sustainability

MDPI

Article

Granite Landscapes and Landforms in the Castro de Ulaca Site (Ávila, Spain): A Narrow Relationship between Natural and Cultural Heritage

Rosa María Ruiz-Pedrosa * and Enrique Serrano

Pangea Research Group, Department of Geography, University of Valladolid, 47011 Valladolid, Spain; e.serrano@uva.es
* Correspondence: rosamaria.ruiz.pedrosa@uva.es

Abstract: Geomorphology is the link between natural and cultural heritage, so the geomorphological map is a useful tool for inventorying landforms and its management. In this paper, a Castro de Ulaca geomorphological map at 1:20,000 scale has been designed, focused on granite landforms and based on bibliographical and cartographic review followed by systematic field work in the Ulaca site and around. It shows a mastery of granite landforms and their relationship with cultural elements, as well as the adaptation of the society to the geomorphological conditions. The twelve granite landforms represented are not relevant in a national or regional scale, but they are of local importance as they represent the links between geomorphology and the archaeological elements present in Ulaca. It is essential to incorporate geomorphological elements in the management of cultural spaces, to guarantee their protection from visitors, as well as to ensure the survival and use of this cultural service for local population.

Keywords: geoheritage; geomorphological mapping; granite landscape; granite landforms

check for updates

Citation: Ruiz-Pedrosa, R.M.; Serrano, E. Granite Landscapes and Landforms in the Castro de Ulaca Site (Ávila, Spain): A Narrow Relationship between Natural and Cultural Heritage. *Sustainability* **2023**, *15*, 10470. https://doi.org/10.3390/su151310470

Academic Editors: Francesco Faccini and Antonella Marsico

Received: 10 May 2023
Revised: 13 June 2023
Accepted: 20 June 2023
Published: 3 July 2023

1. Introduction

An integrative vision points out that geomorphology is one of the components of the cultural heritage of a territory, and at the same time, it considers the relationships between the cultural components and their context, expressed as "cultural geomorphology" [1–4]. In this approach it is particularly relevant to determine the physical framework in which the cultural heritage is inscribed in order to fully understand the site under analysis, and geomorphological mapping is a basic tool for the inventory and assessment of geomorphological elements or geomorphosites.

In most geomorphosite analysis and assessment methodologies, and in particular the one developed by our group [5,6], it is the first step to study the geomorphological heritage of any territory. The geomorphological map is useful to know the heritage elements or places of a specific territory, but it also allows to establish the interrelations with other geomorphological or cultural elements. And in the case of geomorphosites classified as sites, geomorphological diagrams allow us to analyse their internal characteristics and their structural or dynamic relationships with cultural elements [7,8].

Geomorphological mapping is a useful communication tool that becomes a preliminary tool for land and environmental management and geomorphological risk management through a cartographic system understandable by experts [9–12], particularly in its application to protected natural and cultural areas. Published works use geomorphological mapping and its derivatives either for research, management or education, with necessarily differentiated criteria. Thus, geomorphological mapping has been oriented towards different proposals with significant advances in the last twenty years [11,13–15].

Scientific mapping has been proposed by exploring the cartographic methodology and techniques used—such as GIS and geomatics [10,14–16]. In this regard, the importance of data acquisition and representation techniques for geosites is highlighted [11], as well as their fragility in the face of climate change and human impacts, which can affect the intrinsic values of geomorphosites. In order to incorporate geomorphosites into Italian geomorphological mapping, they propose a specific, multi-scale legend. But there are other approaches applied in geomorphological heritage studies, such as interpretive mapping oriented to education and geotourism [3–5,14,15,17–26] or applied to geoconservation and heritage management [8,18,27,28].

All works show the need to incorporate geomorphological cartography and its derivatives for the knowledge and dissemination of geomorphosites but also the difficulties in representing the elements and their characters [11,15,29]. Even knowing that the map is only an interpretation of the territory, where the authors decide what they want to explain and express, the geomorphological map must be as precise, clear and objective as possible. At the same time, it must include an interpretative synthesis useful for users and, therefore, aimed at different audiences, sometimes specialised, such as managers, educators and interpreters of the territory, and sometimes non-specialised, such as tourists, hikers and visitors. Undoubtedly, the maps will be different if they are oriented towards environmental and territorial management or towards educational or geotourism uses. This is where the main challenges are.

2. Study Site

The Cerro del Castillo hill and the Ulaca site (1508 m a.s.l., 40°31′48″ N and 4°53′01″ W) are located in the municipality of Solosancho, Autonomous Community of Castilla y León, province of Ávila, Spain (Figure 1). The study area borders the "Espacio Natural protegido de las Sierras de la Paramera y Serrota", declared as ZEC (Special Area of Conservation) of the Natura 2000 Network, but Castro de Ulaca is not included despite its recognisable natural and landscape values.

Located on the margins of the Sierra de la Paramera (2157 m a.s.l.), it is bordered to the north by the wide valley of Amblés (1100 m a.s.l.) and flows into the river Adaja, which belongs to the Duero hydrographic basin. The materials that outcrop in the study area are granitoids of Upper Carboniferous to Lower Permian age belonging to the Hercynian Massif. It is located in the so-called Gredos Complex, characterised by the extension of fine-grained porphyritic granites and, in its NE portion, the presence of coarse-grained biotitic granites [30].

The Ulaca Hillfort has been an Asset of Cultural Interest since 1986, and in 1994, it was defined as an archaeological area (Spanish Historical Heritage Law), but it was already designated a historic-artistic site in 1931. The archaeological site of Ulaca was occupied at the end of the Iron Age (3rd–5th centuries BC) by the Vettones in a walled settlement that was home to more than 1000 inhabitants [19,31] The Vetton culture was one of the most important Celtic peoples that populated the west of the Iberian Peninsula, living in fortified settlements such as Ulaca, which may have been abandoned with the Roman conquest. The site is of great interest due to its size, with more than 70 ha; its walls, which surround the hill and reach 3 km in length, making it one of the largest fortifications of this period in the Iberian Peninsula [22]; and the complex organisation shown by the craft workshops and the cemetery located outside the walls [32]. But it also preserves important material remains and exceptional and well-preserved Celtic structures such as the settlement (oppidum) with the remains of more than 250 dwellings, the altar (rock sanctuary), the keep, the sauna and the quarries [19,21–23,33,34].

The Ulaca site has been studied since the 1970s and has been interpreted as an urban centre where the elites who exercised control over the adjacent territory resided and as an important witness to the different lifestyles and pastoral strategies of the Vetonean culture [22]. It has a long history of cultural heritage protection, which has taken the form of weak management and maintenance actions [23,35], despite the multiple dissemination initiatives carried out by archaeologists, including innovative analyses and virtual visits [23,36,37]. It is currently a focus of tourist attraction, receiving more than 2500 visitors per year, although visits have been stagnant for the last eight years [23]. It also constitutes an element of identity for the local population due to the numerous activities carried out over the last 20 years. These include the Celtic Moon Festival of Solosancho, which brings together more than 3000 people at the site on a night in which a play is performed in the castro, in addition to a full festive programme inspired by the Celtic roots of the municipality. As pointed out by Rodríguez Hernández et al. [23], these activities aim to attract visitors and promote sustainable tourism in a very fragile natural environment affected by severe depopulation. The study area and surrounding landscapes were severely damaged by the forest fire of 14 August 2021 that devastated more than 22,000 ha, including the Castro de Ulaca.

