinct functionalities, especially La Loma 1, which was constructed as part of a larger network besieging an indigenous hillfort (Peralta Labrador, 2015; Peralta Labrador *et al*., 2022), whereas the contextual evidence analysed and the topographic settings of Montedufe seem to suggest this site might have been linked to territorial control. Indeed, the commanding topographic position of this site naturally provides a sizable visual dominion over the surroundings, particularly towards the northern and eastern lower areas. Concomitantly, the location of the site can also provide rather significant and direct control of natural and historical passageways, particularly the ones taking advantage of the Balsemão River valley where the N2 route is still a modern testimony of this relatively easier course of movement. Further analysis using the GIS computed MADO revealed various relevant theoretical movement flow lines, one of them specifically crossing the ridge where Montedufe is located (Fig. 6). This movement flow, largely running on a southwest-to-northeast axis, can be particularly important as there is a bifurcation in less than a 30-minute walking distance, from which two branches then move onwards to two significant sites in the region, namely Lamego and the relevant Castro de Fontelo (Canha, 2022, II: n. º 41). Although there is no direct visual contact between Montedufe and these sites, there seems to be a direct relation between them, particularly with Lamego, the main urban centre in this area since antiquity (Baeta, 2021), located just 6 km to the north. Interestingly, the movement flows can be further supported with the data resulting from the processing of the isochrone lines, where a clear tendency for easier movement in the southwest-northeast direction can be observed. To a lesser extent, the calculated isochrones also attest to a relatively easier movement from Montedufe towards the east. This can assume a particular relevancy as it coincides with the orientation of the possible main entrance, located on the eastern side of the outer enclosure, presumably indicating the primary orientation of the site. Indeed, this interpretation is further reinforced by the apparent poorly defended western sector of the site, coincidently the one displaying greater fragilities considering the topography and morphology of the site, eventually denoting it was built with an interest towards the east.

As for Alto do Golado, the archaeological evidence analysed

strongly supports the interpretation of the Roman military nature of this site, particularly considering the clear identification of standard features such as the playing-card layout and the entrances protected with *claviculae*. Based on evidence recorded in similar Roman camps such as Alto da Pedrada (Costa-García, Fonte and Gago, 2019: 25-27) and O Penedo dos Lobos (Fonte, Costa-García and Gago, 2022), these constructive and morphological features can also provide a relative chronological framework for the occupation of this site roughly dating between the end of the 1st century BC and the 1st century AD. Whereas the research undertaken at the O Penedo dos Lobos provided secure evidence attesting to a context of occupation concurrent with the Cantabrian Wars (Fonte, Costa-García and Gago, 2022), the paucity of material culture and other dating evidence does not yet allow to sustain a coetaneous occupation at Alto do Golado and a broader relative chronological framework must mandatorily be considered. Though there were Roman legions previously stationed in the province of Hispania Ulterior (Rodríguez Gonzaléz, 1998; Morillo, 2017), in the outbreak of the Cantabrian Wars large military contingents were mobilised and operated all across the northwest, naturally culminating in the widespread emergence of army-related sites. This military presence greatly decreased after the conclusion of this conflict but a still significant military force comprising a minimum of three legions remained in this area of Hispania at least until 40 AD (Rodríguez Gonzaléz, 1998; Morillo, 2017) and, although the main bases were situated further north, there could have been possible detachments of these units operating in this region of present-day central Portugal, as suggested by the stamped Roman tile unearthed at Manigoto (Alarcão, 2006). Considering this greater surge of Roman military activity, it is thus possible to generically and tentatively consider that there is a consequently higher probability Alto do Golado might have been constructed sometime between 30 BC and 40 AD, albeit slightly earlier or later dates cannot be completely discarded. Secure dating evidence is nonetheless mandatory to endorse this hypothesis and, given the scarcity of material culture, absolute dating methods must assume a pivotal role in subsequent archaeological investigations. Indeed, radiocarbon and, notably, luminescence dating, have already revealed some positive potential in assessing the chronology of similar sites in northern Portugal (e.g. Fonte *et al*., 2023; Fonte *et al*., 2024).

