

# Red Ladies of Clay: identifying colour in Neolithic figurines from Knossos using non-invasive methods

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*ABSTRACT - Colour and decoration were prominent features of Neolithic figurines. However, many such details and colours have faded over time, and it is only on close inspection that traces of colour are visible. This paper presents the innovative application to figurines of a technique based on the treatment of images with DStretch, a valuable tool for recovering the visualization of faded pigments in clay figurines examined from Knossos. The method has the potential to illuminate aspects such as gender, age, status, identity or group affiliation through the study of colour in Prehistoric figurines.*

**KEY WORDS** – *Neolithic figurines; Greece; pigment detection; colour*

## **Rdeče dame iz gline: določanje barv na neolitskih figuricah s Knososa s pomočjo neinvazivnih metod**

*IZVLEČEK - Barva in okras sta bili pomembni značilnosti neolitskih figurin. Številni detajli in barve so sčasoma zbledeli in le ob natančnem pregledu so sledi barve še vidne. V članku predstavljamo inovativno uporabo tehnike, ki temelji na obdelavi slik z DStretch orodjem za obnovitev vidnosti obledelih pigmentov na glinenih figurinah s Knososa. Metoda s pomočjo preučevanja barv na prazgodovinskih figurinah pomaga pri pojasnjevanju različnih vidikov, kot so spol, starost, status, identiteta ali skupinska pripadnost.*

**KLJUČNE BESEDE** – *neolitske figurice; Grčija; odkrivanje pigmentov; barva*

### **Introduction**

Colour and decoration were prominent features of Neolithic figurines. However, too often we are robbed of that perception since most publications consist of black and white photos or simplified drawings that usually fail to convey essential decorative details. Although many such details and colours have also faded over time, we know, for instance, that many marble Bronze Age Cycladic figurines or Classical Greek sculptures were painted with bright colours, and it is only on close inspection that traces of these are

visible (Birtacha 2017). From a visual perspective, such painting made figurines radically different from the pure white Cycladic figurines that we have in our imaginary. This probably also occurs with figurines in clay from Neolithic Knossos, Crete, on which the paint has faded. Colour and decoration tell us about different aesthetics and, importantly, about past identities too. Colour and decoration must thus be an integral part of any archaeological study of Prehistoric figurines since they may reflect aspects such as gender, age,

status, identity or group affiliation. More specifically, the study of colour on figurines from Neolithic Greece may help us understand ancient clothing and body ornamentation, elements that could not be studied otherwise as no such archaeological remains are preserved.

The use of colour for the decoration of figurines is known from Prehistoric so-called 'Venus' figurines painted with red ochre or hematite, for instance, the 'Venuses' from Mauern, the Grimaldi Caves, Willendorf and Laussel (*Petru 2006.206*). However, the topic of colour has been understudied and undertheorized in Neolithic figurine research, mainly due to the difficulty of identifying colour traces on the figurines but also the consideration of colour as simply having a decorative purpose (*Ucko 1968; Hourmouziadis 1973; Talalay 1993*), and the problematic classification and objective interpretation of any decoration (*Ucko 1968.329–333; Talalay 1993.70*). Therefore, decoration and colour are commonly interpreted as 'decorative' with no other purposes, forgetting that they may have other meanings beyond the purely aesthetic, perhaps expressing cultural conceptions and practices involving gender and age identities. Colour in itself has not been widely studied in Aegean Neolithic figurines and those studies that have been carried out (*Talalay 1993; Mina 2008; 2014*) have addressed the use of the same colour palette to decorate Neolithic pottery and figurines in the Peloponnese, which may attest to a similar symbolic use of colour (*Talalay 1993.35*), and the relationship between gender, colour and symbolism in Neolithic figurines from the Aegean (*Mina 2008; 2014*). Body marks on figurine's bodies may reproduce real marks and have been mainly interpreted as depicting: body painting, tattooing or scarification, clothing, and jewellery (*Ucko 1968; Talalay 1993; Mina 2008; 2014*).

The known repertoire of pigments used to decorate figurines throughout the Aegean Neolithic are black, white, red, purple, yellow, red-on-white, white-on-red, brown, brown-on-buff, pink and grey; and, additionally, blue and green from the Final Neolithic (*Mina 2008.126*). In the assemblage of figurines from Neolithic Crete, the most widely used pigments are red, yellow, white paste and red-on-white. Black is only reported for rendering hair in a figurine from Knossos (*Mina 2008.126*), but not for bodily decoration. According to Peter Ucko (*1968*) and Mina (*2008.126*), the figurine makers preferred white paint over red paint on the figurines from Knossos. However,

during my study of the Ashmolean Museum material, slight traces of red paint were found on some figurines undetected in previous studies, and more may be identified in the future.

The techniques used so far for the identification of pigments on figurines, particularly on Cycladic ones, are low-power magnification, computer-enhanced photographs to heighten the contrast between painted and unpainted areas and ultraviolet-reflectance photography (*Hendrix 1998; 2003*). This article presents the examination of paint and decoration on figurines from Neolithic Crete, focusing on the site of Knossos, by analysing high-resolution photography of the figurines processed with DStretch (<https://www.dstretch.com/>), a tool that has been widely used for rock art but not for figurines. These results are then compared with personal inspection of the originals.

