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Discovering a Project for the Development of Geotourism in Rural Areas: The Paleontological and Archaeological Interpretation Centre of Tamajón (CIPAT, Guadalajara, Spain)

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Citation: Barroso-Barcenilla, F.; Alcalde-Fuentes, M.d.R.; Audije-Gil, J.; Berrocal-Casero, M.; Callapez, P.M.; Ozkaya de Juanas, S.; Pérez-Valera, J.A.; dos Santos, V.F.; Segura, M. Discovering a Project for the Development of Geotourism in Rural Areas: The Paleontological and Archaeological Interpretation Centre of Tamajón (CIPAT, Guadalajara, Spain). *Land* **2022**, *11*, 444. <https://doi.org/10.3390/land11030444>

Academic Editors:
Rafael Becerra-Ramírez and
Javier Dóniz-Páez

Received: 1 March 2022

Accepted: 17 March 2022

Published: 19 March 2022

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Abstract: The important paleontological and archaeological discoveries made in Tamajón in recent years have enriched the exceptional natural and cultural heritage of this town in the north of the Guadalajara province (central Spain). The extraordinary educational and outreach value of these findings led the Paleolbérica Research Group to develop a project for the design and creation of the Paleontological and Archaeological Interpretation Centre of Tamajón (CIPAT, acronym in Spanish). In this new space, students and the general public have access to knowledge of the past of the region through three exhibition and didactic areas and the support of a rigorous and engaging infographic. The Paleontological Area allows visitors to explore, through fossils, replicas, models (real and virtual) and dioramas, the diversity of coastal and marine life that inhabited the region during the Late Cretaceous Age. Moreover, the area highlights crocodylomorphs, dinosaurs and fishes (identified through their fossilized tracks), and the remains of plants and invertebrates. The Archaeological Area shows the origin and uses of the building material known as Tamajón Stone by means of rough or carved samples, tools traditionally used in its extraction and carving, and historical photographs. Furthermore, in the Didactic Area, innovative specific educational activities are carried out, facilitating the knowledge and appreciation of the rich natural and cultural heritage of Tamajón. After its recent inauguration (August 2021), the CIPAT is a valuable tool to encourage the practice of positive attitudes toward geoconservation and to promote the sustainable and socioeconomic development of the region through geotourism.

Keywords: paleontology; archaeology; didactics; geoconservation; geotourism; interpretation centre

1. Introduction

Among the recent discoveries in the rural locality of Tamajón (Guadalajara, Spain), two Upper Cretaceous paleontological sites can be highlighted for their scientific and didactic values. The first one is a Cenomanian vertebrate track site. This site, with numerous crocodylomorph tracks, is remarkable as it has been the only one discovered, up to date, in

the Arenas de Utrillas Formation [1]. Furthermore, the trackmakers have been described as possible “galloping crocs” [2]. The second one is a Cenomanian-Turonian marine outcrop, recorded mainly in the Picofrentes Formation, with an extraordinary abundance and diversity of invertebrates (bivalves, gastropods, cephalopods, echinoderms), among many other remains [3]. Regarding the archaeological discoveries in Tamajón, in addition to several interesting Palaeolithic sites this locality, holds the original quarries that produce an appreciated raw material (a golden cream coloured dolomitic limestone) known as Tamajón Stone [4].

To jointly show the high scientific and didactic interest of these paleontological and archaeological discoveries, several professors of the University of Alcalá (UAH) presented a project for the design and development of the “Paleontological and Archaeological Interpretation Centre of Tamajón” (CIPAT, from the Spanish Centro de Interpretación Paleontológica y Arqueológica de Tamajón, Guadalajara, Spain) (Figure 1A–C) to the town council and the provincial council of Guadalajara in 2018. After an evaluation, the project was approved, and since then, the Paleolbérica Research Group (UAH), which integrates researchers from diverse paleontological specialities of different Spanish and Portuguese institutions, has been developing this interpretation centre in close collaboration with the local authorities. Since its recent inauguration (August 2021), the CIPAT aims to cover a wide cultural spectrum on paleontological and archaeological subjects that generate a high level of social interest and value.

This work shows in detail the project for the design and creation of the CIPAT, hoping that the experience gathered during its development will stimulate and facilitate the opening of other analogous spaces that aim to promote didactic and outreach initiatives for educational institutions and the general public. The entire program provides a way to reveal the diversity and extraordinary value of natural and urban heritage of rural areas, along with the promotion of geoconservation, understood as the conservation of geodiversity for its intrinsic, ecological and geoheritage values [5] and sustainable geotourism.

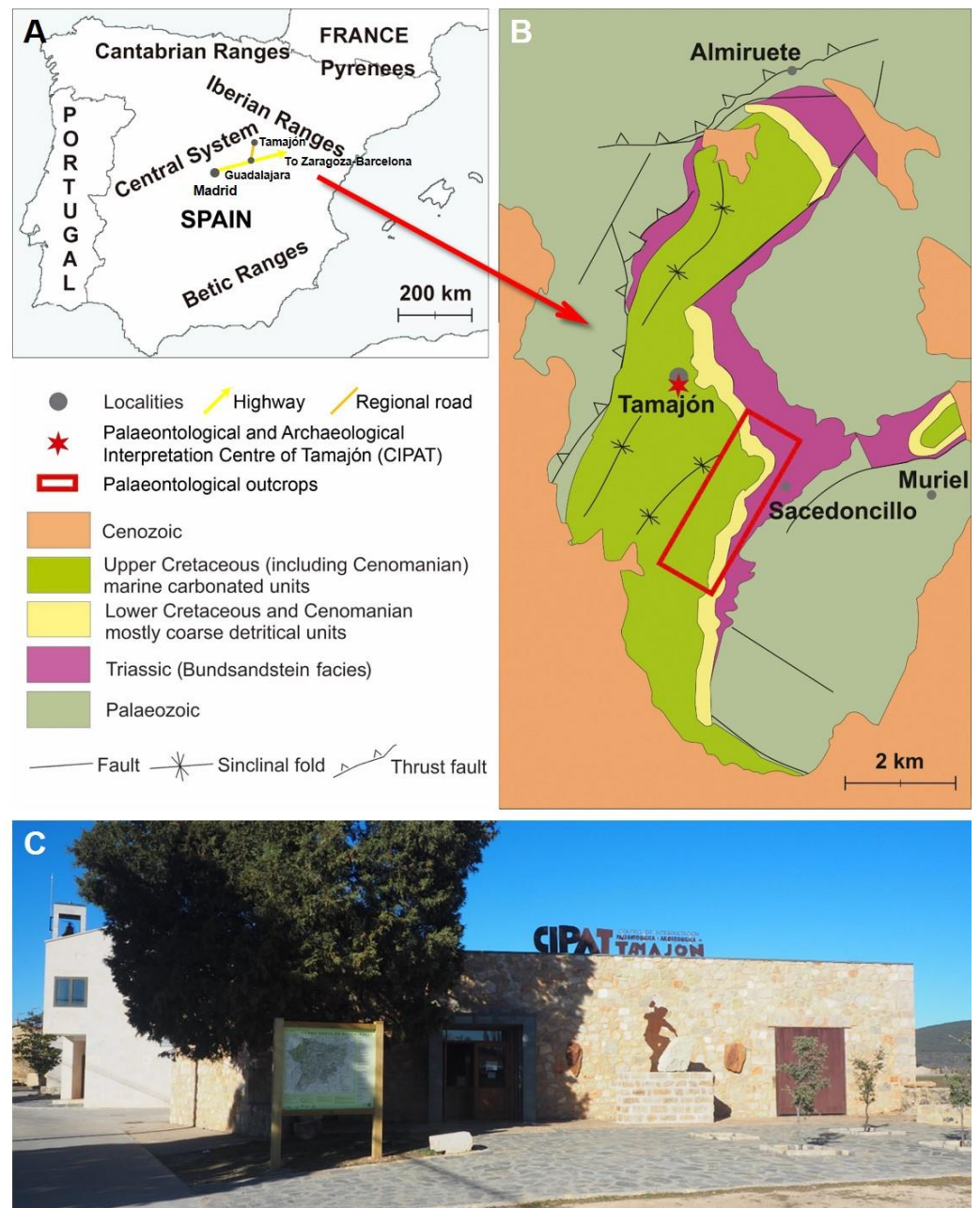


Figure 1. (A) Geographical location of Tamajón (Guadalajara, Spain) in the context of the Iberian Peninsula, with some of the main roads of access to the town; (B) Geological context of Tamajón, showing the main stratigraphic intervals and tectonic structures, and location of the “Paleontological and Archaeological Interpretation Centre of Tamajón” (CIPAT) and the main paleontological outcrops; (C) Image of the current appearance of the exterior of the CIPAT.

