

From Earth to Enlightenment
Materiality, Technology and Cultural Transmission of Terracruda Sculpture Across Buddhist Asia

edited by
Mònica López-Prat,
Emma Cantisani
and Susan S. Bean

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Abstract

How was clay-rich earth transformed into sacred images across Buddhist Asia? This volume highlights terracruda sculpture as a distinctive artistic and cultural tradition and explores what it reveals about the history of Buddhist Asia. From Afghanistan and Central Asia to China and Bhutan, the volume brings together archaeology, art history, materials analysis, textual research and living traditions to examine the materiality, technology, significance and transmission of terracruda sculpture. Shared techniques and local variations illuminate the movement of knowledge, beliefs and practices, inviting renewed appreciation and conservation of this sculptural heritage.

Keywords Buddhist art. Archaeology. Traditional knowledge. Silk Roads. Conservation. Heritage science.

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Reviewers for this volume (listed in alphabetical order)

The editors wish to recognise the time and expertise generously dedicated by the following scholars to the peer review of individual contributions to this volume.

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To the memory of Zafar Paiman, an Afghan-French archaeologist who devoted much of his career to excavating, studying, preserving, and raising awareness of some of the most remarkable examples of Buddhist terracruda sculpture in Afghanistan

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Introduction

Mònica López-Prat
Institute of Heritage Science of the National Research Council of Italy

Emma Cantisani
Institute of Heritage Science of the National Research Council of Italy

Susan S. Bean
Peabody Essex Museum (retired), USA

1 Tracking the Practice of Terracruda Sculpture Across Buddhist Asia

Across Buddhist Asia, from the beginning of the Common Era onwards, clay-rich earth has been transformed into images of Buddhas, bodhisattvas, protective deities, and other sacred figures through sophisticated artistic and technological processes encompassing spatial and architectural planning, structural construction, modelling, surface finishing, and polychromy. This sculptural tradition, referred to here as 'terracruda sculpture', was widely employed during periods of Buddhist patronage to create enduring sacred images, extending from the monasteries of Central Asia and northwestern South Asia to the cave temples of China, the religious complexes of the Himalayan region and the Tibetan Plateau, and the temples of Japan and Korea. Despite its distinctive material characteristics, extensive geographical distribution, and historical significance, this image-making practice has received comparatively limited attention as a coherent field of study. Frequently examined within the frameworks of regional art histories, individual archaeological sites, or the conservation challenges of particular monuments, its technological, cultural, and conceptual commonalities and connections across the wider Buddhist world have barely been considered.

From Earth to Enlightenment seeks to address this gap by bringing together archaeological, art-historical, scientific, textual, and ethnographic approaches to the study of terracruda sculpture within Buddhist image-making traditions. The central premise is that the use of clay-rich earth, shaped and left to harden

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through drying, should not be understood merely as an alternative to more durable sculptural media, such as stone, metal, or terracotta, but rather as a deliberate material and technological choice supported by specialised knowledge. By examining the materials, technical processes, and cultural contexts involved in the creation of terracruda sculpture, the contributions gathered here explore its cultural significance, potential historical connections, technological transformations, and local adaptations within a shared sculptural tradition across different periods and geographical regions.

2 Naming and Understanding the Sculptural Tradition

The challenges of identifying and defining this sculptural tradition begin with terminology. Sculptures produced from clay-rich earthen materials, shaped and hardened without firing, have been variously described as 'clay', 'unfired clay', 'unbaked clay', 'raw clay', 'air-dried clay', 'terracruda', and 'painted clay', among other designations. This terminological diversity is reflected in the contributions to the present volume, whose authors employ different expressions according to their disciplinary approaches and the historical and geographical contexts of their studies.

The significance of this distinctive medium in Asian sculptural traditions has been recognised by scholars whose pioneering studies laid the foundations for its historical, artistic, and technological investigation. Among the earliest influential contributions is K.M. Varma's landmark work, *The Indian Technique of Clay Modelling* (1970), which provided an important framework for understanding the specialised technological knowledge underlying clay sculpture by exploring the relationship between archaeological record, Āgamic literature, and traditional image-making practices in Bengal. The connections between textual prescriptions, sculptural techniques, and living traditions were further explored by James D. Robinson in his doctoral thesis, *The Worship of Clay Images in Bengal* (1983), which examined the technological and religious dimensions of clay image-making in the region. Within the context of Buddhist art, other significant early contributions include Loden Sherab Dagyab's *Tibetan Religious Art* (1977), Giovanni Verardi's *Osservazioni sulla coroplastica di epoca kusana nel Nord-Ovest e in Afghanistan in relazione al materiale di Tapa Sardar* (1983), and Zemaryalai Tarzi's *La technique du modelage en argile en Asie Centrale et au Nord-Ouest de l'Inde sous les Kouchans: la continuité malgré les ruptures* (1986). Subsequent research, notably Christian Luczanits' *Buddhist Sculpture in Clay: Early Western Himalayan Art, Late 10th to Early 13th Centuries* (2004) and, more recently, Susan S. Bean's *Clay Works: Earthen Sculpture in South Asia* (2026), has further broadened historical, artistic, technological, and cultural perspectives on this form of sculptural production. Nevertheless, research in this field has remained fragmented across disciplinary and regional boundaries. The present volume builds upon these scholarly foundations by placing materials and technology at the centre of a cross-regional and diachronic discussion of Buddhist terracruda sculpture.

Rather than imposing a uniform terminology, the editors propose a term capable of highlighting the material characteristics, technological principles, and shared features that allow this sculptural tradition to be recognised and distinguished from other forms of image-making. The Italian

term 'terracruda', adopted as an overarching designation for this volume, emphasises both the principal material employed (*terra*, 'earth') and its raw condition (*cruda*, 'raw'), in deliberate contrast to the well-established Italian term 'terracotta' ('baked earth'). The term 'terracruda' encompasses sculptures produced from earthen mixtures, often incorporating plant materials, through additive modelling processes that may involve internal supporting structures, successive layers whose composition varies according to their function, from building up the sculptural volume to refining its final form, surface preparations, and polychromy. The term does not imply a uniform material composition or manufacturing procedure, nor is it intended to replace historically or regionally specific terminology.

Opening the volume, Yamane et al.'s contribution, *Earth in Buddhist Modelled Sculpture: Material Diversity and Multi-Material Practices from Northwestern Pakistan to Central Asia*, addresses these questions of material identification and classification. By examining the diversity of materials employed in Buddhist modelled sculpture across these regions, Yamane and colleagues highlight the distinction between clay-rich earthen mixtures that harden through drying and other materials, such as lime- or gypsum-based compounds, whose setting involves chemical reactions. The chapter also foregrounds modelling as a fundamental sculptural process, providing a broader technological framework for understanding the terracruda tradition and its continuity and transformation across diverse geographical and historical periods.

3 Shaping the Sacred Body: Material, Technique, and Meaning

Among the most significant properties of clay-rich earth as a sculptural medium is its plasticity. Unlike subtractive carving, modelling permits the gradual addition, removal, and reshaping of material. Internal supporting structures made of stone, wood, or brick, often combined with reeds, ropes, or other materials, can support successive applications of earth-based mixtures, allowing artists to construct figures of considerable scale and complexity. These processes often require prolonged drying periods between stages and involve a sequence of modelling layers, beginning with those that establish the overall sculptural volume, followed by layers that define the torso, limbs, and garments, and culminating in finer finishing layers that enable the detailed rendering of facial expressions, anatomical features, drapery, and other surface details. The resulting sculptures are frequently composite constructions whose material organisation reflects a sequence of specialised technical operations requiring considerable time, skill, and planning.

An especially revealing connection emerges between the construction of sculptural images and conceptions of the human body. Buddhist textual traditions, including an account preserved in the *Mūlasarvāstivāda-vinaya*, draw analogies between the formation of the human body and the making of a clay image (Varma 1970, 140). Similar correspondences between sculptural components and human anatomy appear in Āgamic traditions, where internal supports, ropes, bindings, and earthen mixtures are associated with bones, veins and sinews, fat, and flesh (Varma 1970, chapters 1-12). These analogies suggest that the making of a sacred image could be conceived not merely as the representation of a figure, but as a process of constructing a body.

Mills's chapter, *Flesh of Clay: Instructions for Making a Figure from Unbaked Clay*, contributes to this discussion through its examination of South Indian Sanskrit technical and religious treatises, particularly the *Vimānārcanakalpa* and other Śaiva and Vaikhānasa texts prescribing the materials and procedures for constructing sacred images intended for permanent installation in temples. These written traditions reveal specialised knowledge in which technological practices and religious conceptions are closely intertwined, providing insights into the selection, preparation, and combination of materials used in their construction. Particularly significant is the distinction between unbaked (*apakva*) and baked (*pakva*) clay. The *Vimānārcanakalpa* explicitly warns against the use of baked clay for permanent sacred images, indicating that allowing clay-rich earth to harden through drying was not merely a matter of convenience, but a deliberate choice with metaphysical significance. This raises broader questions about the relationship between the material properties of earth and its capacity to embody sacred presence. One possible interpretation is that, by avoiding firing, the material was perceived as retaining its natural capacity to hold water and sustain life, thereby preserving its fertility and making it particularly meaningful for embodying and vivifying sacred presence. Although this interpretation remains hypothetical, the textual evidence challenges the understanding of terracruda as a simple or expedient medium and invites further investigation into the religious significance of its deliberate selection for the construction of sacred images, particularly within the ritual and conceptual frameworks of Āgamic and Tantric traditions.

The construction of a sacred body did not end with its modelling, as colour played a fundamental role in its completion and vivification. In the Sanskrit textual traditions discussed above, colour is closely associated with life, suggesting that polychromy was not merely a matter of aesthetic finishing or surface decoration, but an essential stage in bringing the sacred image to life. In the contribution *Colouring the Body: Pigments, Symbolism, and Beauty Practices in Ancient Afghan Buddhist Art*, Giulia Forgione extends this discussion by examining the role of pigments and colour in bodily representation, symbolic meaning, and practices of adornment. Considered alongside the Sanskrit textual evidence, this study encourages an understanding of modelling and colouring as interconnected processes through which terracruda was progressively transformed into sacred bodies capable of conveying a sense of living presence.

4 Shared Technological Principles

The geographical and chronological distribution of Buddhist terracruda sculpture reveals both the persistence of shared construction principles and considerable regional diversity. The use of internal supporting structures, additive modelling techniques, and successive clay-rich earthen layers of differing composition to create enduring, often monumental images constitutes a recurrent and distinctive technological sequence documented across widely separated regions of Buddhist Asia. The persistence of these construction principles suggests the circulation of specialised technological knowledge within the religious and cultural networks that accompanied the expansion of Buddhism along the Silk Roads. At the same time, variations in raw materials, aggregate selection, organic additives, armatures, surface

treatments, and finishing procedures may reflect adaptations to existing local artistic and technological traditions, as well as to the availability of resources.

The contributions by Chang et al. and Nurmi et al. provide further evidence of the materials and techniques employed in Buddhist terracruda sculpture in different historical and geographical contexts. The former investigates a polychromed clay sculpture of a kneeling attendant bodhisattva from Mogao Cave 61 (Tang dynasty, 618-704), examining its materials and construction techniques within the context of one of the major centres of Chinese Buddhist art. The latter presents a technical study of terracruda fragments from Khara-Khoto, a major centre of the Tangut-ruled Western Xia Empire (1038–1227 CE), located in present-day Inner Mongolia, China, contributing to our understanding of material selection and sculptural production in this region. Considered alongside evidence from present-day Afghanistan, Pakistan, northern India, and Central Asia, these studies broaden the basis for comparing construction techniques, material composition, modelling procedures, and surface finishing in historical Buddhist terracruda sculpture.

The recurrence of complex construction sequences involving the modelling and air-drying of clay-rich earth across geographically distant regions raises important questions about the historical transmission of specialised technological knowledge. Rather than considering each regional manifestation as an isolated development, the persistence of shared technological principles invites us to investigate the movement of specialised artistic traditions through Buddhist religious and cultural networks. These connections involved the mobility of artists, the circulation of technological practices, and the transmission of religious ideas within monastic and artistic communities. Nevertheless, recognising the technological tradition does not necessarily imply uniformity in its practice or establish the precise mechanisms through which knowledge circulated. Identifying these historical relationships requires the integration of material and technological evidence with chronology, archaeological contexts, religious currents, and artistic practices.

The distinctive geographical distribution of this sculptural tradition is particularly relevant in this respect. Its close association with Buddhist artistic and religious contexts across vast territories suggests that the expansion of Buddhism may have played a significant role in its dissemination, continuity, and transformation. Rather than a uniform or unidirectional process of diffusion, however, this transmission may be understood as a dynamic process through which shared technological knowledge was maintained, adapted, and further developed within different regions and environments.

Technological comparison thus offers a means of investigating cultural transmission beyond formal and iconographic similarities. Materials, internal structures, and construction sequences may preserve evidence of shared knowledge and practices that is not immediately apparent in the finished appearance of an image, providing an additional perspective on the historical connections between Buddhist artistic traditions across Asia.

5 Earth, Ritual Efficacy, and Living Traditions

The relationship between material and sacred meaning becomes especially evident in Himalayan Vajrayāna Buddhist contexts, where earth is valued

not merely for its plasticity or availability, but also for its associations with the natural world, sacred places, and its capacity to incorporate ritually significant substances. The inclusion of medicinal ingredients, sacred earths, relics, and other consecrated materials contributes to the ritual efficacy of sculptural images, investing the sacred body with potencies understood to extend beyond the physical properties of its constituent materials.

López-Prat and Bean's contribution, *Technological and Spiritual Knowledge in Bhutanese Terracruda Sculpture*, offers a contemporary perspective on these relationships through the examination of current sculptural practices in Bhutan. By documenting the knowledge and experience of practitioners, the study reveals how material selection, construction techniques, and ritual prescriptions are closely intertwined in the creation of sacred images. These living traditions demonstrate that the choice of clay-rich earth can be deeply intentional, informed not only by technical expertise but also by metaphysical understandings of the materials considered appropriate for embodying sacred presence.

These observations also invite consideration of possible historical relationships between earth-based image-making and the development of Buddhist ritual traditions. The continued significance of terracruda in parts of the Himalayan and Tibetan regions, together with the importance attributed to substances, consecration, and the construction of sacred bodies, raises questions about the interaction between sculptural technologies and ritual practices. However, chronological and geographical overlaps cannot in themselves establish a causal relationship. The possibility that particular ritual frameworks encouraged, sustained, or transformed terracruda practices remains a subject for further investigation.

Living traditions therefore offer neither direct reconstructions of ancient techniques nor universal models for interpreting archaeological sculpture. Their comparative value lies instead in revealing the range of technical, ritual, and conceptual considerations that may inform material choices and sculptural practices. They also remind us that knowledge of sculptural production is not confined to surviving objects or written texts, but is embodied in the experience, decisions, and expertise transmitted across generations of practitioners.

6 Vulnerability and Durability: Implications for Conservation

The inherent vulnerability of terracruda introduces a further dimension to its historical interpretation and conservation. Sculptures made from clay-rich earth hardened through drying are particularly sensitive to moisture, mechanical damage, environmental fluctuations, and the deterioration of their organic constituents. Nevertheless, the complexity of their construction, the identification of organic compounds in modelling pastes from archaeological sculptures in Afghanistan (see López-Prat et al. 2025), and the elaborate prescriptions for preparing such mixtures found in Sanskrit technical treatises suggest a deliberate concern for material properties and long-term performance. Together with evidence of successive repairs and interventions, these observations indicate that considerable attention was devoted to ensuring the durability of sacred images, even when their preservation required continuous care. Such concerns remain evident in maintenance and repair practices observed in temples where terracruda sculptures continue to fulfil their religious functions.

The conservation of these sculptures therefore raises questions that extend beyond their physical vulnerability. Historical repairs and successive modifications may reflect not only responses to deterioration but also the continued religious significance of the images, complicating conventional distinctions between original materials and later interventions. The analogy between the sacred image and the living body also invites consideration of its material life cycle, in which care, repair, renewal, and eventual replacement may acquire religious significance. Such practices suggest that preserving the physical presence and religious function of sacred images could remain an important concern throughout their material existence, even within religious frameworks that recognise the impermanence of material forms.

These considerations have important implications for conservation. Effective approaches require an understanding not only of material composition and deterioration processes, but also of construction sequences, the functions of constituent materials, historical interventions, and the cultural significance of traditional practices. Such knowledge is essential for evaluating the compatibility of conservation treatments and recognising the potential significance of successive repairs and modifications. The contribution by Schwantes et al., *Polychrome Air-Dried Clay Sculptures (Nísù) in Shanxi, China: Community Practice, Conservation, and Cultural Continuity*, illustrates these interconnected dimensions through its examination of the relationships between traditional sculptural knowledge, community involvement, cultural continuity, and the preservation of *nísù* sculpture in Shanxi.

The preservation of terracruda sculpture also depends on the survival and transmission of the knowledge through which these images were created, maintained, and renewed. As traditional practices disappear or undergo transformation, specialised knowledge that can provide valuable insights into historical sculptural technologies and inform the development of compatible conservation strategies is increasingly at risk. Documenting this knowledge, while recognising the expertise and authority of its practitioners, is therefore an essential part of conservation. Preserving Buddhist terracruda sculptures requires attention not only to the material survival of sacred images, but also to the technological knowledge and cultural values that have sustained them across generations.

7 Towards a Material and Technological History of Buddhist Terracruda Sculpture

The contributions assembled in this volume highlight the importance of approaching Buddhist terracruda sculpture through the materials, technical knowledge, and practices involved in its production. By integrating archaeometric analyses, technical examination, archaeological evidence, textual sources, and the study of living traditions, they offer complementary perspectives on how sculptural technologies were developed, transmitted, and transformed across different historical and cultural contexts. This interdisciplinary approach contributes to a fuller understanding of the role of material choices and technical practices in shaping not only the physical appearance of sacred images, but also their religious meanings and functions.

At the same time, the studies presented here reveal important gaps that call for further investigation. The geographical coverage of the volume is necessarily selective, with limited representation of several East Asian

traditions, particularly those of Japan and Korea. Further comparative research across East Asia would contribute to a more comprehensive understanding of the diversity of terracruda practices and their possible historical connections. Equally important is the systematic investigation of Buddhist textual sources, which may provide further evidence concerning the selection and preparation of materials, sculptural procedures, and the ritual prescriptions associated with image-making. Such research would complement the Sanskrit technical traditions examined in this volume and help clarify the relationships between written prescriptions, material evidence, and historical practices.

Future research would also benefit from closer integration of scientific characterisation, comparative studies of construction techniques, textual interpretation, the examination of religious practices, and the knowledge preserved in living sculptural traditions.

Particular attention should be given to the mechanisms through which specialised technological knowledge may have circulated across regions, and to the ways in which it was transformed through encounters with local materials, artistic practices, and religious traditions. Similarities in sculptural techniques alone cannot establish direct historical transmission, but their systematic investigation may help identify patterns of technological exchange and distinguish shared knowledge from independently developed practices.

Understanding terracruda sculpture in Buddhist Asia requires looking beyond the finished object to the processes, expertise, and relationships through which it came into being. The evidence examined throughout this volume suggests that the transformation of clay-rich earth into a sacred body was not simply a technical operation, but a complex process in which material and metaphysical knowledge were closely intertwined. It is through this wider perspective that the study of terracruda sculpture can contribute not only to the history of Buddhist art, but also to broader discussions of materiality, technological transmission, and the role of making in the creation of sacred images.

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Momoka Yamane
University of Tsukuba, Japan

Yuichi Otsuka
Hirayama Ikuo Silk Road Museum, Japan

Tatsuhiko Maeda
Hirayama Ikuo Silk Road Museum, Japan

Yusuke Mukai
Kyoto University, Japan

Masanori Kurosawa
University of Tsukuba, Japan

Yoko Taniguchi
University of Tsukuba, Japan

Abstract This paper discusses the use of 'earth' in the creation of images at Buddhist temples from northwestern Pakistan to Central Asia. It brings together selected archaeological descriptions and recent analytical evidence regarding the use of earth in Buddhist sculptures, with particular attention to its relationship with architecture, to clarify its material characteristics and diversity, and consider potential interactions within the broader phenomenon of modelled sculptural production in the region; it concludes by outlining hypotheses to be tested in future research.

Keywords Modelling techniques. Buddhist sculptures. Architectural context. Material analysis. White plaster.

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1 Introduction

Sculptural production in Buddhist temples of northwestern Pakistan to Central Asia broadly encompasses stone carving and modelling plastic materials. This article uses 'modelled sculptures' for the latter, and sculptural production using earthen materials forms part of these modelling practices. Although its establishment remains incompletely understood, sculptural production through modelling is considered to have been a central image-making practice in Buddhist temples across the region.

One origin of Buddhist sculptural production can be traced to the stone-carving traditions of Gandharan art, which flourished primarily in Buddhist temples around the Peshawar Basin in present-day northwestern Pakistan. From the second to third centuries onward, however, stone carving within the region declined, while modelled sculpture, made primarily with a white material presumed to be lime and collectively known as 'stucco', is considered to have become prominent.[1] The use of modelling as a major method for creating images in Buddhist temples was not limited to this region but seen across Central Asia and continued for a longer period.

Sculptures made with earthen materials represent one facet of this broader phenomenon of modelled sculptural production within Buddhist temple contexts in northwestern Pakistan to Central Asia; however, their precise classification is not straightforward. Conventionally, coloured, soft, plastic materials that harden through moisture loss have been described in several ways, including clay, mud, or earth. The term 'clay' has frequently been used in archaeological literature as a broad descriptive label. In technical usage, however, 'clay' may refer to a particle-size fraction or to clay minerals. Its use as a general material label can therefore obscure differences among materials in technical discussion. Accordingly, this article uses 'earth' as an operational umbrella term for unfired mineral-based materials containing variable proportions of clay-, silt- and sand-sized particles, with or without organic matter. The term does not imply a uniform composition or a single preparation method.

While there are regional trends regarding the choice of earthen materials as a medium, the examples themselves are widely distributed across the regions considered here and span a broad chronological range. Furthermore, at some sites, these sculptures are found alongside works made from different materials, particularly lime- or gypsum-based plasters, which have traditionally been classified as 'stucco' in scholarship. These whitish, relatively fine-textured plasters typically acquire workability through the addition of water following thermal processing of their raw materials and subsequently set through chemical reactions.[2] In contrast, earth-based materials vary in colour, can become workable through the addition of water without requiring prior thermal processing, and acquire cohesion primarily through drying. This suggests that earthen materials could be used in combination with other materials and techniques within the broader framework of modelling practices.

1 Faccenna 1980-81; Naiki 2016; Olivieri, Filigenzi 2018; Behrendt 2018, etc.

2 Adhesive binders may also have contributed to cohesion, although this remains insufficiently demonstrated.

This article examines the material diversity of earth used in Buddhist sculpture, considering earth-based production both as a distinct technological practice and within broader modelling traditions with attention to its relationship with architecture. It focuses on Central Asia, with comparative evidence from northwestern Pakistan **[fig. 1]**.

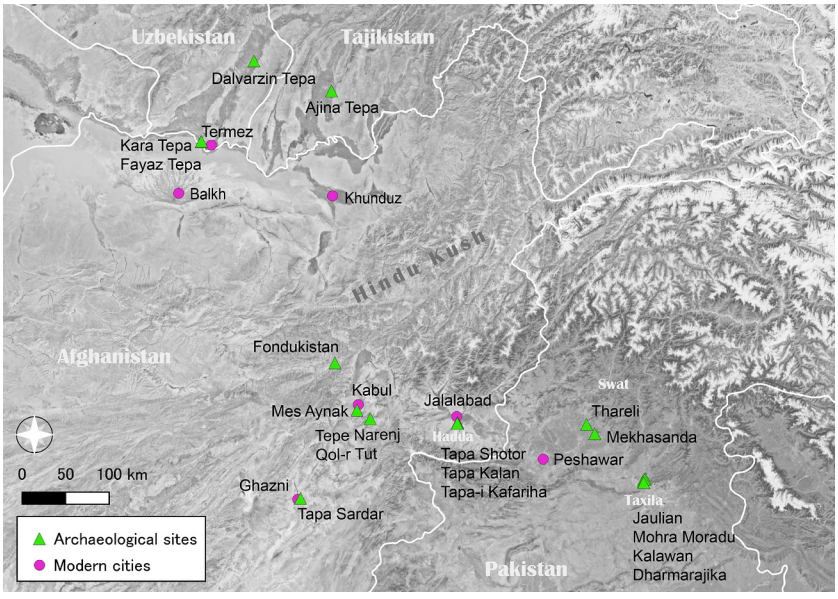


Figure 1 Distribution of archaeological sites discussed in this study. Site locations were plotted by the author through cross-referencing published excavation reports and maps with satellite imagery; coordinates were recorded from Google Maps where precise published coordinates were unavailable. Modern cities are shown for geographical reference. Base map: Google Earth.

2 Earth within Broader Modelled Sculpture Practices

Based on records of archaeological finds from northwestern Pakistan, Afghanistan, southern Uzbekistan, and southeastern Tajikistan, sculptural production using earth includes both sculptures made entirely of earth and those with earthen layers finished with white plaster: lime and gypsum. As previously mentioned, while the term 'stucco' has traditionally been used as a collective term for these materials, its definition has lacked consistency among users; furthermore, given that the term derives from a Western architectural context distinct from that of the region considered here, this study instead employs 'white plaster' as a collective term for white materials that can be visually distinguished from earthen materials.

Excavated evidence and previous studies[3] indicate that modelled sculptures generally consisted of multiple layers. In a broader sense, their structure functionally comprised a 'core', which supports the multilayer structure (solid material in some cases); an 'inner layer', used to build up volume; and a 'shaping layer', which gave the sculpture its final form. The

3 E.g., Varma 1970; 1987; Tarzi 1986; Ohlídalová et al. 2016; López-Prat et al. 2024b.

workable materials used to form these sculptural layers are referred to here as 'modelling pastes'. The modelling paste in each layer is likely to have a different composition or technological function. In this system, the use of earth in sculptural production is not necessarily limited to earth alone; it's also combined with other materials, including white plaster.

Cases involving a white plaster finish fall into two categories: those where the white plaster itself creates the final shape over an earthen base, and those where the shape is first modelled in earth and the white plaster is applied as a thin finishing layer.[4] This article defines as 'earth-based sculptures' those in which earth constitutes the principal modelling material, as in the latter case, irrespective of thin ground, paint, or other surface-finishing layers.

Both techniques produce white surfaces and have sometimes been grouped under 'stucco' or a single technical category.[5] While it is impossible to discuss the precise relationship between these practices here, given the inability to directly examine and classify the excavated specimens, the two techniques were not necessarily mutually exclusive in a single sculpture, and could occur in combination to produce a white finished surface.

Composite earth and white plaster techniques are documented at several sites around the Hindu Kush (e.g., Tapa Shotor, Tepe Narenj, Kara Tepe, and Dalvarzin Tepa) where earthen architecture and earth-based sculptures were common. In northwestern Pakistan, where temples are predominantly coated with white plaster, contrasting with the former regions (this will be discussed later), comparable composite sculptures are less frequently documented in the published record. Some descriptions in Marshall's report on Taxila may refer to such examples, although the materials require further verification.[6]

At several sites around the Hindu Kush, similar technical features occur in these composite sculptures. Gypsum has been identified or proposed as the white plaster component,[7] and the use of cloth between earth and white plaster has been reported at several of these sites.[8]

Their chronological relationships are not uniform: Tarzi (1976) documented a transition from earth-based sculptural production to such combined practices at Tapa Shotor (near present-day Jalalabad) during the Kushano-Sasanian numismatic period, and excavated sculptures of Tepe Narenj (near present-day Kabul) and Tapa Sardar (near present-day Ghazni) suggest that this composite practice occurred during earlier phases at each site, before earth-based production became predominant (Forgione 2021; Verardi 1983). On the other hand, evidence from Kara Tepe suggests a different local sequence (Kovaleva 1996, 230, 235 etc.). Composite techniques may

4 The discussion here encompasses examples in which the coating is thick and homogeneous and completely conceals the underlying layer.

5 Tarzi (1976) reported examples of the latter method at Tapa Shotor. Kovaleva (1996) mentioned its thickness in sculptures from Kara Tepa.

6 For example, according to Marshall (1951), such sculptures were found at Jaulian A11, E1, S1, -3, and -4, and at Dharmarajika P1 and N18.

7 Gypsum is reported at Kara Tepa and Dalvarzin Tepa (e.g., Stavisky 1964; Pugachenkova, Rtveladze 1978) and supported by analyses from Tepe Narenj, Qol-e Tut (López-Prat et al. 2024a), and Fayaz Tepa (Hayakawa et al. 2013). However, lime-based outer modelling layers over earth are reported at Mes Aynak (Ohlídalová et al. 2016, nos 49, 51).

8 Verardi 1983: Tapa Sardar; Paiman, Alram 2013: Tepe Narenj; Tarzi 1986: Tapa Shotor, Kovaleva 1996: Kara Tepe etc.

have characterised an early stage in the broader development of modelled sculptural production in predominantly earthen temple contexts, although their chronological placement across the region remains uncertain.

3 Material Selection in Architectural Context

3.1 Architecture and 'Earth' Selection: A Working Hypothesis

In Buddhist temples of northwestern Pakistan and Central Asia, modelled sculptures were typically integrated with architectural settings, often adjoining architectural surfaces along vertical and/or horizontal planes. A comparison of *in situ* sculptures and their associated architecture also supports the hypothesis that the choice of materials for the sculptures may have been conditioned in part by architectural practices (Yamane 2026).

For heuristic comparison, two recurrent architectural practices may be distinguished: temples featuring extensive application of white plaster (presumed to be lime-based) and those constructed primarily of earth without such large-scale thick white plaster finishing.[9] The former type is characteristic of temples centred in northwestern Pakistan, whereas the latter is widely documented outside northwestern Pakistan. These practices were not mutually exclusive. Mixed architectural traditions occur around the Hindu Kush, while earthen construction is also documented at some sites in northwestern Pakistan,[10] and white finishes occur in earthen architectural contexts.[11] Likewise, earth-based, composite earth and white plaster, and white-plaster-based sculptural practices could coexist. The available evidence is therefore insufficient to posit a deterministic relationship between architectural and sculptural materials of these cases currently.

Correspondences between architecture and sculpture have so far been identified at the level of material description in many cases, but their precise relationship requires further examination, including the extent of material and structural continuity and the possibility of shared raw-material sources or preparation methods. As mentioned earlier, these sculptures consist of multiple layers that likely served different functions, while the nature and degree of their material and technical continuity with architecture may also have varied. It is worth noting that some studies have noted material and compositional similarities between the inner earth used for sculptures and earthen construction materials regarding earth-based sculptures (Tarzi 1986, 80, for Tapa Shotor; Kovaleva 1996, 231, for Kara Tepe). Architectural structures and possibly sculptures may also have undergone repairs in antiquity.

To address this question, while archaeological examination of these interventions is essential to understanding the relationship between

9 Cases where earth serves as the primary wall material with a white plaster surface finish should be seen as a variant of the latter.

10 For example, Jaulian E1 and S1–4 and the niches at Mohra Moradu belong to monastic courts; see also Kalawan B20 (Marshall 1951).

11 Reported examples are Kara Tepa (Stavisky 1964; 1996; etc.); the interior wall at B56 at Bagh Gai (at Hadda) (Barthoux 1933, 164-6); niche C of the Tapa Shotor interior walls (Mustamandi 1968, 64) etc.

architecture and sculpture, the evidence currently available limits the extent to which this relationship can be reconstructed broadly. Thus, the authors have been investigating these issues through detailed material and technological analyses, as discussed in the following sections.

Of course, the choice of materials, specifically the type of earth for sculptural production, cannot be attributed solely to architectural constraints or factors of convenience, cost-effectiveness, and rationality; the specific nature of material selection in image-making warrants further consideration. Earth-based sculpture occurs across a wide range of periods and regions, including in temples characterised primarily by lime plaster, indicating that its occurrence cannot be explained solely by broad regional or architectural tendencies.

3.2 Characteristics of Earth Use in Modelled Sculpture: A Comparison with Lime

As noted above, in the region considered here, sculptural production in architectural contexts characterised by extensive use of white plaster, often presumed to be lime-based, provides a useful contrast to sculptural production in predominantly earth-based architectural contexts. In northwestern Pakistan in particular, lime appears to have been used extensively.[12] Compared with earthen coating, lime plasters are generally more resistant to moisture and weathering and are therefore well suited to exposed architectural surfaces, particularly in environments receiving appreciable rainfall. A characteristic feature of image-making in this region is the repeated representation of figures such as Buddhas modelled in white plaster, often presumed to be lime-based, on exterior architectural elements, including stupas and chapel dadoes (Yamane 2026). By contrast, earth-based sculptures in the same region (cf. footnote 7) were more commonly installed within chapels or niches, where they appear to have functioned more prominently as objects of worship than as architectural decoration. These contrasting contexts suggest that lime-based image-making may have been more closely integrated with architecture, both functionally and in the production process.

To examine this relationship, scientific analyses were conducted by the authors on white plaster artefacts from Mekhasanda and Thareli, including sculptures, architectural decoration, and wall finishes. Both sites are situated on hilltops along the northeastern edge of the Peshawar Basin in present-day Pakistan. The archaeological evidence indicates that Thareli was active from the mid-second to mid-third century and continued into the mid-third to mid-fourth century (Mizuno, Higuchi 1978). Mekhasanda was established by at least the mid-second to mid-third century, flourished during the mid-third to mid-fourth century, and remained active from approximately the mid-fourth to mid-fifth century until the Kidarite period (Mizuno 1969). They were excavated by Kyoto University in the 1960s. Some of the excavated objects

12 Possible lime-preparation tanks occur at several sites (Mizuno, Higuchi 1978, 46; Nishikawa 1999, 69). Lime also occurs in architectural elements at Amluk-dara, Barikot, and Gumbat (Rosa et al. 2019).

were transferred to Japan after the excavations and are currently housed in the Institute for Research in Humanities, Kyoto University.

The analysis covered 19 sculptural fragments (18 from Mekhasanda and one from Thareli) and seven fragments of architectural decoration (four from Mekhasanda and three from Thareli) as well as remnants of the wall structures adhering to the latter's fragments **[fig. 2, tab. 1]**. All objects were examined microscopically and analysed non-invasively using portable X-ray fluorescence spectroscopy (pXRF), with measurement points selected based on microscopic observation. The samples consisted of detached fragments whose original positions within the objects could not be determined; nevertheless, they permitted comparison of the mineralogical and petrographic characteristics of the materials. X-ray diffraction (XRD), thin-section analysis, and cross-section observation by optical microscopy were conducted on selected samples. Details of the analysis settings are provided at the end of the article.

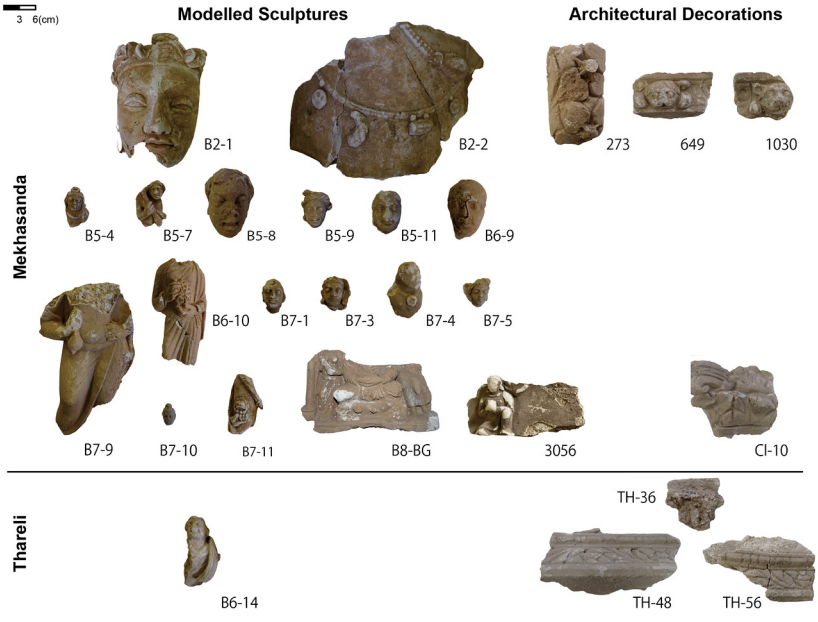


Figure 2 White plaster sculptural fragments and architectural elements from Mekhasanda and Thareli analysed in this study. Photographs by the authors, courtesy of the Institute for Research in Humanities, Kyoto University

These results were reported preliminarily in Yamane et al. (2026a; 2026b). Surface chemical composition analysis indicated that all products were primarily lime-based, with inclusions such as sand or mud-like material. Furthermore, analyses of relatively clean, smooth areas of the shaping layers (sculptures and architectural decorations) and the uppermost wall materials showed inherent variability within individual specimens. Although smaller figures tended to contain higher proportions of admixtures, no clear systematic differences were observed among sculptures, architectural decorations, and wall materials. Thin-section observations were conducted on samples from Thareli (architectural decorations) and Mekhasanda (sculptures and architectural decorations); however, rather than revealing significant

distinctions between modelled sculptures and architectural decorations, the analysis at this stage is highlighting marked differences in mineral composition between the two sites of Thareli and Mekhasanda.[13] Although definitive conclusions cannot be drawn at this stage, and further analysis of a broader range of examples is required, the findings from these two sites lend some support to the hypothesis that lime-based sculptural production was not a completely isolated activity but rather part of a continuous system involving other lime-related operations within the temple complex.