### Neolithic figurines from Knossos, Crete

The site of Knossos is located 8km inland from the northern coast of the island of Crete. It was first excavated between 1900 and 1905 by Sir Arthur Evans, assisted by Duncan Mackenzie. The published corpus of Neolithic anthropomorphic figurines from Knossos consists of 113 examples, of which 63 were found during A. Evans' excavations (*Evans 1904; 1921; 1928; 1939*). The figurines from A. Evans' excavations were published succinctly without precise contextual data. In the later excavations directed by John D. Evans (*1964*) between 1958 and 1970, another 50 figurines were found, as published in a detailed monograph by Ucko (*1968*). The contextual information in this excavation is well documented, although not all the material recovered from excavations at Knossos has been published. For instance, a few figurines from A. Evans' early excavations at Knossos kept in the Stratigraphical Museum are not yet published and could not be studied. Nikos Efstratiou *et al.* (*2013.43*) also mention the finding of figurines in their excavation at Knossos, but there were not many of these due to the limited extent of the excavation, and unfortunately, they have yet to be published.

It is noteworthy that most figurines found in Crete come from Knossos (Fig. 1), which is the main and most long-settled Neolithic site known on the island, covering the whole sequence of the Neolithic period from the Aceramic or Initial Neolithic to the Final Neolithic (c. 7000–3500 BC). Other Cretan sites with figurines are Kato Ierapetra, Phaistos, Gortyna, Ge-

rani cave and Spelαιο Pelekiton (Fig. 1), while three further figurines come from unknown sites. Unfortunately, the contextual data at Neolithic Knossos is scarce regarding the figurines' findspots and other associated objects from A. Evans' excavations, as he noted only some of the figurines found in his excavation diaries and divided the strata mainly into Neolithic and Sub-Neolithic phases (Final Neolithic/Early Minoan transition). However, J. D. Evans' (1964, 60, 238) excavations suggest that the Late Neolithic was the period with most figurine production, and their deposition in pits and contexts was interpreted by J. D. Evans as habitation debris. In Middle Neolithic contexts, figurines are particularly associated with broken bowls smashed *in situ* or with the base missing, which may suggest that the figurines were associated with feasting and drinking rituals (Ramirez-Valiente 2022). In Late Neolithic contexts, figurines are associated with polished and chipped stone tools: maces, axes, chisels, obsidian and chert tools, animal figurines, bone implements and clay objects, suggesting a change in their symbolism and use (Ramirez-Valiente 2022).

Of those found on Crete, 31 figurines are decorated or painted (22%), including five clay fragments that cannot be securely identified as parts of figurines (Evans 1964, Fig. 60, 2–3, 5–6, 14). Most decorated figurines were found at Knossos, except for one figurine found in Ierapetra (Accession Number AMH.249). Paint mainly survives as the filling of incisions and impressions in 13 examples. In three figurines, white paste and red pigment did not accompany incisions or impressions, and only colour decoration was applied.

## Methodology

To assess the presence of painting requires careful handling of the figurines and high-resolution photo-

graphs. The use of specific techniques like Multi-spectral Photography (MP), which uses different light spectra (e.g., daylight, infrared and ultraviolet) and the Decorrelation stretch (DStretch®) enhancement plug-in are helpful tools to bring out the remains of any pigment.

DStretch can bring out faint pigments on surfaces that are invisible to the naked eye. This plug-in was developed by Jon Harman in 2005, and it is a widely used tool for the study of rock art to enhance the visualization of colour in images taken from a digital camera. The enhancement of the images works by increasing differences in hue on photographs using the DStretch plug-in in the program ImageJ®. This method involves breaking down the original image into RGB bands and the application of a series of mathematical operations (using a decorrelation algorithm) on the quantitative information that the image contains (Quesada-Martínez 2008–2010). Harman warns that the enhanced image is a false colour one, meaning that the resulting colours may be radically different from the original ([www.dstretch.com/AlgorithmDescription.html](http://www.dstretch.com/AlgorithmDescription.html)). Despite this, the resulting image enables the visualization of motifs that were otherwise impossible or very difficult to notice with the human eye, and it also allows the distinction between different superimpositions and types of pigments used (Fraile et al. 2016). However, this tool also includes ways of manipulating false colour images. Therefore, this enhancement technique proves more useful than the traditional computer-enhanced modification of the hue and saturation of the images.

DStretch may also prove helpful for visualizing preserved pigments that are not visible or very faint in figurines, pottery and other surfaces, and has produced some excellent results. However, this tool has not been applied to figurines, except for three examples from Koutroulou Magoula in Costas Papadopoulos *et al.* (2019). This paper will demonstrate the usefulness of this technique for identifying the remaining pigments in a group of figurines from Knossos, Crete, for which high-resolution images were available, in order to enhance the perception of pigments present on the figurines that are barely visible to the naked eye.