Considering the different aspects, Alto do Golado can generally be classified as a small *castra aestiva*, a temporary camp, but wheth-

er it is a temporary operational outpost or a mere marching camp for an overnight stop remains largely undetermined. Taking into consideration the functional classification suggested by Lepper and Frere (1988 *apud* Jones, 2017) and the contextual evidence available thus far, the exclusion from sieging contexts seems rather straightforward. A similar assessment can be made for a functional connection related to any construction project in the area, albeit this hypothesis cannot be completely discarded. While similarly assessing the Roman camp of O Penedo dos Lobos, Fonte, Costa-García and Gago (2022: 21) suggested a possible functionality related to the training of locally recruited *auxilia*, as the terrain conditions in this site were identical to the mountainous areas of Asturias and Cantabria. Although further away from the main areas of conflict, a similar functionality can be suggested for Alto do Golado, particularly considering the typological similitude and the mountainous context where the site was established. Alternative hypotheses include the broader category of marching or campaign camps, which have been frequently associated with the movement of troops between more permanent bases or during military campaigns, as well as while policing conquered areas or gathering information (Jones, 2017). Indeed, the late 1st century BC and the first century AD was a period of intense social unrest, marked at first by the Cantabrian Wars and then also by a latent armed peace (Morillo, 2017), and Alto do Golado could have been related to the suppression of eventual local rebellions. Another functionality associated with marching camps is possible territorial surveys (Jones, 2017), frequently linked with mineral resources (Sánchez-Palencia and Currás, 2015), albeit, as Fonte, Costa-García and Gago (2022: 21) noted for O Penedo dos Lobos, the military contingent stationed at camps of this size could perhaps be excessive for such undertakings.

As mentioned earlier, Alto do Golado was built on a high mountain ridge roughly orientated NW-SE, characterised by a steep cliff on the northern slope and an easier, yet still costly, access on the southern side. These features offered not only a superior defensive position and visual control of the surroundings (Fig. 12), but the ridge also provided a relatively easier path to move through this part of the mountain. Indeed, by analysing the layout of the enclosure and based on the evidence discussed for similar sites, it is possible to discern that this camp was orientated to the SE, where its main entrance is located and, therefore, to the longer side of the ridge where immediate transposition would be easier and faster, as was also clearly revealed by the GIS movement cost anal-

ysis. Further computational processing, resulting in a MADO model displaying the optimal movement routes in this landscape, has also revealed that Alto do Golado is located in the middle of two relevant intersections of E-W and N-S routes (Fig. 12). Given the possible orientation towards the SE, it seems possible the military contingent stationed at Alto do Golado would be, however, more interested in the eastern connection, which provided great visual control of the whole region of Viseu and permitted relatively direct access not only eastwards to this region but also northwards to the Montemuro mountain range or southwards to the Vouga valley. The evidence available thus far does not provide any further hint into the movement of Roman troops through the surrounding landscape, as the written sources do not mention any military undertaking in this particular region and archaeological research has thus far been limited. Though there has for a long time been a recurring suggestion that the sizable enclosure of Cava de Viriato, located just north of Viseu, was a Roman camp (VV.AA., 1958), this hypothesis has largely been forsaken (Mantas, 2003; Real and Tente, 2018). Additionally, there are some Late Iron Age to Early Roman hillforts in the area of the referred possible lines of movement, such as Cárcoda (Vaz, 1997: 83-86; Canha, 2022, II: n. º 81) or Ucha (Vaz, 1997: 91-92; Canha, 2022, II: n. º 85) but it is not possible to securely advance any sort of relation between these sites and any military activity.

Concomitantly, the absence of any associated material culture also does not allow us to suggest any possible relation between Montedufe and Alto do Golado thus far. Nevertheless, this hypothesis cannot also be fully discarded, as an increasing number of Roman camps have been found across Northwestern Iberian presenting similar constructive and morphological features to both the Alto do Golado and Montedufe, some of which have been plausibly associated with the same contextual framework – for instance, the Cantabrian Wars. The comparatively reduced dimensions observed at Alto do Golado, further limited by characteristics of the mountainous terrain, imply the presence of relatively small military contingents, a feature already noted for analogous Roman military sites (e.g. Costa-García, Fonte and Gago, 2019; Fonte, Costa-García and Gago, 2022). In fact, this spread of relatively small-sized camps has been putatively associated with a sign of the adaptability of the Roman army towards the conspicuous upland areas of this region of ancient *Hispania*, probably operating a significant number of highly mobile and autonomous military detachments, known

as *vexillationes*, which would have not only been easier to supply but also sufficient to control a landscape characterised by sparse indigenous settlements (Costa-García, Fonte and Gago, 2019; Fonte, Costa-García and Gago, 2022). An interesting archaeological find that could arguably be related to a possible small contingent of the Roman army in this region would be the inscription reportedly found at Castro de Pinho (São Pedro do Sul) which was presumably ordered by a *Tiberius Claudius Modestinus* and partly mentioned an unspecified cohort (Vaz, 1997: 200-202). Unfortunately, the whereabouts of this inscription have been unknown for a long period and, consequently, it was not possible to validate this evidence.

