

Article

Construction Tools in the Pre-Hispanic Andes: A Review from the Perspective of Architecture and Material Culture [†]

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Abstract

This article examines the extent to which it is possible to reconstruct part of the technical knowledge employed in pre-Hispanic Andean constructions. Drawing on chronicles, colonial representations, linguistic studies, ethnography and direct architectural analysis, it demonstrates that Andean societies possessed specialised trades and a wider repertoire of tools than is commonly recognised. A central finding is the identification of gaveras—wooden moulds for making adobe bricks—whose recognition here shows that carpentry techniques were more developed than has been assumed. The poor documentation of these objects—several of them miscatalogued in Peruvian museums—has reinforced the mistaken assumption that complex construction tools were not used in ancient Peru. The study combines three approaches: direct observation of the built fabric (marks, imprints and textures that reveal construction processes), review of the Quechua vocabulary associated with tools and trades—drawn from three sixteenth- and seventeenth-century dictionaries consulted in the Langas repository of the CNRS—and comparison with current practices in Andean communities. This is complemented by a comparison with records from other cultures and a systematic search of the database of the Ministry of Culture of Peru, where plumb bobs, floats, shovels, axes, chisels and other instruments rarely analysed from a constructive perspective were located. Taken together, the article demonstrates that pre-Hispanic architecture was neither intuitive nor improvised, but the outcome of a technical tradition carried out by specialists, tools that are little known today, and construction methods based on measurement, alignment control, mortar transfer and careful surface finishing.

Keywords: ancient tools; pre-Hispanic architecture; Inca period; Quechua lexicon; gaveras; archaeology of construction



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1. Introduction

Construction practices in ancient Peru have been the subject of numerous studies [1–12]. These range from the accounts of foreign travellers who documented the ancient buildings they encountered along their journeys [13], to specialist publications that have explored urban, spatial, structural stability and seismic resistance aspects, among other topics of interest [5].

However, the absence of writing capable of preserving oral and practical traditions meant that a significant body of knowledge about ancient Peru was irretrievably lost, including that related to construction activity. Nevertheless, techniques such as *quincha*¹ and adobe masonry survived, driven by colonial demand for a trained workforce. The Andean state possessed a large and well-trained number of stonemasons and experts in earthwork. As Rostworowski suggests [14], the specialisation of Andean men in particular activities during the *Tahuantinsuyo*² allowed the Spanish to draw on a workforce that could be put to use.

The cultural overlap between Spaniards and Incas not only preserved knowledge but also led to the loss of certain traditions of the ancient Peruvians. This is the case of the *tapial*, which displaced the native technique—whose original name no longer survives—that had been widespread along the coast in the late pre-Hispanic period. This substitution entailed the loss of the associated intangible values, such as the use of procedures and tools from that period, about which very little research has been conducted [15,16]. A concrete example of this lost intangible value is precisely the Quechua technical vocabulary associated with tools and construction processes, the partial recovery of which is one of the aims of this study. The same did not occur with *quincha*, which adapted well to the new constructive needs of the Spanish in Lima and was employed effectively for its seismic-resistant properties, particularly after the earthquake of 1746 [17].

The available written information is scarce: the chronicles of the conquistadors constitute a fundamental source, albeit of limited reliability. Other sources derive from artistic representations such as ceramics, through which architectural forms were depicted [18]. Some references were gathered by travellers such as Wiener during his journey through Peru (Figure 1) [13], although the authenticity of his images may be questioned given the difficulty of interpreting Mochica iconography at the time [19]. Perhaps the only reliable graphic reference to construction work is that offered by Guamán Poma—a seventeenth-century indigenous chronicler whose work *Nueva corónica y buen gobierno* constitutes one of the most complete visual testimonies of Andean colonial life—in the scene entitled: AMOJONADORES DESTE REINO, VNA CAVCHO INGA, CONA RAQVI INGA.

