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LOST ARCHAEOLOGICAL HERITAGE: VIRTUAL RECONSTRUCTION OF THE MEDIEVAL CASTLE OF SAN SALVADOR DE TODEA

PATRIMONIO ARQUEOLÓGICO PERDIDO: RECONSTRUCCIÓN VIRTUAL DEL CASTILLO MEDIEVAL DE SAN SALVADOR DE TODEA

Patricia Valle Abad*, Adolfo Fernández Fernández, Alba Antía Rodríguez Nóvoa

Grupo de Estudos de Arqueoloxía, Antigüidade e Territorio (GEAAT), Universidade de Vigo, Edificio Olga Gallego, Pavellón 2, Despacho 28, As Lagoas s/n, 32004 Ourense, Spain. patricia.valle.abad@gmail.com; adolfo@uvigo.es; albaantia.rodriguez@gmail.com

Highlights:

- Virtual reconstruction of a Late Medieval rock castle, from the archaeological remains recorded during site excavations and the comparison with similar structures.
- Overview of the reconstruction methodology, decision-making process and resulting constructive hypothesis, with a detailed description of the certainty level of each part.
- Multidisciplinary approach to achieve a scientific model that helps to understand the castle distribution and its importance to control the landscape.

Abstract:

The medieval castle of San Salvador de Todea constitutes a remarkable paradigm for the rock castles of Galicia and the northwest of Spain, attending to its features but also to the destruction it was subjected to. The hill where it stands was the object of various archaeological interventions between 2016 and 2018, that identified the site as a medieval fortress and recovered part of its structures. San Salvador de Todea is one of the few 12th-15th centuries medieval castles in Galicia subjected to consecutive interventions and actively studied. Although the excavations provided an important amount of information about the chronology, distribution, material, culture and even diet of the inhabitants, the castle interpretation is complex. The preserved remains correspond to the foundations of the structures, mainly a few walls and a high amount of carvings scattered over the hill. This paper gathers the results of the investigation developed to create a reconstructive hypothesis for the castle and its materialization in a digital model, as a way to interpret and understand its structure. To achieve this aim, the authors combined the analysis of the archaeological data and the geomorphology of the hill, with the study of fortresses with similar disposition and chronology, and the appliance of architectonical rules, in a multidisciplinary study. One crucial objective has been to generate a reasonable, justified and scientific model of the castle, useful as an instrument to study and comprehend this type of construction. The resulting model shows the disposition, height and entity of the castle structures, the transit areas and indoor spaces; it also provides new data to calculate the visibility and predominance of the construction over the landscape, among other fundamental data. Finally, to ensure the rigour and scientific approach of the reconstruction, we utilised a scale of certainty level to show the results, along with photorealistic textures to recreate the probable aspect of the castle.

Keywords: 3D reconstruction; historic-archaeological evidence scale; archaeological heritage; medieval archaeology

Resumen:

El castillo medieval de San Salvador de Todea constituye uno de los mejores ejemplos del castillo roquero de Galicia y el noroeste de España, no solo por sus características, sino también por el tipo de destrucción al que se vio sometido. El cerro sobre el que se encuentra fue objeto de varias intervenciones arqueológicas dirigidas desde 2016 a 2018, identificando el lugar como una fortaleza medieval y recuperando parte de sus estructuras; siendo uno de los pocos castillos medievales de los s. XII-XIV en Galicia que ha sido objeto de varias intervenciones y es estudiado de forma activa. A pesar de que las excavaciones aportaron importantes datos sobre la cronología, distribución, cultura material e incluso dieta de sus habitantes, la interpretación del castillo se presenta compleja. Los restos preservados se corresponden con las cimentaciones del castillo, tratándose principalmente de unos pocos muros y una gran cantidad de rebajes en los afloramientos rocosos, distribuidos por toda la colina. El presente artículo recoge los resultados de la investigación desarrollada para crear una hipótesis reconstructiva del castillo y su materialización en un modelo digital, como forma de interpretar y comprender su estructura. Para lograrlo, se combinó el análisis de los datos arqueológicos y la geomorfología del propio terreno, con el estudio de fortalezas con una distribución y cronología similar, y la aplicación de normas arquitectónicas, en un acercamiento multidisciplinar. Todo ello para crear un modelo razonable, justificado y científico del castillo, útil como instrumento para estudiar este tipo de estructuras. El modelo resultante muestra, entre otros, la disposición, altura y entidad de las estructuras que conformaban el castillo, las zonas de tránsito y los espacios interiores, proporcionando además información para calcular la visibilidad y predominancia de la fortaleza sobre el

*Corresponding author: Patricia Valle Abad, patricia.valle.abad@gmail.com

paisaje. Finalmente, para asegurar el rigor y cientificidad de la reconstrucción, se hizo uso de una escala de nivel de veracidad para presentar los resultados, junto con texturas fotorrealistas para recrear el probable aspecto del castillo.

Palabras clave: reconstrucción 3D; escala de evidencia histórico-arqueológica; patrimonio arqueológico; arqueología medieval

1. Introduction

The virtual reconstruction of archaeological and cultural heritage constitutes, nowadays, an invaluable tool to understand and visualize the former appearance of a long lost or largely changed element. It allows, moreover, to integrate the reconstructed model –and therefore the idea of the real object or structure– in its present environment or even in a simulated one that recreates the original space where it was located. Furthermore, the quick evolution and progress of the virtual representation technologies provide constantly new tools, that lead us to more immersive experiences and helps to disseminate the results of archaeological and historical studies in a more graphic and understandable way.

However, the dissemination, in most cases the main aim of virtual reconstruction, requires an intense and detailed investigation and study of the object to create an accurate and scientific reconstruction. A process whose methodology has been largely discussed and improved over the last years, as shown in many specialised publications (Demetrescu, Ferdani, Unto, Leander Touati, & Lindgren, 2016; El-Hakim et al., 2007; Finan, 2012; François, Leichman, Laroche, & Rubellin, 2021; Mascio, Chiuini, Fillwalk, & Pauwels, 2016; Verdiani, 2017). A methodology that slightly varies depending on a series of factors –the type of represented element; preservation state; number and location of the remains; availability, quantity and types of sources; possibility to create basic models through 3D laser scanner or photogrammetry, etc.–, but follows, in general, a similar approach or close steps. Some notable examples are the reconstructions of the castles of Gauzón in Asturias (Aparicio-Resco, García Álvarez-Busto, Muñiz-López, & Fernández-Calderon, 2021), Piñar in Granada (Benavides López, Martín Civantos, & Rouco Collazo, 2019), Torreparedones in Córdoba (Porcuna Rodríguez, Córdoba de la Llave, Sanz Cabrera, & Montes Tubío, 2016); Elmina in Ghana (Ye, Wu, Jarvis, & Zhu, 2020) and the tower of San García in Algeciras (Aparicio Resco, 2016).

The main reasons to reconstruct or recreate heritage may differ, but most authors agree with the idea that the process of creation of the virtual models helps to improve the understanding of the represented object (Demetrescu, 2018). The reconstructions, aside from their possibilities as graphic representations, have their own value as a source, as they allow to represent, elaborate and evaluate the hypothesis, testing their architectonical or physical logic (Demetrescu, 2018; Mascio et al., 2016). It constitutes a way to discover not previously identified traces or fill gaps of information that were not visible until the 3D modelling. Sometimes implying changes in the initial hypothesis, as the reconstructions show structural or morphological incongruities (Demetrescu, 2018; Verdiani, 2017).

This approach, through the creation of one or more virtual models, is especially relevant in those cases where the heritage is lost, inaccessible, modified by later constructions or additions, or the remains are so scarce that their interpretation and understanding is tough (Verdiani, 2017). The case of the medieval castle of San Salvador de Todea, the object of study in this paper, can be included in the last category. Although the consecutive archaeological campaigns developed by the Universidade de Vigo on the site from 2016 to 2018, that uncovered part of a 12th-15th castle, the general perception of the structure is difficult, due to the scarcity and dispersion of the remains (Fernández Fernández et al, 2017; Rodríguez Nóvoa et al., 2019; Valle Abad et al, 2018). Moreover, the existence of the castle was confirmed by the archaeological excavations, being unknown and classified as a hillfort until 2016. Later research showed that the presence of San Salvador on the medieval documental sources was merely testimonial, not existing either later graphic representations of the castle, as it was abandoned or destroyed at the beginning of the 15th century and used, probably shortly after, as a stone quarry by the neighbours of the homonymous village located at the basis of the mount.

Despite this documental silence, analysing the location and entity of the fortress, there are few doubts about its importance during its lifespan. The hill where the castle was constructed has a privileged visual control of the surroundings, especially to the north, to the valley where Allariz –with its own castle- is located. Moreover, the hill is easily visible from most of its surroundings, occupying a prominent position (Fig. 1). From the information gathered by the documental sources and the archaeological remains, we know that it was a strategical place to control the way that connected Portugal and Galicia.

That said, there was enough data to create a general idea of the castle functions and its probable relation with the surroundings, but the aspect, measures and entity of the structure were still unrecognizable. Therefore, we decided to confront the study of San Salvador from a different perspective, using the possibilities provided by the virtual reconstruction methods, combining the archaeological data and the landscape analysis with the study of another similar fortress, with a close morphology and chronology. All this to create a scientific-based constructive hypothesis, that has been materialised through 3D modelling and that allowed to answer some important questions about San Salvador de Todea:

- *Shape and construction*. The hill where the castle was constructed is formed by numerous granite outcrops and boulders. How was the castle constructed and how did it adapt to those features? What was the shape of the castle?
- *Inner distribution.* The excavations uncovered two different gates for the fortress. How was the inner distribution and transit of the castle?
- *Building features*. The tower dimensions made the structure really narrow. Which height could it afford and how many floors could it have? Were there other living structures inside the compound?