6. Final remarks and future prospects

Reassessing the gathered data for Alto do Golado and Montedufe, it was possible to document several distinctive constructive and morphological features easily associated with the rather standardised Roman military architecture, such as the overall site layout or the protected entrances. Evaluated all the evidence, Alto do Golado is clearly a Roman camp built sometime between the late 1st century BC and the 1st century AD, having a typical playing-card-shaped enclosure with four symmetrical entrances, three of which present extant traces of *claviculae*. This site also includes an annexe, a rather singular feature when compared with other known Roman military sites in the Iberian Peninsula but with parallels elsewhere in the Roman world. As for Montedufe, the data presented and discussed in this paper strongly supports a possible military nature for this site, considering not only distinctive factors when compared with other coetaneous sites in the region but mainly the parallels with known Roman camps across northwestern Iberia. Nevertheless, other hypotheses cannot yet be completely discarded, including even a different chronological framework altogether. Further archaeological research is, therefore, crucial to corroborate, or not, these hypotheses. Whereas the non-invasive methodological approach followed at O Penedo dos Lobos (Fonte, Costa-García and Gago, 2022) could yield interesting results in these sites as well, archaeological excavations have to nonetheless assume a pivotal role in subsequent investigations, aiming to characterise building techniques and architectural solutions, as well as hopefully providing dating evidence, either through material culture or radiocarbon dating of

organic materials, as well as sediment samples from sealed contexts that could be dated though luminescence, a technique that has proved useful in similar contexts (Fonte *et al*., 2023; Fonte *et al*., 2024). Additional and extensive archaeological investigations on the wider landscape of this region are also of the utmost importance, as new evidence might emerge that can significantly add to the better understanding of what was the Roman army doing in this region, when and why.

The results discussed in this study acquire particular relevance given the widespread paucity of knowledge on the Roman military presence in this region and subsequent interaction with the indigenous communities, partly due to the absence of direct literary references but mostly considering the limited archaeological research on this topic. Overall, using a broad methodological framework and analysing different datasets it was possible to present a solid argumentation on the Roman military nature of the two sites discussed above. The methodological approach followed in this research has therefore revealed an interesting potential to investigate Roman military sites, not only in the identification of new ones but, in this case, also further emphasising the need to reexamine previously known archaeological sites, as new data and interpretations may emerge. The forthcoming first national airborne LiDAR survey of mainland Portugal, commissioned by the DGT, will certainly provide a significant leap forward not only in the use of remote sensing techniques in Portuguese archaeology but particularly in the possible identification of new Roman military features, consequently positively enhancing the knowledge of the presence of the Roman army in this westernmost area of *Hispania*, and, simultaneously, the Roman world.

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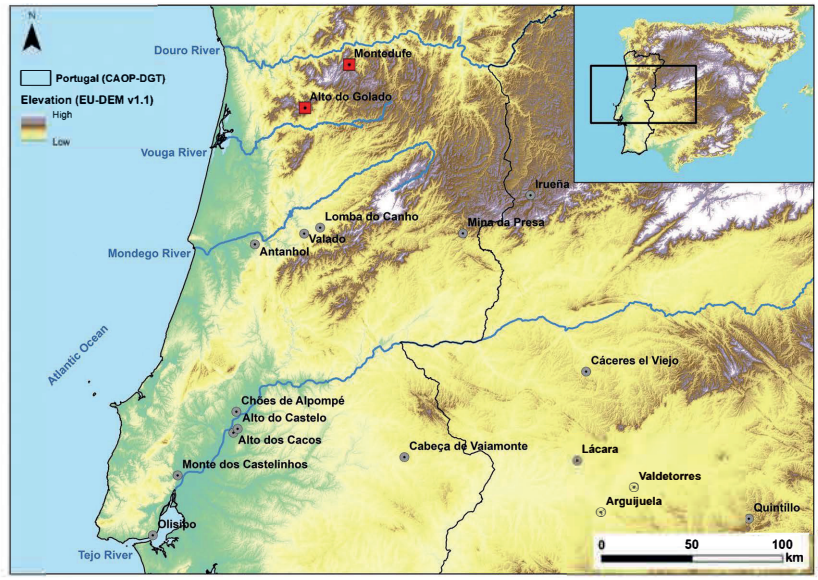