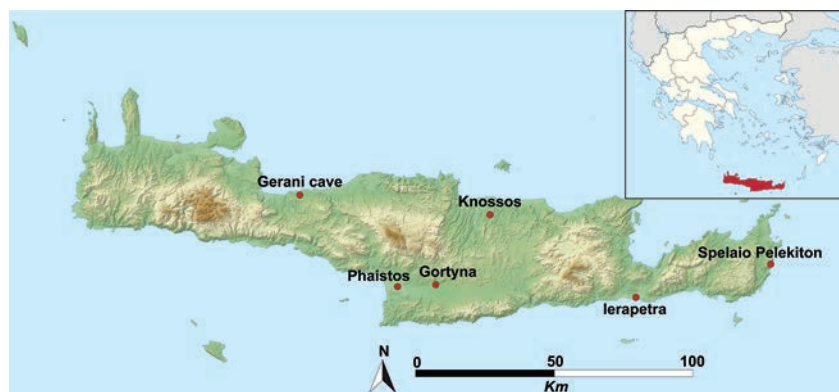


Fig. 1. Map of Crete and sites with Neolithic figurines.



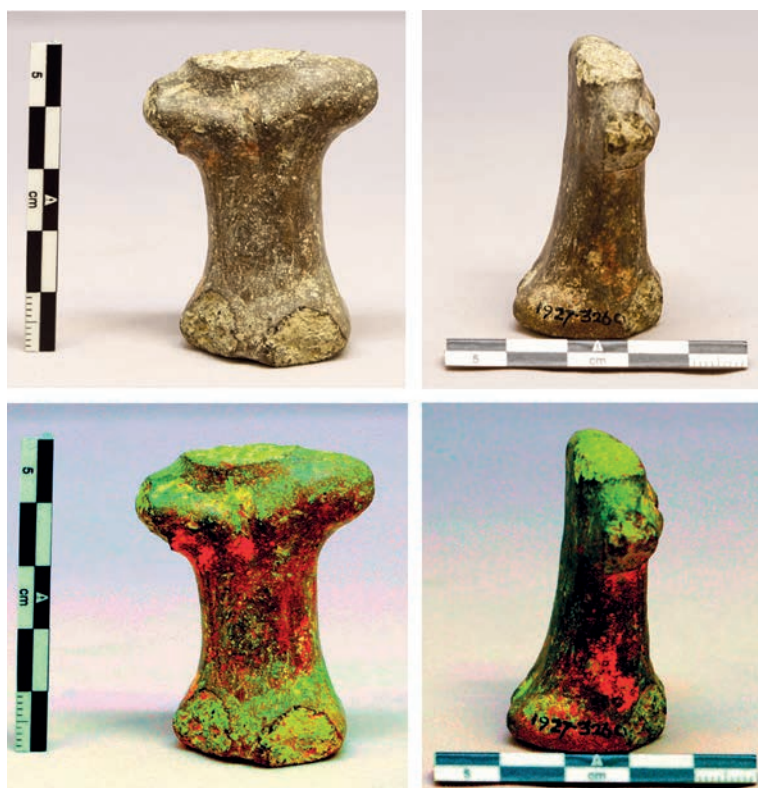
In order to accurately identify pigments, the plug-in requires high-quality images for the analysis, as low-quality photographs may produce errors in the form of false colours. A collection of 16 Neolithic figurines from A. Evans' excavations at Knossos in the Ashmolean Museum at Oxford were available to be handled, studied and photographed personally by the author of the current study. Other high-quality photographs that were used to prove the effectiveness of the method were obtained from those available online showing the British Museum figurines from Knossos.

The photographs from the Ashmolean Museum were taken by the author with a Canon® EOS 1000D with an EF 100mm f/2.8 USM macro lens in the Photo Studio Light Box Foldio2® Plus. The images were processed using the DStretch plug-in for ImageJ to emphasize otherwise imperceptible details in the originals. The examination process involved a great focus on the identification of traces of painting on clay figurines. Some figurines only reveal those traces under specific lighting conditions and are particularly enhanced with the DStretch plug-in. The photographs

selected to be processed with DStretch are in their original state, taken under controlled lighting conditions but without any computer-enhanced modifications that could impact the results by simulating false colour traces. Six figurines with indications of paint are discussed in detail below.

### Discussion of colour and DStretch results

The surface treatment of Neolithic figurines from Knossos has not attracted much attention and remains widely understudied, although it is important to better understand the final colour results. Similar to ceramic vessels, the surface of such figures was either polished or slipped, resulting in a thin compacted layer (Tomkins 2001.53–54). According to Peter Tomkins (L.c.), sometimes the addition of a slip layer was intentional to manipulate the colour and ensure a dark polished surface. The firing techniques ranged from mixed oxidizing/reducing to reducing and firing temperatures, from those seen with clay that is not vitrified (750–800°C) to estimates of more than 1000°C in the vitrified examples. The dark burnished ware required surface vitrification, which is observed



**Fig. 2.** Top: Figurine 1927–3260 front and side with faint traces of red-on-white paste on a dark brown burnished surface. Bottom: DStretch images in colourspace LAB, highlighting red pigment traces (Photographs by the author, reproduced with permission of the Ashmolean Museum).

