

## Pinnettas de pedra: a guide for the valorisation of dry-stone artifacts

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### Abstract

*The dwelling culture in rural Sardinia presents a wide variety of agropastoral construction. One such example still in use today are the "pinnettas de pedra", huts built entirely of drystone walls and lithic corbelled dome, with a technique common across the Mediterranean area. They are located to the north-west and centre of the island, in the areas of Meilogu, Marghine and Planargia. The analysis was based on cataloguing the artefacts: field research and data processing on a GIS platform identified around 500 pinnettas de pedra in the surveyed area. The work resulted in survey cards detailing the state of these buildings: their characteristics in terms of size and materials and the main factors of degradation and structural failure. The cards describe in detail the masonry, the lithic elements and their arrangement, as well as the construction techniques and the structural concept behind the realisation. Our line of investigation brings to light construction methods that stood the test of time. This construction code, an orally transmitted set of established rules defining the art of building, is a valuable heritage of local technical knowledge. An immaterial resource to study and preserve and pass on to future generations. The research aims to deepen and develop the knowledge needed for the conservation of such buildings by compiling a manual of good practices of intervention that respects the characteristics of the material and construction. The broader goal of promoting the pinnettas de pedra is to promote proper care of the land, reduce the factors of risk and degradation, set the standards for safe fruition for local communities and visitors, thus restoring the bond with these places.*

**Keywords:** dry stone masonry; corbelled dome; Sardinian landscape.

### 1. Introduction

The area involved in this research is located in the north-west and centre of Sardinia, in the three historical subregions of the Logudoro: Meilogu, Villanova and Marghine<sup>1</sup>. A vast area where the *pinnettas de pedra*, constructions employed for agropastoral activities, can still be identified and are still in use. The geological varieties and prevalent environments define the three historical provinces and the

borders with other territories<sup>2</sup>. In Meilogu and Villanova, volcanic remains in the shape of craters and domes – legacy of a now stable volcanic phenomenon – are interspersed with islands and basements in Miocene limestone. Conversely, the area of Marghine shows a prevalence of plateau basalt, with peculiar lithofacies insertions. These territories share the same lithological variety and agropastoral tradition.

<sup>1</sup> The range spans 29 municipalities, covering an expanse of 1.376,6 km<sup>2</sup>.

<sup>2</sup> Examples of stone-covered huts in basalt, with other concentrations, can also be identified in the neighboring historic

provinces of Planargia, to the west, and Barigadu, to the south, where investigations are underway.

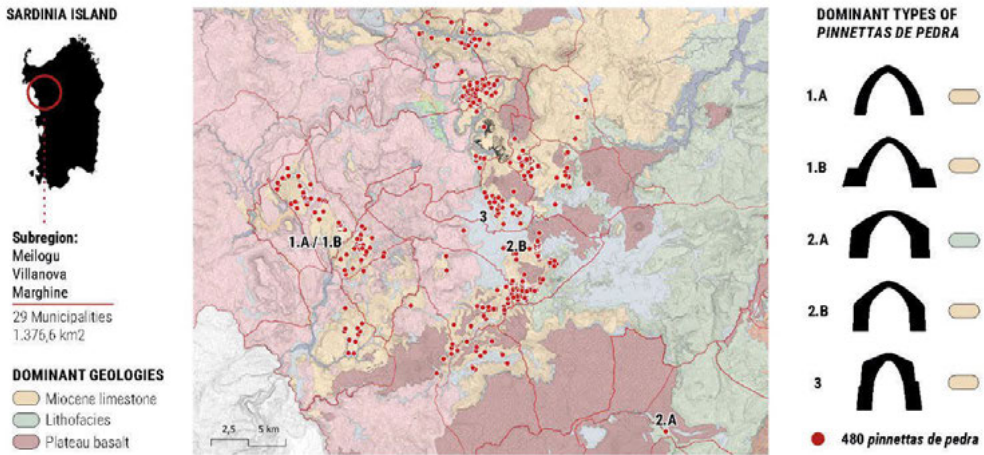


Fig. 1. Territorial framework of Meilogu, Villanova and Marghine. (Source: Cappai & Sotgiu, 2021).

Built entirely of local stone, the construction of the *pinnettas* follows construction concepts and structures originated in the Nuragic Civilisation<sup>3</sup>: a local construction code that stood the test of time and is a valuable resource to learn and preserve.

In the context of rural homes in Sardinia, this type of construction stands out for the peculiarity of the corbelled dome. Indeed, the areas surveyed have lithic slabs (*sas pedras ladas* in the local language) as a primary resource immediately available on site; that allows for the assembly of the dome.