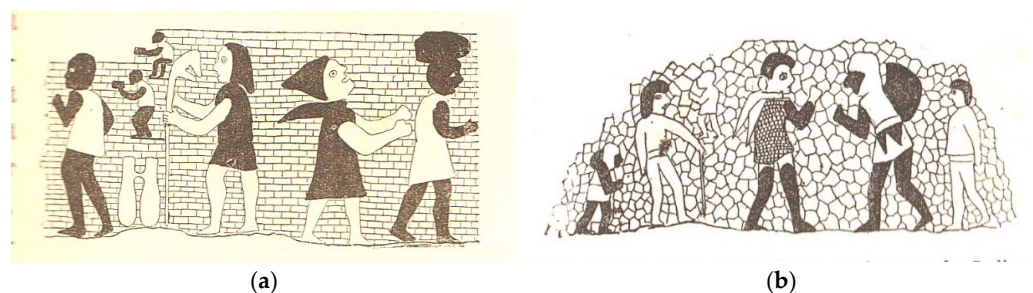


Figure 1. Reproduction of figures that decorated ceramics reported by Wiener in his book *Pérou et Bolivie* [13]: (a) “Painting on a vessel found in Santiago de Cao near Trujillo, depicting masons building a brick wall” p. 481 [13]; (b) “Painting on a vessel found in Puno, depicting Indigenous people constructing a house” p. 471 [13].

In this context of documentary scarcity, the manufacture of adobe bricks offers an illustrative case. The earliest adobes of ancient Peru were made without moulds and took various forms: from convex flat shapes to conical forms, eventually reaching quadrangular ones [4]. The first moulds, made from reeds tied together to form the four faces of the parallelepiped, have not survived due to their organic nature and vulnerability to moisture and insects. However, it has been possible to identify them through the imprints of the reeds visible on the fresh mortar of the adobes. Sawn wooden moulds with flat faces appear towards the Middle Horizon and the beginning of the Late Intermediate Period (1000 AD),

but their existence had not been recognised by most researchers, under the assumption that the lack of specialisation in carpentry made their manufacture impossible (J. Rucabado, personal communication, 2024). The recent findings presented in this article demonstrate that this assumption must be revised.

In the face of this documentary gap, this research addresses the following question: to what degree can the Quechua lexicographic record, museum archaeological holdings and material traces preserved in standing architecture together enable the reconstruction of the repertoire of tools and specialised trades of pre-Hispanic Andean construction? The central hypothesis is that this repertoire was substantially broader than has hitherto been recognised, and that its current invisibility is due in part to the imprecise cataloguing of objects in Peruvian museums and to the absence of studies that systematically integrate the available sources.

2. Materials and Methods

2.1. Research Problem

From the information analysed, it is clear that Andean architecture relied on a complex, specialised division of labour encompassing multiple distinct activities. To this first conclusion must be added the unequivocal presence of wooden tools not officially recognised until now—which indicates that many other tools may remain unidentified and continue to be anonymous.

2.2. Methodological Strategy

The methodological approach draws on four complementary lines of evidence, whose findings are presented jointly in the results section, following a reverse-engineering logic; starting from the preserved material products—the architecture and museum objects—the aim is to reconstruct the processes and tools that produced them.

The analysis began with the built fabric itself, attending to the evidence it yields: form, texture, dimension, marks and imprints on wall surfaces, and other material traces that provide direct information about construction processes. This analysis was carried out through direct in situ observation at archaeological sites on the central Peruvian coast with monumental earthen structures, including Tambo Inga, Cerro Respiro, the Maranga Complex and the Fortress of Campoy, dated between the tenth and sixteenth centuries AD. The record included photographic and metric documentation of marks, imprints, textures and construction phases.

In a second line of inquiry, lexicographic analysis provided valuable data on materials, trades and techniques. For this study, the Llangas repository of the CNRS (Centre national de la recherche scientifique, France) was consulted, a freely accessible database that digitises historical sources of the Quechua language [20]. Three of its files were used: the *Vocabulario de la lengua general de todo el Perv llamada lengua Quichua* (Anonymous, 1586), the *Vocabulario quechua castellano* (Anonymous, 1586) and the *Lexicon* by Domingo de Santo Tomás (1560) [20]. The extracted terms were classified into five categories (structure, material, trade, tool and procedure) and grouped by occupational specialisation. The theoretical premise underpinning this approach is drawn from Porras Barrenechea, cited by Agurto [1]: ‘the vocabulary of a human group is like an inventory of its cultural advances and acquisitions; the absence of a word equals the absence of a thing, just as the existence of the word proves the existence of the thing’.

Ethnography constitutes another highly relevant source. The testimony of the builders of Pacopampa (Cajamarca, Peru), gathered through fieldwork and interviews conducted in 2022 (M. Fernández, personal communication, 2024)., represents an example of techniques

that still survive in the Andes. This source is employed as an interpretive analogy, not as direct evidence of pre-Hispanic practices.

