Geoheritage (2024) 16:86
https://doi.org/10.1007/s12371-024-00990-6

ORIGINAL ARTICLE

Dissemination and Interpretation of Natural Heritage in Sierra de la Paramera (Ávila, Spain). An Experimental Activity on Geomorphosites, Cultural Heritage and Landscape

R. M. Ruiz-Pedrosa[1] · **E. Serrano**[1]

Received: 11 August 2023 / Accepted: 10 August 2024 / Published online: 21 August 2024

Abstract
The inhabitants of Natural Protected Areas are often unaware of the scientific and heritage value of the natural environment in which they live, although they are users and form part of its landscapes and landforms. The scientific community, in turn, does not always include the local population in research projects. Thus, it is necessary to implement mechanisms for participation and knowledge exchange. The scientific dissemination activity carried out at Castro de Ulaca, in the Sierra de la Paramera, in Ávila (Spain), was offered to the residents of the villages of the Natural Area and was focused on the relief, landscape and geomorphosites. The work, carried out through field work with the participants and surveys, shows the knowledge and opinions of the locals about the geomorphological heritage and the environmental protection of the area before the activity, and how it changes after it.

Keywords Sierra de la Paramera · Geomorphosites · Landscape · Dissemination · Natural Protected Areas

Introduction

Landscape is formed by different material, natural and human elements come together, it is dynamic and reflects the territorial structures of its own, from its history to the new current uses, or, in the case of abandonment, of the natural elements (Serrano 2012). Landscape is, therefore, an agglutinator of both natural and cultural heritage, so that a global vision of heritage leads us to landscape as the meeting point of natural and cultural heritage (Martínez De Pisón, 2012).

The Natural Protected Areas (NPAs) are home to a natural, cultural, educational and tourist value that sometimes goes unnoticed by the inhabitants of their towns and villages. So much so that they are often unaware that they live in a NPA, or what are the natural and cultural features that have led to its declaration and protection.

✉ R. M. Ruiz-Pedrosa
rosamaria.ruiz.pedrosa@uva.es

E. Serrano
e.serrano@uva.es

[1] Pangea Research Group, Department of Geography, University of Valladolid, 47011 Valladolid, Spain

This disconnection between protection figures and the inhabitants of Natural Protected Areas (NPAs) leads to a serious problem of lack of interest, apathy or mistrust towards public environmental bodies. Even more seriously, it implies a lack of knowledge of their values, rooted in the erroneous idea that the area does not deserve protection, which leads to a complicated process of acceptance and patrimonialisation of geomorphosites. Geomorphosites are portions of the geosphere that are important for the understanding of Earth's history, are spatially delimited and clearly distinguishable from their surroundings (Reynard 2009). They are manifold: they can be individual objects or systems, active geomorphosites that allow visualizing geomorphological processes in action (e.g. fluvial systems, active volcanoes) or passive ones that bear witness to past processes; in this case, they have a particular heritage value as a memory of the Earth (Panizza and Piacente 2005; Reynard and Panizza 2005).

The value of geomorphological heritage comes from its inherited character, from the uniqueness of certain geoforms and from the worldview of the cultures that use, occupy and interpret the relief in a given territory (Serrano et al. 2020). It can have value at different scales, from planetary to continental, regional or local, and for different societies that share

the territory, and is therefore highly variable according to the territorial scope in which it is inscribed (Serrano et al. 2020).

Thus, NPAs often include a wide and valuable geomorphological heritage with landscape connotations. The first NPAs arose, in Spain and all over the world, from the idea of admiration and enjoyment of nature, from the need to protect a natural heritage that should be delimited and inherited from generation to generation. In this way, the existence of outstanding areas that stand out for their beauty and natural value, and whose preservation is recognized as a common objective of society, begins to be more common. The result is the declaration of strictly delimited NPAs in order to have a legislative framework, restricting uses to ensure the conservation of abiotic and cultural elements. And in these NPAs, abiotic elements, intimately related to biotic and cultural elements, such as Geomorphosites, stand out when they are valued by scientists, managers, local inhabitants and users of NPAs. Their recognition enriches the heritage of NPAs and the experience of both visitors and local inhabitants through new insights and increased knowledge.

In addition, geomorphosites are closely interrelated with human uses and cultural values that generate a reciprocal enrichment of both the cultural elements and Geomorphosites (Panizza 2001, 2003; Serrano et al. 2020). These are the added values, which, in some cases, as in Ulaca, revalue the landforms due to the close relationship between the Geomorphosites, the landforms, the cultural remains and the landscape.

Interpretation is a very useful tool to increase local people's knowledge and awareness of the need to conserve and manage geoheritage, not only on the part of administrations, but the process of raising awareness is capable of awakening conservationist attitudes in the population (Tilden 1957; Coratza et al. 2023). To ensure the success of this process, it is necessary for the scientific community to approach the local population with a language that is easy to understand, with messages that favor dissemination and with a certain sentimental connotation (Valentini et al., 2022) that awakens in the public a feeling of appreciation for their natural heritage. Not only can the local population benefit from this type of activity, but interpreted nature trails, as a form of citizen science, allow the scientific community to undertake research of interest to the entire population from an innovative point of view (Kelly et al. 2020), enabling the transfer of knowledge between both groups. Other experiences to link the researchers and local inhabitants have been realized to raise awareness and share about cultural values and landscape between the implied people in NPAs (e.g. Tormey, 2019).

The aim of this work is to investigate the knowledge and opinion of the inhabitants of The Sierra de la Paramera about the natural heritage of the area around the Ulaca site and the NPAs. In this context, the aim is to find out the attitudes of the local inhabitants towards the management of the NPAs and the archaeological site, as well as to give value to the geomorphological heritage in itself and in relation to the cultural elements through activities of interpretation and dissemination. In this territory there is cultural heritage planning focused on tourism and providing visitors with historical and archaeological information, but no attention has been paid to the natural heritage, despite its early assignment of the figure of NPA, more than 20 years ago, neither for the management nor for the visitors nor for the local population. For this reason, we propose a route through Ulaca Hillfort, where cultural and natural elements are combined for a global understanding of the landscape.

Study Site: Sierra de la Paramera and Ulaca Hill

The Sierra de la Paramera is located in the southwest of the province of Ávila, in the western sector of the Spanish Central System (Fig. 1), and forms part of the Gredos complex, one of the three large structural complexes of the Central System (Capote 1982). The relief of the Gredos complex is a faulted structural relief, where the pop-down and pop-up structures form basin and ranges morphologies. The Sierra de La Paramera is a horst limited by faults and two basins or graben, to the south, the Amblés valley and to the north, the Alberche valley. La Paramera is the water divide between the Duero and Tajo basins, as they are bordered to the north by the Amblés Valley, whose main watercourse is the river Adaja, belonging to the Duero basin, and to the south by the Alberche river, belonging to the Tajo basin. The range is an East–West alignment with altitudes varying between 850 m in the valley bottoms and 2157 m, the maximum altitude at the Zapatero peak.

The study area is composed of the Palaeozoic Hercynian basement, formed of granites and metasedimentary rocks. At the end of the Mesozoic, an erosion surface was generated on which an important alteration profile developed (Martin Parra et al. 2008). During the Alpine orogeny, especially in the Castellana and Neocastellana phases, a Cenozoic pop-up structure with an E–W to NE–SW orientations, thick-skinned tectonics and antiform geometry in the upper crust is generated (de Vicente et al. 2007). During the tectonic phase the faulted structural relief is stablished, characterized by faulted basin and ranges (Fig. 2). Immediately begins the erosion on the raised blocks and the fill of the basins.