Figure 1: General view of the hill where the castle was located.

- *Interpretation of some carvings patterns*. The southern area presents a high number of carvings. Which type of structure could have been constructed there? Which was its function?
- *The rampart configuration*. Was the whole compound surrounded by a rampart? How were the different parts the different parts assembled? Could it have a homogenous height?
- *Visibility*. As the hill is visible from most of its surroundings, how much visible would be the castle if it was complete? Did the height of the tower increase the visual control or were there still some blind spots?

2. The case of study: the castle of San Salvador de Todea

The castle remains are located over a hill known as San Salvador de Todea, west of the homonymous village, in the municipality of Allariz (Ourense, Spain) (Fig. 2). It is easily accessible from the village, as well as from other forest paths that communicate the valley of the Arnoia river and the village of Allariz with the area of A Limia, located south of the castle. The surrounding landscape is covered by autochthonous plant species, mainly oaks (*Quercus robur and Quercus pyrenaica*) and scrub species as a fern (*Pteridium aquilinum*) and butcher's-broom (*Ruscus aculeatus*).

The first excavations of the hill were developed in 2016, due to a research project of the Universidade de Vigo, with founding provided by the Diputación de Ourense. Along the three excavation and conservation-restoration campaigns, we recovered the remains of a medieval castle, as above mentioned, unknown until then. Currently around 40% of the castle's surface has been excavated –mainly the tower area, the two entrance gates and a survey ditch in the lower terrace of the hill–; and a high percentage of the mount has been cleared from undergrown, revealing an important number or carvings and cuts in the rock boulders and outcrops, and even wall remains that are still visible on the ground surface. The excavation recovered also an important amount of materials, that allowed a better understanding of the daily life of the castle, providing information over the customs, tools and diet of the castle's inhabitants (Fernández Fernández et al, 2017; Rodríguez Nóvoa et al., 2019; Valle Abad et al, 2018). Furthermore, once the remains were identified as part of a castle and the first studies posit an accurate chronology, it seemed necessary to search the fortress in the documental

Figure 2: Location of the castle of San Salvador de Todea. Base map: European Environment Agency and SERGAS.

sources of its period. This multidisciplinary approach unveiled the original name of the castle, San Salvador de Todea and provided some information about its land and category (Rodríguez Nóvoa et al., 2019: 63-64).

The main occupation of the castle was between the 12th and the beginning of the 15th, probably related to the control of the communication routes and the defence of the territory, mainly the access to the valley from Portugal. During those centuries, the conflicts between Portugal and the crown of Castilla in Galicia were continuous, due to the southern frontier of the present province of Ourense. Besides, the hill presents at least two previous occupations: one dating of the Early Medieval Age and another of the Late Antiquity (Rodríguez Nóvoa et al., 2019). Although we recovered some of the structural remains of the Early Medieval occupation, the construction of the 12th-15th century produced substantial changes in the distribution and aspect of the hill, hindering a better understanding of the functionality of those preceding structures –perhaps another castle, a hermitage or a living space–. This previous occupation, dated among the 8th and the 10th century is probably related to the ensemble of anthropomorphic stone-carved graves located on the basis of the mount (Fig. 3). Also during this period, the hill was modified and the spaces between the outcrops and boulders filled with soil deposits, whose excavation provided us with materials dated from the Late Roman and Early Medieval times, as for example, slipped plates from Lugo and TSHT (Fernández Fernández et al, 2017; Rodríguez Nóvoa, Valle Abad, & Fernández Fernández, 2021; Rodríguez Nóvoa et al., 2019; Valle Abad et al, 2018).

The castle displays all the main characteristics of the so-called rocky castles. A type of fortress known, not only in the northwest of Spain, but also in the rest of the Iberian geography and even in other regions of Europe. Those castles were commonly built-in high hills –with an approximate height of 700 m over the sea level in the

Figure 3: Anthropomorphic carved graves located on the basis of the mount.

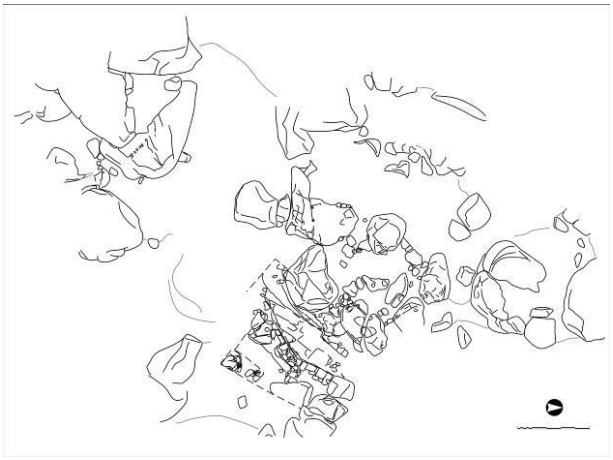
case of San Salvador–, benefiting from the rugged morphology of the mounts and their cliffs, which provided a natural defence and difficult access to the compounds. The structures and shape of those fortresses were conditioned to the morphology of the hills, adapting and making use –through carvings and cuts– of the outcrops and boulders that mould them. Therefore, every rocky castle has its own shape and characteristics, although they share some common features. The function of those castles was, as mentioned before for San Salvador, the control and defence of the surrounding landscapes, taking advantage of their privileged location and tough access.

From the preserved remains, we can affirm that San Salvador de Todea presented a polygonal shape, divided into two different compounds. The main area was crowned by a tower and the castle was acceded by two different gates, located to the north and the south of the compound (Fig. 4). Currently, the castle is composed of a few wall foundations remains and numerous carvings on the outcrops and boulders distributed all over the hill. The excavations showed an important lack of stone deposits from the collapse of the structures, being the site used probably as a stone quarry shortly after its abandonment or destruction.

3. Methodology

As mentioned above, in the last years there has been an intense debate about the most accurate way to develop a scientifically based reconstruction. Following Mascio, there are three main questions that must be answered before beginning any reconstruction (Mascio et al., 2016): what is to be modelled (the object), why should it be modelled (the purpose of the 3D reconstruction) and how should it be done (the technologies and methodologies to use). In the case of San Salvador, our purpose was to reconstruct the last phase of the castle –the one dated among the 12th and the 15th century–, as it is the only one with enough data to reach conclusions. The reason for the modelling was to obtain information through the reconstruction, due to the complex interpretation of remains on the field and through 2D representations. Finally, to describe how the modelling was done, we followed the steps stated by authors like Mascio (2016), Verdiani (2017) or Demetrescu (2018), and implemented in reconstructions like the one of the Castle of Gauzón (Aparicio-Resco et al., 2021) or the Castle of Torreparedones (Porcuna Rodríguez et a., 2016), to reference some similar cases.

(a)



(b)

Figure 4: (a) Aerial view and (b) excavations plan from the remains of the castle.

A. Gather information of the subject, analysing the data from the archaeological remains (primary sources)
B. Collect information from secondary sources: documents, drawings, old photographs, etc.
C. In-depth analysis and study of the historical context and typological and chronological similar constructions.
D. Design of a constructive hypothesis, following the information drawn from the sources, attending to the level of accuracy of each of them.
E. Development of a first reconstructed model, following the constructive hypothesis.
F. Discussion of the results and analysis through other disciplines. Test of the architectonical logic and correctness of the model.
G. Creation of the final model, carrying out possible corrections, adding elements or testing variations in the reconstruction choices.

Therefore, the modelling will always be primarily based on solid and justified references, based on an accurate comprehension of the subject, its environment and its historical context (Verdiani, 2017). Every reconstruction needs a scientific basis, only achieved through the

historical sources (Demetrescu, 2018; Mascio et al., 2016), as the physical pieces of evidence represented by the archaeological remains and other surviving parts, perhaps relocated (primary sources); as well as archive documents and old drawings and photographs (secondary sources).

However, there are always some missing parts on the constructions, whose interpretation and later modelling has to be done using external sources, for example, parallels (Verdiani, 2017), or even some logic and deduction, following symmetry, continuity or structural criteria (El-Hakim et al., 2007; Finan, 2012; Porcuna Rodríguez et al., 2016). This does not mean a total loss of accuracy or to incur a historical fallacy, as long as it is displayed or stated (ICOMOS, 2017), as in conservation-restoration works.

Moreover, the recreation allows creating different models, with numerous options of how the construction or modelled element could have looked like, not restraining the interpretation to a unique possibility (Finan, 2012). From the first hypothesis to the final modelling, the recreation constitutes a way to verify, qualify or refute possible solutions, changing constantly the initial hypothesis (Aparicio-Resco et al., 2021; Verdiani, 2017). Therefore, it is highly necessary to work with multidisciplinary teams, where archaeologists, historians and, in our case, architects can contribute to resolve constructive inaccuracies or fill information gaps that were not visible in the first sketches or interpretations of the castle.

4. Documentation and survey

Each reconstruction has its own particularities, beginning with the quantity and type of information at hand. Therefore, it seems necessary to point out the sources we used to develop our hypothesis and the final model of the castle.

4.1. Structural evidence

As mentioned before, the archaeological campaigns uncovered some structural remains, mainly stone walls and carvings on the rocky outcrops, some of them already visible before the grubbing works. The analysis of those elements and their display on excavation plans, allowed a first interpretation of the fort, following the path of the walls and the carvings to recreate the ensemble. Due to its particular constructive typology –with walls directly raised over the granite outcrops- and the use of the site as a stone quarry, most of the structures are lost, being the carvings the primary witness of the existence of walls and other support structures.

Each part of the fort has their own characteristics, with particular evidence that lead to the recreation of the structures that composed it. Although, the walls and carvings share some common aspects that allow establishing some general features.