Additionally, previous research on ancient tools in different cultural contexts was reviewed. The contrast with records from Europe and Africa—in particular with Flinders Petrie’s study of the Egyptian collection at University College London [21]—allowed the recognition of technical similarities between geographically distant constructive traditions. Likewise, the bibliographic search identified complementary sources, among which Protzen [20], Chalón [6] and Agurto [2] are particularly significant.

For the search in the catalogue of the Ministry of Culture of Peru [22], explicit classification criteria were established. A piece was classified as a confirmed construction tool only when it met three conditions simultaneously: a form compatible with a documented constructive function, a material consistent with that use, and at least one additional corroborating source (lexicographic, ethnographic or architectural). Pieces classified as possible meet at least one of these conditions. It is acknowledged as a limitation of this source that the catalogue records systematically lack functional descriptions and adequate metric data, which restricts the possibility of precise morphological analysis.

2.3. Identification of Adobe Moulds in Peruvian Museums

Pieces forming part of pre-Hispanic adobe moulds have been identified in at least two Peruvian museums: the Pachacamac Museum [23] and the Arturo Jiménez Borja Museum, both in Lima. In both cases the pieces were catalogued as of indeterminate function, despite the fact that their form, material and dimensions are consistent with the function of an adobe mould [22]. The piece from the Pachacamac Museum (National Registry No. 000075934) is a roughly made wooden board with smooth faces, approximately 60 cm long and 2 cm thick, with pronounced warping and a lateral crack possibly due to bending stress. The identified pieces present perforations at their four corners that allowed the four faces of the mould to be tied together without damaging the edges of the freshly moulded adobe brick.

Figure 2, drawn by the author from analysis of the identified pieces, illustrates a possible assembly of the components of a pre-Hispanic adobe mould; it does not depict any single piece but rather synthesises the shared characteristics observed across the specimens examined [24].



Figure 2. Piece that formed part of a pre-Hispanic adobe-making mould: (a) piece located in the Arturo Jiménez Borja Museum in the city of Lima [22]; (b) proposal of how the components of a pre-Hispanic adobe mould might have been joined together [23].

By way of comparison, an Egyptian mould considered authentic—held at the Manchester Museum with identification number 51 and described by Flinders Petrie [21], from the site of El-Lahun—presents notable functional and material similarities with the Andean

specimens. The formal differences are also significant: the joint in the Egyptian mould is mortise-and-tenon, whereas in the Andean ones it was achieved through lashing; and the Egyptian tool has a handle formed by the extension of one of its faces, which is absent in the Peruvian specimens. This comparison reinforces the hypothesis that the use of wooden moulds for the manufacture of adobe bricks constituted a technical solution that arose independently in different constructive traditions.

The presence of the gavera is furthermore an example of the level of craftsmanship achieved in ancient Peru, not only in terms of the cutting of the boards but also in the mastery of the perforations that allowed lashing without damaging the edges of the freshly moulded adobe brick. Woodworking in pre-Columbian times produced objects through techniques such as carving, drilling and cutting, giving rise to sculptural pieces as well as tools used in weaving and agriculture. It cannot therefore be ruled out that woodworking also produced tools for specifically constructive purposes.

2.4. Analysis Based on the Quechua Lexicon

Lexicographic analysis goes beyond recording words and meanings; it opens a window onto how a society structured and passed on its technical knowledge. As Porras Barrenechea states, cited by Agurto [9]: ‘the vocabulary of a human group is like an inventory of its cultural advances and acquisitions; the absence of a word equals the absence of a thing, just as the existence of the word proves the existence of the thing’. Applied to construction, the presence of specialised Quechua terms for tools, trades and procedures constitutes direct evidence of their existence, even when no physical remains have survived.

The analysis of the Llangas repository, which compiles the Vocabulario de la lengua general de todo el Perú (Anonymous, 1586), the Vocabulario quechua castellano (Anonymous, 1586) and the Lexicon by Domingo de Santo Tomás (1560) [20], allowed the identification of three differentiated construction trades, each with its own set of tools and procedures. This grouping by occupational specialisation reveals that Andean construction activity was an organised system of knowledge transmitted across generations:

- *Ch’iquy kamayuq/Rumi checoc*: stonemason, specialist in stone dressing;
- *Llaqlay kamayuq/Llacllaycamayoc*: carpenter;
- *Llunch’iq*: plasterer, responsible for surface finishing.

