Exploring polychrome traces on 11th century clay figurines from Schroda, northern South Africa.

by

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ABSTRACT AND KEY TERMS

Title of dissertation: Exploring polychrome traces on 11th-century clay figurines from Schroda, northern South Africa.

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This study analysed three selected figurines from the Schroda collection from the Ditsong National Museum of Cultural History. The primary objective of this thesis is to identify and assess any remnants of polychrome pigments present on the figurines, thereby contributing to a deeper understanding of their manufacturing techniques and potential functions. By expanding the knowledge base surrounding the Schroda archaeological site, this research seeks to enhance our understanding about the cultural and historical significance of these artefacts and the site they originate from. The study will explore the historical context of the Schroda site and its associated figurines.

A thorough documentation process was carried out in which the use of technical photography and detailed condition reports for each figurine was be conducted. These foundational steps provided a comprehensive baseline for further analysis where technical analysis was carried out with a range of methods to investigate the figurines. These include visible light photography, ultraviolet fluorescence (UVF) and infrared (IR) photography, as well as X-ray fluorescence spectroscopy (XRF) and Micro-XRF scanning (μ-XRF). In combination, these analytical techniques could determine traces of polychrome pigments found on the figurines.

Key words: Schroda; Ditsong; South African archaeology; clay figurines; documentation; condition report; technical photography; ultraviolet fluorescence; infrared; X-ray Fluorescence Spectroscopy; Micro-XRF scanning

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ABBREVIATIONS

CCP- Central Cattle Pattern

CHSOS- Cultural Heritage Science Open Source

TP- Technical Photography

UV- Ultraviolet

UVF- Ultraviolet Fluorescence

ISO- International Organization for Standardization

IR- Infrared

SWIR- Short-wave Infrared

XRF- X-ray Fluorescence Spectroscopy

µ-XRF- Micro-XRF scanning

PLAGIARISM DECLARATION

I Adrién Kell Diamond hereby declare that this thesis: *Exploring polychrome traces on 11th century clay figurines from Schroda, northern South Africa* is my own original work, and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

Adrién Kell Diamond

20 November 2024

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Chapter One: Introduction

1.1 Background and Context

Schroda, a late first millennium AD settlement situated in the Limpopo Valley, stands out as a pivotal archaeological site in southern Africa. It is one of the earliest sites in the South African interior with evidence of increased participation in Indian Ocean trade networks (Antonites, 2018:223; Hanisch, 2002:21). This study aims to contribute towards understanding the creation of material culture found at the Schroda site. The site has been investigated, but it remains relatively less studied, especially when compared to K2 and Mapungubwe. Schroda's significance in shaping the sociopolitical landscape of the region is highlighted, particularly with the discovery of its large collection of ceramic and clay figurines, the largest cache of its kind in the archaeology of the region with the discovery of a substantial collection of ceramic and clay figurines (Antonites, 2016:14; Huffman, 2000:17; Hanisch, 2002:24).

The archaeological site of Schroda, nestled in the Limpopo Valley, emerges as a focal point due to its large repository of ceramic and clay figurines, potentially associated with initiation ceremonies (Antonites, 2014:198; van Schalkwyk, 2002:70). Through the analysis of ceramic styles, glass bead sequences, and radiocarbon dating, two distinct occupation phases at Schroda have been identified: a Zhizo phase (900-1000 AD) and a Leokwe phase (1000-1100 AD) (Antonites, 2018:223; Huffman, 2002:10; Vogel & Calabrese, 2000:48). Despite research on various facets of Schroda's material culture, a notable gap exists in the study of the possible use of polychrome on the figurines.

Despite the pivotal role Schroda, a late first millennium AD settlement in the Limpopo Valley plays in southern African archaeology, there remain gaps in the academic research addressing both Schroda and its figurines. The compositional analysis of clay figurines has been conducted, yet there is an absence of systematic studies of the traces of polychrome present on these clay artefacts (van Schalkwyk, 2002:74-75). The analysis of these Schroda figurines poses an intriguing avenue for exploration, as they could offer valuable insights to future studies in understanding the symbolic meanings, cultural practices, and artistic techniques of the inhabitants of Schroda. Thus, a

comprehensive academic inquiry into the polychromatic aspects of Schroda's figurines signifies an untapped area in the exploration of this archaeological site and calls for further research to unveil the hidden dimensions of this ancient civilisation.

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1.2 Research questions

The primary research inquiry aims to ascertain the presence or absence of polychrome traces on clay figurines discovered at the Schroda site in Limpopo. To enhance the depth of understanding regarding this central query, subsidiary questions have been formulated:

1. **Historical and Symbolic Context:**

- What is the archaeological background of these figurines?
- What symbolic significance do these figurines hold?
- What is the meaning of the colour found on these figurines?

2. Site Information:

- What pertinent information is available concerning the archaeological site where these figurines were excavated?

3. Technical Analysis:

- Are there any residual polychrome residues discernible on the figurines?

4. Insights of the Study:

- What can we learn from the composition of pigments found on these figurines?

By addressing these sub-questions, the research aims to provide a nuanced and comprehensive exploration of the polychrome aspects associated with the clay figurines discovered at Schroda, Limpopo.

1.3 Aims and Objectives

This study aims to examine and discuss the analysis of the Schroda figurines. In addition to garnering insights from various scholarly works, analytical techniques will be employed to further illuminate the nature of these artefacts. The examination will adhere to a structured approach encompassing five systematic steps:

1. Provenance Investigation: The initial step involves delving into the figurines' origin and craftsmanship. This entails a meticulous exploration of archaeological sources from relevant literature to contextualise the production of these artefacts.

2. Photographic Documentation: Photographic documentation will establish a comprehensive record of the clay sculptures. This visual documentation aims to capture intricate details and nuances, providing a visual reference for subsequent analyses.

3. Object Description and Condition Report: A detailed written account encompassing both an object description and a condition report will be formulated. This step involves a thorough examination of the figurines' physical attributes and an assessment of their current state of preservation.

4. Technical Photography: Visible light photography will be used for photo documenting purposes as well as to reveal details not visible to the naked eye. The use of infrared and ultraviolet fluorescence photography will be used to see if any fluorescing minerals, such as calcite, sodalite, and corundum can be seen.

5. Material Composition Analysis: The fifth stage entails a rigorous analysis of the materials employed in crafting the figurines. Utilising established methodologies, like X-ray Fluorescence Spectroscopy (XRF) and Micro-XRF (μ-XRF) scanning, the study will scrutinize the composition of the clay sculptures, as well as try to differentiate the visible coloured areas, shedding light on the raw materials and techniques employed by the artisans.

1.4 Literature Regarding Schroda

The literature relevant to this research focuses on information on the Schroda site and the figurines discovered there. Literature written on Schroda is limited, particularly regarding the figurines and the meaning of their colour. This literature review will discuss the historical, political, and cultural significance of the Schroda site.

Additionally, it will explore the figurines found at the site, addressing their characteristics, cultural purpose, symbolism, and the meaning associated with their colours.

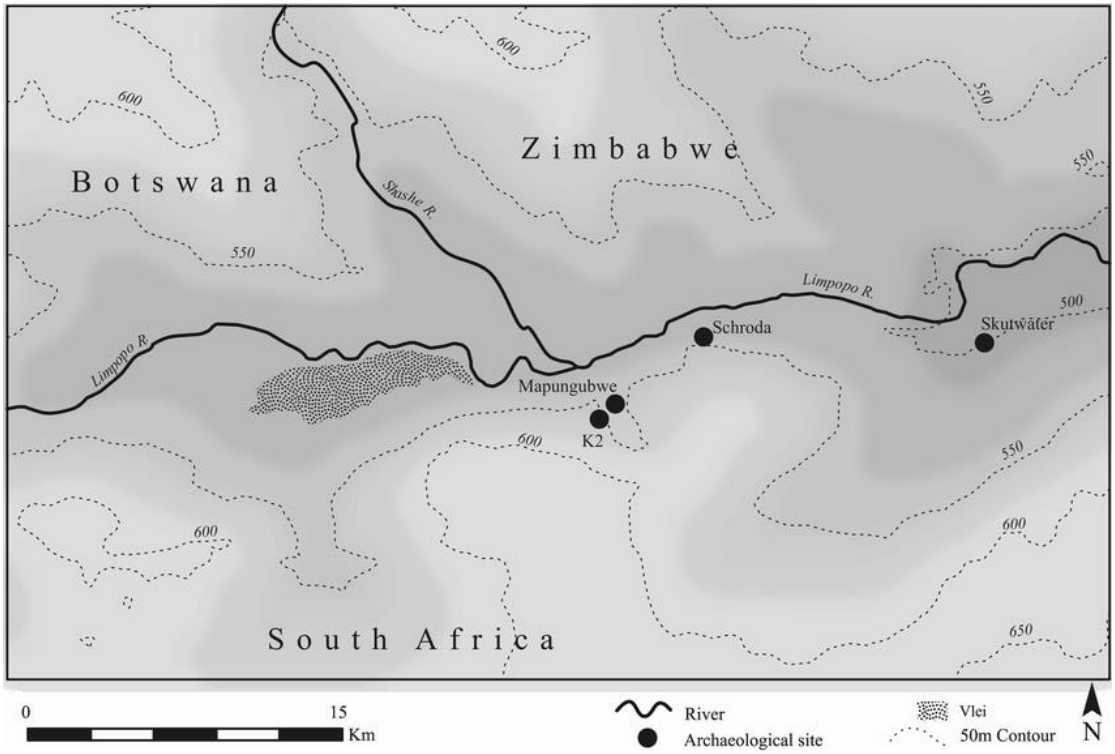


Figure 1: Location of Schroda in the Limpopo Valley (Antonites 2016: 15).

1.4.1 Schroda Site Background

The archaeological site of Schroda (Figure 1), located in the Limpopo Valley, presents significant evidence for understanding the sociopolitical, economic, and cultural developments of early southern African societies. Schroda, dating from approximately AD 900 to 1025, provides the earliest archaeological evidence of large-scale trading between the central and East African coast, indicated by the recovery of glass beads and ivory objects (Antonites, 2014:13). This trade likely established Schroda as an economic and political hub within the Limpopo Valley (Antonites, 2014:13). According to Hanisch (1980), Schroda stands out as the largest and most important Zhizo settlement in the area. The size of settlements, including Schroda, is posited to be directly related to political power, reflecting the unequal distribution of wealth in Southern Africa during the recent past (Huffman, 2000:16). This connection between settlement size and political influence serves as a crucial foundation for understanding Schroda's role in the Zhizo phase. It is also noted that the continuity in material culture between the Zhizo people of Schroda and the later Leopard's Kopje culture represented

by K2 and Mapungubwe, notably, the presence of female fertility figurines in both Schroda and K2 suggests a cultural link despite their distinct ceramic styles (Graham, 2013:20; Huffman, 2011:33; Matenga, 1993:12).

Schroda's significance in the 10th to 11th century AD as an agro-pastoralist settlement during the Zhizo and Leokwe phases is crucial for the understanding of the broader context of the rise of complex societies in Southern Africa. Antonites (2016:16) mentions that Schroda played the role of one of the earliest settlements known for its economic and socio-political importance within the Mapungubwe sequence. This period of roughly 400 years marks the emergence of class distinction and the formation of the centralised Mapungubwe polity in the 13th century AD. Schroda's historical trajectory is connected through its dynamic use of trade, particularly with the East African coast. Here during the 10th to 11th century AD, trade intensified, which was facilitated by the change in climate that allowed for more intensive agriculture (Antonites, 2016:16-17). The pivotal shift in socio-political and economic activities from Schroda to the settlement at K2 shows the dynamic nature of regional power structures and the interconnectedness of settlements within the Mapungubwe sequence (Antonites, 2016:16, Huffman, 2000:17). While extensive research has been conducted on the material culture and trade at Schroda, integrated studies on foodways and the daily lives of its inhabitants are notably absent. Antonites (2014:20) points out that despite long-term excavations at regional centres like Schroda, K2, and Mapungubwe, more research is needed to understand how food production, consumption, and social practices interacted with these societies' broader economic and political transformations. Trade played a crucial role in shaping Schroda's regional significance. The discovery of thousands of shell disc beads suggests that these were likely part of the local trade networks, extending Schroda's influence across economic and social realms in the Limpopo Valley (Antonites, 2014:39). This increased influence would have granted the Schroda inhabitants' control over valuable commodities, including metals. Although the extent of Schroda's involvement in metal production remains debated, it is said its people were engaged in copper and iron smithing, but not necessarily smelting (Antonites, 2014:39).

The connection between metallurgy and social practices at Schroda is evident from the co-occurrence of metallurgical debris and clay figurines. These figurines, primarily human, animal, and phallic shapes, were likely used in initiation rites that guided young

individuals through various stages of transformation. Alongside these figurines, ritual practices involving animal offerings and human burials were performed. Animal body parts, such as skulls, were interred with ceramic vessels and rocks, while human graves often contained grave goods such as beads and pottery (Antonites, 2014:39-40). This close association between metallurgy, fertility, and leadership is typical of Iron Age Southern African societies (Calabrese, 2000:101). The presence of large mammals in artistic depictions also reveals the symbolic role these animals played in Schroda society. For instance, the golden rhino found at Mapungubwe Hill underscores the importance of animal symbolism in the political and spiritual realms of the region. In a similar vein, clay figurines of large mammals like elephants, hippos, and giraffes were unearthed at Schroda, which were likely associated with initiation ceremonies (Antonites, 2014:198). Despite its patriarchal structure, Schroda's society displayed gender dynamics that transcended simple male dominance. Dederen and Mokakabye (2018:9) argue that, although patriarchy was prevalent, women actively participated in the social order through symbolic and ideological means, particularly in ceremonies related to human fecundity. This suggests that both men and women contributed to maintaining the symbolic balance of power within Schroda society.

Schroda's role as a central cattle pattern (CCP) settlement further demonstrates its sociopolitical complexity. The CCP model, often characterized by spatial divisions, placed the cattle enclosure and the male-dominated public domain at the centre, where political decisions were made, and disputes were resolved. Surrounding this male domain were the more private spaces, such as homes and kitchens, belonging to the women. This spatial organisation highlights the hierarchical structure that was beginning to emerge during Schroda's occupation (Dederen & Mokakabye 2018:2). As the first major settlement in the Mapungubwe sequence, Schroda holds a key position in the broader narrative of sociopolitical development in the region. According to Huffman (2007:362), Schroda marks the beginning of a roughly 400-year period that saw the rise of class distinctions and the formation of the Mapungubwe polity by the 13th century AD. Schroda's occupation spanned from the 10th to the 11th centuries, but the settlement was eventually superseded by K2 around AD 1030, as regional power shifted (Antonites, 2016:16). Excavations at Schroda, particularly in Area 6, have yielded a large number of clay figurines, tuyere[1] fragments, and slag, indicating that the

[1] A nozzle through which an air blast is delivered to a forge or blast furnace (Merriam-Webster, 2024)

area was likely used for both ritual and metallurgical purposes (Calabrese, 2000:103). This dual use of space supports the theory that metallurgy and ritual were closely intertwined, reflecting the broader cultural associations between metallurgy, leadership, and fertility in the region. Despite ongoing research, many aspects of Schroda's material culture and human remains remain insufficiently studied (Antonites, 2016:16).

Schroda's political significance can be inferred from its size and the wealth of its elite. In Iron Age Southern African societies, settlement size was often correlated with political power, as wealth and political control were concentrated in the hands of senior leaders. Schroda likely functioned as a level-3 capital, the only one in the region during its time, further supporting its importance in regional politics (Hall & Smith, 2000:30, Huffman, 2000:17). By approximately AD 1000, Schroda was abandoned, and its distinctive ceramic style disappeared. Around the same time, a new political centre emerged at K2, characterized by the spread of Leopard's Kopje pottery (Huffman, 2000:17). This transition from Schroda to K2 reflects broader shifts in regional power and material culture, as new social hierarchies and class distinctions began to solidify during this period. Schroda's central role in early trade, metallurgy, and ritual activities offers a unique lens through which to understand the rise of complex societies in Southern Africa. By examining the site's archaeological remains, including its figurines, burials, and material culture, scholars can better appreciate how early African communities like Schroda contributed to the broader processes of political centralisation and economic specialisation that eventually culminated in the Mapungubwe polity and its successors. Schroda represents an essential chapter in the development of sociopolitical complexity in Southern Africa, offering insights into the ways trade, metallurgy, and ritual practices intersected to shape the region's early history (Calabrese, 2000:100; Mitchell & Whitelaw, 2005:238).

1.4.2 Schroda Figurines

The archaeological excavations at Schroda have revealed one of the most significant assemblages of small figurines in Southern African archaeology. The site, known for its association with early Iron Age farming communities, has yielded over 2 000 figurine fragments depicting stylised human and animal forms (Hanisch, 1980:188; Matenga, 1993:12-13; van Schalkwyk, 2002:71). These artefacts, along with other material remains, provide key insights into the socio-political and cultural dynamics of early

African civilisations, particularly the communities that preceded the formation of Great Zimbabwe (Huffman, 2002:9-19; Hall, 1987:74). Researchers such as Dederen and Mokakabye (2017:171) have analysed these figurines, offering interpretations that link them to initiation rites and symbolic representations of fertility. Figurines from Schroda can be broadly divided into two categories based on their material and stylistic characteristics: large, coarse figurines and smaller, finely crafted ones. Many of these figurines were not fully dried before firing, resulting in cracks, while others were sun-dried (Hanisch, 2002:30-32). After firing, some were decorated with white ash, red ochre, or orange-yellow colouring, applied in thick layers (Hanisch, 2002:62-63). A key feature of the figurines is their pedestal bases, which indicate that they may have been used as portable objects in ritualistic contexts (Hanisch, 2002:34-35).