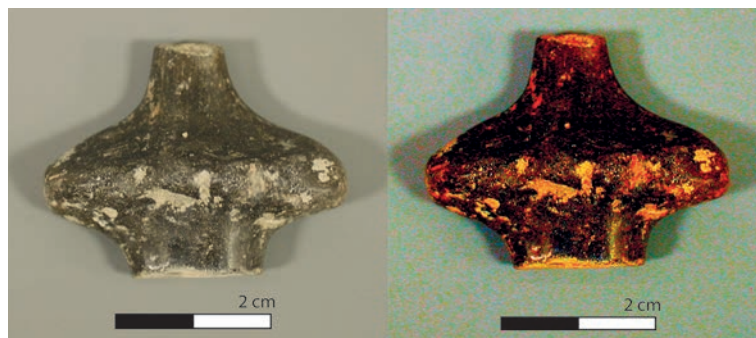
in specific figurines and pottery found in Knossos. To achieve the highly burnished black wares (e.g., AE.731, Fig. 3) required considerable firing skills and the use of completely reducing firing conditions. This technique differentiates black burnished wares from other medium or dark grey and brown wares, also common in Neolithic figurines from Knossos. Black burnished figurines achieved a lustrous black produced by the ceramic surface's vitrification at very high temperatures. The aesthetic result of this technical achievement was an attractive object with a shining, almost obsidian-like surface (Gaydarska, Chapman 2008). Bisserka Gaydarska and John Chapman (O.c.) suggest that the colour symbolism and aesthetic appeal of dark and especially black burnished and polished wares were of major significance for their gradual emergence as the preferred fine ware over wide areas of Anatolia, the Aegean, and the Balkans in the late 6<sup>th</sup> and early 5<sup>th</sup> millennia cal BC. Equally, the use of this surface treatment for figurines from Knossos

may have had a similar effect to that seen with the pottery. The black background of these shiny objects easily created colour contrasts, which may explain why red and white colour paste was applied to decorate some dark burnished figurines, e.g., AE.731 (Fig. 3).

Colour and brightness must have been important in categorizing material culture, based upon the striking colours and brilliance of fine painted, slipped and burnished clay figurines. These surface treatments may have had symbolic properties that were imbued in the figurines and manifested in distinctive colours and polished textures. These aesthetic and symbolic properties may thus explain the preference in Late Neolithic clay figurines at Knossos for a dark-colour canvas, ranging from dark brown to black.

In the Ashmolean Museum collection, traces of red paint applied on at least five figurines from Knossos have been identified (1927-3260, AE.731, 1938.661, 1938.660, 1938.662 Figs. 2-6). Another figurine with painting has been identified in the British Museum collection: 1934,0115.3 (Fig. 7). The motifs depicted are not always identifiable because of the poor preservation of the pigment, with red paint being especially poorly preserved. As such, red pigment mainly survives when white paste was applied beforehand. The wide application of red-on-white paste at Knossos might be a way to apply red onto a white canvas so that the pigment adhered better to the surface, perhaps to render the pigment more durable or to make it stand out. The pigments were probably applied after the firing of the figurines, which would result in a much brighter colour but also in the poor preservation of the pigment in the long run.

Figurine 1927-3260 (Fig. 2) from Late Neolithic Knossos (c. 5300-c. 4400) represents a sitting individual with the head missing and the arms to the chest touching or covering the breasts, and therefore probably depicting a female. Very faint traces of red paint have been detected between its breasts or arms, below its arms or elbows, possibly along its sides on the lower torso and on its right side starting below its arm to the buttocks area. The photographs processed with DStretch colourspace LAB visually enhance the red pigment traces and may be identified with those



**Fig. 3. Left: Front of figurine AE.731 with almost imperceptible traces of red-on-white paste on a black burnished surface. Right: DStretch image in colourspace LAB, highlighting red pigment traces. The red colour on the broken area of the neck represents false colour as no traces could be identified through personal inspection (Photograph by the author, reproduced with permission of the Ashmolean Museum).**

areas with a deep, bright red colour. This paint could have indicated different motifs, although perhaps all the figurine's body was covered in red given that similar pigment was also visible on its back.

Figurine AE.731 from Late Neolithic Knossos represents a fragment of a torso with the neck partially broken and the hands to the chest touching or covering the breasts. DStretch in colourspace LAB reveals traces of red-on-white paste on its right neck, left hand or breast, and elbows (Fig. 3), while similar traces are visible on the elbows on its back. Unfortunately, the remaining paint is so scarce that it does not show any clear motifs.

Figurine 1938.660 from Late Neolithic Knossos (Fig. 4) depicts a fragment of a torso with the head missing and arms to the chest below the breasts, thus representing a female. At close inspection, remains of paint can be seen with the unaided eye in the chest area between the hands. With DStretch, the pigments become more noticeable, revealing other traces of red paint on the figurine's chest between the left hand and left breast, on the breast area, on its elbows, between its hands at the centre of its chest, along its sides on the lower torso and below its belly. Although paint seems to cover most of the figurine's torso, without any particular pattern, a central motif between the figurine's hands appears to be a lozenge in a turned position compared to the incised lozenge on its abdomen.