The presence of a specific term for plasterer (*llunch’iq*) is particularly significant given the extensive archaeological record of polychromy in Andean architecture. Equally relevant is the identification of the carpenter as a recognised trade, a finding that directly contradicts the colonial assertion—reproduced in recent literature [20]—that woodworking in ancient Peru was rudimentary. Table 1(a)–(c) present the full set of terms organised by trade, integrating associated tools and procedures.

Table 1. (a). Quechua terms associated with the stonemason trade. (b). Quechua terms associated with the carpenter trade. (c). Quechua terms associated with the adobe maker and mason trade.

Tool	Meaning	Procedure	Meaning
(a)			
<i>Ch’iqunakuna</i>	Stonemason’s tools	<i>Ch’iquni</i>	To dress stone
<i>Guasca/guacora</i>	Rope or cord	<i>Checoni</i>	To cut stone for building
<i>Huypa</i>	Mason’s plumb bob	<i>Callquini</i>	To pave with stone
<i>Huypachina</i>	Plumb bob for adjusting	<i>Khallkini</i>	To pave or lay stone flags

Table 1. Cont.

Tool	Meaning	Procedure	Meaning
(b)			
<i>Llacllana</i>	Chisel, adze or plane	<i>Llacllani</i>	To carpenter generally
<i>Llaqlłani</i>	To work with adze	<i>Tupani</i>	To saw or file
<i>Tacaycona</i>	Hammer	<i>Ch'iqłtani</i>	To cut or split wood
<i>Tupana</i>	File or float	<i>Tacani</i>	To hammer or mallet
(c)			
<i>Llumchina/Llunch'ina</i>	Mason's float	<i>Ticani</i>	To make bricks or adobes
<i>Parpana</i>	Rammer	<i>Tactani</i>	To tamp with rammer
<i>Pacpana</i>	Rake	<i>Chapuni</i>	To knead clay with water
<i>Lampa</i>	Hoe	<i>Sicnini</i>	To spread straw for mud
<i>Huypu</i>	Stone on a stick, clod breaker	<i>Maçani</i>	To dry in sun or air
<i>Tacarpu</i>	Stake	<i>Huypachini</i>	To plumb and level a wall
<i>Llunch'ina</i>	Mason's float	<i>Llunch'ini</i>	To render or plaster
<i>Huypa/Huypaychi</i>	Mason's plumb bob	<i>Sikñini</i>	To spread ichu straw for mud
<i>Huypachina</i>	Plumb bob for adjusting	<i>Chhullukun</i>	To soak adobe in water

Four terms merit particular analysis for their direct architectural implications. The verb *tupani.gui*—‘to saw’—implies the existence of specialised instruments for cutting wood, which reinforces from an independent source the physical evidence of wooden elements that were cut, such as lintels; both lines of evidence converge on the same conclusion from different sources. The term *mitacuni.gui*—‘to do something alternately’—may be related to the construction of stereotomic earthen blocks archaeologically documented at the sites studied. The verbs *asp'ikuni* (to dig or pierce the earth or a wall) and *haspirqumuni pirqakta* (to perforate a wall) suggest that access openings may have been carved after the completion of the wall. Finally, the term *quenchani*—‘to fence with cane’—is the direct etymological origin of the Hispanicised word *quincha*, confirming the pre-Hispanic origin of this technique and its uninterrupted cultural transmission to the present day.

2.5. Information from the Constructed Element

The abundance of information provided by the built element had to be considered in order to identify the possible use of tools. The external appearance of the architecture—dimensions, textures, proportions, construction phases and details of the mortar study—were data considered in shaping the proposal of the tools employed, organised according to four basic tasks: (a) measurement and alignment; (b) mix production and transport; (c) clay placement; (d) surface finishes.

Topics such as scaffolding or temporary support structures have been set aside, given that no evidence of external scaffolding was identified at the sites studied. The practice observed in Pacopampa—where workers operate from the top of the wall—supports the hypothesis that the large monumental walls were built in this manner, reducing the need for external support structures.

To achieve alignment, ropes or other means were required to connect two distant points, which could include vertical rods and the operator's line of sight. To control the verticality of the wall faces, objects similar to a mason's plumb bob must have been used, a task that becomes more complex when working inclined faces. To control the width of the element, drawing on the ethnographic traditions still present in the community of

Pacopampa, it has been proposed as a hypothesis that a gauge rod or short stick was used to maintain a consistent wall width.

For the production and transport of the clay mix, baskets or blankets may have been used. This hypothesis is supported by a block of clay found inside the structure of a wall at Huaca Bellavista (Lima), where the intact marks of the artefact that must have been used for transport were clearly visible (Figure 3) [25].