FIG. 1 - *Location of the main archaeological sites mentioned in the text. Data source: EU-DEM. 1.1 and DGT.*

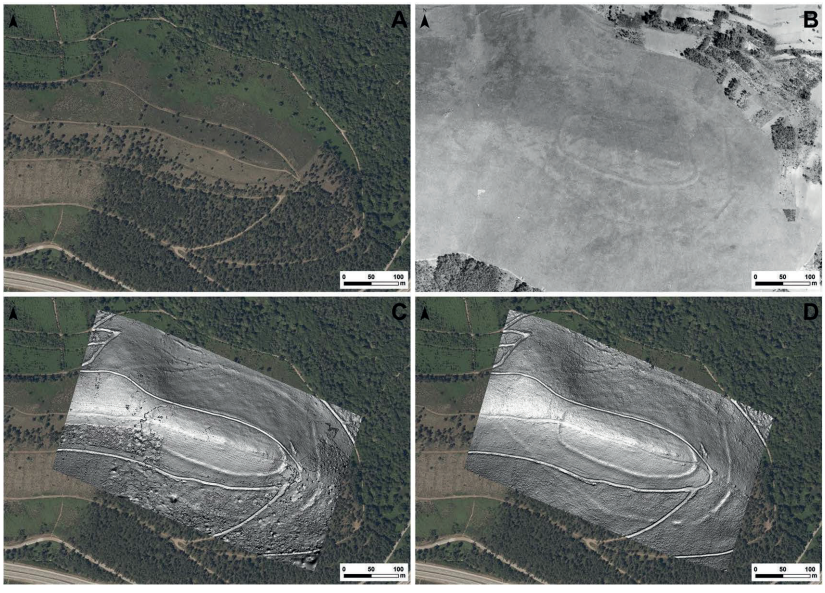

FIG. 2- *Montedufe: 2021 DGT orthophoto (A); 1945 SPLAL orthophoto (B); UAV-based photogrammetry-derived DTM (C); and UAV-based LiDAR-derived DTM (D). Data sources: DGT; CIGeoE; ERA Arqueologia S.A. and authors.*

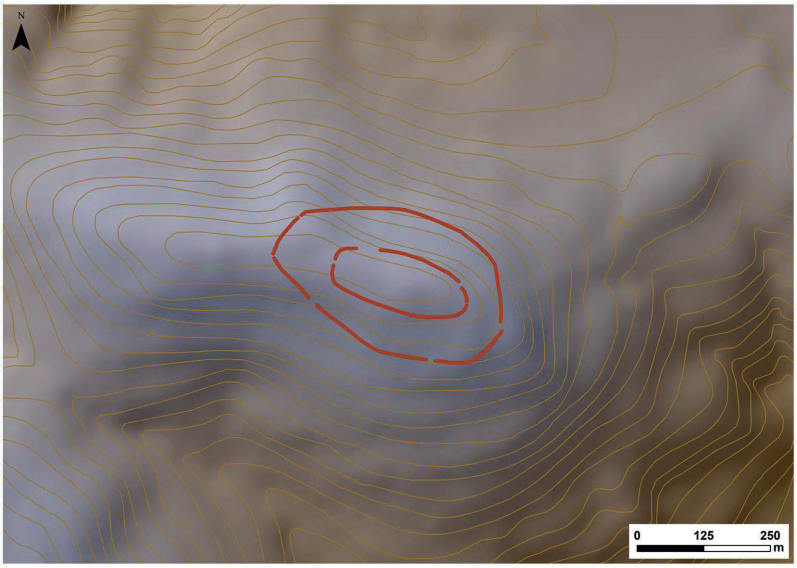

FIG. 3 - *Topographical plan of Montedufe*
Data source: EU-DEM. 1.1.

