

Article

Tracking Trajectories: Projecting Polychromy onto a Roman Relief from a Scottish Castle

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Abstract: The Antonine Wall Distance Sculptures are iconic and unique sculptural reliefs that marked Rome's most north-westerly frontier across central Scotland. Their inscribed texts and iconography depict graphic tales of frontier life, and recent non-invasive analysis has confirmed they were originally brought to life through vibrant polychromy. This paper tracks the trajectory of one Distance Sculpture that was embedded into the dramatic setting of Dunnottar Castle off the north-east coast of Scotland during the 16th century, where it was recorded as having been repainted during that episode of use. A suite of complementary analytical techniques, including pXRF, FTIR, and SEM/EDS, was recently reported on which identified pigments and surface treatments as well as their chronology of application, confirmed through stratigraphic sequencing visible in cross-section. That approach facilitated the investigation of all episodes in the itinerary of this iconic sculpted relief from the second century to the Scottish Renaissance. That vanguard research has provided an unprecedented opportunity to unravel the rich hidden history behind this unique monumental inscription and re-tell a fascinating transformational tale of a pivotal period in its past. The combination of historical, archaeological, and scientific approaches to an understudied, and overlooked, phenomenon of post-antique colouration is revolutionary in polychromy studies. It provides innovative and well-contextualised information that lifts an aesthetically modest Roman monument into a vibrant, colourful, and sumptuous decorative feature fit to grace the walls of a Renaissance castle emulating Roman imperial practices. We can now trace its journey through time by delving into the detail of its Renaissance repainting to present, for the first time, an accurate digital reconstruction as it performed for 16th century audiences.



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1. Introduction

Commissioned by Emperor Antoninus Pius around 142 CE, the Antonine Wall cleaved a route across the central belt of Scotland and marked the Roman Empire's most north-westerly frontier [1–3]. This turf-built monument was in operation for only c.25 years and effectively separated a hostile indigenous population to the north from those in the Roman-controlled south. That control was maintained by Legions and Auxiliaries who were also tasked with constructing the mural barrier and its associated infrastructure, as attested on inscriptions recovered from its environs. The most iconic of these are carved from locally sourced sandstone and known as Distance Sculptures since they record detailed measurements of frontier sections constructed by the three Legions commemorated upon them in formulaic and highly abbreviated Latin inscribed text (*Legio II Augusta*, *Legio VI Victrix* and *Legio XX Valeria Victrix*).

These relief sculptures are unparalleled in any other Roman frontier [4] (p. 268), [5] (pp. 110–113), [2] (p. 69) and provide an invaluable record of the frontier as well as the people who created and managed it [6]. They were originally adorned in vibrant colours to reinforce decorative details and bring life to iconographic scenes depicting religious

ceremonies, legionary emblems, deities, and brutal battles combined with messages conveyed through inscribed text [7] as a means of promoting Roman military might through propagandist monumentality [5] (pp. 130–134), [8] (p. 5). One of these, Figure 1 (Hunterian Museum Number GLAHM.F1, Roman Inscriptions of Britain [RIB] 2173) [9], has a rich and diverse history with a trajectory that saw it travel from its original position at the Antonine Wall to the far north-east coast of Scotland before returning south to join others in the collection of the Hunterian Museum. Thereafter, it was installed into its current position as an integral component of the museum’s showcase exhibit “The Antonine Wall: Rome’s Final Frontier”. The sculpture retains visible traces of polychromy that permit a detailed exploration of one episode in its trajectory using cutting-edge, non-invasive technologies for in situ scientific analysis supplemented with micro-analytical techniques [10].



Figure 1. Antonine Wall Distance Sculpture, Hunterian Museum Number GLAHM.F1 (RIB 2173).

2. Tracking the Trajectory of a Roman Distance Sculpture (GLAHM.F1)

Carved on buff sandstone, this substantial relief measures 0.97 m (length) × 0.84 m (height) × 0.12 m (depth). It is one of 19 Distance Sculptures recovered from the vicinity of the Antonine Wall (one additional sculptural relief from Arniebog has no inscription, and another from close to Bar Hill fort is lost and may be a column-shaft milestone, so neither can be definitively categorised as Distance Sculptures). It differs stylistically from other examples dedicated by the 20th Legion and bears more similarity to tombstones from the Danube and Britain (e.g., RIB 832 from Maryport dated to c. 139–65 CE—a dedication to Antoninus Pius from Postumius Acilianus, prefect of the first cohort of Dalmatians),

possibly indicating that it derives from a different season of construction or sculptural style [11].