Numerous scholars have argued that the Schroda figurines were likely used in rites of passage, particularly initiation ceremonies (Antonites, 2014:302; Dederen & Mokakabye, 2017:171; Huffman, 2000:17). van Schalkwyk (2002:70) has suggested that these artefacts were used as didactic tools, possibly to instruct initiates in a puberty initiation school (Dederen & Mokakabye, 2017:171; Humphreys, 2023:42-43). Further published evidence linking the figurines to initiation rites comes from their fragility and the apparent deliberate destruction of many artefacts, a practice that aligns with the ephemeral nature of objects used in puberty rituals (Nettleton, 2002:97). According to this author, this statement is speculative, as it is impossible to determine whether damage to the artefacts were by the makers or just a natural result of time.

The spatial distribution of figurines found at Schroda also supports the idea of their ritual use. Excavations revealed that the figurines were often found in clusters, with larger figurines concentrated near cattle pens, which may have been ritual spaces (Huffman, 2010:169; Humphreys, 2023:80-82). Similar figurine finds from other sites in the Limpopo Valley, including Bambandyanalo and Mapungubwe, suggest that these artefacts played a significant role in the ritual and political life of early Southern African societies (Matenga, 1993:12). At Schroda, the cache of figurines, along with other archaeological finds such as potsherds, animal bones, and slag, indicates that the settlement functioned as a political and ritual centre (Huffman, 2002:9-19). A critical aspect of the figurines' interpretation involves their symbolic meanings, particularly their associations with fertility and gender identity. The presence of phallic shapes among the figurines has led to suggestions that these artefacts symbolised fertility, a

concept reinforced by their use in rituals overseen by the ruling chief (Huffman, 2000:17; Huffman, 2002:18; Matenga, 1993:144-145). These figurines found depict exaggerated sexual characteristics which further support this interpretation (Dederen & Mokakabye, 2017:172). Additionally, figurines from Schroda, the most being numerous zoomorphic representations, are believed to embody women's cosmological constructs and symbolise their reproductive power (Dederen & Mokakabye, 2018:2-9). The role of the figurines in reflecting and constructing gender identities has been explored by Schoeman (2017), who argues that these artefacts represent early farming communities' ideas about sex, gender, and selfhood. The figurines, although not anatomically accurate, served as material embodiments of cultural beliefs about the body, which were reinforced through their use in everyday and ritual contexts (Schoeman, 2017:129-147). The ceremonial handling of the figurines, particularly the bird models, may have been a way for women to assert their symbolic power in opposition to the male-dominated ideological sphere (Dederen & Mokakabye, 2018:9).

The figurines' association with fertility rituals and sacred chieftaincy suggests that they may have been used to legitimise the ruler's authority by linking it to the fertility of the land and the well-being of the community (Matenga, 1993:13; Humphreys, 2023:82). This ritual function aligns with the broader role of figurines in African cosmologies, where symbolic objects are often used to mediate between the physical and spiritual worlds (van Schalkwyk, 2002:70-71). The associations these figurines have with initiation rites, fertility symbolism, and gender identity construction reflect the complex ways in which material culture was used to express and reinforce social hierarchies and cosmological beliefs. These figurines, therefore, are not merely artistic objects but are integral to understanding the ideological and ritual practices of early southern African civilisations.

1.4.3 The Meaning of Colour

References to the presence and meaning of colour in the Schroda figurines are scarce. The only references I could find was in the book, *Sculptured in Clay: Iron Age figurines from Schroda, Limpopo, South Africa*, by van Schalkwyk and Hanich, (2002). The representation of the human form in art often intersects with cultural practices and beliefs, particularly in the context of initiation rites. In the Schroda collection, a range

of human figurines exemplifies this intersection, as they reflect significant social and ritualistic meanings attributed to their forms and colours. The figurines can be classified into at least three distinct categories, primarily comprising paired male and female figurines that explicitly depict genitalia, an important aspect of fertility and reproduction within many cultures (van Schalkwyk, 2002:71). The application of colour on these figurines is notable, as it extends beyond mere aesthetic enhancement. Various colours, including red (ochre), white (ash), and black (graphite), which were the most commonly sourced pigments of the era, are used in decoration and differ from the intrinsic hues of the clay and the effects of firing (van Schalkwyk, 2002:74). This deliberate use of colour may serve multiple purposes, with one primary function being the enhancement of realism these figurines portrayed. For instance, the depiction of giraffes incorporates red dots to illustrate their spots, while some bird figurines have their wings and beaks accentuated through colour differentiation (van Schalkwyk, 2002:75). However, colours in the context of the Schroda figurines are most possibly imbued with deeper meanings, particularly within the framework of Bantu-speaking cultures. The concept of "ritual danger," is a phrase that described the idea of pollution and the need for social order. This was portrayed through the use of specific colours during various life cycle rituals. Ritual danger is articulated through symbols such as pollution (ditshila), heat (go fisa), darkness (sef), and shadow (moriti), suggesting that the placement and recognition of objects and individuals within social categories are paramount for maintaining societal stability (van Schalkwyk, 2002:75).

Central to the ritualistic use of colour three primary hues: white, red, and black were applied to the figurines. Each of these colours possesses distinct meanings and associations that resonate with life cycle events. The colour white was associated with fertility and represented through symbols such as mother's milk and rain, being perceived as having 'cooling' properties. Conversely, red is tied to danger, representing elements like blood, fire, and lightning, which are viewed as harmful. The duality of these colours illustrates a nuanced understanding of life and death within the context of conception and birth, where the interplay of maternal and paternal 'blood' results in the creation of life (van Schalkwyk, 2002:75). The use of red during significant life transitions further emphasises its importance in rituals. This practice signifies that individuals are ‘hot’ during these transformative periods, cautioning others to exercise avoidance measures (van Schalkwyk, 2002:75). In contrast, the colour black carries

purificatory connotations, symbolising a state of neutrality and absence of heat. Widowed women, for instance, are often coloured with black to signify their status and the need for purification. This highlights the intricate relationship between colour symbolism and social status within these communities (van Schalkwyk, 2002:76).

1.5 Delimitations, Significance and feasibility of the study

Ditsong Museum, located in Pretoria, South Africa, houses an extensive collection of fragmented, reconstructed, and complete figurines as well as a large quantity of ceramic shards excavated from the site. From this, a few figurines will be selected that indicate visual different-coloured areas on the clay.

As this is a historically significant site in Southern African Archaeology, any additional information on the figurines will increase the indigenous knowledge base of the collection. Ditsong National Museum of Cultural History has an existing Memorandum of Understanding with the University of Pretoria and is willing to give permission for the investigation. The collection is housed at the Ditsong National Museum of Cultural History in Pretoria, making the study quite feasible.

1.6 Preliminary outline of chapters

Chapter One: Introduction

Chapter One introduces the study by providing a historical and contextual overview of the Schroda figurines. It outlines the aims and objectives of the research, establishing the foundation for the following chapters.

Chapter Two: Investigative Methodologies

Chapter Two focuses on the investigative and analytical methodologies employed in the study of the Schroda figurines. Each technique is defined, and the processes involved are explained in detail.

Chapter Three: Documentation and Visual Examination of Schroda Clay Figurines

Chapter Three examines the condition of the figurines. A comprehensive object and condition report is presented, documenting the physical state and characteristics of the three figurines under study.

Chapter Four: Technical Analysis and Investigation of Polychrome Traces

Chapter Four explores the technical analysis of the figurines, employing methods such as technical photography, X-ray fluorescence spectroscopy (XRF), and Micro-XRF(μ-XRF) scanning. These techniques are used to detect potential traces of pigment on the figurines.

Chapter Five: Conclusion

Chapter Five concludes the thesis by summarizing the findings from the previous chapters and addressing the primary research question of whether traces of polychrome are present on the Schroda figurines as well as the sub questions asked. The chapter also proposes potential directions for further research to advance this area of study.

Chapter Two: Investigative methodologies

2.1 Chapter Introduction

This chapter looks into the methodologies used to analyse the Schroda Figurines. These analytical techniques aim to examine and document these artefacts through various techniques, focusing on condition reporting and a range of analytical imaging methods. The primary objective of this Chapter is to explain the process of the various techniques used as well as the process in which they are applied. Condition reporting, the first stage of the investigation, combines written and visual documentation to establish a baseline for preservation and future conservation efforts. Building upon this, multiple non-invasive imaging techniques, including Visible Light, Infrared (IR), and Ultraviolet Fluorescence (UVF) photography, provide valuable insights into the object's condition and details. These methods, used alongside X-ray fluorescence spectroscopy (XRF) and Micro-XRF scanning (μ-XRF) offers a comprehensive understanding of the figurines' composition and possible traces of polychrome pigments.

2.2 Condition reporting and visual inspection.

The documentation of cultural objects encompasses both written and visual records of examination, sampling, scientific investigations, and treatments. The extent and detail of documentation may vary based on the specific circumstances, the nature of the object, and whether an individual artefact or a collection is involved (Warda, 2011:13). The primary aims of such documentation include establishing a current condition report of the object. A condition report serves as a visual observation for a conservator to assess and detect any signs of damage or causes for deterioration (Taylor, 2005). Here information involves the description of an object which makes up the basis of the report in which a detailed description, including the dimensions of an object, materials, and a detailed report of the object's current condition, is noted (Taylor, 2005, Warda, 2011:13). This process helps aid in the future care of artefacts by offering valuable data for potential treatments as well enhancing the understanding and documentation of an object's aesthetic, conceptual, and physical qualities to serve as a reference in aiding in the knowledge and historical longevity of an object. Additionally, documentation

serves a vital role in advancing the field of conservation collective knowledge base (AIC, 1994).

2.3 Technical Photography (TP)

Technical Photography (TP) is a method that involves a modified digital camera sensitive to the spectral range between 360 and 1000 nm with the assistance of various lighting sources and filters to capture an object as technical images. This provides distinct insights into the objects under examination (CHSOS, 2024). The use of TP as a method of documentation and analysis is a powerful tool for analysing artwork comprehensively and non-invasively, allowing for a deeper understanding of its composition and condition without causing any damage. This approach enhances visualisation by revealing details not visible to the naked eye, which is invaluable for authentication, conservation, and historical research (CHSOS, 2024). Technical photography also supports condition assessment by documenting the state of preservation and identifying the deterioration of an object, which in turn informs conservation planning and restoration strategies. Additionally, this method also aids in historical research by uncovering the artwork's modification and restoration history (CHSOS, 2024).

Often called multispectral imaging, TP encompasses techniques for examining cultural heritage materials across specific wavelength regions in the electromagnetic spectrum, including Ultraviolet (UV) radiation (200-400 nm), visible light (400-700 nm), and Infra-Red (IR) radiation (760-1700 nm) (Dyer, Verri & Cupitt, 2013:1). Each radiation type reveals information typically invisible to the human eye, with UV and IR imaging providing valuable details on underdrawings, earlier restorations, and other hidden elements (Warda, 2011:113). Through this non-invasive and cost-effective approach, TP captures critical visual data that enhances our understanding of an artwork's present condition, the artist's techniques, and the materials used, forming a foundational tool in art conservation (Dyer, Verri & Cupitt, 2013:1).

Figure 2: Setup for Technical Photography, Anton van Wouw House, Pretoria, Photographed by author.

A modified Nikon D800 camera with a 50mm lens and X-rite ColorChecker Passport Photo II[2] was used for the analysis of the Schroda figurines. The camera was set to manual focus with an International Organization for Standardization ISO of 100, a shutter speed of 1/3 and an aperture of 8. Here the aperture is set at a higher setting compared to the 5.6 usually used in paintings to help focus on the edges since the figurines are relatively round. Visible light photography was captured with the use of two halogen lamps on either side of the figurines, with a floodlight under the photography table used as a diffuser to remove most any cast shadows from the figurines (the setup seen in Figure 2), for Infrared (IR) photography an IR filter was applied to the camera with similar lighting conditions being used as the visible light photography. Ultraviolet fluorescence photography has a UV filter applied to the camera with normal lighting conditions, which helped distinguish if there were any fluorescing pigments present on the figurines. The images were captured using the application Digicam and edited on Rawtherapee 5.10 and Gimp 2.0.

[2] The X- Rite ColorChecker is added in photographs to fix the images exposure, white balance , and colour correction in the post-production (Warda,2011 :44-45).

2.4 Visible Light

Visible light photography is the use of high-quality photographic images for examination and documentation of art and archaeological objects. This method is used for accurate photographic documentation, including proper camera calibration, exposure correction, white balance, sharpness, use of colour checkers, and optimal resolution, all of which contribute to a faithful visual record of the object (CHSOS, 2024). Visible light photography is essential in capturing an object accurately within the visible range of the electromagnetic spectrum. This appears under standard viewing conditions, typically achieved through uniform, diffuse illumination to minimise surface glare and highlight details uniformly (Warda, 2011:113). Visible light photography relies on light within the 400–700 nm wavelength range, corresponding to the range naturally perceived by the human eye (American Museum & Natural History, 2002:3).

2.5 Infrared (IR)

Infrared photography (IR) is a specialised imaging technique that enables the examination of underlying layers of a painted object, thereby revealing underdrawings and alterations made by the artist. Some pigments exhibit transparency in the near-infrared range, allowing infrared photography to expose sketches and modifications hidden beneath visible surface layers (CHSOS, 2024; Warda, 2011:131). This technique operates within the infrared portion of the electromagnetic spectrum, where wavelengths are longer and of lower energy than visible light, they extend just beyond the red end of the spectrum (MacBeth, 2012:296). The infrared range spans approximately from 780 nm to 15 umm which are divided into three regions: near infrared (780–3000 nm), mid infrared (3000–6000 nm), far infrared (6000–15000 nm) (MacBeth, 2012:296; Warda, 2011:131). For most imaging applications, sensitivity up to 900 or 1000 nm with the combination of selective filters enables us to see the presence of materials like inks, dyes, retouching marks, and enhancement of inscriptions (Warda, 2011:131).

The process of Infrared imaging, particularly in the short-wave infrared (SWIR) range, is often required to penetrate through dense paint layers and certain traditional pigments. These opaque pigments become increasingly transparent in the range of

infrared. For instance, pigments such as Prussian blue, azurite, malachite, and iron oxide yellows absorb infrared light at shorter wavelengths but allow more transmission at longer SWIR wavelengths. Additionally, pigments like lead white and lead-tin yellow, whose opacity arises from internal scattering, reach maximum transparency between 1500 and 2000 nm (Warda, 2011:131).

2.6 Ultraviolet Fluorescence (UVF)

Ultraviolet fluorescence (UVF) photography is a technique that uses ultraviolet (UV) light to illuminate artworks, revealing information about varnishes, repairs, and pigments that may not be visible under normal lighting conditions (CHSOS, 2024). Certain materials used in art and conservation, such as pigments, binders, varnishes, consolidants, and adhesives, produce ultraviolet fluorescence when exposed to UV radiation. This fluorescence appears as visible light in various colours, which can be documented through specific filters and UV lamps. This provides valuable insight into the inspection, composition, and condition of the materials found on the studied objects. (CHSOS, 2024). Ultraviolet fluorescence photography captures how ultraviolet radiation interacts with the subject; this is either through how UV is absorbed, reflected, or transmitted on an object. Such imaging requires a camera or filter sensitive to the ultraviolet region to effectively document these interactions, much like in infrared photography (Warda, 2011:148).

Ultraviolet light is distinguished by its shorter wavelengths and greater energy compared to visible light. This can be divided into four segments with increasing energy and decreasing wavelength: near or long-wave ultraviolet radiation (UVA, 320–400 nm), middle ultraviolet radiation (UVB, 280–320 nm), far or short-wave ultraviolet radiation (UVC, 200–280 nm), and vacuum ultraviolet radiation (10–200 nm). Among these, UVA is most suitable for examining objects, as it lies closest to the visible spectrum and effectively induces visible fluorescence in various organic materials. These examinations under UVA light allow for visible fluorescence to be observed in how it interacts with the surface materials of objects. This interaction results in the fluorescence of these materials varying in colour and intensity, giving greater insight for examination (MacBeth, 2012:294).

2.7 X-Ray Fluorescence Spectroscopy (XRF)

In this study, X-ray fluorescence spectroscopy (XRF) was used as a primary analytical method to examine the pigments found on the Shroda figurines. XRF is explained to be a non-invasive analytical tool used to investigate the elemental composition of cultural heritage materials, including pigments. The non-destructive nature of XRF is particularly advantageous in cultural heritage studies as it preserves the integrity of delicate and historically significant objects (Bezur, Lee, Loubser & Trentelmann, 2020:17; Shugar, 2009:8). XRF spectroscopy works by irradiating the materials being analysed with high-energy X-rays, which causes the emission of secondary, characteristic X-ray photons from the elements within the material. These emissions are then detected and analysed to identify the specific elements found on the object being analysed by looking at the specific energies at which emissions are detected (Loubser & le Roux 2021:5).