The Paramera tectonic block has an uniform relief, modelled by very continuous erosion surfaces, partially dissected by grus weathering mantles (Bullón et al. 1988). The grus mantles allow the development of the soils and their suitability for agricultural exploitation, which reduces livestock use.

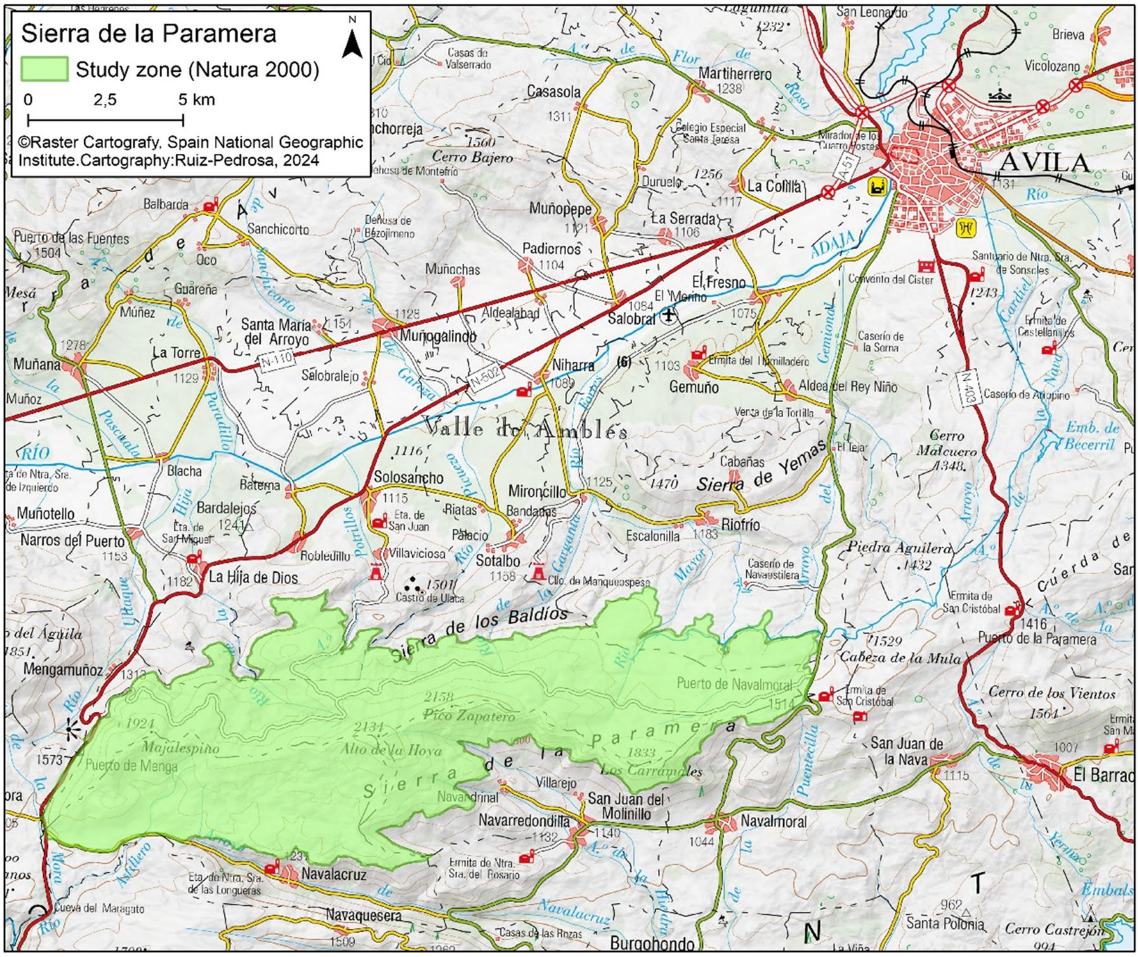

Fig. 1 Sierra de la Paramera área (in green), 30 kms from Ávila capital city. Cartography: Spain National Geographic Institute. Own map

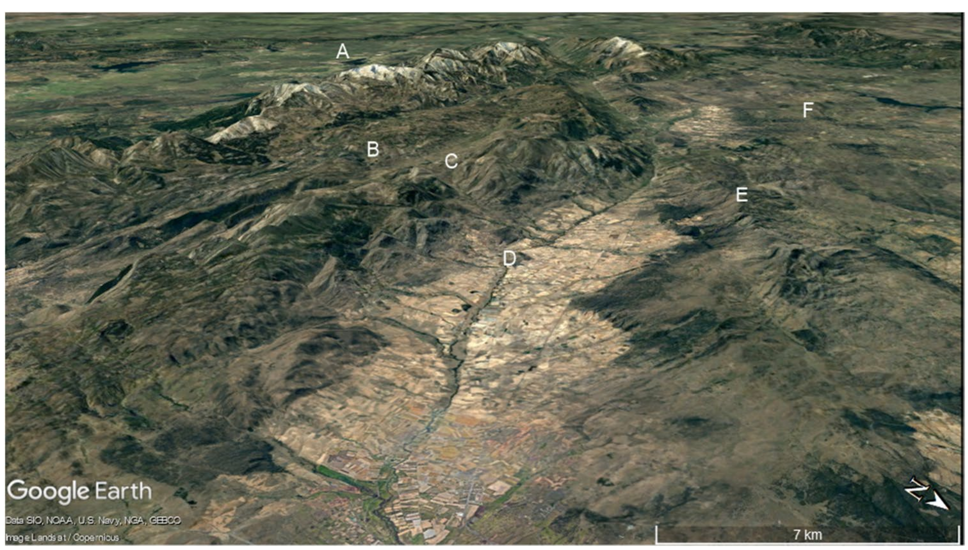

Fig. 2 Oblique view of Spanish Central System, Gredos complex. It is possible to differentiate the structural relief units: **A** Gredos horst, **B** Alberche graben, **C** La Paramera horst, **D** Amblés valley graben, **E** Sierra de Ávila horst, **F** Duero basin.

The limit between the Sierra de la Paramera horst and the grabens are formed by abrupt scarps to the South, limited by a fault, and less abrupt to the north, toward the Amblés valley graben, where a succession of stepped tectonic blocks links with the Ambles tectonic valley (Fig. 2). On a half-horst, at 1508 m a.s.l., is located the Ulaca Archeological area, on the Cerro del Castillo (which means the Castel Hill in Spanish). It is formed by granitic rocks and limited by NE-SW and E-W faults. The top of the hill is located 390 above the Amblés Valley, and separated from the upper tectonic blocks to the North by the depth Picuezo valley, a fault-line valley with abrupts slopes modelled by granite landforms.

The Ulaca site (1508 m a.s.l., 40°31′48″ N and 4°53′01″ W), located in the municipality of Solosancho, is an archaeological site that was designated a historic-artistic site in 1931, declared an Asset of Cultural Interest (BIC in Spanish law) since 1986, and in 1994 it was defined as an archaeological area (Spanish Historical Heritage Law).

The Ulaca site is a fortified Vetonean settlement from the late Iron Age (3rd–fifth centuries BC). The site occupies more than 60 hectares, as well as housing some exceptional structures from the Celtic world in an excellent state of preservation (Ruiz Zapatero 2005; Maté-González et al. 2021; Ruiz Zapatero et al. 2020). These include a wall with a perimeter of 3,000 m, a sanctuary, a ritual sauna, the remains of more than 250 dwellings, the tower in the center of the settlement, and some spectacular granite quarries that show how the Vetons made use of the geomorphological resources that La Paramera offered them (Ruiz Zapatero 2005; Rodríguez-Hernández 2012; Ruiz Zapatero et al. 2020; Rodríguez Hernandez et al. 2023).