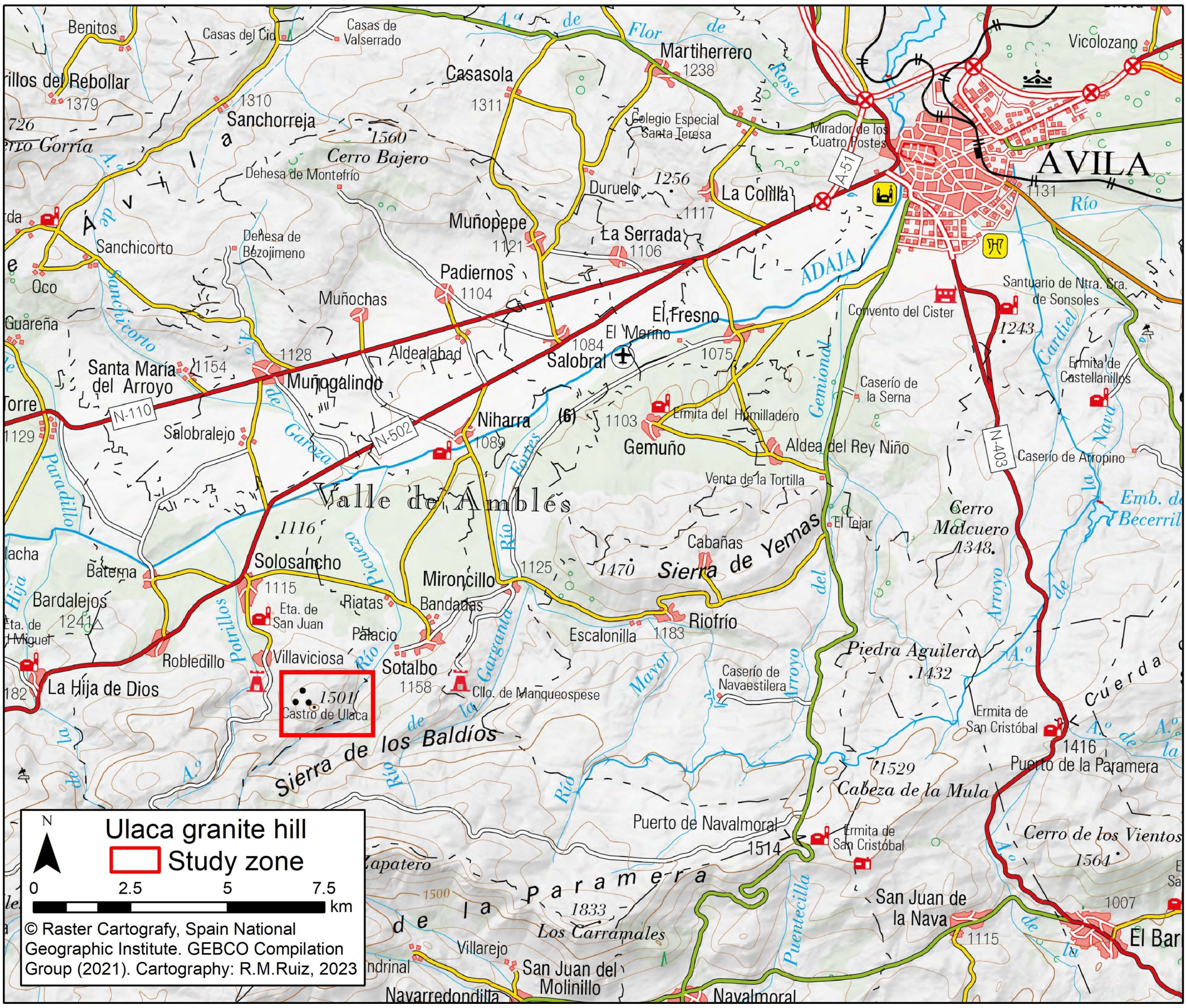

Figure 1. Castro de Ulaca location map (Villaviciosa, Ávila, Spain), 30 kilometres from Ávila capital city.

3. Methodology

Geomorphological maps are efficient landforms graphical inventories representing landforms surface and subsurface materials. The availability of high-resolution remote sensing data (aerial and satellite imagery, digital elevation data) permits proficient interpretation and spatial representation of landforms [12,24,38].

The elaboration of the geomorphological map at 1:20,000 scale was based on the bibliographical and cartographic review, including georeferencing of existing geomorphological sketches [39,40], and remote sensing data interpretation (Table 1). The remote data include digital elevation model, hill shade and slope derived from LiDAR terrain models, digital orthophotomaps and Google Earth imagery (Table 1). Images obtained by UAV [36] have been used to analyse small-scale elements and granite micro-landforms.

Table 1. Products used to compile the geomorphological map.

Product	Source	Characteristics
Topographic Map 1/25,000	Instituto Geográfico Nacional (IGN) http://centrodedescargas.cnig.es/ (accessed on 10 October 2022)	Contours line, interval original 10 m, in the map 50 m.
Aerial photography	Agrarian Research Institute of Castilla y León (ITACYL)	25 cm resolution aerial photographs
Orthophotomaps	PNOA Plan Nacional de Ortofotografia Aérea. (https://mirame.chduero.es/chduero/viewer, accessed on 15 January 2023) Instituto Geográfico Nacional (IGN).	Variable resolution (25–45 cm/pixel) Terrain characteristics and landforms recognition (outcrops, deposits, landforms, etc.)
MDT	Confederación Hidrográfica del Duero (https://mirame.chduero.es/chduero/viewer, accessed on 15 January 2023)	5 m/pixel Terrain characteristics and landforms
Stereoscopic viewer	Instituto Geográfico Nacional (IGN) http://www.ign.es/3d-stereo/, accessed on 21 Novenber 2022) Photograms of the PNOA.	Variable resolution (22–45 cm/pixel) Characteristics of the ground surface morphology
3D models satellite images	Browser of Google Earth (https://earth.google.com/web/, accessed on 10 October 2022) IGN imagery (large scale) and Landsat imagery	Validation of the ground and terrain characteristics and a broader frame-work of geomorphological features
3D models, UAV images.	Ulaca Virtual Tour USAL, Diputación de Ávila, IGDA. https://tidop.usal.es/Ulaca/ (accessed on 15 February 2023)	High resolution images. Micro-landforms and detailed features recognition

Systematic field surveys were made in the Ulaca archaeological sites and around (valleys and Paramera Range) and structural, granite and modelled landforms were recognized and identified. Finally, all information was edited in QGIS and the final map layout (CorelDrawX5, software version number 15.0.0.486).

The granite landforms are the focus of the geomorphological map, but structural and fluvial ones have also been represented, as well as lithology and human features (Table 2). The landforms were outlined and symbolized according to geomorphological cartographic systems where granite landforms are included [41–46] modified and adapted to the granite environment where the lithology is a main factor to shape the studied area. New symbols and plots have been used to be adapted to the scale. The criteria used for landforms representation are the colours for lithology, granite landforms domain and accumulative ones, symbols to granite landforms and fluvial. The main objective is to facilitate a coherent, clear and legible map [44] useful for managers, guides and coaches.

Table 2. Landforms represented in the geomorphological map.

Typology	Landforms and Processes	Geomorphological Setting	Morphological Criteria
Structural	Pop up limit	Limits of the half-horst and raised blocks	Structural lineaments limiting the raised blocks
	Tectonic lineament	Wide range of settings	Lineal structures related to faults and joints
	Fractured-aligned valley	South side of Ulaca half-horst	Rectilinear valleys

Table 2. *Cont.*

Typology	Landforms and Processes	Geomorphological Setting	Morphological Criteria
Erosional surface	Degraded erosional surface	On the top of the half-horst	Culminant limit of flatted surface
Granite	Nubbin	Wide range of settings on slopes and borders of the half-horst	Granite outcrop with redounded and vertical features
	Tor	On the top of the half-horst	Isolated granite outcrops partitioned by fractures
	Rock platforms	Wide range of settings on the top of half-graben and the southern raised blocks	Granite outcrops with sheet structure and flat and curve morphologies directed by curve joints
	Convex and steeply slope rock surface	Wide range of settings on the slopes of the half-horst	Granite outcrops with sheet structure, hard slope and curve morphologies directed by curve joints
	Granite dome	Borders of the raised blocks	Domatic landforms directed by curve joints
	Granite half-dome	Borders of the raised blocks	
	Granite crest shaped	Water divides out of the half-horst	Towered and vertical granite out-crops limit by fractures
	Boulder fields	On slopes and the bottom of the peripheral valleys	Rock fragments of big size on slopes and flats
	Sandy depression	Wide range of settings on the top and the raised blocks	Small basin infill by fine sediments
	Lineal sandy corridor	Wide range of settings on western and eastern slopes	Lineal basin on slopes infill by fine sediments.
	Arenizations	On eastern slope	Surfaces and slopes covered by sands
	Pedestal rocks	Wide range of settings on the half-horst borders and raised blocks	Isolated or free-standing blocks on a rock platform
Fluvial	River/stream	Bottom of the valleys	Water current
	Central depression limit	On the top of the half-horst	Curved limit of the central small basin
	Palaeochannel	On the top of the half-horst	Narrow and small channel without water flow
	V-shaped Fluvial valley	The northern limit of the half-horst	Valley with homogeneous slopes
	Fluvial terraces	Bottom of the valley	Flat surfaces formed by fluvial and torrential sediments and hanging on the water flow

4. Results and Discussion: The Granite Landform System and the Relationship with Cultural Heritage

4.1. The Landforms in the Castro de Ulaca

The central portion of the Central System is organized by a pop-up and pop-down structure where, from north to south, successive tectonic blocks or horst alternate with tectonic valleys or graben, forming a structural relief known as Germanic relief [39,47]. The structural relief was generated by deformation of the paleozoic basement by means of south compression, faulting and displacement to the north during the Alpine tectonic phase. In the studied area, a thick skin tectonic is combined with a thin skin one with basement implied and formation of cortical pop-ups as the Sierra de la Paramera one [48,49].The limits between the Sierra de la Paramera tectonic block and the tectonic valley are formed by abrupt faults scarps to the south, the Paramera Cenozic fault, but less abrupt to the north, toward the Amblés tectonic valley, where a sequence of stepped tectonic blocks or half-horst links the Paramera tectonic block with the Ambles tectonic valley. The Castro de Ulaca is located on a minor and intermediate stepped block, located between the main tectonic block and the valley (Figure 2), and the top of the half-horst has a levelled physiography. It is the degraded fundamental erosional surface prior to the tectonic uplift [39,40,50–52].