The red paint on these three figurines (Figs. 2-4) is thus applied to the same areas: left breast or hand, elbows, between hands or breasts, and left and right





**Fig. 4. Left: Figurine 1938.660 with incised motifs filled with white paste and the remains of red paint on a dark brown burnished surface. Right: DStretch image in colourspace LAB, enhancing traces of red pigment (Photograph by the author, reproduced with permission of the Ashmolean Museum).**

side of the body in figurines 1938.660 and 1927.3260. However, rather than revealing a pattern, the remaining pigment is probably due to normal wear and tear and the deterioration of figurines with time. Presumably these figurines were coloured almost entirely in red, which is only preserved in some areas of their bodies.

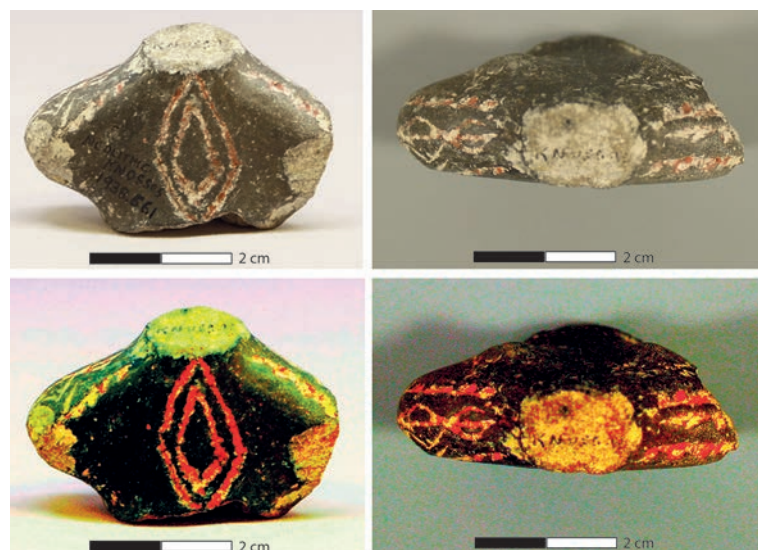
The Late Neolithic figurine 1938.661 (Fig. 5) from Knossos also represents a fragment of torso with the head and part of the right arm missing. The figurine depicts small breasts indicative of a female individual. It is decorated with two concentric lozenges on the back and, on the shoulders, a pattern that combines hatched-lozenges, triangles, and lines. All the decoration has white and red-on-white paste filling. The concentric lozenges are a common design pattern that probably represents the decoration of the dress. Another figurine from Knossos bears a motif depicting a similar lozenge at the back, hatched into three partitions, but unfortunately, this figurine is only partially published (see *Mina 2009.Fig. 7*).

Figurine 1938.662 (Fig. 6) from Late Neolithic Knossos depicts a fragment of torso with the head missing and arms to the chest touching the breasts, indicating a female. The decoration is composed of roughly parallel lines of

impressed dots at the front and back. The dotted decoration covers its remaining torso with white and red-on-white pigments applied to the impressions. Although white and red pigments are visible, enhancement with DStretch highlights the areas with the most paint remaining at the back on the dotted decoration and the elbows. The pigments are more poorly preserved on the front but are faintly visible on the arms as well as some dots, which may depict beads sewn onto the garment. Parallels may be found, although much later in date, in the 'Veiled Girl' from the Late Minoan 'Adorants' fresco from Thera. In this fresco, the figure of a girl has a mantle covered in red dots, possibly representing carnelian shell

beads sewn to it, probably to symbolize drops of blood (*Gallow 2018.69, Fig. 2*). A similar garment might also be represented on a figurine from Neolithic Corinth with red painted dots covering the fragmented leg (MF.70-24, *Talalay 1993*).

Figurine 1934.0115.3 (Fig. 7) has only the lower torso and legs remaining and is represented in a squatting posture. This fragment is richly ornated with an incised zigzag, slanting and linear lines, impressed dotted lines, and a 'railway track' motif formed by a



**Fig. 5. Top: Back and top views of figurine 1938.661 with incised motifs filled with white paste and the remains of red paint on a black burnished surface. Bottom: The same photographs viewed with DStretch in colourspace LAB, enhancing traces of red pigment (Photographs by the author, reproduced with permission of the Ashmolean Museum).**

long straight line crossed by a series of perpendicular lines on the back of the hips. All the decoration is filled with white and red-on-white paste. However, the red paste seems to be applied all over the figurine, as traces of it are found that do not only fill incisions. Analysis of the images with DStretch confirms the wide application of red colour on this figurine (Fig. 7). The red pigment is especially visible on the top and bottom sides of the figurine. The incised and impressed motifs and the paint covering most of the remaining body suggest that this figurine was probably depicted wearing a richly ornate attire.