The decoration comprises a central inscription panel framed with a triple-ribbed border, swirling ivy tendrils above and below, and flanked by elongated *peltae* depicting deeply grooved plumage of open-beaked griffins mounted with central rosettes. Two crampholes dovetail at the top, confirming it was originally embedded into a frame [12] (p. 63), probably also constructed of stone. Although none of these sculpted reliefs were recovered in situ, they are historically considered to have been set into the rampart of the Antonine Wall [12] (p. 51). Recent research, however, suggests a more likely placement would have been at strategic and easily accessible locations along the Military Way where they would have had maximum impact on diverse audiences [6].

The central inscription is set out in prescriptive and highly abbreviated Latin:

**IMP CAESARI T AELIO HADRIANO ANTONINO AVG PIO P P VEXILLATIO LEG
XX VAL VIC F PER MIL P III**

(for the Emperor Caesar Titus Aelius Hadrianus Antoninus Augustus Pius, Father of his Country, a detachment of the Twentieth Valerian and Victorious Legion built this over a distance of 3000 units of measure).

Frustratingly, aside from a comment that it was “dug up from the Ruins of this wall [thought to be the Antonine Wall] and made a present long ago to the ancestors of the late Earl [George Keith, Fifth Earl Marischal from 1581–1623]” [13] (p. 62), its findspot and context of discovery are unrecorded. Although conventional wisdom proposed it derived from east of Auchendavy fort [14] (p. 365), it has more recently been assigned to somewhere in the central sector, probably between Auchendavy and Twechar [11] (p. 72), where the mural barrier’s construction sequences are less well-understood.

The sculpture’s date of recovery is similarly undocumented, though it is recorded as having been seen at Dunnottar Castle by Servas Reichel around 1603, who subsequently reported it to William Camden [15] (pp. 699). Dunnottar is an impressive stronghold built on a promontory off the coast of Aberdeenshire, south of Stonehaven (Figure 2, top). The site is rich in cultural and religious significance that stretches back into prehistory and is the location of a church established by St. Ninian in the early 5th century. At the castle, the sculpture was initially installed into the porch or portico [16] (pp. 939) then later into an alcove on the north wall of the ballroom or gallery in a building constructed after 1550 by George, the Fifth Earl Marischal (Figure 2, bottom). It remained visible in that prominent position of the castle’s most prestigious space in 1642 [17] (pp. 239). Thereafter, it survived a brutal and protracted siege in 1652 when Oliver Cromwell failed in his attempts to seize the Scottish Crown Jewels (the “Honours of Scotland”) temporarily hidden at Dunnottar for safekeeping [18] (pp. 87–88), [19].

The monument’s intrinsic value and significance to the Earls Marischal is perhaps most strikingly articulated through its preservation and relocation to Marischal College in Aberdeen in 1723 by the Countess Marischal, mother of George, Tenth Earl Marischal (1712–1778), after his estates were forfeited and Dunnottar Castle was dismantled when he was exiled for Jacobite sympathies in 1716 [13] (p. 62), [20] (p. 204), [21] (p. 40), [17], [11] (p. 72). This preservative act marks it out as holding prestige beyond any other architectural feature of the castle. It was thereafter donated to Glasgow College (University of Glasgow) in 1761 after the annulment of the Earl’s exile where it apparently arrived in one piece, as confirmed by Horsley’s illustration (Figure 3, left), before subsequently splitting into two. Another rendition a century later [22] records the breakage (Figure 3, right), though, intriguingly, not the damaged indentations on parts of the surface that Horsley clearly depicted. Here, it continues to play a pivotal role in the Hunterian Museum’s unrivalled collection of carved stones documenting Rome’s short-lived campaigns in Scotland.