This scouring of the materials involved the partial export of the alterites generated prior to the Alpine tectonics, which have their correlative deposits in the arkosic sandstones of the southern part of the Duero Basin, and the flattening of the granitic outcrops. During the tectonic uplift, weathering and mechanical erosion on the upper surface of the stepped block generated a circular NE-draining depression denoting a possible N-NE tilting of the block. The central culminating depression contains NE-draining palaeochannels, adapted to the fracturing, and small hollows with sandy fills where springs outcrop.

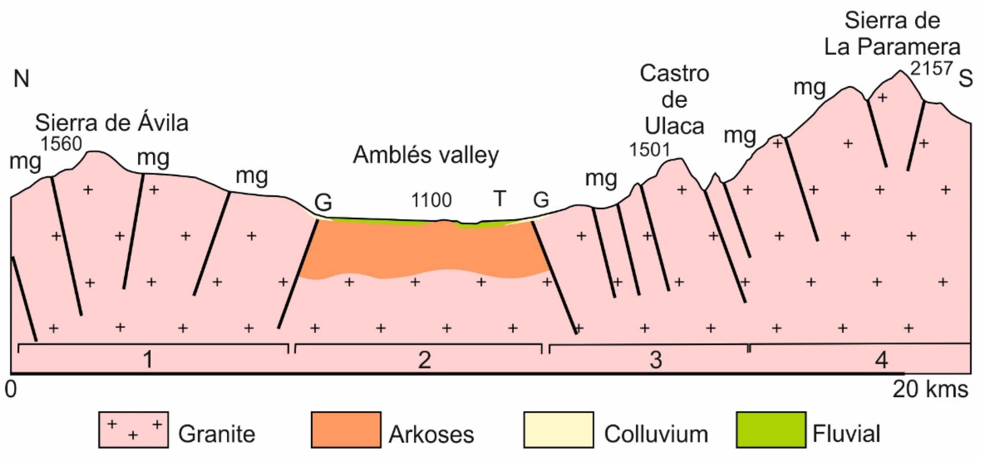

Figure 2. Morphostructural profile and location of the Castro de Ulaca: (1) Sierra de Ávila tectonic block, (2) amblés tectonic valley, (3) Ulaca halfhorst, (4) La Paramera tectonic block, (mg) granite landforms, (g) glacis, (t) fluvial terraces.

The bottom of the Amblés valley crops out tertiary materials—Oligocene and Miocene arkosic sandstones—but the stepped block of Cerro del Castillo is only made by granites. In the Central System, the weathering of granite by hidrolisis generated alterites formed by quartz and feldspar grains [53]. These alterites occupy wide extents, named "grus" and "saprolites" [25,54], with granite outcrops between the sandy deposits.

In the Central System, granitic landforms and processes have been studied since the 19th century, both from genetic and morphological perspectives, and the most characteristic landforms and emplacement processes have been established [25,47,55–59]. Examples of all these forms can be found in the Sierra de la Paramera.

Modelling landforms are conditioned by the type of granite, fracturing patterns, climatic conditions and location in relation to topography [56,59]. Classifications of granite forms are very varied, either by genesis, location or size [54,56,59–62].

In the Ulaca half-horst, the rock is homogeneous, medium-grained adamellites, biotitic and porphyritic, and the fracturing patterns present vertical and curved fractures, with flat emplacements at the culmination and steep slopes at the margins. The most characteristic landforms of Cerro del Castillo are nubbins, rock platforms, followed by tors, granite domes, half-domes and pedestal rocks (Figure 3, Table 2), among the larger ones; and gnammas, tafonis and polygonal pattern of cracks among the microforms, the latter not represented in the map (Figure 4). At Ulaca, the granitic landforms are distributed according to their location, and this, in turn, has conditioned the uses and modes of exploitation by the Vetons. The granitic relief of Ulaca can be classified according to Migoń [7] as a dissected plateau with representative medium-size and minor granite landforms. Ulaca landscape is characterised by granite landforms and the processes involved in their setting.

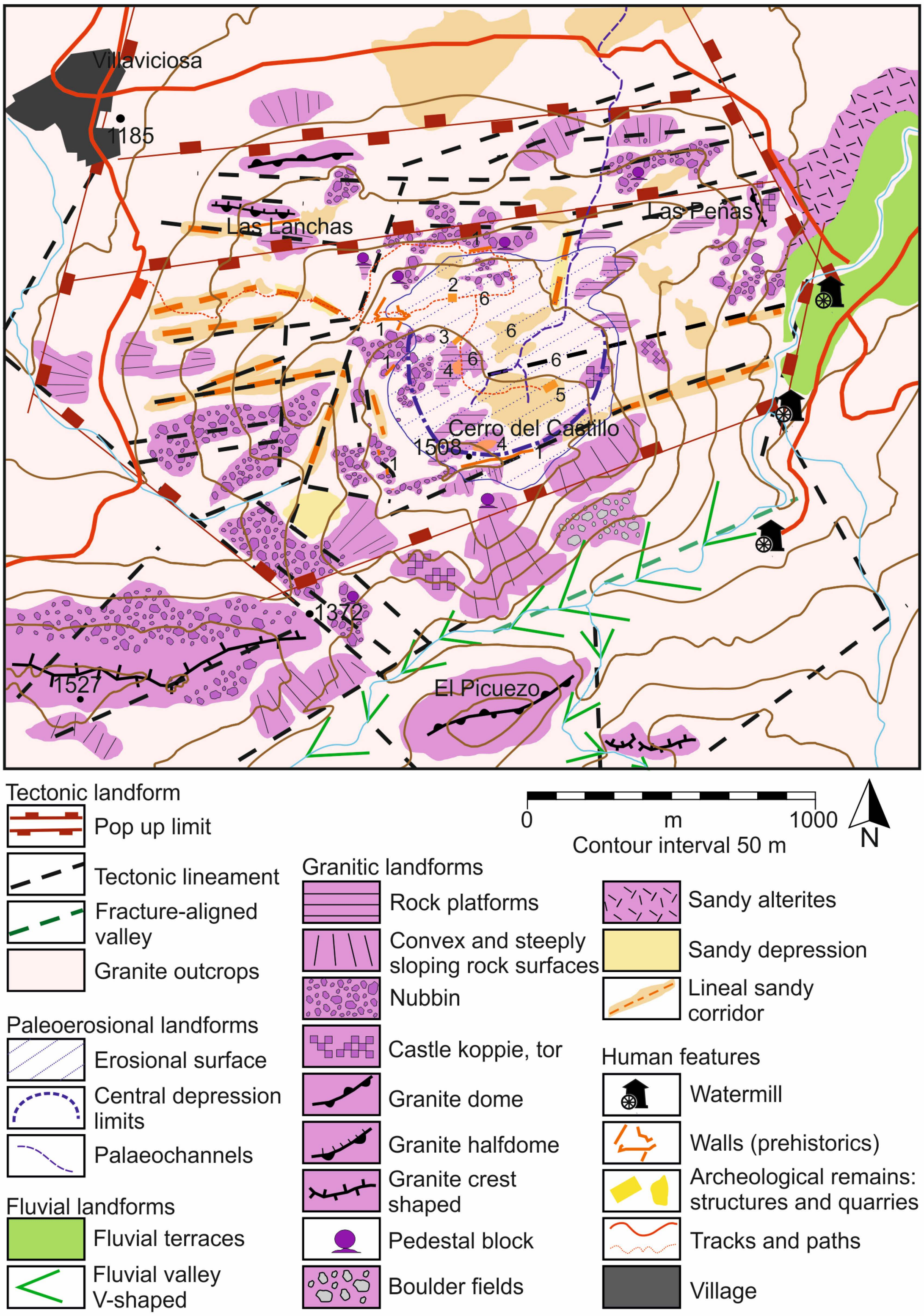

Figure 3. Cerro del Castillo and Ulaca site Geomorphological map. 1, walls. 2, rock sanctuary. 3, sauna. 4, stone quarries. 5, tower remains of "El Torreon". 6, houses remains.