The Ulaca site, studied since the 1970s, has been interpreted as an urban center where the elites who exercised control over the adjacent territory resided. Also it was an important witness to the different lifestyles and pastoral strategies of the Vetonean culture (Ruiz Zapatero et al. 2020). It has a long history of cultural heritage protection, which has taken the form of weak management and maintenance actions (Rodríguez-Hernández et al. 2023; Mariné, 1998), despite the multiple dissemination initiatives carried out by archaeologists, including innovative analyses and virtual visits (Rodríguez-Hernández et al. 2023; Maté-González et al. 2021, 2022).

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 (Rodríguez-Hernández et al. 2023). The site is of great archaeological, historical and anthropological wealth, around which a whole series of traditions have been created, especially among the inhabitants of the villages of Solosancho and Villaviciosa, such as the Celtic Moon Festival of Solosancho, which reunites more than 3000 people on a night in which a play is performed in the hill, in addition to a full festive program inspired by the Celtic roots of the municipality (Ruiz-Pedrosa and Serrano 2023). As pointed out by Rodríguez Hernández et al. (2023), these activities aim to attract visitors and promote sustainable tourism in a very fragile natural environment affected by severe depopulation.

The Sierra de la Paramera, together with the Sierra de la Serrota and including the Ulaca site, form part of the Natura 2000 Network as a Special Area of Conservation (ZEC in Spanish) but have not yet been integrated into the Regional Network of Natural Protected Areas of Castilla y León. In 1991, it was ordered to initiate the processing of the legislation for its protection and integration into the Regional Network, although more than thirty years later the processing has not yet begun. As a result of its neglect and lack of management, in August 2021 the Sierra de la Paramera was severely affected by a large forest fire that burnt practically its entire surface area. In some municipalities, such as Sotalbo, it burnt 90% of the municipal territory, burning more than 22,000 hectares of the Natura 2000 surface. In its advance, the fire also affected the Ulaca hillfort, and fortunately no archaeological elements were lost.

Methodology

This interpretation activity took place in the Cerro del Castillo, where the Ulaca hillfort is located. Prior to the activity, fieldwork was carried out for the geomorphological analysis of the Sierra de la Paramera and for the identification and evaluation of its geomorphosites. The qualitative method of Identification of Places of Geomorphological Interest of Valladolid was applied, which considers the intrinsic aspects, i.e. geomorphological, those of use and management of the places and the NPA, and the cultural or added aspects. In addition, a geomorphological map has been drawn up at a scale of 1:20,000 based on a bibliographic and cartographic review and fieldwork (Ruiz-Pedrosa and Serrano 2023). Thirteen geomorphosites have been inventoried in the Sierra de La Paramera, one of which is the Castro de Ulaca, which stands out not only for its geomorphological heritage, but also for the special relevance of its cultural heritage.

The activity consisted of a field trip with volunteer local inhabitants, therefore, the strategy used for the dissemination of natural heritage in this activity was that of heritage interpretation, which is characterized by the transmission of knowledge through first-hand experience and illustrative means (Tilden 1957), in contact with a territory that is close to the participants.

To find out what knowledge the participants had about the Sierra de la Paramera and its granite modelling, a pre-activity questionnaire was carried out to find out whether they were aware of the environmental protection status of

Table 1 Pre- and post-activity questionnaires

Pre-activity	*Post-activity*
1. Does the Sierra de la Paramera have any environmental protection? Can you tell us which one?	1. Do you remember what the environmental protection of the Paramera is and Serrota?
2. Have you ever been to the Sierra de la Paramera before?	2. Mark the concepts you remember from the explanations: horst, graben, fault, granite dome, nubbin, tor, rock platform, gnamma, tafoni and pedestal rock
3. And in the Castro de Ulaca?	3. Do you think that the Paramera and Serrota should be declared a Natural Park o NPA? Why?
4. And in the Sierra de Gredos?	4. Do you know local terms for the granitic forms explained?
5. Mark the concepts that you know and can explain: horst, graben, fault, granite dome, nubbin, tor, rock platform, gnamma, tafoni and pedestal rock	5. Any comments or suggestions you would like to make about the activity

the Sierra, whether they had been to the Paramera and Ulaca before, and whether they were familiar with terms related to granite landscape and the morphostructure of the area in which we were (Table 1). These same questions were asked at the end of the activity with the aim of evaluating the usefulness of the explanations given on the route, comparing the absorption of information, evaluating the interest of the activity, and the change in the attitude of the participants towards natural heritage.

The surveys were answered by a total of 32 participants (Fig. 3), all of them inhabitants of the villages of La Paramera and the city of Ávila, of different ages (between 18 and 60 years old), with different levels of education (from compulsory studies to higher education) and whose professional profiles were far from any job related to geoheritage or landscape, except for three assistants, one of them a geographer, and two employees of the Iruelas Valley Nature Reserve.

Fig. 3 Participants at one of the stops along the route. In the background, the Amblés graben. Own photograph

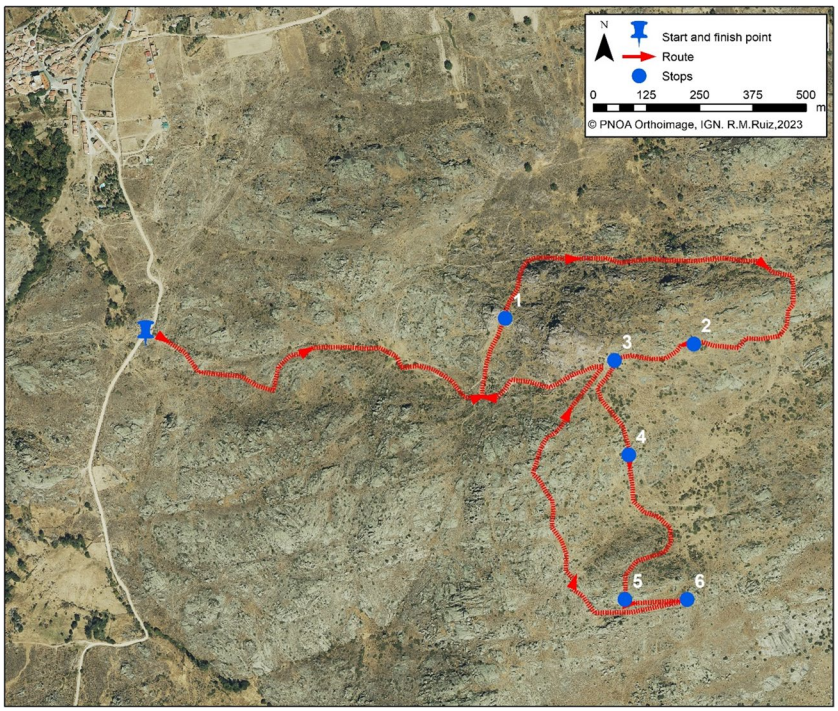

Fig. 4 Route and stops made during the activity. At the top left, the village of Villaviciosa (Solosancho), which leads to the car park set up for the ascent to the Ulaca Hillfort, which is the starting and finishing point of the route. Stop 1: west entrance to the hillfort. Stop 2: north and east sector. Stop 3 and 4: north-western sector, at the altar of sacrifices and ritual sauna. Stop 5 and 6: quarries in rock platforms, next to the vetonean village and unfinished walls

Along the route (Fig. 4), structural geomorphology, granite landscape and the relationship between natural elements and cultural uses were explained in different stops (Table 2, Fig. 3). To reinforce the explanations, various illustrations and diagrams were used as support material (Fig. 5).