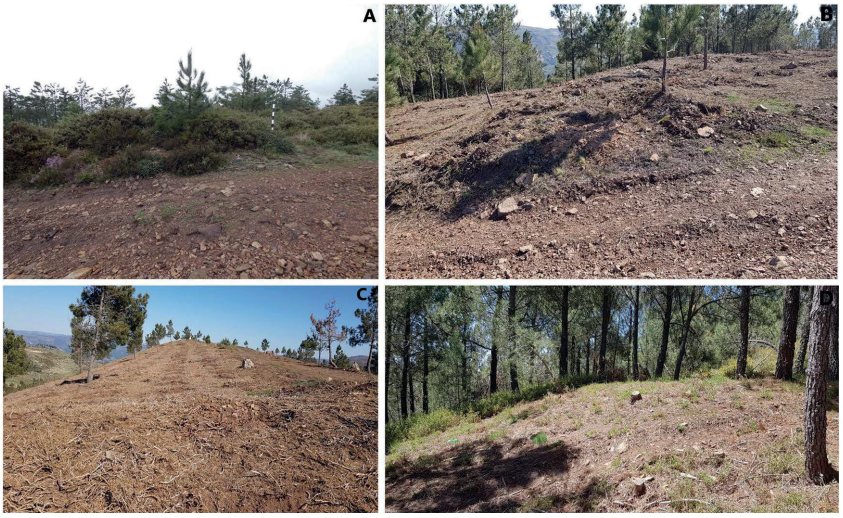

FIG. 4 - *Ground perspectives of the Montedufe defensive system: internal slope in the entry zone (East) before deforestation (A); internal slope in the entry zone (East) after deforestation (B); internal slope to the west (zone of least defensibility) (C); and section of external slope to the south (D). The scale bar measures 1m.*
Data source: authors.

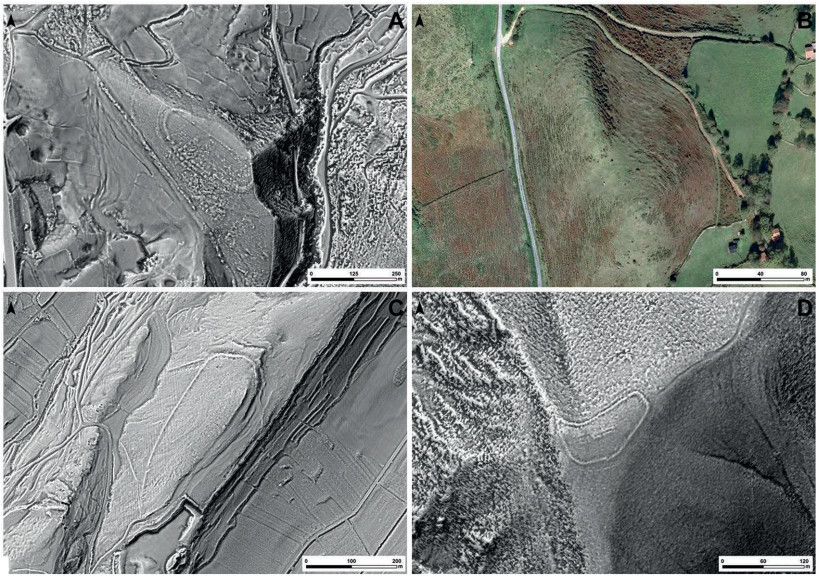

FIG. 5 - *2018 IGN-PNOA LiDAR-derived DTM of Sierracastro (A); 2006 IGN-PNOA orthophoto of El L.laurienzu (B); 2019 IGN-PNOA LiDAR-derived DTM of La Loma I (C); and 2021 IGN-PNOA LiDAR-derived DTM of A Recacha (D). Data source: IGN.*