Compared with earthen materials, lime requires additional transformation steps, including calcination and slaking. Where lime was extensively used for architectural finishing and sculptural production, these activities may therefore have drawn on shared systems of material procurement and preparation. Earthen materials, by contrast, could potentially be obtained from a wider range of local deposits and often required less specialised, systematic processing before modelling, potentially reducing the need for coordinated systems of procurement and preparation. This distinction may have allowed greater variation in sourcing and preparation, although actual procurement practices must be assessed on a site-by-site basis. Consequently, the materials collectively referred to here as earth are likely to present a diverse and complex profile.

4 Material Diversity within 'Earth'

4.1 Excavated Evidence

Earlier excavation reports already document considerable variation in earthen modelling materials, typically differentiated by colour, which may reflect compositional differences but do not necessarily represent discrete material categories. At Tapa Shotor, 'greenish' or 'bluish' earth was primarily used for sculpting; although 'yellow' earth was sometimes employed for the core, it was rarely used in the sculptures themselves and was used mainly for components such as sun-dried bricks (Tarzi 1986). In contrast, 'yellow' earth has been reported as a primary material at sites such as Tepe Narenj and Tapa Sardar (Verardi 1983; Paiman, Alram 2013). At Kara Tepe, alongside the dominant 'yellow' earth, the use of 'reddish yellow' and 'bluish' earth has also been reported in some cases (Kovaleva 1996, 239), and at Ajina Tepe, 'brown' or 'green' earth specifically served for the surface sculpturing, whereas a distinct, 'finer and softer dark brown' earth was used for moulded components (Litvinsky, Zeimal 1971). Beyond these site-specific details, a 'red-clay' surface finish is documented at several sites along the southern foothills of the Hindu Kush from the later seventh to early eighth centuries onward (Forgione 2019, e.g., Fondukistan, Tepe Narenj, Tapa Sardar etc.).

These observations indicate that site-specific differentiation in earth selection had already been recognized in previous studies, although earlier reports recorded material differences using descriptive vocabularies appropriate to their respective research contexts. Because these

13 Mineral assemblages suggest local sediments from the foot of the site hills as potential sources (Yamane et al. 2026b).

vocabularies are not always directly equivalent, comparison between sites remains difficult. Thus, although red finishes are recognized as having become popular especially in the southern Hindu Kush in later periods, the temporal and regional trends in the use of earthen materials before that time remain poorly understood.

In recent years, visual inspection has increasingly been complemented by scientific methods, enabling more detailed characterisation of material properties. To date, studies have addressed the mineralogical characteristics and firing condition of earthen sculptural materials, their surface structures and polychromy at Mes Aynak and Kharwar, and sculptural structures at Tepe Narenj using CT (Ohlídalová et al. 2016); the surface polychromy of earth-based sculptures from Fondukistan (Pannuzi et al. 2019); and comprehensive analysis including the chemical and mineralogical characteristics as well as potential use of organic binders in sculptures from Tepe Narenj and Qol-e Tut (López-Prat et al. 2024a).

Although examples remain few and the research is still at a verification stage, establishing comparative criteria based on such detailed information may make it possible to compare analytical results from multiple archaeological sites and potentially integrate findings from different research groups into a systematic classification. Future research should apply similar methods to excavated sculptures to develop a broader understanding of their material and technical characteristics.

4.2 The Potential for Diversity in Earth-Based Sculpture: The Hirayama Ikuo Silk Road Museum Collection

To illustrate the material and, in part, technical diversity of earth-based sculptural practices, this section draws on the results of a comprehensive study of sculptures in the Hirayama Ikuo Silk Road Museum collection. Although the specific provenance of individual sculptures in the collection remains unconfirmed, the collection contains a large number of earth-based sculptures from the region considered here with varied styles and visible material characteristics. They are presented here to clarify the technical details and diversity of earth-based sculpture, aspects that remain largely unresolved for excavated examples.

The broader survey comprised 51 modelled sculptures, of which 19 were classified as earth-based. The present section focuses primarily on these 19 objects **[fig. 3, tab. 2]**. The surfaces were examined using a portable microscope and ultraviolet (UV) light. Subsequently, pXRF analysis was conducted on all the sculptures to investigate the elemental composition of the paint layers and modelling paste. To characterise the mineralogical composition in greater detail, samples were collected from modelling paste of four earth-based sculptures for XRD analysis and thin-section observation.

Based on visual observation of the modelling materials exposed at the surface, the earth-based sculptures in this collection were broadly classified into reddish and yellowish types as descriptive categories based on macroscopic observation. When the pXRF results were also considered, the reddish type exhibited three different surface-finishing techniques: a lead (Pb)-containing layer covering the surface; a white ground layer composed of lime or gypsum beneath the paint; and paint applied directly without a white ground layer **[figs 3-4]**. Among the yellowish type, examples

both with and without a white ground layer were identified. The ground layers included lime-based white layers. In addition, a relatively thick, pale reddish-pink layer was also identified and may have served as a ground.

Because clean, flat areas of exposed modelling paste are scarce, pXRF analysis was conducted on relatively well-preserved, suitable surface areas to assess compositional variation among the earth-based materials. The results indicate that ten reddish-type sculptures (100214, 101572, 102001, 102005, 102006, 102008, 102180, 102181, 102629, and 103719) show relatively similar surface elemental profiles, although two objects (102005 and 102180) are less closely associated with the main cluster because of their relatively low iron (Fe) content **[chart. 1]**, and this group includes examples of all three surface-finishing categories. Among the remaining objects, reddish-type sculptures 102956, 102958, and 102960 are characterised by relatively low silicon dioxide (SiO_2) and aluminium oxide (Al_2O_3) and high calcium oxide (CaO) contents, while the yellowish-type sculpture 103476 shows a similar composition. Two further sculptures (105274 and 102161) are distinguished from the others by their high CaO contents.

Although the number of sampled objects was limited, the analyses further revealed that, in addition to clay-dominated materials (102005 and 102181), some yellowish-type sculptures were made from silt-rich materials (102995 and 105274) **[fig. 5]**. The sample from the inner layer of sculpture 102995 consists of a silty matrix containing numerous fine mineral grains. Their relatively uniform grain size is consistent with the use of a naturally silty raw material, although deliberate processing cannot be excluded. The modelling layer of sculpture 105274 is also silt-rich. The material is also calcareous and contains calcite crystals, which may represent a naturally occurring component of the raw material, secondary formation, or deliberate addition; their origin cannot yet be determined.

Selected comparisons with lime- and gypsum-based objects in the collection further indicate that some surface-finishing practices were not exclusive to a single modelling material. Similar pigments and ground layers occurred across different modelling substrates. These observations suggest that the selection of modelling paste and the treatment of the visible surface were partly independent technological decisions. Comparable cases have been reported in excavated material, indicating shared surface-finishing practices across the regions in both earth- and white-plaster-based techniques (Yamane forthcoming).

The analytical results from the objects grouped here as 'earth-based sculpture' indicate material and technological heterogeneity. Because the pXRF surface measurements may reflect modelling paste, ground, and paint in combination, they cannot be interpreted as the composition of the earth alone. Nevertheless, surface elemental profiles did not necessarily correspond to either the descriptive colour categories or the surface-finishing categories. The recurrence of similar surface-finishing practices across objects with different modelling materials may further suggest that such treatments could be shared beyond a single material tradition. However, because the provenance of the museum objects remains uncertain, it is not possible to determine whether these similarities reflect regional, chronological, or workshop-related patterns. As further analytical data from securely excavated sculptures become available, comparative analysis may eventually allow such objects of uncertain provenance to be situated more securely within regional, chronological, and technological contexts.

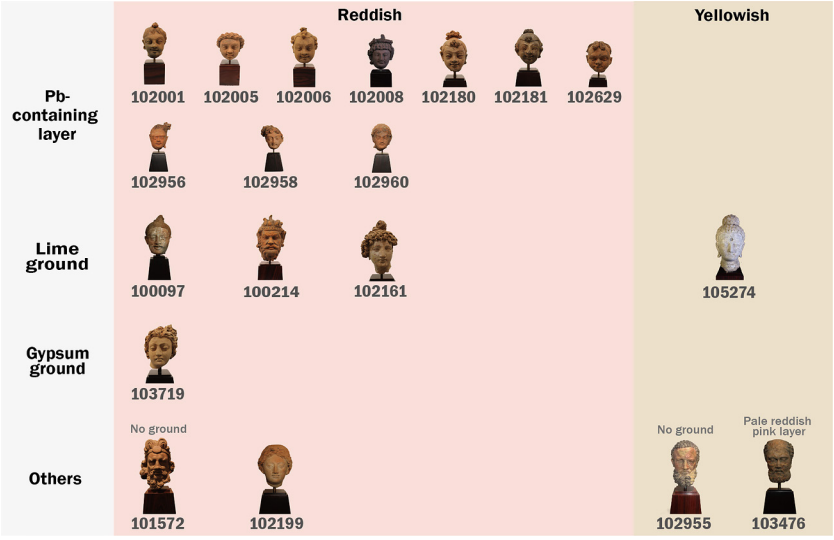


Figure 3 Overview of earth-based sculptures from the Hirayama Ikuo Silk Road Museum collection, classified according to the colour of the modelling paste and the ground layer. The scales are not standardised; for actual dimensions, see Table 2. Photographs by the authors, courtesy of the Hirayama Ikuo Silk Road Museum



Figure 4 Selected surface details illustrating different combinations of modelling paste and ground layers. Photographs by the authors, courtesy of the Hirayama Ikuo Silk Road Museum

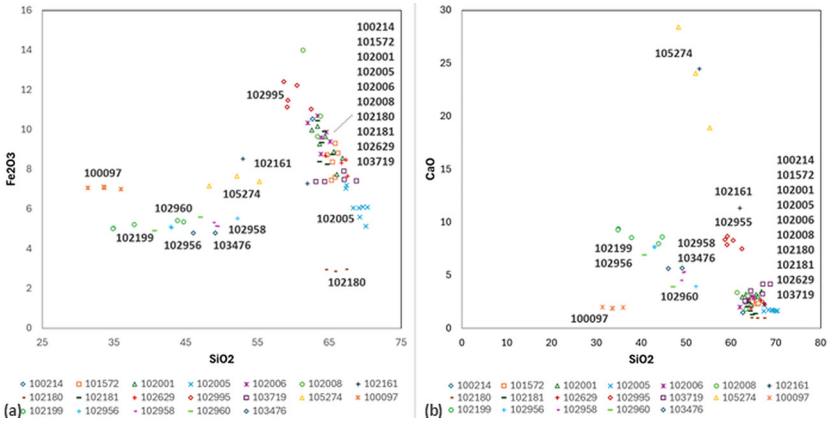


Chart 1 Bivariate plots of pXRF-derived elemental profiles in earth-based sculptures from the Hirayama Ikuo Silk Road Museum collection: (a) SiO_2 versus Fe_2O_3; (b) SiO_2 versus CaO

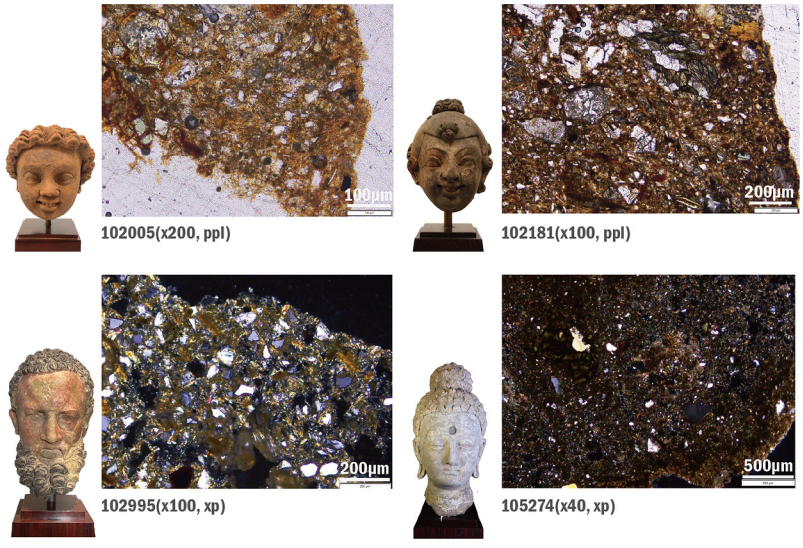


Figure 5 Thin-section images of the sampled earth-based sculptures. Observation under ppl: plane-polarized light; xp: crossed Nicols. Photographs and images by the authors

5 Conclusion

This study has shown that 'earth' encompasses materially and technologically diverse practices rather than a single homogeneous category in Buddhist sculptural contexts across Central Asia. Recent analyses have begun to reveal the internal diversity of the category previously classified as earth largely on the basis of visual inspection. In particular, the results from the Hirayama Ikuo Silk Road Museum collection suggest that 'earth' encompasses not only clay-dominated, but also silt-rich modelling pastes, some of which are also calcareous; consequently, characteristics previously identified by the naked eye are likely to be re-evaluated as distinct materials with specific

properties. While available evidence suggests that the selection of earth for Buddhist sculptures from northwestern Pakistan to Central Asia could be related to architectural practices in some contexts, material selection nevertheless also needs to be considered in relation to the requirements of modelling, desired visual effects, and access to raw materials.

Although this overview has focused primarily on material characteristics, future research should examine internal structure and architectural integration together, building on the technical classifications of Tarzi (1976), Verardi (1983), and Forgione (2021) for examples from the southern foothills of the Hindu Kush, as well as modelling materials. Following Varma (1970), comparisons between excavated and textual resources could clarify the range of technical choices by identifying agreements and divergences.

Earth-modelling practices should also be considered in relation to modelling with white plaster. The two material systems may be used separately or combined within the same sculptural construction, and their relative use may change through successive phases at individual sites. Notably, several documented examples of composite earth and white plaster occur in predominantly earthen architectural contexts during particular phases at some sites, and gypsum has frequently been identified or proposed as the white component at sites. These observations suggest possible relationships among modelling traditions, desired surface finishes, and architectural material practices, but the studies remain insufficient to establish any of these as a general regional pattern. They are therefore presented here as working hypotheses for future investigation.

Acknowledgements

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Analytical Settings

pXRF: Thermo Scientific Niton XL3t-950 portable XRF (output tube voltage: 50 kV; variable output current: maximum 200 μA; analysis mode: Mining Cu/Zn; measurement time: 60 s or 120 s).

Portable microscope: Three R Solutions Viewty autofocus microscope.

Optical microscopes: LEICA DMS (low-magnification observation: 0.75-6.0×); OLYMPUS BX53M (high-magnification observation: 20-400×).

XRD: Rigaku MiniFlex (output tube voltage: 40 kV; output current: 15 mA; goniometer scan speed: 1 deg/min; step: 0.02-0.06 deg; Kβ filter; divergence slit (DS): 0.65; divergence longitudinal limiting slit: 2 mm; receiving slit: open). The sample was crushed in an agate mortar and then packed into a fine-powder sample holder for measurement.

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Table 1 List of analysed objects from Kyoto University

Object no.	No. in this study	Report	Find spot	Microscopy	pXRF painting	pXRF Modelling paste	Sample analysis
—	B2-1	Mizuno ed. (1969) Pl52-6	Behind Chapel 48	Yes	Yes	Yes	XRD Thin section
3274	B2-2	Mizuno ed. (1969) Pl52-8	Behind Chapel 48	Yes	Yes	Yes	No
402	B5-4	Mizuno ed. (1969) Pl57-19	—	Yes	No	Yes	No
545	B5-7	Mizuno ed. (1969) Pl57-31	West of Stupa11	No	No	Yes	No
1191	B5-8	Mizuno ed. (1969) Pl56-4	—	Yes	No	Yes	No
1252	B5-9	Mizuno ed. (1969) Pl56-5	—	No	No	Yes	No
2674	B5-11	Mizuno ed. (1969) Pl56-12	—	No	No	Yes	No
859	B6-9	Mizuno ed. (1969) Pl56-13	—	Yes	No	Yes	No
905	B6-10	—	—	Yes	Yes	Yes	No
TH31	B6-14	—	—	No	Yes	Yes	No
203	B7-1	—	—	Yes	No	Yes	No
313 (S?)25	B7-3	—	—	Yes	No	Yes	No
517	B7-4	—	—	Yes	No	Yes	No
S.15 432	B7-5	—	—	Yes	Yes	Yes	No
2026	B7-9	Mizuno ed. (1969) Pl59-17	—	Yes	Yes	Yes	No
242	B7-10	Mizuno ed. (1969) Pl57-12?	—	Yes	Yes	Yes	No
—	B7-11	Mizuno ed. (1969) Pl59-16	—	Yes	Yes	Yes	No

Object no.	No. in this study	Report	Find spot	Microscopy	pXRF painting	pXRF Modelling paste	Sample analysis
—	B8-BG	Mizuno ed. (1969) Pl59-13	—	Yes	Yes	Yes	No
273	273	Mizuno ed. (1969) Pl63 63	—	No	—	Yes	No
694	694	Mizuno ed. (1969) Pl60-2	—	Yes	—	Yes	No
1030	1030	Mizuno ed. (1969) Pl60-3	—	Yes	—	Yes	XRD Thin section
3059	3059	Mizuno ed. (1969) Pl57 34	—	Yes	—	Yes	XRD Thin section
Cl10	Cl10	—	—	Yes	—	Yes	XRD Thin section
TH36	TH36	—	—	No	—	Yes	Thin section
TH48	TH48	—	—	Yes	—	Yes	XRD Thin section
TH56	TH56	—	—	Yes	—	Yes	XRD Thin section

Table 2 List of earth-based sculptures from the Hirayama Ikuo Silk Road Museum collection

Inventory no.	Object	Height (cm)	Attributed provenance (unverified)	Modelling paste	Ground layer	Tentative interpretation of polychromy and surface finish based on elemental composition	Sample analysis
100097	Head of worshipper	20.0	Pakistan or Afghanistan	Reddish	A Ca-rich white ground, lime-based ground layer	Arsenic was detected across much of the surface, presumably indicating orpiment, while a red pigment (ochre?) was used for linear details	—
100214	Head of worshipper or royalty	22.8	Pakistan or Afghanistan	Reddish	A Ca-rich white ground, lime-based ground layer	The original polychromy is difficult to reconstruct	—
101572	Head of worshipper or royalty	24.5	Pakistan or Afghanistan	Reddish	No ground layer	Red lead paint on the facial flesh areas, whereas the other areas appear to have been painted with earth pigments, possibly iron-containing ochres	—
102001	Head of worshipper (vidūṣaka)	14.0	Pakistan or Afghanistan	Reddish	A Pb-containing layer covering the surface	The surface appears to have been exposed to fire	—

Inventory no.	Object	Height (cm)	Attributed provenance (unverified)	Modelling paste	Ground layer	Tentative interpretation of polychromy and surface finish based on elemental composition	Sample analysis
102005	Head of worshipper	12.0	Pakistan or Afghanistan	Reddish	A Pb-containing layer covering the surface	The surface appears to have been exposed to fire	XRD Thin section
102006	Head of worshipper (vidūṣaka)	13.0	Pakistan or Afghanistan	Reddish	A Pb-containing layer covering the surface	The surface appears to have been exposed to fire	—
102008	Head of worshipper	11.2	Pakistan or Afghanistan	Reddish	A Pb-containing layer covering the surface	The surface appears to have been exposed to fire	—
102161	Head of worshipper	31.0	Pakistan or Afghanistan	Reddish	A Ca-rich white ground, lime-based ground layer	Yellow flesh paint, probably orpiment-based, with unidentified orange linear details	—
102180	Head of worshipper (vidūṣaka)	21.5	Pakistan or Afghanistan	Reddish	A Pb-containing layer covering the surface	The surface appears to have been exposed to fire	—

Inventory no.	Object	Height (cm)	Attributed provenance (unverified)	Modelling paste	Ground layer	Tentative interpretation of polychromy and surface finish based on elemental composition	Sample analysis
102181	Head of worshipper (vidūṣaka)	18.0	Pakistan or Afghanistan	Reddish	A Pb-containing layer covering the surface	The surface appears to have been exposed to fire	XRD Thin section
102199	Head of worshipper	20.0	Pakistan or Afghanistan	Reddish	No ground layer	Painted predominantly with orpiment, with red lead used for the lips?	—
102629	Head of worshipper (vidūṣaka)	12.0	Pakistan or Afghanistan	Reddish	A Pb-containing layer covering the surface	The surface appears to have been exposed to fire	—
102956	Head of worshipper	11.0	Pakistan or Afghanistan	Reddish	A Pb-containing layer covering the surface	Cinnabar paint on the lips and eyes; lapis lazuli on the eyes? An As-containing pigment was also detected	—
102958	Head of worshipper	10.0	Pakistan or Afghanistan	Reddish	A Pb-containing layer covering the surface	Lapis lazuli on the eye? Small remnants of gold leaf remain on the head	—

Inventory no.	Object	Height (cm)	Attributed provenance (unverified)	Modelling paste	Ground layer	Tentative interpretation of polychromy and surface finish based on elemental composition	Sample analysis
102960	Head of worshipper	10.0	Pakistan or Afghanistan	Reddish	A Pb-containing layer covering the surface	Cinnabar paint on the lips; an As-containing pigment on the ornament and skin? Lapis lazuli on the eyes?	—
102995	Vajrapāṇi or Heracles	31.0	Afghanistan	Yellowish	No ground layer	Red ochre was applied directly to the surface for the flesh, and black pigment, presumably carbon black, for the hair	XRD Thin section
103476	Head of worshipper	22.0	Pakistan or Afghanistan	Yellowish	A pale reddish-pink ground layer	No additional paint was identified on the flesh areas, whereas the hair was painted black. Traces suggest that the sculpture may originally have been entirely covered with gold leaf.	—
103719	Head of worshipper	21.0	Pakistan or Afghanistan	Reddish	A Ca- and S-rich ground, consistent with a gypsum-based material	Orpiment, realgar, and red lead appear to have been used	—
105274	Head of Buddha	21.0	Pakistan or Afghanistan	Yellowish	A Ca-rich white ground, lime-based ground layer	Covered with gold leaf	XRD Thin section

From Earth to Enlightenment
Materiality, Technology and Cultural Transmission of Terracruda Sculpture Across Buddhist Asia
edited by Mònica López-Prat, Emma Cantisani, Susan S. Bean

Flesh of Clay
Instructions for Making a Figure from Unbaked Clay

Libbie Mills
University of Toronto, Canada

Abstract The article treats the *Vimānārcanākalpa*, chapters 17 and 18 of which describe the procedure for making unbaked clay (terracruda) figures that are established permanently in place, as a part of the building around them. This text, being dated to the 9th century, is the earliest such account available to us, and is rich in instruction, both technical and ritual. An edition in Roman transliteration and English translation of both chapters are presented, along with a framing discussion.

Keywords Vimānārcanākalpa. Textual instruction. Technique. Ritual. Vaikhānasa.

Summary 1 Introducing the Text. – 2 Field Background. – 3 Methodology. – 4 Analysis. – 5 Links to the Edition and Translation. – 6 Ramifications.

1 Introducing the Text

Presented here is an edition in Roman characters, an English translation, and an analysis, of chapters 17 and 18 of the *Vimānārcanākalpa* (henceforward VAK). In taking part in this writing project, the aim is, of course, to increase access to this particular textual material, and to further the comprehension of the tradition it represents.[1] It is exciting, too, to bring the material into the enriching conversation that is this book, laying the old techniques and viewpoints of the VAK beside the newer methodological approaches and interpretations presented in the volume.

1 To compact the material down to something manageable in print, the edition and translation are posted at Zenodo, `https://doi.org/10.5281/zenodo.23272304`, leaving space here for the discussion, including details of methodology, analysis, and future planning.

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The VAK, being dated to the 9th century, is the earliest extensive account available to us of the unbaked clay (terracruda) sculpture-making process. It is chosen in part for that reason, and also for its relative compactness and completeness.

It belongs to the *Vaiṣṇava* tradition, that tradition which takes Viṣṇu as the principal deity. Within the *Vaiṣṇava* tradition, there arose two chief movements: the *Pāñcarātra* and the *Vaikhānasa*. Current thinking holds that the *Pāñcarātra* movement had authoritative texts by the 7th century, while the *Vaikhānasa* textual record begins in the 9th c. (Colas 2018). A determination of a geographical origin for the movements is difficult: while the manuscript record is largely South Indian, Colas points out that the *Pauṣkarasaṃhitā*, an early *Pāñcarātra* text, refers to sacred locations in both North and South India (Colas 2018).

The *Pāñcarātra* and *Vaikhānasa* movements come to place themselves in opposition to each other. They do so in terms of both affiliation and practice. In the *Pāñcarātra* movement, affiliation is by initiation, while that in the *Vaikhānasa* movement it is by heredity. And difference in practice is discussed in terms of a contrast between a tantric nature for the *Pāñcarātra* stream and a Vedic one for the *Vaikhānasa*. However, these oppositions must be understood to be nuanced (see Colas 2018), and the VAK is recognisable as a tantric text, in structure and content.

The VAK is understood to be the earliest of the *Vaikhānasa* texts. Like much of the corpus, it concerns every aspect of temple ritual. Its very name tells us so: this is the procedure (*kalpa*) for worship (*arcana*) in a temple (*vimāna*). It is also an interestingly hybrid text. In the first instance it is very much a *Vaikhānasa* composition, attributed to the sage Marīci, and detailing the procedure for *Vaikhānasa* temple ritual. But it also includes a remarkable account of yogic practice in preparation for that ritual. James Mallinson and Mark Singleton (Mallinson, Singleton 2017) have demonstrated that its account represents a transition in yogic practice, from the predominantly seated postures of earlier *yoga* accounts to non-seated and dynamic ones that influence later *haṭha* traditions of *yoga*.

Its alternative name, the *Marīcisaṃhitā*, which indicates its authorship, as the compilation (*saṃhitā*) of the sage Marīci, takes us back to its origins. Its usage, on the other end of the scale, carries us forward to the present, in that this remains a guide for artists producing deity images in South India today (Colas 2018, paragraph on "Levels of Ritual Action"), a factor that makes it a particularly useful text for our purposes. But there is a subtlety to add here. While deity images in stone and metal are still made and used in South India as directed by this text, the tradition of making permanent images in terracruda died out in this region at about the time of the composition of the VAK. This part of its record became, for South India, something stuck in time, no longer used, even as terracruda technology continued to thrive elsewhere, beyond South India. However, the situation is more nuanced than it might seem, in that, while widespread production of permanent terracruda temple images has died out in the region, elements of the technology appear to survive. López-Prat et al. 2025 point out that, while permanent terracruda images are no longer produced, there is an ongoing manufacture of ephemeral ones, for temporary ritual use, using recognisably alike materials in a layered technique.

The VAK is one of a number of South Indian accounts of the terracruda construction from unbaked clay composites of images for permanent

installation in a temple. Of these accounts, five are particularly useful to this project. The first two are roughly 12th-century works, and *Śaiva* (dedicated to the deity Śiva): the *Kāśyapaśilpa* (henceforward KŚ) and the *Kāmikāgama*. The next two are roughly 16th-century, and *Vaikhānasa*: the *Atrisaṃhitā*, also known as the *Samūrtārcanādhikaraṇa*; and the *Kāśyapajñānakāṇḍa*, also known as the *Kāśyapasaṃhitā*. The last is the *Śilparatna*, a 16th-century treatise on architecture and iconography which, while its opening invocation is to Viṣṇu, treats material supports in an inclusive manner, across traditions.

The accounts at the KŚ and *Śilparatna* are very close parallels, large sections being similar enough to indicate borrowing on the part of the *Śilparatna*. Other than that close pairing, the texts treat the same procedure, but each in its own manner, and with differences of detail.

The present analysis will draw from all of these sources. It is of interest to note how quickly, though, the record runs dry as one moves out of South India. A survey of North Indian *Vaiṣṇava* and *Śaiva* texts has so far yielded no substantial parallels, beyond short passages discussing the preparation of clay composites for buildings rather than figures. The investigation continues. To date, no Buddhist texts directly addressing the technology have yet been identified.

It is worth thinking about the intended audiences of the texts used here. Among them, the *Śilparatna* is the only full-on *śilpaśāstra*, that is, a text (*śāstra*) specifically designed to convey information on the arts (*śilpa*) of architecture and iconography. The KŚ is, as Ślączka 2007, 11-13 shows us, an interesting combination of *śilpaśāstra* and *tantra*. The rest are all tantric texts, with a wider goal of presenting every aspect of worship within their particular tantric stream, including the creation of architecture and icons as substrates for it. Interestingly, the tantric VAK, at Chapter 17 paragraph 28, itself acknowledges this distinction when it refers one to the *śilpaśāstra* tradition to fill in any procedure that it misses.

In the chapters that treat terracruda one notices the difference between the two types of text. The *Śilparatna* and KŚ read as records for makers rather than ritual protagonists, including, for example, full recipes for making the materials used. The remaining texts also treat manufacture but always couched in ritual. They need to deliver both, so that the ritual officiants and artists, working side by side, can each follow enough of what the other side is doing, but not necessarily in full detail.

One may wonder, then, why the KŚ (or *Śilparatna*) was not chosen as base text for this study. The reasons are two: first, since Varma 1970 grounded his presentation in the KŚ, with reference to the parallel account in the *Śilparatna*, it is good to widen the textual base available in translation; and second, it is important that the ritual work that is the needed concomitant of the artistic one be squarely here before our attention. To address any gaps on the technical side, a materials-and-technology-focused translation of the terracruda account in the KŚ, is underway for future publication.

2 Field Background

The present work is made possible by editions published over the course of the past century, and the digitising of manuscripts by such bodies as the Institut Français de Pondichéry. Also invaluable is Goudriaan's 1965 English translation of the *Kāśyapajñānakāṇḍa,* accompanied by annotations

and glossaries. More tightly aimed at terracruda in particular, and highly influential in connecting terracruda sculptural technology with the South Asian textual traditions, is Varma 1970, a study with a broad vision, working from three types of source: texts, archaeological finds as evidence of past practice, and present practice as seen in Bengal. Varma presents an analysis of what each type of source can yield, together with the results of his experiments to create the objects of study.

He bases his textual analysis mostly on the KŚ, with support from the *Vimānārcanākalpa*, *Kāśyapajñānakāṇḍa*, *Atrisaṃhitā*, and *Śilparatna*. He acknowledges that he does not treat every topic in the written record. The aspects that he chooses to omit are: the ritual that accompanies the construction of the clay image, instead confining the study to questions of construction technique alone; and attention to the 8-fold binding medium (*aṣṭabandha*), limestone paste (*śarkarākalka*), cloth (*paṭa*) and pigment (*varṇa*) layers, instead focusing on the armature (*śūla*), rope (*rajju*), and clay (*mṛd*) layers. Additionally, in his construction experiments, he uses plain clay, rather than the complex clay-composite recipes taught in the texts.

His synthesis is very useful, and one follows with interest his experience as he experiments with the technology, finding the problems and solutions to them, or discovering the purpose of a step that might not at first sight have seemed worth it. But a synthesis inevitably loses the distinct voice of any single text. The hope, in this much more modest study, is to add a sense of the full voice of just one text as it describes the entirety of the production process in both ritual and material domains. To further round out the picture, one might want to compare the account of the VAK with that of the *Kāśyapajñānakāṇḍa* as given in Goudriaan's 1965 English translation.

3 Methodology

In presenting two complete chapters from the VAK, annotated as needed with material drawn in from other parts of the same text and other related sources, the intent is to give a full picture of this telling, so that readers can draw from it their own conclusions. The chapters describe the entirety of the process, in both ritual and material domains, and emphasis is placed on the importance of doing the work precisely and without hurry. The reader who is interested only in production technology will have to be patient as it emerges from a bedding of ritual action and speech. That ritual practice, and the thinking behind it, should be understood as important to the slow, careful and respectful work that produced the beautiful and enduring creations that are our central interest here.

The analysis is here kept separate, as would be a commentary on the text if there were one. On that point, it is worthwhile to stop and think about the fact that there is no commentary. Sanskrit holds a literature full of commentaries upon commentaries. But, in the more technical corners, such as the one we are in here, the instructions given are generally designed to be clear enough to stand alone.

The style of the text is plain, more communicative than beautiful, and the translation will be plain too, to reflect the instructive mode of the original without, as far as possible, translator overlay. There are plenty of technical terms. As each is introduced, the underlying Sanskrit equivalent will be highlighted.

4 Analysis

The VAK, in chapters 17 and 18, describes the procedures behind the shaping of an enduring figure from unbaked / terracruda clay (*mṛd*). The Sanskrit term *mṛd* may, in fact, refer both to plain earth, as dug from the ground (see, for example, chapter 18, paragraphs 31 and 34), and also to the malleable clay composites made from it (see, for example, chapter 18, paragraph 36). The reader needs to be attuned to what is going on, in order to decide which is meant in any particular passage.

The English and Italian terms 'unbaked' and 'terracruda' also need addressing. 'Unbaked' stands well for the Sanskrit *apakva*, which translates directly as 'uncooked / unbaked', rather than 'cooked / baked' (*pakva*). 'Terracruda' comes at the matter from a slightly different angle, referring as it does, more positively, to the raw, rather than uncooked, nature of the clay. But, as the natural counter to 'terracotta', it is a useful term for the resulting sculptural tradition, as discussed in a broader context; and it serves well to communicate the important point, which is that the clay, while admixed with other ingredients, ground, wetted, dried, and matured, is never baked.

It is noteworthy that this account specifically recommends creation with clay (*mṛd*) that is unbaked (*apakva*), rather than baked (*pakva*): VAK chapter 64, which treats remediation (*prāyaścitta*) in the case of wrong procedure or damage to the materials of worship over time, pointedly warns against the use of baked clay, including it in a list of factors that bring harm.

> *dhruvaberaṃ* [...] *pakvamṛṇmayaṃ* [...] *ajñānād arthalobhād vā sthāpitaṃ cet tad ābhicārikaṃ bhavati*.
>
> If (*cet*), through ignorance or error (*ajñānād arthalobhād vā*), a permanent image (*dhruvabera*) made of [...] baked clay (*pakvamṛnmaya*) [...] is established (*sthāpitam*), it becomes harmful (*ābhicārikaṃ bhavati*).

The unbaked nature of these figures is, then, not a happenstance or convenience, but a positive choice, and important to their meaning and function.

On the other hand, one should also note that other texts of this genre do permit baked clay for certain peripheral deities, for example *Atrisaṃhitā* chapter 19.66-70, which begins with stipulating that the principal deity should be unbaked, considers baking optional for certain minor deities, and ends by recommending baked clay for demons:

> *sthānake cāsane caiva śayane ca vidhiḥ smṛtaḥ*
> *mṛṇmayaṃ dvividhaṃ proktam apakvam pakvam ity api*
>
> The procedure has been taught for standing, sitting, and recumbent images.
> Clay [images] are said to be of two kinds: unbaked and baked.
>
> *pūrvoktaṃ mṛṇmayaṃ yat tad apakvam abhidhīyate*
> *mṛdā kṛtvā'gninā dagdhaṃ yat tat pakvam itīritam*
>
> The clay [image] discussed so far is designated as unbaked.
> That which is made of clay and fired with flame is declared to be baked.

apakvaṃ mṛṇmayaṃ viṣṇoḥ kārayeta vidhānataḥ
yadi pakvaṃ ca kuryāc cet sarvanāśakaraṃ bhavet

One should have the clay image of Viṣṇu made unbaked, according to the rules.
If one were to make it baked, it would bring about total destruction.

sarveṣām api devānām apakvaṃ beram ucyate
jyeṣṭhāyāś cāpi kuryāc ced apakvaṃ pakvam eva vā

For all gods, the image is said to be unbaked.
However, for Jyeṣṭhā, one may make it either unbaked or baked.

vakratuṇḍasya śāmboś ca pakvaṃ vāpakvam eva ca
piśācānāṃ ca sarveṣāṃ pakvam eveti kīrtyate

For Vakratuṇḍa (Gaṇeśa) and Śambhu (Śiva), too, it may be baked or unbaked.
For all the demons, it is proclaimed to be baked only.