Stop 1. The first stop was made to the west of the entrance to hillfort, taking advantage of the existence of a shining example of a pedestal rock on the edge, with views of the Amblés Valley. With this panoramic view we made a brief introduction to the legislative situation of the Sierras de la Paramera and La Serrota, specifically about the Natura 2000 Network and the Network of NPAs of Castilla y León. We also talked about landscape and land uses, faulted structural relief, with the Amblés graben in the background and the Sierras Paramera and Serrota as a tectonic horst, and an introduction to granite landforms and arenization processes was made.

Stop 2. After rounding the hillfort along the north side, the second stop was made to explain and visualize examples of granite landforms such as domes and tors. It is next to the north wall, buildt with granites worked by humans.

Stop 3. The third stop was at the Altar de los Sacrificios, in the north-western sector of the settlement. This is a rock excavation in which animal sacrifices were carried out (Ruiz Zapatero 2005) with blood being poured through two granite gnammas. Thus, at this stop, we were able to focus on the relationship between natural and cultural heritage, and the use that humans, and specifically the Vetonians, made of the natural gammas that already previously existed in a large granite block (Ruiz-Pedrosa and Serrano 2023), which they continued to carve and work to create this altar.

Stop 4. Next to the Altar de los Sacrificios, we stopped at the ritual sauna, as another example of a small tor modification

Stop 5. The fifth stop was at the top of the Cerro del Castillo, next to one of the quarries of the hillfort, which was near the vetonean village, where we could once again see the human exploitation of a natural resource. In these quarries the wedges and blocks cut in different degrees of development on large rock platforms can be seen, taking advantage of the natural joints of the granite. From this point, overlooking the Picuezo river valley, we could also see the granite dome of the Picuezo and the granite peaks of the Picos Zapateros.

Stop 6. The last stop was also next to a quarry, seeing the north unfinished wall.

Geomorphological Heritage in Sierra de la Paramera: Granite Landscape

In the Ulaca halfhorst, the rock is homogeneous, medium-grained adamellites, biotitic and porphyritic, and the fracturing patterns change, with vertical and curved fractures and erosion-directed emplacements. Throughout the Sistema

Table 2 Stops and explanations made during the activity

Stops (see Fig. 2 for cartography)	Sites and elements	Explanations
Stop (1) South side of the hillfort, west of the entrance to the hillfort	- Pedestal rock on the edge of the hillfort - Panoramic view of the Amblés graben	-Brief introduction to the legislative situation: Natura 2000 Network and the Regional Natural Protected Areas of Castilla y León, Cultural Heritage - Landscape and land uses - Faulted structural relief, the tectonic graben of the Amblés valley and the horst of the Sierra de Ávila in the background - Introduction to granite modelling and sandification processes
Stop (2) North and east sector of the hillfort	- Granite outcrops - Panoramic view to the east - Hillfort wall	- Granitic microforms: tafoni, gnammas - Granitic mesoforms such as domes, tor, rock platforms
Stop (3) North-western sector of the Hillfort	- Altar of Sacrifices of the Vetonean Hillfort	-Rock excavation for animal sacrifices (Ruiz Zapatero 2005) -Relationship between natural elements/cultural use: granite gnammas used for pouring blood - Reflection on the relationship between natural and cultural heritage, the use that humans, and specifically the Vetoneans, made of the natural gnammas, which already existed in a tor, which they reworked to create this altar
Stop (4) North-western sector of the Hillfort	Sauna worked on a tor	-Relationship between natural elements/cultural use -Reflection on the relationship between natural and cultural heritage, the use that humans, and specifically the Vetoneans, building a sauna in a small tor
Stop (5) Northern sector	-Quarries in the granitic rock platforms -Panoramic view: La Paramera and Zapatero peak	-Human exploitation of a natural resource -Observation of the methods of exploitation: wedges and blocks cut in different degrees of development on large rock platforms, taking advantage of the natural joints in the granite - Granite landforms: Microforms and observation of the granite dome of the Picuezo and the granite peaks of the Picos Zapateros
Stop (6) Northern sector	-Quarries in the granitic rock platforms next to Vetonian walls under construction	-Human exploitation of a natural resource

Central, included the study area, the chemical alteration of granite by hydrolysis is frequent (Molina et al. 1987; Molina 1991) creating scarce hollows and sandy plains. Granitic landforms have numerous ways of classification, either by genesis, location or size (Twidale, 1982; Twidale and Romani, 2005; Migoń, 2006, 2021), and examples of all of them can be found in the Paramera and the Ulaca site (Fig. 6). The granitic landforms of La Paramera, although little known, is outstanding on a local and regional scale. In the Sierra de la Paramera and Castro de Ulaca, the major granitic landforms include domes, nubbins and tors. Among the smaller ones, the most outstanding are gnammas, tafonis and pedestal rocks.

The granitic landforms are distributed according to their location, and this has conditioned the uses and modes of exploitation by its inhabitants. In Ulaca, there are differences between the culminating portions, which are more flattened, and the slopes, where the alternation of curved and vertical fractures and the greater energy of the relief condition different landforms (Ruiz-Pedrosa & Serrano 2023). Ten main granite landforms can be differentiated in the Ulaca site (Table 3).

In the upper zone there are sandy depressions forming small landings that are very deteriorated by human uses and nowadays with vegetation, as they are places of soil moisture retention. On the culminating areas there are tors, platforms rocks and pedestal rocks. The tors are common throughout the upper part of the area, although they are of moderate size (Ruiz-Pedrosa and Serrano 2023). The platform rocks found in the higher portions were used as quarries, because of the ease with which blocks of homogeneous dimensions could be extracted. The pedestal rocks often form the surface of the