The various types of *pinnettas de pedra* found throughout the island belong to “*rural architecture of historical or ethnoanthropological interest as heritage of the traditional rural economy*”<sup>4</sup> according to the Codice dei Beni Culturali e del Paesaggio (Law on Cultural Heritage and Landscape). The Piano Paesaggistico Regionale (Regional Landscape Plan) of Sardinia<sup>5</sup> identifies them as heritage assets, because they constitute

elements and networks of connection, as well as artifacts of the historical and cultural landscape.

The *pinnettas de pedra* represent the agropastoral culture active until the 1970s. Although some are still in use, nowadays they are gradually being abandoned. That reflects a mental detachment from a culture rooted in the land and a physical departure from places that were once bustling with activity and people, whose significance seems to have disappeared.

## 2. The pinnettas de pedra: a spread rural heritage

### 2.1 Survey of the area and processing of data on a GIS platform

The first assessment phase is the direct field survey. It is backed by written and oral sources, linked to the memory and stories by the local people involved in the data collection. During the study phase, the information acquired is verified, to identify the *pinnettas de pedra* and assess the accessibility along the ancient rural roads.

<sup>3</sup> The majestic Nuragic monuments, visible across Sardinia, constitute an exhaustive model of architecture and construction with dry stone masonry, thanks to the technical solutions adopted to build complex and imposing mural facings and domes following the principle of the progressive overhang of blocks. The reconstruction hypothesis of Nuragic huts, formed through archaeological excavations, presents the

same dimensions and construction characteristics as the current *pinnettas de pedra*. Cappai S. N., Marras G., (2007)

<sup>4</sup> Codice dei Beni Culturali e del Paesaggio (Decreto legislativo 22 gennaio 2004, n. 42; art. 10, comma 4 l;

<sup>5</sup> Piano Paesaggistico Regionale, Legge Regionale 25 Novembre 2004, n°5, Norme Tecniche di Attuazione, p.43/88, Art. 54 -

Tools such as QGIS software – geographic information system – as well as the Google Earth satellite platform and the regional geological map have helped identify every single *pinnetta de pedra* and their location, highlighting the areas with the greatest concentration of artefacts<sup>6</sup>. A land map showing the distribution of these constructions in relation to the hydrogeological characteristics and permeability routes of the area has been created.

Over time and up to the present day, such buildings have been destined for agropastoral activity. However, some examples served a community and religious function, like the four *pinnettas* around the Sanctuary of Santa Maria de Saucchu, on the Marghine mountain range.

This survey method has allowed us to identify 480 *pinnettas de pedra*, a significant number that speaks to the current state of the census. The preservation state of such artefacts varies according to the location and use of the land where they stand, highlighting the scattering of such rural heritage. The Landscape Plan of the Region of Sardinia identifies the isolated distribution in the countryside of the *pinnettas* as representative of the building culture of people engaged in working the land.

## 2.2 The *pinnettas de pedra*: morphology and construction

The *pinnettas* are single-room constructions, mostly individual, and only in a few rare cases grouped together. They are spread across the area according to the availability of resources functional to agropastoral production activities. The morphological-volumetric scheme features truncated cone-shaped walls, with an average diameter of 5.50 m at the base, defined by the inclination of the wall facing, above which a roof structure of an average height of 3.50 m is set. The circular chamber, with an average diameter of 3.5 m, is vaulted with a progressive overhang of lithic slabs, placed at an outward angle and reaching an average height of 3.30 m at the apex of the vault. The

masonry structure of the main body has an average height of 1.50 m on the outside and is built of local stones of irregular shape and dry set. The construction rules dictate a double-wall facing made of stone elements: its long side integrates into the masonry parallel to the wall surface (the courses), with transversal binding elements between the two faces (diatons and semidiatons).

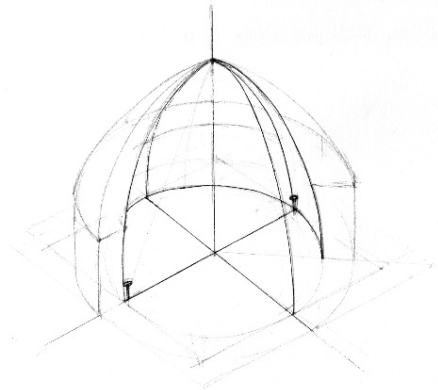


Fig 2. Axonometric representation of the hypothetical constructive method (Source: Cappai, 2021).