2. Natural and Urban Context (General Framework)

The locality of Tamajón (in the north of the Spanish province of Guadalajara) together with its districts (Almiruete, Muriel and Palancares), gathers a large and sparsely populated territory with a natural and urban heritage with exceptional character. Among its natural treasures, the “Ciudad Encantada” stands out, being a curious karstic area with peculiar natural sculptures created by the prolonged erosive action on Cretaceous limestones that water has exerted during tens of thousands of years (Figure 2A). Likewise, the freshwater lagoon “Laguna de Tamajón” and its surroundings with extensive cereal fields and forest areas allow visitors to take different walks to contemplate the natural landscape of the locality.

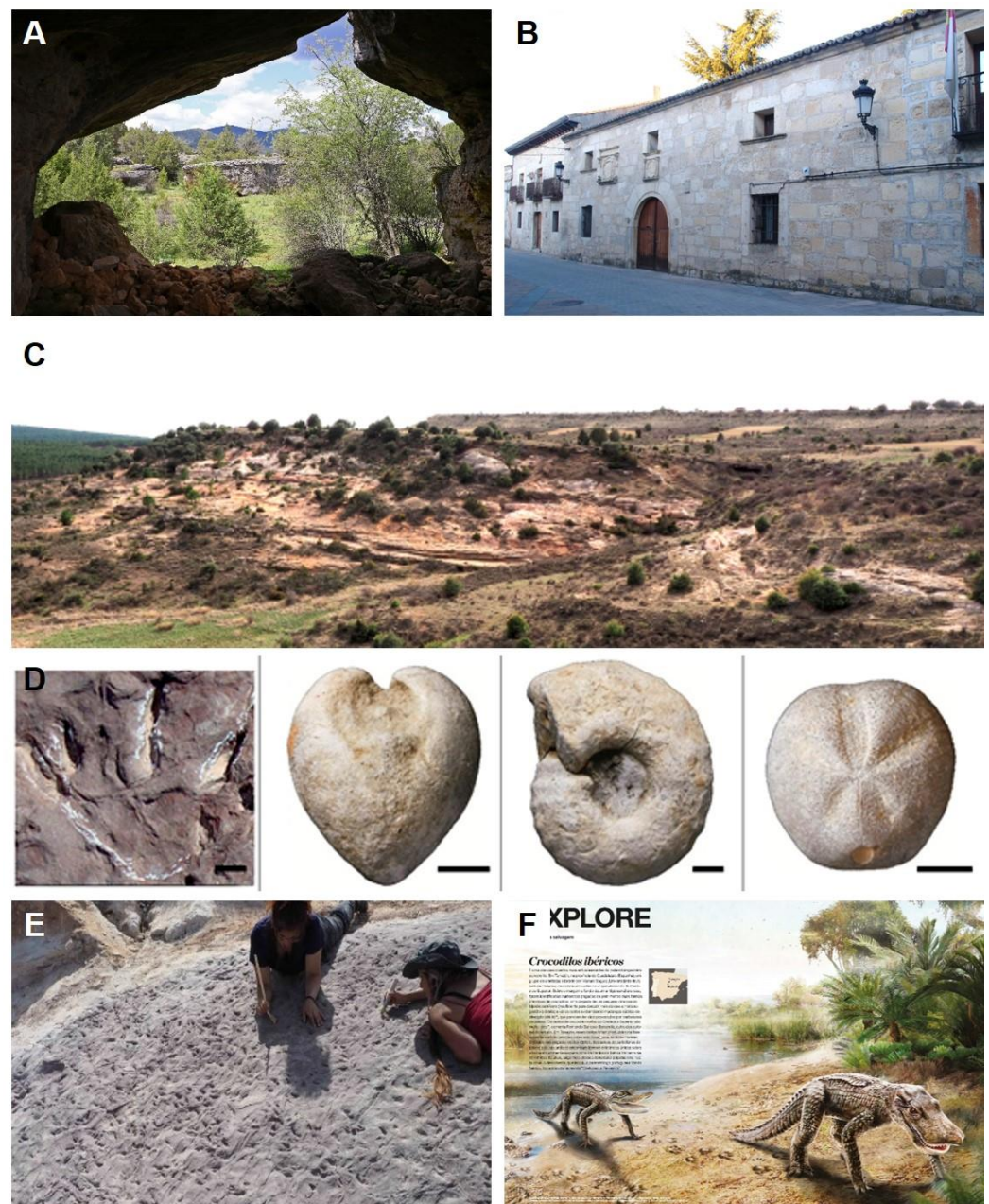


Figure 2. (A) Photographic view from the inside of a karstic hollow of the “Ciudad Encantada” of Tamajón (Guadalajara, Spain), where important paleontological and archaeological discoveries have been made; (B) View of the “Palacio Mendocino”, a palace in Renaissance style and with a 16th century Plateresque facade, with a vaulted semicircular arch entrance and noble coats of arms carved in Tamajón Stone, which is currently used as the town hall; (C) Panoramic view of the Upper Cretaceous of Tamajón, where paleontological outcrops include several levels rich in fossil plants, numerous invertebrates and some vertebrates; (D) Fossils from the Upper Cretaceous site of Tamajón. Ichnite (fossil footprint) corresponding to a foot of the main crocodylomorph track (left). Lateral view of a mold of a bivalve *Granocardium* (*Granocardium*) *productum* (centre, left). Lateral view of an ammonoid *Spathites* (*Jeanrogericeras*) *saenzi* (centre, right). Apical view of an echinoid *Hemiaster bufo* (right). Graphic scales: ichnite: 2 cm, bivalve and ammonoid: 1 cm, echinoid: 0.5 cm; (E) Image of the track surface discovered by Professor Manuel Segura of the University of Alcalá, with traces of crocodylomorphs, a theropod dinosaur and fishes, during the process of preparation and study during July 2018; (F) Image of the report “Crocodylus Ibéricus” about the Cretaceous fossil footprints of Tamajón, published in May 2016 in the Portuguese edition of the *National Geographic Journal*.

The urban heritage of Tamajón includes several buildings of cultural and touristic interest, such as the “Iglesia de Nuestra Señora de la Asunción”, a parish church of Romanesque origin from the 13th century, although with Gothic details and further additions of different architectural styles. Its beautiful south wall remains since the first period, showing a porticoed gallery with semicircular arches and ribbed vaults decorated with corbels with human and zoomorphic representations. The old palace, “Palacio Mendocino”, in Renaissance style and with a 16th century Plateresque facade, exhibits a vaulted arch entrance and the coats of arms of the “Mendoza y de la Cerda” family. It has recently been restored and is currently used as the town hall (Figure 2B). Nearby is the “Casa de los Montufar”, a stately building with a simple baroque facade from the 17th Century. Other singular buildings configure the central axis of the municipality. Heading north of the town centre is the hermitage “Ermita de los Enebrales”, built at the beginning of the 16th century, which is the home of the patroness Saint of Tamajón, the “Virgen de los Enebrales”.