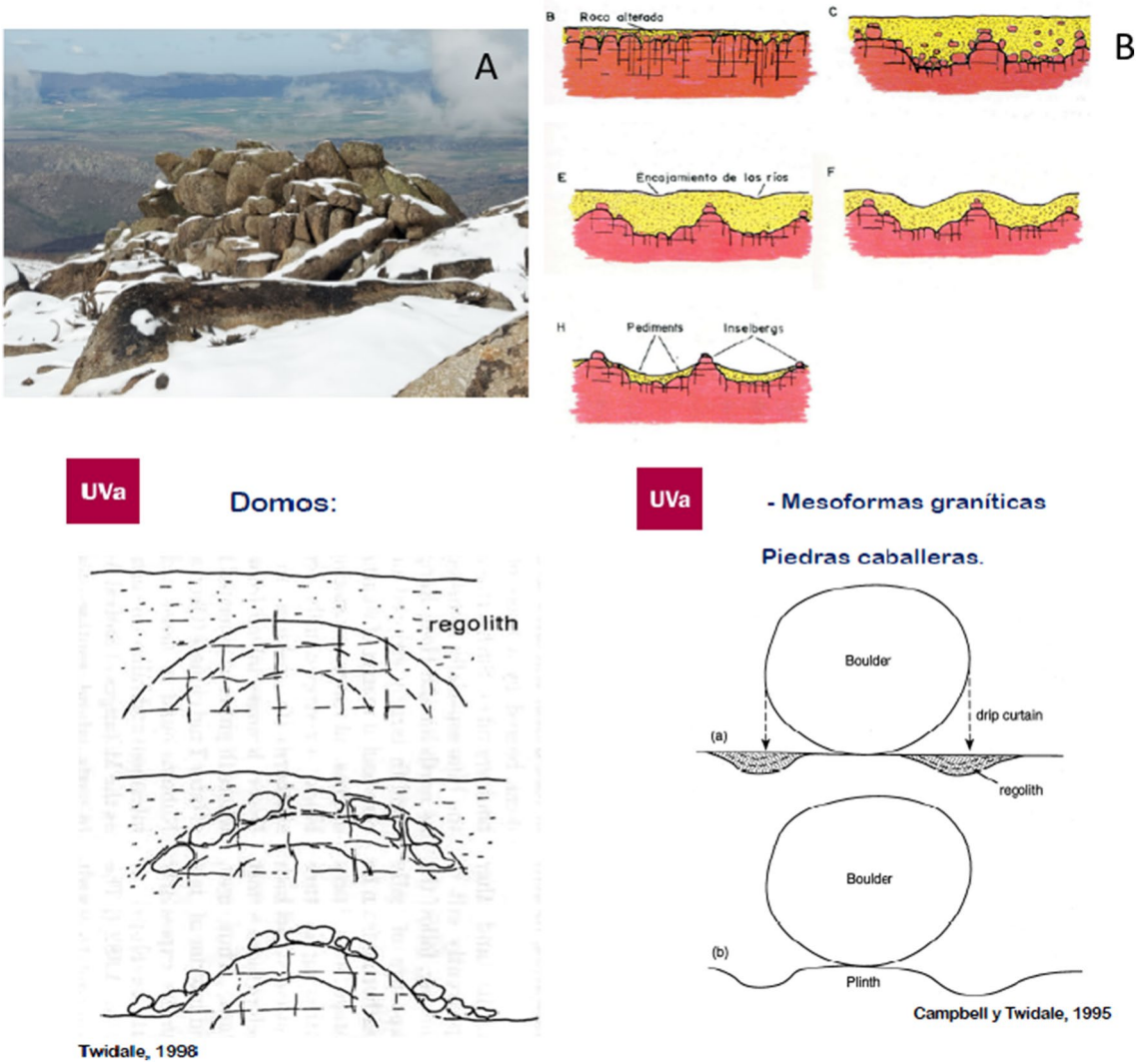

Fig. 5 Illustrations and diagrams used in the field activity. Contents: **A** Thor in Sierra de la Paramera (own photography), **B** sandblasting of granite (Pedraza et al. 1989), **C** domes evolution (Romaní and Twidale, 1998), **D** pedestal rocks (Campbell y Twidale, 1995)

ground with very moderate slopes and without generating a positive relief. They are also often found in the nubbins or tors, as a consequence of already very degraded reliefs (Ruiz-Pedrosa and Serrano 2023).

On the slopes the nubbins are the dominant landforms. and the most representative granite landform in the studied area. Granite boulder fields on the slopes alternate between pedestal rocks, platform rocks and slabs from which the blocks break off. There are also granite domes, domed and upright landforms limited by smooth and curvilinear walls that give rise to large platform rocks. These are the early granite landforms, as they are hardly degraded and are dominant on the slopes towards the Picuezo valley.

Among the minor granitic landforms, gnammas and tafonis stand out. They are very frequent in Ulaca and have given rise to different uses. Gnammas, circular depressions with little depth and formed on horizontal surfaces in tor, pedestal rocks or platform rocks have been used during religious offering. Tafonis are also very frequent, always carved in the larger landforms.

As a whole, the granitic landforms of La Paramera form a particular geomorphological landscape (Fig. 7). This landscape has been highlighted as an important element of the world geoheritage, although it is scarcely recognized, despite the fact that it combines the interpretation of landscape evolution and environmental changes on a geological scale with high aesthetic values (Migoń, 2021).

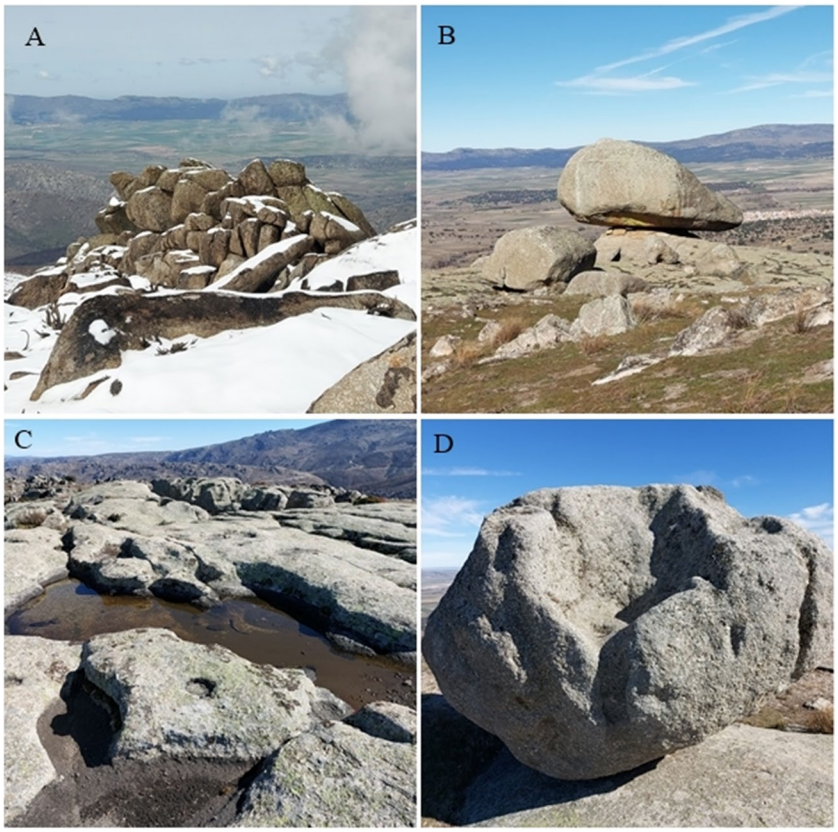

Fig. 6 Granite landforms in the Sierra de la Paramera: **A** nubbin, **B** pedestal rock, **C** gnammas in a rock platform, **D** gnammas and tafoni

Table 3 Granite landforms in the Ulaca site represented in the map. Modified from Ruiz-Pedrosa and Serrano 2023

Landforms	Geomorphological setting	Morphological criteria	Human uses
Nubbin	On slopes and borders of the halfhorst	Granite outcrop with redounded and vertical features	Defensive
Tor	On the top of the halfhorst	Isolated granite outcrops partitioned by fractures	Ritual and power building
Rock platforms	On the top of halfhorst and the southern raised blocks	Granite outcrops with sheet structure and flat morphologies directed by curve joints	Quarries
Convex and steeply slope rock surface	On the slopes of the halfhorst	Granite outcrops with sheet structure, hard slope directed by curve joints	Defensive
Granite dome	Borders of the raised blocks	Domatic landforms directed by curve joints	Defensive
Granite halfdome	Borders of the raised blocks	Dissymmetric domes directed by curve joints and vertical faults	–
Granite crest shaped	Water divides out of the halfhorst	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	On the top and the raised blocks	Small basin and slopes covered by fine sediments	Settlements
Pedestal rocks	On the halfhorst borders and raised blocks	Isolated or free-standing blocks on a rock platform	Ritual

Results and Discussions: Population, Geomorphology and Heritage

The Ulaca hillfort, known by all the locals for its history and archaeological wealth, is the perfect setting to emphasize the natural environment on which the archaeological site is based, the structural relief and the landforms developed over millions of years, which has survived fires such as the one in 2021, as well as the landscape, the land uses and the confluence of human beings and the environment. In short, the interrelation of natural and cultural