The interaction between X-rays and the material analysed involves three possible processes: absorption, scattering, or transmission. For XRF analysis, absorption is the most critical interaction in which an X-ray photon strikes an atom which may transfer all its energy to an inner-shell electron that results in a photoelectric effect occurring. This emission of a photo electron excites the atom, ejecting an inner-shell electron and creating a vacancy. The atom returns to the ground state and emits a fluorescent X-ray during this process. Since each element has a distinct electronic structure, the emitted photon energy is characteristic of the specific element, allowing for reliable elemental identification through XRF spectroscopy (Bezur, Lee, Loubser & Trentelmann, 2020:17). In applying XRF to the study of pigments, elemental analysis offers insights into the types of materials likely used in an object's production. By analysing the elements present, one can infer the presence of specific pigments based on their known compositions.

With the use of XRF it is essential to note that XRF provides elemental, not molecular, information. Since many pigments are complex compounds, XRF cannot distinguish between compounds sharing the same elemental composition. This limitation makes it challenging to differentiate between similar pigments, such as copper carbonate and copper acetate, both of which contain copper but differ in their counterions (Shugar & Mass, 2012:26). XRF also cannot detect elements with low atomic numbers, such as

carbon and oxygen which are often found in organic materials (Shugar & Mass 2012: 26; Loubser & le Roux 2021:5).

XRF is a highly effective tool for identifying a range of elements, from sodium (Na) to uranium (U), the method is limited by its inability to detect lighter elements such as hydrogen (H), carbon (C), nitrogen (N), and oxygen (O). These light elements are central to many organic compounds, including binders and certain pigments, but their absence from XRF data complicates the comprehensive analysis of organic and carbon-based materials (Loubser & le Roux 2021:5). To address this limitation, supplementary analytical techniques like X-ray Powder diffraction (XRD) or Raman spectroscopy may be necessary to conclusively identify certain pigments or to capture data on organic materials. These techniques can aid XRF by analysing the molecular structures of objects by differentiating between their compounds with similar elemental compositions (Bezur, Lee, Loubser & Trentelmann, 2020:17).

A key benefit of XRF spectroscopy in conservation is its capacity for rapid and precise elemental analysis. Heavier elements, which emit more easily are easier to detect and identify through fluorescent X-rays compared to lighter elements which require different techniques beyond the reach of XRF (Loubser & le Roux 2021:5). This rapid analysis capability makes XRF a valuable initial assessment tool for identifying elemental compositions in the detecting of pigments found in the Shroda figurines.

On each of the three figurines in the sample, about 12 points were selected based on colour deviations and spot analyses executed to try to identify the pigments used. Uncoloured clay parts were also analysed to get an idea of the base clay composition.

A Bruker Tracer 5i with a Rhodium X-ray Tube for excitation and Silicon Drift Detector and the GeoChemical factory calibration was used for the analyses (the setup is seen in Figure 3), as clays are basically earth elements, and the Geochem calibration covers all the elements of interest. The calibration includes three settings, 30kV with an Al filters[3], 50kV with a TiAl filter and 15kV with no primary beam filters, and analyses 30 seconds in each setting, thus 90 seconds in total. These three settings functionally cover all the elements on the periodic table, but after the scans were evaluated, it was found

[3] Filter: Allows you to focus on key elemental ranges to identify elements at detection limits (Drake 2018).

that the 30kV setting provided the necessary information, and these spectra were used in further representations.

Figure 3: Handheld XRF analysis setup, Anton van Wouw House, Pretoria, Photographed by author.

2.8 Micro-XRF Scanning (µ-XRF)

We had the opportunity to use a Bruker M4 Tornado Micro-XRF scanner. This instrument differs from the Energy Dispersive Bruker Tracer 5i handheld, in that it has a polycarpellary lens offering small spot sizes and high X-ray intensity and can be used in a 2D mapping mode, thus collecting 1000's of analyses on sequential small spots. This produces elemental distribution maps of the objects. It also uses a Rhodium X-ray Tube for excitation and a Silicon Drift Detector, but in this case a vacuum system was available enhancing light element detection. Anything lighter than Na on the periodic table remains a challenge for Energy Dispersive XRF. The theory of the XRF spectroscopy is identical to that of the handheld instrument used. An area on each of the three figurines, where pigment presence was identified during the handheld analyses was selected for scanning.

For the bird, an area of 70.5 x 53mm area was selected and analysed at spot intervals of 20 um collecting 3525 spectra. For the Phallic symbol an area of 88.7x48.5mm area was selected and analysed at spot intervals of 20um collecting 4435 spectra. For the

Giraffe an area of 60.8 x 43.4mm was selected, but as we realised the resolution was totally adequate for what we needed, this time spot intervals of 50um was used decreasing the measurement time by several hours and still collecting 1216 spectra. The results for this are expressed as element maps in Chapter four.

2.9 Chapter Conclusion

In conclusion, the documentation and analytical methods described in this chapter demonstrate how condition reporting and technical imaging will be conducted. Condition reporting provides a detailed baseline for the physical and structural state of these artefacts, whilst visible light photography and advanced imaging techniques such as infrared and ultraviolet fluorescence aid in the documentation of these figurines as well as highlighting hidden details not visible to the naked eye. Additionally, advanced tools such as XRF and Micro-XRF scanning further refine the ability to map and analyse elemental composition and distributions of the clay figurines. These methodologies are non-invasive, preserving the integrity of artefacts while offering further information for conservation, and analytical research.

Chapter Three: Documentation and Visual Examination of Schroda Clay figurines.

3.1 Chapter Introduction

This chapter will focus on an in-depth discussion of the three selected Schroda figurines, emphasising a visual examination rather than a scientific analysis. This approach will contribute to the understanding and contextualisation of these objects, complementing the scientific processes discussed in Chapter 4. By conducting a detailed visual inspection, this chapter aims to document the figurines comprehensively, relying solely on observations made with the naked eye. Each of the three figurines will be thoroughly documented, with detailed reports and descriptions compiled for each piece. This documentation will include empirical details such as dimensions, materials, and estimated dates, followed by concise descriptions of each figurine. The purpose of these observations is to provide a clear and thorough account of the visual characteristics of the figurines. Furthermore, the chapter will include detailed condition reports for each figurine, offering a comprehensive assessment of their current state. These reports will note any signs of previous repairs, evidence of physical damage, or indications of imperfections stemming from the production process. The aim is to provide a full account of the physical condition of each figurine, enhancing the overall understanding of their preservation and history.

3.2 Current Storage of the figurines

Whilst on loan from the Ditsong: National Museum of Cultural History, the Schroda figurines were stored at van Wouw House during the time of this study (2024). Here the figurines were securely stored in a cool room with no possible exposure to sunlight, in an airtight plastic container. Each figurine was wrapped in acid-free tissue paper and bubble wrap, resting on a towel at the base of the container with styrofoam supports to relieve any stress points caused by the different heights of the figurines whilst lying on their sides.

3.3 Phallic Symbol Figurine

3.3.1 Empirical details:

- Title: Schroda Figurine
- Date: AD 900-1025
- Site Name: Schroda
- Province: Limpopo
- No. of frags/pieces: 1.
- Artifact name: Schroda Phallic symbol figurine
- Dimensions: 240 x 90 mm
- Materials: Ochre Pigments (analysis in Chapter 4) on fired clay.
- Classification: Figurine, sculpted, possibly low fired
- Classification Type: Figurative- Phallic Symbol

Figure 4: Schroda, Phallic Symbol figurine, AD 900-1025, Ochre pigments on clay, 240 x 90 mm, Ditsong Museum Collection, Pretoria, South Africa, Photographed by author.

3.3.2 Object description

The object in question is a clay figurine characterised by its distinct phallic form (Figure 4). This handmade piece presents a long, cone-shaped object that tapers from a relatively narrow tip to a broader, slightly flattened base. The top of the figurine features ten punctated [4]holes of varying sizes, carefully arranged across the surface, adding to an uneven surface. The material appears to be fired clay, with pigments applied after firing. It exhibits a warm reddish-brown hue suggestive of ochre pigments across the upper portion. This colouration gradually deepens as it moves towards the base, transitioning into a darker, almost black tone, intentional pigment variation. The surface of the figurine is generally smooth but displays minor irregularities and subtle bumps

[4] Punctated: refers to a decorative technique on ceramics where small depressions are created using a sharp or pointed tool (LeCompte, 2015:17).

throughout. The combination of smoothness and occasional unevenness speaks to the meticulous, yet organic process involved in its creation.

3.3.3 Condition Report

The phallic symbol figurine shown in Figure 5 and 6 exhibits visible areas of damage, which are marked on the artefact. These locations have been categorized and grouped for discussion regarding the overall condition of the object.

Figure 5: Marked locations of damage/ defects found on Phallic Symbol figurine. Photographed and marked by author.

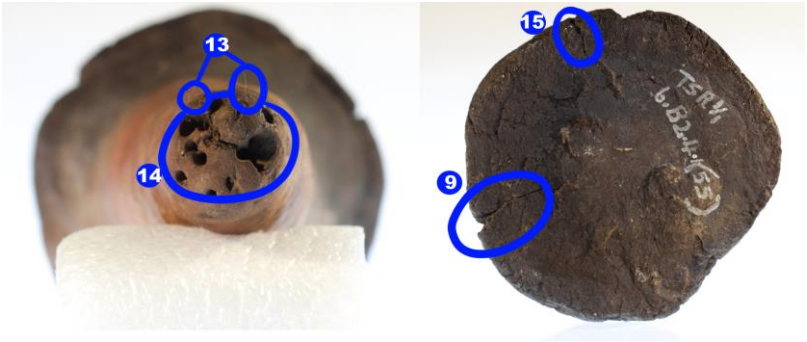


Figure 6: Marked locations of damage/ defects found on top and underside of the Phallic Symbol figurine. Photographed and marked by author.

A total of 17 locations (Figure 5 & 6) were marked on the phallic symbol for this condition report. Overall, the figurine is in good condition. It is structurally stable with no signs of physical instability or trauma. Most of the observed imperfections appear to have originated during the manufacturing process of the artefact. Throughout the

figurine, there are numerous small pitting holes of varying sizes, likely caused by air bubbles popping during the firing process. These pitting spots are evident in Locations 5, 6, 10, 12, 16 and 17 in Figures 5, 6 & 7. In Locations 3, 4, 8, 9, and 15 (Figures 5, 6 & 7) cracks are visible, which most likely formed during the firing process. These cracks may be shrinkage cracks, caused by the clay expanding during firing and shrinking rapidly upon cooling, resulting in aggressive-looking fissures. Most cracks are concentrated at the base of the figurine, suggesting it may have been upright during firing or positioned near the flame. A missing section of clay is observed in Location 7 (Figure 5 & 7), which might be the result of an air pocket that left behind a large hole during firing.

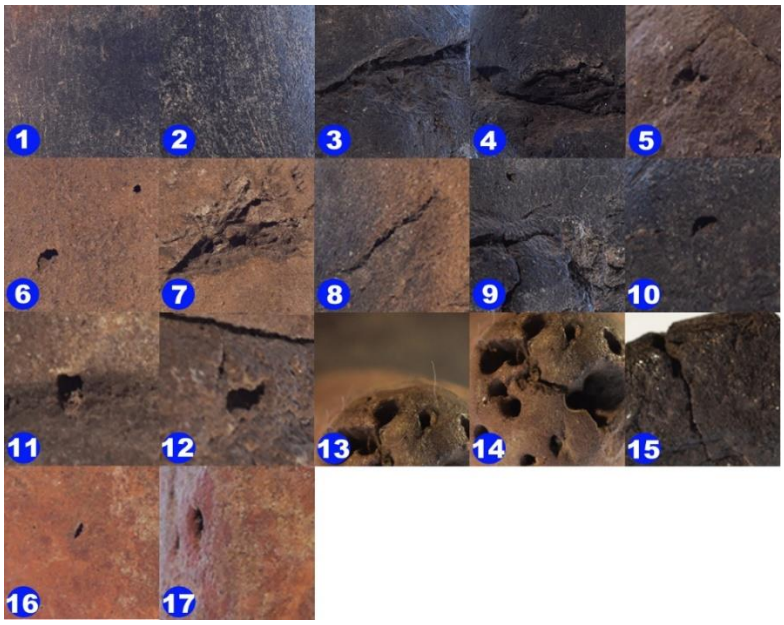


Figure 7: Close up images of marked locations on Phallic Symbol figurine. Photographed and marked by author.

Figure 8: Written tag on the underside of the Schroda, Phallic Symbol figurine. Photographed by author.

Fine abrasion marks are visible on the surface of the figurine at Locations 1 and 2 (Figure 5 & 7), likely caused over time by physical contact or exposure. At the tip of the phallic symbol, punctate holes are present in Location 4 (Figure 5 & 7), which

appear to have been created during the artifact's production. Cracks have formed between these holes, possibly due to their proximity and the thinness of the clay in these areas. At Location 13 (Figure 6 & 7), small fibre strands appear to have become stuck to the object, though no visible signs of dust are present within the holes. Finally, there is a written tag on the underside of the object (Figure 8), likely added by an archaeologist as part of the documentation process.

3.4 Bird Figurine

3.4.1 Empirical details:

- Title: Schroda Figurine
- Date: AD 900-1025
- Site Name: Schroda
- Province: Limpopo
- No. of frags/pieces: 1.
- Artifact name: Schroda Bird figurine
- Dimensions: 205 x 70 mm
- Materials: Ochre Pigments (analysis in Chapter 4) on fired clay.

Figure 9: Schroda, Bird figurine, AD 900-1025, Ochre pigments on clay, 205 x 70 mm, Ditsong Museum Collection, Pretoria, South Africa, Photographed by author.

- Classification: Figurine, sculpted, possibly low fired
- Classification Type: Figurative- Bird

3.4.2 Object description

The clay figurine depicts a bird (Figure 9) with a long slender neck that curves upwards. The neck tapers downwards to a slightly thicker flat base. On the central body portion of the figurine a visible section of clay flares art forms a wing like shape projecting

outwards from the junction of the bird's neck and body. The figurine is light brown in colour with variations in the different hues of brown shades. There appears to be red ochre pigments present on the figurine, that was possibly administered post low firing. The surface of the figurine is smooth with slight bumps.

3.4.3 Condition Report

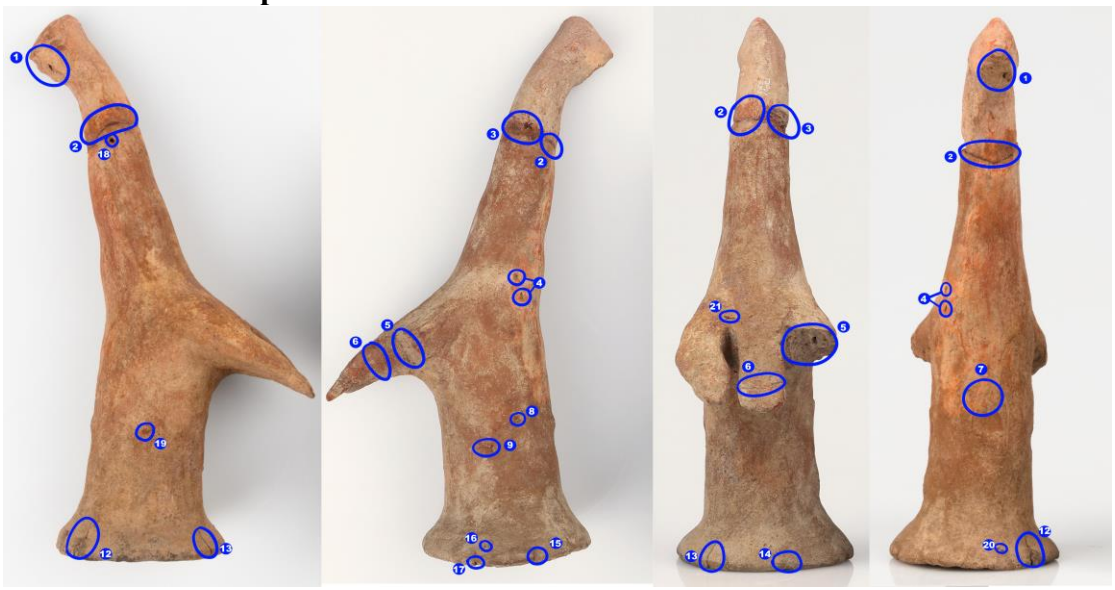


Figure 10: Marked locations of damage/ defects found on Bird figurine. Photographed and marked by author.

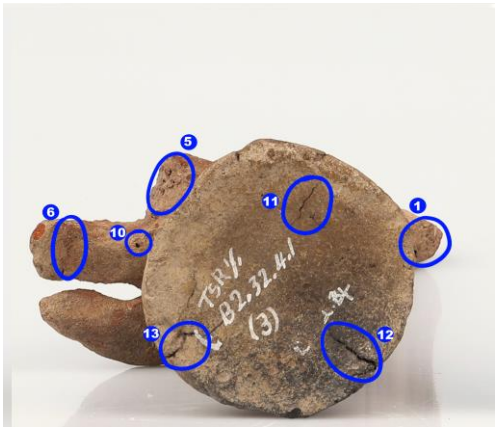


Figure 11: Marked locations of damage/ defects found on the underside of the Bird figurine. Photographed and marked by author.

In Figure 10 and 11, 21 locations are marked to show the spots where visible damage is present on the bird figurine. As previously mentioned in the condition report for the phallic symbol each location will be categorized and discussed in relation to the related condition. The overall condition of the figurine is fair with there being visible signs of repairs. In location 8, 9, 10, 16, 18, 19, 20 and 21 (Figure 10, 11 & 12) there appears to

be pitting holes, which as previously mentioned, are formed during firing. Cracks most likely caused during firing appear to be visible on the base of the figurine, as seen in Location 11, 12, 13, 15 and 17 (Figure 10, 11 & 12).