Historically, Tamajón has been a town closely related to architecture, as the local quarries yield Tamajón Stone (Figure 2B), a golden-cream dolomitic limestone used in the construction of numerous unique buildings in central Spain (including Madrid), particularly in the north of the Guadalajara province. In the same way, Tamajón is located at the foot of the peak “Pico Ocejón” (2046 m), the natural entrance to the area of the “Arquitectura Negra” (Black Architecture). This is one of the most characteristic examples of popular rural architecture in the Spanish central system, in which black slate is the main and almost exclusive construction material for traditional houses and other buildings.

3. Paleontological and Archaeological Heritage (Scientific Framework)

Among the rich and diverse paleontological and archaeological heritage of Tamajón, the Upper Cretaceous fossil sites and Tamajón Stone architectural values stand out, providing to this town an important scientific potential, which can be used for educational and outreach purposes [3,4].

3.1. Upper Cretaceous Fossil Sites

Although certain aspects of the interesting geology of Tamajón, such as the richness of its mineral resources and the lithological diversity of the recorded materials (Figure 2B) have been known since ancient times, it was not until the first third of the 20th Century [6] that the Upper Cretaceous outcrops of this locality began to be used for educational purposes. This didactic use continues to the present day, especially with field trips for paleontological studies carried out by professors and pupils of the Complutense University of Madrid and the University of Alcalá who view Tamajón as a valuable field teaching resource for Earth Science [3].

Especially since the 1970s and 1980s, the exceptional scientific and didactic value of the Upper Cretaceous strata, holding an extraordinary abundance and diversity of fossils, have been recognised (Figure 2C). In particular, the Cenomanian-Turonian (100–90 million years ago) sandstones, marls and limestones yield tracks of vertebrates (crocodylomorphs, a theropod dinosaur and fishes), some woody vascular plants, and a considerable variety of invertebrates, including corals, molluscs (bivalves, gastropods and cephalopods), echinoderms (regular and irregular) and crustaceans, along with some remains of fishes (mainly sharks) and marine reptiles, among many other fossils (Figure 2D). Some of these organisms lived in continental and transitional (coastal) paleoenvironments, while others inhabited full marine settings highly rich in invertebrates. Their presence demonstrates that the high sea levels of that time covered Tamajón during certain intervals of the Late Cretaceous [3,7,8].

The authors of this work, in collaboration with specialists of different universities, have been working for years in Tamajón to discover and rescue some of its paleontological jewels. Among their main findings, a site of vertebrate tracks was unveiled in 2016. This site corresponds to the middle-upper Cenomanian, about 95 million years ago, an interval in which the fossil record of vertebrates in Europe is scarce. Its knowledge remains

very limited, making its study highly significant [1]. The fossil site records numerous crocodylomorph tracks, a small theropod dinosaur footprint, and several fish fin traces (Figure 2E).

Specifically, this track site was discovered by Professor Manuel Segura of the University of Alcalá in the 1980s, during the completion of his Ph.D. thesis. Recently, Professor Segura began to study the site in depth together with other members of the Paleolbérica Research Group. This discovery represents the first record of vertebrate ichnites (fossilized prints) in the Arenas de Utrillas Formation, a geological unit where paleontological remains are still very scarce and confirms that some crocodylomorphs lived in coastal channels of central Spain during the Late Cretaceous [1]. The interpretation of the crocodylomorph tracks also suggests the presence of “galloping crocs” in Europe [2,8]. As a whole, the track site has attracted the interest of important institutions, such as the National Geographic Society (which has published the report “Crocótilos Ibéricos” in May 2016, in Portugal, and June 2016, in Spain) that promoted its uniqueness and exceptional character and facilitated the acceptance and development of this project (Figure 2F).

3.2. The Tamajón Stone Architectural Values

Natural stone (rock which, due to its technical characteristics, can be extensively used as a raw material in the construction of buildings and other civil works) has been used since antiquity. This is because, first, it was the main locally available material, and second, buildings constructed with stone have been considered, depending on the historical period, more economical, more durable, more representative and, currently, more environmentally friendly.

An outstanding example of natural stone, of which utilisation many examples can be found from prehistoric times, is the so-called “Tamajón Stone”. In this sense, the important findings taking place in the Tamajón archaeological sites of “Cueva de Los Torrejones” and “Abrigo de la Malia” stand out, as they include archaeological remains from the Upper Paleolithic (between 30,000 and 10,000 years ago), representing one of the oldest settlements of *Homo sapiens* on the “Meseta Central”, the Central Plateau of Spain [9,10]. These and other sites show how this stone was already used to create fences in improvised camps dedicated to gathering, or in caves and shelters to allow different uses of the living spaces (Figure 3A,B).

When the first farmers appeared, they began to build shelters for themselves and their livestock around cultivated fields, making natural stone increasingly necessary. In Tamajón, as in other regions of central Spain, simple buildings were raised, built (as the primitive cave door walls) with the materials available in their surroundings. Gradually, the builders began to compartmentalise their spaces until a clear differentiation between home-bedroom-pantry-barn was made. These houses were located in suitable places for working the nearby fields, or on hills where it was easier to set up defenses, using stone walls, roofs with branches, and the first individualised spaces. Their divisions of space and construction forms have been maintained, even with the logical and progressive adaptations and technical improvements, up to the present day (Figure 3C).

The term Tamajón Stone already appeared in numerous documents regarding buildings constructed between the 16th and the 19th centuries in towns of central Spain (Guadalajara, Alcalá de Henares, Madrid), to refer to a quality building material, usable in the construction of walls, facings, columns or slabs [11,12]. Tamajón Stone is an Upper Cretaceous (upper Turonian) golden-cream coloured dolomitic limestone [$\text{CO}_3\text{Ca}_2\text{-CO}_3(\text{Ca}, \text{Mg})$] or dolomite [$\text{CO}_3(\text{Ca}, \text{Mg})$] containing a small proportion of clay and iron oxide locally, as well as microfossils and small fragments of invertebrate shells. Texturally, it is a fine-grained (micritic) rock, which contribute to a homogeneous appearance. Its only included elements are bioturbations (small tubes made by organisms that lived in the sediments that led to these rocks) filled with a fine-grained calcareous matrix, slightly ferruginous at the edges. This textural peculiarity and the presence of a small proportion of

iron oxides dispersed in the matrix give this rock its aesthetic golden-cream colour and its almost uniform appearance (Figure 3D).