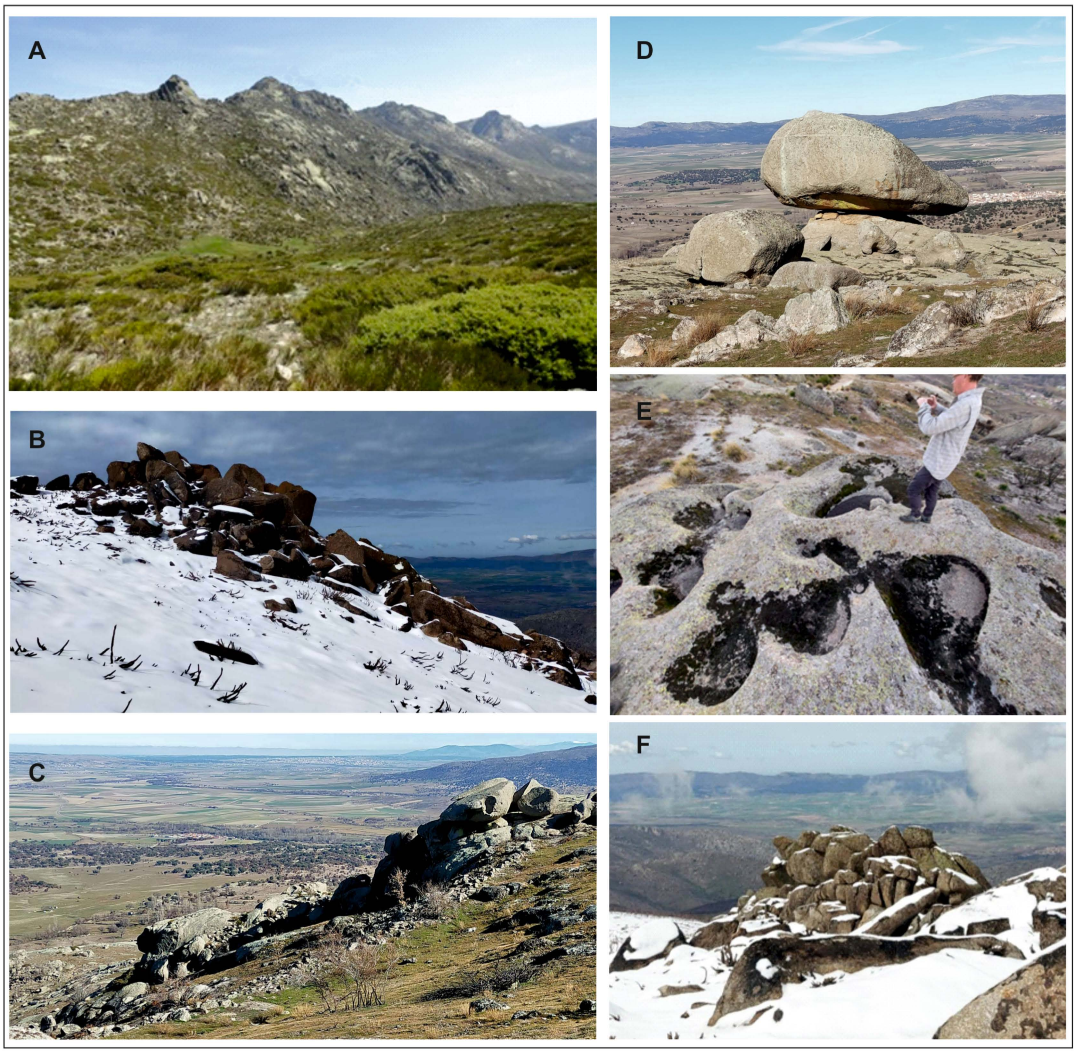

Figure 4. Ulaca granite landforms: (**A**) the Sierra de la Paramera, with the highest peaks (Pico Redondo, Pico Zapatero, Canchal Moreno, Risco del Sol and Peña Cabrera) and granite landforms as half-domes and convexes and steeply sloping rock surface. (**B**) Nubbin and boulder fields. (**C**) Nubbin on the northern slopes, the Amblés tectonic valley in the background. (**D**) Pedestal rock in the northern side of the Ulaca site. (**E**) Gnammas developed on a rock platform. (**F**) Nubbin.

4.2. Distribution of Granite Landform in the Castro de Ulaca

In Cerro del Castillo, there is a clear morphological difference between the more flattened summit portions and the slopes, where the alternation of curved and vertical fractures and the greater energy of the relief condition different landforms (Table 3).

Table 3. Granite landforms distribution in the Castro de Ulaca.

Unit	Physiography	Granite Landforms		Human Uses
		Main	Secondaries	
Top	Flat and moderate slopes.	Small weathering depressions. Sheet structure rock platforms	Pedestal rocks Tor	Settlements, quarries, ritual and power building (altar and sauna)
Northern Stepped blocks slopes	Steps and plains with hard slopes	Nubbins Boulder fields and Pedestal rocks	Tor Rock platform, half-domes, sandy depressions	Complex walls, settlements and cattle meadows
Southern, eastern and western fault line valleys	Rectilinear slopes, hard slope ~24°	Subvertical rock platforms and convex and steeply slope rock surface	Half-domes, domes, boulder fields and Nubbins	Defensive

- Culmination: It is characterized by the presence of flat areas with moderate slopes organized in a semicircle produced by the dismantling of the alterites in an initial phase of erosion. It has a general slope of 8° towards the NE. This wide culminating tectonic block, as in all cases in the Sierra, is the legacy of a pre-Oligocene erosion surface unlevelled by block tectonics [39,50–52] and partially eroded. In the upper zone, there are sandy depressions linked to the fracture crossings, forming small landings. These are where the springs are located, where the numerous remains of huts are located, as settlement was concentrated in this sector [20,34,63]. This environment is very deteriorated by human uses and nowadays colonized by vegetation, as they are places of wetness availability and are mainly staggered in the central and eastern depression. Sub-horizontal rock platforms and small-sized pedestal rocks are found in the culminating areas. The sub-horizontal rock platforms form wide rocky slopes, with a moderate inclination that follows the curvature of the joints without generating a positive relief. In ancient times, they were used as quarries due to the ease of extracting blocks of homogeneous dimensions. The tors, generated by differential fracture-controlled subsurface weathering and evacuation of debris, generate free-standing landforms on the slopes and elevated areas. They are common throughout the upper portion, although they are small in size.
- Stepped block slopes: On the northern slopes of the tectonic block, the dominant landforms are nubbins and boulder fields, but large pedestal rocks and tors are also present. The nubbins are the most representative granite landforms, as they are the beginning of the other landforms after dismantling by the erosion surface. They can be defined as the chaotic association of granite outcrop and boulders of different shapes and sizes, as a result of the alteration or weathering of granitic bodies. The boulder fields are gentle slopes dotted with blocks and boulders of varying sizes scattered across the slope. These landforms alternate with pedestal rocks, in some cases of large dimensions, rock platforms and half-domes in the lower parts, sandy depressions—locally called navas—and alterite corridors, the latter aligned in the direction of the fractures. It is, therefore, the area with the greatest diversity of granitic landforms, with straight and curved, vertical and horizontal fractures, slope erosive processes and periglacial ones. This diversity is derived from the greater structural complexity of the stepped blocks and the energy of the relief on the slopes. The main and best-defended access is concentrated in this sector, with the most complex walls, given that it was the most passable place, but there are also areas of settlement and cattle ranches in the navas [34,63].
- Fault line valley. On the southern slope, where the Picuezo River has incised a deep valley, the slopes are rectilinear and of approximately 24°. They form smooth, curvilinear walls that give rise to large subvertical rock platforms. Their morphology originates from curved fracturing, fluvial incision and stress relaxation, which generates half-domes and convex, steeply slope rock surfaces. These are the dominant granite landforms towards the Picuezo valley, together with boulder field, granite domes and domed landforms. Defensive use dominated in this sector, with walls between the nubbins, the latter being used for defence. The accesses to the river, where the mills were located, were also built.
- Microforms are found in all the environments of the study area. Among the smaller granitic landforms, gnammas and tafonis stand out. They are very frequent in Ulaca and have given rise to different uses, both sacred and every-day. The gnammas depressions with little depth are very frequent on horizontal surfaces of the higher areas where they reach depths of more than 50 cm, in all cases linked to joints. In the sanctuary or sacrificial altar, they have been used by humans and retouched to drain blood during ritual ceremonies. Tafonis, hollows in the vertical portions formed by the disaggregation of the rock due to humidity, are also very frequent. They are part of the larger forms and appear in the nubbins, boulder field, tor and pedestal rocks, forming a set of blocks and morphologies associated with arenizations.