While *Vimānārcanākalpa* chapters 17 and 18 discuss only fully three-dimensional terracruda sculptures, other chapters treat other operations. There are sections that guide the creation of images in stone, metal and wood, and chapter 15 includes those that are less than fully 3-D, assigning three possible grades of depth: *citra* (3-D statue), *ardhacitra* (bas-relief) and *ābhāsa* (flat representation).

Something remarkable to note is that this text, like the others of its genre, is altogether unillustrated. Every step of this highly visual creation is described in words alone. And those words are delivered in a distinctive category of the Sanskrit language termed *Aiśa* (divine). *Aiśa* material is not required to follow standard language rules, but is free to work in its own register, with non-standard spelling and grammar being taken as markers of divine origin. An excellent account of *Aiśa* language may be found in the introduction to Goodall 1998. As is observed by Oberlies (2003, xxxi), *Aiśa* and standard forms will, at times, both appear in the same passage, with the *Aiśa* structures often introduced to meet metrical rules.

The VAK is presented in prose, but other such texts, the *Atrisaṃhitā*, KŚ, *Śilparatna*, and *Kāmikāgama*, for instance, are composed in metric verse, for ease of memorisation, with the many technical terms neatly folded into a catchy rhythm. This material is full of numbers and proportions. To assist in fitting numbers into the metre of verse, and sometimes in prose, too, many synonyms for numbers are used. Besides the standard number words: *eka, dvi, tri*... (one, two, three...), other words, termed *bhūtasaṃkhyā*, are used as alternative number words. In this system, an object that has a tight association with a particular number is used to stand in for that number. So, for example, since eyes come in twos, words that mean 'eye' (*netra*, *nayana*, *īkṣaṇa*) may stand in for the number two. VAK chapter 22 gives a full account of the *bhūtasaṃkhyā*s used in the text, as tabulated in the footnote VAK chapter 17 paragraph 16.

Besides being full of numbers, the textual material is packed with linear measurements, the rules for which are also set out in VAK chapter 22. It is a system of relative measures which, for images, is centred on the *aṅgula*

(finger breadth), a unit of which there are 3 types: the *māna aṅgula* (an absolute measure); the *mātrā aṅgula* (a measure determined by the size of the middle joint of the finger); and the *dehalabdha aṅgula* (a measure determined according to the height of the image), which is the one we will see used here, for example at VAK chapter 17 paragraph 14. The *aṅgula* is subdivided in a one-eighth system descending down to the miniscule, of which all we need to know here is that 8 *yava*s (barley-corns) make one *aṅgula*. Multiples of the *aṅgula* that will be referred to are: the *tāla* (palm), which is 12 *aṅgula*s and the *hasta* (fore-arm) which is 24.

Our focus in the present study is an examination of the ways in which the VAK presents its account of the procedural knowledge behind the production of unbaked clay figures. That knowledge is highly practical, and the VAK gives detailed attention to each stage in the process, both ritual and material, for three classes of participant – ritual officiant (*ācārya*), patron (*kartṛ* or *yajamāna*), and artist (*śilpi*) – each with a part to play. It is not always precisely specified who does what: in translation, the impersonal 'one' is used to represent that mode. But, in general terms, it should be presumed that ritual is done by ritual practitioners and artwork is done by artists. Our interest here is largely in the instructions for the artist, which we will follow for a view into the materials and technological systems in play, and the rationale behind them, too. VAK chapter 17, at paragraph 25, stipulates that these artists must know the teachings for the procedures, that they must be versed in the tradition.

We will sometimes see the ritual officiant partake, at least in a token fashion, in the physical work done, and then hand it over to the artisans to complete. An example is seen at VAK chapter 17, paragraph 11, where, on the occasion of the felling of a tree from which the armature of the figure will be made, the officiant first makes cuts in the tree on four sides, then summons a wood-cutter to complete the felling. In redirecting the work to the artisans, the language of the text moves into a distinctive mode termed the causative, used to describe action that one makes somebody else do.

The patron pays for the entire procedure. We see payment happen at multiple points, as an example at VAK chapter 17 paragraph 13. In paying the practitioners, the patron ensures that the benefit from the procedure comes to him and not to them.

All the work, whether done by patron, ritual officiant or artist, must be done properly and without haste. This direction, too, is given on repeat, for example, again, at VAK chapter 17, paragraph 13.

The unbaked clay figural project embarked on by these participants belongs to tantric tradition. *Tantra*[2] begins in India and is exported from there, in Hindu, Buddhist, and Jain thought streams. There is material evidence of, and a textual record for, tantric temples in India from roughly the 5th century on. The earliest textual record describes minor shrines

2 The term *tantra* can serve as a label for a category of thought and behaviour. In its first usage, however, the word is a label for a category of text: one designed to hand on its tradition, from teacher to student, by initiation. As text referents, the terms *tantra* and *āgama* are used synonymously. Some texts call themselves *tantra*s; others call themselves *āgama*s; others call themselves both. Both terms refer to the transmission of information. That transmission teaches deity-centred practices, for liberation on the one hand, or, on the other hand, for worldly powers or rebirth in a heaven. Good accounts of *tantra* may be found here: Padoux 2017 gives a full account of Hindu *tantra*; Williams et al. 2012, in an overview of Buddhism in India, includes a chapter on Buddhist *tantra*; and White 2018 treats *tantra* broadly, including attention to Jain *tantra*.

perhaps intended for private esoteric ritual. Later texts present grander shrines clearly designed for public recognition and usage. However, despite the difference in scale, the essential purpose of both is the same: to serve as the domicile of the deity or deities within, and as the locus for their ritual service. The duty to house the deity being an ongoing one, maintained up to the present time, we see temples taking distinctive forms across place and time, from rock-cut cave temples to free-standing structural ones of evolving forms. Once constructed, the temple is consecrated. Then the deity may be installed within it, in iconic or aniconic form, and the deity is, in turn, consecrated. Thereafter, the deity must be attended to with daily ritual conducted by initiated officiants.

The images described in the VAK are created as the iconic forms into which the deity may be installed for worship. For this serious purpose, we will see a well-ordered presentation of a complex sequence of preparations for composite materials in a layered construction of seven principal strata: a wooden armature (*śūla*) assembled from individual wooden stakes which are also called *śūla* or sometimes *daṇḍa*; an 8-fold binding medium (*aṣṭabandha*); rope (*rajju*); clay composite (*mṛd*); limestone paste (*śarkarā*(*kalka*)); cloth (*paṭa*); and pigment (*varṇa*). Besides these seven principal materials, copper filets, pins, and gemstones are also used. All the materials are carefully chosen and prepared, and, in particular, the binding medium and clay are composites of many ingredients, with lengthy curing times. The text will speak for itself, but here are comments on the 7 component layers in sequence:

1. Wooden stakes (*śūla*, *daṇḍa*)

The VAK assigns a full chapter (chapter 17) to the formation of the stakes alone, packing all the other layers together into a single chapter (chapter 18). The wooden stakes form an armature skeleton as follows: The *mauli* stake is for the head, although not every text has a head stake separate from the spine one. The VAK gives it as an option. The spine (*vaṃśa*) stake runs vertically from the base of the spine to the top of the head. The chest (*vakṣaḥ*) stake lies horizontally across the upper chest. The hip (*kaṭi*) stake lies horizontally across the hips. The 2 thigh (*ūru*) stakes run from groin to knee. The 2 lower leg (*jaṅghā*) stakes run from knee to ankle. The 2 sole (*tala*) stakes run from heel to toes. The 2 upper arm (*bāhu*) stakes run from shoulder to elbow. The 2 lower arm (*prakoṣṭha*) stakes run from elbow to wrist. The 2 side (*pārśva*) stakes run down the two sides of the torso between the chest and hip stakes. The hands, fingers, toes and ears are made with copper strips (*tāmrapaṭṭa*).

To hold the stakes together, tenon (*śikhā* or *udaya*) and mortise (*avagāḍha*) joints (*sandhi*), pins (*kīla*), pegs (*dāru*), and more copper strips (*tāmrapaṭṭa*) are used. And to secure the finished statue, subsidiary stakes (*upaśūla*, *ādhāraśūla*, *ādhārabhitti*, *bhittiśūla*, or *phalaka*) attach the armature of the standing figure to the wall behind it, and the seated or recumbent figure to the seat or bed beneath it, see VAK chapter 18 paragraphs 16-20.

The way in which the armature is formed is fairly standardised across texts, with some minor variants. A noteworthy feature is the straight spine stake for a male deity, while that of female deities is curved to give a sway of the torso, see VAK chapter 17 paragraph 27. The female deities also do not have side stakes, as noted at VAK chapter 17 paragraph 26.

The spine stake is described in VAK chapter 17 paragraph 15 as being formed with a different cross section at each of three levels: square in cross section from penis to navel, octagonal from navel to throat, and circular from throat to crown of head.

The knee and elbow joints are less clearly explained in the VAK than at the KŚ and *Śilparatna* chapters on the stakes, where it is made clearer that the 4 *aṅgula*s of the knee are, in fact, made up of the bottom 2 *aṅgula*s of the thigh stake and the top 2 *aṅgula*s of the lower leg stake with a tenon and mortise joint between them, and the elbow joint is similarly made out of the elbow ends of the upper arm and lower arm.

As the stakes are being laid ready for assembly into a complete armature, the text, at chapter 18 paragraph 7, warns against crowding the stakes or mixing them up. They are to be marked in order to avoid the possibility of confusing them.

2. Eight-fold binding medium (*aṣṭabandha*)

The *aṣṭabandha* eight-fold binding medium coats the wooden armature. Its recipe is not discussed at all at the *Atrisaṃhitā*, *Kāmikāgama*, or *Kāśyapajñānakāṇḍa*. At the VAK and KŚ (and its close copy at the *Śilparatna*) it is presented with very similar ingredients, but in different proportions **[tab. 1]**.

Table 1 The recipe for 8-fold binding medium in the VAK and KŚ / *Śilparatna*

Ingredient of 8-fold binding medium (*aṣṭabandha*)	**Parts out of 24 in VAK chapter 18**	**Parts out of 24 in the KŚ / *Śilparatna* chapters on tying the ropes**
śrīveṣṭaka (resin of *Pinus longifolia*)	4	4
kunduraṣka (resin of olibanum)	5	3
guggulu (resin of bdellium)	1	5
guḍa, *guḷa* (molasses)	8	1
sarjaka (resin of *Vatica robusta*)	3	8
gairika (red ochre)	–	3
dhātucūrṇa (talc)	3	–

The above ingredients are mixed and ground, and cooked with sesame oil and ghee. At the KŚ (and *Śilparatna*), we are told that they are cooked until they have the consistency of honey.

3. Rope (*rajju*)

Ropes, made from coconut husk and grass, are wrapped around the *aṣṭabandha*-coated armature. From a practical point of view, this is done to bind them firmly, but we are told, too, that the wrapping is done in such a way as to map the patterns of the bodily vessels (*nāḍī* or *sirā*), running from

the navel and covering the body from head to foot. At the VAK, chapter 18 paragraph 29, the vessels are said to be 14 in number, and we are given minimal information about how they wrap the frame beyond the fact that there are two phases of wrapping, with a layer of cotton thread in between them. The KŚ (and *Śilparatna*) chapters on the ropes list many more vessels, naming each of them, and giving much more information on their patterning. Varma 1970 follows these latter instructions in his experiments.

4. Clay composite (*mṛd*)

Clay composite is applied next. The VAK describes the application as happening in two stages, with another wrapping of rope in between. The first application is described in chapter 18 paragraph 36 as being done using a *karaṇḍikā* basket tool rather than the hands. This ruling is not seen in other texts, and remains something of a puzzle. In a final step, gems are inserted into the clay at specific points across the limbs of the body, as described at paragraph 37.

The VAK gives a recipe for the clay composite that is thorough in terms of the ingredients and the substantial lengths of maturing time required, but not clear on amounts. So it is good to turn to other records in search of a more usable recipe. There is minimal information on the clay mix at *Atrisaṃhitā* and *Kāmikāgama*. At *Kāśyapajñānakāṇḍa* chapters 47 and 48, there is plentiful information but it, like that of the VAK, is not precise on ingredient amounts. More useable, as Varma noted, are the KŚ (and *Śilparatna*) chapters on the preparation of clay, which give a complete recipe with full precision around amounts of ingredients to be added, and textures to be obtained. Interestingly, in the KŚ (and *Śilparatna*) accounts, the dug earth from which the composite is made is referred to as *paṅka* rather than *mṛd*. Both words refer to earth or clay, but *paṅka* carries a more immediate meaning of mud, thus differentiating the earth base from the clay composite. And unlike other accounts, that of the KŚ (and *Śilparatna*) records the addition of coconut fibre to the mix before it is applied.

As to the ingredients given in the VAK, they are:

- the clay itself
- perfumed sand
- decoctions of the bark of *khadira* (*Acacia catechu* Willd.), and *kakubha* (*Terminalia arjuna*)
- decoctions of the bark of *aśvattha* (*Ficus religiosa*), *udumbara* (*Ficus glomerata*), *plakṣa* (*Ficus microcarpa* L.), and *nyagrodha* (*Ficus benghalensis* L.)
- water imbued with the three Myrobalan fruits (the fruits of *Terminalia chebula*, *Terminalia bellerica* and *Phyllanthus emblica*)
- powdered stone
- *śrīveṣṭaka* (the resin of *Pinus longifolia*)
- powdered barley corns (*yavasāra*), wheat (*godhūma*), and black gram (*māṣa*)
- resin of bdellium (*guggulu*), olibanum (*kunduruṣka*) and *sajjarasa* (*Vateria indica* L.)
- curd, honey, ghee, flax oil, sesame oil, and the juice of the fruit of the wood apple tree (*bilva*)
- powdered turmeric (*rajanī*)
- the three *kaṭuka* pungents (long pepper, black pepper and ginger)

- powdered extract of *kapittha* (*Feronia acidissima* L.); powdered yellow orpiment (*haritāḷa*), *koṣṭha* (*Saussurea lappa.* C.B.Clarke), ox-gall (*rocanā*), black sandal (*kṛṣṇa candana*), and *agaru* (*Aquilaria agallocha* Roxb., Aloe wood)
- powdered gold and silver
- banana fruit, coconut milk, and cow milk
- earth from a river, mountain, corn field, ant hill, or ocean, or the hole made by a crab, or dug up by the horn of an elephant or bull

5. Limestone paste

In translating *śarkarākalka* as limestone paste, the present account is following, and agreeing with, Varma (1970, 24-5), where he argues that this paste (*kalka*) is made from a gravel (*śarkarā*) that is, specifically, limestone. His argument for limestone is, in part, based on the term *ghaṭi*, that we sometimes see drawn into the name of the paste, as *ghaṭiśarkarā*. He works from a range of meanings of the root *ghaṭ* - "to connect, unite, form, shape"- that indicate a binding element. Following Varma, the present study understands the paste as a finer and paler clay, layered over the base clay to make a smooth surface for the application of pigment (Varma 1970, 105).

The VAK treats the limestone paste, but briefly. The *Atrisaṃhitā*, *Kāśyapajñānakāṇḍa*, and *Śilparatna* too, are curt. But then, there is not much to say as far as ingredients are concerned, there being only the limestone itself, washed, ground, and mixed with resins and water. The KŚ offers more in the way of a record of the viscosity one is looking for, and items admixed to the paste.

The materials given in the VAK for the limestone paste are:

- powdered limestone
- water imbued with the three Myrobalan fruits (the fruits of *Terminalia chebula*, *Terminalia bellerica* and *Phyllanthus emblica*)
- water decocted with the resin of *kapittha* (*Feronia acidissima* L.)
- cotton fibre

6. Cloth

Varma (1970), in his practical experiments, found the cloth layer to be essential, not only for the smooth surface it gave, but also to reinforce the joints of the armature. Made of cotton (*kārpāsa, ambara*), it covers the body. Over it goes another layer of limestone paste, then ornaments, then a layer of *mauktika* (pearl) clay is applied. This last is not further described but is, one takes it, named for its pale pearly colour, presumably good as a base layer beneath pigment ones. A final layer of limestone paste is added, too.

7. Pigment

Pigments are mixed with water containing extract of *kapittha* (*Feronia acidisssima* L.) as a binding medium, and applied with a brush (*tūlikā*), with gold in the final layer, bringing power (*śakti*) to the figure. The VAK offers only 4 basic colour choices: white, golden, dark, and black. In the KŚ on the other hand, there are 3 full chapters on colours, the source materials for them, and how to mix and apply them, in 6 layers, each with a different brush

action – from a full stroke to the finest dots – and each with less binding medium than the last.

As the VAK notes in chapter 17 paragraph 29, referring back to a fuller discussion in chapter 15, the completed figure is installed in the innermost chamber of the temple in a position determined within a grid of parts laid over the floor of the temple. The positioning of a permanently installed, immobile, image is done with a grid of 7 by 7 parts, whereas for a temporary, mobile, image it is done in a grid of 16 by 16.

The preparation and application of each of the seven layers for that completed figure (stakes, binding medium, rope, clay, limestone paste, cloth, and pigment) is accompanied by ritual action and attention, vocalised in *mantra* form. The layers are more than just useful material substrates. VAK chapter 17 paragraph 30 equates the seven principal layers of terracruda construction with layers of the body: the stake is bone, the binding medium is fat, the rope is the vessels of the body (*nāḍī* or *sirā*), the clay is flesh, the limestone paste is blood, the cloth is skin, and the pigment is vitality, life (*jīva*). Such an equation of materials with bodily organs aligns with the actual creation of a being rather than its mere representation - a created being that will be animated by means of pigment and ritual, and a living being that should not be baked.

Our examination of this layered account of the procedure naturally leads one to consider how the text, and the body of literature that it represents, can inform the interpretation of terracruda practice across time, place and culture. The host text for this account, the VAK, is a *Vaikhānasa Vaiṣṇava* ritual account from South India. That might seem to be an oddly dislocated record, given that the sculptural production under archaeological study is largely Buddhist and Central Asian. But it is also a tantric text, part of a thought-line of *Tantra* that runs through not just this one *Vaikhānasa Vaiṣṇava* tradition, but also through the wider *Vaiṣṇava*, *Śaiva*, Jain and Buddhist worlds. *Tantra* is (as its name avers) a connecting thread of continuity. This continuity of ideas, handed on over time, place, and tradition, is surely a bridge between a set of instructions held in a *Vaikhānasa* text from South India and sculptural production in Buddhist contexts all along the silk route. One can understand this transmission of technological instruction to have followed a Tantric thought route that is the ideational companion of that physical silk route, filling the apparent geographical and religious gap between textual instruction and surviving material traditions. For a vision into the ways in which the ideas of *Tantra* could have travelled, see the account of textual transmission along the silk route in Wen (2023, 73-76).

At the same time, the VAK itself calls for caution: in chapters 74 and 77, it warns of the dangers of crossing ritual traditions. In comparing this text with *Śaiva* parallels, and in using it to understand the production of Buddhist figures, we will need to be aware of its own *Vaikhānasa* context, even as we conceive of it as part of a broader transmission and transformation of technological knowledge across regions and traditions. With that caution in mind, though, we can benefit from the richnesses offered by a cross-traditional and cross-regional transmission of terracruda technology.

The VAK is also cautious in regard to any possible error in procedure. Towards the end of its account of the entirety of procedure for worship in a temple, the text, in chapter 64, gives the rules for remediation in the case of error in procedure. Having, in chapters 17 and 18, detailed what should be done to make an unbaked clay image, VAK chapter 64, in listing the possible

failures in the procedure, recaps the steps in the technique, giving us one last insight into anxieties over error:

> *beroktaśūlānāṃ pratyekaṃ taduktamānadvitricatuṣpañcaṣaḍyavamānaṃ hīnaṃ cet, tāmreṇa saṃpūrṇaṃ kṛtvā vaiṣṇavaṃ puruṣasūktaṃ dadbhyaḥ svāhety aṃgahomaṃ ca hutvā punar ārabhet*
>
> If, for any of the stakes taught for the image, the size of the stake is 2, 3, 4, 5, or 6 *yava*s less than that taught, one should fill the gap with copper, and having offered a *Vaiṣṇava*, a *Puruṣasūkta*, '*dadbhyaḥ svāhā*' and an *aṅgahoma*, one may proceed.
>
> *snehadravyacūrṇakaṣāyauṣadhiṣu hīneṣu prayogaviparyāseṣu ca rajjub andhāṣṭabandhamṛdālepanaghaṭīśarkarālepanapaṭāchādanābharaṇādiṣu kramahīneṣu varṇavyatikrame ca vaiṣṇavaṃ brāhmaṃ aiṃdram āgneyaṃ mahābhūtadevatyaṃ prājāpatyaṃ ca vyāhṛtyantaṃ hutvā yathāvidhi yathāsthāne krameṇa kārayet*
>
> If oils, powders, astringents or herbs are lacking, or there is an error in mixing, or there is a deficiency in the binding of the ropes, the binding medium, the anointing with clay, or the anointing with limestone paste, the covering in cloths, the adornments, etc., or a fault in the pigments, one should offer a *Vaiṣṇava*, *Brāhma*, *Aindra*, *Āgneya*, *Mahābhūtadevatya*, and *Prājāpatya* ending with *vyāhṛti*, then make it properly in due sequence according to the situation.

So, errors may be corrected. We learn, too, that while such rectitude may come first, beauty is also attended to. As an example, *Kāśyapajñānakāṇḍa* chapter 49 advises that the finished figure should delight the mind:

> *tataḥ śilpī bhagavantaṃ dhyātvā mūrdhādi pādaparyantaṃ krameṇa bhaktyā yuktyā tattaccharīre krameṇa yāvat dravyaṃ manoharaṃ budhyāhlādakaraṃ śāntikādyujjvalitaṃ kārayet*
>
> After that the artist should meditate on the Lord and have the parts of the body rendered, from head to foot in turn, with devotion and rectitude, so that the material is charming, pleasing to the mind, appeasing, and gleaming.

It is nice to end by noting that, for all their dry and procedural style, the texts that direct terracruda production also call for it to be beautiful.

5 Links to the Edition and Translation

Please turn to Zenodo `https://doi.org/10.5281/zenodo.23272304` for the edition in Roman characters and English translation of VAK chapters 17 and 18. The edition is, at base, a transliteration into Roman characters of the 1926 Madras edition with some emendments marked in the footnotes.

In a step away from the textual tradition, the edition and translation are divided into numbered paragraphs for referencing purposes.

6 Ramifications

Rather than draw this account together into a conclusion, this final paragraph will consider what could grow out of it. It is hoped that an eased access to the VAK will make it a useful resource, for both those who work on texts and those who work with materials. While old, the text, being highly practical, lends itself to adoption for practical purpose today. Its way of thinking about terracruda, the words used to describe it, too, can be useful, as we think about and discuss terracruda in the present.

A further line of research concerns the experimental reconstruction of the recipes for the *aṣṭabandha* wood varnish, clay-based composites, and limestone paste, in order to assess the properties and practical behaviour of the resulting materials. This work is already underway for the TANTRiC project (Traditional Knowledge for the Conservation of the Silk Roads Monumental Terracruda Sculptures), a Marie Skłodowska-Curie Actions Postdoctoral Fellowship funded by the European Union under Horizon Europe (Grant agreement No. 101105953).

Comparison between the materials produced according to these textual recipes and the technological evidence documented archaeologically may also provide further insight into the relationship between prescribed practice and material execution.

This author will continue to examine known textual sources related to unbaked clay technology, beginning with the KŚ, while also seeking additional relevant texts. Further references or suggestions concerning such sources would be welcome.

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From Earth to Enlightenment
Materiality, Technology and Cultural Transmission of Terracruda Sculpture Across Buddhist Asia
edited by Mònica López-Prat, Emma Cantisani, Susan S. Bean

Colouring the Body
Pigments, Symbolism, and Beauty Practices in Ancient Afghan Buddhist Art

Giulia Forgione
University of Naples "L'Orientale", Italy; Italian Archaeological Mission in Afghanistan

Abstract This paper examines the role of colour, pigments, and ornamentation in Afghan Buddhist clay and stucco sculpture (4th-8th c. CE). Moving beyond purely symbolic interpretations, it considers pigments both as precious materials and as elements of visual experience. The relationship between sculptural ornamentation, real objects, and broader visual traditions receives particular attention. The study also investigates whether pigment choices may reflect culturally embedded ideals of beauty and bodily appearance, including practices comparable to the use of cosmetics, thereby opening new perspectives on artistic production, material culture, and perceptions of the body.

Keywords Buddhist art. Pigments. Cosmetic practice. Ornamentation. Beauty. Bodily appearance.

Summary 1 Introduction. – 2 Bodily Appearance and Ornaments. – 3 Precious Stones and Pigments: Shared Material Knowledge. – 4 From Minerals to Pigments: Colour, Materiality, and Meaning. – 5 Pigments Across Sculptural Polychromy and Cosmetic Practices. – 6 Conclusions.

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1 Introduction

Between the 4th/5th and 8th c. CE, clay, stucco,[1] and mixed techniques[2] became particularly widespread across a vast region extending eastwards from Afghanistan to Xinjiang and southwards from Uzbekistan to India, where they were used to decorate Buddhist sacred spaces. Among the richest surviving *corpora* are Buddhist clay and stucco sculptures[3] produced in Afghanistan, many of which retain remarkable evidence of their original polychromy. Although the origins and transmission of this sculptural practice remain debated, its relationship with the Indian world is reflected in Sanskrit technical and ritual literature. Compiled between the 6th and 12th c. CE, the *Śilpaśāstra*s, *Āgama*s, and other treatises on arts and crafts also prescribe the production and polychromy of clay images.

Indian cultural influence extended beyond the technological and material aspects of this tradition to its aesthetic and iconographic language, since most of the figures represented belonged to the Indian cultural sphere. Colour likewise helped define iconographic types and shape how sacred images were understood and experienced.

Although colour has often been lost or survives only in fragmentary form, the remaining evidence shows that pigments formed an integral part of the sculptural conception rather than serving merely as a decorative finishing layer. According to the texts, through colour, artists completed the transformation of clay into living sacred images, contributing not only to their visual appearance but also to their symbolic and ritual efficacy.

Despite the importance of polychromy, its systematic study has long been hampered by several factors. Traces of colour are often poorly preserved, and their survival depends not only on the pigments themselves but also on the integrity of the complex stratified system to which they adhere. Clay sculptures are composite objects made from materials with very different physical and chemical properties. An inner clay core, prepared by mixing vegetal fibres into the clay paste, was modelled around a wooden armature, sometimes reinforced with reeds and ropes. The core was then covered with progressively finer layers of clay, followed by finishing layers of clay or stucco intended to receive the polychromy. All these constituent materials, together with any organic binding media, are susceptible to deterioration over time. Consequently, surviving polychromy is often difficult to detect and may not be visible to the naked eye.

Moreover, access to the archaeological material remains limited. Many sculptures are held in Afghan museums, while others are dispersed among

1 In this study, 'stucco' is used as a conventional broad term for white, malleable composite sculptural materials whose precise composition has not been established by archaeometric analysis. In Central and South Asia, these may include gypsum, lime-based compounds, or mixtures of components, depending on local traditions and technological practices. The term therefore refers to a class of modelling materials rather than a specific composition, unless a more precise identification is available.

2 'Mixed techniques' refers to sculptures combining clay and stucco, generally with a clay core and an external stucco coating of variable thickness, ranging from a few millimetres to more than 2 cm. The stucco could also be extensively modelled to achieve the final shape and surface details.

3 In this study, 'clay sculpture' refers specifically to sculptures made of clay and dried without firing.

collections elsewhere.[4] Where such evidence has been investigated, research has focused mainly on identifying pigments and painting techniques through archaeometric analysis (Stančo 2016; Olivieri, Pannuzi 2019). By contrast, the principles underlying these techniques, together with the cultural significance of colour, have received far less attention (Forgione 2019; Filigenzi 2020; Forgione 2025). Still less attention has been paid to the relationship between sculptural polychromy and culturally constructed notions of bodily appearance – including complexion, cosmetic practices, and the use of precious materials and ornaments.

This paper proposes a more integrated approach to the study of colour in the Buddhist sculpture of Late Antique Afghanistan. Drawing on archaeological evidence from major Buddhist sites such as Tapa Sardar, Tepe Narenj, Fondukistan, Mes Aynak and Hadda,[5] as well as comparative data from neighbouring regions and Sanskrit texts, it considers pigments not simply as technical materials but as elements embedded within a wider cultural system.

Comparisons with available analyses of pigments used in cosmetic practices in earlier periods and more distant regions also help situate this fragmentary evidence within the longer history of material and aesthetic traditions.

Ornaments, jewellery, and coloured surfaces are examined as interconnected expressions of shared concepts of beauty, status, and sacredness, embodying visual codes common to both artistic production and everyday life.

The paper also considers whether certain pictorial conventions observed in Buddhist sculpture – especially in the rendering of the skin, lips, and eyes – may have drawn on contemporary practices of bodily adornment and cosmetics. Rather than treating symbolic and naturalistic interpretations as opposed, these dimensions are considered complementary in the construction of the figures.

4 At present, direct access to archaeological material in Afghanistan remains severely restricted by the security situation, while opportunities for fieldwork and institutional collaboration are limited. The dispersal of sculptures among museums and collections in Afghanistan and abroad further complicates the study of coherent archaeological and artistic *corpora*.

5 The sites discussed here comprise a selection of well-documented Buddhist sites in Afghanistan and neighbouring regions investigated by different archaeological missions during the twentieth and twenty-first centuries. They were selected for the quality of the available archaeological record and their importance for the study of clay and stucco sculpture. With the exception of Hadda and Mes Aynak, which comprise several sacred areas, most are organised around a principal cultic space centred on a main stupa and associated with subsidiary structures and monuments. Mes Aynak and Tepe Narenj are among the few major Afghan Buddhist sites extensively excavated in the twenty-first century, through large-scale rescue excavations and a planned archaeological programme, respectively. Together with earlier discoveries at key sites such as Tapa Sardar and Fondukistan, these excavations have substantially expanded our understanding of the artistic and technological development of Buddhist sculpture in Afghanistan. For detailed information on the individual sites, excavation histories, and archaeological missions, the reader is referred to the extensive published literature; only the principal excavation reports and selected reference studies are cited here. These include: Taddei 1968; Taddei, Verardi 1978; Verardi, Paparatti 2005 (Tapa Sardar); Paiman, Alram 2013 (Tepe Narenj); Hackin, Carl, Meunié 1959 (Fondukistan); Hackin 1928; Barthoux 1933 (Hadda); Massoudi 2011; Litecka, Marquis, Engel 2013 (Mes Aynak).

2 Bodily Appearance and Ornaments

Figures in Indian art, as well as in the Buddhist art of Central and South Asia, are governed by iconographic conventions that define the identity of represented beings through a complex system of visual codes. Alongside postures (*āsana*s), gestures (*mudrā*s), garments and hairstyles, the body itself is constructed according to precise proportional canons that help express the nature, rank and spiritual qualities of the figure. The perfection attributed to divine or sacred beings is thus conveyed through bodily appearance, making beauty a visible manifestation of purity, virtue and transcendence. Physical features could likewise convey ideals of conduct and morality.

Within this cultural framework, ornamentation – including colour as an integral element of appearance – was never understood as mere decoration. The Sanskrit concept of *alaṃkāra*, meaning 'to make sufficient' and usually translated as 'ornament' or 'adornment', originally conveys the idea of rendering something complete, perfect, and appropriate to its function. The same term was used in Sanskrit poetics to designate rhetorical devices that embellish literary language, whereas in the visual arts it primarily refers to the adornment of the human form with jewellery, garments, flowers, hairstyles, auspicious marks, and cosmetics.

Accordingly, these elements did not simply beautify the body; they completed it, making it appropriate to its intended role, whether divine, royal, or ritual. *Alaṃkāra* also had an auspicious and protective dimension: jewellery, unguents, perfumes, and cosmetics could act as talismanic elements, invoking prosperity and warding off harmful forces (Gonda 1975).

Although Buddhas, monks, and ascetics generally lack jewellery – which symbolically expresses renunciation of worldly possessions – they are nevertheless visually characterised by other forms of adornment, including distinctive colours, garments, and iconographic attributes. By contrast, most other figures are richly adorned with necklaces, bracelets, *keyūras*, rings, earrings, and elaborate hair ornaments, as well as, in some cases, sumptuous crowns and garments decorated with rows of plaques representing jewelled textiles. Comparable motifs also occur elsewhere in sculptural programmes, for example in representations of textiles and thrones supporting sacred images, reflecting a broader visual culture in which precious materials and adornment held particular significance.[6]

Moreover, several studies have shown that jewellery and other objects represented in sculpture, including thrones and furniture (Srinivasan 2021), often reproduce items from contemporary material culture. This correspondence is particularly well documented in Gandharan art (1st c. BC-3rd c. CE), both in schist and limestone sculpture (Tissot 1999; Rabbani 2020) and in later clay and stucco productions (Forgione 2024).

Examples from geographically distinct sites show how similar forms could reflect a broader body of technical knowledge, aesthetic conventions, and practices associated with valuable materials. These include sculptural

6 For several examples of figures and their distinctive features, including ornaments, attributes, garments, and decorative motifs, see Faccenna, Filigenzi 2007.

ornaments from Fondukistan, decorative plaques from Tapa Sardar and Tepe Narenj, and artefacts made of precious materials from Mes Aynak.[7]

Clay ornaments therefore did not merely reproduce jewellery; they translated objects already familiar in contemporary society into sculptural form. Among these, precious stones and coloured inlays – whether real gems, semi-precious stones, or coloured glass – held a particularly prominent place.

3 Precious Stones and Pigments: Shared Material Knowledge

Precious materials have long played an important economic role. From a religious perspective, Buddhism also encouraged the circulation and use of precious and semi-precious substances, including gemstones, metals and, arguably, pigments. These materials were used for ritual offerings and donations and to embellish sacred images and religious monuments.

Buddhist literature frequently refers to the so-called Seven Precious Substances (*saptaratna*), a group of seven precious materials whose composition varies among textual traditions.[8] These substances adorned Buddhist paradises and constituted especially meritorious offerings. Their presence in sacred spaces, relic deposits, and sacred images conveyed not only wealth and prestige but also profound religious and symbolic meanings. At the same time, their economic and symbolic value depended not only on rarity and visual qualities but also on the specialised knowledge and technical skills required to recognise, acquire, and transform them.

This material framework is also essential to understanding sculptural polychromy and its possible relationship with cosmetic practices. At first sight, precious substances, pigments, and cosmetics may seem to belong to distinct domains. Yet these domains were interconnected by knowledge of how mineral and organic raw materials were identified, acquired, and processed. Minerals thus formed a common resource base from which pigments, cosmetics, and precious objects could be produced for different purposes, with some materials circulating between these spheres (malachite is one example).

This does not necessarily imply that the same artisans worked across all these domains. Rather, it points to a broader technological and economic system in which specialised knowledge, natural resources, and artisanal practices circulated among different crafts, workshops, and networks of production and exchange.

Another important link between precious and semi-precious stones and mineral-derived pigments lies in their natural origin. Their provenance – often associated with mountains, caves, and other powerful natural environments – contributed to their symbolic significance. In Indian thought, certain precious substances and naturally occurring materials

7 Although the gem-like forms reproduced in clay cannot be conclusively associated with specific minerals, they may be compared with those found in actual gemstones and other precious substances. Some shapes were associated with specific materials, as cutting techniques were intended to enhance properties such as transparency, colour, and brilliance. Such forms of expertise are not exclusive to the modern world, but belonged to long-standing traditions of recognising, processing, and appreciating mineral resources. These comparisons may therefore help reconstruct the possible original appearance of the clay ornaments, including their colours.

8 For further information and references, see Forgione 2024, 48-51.

could be understood as *svayambhū* ('self-existent' or 'self-generated'), a concept referring to entities that arise spontaneously in nature rather than through human intervention (Filigenzi 2015). Their perception as manifestations of nature rather than products of human manufacture could, in turn, enhance their sacredness and exceptional ritual value. Natural properties were therefore closely connected to the meanings attributed to these materials. Many minerals were associated with mythical origins and consequently endowed with cosmological, spiritual, apotropaic, and even therapeutic properties.

4 From Minerals to Pigments: Colour, Materiality, and Meaning

The visual, physical, and chemical properties of minerals shaped the economic, cultural, and symbolic values attributed to them. Among the criteria used to assess raw materials, colour, lustre, transparency, and crystalline structure were key (Biswas, Biswas 1996).

Of these, colour held a particularly prominent place. Colour could evoke natural elements such as the sky, the sea, the moon, the stars, and vegetation, generating emotional and symbolic associations.