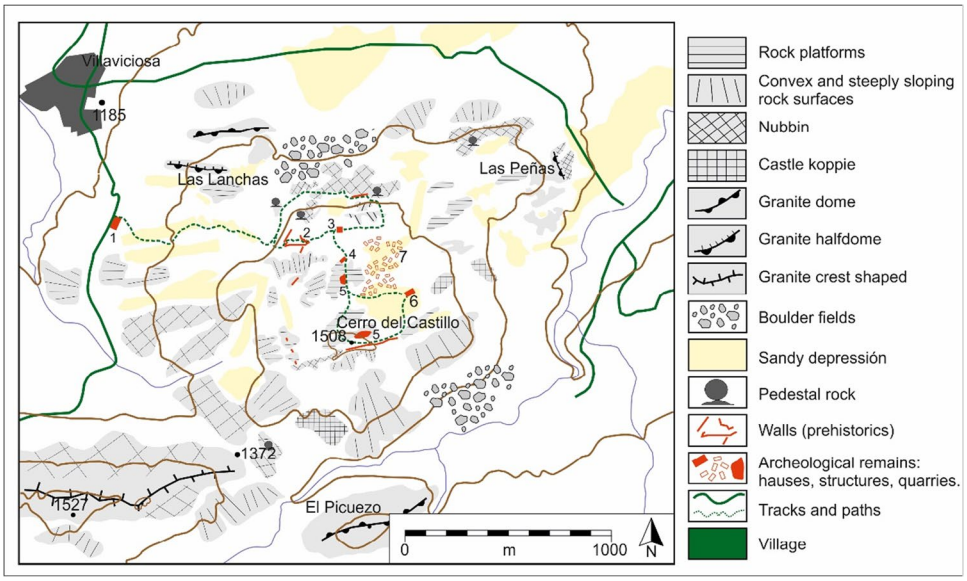

Fig. 7 Ulaca hillfort geomorphological map. Modified from Ruiz-Pedrosa and Serrano 2023

values in these mountains explains both their high natural and cultural value and the need for protection.

In the first question prior to the activity, "Does the Sierra de la Paramera have any environmental protection, could you say which one?", 75% of the participants answered that they did not know about its protection (Fig. 8 left). In contrast to this large majority, 10% knew that it belonged to the Natura 2000 Network, 12% knew that it was a ZEC (Especial Conservation Area, ZEC in Spanish) and only 3% answered unspecifically that it was a Natural Area of Castilla y León.

At the end of the activity, when asked the question "Do you remember what the environmental protection of the Paramera and Serrota is?", 46% of the participants a Network and 8% specifically remembered that it was a ZEC (Fig. 8 right). 38% of the participants did not know how to answer the question, compare to 75% who did not know how to answer it before the activity. Therefore, more than half of the participants finished the activity knowing the Paramera protection figure.belongs to the Natura 2000.

Another of the starting hypotheses for the activity was the dominance of the Sierra de Gredos in nature tourism in the province of Ávila, as opposed to the lack of knowledge of the Sierra de la Paramera and the Serrota. The Sierra de Gredos, located in the extreme south of the province of Ávila, was declared a Regional Park in 1996, and since then has led the way in nature and rural tourism in the province. Today it is a well-preserved glacial complex, where you can see glacial lakes, cirques and morainic deposits. The Circo and Laguna Glaciar Grande de Gredos stand out, with the Almanzor peak in the background, at 2,592 m, the highest peak in the whole of the Sistema Central. The proximity between the Sierras de la Paramera and la Serrota and the Sierra de Gredos, barely 70 km away, has not facilitated tourist interest in the former. But it is not only a problem of tourism, but also that most of the inhabitants of the Paramera villages have abandoned traditional jobs linked to natural resources. As a result, they know little about the mountain, or they know it because they use it for recreational purposes but do not value its richness as a natural heritage. This could be seen

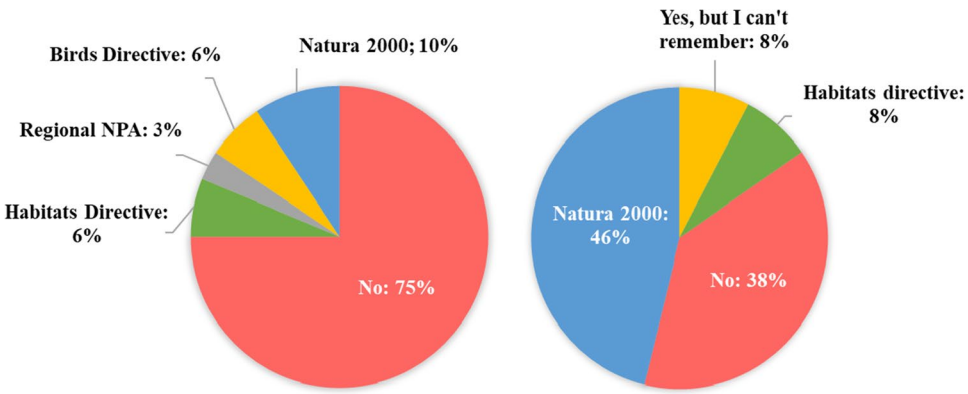

Fig. 8 Answers to the question "Does the Sierra de la Paramera have any environmental protection? Can you say which one? Before (left) and after (right) the activity. Sample: 32 surveys

in the answers to the second question of the pre-activity survey, to which 31% of the participants answered that they had not previously visited the Paramera, compared to only 9% who had not visited the Sierra de Gredos (Fig. 9). Ulaca was known to 72% of the participants, although all of them were able to state that they had visited it to learn about the hillfort and, therefore, its history and archaeological values, but not its natural values.

Regarding geomorphological concepts, prior to the activity, the most familiar concepts were fault, nubbin, rock platform and pedestal rock, with 71%, 62%, 59% and 56% of participants knowing them, respectively (Fig. 10, left). The most unfamiliar terms were horst, gnamma, tafoni and granite dome, all of which more than 56% of participants did not know how to define, reaching 78% in the case of horst. In the pre-activity questionnaire, practically half of the participants did not know more than half of the terms, and none of the concepts were familiar to the whole group. This is normal, given the diversity of participants and the specialized nature of the terms, which nevertheless correspond to the most salient features of their territory.

The results of the post-activity questionnaire show the educational usefulness of the explanations given during the activity (Fig. 10, right). There was an evident learning of all the concepts that were mostly unknown, and all the participants knew what a dome, fault, pedestal rock and tor were at the end of the activity, as magnificent and numerous examples of all of them could be seen along the route. Thus, these forms are also the most useful for the dissemination of geomorphosites in a first approach. The most poorly assimilated concepts were horst and graben, which is understandable given that they represent morphostructures that are not as easily visualized as granite landforms.