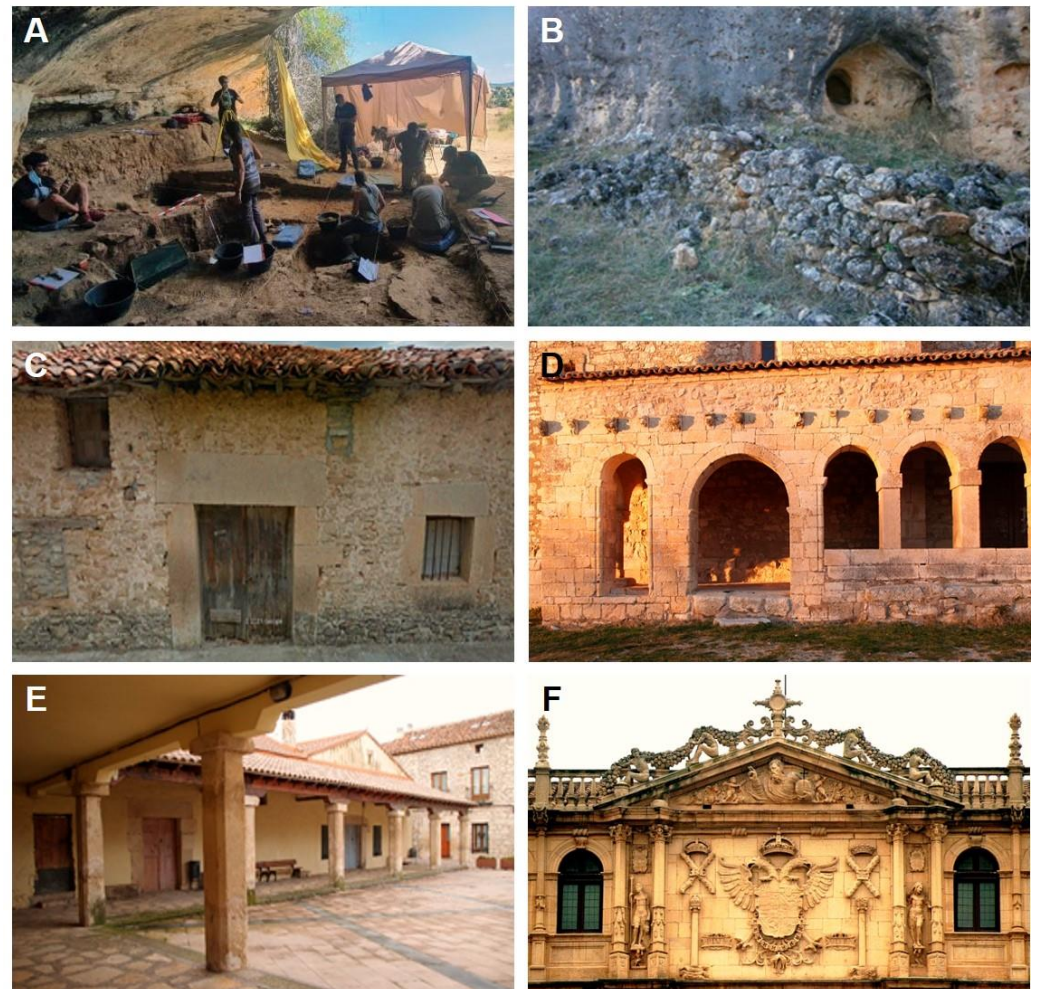


Figure 3. (A) Archaeological excavation campaign in the “Abrigo de la Malia” site of Tamajón (Guadalajara, Spain); (B) Image of one of the karstic caves of the “Ciudad Encantada” of Tamajón, inhabited since the Upper Palaeolithic, with a stone fence placed in front of its access; (C) View of a house in Tamajón, which has retained traditional spatial divisions and construction methods; (D) Image of the portico of the “Iglesia de Nuestra Señora de la Asunción”, a church in Romanesque style, showing the characteristic appearance of Tamajón Stone; (E) View of the portico of the main square “Plaza Mayor” of Tamajón with columns that show the suitability of the Tamajón Stone for obtaining uniform blocks; (F) Detail of the main facade of the “Colegio de San Ildefonso” college (Alcalá de Henares, Spain), current seat of the Rectorate of the University of Alcalá and an example of the use of Tamajón Stone outside the locality.

The sedimentary rocks that give their name to the Tamajón Stone, outcrop with a particularly high quality in the surroundings of this town. However, they can also be obtained in other localities of the northern area of the provinces of Guadalajara and Madrid. They are located in 0.2 to 0.4 m thick banks, with well-marked discontinuity joints, which usually outcrop with a gentle dip and are cut by a system of orthogonal fractures. These characteristics make these rocks easy to handle in quarries. In addition to their mechanical and aesthetic properties, another characteristic that makes Tamajón Stone an ideal building material is the ease with which blocks of uniform dimensions can be cut (Figure 3E).

Consequently, it was considered to be a very suitable rock for the construction of noble buildings, both due by its technical qualities (mechanical resistance, compressibility, alterability, low density, hardness) and its aesthetic characteristics (e.g., colour, texture). It was used in significant historical buildings, such as the “Palacio del Infantado” palace in Guadalajara, or the main facade of the “Colegio de San Ildefonso” college of the University of Alcalá, as well as in diverse churches, convents and stately buildings (Figure 3F).

4. A Project for the Paleontological and Archaeological Interpretation Centre of Tamajón (CIPAT)

Moved by the idea that the rich natural and architectural heritage can be used as a valuable didactic resource for different educational levels (from schools to universities) and also for outreach activities, the research group proposed to the town council and the provincial council of Guadalajara a specific project for the design and development of the Paleontological and Archaeological Interpretation Centre of Tamajón (CIPAT) [8,10,13–16].

4.1. Proposed Building

After a quick and very positive reception of the project, the first task was to choose a place for its future location, for which the town council offered the former tourist information building of the cultural centre of Tamajón.

This building is located next to the southern entrance of Tamajón (Guadalajara, Spain) in an attractive setting next to cereal fields and natural vegetation with extraordinary views of the nearby mountains, including the “Pico Ocejón”. It is visible from the CM-1004 road, which links Tamajón with Humanes and, from there, via different communication routes, with the city of Guadalajara and the A-2 highway (Madrid-Zaragoza-Barcelona). As it is located next to the road, the building is easily accessible by car or bus and has a wide parking space for vehicles, motorbikes and bicycles (Figure 4A,B).

4.2. Original State

The proposed building for the CIPAT is of recent construction, and the cladding of its main facade is made of local materials, mainly Tamajón Stone, which makes it visually integrated with most of the surrounding buildings. It is accessible for people with reduced mobility and is divided into two independent spaces, each with access from the outside through the main facade and not linked internally. The one on the right, which is smaller and was previously used as a tourist information point-mountain bike centre, has toilets and a storage area with lockers (Figure 4B, right side closed with a white metallic grille). The larger one on the left has a zinc-clad porch that gives access to the main hall (Figure 4B, left side closed with a wooden door) which, after the necessary technical adaptations, would reach the essential conditions to house the future CIPAT.

The main hall of the proposed building originally consisted in an open-plan space with direct access from the outside. It had natural lighting, although scarce and irregular, and lacked adequate artificial lighting. Rustic materials were used for the interior cladding, showing terrazzo floor and exposed ceiling wooden beams, which add warmth to the atmosphere. The room was originally equipped with heating and cooling systems with three wall-mounted split-type air conditioners, positioned in such a way that they did not affect the positioning of the expositive elements (Figure 4C).

Once the original state, both exterior and interior, of this building had been assessed, a technical proposal for external and interior renovation was drawn up to adapt it to its future function as an interpretation centre. Simultaneously, the exhibition materials were selected (original samples, replicas, dioramas), all the associated infographics were designed and different didactic activities were developed specifically for the CIPAT.



Figure 4. (A) Location of the former tourist information building of the cultural centre of Tamajón (Guadalajara, Spain), currently housing the Paleontological and Archaeological Interpretation Centre of the locality (CIPAT), next to the access by the CM-1004 road to Guadalajara and the A-2 Highway (Madrid-Zaragoza-Barcelona); (B) Image of the original appearance (before development of this project) of the access area to the main facade of the former tourist information building of Tamajón; (C) Image of the original appearance of the interior of the former tourist information building of Tamajón; (D) Division of spaces proposed for the CIPAT, differentiating the Paleontological, Archaeological and Didactic areas and showing the itinerary designed for the visit; (E,F) Three-dimensional (3D) virtual models of a visit to the Paleontological (E) and Archaeological (F) areas of the CIPAT, showing the main central pieces, display cases with original samples and other materials, explanatory panels and dioramas; (G) Logo of the CIPAT, black and white version; (H) Motifs referring to the Paleontological (left), Archaeological (centre) and Didactic (right) areas of the CIPAT.

4.3. External Refurbishment

The technical renovation proposal for the building first emphasised that the outside should be adequately signposted to make it even more visible from the road, indicating that it is a scientific and cultural (paleontological-archaeological) interpretation centre. For this reason, it was noted early that it was essential to design a logo which, in addition to

being used as a physical signpost outside the building, would also serve as the “corporate image” of the CIPAT that could be added into all the infographics of the centre (Figure 4D).

It was also recommended to rehabilitate the outdoor space located in front of the main facade. Given that materials from the natural environment had been used in the building, it was emphasised that this exterior space should enhance the value of the natural environment, taking special care of the surrounding landscape, while respecting its geoconservation. For this reason, it was suggested planting autochthonous botanical species and using natural stone as the main construction material, in particular, slate and Tamajón Stone, both typical of the traditional architecture of the region.