4.3. The Granite Landforms and the Human Work

The geomorphological map permits to do a landform inventory to know the distribution of the main landforms of the Castro de Ulaca and to establish the spatial relationship between landforms, geomorphological units and cultural remains.

The sandy depression infill by quartz sands and fines are places with more wet availability, and the springs are in the contact between granite and sandy accumulation. The small depressions are occupied by a wall of ancient houses, and on the central depression are located all the small settlements scattered by the site. In a depression near the spring is located the most important building, the power tower built with big granite ashlars obtained in the quarries.

The rock platforms and, in some cases, the convex and steeply slope rock surfaces are used as quarries to obtain building materials. The granite rock platform characterised by the sheet structure and sub-horizontal curve joints, where the separation between joints is short (50–100 cm), was used to obtain suitable regular blocks, depending on the building supplies. Today, the features to work the stones are evident, and granite ashlar of different sizes are scattered around the exploitation front (Figure 5A).

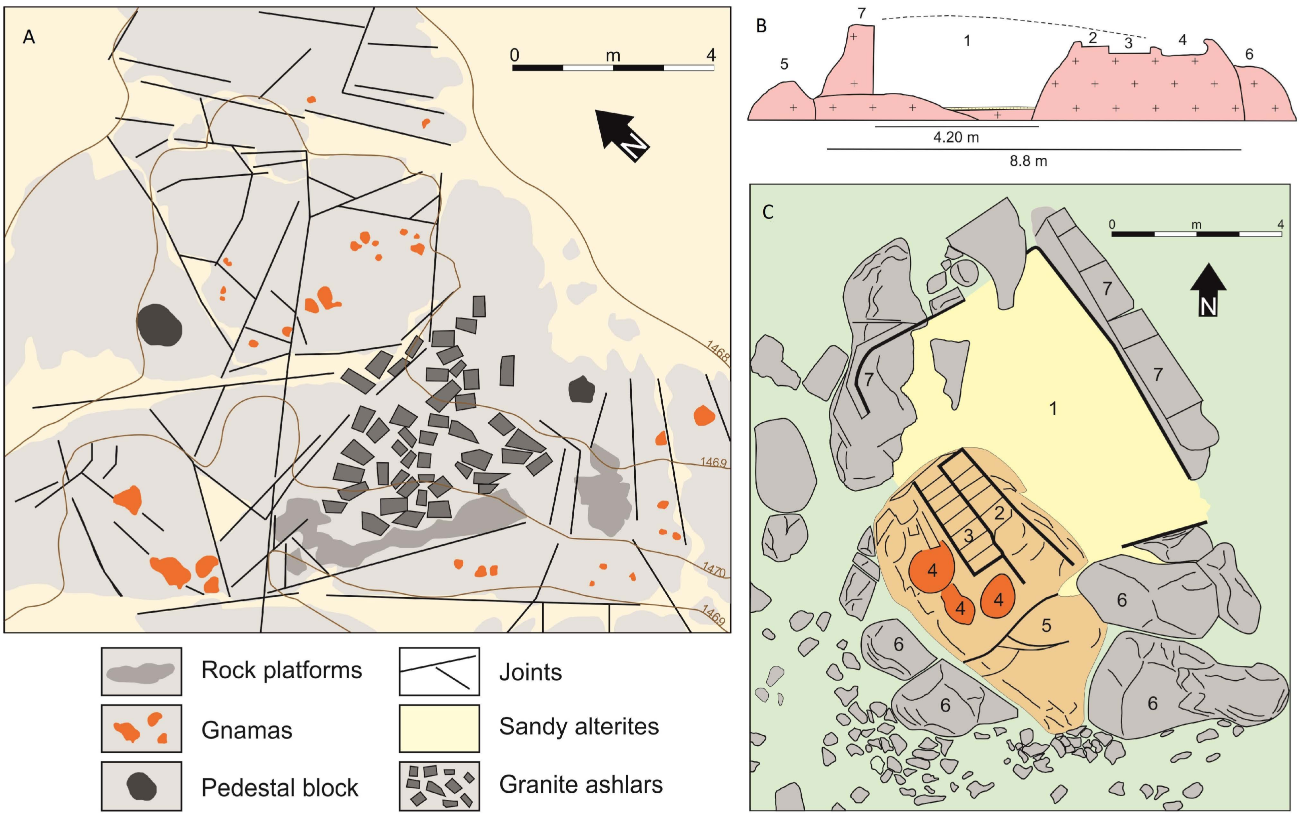

Figure 5. (**A**) Human and natural features relationship and the quarry components (**A**), (**B**,**C**) the sanctuary and the altar: (**B**) Profile of the tor worked by humans, (**C**) Map. Numbers mean: 1 Sanctuary main hall, 2 Ledges carved by human in the rock, 3 Steps carved by humans in the rock, 4 Gnammas used for sacred rites, 5 Natural boulder used as shrine, 6 Natural boulders, 7 Granite carved as santuary wall.

On the top of the block, above the sandy depressions and where the granite outcrops are more common, symbolic and ritual elements are located directly carved on the rock. A small tor was worked to be a ritual sacrifice altar. The gnammas on the top and slopes of the small tor served to spill and channel the blood streams of the slaughtered specimens. The tor has been deeply reworked, emptied in the eastern side to build a chamber and stairs carved in the rock to reach the upper area and the gnammas (Figure 5B,C). It is a good example where the natural landforms and human work are closely related. Another ritual structure built only 160 m away is explained as a sauna [31,33]. The isolated granite blocks have been empty and worked to build different chamber and elements for sauna use.

The topography and granite landforms have been used as defensive walls. The big walls built around all sites are linked to nubbins, half-domes and tors where it was not necessary to build a wall. At the northeastern area, the separation between two tors allowed to open a useful door in the wall. Finally, the structural flats located to the north of the main hill and the sandy channel linked at the top with the fluvial valleys are favourable sites for the emergence of springs. The existence of channel, flats and springs favoured the location of the main access at NW and the livestock use.

4.4. Education, Conservation and Management: The Mapping Distribution of Granite Landform in the Castro de Ulaca

Geomorphological mapping allows the abiotic environment to be incorporated into the use and management of sites of cultural interest. The landscape and granite landforms of Ulaca constitute elements of geodiversity that complement cultural assets. For Migoń [7], granite landforms can be significant in three respects: for science itself; for ecosystems, by supporting their existence and biodiversity; and for cultural heritage. In Ulaca, the cultural heritage stands out, as the archaeological site and its surroundings are part of a granitic landscape in which the Vetton culture developed. However, although it is locally significant, it cannot be considered an element of outstanding universal value.

In Ulaca, granite landforms are part of its essence, and on a local scale, they have a high value, both in terms of landscape and heritage. The presence of granite landforms not only allows a deeper understanding of the relationship between the environment and human activity but also provides information for a more appropriate management of the environment. For this reason, the two fundamental aspects of the application of knowledge of geomorphological elements are highlighted: (1) the use of the didactic and geotourism potential of the natural environment, a complementary heritage to cultural heritage; (2) support for conservation-oriented management that includes natural elements.