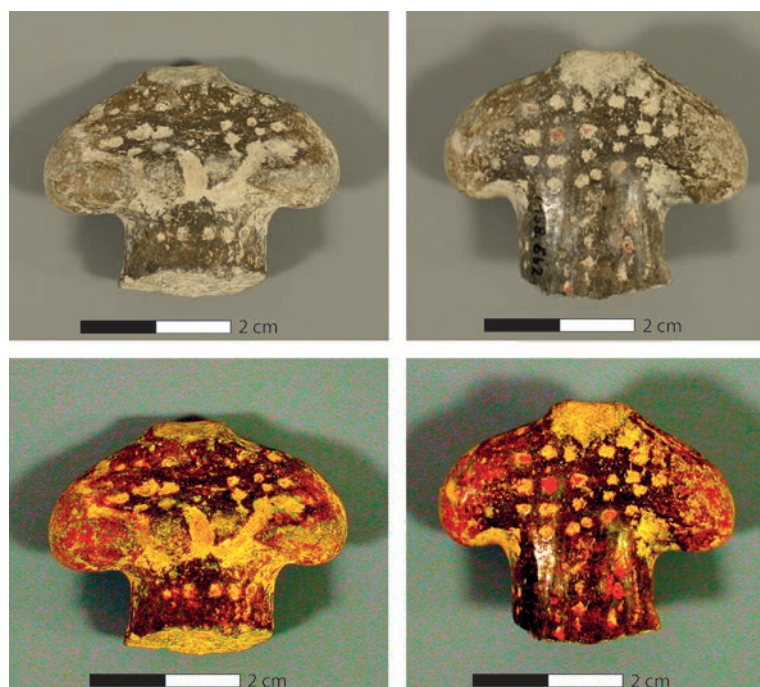
### Interpretation of colour and decoration

In Neolithic Knossos, complex decorative patterns covering most of the figurines' bodies may represent elements of attire. The ornamentation includes zigzag and parallel incised lines, sometimes accompanied by impressed dotted lines and generally painted with white or red paste. This decoration concentrates mainly on the shoulders, arms, back, belly, hips, and legs. Marianna Nikolaidou (2007:195) considers it very likely that Neolithic Aegean textiles were beaded or decorated with bone and shell appliqué, as has been attested in Neolithic and Bronze Age Europe

and Anatolia (Barber 1991). Garments were probably quite ornate from the Late Neolithic onwards. Perhaps tiny beads were sewn onto clothing as it may be the case in figurine 1938.662 from Knossos and in examples from Sitagroi, as suggested by Nikolaidou (2007:195).

The colour reconstruction with DStretch illustrates that the preserved traces of red pigment frequently correspond to incisions or impressions, particularly in figurines 1938.661, 1938.662 and 1934.0115.3 (Figs. 5–7). However, red pigment not accompanying incisions or impressions also appears on figurines 1927.3260, AE.731 and 1938.660 (Figs. 2–4). Therefore, some figurines were covered with strong and bright colours and bore motifs and patterns, which are often not clear nowadays. The results suggest that different colourspaces applied with the DStretch plug-in provide different outcomes. Colourspace LAB is extremely useful to enhance red pigment. While RGB, YBR and LRE also bring out reds, for our figurine collection they are less successful and may induce false colour errors. YDS and LDS colourspaces provide good results with white and yellow pigments. However, when present, these tend to be more visible to the naked eye in our assemblage. Clay figurines from Neolithic Knossos were mostly given a dark burnished finish to which paint could not easily adhere, explaining the deteriorated state of pigment preservation.

No analysis of the pigments has been carried out to date. However, a figurine from Knossos (Accession Number 1905.1136a.1, Stratigraphical Museum at Knossos) was found together with a large fragment of the base of a bowl that, once broken, was inverted and had traces of yellow ochre (Tomkins 2017:98). The figurine and sherd probably date from Middle Neolithic Knossos like the other objects, principally pottery, contained in the box from the same excavation levels. The staining and scattering of the ochre powder on the sherd left a mark that perfectly matched the figurines' size and shape, and there is still a thin stain of yellow ochre on the front of the figurine. XRF analysis on the figurine's yellow ochre stain and the bowl showed a similar



**Fig. 6. Top: Front and back views of the dark brown burnished figurine 1938.662 with dot-impressed decoration filled with white and red paste, possibly representing clothing, Late Neolithic Knossos. Bottom: Same figurine viewed with DStretch in colourspace LAB to enhance the red pigment (Photographs by the author, reproduced with permission of the Ashmolean Museum).**