Walls:

- All the preserved walls are constructed with rather regular granite ashlars of medium size, with laboured outside faces.
- Although only a few sections are preserved, their width is almost regular, with a mean of 1 m.
- The walls are rarely straight and were mainly build following curves or sharp edges.
- The preserved structures belong mainly to the inner divisions of the ensemble.
- The walls are constructed directly over the rocky outcrops, adapting to their morphology.

Cuts and carvings:

- They can be located in several outcrops and boulders of the hill, at very different heights.
- They show a high diversity of shapes, with carvings for supporting seams, place ashlars, staircases, postholes, and gates or doors.
- The trace of the structures usually combines carvings and cuts with ashlar walls constructed over the base of the hill.
- Some of the carvings and cuts were identified as isolated, hindering their interpretation.

As mentioned above, before the construction of the 12th -15th century castle, the mount was occupied by another structure/s. Those previous remains are difficult to interpret, as very few details were preserved, not being able to determine if some of the visible carvings (mainly those isolated and detached from the identified structures), could have been done during this previous occupation of the hill.

As each part of the castle presents a different distribution of structural pieces of evidence and their presence was fundamental to recreate the structures, they will be explained in detail in the section dedicated to the different parts of the castle.

4.2. Medieval source documents

The castle of San Salvador de Todea was largely forgotten and remained unidentified, although some of its remains were still visible on the hill. Classified for a long time as an Iron Age hillfort, the mount where it is placed was known by the near villagers by the name of *Mouresiños* or *Malpaso*. Therefore, after its identification as a medieval fortress, the next step was to search for information on the medieval source documents.

The first attempts were unsuccessful, as the sources did not gather castles named *Mouresiños* or *Malpaso* in the surrounding region of Allariz. However, a deeper approach revealed that in a document of 1247 a place named “Sancti Salvatoris de Todea” was located on the edge of the parish of Santiago de Allariz, probably in the area where the castle is located. The same land of Todea or Tudea is referred in the other three documents of 1197, 1366 and 1310. But the first and actually only known mention of the castle is from 1433, presented as “Castelo de Tudea” (Rodríguez Nóvoa et al., 2019).

Although it appears in a significant number of documents, none of them provides information about the castle features, distribution or dimensions. Being archaeological remains, despite their scarcity, the only reliable and primary pieces of evidence to recreate the ensemble.

4.3. Parallels

Aside from main sources, we developed an intense study around castles or fortresses with similar distribution (rock castles) and close chronology (12th-15th

century). As stated before, the preserved remains of the castle correspond mainly to the foundations of the structures, hindering a complete vision of the compound, as some of its elements (vertical sections, masonry distribution, total height of the structures, gates and accesses, etc.) were long lost and impossible to recreate without external data.

There are numerous examples of rock castles along the Galician region, but most of them are partially destructed, were never excavated or have been subjected to later modifications and rebuilds. Therefore the castles of Narahío and Nogueirosa in A Coruña (Galicia, Spain) are two paradigmatic examples, as they meet the premises of being still-standing and well-preserved structures, located over rocky outcrops and with a closed chronology between the 12th and 15th century, without later add-ons (López-Felpeto Gómez, 2015; López Hermida, 2009). Both share the particularity of being fortresses raise by the Andrade family, which owned an important amount of land in the region.

However, other cases helped to comprehend the distribution and characteristics of San Salvador, for example the towers of A Pena, Sandiás, Porqueira and Portela (Galicia, Spain) and the castle of Mogueira in São Martinho de Mouros (Portugal). Although it was not fully intervened[1] and the visible remains are scarce, Torre da Pena (Vidal Álvarez, 2014) represents the nearest geographic example of a rock castle for San Salvador; sharing constructive characteristics with the nearby but isolated towers of Sandiás and Porqueira, all of them located in the region of A Limia. In addition, the castle of Mogueira, located on Portuguese territory, served as a parallel to comprehend the distribution and destruction of this type of castle (Correia dos Santos, 2012).

4.3.1. Castle of Narahío

Rock castle located in San Sadurniño (A Coruña) and dated among the 12th and the 14th century. The fortress was built over a rock platform (Fig. 5), occupying all its surface and adapting the different structures to its morphology. It holds a privileged view of the surroundings, with a major control of the north valley, while the south side of the castle faces a higher mountain, which limits the view (López-Felpeto Gómez, 2015).

Structurally it presents a polygonal or irregular shape, with two compounds at a different height. The main compound, the first to be constructed, hosts the main tower, surrounded by a courtyard. The second compound, accessible through stone staircases from the east and the west, preserves the remains of minor structures or buildings, that leaned against the rampart.

The tower, constructed over the highest outcrop of the compound, was built in a quadrangular shape with granite ashlars. The actual height of the structure is 16 m, although it is incomplete, with a wall length of 9 m and a width of 2.25 m. It had at least two floors and the basement, occupied by a vaulted pool or water cistern. The main access to the Tower was through the main floor on the southeast side of the structure, probably through the inner rampart walls (López-Felpeto Gómez, 2015).

Both compounds were surrounded by large ashlar walls, with arrow loops or loopholes in the southern section. The second compound hosted at least three different structures and a secondary tower, raised on the southeast corner of the rampart.

4.3.2. Castle of Nogueirosa

Also known as the Castle of Andrade, it is located in Pontedeume (A Coruña), over a narrow hill, accessible only from the south (Fig. 5). As a rock castle, it occupies a high position over a rocky outcrop that controls all the surrounding territory. The castle is dated from the 14th century.

Structurally it presents a polygonal shape, that covers the whole rock platform, surrounded by a massif rampart with three towers. Inside the single compound, we can find the main tower and a courtyard (López Hermida, 2009). The complex is surrounded by a ditch.

The tower presents a rectangular shape and granite ashlars, crowned by an overhanging machicolation with loopholes. It has a total height of 20 m, with walls 2 m in length and 2 m in width. The only access to the building lies on the main floor, reaching it probably by a staircase or drawbridge from the upper side of the rampart. The basement of the tower housed the pool or water cistern (López Hermida, 2009).

The courtyard is surrounded by a large ashlar wall, that follows the morphology of the terrain. The rampart walls still preserve the remains of arrow loops or loopholes, located at a different height. Those voids are usually identified as part of minor constructions, that leaned against the rampart and would probably have at least two floors.

5. Technical resources: software and procedures

Before we posed the idea of recreating San Salvador de Todea, a considerable amount of graphic information was already recorded. As the castle entailed such a difficult understanding, during the archaeological works numerous field plans were drawn and we developed a detailed photographic record of each know feature on the hill. Besides, at least three different photogrammetric models were undertaken: one with a drone to register the whole hill and two terrestrial surveys for the archaeological areas of 2016 and 2017.

Those materials were the base of the recreation, working as references to determine the position and disposition of each structural remain. Allowing an elaborated analysis of the carvings and structures, their characteristics, shapes, dimensions, etc. Additionally, new graphic materials were added to the project as it evolved, through punctual visits to the site, covering the necessities or doubts that the works generated. Among this extra material, another photogrammetric model of the platform was achieved, that covered the whole surface of the hill, to create a suitable base to place the final recreation.

[1] Torre da Pena was recently subject of an archaeological and preservation-restoration intervention, promoted by the Xunta de Galicia. The results of the works and some graphic information are accessible in: https://www.contratosdegalicia.gal/licitacion?OP=50&N=802317&lang=gl

(a)

(b)

(c)

Figure 5: General views of the castles: (a) Narahío; (b) Nogueirosa; and (c) Torre da Pena.

The photogrammetry models were created separately in Agisoft Metashape v. 1.6.5. The dense cloud was edited before the creation of the mesh, to eliminate the trees and vegetation that occupies the upper platform of the hill. Therefore, we acquired an almost clean high-poly mesh, whose texture was also built in Metashape.

Those models were not postprocesed (except for the elimination of some remaining vegetation that was impossible to erase) as we wanted to preserve the highest detail of the surface of the hill. This allowed us to recognize the cuts and carvings on the boulders, as well as identify others not previously seen on the field, but that were visible on the solid mesh. Only the final base model of the hill (whose photoshoot was made specifically for the recreation) was subjected to a retopology process and a reprojection of the textures. This resulted in a lighter model with high-quality textures, easier to move (as it weighs less than the high-poly photogrammetric mesh) and usable in digital viewers.

The recreation of the castle sections was processed entirely with Blender v. 2.8, trying to create low-poly meshes, but with enough detail to assure a realistic aspect and cover all the details of the remains (Ye, Wu, Jarvis, & Zhu, 2020). Therefore, we used the imported photogrammetric models –once assembled in Blender- to raise and build the different sections of the still preserved walls, as well as fill the cuts and carvings.

The whole recreation was manually achieved, following the first reconstruction hypothesis, sustained by the structural pieces of evidence, plans and field photography, and adding new elements following the previously mentioned examples of rock castles. The final textures were baked using the software Materilize or downloaded from textures.com and textureheaven.com[2].

The process of recreating the castle was complex and lasted for several months. Some sections of the ensemble had to be rebuilt several times, as the different features of the castle were discussed and new questions were raised from the models, resulting in a constant search for more documental information or parallels. To summarize, the steps followed to recreate the castle were:

- Creation of the 3D photogrammetric models, geographically referenced.
- Import and assemble the models.
- Import and disposition of plans, photographs and other graphic material (Fig. 6) to help in the recreation of the different sections of the castle.
- Recreation of the preserved sections using basic geometries (mainly cubes and cylinders), to emphasise their presence.
- Filling of the in-between spaces, following the most probable paths of the walls and shapes of the structures, creating a first 3D plan to work with.
- Recreation of the different sections of the castle, in the following order: tower, rampart, southern structure and inner spaces.