Indian aesthetic thought also recognised a psychological dimension of colour. This is embodied in the concept of *rasa*, the aesthetic and emotional experience that works of art were expected to elicit in viewers. Like poetry and theatre, the visual arts therefore conveyed emotions through form, gesture and colour. At the same time, colour (*varṇa*) occupied a central place in Indian systems of classification and evaluation, extending well beyond artistic production.

These observations are particularly relevant to the study of sculptural polychromy. If substances derived much of their significance from visual qualities, especially colour, the same principle may apply to pigments. Whether obtained from costly minerals or cheaper substitutes, pigments could reproduce the chromatic, symbolic, and emotional qualities associated with precious materials, allowing clay sculpture to participate in the same visual and conceptual language.

Less expensive substances, including coloured glass and ornamental stones, were also frequently used as substitutes, suggesting that, in some contexts, visual appearance – especially colour, brilliance, and transparency – could outweigh the intrinsic value of the material itself. This is particularly relevant to painted sculpture, where pigments of differing economic value could fulfil comparable visual and symbolic functions.

Orpiment provides a useful example. Although modern mineralogy has shown that it contains no gold, its brilliant golden-yellow appearance led ancient societies to associate it with the precious metal. This association gave orpiment symbolic meanings related to the sun, prestige, and wealth, and may also have increased its economic and social value relative to ordinary yellow pigments such as ochres. At Fondukistan, orpiment appears to have been applied to the earrings of some figures to imitate gold jewellery, while at Mes Aynak it was used beneath gilding, presumably to heighten its brilliance and chromatic effect.[9]

9 See Forgione 2025, 135-7, with previous bibliography.

Lapis lazuli offers another example. Although technically a rock rather than a mineral, it has been among the most highly prized blue materials since antiquity. Its deep blue surface, punctuated by golden inclusions of pyrite, evokes the night sky and may help explain its association with ideas of transcendence, stability, serenity, and meditation.

Other pigments derived from valuable mineral resources include cinnabar and gold, the latter also applied as leaf or powder.

The symbolic significance of colour, however, extended well beyond the imitation of precious materials. In Buddhist sculpture, colours were not always used naturalistically; instead, they could express qualities attributed to the figures represented. Gold leaf, for example, was applied to the skin of enlightened beings such as the Buddha, thereby manifesting their perfected nature **[fig. 1]**. Likewise, blue was frequently used for the Buddha's hair and around the eyes, not as a naturalistic colour but to reinforce his transcendent appearance and convey his transformative power **[figs 1-2]** (Forgione 2019; Filigenzi 2020).

From this perspective, sculptural polychromy should be understood not merely as a decorative or technical practice but as a visual language embedded in broader cultural conceptions of colour, materials, and bodily appearance. This raises the further question of whether colours applied to the face, beyond explicitly codified choices such as the golden complexion of enlightened beings, drew on contemporary cosmetic practices and culturally defined ideals of bodily appearance.



Figure 1 Buddha head from Qol-e-Tut. © Zafar Paiman/ Italian Archaeological Mission in Afghanistan



Figure 2 Buddha head from Tepe Narenj. © Zafar Paiman/ Italian Archaeological Mission in Afghanistan

5 Pigments Across Sculptural Polychromy and Cosmetic Practices

Although many pigments employed in antiquity are now known to be toxic, they were widely used not only in painting and sculpture but also in cosmetic practices. Archaeological evidence remains limited, particularly for Afghanistan and South Asia; nevertheless, the available laboratory analyses indicate that several mineral pigments were used in both domains, often serving comparable aesthetic, symbolic, and, in some cases, functional purposes.

This overlap is particularly evident in the treatment of the eyes. As noted above, the eyes of Buddhas, bodhisattvas and occasionally donor figures were frequently outlined with a dark pigment, often blue **[fig. 2]**, although black examples and instances combining blue and black are also well documented.

This aesthetic may be compared with the long-standing practice of outlining the eyes with kohl, usually black or dark grey, which remains widespread throughout India, Pakistan, and Afghanistan and is traditionally applied by both women and men (Simpson 2021, 2).[10] Pāli and Sanskrit do not clearly distinguish between blue and black, as both colours may be encompassed by the term *nīla*, broadly meaning 'dark'. The same term is used in textual descriptions of the Buddha's eyes, suggesting that this feature belonged to the set of idealised bodily characteristics defining the Buddha as a perfect being (Filigenzi 2020).

This broad semantic range suggests that the visual effect of darkness may have been more significant than the precise hue. At the same time, it may have allowed some flexibility in the choice of pigments and in the interpretation of the tradition, depending on resource availability, economic constraints, and the scope for artistic creativity. Preliminary, as yet unpublished analyses from Tepe Narenj, for example, indicate the use of lapis lazuli for blue details on the sculptures, probably including the eyes.[11] Unfortunately, no chemical or physical analyses are currently available to identify the materials used for the black lines at other sites.

Similarly, the archaeological evidence for pigments used in eye cosmetics remains fragmentary, with available data spanning different regions and periods. Nevertheless, these data reveal both regional preferences and patterns of circulation. For example, galena and malachite were widely used as eye cosmetics in Egypt as early as the 2nd and 5th millennia BC, respectively (Mocchiutti 2013, 5). By contrast, analyses from Afghanistan, Pakistan, and India point primarily to the use of antimony-based preparations.

This geographical distinction should not, however, be interpreted too rigidly. Antiquity was characterised by extensive exchange networks through which raw materials, finished products, technical knowledge, and aesthetic practices circulated across vast areas. The use of pigments such as galena (see Chandra 1940, 66; Simpson 2021, 2) and the more widely available malachite

10 The use of kohl has deep historical roots and is attested as early as the Indus Civilisation (Chandra 1940, 62-5). Beyond its decorative function in emphasising the eyes, kohl also fulfilled ritual, protective, and therapeutic purposes. Brides traditionally wore kohl during marriage ceremonies, children received it as protection against the evil eye, and many formulations were believed to prevent eye diseases and alleviate discomfort caused by intense sunlight owing to the properties of their ingredients.

11 The analysed sample cannot be conclusively associated with a specific area of the sculpture. Nevertheless, detecting lapis lazuli in a fragment preserving barely visible pigment traces remains informative, as it suggests a wider use of this pigment at the site, where blue traces are commonly observed on sculptural and painted surfaces.

in South Asia and Afghanistan therefore remains possible, even where direct evidence is lacking. Conversely, the repeated archaeological discovery of antimony rods – often elaborately decorated – at sites such as Besnagar in India, Bala Hisar in Afghanistan, and Taxila, Sirkap[12] and Barikot (Colliva 2012, 49-50, tab. 3.4) in Pakistan attests to a well-established tradition of antimony-based eye cosmetics across the region, at least during the Kushan and Gupta periods, with possible textual references dating as early as the *Atharva Veda* (Chandra 1940, 70, 105). At Mohenjo-daro (3rd/2nd millennium BC), green earth has also been identified as an eye cosmetic, providing a close functional parallel with the use of malachite in Egypt (Chandra 1940, 66).

By contrast, the use of lapis lazuli as a cosmetic pigment has not yet been established with certainty. Only two cosmetic containers from the Tehran Plain (6th-5th millennium BC) have been reported to contain lapis, and these findings require further investigation (Vidale et al. 2016, 19, fn. 56).

However, several pigments used in the polychromy of clay sculptures also occur in cosmetic practices. These include ochres, cinnabar, and lead-based compounds such as red and white lead. White lead, like gypsum, could be used either on its own or mixed with other pigments to modify their hue or increase opacity. Copper-based minerals are also documented.

Red ochres, derived from hematite, were among the most widely used pigments throughout antiquity, including in cosmetics. Equally significant is the apparent use of cinnabar at Mohenjo-daro. Unidentified red pigment residues on an applicator stick provide early evidence for the use of such materials on the lips or cheeks (Chandra 1940, 66), suggesting that this was already an established aesthetic practice. Their use on the lips continued in later historical periods and, in many regions of South Asia, has survived to the present day (Chandra 1940). Given the widespread production of lead-based pigments, red lead may also have served similar cosmetic purposes, although direct evidence remains limited.

White lead was extensively used as a cosmetic foundation to lighten the complexion, reflecting an aesthetic ideal that associated fair skin with beauty, refinement, and, in many cultural contexts, elevated social status. This practice is attested as early as the 4th millennium BC in Iran, at Shahdad and Shahr-i Sokhta. Similar evidence comes from Mohenjo-daro during the 3rd/2nd millennium BC, where lead carbonates were used to whiten the face. The production of synthetic white lead is well documented in Egyptian cosmetics during the 2nd millennium BC and was later described by Pliny the Elder in the *Naturalis Historia*. Comparable practices are also reported in the Greek and Chinese worlds (Chandra 1940, 66; Mocchiutti 2013, 4-8).

Gypsum provides a less prestigious but equally significant example. It could be used in cosmetics either in pure form or mixed with other pigments to lighten their colour, a practice documented in both Iran and Egypt. Although direct evidence from Afghanistan and South Asia is currently lacking, its use in these regions cannot be ruled out.

Copper-based minerals, including atacamite and paratacamite, have been identified in cosmetic materials from Shahr-i Sokhta in Iran (Mocchiutti 2013, 33-4, 38). Given the shape of the containers and their reconstructed use, these minerals may have been used as ingredients in eye cosmetics to produce green or bluish hues.

12 For a detailed bibliography, see Chandra 1940, 27 fn. 3.

Comparable conventions can be observed in the sculptural polychromy of late antique Afghanistan, particularly in the treatment of facial features and skin tones.

White complexions, produced with pigments such as calcium carbonate, gypsum, or possibly white lead, are particularly common among sacred figures, including Buddhas, bodhisattvas, and attendants (see, for example, Stančo 2016, 182, 187, 192-3). Their recurrent association with enlightened or morally elevated beings suggests that a light complexion was deliberately chosen to convey ideals of purity, spiritual perfection, and elevated status. Conversely, dark complexions could in some cases characterise demonic or malevolent beings, as in the depiction of the *yakṣa* Āṭavika at Mes Aynak (Filigenzi 2013, 49-50). However, conventions of skin colour were not limited to this opposition. In several painted contexts, the alternation between light- and dark-complexioned figures may also have served other purposes, including the visual differentiation of geographical or cultural identities.[13]

Red pigments were equally important in shaping the appearance of the face. Shades of red were often applied to the lips, cheeks, and eyelids, while fine red lines emphasised physiognomic details. Red ochre was by far the most common pigment, although red lead has also been detected on the cheeks of a sculpture from Hadda, one of the major Buddhist centres of the Kushan and Huna periods, where it was used with ochre to enhance the skin tone.[14] In another case, physicochemical analyses identified cinnabar on the lips of a Buddha head from Mes Aynak (Stančo 2016, 131, 183; Forgione 2025, 137). The emphasis placed on the mouth – a feature closely associated with breath, speech, life, and the transmission of the Buddha's teaching – is potentially significant.[15] It cannot be excluded that this choice also echoed contemporary cosmetic practices, in which cinnabar was likewise applied to the lips; the early evidence from Mohenjo-daro offers a possible, much earlier parallel for its cosmetic use.

Realgar and orpiment (for the latter, see also above) provide a further example of pigments shared between artistic and cosmetic contexts. According to Pāli textual sources, both were used as cosmetics and in various ritual practices (Chandra 1940, 77, 125). In artistic contexts, they are documented, for example, at Ajanta in the rendering of skin tones.[16]

Green hues are less frequently documented and analysed in clay sculpture and were generally obtained from copper-based pigments (see, for example, Stančo 2016, 136-7). These pigments, however, were typically used for garments, body haloes and other elements rather than for the face and body, although green earth has been reported in the flesh tones of some figures at Ajanta (Bon Valsassina, Capanna, Ioele 2013).[17]

13 Such distinctions are visible, for example, in painted contexts from Bamiyan, Ajanta (India) and Kizil (Xinjiang), where differences in skin tone may have functioned as visual markers of geographical or ethnic diversity (see the demons and the Gods of the Directions at Kizil in Zin 2010, 26-7). Colour conventions therefore appear to have conveyed a range of symbolic, social, and cultural meanings.

14 For further discussion and references, see Forgione 2025, 134.

15 Cinnabar was also associated with ideas of transformation and regeneration, partly because it was the principal source of mercury, whose capacity to bond with gold was interpreted as evidence of transformative power (Biswas, Biswas 1996, 50).

16 See Bon Valsassina, Capanna, Ioele 2013; ASI, NRICP 2015.

17 It should be noted that green earth is distinct from copper-based green pigments and was available locally at Ajanta.

6 Conclusions

The evidence discussed in this study suggests that pigments and coloured materials cannot be understood solely within the sphere of artistic production. Rather, they formed part of a cultural system in which the same, closely related, or functionally equivalent substances circulated across different domains, including sculpture, painting, cosmetics, ritual practices, medicine, and, in some cases, metallurgy. Their meanings and functions were shaped not only by aesthetic choices but also by technological knowledge, the availability of natural resources, shared cultural traditions of beautification, and symbolic values. Comparison with cosmetic practices further suggests that such materials could contribute to the appearance and adornment of both sculpted and living bodies.

Although the available evidence remains fragmentary and unevenly documented, bringing together archaeological, archaeometric, and textual sources offers a more integrated perspective on the role of colour in Buddhist societies. Future research based on broader datasets and more systematic interdisciplinary investigation may refine this picture and clarify connections that remain tentative at present.

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From Earth to Enlightenment
Materiality, Technology and Cultural Transmission of Terracruda Sculpture Across Buddhist Asia
edited by Mònica López-Prat, Emma Cantisani, Susan S. Bean

A Technical Study of *Kneeling Attendant Bodhisattva* from the Mogao Caves, Dunhuang

Construction Materials and Techniques of the Polychromed Air-Dried Clay Sculpture

Angela Chang
Straus Center for Conservation and Technical Studies, Harvard Art Museums, USA

Katherine Eremin
Straus Center for Conservation and Technical Studies, Harvard Art Museums, USA

Georgina Rayner
Straus Center for Conservation and Technical Studies, Harvard Art Museums, USA

Isabel McWilliams
Iowa State University, USA

Abstract This study of a *Kneeling Attendant Bodhisattva*, a Tang-dynasty polychromed, air-dried clay sculpture from the Mogao Caves, Dunhuang, China, characterises its materials and construction. Removed by Langdon Warner in 1924 for Harvard University's Fogg Art Museum, it remains the only sculpture from the site outside of China. The sculpture has been minimally restored. Examination, imaging, and instrumental analyses reveal that the sculpture was made in situ with traditional techniques of Dunhuang: a bound wooden framework is layered with clay mixtures and decorated with applied details, paint, and gilding. Copper inlays were discovered in the eyes.

Keywords Dunhuang. Mogao. Mogaoku. Sculpture. Langdon Warner. Terra cruda. Clay. Fibres. Air-dried. Polychromy. X-radiography. XRF. SEM-EDS

Summary 1 Introduction. – 1.1 History. – 1.2 Description. – 1.3 Dunhuang Sculpture-making Process. – 1.4 Objectives. – 1.5 Previous Studies. – 2 Examination and Analytical Methods. – 2.1 Ultraviolet-induced Visible Fluorescence Photography. – 2.2 Computed Radiography (CR). – 2.3 X-Ray Fluorescence Spectroscopy (XRF). – 2.4 Scanning Electron Microscope with Energy Dispersive Microanalysis (SEM-EDS). – 2.5 Polarised Light Microscopy (PLM). – 3 Materials. – 3.1 Clay. – 3.2 Fibres. – 4 Construction. – 4.1 Wooden framework. – 4.2 Modelling. – 5 Condition. – 5.1 Condition history. – 5.2 Current condition. – 6 Discussion. – 7 Conclusions

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1 Introduction



Figure 1 (a) Side originally facing the cave entrance, (b) 'Hidden' side facing into the cave niche, (c) Back. *Kneeling Attendant Bodhisattva* (from Mogao Cave 328, Dunhuang, Gansu province). Late-7th c. Air-dried clay with paint and gilding, 121.9 × 67.3 × 67.3 cm. Harvard Art Museums/Arthur M. Sackler Museum, First Fogg Expedition to China (1923-24), 1924.70. Cambridge, MA, USA, © President and Fellows of Harvard College

1.1 History

Dunhuang, located in present-day Gansu Province, was once a thriving waystation oasis along the travel routes connecting Central and East Asia from the second to the fourteenth century. Located 25 km from Dunhuang, the Mogao Caves (*Mogaoku* 莫高窟 'peerless caves') remain a rich repository of Buddhist culture, preserving textual and visual traditions in its massive cliffside complex of 492 embellished cave shrines. With many cave-shrines decorated corner to corner and including sculptural and wall-painting programs, the visual imagery is distinctly multicultural, reflecting Buddhist and Daoist themes. The spaces were built as sites of familial veneration and Buddhist devotion, constructed primarily by monastics or lay patrons of multiple generations of powerful families. Dating to the early Tang dynasty (618-704), Cave 328 demonstrates the flourishing of Pure Land Buddhism, centred on devotion to the Buddha Amitabha of the Western Pure Land and featured on the transformation tableaux of the north and south walls of the main hall. Consistent with Mogao caves of the early Tang, Cave 328 consists of an anteroom, a corridor, and a square hall with a truncated ceiling depicting the future Buddha Maitreya. Along the west wall, opposite from the hall's entrance from the east, is a recessed niche graced by a total of nine sculptures, one of which was the *Kneeling Attendant Bodhisattva*, originally positioned at the Buddha's proper far right **[figs 1-2]**.

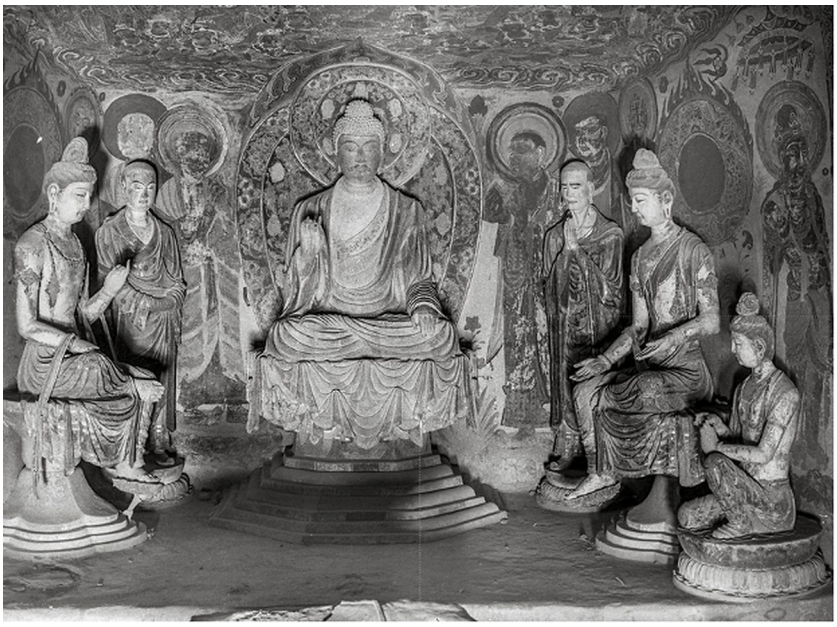


Figure 2 A shallow depression remains where the *Kneeling Attendant Bodhisattva* was positioned. West wall Buddha niche, Mogao Cave 328, Early Tang (618-704). Lo Archive photograph, 1943-44 (Lo 328-2). Lo Archive Images, Princeton, New Jersey, USA. © Trustees of Princeton University

In 1923, American art historian Langdon Warner (1881-1955), the newly appointed curator of East Asian Art at Harvard University's Fogg Museum, led the First Fogg Expedition to China. As the young museum sought to become the first American institutional presence in Asian Art scholarship and collecting, Warner was expected to join the ranks of the archaeologist Aurel Stein and the sinologist Paul Pelliot, who had published reports on the Mogao Caves and dispersed the contents of the Library Cave two decades earlier. In January 1924, Warner removed twelve wall-painting fragments and the *Bodhisattva* sculpture with its base for the Fogg Museum, justifying his actions as an effort to salvage them from further damage caused by the White Russian soldiers **[fig. 3]**.[1]

The fragments and the sculpture arrived at the Fogg in 1924, where they became the subject of scientific study by chemist Rutherford J. Gettens. He analysed the sculpture's pigments and media using optical microscopy and microchemical testing. Although his work remained largely unpublished, it represented pioneering research in the emerging field of conservation science. His notes from 1936 remain in the Harvard Art Museums' conservation records, and he included some findings in his encyclopedia of painting materials (Gettens, Stout 1942).

In 1944, China established the National Dunhuang Art Research Institute (now the Dunhuang Academy), dedicated to research and preservation, emphasizing the study of painting and sculpture through copying images using traditional techniques. Chen Zhixiu is recognised as Dunhuang's first artist to copy sculptures. In 1951, she created scaled-down replicas

1 Warner, *Letter to E.H. Bell* 1924.

of at least five major figures (Du, Du 2025, 7). Generations of artists have since handed down this practice as a critical mode of studying imagery and perpetuating artistic knowledge. Reflecting its cultural significance, the Dunhuang painted sculpture technique received recognition in 2007 as an intangible cultural heritage in Gansu Province (Du, Du 2025, 11).



Figure 3 Langdon Warner, Removal of the *Kneeling Attendant Bodhisattva* statue. January 1924. Black and white photograph. Harvard Fine Arts Library, Special Collections, Cambridge, Massachusetts, USA [public domain]

1.2 Description

The life-sized *Kneeling Attendant Bodhisattva* and its base were constructed *in situ*, measuring 121.9 × 67.3 × 67.3 cm including its base **[fig. 1]**.[2] Free-standing, the figure kneels on the right knee, with the left foot planted on a double lotus base. The *Bodhisattva* leans slightly forward, pressing hands together in a praying gesture. The smooth face has a tranquil, downcast expression, with lips resting closed. Subtle folds modelled on the neck help to emphasise the downward tilt of the head. The ears are elongated, and the hair is styled with a loose, tall topknot. The flesh is painted white with areas of pink shading. The figure is adorned with gilded jewellery, including a long necklace, arm bands, and bracelets. A long scarf is draped over the shoulders, trailing down through the arms. The lower body is dressed in a flowing skirt painted with colourful floral and striped patterns and enhanced with gold details. The skirt has wave-shaped folds that depict a thin, clinging fabric that pools on the top of the base. Painted decoration is executed in a palette of white, red, blue, green, and yellow, with some pink toning and gilded details.

2 Additional information and link to a 3D model can be found on the museum's website: `https://hvrd.art/o/303672`.

1.3 Dunhuang Sculpture-making Process

Since the mid-twentieth century, artists at Dunhuang have developed deep knowledge and insights into traditional materials and painting techniques based on their study and reconstructions of original painted clay sculptures (*caisu* 彩塑). While some modern adaptations appear to have been made for reconstructions, the following summary of the traditional, four-stage process is based on descriptions by Du and Du (2025, 99-136) and Fu (2026, pers. comm.).

1.3.1 Constructing the Core or Armature

Clay mixtures are applied over a core. The type of core depends on the size of the figure. Large-scale figures are formed over stone cores carved during the excavation of the cave. Medium-sized statues, the most common, are modelled over a wooden armature (*mugujia* 木骨架) made with joined timbers or branches. The primary woods used at Dunhuang are the native desert species red willow (*hongli* 红柳; *Tamarix ramosissima*) and Euphrates poplar (*huyang* 胡杨; *Populus euphratica*).

1.3.2 Binding the Straw Core (*caoxin* 草芯)

Organic materials are wrapped around the armature to reinforce the wooden framework, add mass, and reduce the clay's volume and weight. Abundant jiji grass (*jiji cao* 芨芨草; *Neotrinia splendens*) with long, flexible leaves and stalks is used for wrapping and tying; chopped wheat straw (*maijie* 麦秸) has a rough texture that binds the clay mixture; and reeds (*luwei* 芦苇) add bulk.

1.3.3 Modelling

Chengban tu (澄板土) is the alluvial sediment from the Dangquan River at Dunhuang. Often translated as just 'clay' or 'mud', *chengban tu* is the basis for all sculpture and painting at Dunhuang. It is fine-grained and has low shrinkage properties.

- Ground layer (*dizhangceng* 地仗层): A coarse 'straw mud' composed of *chengban tu*, chopped straw, sand, and water is worked into the straw core and built up to model the figure. Du and Du (2025, 112-13) note that since *chengban tu* has poor binding strength, it must have been mixed with a tackier clay, *niantu* (黏土), to hold to the straw-wrapped core. Though yet unproven, they hypothesise that a source of excavated *niantu* for the caves was located 15 km from Mogao.
- Fine layer: 'Fine mud' (*xini* 细泥) or 'hemp mud' made from c*hengban tu* mixed with sand, water, and beaten hemp fibres, is used to model or mould fine details, and to make a smooth surface for painting the sculpture. Other additives may include grass, cotton, rice water, animal glue, or egg whites. As the sculpture slowly dries, shrinkage cracks are filled and smoothed in multiple cycles.

1.3.4 Painting and Gilding

An alum and animal glue solution may be applied to seal the dried clay and improve its water resistance. A ground layer is applied before painting and gilding. Mineral and organic pigments in an animal glue binder[3] are applied.

1.4 Objectives

Today, the *Kneeling Attendant Bodhisattva* remains the only work of its kind outside of China. Despite its long history at the Harvard Art Museums, it has never been the subject of a dedicated technical publication. Aligning with the Dunhuang Academy's commitment to sustaining artistic traditions, this technical study aims to support heritage preservation by advancing understanding of materials and technologies. In turn, this understanding can be applied to planning care and conservation interventions. The study has three objectives:

- Document the condition and condition history of the sculpture, originally intended to be immovable;
- Interpret analysis of the air-dried clay mixtures and fibres, comparing data with existing literature;
- Characterise the construction and modelling techniques, relating observations from visual examination and imaging to published descriptions of sculpture-making.

This paper focuses on the sculpture's condition, the clay mixture's composition, and its construction. A forthcoming paper will address the analytical findings on the grounds, pigments, gilding, and chemical alterations in pigments that have changed their appearance.

1.5 Previous Studies

Previous research on the materials and techniques at Dunhuang has favoured wall paintings over sculpture, reflecting the site's traditional hierarchies and the focus on murals more globally. Despite their technological overlap, references for sculpture remain scarce, particularly in English. This study draws from several publications for terminology, materials, and construction techniques.

For general classification, López-Prat et al. (2024) advocate for the term 'monumental terracruda sculpture' to describe earthen-based sculptures made with shared artistic traditions transmitted via the Silk Roads. Bean (2026) suggests the direct descriptor 'air-dried' for terracruda clay mixtures, rather than misleading words such as 'unfired' or 'sunbaked'.

On earlier sculpture-making practiced in Central Asia, Afghanistan, and India, Tarzi (1986) and Varma (1987) document related modelling techniques for clay and stucco sculptures. For technical execution, Du and Du (2025, in Chinese) offer a contemporary primary source on Dunhuang sculpture-making that combines the perspectives of a master craftsman and a scholar.

3 Researchers at the Dunhuang Academy identified oxhide glue binder on murals through analysis. Plant glues, including peach gum, were also available (Du, Du 2025, 170).

Invaluable to this study, they detail the sources, preparation, and application of traditional materials. Importantly, they document terminology specific to the local materials and processes. Many publications on materials research for Dunhuang wall painting techniques exist; Wong, Agnew 2013 and Su 2021 were the English-language references consulted here.

Historical context is drawn from archival sources and from Bewer 2010, which chronicles the emergence of the conservation profession in the United States, linked with and fueled by the First Fogg Expedition. Balachandran (2007) examines the expedition's preservation ethics and provides the first published descriptions of the damaged sculpture and wall painting fragments.

2 Examination and Analytical Methods

Multiple analytical methods were employed to examine and characterise the sculpture's original materials and alterations. Analysis initially focused on non-destructive methods, followed by limited sampling for further analysis. All techniques were carried out by the authors at the Harvard Art Museums, except where noted.

2.1 Ultraviolet-induced Visible Fluorescence Photography

Materials or conditions that fluoresce in the visible light range (400-780 nm) when illuminated by UV light (typically 315-400 nm) can be identified or distinguished. These include some pigments, binding media, coatings, and restoration materials.

UV-induced visible fluorescence images were captured with a Canon EOS 5D Mark IV camera fit with Peca 918 and Kodak Wratten 2E filters and using TripleBright 3 lights, model LW370-FL68 (370 nm).

2.2 Computed Radiography (CR)

Two-dimensional X-radiographs were taken to examine the internal structure, materials, repairs, and condition. The different radiodensities of materials result in value contrasts in the images.

The X-ray source was an XRS Comet system with MXR-320/26 X-ray tube. Images were captured on a Carestream INDUSTREX XL blue digital imaging plate processed with a Carestream INDUSTREX HPX-1 digital system. The X-ray tube was set with a 3.0 mm focal spot size, using a 3 mm copper tube filter. Exposures were taken at 320 kV, 4.65 mA, 125-270 seconds, with a 250 cm tube-CR plate distance. Images were enhanced with filters applied in INDUSTREX software.

2.3 X-Ray Fluorescence Spectroscopy (XRF)

XRF analysis is a non-destructive, elemental technique that can identify the inorganic elements present on the surface of a sample site. The XRF system employed was a lab-based Bruker Artax XRF spectrometer with a Silicon Drift Detector (SDD) and a rhodium anode X-ray tube. The primary X-ray

beam was collimated to give a spot size of 0.65 mm. Using the Bruker Artax (version 7.6) software, spectra were acquired for 100 seconds live time at 50 kV and 600 μA. Analysis was undertaken without a helium flux, resulting in poor detection of light elements (atomic number of potassium and lower).

2.4 Scanning Electron Microscope with Energy Dispersive Microanalysis (SEM-EDS)

SEM imaging and elemental analysis were used on cross-sections of clay samples to reveal their micro-structure and the elemental composition of different particles and layers.

SEM-EDS was carried out by the authors at the Museum of Fine Arts, Boston. Samples were analysed using a JEOL JSM-IT500LV SEM (tungsten filament) with an Oxford Instruments X-MaxN SDD, 80 mm^2 detector (resolution Mn Kα, 126 eV) running the Oxford Instruments Aztec software (version 4.2 SP1). The SEM was operated in low vacuum mode at a chamber pressure of 60 Pa, with an operating voltage of 20 kV, beam current optimised for dead time of analysis and working distance of 10 mm. The cross-sections were not carbon coated prior to analysis.

2.5 Polarised Light Microscopy (PLM)

PLM uses high magnification and filters to examine samples in detail. This technique was used to study fibre morphology to aid in the identification of the incorporated plant material.

To prepare fibre samples for PLM a sample was covered with a drop of deionised water. The individual fibres were manually separated using tungsten needles under a microscope and then covered using a cover slip. The prepared sample was observed using a Leica DMRX microscope equipped with four objectives (10×, 20×, 40× and 63×). The fibrillar orientation of the fibre was studied using the Herzog test. Images were captured using a Zeiss Axiocam 305 Colour digital camera using the Zeiss Zen 2.6 (blue edition) software. The water was allowed to evaporate before the introduction of the Graff 'C' stain, and the sample was observed for colour changes and images taken as previously described.

3 Materials

3.1 Clay

Clay samples from the *Bodhisattva* were examined with SEM-EDS, revealing a mixture of platy alumino-silicate minerals surrounding inclusions of quartz, feldspar, lesser amounts of calcite, and rare dolomite. The compositions of the platy minerals measured by SEM-EDS are consistent with those of illite (a sheet silicate primarily containing potassium, aluminum, and silicon) and chlorite (a sheet silicate with iron, magnesium, aluminum, and silicon). An alternative technique such as X-ray diffraction (XRD) would be required to confirm the exact clay minerals and/or micas present. All samples were too

small for conventional XRD analysis and would require use of synchrotron XRD (which was not explored in this study). The size of the quartz and feldspar inclusions is highly variable, with larger grains (up to 200 µm) in samples from applied elements. However, the available samples were too small to ascertain the stratigraphy.

Studies of Dunhuang wall paintings have found that the cave walls were prepared for painting by applying a layer of coarse earthen plaster to the walls, followed by a finer plaster layer (Wong, Agnew 2013, 156-61). The primary component of these "earthen plasters" was the local alluvial sediments (*chengban tu*) mixed with sand and vegetable fibres. Analysis of the river sediments shows this is composed mainly of illite and chlorite, with a small proportion of a mixed illite-smectite mineral formed by alteration of illite (Wong, Agnew 2013, 157-60, 266-8). Analysis of the earthen plaster of the cave walls has identified inclusions of quartz, calcite and feldspar, with some dolomite (Dai et al. 2025, 6). This mixture – platy clay minerals around inclusions of quartz, feldspar, calcite and dolomite – is very similar to that identified here from the terracruda of the *Bodhisattva*. This suggests that similar mixtures of river sediments and sands were used for construction of statues and applied to cave walls before painting. This is consistent with Du and Du's discussion of manufacture of sculpture at Dunhuang, using local river sediments mixed with sand and other additives (2025, 111-14).

The use of alum (potassium aluminum sulfate) and animal glue has been described to seal the surface of the fine clay before applying the ground and paint layers (Du, Du 2025, 116-7, 159; Su 2021, 256).

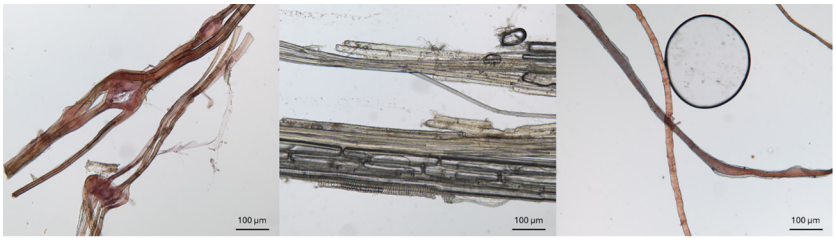


Figure 4 Fibre samples stained with Graff C and viewed in polarised light of (a) twine made from bast, (b) coarse straw fibres in lower clay, (c) fine individual fibres in upper clay. Kneeling Attendant Bodhisattva (from Mogao Cave 328, Dunhuang, Gansu province). Late-7th c. Air-dried clay with paint and gilding, 121.9 × 67.3 × 67.3 cm. Harvard Art Museums/Arthur M. Sackler Museum, First Fogg Expedition to China (1923-24), 1924.70. Cambridge, MA, USA, © President and Fellows of Harvard College

3.2 Fibres

Polarised light microscopy (PLM) was used to characterise different fibres, including reed-like fibres wrapped with minimally processed bast fibres in the scarf armature. Here, the lower clay layer contains coarse straw, whilst the upper clay layer contains finer, individual bast fibres **[fig. 4]**. Wong and Agnew identified beaten hemp in fine clay layers of wall paintings (2013, 160). Its use cannot be ruled out here; however, PLM of the fibres in the finer clay revealed that many were covered with a membrane, a feature not typically associated with hemp. Analysis of manuscripts found within the Library Cave at Dunhuang identified papers made from varying mixtures of ramie, hemp and paper mulberry indicating that other fibres may have been available (Helman-Ważny 2016). Paper mulberry is well-known for the presence of an

outer membrane on individual fibres and could be a potential match for the fibres observed here, although further investigation is required of the fibre samples and available fibre sources when the *Bodhisattva* was created.

4 Construction

X-radiography revealed the form of the wooden framework, as well as some damage and repairs **[figs 5c, 6a]**. Organic materials with lower densities than the wood could not be resolved at the settings used to penetrate the sculpture's thick clay mass (320kV, 4.65mA, see 2.2).



Figure 5 (a) Visible light, (b) UV light, (c) X-radiograph, *Kneeling Attendant Bodhisattva* (from Mogao Cave 328, Dunhuang, Gansu province). Late-7th c. Air-dried clay with paint and gilding, 121.9 × 67.3 × 67.3 cm. Harvard Art Museums/Arthur M. Sackler Museum, First Fogg Expedition to China (1923-24), 1924.70. Cambridge, MA, USA, © President and Fellows of Harvard College

4.1 Wooden framework

The wooden armature is constructed with a central vertical timber shaped to support the primary sections of the body. The timber is narrower in the head and neck and cut deeper in the head **[fig. 6a]**. The timber widens towards the base, where a short section is visible.[4] Attached at shoulder height, a horizontal element forms a T-shape (the hands obscure a view of its attachment). Pieces of wood or branches lashed at the shoulders support the arms. Du and Du noted that such joints are typically bound using hemp rope or reeds (2025, 131). A piece of tapered wood extends from each elbow to the centre of the palm, where they appear to join, possibly in a knot **[fig. 7a]**. No additional structure is visible within the hands, though Du and Du (2025, 119-20, 132) note that hands and fingers typically require armatures, such as a small wooden board and bent twigs or reeds, to support the precise gesture and details.