The natural environment and the granite landscape in Ulaca are juxtaposed with the archaeological remains resulting from the abandonment and naturalisation of the ancient oppidum. In this way, the abiotic elements become interesting for the understanding of the site itself and for the tourist or cultural visit. The granite elements are shown to have been used by humans on some occasions and without intervention on others, favouring the interpretation of the environment and the potential it offered for the settlers. These multiple interrelationships, together with the dominant granite landscape today, provide the geomorphological elements with a tourist, one might say geotourist, and didactic potential, which complements the valuable cultural elements. The complex relationship between the environment and the people, to which they had to adapt and modify, is expressed through the knowledge of the landforms and processes that shaped the terrain where Ulaca is located. In addition, it constitutes a cultural aspect for the visitor, who thus complements the understanding of the site with a more integrated vision related to the environment. This is shown in potential routes where landscape, geomorphological and cultural information is integrated. The latter are already integrated into the space, with signage and virtual and guided tours [23], but they do not include geographical and geomorphological aspects, neither of the past, when the Vetton culture flourished, nor of the present, which are necessary to understand the landscape almost two-thousand years after the Vetton abandonment of the hill.

One of the possible tools are the routes for visitors, both virtual and real. In Ulaca, the information on the geomorphological map is incorporated into the dissemination of the environment through its incorporation into the interpretative routes. The routes include three significant aspects: (1) the observation and understanding of singular elements, mainly granite; (2) the observation of the landscape inside the walls and the whole visible from this watchtower by means of viewpoints that allow the interpretation of the surrounding landscape, both physical (relief, lithology, hydrology) and cultural (land use, vegetation, exploitation of the environment, active or abandoned rural structures, etc.); and (3) the understanding of the complex relationships between the natural environment and human uses, such as the distribution of housing, the location of singular elements and the internal organisation of the territory. To this end, in coordination with the archaeological itineraries, routes and stops are proposed where the different aspects indicated are explained, with a simple map of stops where their orientation is represented by symbols and colours (Figure 6). The significant elements of the route show the three aspects highlighted above: understanding the granite landforms in their natural context (gnammas, tafonis, polygonal pattern of cracks, rock platforms, pedestal rocks, nubbins, domes); the interpretation of the landscape visible from the hill (Amblés valley and stepped blocks, Picuezo valley, La Paramera and its summits) and the interior of Ulaca (internal depression, stepped blocks, sandbanks on the slopes); and finally, the adaptation and human modifications of the landforms (altar, sauna, quarries, distribution of dwellings and springs, buildings and walls). These objectives have been shown on the geomorphological map (Figure 3) by means of symbols with different background colours which indicate their morphological, landscape or interrelation ascription. These symbols are accompanied by an explanatory and interpretative sheet.

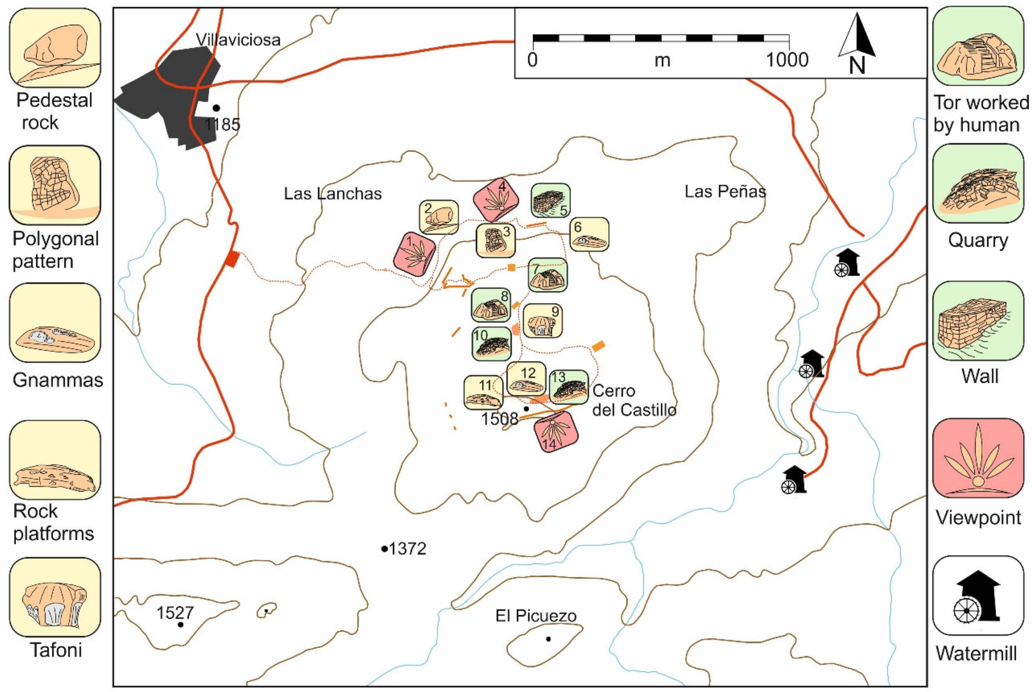

Figure 6. Geotouristic and educative itinerary in the Ulaca site. Numbers indicate the stop order. Stop 1, viewpoint on the tectonic valley and granite landscape. Stop 2, pedestal rock. Stop 3, polygonal pattern view on a vertical wall of a granite block. Stop 4, viewpoint on the tectonic valley, the semi-horst and sandy depression. Stop 5, north wall of Cerro del Castillo remains. Stop 6, gnammas observation on vertical and horizontal granite surfaces. Stop 7, sanctuary rock. Granite substrate and gnammas worked by humans. Stop 8, sauna. Granite substrate worked by humans. Stop 9, tafoni and arenization processes observation next to the path. Stop 10, quarry remains. Stop 11, rock platforms linked to curved joints on the top of Cerro del Castillo. Stop 12, gnammas linked to joints on rock platform. Stop 13, quarry remains near the South wall of Cerro del Castillo. Stop 14, viewpoint on granite landforms (convex and steeply sloping rock surfaces, domes) and the summits landscape of the La Paramera range.

The geomorphological map provides the necessary spatial information to be incorporated into the management of Ulaca. This is a territory of more than 70 ha, which must be spatially managed. It is not only necessary to know the cultural remains, but it is also important to analyse the abiotic environment in order to conserve the environment in an integral way. Proposals have already been made to integrate the natural aspects [23,36] but they have not been implemented yet. The significant geomorphological and hydrological elements must be known and included in the management of the protected area. In a small site, the elements do not constitute geomorphosites in themselves, nor can they be included in regional or national inventories. However, they are considered valuable elements from a local and tourist or educational point of view and should be preserved against possible deterioration due to access, archaeological excavations or tourist uses. To this end, it is necessary to incorporate those of greatest value (due to their orientation, distribution or uniqueness) into the management and protection plans that may be developed in the immediate future. Experience in Castilla y León shows that geomorphological elements are not considered in heritage management or protection plans, nor in cases where geomorphological elements are the primary basis for the origin of cultural elements [8].

5. Conclusions

The connection between natural and cultural elements in culturally relevant spaces allows for a better understanding of both the current landscapes and the environment in which the different societies that occupied them developed. It is a matter of knowing in detail the geographic conditioning factors and the capacities of cultures to exploit the environment or adapt to it. To this end, the landforms, which express on the surface aspects such as lithology, geological structure, past and present processes or hydrological organization, as constituents of the landscape and the product of its evolution, are exceptional indicators. And the geomorphological map is a useful tool to inventory existing landforms, their spatial distribution and relationships with cultural elements. It facilitates the connection between cultural and environmental aspects, in particular geomorphological aspects, as legacies present in the past and in the present. It is a technical document, useful for acquiring information, to be used by managers, interpreters or archaeologists for a better understanding of the environment. But it is not a tool for dissemination, and its analysis and information must be qualified and transcribed using tools adapted to the users (educational levels, tourists, geotourists, hikers, local inhabitants).

The Ulaca map shows the dominance of granitic landforms, the processes inherited and their relationship with cultural elements, as well as the adaptation to the environment of this society, forced to occupy specific sites, the high half-horst, for socio-economic and defensive reasons, but adapting to the geomorphological conditions (dwellings, defences, gates) or developing skills on the ground (granite carving, stonemasonry). The twelve granitic landforms represented, compared to other structural, fluvial or hillside ones with less representation, point to the potential of a granitic landscape characterized by the diversity of granitic geoforms. They are not elements of high scientific value, geomorphosites on an international, national or regional scale, but they are of local value due to their relationship with archaeological remains. They constitute a cultural resource of tourist and educational orientation complementary to the archaeological elements.