Figure 6: Illustration of 2018, showing the first reconstructive hypothesis of the castle. Drawing: Iago Araujo.

[2] The downloaded textures are mainly the ones used for the wooden elements. The rest of the textures were created specifically for the model of the castle, using photographs of other similar castles.

- Manual creation of the UV-maps for the different elements.
- Download or creation of specific textures to obtain PBR (Physically Based Rendering) textures based on Metal-Roughness workflow (Fig. 7).
- Optimization of the hill model (retopology and reprojection of textures), replacing the high-poly model used to recreate the castle.
- Use of GIS *Add-on* to create a realistic background for the castle, placing the final model (hill low-poly mesh and castle) in its real landscape, adding some low-poly models of autochthonous vegetation.

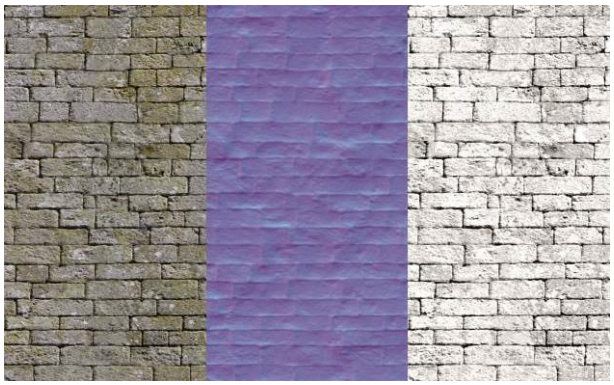


Figure 7: Granite ashlar texture (Diffuse-Normal- Roughness) created with Materialize, from a photograph of the castle of Nogueirosa.

6. Recreating the castle

To achieve a better understanding of the reasons that led to the final recreation of each section of the castle, it is necessary to explain its construction in the same order as it was recreated. Therefore, the different sections of the ensemble will be discussed separately (Fig. 8).

6.1. The tower

Located on the top of the hill, the tower was the main building of the ensemble. It occupied a prominent position, on a narrow platform comprised of granite outcrops and boulders, with high visibility of the surroundings, especially of the valley of the Arnoia river and the village of Allariz, located to the North.

The structure's foundations are the only preserved remain and indicator of the tower existence, as the rest of the building and the materials that composed it are long lost. The tower rested or was raised over the granite outcrops that form the platform, constructing the walls directly over the rock surface or the natural sediment of the terrain. In those cases where the walls were raised over the stone outcrop or boulders, the stability of the structures was ensured through the carving of the rocks, creating cuts and levelled faces to place the ashlars (Fig. 9).

Only two small sections of the wall are still visible, forming the foundations of the North and West sides of the building. The structures are composed of regular granite ashlars -medium size- with hewed external faces, intercalated in some points with bigger stones with irregular shapes. Both walls present a maximum wide of 1 m, and a length of approximately 2.7 m in the western structure, and 1 m in the northern one. The squares of the tower were raised over four different boulders, oriented to the northwest, northeast, southwest, and southeast. The western side leans against two exempt rocks, with a rounded shape and a bigger elevation than the eastern counterpart; while on the eastern side the carvings were done over two flat and almost ground levelled boulders, that reach from the top of the hill to the main entrance of the castle, in a fall of approx. 4 m.

The resulting structure is an irregular building of 40.7 m^2, with varying side lengths and a major east-west axis, being the eastern wall the narrowest of all. However,

Figure 8: Aerial view of the castle reconstruction, with the location of every section.

both the walls and the carvings provide a more or less steady width of 1 m for the entire building. Among the scarce remains of the tower, three more carved elements need to be noted: 1) a circular hole located in the middle of the ground floor, probably for a wooden pillar; 2) levelled carvings in the southwest boulder, that could have been probably used as support for a staircase; and 3) an alquerque or qirkat board, on the floor level, near to the eastern wall.

(a)

(b)

Figure 9: Carvings and wall remain of the (a) northern and (b) western sides of the tower.

6.1.1. Modelling the tower

Despite the data provided by the archaeological research, there were many aspects of the tower that remained and still remain unknown. However, the architectonical study of the castles of Narahío, Nogueirosa and Torre da Pena (Fig. 5), as well as other isolated towers as Porqueira and Sandiás, has allowed setting a reasoned hypothesis about what could have been the aspect of the tower before its abandonment:

Masonry: analysing the walls of the site, those of the tower but especially others that preserved more than two rows, there can be considered that the walls of the structure would have been constructed with regular ashlars of granite, from the floor to the top, in a straight vertical section. This is a common constructive facing, visible in other rocky castles and towers of Galicia and the north of Portugal, as the above mentioned (Freire Tellado, 2003; López-Felpeto Gómez, 2015; López Hermida, 2009) (Fig. 10).

Figure 10: Masonry of the tower of Nogueirosa. The few vertical sections preserved in San Salvador show a similar type of stone and distribution, therefore this image was used to create the ashlar texture of the castle.

Height: due to the condition of the preserved remains, the total height of the building is unknown (Fig. 11). However, Freire Tellado (2003) analysed in a general article the common features of the Galician medieval towers, concluding that usually, they had two or three top floors plus a basement or ground floor. Besides, we needed to determine the maximum height that the tower could reach, without incurring an architectonical mistake. Therefore, we used the slenderness ratio (λ), an architectonical measure that calculates the maximum height that could reach a wall in relation to the width of the facing (height/width = λ). Modern architecture states that a stable wall has λ= 27 or less[3]. Nonetheless, this

Figure 11: Shape of the tower, following the wall remains and carvings located on the top of the hill.

[3] Documento Básico SE-F. Seguridad estructural: Fábrica. Ministerio de Fomento. Secretaría de Infraestructuras, Transporte y Vivienda. 20 de diciembre 2019.

measure could have been different in the Late Medieval period, therefore the slenderness ratio was applied to other towers to analyse if there was some kind of pattern. The result of these calculations (Table 1) shows that all the towers have λ ≥ 10 (Freire Tellado, 2003; López-Felpeto Gómez, 2015; Vila Álvarez 2014; López Hermida, 2009).

Table 1: Slenderness ratio of different Late Medieval towers located in Galicia. The result of dividing the height by the width is always ≥ 10. (*) The whole height of the tower is not preserved.

Tower	*Wall width*	*Wall height*	λ
Nogueirosa	2 m	20 m	10
Narahío	2.25 m	16 m (*)	7.11 (*)
Torre da Pena	2.5 m	20 m	8
Sandiás	3.5 m	17.5 m	5
Monforte	3 m	30 m	10
Castroverde	2 m	20 m	10
Vilanova dos Infantes	2 m	19 m	9.5

Hence, the maximum height that the Tower of San Salvador could reach is 10 m, as the width of the walls is 1 m (λ (10 m / 1 m) = 10). Combining the architectonical measure and the information provided by Freire Tellado (2003), the building probably had at least two top floors and a basement. Therefore, the tower altitude would probably revolve between 8 and 10 m.

Gates and accesses: the lack of vertical section raised the problem of knowing how was the access to the inside of the tower. The archaeological campaigns did not provide enough information to clarify this question and, attending to the remains and the solutions taken in other ensembles, there are three different possibilities or hypotheses:

- *Access through the ground floor:* the entrance to the tower platform is through a passage with a secured door, which existence is known due to a group of carvings that crown the stone sculpted staircase that communicates the lower part of the hill with the top. At first, this door seemed a reasonable indicator of a ground-level entrance, but a late analysis and comparison with other cases showed that this kind of access is very uncommon. However, as there is not enough evidence to assure or deny any type of entrance, this probable access has to be attested.
- *Access through the first floor (northern side):* the rampart of the castle embraces the tower on the western and northern sides, creating a platform that would probably be transited. This raised the possibility of an entrance through the northern face of the tower, using the platform, in combination or not with a staircase, to reach the first floor. However, this access presents some defensive issues, but as noted before, the possibility of northern access cannot be denied.
- *Access through the first floor (western side):* the last hypothesis proposes the entrance to the tower through the western side, as it is the better defended and most secure part of the tower, with a fall from the first floor to the ground of minimum 4 m. The door could be reached from the northern rampant or from the ground, with the help, for example, of a wooden staircase, a structure that could be disposed of in case of assault. This kind of access solutions are used, for example, in the castles of Narahío, Nogueirosa and Torre da Pena as well as in towers like Porqueira (Freire Tellado, 2003; López-Felpeto Gómez, 2015; Vila Álvarez 2014; López Hermida, 2009).

As the last hypothesis was the most logical one, attending to the tower structure and the surrounding remains, and the only with demonstrable parallels, we choose it for the final representation of the castle.

Inner distribution and uses of the spaces: as stated before, the tower could have had at least two different levels plus the ground floor. However, there is not enough data to determine the inner distribution and the uses of those spaces, as well as the materials used to build the floors. Only in the case of the ground floor, there are some indicators that could help to understand this space. The excavation uncovered a group of carvings in the southwest boulder, not related to the tower walls, that could have been used to raise a staircase, to communicate the main floor with the basement; as well as a pillar hole and an alquerque (Fig. 12). Those elements, as well as the lack of an isolating floor, discard the use of the basement as a pool or water tank, differing from the cases of Narahío and Nogueirosa (López-Felpeto Gómez, 2015; López Hermida, 2009); being probably used as cellar, warehouse or even as a bedroom.

Figure 12: Remains of the alquerque table board, located in the basement of the tower, recovered during the excavation campaign of 2016.

Other elements: the tower of San Salvador probably counted with a series of characteristics or elements in its vertical section, that are nowadays lost, but that can be commonly identified in similar buildings. They are, primarily, defensive features as crown finials or voids. Therefore, and despite the lack of information and remains, to enrich and create a more realistic recreation of the tower, some of those elements were added, following a studied distribution but being aware of their most probable inaccuracy.