It was also recommended installing external passive and active security systems, either by means of cameras and/or alarms, which deterrent effect would ensure the integrity of the exhibition material as well as that of the building itself.

4.4. Interior Refurbishment

To fit out the interior of the building for its future exhibition and didactic function, an economical technical proposal that would use the existing space and resources, was chosen. Specifically, the proposal was to reconfigure the proposed building, using the available resources and generate a new exhibition environment that, together with the planned educational and outreach activities, would make Tamajón a point of geotouristic interest.

Given the differences between the types of materials, ages and working methodologies, it was considered that the two main disciplines represented, paleontology and archaeology, should be clearly differentiated in separate areas, although integrated in the same interpretation centre. For this reason, it was planned to divide the available space into two areas. One for paleontological content (Paleontological Area) and the other for archaeological content (Archaeological Area), respectively to the right and left of the entrance door, separated by a specific space for educational activities (Didactic Area) (Figure 4D).

The visit to the interpretation centre was planned to follow a counterclockwise route, with the expositive material and physical infographics arranged alternately along the walls. To allow a detailed view of the samples and, because it is not advisable for them to be directly accessed by visitors, it was decided that fossils and other objects would be included in display cases, mostly wall-mounted but also table-topped, fitted with interior lighting, and accompanied by their corresponding explanatory panels.

Likewise, the itinerary was designed to be developed around two eye-catching elements representative of each of the two main specialities: a paleoreconstruction on a themed surface of one of the Upper Cretaceous crocodylomorph trackmakers that imprinted the ichnites of Tamajón; and an original frame of one of the rose windows from the “Ermita de los Enebrales” hermitage, carved in Tamajón Stone. It was therefore suggested that each of these should be placed, respectively, in the centre of the exhibition spaces of the Paleontological Area and of the Archaeological Area. It was also recommended that the two central motifs in the Paleontological and Archaeological areas should be high enough to prevent visitors from damaging them, but simultaneously allow the diversity of the public (children, people with reduced mobility) to view them properly. In addition, it was proposed that these central motifs be delimited by a simple separation system, a lace.

For the exhibition of the paleontological and archaeological samples, simple, discreet and elegant display cases were chosen, with a silver anodised aluminium finish. One vertical floor display case, with dimensions of 1800 × 800 × 400 mm, and six horizontal wall display cases, with dimensions of 800 × 1000 × 200 mm, were selected, all of them including security locking systems and cold lighting. These display cases have glass shelves, where methacrylate bases, cut to the size of the selected samples, can be placed.

Regarding the infographic associated with the paleontological and archaeological samples and the didactic activities, explanatory panels with standard A0 dimensions (1189 × 841 mm) were suggested, with the only exception of one panel (for the geological time scale) with special dimensions (1422 × 600 mm). Considering the diversity of visitor

heights (e.g., children, people with reduced mobility) it was estimated that the display cases and the explanatory panels should be placed at a specific height, resulting in an axis of observation approximately 120 cm from the floor.

To carry out the activities of the Didactic Area and to store the necessary resources, a table was designed with drawers and a central panel (for the specific infographics), made of “sabina” wood from the local tree *Juniperus sabina*, a traditional construction material of the region.

To illuminate the exhibition and didactic space, a system of hanging rails attached to the ceiling was proposed to facilitate installation and improve functionality because the spotlights can be moved and rotated 360°. This arrangement would offer a broader possibility to include new elements and reconfigure the exposition.

Finally, with those elements, three-dimensional (3D) virtual models of the Paleontological and Archaeological areas of the CIPAT were designed, which made possible to verify the adequate distribution of the exhibition and didactic space, facilitating the subsequent technical installation of the display cases, the infographic panels and the remaining elements (Figure 4E,F).

4.5. Corporate Image and Logos

From the beginning of the project, the need to come up with a name and to create a brand that would differentiate this interpretation centre and a logo that could be incorporated into the building and its infographics became clear. For this purpose, a specific graphic design was created, including the full name and the acronym of the Centro de Interpretación Paleontológica y Arqueológica de Tamajón (CIPAT: Figure 4G). To individualise and help differentiate each space and its respective infographic, a green toned crocodylomorph for the Paleontological Area, a cream-toned rosette for the Archaeological Area and a purple toned light bulb with a question mark for the Didactic Area were designed (Figure 4H).

4.6. Exhibiting and Didactic Material

As mentioned above, both the Paleontological and Archaeological areas would house a representative and outstanding central piece. For the Paleontological Area, a full-scale model of one of the Upper Cretaceous crocodylomorph trackmakers representing the moment that the ichnites were recorded, was specifically designed and prepared for the CIPAT (Figure 5A). This crocodylomorph model has been named “Tami”, becoming an icon, among visitors, to the interpretation centre. In addition to this first outstanding piece, the Paleontological Area also includes original specimens (lithological and paleontological samples), replicas and photographs of ichnites and the track surface, and a didactic diorama that represents an Upper Cretaceous marine coast [17].

Specifically, the selected resources aim to be representative of the Cenomanian-Turonian geological units of Tamajón, which include the Utrillas, Villa de Vés and Picofrentes formations, and the lower part of the Ciudad Encantada Formation, recreating for this purpose an illustrative lithological section (Figure 5B). This interval contains vertebrate tracks (crocodylomorphs, a theropod dinosaur and fishes), other ichnofossils (mainly *Thalassinoides*), vascular plants, a considerable diversity of invertebrates, including corals, bryozoans, brachiopods, bivalve, gastropod and cephalopod molluscs, echinoderms (echinoids) and decapod crustaceans, and some remains of fishes and marine reptiles, among other fossils [3,18] (Figure 5C). Along with the locally recollected fossils, 23 representative specimens have been selected to be part of the permanent exposition, having the corresponding permits of the Vice-Ministry of Culture and Sports of the Junta de Castilla-La Mancha that allow the exposition of this natural heritage. The diorama represents different paleo ecosystems of Tamajón, showing a detailed Upper Cretaceous marine environment, with numerous algae and invertebrates (mainly bivalves, gastropods, ammonites and echinoderms) and a large marine reptile, all of them examples of past organisms whose remains are recorded in the locality (Figure 5D).



Figure 5. (A) Detailed image of the reconstruction of a crocodylomorph, producer of the ichnites found in the Upper Cretaceous of Tamajón (Guadalajara, Spain), on themed surface, as central outstanding piece of the Paleontological Area of the Paleontological and Archaeological Interpretation Centre of the locality (CIPAT); (B) Photograph of the display case of the same area with the recreation of the Cenomanian-Turonian lithological section of Tamajón, which includes the Utrillas, Villa de Vés and Picofrentes formations, and the lower part of the Ciudad Encantada Formation, showing on its right the panel “La Geología de Tamajón-The Geology of Tamajón”; (C) Image of the display case of the same area with representative fossils of Tamajón and, on the right, the panel “El afloramiento marino: Cuando Guadalajara era un mar-The marine outcrop: When Guadalajara was a sea”; (D) Photograph of the diorama of the CIPAT Paleontological Area, representing different Upper Cretaceous transitional and marine ecosystems of Tamajón, showing on its right the panel “Interpretación paleoambiental: ¿Cómo era Tamajón en el Cretácico-Paleoenvironmental interpretation: How was Tamajón during the Cretaceous?”.

The second outstanding piece, selected for the Archaeological Area, was the frame of an original 16th century rose window from the “Ermita de los Enebrales” hermitage, carved in Tamajón Stone (Figure 6A). It was found, unfinished, in the vicinity of this religious building, so it is thought to have been discarded and not incorporated into the building during its construction. In addition to this rose window frame, the exposition material of this area also includes lithological samples (lithotypes of Tamajón Stone quarries of the locality), original historical tools used in the extraction and carving of natural stone, and photographs of buildings, both ancient and modern, which have used this valuable building material (Figure 6B–D). These exhibition items are complemented by a proposal for an educational itinerary walk through the locality of Tamajón, to be done after the visit to the CIPAT, touring the town, discovering and interpreting different buildings constructed with Tamajón Stone (Figure 6D).