4 Warner (1926a, 31) observed the post extending about eight inches from the bottom of the figure to insert into the base, though it appears shorter in the X-radiograph.



Figure 6 (a) X-radiograph of the head and neck, side view, (b) detail of the inlaid copper eyes with top edge visible, (c) X-radiograph front view, detail showing the inlays' lens shape and position. *Kneeling Attendant Bodhisattva* (from Mogao Cave 328, Dunhuang, Gansu province). Late-7th c. Air-dried clay with paint and gilding, 121.9 × 67.3 × 67.3 cm. Harvard Art Museums/Arthur M. Sackler Museum, First Fogg Expedition to China (1923-24), 1924.70. Cambridge, MA, USA, © President and Fellows of Harvard College

Supports for the legs appear to attach directly to the central post. The left leg has two pieces of wood bound together at the knee **[fig. 7b]**. The right leg has a single piece of wood inside.

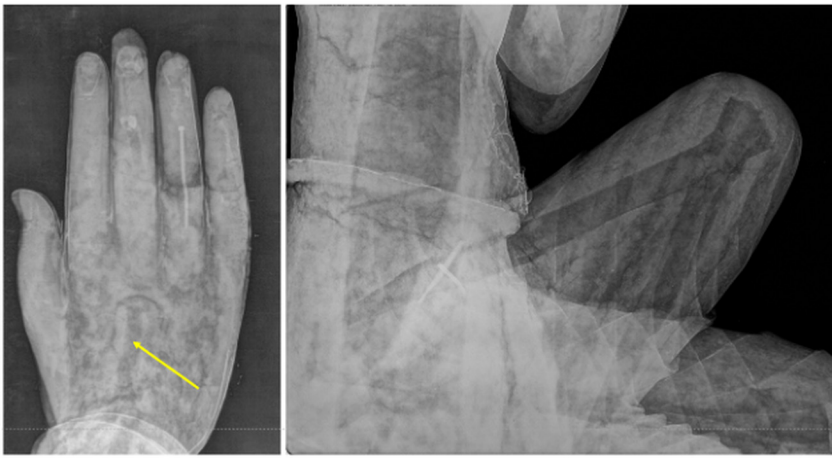


Figure 7 X-radiographs of (a) hands with armature (yellow arrow) in the palm and modern nail repair in the proper left third finger, (b) lower torso and legs showing lashed armature in the left leg. *Kneeling Attendant Bodhisattva* (from Mogao Cave 328, Dunhuang, Gansu province). Late-7th c. Air-dried clay with paint and gilding, 121.9 × 67.3 × 67.3 cm. Harvard Art Museums/Arthur M. Sackler Museum, First Fogg Expedition to China (1923-24), 1924.70. Cambridge, MA, USA, © President and Fellows of Harvard College

4.2 Modelling

The body is modelled with smooth, rounded contours characteristic of Dunhuang sculpture: the torso and arms are simply formed, and the face and hands are shaped with subtle details. By contrast, the added details depicting the drapery, hair, and ornaments are more loosely modelled, appearing more expressive.

4.2.1 Drapery

The drapery style on the *Bodhisattva* exhibits what Du and Du call 'wave-style' folds, made with applied rolled strips of clay, flattened on one side and attached **[fig. 8]**. Slopes of clay are formed on either side of the strip. In some fragments, incised guidelines for the strips are visible on the underlying clay **[fig. 10b]**. Du and Du (2025, 138, 190-4) indicate that some strips are reinforced with an internal string or cord, though neither was observed. The undersides of the pooled drapery fragments show a straw-bulked clay layer under the drapery **[fig. 10c]**.



Figure 8 Drapery technique (a) left back side of skirt, (b) right leg. *Kneeling Attendant Bodhisattva* (from Mogao Cave 328, Dunhuang, Gansu province). Late-7th c. Air-dried clay with paint and gilding, 121.9 × 67.3 × 67.3 cm. Harvard Art Museums/Arthur M. Sackler Museum, First Fogg Expedition to China (1923-24), 1924.70. Cambridge, MA, USA, © President and Fellows of Harvard College

4.2.2 Hair

The bulk of the hair is comprised of the coarse clay mixture. This clay is visible through small holes between the tiers, which appear to have been locations where a crown ornament (likely metal,[5] missing before 1924 removal from the cave) was attached. The top knot was formed separately and attached (and reattached in 1924-25). An X-radiograph shows a shallow

5 In Cave 328, the author observed intact, full or partial metal crowns on two other *Bodhisattva*s in the figural group.

void in the head under the knot, which is not understood **[fig. 6a]**. Finished with the fine clay mixture, the hair was textured with loose, incised lines suggesting strands.

4.2.3 Applied elements

Elements formed separately and attached include the scarf, belt, lotus petals, and jewellery. The scarf was made from coarse clay mixed with straw, layered with fine clay, shaped into a long, flat sheet. In front of each upper arm, the scarf floats down unsupported, except for a thin wood prop extending from each hip. The floating portions have an internal support comprised of thin bundles of reed-like fibres wrapped with a Z-twisted twine (identified as bast fibres, fig. 4a), visible at losses.

The belt was formed as a long, rolled coil of fine clay applied to the waist. Deep incised lines form a wavy pattern resembling rope or twisted cloth. Nubs of displaced clay along the lines and clear fingerprints indicate that the clay was quite soft when handled.

The lotus petals were likely modelled from a trimmed slab or cast in a mould and finished with incised lines. One petal appears to have a fibrous internal support along its central axis (visible at a loss).

The necklaces, bracelets, and arm bands appear to have been cast in press moulds, applied, and leaf-gilded **[figs 9c-d]**.[6] Their repeating forms and flat backs, sometimes poorly attached, indicate the use of an open mould. It is not clear if the plain bracelets were moulded. Edges of gold leaf are visible, sometimes overlapping the surrounding area. On the left arm band, gilding stops partway around, where it would be hidden from view.



Figure 9 Gilded, moulded jewellery details: (a) scarf, (b) belt, (c) bracelet on right wrist, (d) necklace pendant. *Kneeling Attendant Bodhisattva* (from Mogao Cave 328, Dunhuang, Gansu province). Late-7th c. Air-dried clay with paint and gilding, 121.9 × 67.3 × 67.3 cm. Harvard Art Museums/Arthur M. Sackler Museum, First Fogg Expedition to China (1923-24), 1924.70. Cambridge, MA, USA, © President and Fellows of Harvard College

6 Clay press moulds with hemp fibres were excavated in 1965 at Dunhuang. The pattern resembles the armlets in Cave 328 (Du, Du 2025, 149).

4.2.4 Eyes

The eyes are inlaid with thin copper sheets depicting the iris and pupil together **[fig. 6]**. The metal surfaces appear black with a slight sheen. The edge of the right inlay is visible under the upper right eyelid **[fig. 6b]**. X-radiographs show that the inlays have a concave, lens shape, though with the top edge cut straight, aligning with the upper eyelid **[fig. 6c]**. The sheets appear to be set onto elliptical forms incorporated into the face as it was modelled. *In-situ* XRF analysis identified copper metal. There is no evidence of restoration around the inlay.

5 Condition

The sculpture remains in fragile, though remarkably well-preserved, condition, considering the brittle medium, its weight (88 kg, including the replacement base), and the removal and transit it endured.

5.1 Condition history

Of the nine sculptures in Cave 328, Warner selected the *Bodhisattva* for its well-preserved condition.[7] Damages visible in the 1924 image after its removal from the cave include cracks in the scarf, a lost crown ornament and a section of the necklace, drips beneath the forearms, and uneven, darkened areas on the white-painted skin **[fig. 3]**. Most or all the lotus petals on the base appear intact.

Repairs at the Fogg Art Museum are sparsely documented,[8] though brief mentions in correspondence and evidence of repairs make it clear that structural repairs undertaken after its arrival addressed damage sustained during the sculpture's transit. They included replacing the lotus base with a wood-and-plaster structure and reattaching only sixteen original petals. Several elements were reattached (the top knot, arms, wrists, fingers, and parts of the scarf) using an opaque, light-brown adhesive, identified as animal glue by its solubility in water.[9] Under ultraviolet (UV) light, this glue fluoresces bluish-white **[fig. 5b]**. The bright, yellow-white UV-induced fluorescence corresponds to the lead-white-painted skin and/or lead-white-containing ground, rather than to a restoration material. Cellulose nitrate, a 20th-century adhesive, was detected in numerous paint samples (both in 1936 by Gettens and in this study), suggesting it was applied to consolidate flaking paint.

In 2015, eleven disassociated painted and gilded clay fragments found in a Harvard Art Museums' storage room were identified as original sections of the skirt that pool on the base **[fig. 10]**. Although Warner no doubt collected them, they are not visible in the 1924 image, the museum's early photographs,

7 Warner *Letter to E.H. Bell* 1924.

8 Forbes *Letter to L. Warner* 1924, briefly described work done by John Evans & Co., Boston: replacing the 'pedestal' and gluing the sculpture to it. His description of the internal structure of an arm indicates it was detached. Also, Forbes, *Letter to L. Warner* 1925, referred to Arthur Pope (Harvard Prof. of Fine Arts) "gluing on the remaining pieces" of the sculpture.

9 2015 Harvard Art Museums conservation treatment report by Anthony Sigel.

or descriptions. Notably, the comparable elements on other figures in the cave are unpainted, appearing as plain clay in low relief **[fig. 2]**.[10]



Figure 10 (a) 'Pooled' drapery on base with painted and gilded decoration, (b) fragment with detached fold and incised guidelines, (c) back of fragment showing coarse clay bulked with straw. *Kneeling Attendant Bodhisattva* (from Mogao Cave 328, Dunhuang, Gansu province). Late-7th c. Air-dried clay with paint and gilding, 121.9 × 67.3 × 67.3 cm. Harvard Art Museums/Arthur M. Sackler Museum, First Fogg Expedition to China (1923-24), 1924.70. Cambridge, MA, USA, © President and Fellows of Harvard College

5.2 Current condition

While earlier repairs seem stable, compound breaks or cracks have occurred in other inherently weak areas of the construction: the neck, where the clay is especially thin and bears the weight of the head **[fig. 6a]**, and around the waist below the belt, where the top-heavy torso meets the stable lower body. Along horizontal cracks, some areas have settled and become misaligned, disrupting the paint and fine clay. Additionally, repaired breaks across the upper arms correspond with the area just below the crossmember of the armature where the heavy arms angle forward and extend from the torso, unsupported **[fig. 5c]**. At these inherently weak areas, it is assumed that the object's transit and time have exacerbated their severity.

There is little to no observed retouching of the painted surface. The darkened white skin tones, observed by Warner in 1924, appear unchanged in severity or spread. It appears on the figure's facets facing the cave opening. Notably, the other figures in the cave exhibit the same effect on their respective presentation sides.

6 Discussion

The wooden armature, clay mixtures, fibres, and construction techniques identified in the *Kneeling Attendant Bodhisattva* align with Dunhuang traditions as documented by artists and researchers.

The term "monumental terracruda sculpture" is apt: it underscores the figure's original (and now lost) cave-shrine context while describing its air-dried clay composition and structure. The fine execution of modelling and techniques for applied elements further demonstrate the artist's (or

10 As observed by the author on site.

artists') versatility. While intended as an immovable work, the sculpture's intact, yet fragile, condition after removal reflects its skilled construction. X-radiographs show the configuration of the robust wooden armature that continues to hold the surrounding brittle, heavy clay layers. Furthermore, the images highlight the structural balance of the leaning posture with unsupported, 'floating' arms. Despite historical repairs, the sculpture's inherently fragile areas now require intervention to stabilise cracks. This understanding of the sculpture's materials and condition can now inform conservation treatment planning.

The characterisation of materials shows that the clay composition and stratigraphy over the bound wooden armature are comparable to those of Dunhuang wall paintings on the conglomerate rock wall of the caves. Both have layers based on local *chengban tu:* a coarse layer (*dizhang*) mixed with straw, other fibres, and sand, followed by a finer (*xini*) clay with finer fibres. For the wall paintings, these layers are sometimes called earthen "plasters" (Wong, Agnew 2013, 156-60). For sculpture, Du and Du noted the additional need for another tackier clay, *niantu*, which can bind the coarse layer to the straw-wrapped core (2025, 112-3). In the absence of reference samples, it is not possible to confirm the presence of two types of clay.

The discovery of copper-inlaid eyes is notable and without known parallel at Dunhuang. However, earlier and contemporary lacquer sculptures, dating from the late sixth to the seventh century, from China, have documented examples with inlaid black and dark green glass eyes (Strahan 2023, 28). Du and Du (2025, 155) note that Dunhuang sculptures typically feature painted eyes, though some Qing Dynasty figures have inlaid porcelain or glass beads. On this *Bodhisattva*, the copper inlays are difficult to discern, appearing dull black in the shadow of the eyelids. It is unclear if this dark appearance resulted from intentional colouration or natural oxidation, which occurs quickly on copper. Because the visual effect is so subtle, similar inlays may have gone unnoticed on other sculptures at Dunhuang. However, the metal crowns decorating other *Bodhisattva*s in Cave 328 confirm the use of metal components with the clay sculptures. Beyond their aesthetic function, the inlays may have been added for ritual purposes or iconographic significance.

Although visual examination and X-radiography revealed the general structure of the wooden armature, 2D X-radiography presented limitations due to the object's bulk and density. As mentioned, the high energy levels used to penetrate the clay mass could not simultaneously resolve the wood armature and less radio-dense organic components, such as the fibre bundles wrapping the framework. Additionally, overlapping elements and cracks were obscured. A 3D X-ray imaging technique with greater dynamic range, such as computed tomography or other 3D X-ray imaging[11] could better discern internal structures and materials with varying densities. CT scanning was not an option for this study since the available equipment could not accommodate the size of the sculpture.

Imaging and analysis cannot reveal important intangible and time-based aspects of fabrication known to artists copying Dunhuang sculptures. For example, Du and Du (2025, 131) describe the consecration ritual of inscribing the wooden armature with a dedication or sutra before binding and adding clay. Also, the time and labour required for processes such as gathering

11 Such as the technique developed by Bossema et al. (2024).

and preparing materials, drying, and making repairs remain invisible in the finished work and cannot be grasped without practical knowledge. The perspectives of contemporary artists at Dunhuang are therefore invaluable to understanding these essential aspects of the sculpture.

7 Conclusions

This study documents the condition and condition history of the *Kneeling Attendant Bodhisattva*, which suffered structural damage during its 1924 removal from Cave 328 at Dunhuang and subsequent transit to Harvard University. Integrating archival records with visual examination and X-radiography provided a comprehensive assessment of its current fragile condition.

Du and Du's (2025) technical descriptions of Dunhuang sculpture-making proved invaluable for understanding a single work, long separated from its original site. Researchers interested in monumental terracruda sculpture and contemporary Dunhuang sculptors may gain insights from this study, particularly concerning the structure of the wooden armature and the copper inlaid eyes. Analysis of the paint and gilding will be reported in a future publication. Notable findings will include the varied colour techniques and shifts in colours resulting from chemical changes.

Future research could utilise advanced 3D imaging and collaborative consultations with Dunhuang Academy specialists to compare findings across Cave 328's other sculptures and wall paintings, deepening a contextual understanding of the *Bodhisattva* and informing conservation strategies to stabilise the structural cracks.

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From Earth to Enlightenment
Materiality, Technology and Cultural Transmission of Terracruda Sculpture Across Buddhist Asia
edited by Mònica López-Prat, Emma Cantisani, Susan S. Bean

A Technical Study of Terracruda Sculpture Fragments from Khara-Khoto

Kaela Nurmi
Fine Arts Museums of San Francisco

Angela Chang
Harvard Art Museums

Katherine Eremin
Harvard Art Museums

Georgina Rayner
Straus Center for Conservation and Technical Studies, Harvard Art Museums

Isabel McWilliams
Iowa State University

Abstract Khara-Khoto was a thriving Buddhist centre of the Tangut-ruled Great Xia empire (1038-1227 CE), producing art that reflected both Himalayan and Chinese traditions. In 1923-24, art historian Langdon Warner removed 250 sculptural fragments, now in the collection of the Harvard Art Museums. Eighteen representative objects were studied to understand their materials and fabrication techniques. Findings included the consistent use of layered clay construction, different internal support systems, modelling, and moulding, a consistent palette of traditional mineral and synthetic pigments, and fragments with ritual deposits.

Keywords Khara-Khoto. Edzina. Tangut. Terracruda. Clay. Polychromy. Micro-CT. Langdon Warner. Ritual deposits.

Summary 1 Introduction. – 1.1 The Site of Khara-Khoto. – 1.2 Khara-Khoto Materials at the Harvard Art Museums. – 1.3 Technical Study Objectives. – 2 Analytical Methods. – 3 Clay and Construction. – 3.1 Clay Composition. – 3.2 Organic Fibres. – 3.3 Forming Techniques. – 3.4 Wooden Armatures and Internal Structures. – 4 Surface Finish and Decoration. – 4.1 Ground Layers and Surface Preparations. – 4.2 Pigments and Polychromy. – 4.3 Repainting. – 4.4 Consolidation and Restoration. – 4.5 Binders. – 5 Discussion. – 6 Conclusion.

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1 Introduction

1.1 The Site of Khara-Khoto

Khara-Khoto, *Hei Shui Cheng* (黑水城) in Chinese or *Khar Khot* (Хар хот) in Mongolian, was a thriving trade hub and the most northern point of defence for the Tangut-ruled Great Xia dynasty (1038-1227 CE). The Tangut state was distinctly multicultural, maintaining strong diplomatic, religious, and trade ties with Tibet and a complex relationship with Song China. Khara-Khoto flourished as a regional Buddhist centre, producing art reflecting both Himalayan and Chinese traditions. In 1227, the Tangut state, including Khara-Khoto, was toppled during Genghis Khan's final campaign. Marco Polo visited Khara-Khoto in the late 13th century when it was under Mongol rule, referring to it as Edzina in his travel documents. The city was abandoned in the 14th century during the Ming dynasty.

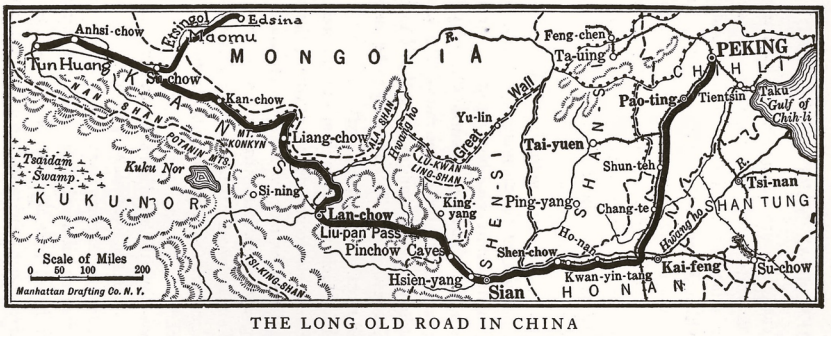


Figure 1 Map of Warner's 1923-24 expedition route with Khara-Khoto labelled as 'Edsina' (Warner 1926, 12)

The walled city of Khara-Khoto formed an irregular rectangle (440 x 370 m) with gateways on the east and west walls. At its peak, the interior had many buildings, stupas, and temples. As an oasis situated near the Ejin River (also referred to as Edzingol or Etsingol), the city used a network of canals for irrigation. The Tangut economy was based on agriculture and animal husbandry, with skilled ironworking and ceramic production (Kychanov 1993, 54). While direct evidence is limited, Khara-Khoto likely participated in these regional practices. The densely populated city prospered, with merchant caravans passing through between China and lands to its West.

Located in modern-day Inner Mongolia, Khara-Khoto was the destination of three expeditions in the early twentieth century. In 1908, Russian explorer Pyotr Kuzmich Kozlov, funded by the Imperial treasury, disturbed structures and stupas and removed objects without systematic documentation. These portable paintings and objects are now housed at the State Hermitage Museum in St. Petersburg. In 1914, archaeologist Sir Marc Aurel Stein, funded by the government of British India, sifted through the remains left by Kozlov's team and collected a range of materials, now divided amongst the National Museum, New Delhi, and the British Museum, London (Stein 1928, 447).

Archaeologist and art historian Langdon Warner led the First Fogg Expedition to China (1923-24), which was organised by the Fogg Museum of Harvard University and launched as a bold effort to enhance the Fogg Museum's collection of Asian art (Bewer 2010, 114). Closely following the footsteps of Kozlov and Stein and eager to join their ranks, Warner was intent on bringing back what remnants he could from the site. Warner and a team of local workers spent ten days excavating at Khara-Khoto, collecting approximately 250 objects, primarily air-dried clay figural sculptures, mould-made plaques, architectural elements, and small votive objects. Warner likely retrieved many objects in the rubble along the base of the city wall, caused by previous disturbances to the site. He named his route from Peking to Khara-Khoto (which he called Edsina, following Marco Polo) and to the cave site of Dunhuang (Tun Huang), 'The Long Old Road in China' **[fig. 1]** – the same title used for his published account of the journey (Warner 1926). During the expedition, he photographed the remains of Khara-Khoto and other sites **[fig. 2]**.

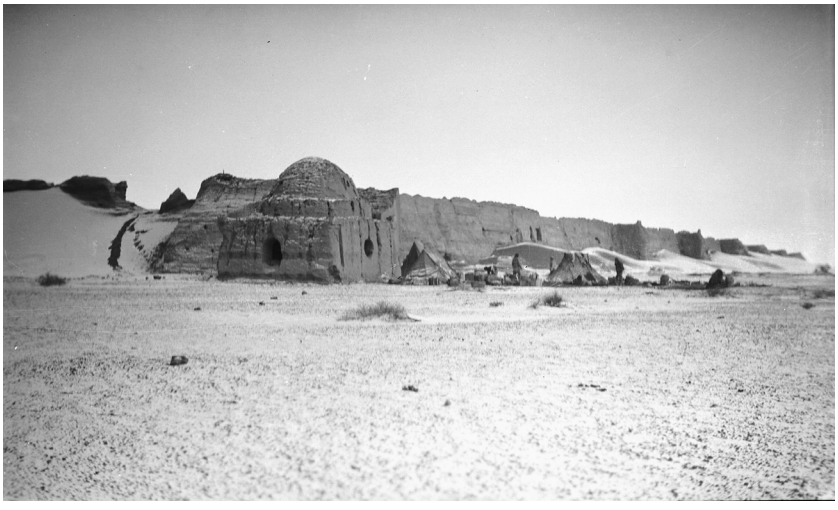


Figure 2 Warner, L. (1923-24). Khara Koto, view of ruins nestled against cliffs from afar, barren land in foreground. Langdon Warner Collection, Harvard Fine Arts Library, Special Collections. Cambridge, Massachusetts, USA, [Public domain]

Given that the Xia empire was one of a thriving community of Tanguts, Chinese, Uyghurs, Khitans, and Tibetans, its artistic and visual culture was distinctly multicultural. Tangut Buddhist art, as is also found in excavated pagodas, shows the close co-existence of Chinese and Himalayan styles (Linrothe 1995). The fragile nature of the *terracruda* sculptures that Warner brought back to Harvard has long signalled the likelihood of local manufacture over Tibetan import to art historians, speaking to the movements of artists, monks, and portable objects along the routes connecting Khara-Khoto and the Western Himalayas. Furthermore, studies have shown how royal Xia patronage of Esoteric Buddhism strengthened the Tanguts' relationship with Tibet and participation within a network beyond the Xia borders (Meinert 2020). The harmonious co-existence of Chinese and Himalayan styles and the local activity of multicultural artistic devotion are present in the Khara-Khoto materials at the Harvard Art Museums.

1.2 Khara-Khoto Materials at the Harvard Art Museums

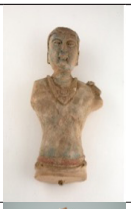
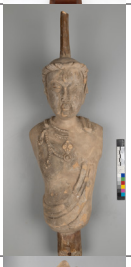
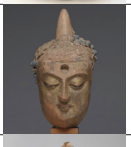
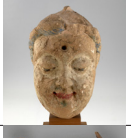
The objects brought to Harvard from the 1923-24 First Fogg Expedition illustrate the range of air-dried clay object types from the site, including figural sculptures, architectural elements, plaques, and votive objects. While these objects share close affinities with Tibetan sculpture, they uniquely attest to local production in the Khara-Khoto region, suggesting that the artistic connections between Tangut and Himalayan societies influenced local Tangut Buddhist practice, devotional image making, and architectural adornment (Klimburg-Salter 1982, 119).

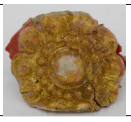
1.3 Technical Study Objectives

The collection of Khara-Khoto materials at the Harvard Art Museums has remained unpublished since entering the museum in 1924. This paper reports on the technical investigation of eighteen representative fragmentary air-dried clay objects with polychrome decoration, detailed in Table 1. Based on size, construction methods, and comparisons with other sites on the Silk Roads, the figural fragments and roundels were components of larger architectural settings, though their original contexts remain unknown. Similarly, the small plaques and votives were deposited within stupas or left as offerings within these settings. Thus, all of the objects may be described as monumental terracruda sculpture: raw earth-based objects made *in situ* and linked to their surroundings, such as an architectural framework or monument (López-Prat et al. 2024). Differences in the degree of finish for some objects suggest that they were intended for different display contexts. For example, the back of Torso_12 is roughly finished, with incised striations in multiple directions across the clay surface. This contrasts with the smooth, even front surface. The rough back was likely positioned against a wall or other architectural element.

Table 1 Objects included in technical study

Accession Number	Image	Title	Dimensions	Term in Paper
1924.65.2		*Headless Seated Figure*	18.4 × 14 × 10.5 cm	Torso_2
1924.65.6		*Headless Seated Figure*	15.2 × 18.4 × 12.1 cm	Torso_6
1924.65.7		*Sculpture Fragment: Torso and Arms of a Figure*	19 × 17.5 × 6.5 cm	Torso_7

Accession Number	Image	Title	Dimensions	Term in Paper
1924.65.12		*Head and Torso of a Bodhisattva*	31 × 15 × 8 cm	Torso_12
1924.65.18		*Headless Standing Figure*	69.5 × 23 × 20 cm	Torso_18
1924.65.23		*Head and Torso possibly of an Eleven-Headed Avalokiteshvara*	58.5 × 18 cm	Torso_23
1924.65.24		*Head and Torso of a Seated Figure*	28 × 16.5 × 10.5 cm	Torso_24
1924.65.11		*Head of a Buddha*	22 × 12 × 13 cm	Head_11
1924.65.20		*Head of a Buddha*	16 × 12 × 13 cm	Head_20
1924.65.5.D		*Figure Fragment*	3 × 5 × 13 cm	Arm_5D
1924.65.27		*Lotus Architectural Roundel*	16 × 16 × 7 cm	Roundel_27
1924.65.34.M		*Small Architectural Stupa*	7 × 8.5 × 8.5 cm	Tsatsa_34M

Accession Number	Image	Title	Dimensions	Term in Paper
1924.65.36.F		*Stippled Votive Stupa*	7.5 × 7.5 × 7.5 cm	Tsatsa_36F
1924.65.32.F		*Plaque in the form of a Head*	4 × 2.7 × 1.3 cm	Plaque_32F
1924.65.32.K		*Plaque in the form of a Head*	4.8 × 2.3 × 1.3 cm	Plaque_32K
1924.65.40.G		*Fragment of a Plaque with colour pigments*	0.8 × 2.8 × 3 cm	Plaque_40G
1924.65.40.K		*Fragment of a Plaque with colour pigments*	2.5 × 3.8 × 1 cm	Plaque_40K
1924.65.40.Q		*Fragment of a Plaque with colour pigments*	3 × 1.6 × 2.5 cm	Plaque_40Q

2 Analytical Methods

Visual examination complemented a multi-analytical approach to investigate object construction and material composition. X-radiography and micro-computed tomography (micro-CT) were used to study construction methods. Polychromed surfaces were first analysed with in-situ X-ray fluorescence (XRF) to determine likely pigments based on the elemental composition. For a more complete understanding of the materials and their relationships, micro-samples were taken from areas of loss or damage. Excised samples were analysed by Fourier-transform infrared spectroscopy (FTIR) and Raman spectroscopy to characterise pigments and applied organic materials. Where possible, samples were mounted and polished to provide cross-sections for optical microscopy (OM) and scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS) to examine stratigraphy and identify specific pigments and preparatory layers. Samples of clay were removed from the underside or damaged areas of three objects to investigate the clay substrate using FTIR, SEM-EDS and X-ray diffraction (XRD). Fibres embedded within the clay matrix were examined using polarised light microscopy (PLM). Finally, selected wooden elements were sampled for accelerator mass spectrometry (AMS) radiocarbon dating at the University of Georgia. Further analytical details can be found in Chang et al. (2025).

3 Clay and Construction

The figural fragments are made from clay mixtures, applied in layers over different styles of armatures or cast in moulds. The clay composition, as characterised by analysis, is described below, followed by details of the armatures, forming techniques, and ritual deposits observed with X-radiography imaging.

3.1 Clay Composition

Preliminary XRD of clay samples from three objects identified quartz, calcite, and gypsum, and showed weak signals from sheet silicates such as illite and/or kaolinite. FTIR analysis confirmed the presence of strong -OH absorption bands from hydrated sheet silicates. This suggests the clay was not fired at or above 400 ^{0}C, although rehydration of sheet silicates cannot be ruled out.

SEM-EDS analysis of cross-sections with clay identified silicates such as quartz, feldspars, mica and clay minerals (likely illite-group), carbonates such as calcite and (sparse) dolomite, and iron oxides. Talc, another sheet silicate, is present between the pigment and clay, likely as a white ground layer. The relative proportions of clays (with high aluminium and potassium) and non-silicates (calcite and/or gypsum) differ significantly between samples. Full distinction of the different minerals and their proportions, particularly sheet silicates, would require larger samples for quantitative XRD. Overall, the clay mixture is broadly similar across the study group, suggesting a consistent approach to clay preparation and to the formulation of surface layers.

3.2 Organic Fibres

Organic fibres are distributed throughout the clay matrix, providing further evidence for the use of air-dried clay rather than fired ceramic. The quantity and visibility of organic fibres within the clay vary considerably, ranging from sparse, fine fibres to abundant, coarse bundles. Sampling was limited to objects with accessible fibres at the surface, and it was not possible to obtain fibres from any figural objects. Fibres were sampled from Roundel_27 and Plaque_40Q, both of which are likely mould-made from a single clay body rather than constructed from multiple applied layers.

The clay body of these objects contains both fine and coarse plant materials distributed through the matrix, visible at the surface of the reverse impression. PLM identified a bast fibre in the fine material and straw in the coarse material. It is likely that the figural sculptures contain similar plant materials incorporated into the clay matrix to deliberately modify the working and drying properties of the air-dried clay.

3.3 Forming Techniques

All sculptural objects in the study group exhibit layered construction with variations in execution, as revealed through X-radiography and micro-CT scanning. In virtual micro-CT cross-sections, voids visible between clay layers indicate successive additions of the material.



Figure 3 Torso_2, micro-CT 'slice' views across (a) the torso and arms and (b) crossed legs, with (c) slice locations indicated with red lines. Three pieces of wood (dark rectangles) support the legs.
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Figure 4 Head_20, micro-CT profile (a) and X-radiograph frontal (b) views show layers of successively fine clay packed around a wood armature. Embedded behind each eye is a round, flattened radio-dense object that appears bright white in the image. A third, similar object, not visible in the X-radiograph, was observed between the eyes through micro-CT. Clay was packed over these objects, which are not visible on the surface

In smaller figural sculptures, uniformly textured clay layers were added to simple internal structures. For example, in Torso_2, clay was built up around a bundle of fibres (see 3.4) in pieces and layers, with the arms added last **[fig. 3]**.

In contrast, larger sculpture fragments exhibit more varied internal structures. The core clay is coarser, containing abundant inclusions (likely organic). For Head_20, the clay is built around a solid wooden support. Clay packed around the wood is granular with irregular air pockets and variably sized inclusions; layers of clay are finer and more uniform towards the surface **[fig. 4]**. While larger figural sculptures were modelled directly and developed with applied elements, smaller forms and some details were mould-made.

The face on Torso_24 and two of the three faces on Torso_23 show evidence they were pressed into an open mould: the overall thickness is uniform, thin layers and underlying voids in the clay follow the arc of the face, and the backs of the forms are smooth from pressing the clay. The resulting 'masks' are integrated with the core structure, showing irregular gaps where they are attached to a fine homogeneous clay **[fig. 5]**. By contrast, the large face on Torso_23 is thinner and more variable in thickness, likely modelled *in situ* onto the coarse underlayer. The multiple faces suggest that this sculpture was originally an image of the eleven-faced Avalokiteśvara *bodhisattva*.

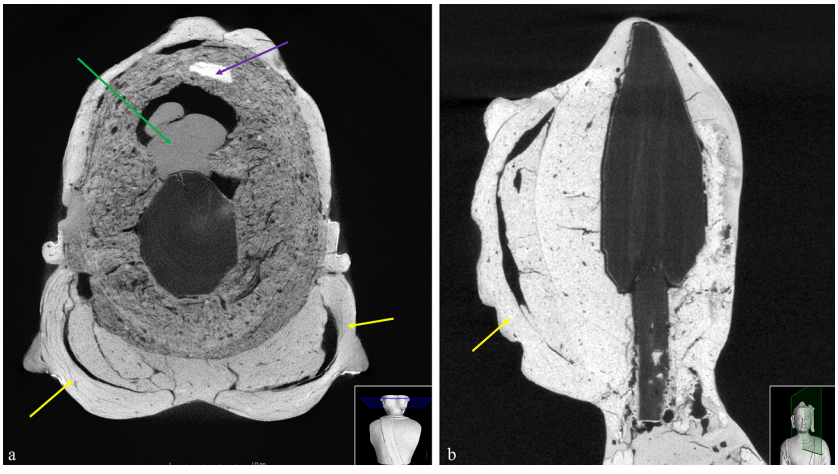


Figure 5 Micro-CT views of (a) Torso_23, horizontal section across head (location indicated by small image at lower right corner), showing mould-made face 'masks' (yellow arrows) with underlying voids, modern plaster (green arrows) and a ferrous ritual deposit (purple arrow); (b) Torso_24, profile, showing mould-made face 'mask' with underlying void

The observed distinction between fine surface clay and coarser interior layers likely reflects different structural and aesthetic purposes: the coarse mixture with fibres is stronger and bulks out the form, and the finer mixture can be modelled or moulded with sharp details to make a smooth surface for painting. Small, mould-made objects such as plaques and *tsatsas* do not require the supporting coarse layer.

3.4 Wooden Armatures and Internal Structures

Though varied, all figural sculpture fragments contain internal wooden armatures. A summary of non-clay materials identified within the sculptural fragments is presented in Table 2.

Radiocarbon dating was carried out on some wood samples to verify their 12th-century attribution. Results from three figural pieces, Torsos 2, 7, and 23, show distinct chronological differences between the three samples, summarized in Table 3. While radiocarbon dating indicates when wood ceases to exchange carbon with the atmosphere, rather than when the sculpture was made, the results suggest that Torso_7 is earlier, and Torso_2 is later than the 12th-century. These results point to a more complicated chronology for the Khara-Khoto objects and warrant further investigation.

Table 2 Non-clay materials observed

Object	Wood	Twine/lashing material	Metal hardware	Other organic material
Torso_2	Yes	No	No	Yes
Torso_6	Yes	No	No	No
Torso_7	Yes	Yes	No	No
Torso_12	Yes	No	No	No
Torso_18	Yes	No	Yes	No
Torso_23	Yes	No	Yes	No
Torso_24	Yes	No	No	No
Arm_5D	Yes	Yes	No	No
Head_11	No	No	No	Yes
Head_20	Yes	No	No	No

Table 3 Radiocarbon dating of select wood samples

Object	Wood sampled	Calibrated date (95%)[1]
Torso_2	Exposed piece in seated base	1217-70 CE
Torso_7	Exposed armature in torso	993-1035 CE
Torso_23	Armature extending from bottom of object	1043-1213 CE

1 Radiocarbon dates were calibrated with IntCal120.14c and reported at 95% (2s) certainty.

3.4.1 Comparison of Armature Systems

Internal armatures were categorised into three main types: vertical post(s), horizontal crossbars, and wood incorporated into arms, summarized in Table 4.