The long side of these stones crosses the wall section for at least 2/3 of its thickness, and they are known as "living stones" because they perform the function of making the two facings joint and interlocked, thus making them stable. During the construction of the wall, which is laid in horizontal planes, the stones are lined with earth mortar and the layer is completed with filler stones positioned to cover the voids between the two coats. Thus, the stability is determined by the masonry engagement represented by the blocks alternated with the binding and filling elements, placed according to the staggered joints and braced with stone chips.

The inner chamber is a circular space of 9-10 square metres, covered by a vault formed by a progressive overhang of lithic slabs that follows a distinctly curvilinear intrados profile from the base to the apex.

<sup>6</sup> The macro areas are defined in Fig. 1.

T	SECTION	IMAGE	DIMENSION		CHARACTERISTICS OF THE WALL AND OF THE CORBELLED DOME
			BASE (m)	HIGH (m)	
1.A			BASE (m)	HIGH (m)	Base masonry with a circular layout, made of laminar-shaped limestone troughs, placed flat, juxtaposed and inter locked with each other, with leveling courses placed at irregular intervals, laid with earth mortar according to occasional courses and re-filling of the voids with flakes. External volume of coverage made of lithic slabs inclined to follow a curvature of the extrados from the ogival profile. Internal dome built with a progressive projecting of the lithic slabs. The tax of the intrados curvature of the vault starts from the base level; at the lintel line, the curvature is more pending due to the outward inclination of the lithic slabs.
			4.90	3.35	
1.B			BASE (m)	HIGH (m)	Base masonry with a circular layout, made of laminar-shaped limestone troughs. The presence of a perimeter wall body built in successive phases to the pre-existing structure is noted, with the function of stabilizing the construction. External volume of coverage made of lithic slabs inclined to follow a curvature of the extrados from the ogival profile. Internal dome built with a progressive projecting of the lithic slabs. The tax of the intrados curvature of the vault starts from the base level; at the lintel line, the curvature is more pending due to the outward inclination of the lithic slabs.
			3.30	2.90	
2.A			BASE (m)	HIGH (m)	Base masonry with a circular layout, made of roughly hewn basalt blocks and basalt blocks, laid with earth mortar according to occasional courses and replenishing the voids with flakes. External covering volume made of compacted earth. The curvature of the extrados follows a low profile. Internal dome built with a progressive projecting of the lithic slabs. The tax of the intrados curvature of the vault starts from the base level; at the lintel line, the curvature is more pending due to the change of lithic elements, from blocks to lithic slabs inclined towards the outside.
			5.90	3.15	
2.B			BASE (m)	HIGH (m)	Base masonry with a circular layout, made of calcarenite boulders of different sizes, roughly hewn, laid with earth mortar according to occasional courses and replenishing the voids with flakes. Conical-shaped external volume of coverage, covered with inclined lithic slabs. Internal dome built with a progressive projecting of the lithic slabs. The tax of the intrados curvature of the vault starts from about 1.00 m from the base level in correspondence with the line of the architrave; the curvature is more pending due to the change of lithic elements, from blocks to stone slabs inclined towards the outside.
			4.00	3.50	
3			BASE (m)	HIGH (m)	Base masonry with a circular layout, made of calcarenite troughs of different sizes, roughly hewn, laid with earth mortar according to occasional courses and replenishing the voids with flakes. External coverage volume. Internal dome built with a progressive projecting of the lithic slabs.
			4.90	3.35	
			WALL THICKNESS		
			BASE (m)		
			0.90		

Fig. 3. Types of pinnettas de pedra. (Fig. Cappai & Sotgiu, 2021).

The volume is determined by the rotation around the main axis of the curvature of the intrados, which is described as an arc of a circle with a radius equal in size to the base diameter of the chamber. The apex of the vault coincides with the point of intersection of the two equally sized arcs of a circle.

Linking the intrados profile to a geometric construction<sup>7</sup> helps understand the construction methods employed for this seemingly simple structure. In particular, it helps identify the type of curvature of the intrados of the vault. This curve, far from being accidental, is, in effect, the reference system for the correct laying of the stone slabs and defines the size of the overhang that each slab must have in relation to the one below. There is a close correspondence between construction method and geometric rule. A hypothetical implementation method may be as follows: having obtained the circumference at the

base of the chamber and having identified the diameter as a segment of known size, a stake is placed at the far end of the segment, point A; then, a rope with an extension the same size as the diameter is tied to the stake. A fixed point and a free end generate a curve capable of reaching and intersecting the vertical line of the pole placed vertically in the centre of the diameter. The same procedure is employed at the opposite end, at point B, the centre of the curvature mirroring the first. This simple construction method, applied to a building that follows horizontal construction plans, makes it possible to control the different projections of the stone slabs in each row; this method creates a self-supporting structure that does not require centring during construction. The *pinnettas* surveyed in the area in question share a common morphological pattern, with variations in form that result from the different masonry devices employed because of the

<sup>7</sup> For the geometric procedure, see the construction of the equilateral triangle given one side AB.