Figure 6. (A) Image of the frame of the 16th century rose window from the hermitage “Ermita de los Enebrales” of Tamajón (Guadalajara, Spain), carved in Tamajón Stone, as central outstanding piece of the Archaeological Area of the Paleontological and Archaeological Interpretation Centre of the locality (CIPAT); (B) Photograph of the display case of the same area with lithotypes from different historical quarries of Tamajón Stone and, on the right, the panel “La Piedra de Tamajón-The Tamajón Stone”; (C) Image of the display case of the same area with traditional stonemason tools historically used in the extraction and carving of natural stone; (D) Photograph of the display cases of the same area with images of buildings and details, both ancient and modern, constructed with Tamajón Stone, separated by the two panels “Un itinerario para descubrir la Piedra de Tamajón-An itinerary to discover the Tamajón Stone” and a map, with a proposal for an educational itinerary in the town to discover and interpret some of the buildings constructed with this valuable raw material; (E,F) Images of the table with drawers and a central panel to carry out the activities of the Didactic Area of the CIPAT, showing the panels “Las huellas también fosilizan: Icnitas-Tracks also fossilise: Ichnites” (E); and “¿Cómo descubrimos el pasado?: Paleontología vs. Arqueología-How do we discover the past: Paleontology vs. Archaeology?” and other educational resources (F).

Since the fossils (original samples and replicas) and the archaeological remains allow the development of different didactic activities aimed mainly at children at different educational stages [19,20] but also to adults, a specific space was created for this purpose: the Didactic Area. Therefore, a large “sabina” wooden table was designed and manufactured, being divided into two halves by a high vertical board and containing drawers for storing

learning material when not in use. In the Didactic Area, not only the main scientific results obtained in Tamajón are being shown in a simple and engaging way, but also how paleontologists and archaeologists work, and the scientific method that allows them to infer what the past was like. Among the didactic activities prepared specifically for the CIPAT, we can highlight those that show how to deduce paleontological information from ichnites [21] or how to recreate the appearance and way of life of the flora and fauna that later became the fossils found in Tamajón. Special attention has been paid to the Didactic Area to provide the means (specific panels, surveys) to collect feedback, expecting to improve and adapt expositive materials and the educational activities of the CIPAT (Figure 6E,F).

All the activities have been designed upon different didactic methodologies (e.g., Theory of Multiple Intelligences) [22] and educational strategies, e.g., [23,24]. Aiming to reach a meaningful learning experience, these approaches can be carried out inside or outside the centre, either individually or in groups, guided by a teaching specialist or autonomously completed, reasoning to encourage a wide variety of geoscientific skills through the manipulation of real objects, direct observation, the stimulation of creativity and motivation of critical thinking (Figure 6F).

4.7. Infographic Design

The exposition items displayed at the CIPAT have been supported by different infographics (such as panels, posters, leaflets and virtual images) with rigorous and engaging information to help the public understand and value its scientific relevance. All of them include the logotype of the interpretation centre, and to differentiate the areas, the designed motifs have been added to the panels, specifically, a green toned crocodylomorph for the Paleontological Area, a cream toned rosette for the Archaeological Area, and a purple toned light bulb with a question mark for the Didactic Area (Figure 4G,H and Figure 7A–E).

Specifically, a general presentation panel has been designed and prepared for the interpretation centre: “Bienvenidos/as al CIPAT-Welcome to the CIPAT”. Five specific panels for the Paleontological Area: “La escala de tiempo en Geología-The time scale in Geology”, “La Geología de Tamajón-The Geology of Tamajón”, “El afloramiento continental: Cuando los cocodrilomorfos caminaban por Tamajón-The continental outcrop: When dinosaurs walked through Tamajón”, “El afloramiento marino: Cuando Guadalajara era un mar-The marine outcrop: When Guadalajara was a sea” and “Interpretación paleoambiental: ¿Cómo era Tamajón en el Cretácico-Paleoenvironmental interpretation: How was Tamajón during the Cretaceous?” (Figure 5B–D); and five for the Archaeological Area: “La piedra natural en la edificación-Natural stone in building”, “La Piedra de Tamajón-The Tamajón Stone”, “Las canteras de la Piedra de Tamajón-The quarries of the Tamajón Stone”, “Un itinerario para descubrir la Piedra de Tamajón, 1-An itinerary to discover the Tamajón Stone, 1” and “Un itinerario para descubrir la Piedra de Tamajón, 2-An itinerary to discover the Tamajón Stone, 2” (Figure 6B,D). For the Didactic Area, two panels have been designed: “¿Cómo descubrimos el pasado?: Paleontología vs. Arqueología-How do we discover the past: Paleontology vs. Archaeology?” and “Las huellas también fosilizan: Ichnitas-Tracks also fossilise: Ichnites” (Figure 6E,F). Additionally, an “Agradecimientos-Acknowledgements” panel has also been prepared. All these panels have been printed on 10 mm thick foam boards, in A0 dimensions, except for “The time scale in Geology”, for the Paleontological Area, which, for didactic reasons, has special dimensions as indicated above.

In addition, specific backgrounds have been designed for the interior of the display cases, which serve as a visual support for the exhibited pieces. Furthermore, a triptych flyer has been designed and printed to present the CIPAT and inform about its exposition and educational content, which can be distributed free of charge to all those interested in visiting the interpretation centre (Figure 7A,B). For the outdoor space located in front of the main facade of the building, a panel (with greyish background for easy reading in sunlight) has been designed. Since the day of the inauguration, it presents the main content of the CIPAT and invites visitors to enter and get to know the interpretation centre (Figure 7C).