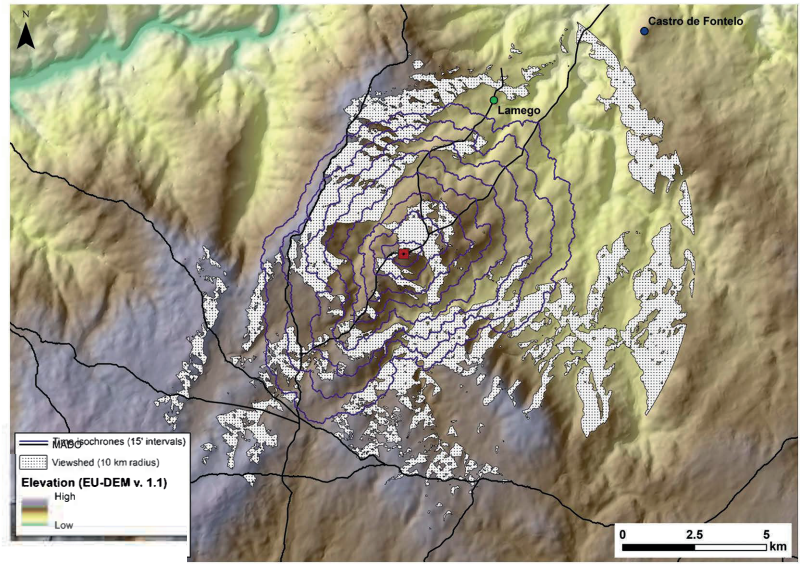

FIG. 6 - *GIS-based spatial analysis of Montedufe: viewshed, time isochrones and MADO. Data source: EU-DEM. 1.1.*

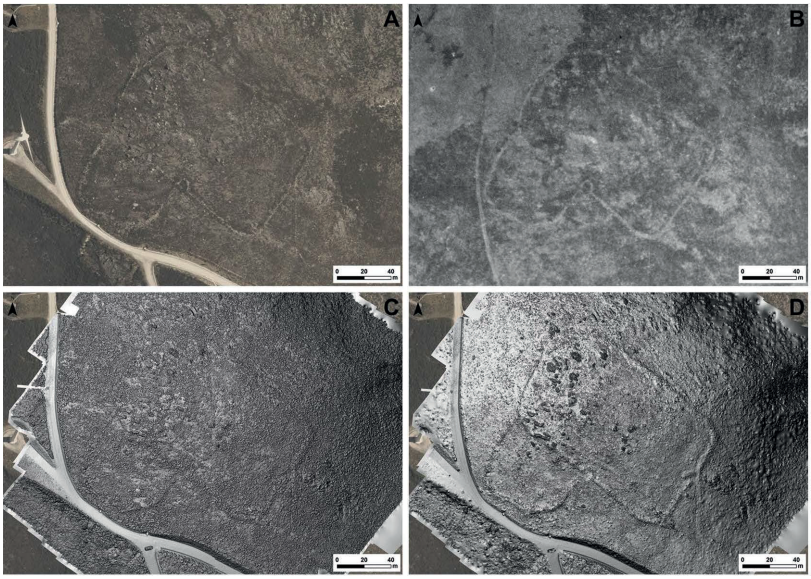

FIG. 7 - *Alto do Golado: 2021 DGT orthophoto (A); 1945 SPLAL orthophoto (B); UAV-based photogrammetry-derived DSM (C); and UAV-based photogrammetry--derived DTM (D). Data source: DGT, CIGeoE and authors.*

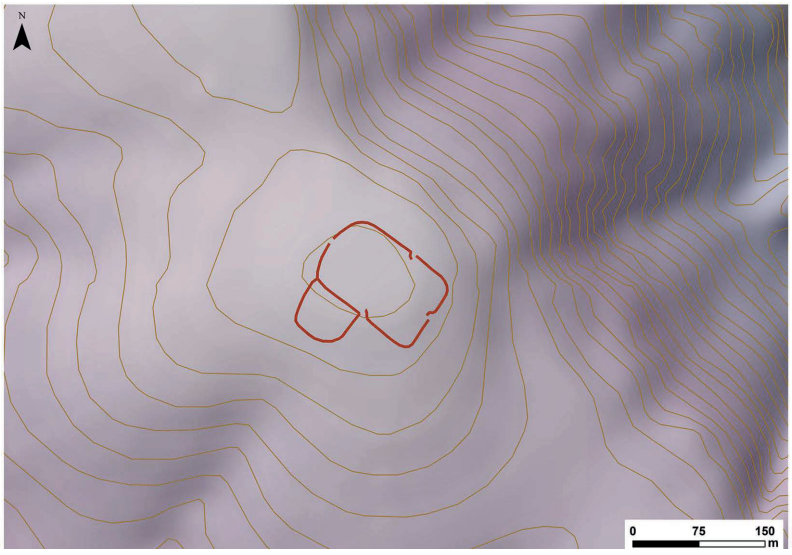

FIG. 8 - *Topographical plan of Alto do Golado. Data source: EU-DEM. 1.1.*

FIG. 9 - *Ground perspectives of the Alto do Golado defensive system: the northwestern entrance, damaged by the superimposition of a trackway in the second half of the 20th century (A); a section of the southwestern wall where construction took advantage of rock outcrops (B); overall aspect of the southwestern wall (C); and construction detail where larger stones were used to outline the wall on the southeastern side (D). The scale bar measures 1m. Data source: authors.*