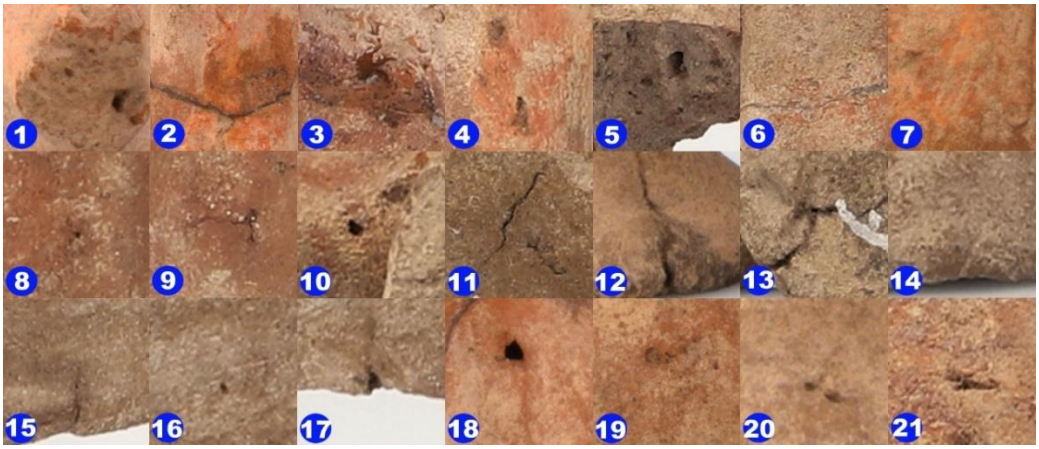


Figure 12: Close up images of marked locations on Bird figurine. Photographed and marked by author.

On location 1 and 5 (Figure 10, 11 & 12) there appears to be missing pieces on the figurine, this could be due to physical damage. Although due to there being holes in the exposed breakage areas it could also be spalling in which pieces broke off during firing, due to there being air bubbles present in the clay. There appears to be abrasion marks visible on location 7 and 14 (Figure 10 & 12) as well. On the neck of the bird in location 2 and 3 (Figure 10 & 12) visible repair is seen to be done to the figurine. This is seen by visible signs of adhesive along with the adhesive darkening on the clay around the repair. On the neck there does appear to be a missing piece which can be seen in location 3. Adhesive appears to be seen in location 6 which the tip of the bird's wing is reattached with no signs of residual adhesive around the repair.

Figure 13: Ultraviolet Fluorescent Photograph of Bird figurine showing adhesive repairs. Photographed by author.

Ultraviolet photography has been used in which this figurine has showed visible signs of repair. In Figure 13 the adhesive used to reattach the bird's head and wing to the body is visible. This is seen by the fluorescing white glow of the adhesive. There also appears to be a label by the archaeologists marked on the underside (Figure 14) of the bird's base as well as on its head (Figure 15). The label on the bird's head could be that prior to its repair the two separate pieces were excavated separately and were already broken and documented as two different fragments.

Figure 14: Written tag on the underside of the Schroda, Bird figurine. Photographed by author.

Figure 15: Written tag on the head of the Schroda, Bird figurine. Photographed by author.

3.5 Giraffe Figurine

3.5.1 Empirical details:

- Title: Schroda Figurine
- Date: AD 900-1025
- Site Name: Schroda
- Province: Limpopo
- No. of frags/pieces: 1.
- Artifact name: Schroda Giraffe figurine
- Dimensions: 230 x 130 mm

Figure 16: Schroda, Giraffe figurine, AD 900-1025, Ochre pigments on clay, 230 x 130 mm, Ditsong Museum Collection, Pretoria, South Africa, Photographed by author.

- Materials: Ochre Pigments (analysis in Chapter 4) on fired clay.
- Classification: Figurine, sculpted, possibly low fired
- Classification Type: Figurative- Giraffe

3.5.2 Object description

This figurine represents a giraffe (Figure 16) with a notably elongated and slender neck that tapers gently towards an abstracted head form. The neck is marked by uneven cuts and irregular shaping, suggesting a stylized interpretation of the giraffe's mane. The body of the figurine is broader and curves smoothly downward to a sturdy base, from which the animal's legs extend at varying heights. A small tail is also evident at the rear of the body, adding to the overall anatomical detail. The figurine's colouration is primarily a light brown, with patches and streaks of reddish-brown pigment dotted on the body. These markings create a textured effect reminiscent of a giraffe's distinctive spotted pattern. Toward the base and along the legs, the colour deepens to a darker, almost black-brown hue. The surface of the figurine is predominantly smooth, although slight bumps can be felt along the length of the neck. This texture transitions to a

rougher, more uneven finish near the base, where visible cracks and irregular sculpting do contribute to this surface texture.

3.5.3 Condition Report

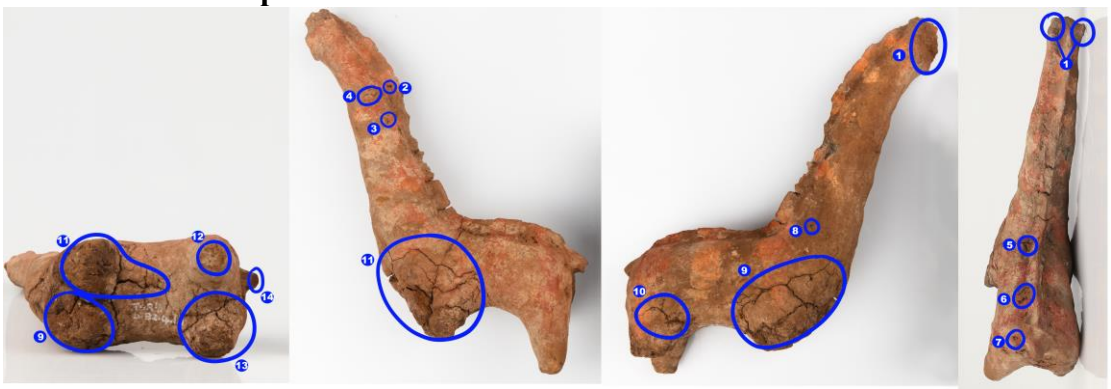


Figure 17: Marked locations of damage/ defects found on the sides, top and underside of the Giraffe figurine. Photographed and marked by author.

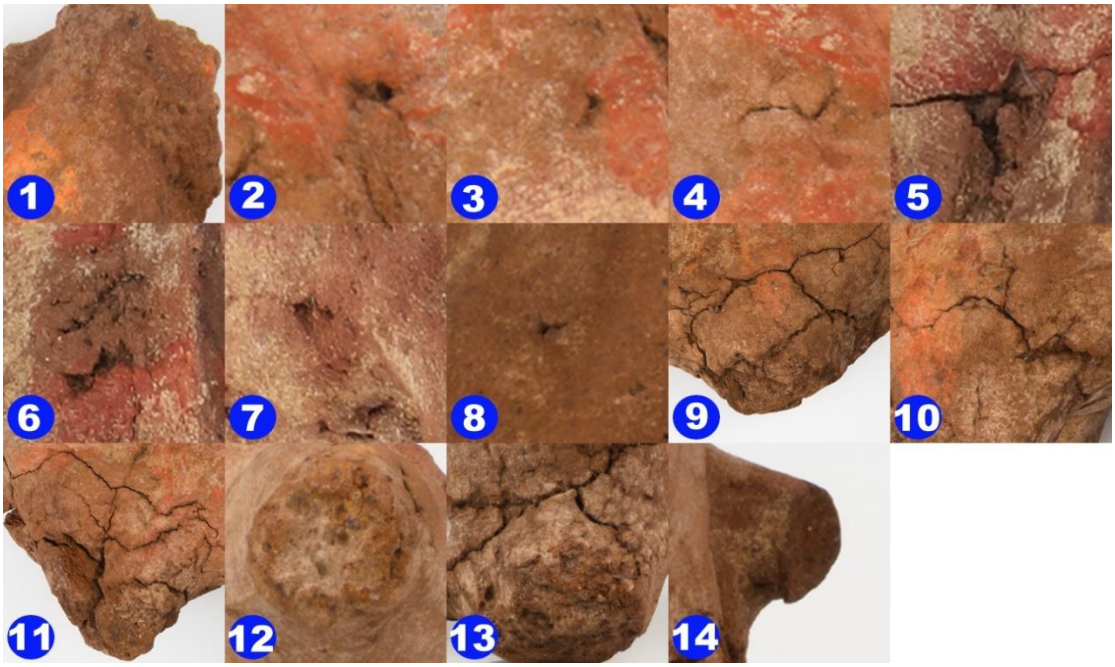


Figure 18: Close up images of marked locations on Giraffe figurine. Photographed and marked by author.

The condition of the giraffe figurine is fair and appears stable with no signs of weak points or probability of breaking. On the figurine (Figure 17) 14 locations have been marked for visible damage on the artefact these are categorised and discussed in correlation to one another, as similarly discussed in the condition reports above. The giraffe figurine primarily consists of cracks visible in location 4, 5, 6, 9, 10, 11 and 13 (Figure 17 & 18). These cracks primarily reside on the lower body of the giraffe with

larger cracks visible on the giraffe's rump and underbelly. The formation of these cracks are most likely formed during firing, whilst the cracks on location 4, 5 and 6 (Figure 17 & 18) appear to be formed as stress cracks originating from the incisions made the detail the drafts main during sculpting. Numerous pitting holes also seem to be present on the figurine on location 2, 3, 7 and 8 (Figure 17 & 18). Missing areas on the draft's head, tail and legs are visible, as seen in location one, 12 and 14 (Figure 17 & 18). These could either be due to physical breaks or spalling breaks during firing. On the underside of the figurine appears to have a label (Figure 19), this is previously discussed in the condition reports above to probably been done by archaeologists as a form of documentation.

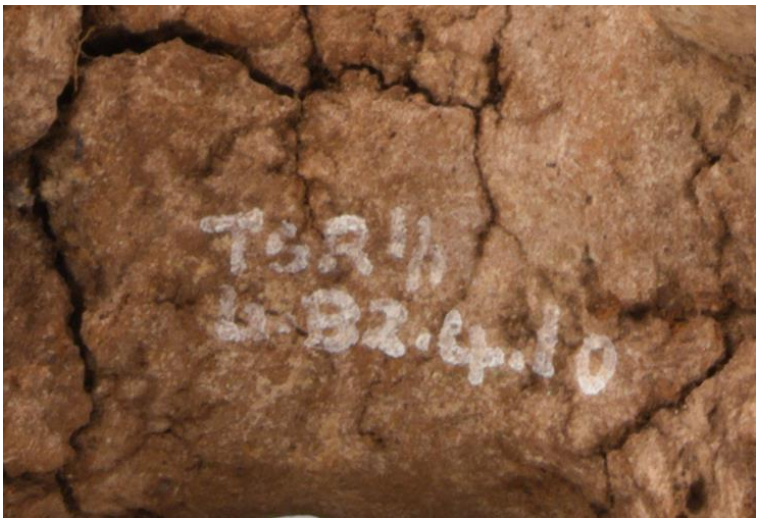


Figure 19: Written tag on the underside of the Schroda, Giraffe figurine. Photographed by author.

3.6 Chapter Conclusion

This chapter provides a comprehensive visual examination and condition assessment of three selected Schroda figurines: the Phallic Symbol, Bird, and Giraffe. By focusing on detailed documentation, this chapter has highlighted the empirical details physical characteristics, and preservation states of each artifact.

Chapter Four: Technical Analysis and investigation of polychrome traces

4.1 Chapter Introduction

This chapter aims to provide an in-depth discussion of the technical analyses conducted on the three Schroda figurines to investigate the presence of any polychrome traces. It will review and analyse the results of three scientific methods applied in the study, as detailed in Chapter Two: Technical Photography, X-ray Fluorescence Spectroscopy (XRF), and Micro-XRF (µ-XRF) scanning. The first method employed was technical photography, which encompassed three types of imaging: visible light, infrared (IR), and ultraviolet fluorescence (UVF) photography. The visible light photography was conducted to create a comprehensive record of the appearance of the figurines and to document any relevant characteristics observed during the study. Infrared photography was utilised to detect any underlying layers or transparent pigments that may not be visible to the naked eye. Ultraviolet fluorescence photography, on the other hand, was performed to reveal fluorescing pigments or any previous restorations that could be present on the figurines.

X-ray Fluorescence Spectroscopy (XRF) was used as the second analytical technique to identify any pigments present on the three figurines and determine their composition. This analysis was carried out using a handheld XRF spectrometer in a non-invasive and non-destructive manner (as thoroughly described in Chapter Two). The purpose of this analysis was to gather detailed information about the elemental composition of the areas studied on each figurine. The detection of specific elements through this process provides significant insights into the composition and types of pigments used in these figurines. Lastly, Micro-XRF scanning was selectively applied to sections of each figurine where pigment traces were highly visible. This method allowed for a more refined examination of the distribution of elements within these targeted areas. The resulting data were visualised through colour-coded maps, each representing the distribution of individual elements. These maps offer a clear depiction of the dispersion and variation of elements present in the analysed sections of the figurines, providing a comprehensive understanding of the materials used. In summary, this chapter outlines

the technical approaches and findings related to the investigation of polychrome traces on the Schroda figurines. Each technique's contributions to the overall analysis are discussed, revealing crucial information about the polychrome pigments employed in the creation and subsequent history of these significant artefacts.

4.2 Phallic Symbol Figurine (AD 900-1025)

4.2.1 Technical Photography

4.2.1.1 Visible Light

Figure 20: Visible Light Photography of Schroda, Phallic Symbol figurine. Photographed by author.

The Schroda Phallic Symbol figurine (Figure 20) was photographed in the photography studio at the Anton van Wouw House with the assistance of lecturer Salomé le Roux.

The clay figurine was illuminated using two halogen lights positioned on either side of the artefact and a floodlight placed beneath the table to eliminate any casted shadows. Additionally, an X-Rite ColorChecker Passport Photo II was included for accurate colour correction. The photographs were edited using RawTherapee 5.10 and GIMP 2.0, where adjustments were made to the exposure, white balance, and colour accuracy of the images. The images were also cropped to remove any unwanted white background.

Visible light photography was extremely useful, revealing fine details on the figurine that were not visible to the naked eye. Furthermore, it enhanced the visibility of the ochre pigments, allowing their colouration and variations to stand out more distinctly.

4.2.1.2 Infrared (IR)

Infrared photography was used to identify the presence of transparent pigments or variations in the clay materials that were not detectable through visual observation or visible light photography. The images were taken with the same lighting conditions as mentioned in the above results with the exception of infrared filters being used on the camera and a CHSOS pigment colour checker. The infrared images of the Schroda Phallic Symbol figurine (Figure 21) did not reveal any notable results.

Figure 21: Infrared Photography of Schroda, Phallic Symbol figurine. Photographed by author.

4.2.1.3 Ultraviolet Fluorescence (UVF)

Ultraviolet fluorescence (UVF) photography was performed in this study, with the lighting conditions of the photography studio being relatively dark. The photos were captured using a camera equipped with a UV filter and a CHSOS pigment colour checker. Figure 22 revealed no visible signs of repairs or fluorescing pigments. However, white specks were observed scattered across the figurine, which might be fluorite[5] (CaF_2), a material that becomes visible under UV light.

Figure 22: Ultraviolet Photography of Schroda, Phallic Symbol figurine. Photographed by author.

4.2.2 X-Ray Fluorescence Spectroscopy (XRF)

Non-destructive XRF analysis was conducted on 15 targeted areas of the clay figurine, as shown in Figure 23, to assess the potential presence of pigments. The selection of these specific areas was based on visual inspection, focusing on regions that exhibited the most pronounced indications of pigment. Additionally, areas that appeared to consist of base clay were analysed to provide a comparative baseline. This study was held at Anton van Wouw House with the guidance of lecturer Maggi Loubser.

[5] Fluorite (CaF_2) is a mineral in the form of calcium and fluorine but fluorine is an element handheld XRF cannot detect.

Figure 23: Locations of Handheld XRF analysis on the Phallic Symbol figurine. Photographed and marked by author.

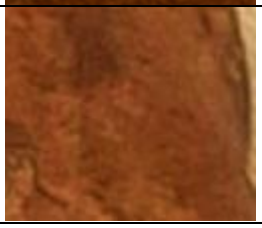
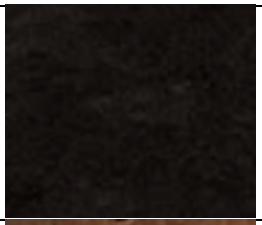
In the tables below (Table 1, 3 & 5), as well as in subsequent tables presenting related data, the targeted data points are highlighted in bold to indicate elevated levels of iron (Fe), whilst data points pertaining to the base clay are represented in italics for clarity. The table headings detail the different elements detected during the XRF analysis, with each element colour-coded to correspond with its representation in the Micro-XRF layered image scans.

Table 1: Break-down of analysed XRF spots (as shown in Figure 23) showing; Location, Elements, and elements average.