- *Crown final:* their typology is unknown and, despite the use of the site as a stone quarry for the near village of San Salvador, we could not find defining elements that lead to a better knowledge of this feature. Therefore, the examples of other

Figure 13: (a-d) Final aspect of the tower after its reconstruction and (e) hypothesis of its inner distribution. The possible entrance through the first floor and on the upper side the machicolation with reinforcements (a) were modeled following the aesthetic of other contemporary towers.

contemporary towers were followed, creating a simplified overhanging or bent Machicolation with reinforcements (Freire Tellado, 2003; López-Felpeto Gómez, 2015; López Hermida, 2009) (Fig. 13).

- *Voids:* despite not having remains of their existence, loopholes are a very common defensive feature, present in all the towers of the Galician territory. Therefore, we added a set of simple loopholes to the different levels of the tower, following again the distributions shown in other contemporary towers (Freire Tellado, 2003; López-Felpeto Gómez, 2015; López Hermida, 2009).

6.2. The rampart

Besides the tower, there are enough indicators to establish that the castle counted with a solid rampart that surrounded both platforms of the hill. It is a common feature of this type of castle, constructed over rocky outcrops, whose defence relied on the rugged terrain as well as in the height of the defensive walls (López Hermida, 2009), creating an impenetrable fortress.

Once again, the destruction of the castle and the use of the site as a stone quarry result in the inexistence of walls, whose paths can solely be followed due to the numerous carvings identified in the rocky outcrops and boulders located in the edges of the hill (Fig. 14). The carvings and cuts show different typologies, being the most common ones the levelled surfaces to place ashlars and those used to support beams. The carvings

(a)

(b)

Figure 14: (a) Wall remains and (b) carvings located at different points of the hill and used to raise the rampart.

are commonly displayed at different levels, in a step-like sequence, that assures higher support and stability for the structures (Correia dos Santos, 2012). Moreover, due to the irregularity of the terrain, the rampart walls would have adapted to the hill's morphology, with foundations at different levels and partially supported by the rock boulders, that would remain visible inside and outside of the ensemble at some points. The structure would probably have had an angular design that reinforced its stability, instead of a continuous curved wall, resembling the ramparts of Nogueirosa and Narahío (López-Felpeto Gómez, 2015; López Hermida, 2009).

Besides the carvings that show the wall's path, during the archaeological intervention we recovered the remains of the entrances of the castle, discerning that the ensemble counted with two different gates, located to the north and the south of the hill. One of them, the northern gate, preserved part of the inner walls -1 m wide and with an angled path- allowing a better understanding of the rampart masonry. The other one, the southern gate, was solely composed of carvings.

Finally, following the distribution of carvings and wall remains, we can assert that the rampart created two different but connected compounds: the main compound that surrounded the tower, in the highest part of the hill, and a secondary compound, on the lower platform, that was attached in two different points to the main structure. The major indicatives of the existence of those distinct areas are the carvings on the boulders that follow the western wall of the Northern gate and extend from northeast to southwest through the edge of the upper platform, where the remains of an inner/minor gate are still visible.

6.2.1. Modelling the rampart

Masonry: as stated before, there are no remains of the rampart walls, except the sections preserved in the northern gate. Although those walls are part of the inner side of the rampart, and therefore probably less reinforced, they provide enough data to know how the outside walls could have been constructed (Fig. 15). Probably, the in-between walls of the rampart were built using granite ashlars, similar to those used in the northern gate or to build the tower. The analysis of the masonry of other contemporary castles shows that the size of those ashlars could have been the same for all the structures that formed the castle.

Height and width: the recreation of the rampart implied the problem of estimating the total height and width of the whole structure, as the preserved remains had not provided enough data to determine it. The presence of carvings on the top of some boulders indicated that at least the structure needed to surpass this height but without a possible maximum. Besides, the measurement system used for the tower - slenderness ratio (λ)- was not applicable to the rampart, as the walls adapt to the terrain and the cases used as paradigms –Narahío, Nogueirosa, Torre da Pena, etc.– did not preserve the total height of the defensive structures.

Therefore, the minimum height was established using as reference the topmost carving located on a boulder. As this kind of castle usually have continuous and homogeneous ramparts –with a fairly stable height, unequal only between compounds (Porcuna Rodríguez et al., 2016)– this measure was used for the whole length of the wall. For the secondary compound, it was settled in the southern cliff, where the southern structure could be located; while for the main compound, the reference was the inner edge of the northern platform. This lead to a quite homogeneous height between the two areas.

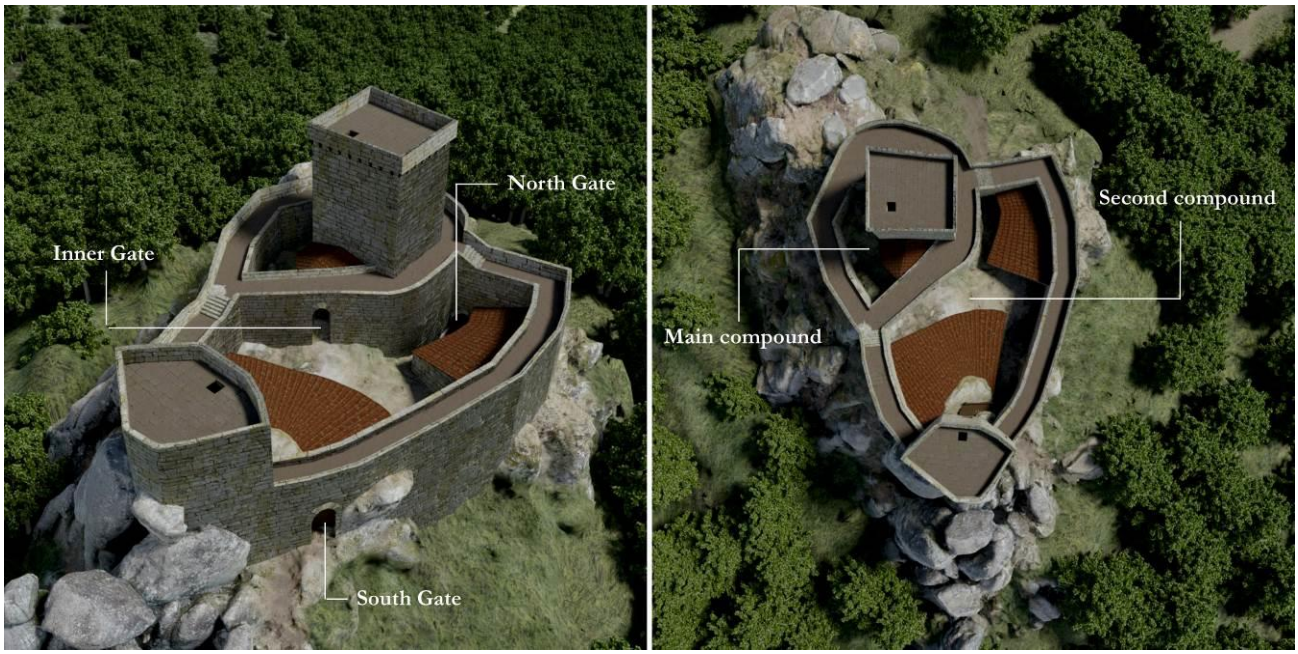
(a)

(b)

Figure 15: Wall remains of the north gate, seen from (a) the ground level and (b) the tower area, that served as an example for the recreation of the rampart masonry.

However, considering the presence and height of the inner gate that communicates both compounds, as well as the western connection between the rampart sections, the main compound walls needed to be higher. Conversely, the secondary compound could not surpass the established height, as it was levelled with the probable floor of the second tower or southern structure. Therefore, we posit the idea that the main compound could probably be slightly higher than the second one and connected by stairs or a similar solution that assured an easy transit over the walls (Fig. 16). Still, as the archaeological data is so scarce, other probable workarounds are not discharged, as the rampart could have been homogeneous in height or even present a higher difference between both compounds.

Regarding the width of the rampart, once again the lack of remains hinders our insight. However, there are two points in the eastern side of the secondary compound where the total width of the wall can be ascertained: the northeast corner, near the north gate, and the southeast boulder, where the south gate is carved. In both cases, the total width of the carvings provides a measure of approximately 2.30 m. Therefore, this measure was used to recreate the whole rampant, as a similar width was also recorded in the carvings for the inner gate that communicates the compounds. Only the north side of



(a) (b)

Figure 16: Distribution of (b) the rampart and (a) its gates.

the main compound presents a wider dimension, perhaps related to its use as a surveillance point and tower main access.

Gates and accesses: the archaeological works allowed to identify the entrances of the castle, located to the north and the south of the hill. Each gate presents a different typology, dimensions, and integration in the

rampart. Due to its characteristics, the north gate was probably the main entrance to the castle, while the south gate seems to be the second access or postern. Besides those accesses, on the southern edge of the upper platform, where the tower was built, are the remnants of a third gate, that communicated the main compound with the second one (Fig. 16).