Table 4 Armature types inside figural sculptures

Object	Vertical posts(s)	Horizontal crossbar	Wood in arms	Notes
Torso_2	No	No	No	Bundle of organic fibres forms the core. Wood pieces in the legs
Torso_6	Yes	No	No	Two vertical posts, clay slabs
Torso_7	Yes	Yes	Yes	Bundle of vertical sticks; horizontal stick at shoulders
Torso_12	Yes	No	No	Additional wood piece in head
Torso_18	Yes	Yes	Yes	Crossbar at hips
Torso_23	Yes	Yes	No	Crossbar at shoulders
Torso_24	Yes	No	No	Conical shape in head (separate from vertical wood in torso)
Arm_5D	No	No	Yes	Twine wrapped around length of wood
Head_11	No	No	No	Bundle of organic strands forms the core
Head_20	Yes	No	No	Irregularly shaped wood, all one piece

Although similarly scaled, the seated figures Torso_2 and Torso_6 feature different internal structures. The core of Torso_2 is formed from a vertical bundle of organic fibres cinched together at the top and at the waist with a horizontal tie, probably made of the same type of fibre. Below the waist, a bundle has been lost, though fibre impressions in the clay remain **[figs 3, 6a]**. Head_11 has a similar structure **[figs 10a-b]**. Within the crossed legs, three unconnected pieces of wood provide internal structural support. In contrast, Torso_6 is built around two vertical wooden supports arranged together, though not visibly bound. Micro-CT revealed vertical clay slabs flanking the supports and other horizontal slabs in the lap **[fig. 6]**. Formed separately and added, the slabs appear to serve as rigid support and bulk in thick sections of the body. The slabs' grain and composition are visually similar to the surrounding clay. No slab elements were observed in the other objects.

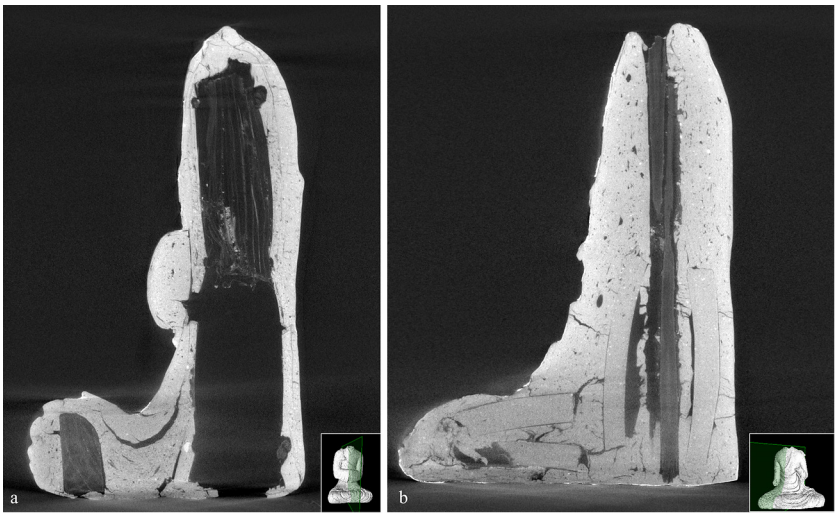


Figure 6 Micro-CT images comparing core structures of (a) Torso_2 and (b) Torso_6. Slice locations are indicated by small reference images, lower left corners. © President and Fellows of Harvard College

3.4.2 Binding Systems and Metal Fasteners

A twine-like organic binding material was observed in multiple objects. The armature for Torso_7, consisting of three vertical supports, is bound together at the waist, while Arm_5D has twine wrapped along the length of the wooden armature and lashes around another armature element inside the elbow **[figs 7-8]**. The wrapped twine would also have provided texture to help the clay bond to this armature.

Metal hardware was also used to secure internal wooden elements. The largest sculptures, Torso_18 and Torso_23, incorporate ferrous metal fasteners (tested with a magnet), with irregular faceted and tapered shanks to connect internal wooden elements and reinforce cross-shaped armatures **[fig. 9]**.

Torso_18 has a central vertical wooden support with a horizontal crossbar at hip level secured by multiple nails. Two supports for the lower body are fastened to the crossbar with nails. A sizable nail at each shoulder appears to connect supports for the arms to the central vertical element through a layer of clay. A modern metal rod has been inserted into the figure through the base.

Micro-CT of Torso_23 shows a broad, horizontal crossmember fastened to the central vertical post at the chest. The crossmember is joined using a lap joint and secured with a ferrous metal nail. Nails at both ends of the crossmember correspond with areas of loss and plaster repairs, suggesting they may have originally secured additional structural components or arms.

Micro-CT of Torso_23 also reveals that the visible wooden column is continuous, extending through the torso and principal head, serving as the structure for the smaller faces of the eleven-faced Avalokiteśvara *bodhisattva* (see Linrothe 1996, 38).

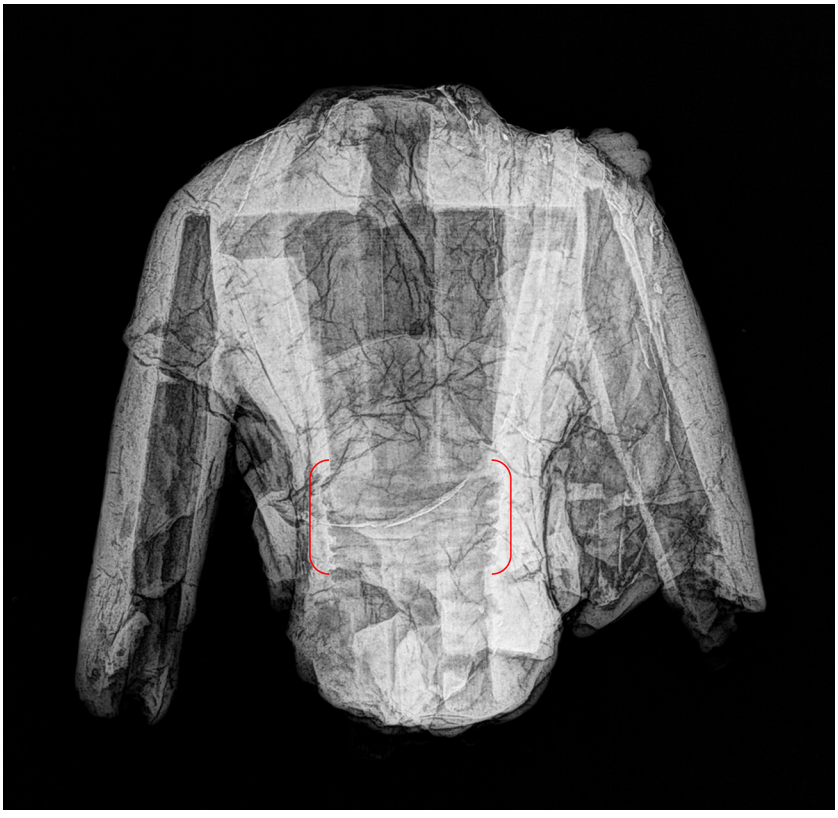


Figure 7 Torso_7, X-radiograph showing binding (within red brackets) around the armature components at the waist.
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Figure 8 (a) Arm_5D, a loss on the back reveals a twine-wrapped armature; (b) Arm_5D, X-radiograph shows wrapping along the wooden support and binding another element at the elbow. © President and Fellows of Harvard College



Figure 9 (a) X-radiograph of Torso_23; (b) top half Torso_18. © President and Fellows of Harvard College

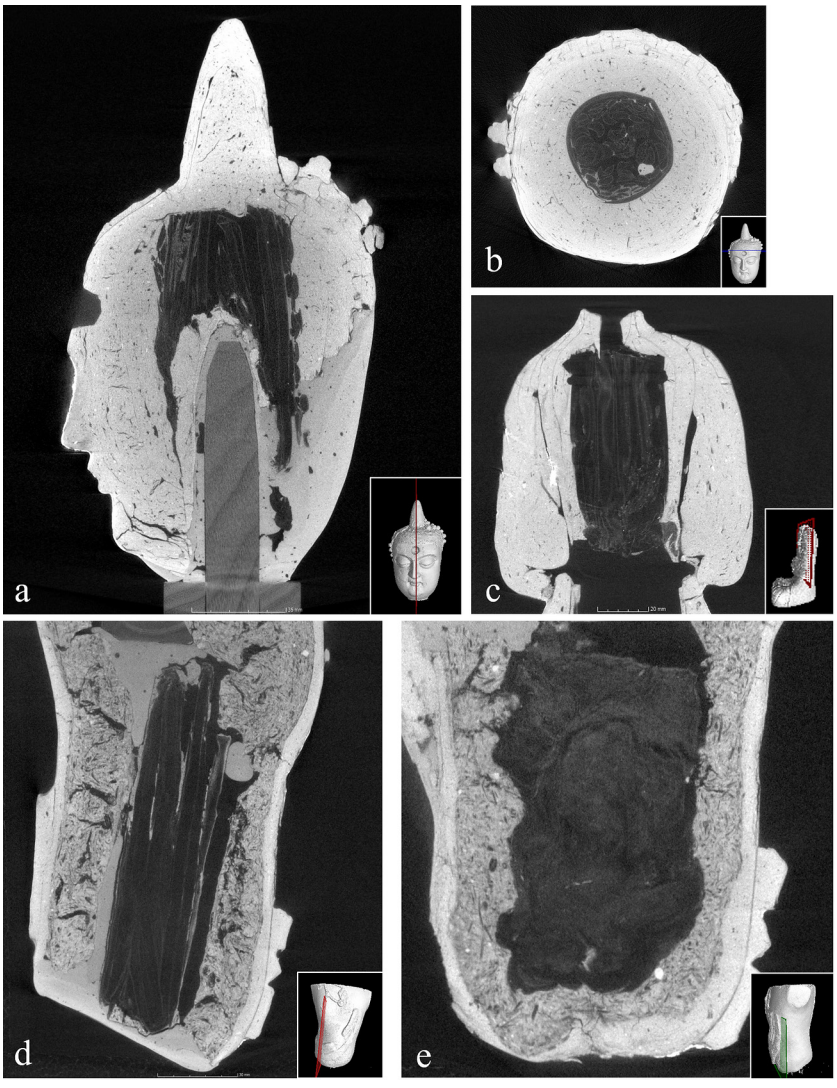


Figure 10 Micro-CT images: (a) Head_11, core comprised of organic fibres; (b) Head_11, horizontal slice showing crescent-shaped cross sections of fibres; (c) Torso_2 fibres arranged around small clay chunks in the upper back; (d) Torso_23 fibres in the lower torso, proper right side; (e) Torso_23, slice across front, lower torso containing a mass of finer, fibrous material, possibly wool. © President and Fellows of Harvard College

3.4.3 Unidentified Materials

Micro-CT imaging revealed numerous instances of materials deposited within the clay body during fabrication. The long, folded fibrous strands forming the core in Torso_2 and Head_11 are also found in Torso_23, packed within the proper right side of the abdomen [fig. 10d]. Each strand has a crescent-shaped cross-section up to 1 cm wide [figs 3a, 10a]. Their plain, hollow morphology resembles that of reeds. In Head_11, Torso_2, and Torso_23, there is modern plaster adjacent to the strands, indicating they

were exposed during a repair. The closely packed clay and imprints from the strands indicate they are original.

Torso_23 contains a second cavity in the lower abdomen positioned in a flat, wide space in front of the central timber **[fig. 10e]**. This encloses a distinct mass of an organic material with fine, clumped fibres, possibly wool.

The small stupa-shaped *tsatsas* provide a related devotional context in which incorporated organic materials could be examined directly. Fibrous organic materials are incorporated into some of the *tsatsas* as evidenced by broken examples exposing bundles of dark brown, wiry, hair-like material within the air-dried clay. Microscopic examination of a sample from Tsatsa_34 found that the morphology was consistent with hair. Further analysis and microscopy could help characterise the hair and other organic materials identified in the figural *terracruda* sculptures, although access for sampling is limited. In addition to the organic materials discovered in Torso_23, three small deposits, presumed to be stone, metal, or another radio-dense material, were discovered: one embedded in the clay behind the eyes **[fig. 5]**, one on the proper left side of the lower torso, and one in the belly within the wool-like mass. Head_20 contains three similar elements embedded in the head, one behind each eye, and a third between the eyes **[fig. 4]**.

4 Surface Finish and Decoration

The air-dried clay fragments exhibit complex and visually rich polychrome decoration with similar pigments in all object types. To identify the pigments, all colours were analysed initially with in-situ XRF to determine the main inorganic elements present. This was followed by sampling in areas of loss or flaking. In some instances, only in-situ XRF was possible due to later-applied surface consolidation. Unmounted samples were analysed by FTIR and Raman spectroscopy. Mounted samples were analysed with SEM-EDS, revealing multiple layers in some samples. The materials and layers identified with SEM-EDS analysis are summarized in Table 5.

Table 5 Summary of analysis of pigments on objects studied, with gold and silver content of gilding in weight percentage (wt%). Abbreviations used in table: PL – proper left; PR – proper right; NX – geometry did not allow XRF analysis; NS – not sampled; NA – sample not available (whole sample mounted); NP – no peaks; and NM – sample not mounted for SEM (too small)

Colour	Object	Location	XRF	FTIR	Raman	SEM (pigment layer)
Red	Torso_2	neck (dark red)	Fe, (Pb)	Calcite, kaolin, quartz	Hematite, quartz	Fe, Pb, Cl
		PL sleeve	Fe, (Pb)	Calcite, kaolin, quartz	Hematite, quartz	Fe, Pb, Cl
		PR sleeve	Hg, (Pb, Fe)	Kaolin, quartz	Vermilion	NM
	Torso_6	PR arm	Hg, Pb, (Cu, Fe)	Calcite, gypsum?, kaolin, quartz	Vermilion	Hg, S, (Pb, Cl)
	Arm_5D	wrist	Fe	Kaolin, quartz	Hematite, quartz	NM
	Torso_7	PL sleeve	Hg, Pb, (Ca)	Calcite, kaolin	Vermilion, red lead, calcite	NM
	Torso_12	belt	Hg, (Ca, As, Pb)	Calcite, kaolin	Vermilion	Hg, S, Ca
	Torso_18	robe (dark red)	Hg, (Pb)	Calcite, kaolin, talc	Vermilion	Hg, S
		robe (pink)	Hg, (Pb)	Calcite, talc	Vermilion	Hg, S, Pb
		robe (maroon)	Fe, (Pb)	Kaolin, quartz	Hematite, magnetite or hausmanite	Fe, Si, Al
	Torso_23	face	Hg	Gypsum?, talc?	Vermilion	Hg, S, (Ca, Mg, Si, Al)
		sash (orange-red)	Hg, (Fe)	Calcite, gypsum?, talc	Vermilion	Hg, S, (Ca, Mg, Si, Al)
	Torso_24	robe	Hg, Pb	Calcite, kaolin	Vermilion, red lead, calcite	Hg, S, Pb
	Head_11	lips	NX	Calcite, gypsum, quartz	Vermilion	NM
	Head_20	lips	Hg, (Pb)	Calcite	Vermilion	NM
	Head_20	Chin (pink)	Pb, (Hg)	NS	NS	NS
	Roundel_27	Top (pink under gold)	Au, (Fe, Ag)	Calcite, gypsum?, talc	Hematite	NM
	Plaque_32F	PR eye	Hg, Pb	Lead white	Vermilion, lead white	Hg, S, Pb, Cl
	Plaque_40Q	edge	Hg	Mica, quartz	Vermilion	NM
	Tsatsa_36F	surface (orange-red)	Fe	Gypsum, kaolin, quartz	Hematite, quartz	Fe, Si, Al
Yellow	Torso_2	drapery	As, (Cu, Fe)	Calcite	Orpiment	NM
	Plaque_40G	top	As, S	Gypsum?, kaolin?, talc?	Orpiment	NM

Colour	Object	Location	XRF	FTIR	Raman	SEM (pigment layer)
Green	Torso_2	legs	As, Ca, (Pb)	Calcite, kaolin quartz,	Carbon black indigo, orpiment	NM
	Torso_6	drapery (with white)	Cu, Cl, As, Pb, Sn, (Ca)	Atacamite, calcite, kaolin	Atacamite, orpiment vermilion	Cu, Cl, Sn; over lower layers with As, S & Hg, S
	Torso_7	PR robes	Cu, As, (Ca)	Atacamite, brochantite	Atacamite, orpiment	As, S; over Cu, Cl, S, Si, Pb, Sn
	Torso_18	PR sleeve	Cu Cl, Sn, Pb, As	Atacamite	Vermilion	Cu, Cl, S, Pb, Sn
		PL sleeve	NX	Atacamite	Atacamite	Cu, Cl, S, Pb, Sn
	Torso_24	PR robe	Cu, Cl, Pb, Sn	Atacamite	calcite	NM
	Head_11	mustache	NX	Atacamite	NP	NM
	Head_20	chin	Cu, (Pb, Cl, Sn)	Atacamite, lead white	Atacamite, azurite	NM
Blue	Torso_7	back	Fe, Ca, As	Calcite, indigo	Indigo, orpiment	As, S, Si Al; over C-rich blue layer
		PR arm	Cu	NA	NA	Cu, Ca, Pb
	Torso_12	face; skin	Cu, (Ca)	Azurite, calcite, gypsum, kaolin,	Azurite	NM
	Torso_18	PL skirt	Cu, (As)	Azurite, calcite, talc	Azurite, indigo	Cu, Ca, Mg, Si
		ribbon	Cu, Fe, (Ca, Pb)	Azurite, talc	Azurite, hematite	NM
		back	Cu	Azurite, kaolin, quartz	Azurite	Cu, Fe, Si, Al
	Torso_23	hair	Cu, (Ca, Pb)	Azurite, kaolin	Azurite	Cu, Fe, Si, Al
	Torso_24	PL arm	Cu	Azurite, mica	Azurite	NM
	Head_11	PL hair curl	Ca, (Fe, Pb)	Calcite, indigo, quartz	Indigo, calcite	NM
		PR hair curl	Cu, (Ca)	Calcite, kaolin, quartz	Azurite, carbon black, indigo	NM
	Head_20	hair	Cu	Azurite, kaolin, quartz	Azurite, vermilion, quartz	NM
	Arm_5D	hand	Cu, Ca	Azurite, calcite, kaolin	Azurite, calcite	Cu

Colour	Object	Location	XRF	FTIR	Raman	SEM (pigment layer)
White	Torso_7	shirt	Pb, (As, Ca)	Lead white, calcite talc	Lead white, hematite,orpiment, vermilion	Pb, Hg, S
		below other colours	Ca	NS	NS	NS
	Torso_12	body	Ca	NS	NS	NS
	Torso_18	PR sleeve	Ca	Calcite, gypsum?, talc	NP	NM
		decoration on drapery	Pb	NS	NS	NS
	Torso_23	face	Fe, (Ca, As, Pb)	Calcite, gypsum, talc	Dolomite, gypsum	Pb, Cl, Hg, S
	Torso_24	below other colours	Ca	NS	NS	NS
		chest	Ca	Calcite, gypsum, kaolin, quartz	Calcite	NM
		PL robe	Ca, (Pb)	Calcite, gypsum, kaolin, quartz	Calcite	NM
	Head_11	eye	Pb	NS	NS	NS
	Head_20	PR skin (with red)	(Pb, Hg)	Calcite, gypsum, kaolin, quartz	Calcite, gypsum, vermilion	Cu, Cl, Pb, Sn, Ca (green); over Pb, Ca, Hg, S, Cl (white with red)
	Arm_5D	below blue	Ca	NS	NS	NS
Black	Torso_12	PR eye	Ca, (Pb)	Calcite, huntite, kaolin	Carbon black	NM
		PR hair	Ca, (Fe)	Calcite, gypsum	Carbon black	NM
		hair	Ca, (Fe)	Calcite, gypsum, kaolin	Carbon black	NM
	Plaque_32K	hair	Like clay	Huntite, kaolin, quartz	Carbon black	Carbon-rich, Ca, S
Gold	Torso_6	PR arm	As, Pb, Hg, Au (Fe)	NA	NA	Au 94, Ag 6, <1 µm; over As, S; over Hg, S
	Torso_18	robe	Au, As	Gypsum?, talc	NP	Au 94, Ag 8, 2 µm; over As, S
	Head_11	PL eye (over pink)	Au, Hg, (Ag)	NA	NA	Au 94, Ag 6, 5 µm, multiple compressed layers; over Hg, S
	Roundel_27	top (over pink)	Au, (Ag)	Calcite, huntite, gypsum?, talc	Hematite	Au 92, Ag 8, <1 µm; over Mg, Si, Al, Fe
	Plaque_40K	top (over pink)	Au, (Ag)	Calcite, gypsum, talc	NP	Au 94, Ag 6, <1 µm; over Mg, Si, Al, Fe,
	Plaque_40Q	outside petal	Au, Pb	Gypsum, talc?	NP	Au 88, Ag 12, 3 µm; over Hg, Pb. Cl

4.1 Ground Layers and Surface Preparations

Coloured pigments were applied over white ground layers of talc (magnesium- and silicon-rich layers in SEM-EDX), kaolin, and/or calcite which overlie the clay. In some samples, gypsum occurs within the ground layer and/or upper part of the clay substrate. Thin layers of gypsum may be due to alteration of an original alum sealant on the clay surface, as proposed at Dunhuang (Wong, Agnew 2013). However, thicker layers of gypsum were likely applied deliberately. Lead white and lead chloride were also present, likely as white surface layers rather than a preparatory or priming ground.

4.2 Pigments and Polychromy

4.2.1 Red

The dominant red pigments are red ochre (containing hematite) and mercuric sulfide, cinnabar or vermilion. The fine particle size suggests use of synthetic vermilion rather than natural cinnabar. Red ochre and vermilion were often used separately in different areas of a single figure. Red lead was relatively rare and only used in combination with vermilion.

4.2.2 Yellow

Orpiment was the only yellow pigment identified, used alone and combined with indigo for green.

4.2.3 Green

Atacamite was the main green pigment, with occasional mixtures of orpiment and indigo. Malachite was not identified in any sample, although azurite occasionally occurs with atacamite. SEM-EDS showed that tin- and lead-rich inclusions occur within some atacamite particles, and copper sulfate is mixed with atacamite in Torso_18. In Torso_7, brochantite is intergrown with copper-containing silicates and mixed with atacamite. Yong (2012) found that synthetic production of copper chloride pigments began to dominate the green pigments used in China from the 10th century. The morphology of the particles was used to determine the nature of the copper chloride pigment: angular particles were attributed to natural copper chloride, rounded to spherical particles to synthetic copper chloride (Yong 2012). The angular morphology of the atacamite particles in these samples is hence more consistent with use of natural atacamite. Similarly, the intergrowths and morphology of atacamite, brochantite, and azurite suggest a natural source – a mixed deposit of atacamite with other minerals.

4.2.4 Blue

Azurite and indigo were the only blue pigments identified. These were normally used separately: azurite for lighter, brighter blues, and indigo for

darker blues. Mixtures of azurite and indigo occur in only two instances. A dark blue hair curl from Head_11 contains azurite, indigo, and carbon black, whilst the adjacent lighter blue hair curl contains only indigo. Similarly, azurite and indigo are present in the blue skirt of Torso_18, whilst other blue areas of the figure only contain azurite. These variations may indicate the selection of different mixtures to achieve a specific blue.

4.2.5 White

White pigments include kaolin, talc, calcite, and gypsum, used for ground layers and white details, and occasional lead white and lead chloride in paint layers and details. Lead white is notably more opaque than the other white materials. A pink tint was created on some figures using layers of lead white containing vermilion with different particle sizes. In many samples, thin layers of lead chloride are present alone, within layers of lead white, or as scattered particles mixed with other pigments. Lead chloride may have been deliberately used in mixtures, perhaps as a less opaque white than lead white. Colour blending with lead oxychloride and other pigments was noted at the Tiantishan grottos (Zhou, Zhang, Cheng 1997).

4.2.6 Black

Carbon black was used as the black pigment.

4.2.7 Gold

Gilding is present on six objects. Most samples show a single layer of extremely thin gold foil (less than 3 microns) with some overlapping and crumpled edges. However, multiple layers of compressed, crumpled gold foil are present in the sample from Head_11. Most foil is high purity gold with only 6-8 wt% silver, with one example containing 12 wt% silver. The gold foil was often applied over coloured layers, with simple layering of gold over talc and red ochre in Roundel_27 and Plaque_40K, and over vermilion in Plaque_40Q. More complex layering occurs on the figures: gold was applied over orpiment and vermilion in Torso_6, and gold was used over orpiment and red ochre in Torso_18.

4.3 Repainting

Cross-sections from four objects, Torso_6, Torso_7, Head_20, and Plaque_32F, contain multiple coloured layers. The composition of these layers is given in Table 5. The pigments in all layers are the same as those used elsewhere, and the colour change is often minimal, suggesting historic repainting, documented at cave sites including Dunhuang (Shui et al. 2022) and Yungang (Piqué 1997).

4.4 Consolidation and Restoration

Cellulose nitrate, available in the early 20th century, was detected with FTIR in most figural sculptures, apart from Torso_6 and Arm_5D. Many surfaces are covered in fine sand-like particulates, with heavy concentrations in the interstices of the decoration. The particulate is trapped in place by the consolidation layer, suggesting hasty application during the excavation or shortly after the sculpture arrived at Harvard. Unfortunately, there are no extant treatment records documenting this modern consolidation.

Torso_18 has an applied layer of poly(vinyl acetate), available from ca. 1930, and cellulose nitrate on the surface, both identified with FTIR. Some areas of this figure also had evidence of restoration in the form of chromium green pigments, available from the late 19th or 20th century, and Prussian blue, available from the 18th century. However, there are no records of when restoration occurred.

4.5 Binders

Protein was detected with FTIR in paint samples from two figures (Torso_7 and 18), Roundel_27, and Plaques_32K, 40G, 40Q. However, all samples from the figures contain cellulose nitrate, and the roundel and plaques have a glossy surface despite the lack of detectable cellulose nitrate. This evidence of previous treatment prompts caution in the interpretation of results. Although there is some evidence for use of a protein-based binder, further investigation is required to distinguish between its presence as an original binder or later restoration material.

5 Discussion

The figural sculptures examined follow a sequence of manufacture consistent with the common elements of monumental *terracruda* sculpture as described by López-Prat et al. (2024) and aligned with earlier practices in greater Gandhara and India, as described by Tarzi (1986) and Varma (1987), respectively, as well as at Dunhuang (Chang et al. 2026). The figural sculptures studied provide insights into technical consistencies and variability of air-dried sculptural forms at Khara-Khoto.

The variability in armature designs demonstrates object-specific construction practices using wood as a primary structural support. For larger figures, a central wooden post was necessary for structural integrity. In Torso_23, the substantial column extending through and beyond the figure may have supported the visages of an eleven-faced bodhisattva. If so, it would be the only sculpture of its form to survive in the Tangut corpus; painted examples remain at the State Hermitage Museum and on the wall of Yulin Cave 3. For smaller, compact figures, such as Torso_6, wooden armatures may not have been structurally necessary, though their use has reinforced their enduring forms. The bundle of organic fibres serving as a core in Torso_2 was packed directly with clay, though the fibres have shrunken, leaving their original impressions in the clay. Torso_7, similar in scale, has extended arms, which do require internal support. Wooden

elements were secured together with twine or metal nails, particularly in larger sculptures.

Clay was added to internal frameworks in successive layers, progressing from coarser structural clay to finer exterior modelling layers. Within several objects, the discovery of similar materials placed within the clay bodies during the manufacture is particularly significant: these objects (perhaps metal or stone) and organic materials may be ritual deposits or symbolic organs, akin to those found in Buddhist sculptures of different media across cultures. The recurring strands, used as a structural core in Torso_2 and Head_11, but deposited in a discrete, non-structural bundle in Torso_23, warrant further investigation. Although material identification requiring samples is limited due to the deposits' inaccessibility, identification with micro-CT at higher resolution may be possible.

Applied details, modelled or cast in moulds, were attached to the sculpture. The use of moulds aligns with the evidence of extensive use of moulds for clay-based sculptures across sites on the Northern Silk Road (Schmidt 2025, 152-3) and described by Tarzi (1986) in sites at Hadda.

The surfaces were finished with a fine layer of clay, often covered with whitish ground containing mixtures of talc, calcite, and/or gypsum. Polychrome decoration was applied over the white ground using a palette of mineral and manufactured pigments, including red ochre, vermilion, azurite, indigo, atacamite, orpiment, talc, calcite, gypsum, lead white, and lead chloride. This assemblage is consistent with pigments used from the late Tang onwards, particularly the lack of malachite and lazurite, scarcity of red lead compared to vermilion and hematite, and use of lead white.[2] Thin layers of gilding were added in the final stages of surface decoration. A protein-based binding medium, likely animal glue, may have been employed as a binder in the paint layers.

Notably, there was no detection of smalt on any clay sculpture. This contrasts with an early identification of smalt from a fragment of a wall painting attributed to Khara-Khoto and given to Gettens by Langdon Warner in 1925 (Gettens, Stout [1942] 1966, 159; Mühlethaler, Thissen 1969, 48-9, 57; 1993, 114, 128). This fragment was reportedly taken to the Smithsonian by Gettens but has yet to be located. Gettens' identification has frequently been referenced as the earliest occurrence of smalt in Eurasia. However, recent examination of the three wall paintings, several unidentified clay fragments with remaining pigment, and the clay objects presented here found only azurite and indigo with no smalt detected.

6 Conclusion

This technical investigation provides the first comprehensive study of materials and construction technologies of air-dried clay objects from Khara-Khoto. The results demonstrate that sculptural production at the site was based on layered clay construction, diverse internal support systems, hybrid moulding and hand-modelling techniques, and a consistent palette of mineral and synthetic pigments. Several fragments included more than one

2 Piqué 1997; Wainwright et al. 1997; Li 2002; Wong, Agnew 2013; Liu et al. 2016; Shui et al. 2022.

ritual deposit. These techniques align with broader traditions of Buddhist monumental *terracruda* sculpture while exhibiting their own characteristics.

Having remained largely unexamined for a century, the Harvard Art Museums' holdings of Khara-Khoto fragments provided an exceptional opportunity to investigate the materials and technologies of Tangut Xia clay sculpture. Visual examination and analytical evidence confirmed that these objects are air-dried clay, resolving inconsistencies in museum records (which had variously categorised them as unfired clay, ceramic, and sun-dried clay) and establishing more accurate and consistent terminology for future documentation. Additionally, micro-CT imaging proved to be an effective, non-invasive tool for investigating internal structure, morphology, distribution, and assembly of components.

This study provides an important technical foundation for future scholarship and conservation of the fragments, as well as related traditions of *terracruda* sculpture across the Silk Roads. The rich findings from this small group of objects have prompted interest in the identification and study of the internal ritual deposits, as well as an expanded technical study of remaining fragments at the Harvard Art Museums to further illuminate artistic practices at Khara-Khoto.

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From Earth to Enlightenment
Materiality, Technology and Cultural Transmission of Terracruda Sculpture Across Buddhist Asia
edited by Mònica López-Prat, Emma Cantisani, Susan S. Bean

Polychrome Air-Dried Clay Sculptures (*Nísù*) in Shanxi, China
Community Practice, Conservation, and Cultural Continuity

Gesa Schwantes
Academy of Fine Arts Vienna, Austria

Chunyan Ye
Yuncheng Ancient Color Sculpture and Mural Conservation Research Institute, China

Xianliang Liang
Shanxi Cultural Heritage Survey and Conservation Research Institute Co., Ltd, China

Qun Cheng
Shanxi Cultural Heritage Survey and Conservation Research Institute Co., Ltd, China

Yiyan Niu
Shanxi Cultural Heritage Survey and Conservation Research Institute Co., Ltd, China

Pengxiao Hao
The Cyprus Institute, Cyprus

Mònica López-Prat
Institute of Heritage Science of the National Research Council of Italy

Abstract This paper examines *nísù* (泥塑), the Chinese tradition of polychrome air-dried clay sculpture, through a field study of twenty-one temple sites in Shanxi Province, which preserves one of the world's richest concentrations of monumental examples from the Tang to Qing dynasties. Combining field observation, stratigraphic examination, photography, and interviews with nísù artisans and temple caretakers, the study investigates the relationship between craft practice, ritual life, community stewardship, and conservation. The results show nísù to be a composite, stratified system whose fundamental logic has remained remarkably stable over time, with two interconnected systems of care: community-based maintenance embedded in devotional practice, and professional conservation-restoration. Preservation outcomes depend on material conditions, architectural maintenance, ritual use, and community engagement. Conservation strategies must address both material stability and living cultural continuity.

Keywords Air-dried clay. Nísù 泥塑. Conservation. Traditional knowledge. Shanxi Province.

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Summary 1 Introduction. – 2 Context and Methodology. – 3 Results. – 3.1 Construction and Material Characteristics of Nísù. – 3.2 Community Practice, Devotional Care, and Living Heritage. – 3.3 Conservation Challenges Observed Across the Surveyed Sites. – 4 Discussion. – 4.1 Nísù Within the Transregional Clay Sculpture Tradition. – 4.2 Continuity and Change in Materials and Techniques. – 4.3 Community Practice, Conservation Ethics, and Implications for Strategy. – 5 Conclusion.

1 Introduction

Nísù (泥塑) is the established Chinese term for polychrome clay sculpture using mud as the primary material (Xu 2012). Here, mud refers to a workable mixture of clay-rich earth, water, fine mineral aggregates such as sand, and organic additives including fibres and chaff. The term encompasses both material and process, with no direct equivalent in English: *ní* refers to the malleable, clay-based material used in modelling, which can be understood approximately as 'mud' or 'earthen material', while '*sù*' refers to the act of shaping, distinguishing the practice from carving. These works are also known as *cǎisù* (彩塑), a term that emphasises their painted surface. The two terms are widely used interchangeably (Xu 2012). For consistency, this study, conducted in China, uses nísù throughout.

In English-language publications, finished sculptures are generally not described as 'mud sculptures', since they are no longer wet or workable. Instead, terms such as 'unfired clay sculpture', 'air-dried clay sculpture', 'earthen sculpture', and 'terracruda' (unfired earth, as opposed to terracotta, fired earth) are used to describe the material and technique of the completed object. Unlike these English terms, which refer primarily to the finished state, nísù encompasses both process and product. This reflects a tradition in which the process of modelling is as significant as the finished work (Li, Howard 2003, 10; Ōmura 2020, 1050).

Nísù sculptures **[fig. 1]** are composite, stratified, site-specific works modelled in situ and are inseparable from their architectural and social contexts. This inseparability is particularly important for conservation, since the material conservation of the sculptures cannot be separated from the cultural and devotional environments in which they continue to function. The study therefore examines the continuity between the making and conservation of sculptures through two coexisting systems of maintenance: local devotional care and professional conservation. It considers these works not as static artefacts, but objects subject to ongoing intervention. The central question which we are discussing in this article is how these forms of care affect the material preservation, devotional function, and cultural significance of nísù sculptures. In particular, the study considers the benefits and risks of continuous, locally embedded maintenance alongside the constraints and limited scalability of professional conservation.



Figure 1 Monumental nísù sculpture at Shuanglin Temple (T11), illustrating the scale, polychrome surface, and architectural integration characteristic of Shanxi's sculptural tradition. Photograph: Schwantes 2024

2 Context and Methodology

Shanxi Province was selected for its exceptionally rich, continuous record of nísù production and its unusually high concentration of surviving monumental examples. According to the Information Office of the People's Government of Shanxi Province (2024), the province contains nearly 30,000 historical architectural sites, many of them temples, and approximately 12,000 historical nísù sculptures, the highest concentration in China. This density reflects Shanxi's long-standing role as a religious and cultural centre where Buddhism, Daoism, and local folk traditions coexisted. The

province is also known for strong local patronage and artisan networks as well as relative political stability, which contributed to the preservation of many historical sites (Chai, Chai 2008, 2-3). Although most nísù figures represent Buddhist or Daoist deities, they also provide evidence of everyday life, regional culture, clothing, and evolving artistic practices.

Twenty-one temple sites across the province were examined. The sites were selected to represent a range of historical periods, sculptural scales, forms of institutional management, and levels of community use. They include major urban monastic complexes as well as modest rural shrines maintained primarily through local initiative. Together, these sites reflect the range of conditions in which nísù sculptures exist and are cared for today. The sites span the Tang (618-907 CE), Song (960-1279 CE), Liao (916-1125 CE), Jin (1115-1234 CE), Yuan (1271-1368 CE), Ming (1368-1644 CE), and Qing (1616-1912 CE) dynasties, representing nearly the full chronological range of Chinese nísù. The survey provides a sample of the diverse temple sites in Shanxi rather than a representative count of the province's temples as a whole.

The survey formed part of an international collaboration initiated by Shanghai University and the Yuncheng Ancient Colour Sculpture and Mural Conservation Research Institute. The Taiyuan-based Shanxi Cultural Heritage Survey and Conservation Research Institute Co., Ltd coordinated and organised fieldwork, providing a platform for interaction among scholars, experts, craftspeople, and students. The approximate locations of all twenty-one sites are listed in table 1 and shown in figure 2.