Likewise, the answers to the question "Do you think that the Paramera and Serrota should be declared a Natural Park, why?" given at the end of the activity, show a better collective awareness of the value and importance of the natural and cultural heritage, its need for protection and its potential

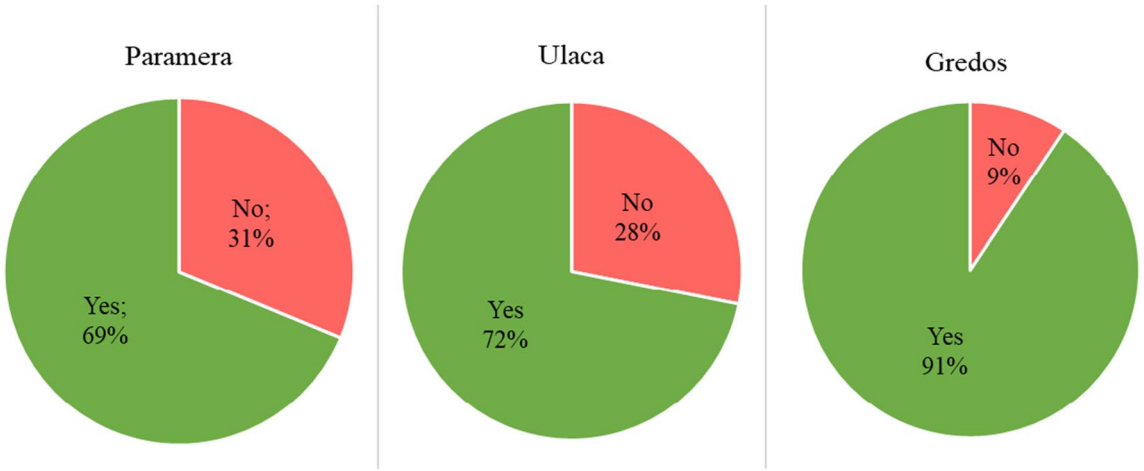

Fig. 9 Responses to the question: Have you ever been to the Sierra de la Paramera before? Have you ever been to the Castro de Ulaca? Have you ever been to the Sierra de Gredos? Sample: 32 surveys

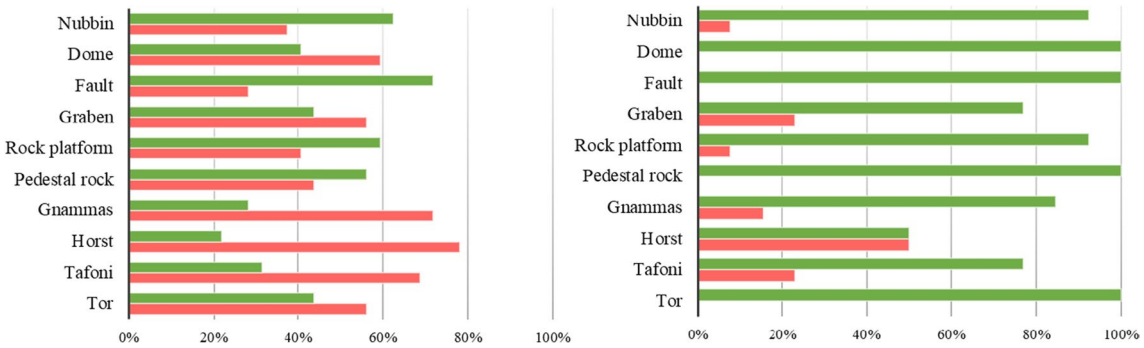

Fig. 10 Responses to the question: Mark the concepts that you know and can explain (pre-activity, left)/that you remember from the explanations (post-activity, right) Sample: 32 surveys

as a tourist attraction. Thus, the objective of the experimental activity, which was precisely to transmit these values of appreciation for natural heritage, was achieved by all participants, all of whom provided valuable and reasonable justifications for the need to protect this Natural Area (Table 4).

The route was not only successful from a didactic point of view, but the attendees showed their appreciation for the organization of the experimental activity, some of them leaving positive comments at the end of the activity (Table 5). The activity was well received not only by the participants, but also by the local authorities, with the Mayor and the Councilor for Culture of the Solosancho Town Council being present at the inauguration of the activity. This kind of collaboration between the research community and the local population was beneficial for both parties, allowing to disseminate the advances in the research of the geoheritage and geomorphosites of the Sierra de la Paramera. The inhabitants were grateful for the attention and work being devoted to their natural heritage, which had always been forgotten. The tragic fire that occurred almost two years ago has awakened concern and a certain conservationist attitude among the villagers, who feel abandoned by the regional authorities and feel that they have lost their territory. They are therefore more receptive to the organization of all kinds

Table 4 Responses to the question "Do you think the Paramera and Serrota should be declared a Natural Park? Why?" Literal translation of the Spanish answers. Responses out of 26 respondents

It should be declared with another category of protection, perhaps landscape. But because of its natural and cultural values and above all its size, it could also be declared a natural park
Because I consider it to be a landscape of great natural and tourist interest
It is a landscape with little human influence, it is very characteristic and very interesting
Because it has fauna, historical remains and all kinds of reliefs
Because it would help to conserve and perpetuate our history
Its natural values. The granitic modelling
Because of its rich forest and bird life
For its geomorphological richness
For protection, dissemination, development and tourism in the area
For the protection of the landscape and investment to maintain the natural assets
I believe it has the identity to be considered a Natural Park
For its landscape and geomorphological and cultural value
Because it meets the landscape conditions for it
For example, cultural, human, geological, all integrated
It brings together the different aspects for it to have greater protection
For its geomorphological, archaeological, biological and landscape values
To protect the natural heritage
Because it has a lot of history
It means recognition and "being on the map". The consequences of all this can bring important benefits in many ways to a depressed area such as the Valle de Amblés
Not only for the fauna and flora but also for the characteristic geomorphology and evidence of modelling
For the cultural and geological richness that it encompasses
To have more financial support to make it better known

Table 5 Comments and suggestions made at the end of the activity. Responses out of 26 respondents

Thank you for the activity
Perhaps, at the beginning of the activity, I missed a general explanation of how the activity was going to be structured
Interesting and informative activity, the only thing missing is some more graphs or drawings
It could be useful for the local authorities and the Junta de Castilla y León, to show the values we have, which nowadays have no touristic value
This type of activity is worthwhile for all types of public, from a point of view other than the archaeological in the area. The importance of the relationship between the natural and cultural landscape that has come to our days to treat them together with coherence. Thank you for this opportunity, we will repeat if you organize !!!! Congratulations
The graphs on paper have been very useful A great, very well explained, I loved it, thank you very much!
It has been very interesting, and I have learned curious things about an area that always went
Very well all, entertaining and interesting I loved the explanations, and I learned a lot of things I didn't know

of activities to promote their heritage, not only the cultural one, which they already knew about thanks to the promotion of the Castro Vetón de Ulaca (local and, even so, scarce), but especially the natural heritage, which is in a critical moment of recovery after the fire.

Conclusions

The inhabitants of the NPAs must be aware of the natural heritage that surrounds them in order to be included in the management and research processes carried out in them. This participation is beneficial not only for the local population, favoring their link with the natural heritage and therefore their conception of heritage and desire for conservation, but also for the researchers themselves, as local people can actively participate by contributing their knowledge and experience. In order to achieve this, the local inhabitants, nowadays partially detached from the natural environment, traditional uses and land use due to the depopulation of the mountains, must have a knowledge of the natural values and outstanding elements that will enable them to value the territory as a collective and outstanding asset.

The high participation in this activity, despite its promotion only among the local population of the NPA and close to the capital of the province, and its focus on geomorphology, demonstrates the remarkable interest in geography, natural heritage and landforms, contrary to what may appear to be the case. This was also expressed by the participants in the final comments, valuing the geographical and geomorphological approach given to a space in which historical and archaeological explanations predominate.

Interpretation and dissemination activities thus demonstrate the necessary collaboration between the local community and the scientific community. If the local inhabitants respond positively when invited to participate in these processes and outreach activities, the scientific community often forgets how valuable the participation of the local population is. The residents of The Sierra de la Paramera who participated in the activity were able to understand the geomorphological processes that have shaped the landscape in which they live, not only giving meaning to those e landforms they know -tors, nubbins, domes, pedestal rocks-, but also contributing their own knowledge in local terminology and legends about granite landforms, or complementing the appreciation and understanding of the territory through a global understanding of the natural and cultural elements. Geomorphosites, then, prove to be a useful tool in the understanding of natural heritage and landscape, fundamental sites for the interpretation of geomorphological heritage.