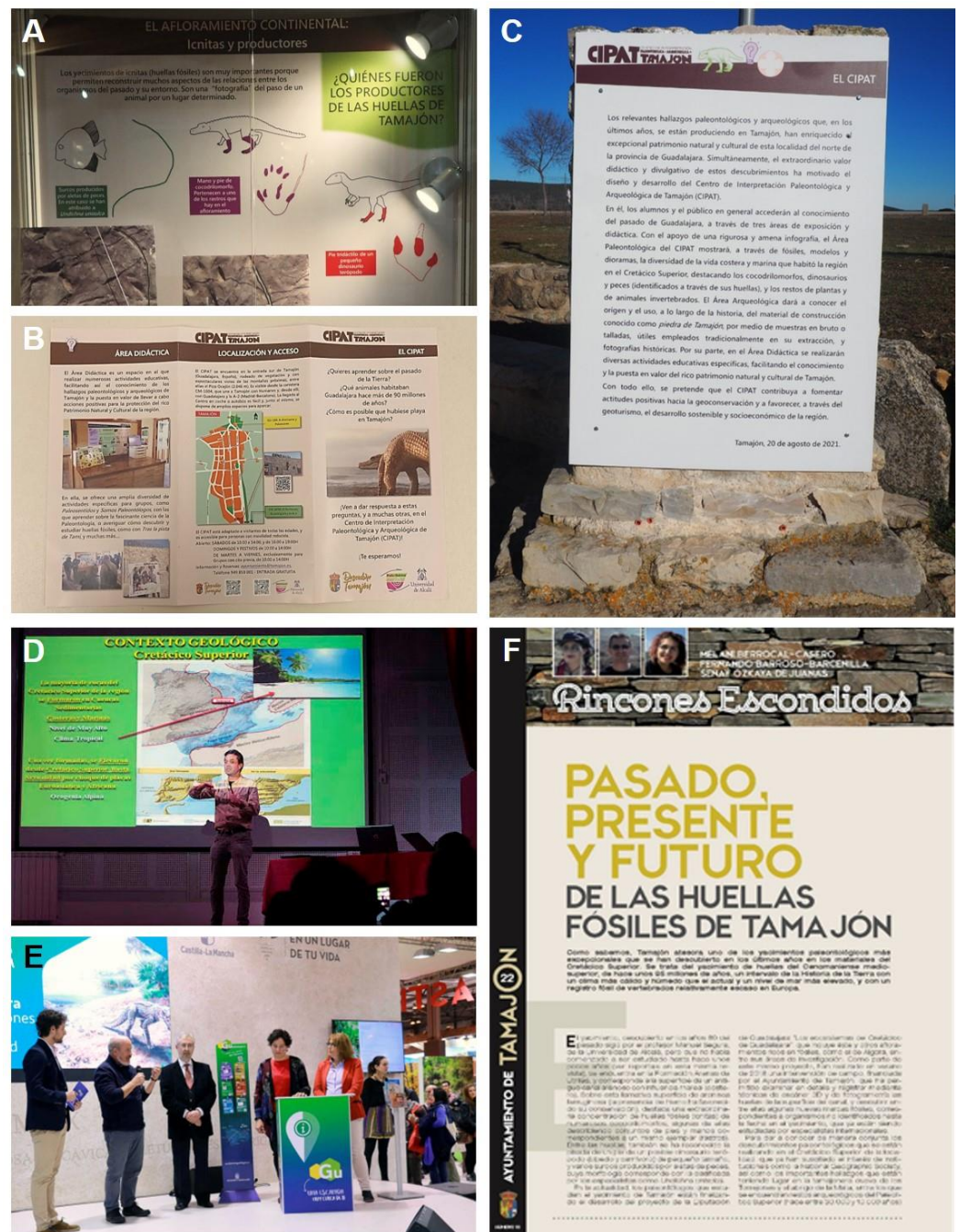


Figure 7. (A) Detailed view of the background designed for the interior of the display case for the continental outcrop (track site) of the Paleontological Area of the Paleontological and Archaeological Interpretation Centre of Tamajón (CIPAT); (B) The triptych with information about the CIPAT, which is being distributed free of charge to all visitors; (C) Photograph of the panel at the exterior of the interpretation centre, which presents the CIPAT and invites the visitor to enter and get to know it; (D,E) Outreach of different aspects of the CIPAT at the paleontological weekend organised by the Tamajón town council in September 2018 (D), and at the Guadalajara Day organised by the International Tourism Fair (FITUR) in January 2019 (E); (F) Outreach publication on the content and the scientific and didactic potential of the Cretaceous track surface [10].

4.8. Previous Outreach Actions

From the beginning of the project, special attention was paid to ensure that the scientific, didactic and heritage value of the CIPAT was transmitted to pupils and the general public. Among the outreach activities to present to the neighbors of Tamajón, and other members of the public, the main aspects of the project and its relevance for the conservation of natural heritage and the promotion of geotourism, a variety of sessions and meetings were carried out before the inauguration. (Figure 7D,E).

Simultaneously, articles and news related to the Paleontological and Archaeological heritage of the region, its didactic possibilities, and the forthcoming inauguration of the CIPAT, were disseminated in free distribution and free access media. The main aim of these actions was to raise awareness among the general public about the value of the paleontological and archaeological heritage, not only of the region in which they are located, but also of their scientific repercussions on an international scale. Making scientific knowledge available for the use and enjoyment of all is the key to promoting cultural awareness, to achieve geoconservation strategies and to promote geotourism (Figure 7F).

5. Inauguration Opening and First Steps

On the 20th of August 2021, the Paleontological and Archaeological Interpretation Centre of Tamajón (CIPAT) e.g., [25] was inaugurated, with a great attendance and significant media coverage (Figure 8A–E).

Since then, this new interpretation centre has been open to students and the general public, with free entrance due to the financial support of the town council, and through an agreement, it has the scientific support of the University of Alcalá. The CIPAT is attracting many visitors to this small town in the north of Guadalajara province and has already generated several job offers for young people. The success of visitors (mainly families, school and university groups) to the interpretation centre is supported by the interest generated by its exposition and educational activities, which arouse great interest among the public, enhancing awareness about the value of the local natural and cultural heritage and promoting geoconservation and geotourism (Figure 8F,G).

The development of positive attitudes toward geoconservation and the promotion of geotourism in rural areas is key to enhancing the sustainable socioeconomic development of a region. Despite the short time that has elapsed since its inauguration, the CIPAT has already won the prize “Aid for Rural Development 2021”. This prize is awarded by the Eurocaja Rural Foundation to projects whose objectives help repopulate rural areas and create opportunities for young people, promoting generational change, and narrowing the gap between rural and urban areas.

The CIPAT is therefore already acting as a multidisciplinary space where science and didactics come together to show students and the general public the value of the paleontological and archaeological heritage of the locality, thus providing an enriching cultural offering that reaches a wide diversity of visitors. Furthermore, the impact of the interpretation centre as a tourist attraction will enhance the sustainable and socioeconomic development of the region through geotourism and the promotion of positive attitudes toward geoconservation in a framework of increasing initiatives related to geoeducation. The centre also addresses knowledge regarding the importance and the components of geological heritage and geoethics [26], serving as a model for other rural municipalities that share an exceptional heritage.



Figure 8. (A,B) Inauguration of the Paleontological and Archaeological Interpretation Centre of Tamajón (CIPAT) (20 August 2021); (C–E) Different media covering the inauguration and first days of the CIPAT: ABC Newspaper (C); Castilla-La Mancha Television (D); and Youtube Website (E); (F,G) A family visit, in the outer facade (F); and the development of an educational activity, in the Didactic Area of the CIPAT (G).

6. Future Projection and Conclusions

The exhibition of specimens from the paleontological and archaeological collections that have been designed and selected, enhanced through educational activities that are currently being carried out at the CIPAT, such as that called “Paleosenses” [19], discloses the relevant scientific discoveries at Tamajón. They are being used as valuable educational resources, especially designed for school groups, but also for the general public, helping to raise awareness about the importance of protecting paleontological and archaeological heritage, and promoting cultural tourism in the region from a perspective of international

cooperation [15,27–29]. All these exhibition materials and didactic activities are being improved continuously by means of r-collection of qualitative and quantitative feedback from visitors, by using panels and completing surveys where they share their interests and what they have learned during the visit (Figure 9A).