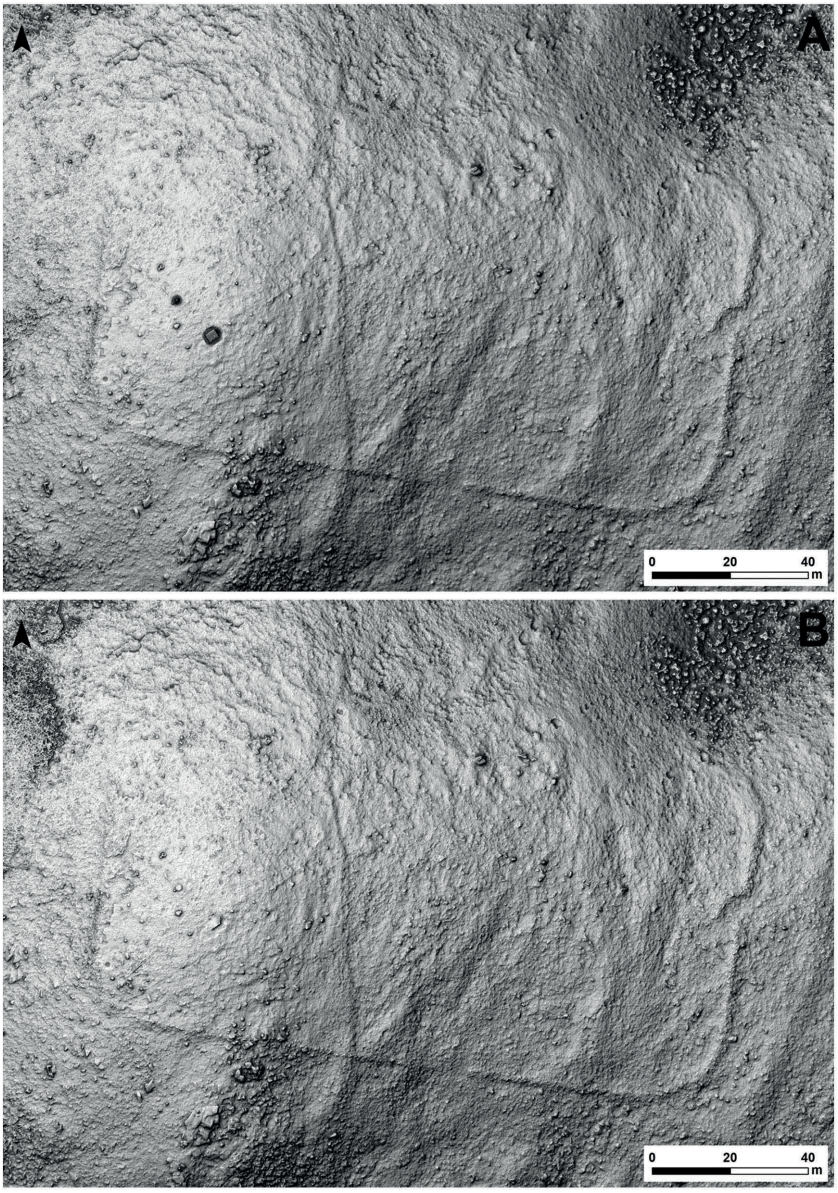

FIG. 10 - *Alto da Pedrada: UAV-based photogrammetry-derived DSM (A); and UAV-based photogrammetry-derived DTM (B). Data source: authors.*