Funding Open Access funding provided thanks to the CRUE-CSIC agreement with Springer Nature. Activity funded by the Scientific Culture Unit of the University of Valladolid (Call for grants for the implementation of scientific dissemination activities of the University of Valladolid. Second period, academic year 2021–2022), and the Pangea Research Group (Natural Heritage and Applied Geography Research Group, University of Valladolid). Rosa María Ruiz-Pedrosa holds a Pre-Doctoral fellowship funded by University of Valladolid.

Declarations

Competing Interests The authors declare no competing interests.

References

Bullón Mata T, Martinez de Pison E, Arenillas Parra T, Arenillas Parra M, Sanz Herráiz C, Troitiño Vinuesa MA, Burgues Hoyos JA, Juarez del Canto D (1988) Análisis del medio físico de Ávila: delimitación de unidades y estructura territorial. Junta de Castilla y León, Consejería de Fomento, Dirección General de Urbanismo, Vivienda y Medio Ambiente. Valladolid, Spain

Campbell EM, Twidale CR (1995) The various origins of minor granite landforms. Cadernos Laboratorio Xeolóxico De Laxe 20:281–306

Capote R (1982) Evolución sedimentológica y tectónica del ciclo alpino en el tercio noroccidental de la rama castellana de la Cordillera Ibérica. Instituto Geológico y Minero de España

Coratza P, Vandelli V, Ghinoi A (2023) Increasing geoheritage awareness through non-formal learning. Sustainability 15(1):868. https://doi.org/10.3390/su15010868

De Vicente G, Vegas R, Muñoz-Martín G, Silva PG, Andriessen P, Cloetingh SAPL, González Casado JM, Van Wees JD, Álvarez J, Carbó A et al (2007) Cenozoic thick-skinned deformation and topography evolution of the Spanish Central System. Glob Planet Chang 58:335–381

Kelly R, Fleming A, Pecl GT, von Gönner J, Bonn A (2020) Citizen science and marine conservation: a global review. Philosophical Transactions of the Royal Society b: Biological Sciences 375(1814):20190461. https://doi.org/10.1098/rstb.2019.0461

Mariné M (1998) 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, pp 381–395

Martínez De Pisón E (2012) Sobre la idea y la enseñanza del paisaje. Nimbus 29–30:373–380

Martín-Parra LM, Martínez-Salanova J, Moreno F (2008) Mapa Geológico de España. Escala 1:50.000. Vadillo de la Sierra (Nº530); IGME: Madrid, Spain

Maté-González MÁ, Sáez Blázquez C, Carrasco García P, Rodríguez-Hernández J, Fernández Hernández J, Vallés Iriso J, Torres Y, Troitiño Torralba L, Courtenay LA, González-Aguilera D (2021) 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 21:2934. https://doi.org/10.3390/s21092934

Maté-González MA, Rodríguez-Hernández J, Sáez Blázquez C, Troitiño Torralba L, Sánchez-Aparicio LJ, Fernández Hernández J, Herrero Tejedor TR, Fabián García JF, Piras M, Díaz-Sánchez C (2022) Challenges and possibilities of archaeological sites virtual tours: the Ulaca Oppidum (Central Spain) as a case study. Remote Sens 14:524. https://doi.org/10.3390/rs14030524

Migoń P (2006) Granite landscapes of the world. Oxford University Press, Oxford

Migoń P (2021) Granite Landscapes, Geodiversity and Geoheritage—Global Context. Heritage 4:198–219. https://doi.org/10.3390/heritage4010012

Molina E (1991) Geomorfologia y geoquímica del paisaje: dos ejemplos en el interior de la meseta ibérica. Ediciones Universidad de Salamanca, Salamanca, p 72p

Molina E, Blanco JA, Pellitero E, Cantano M (1987) Weathering processes and morphological evolution of the Spanish Hercynian massif. In: Gardiner V (ed) International Geomorphology. Wiley, Chichester, pp 957–977

Panizza M (2001) Geomorphosites: concepts, methods and examples of geomorphological survey. Chin Sci Bull 46:4–6

Panizza M (2003) Geomorfologia culturale. Pitagora, Bologna

Panizza M, Piacente S (2005) Geomorphosites: a bridge betwen scientific research, cultural integration and artistic suggestion. Il Quaternario, Italian Journal of Quaternary Sciences 18(1):3–10

Pedraza J, Sanz MÁ, Martín A (1989) Formas graníticas de La Pedriza. Comunidad de Madrid, Madrid, p 205

Reynard E (2009) Geomorphosites: definitions and characteristics. In: Reynard E, Coratza P, Regolini-Bissig G, Pfeil Verlag (eds) Geomorphosites, München, Germany, pp 9–20

Reynard E, Panizza M (2005) Geomorphosites: definition, assessment and mapping. Géomorphologie : Relief, Processus, Environnement 11(3):177–180. https://doi.org/10.4000/geomorphologie.337

Rodríguez-Hernández J (2012) Los procesos técnicos de la cantería durante la Segunda Edad del Hierro en el occidente de la Meseta. Zephyrus 70:113–130

Rodríguez-Hernández J, Álvarez-Sanchís JR, Maté-González JA, Díaz-Sánchez C, Fernández-Barrientos S, Ruiz-Zapatero G (2023) Ancient sites and modern people: raising awareness of iron age heritage in Central Spain. Heritage 6:1128–1147. https://doi.org/10.3390/heritage6020063

Romani V, Twidale CR (1998) Formas y paisajes graníticos. Universidade da Coruña, Servicio de Publicacións

Ruiz Zapatero G (2005) Castro de Ulaca. Institución Gran Duque de Alba. Diputación de Ávila, Solosancho, Ávila

Ruiz Zapatero G, Álvarez-Sanchís JR, Rodríguez-Hernández J (2020) Urbanism in iron age Iberia: two worlds in contact. J Urban Archaeol 1:123–150. https://doi.org/10.1484/J.JUA.5.120913

Ruiz-Pedrosa RM, Serrano E (2023) Granite landscapes and landforms in the Castro de Ulaca Site (Ávila, Spain): a narrow relationship between natural and cultural heritage. Sustainability 15(13):10470. https://doi.org/10.3390/su151310470

Serrano E (2012) Montañas, paisaje y patrimonio. Nimbus 29:701–718

Serrano E, González-Amuchastegui MJ, Ruiz-Pedrosa RM (2020) Patrimonio natural y geomorfología. Los lugares de interés geomorfológico del Parque Natural del Cañón del Río Lobos. Ediciones Universidad de Valladolid

Tilden F (1957) Interpreting our heritage. The University of North Carolina Press, Chapel Hill

Tormey D (2019) New approaches to communication and education through geoheritage. International Journal of Geoheritage and Parks 7(4):192–198. https://doi.org/10.1016/j.ijgeop.2020.01.001

Twidale CR (1982) Granite landforms. Elsevier, Amsterdam

Twidale CR, Vidal-Romani JR (2005) Landforms and geology of granite terrains. CRC Press, Londres

Valentini L, Guerra V, Lazzari M (2022) Enhancement of geoheritage and development of geotourism: comparison and inferences from different experiences of communication through art. Geosciences 12(7):264. https://doi.org/10.3390/geosciences12070264