Location	MgO	Al_2O_3	SiO_2	P	S	K_2O	Ca	Ti	Mn	Fe	Ba
P1	2,34	0,71	16,89	0,06	0,42	0,63	0,81	< LOD	0,02	1,41	0,17
P2	**2,64**	**13,43**	**42,72**	**0,15**	**0,36**	**1,79**	**1,07**	**0,74**	**0,09**	**4,11**	**0,18**
P3	2,14	5,70	35,54	0,13	0,25	1,35	0,84	0,31	0,05	2,35	0,09
P4	1,60	9,76	27,77	0,09	0,30	1,31	0,81	0,54	0,07	3,71	0,22
P5	1,95	2,25	20,06	0,04	0,15	0,82	0,41	0,11	0,03	1,32	0,09
P6	**2,14**	**6,41**	**34,23**	**0,12**	**0,56**	**1,95**	**1,37**	**0,46**	**0,07**	**4,07**	**0,21**
P7	**2,07**	**4,53**	**30,83**	**0,27**	**0,56**	**1,27**	**1,50**	**0,30**	**0,08**	**6,46**	**0,19**
P8	2,51	9,44	41,14	0,16	0,41	1,83	0,92	0,64	0,06	3,96	0,11
P9	2,90	5,71	37,00	0,08	0,35	1,48	0,98	0,33	0,05	2,36	0,20
P10	**1,67**	**13,63**	**44,84**	**0,15**	**0,40**	**2,67**	**1,32**	**0,68**	**0,09**	**4,04**	**0,18**
P11	1,78	14,24	44,98	0,14	0,40	2,65	1,32	0,68	0,09	3,98	0,17
P12	2,81	2,00	21,35	0,12	0,60	0,91	1,44	0,18	0,05	3,91	0,15
P13	2,25	4,08	33,20	0,19	0,41	1,38	0,93	0,32	0,05	2,89	0,15
*P14**	*2,52*	*8,37*	*47,35*	*0,13*	*0,34*	*2,24*	*1,01*	*0,48*	*0,05*	*2,65*	*0,10*
P15	1,80	4,69	32,59	0,08	0,37	1,36	0,96	0,27	0,06	2,08	0,11
Average	2,21	6,52	33,26	0,13	0,39	1,50	1,03	0,41	0,06	2,78	0,15

<LOD= Limit of Detection

Table 2: Locations P2,P6, P7, P10 and P13 showing levels of Iron (Fe) and base clay detected on XRF spots (as show in Figure 23); Location, image, description, and percentage of Iron (Fe).

Location	Image	Description	%Fe
P2		**Possibly a hydrated ferric oxide, FeO(OH)(Yellow ochre)**	**4.11**
P6		**Possibly a hydrated ferric oxide, FeO(OH)(Yellow ochre)**	**4.07**
P7		**Clear strong red markings on the phallic symbol possibly hematite($\propto$-Fe_2O_3) due to red colour The black marking next to the red pigment could suggest traces of magnetite ($Fe^{2+}Fe^{3+}{}_2O_4$).**	**6.46**
P10		**Probably magnetite ($Fe^{2+}Fe^{3+}{}_2O_4$) due to dark black colour.**	**4.04**
P14		**Base clay, this is used to compare the clean clay to that of higher iron(Fe) contents.**	**2.65**

The XRF analysis yielded a comprehensive set of elements detected within the composition of the clay. The predominant elements identified include calcium (Ca), magnesium (Mg), titanium (Ti), iron (Fe), and aluminium (Al), all of which are reflected in the results displayed in Table 1. According to Jacobson & van der Westhuizen (2002:43-44), the Schroda site was situated on a sandstone substrate interspersed with numerous basalt outcrops. Jacobson & van der Westhuizen notes that the presence of MgO and Cr, along with significant levels of TiO_2 and CaO, are

associated with mafic minerals[6] and may indicate the inclusion of basalt components. He suggests that there is a strong likelihood of fine natural temper fragments, potentially derived from basalt, being incorporated within the clay (Jacobson & van der Westhuizen, 2002:44).

The XRF analysis revealed significant concentrations of iron (Figure 24) these levels are seen mainly on the specific targets, P2, P6, P7, and P10, as shown in Table 2. This finding strongly suggests the presence of ochre pigments on the figurine. When compared to the baseline iron content of the base clay (measured at approximately 2.65% in target P14), the notably higher iron content observed in target P7, which reached 6.46%, indicates a substantial increase in iron levels and the use of ochre pigments. The particularly high iron content detected on P7 compared to other analysed spots may point to the presence of hematite (α-Fe_2O_3), which is associated with a deep red ochre pigmentation. This characteristic red hue is seen in the imaging data that corresponds with the iron levels detailed in Table 2. Additionally, the analysis suggests the potential presence of limonite or hydrated ferric oxide (FeO(OH)), commonly known as yellow ochre, which typically corresponds to lower iron concentrations than those found in red ochre. Evidence of yellow ochre is most prominently noted on target P2, which displays a distinctive yellow colouration. This hue is also visible on P6, which exhibits a similar shade of yellow, albeit with a slightly darker, orange-tinged appearance. These findings provide further support for the hypothesis that different types of ochre pigments were utilised on various parts of the figurine, contributing to a diverse colour palette of various shades of red and yellow ochres. Unfortunately, XRF can only identify the element and not its oxidation state, so the mineral phases are inferred. As a further study, X-ray Powder Diffraction can be done to confirm the specific mineral compositions.

[6] Mafic minerals, such as pyroxenes and olivine, are rich in magnesium and iron (Comunale & Lange, 2023).

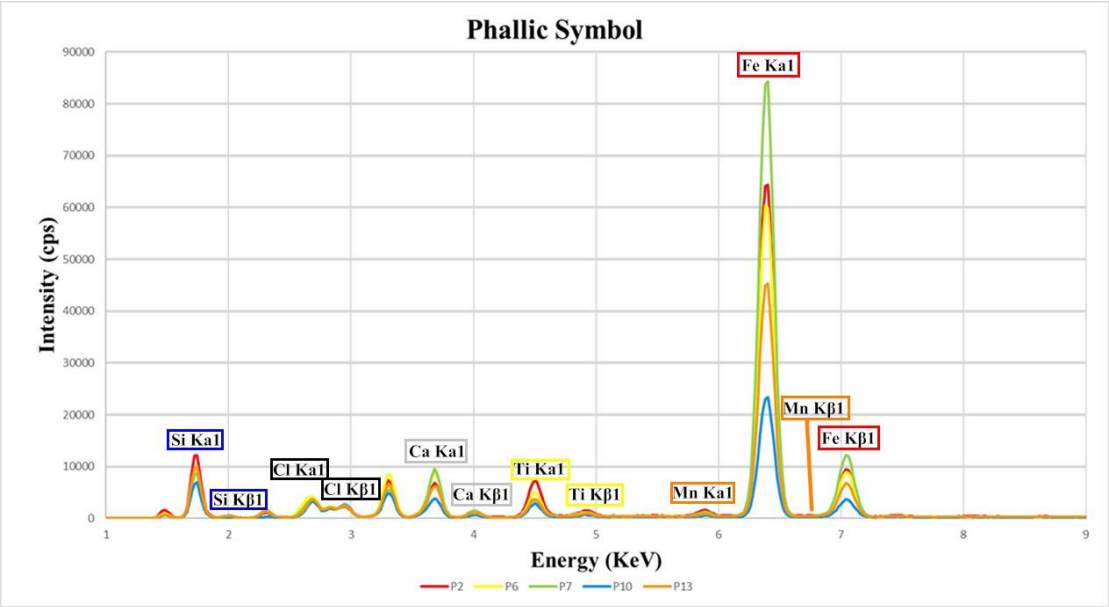


Figure 24: Elemental peaks of locations P2, P6, P7, P10 and P13 on Phallic Symbol figurine.

4.2.3 Micro-XRF Scanning (µ-XRF)

In this study, Micro-XRF (µ-XRF) analysis was employed in a limited capacity, specifically focusing on the elemental mapping of two-dimensional compositional maps (Figure 25 & 26). The initial step for this analysis involved selecting a region on the Phallic Symbol figurine (Figure 25) to generate a mapped image. This enabled the creation of overlapping elemental maps, represented in various distinguishable colours (seen in Figure 26), facilitating detailed compositional analysis. Figure 26 illustrate the Micro-XRF mapping conducted on a selected section of the phallic symbol figurine. The mapped area measured 88.7 x 48.5 mm, with spot intervals set at 20 µm. This allowed for a comprehensive assessment of different element distribution throughout the sample. The multi-elemental map revealed the presence of several key elements, including iron (Fe), aluminum (Al), silicon (Si), potassium (K), calcium (Ca), titanium (Ti), and manganese (Mn).

Figure 25: Location of Micro-XRF scan on Phallic Symbol figurine. Phallic Symbol figurine Photograph by author. Micro- XRF scan done by Liberty Kapesi for author, at University of Johannesburg.

The results of the analysis showed a significant distribution of iron across the figurine, indicating the presence of ochre pigments. The elemental map depicting iron, highlighted in red (Figure 26), revealed regions of high iron concentration, while other areas displayed more scattered and sparse distributions. Notably, the highly concentrated areas corresponded to the handheld XRF target spot labeled P7 (Figure 23, Table 2), which exhibited the highest measured iron content at 6.46%. This result marked the most substantial level of iron detected among the sampled spots on the phallic symbol figurine, underscoring the use of iron-based pigments in the artefact's composition.

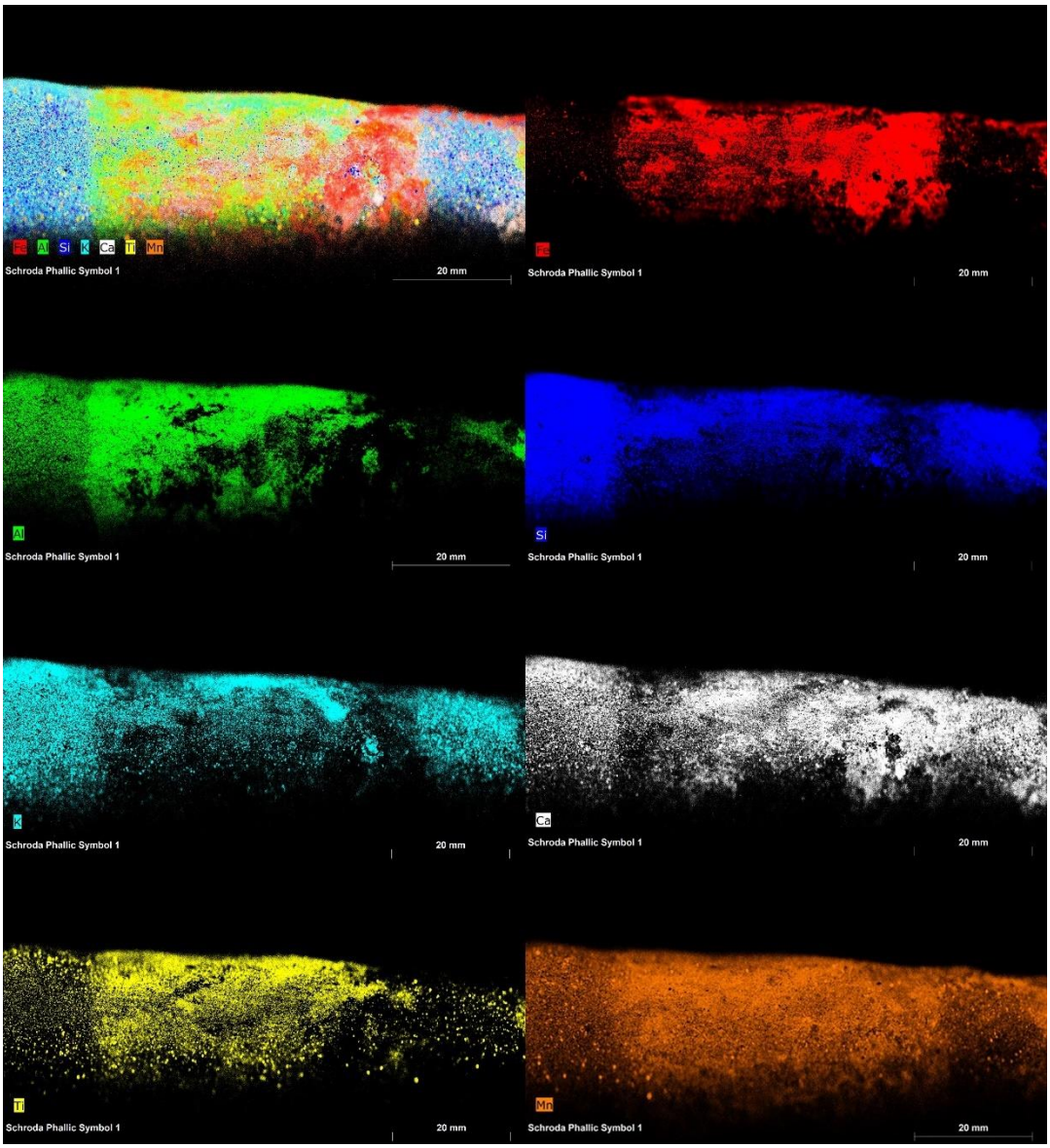


Figure 26: Colour coded elemental maps of Micro-XRF scan on Phallic Symbol figurine. Scan done by Liberty Kapesi for author, at University of Johannesburg.

4.3 Bird Figurine (AD 900-1025)

4.3.1 Technical Photography

4.3.1.1 Visible Light

The Schroda Bird figurine (Figure 27) was photographed under the same conditions as the Phallic Symbol figurine discussed earlier. The setup included two halogen lights, a flood light, and an X-Rite ColorChecker Passport II. The photograph was edited in the same manner as described for the figurine in section 4.2.1.1.

Figure 27: Visible Light Photography of Schroda, Bird figurine. Photographed by author.

4.3.1.2 Infrared (IR)

The Bird Figurine (Figure 28) was photographed using the same process as the Phallic Symbol, yielding similar results. No evidence of variation in the clay composition or the presence of transparent pigments was present.

Figure 28: Infrared Photography of Schroda, Bird figurine. Photographed by author.

4.3.1.3 Ultraviolet Fluorescence (UVF)

While the light conditions were identical to those used for the previously analysed figurine, the Bird figurine did display some notable differences. As shown in Figure 29, there appears to be visible signs of repair to the artifact. This aligns with observations discussed in Chapter 3, where adhesive fluorescence is evident on both the neck and wing of the figurine. Additionally, similar specks, as noted on the Phallic Symbol, are visible. These may suggest the presence of fluorite (CaF_2).

Figure 29: Ultraviolet Photography of Schroda, Bird figurine. Photographed by author.

4.3.2 X-Ray Fluorescence Spectroscopy (XRF)

Figure 30: Locations of Handheld XRF analysis on the Bird figurine. Photographed and marked by author.

Non-destructive X-ray fluorescence spectroscopy (XRF) was performed on 16 target spots on the Bird figurine (Figure 30). These target areas were chosen based on visual inspection, similar to the approach used for the phallic symbol. Prominent regions with possible pigment and base clay were selected for analysis. The data presented in the tables (Table 3 & 4) and figure (Figure 31) below follow the same conventions for markings, including bold and italic text as well as colour codes, as described in section 4.2.2.

Table 3: Break-down of analysed XRF spots (as shown in Figure 30) showing; Location, Elements, and elements average.

Location	MgO	Al_2O_3	SiO_2	P	S	K_2O	Ca	Ti	Mn	Fe	Ba
B1	2,29	8,05	36,87	0,04	0,74	1,07	1,15	0,46	0,06	2,30	0,10
B2	2,55	1,79	19,37	0,08	0,27	0,70	0,89	0,16	0,04	1,62	0,07
B3	2,68	8,72	38,57	0,14	0,65	1,10	1,41	0,68	0,09	3,42	0,11
B4	2,02	1,76	11,57	0,06	0,13	0,42	0,49	< LOD	0,02	0,99	0,11
*B5**	*2,48*	*6,63*	*41,00*	*0,13*	*0,51*	*1,48*	*1,19*	*0,43*	*0,07*	*2,50*	*0,13*
B6	2,59	1,85	16,44	0,03	0,10	0,82	0,53	0,10	0,03	1,25	0,10
B7	2,40	7,05	32,98	0,25	0,91	1,15	1,56	0,37	0,06	2,85	0,10
B8	2,72	2,18	28,15	0,17	0,31	0,85	1,51	0,21	0,05	2,95	0,09
B9	2,09	5,21	28,93	0,07	0,27	1,05	0,97	0,21	0,04	1,92	0,10
B10	3,06	8,47	41,11	0,31	1,27	1,33	1,47	0,34	0,06	2,84	0,08
B11	3,37	2,36	22,92	0,16	0,17	0,84	1,07	0,20	0,03	1,75	0,07
B12	**3,93**	**4,59**	**46,05**	**0,25**	**1,49**	**1,22**	**3,28**	**0,33**	**0,08**	**5,03**	**0,10**
B13	2,19	6,82	38,29	0,34	2,22	1,22	1,33	0,37	0,05	2,48	0,09
B14	**2,51**	**12,33**	**47,64**	**0,21**	**0,53**	**1,76**	**1,35**	**0,86**	**0,10**	**3,79**	**0,16**
B15	2,41	7,53	33,64	0,09	0,23	1,12	1,00	0,42	0,06	2,35	0,13
B16	2,51	5,42	38,11	0,07	0,20	1,40	1,00	0,35	0,05	2,22	0,10
Average	2,61	5,67	32,60	0,15	0,62	1,10	1,26	0,37	0,05	2,25	0,10

<LOD= Limit of Detection

Table 4: Locations B5, B12 and B14 showing levels of Iron (Fe) and base clay detected on XRF spots (as show in Figure 30); Location, image, description, and percentage of Iron (Fe).