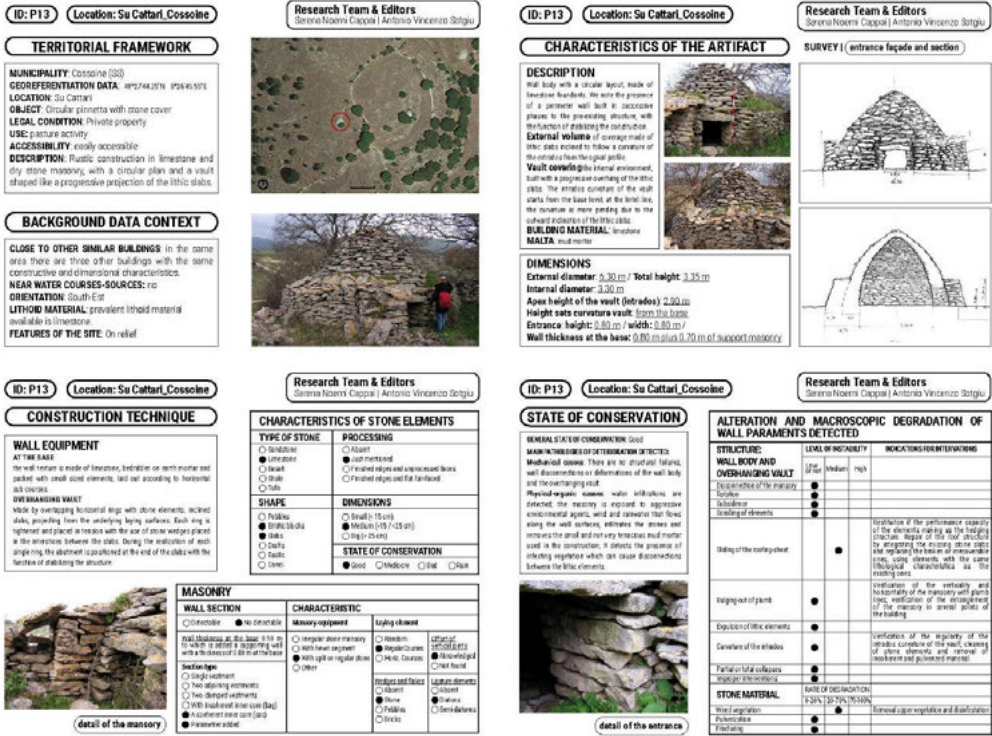


Fig. 4. Model of survey card. (Cappai & Sotgiu, 2021).

variety of lithology used for the construction. One of the construction features, useful to characterise the three models identified, is the reading of the external volume of the building, defined by the link between the basic wall structure and the roof structure and, in particular, by the laying of the stone elements: horizontal for the wall structure, sloping for the roof structure. The first type comprises the *pinnettas* whose external volume comprises a continuous uninterrupted line between the base wall and the roof, an ogive-shaped volume made of laminar stone slabs, laid flat in the base wall and sloped as the building rises. On the inside, the intrados of the vault has a curve starting at the base level and increasing in gradient at the lintel line. The laying of the stone slabs shows a common inclination plane between the inside and the outside: the plane follows the course of the two curves of the intrados and extrados and serves to remove rainwater. A variant of this model envisages the addition of a perimeter wall built at a later stage to the pre-existing structure, with the function of stabilising the

construction. The second type found appears to have in its external volume a broken line determined by the slight slope of the base wall onto which the conical or low-profile roofline is inserted. The circular wall body is made of basalt or calcarenite stones, roughly hewn, set with earth mortar according to occasional courses, the empty spaces being filled with chips. The third type identified is characterised by a new formal feature: the superimposition of two truncated cone-shaped walls, above which the lower profile of the roof structure is inserted.

### 3. The survey method adopted

#### 3.1 The survey cards of the state of the art and preservation of the dry-stone artefacts

The analysis is based on a survey method that provides the preliminary assessment and evaluation of the physical substance of the artefacts. A survey card compiled directly on-site summarises the essential data of the construction



through a direct and photographic survey featuring notes of the observations relating to the state of conservation and identifying the main factors of degradation and structural instability.