- *North gate*: with 1.50 m wide on its narrowest point and 2.10 m in the widest one, the north entrance was probably the main access to the castle, not only because of its size but also because of the entity of the structure. The archaeological excavations recovered two sections of the lateral walls of the entrance, with three ashlar rows at some points and a fairly stable wide of 1 m. The west wall, the smallest of the preserved sections (2.20 m) would continue to the inner part of the castle, progressively losing width as it approached one of the boulders of the upper platform, leaning against it, tracing a progressive curve, due to some levelled carvings. The wall continues until the stairs cut on the rocky outcrop that allows access to the upper part of the castle. In turn, the east wall preserves a regular width along its 5 m length, which describes a curve or angle, following the orientation of its counterpart. This wall continued north, where some carvings mark the end of the gate and rampart, and to the south, where the ashlars are progressively scanter, due to the loss of terrain volume. Both walls are directly constructed over a rocky outcrop, that gradually ascends to the centre of the secondary compound (Fig. 17a).
- *South gate or postern*: located nearby the southern structure or second tower, the south gate is a narrower entrance, approx.1.30 m wide. Currently, it can be identified through one of its jambs, sculpted in the southeastern boulder of the rampart, as well as the carvings used to bar the bolt and a latch (Fig. 17b).
- *Inner gate:* used to cross from the second compound to the main area of the castle, the only remains of this gate are once again carvings, this time over the rocky outcrop that conforms to the upper platform of the hill (Fig. 17c). The door would have been reinforced by a latch, whose bore is still visible, and probably a bolt. It was 1.10 m wide.

The recreation of the rampart gates followed the photogrammetric models (width) and mean values gathered during the study of other castles (height and shape).

Inner distribution and transit: as stated before, the castle was divided into two different compounds, due to the distribution of the rampart. The access from one area to the other was done through a staircase carved on the rocky outcrop that composes the upper platform of the hill, accessible following the curve traced by the north gate. After the staircase, the inner gate would give access to a narrow roofed space with a pentagonal shape, that leaned against the tower and two sections of the rampart wall. From this structure was possible to access the upper platform and surround the basement of the tower. Both compounds comprise wide and delimited inner spaces, that will be analysed in a specific section, due to their complexity.

The upper part of the rampart would probably be walkable, as it was stated in other cases (López-Felpeto Gómez, 2015; López Hermida, 2009), but its access remains unknown as there are no indicia that lead to a conclusion. However, a suitable point of access could have been the southern structure. Moreover, as stated in the section dedicated to the tower, the northern side of

(a)

(b)

(c)

Figure 17: Remains of the gates located on the rampart: (a) north; (b) south; and (c) inner gate.

the rampart was probably the main point to accede the tower entrance.

Other elements: once again, as in the case of the tower, some aesthetic and defensive elements would have to be part of the structure of the ramparts, but remain unknown, e.g. the crown finals and the voids, whose introduction in the recreation was made following a similar procedure, to give the final product a realistic aspect. However, we are aware that they could have a different appearance and therefore the most basic and common version of those elements was chosen.

- *Crown finals:* a simple levelled wall for the inside and outside of the rampart, with no reinforcements, loopholes, or embattled ends. We decided to use this simplified version of the crown finals as they are the simplest ones and none of the reference rock castles preserves the crown finals.
- *Voids:* analysing other rocky castles, it is common to observe the presence of arrow loops or loopholes in different sections of the rampart. However, there are some points of the defensive walls where those features are not displayed, for example, on the section where the main gate is located, the areas where the walls lean against the outcrops, or on those parts of the rampart where the height or rugged terrain make it unnecessary. Therefore, San Salvador could probably have loopholes on the east section of the rampart, as it is the less defended area and the only one that did not meet the previously mentioned features.

6.3. The southern structure

One of the most complex areas of the castle's hill is the southern area. Composed by various outcrops and boulders, it presents a high number of carvings and cuts, with different shapes and at different heights, not always identifiable at first sight (Fig. 18). Its interpretation was especially complicated, as the representation of the area in the excavation plans hindered a complete vision of the ensemble. Therefore, its recreation and analysis were only possible through the creation of a 3D model, that allowed us to assemble the elements that filled the carvings, sometimes visible only from certain perspectives. This three-dimensional puzzle finally led us to understand the structure that could have been constructed on this part of the hill.

The most common carvings in this area are those levelled to put stone ashlars and beams. The structure would be located on the upper part of the cliff, leaning against three different boulders, whose middle point preserves a ground area. To access this point, there are some cuts that descend to the east –to the southern gate– in the north boulder.

Each of those boulders presents numerous carvings, resulting in a trapezoidal structure with, at least, a ground floor and the main floor –attending to the

Figure 18: Location of the southern structure, where the carvings used as foundations for the walls of the building are still visible.

Figure 19: Structure shape resulting from the carvings located over the southern boulders.

presence of beam carvings– (Fig. 19). Besides, the structure shares space, and carvings, with two different sections of the rampart, being probably united to it. Other similar castles show that it was not uncommon to construct secondary towers on the edges of the ramparts, to assure better surveillance of an area and reinforce the defences. For example, in Narahío, a second tower was built on the edge of the second compound (López-Felpeto Gómez, 2015), directed to the point with the worst visibility of the castle; resembling the disposition and location of the southern structure of San Salvador.

6.3.1. Modelling the southern structure

Masonry: once again there are no remains of walls on this part of the ensemble, but attending to the similarity of the carvings with those identified in other areas of the castle, we can presume that the southern structure could have been built with stone ashlars. Therefore, we propose a similar masonry for this structure to the one used in the main tower.

Height: the east section of the rampart ends on a high boulder, where it was possible to identify carvings for beams, that prolonged over the middle space of the southern structure. The presence of those beams indicates the existence of, at least a first or main floor, different from the ground floor in-between the boulders. Moreover, those beams create an approximately 2 m height space for the ground floor, which assures its usability. The first interpretation of this structure identified it with an open space that communicated the east and west section of the rampart, through a swelled area. But as the structure was modelled, we could observe that the south wall of the building ended in a fourth boulder, higher than the ones that support the rest of the structure. The difference of height hindered the surveillance of the postern area and the southern access to the castle –losing, consequently, the sight of the road and its path from A Limia to the valley–. Therefore, and following the carvings identified in this fourth boulder, we decided to give the structure more height, creating consequently a second tower on the compound.

As stated before, the presence of those secondary towers, connected with the rampart walls, is a common feature of the rocky castles, to reinforce areas of difficult surveillance. Besides, in this case, its presence is consistent, as the south cliff is one of the less defended areas and the most uneven terrain of the surrounding, slightly visible from the main tower. It is associated with the postern and also with a group of carvings, located outside of the compound over the cliff, that could have been part of an outside platform (see below).

Gates and accesses: the middle area of the ground floor of the second tower can be acceded from the postern area, using a group of steps or cuts carved to support stairs. It is not inconsistent to suppose that this ground floor could give access, through some kind of stairs, to the main floor of the tower, that would be probably connected with the rampart, assuring the transit from one section to the other. As a defensive structure, the upper part of the tower would probably be also accessible (Fig. 20).

Other elements: to complete the aesthetic of the second tower, once again some unknown elements were added to complete the ensemble, being still aware that they could be slightly different. As the tower is part of the rampart, we decided to follow the same principles to create the crown finals (simple levelled wall with no reinforcements, loopholes, or embattled ends) and the voids (located only on the south side of the tower, to reinforce the defence of the cliff).

Figure 20: The southern structure and its possible distribution, attending to the carvings recovered over the boulders.

6.4. Inner spaces

The distribution of the rampart divides the hill into two different areas, where the daily life of the castle would have taken place. Each of those spaces presents its own characteristics and therefore a different interpretation (Fig. 21).

Figure 21: Distribution of the spaces inside the rampart.

6.4.1. The main compound

Located on the top of the hill, it comprises the main tower, as well as an open space to the west. Aside from the excavation of the tower and the inner gate, the rest of the compound was never subjected to archaeological works. However, the grubbing works uncovered some carvings on the boulders of this area, all of them probably used to raise the rampart. The only standing structure identified is a wall, related to the inner gate, that would probably be part of a narrow roofed space –established due to the presence of collapsed tiles and a wooden beam that supported the roof -with a pentagonal shape, that leaned against the tower and two sections of the rampart. There are no other indicators of the existence of structures, although it is not possible to discard their existence, as the depth of the original surface of this area is unknown.

Modelling the main compound

Due to the lack of information, we decide to represent this space as an empty yard, similar to the one observed in Narahío. On this castle, the tower is also located on the top of the hill, surrounded by the rampart, creating an open or empty area around the tower's basement.

6.4.2. The second compound

Located on the lower platform of the hill, this area communicates the different spaces and structures of the castle, being accessible from both rampart gates. Representing approximately half of the usable surface of the castle, it was occupied by at least two different buildings: one at the north (Building-A), adjacent to the northern gate, and one to the south (Building-B), below the southern structure. Both structures were identified by the presence of wall remains –with a regular 1 m width and curved or angled path-, as well as soil pavements and roof tiles fragments.

- Building-A: it shares the western wall with the north gate, occupying the space between this structure and the rampart, with a surface of 3.5 m in the narrowest part and 7 m in the widest. However, the whole length of the structure is unknown, as the preserved wall disappears progressively to the south (Fig. 22). The building was roofed and it had a soil pavement.
- Building-B: this structure was identified through the remains of a curved wall, that leans and probably continued on the outcrop where the middle stairs that communicate both compounds were carved; as well as some cuts for beams carved on the boulder that gives access to the southern structure. The space between both boulders presents an almost homogenous width of 7 m. This structure was also roofed and its pavement –again a simple soil floor- was recovered 2 m below the actual surface of the hill (Fig. 23).

Modelling the second compound

- Masonry and roofing: both structures preserve the remains of granite ashlar walls, with similar features to the ones recovered in other areas of the castle. Therefore, it is not inconsistent to posit the idea that they were constructed with a similar masonry as the tower or the rampart.

(a)

(b)

Figure 22: Remains of Building-A, that was partially united to the rampart of the castle. During the excavations, the western wall of the structure (a) and the original paving (b) of the structure were recorded.