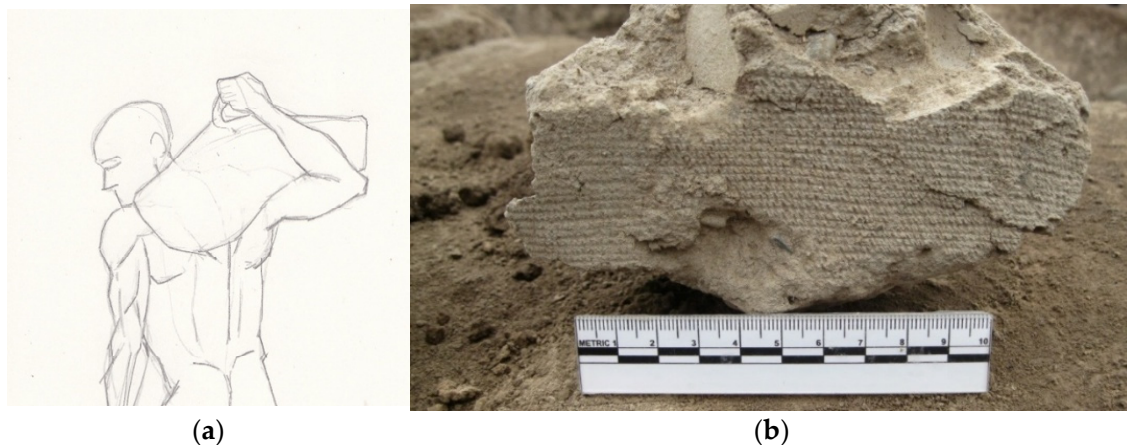


Figure 3. Hypothesis on the use of baskets for transporting mortar for the construction of shaped-earth walls: (a) image depicting the method of transport; (b) block showing a piece of mortar bearing the imprint of a basket [25].

The surface finishes of the walls involved a finishing process consisting of the application of a layer of earth mortar of a different consistency from that of the wall itself. The fingerprints preserved in the render layer of several walls at the sites studied confirm that the final application of the mortar was carried out manually, without any intervening tool, and allow the plastic state of the mortar at the moment of application to be inferred. Among the tools that may have been used for prior profiling are small shovels or rods with a flat end. Experiences such as that developed at the village of Tumor in the 1980s [26], which allowed walls to be reconstructed using pre-Columbian techniques, demonstrated that this type of construction required a deep knowledge of earth as a material.

2.6. Ethnographic Contributions: The Builders of Pacopampa

The tools used by the Pacopampa builders include plumb bobs, squares and levels, all indispensable for ensuring the correct direction of the walls and the proper arrangement of the layers (Figure 4). The work is entirely manual as regards the formation of the courses, where a gauge rod or wooden element guides the operator. The wall faces are smoothed while avoiding the use of floats, which could cause cracking. The render is applied with a fluid mortar to which chopped straw and frequently animal manure are added. This contemporary experience demonstrates that with a small number of simple tools it is possible to construct structures of considerable size, which lends plausibility to the proposed reconstruction of the pre-Hispanic technical repertoire.

2.7. Search in the Database of the Ministry of Culture of Peru

The website of the Ministry of Culture of Peru offers a collections search engine at <https://gestiondecoleccion.cultura.gob.pe/catalogo> [22] (accessed on 20 June 2024). Using the information previously gathered and applying the criteria described in the methodology, the archives were searched for the tools mentioned in the lexicographic sources. The search was successful. In all cases the records lack functional descriptions

and measurements. This systematic absence of cataloguing data confirms the under-identification problem described in the working hypothesis.



Figure 4. Various types of pre-Hispanic instruments that may have been used to smooth wall surfaces: (a) Agricultural? Tool³. Huallamarca Site Museum, Lima. (b) Metal-made shovels with no assigned function according to the records of the Ministry of Culture of Peru [22].

The tools identified as confirmed—by convergence of lexicographic, architectural and formal evidence—are:

- Plumb bob (metal) National Registry No.: 0000247554;
- Shovel (metal) National Registry No.: 0000187138;
- Trowel (wood) National Registry No.: 000084305;
- Float (metal, handle) National Registry No.: 0000150387;
- Axe (metal) National Registry No.: 0000151389.