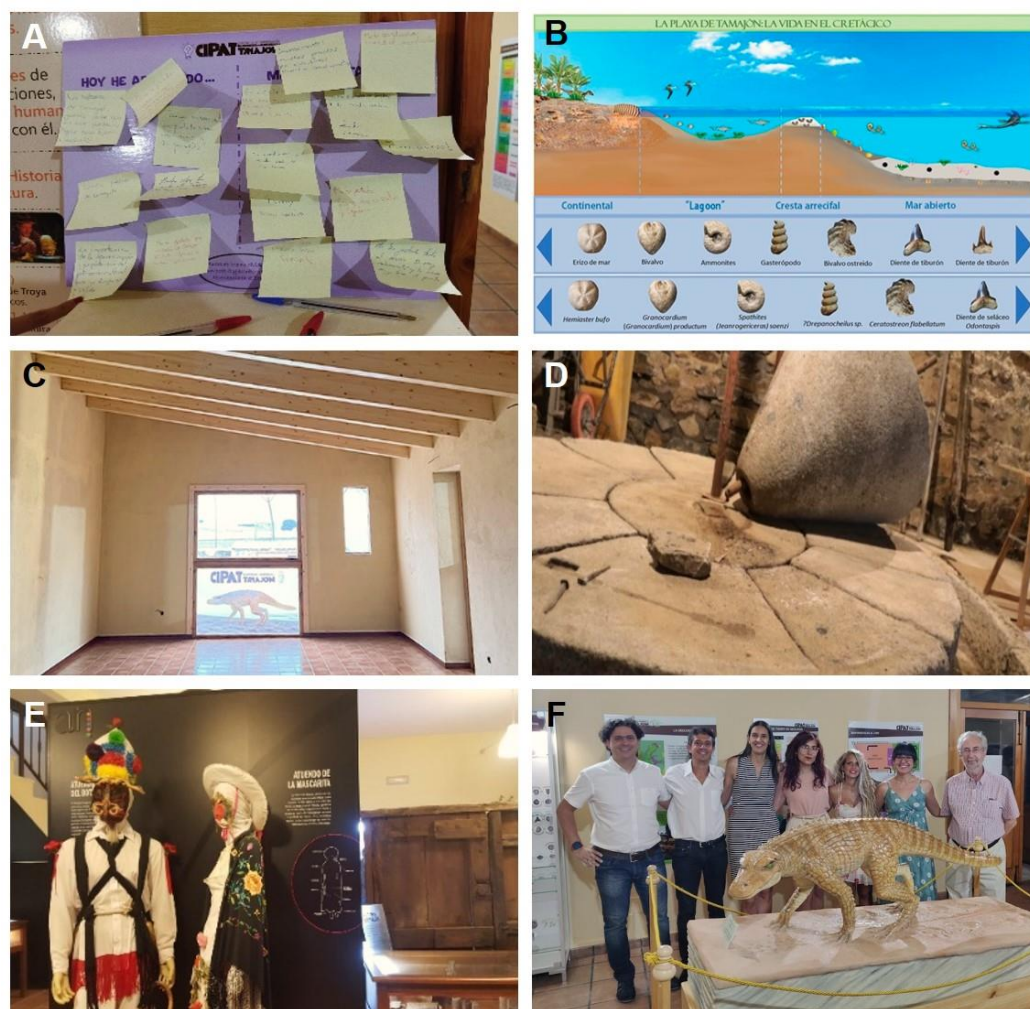


Figure 9. (A) Panel for qualitative feedback recollection to improve expositive materials and educational activities of the Paleontological and Archaeological Interpretation Centre of the locality (CIPAT); (B) Interface of the virtual educational activity “La playa de Tamajón-The beach of Tamajón”, showing two levels of difficulty; (C) Image of the extension of the CIPAT, for the future “Human Evolution Room” of the Archaeological Area; (D,E) The olive oil mill of Muriel (D); and the Botargas and Mascaritas Museum of Almiruete (E); which will be integrated with the CIPAT in a future tourist circuit along Tamajón and its districts; (F) Some of the members of the PaleoIbérica Research Group of the University of Alcalá, who have developed this project for the design and creation of the CIPAT, the inauguration day of this space to outreach the diversity and extraordinary value of scientific and cultural heritage of rural areas and promote geotourism.

Some areas and samples of special paleontological or archaeological interest of Tamajón have been three-dimensionally modelled for scientific purposes. Nonetheless, the digital information obtained can also be used through information and communication technologies (ICTs) as a valuable educational resource and a geotouristic attraction without jeopardising the original samples. Among them, the track surface was recorded using phase-shift scanning and photogrammetry techniques. Moreover, some invertebrate fossils from the marine outcrop were digitalised using a small object scanner. Subsequently, the data have been processed using different programs that have allowed the construction of complete

three-dimensional reconstruction models of the track surface and the main ichnites as well as of fossils of bivalves, gastropods and cephalopods. These reconstructions, in addition to printing three-dimensional replicas for educational purposes, are also allowing the development of a virtual repository, and the promotion of geotourism without damaging paleontological sites or their fossils. The virtual models created are a powerful teaching resource which, combined with the Theory of Multiple Intelligences [22], is facilitating the design and implementation of a series of didactic activities for the CIPAT with the aim of providing meaningful learning experiences for visitors (Figure 9B).

In addition to this, the town council has approved (and work has begun) an extension of the CIPAT to house the “Human Evolution Room” of the Archaeological Area, which will expose representative materials of the Upper Paleolithic sites (between 30,000 and 10,000 years ago) located in Tamajón, such as “Cueva de los Torrejones”, “Abrigo de la Malia” [9], “Peña Cabra” and “Peña Capón” [30]. This new exhibition room features amusing replicas (mainly of lion and cave bear skulls, leopards and hyenas from the Pleistocene) and some original lithic industry remains (flint tools) and bone fragments, also accompanied by the corresponding infographic information (Figure 9C).

Among the actions to promote the interpretation centre, it is planned to integrate it into a wide tourist circuit designed by the town council of Tamajón. It will include, in addition to the CIPAT, other attractions of the village and its districts, such as the “Almazara” olive oil mill of Muriel, the most northerly of all central Spain, and the “Museo de Botargas y Mascaritas” museum of Almiruete, where ancestral and colourful carnival ethnographic costumes, characteristic of the locality are displayed (Figure 9D,E). At the same time, it is intended to implement a project to promote and coordinate educational actions jointly with other interpretation centres or museums located in rural areas or small cities of Spain (e.g., Colunga, Igea, Teruel, Cuenca) and Portugal (e.g., Figueira da Foz, Lourinhã, Sesimbra), with the aim of advancing with geoeeducation aspects within an Iberian framework of cooperation [25,27,31].

As a whole, the CIPAT is being offered as a multidisciplinary interpretation centre (one of the first in Guadalajara) which facilitates the transmission of knowledge of the extraordinary diverse scientific and heritage value of the area to students and the general public. It has a team of specialised guides who are presenting the main paleontological and archaeological discoveries, as well as their geological context and cultural framework, in a precise and engaging way, adapted to the broad diversity of visitors.

Simultaneously, the CIPAT supports both educational and tourist visits, being included as a visiting point of different routes and itineraries, helping to raise awareness of the need to study and preserve the rich heritage of Tamajón and its importance as a valuable resource for the promotion of local development through cultural tourism (Figure 9F), especially geotourism [32], understood according to the Arouca Declaration [33] as that “which sustains and enhances the identity of a territory, taking into consideration its geology, environment, culture, aesthetics, heritage and the well-being of its residents”.

Author Contributions: Conceptualization, F.B.-B., M.B.-C., S.O.d.J. and M.S.; investigation, F.B.-B., M.d.R.A.-F., J.A.-G., M.B.-C., P.M.C., S.O.d.J., J.A.P.-V., V.F.d.S. and M.S.; writing—original draft preparation, F.B.-B., M.B.-C. and S.O.d.J.; writing—review and editing, F.B.-B., M.d.R.A.-F., J.A.-G., M.B.-C., P.M.C., S.O.d.J., J.A.P.-V., V.F.d.S. and M.S.; supervision, F.B.-B.; funding acquisition, F.B.-B., M.B.-C., P.M.C., S.O.d.J. and M.S. All authors have read and agreed to the published version of the manuscript.

Funding: Research Projects and Contracts UI/BD/150971/2021 of the Foundation for Science and Technology (Portugal), and UCM.CT31/21 of the Complutense University of Madrid (Spain); and BOP-168 of the Provincial Council of Guadalajara, and 94/2018, 21/2019, 147/2021 of the University of Alcalá-Town Council of Tamajón (Spain). Aid for Rural Development 2021 of the Eurocaja Rural Foundation (Spain).

Acknowledgments: The authors would like to thank the editors and all the reviewers of the original manuscript, who have helped to improve its content with their valuable comments. To Dra. Beatriz

Carenas Fernández, of the Autonomous University of Madrid, Ignacio Martínez Mendizábal, of the University of Alcalá, Dña. Paloma Blandín Parras, of BlandínStudio, D. Sergio Fernández Carenas, of StuArqLittle, and D. Eduard Grau Molina, of Grau Alcázar Maquetas, for their help and contributions to this project. To D. Eugenio Esteban de la Morena, the remaining members of the Town Council of Tamajón, and to everyone who has helped to make the CIPAT project a reality. To the Eurocaja Rural Foundation (Spain).

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

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