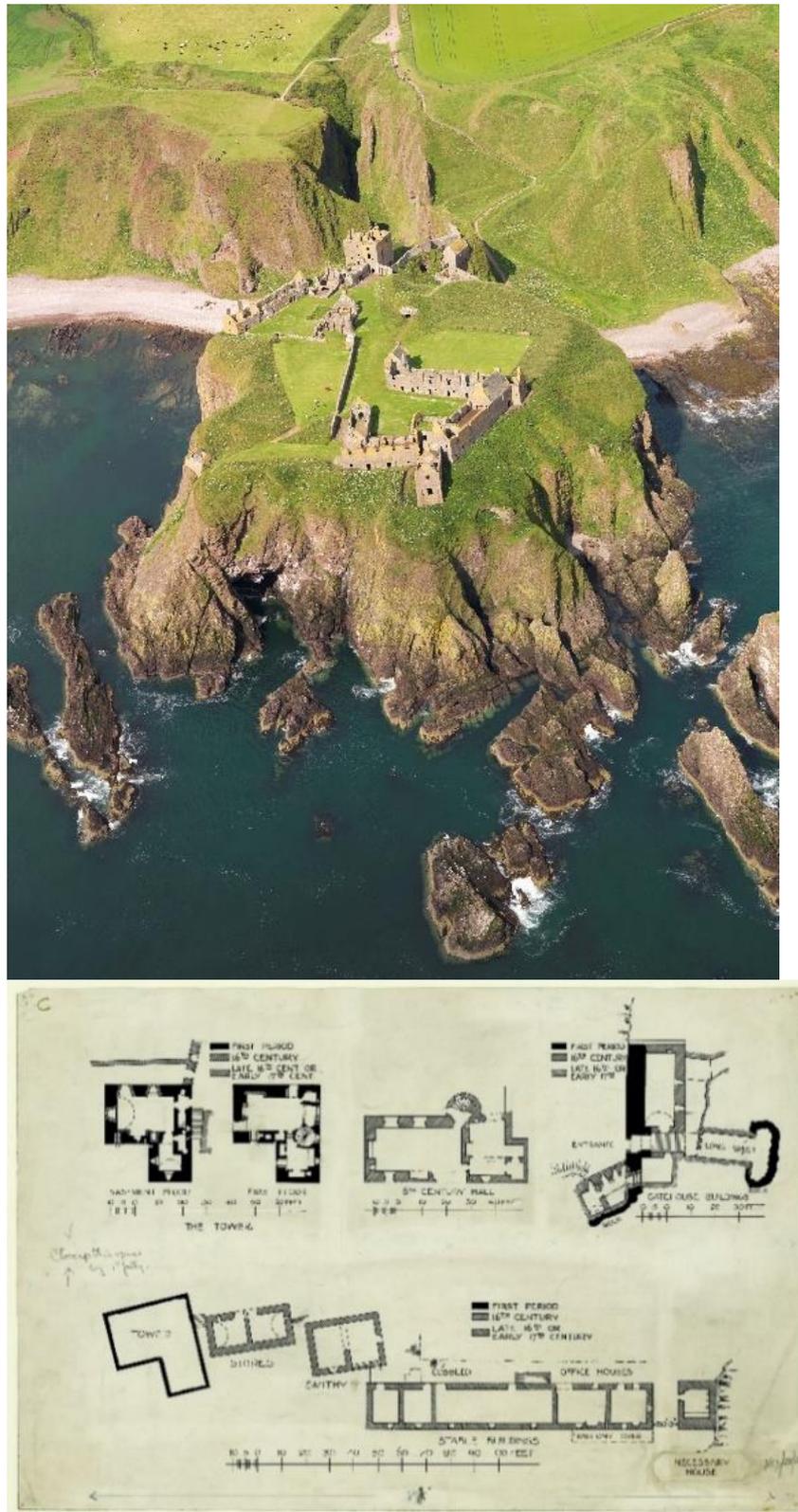


Figure 2. Dunnottar Castle—airial view (top) and 16th–17th C site plan (bottom) © Crown Copyright: HES, used with permission.



Figure 3. (Left)—GLAHM.F1 before it was split into two pieces (after Horsley 1732, XXVI); (Right)—after breakage (after Stuart 1844, Plate XV, 8).

George, the Fifth Earl, was an infamous Antiquarian traveller [15] (pp. 711–712), [11] (p. 72) and Ambassador to Queen Anne of Denmark [17] (p. 239) and so highly regarded at Court that he was tasked with escorting her as bride to James VI [14] (p. 366). His travels during a Renaissance period that prompted the rediscovery of Classical philosophy, literature, and art [23–26], [27] (pp. 4–5) would doubtless have exposed him to Greek and Roman architecture and sculpture, some of which may well have retained visible evidence of polychromy from Antiquity [28]. Certainly, through his social position, he would have been acutely aware of the cultural significance of this sculpted inscription and motivated to have it erected in a prominent location in the majestic setting of Dunnottar in line with the contemporary practice of the collection and display of Classical statuary, sculpted reliefs, and inscriptions in the stately homes of nobility [29] (p. 16), [30], [31] (p. 30), [32].