The tools identified as possible—on the basis of formal consistency but with functional ambiguity—are:

- Hammer: National Registry No.: 0000218804;
- Tool possibly used for marking lines. National Registry No.: 000076015;
- Adze (wood and metal, V-shaped piece with metal element): National Registry No.: 0000196283.

The presence of chisels (National Registry No.: 0000183480) in various sizes is widely documented in the Ministry's deposits, and would be consistent with both stonework and woodwork. These findings significantly enrich knowledge of Andean constructive technology (Figure 5).



Figure 5. Two tools recorded in the catalogue [22]: (a) mason's plumb bob; (b) probable adze, a tool used for shaping wood; note the associated metal piece.

3. Discussion

Identifying the tools involved in pre-Hispanic construction has required a process that brings together vocabulary, vernacular traditions, direct analysis of standing structures and archaeological records. The most relevant aspect of the results is not each individually identified tool but rather the convergence of the three lines of evidence; the lexicographic terms, the museum objects and the architectural traces all point independently to the same conclusions, which reinforces their solidity. The discovery of gaveras in Peruvian museums, the identification of the verb tupani (to saw) in sixteenth-century Quechua dictionaries, and the presence of cutting tools in the Ministry of Culture catalogue all point in the same direction: pre-Hispanic Andean carpentry was a specialised activity, not a rudimentary one.

The cataloguing problem identified is not trivial. The lack of functional identification in museum records has created an evidential void that has sustained inaccurate historiographical narratives about the technical capabilities of Andean builders. The systematic correction of this deficit requires collaboration between archaeologists, architects and construction historians, and constitutes a concrete agenda for Peruvian heritage institutions. The incorporation of constructive criteria into movable heritage cataloguing protocols would be an immediate and low-cost first step.

Knowledge of these tools was likely transmitted between generations through oral instruction and hands-on practice rather than written records. The specialised Quechua vocabulary—with technical terms differentiated by trade—suggests that systematic mechanisms for the transmission of information existed, linked to the organisation of labour in the Tahuantinsuyo. The disappearance of these mechanisms following the conquest partly explains the current difficulty in identifying the tools: not only the object was lost, but also the knowledge that allowed it to be named and interpreted.

It is important to note that this work does not conclude with the results presented. The study of pre-Columbian tools must continue to deepen through the analysis of the materials used and their transformation processes, the techniques of manufacture, and the correct forms of use of these artefacts. An equally significant task will be to identify the types of wood used in tools of organic origin, as well as the casting techniques employed in metal tools. It would furthermore be advisable for these tools to be replicated and used in experimental archaeology projects.

4. Conclusions

The results of this research allow the following conclusions to be established.

First, pre-Hispanic Andean earthen architecture was sustained by a specialised technical tradition, with differentiated trades—stonemason, carpenter, adobe maker and plasterer—documented in the sixteenth-century Quechua vocabulary. The existence of these trades implies mechanisms of knowledge transmission and an organisation of construction work more complex than historiography has recognised.

Second, the tool repertoire identified through convergent evidence includes plumb bobs, trowels, shovels, chisels, adzes, axes and rammers, among others—none of which has been explicitly linked to construction activity in the museum records where they are held.

Third, the discovery of gaveras in Peruvian museums catalogued as pieces of indeterminate function evidences a systematic problem of under-identification that may affect other tools not yet recognised. The correction of this deficit, through multidisciplinary criteria that incorporate the constructive perspective, is an urgent and achievable task.

The results have implications in three fields: for the history of Andean architecture, which must revise the narrative inherited from the colonial chronicles regarding the technical level of its builders; for museum cataloguing policy in Peru, which requires the

incorporation of constructive functional criteria into its protocols; and for experimental archaeology, which now has at its disposal a set of replicable tools with which to test hypotheses about pre-Hispanic construction processes.

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Notes

- ¹ Quincha: traditional Andean construction technique consisting of a cane or timber framework covered with mud. Its name derives from the Quechua term quenchaní (to fence with cane).
- ² Tahuantinsuyo: Quechua name for the Inca Empire, meaning 'the four regions of the world'.
- ³ This constructive interpretation is based on comparative evidence drawn from traditional earthen construction techniques, such as those documented at Pacopampa and in the French tradition of 'bauge' [27], where hand tools were used to smooth the wall surfaces during the finishing phase. Similarly, pre-Columbian earthen walls retain surface textures and finishing mortars with a finer grain size, clearly distinct from the core of the wall, which indicates deliberate smoothing operations that would have required the use of specialised tools.

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