When cultural spaces occupy large areas and prominent physiographies, landforms allow us to understand and interpret a part of the past, and it becomes necessary to incorporate this knowledge not only into spatial and archaeological analysis but also to apply it in two separate facets: to the management of the territory; and to interpretation and dissemination as a cultural service for visitors. One of the ways of bringing this information closer to the visitor is to incorporate the information into routes and walks by means of interpreters (the most effective system of cultural transfer), documentation, signage or virtual guides, closely related to the archaeological remains. At Ulaca, the succession of sites allows for a high degree of effectiveness in incorporating these forms of information into the established routes.

Finally, the incorporation of geomorphological elements in the management of cultural spaces is necessary to guarantee their protection against potential visitor flows and infrastructure development, as well as to guarantee the survival and use of this cultural service for local societies and visitors.

Author Contributions: Conceptualization, R.M.R.-P. and E.S.; Methodology, R.M.R.-P. and E.S.; Investigation, R.M.R.-P. and E.S.; Writing—original draft, R.M.R.-P. and E.S.; Writing—review & editing, R.M.R.-P. and E.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Pangea Research Group (Natural Heritage and Applied Geography Research Group, University of Valladolid). R.M.R.-P. holds a Pre-Doctoral fellowship founded by University of Valladolid.

Institutional Review Board Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Panizza, M.; Piacente, S. *Geomorphologia Culturale*; Pitagora: Bologna, Italy, 2003.
2. Panizza, M. Géomorphologie et tourisme dans un paysage culturel integré. In *Géomorphologie et Tourisme*; Reynard, E., Holzmann, C., Guex, D., Summermater, N., Eds.; IGUL, Université de Lausanne: Lausanne, Switzerland, 2003; pp. 11–18.
3. Reynard, E. Geomorphosites and landscapes. In *Geomorphosites*; Reynard, E., Coratza, P., Regolini-Bissig, G., Eds.; Pfeil Verlag: München, Germany, 2009; pp. 21–34.
4. Reynard, E.; Brilha, J. Geoheritage: A multidisciplinary and applied research topic. In *Geoheritage: Assessment, Protection and Management*; Reynard, E., Brilha, J., Eds.; Elsevier: Amsterdam, The Netherlands, 2018; pp. 3–9.
5. Serrano, E.; González, J.J. Assessment of geomorphosites in natural protected areas: The Picos de Europa National Park (Spain). *Géomorphologie Relief Process. Environ.* **2005**, *3*, 197–208. [CrossRef]
6. Serrano, E.; González-Amuchastegui, M.J.; Ruiz-Pedrosa, R. Patrimonio natural y geomorfología. In *Los Lugares de Interés Geomorfológico del Parque Natural del Cañón del Río Lobos*; Universidad de Valladolid: Valladolid, Spain, 2020; 278p, ISBN 978-84-1320-106-1.
7. Migoń, P. Granite Landscapes, Geodiversity and Geoheritage—Global Context. *Heritage* **2021**, *4*, 198–219. [CrossRef]
8. Serrano, E.; González-Amuchastegui, M.J. Cultural heritage, landforms and integrated territorial heritage: The close relationship between tufas, cultural remains and landscape in the upper Ebro Basin (Cantabrian Mountains, Spain). *Geoheritage* **2020**, *12*, 86. [CrossRef]
9. Cendrero, A. Geología ambiental, bases doctrinales y metodológicas. In *Ponencias de la I Reunión de Geología Ambiental y Ordenación del Territorio*; Grupo Español de Geología Ambiental y Ordenación del Territorio: Santander, Spain, 1980; pp. 1–62.
10. Coratza, P.; Regolini-Bissig, G. Methods for mapping geomorphosites. In *Geomorphosites*; Reynard, E., Coratza, P., Regolini-Bissig, G., Eds.; Pfeil Verlag: München, Germany, 2009; pp. 89–103.
11. Coratza, P.; Bollati, I.M.; Panizza, V.; Brandolini, P.; Castaldini, D.; Cucchi, F.; Deiana, G.; Del Monte, M.; Faccini, F.; Finocchiaro, F.; et al. Advances in Geoheritage Mapping: Application to Iconic Geomorphological Examples from the Italian Landscape. *Sustainability* **2021**, *13*, 11538. [CrossRef]
12. Otto, J.C.; Smith, M. Geomorphological Mapping. In *Geomorphological Techniques*; Clarke, L., Ed.; British Society for Geomorphology: London, UK, 2013; Section 2.6.
13. Fuertes-Gutiérrez, I.; Fernández-Martínez, E. Mapping Geosites for Geoheritage Management: A Methodological Proposal for the Regional Park of Picos de Europa (León, Spain). *Environ. Manag.* **2012**, *50*, 789–806. [CrossRef] [PubMed]
14. Regolini-Bissig, G.; Reynard, E. Mapping Geoheritage. In *Integrated Approach for the Inventory and Management of Geomorphological Heritage at the Regional Scale*; Reynard, E., Perret, A., Bussard, J., Grangier, L., Martin, S., Eds.; Geoheritage: Lausanne, Switzerland, 2016; Volume 8, pp. 43–60.
15. Regolini-Bissig, G. *Cartographier les Géomorphosites: Objectifs, Publics et Propositions Méthodologiques*; University of Lausanne: Lausanne, Switzerland, 2012.
16. Carton, A.; Coratza, P.; Marchetti, M. Guidelines for geomorphological sites mapping: Examples from Italy. *Géomorphologie Relief Process. Environ.* **2005**, *3*, 209–218. [CrossRef]
17. Bailey, H.; Smaldone, D.; Elmes, G.; Robert, B. Geointerpretation: The interpretive potential of maps. *J. Interpret. Res.* **2007**, *12*, 46–59. [CrossRef]
18. Bouzekraoui, H.; Barakat, A.; Mouaddine, A.; El Youssi, M.; Touhami, F.; Hafid, A. Mapping geoheritage for geotourism management, a case study of Aït Bou Oulli Valley in Central High-Atlas (Morocco). *Environ. Earth Sci.* **2018**, *77*, 413. [CrossRef]
19. Ruiz Zapatero, G. *Castro de Ulaca. Solosancho, Ávila*; Institución Gran Duque de Alba: Ávila, Spain, 2005.
20. Ruiz Zapatero, G.; Álvarez Sanchís, J.R. Ulaca, la Pompeya Vetona. *Rev. Arqueol.* **1999**, *216*, 36–47.
21. Rodríguez-Hernández, J. Los procesos técnicos de la cantería durante la Segunda Edad del Hierro en el occidente de la Meseta. *Zephyrus* **2012**, *70*, 113–130.
22. Ruiz Zapatero, G.; Álvarez-Sanchís, J.R.; Rodríguez-Hernández, J. Urbanism in Iron Age Iberia: Two Worlds in Contact. *J. Urban Archaeol.* **2020**, *1*, 123–150. [CrossRef]