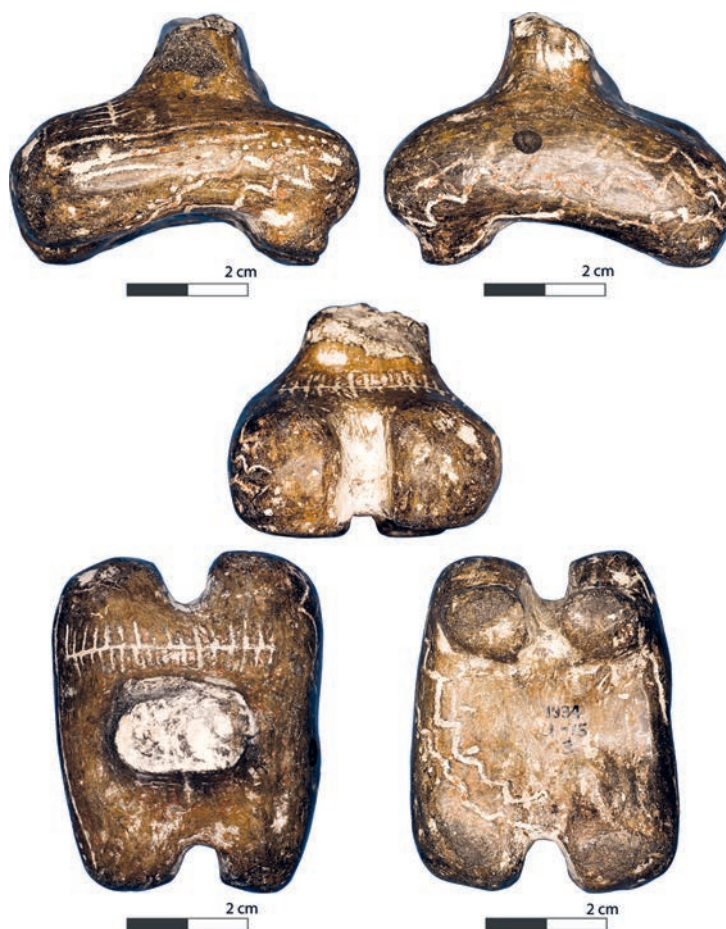
composition, and thus they were probably coloured with the same pigment (*Giunlia-Mair 2017.99–101*). The archaeological evidence associating ochre pigment on the bowl with figurine 1905.1136a.1 may imply its use to colour the figurine. Ochre was probably the main pigment used for figurines of Neolithic Knossos. However, we should not exclude other pigments for the red colour, such as cinnabar, which is attested to for the painting of Cycladic figurines (*Hendrix 1998.8–9*), even though no local sources of this mineral are known in Crete or the Cyclades. Conversely, iron oxides were readily available on the island, and in the case of figurine 1905.1136a.1 yellow ochre was heated to achieve a bright red colour (*Giunlia-Mair 2017.99–101*).

Maria Mina (*2008.126*) considered paint to have a clear pattern: it occurs on breasts and genitalia, which are body parts related to fertility. However, my analysis of the evidence suggests that this pattern is not as clear as previously thought, as no figurines feature colour applied to the genitalia, and only occasionally do red or white colours appear on the breasts or the surrounding area, such as on figurine 1927.3260 (Fig. 2), or applied to incisions in the buttocks area, but decoration and colour were also applied to other areas of those figurines.

The significance of the patterns of paint present on figurines from Neolithic Knossos probably signified the idea of body embellishment either on actual people or those represented by the clay figurines. There is a great deal of variety in the decorative patterns on Neolithic figurines from Knossos. The spacing of the elements, whether incised lines or impressed dots, varies, and the general density of the chosen decoration pattern differs widely, even among examples from the same site. This means that figurines were produced in small quantities and handcrafted individually. In this sense, figurine decoration may be a corporeal extension of the individualized human body, since they are decorated in a unique fashion.

In particular, the figurines suggest the relationship of painting with clothing or

perhaps body painting, considering that the areas with the remains of pigment are spread over the figurines' bodies. Incisions and impressions were probably widely used to represent elements of attire and ornaments, since they are frequently painted. Consideration of ethnographic parallels of practices related to body modification and ornamentation may also shed light on how some of these clay figurines were used. Bodily decoration and ornate garments are often worn in rites of passage to mark puberty, adulthood, marriage, childbirth and death (*Hoffman 2002.537*). Women are frequently the primary bearers of such marks due to their critical role in these life transitions (*Hoffman 2002.537–538*), possibly explaining why most decorated figurines in Knossos are female (except for two asexual figurines AMH.2716 and 1905.1136a.1, see *Ramirez-Valiente 2022*). Notably, in figurines with an identifiable sex the most decoration is on female bodies. The figurines analysed in this study may be classified as females and