- In addition, we recovered the remains of curved roof tiles in both areas, indicating that the structures were roofed. Attending to the location and distribution of the remains, it is highly probable that both structures were covered with a mono-pitch roof, that bent to the west in Building-A and the north in Building-B.

Height and width: as mentioned before, the whole shape and extent of both buildings is unknown, as well as its total height, as no vertical sections were preserved.

- Building-A: after analysing the distribution of both structures, our hypothesis is that the total length of this construction could not be much longer than the preserved area, as it would hinder the transit through the compound. Besides, it is probable that it had a single ground floor, achieving the roof a similar height to Building-B.
- Building-B: the only preserved wall, did not close the structure to the east, being unknown how this part of the building would be closed. Therefore, we posit two different solutions for this space: that the curved wall ended leaning to the rampart, closing the access to the poster or south gate, or that the building had a second wall that closed the space north-south, leaning against the boulder that gives access to the southern structure. In each case, the building had probably two floors and the roof did not surpass the total height of the south boulder, where some carvings for beams and a water channel were identified.

(a)

(b)

Figure 23: Original paving of Building-B (a), located 2 m below the actual surface, and remains of the curved wall (b) that leads against the boulder that separates the compounds.

Gates and accesses: there are not enough indicators to determine where the accesses of those buildings were located, as they were not fully recovered. Following the distribution of the spaces, the preserved remains and structural criteria, Building-A could probably be entered by the south or, perhaps, at the end of the western wall, while Building-B would probably be acceded by the eastern wall.

Inner distribution: the inner distribution of those buildings is unknown, as well as their main function, being perhaps living or storage spaces. The excavations developed in Building-B determined that the lowest floor of the structure was 2 m below the actual surface of the terrain, while its roof was at least 2 m above. Therefore, this building could have had two different heights. Moreover, on the bottom of the survey ditch practised in this area, we found remains of food (animal bones and oyster shells, among others), that could indicate its use as a storage area.

6.5. Other structures and occupied spaces

Besides the above-mentioned remains and structures, a detailed exploration of the hill's boulders and outcrops revealed the presence of other carvings and at least two walls, not related to the towers, ramparts or inner spaces. Those remains, located outside the main enclosure, have a difficult interpretation, due to their isolation, the tough access, the lack of a direct connection with the known structures and the absence of parallels –each rocky castle has its ow distribution, predetermined by the hill's morphology–. However, to achieve a complete study of the ensemble, it seems necessary to indicate at least their existence and location.

6.5.1. Outer platform

On the south side of the hill, behind the Southern structure, the castle platform ends on a rugged cliff with numerous outcrops and boulders. The highest of them, where part of the second tower was built, shows two slightly eroded carvings on the outermost side, that probably were used to place wooden beams in a roughly 45º disposition; as well as two thin cuts with 1 m length and unknown use. Besides, about 3.5 m below, there is a second boulder with four square imprints and some cuts, that could suggest the presence of wooden pillars and more beams.

Despite following the carvings and recreating all those elements on the 3D photogrammetric model (Fig. 24), the data we can draw from them is not enough to state the structure that could have been placed on this part of the hill. Some information or structural elements seem to fail. However, attending to their distribution, we posit the idea that perhaps all those carvings were used to support a wooden platform. However, the function of this platform remains unknown: it could have been part of the former structures located on the hill –in the 8th-10th century–, a provisional structure used to construct the second tower or even an outside advanced surveillance point.

Figure 24: Possible filling of the carvings recorded in the southern cliff.

6.5.2. Southern cliff walls

Below the outer platform, the disposition of the outcrops and boulders of the cliff creates a natural cavity or rocky shelter, accessible from the south gate or postern. This inner space communicates the east side of the cliff with the western slope, where the cavity abruptly ends, about 4 m below the actual ground of the castle. On the western side of the cavity, a few meters before the slope, we found the remains of a wall foundation, that closes the space (Fig. 25). The presence of this structure posits the idea that this space was known and

probably used during the castle's dwell. However, its function is unknown as no other remains were preserved.

Figure 25: Remains of the wall foundations recovered under the southern cliff.

6.5.3. Western terrace

On the western side of the first compound, outside of the rampart wall, we can find a small but levelled terrace, with easy access from the tower's yard. Although the first idea was that the rampart could have been built over this space, the narrowness of the terrace and the abrupt end of its northern side, as well as the presence of numerous carvings with a continuous distribution on the peripheral boulders of the first compound, lead us to move the rampart path to the upper platform of the hill. Moreover, despite identifying some carvings and the presence of an ashlar wall –constructed between two boulders, closing the terrace to the south- the remains of this area have not enough entity to support a huge structure as a defensive wall and their distribution is too haphazard to state its function. However, there are enough remains to assert that the terrace was occupied or in use during the castle's dwell (Fig. 26).

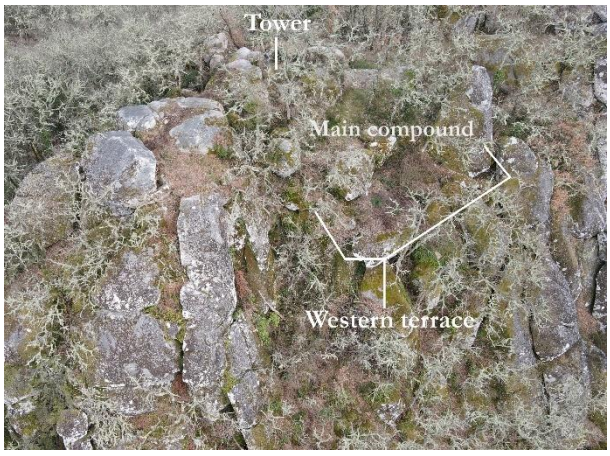


Figure 26: Location of the western terrace and its relation with the main compound and the tower.

6.5.4. Northern platform

Unlike the southern side of the hill, the castle did not end to the north on the edge of the promontory. Beyond the main compound, we can find a non-levelled rocky platform, composed of outcrops and boulders, with a circulating area in the middle. Again, unlike the previously noted areas, this platform did not present any kind of structures or carvings that could indicate some type of functionality (Fig. 27). However, aside from the tower, it is the point of the castle with major and wider visibility over the valley of the Arnoia river and the village of Allariz, as well as the most visible point from the outside. Therefore, it could have been used as a surveillance point or even to place some defensive or alert systems, for example a beacon (Muñoz Clares, 2003; Valdecantos, 1996).

Figure 27: Northern platform viewed from the east.

7. Results

So far, each part of the castle and the reasoning of their final modelling have been described singularly. However, as part of an ensemble, those structures can only be correctly understood once they are assembled. Moreover, during the modelling works of each structure, there was a constant need to display and observe other parts of the castle, as a guide to comprehend their distribution and architectonical logic. Changes, for example, on the height of a doorframe implied recalculating the height of the rampart and therefore, ascertain the consequences of those changes in other structures (Demetrescu, 2018; Mascio et al., 2016).

The main aim of the project was to reconstruct the castle as a whole, drawing in the process the information provided by each structure. Once combined and displayed all together, it results in a new and more accurate constructive hypothesis, that corrects some initial misconceptions –mostly architectonical inaccuracies- and fills information gaps that were not visible at the beginning of the project (Aparicio Resco et al, 2021). However, it must be stated that in general the results obtained from the castle's reconstruction match considerably with our initial hypothesis.

To summarize, San Salvador de Todea was a polygonal rocky castle, surrounded in all its perimeter by an almost homogenous rampart. It was divided into two different compounds, located at different heights and communicated by a reinforced gate. The castle could be acceded from the north, through the main gate, or from the south, through a second gate or postern. Both lead to an open yard, where at least two different buildings gave service to the inhabitants of the castle. This lower compound provided also access to other areas of the castle, being probably the space where the daily life would have taken place.

The upper or main compound comprised the main tower of the ensemble, as well as an annexed and probable open space. The access to the main compound was reinforced by a narrow and roofed structure built between the southern face of the tower and the inner section of the rampart. From the second or lower compound, there was also access to the structure located over the southern cliff, probably a second tower, that assured the surveillance of the southern area of the hill.

Moreover, the assembling of the final model and its integration in its real environment through the Blender GIS *Add-on* allowed us to answer the initial questions about the castle and its configuration.

- *Shape and construction.* The castle, as stated before, was constructed in a polygonal shape, adapting to the morphology and form of the hill, a common feature in this type of construction. The walls foundations of the different structures were built directly over the rocky outcrops or the natural sediment. In those cases where the outcrops or boulders hindered the path of those walls, they were carved to create plain and stepped surfaces. The ashlars, as seen in Narahío and Nogueirosa, would be adapted to the shape of those boulders, filling all the gaps, embracing them.
- *Inner distribution.* The castle was acceded by the north gate or the southern postern, through steep slopes, arriving in both cases to the lower compound. Here, the distribution of Building-A and Building-B would create a central transit area, that gave access to the southern structure and the main compound; communicating also both gates. Moreover, the rampart would probably be walkable and viable access to the upper part was through the southern structure. On the other hand, the tower was probably acceded from the northern side of the rampart, instead of from the main compound yard.
- *Building features*. The tower would probably present a height between 8 and 10 m (Fig. 28), divided into a basement and at least two different floors. Despite this height, the inner space of the building is rather narrow and the presence of other buildings in the lower compound let us posit the idea that it was not the only living area of the ensemble.
- *Interpretation of some carvings patterns*. The reconstruction of the southern area of the castle, lead to the hypothesis of a second tower, attached to the rampart. There is no doubt that this space was occupied by a structure, whose carvings are still visible. Nonetheless, the analysis of those features lead us to the theory that it could have been a second or minor tower, that would help to survey this area. Moreover, taking into account the step-like carvings located in the lowest boulder, that indicate the existence of a staircase, this structure could have been the access to the upper part of the rampart.
- *The rampart configuration.* The rampart surrounded the whole perimeter of the hill, even those areas where this type of defence was not really necessary –for example, the western cliff–. As mentioned before, its construction combined walls with ground foundations with carved boulders and outcrops, that would be visible in some sections of the walls. These boulders served sometimes as assemble points for different parts of the rampart. Furthermore, following the carvings and analysing some parallels, the walls would probably prevail an angular design to reinforcing the stability. Moreover, after finishing the castles reconstruction, we posit that the rampart was not homogeneous in height, being probably the one that surrounds the main compound slightly higher than the one that surrounds the second one.
- *Visibility*. After integrating the final model in its real landscape, through the GIS *Add-on*, it was evident that the castle, with its 8 to 10 m tower and rampart, would have been more prominent, even though the abundant grove that surrounds the hill. Moreover, with the newly acquired data about the heights of the ensemble, it will be possible to create new predictive and visibility maps to know the real extent of the castle's visibility (Fig. 28). On the other hand, the confirmation of the existence of a second or minor tower to the south covered the only known blind spot of the main tower, providing the castle with a 360º visual control.