23. Rodríguez-Hernández, J.; Álvarez-Sanchís, J.R.; Maté-González, J.A.; Díaz-Sánchez, C.; Fernández-Barrientos, S.; Ruiz-Zapatero, G. Ancient sites and modern people: Raising awareness of Iron Age heritage in Central Spain. *Heritage* **2023**, *6*, 1128–1147. [CrossRef]
24. Seijmonsbergen, A.C. The Modern Geomorphological Map. In *Treatise on Geomorphology*; Volume 14.4 Methods in Geomorphology; Switzer, A.D., Kennedy, D., Eds.; Elsevier: Amsterdam, The Netherlands, 2013; pp. 35–52.
25. Sequeira, M.A.; Paquet, H.; Begonha, A. Weathering of granites in a temperate climate (NW Portugal): Granitic saprolites and arenization. *Catena* **2002**, *49*, 41–56. [CrossRef]
26. Serrano, E.; González, J.J. Environmental education and landscape leisure. Geotourist map and geomorphosites in the Picos de Europa. *Environ. Sci. Geoj. Tour. Geosites* **2011**, *8*, 295–308.
27. Bouzekraoui, H.; Barakat, A.; El Youssi, M.; Touhami, F.; Mouaddine, A.; Zwolinski, Z. Mapping Geosites as Gateways to the Geotourism Management in Central High-Atlas (Morocco). *Quaest. Geogr.* **2018**, *37*, 87–102. [CrossRef]
28. Erhartic, B. Conserving geoheritage in Slovenia through geomorphosite mapping. In *Mapping Geoheritage*; Regolini-Bissig, G., Reynard, E., Eds.; Geovisions: Lausanne, Switzerland, 2010; Volume 35, pp. 47–63.
29. Coratza, P.; Hobléa, F. The Specificities of Geomorphological Heritage. In *Geoheritage. Assessment, Protection, and Management*; Reynard, E., Brilha, J., Eds.; Elsevier: Amsterdam, The Netherlands, 2018; pp. 87–106.
30. Martín-Parra, L.M.; Martínez-Salanova, J.; Moreno, F. *Mapa Geológico De España. Escala 1:50.000. Vadillo de la Sierra*; IGME: Madrid, Spain, 2008.
31. Álvarez-Sanchís, J.R. *Los Vettones*; Real Academia de la Historia: Madrid, Spain, 1999.
32. Estaca-Gómez, V.; Rodríguez, J.; Gómez-Hernández, R.; Yravedra, J.; Ruiz-Zapatero, G.; Álvarez-Sanchís, J.R. Zooarchaeology of the Iron Age in Western Iberia: New Insights from the Celtic Oppidum of Ulaca. *Archaeol. Anthropol. Sci.* **2022**, *14*, 168. [CrossRef]
33. Almagro Gorbea, M.; Álvarez Sanchís, J.R. La sauna de Ulaca: Saunas y baños iniciáticos en el mundo céltico. *Cuad. Arqueol. Univ. Navar.* **1993**, *1*, 177–253. [CrossRef]
34. Álvarez Sanchís, J.R.; Ruiz Zapatero, G. Ulaca, la gran ciudad fortificada de los vettones. *La Aventura De La Hist.* **2004**, *72*, 104–107.
35. Mariné, M. El castro de Ulaca (Solosancho, Ávila). Cien Años de gestión del patrimonio arqueológico. In *Homenaje al Profesor Carlos Posac Mon*; Instituto de Estudios Ceutíes: Ceuta, Spain, 1998; pp. 381–395.
36. Maté-González, M.A.; Rodríguez-Hernández, J.; Sáez Blázquez, C.; Troitiño Torralba, L.; Sánchez-Aparicio, L.J.; Fernández Hernández, J.; Herrero Tejedor, T.R.; Fabián García, J.F.; Piras, M.; Díaz-Sánchez, C. Challenges and possibilities of archaeological sites virtual tours: The Ulaca Oppidum (Central Spain) as a case study. *Remote Sens.* **2022**, *14*, 524. [CrossRef]
37. Maté-González, M.Á.; Sáez Blázquez, C.; Carrasco García, P.; Rodríguez-Hernández, J.; Fernández Hernández, J.; Vallés Iriso, J.; Torres, Y.; Troitiño Torralba, L.; Courtenay, L.A.; González-Aguilera, D. Towards a combined use of geophysics and remote sensing techniques for the characterization of a singular building: "El Torreón" (the Tower) at Ulaca Oppidum (Solosancho, Ávila, Spain). *Sensors* **2021**, *21*, 2934. [CrossRef]
38. Smith, M.; Griffiths, J.; Paron, P. (Eds.) Geomorphological Mapping: Methods and Applications. In *Developments in Earth Surface Processes*; Elsevier: Amsterdam, The Netherlands, 2011; Volume 15.
39. Garzón, M.G.; Ubanell, A.G.; Rosales, F. Morfoestructura y sedimentación terciarias en el valle de Amblés (Sistema Central español). *Cuad. Geol. Ibérica* **1981**, *7*, 655–665.
40. Moreno, F. *Geomorfología. Memoria del Mapa Geomorfológico 1/50.000. Vadillo de la Sierra. Nº 530*; Instituto Geológico y Minero: Madrid, Spain, 2008; pp. 29–37.
41. Herrrero, M. *Toledo Sonseca. Mapa geomorfológico E. 1/50.000*; Intituto Geográfico Nacional: Madrid, Spain, 1988; pp. 629–657.
42. Herrero, M. Método de Trabajo Para la Formación y el Diseño de Mapas Geomorfológicos. *An. Geogr. Univ. Complut.* **1988**, *8*, 25–40.
43. IGUL. *Légende Pour le Leveé de Cartes Géomorphologiques au 1:10.000*; Institute de Geographie, Université de Lausanne: Lausanne, Switzerland, 1996.
44. Peña Monné, J.L. (Ed.) *Cartografía Geomorfológica. Básica y Aplicada*; Geoforma Ediciones: Zaragoza, Spain, 1997.
45. Tricart, J. *Legende Pour le Carte Géomorphologique de la France au 1/50.000*; Memoirs et Documents; CNRS: Paris, France, 1971.
46. Twidale, C.R. Granite outcrops: Their utilisation and conservation. *J. R. Soc. West. Aust.* **2000**, *83*, 115–122.
47. Bullón Mata, T.; Martinez de Pison, E.; Arenillas Parra, T.; Arenillas Parra, M.; Sanz Herráiz, C.; Troitiño Vinuesa, M.A.; Burgues Hoyos, J.A.; Juarez del Canto, D. *Análisis del Medio Físico de Ávila: Delimitación de Unidades y Estructura Territorial*; Junta de Castilla y León: Valladolid, Spain, 1988.
48. De Vicente, G.; Vegas, R.; Muñoz-Martín, G.; Silva, P.G.; Andriessen, P.; Cloetingh, S.A.P.L.; González Casado, J.M.; Van Wees, J.D.; Álvarez, J.; Carbó, A.; et al. Cenozoic thick-skinned deformation and topography evolution of the Spanish Central System. *Glob. Planet. Change* **2007**, *58*, 335–381. [CrossRef]
49. De Vicente, G.; Cunha, P.P.; Muñoz-Martín, A.; Cloetingh, S.A.P.L.; Olaiz, A.; Vegas, R. The Spanish-Portuguese Central System: An example of intense intraplatedeformation and strain partitioning. *Tectonics* **2018**, *37*, 4444–4469. [CrossRef]
50. Birot, P.; Sole Sabaris, L. *Investigaciones Sobre Morfología de la Cordillera Central Española*; CSIC-Inst. J. S. Elcano: Madrid, Spain, 1954; pp. 1–87.
51. Garzón, M.G.; de Pedraza, J.; Ubanell, A.G. Los modelos evolutivos del relieve del Sistema Central Ibérico (Sectores de Gredos y Guadar rama). *Rev. Real Acad. Cienc. Exactas Físicas Y Nat.* **1982**, *76*, 475–496.

52. Moreno, F. Superficies de erosión y tectónica neógena en el extremo occidental del Sistema Central español. *Geogaceta* **1991**, *9*, 47–49.
53. Molina, E.; Blanco, J.A.; Pellitero, E.; Cantano, M. Weathering processes and morphological evolution of the Spanish Hercynian massif. In *International Geomorphology*; Gardiner, V., Ed.; Wiley: Chichester, UK, 1987; pp. 957–977.
54. Migoń, P.; Thomas, M.F. Grus weathering mantles. Problems of interpretation. *Catena* **2002**, *49*, 5–24. [CrossRef]
55. De Prado, C. *Descripción Física y Geológica de la Provincia de Madrid*; Junta General de Estadística: Madrid, Spain, 1864; 219p.
56. Migoń, P.; Vieira, G. Granite geomorphology and its geological controls, Serra da Estrela, Portugal. *Geomorphology* **2014**, *226*, 1–14. [CrossRef]
57. Molina, E. *Geomorfologia y Geoquímica del Paisaje: Dos Ejemplos en el Interior de la Meseta Ibérica*; Ediciones Universidad de Salamanca: Salamanca, Spain, 1991; 72p.
58. Pedraza, J. La morfogénesis del Sistema Central y su relación con la morfología granítica. *Cuad. Lab. Xeolóxico Laxe* **1989**, *13*, 31–46.
59. Pedraza, J.; Sanz, M.Á.; Martín, A. *Formas graníticas de La Pedriza*; Comunidad de Madrid: Madrid, Spain, 1989; 205p.
60. Migoń, P. *Granite Landscapes of the World*; Oxford University Press: Oxford, UK, 2006.
61. Twidale, C.R. *Granite Landforms*; Elsevier: Amsterdam, The Netherlands, 1982.
62. Twidale, C.R.; Vidal-Romani, J.R. *Landforms and Geology of Granite Terrains*; CRC Press: Londres, UK, 2005.
63. Álvarez Sanchís, J.R. Ulaca: Una ciudad vetona. *Desperta Ferro. Arqueol. E Hist.* **2017**, *15*, 44–49.