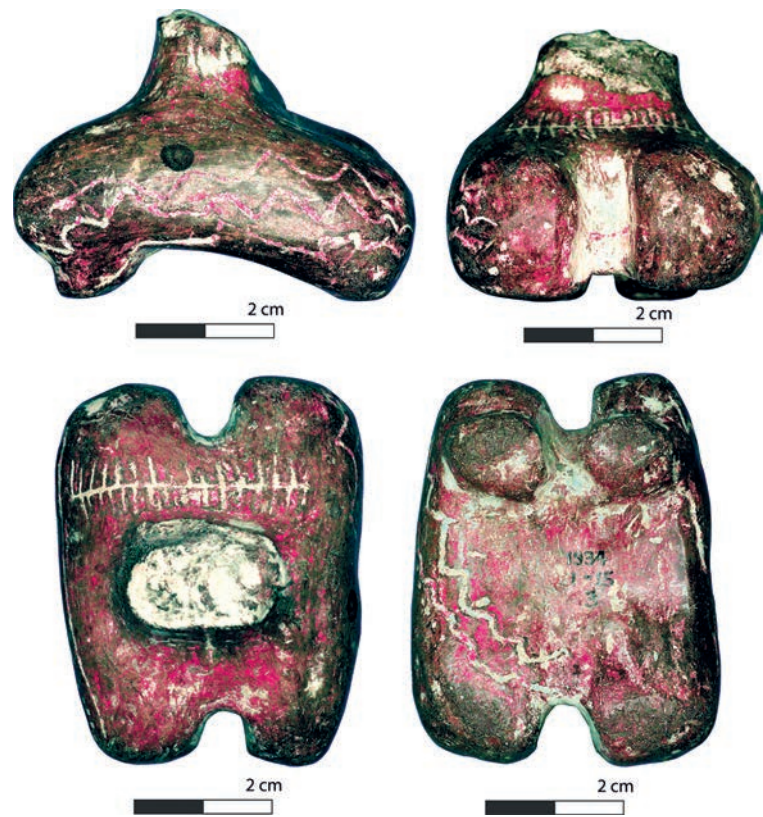
**Fig. 7.** Right, left, back, top and bottom sides of the brown burnished figurine 1934.0115.3, Late Neolithic Knossos (after [https://www.britishmuseum.org/collection/object/G\\_1934-0115-3](https://www.britishmuseum.org/collection/object/G_1934-0115-3), © The Trustees of the British Museum; 10/09/2020, reproduced with permission of the British Museum).



probably females (for a gender analysis of figurines from Greece, see Ramirez-Valiente 2023). Arnold Rubin (1988:16, 19) emphasizes the focus on female bodily changes, particularly in the case of girls of marrying age, who are given marks on their faces, breasts or bellies in recognition of their position in society and future biological role. The symbolism associated with ochre might add significance to female decorations. For instance, Alfredo González-Ruibal (2014:127) suggests that use of ochre among the Gumuz and Dat'sin (<https://www.tandfonline.com/doi/abs/10.1080/17531055.2019.1628364>) peoples in Africa is related to women who employ this pigment on the occasion of their wedding, with one of his informants stating that *“in old times if a girl wanted to get married, she had to look red”*. However, given the use of red in rites of passage, perhaps this colour was used in girls' puberty rituals to signify blood, since red naturally tends to be a rather universal symbol for blood. Bodily decorations on figurines from Neolithic Knossos focus on female figurines, perhaps representing body painting or most probably ornate gowns used in special ceremonies, such as those marking puberty, coming of age or a wedding. In this sense, it may be significant that only a certain number of female figurines show either painted or incised decoration. The decoration may have represented transient notions of gender, age, status, group affiliation, and family prestige, but also acted as a learning tool to pass on ideas and ideals of beauty and propriety.

## Conclusions

The goal with this article was to present the utility of DStretch for the analysis of colour and painting on Neolithic figurines from Knossos. However, the results also suggest its applicability for figurines of any other period. The aim was also to increase the body of evidence available by suggesting further surface analysis of figurines with digital aids, as it is, in some cases, difficult or impossible to recognize such painting with the unaided eye. Further benefits of this method include its affordability (DStretch is available with a small contribution fee to its creator, Jon



**Fig. 8.** Left, back, top and bottom sides of figurine 1934,0115.3, viewed with DStretch in colourspace LAB to enhance the red pigment.

Harman) and the simple and uncomplicated process of learning how to use it. Furthermore, this is a non-invasive method that allows the obtaining of data by using photographs, and thus does not affect the figurine or the preservation of pigments.

The results of applying DStretch to the figurines analysed in this work are promising, particularly for the identification of the faint red pigments on Neolithic figurines from Knossos, which were undetected by previous scholars. The examination of the figurines from Knossos in the Ashmolean Museum collection shows that many were finished with strong colours after firing in patterns that are not easily visible to observers today. Colourspace LAB, in particular, is effective in enhancing red pigments. However, we must be careful when applying this technique. First, we must acknowledge that the visualization results show false colours, and thus they do not reproduce the real colour but an intensely bright version. Secondly, applying this tool to low-resolution photographs may cause false colour traces to be found. For that reason, the personal handling and inspection of any pigment that remains on the original figurine is necessary.

Finally, the use of colour in the Neolithic suggests the symbolic importance of red, white and red-on-white, which are the most widely attested colours. In particular, the use of red and red-on-white on the figurines from Neolithic Knossos analysed in the

present study likely implies the representation of richly ornated attires associated with female and probably female figurines, perhaps hinting at their use in special ceremonies such as coming-of-age rituals or weddings.

#### Acknowledgements

*This article was developed as part of my doctoral project funded by the University of Nottingham Vice Chancellor's Scholarship for Research Excellence. I want to express my gratitude to Andrew Shapland, who kindly permitted me to study the figurines from A. Evans' excavations at Knossos in the Ashmolean Museum. I would also like to thank the Ashmolean Museum for allowing me to use my own photographs taken in the museum. Thanks are also due to Professor Mark Pearce and Chrysanthi Gallou for the invaluable comments that led to this paper. I also greatly appreciate the help of the Digital Transformations Hub of the University of Nottingham for providing me with essential equipment, including the macro lens and Foldio 2.*

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