Location	Image	Description	%Fe
B5		**Base clay, this is used to compare the clean clay to that of higher iron (Fe) contents.**	**2.50**
B12		**Possibly hematite(∝-Fe_2O_3) due to red colour**	**5.03**
B14		**Possibly a hydrated ferric oxide, FeO(OH)(Yellow ochre)**	**3.79**

The elemental composition of the clay was consistent with that of the phallic symbol, revealing the presence of calcium (Ca), magnesium (Mg), titanium (Ti), iron (Fe), and aluminium (Al), as shown in Table 3. High levels of iron (Fe) were particularly notable in target spots B12 and B14, as indicated in Table 4. A comparison of the base clay found on spot B5, which is not to have an iron content of 2.50% compared to spots B12 (5.03%) and B14 (3.79%) suggests the presence of pigment on the figurine. The significant variation in iron content, particularly in spot B12, may indicate the presence of hematite (α-Fe_2O_3), commonly associated with red ochre, as seen in Table 4. The slightly lower iron content in spot B14 may suggests the presence of limonite (FeO(OH)), also known as yellow ochre, which is seen by the target area having a more orange hue. These findings suggest that ochre pigments are most likely present, as supported by the high iron content and photographic evidence visible in Table 4.

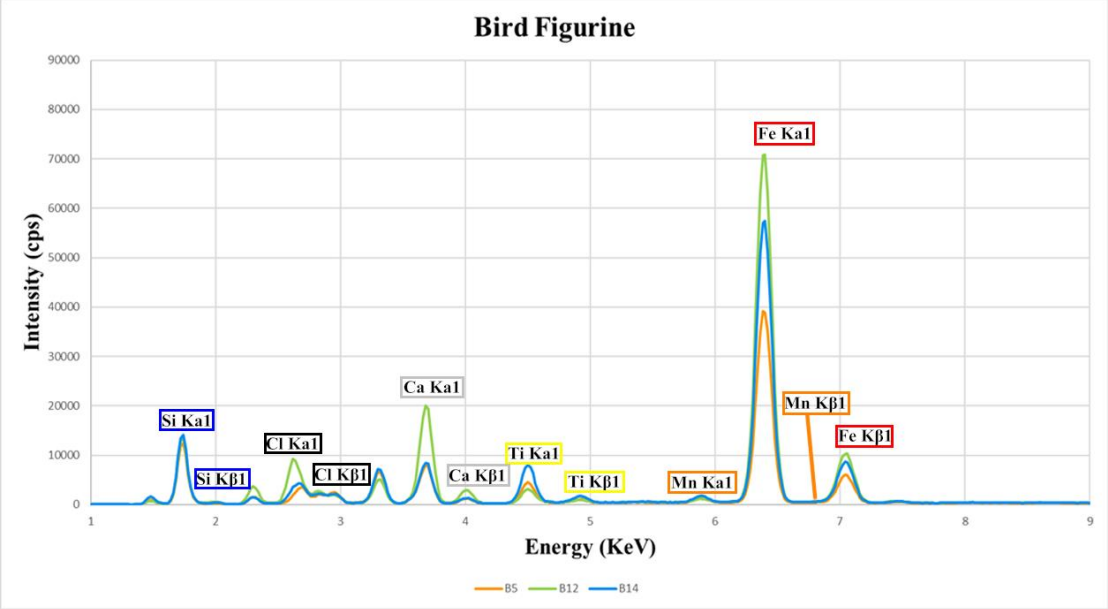


Figure 31: Elemental peaks of locations B5, B12 and B14 on Bird figurine.

4.3.3 Micro-XRF Scanning (µ-XRF)

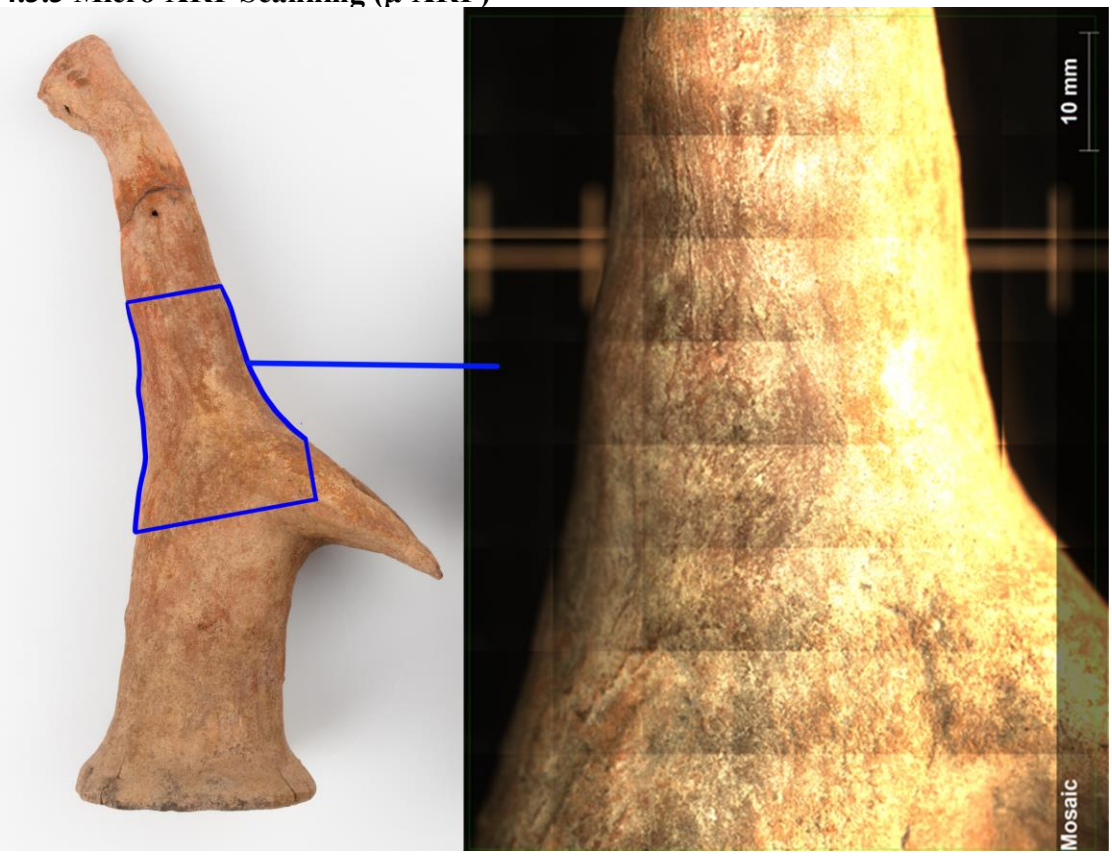


Figure 32: Location of Micro-XRF scan on Bird figurine. Bird figurine Photograph by author. Micro- XRF scan done by Liberty Kapesi for author, at University of Johannesburg.

Micro-XRF scanning was performed on a selected target area of the Bird figurine (Figure 32). The analysis revealed overlapping elemental compositions similar to those observed in the phallic symbol, including iron (Fe), aluminium (Al), silicon (Si), potassium (K), calcium (Ca), titanium (Ti), and manganese (Mn). The scanned area measured 70.5 x 53 mm, with spots analysed at intervals of 20 µm.

The analysis showed comparable element dispersion patterns to the phallic symbol. However, the concentration of iron was notably higher near the central neck area of the figurine, as seen in Figure 33. This area corresponds to target spot B14 (Table 4, Figure 30), which had already been identified as having significant amounts of ochre pigment, with an iron content of 3.79%. This alignment of high iron concentration in the µ-XRF map with the visual and elemental analysis of spot B14 (Table 4, Figure 30) further supports the hypothesis of ochre pigment presence on the Bird figurine.

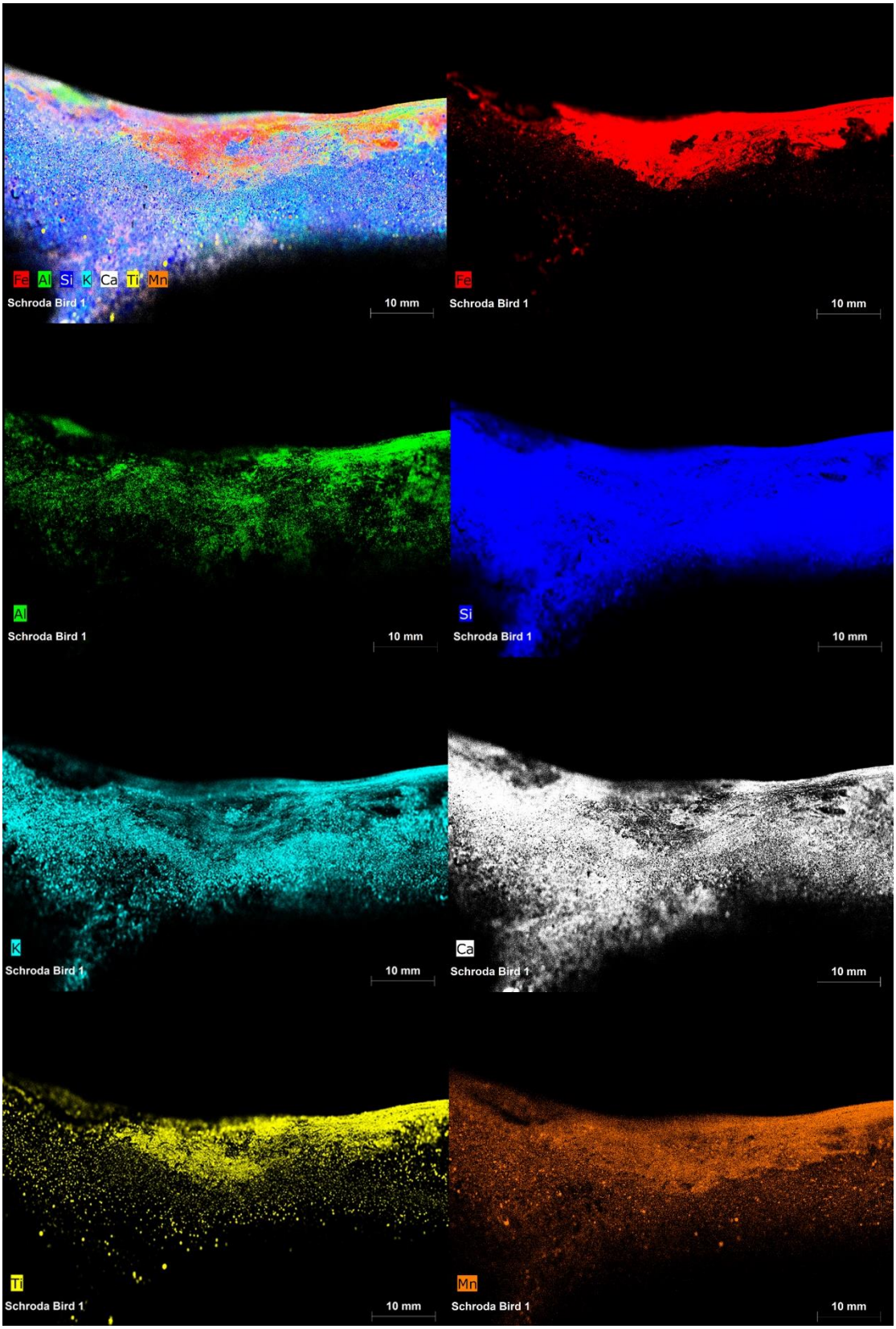


Figure 33: Colour coded elemental maps of Micro-XRF scan on Bird figurine. Scan done by Liberty Kapesi for author, at University of Johannesburg.

4.4 Giraffe Figurine (AD 900-1025)

4.4.1 Technical Photography

4.4.1.1 Visible Light

The Schroda giraffe figurine (Figure 34) was photographed under identical conditions to those used for the Phallic Symbol and bird figurine previously discussed. The setup featured two halogen lights, a floodlight, and an X-Rite ColorChecker Passport II. The photograph was processed using the same editing techniques outlined in Section 4.2.1.1.

Figure 34: Visible Light Photography of Schroda, Giraffe figurine. Photographed by author.

4.4.1.2 Infrared (IR)

The giraffe figurine (Figure 35) was photographed using the same lighting as the phallic symbol and bird figurine. Like the other two figurines, no visible signs of clay differences or transparent pigments were observed.

Figure 35: Infrared Photography of Schroda, Giraffe figurine. Photographed by author.

4.4.1.3 Ultraviolet Fluorescence (UVF)

Under the same lighting conditions used to examine the two figurines above, the Giraffe figurine (Figure 36) had similar results as the phallic symbol. There showed to be no signs of repair, unlike the bird figurine. Only traces of fluorite (CaF_2) appeared to be present.

Figure 36: Ultraviolet Photography of Schroda, Giraffe figurine. Photographed by author.

4.4.2 X-Ray Fluorescence Spectroscopy (XRF)

Figure 37: Locations of Handheld XRF analysis on the Giraffe figurine. Photographed and marked by author.

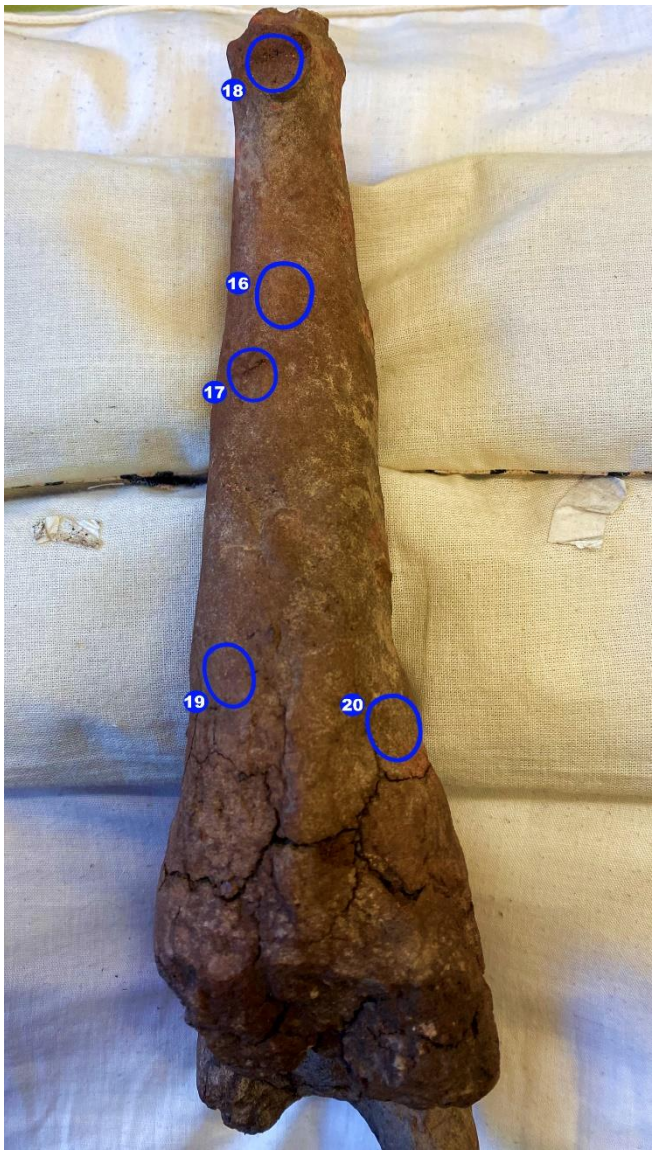


Figure 38: Locations of Handheld XRF analysis on the Giraffe figurine. Photographed and marked by author.

Non-destructive X-ray fluorescence spectroscopy (XRF) was performed on 20 target spots of the Schroda Giraffe figurine (Figure 37 & 38). As with the previously discussed figurines, the process of data presentation and the XRF results for the Giraffe figurine identified the same elements: calcium (Ca), magnesium (Mg), titanium (Ti), iron (Fe), and aluminium (Al), as shown in Table 5. The iron (Fe) levels in this figurine were notably high at specific target spots G6, G7, and G12. The base clay percentage of the figurine, seen on target spot G19 (3.21%), is relatively higher compared to the base clay content of the other two figurines. Furthermore, the iron levels at the high-reading iron spots on the Giraffe figurine are significantly higher than those found on the other figurines. The visible colour on the Giraffe figurine does also appear to have a more extensive coverage of ochre pigments compared to the other two figurines. Target spots

G6 (6.27%), G7 (4.74%), and G12 (4.96%), as shown in Table 6, display deep pigment coverage corresponding to their high iron content. These spots appear to consist predominantly of hematite (α-Fe_2O_3), a deep red ochre. These high levels of iron, as with the other two figurines, are indicators of the present of pigments.

Table 5: Break-down of analysed XRF spots (as shown in Figure 37 and 38) showing; Location, Elements, and elements average.