The study themes for the different levels of cognitive detail are included in the card's layout. The identification of the construction contains useful information about its geographical location, with a description of the environmental context and accessibility conditions. The card describing the artefact's characteristics details the construction features: the size and material; the analysis of the masonry, the stone elements that constitute it and their setting; the construction technique and its underlying structural concepts. The survey phase, recording the state of preservation, makes it possible to identify the phenomena of degradation and instability that have the greatest impact on the construction. Based on the findings, it is possible to identify the pathologies of degradation and instability in two distinct areas: pathologies inherent to the construction and pathologies induced by human activities and environmental conditions. The first category includes the causes resulting from an incorrect laying of the stone elements, whereby the masonry components are not interlocked properly, and the connection between the structure of the base wall and the roof structure is not solid.

In summary, the effects found to stem from mechanical causes are: through-wall cracks, disconnections of lithic elements, deformations of the masonry such as "bulging" and out of plumb, total and partial collapses of the corbelled dome and portions of the masonry body. The causes resulting from the lack of care and maintenance include physical and organic degradation pathologies due to invasive vegetation altering the wall and roof connections. Incorrect anthropic interventions deserve to be mentioned among the causes of degradation detected; they include alterations, such as replacing masonry parts with concrete blocks or additions in reinforced concrete. Neglect and abandonment,

mirroring a lack of care for the land, decrease the chances of recovering these buildings, inevitably destined to collapse.

### **3.2 The digital manual: a tool to communicate the learning process and prepare interventions**

Upon completion, the survey incorporates activities to communicate the data acquired, making the information accessible at different levels of understanding of the artefact and the geographical area in question. A database was set up using the cards that contain the entire study process. The visual structure of the cards and analytical process is based on an operational approach that follows a flow chart and leads to the programming of digital applications. Upon this basis, the idea emerged to convert the information into an interactive experience for users, fostering communication without limiting or undermining the study process.

Thus, the learning path developed according to this survey becomes a digital manual, for both fieldwork and study; a useful tool to understand the context, to categorise and guide interventions. It is a good practice guide<sup>8</sup> that can lead the end user on a learning path through the digital medium and back to direct study on the ground. The prototype of the digital handbook is an application for portable devices (mobile phones, tablets, notebooks) with an interface designed to be appropriately accessible to the user. This tool, both as an atlas of the dry-stone artefacts already surveyed and as an intervention guide for recovery, is intended for public administrations and bodies responsible for the protection of historical buildings and the landscape, as a support for the design phase of recovery plans and for specific work of restoration and stabilisation. Further simplified versions of the digital manual provide a learning tool for a wide audience of local history enthusiasts, who work in the area, look after it and live and operate in it daily. As an addition to the research already undertaken, this tool supports all the activities of the architectural survey in situ: it allows geolocalisation on the map,

<sup>8</sup>Examples of executable interventions are visible in the Fig. 4, in the "state of conservation" section.

audio and video recording for quick notes, acquisition of images and texts and data storage in the internal memory. A tool that acts as a support for both study work and direct surveys in the field.

Understanding and intervening appropriately on the *pinnettas de pedra* provides the tools to work on all minor dry-stone artefacts (boundary walls and fences, terraces, dwellings and other rural shelters) where it is necessary to intervene locally in order to curb soil erosion and prevent hydrogeological risk, to make the ancient paths accessible and thus enjoy the natural resources. Only preserving and protecting the land makes it possible to envisage short- and long-term development scenarios.

#### 4. Conclusions

The present research retraces the learning experience conducted on the *pinnettas de pedra* and transforms it, as mentioned, into a guiding tool for study, planning, surveying and archiving; a tool that leads to further phases of conservation and fruition, along the path of development.

Although in the past the transmission of building knowledge happened orally and through the act of doing, today such process happens through the digital medium as a dominant and accessible language. This research does not intend to attribute a dominant role to digital tools in transmitting the knowledge and enhancing the appreciation of drystone masonry; it instead acknowledges their usefulness as a support tool.

For this reason, the manual is an integrated part of a process of appreciation of the *pinnettas de pedra*, which must necessarily include a system of experiences and projects aimed at increasing the knowledge, conservation, use and communication of dry-stone architecture. Since 2015, several theoretical and practical discussions on the subject have taken place: school workshops, research opportunities and cultural gatherings in the area. Recently, an audio-visual documentary, recorded between October 2020 and September 2021, was produced as a tool to communicate and interact with local communities.

The project to enhance the significance of these constructions is closely tied to the accessibility and practicability of these areas, often hampered by neglect and lack of maintenance. The aim is to encourage local authorities to undertake maintenance work in the area and implement initiatives to enhance the landscape and make it safely accessible.

On the other hand, we rely on the active participation of those who live in those areas to recognise the value of dry-stone masonry constructions as heritage assets that are part of the future landscape in the making.

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