Table 1 Temple sites in Shanxi Province surveyed during the fieldwork, listed from north to south corresponding to the numbering in Figure 2

No.	Temple place, name	Time period/Dynasty
T1	Datong, Huayan Temple: Upper Temple Lower Temple	 Ming (1368-1644 CE) Liao (916-1125 CE)
T2	Datong, Shanhua Temple	Liao (916-1125 CE), Jin (1115-1234 CE)
T3	Shuozhou, Chongfu Temple	Jin (1115-1234 CE), Ming (1368-1644 CE)
T4	Wutai, Shuxiang Temple	Ming (1368-1644 CE)
T5	Wutai, Foguang Temple	Tang (618-907 CE)
T6	Yuanping, Huiji Temple	Song (960-1279 CE), Ming (1368-1644 CE), Qing (1616-1912 CE)
T7	Wutai, Nanchan Temple	Tang (618-907 CE)
T8	Dingxiang, Hongfu Temple	Song (960-1279 CE), Ming (1368-1644 CE)
T9	Taiyuan, Jin Temple	Song (960-1279 CE), Yuan (1271-1368 CE), Ming (1368-1644 CE), Qing (1616-1912 CE)
T10	Pingyao, Zhenguo Temple	Five Dynasties (907-960 CE)
T11	Pingyao, Shuanglin Temple	Song (960-1279 CE), Yuan (1271-1368 CE), Ming (1368-1644 CE)
T12	Pingyao, Qingxu Taoist temple	Yuan (1271-1368 CE)
T13	Jiexiu, Houtu Temple	Ming (1368-1644 CE)

No.	Temple place, name	Time period/Dynasty
T14	Lingshi, Xunjia Geduo Village Sanguan Temple	Ming (1368-1644 CE) or Qing (1616-1912 CE)
T15	Xi County, Xiaoxitian	Ming (1368-1644 CE)
T16	Hongtong, Guangsheng Temple	Yuan (1271-1368 CE) and Ming (1368-1644 CE)
T17	Changzhi, Guanyin Hall	Ming (1368-1644 CE)
T18	Changzhi, Chongqing Temple	Song (960-1279 CE)
T19	Jincheng, Gaoping Iron Buddha Temple	Ming (1368-1644 CE)
T20	Jincheng, Qinglian Temple	Tang and Song (960-1279 CE)
T21	Jincheng, Yuhuang Temple	Song (960-1279 CE) and Yuan (1271-1368 CE)

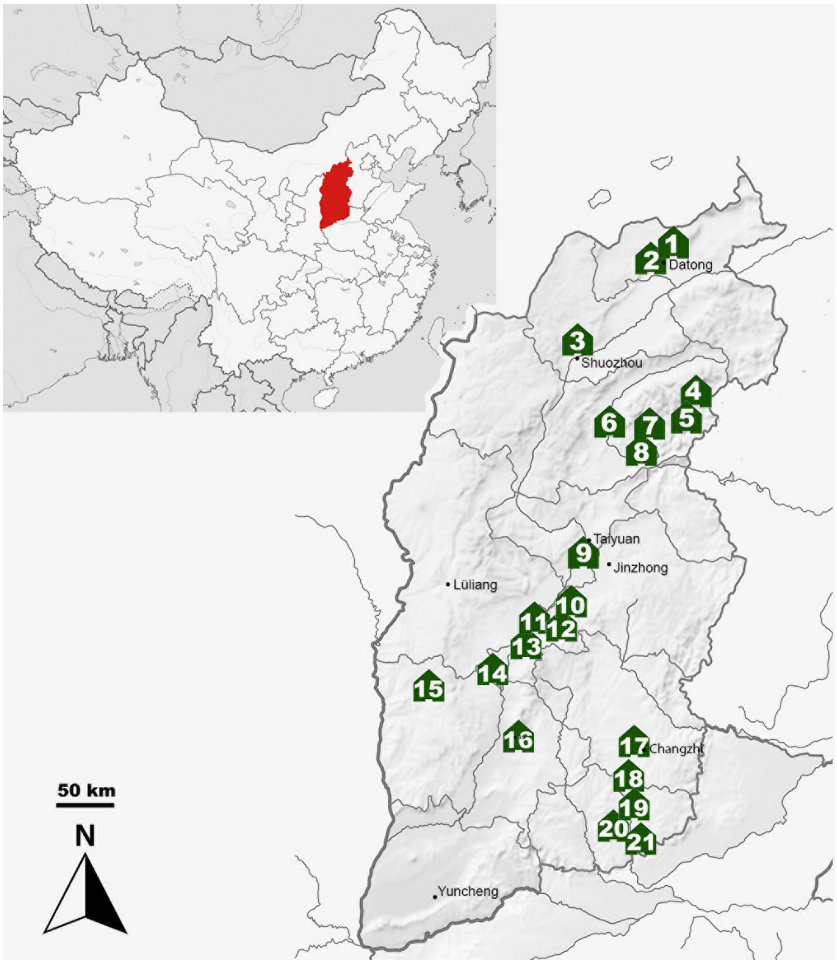


Figure 2 Map of Shanxi Province showing the approximate locations of the 21 surveyed temple sites, numbered from north to south as listed in Table 1. Source: Compiled and adapted by Gesa Schwantes from an open-source base map

The methodology focused on documenting the sculptures' construction, materials, and current conservation conditions while considering the social and devotional contexts in which they function. The research combined direct observation, photography, examination of exposed construction layers, and comparison across the surveyed sites. Sculptures were documented under the available lighting conditions to record their form, surface condition, and visible construction layers. Field notes recorded materials, layering sequences, scale, condition and visible signs of deterioration.

Deterioration was assessed in relation to both physical and functional factors. Physical factors included climatic conditions, the condition of the surrounding architecture, and biological activity, while functional factors included devotional use, visitor access, and site management. These observations were supplemented by informal conversations with practitioners and site custodians during the field survey, including a contemporary nísù artist and temple caretakers. The professional knowledge of team members from the Yuncheng Ancient Colour Sculpture and Mural Conservation Research Institute and the Shanxi Cultural Heritage Survey and Conservation Research Institute Co., Ltd in Taiyuan also provided contextual information on maintenance practices and devotional use that could not be fully understood through direct observation alone.

As active places of worship, many temples required adherence to religious schedules and local protocols, which sometimes limited access to particular sculptures. These conditions were treated not simply as limitations on the survey but as part of the context in which the sculptures continue to function as living heritage. Observing how religious activities intersected with sculptural spaces was therefore also part of the study's empirical scope.

3 Results

3.1 Construction and Material Characteristics of Nísù

Museums and heritage exhibitions widely present the making of nísù as an example of traditional Chinese craft **[fig. 3]**. Although the basic construction sequence is relatively consistent, the materials and techniques used at individual sites and by different makers can vary. The construction process can be broadly understood as a sequence of layers, beginning with the internal structural support and progressing through successive modelling, preparation, and decorative layers. In a typical construction sequence, construction begins with a wooden core, sometimes set on a brick or stone base, which is wrapped in rope and built up with successive layers of mud mixed with organic fibres. A final preparation layer provides a smooth surface for the white ground and paint layers (Chai, Chai 2008; Blänsdorf, Ma 2010; Song et al. 2021; López-Prat et al. 2024b).



Figure 3 Typical nísù manufacturing sequence displayed in an exhibition room (T21): wooden core, successive modelling layers, ground preparation, and final painted or gilded surface. Photograph: López-Prat 2024

3.1.1 Armature and Structural Support

The internal armature systems vary in their structural configuration, including central-post and box-frame forms (Yang 2015, 50; Jia, Li 2021, 13). Seated figures often rest on a solid stone or brick pedestal, while standing figures may be supported by wooden poles extending into the floor through the legs **[fig. 4]**. The wooden core may be supplemented with smaller wood splints, branches, and packed straw to approximate the intended volume **[fig. 5]**. Arms and hands are supported by thinner wooden sticks, secured and joined with nails and ropes **[fig. 6]**. These elements form the structural framework around which the modelling layers are built.



Figure 4 Variations in nísù base construction: The main Buddha sits on a stone and/or brick base; others are freestanding, on raised podiums or anchored directly into the floor using wooden poles inside the legs (one intact, one missing in the left foreground) (T7). Photograph: López-Prat 2024

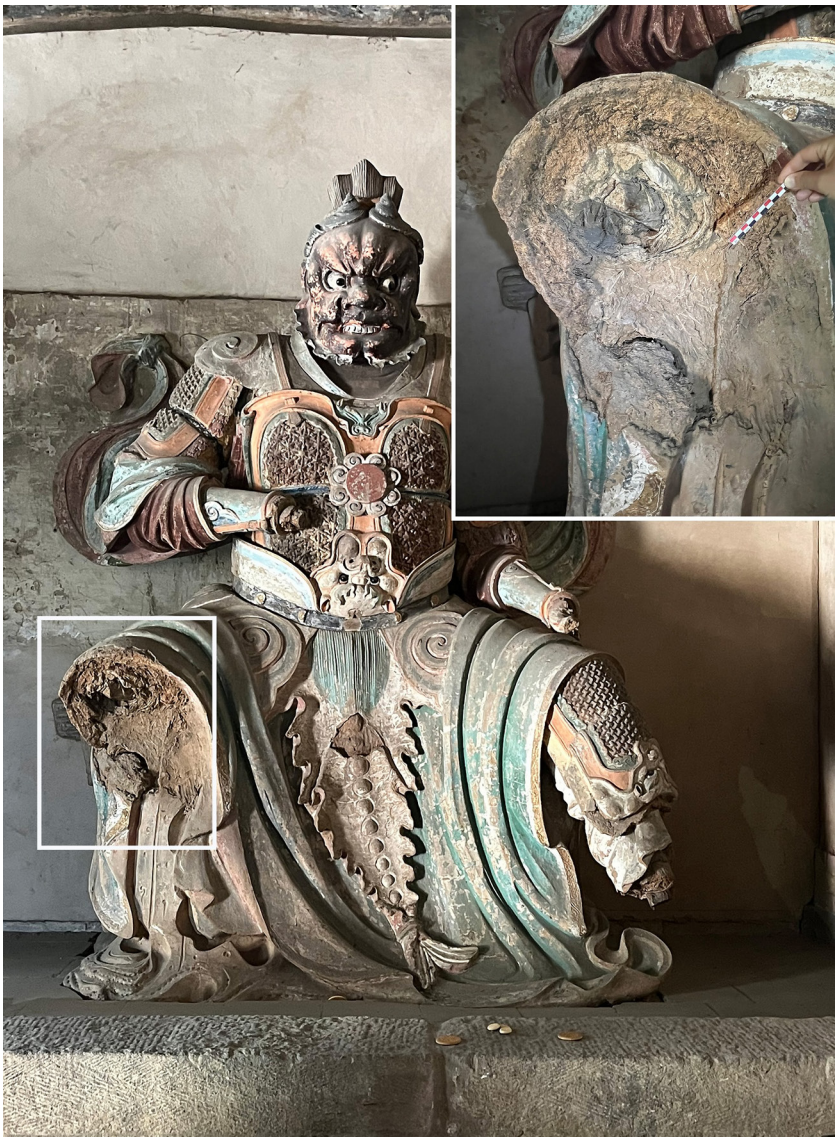


Figure 5 Detail of a broken nísù knee, revealing the wooden core wrapped with rope, inner modelling layers mixed with straw, and outer layers without straw (T18). Photograph: López-Prat 2024



Figure 6 (a) Nísù sculpture with a broken arm, showing ropes used for joining at elbow height (T8); (b) nísù sculpture with a broken arm showing nails used for joining (T7). Photograph: López-Prat 2024

Fingers are modelled in fine clay-based paste over wires or bent bamboo splints. Copper- and iron-wire making developed during the Song dynasty and was used in nísù as early as the Yuan dynasty (Yin, Zhang 2023). According to Master Liu (pers. comm., 2024-06-14), a nísù sculptor from Jiexiu, wire is commonly used to support the hands, which are shaped separately towards the end of the modelling process. He noted that earlier practice used boiled and softened bamboo, while twisted hemp also served a similar structural function. These materials served similar purposes despite changes in workshop practice and material availability. The shift to wire reflects broader changes in both material availability and workshop practice (Xu 2012, 112).

3.1.2 Modelling Layers and Surface Preparation

Over the armature, successive mud layers build up the sculptural form. The coarser inner layers contain a high proportion of straw, followed by two progressively finer modelling layers containing very fine organic fibres (Xu 2012, 113-14; Cao, Yang 1998, 226). The coarser layers establish the volume, while the finer layers progressively refine the surface. The outermost modelling layer provides a smooth surface for the finishing and decorative layers. A white ground, consisting of kaolin clay, gypsum, chalk, or mixtures of these materials in varying proportions is applied before the paint layers (Yang 2015, 50; Hui et al. 2018, 122), with animal glue used as a binder (Cao, Yang 1998, 230).

3.1.3 Paper Layers and Repair

The use of paper represents a more complex aspect of nísù construction because published sources interpret its function differently. Studies of nísù production report the use of paper layers from the Yuan dynasty onwards (Song et al. 2021; Yin, Zhang 2023), while other studies describe paper layers as the result of repair interventions (Zhang, Chen 2012, 16, 43; Chai, Chai 2008, 16). The function of paper therefore cannot be determined from its presence alone and must be assessed in relation to its position within the stratigraphy and the condition of the surrounding layers. Master Liu (pers. comm., 2024-06-14) confirmed paper is still used traditionally to reduce cracking and to smooth the transition between clay and ground layers. Paper-layer repairs were identified at both Huiji Temple (**T6**) and Sanguan Temple (**T14**). These observations indicate that paper may have been used both in traditional construction and in later repair, depending on the context.

3.1.4 Variation in Construction and Execution

The technological system described above reflects a broadly consistent construction logic across the surveyed sites, but not a uniform one. Variations in the scale and elaboration of internal armatures, the thickness and composition of modelling layers, and the quality of surface finishing were observed across the surveyed sculptures. These differences may reflect variation in patronage, available resources, and the experience and technical skill of the makers. They occur across individual sculptures and sites and do not, on their own, indicate fundamentally different construction traditions.

3.2 Community Practice, Devotional Care, and Living Heritage

Nísù sculptures in Shanxi can be understood as living heritage insofar as they remain subject to ongoing engagement, including touching, decoration, repainting, cleaning, and devotional use by local communities (Schnüttgen 2025; UNESCO 2015). Historical evidence also documents repeated maintenance and restoration. According to stele inscriptions, the nísù at Shanhua Temple (T2) underwent at least three major restorations (1128-43 CE, 1576-83 CE, and 1708-16 CE) from the Jin to the Qing dynasties, alongside five large-scale architectural restorations (Zhang, Chen 2012, 20). These interventions have been interpreted as acts of belief and respect rather than as professional conservation interventions (Zhang, Chen 2012, 42). At the same time, maintenance principles recorded during the Ming dynasty indicate an explicit concern with limiting unnecessary renewal while repairing damaged or deteriorated elements, as stated by Zhang and Chen:

> sù xiàng fēi shèn huǐ zhě bù yǐ gèng， zhuāng yán fēi shèn lòu zhě bù yǐ shì 。wéi yú xiǔ zhě yì zhī， tuí zhě lǐ zhī
>
> 塑像非甚毁者不以更，妆严非甚陋者不以饰。惟于朽者易之，颓者理之
>
> Sculptures were not to be renewed unless severely damaged, nor decorative elements repainted unless seriously deteriorated; only decayed

components were replaced and damaged portions repaired. (Zhang, Chen 2012, 32; authors' translation)

Historical accounts describe two broad forms of nísù maintenance: repair of the clay body, including the replacement of missing parts or the addition of mud layers, and renewal of the surface through sanding of existing paint, application of a new ground or paper layer and repainting (Zhang, Chen 2012, 43). Such repainting often reflects the visual styles of the period in which it was undertaken, as also observed in the redecoration of religious sculptures more broadly. The surveyed sculptures provide evidence of both continued surface intervention and ongoing devotional use.

The most visible evidence of ongoing devotional engagement was observed on the sculptures' surfaces. At several sites, more recent paint layers of a different material character from underlying historic finishes indicate repainting that appeared to be associated with devotional renewal rather than professional conservation treatment. At others, fabric offerings and draped clothing placed on or around figures provided visible evidence of continued devotional use. The accumulation of incense smoke and candle soot on accessible surfaces, together with abrasion of painted areas within the reach of worshippers, provided further evidence of sustained human interaction with the sculptures.

The extent and forms of community interaction with the sculptures varied considerably across the surveyed sites. Three recurring patterns of community engagement and care emerged from these observations. These patterns are analytical groupings rather than formal classifications of the surveyed temples, and individual sites may display characteristics of more than one pattern. They distinguish different relationships between devotional use, maintenance, intervention, and the material condition of the sculptures.

3.2.1 Pattern 1: Active Use with Regular Maintenance and Conservation Support

At several surveyed temples, active devotional use was accompanied by regular maintenance and conservation support. Sculptures at these sites were generally maintained in comparatively clean environments, with structural problems addressed and surfaces periodically cleaned. Simple mechanical supports and, in some cases, professional conservation treatments were also observed. Institutional support was evident at several of these sites, some of which also received substantial visitor use. These observations represent a pattern in which ongoing devotional use coexists with regular maintenance and conservation intervention.

3.2.2 Pattern 2: Limited Intervention and Accumulated Deterioration

At other surveyed sites, intervention was limited and signs of deterioration had accumulated. Thick deposits of dust and dirt, signs of biological activity including insect damage and evidence of rodents, and deterioration of the surrounding architectural fabric were observed around the sculptures. The absence of intervention did not necessarily indicate a lack of awareness or care. Conversations with members of the local heritage authority indicated

that caretakers and local communities were often aware of deterioration but were reluctant to intervene without qualified expertise, concerned that inappropriate treatment might cause further damage.

3.2.3 Pattern 3: Active Use with Repeated Aesthetic Renewal

At other surveyed sites, active worship and visitor interest were accompanied by repeated surface renewal. Sculptures had been repainted, in some cases repeatedly, resulting in bright or visually renewed surfaces. These interventions altered or obscured earlier paint layers and, in some cases, original iconographic details; some also involved modern materials such as acrylic paint. The resulting surfaces often differed substantially in material and visual character from the underlying historic finishes. This pattern reflects a form of active engagement in which repainting and surface renewal form part of ongoing care and use.

The three patterns described above concern community use, maintenance, and intervention and are intended to describe recurring relationships observed within the surveyed sites. Because the survey covered only a selection of temple sites, their relative frequency should not be taken to represent their prevalence across Shanxi. Individual sites may also display characteristics of more than one pattern. The conservation challenges discussed below cut across these patterns and include both material deterioration and the effects of previous interventions.

3.3 Conservation Challenges Observed Across the Surveyed Sites

The surveyed nísù sculptures exhibit a wide range of conditions, from relatively intact historic surfaces to severe material loss and structural instability. As site-specific works integrated into active temple environments, their condition reflects not only material deterioration but also the condition of the surrounding architecture and the effects of previous maintenance and conservation interventions. The following observations identify recurring conservation problems and types of intervention documented across the surveyed sites. They do not constitute a systematic condition assessment of all the sculptures surveyed.

Many of the conservation problems observed during the survey were associated with the architectural environment rather than the sculptures alone. Because nísù sculptures are modelled in situ and remain integrated with the buildings that house them, deficiencies in roofing, drainage, and structural maintenance can directly affect the mud, ground, and paint layers. Water infiltration, rising damp, and associated salt migration and crystallisation were among the most destructive deterioration processes encountered. At Zhenguo Temple (T10), rising damp and suspected salt crystallisation had caused severe disintegration of the lower sculptural layers **[fig. 7a]**, demonstrating the direct relationship between building condition and sculpture deterioration. Heavy dust accumulation, biological activity, and architectural deterioration were observed across sites with different geographical settings and levels of historical and artistic significance **[fig. 7b]**.



Figure 7 (a) Rising damp and salt damage causing disintegration of the clay plaster layers (T10); (b) Dust accumulation on the sculptures in a populated temple (T1). Photograph: López-Prat, Ye 2024

The survey documented a range of conservation situations, from sculptures retaining substantial original material and historic surface layers to cases involving stabilisation measures and professional conservation treatments. Shuanglin Temple (T11) provides an example in which historic paint layers and surface details remained substantially preserved despite prolonged use and limited large-scale modern intervention **[fig. 8a]**. Simple wooden supports observed at this site provided structural support while retaining the visible original material **[fig. 8b]**.

Emergency stabilisation measures were observed at approximately one-third of the surveyed sites. Wooden poles and fabric supports had been used to redistribute the load of structurally unstable figures or to support detached elements such as arms. In one case, a large-scale sculpture at **T12** was supported in a manner that gave it the appearance of a limb in a medical splint **[fig. 9a]**. Several supports appeared to have been in place for years, suggesting that initially introduced as temporary stabilisation had become long-term features of the sculptures' condition. Where supports were appropriately positioned, they provided structural stabilisation while leaving the original sculptural material largely visible.

Professional conservation treatments were also observed at some surveyed sites. At T16, unpainted earthen infills had been used to secure losses and exposed edges without reconstructing missing areas **[fig. 9b]**. The treatment retained the existing sculptural material and left the areas of loss visually distinguishable from the surrounding historic surface.

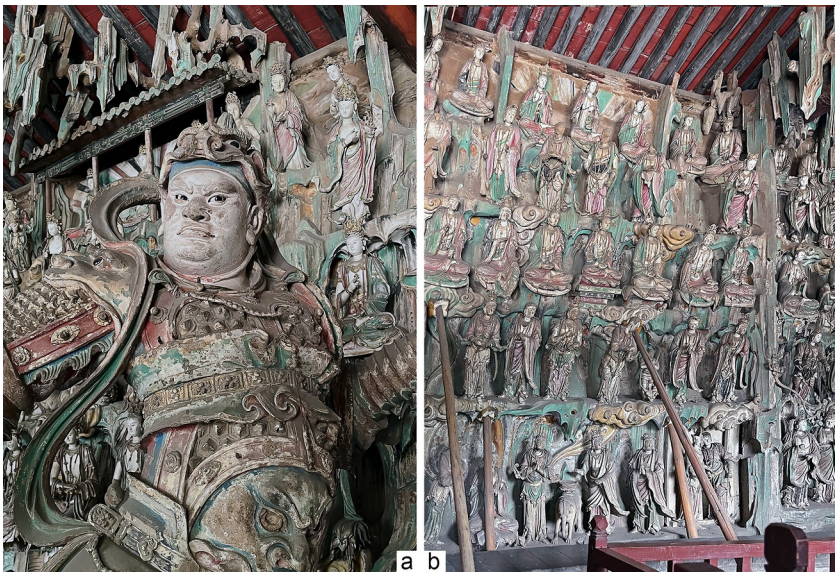


Figure 8 (a) Unrestored for centuries, the sculptures display remarkable artistic skill despite surface abrasion and dust; (b) Simple wooden supports stabilise the wall-mounted figures (T11). Photograph: Schwantes, López-Prat 2024



Figure 9 Conservation interventions: (a) Emergency stabilisation using wooden supports and fabric bandages (T12); (b) Modern preservation approach with repair fills stabilising losses without reconstruction (T16); (c) Peeling of surface layers caused by invasive restoration with acrylic paint (T4). Photograph: López-Prat 2024

In contrast, the survey also documented interventions involving materials that differed substantially from the original material systems. Cement-based mortars were observed in architectural repairs, while acrylic paint had been applied to some sculptures as part of surface renewal (T4) **[fig. 9c]**. The acrylic overpaint obscured earlier paint layers and altered the visual and material character of the historic surfaces. In some cases, the new paint layer was visibly peeling or separating from the underlying surface, resulting in further loss of the historic paint layers.

4 Discussion

The findings presented in the preceding sections provide a basis for considering Shanxi's nísù within the wider history of air-dried clay sculpture, the continuity and adaptation of its material and technical traditions, and the implications of the community practice for conservation. The discussion considers these three dimensions in turn and then draws together their implications for understanding and sustaining nísù as living heritage.

4.1 Nísù Within the Transregional Clay Sculpture Tradition

The survey indicates that nísù should be understood not as a homogeneous "clay" object but as a composite, stratified technological system. The construction principles documented across the surveyed Shanxi sites reveal clear parallels with air-dried clay sculpture traditions elsewhere in Asia. Despite regional and chronological differences in style, iconography, and devotional context, these shared material and structural features situate Shanxi's nísù within a broader Buddhist sculptural tradition characterised by the circulation and local adaptation of technical knowledge (López-Prat et al. 2024b).

Evidence from the surveyed temples is consistent with documented practices at other Chinese sites,[1] as well as in Central Asia and Afghanistan (López-Prat et al. 2021; 2022; 2024a), and in Himalayan and North Indian contexts (Luczanits 2004; López-Prat et al. 2024b). These parallels point to a broad technical tradition in which air-dried clay provided a shared material basis for Buddhist sculpture, while construction methods were adapted to local resources, environments, artistic conventions, and workshop practices.

At the same time, the Shanxi examples demonstrate that technological continuity did not result in uniformity. The examples show how a shared air-dried clay sculpture vocabulary was adapted to different historical contexts, material resources, patronage conditions, and workshop practices. Differences in the scale and complexity of sculptural ensembles likewise reflect variation in the contexts in which they were produced, while examples preserved at sites with comparatively limited resources demonstrate that technically accomplished production was not confined to major urban or monastic centres. Large temple complexes that remained active over extended periods also accumulated sculptures and architectural elements from different phases, reflecting successive episodes of production, renewal, and intervention.

1 Li et al. 2007; Liu 2014; Wang, Zhang, Wei 2014; Hui et al. 2018; Du 2020; Song et al. 2021.

This combination of shared technical principles and local adaptations is important for understanding the place of Shanxi's nísù within the wider history of Buddhist sculpture. It also has practical implications for conservation. Vulnerability to moisture, deterioration of organic fibre reinforcement, and the risks associated with incompatible repair materials are not unique to Shanxi but recur across air-dried clay sculpture traditions. Comparative research can therefore provide useful reference points for understanding material behaviour and conservation challenges beyond the regional context of this study.

4.2 Continuity and Change in Materials and Techniques

The survey evidence, together with testimony from nísù artists, indicates that the tradition has maintained its fundamental construction logic while adapting to changes in materials, tools, and workshop practice. The basic sequence of armature, clay-based modelling layers, surface preparation, and polychrome decoration documented at historical sites remains recognizable in contemporary nísù production in Shanxi **[fig. 10a]**.

Continuity within the tradition therefore does not depend on the continued use of identical materials. Contemporary production shows that new materials may be incorporated when they provide advantages while retaining established structural principles. Wire has replaced bamboo for the internal support of fingers and hands, while plywood box structures have replaced traditional wooden poles and boards in some contemporary armatures **[fig. 10b]**. These substitutions reflect changing material availability, workshop conditions, and craft practice without necessarily disrupting the underlying structural logic.



Figure 10 Contemporary nísù production in Lüliang, Shanxi: (a) modelling a sculpture using traditional layered clay techniques; (b) internal plywood box armature used in contemporary workshop practice. The images illustrate continuity and innovation coexisting within a living craft tradition. Photograph: Schwantes, Hao 2024

The historical record of surface interventions adds another dimension to this continuity. Documentary evidence indicates that sculptures at Nanchan Temple (T7) were repainted during the Ming dynasty, while Tang-period figures at Foguang Temple (T5) were repainted in 1928 and 1929 (Chai, Chai 2008, 16). These episodes of renewal should not be regarded simply as disturbance of, or damage to, the original. Rather, they form part of a longer history of periodic surface intervention associated with the continued devotional use of the sculptures. The paper layers identified at T6 and T14 likewise suggest that surface intervention and repair have formed part of the material histories of these sculptures. Such practices can therefore be understood as forms of material care as well as sources of later alteration (Zuanni 2023, 696-97).

The introduction of modern synthetic materials represents a more consequential form of material change. Unlike substitutions such as wire for bamboo, which can retain a comparable structural function while responding to contemporary workshop conditions, acrylic paints and cement-based mortars have material properties that differ substantially from those of the original clay-based systems. At the surveyed sites, acrylic overpainting obscured earlier surfaces and was associated in several cases with peeling and paint loss, while cement-based mortars were observed in architectural repairs. Such interventions can create additional conservation challenges when their material properties are poorly matched to the existing fabric or when their removal or treatment complicates future intervention. Their assessment should therefore consider not only their immediate stabilising or aesthetic function, but also their compatibility with the existing material system and the potential consequences for subsequent conservation (Caple 2000; Delgado Rodrigues, Grossi 2007; Muñoz Viñas 2022).

The evidence thus suggests that material change is not in itself incompatible with continuity. The more significant issue for conservation is whether new materials and techniques remain compatible with the existing construction system and whether their introduction results in the loss or concealment of significant historic material.

4.3 Community Practice, Conservation Ethics, and Implications for Strategy

The material condition of nísù sculptures cannot be understood independently of the social and devotional contexts in which they continue to exist. Community practice contributes to their continued use, care, and heritage significance and therefore has direct implications for conservation decision-making in living heritage contexts. The three patterns identified in the survey demonstrate that community engagement can have different material consequences: it may support regular maintenance and conservation, coexist with limited intervention and accumulated deterioration, or involve repeated surface renewal that alters or obscures historic material.

A central issue is the tension between conservation approaches that prioritize the retention of historic material and devotional practices that seek to maintain the visual and religious presence of the sculptures. Repainting, surface renewal, and the replacement of deteriorated elements may be understood within the communities concerned as forms of continued care rather than as the alteration or loss of heritage material. From a

conservation perspective, however, repeated repainting can obscure earlier layers, alter historic iconographic details, and introduce materials that complicate the preservation of the underlying fabric. These different understandings of care should therefore be considered when developing conservation strategies for nísù and other forms of living religious heritage.

The tension is particularly evident in active places of worship, where perceptions of completeness, care and authenticity may be shaped by devotional expectations that a sacred image should remain whole, vivid, and visually present. A sculpture in which losses have been stabilised but not reconstructed, and abraded historic surfaces have been left visible, may meet conservation objectives while producing a different perception of completeness for worshippers. This tension is illustrated at Guangsheng Temple (T16), where stabilised but unreconstructed losses remain visible. Conversely, repainting a sculpture in bright colours to give it a renewed appearance may satisfy devotional expectations while obscuring or destroying historic layers that contribute to its art-historical and material significance. These different perspectives do not need to be treated as mutually exclusive; rather, they reflect different values and relationships to the same object.

For this reason, repainting and surface renewal should not be treated as categorically unacceptable, but neither should they be regarded as automatically appropriate. Periodic renewal is not a recent development but a historically embedded practice documented at least since the Ming dynasty. Decisions about renewal should instead take into account the significance, condition and legibility of the existing surface. Sculptures retaining substantial original or early historic polychromy may require different approaches from those that have already undergone repeated alteration. The critical distinction is therefore not between intervention and non-intervention, but between interventions informed by an assessment of significance, condition, and potential loss.

Where renewal is considered appropriate, the choice of materials and techniques should take account of the existing material system and the potential consequences for historic fabric. Conservation priorities should therefore be guided by the nature and potential impact of different forms of loss (Pedersoli et al. 2016), while recognising that decisions concerning living heritage cannot be based on material risk alone. Continued devotional use and community values are themselves part of the significance of these sculptures. Providing communities and local caretakers with accessible guidance on compatible materials and treatment approaches could therefore support continued use while reducing avoidable material loss.

Conservation in Shanxi involves local and provincial conservators, nísù artists, and specialists from national institutions. The survey nevertheless indicates uneven approaches to intervention, particularly where repeated treatments have been undertaken without adequate technical understanding or materials suited to the existing system. At the same time, the absence of large-scale intervention should not automatically be interpreted as neglect. Shuanglin Temple (T11), for example, illustrates how limited intervention, under favourable environmental conditions, can coincide with substantial retention of original material. At many temples, however, conservation priorities extend beyond the sculptures themselves to the architectural environment. Water infiltration, rising damp, and salt-related deterioration associated with defective roofing and drainage can directly affect the sculptures.

The survey also points to a gap between diagnostic knowledge and its implementation at site level. Conversations with local heritage authorities indicated a recurring dilemma: deterioration may be recognised but left untreated because appropriate intervention exceeds locally available expertise or resources. In such cases, limited intervention may reflect uncertainty, limited capability, and concern about causing further damage rather than an absence of care. Addressing this situation requires coordination among researchers, conservation professionals, heritage authorities, and the communities responsible for maintaining the sites.

Community practice should therefore be understood not only in relation to conservation risk but also as a resource for sustaining nísù heritage. Active devotional engagement, local stewardship, and inherited craft knowledge have contributed to the continued use and maintenance of many sculptures, while changes in population, skills, and materials may weaken these forms of care. The decline of clay-sculpting skills in the twentieth century further highlights the importance of sustaining craft knowledge alongside material conservation. Training, documentation, and the involvement of practising nísù artists in conservation projects could help maintain this knowledge while supporting appropriate treatment.

More broadly, conservation planning for nísù would benefit from guidance tailored to its material system, environmental conditions, and living heritage context. Such guidance would need to bring together conservation science, art history, heritage management, and traditional craft knowledge rather than treating these as separate areas of expertise. Collaboration among conservation professionals, heritage authorities, local caretakers, and practising nísù artists could provide a practical basis for longer-term conservation planning while allowing continued devotional use (Schwantes 2011).

5 Conclusion

This field survey of nísù sculptures across twenty-one sites in Shanxi shows that understanding this tradition requires attention to its material, social, and devotional dimensions. Construction principles spanning nearly fourteen centuries confirm the technological consistency discussed above even as materials, techniques, and workshop practice evolved. At the same time, the condition of individual sculptures reflects not only the quality of their original making but also their subsequent life: community stewardship, devotional renewal, and local maintenance have played a central role in sustaining many sculptures over time. Their effects, however, are not uniformly beneficial. Compatible materials and inherited craft knowledge can support preservation, whereas synthetic paints, cement-based repairs, or the loss of community stewardship can accelerate deterioration or obscure historic surfaces.

Situating Shanxi's nísù within the transregional network of air-dried clay sculpture confirms that the construction principles, material vulnerabilities, and conservation challenges documented here belong to a shared tradition extending across Central, South, and East Asia. This framing enriches the art-historical understanding of nísù and highlights the value of cross-regional exchange in conservation research and practice.

These findings call for conservation strategies that combine technological understanding and informed condition assessment with attention to living

practices. Community engagement should be integrated into conservation rather than treated as separate from it. Such an approach protects both the material integrity of these sculptures and the cultural practices that sustain their meaning.

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From Earth to Enlightenment
Materiality, Technology and Cultural Transmission of Terracruda Sculpture Across Buddhist Asia
edited by Mònica López-Prat, Emma Cantisani, Susan S. Bean

Technological and Spiritual Knowledge in Bhutanese Terracruda Sculpture

Mònica López-Prat
Institute of Heritage Science of the National Research Council of Italy

Susan S. Bean
Peabody Essex Museum (retired), USA

Abstract This article examines the materials, techniques, and religious significance of Buddhist terracruda sculpture in Bhutan, where it continues to be practised as a living tradition. Based on fieldwork conducted in 2024, it documents clay selection, paste preparation, modelling, repair, and maintenance through workshop observations, temple visits, and interviews. It explores the integration of material practices, ritual requirements, and specialised knowledge transmitted through artists' lineages and formal training. The study offers comparative insights for interpreting archaeological terracruda sculpture across Buddhist Asia and informing its conservation.

Keywords Clay. Traditional knowledge. Buddhism. Sacred image-making. Material culture.

Summary 1 Introduction. – 2 Fieldwork and Methodology. – 3 Results. – 3.1 Clay Selection, Paste Preparation, and Material Knowledge. – 3.2 Layered Modelling, Structural Logic, and Sculptural Construction. – 3.3 Ritual Filling, Consecration, and the Sculpture as Sacred Body. – 3.4 Maintenance, Repair, Renewal, and Conservation Challenges. – 4 Discussion: Bhutan in Comparative Perspective. – 5 Conclusions: Towards a Metaphysical-Technological Understanding of Buddhist Terracruda Sculpture.

1 Introduction

This article is intended as a contribution to the understanding of the materials, techniques, and religious significance of terracruda (air-dried clay-based) sculpture in Buddhist Asia. We opted to focus on Bhutan, where the tradition remains dynamic, largely because of ongoing support from the government, the royal family, and the Central Monk Body. Here, terracruda sculpture is among the most highly valued forms of Buddhist sculptural

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expression. Its value does not reside solely in plasticity or local availability, but in its capacity to become a receptive, filled, and ritually activated image. The Bhutanese tradition is closely linked to terracruda sculptural practices across the Buddhist Himalayas and the Tibetan Plateau, including those found in Tibet, Nepal, and the Indian regions of Ladakh, Himachal Pradesh, and Sikkim.[1] These traditions developed within a broader religious context characterised by the prevalence of Vajrayāna Buddhism, in which material practices, ritual prescriptions, and the consecration of sacred images are closely interconnected (Bentor 1996).