Location	MgO	Al_2O_3	SiO_2	P	S	K_2O	Ca	Ti	Mn	Fe	Ba
G1	1,48	19,68	46,03	0,11	0,45	2,07	1,14	0,63	0,09	2,67	0,17
G2	2,30	4,93	28,90	0,07	0,44	1,08	1,10	0,32	0,06	2,37	0,13
G3	2,11	2,02	15,74	0,06	0,21	0,42	0,67	0,08	0,03	1,40	0,13
G4	2,12	5,02	27,29	0,24	0,72	1,01	5,03	0,29	0,05	2,42	0,10
G5	2,77	7,06	29,33	0,05	0,40	0,96	1,17	0,47	0,07	3,02	0,13
G6	**2,50**	**11,48**	**40,23**	**0,10**	**0,52**	**1,27**	**1,30**	**0,65**	**0,09**	**6,27**	**0,13**
G7	**2,82**	**4,30**	**42,22**	**0,15**	**1,32**	**1,04**	**2,10**	**0,38**	**0,07**	**4,74**	**0,12**
G8	2,04	6,99	26,35	0,07	0,31	1,06	0,82	0,31	0,06	2,60	0,14
G9	2,25	4,46	28,88	0,10	0,47	0,95	1,32	0,24	0,05	2,61	0,08
G10	2,26	6,90	38,58	0,16	0,61	1,41	1,48	0,37	0,07	3,05	0,10
G11	3,41	5,15	41,05	0,30	1,16	1,55	2,09	0,34	0,06	3,65	0,12
G12	**2,56**	**10,61**	**34,53**	**0,12**	**0,62**	**1,81**	**1,44**	**0,68**	**0,07**	**4,96**	**0,09**
G13	1,94	2,39	17,97	0,04	0,02	0,66	0,49	0,14	0,03	1,36	0,09
G14	1,88	4,46	28,60	0,13	0,44	1,29	1,16	0,28	0,04	2,35	0,11
G15	2,13	8,52	44,60	0,11	0,21	1,75	1,33	0,43	0,05	3,11	0,11
G16	2,58	6,85	30,61	0,11	0,39	1,28	0,92	0,30	0,09	3,01	0,20
G17	2,46	3,41	23,00	0,04	0,16	1,04	0,76	0,15	0,04	1,70	0,19
G18	1,99	5,06	28,63	0,07	0,17	0,91	0,88	0,25	0,04	2,10	0,10
*G19**	*2,07*	*9,26*	*49,26*	*0,10*	*0,44*	*1,95*	*1,67*	*0,54*	*0,06*	*3,21*	*0,11*
G20	2,18	7,25	39,68	0,13	0,41	1,54	1,33	0,34	0,05	2,67	0,12
Average	2,29	6,79	33,07	0,11	0,47	1,25	1,41	0,36	0,06	2,68	0,12

<LOD= Limit of Detection

Table 6: Locations G6, G7, G12 and G19 showing levels of Iron (Fe) and base clay detected on XRF spots (as show in Figure 37 and 38); Location, image, description, and percentage of Iron (Fe).

Location	Image	Description	%Fe
G6		Clear strong red markings on Giraffe's rump, possibly hematite($\propto$-Fe_2O_3) due to red colour	6.27
G7		Possibly a hydrated ferric oxide, FeO(OH)(Yellow ochre)	4.74
G12		Possibly a hydrated ferric oxide, FeO(OH)(Yellow ochre)	4.96
G19		Base clay, this is used to compare the clean clay to that of higher iron (Fe) contents.	3.21

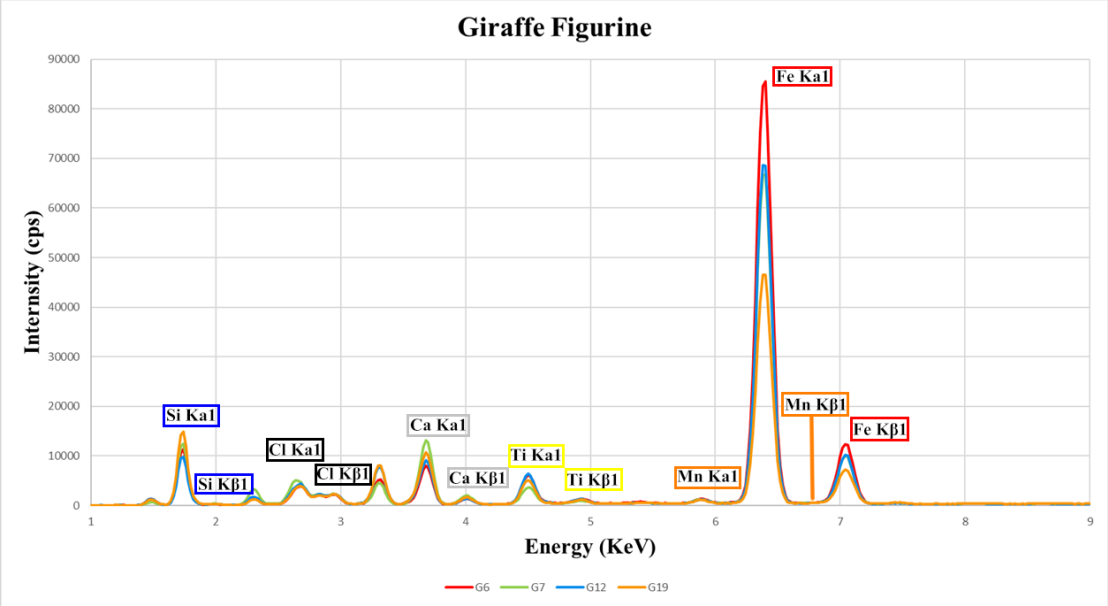


Figure 39: Elemental peaks of locations G6, G7, G12 and G19 on Giraffe figurine.

4.4.3 Micro-XRF Scanning (µ-XRF)

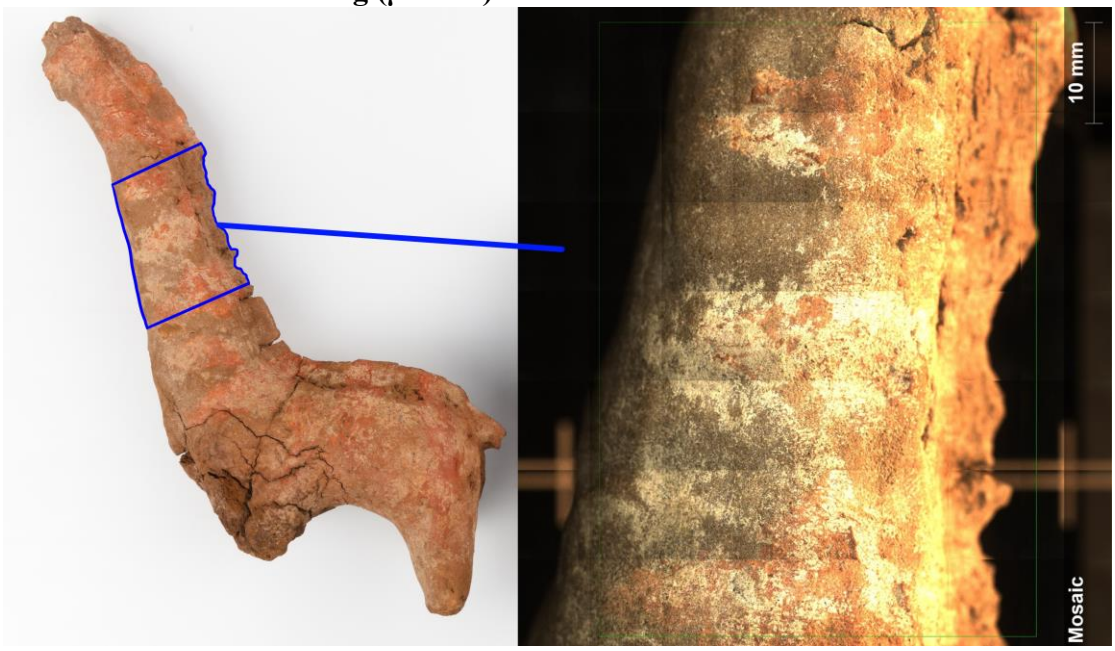


Figure 40: Location of Micro-XRF scan on Giraffe figurine. Giraffe figurine Photograph by author. Micro- XRF scan done by Liberty Kapesi for author, at University of Johannesburg.

Micro-XRF scanning was conducted on a selected area of the Giraffe figurine (Figure 40). The scanned region comprises overlapping, colour-coded elemental compositions (Figure 41) and contains the same elements as the previously analysed figurines, these including the elements: iron (Fe), aluminum (Al), silicon (Si), potassium (K), calcium (Ca), titanium (Ti), and manganese (Mn).

The target area, measuring 60.8 x 43.4 mm with spot intervals of 50 µm, was scanned at a higher resolution compared to the bird and phallic symbol figurines. However, this higher resolution did not significantly impact the results, so a lower resolution was used for the scans of the other two figurines. The scans revealed similar elemental distributions across all three figurines. The concentration of iron is relatively widespread, with solid red mapping visible in distinct areas, matching that of the Giraffe figurines spots (Figure 40). In contrast, the calcium content in the Giraffe figurine's mapping is significantly lower than that of the other two figurines. My hypothesis is that this difference may indicate the Giraffe figurine was produced in a different area of the site, using clay with a lower calcium content.

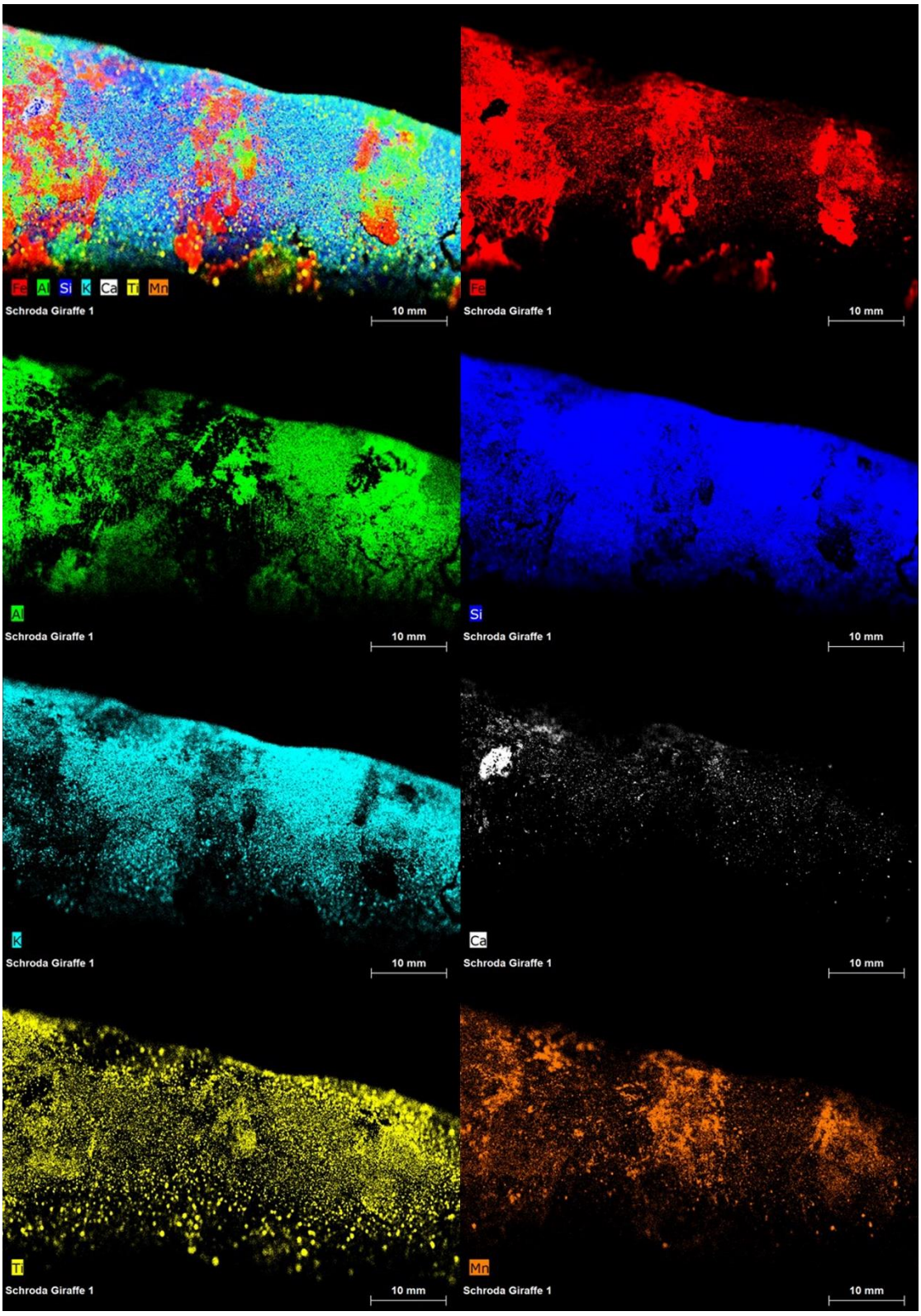


Figure 41: Colour coded elemental maps of Micro-XRF scan on Bird figurine. Scan done by Liberty Kapesi for author, at University of Johannesburg.

4.5 Chapter conclusion

In conclusion to this chapter, the analysis of the Phallic Symbol, Bird, and Giraffe figurines has provided insights into their possible polychrome traces. Through the combined application of technical photography, X-ray fluorescence spectroscopy (XRF), and Micro-XRF (µ-XRF) scanning, this study has identified significant evidence of these artefacts containing ochre pigments, primarily iron-based, on all three figurines. Visible light photography revealed surface and pigment details that were not visible to the naked eye. Whereas ultraviolet fluorescent photography, although limited in its results, revealed traces of potential fluorite present in the clay. Visible light photography was effective in highlighting the ochre pigments found on the figurines. X-ray Fluorescence spectroscopy analysis confirmed the presence of high levels of iron in the figurines this suggesting the use of both red and yellow ochre pigments. The higher iron concentrations in specific areas, particularly on the Giraffe figurine, indicate more extensive pigment use compared to the other figurines.

Micro-XRF scanning provided a detailed visual representation of the distribution of the various elements found on the figurines through colourful layered elemental maps. These maps reinforce the high concentrations of iron (Fe) observed using XRF and their relation to the presence of ochre pigments found on the figurines. The use of Micro-XRF has also helped reveal the differences in the material composition across the figurines. Notably, the Giraffe figurine exhibited lower calcium content than the others, suggesting the potential use of distinct clay sources. Together, these analyses present a comprehensive understanding of the materials and techniques used in creating these culturally significant artefacts.

Chapter Five: Conclusion

This study set out to address the primary question of whether any residual polychrome residues could be identified on the Schroda clay figurines. The reason for choosing to study these figurines was due to there being limited research conducted on Schroda as an archaeological site and, more specifically, on the figurines themselves. Despite their significant cultural and symbolic value, much about their material composition and artistic techniques remains underexplored. This research aimed to determine whether traces of pigments were present on the figurines. The results of this study could help provide valuable insights into the symbolic meanings, cultural practices, and artistic methods of the Schroda inhabitants, offering a deeper understanding of their society and its connection to broader regional traditions. This further broadening the limited knowledge known about Schroda.

5.1 Summary of Chapters

Chapter one provided a brief summary of what the study entails and its significance The aims and objectives of the work were discussed, along with a brief explanation of the systematic techniques used in the study. This chapter also established the context of Schroda by exploring its archaeological importance, demonstrating how the site has been pivotal for understanding the sociopolitical, economic, and cultural evolution of southern African societies. The discussion included a background on Schroda's figurines, emphasising their ritualistic and metallurgical significance and symbolic connections to initiation rites, fertility ceremonies, political authority, and gender roles. Furthermore, the meaning of colour in these figurines was briefly explored with the limited available literature relating to colour symbolism on Schroda figurines.

Chapter Two focused on the investigative and analytical methodologies applied to the study of the Schroda figurines. Each methodological approach was clearly defined and discussed, supported by relevant literature. The chapter also detailed the processes and equipment utilised in the investigation, offering a structured explanation of the analytical approach and examination of the figurines.

Chapter Three was centred on the visual examination and documentation of the three selected Schroda figurines. The visual examinations were completed first in which the empirical details and object description of each figurine were explained and listed. The condition of the figurines was then assessed in which selected spots consisting of signs of damage were observed during the visual inspection and discussed, with particular emphasis on adhesive repairs visible under ultraviolet fluorescence photography, as noted on the bird figurine. The presence of written tags on each figurine was also briefly explained, providing additional context to the documentation process.

Chapter Four investigated the presence of polychrome traces on the figurines and examined the composition of the detected pigments. This chapter applied the analytical methodologies introduced in Chapter Two, including technical photography techniques such as visible light, infrared, and ultraviolet fluorescence photography, to identify visual differences and potential signs of polychrome. X-ray fluorescence spectroscopy and Micro-XRF scanning were also used, and spot analyses of areas showing visible colouration and suspected pigment residues were analysed. These methods resulted in the identification of elemental compositions, in which they corresponded to traces of iron-based pigments.

It was thus definitively confirmed that iron pigments were present on the figurines.

5.2 Contribution of Study

This dissertation contributed to the understanding of polychrome traces on the Schroda figurines, further broadening the knowledge of both the site and its material culture. Through a combination of investigative and analytical approaches, traces of polychrome were identified on the figurines, providing insights into their composition. Visual inspection revealed variations in colour hues on the figurines, suggesting deliberate application of different pigments. Advanced analytical techniques, including X-ray fluorescence spectroscopy and Micro-XRF scanning, confirmed that the pigments contained high concentrations of iron (Fe), indicating the use of materials were consistent with the Iron Age period, such as red ochre (hematite), yellow ochre (limonite), and magnetite. Additionally, the analysis detected lower levels of calcium on the giraffe figurine, which may point to it being sculpted using a different clay source on the site.