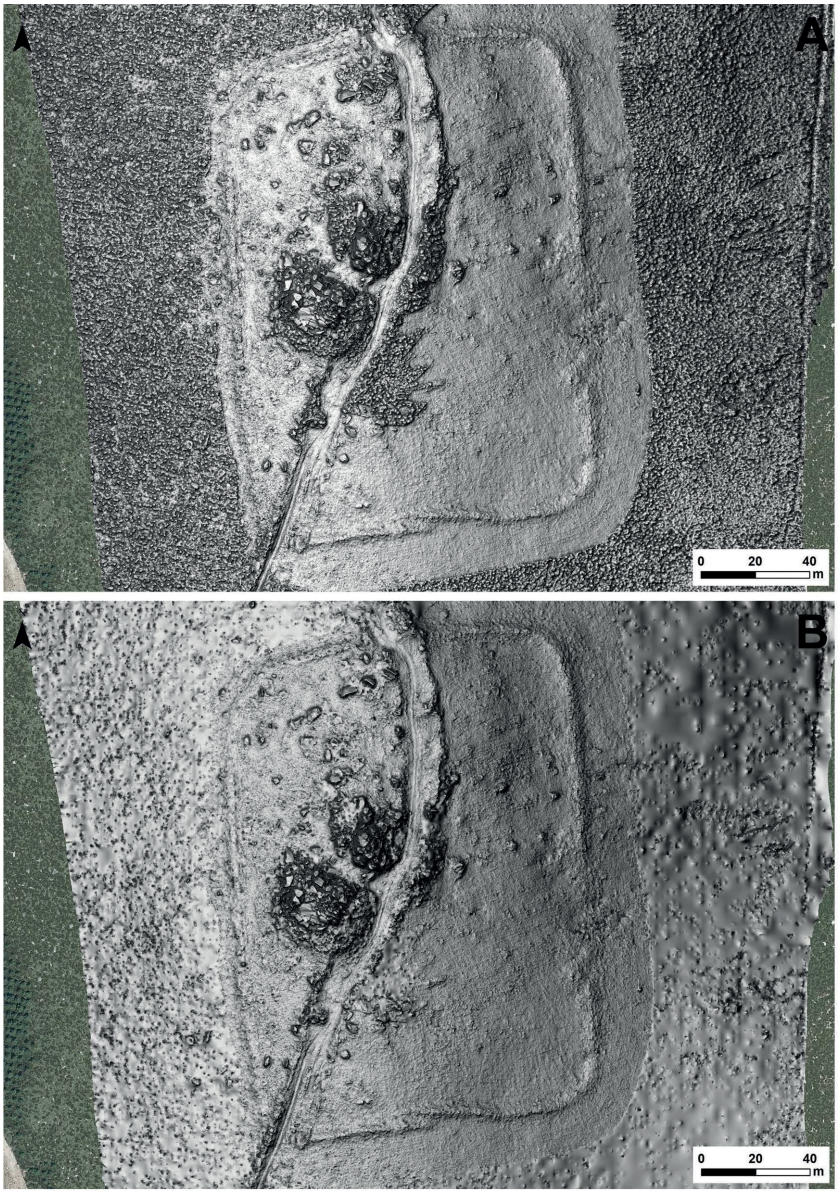

FIG. 11 - *O Penedo dos Lobos: UAV-based photogrammetry-derived DSM (A); and UAV-based photogrammetry-derived DTM (B). Data source: Manuel Gago.*

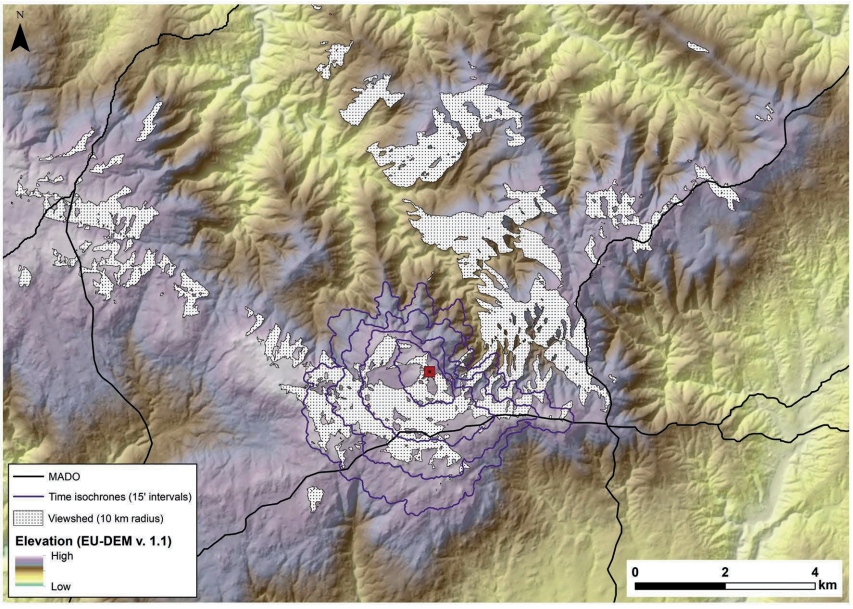

FIG. 12 - *GIS-based spatial analysis of Alto do Golado: viewshed, time isochrones and MADO. Data source: EU-DEM. 1.1.*