Historical texts and regional narratives trace the origins of terracruda sculpture in Bhutan to King Songtsen Gampo (ca. 604-650), founder of the Tibetan empire, remembered for invigorating Buddhism in Tibet and across the Himalayan region, and constructing 108 temples, two of which are in present-day Bhutan (Rai 2009). According to tradition, he commissioned a terracruda image of Maitreya for Jampa Lhakhang in Bumthang (Phuntsho, Maki, Pakhoutova 2023). Later masters of Tibetan Buddhist teachings, including the eighth-century Padmasambhava (Guru Rinpoche), are also associated with the further development of the sculptural practice (Bean 2026, 61; Rai 2009; Yablonsky 2002).

Although the historical record of artistic exchanges between Bhutan and neighbouring Himalayan regions remains fragmentary, evidence suggests that such connections persisted over time. His Holiness the 9th Neyphug Trulku Rinpoche explained that, centuries ago Tibetan sculptors travelled to Neyphug Monastery in Paro to learn from local *jimzops*[2] ('clay sculptors') (9th Neyphug Trulku Rinpoche interview 2024; Rai 2009, 218). Lopon Dawa Penjor, head of the sculpture department at the National Institute for Zorig Chusum in Thimphu, mentioned recent assignments that Bhutanese sculptors accepted in Nepal and Sikkim (Lopon Dawa Penjor interview 2024).

The tradition emerges into documented history in the seventeenth century, when the Zhabdrung Ngawang Namgyal, founder of modern Bhutan, came from Tibet. The Zhabdrung consolidated military and political authority through the construction of fortress-monasteries *(dzongs),* which served as centres of administration and Buddhist practice. As part of this programme, he invited Trulku Dzing, a Tibetan master sculptor skilled in both terracruda and metal sculpture, who produced terracruda images, some of which have survived to the present (Bean 2026, 54-7; Rai 2009; Yablonsky 2002) **[fig. 1]**. From the seventeenth century onwards, terracruda sculpture flourished, and oral traditions developed around successive generations of masters and apprentices, preserving the memory of outstanding sculptors despite the absence of signed works.

1 Bentor 1994; Harris 2005; Heath, Russell, Zucker 1992; Lo Bue 1981; Luczanits 2003; 2004; von Schroeder 2001; Slusser 1996; 2001.

2 Bhutanese terms in Dzongkha, the national language of Bhutan, are written in Latin characters to reflect their approximate pronunciation. Their meanings and corresponding spellings in Tibetan script, represented using the Wylie transliteration system, are provided in the glossary at the end of the article.



Figure 1 Life-size portrait of Zhabdrung Ngawang Namgyal attributed to Trulku Dzing, mid 17th c., Tango Lhakhang, Thimphu. Photograph courtesy of the Honolulu Museum of Art. Photograph: Ephraim Jose, with permission from the Department of Culture and Dzongkha Development

In the twenty-first century, the practice of terracruda sculpture in Bhutan remains notably vigorous. This continuity is closely linked to twentieth-century cultural policy. In the 1960s, during the reign of King Jigme Dorji Wangchuck (r. 1952-72), Bhutan initiated a programme of modernisation through five-year plans, including the construction of schools, hospitals, and national infrastructure. At the same time, the government also supported traditional culture as a means of strengthening national unity and maintaining a distinctively Bhutanese identity with Buddhist heritage at its core (Bean 2026, 77).

According to *jimzop* Lopon Dawa Penjor at National Institute for Zorig Chusum, *jimzops,* both *lamas (*spiritual masters) and lay sculptors, acquired their skills through apprenticeships. The main centre of the practice was in western Bhutan at Neyphug, near Paro. In the 1960s, Lopon (master) Palden, from Neyphug, was selected to devise a programme that would complement workshop apprenticeship with formal instruction for interested and talented students from diverse backgrounds (Rai 2009, 220). To support the spread of *jimzo* (clay sculpture) across the country, this programme was initiated in eastern Bhutan, in Bumdeling, Trashiyangtse District. Students acquired both the technical skills and the iconographic knowledge required to make new statues and repair old ones. With the establishment of formal art schools in the mid-twentieth century, access to training opened to applicants of all backgrounds, including women, who demonstrated aptitude for clay modelling.

The practice has evolved over centuries, but the pace of change increased during the period of official modernization from the mid-twentieth century onwards. As Meenakshi Rai observed, there are noticeable stylistic differences between images made in the seventeenth century and those made today: earlier images are described as having raised shoulders, whereas many twentieth-century images have drooping shoulders and a more human appearance, partly because of modern technologies, tools, and broader exposure to modern art (Rai 2009). Bhutanese terracruda sculpture is not a static survival, but a living practice that continues to adapt.

2 Fieldwork and Methodology

Fieldwork was conducted in Bhutan in November and December 2024 with the aim of documenting technical knowledge related to the production, maintenance, and repair of terracruda sculpture. The research combined visits to workshops, temples, art schools, museum collections, and private devotional spaces, as well as conversations and semi-structured interviews with sculptors, monks, institutional representatives, and other cultural heritage practitioners. The documentation methods included direct observation of sculptural processes, video and photographic recording, interviews, collaborative discussions with practitioners, and macroscopic observations of materials. Particular attention was paid to clay selection, paste preparation, and construction process, including hollow structure, armatures, repair techniques, and the role of sacred substances in the modelling process.

The study should be understood as preliminary field documentation rather than a full ethnographic or analytical characterisation of terracruda sculpture in Bhutan. The observations derive from specific workshops, temples, and practitioners visited during a limited period. Although some material samples of current clays, fibres, and other materials were collected, their systematic

laboratory analysis remains ongoing. For this reason, references to clay types, fibres, binders, pigments, sacred additives, and repair materials are based on practitioners' accounts and macroscopic observation. Ethical and methodological caution was essential throughout the fieldwork. Many of the sculptures documented are consecrated images that remain in worship. The research therefore followed a collaborative approach, including information and observations from sculptors and religious practitioners as holders of technical, metaphysical, and historical knowledge.

The fieldwork began in Thimphu with meetings at the Royal Textile Academy, which facilitated access to artists, temples, and institutional contacts. Interviews and workshop visits were conducted with several *jimzops*, including Lopon Karma and his team at the clay sculpture workshop of the Department of Culture and Dzongkha Development **[fig. 2]**; teachers and students at the National Institute for Zorig Chusum; the workshops of Lopon Nyim Dorji, Tshedar Dorji, and Tshewang Dorji in Thimphu; Dawa Gyeltsen and Namgay Wangdi in Punakha; and Singye Wangchuk at Khewang Lhakhang. Additional discussions were held with monastic and institutional interlocutors, including Lopon Namgay from the Central Monk Body and His Holiness the 9th Neyphug Trulku Rinpoche. These conversations provided information on both technical procedures and the ritual, historical, and devotional frameworks within which clay sculpture is produced and maintained.



Figure 2 Lopon Karma and his team at their workshop. Photograph: López-Prat 2024

The fieldwork also included visits to temples and monasteries where terracruda sculptures are maintained by caretakers. These included Changangkha Lhakhang, Punakha Dzong, Khewang Lhakhang, Chimi Lhakhang, Gangtey Monastery, Jampa Lhakhang, Kurjey Lhakhang, Kenchogsum Lhakhang, Tamshing Lhakhang, Neyphug Monastery **[fig. 3]**, Kyichu Lhakhang, as well as private chapels in Thimphu, Punakha, Bumthang, and Paro. The visits allowed direct visual documentation, but photography was permitted only in a few instances, as photographing venerated images is generally restricted out of respect for their sacred character.



Figure 3 The Buddhas of the past, present and future at Neyphug Monastery. Photograph: López-Prat 2024, with permission of His Holiness the 9th Neyphug Trulku Rinpoche

3 Results

3.1 Clay Selection, Paste Preparation, and Material Knowledge

In Bhutan, *jimzops* – makers of *jimzo*, clay sculpture – create terracruda images ranging from miniature devotional figures to larger-than-life temple sculptures. Small images of the Buddha, Buddhist masters, and deities may be produced for domestic shrines, whereas larger images intended for temples (*lhakhangs*), fortified administrative and monastic complexes (*dzongs*), and monasteries (*gonpas*) are generally made in situ because of their weight and the intrinsic fragility of the medium.

Several closely related terms are used for images made from clay: *jimku* 'clay image or sacred statue', *saku* 'earthen image/sacred statue', and *menku* 'medicinal image'. Together these terms emphasise the spiritual and physical potency of substances comprising the terracruda medium. Terracruda is not conceived merely as earth shaped into form, but as a receptive material capable of incorporating substances that enhance an image's efficacy.

A recurring theme across the interviews was the importance of selecting appropriate clays for sculpture. *Jimzops* repeatedly identified the clay from an active source in Gedu, southern Bhutan, as the most valued for making terracruda images. The clay was described as very fine-grained, plastic, and suitable for producing smooth surfaces. Referred to as *kudam* (*ku* 'sacred image' and *dam* 'mud, clay'), this clay was said to occur in several colours, including white, yellow, and black. The white clay was generally described as the best for statues, especially for finishing layers, because of its fine texture and the presence of shiny mineral particles. Several practitioners explained that the best clay is taken not from the upper or lower part of a deposit, but from the middle, where the material retains a suitable degree of moisture and plasticity. The clay should feel slightly gummy when rubbed

between the fingers, a quality compared by one *jimzop* to chewing gum and by another to butter. Such assessments show that clay quality is recognised empirically through touch, texture, plasticity, moisture, and behaviour during preparation. This clay is principally used for the finishing layer, because its refined texture enables modelling subtle detail and creating a smooth compressed surface suitable to receive pigments and binders for painting.

Jimzops assess clays according to colour, texture, plasticity, shrinkage, cracking behaviour, and intended use in the modelling process. The availability of good clay is a growing concern. *Jimzops* noted that sources formerly used in the Thimphu and Neyphug areas have become difficult to access because of land control, construction, ownership issues, or the depletion of deposits. Gedu clay is now widely used, but practitioners also stated that this source is becoming increasingly limited. Many sculptors have only limited access to high-quality clays similar to that from Gedu which can be found in other locales. In Punakha **[fig. 4]**, red, black, or yellow alluvial clays serve well for the inner structural layers and *jimzops* reserve refined clay, like that from Gedu, for the finishing layer. Clay from Bumthang was also said to be used, but more prone to cracking, while Trongsa clay, while workable, was described by some sculptors as less satisfactory. Neyphug clay, yellowish or black, was described as medium quality and available only in small quantities. These assessments show that clays from different locales vary significantly in performance and modelling capacities. Sometimes *jimzops* produce refined clay by a laborious process of boiling, separating, and sieving alluvial clay.



Figure 4 Namgay Wangdi, jimzop, indicating the clay extraction site used for terracruda sculpture on the banks of the Mo Chhu River in Punakha, Bhutan. Prayer flags mark the sacred character of the site. Photograph: López-Prat 2024

Clay preparation aims to manage particle size, water content, plasticity, and workability by pounding to fine grit, and removing extraneous matter. In Punakha, the brothers Dawa Gyeltsen and Namgay Wangdi, both *jimzops*, explained that the collected clay was soaked for several days in water, cleaned by removing stones and coarse inclusions, and dried and sieved before use. At Neyphug, practitioners were said to grind, sieve, and sometimes boil clay in order to improve its texture. One sculptor noted that, if necessary, *jindam*, the finest finishing clay, can be prepared by boiling the clay for a day.

Once the clay is prepared, it is ready to be mixed with other substances. Several types of clay paste are prepared, each associated with a different stage of modelling. The principal substance added is plant fibre. Three categories of clay blends were repeatedly documented. *Thendam* (pull clay) was described as a firmer clay blend used for the first stage, building the

main volume of the sculpture. *Thendam* contains more plant fibre than other layers, and less water. Several *jimzops* gave an approximate proportion of 250 g of paper fibre per 1 kg of clay (1:4). This clay must be firm enough to hold its shape and strong enough to form the initial body of the sculpture. *Kongdam* (shaping clay) is used to model the main contours of the figure. Kongdam contains less plant fibre than *thendam* and more water, making it softer and more suitable for modelling the contours of faces, bodies, and garments. One sculptor gave an approximate proportion of around 200 g of plant fibre per kilogram of clay. *Jindam* (finishing clay) was described as creating a densely compact, smooth, polished surface. Jindam contains less fibre, around 150 g of fibre per kilogram of clay, and more water, making it very soft and appropriate for refining surfaces and details.

The fibres of the *Daphne bholua* shrub, which grows at high altitudes, have long been an essential component in the preparation of clay for sculpture. Until a few decades ago, *jimzops* had to process the Daphne bark themselves, laboriously separating the inner fibres, and processing them by hand. Since the Ministry of Trade and Industry established the Jungshi Handmade Paper Factory in Thimphu in 1990, sculpture workshops have been able to purchase sheets of *desho*, which are soaked in water until the fibres separate and can be incorporated into the clay mixture. The paper fibres improve cohesion, reduce cracking, and increase the workability of the paste. At the *desho* paper factory in Thimphu, it was reported that *jimzops* often purchase offcuts of high-quality paper for this purpose. Several practitioners noted, however, that *desho* has become expensive and harder to obtain. For this reason, cotton fibre is often used, either as a substitute or in the inner layers with *desho* reserved for the finishing layer. Sculptors pointed out that cotton is cheaper and readily available, but it does not produce the same quality of finish as *desho*. Tshedar Dorji explained that cotton does not polish as well. In recent years, some workshops have acquired mixing machines that blend clay, paper pulp, and other additives more evenly and reduce the labour required to prepare a homogeneous sculptural paste.

The incorporation of potent and sacred substances into the clay was also regularly reported, including *mendrup* (consecrated medicinal herbs prepared by *lamas),* holy water, powders of gold, ground precious stones, soil or substances from sacred Buddhist sites, and fragments of garments or cremation ashes of Buddhist masters. In one private temple in Thimphu, the patron stated that small pieces of cloth associated with Guru Rinpoche were powdered and mixed into the clay used for the statues. The *jimzops* Dawa Gyeltsen and Namgay Wangdi accompanied us to a natural source in Punakha, where a medicinal substance or *mendrup* emerges from the earth. According to their account, Drugpa Kunley, a revered 15th-century *lama* known as the *Divine Madman,* passed through and blessed the place, thereby sacralising the deposit. This naturally occurring earthen medicine is believed to regenerate itself when placed inside the modelling clay and was described not only as a sacred additive for sculpture, but also as a precious medicinal substance beneficial for all people.

The primary value of these additions, as described by practitioners and religious interlocutors, lies in their capacity to transmit blessing, sacred presence, and spiritual potency. Several interlocutors stressed that clay is especially powerful because, unlike other materials, it can receive and incorporate many kinds of potent substances. The sculptor Lopon Nyim Dorji explained that clay is precious because it comes from the earth, and the earth

contains medicines, minerals, and powerful substances. He said that this idea is associated particularly with Bhutan, which is also known as Menjong, 'the land of medicine', where earth naturally contains 'medicine'. During an interview with His Holiness the 9th Neyphug Trulku, he pointed out that the advantage of clay above other materials for sculpting is precisely that herbs, holy waters, soils from Buddhist sites, relics, and other blessed materials can be incorporated. This makes the sculptures not merely representations but spiritually charged bodies. The air-dried (unfired) condition of terracruda sculpture is not simply a technical prescription. It is part of the material and metaphysical logic of the object, enabling the sculpture to preserve the power of the substances mixed into the clay.

3.2 Layered Modelling, Structural Logic, and Sculptural Construction

In Bhutan, terracruda sculptures are commonly made hollow through a staged, layered process. The sequence documented during fieldwork reveals a coherent technical system that begins with the construction of the base and internal structure, followed by the coil-based modelling of the torso, the addition of the limbs and head, the application of successive layers of materially distinct modelling pastes, the careful management of the drying process, and, finally, during consecration, completing the filling of the image's hollow core with sacred texts and objects.

The scale of the image determines important structural decisions. Because of the weight of the medium, larger-than-life figures for temples, dzongs, and monasteries are usually made in situ and attached to the floor or wall behind. The hollow interior reduces weight, lessens the difficulty of drying thick air-dried clay without cracking or flaking, and creates an internal space for the insertion of sacred contents. Smaller portable images for private devotional spaces and temples are provided with a similar interior space. Several sculptors explained that the centre of the statue must remain open for the *zung* (sacred objects) and the *sogshing* (life-stick) that is placed inside the image **[fig. 5]**. Hollowness is both a technical and ritual requirement for sacred images of all sizes, but the structural solutions differ according to intended location, portability and ritual use.



Figure 5 Jimzop Singye Wangchuk working on the sculptural programme at Khewang Lhakhang. Right: rear view of an upright terracruda sculpture showing the sealed access opening used to insert the zung and other sacred contents. Photograph: López-Prat 2024

For colossal sculptures, the pedestal base is commonly built with unfired clay bricks mixed with cotton fibre. Wooden poles, bamboo or steel rods were documented as primary supports, depending on the scale, location and period of production. Older methods were repeatedly described as relying on bamboo and wood, sometimes cypress, padded with rice straw, and secured with plant-fibre ropes, such as coconut-fibre. Several artists stressed that older support systems were organic. In old statues, practitioners observed wooden sticks, straw padding, ropes made from plant fibres, bamboo elements, and clay mixed with *desho*. Tshedar Dorji, who has restored old sculptures, noted that, in some cases, the whole body of a sculpture could be made of straw around a central wooden element, with clay applied over it. At Phajoding Monastery, old statues were described as being attached to the wall at the back with pieces of wood. At Khewang Lhakhang, old figures were said to be anchored to the back wall and floor. The orientation of the wood is important: the top of the tree must correspond to the top of the sculpture. Bamboo sticks wrapped with thread were formerly used for fingers and delicate projecting elements. In more recent practice, copper wire is preferred because it readily forms desired shapes and angles, is commercially available, does not rust, and is not attacked by insects. Steel rods and metal armatures are also common. Wire mesh was documented only in one case, in the workshop of Tshedar Dorji, a self-taught *jimzop*, where it was used as a supporting structure over which clay was applied **[fig. 6]**.



Figure 6 Smaller-than-life-size terracruda sculptures at different stages of production outside Tshedar Dorji's workshop. Left: In the foreground, an early stage in which thendam is applied over metal-wire supports to form the hollow internal structure. Right: a mesh armature, a construction method documented only at this workshop. Photograph: López-Prat 2024

The modelling itself begins with *thendam*. At the Department of Culture and Dzongkha Development's *jimzo* workshop, Namgay Lendhup described the process as beginning with thick coils of *thendam* progressively built upwards around an internal armature to establish the hollow body of the sculpture. Depending on the scale of the image, the armature is made from metal rods or wire. To avoid sagging and distortion, the initial clay layer must be allowed to dry sufficiently before further modelling layers are applied. Practitioners repeatedly stressed the importance of waiting until the clay reaches the correct degree of dryness. Artificial drying may occasionally be accelerated by placing fire near the sculpture, but *jimzops* warned that excessive heat can damage the work.

The second stage involves *kongdam* (shaping clay), a softer paste that enables the sculptor to establish the main contours, iconographic features, and attributes. The final surface is prepared with *jindam* (finishing clay), the finest mixture, which is used for smoothing, compressing, polishing, and refining details **[fig. 7]**. Some practitioners explained that smaller sculptures may not require all three clay types; they may be made with only *thendam* and *jindam*.



Figure 7 Models illustrating the successive stages in the modelling of a small portable sculpture, stored in a classroom at the National Institute for Zorig Chusum. Photograph: López-Prat 2024

Movable images, large altar figures, and monumental temple sculptures share technical principles but require different structural strategies. A large principal image on an altar may require seven or eight months, or even a year, to complete, partly because of the drying intervals between stages **[fig. 8]**. Sculptural scale also affects the selection of supports, the thickness of layers, and the planning of openings for inserting sacred contents.

Surface preparation forms the transition between modelling and painting or gilding. Practitioners described the use of fine clay, *desho*, animal glue, and, in more recent practice, Fevicol® – a polyvinyl acetate (PVA) adhesive manufactured in India. A white ground for painting may be commercial white tempera, applied before painting. Some sculptors do the painting themselves using powdered pigments mixed with animal glue. Tshedar Dorji, for example, paints his own sculptures, preparing animal glue from cow skin as a binder, and selecting pigments according to the budget set by the patron – natural pigments are more expensive than synthetic commercial pigments, and require labour-intensive preparation. Currently, painting is frequently entrusted to professional painters.

Moulds are also used especially for ornaments and faces. *Kongdam* is pressed into the mould and removed while still slightly plastic. Vegetable oil, imported from India, may be applied inside the mould to prevent the clay from adhering to the mould. Once attached to the figure, the moulded component is refined with applications of *jindam*. Moulds may be made from

dried clay, plaster of Paris, M-seal® (an epoxy resin made in India), or sealing wax derived from lac insects (*Kerria lacca* or *Kerria chinensis*) **[fig. 9]**.



Figure 8 New chapel under construction at Khewang Lhakhang, with larger-than-life terracruda sculptures observed by our guide and Bhutanese translator, Chandra Kumar. Phobjikha Valley, Bhutan. Photograph: López-Prat 2024



Figure 9 Examples of moulds, casts, and sculptures at different stages of modelling, stored outside Dawa Gyeltsen's workshop in Punakha. Photograph: López-Prat 2024

3.3 Ritual Filling, Consecration, and the Sculpture as Sacred Body

In Bhutan as elsewhere across the Buddhist Himalayas and Tibetan Plateau, the production of sacred images is closely connected to Vajrayāna Buddhist traditions, in which material preparation, ritual prescriptions, and consecration are integral to the creation of sacred images (Bentor 1996). Terracruda sculptures are conceived not merely as representations of deities or revered masters, but as sacred bodies capable of manifesting their presence through ritual consecration. A *lama* is engaged to perform the *rabney* (consecration) which completes the transformation of a figure into a sacred image. During the creation of the image, the clay mixtures used in modelling are typically augmented with potent substances, such as water or earth from holy places, fibres from the robe of a revered *lama,* and powders of precious gems. Terracruda sculptures and many bronze images are provided with hollow torsos to receive *zung* ('sacred contents') including relics of holy men, small sacred images, sacred texts, and medicinal substances during the consecration ceremony (Reedy 1991; Bentor 1994; 2003). In Bhutan, as in Nepal and Tibet, a central *sogshing* (life-stick) is inserted into terracruda images as a central axis, like a spinal column. Several *jimzops* mentioned that the cutting and orientation of the wood for the *sogshing* are significant. The person cutting the wood should be ritually qualified and may be required to observe restrictions, such as avoiding meat. One interlocutor also noted that the person should not have recently experienced a family death. Juniper and cypress, especially those trees growing at higher elevations, are often preferred, as they are understood to combine spiritual and technical efficacy. They have strong wood and their aromatic properties repel insects and harbour medicinal properties. The *sogshing* should preserve the cardinal orientation of the original tree: its upper end should be the one that was closest to the top of the tree and the side that faces east should be oriented towards the face of the image. The *sogshing* is segmented, to represent head, neck, heart and navel, and may be inscribed with mantras according to the deity represented. The parts and placement of the life-stick suggest that the filled image is understood as a constructed sacred body with internal anatomy. Lopon Dawa Penjor of the National Institute for Zorig Chusum explained that rolls of mantras written on paper may be placed in specific areas corresponding to parts of the body such as stomach, intestines, or internal organs, giving life to the sculpture. His Holiness the 9th Neyphug Trulku Rinpoche pointed out that sacred contents may correspond to Body, Speech, and Mind and extend through the body from head to lower torso, coinciding with subtle bodily centres or *chakras*. He also described the insertion of hair, nails, and other elements as making a consecrated image "better than me", a phrase that powerfully expresses the transformation of the sculpture into a sacred presence that exceeds ordinary material representation.

3.4 Maintenance, Repair, Renewal, and Conservation Challenges

Maintenance, repair, and repainting form an integral part of the life cycle of a terracruda sculpture in Bhutan. Repair is not merely a technical intervention on damaged material; it is devotional care that prolongs the ritual life of the image, accrues merit to those who sponsor and carry out the work, and

also enhances the transmission of sculptural knowledge embedded in the sculpture from earlier generations of *jimzops* to active practitioners.

When a consecrated statue is damaged, ritual action may precede technical repair. Lopon Sangay explained that before a damaged sculpture is restored, a *lama* may perform a ritual. If possible, the *zung* is left inside the image. The internal sacred contents are not normally removed unless necessary; their preservation is essential to the sculpture's enduring spiritual power.

Common forms of deterioration include crumbling, cracking (especially at structurally vulnerable points such as the waist and neck), broken limbs, structural instability, and surface alteration caused by rodents, previous repair or repainting, and practices of ritual veneration. Several *jimzops* identified rats as a major threat, especially because they may attack organic materials such as paper, fibres, and sacred contents. Namgay Wangdi stated that cracking at the waist can be normal, partly because the hollow space for the *zung* constitutes a structural weakness. Lopon Nyim Dorji noted that wire mesh is now sometimes placed around the *zung* to protect it from rats. Some artists observed that insects are repelled by *desho*, enabling the survival of very old mantra scrolls found inside damaged sculptures.

Repair techniques documented during the fieldwork involve a combination of traditional and modern materials. The interview with the sculptor Tshedar Dorji provided a particularly clear description of this practice. In the case of a broken arm, the damaged area may first be enlarged to allow the insertion of a metal pin or frame that reconnects and reinforces the fragments. The old clay surface is then softened by applying wet *desho* paper. Fevicol® is applied to the broken surfaces before the detached fragment is reattached. Finally, fresh clay mixed with *desho* or cotton fibre is added to fill losses and restore the original contours. The surfaces may also be scored to improve the adhesion of the repair material. These practices demonstrate the importance of moisture control: the old clay must be softened enough to receive the repair material, but not so much that the original structure is destabilised.

For cracks or small holes, the damaged area may be moistened and filled directly with fresh clay. Some *jimzops* continue to prefer clay mixed with animal glue, but most interlocutors referred to the current use of Fevicol®, which has largely replaced animal glue in many repair contexts. Crack repair was directly observed at Khewang Lhakhang, where the *jimzop* Singye Wangchuk applied a thick layer of Fevicol® into the crack using a wooden spatula and then pressed in a stiff clay mixture with the same tool. Once the crack had been filled, the surface was refined with *jindam* **[fig. 10]**. This sequence shows that repairs are layered in a manner comparable to the original construction process: a stronger fill is applied first, followed by a finer finishing clay. Adhesive may also be applied at the interface between the old and new clay or used to attach moulded decorative elements, such as jewellery.

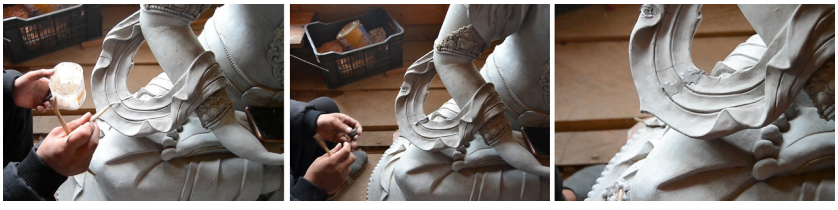


Figure 10 Sequence showing the repair of a crack that developed during drying, carried out by Singye Wangchuk while working on the sculptural programme at Khewang Lhakhang. Photograph: López-Prat 2024

Several practitioners described the use of holy water, medicinal herbs, precious stones, and other sacred powders in clay repairs. Lopon Sangay explained that for repairing broken arms he uses water mixed with herbs and precious substances collected from Buddhist places. This indicates that repair can reactivate or reinforce the spiritual energy of the image, rather than merely replacing lost fabric.

Repainting and surface renewal are central to the life cycle of Bhutanese terracruda sculpture. A monk at Jampa Lhakhang stated that the statues cannot be restored, but their colours can be refreshed. This distinction suggests that, within ritual contexts, intervention on the surface may be acceptable when understood as devotional care, while deeper structural alteration may be restricted. The caretaker monk of Kyichu Lhakhang told us that a habitual practice is the removal of dust with a dry soft brush.

Repair and maintenance preserve the ritual life of images and the relationship between sacred images, caretakers, *jimzops*, monastic communities and patrons, who gain merit for sponsoring the repairs and enable the faithful to continue venerating a sacred image. The work of repairing transmits knowledge between practitioners and their forebears by allowing sculptors to observe older construction systems. If a sculpture is considered damaged beyond repair, its clay may be reused in the making of a new statue. This practice is especially significant, as it suggests another form of sacred material and metaphysical continuity.

4 Discussion: Bhutan in Comparative Perspective

The evidence documented during the 2024 fieldwork provides a rare opportunity to examine terracruda sculpture as a living Buddhist artistic tradition. Its comparative value does not lie in treating present-day practice in Bhutan as a direct model for earlier air-dried clay-based sculpture elsewhere in Asia. Rather, it offers a framework for identifying technical and metaphysical principles that may help formulate more precise questions when interpreting archaeological terracruda sculpture from Central Asia, Afghanistan, Pakistan, Tibet, the Himalayas, and China.

One of the most significant comparative insights is the existence of a technical grammar in Bhutan. Terracruda sculpture combines internal structural systems, the selective use of different clays, the differentiated incorporation of fibres according to layer, the addition of organic and mineral substances, sequential modelling, controlled drying, surface finishing, and polychromy. These operations do not function as isolated choices, but as interdependent components of an integrated making process in which certain materials also possess metaphysical efficacy. Particularly suggestive are the parallels between the composite substances documented in contemporary Bhutanese practice and the complex lists of organic and mineral additives prescribed in earlier technical texts (Varma 1970, 20-2). These parallels raise the possibility that some contemporary preparations represent condensed formulations of a formerly broader repertoire of ingredients. While these parallels cannot be taken as evidence of direct historical continuity, they provide a productive framework for investigating whether some elements of the making process may once have fulfilled specific technological functions that, over time, became invested with metaphysical significance, this latter dimension being the one that has persisted in contemporary practice.

At the same time, the practice in Bhutan presents characteristic features that should not be generalised to other traditions. The geographical distribution of incorporating substantial quantities of paper fibre into the modelling pastes remains uncertain. The practice appears to facilitate the coiling technique through which sculptures with large hollow interiors can be constructed. The presence of an internal cavity is essential to the ritual prescriptions, providing space for the insertion of the *sogshing* and other sacred elements that contribute to the transformation of the sculpture into a consecrated body within the Vajrayāna Buddhist tradition.

The practice in Bhutan also encourages a reassessment of the material status of terracruda sculpture. In several archaeological contexts, air-dried clay sculpture has been interpreted as a comparatively rapid means of producing images or as a pragmatic response to the limited availability of materials regarded as more durable or prestigious (Luczanits 2004, 11 n. 19; Olivieri, Filigenzi 2018; Schmidt 2023). The Bhutanese evidence suggests other reasons for choosing terracruda as a medium. Clay may be deliberately selected as a preferred medium because of its plasticity, its capacity to receive different fibres and additives and, above all, its ability both to incorporate sacred substances into the modelling pastes and to form a space for contents through which the image acquires spiritual potency. The production of these sculptures therefore depends on highly specialised technical and ritual knowledge, careful planning, skilled craftsmanship, and an extended sequence of construction, drying, finishing, filling, and consecration.

The unfired condition is integral to this technological and metaphysical logic. Firing would transform or destroy many of the organic, medicinal, and sacred substances incorporated into the modelling pastes. Remaining unfired allows the clay to retain its material receptivity while preserving the substances embedded within it. The air-dried state should therefore be understood as a deliberate condition that supports the ritual efficacy of the image.

The Bhutanese evidence further challenges a strict separation between original production and later repair or restoration. The life of a sculpture encompasses construction, filling, consecration, devotional use, damage, repair, repainting, and periodic renewal, as well as processes for replacement of irreparably damaged images. Conservation and renewal are therefore not necessarily external interventions, but interventions that may form part of the continuing material and devotional life of the image.

Changes in training have also transformed the transmission of knowledge. The expansion of *jimzo* instruction through formal art schools has broadened access to the tradition beyond its earlier monastic and lay workshop settings, enabling students from across the country, including women, to acquire technical skills that were formerly transmitted within more restricted contexts. This institutional shift indicates that the social mechanisms through which knowledge is transmitted can change while other fundamental requirements remain in place. The ritual status of the image continues to depend on the appropriate selection and preparation of materials, the insertion of sacred contents, consecration, and continued devotional use.

Comparison with other regions must therefore remain cautious. The practice of terracruda sculpture in Bhutan is closely connected to broader Himalayan and Tibetan traditions, and although it cannot serve as a template for Gandharan, Central Asian, or Chinese traditions, Bhutanese practices nevertheless provide a living example of how air-dried clay can be deliberately selected as a preferred medium for Buddhist sculpture and

how its production may depend on highly specialised knowledge integrating material selection, technical processes, ritual efficacy, spiritual potency, lineage transmission, repair practices, and sacred presence within a single technological and metaphysical system. Its principal comparative contribution is to demonstrate the range of technical, metaphysical, and ritual factors that should be considered when interpreting archaeological terracruda sculpture across Asia.

5 Conclusions: Towards a Metaphysical-Technological Understanding of Buddhist Terracruda Sculpture

The present-day vitality of terracruda sculpture in Bhutan offers a rare opportunity to document material procedures, technical terminology, ritual prescriptions, and conservation-restoration practices within a single living tradition. The Bhutanese case therefore allows terracruda sculpture to be examined as both a technological and devotional system, shaped by religious authority, patronage, and the transmission of knowledge between experienced practitioners and apprentices or students.

The 2024 fieldwork showed that the making of a terracruda image involves a highly specialised sequence of operations: the selection and preparation of clays; the differentiated incorporation of fibres and other substances according to the function of each layer; the construction of internal supports; the application and controlled drying of successive layers; and the finishing and painting of the surface. These procedures do not constitute a series of isolated technical decisions but form an integrated system of production.

Technical production and metaphysical efficacy are inseparable in the creation of terracruda sacred images. Clay is valued not only for its plasticity or availability, but for its capacity to incorporate medicinal, spiritually potent and precious materials, and to enclose sacred contents. The design of the individual sculpture or broader sculptural programme, its construction, filling, and consecration are therefore interdependent stages in the transformation of clay and additives into a ritually efficacious image. The air-dried condition forms part of this logic, as it preserves both the incorporated substances and the receptivity of the clay body as a potentially vital material.

Bhutanese practices also provide a valuable comparative framework for interpreting archaeological evidence. Its relevance lies not in treating present-day practice as a direct model for earlier traditions, but in helping to formulate more precise questions about technical procedures and to recognise the possible role of metaphysical considerations in the sculptural process.

At the same time, the practice is evolving. Formal training has expanded the practice of *jimzo* by opening instruction to a broader range of students who might not previously have had access to traditional apprenticeships. Synthetic adhesives and modern armatures are altering production and repair practices. New materials and production techniques, especially moulded plaster-of-Paris images and foundry-cast metal images, are gaining popularity as more durable and often less expensive alternatives to terracruda sculpture. These developments reflect adaptation to changing social, economic, and material conditions rather than a simple rupture with tradition. Nevertheless, they raise important questions concerning the transmission of knowledge, ritual authority, material choice, and conservation of tradition.

Terracruda sculpture in Bhutan must be understood as the product of intertwined and inseparable technological and metaphysical processes involving materials, skills, spiritually potent substances, devotional intention, and consecration. This complex perspective is essential not only for documenting the living tradition and the knowledge embedded within it, but also for advancing the interpretation and conservation of Buddhist terracruda sculpture across Asia.

Glossary

Dzongkha term	English meaning	Wylie transliteration
Desho	Paper made from inner bark of the *Daphne bholua* shrub	dri shog
Dzong	Fortress monastery	rdzong
Gonpa	Monastery	dgon pa
Jimku	Sacred image or statue made of clay	’jim sku
Jimzo	Art or practice of clay sculpture	’jim bzo
Jimzop	Clay sculptor	’jim bzo pa
Jindam	Finishing clay	’jim ’dam
Kongdam	Shaping clay	kong ’dam
Kudam	Sacred image made with clay/mud	sku ’dra
Lama	Spiritual master	bla ma
Lhakhang	Temple	lha khang
Mendrup	Consecrated medicinal herbs/substances	sman sgrub
Menku	Medicinal image	sman sku
Menjong	The land of medicine	sman ljongs
Rabney	Consecration	rab gnas
Saku	Earthen image/sacred statue	sa sku
Sogshing	Life-stick	srog shing
Thendam	Pull clay	then ’dam
Zung	Dhāraṇīs (sacred formulas) and other sacred elements inserted into the internal cavities of sculptures as part of their ritual preparation and consecration	gzungs

Note: The Dzongkha terms *jim* and *dam* refer to clay or mud, with overlapping meanings that do not necessarily correspond to the distinctions between these materials in English.

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