5.3 Suggestions for further research

Iron pigments that were consistent at the time were identified on the figurines, yet unfortunately, XRF cannot distinguish different iron phases, such as limonite, magnetite and haematite. An interesting further study would be to get permission for micro sampling and executing X-ray powder diffraction on these samples to identify the mineral composition or get access to an in-situ XRD, of which there is currently none in Southern Africa. Although transporting artefacts this valuable abroad would be an insurance and bureaucratic nightmare! An alternative approach could be to salvage sacrificial sherds with clear polychrome traces from the remaining Schroda collection and use them as samples for further analyses. Going to the Schroda site itself would also provide a good understanding of the composition of the clay figurines. Clay samples from different areas on the site could be used for analysis comparison and answer whether the figurines were made from different clay sources around the site, this could contribute to the understanding of the Giraffe figurine having lower levels of Calcium(Ca).

In this study, it was fortuitous that the iron pigments were clearly visible and thick enough for analyses when often-practised excavation procedures were considered. Often, when excavated, the materials are cleaned by scrubbing, which could remove pigment traces from the surface. In the condition reports, abrasion marks were mentioned, which probably proves this treatment. As a future study, standard excavation practises should be revisited, especially with the possibility of applying modern analytical techniques.

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APPENDICES

Appendix A: Letter requesting research access and permission and consent

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

School of the Arts
Tangible Heritage Conservation

28 May 2024

Letter requesting research access and permission

Dear Sir/Madam

You are herewith invited to participate in a Masters mini dissertation by Adrién Diamond for the requirements of the MSocSci Heritage and Cultural Sciences; Heritage Conservation at the University of Pretoria. The study is provisionally titled : *Searching for colour: Exploring polychrome traces on archaeological animal figurines.*

The research aims to determine whether the Schroda figurines have polychrome surfaces.

Permission is requested for visual analysis, technical photography and X-Ray Fluorescence Spectroscopy (XRF) of the clay Schroda figurines from the 10th century in the DITSONG: National Museum of Cultural History collection. The visual analysis includes thorough visual documentation and USB microscope imaging, the technical photography includes visible light, ultraviolet light and infrared light imaging, and the XRF analysis is non-invasive and non-destructive in nature.

Any questions you may have about this study can be directed to Adrién Diamond at 0793913213 or U19201992@tuks.co.za or the dissertation supervisor Maggi Loubser at 0829228184 or maggi.loubser@up.ac.za

Regards

Adrién Diamond

Maggi Loubser

Page 1 of 2

SCHOOL OF THE ARTS
UNIVERSITY OF PRETORIA
FACULTY OF HUMANITIES

Research Consent Form

Statement of voluntary consent:

When signing this form, I am agreeing to voluntarily participate in the research entitle *Searching for colour: Exploring polychrome traces on archaeological animal figurines.*
I have had a chance to read this consent form, and it was explained to me in a language which I understand. I have had the opportunity to ask questions and have received satisfactory answers. I understand that participation is voluntary, unremunerated and that I can choose to opt out, or withdraw at a later stage even if I initially opted in. By signing this form I also agree that data generated during the research process will be kept at the School of the Arts, at the University of Pretoria for 15 years and can be accessed by requesting permission from the researcher or the dissertation supervisor.

Opting in (Circle which is appropriate): YES/NO

Signature of participant:.....
Print name:.....Frank Teichert.....
Capacity:.....Curator Ditsong Museums of South Africa.....
Date:.....04/06/2024.....
Place:.....Pretoria.....

By signing below, I indicate that the participant has read and, to the best of my knowledge, understands the details contained in this document and has been given a copy.

Signature of researcher:.....
Print name:.....Adrién Diamond
Date: 04/06/2024
Place: Pretoria

Appendix B: MOU Ditsong

MEMORANDUM OF UNDERSTANDING

IN RE: INTANGIBLE HERITAGE CONSERVATION MASTER'S PROGRAMME

entered into by and between

CONSTITUTIONAL COURT TRUST

Trust no. 3836/95, NPO-004-997, PBO no. 930003141

duly represented by Catherine Kennedy (ex officio)

in her capacity as Trust Manager of Constitutional Court Trust

(hereinafter referred to as "CCT")

and

UNIVERSITY OF PRETORIA

duly represented by Professor Alexander Johnson (ex officio) in his capacity as the Head of the School of the Arts at the University of Pretoria

(hereinafter referred to as "UP")

(hereinafter collectively referred to as the "Parties" and individually the "Party" as the context may indicate)

1

TABLE OF CONTENTS

PREAMBLE

- The University of Pretoria and CCT hereby wish to formally record a memorandum of understanding as reached by the Parties regarding a collaboration that will lead to future cooperation and future projects related to art conservation.
- The purpose of this Memorandum of Understanding is to set out the basic principles according to which the Parties wish to conduct their future discussions to enter into formal agreements on a project-by-project basis.
- The Parties record that in leading to the formal agreements, they will act in good faith and endeavour to finalise the agreements as soon as possible.

1. PARTIES

This Memorandum of Understanding ("MOU") is entered into between CCT, duly represented by Catherine Kennedy in her capacity as manager of the Constitutional Court Trust, and the UP, duly represented by Prof Alexander Johnson, in his capacity as Head of the School of Arts. The agreement is ultimately between the CCT and UP and will continue even if individual function bearers should not be employed at these organisations in the future.

2. INTERPRETATION

For the purposes of this MOU, unless inconsistent with or otherwise indicated by the context:

2.1. The singular includes the plural and *vice versa*;

2.2. The headings in this MOU are for convenience only and are not to be taken into account when interpreting this MOU;

2.3. The words "include" and "including without limitation" followed by a specific example or examples, shall not be construed as limiting the general wording preceding it;

2.4. Any substantive provision, conferring rights or imposing obligations on a Party and appearing in any of the definitions in clause 3 or elsewhere in this MOU, shall be given effect to as it were a substantive provision in the body of this MOU;

2.5. Words and expressions defined in any clause or an annexure to this MOU shall, unless the application of any such word or expression is specifically limited to that clause, bear the meaning assigned to such word or expression throughout this MOU;

2.6. Unless otherwise provided, defined acronyms or abbreviations appearing in this MOU in upper case shall be given their meaning as defined, while the same words appearing in lower case shall be interpreted in accordance with their plain English

meaning;

2.7. A reference to any statutory enactment shall be construed as a reference to that enactment as at the signature date and as amended or substituted from time to time;

2.8. In this MOU, the words "clause" or "annexure" refer to clauses and annexures to this MOU;

2.9. Natural persons include juristic persons such as entities (corporate or non-corporate) and the State and *vice-versa*;

2.10. In the event any of the provisions of this MOU are found to be invalid, unlawful or unenforceable, such provisions shall be severable from the remaining provisions, which will continue to be valid and enforceable; and

2.11. The MOU shall be regulated by, and interpreted according to the laws of the Republic of South Africa.

3. DEFINITIONS/ABBREVIATIONS

Unless inconsistent with the context, the abbreviations and terms set out below will bear the following meanings and similar expressions will bear corresponding meanings:

3.1. "Addendum" means a document that is used to record details of any project-specific additions to this MOU;

3.2. "Day" means any day other than a Saturday, Sunday or official public holiday in the Republic of South Africa;

3.3. "Know-how" means all ideas, designs, documents, diagrams, information, devices and methods used in connection with the Party's business, information regarding marketing and promotion of its business, as well as any and all modifications or improvements to any of them, which do not constitute entirely new services or products. Know-how that is in the public domain on the effective date through no act or omission by a Party, is excluded from this definition;

3.4. "MOU" means this Memorandum of Understanding which constitutes the whole agreement between the Parties;

3.5. "Governance Committee" means the committee referred to in clause 9.

3.6. "Signature date" means the date of the signature of the Party last signing this MOU.

4. OBJECTIVES OF THE MOU

4.1. The objectives of this MOU are *inter alia*:

4.1.1. To advance the notion of collaboration between the Parties;

4.1.2. To jointly implement art conservation projects as identified and agreed upon by both Parties;

4.1.3. To assist the University to provide practical experience to its students in the Tangible Heritage Conservation Masters programme;

4.1.4. To assist CCT with skills related to conservation and making UP experts in this field available to CCT, including for the purposes of skills training, as may be mutually agreed upon.

5. CO-OPERATION AND GOOD FAITH

5.1 The Parties undertake to do all things, perform all such acts as may be necessary or incidental to give or conducive to the giving of effect to the terms and conditions and import of this MOU.

5.2 The Parties shall at all times during the currency of this MOU observe principles of good faith towards one another in the performance of its obligations in terms of this MOU. To this end and without limiting the generality of the aforegoing the Parties shall:

5.2.1 At all times during the term of this agreement co-operate reasonably, honestly and in good faith;

5.2.2 Perform their obligations arising from this agreement diligently and with reasonable care; and

5.2.3 Make full disclosure to each of any matter that may affect the execution of this MOU.

6. EFFECT OF UNDERTAKING

The Parties hereby wish to record that this MOU:

6.1 Does constitute a framework document to assist the Parties in reaching agreements in future; and

6.2 Does not constitute an agreement in any way through which any form of separate legal entity is created or the current identity of the Parties is changed or affected in any way.

7. DURATION OF THE MEMORANDUM OF UNDERSTANDING

7.1. This MOU commences on the Signature date and endures for a period of 5 years, to be reviewed annually.

7.2. The MOU may be terminated by any of the Parties by giving 90 days' notice by a Party in writing.

8. PRINCIPLES OF COLLABORATION

The Parties undertake:

8.1. To act in good faith.

8.2. To give their full cooperation in the implementation of this MOU.

8.3. To ensure an equitable relationship.

8.4. To recognise their distinctive roles and independence.

8.5 To give each other a minimum of 3 months lead-time in advance of proposed projects, for planning and sourcing of necessary organisational approvals.

9. JOINT OBLIGATIONS OF THE PARTIES

9.1. The Parties undertake to:

9.1.1. Establish a Governance Committee that will govern the execution of this MOU. It shall meet at least once every year, noting that email exchange may also constitute such meetings if all matters requiring attention can be sufficiently addressed in writing. The Governance Committee shall comprise:

9.1.1.1. The Trust manager of the CCT (ex officio);

9.1.1.2. Members of the Constitutional Court Art Collection (CCAC) curatorial team, as nominated by the CCT, normally being Curator(s) working on the CCAC (ex officio);

9.1.1.3. The Heads of the School or Department that are part of the collaboration (ex officio);

9.1.1.4. Isabelle McGinn as Tangible Heritage Conservation Master's programme representative, or another lecturer of this programme as nominated by UP (ex officio);

9.1.1.5. Any other members nominated at the discretion of the Governance Committee.

9.1.2. Specific collaborative project agreements will serve as addenda to this MOU.

9.1.3. Each Party will designate a person responsible for coordinating the cooperation under this MOU. The coordinators shall meet as may be necessary to facilitate, monitor and report on the cooperation under this MOU.

9.1.4. Each Party shall for the duration of this MOU ensure that it has sufficient insurance over its respective collections and activities.

9.1.5. While this MOU seeks to establish collaboration that can be reported on as in-kind sponsorship, some monetary expenses may arise for the execution of specific projects. Any and all expenses should be noted in the project plan and the

responsibility of payment must be determined by the Parties.

10. AREAS OF COLLABORATION

10.1. The collaborative areas include, but are not limited to:

10.1.1 The use of CCT's artworks collection and related archival records for practical and hands-on sessions for both preventive and remedial conservation. The terms to be defined in the project specific agreements;

10.1.2 The use of CCT's art collection and related archival records for art conservation research activities by UP staff and students;

10.1.3 The arrangement of long-term loans to transport artworks to the UP campus for supervised treatments. This arrangement will be set out in a separate loan agreement to be concluded between the Parties;

10.1.4 Publication of research outputs on CCT's art collection in in-house and/or external publications with recognition of each Party's contribution to the paper or project;

10.1.5 Youth development workshops for the CCT's curatorial team members with UP appointed heritage conservation staff and graduates;

11. INTELLECTUAL PROPERTY RIGHTS

11.1. The ownership of and rights in and to any intellectual property owned by any Party prior to the Signature date, shall be and remain vested in such Party.

11.2. Should the collaboration on any projects envisaged in this MOU result in the creation of any intellectual property, the Parties agree that the treatment of such intellectual property shall be governed by the provisions of the specific agreements entered into for the pursuance of such specific project.

12. CONFIDENTIALITY

12.1 No information of a confidential nature, which the other Party may acquire during the duration of this MOU, may be disclosed by such Party to any unauthorised person, whether before or after the termination of this MOU, without the prior written authority of the Party concerned.

12.2 The Parties agree to hold each other's confidential information in the strictest of confidence and not to make use thereof other than for the performance of its obligations in terms of this MOU.

13. DISPUTE RESOLUTION

13.1 Any dispute resulting from this MOU shall be resolved by means of joint-co-operation or discussions between the individuals directly involved with the execution of this

MOU, within one week after a dispute arises or such an extended time period as the Parties may agree.

13.2 If the Parties are unable to resolve any dispute in terms of clause 13.1 above, then such dispute shall first be submitted to independent mediation and if the Parties are unable to resolve the dispute to arbitration to be paid for jointly and equally between the Parties.

14. WHOLE AGREEMENT

14.1 This MOU constitutes the whole agreement between the Parties.

14.2 No amendments to this MOU will be binding on the Parties unless put to writing, signed by the Parties and attached to this MOU as an Addendum.

15. TRADEMARKS

Neither Party, both during the currency and after termination of this MOU, shall use the other Party's brand name and/or any trademark, logo, slogan, insignia or emblem connected to or used by the other Party, without the prior written approval of the other Party, nor shall any of the Parties engage in any action or conduct whatsoever that might in any way affect or prejudice the other Party's rights in such Party's reputation, brand name and/or any trademark, logo, slogan, insignia or emblem connected to or used by the other Party.

16. COSTS OF IMPLEMENTATION OF MOU

Unless otherwise agreed to in writing each Party will be responsible for its own costs relating to the implementation of this MOU.

17. NOTICES AND DOMICILIA CITANDI ET EXECUTANDI

The Parties choose as their *domicilia citandi et executandi* for all purposes under this MOU, whether in respect of court processes, notices or other documents or communications, the following addresses:

17.1 In the case of the CCT:

Physical Address:

Constitutional Court of South Africa
Constitution Hill
1 Hospital Street
Braamfontein
2017
Attention of: Constitutional Court Trust Manager
Or via email: trust@concourt.org.za

17.2 In the case of UP:

Physical Address:
Room 4-23
Administration Building
Hatfield Campus
Lynnwood Road, Pretoria
Attention of The Registrar

18. SIGNATORIES

SIGNED AT Johannesburg ON THIS 25th DAY OF July 20 23

by Catherine Kennedy (ex officio) for and on behalf of the CCT, duly authorised thereto:

Signature

Witness 1: Witness 2:

SIGNED AT **Pretoria** ON THIS **25** DAY OF **July** 20 **23**

by **Alexander Johnson** (ex officio) for and on behalf of UP, duly authorised thereto:

Signature

Witness 1: Witness 2:

Addendum A

Project agreement template (to be adapted as required)

Project title
Document date
Version:

This project agreement is made subject and in addition to the MOU (dated XX/XX/20XX) between the Constitutional Court Trust (CCT) and the University of Pretoria (UP), in relation to the latter's Tangible Heritage Conservation Master's programme and the CCT's work in caring for the Constitutional Court Art Collection (CCAC).

1. Descriptive project plan:	
2. Duration of project and timeline of deliverables:	
3. Roleplayers and responsibilities:	
4. Project budget, funding (monetary and in-kind) and payments:	
5. Credit and intellectual property:	
6. Record-keeping, documentation and reporting:	
7. Insurance:	
8. Additional notes and stipulations:	

Appendix C: Ditsong Research Application form

DITSONG
MUSEUMS OF SOUTH AFRICA
an agency of the Department of Arts and Culture

PO Box 413, Pretoria 0001, Republic of South Africa
432 Paul Kruger Street, Pretoria Tel: 012 492 5708

DNMCH research application form

Name of Researcher: Adrién Diamond/Salome le Roux/Maggi Loubser

Name of the Institution:. Heritage Conservation, University of Pretoria

Collection to visit:. Schroda Figurines

Provide a short description with references of why you require access to the collection (250 words, 10 references max):

- To use technical analysis to identify and reveal faded pigments on the Schroda figurines.
- To determine whether polychrome can be identified on the figurines using different photographic techniques.
- To use a small sample size of figurines most likely to be pigmented, for the technical analysis.
- To Contrast different photographic techniques and determine what each of them reveals.
- To use XRF to identify pigments on the figurines and compare the results with those of the imaging techniques.

References

- Antonites, A.R. 2016. Zhizo and Leokwe period human remains and burial practices at Schroda. The South African Archaeological Bulletin. 71 (203): 14-26.
- Antonites, A.R. 2020. Cooking, Serving, and Storage: ceramic vessel function and use contexts at Schroda. Africa Archaeological Review. 37: 251–270.

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- Schreiner, M., Weisinge, R., Vetter, W. 2017. Identification and Preservation of Cultural Heritage.Available.https://www.chemistryviews.org/details/ezine/9610631/Identification_and_Preservation_of_Cultural_Heritage.html [2022, March 3]

Indicate what part of the collection you require access to:

Figurines

Briefly describe the method/techniques you wish to employ in your use of the collection:

XRF Spectroscopy

Technical Photography

What dates do you wish to access the collection?

To be decided

What infrastructure requirements are you expecting?

None

Frank Teichert

Visit approved by **Date: 04/06/2024**