Figure 28: View of the castle reconstruction from the south-west, displaying the high visibility of the hill and therefore the structure over the north valley and the eastern area.

8. Discussion

From the beginning, the aim of the reconstruction project was not to create an aesthetic dissemination product, but to create a scientific tool to work with. A model based on archaeological evidence and on historical parallels, useful to understand and contextualize the already known data. Therefore, once the modelling process and its reasoning were displayed, it is highly important to show clearly the level of accuracy of each part of the reconstructed castle. Previous works (Addison, 2001; Manžuch, 2017) have already discussed the ethical issues behind reconstruction works and the necessity of attesting the veracity of each recreated section to doesn't mislead the viewer.

Therefore, following the *International Principles of Virtual Archaeology* stated in Seville (ICOMOS, 2017), other authors have already proposed viable historic-archaeological evidence scales. For example, the Extended Matrix of Demetrescu (2018), the certainty maps of Verdiani (2017) or the evidence scale of Aparicio Resco & Figueiredo (2016). All these graphic representations follow the stratigraphic principles, dividing the different sections of the models regarding their accuracy or information sources, represented in a diverse colour range. However, they differ in the categories that should be displayed, some of them

providing a high range of levels and others proposing a simpler classification.

To display the level of certainty of our model, we decided to use the evidence scale proposed by Aparicio Resco & Figueiredo (2016). Their classification goes from 1 (less accurate) to 10 (highly accurate), in a progressive colour range, that depends, primarily, on the type of remains or sources used to reconstruct each part.

As shown in the image (Fig. 29), the castle was reconstructed following primarily existing remains preserved partially in their original position [pink], like walls and carvings; archaeological evidence, using plans and photographs [beige and yellow], that allowed to link the different sections of the castle; and conjectures based in similar structures [dark blue], adding some other elements based approximately in the historical and natural context [purple]. The scarcity of the remains, as well as the lack of external documental or graphic sources, result in a reconstruction where conjectures based on historical parallels have a lot of weight. The base plan of the castle, its shape and distribution are the most accurate parts of the reconstruction, as we preserve enough remains or indicators to understand how they were [yellow-beige-pink]. Conversely, the higher we ascend from the base of the hill and farther we go from the boulders, the less truthful becomes the model [purple-dark blue], as no vertical sections were preserved.

However, this circumstance does not decrease the veracity of the model, as each element that composes it was integrated after detailed research and analysis. Each rocky castle is different, but they present similar features, thereby we are aware that the reconstruction of San Salvador could probably differ in some details from the original construction, but it poses a logical and scientific-based hypothesis of how it could have looked like.

Virtual reconstructions are an accessible and affordable tool that, in the last years, have helped to increase the knowledge and understanding of lost or damaged heritage. A way to approach not only the remains to the community, but also to the investigators and researchers, prompting new discussions and the creation of multidisciplinary groups. However, as many other authors stated before, the modelling of heritage has to be done following a strict methodology based on a scientific base, bearing in mind that this is the only suitable way to create a valid representation of our past (Addison, 2001; Aparicio Resco & Figueiredo, 2016; Demetrescu, 2018; Demetrescu et al., 2016; Manžuch, 2017; Verdiani, 2017). We cannot dismiss the ethical duty that should lead every research project, not letting the visual and aesthetical part of the reconstructions impose over the veracity. Virtual reconstruction is, basically, a virtual restoration process and, although it did not modify the real object, it should follow the same principles. In turn, virtual modelling offers a new range of possibilities, as the representation must not be restricted to a unique solution, being possible to represent a wide range of variants, all of them based on historical-archaeological sources and equally valid.

Finally, although the aesthetic of the reconstruction is not always its main aim, it cannot be disregarded. Correct use of textures, landscape representations, shadows and lights is as helpful as the own model to comprehend it as a whole and as part of a wider space. The reconstruction, in this case, is not only a tower surrounded by a rampart and a few more structures. It is a rock castle, located on the top of the hill, dominating the valley of the Arnoia river and the village of Allariz. A defensive feature, that had a specific function during the 12th-15th century and whose general aspect was subdued to this specific use. Therefore, the castle is more understandable through its its real landscape representation, with a realistic range of textures.

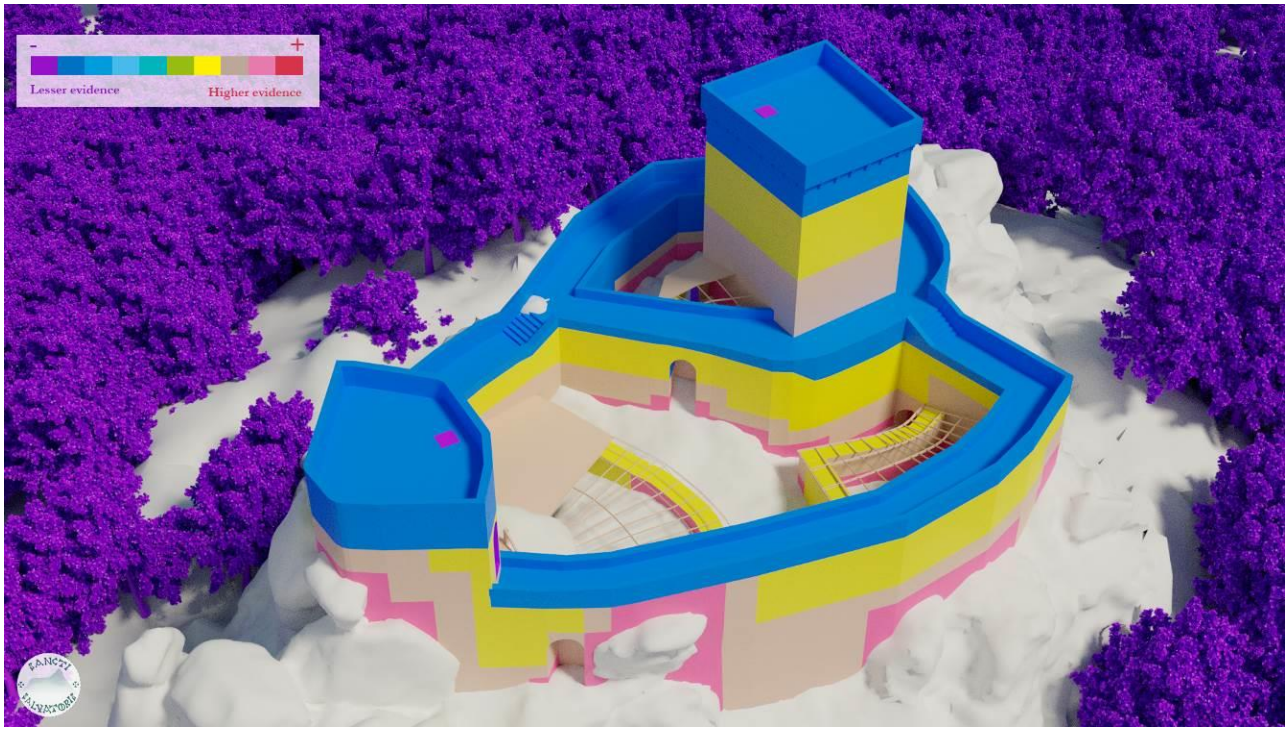


Figure 29: Evidence scale of each part of the reconstruction, following the evidence scale of Aparicio Resco & Figueiredo (2016).

9. Conclusions

The reconstruction of San Salvador de Todea' castle met the aims proposed at the beginning of the recreation project. Through intense research and analysis, not only of its structure but also of other similar fortresses, we achieved a better knowledge of the castle and its historical context, answering some of the questions raised during its excavation. The castle, barely perceptible on the surface of the hill and hardly understandable, is now virtually visible (Fig. 30). Moreover, the research works developed to obtain the information that lead to the reconstruction, have resulted in a new approach to the remains, prompting the discussion about possible solutions and increasing the knowledge of the site.

Certainly, virtual reconstruction is a valid method to approach lost heritage, helping to understand, analyse and study the remains. It allows also to gather accurate data, that permit the development of parallel projects, as territory studies based on visibility or accessibility. Remembering always that the reconstruction should be based on historical and archaeological pieces of evidence and bearing in mind that the recreation can differ from reality. Moreover, sharing not only the results but also the process of modelling and decision making can help other researchers to solve problems, once they have to face a reconstruction process. Not only the final models are important, but also the way they were achieved, prompting the discussion, to increase the scientific quality of the representation and allowing to reuse the available records and methods (Demetrescu, 2018; Verdiani, 2017).

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Figure 30: Virtual reconstruction of the castle, viewed from the village of San Salvador at sunset.

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