Indeed, recognition of the prestige of these unique Roman inscriptions from Scotland during the Renaissance is further verified through other examples of their careful installation into prominent positions of stately homes. For example, two further Antonine Wall inscriptions dedicated by the 2nd Legion Augusta were built into the walls of Cawder House, Bishopbriggs, Glasgow, by the predecessors of its early 18th-century owner, Mr. Stirling of Kier [13] (p. 54). One is another Antonine Wall Distance Sculpture (Hunterian Museum No. GLAHM.F.4, RIB 2186)—a poorly preserved panel inscription with plain mouldings flanked by one ansa with central rosette that was built into the west end of the House before being donated to the University of Glasgow in 1735 [6] (p. 67) where it too is now displayed in the Hunterian Museum’s showpiece exhibit. Intriguingly, the other is a building inscription (RIB 2209), set within a relief-sculpted wreath flanked by two nude Genii standing on the heads of eagles emerging from behind a cornucopia. It is recorded as having been built “within the walls of Calder House, for Preservation” [13] (p. 54), where it remains to this day [33].

Like the Dunnottar relief, both Cawder House inscriptions are unprovenanced, with the Distance Sculpture originally assigned to Balmuildy [13] (p. 54), but this was later disputed [34]. Macdonald originally assigned it to “the western end of the Wall, conceivably from New Kilpatrick” [4] (p. 312), but later hypothesised it “may conceivably come from Auchendavy” [14] (p. 404) largely based on the presence of other 2nd Legion inscriptions from that location. Although their exact positioning is not recorded, and it is possible that they were embedded into exterior walls, the explicit mention of the building inscription being installed into the wall “for preservation” [13] (p. 54) may favour its placement in a protected interior position.

Two further records of Distance Sculptures embedded into architecture exist. The first (Hunterian Museum No. GLAHM.F.12, RIB 2204), another dedication of the 2nd Legion Augusta, was incorporated into the gate of Cochno House near Duntocher [20] (p. 195). Like the Dunnottar example, it was placed in a highly prominent position that visitors could not fail to see as they passed through the estate entranceway, but in an external location unprotected from the elements. The other (Hunterian Museum No. GLAHM.F.6, RIB 2196) is stylistically quite similar to the Dunnottar sculpted relief, this time dedicated by the 6th Legion Victorious. It was embedded into the end wall of a small, thatched cottage near Castlehill, New Kilpatrick, Dunbartonshire [35] (p. 756), [11] (p. 78): a very different setting compared to grand stately homes where the other examples were placed and likely incorporated into the building for its large size combined with its decorative detail.

3. Polychromy on GLAHM.F1

Taking account of sculptures from the German *limes* retaining evidence of polychromy, it has historically been suggested that the Distance Sculptures were probably “brightly, if crudely, coloured [though] no vestige of anything of the sort is visible on them now” [4] (p. 310). The extant gilding on inscribed letters on the Dunnottar sculptural relief were considered to belong to more recent times, aligning with earlier references that the Fifth Earl, “a great admirer of antiquity, caused [the letters] to be gilded” [15] (pp. 711–712), [16] (p. 939). Contemporary antiquaries were critical of the Earl’s “expression of his value and zeal for antiquity” and mention “there is *now* [my emphasis] some black colouring as well as gilding upon it” [20] (p. 204). Others were careful to make clear that the “foppery” of applying gilding was not the work of university staff [21] (p. 40) and confirm that the gilding “has been very properly washed off” [36] (p. 80) before gold on letters once more became visible during cleaning in 1976 along with gilding in the frame and dark colours on the floral motifs and griffin peltae [11] (p. 73).

The practice of restoring Classical sculptures is well attested during the 16th and 17th centuries, particularly in Italy where it was then routinely shipped to overseas collectors [37] (p. 152). This included the composites of fragments from different statues [38] (p. 2), [39] (p. 15) and intensive cleaning of surfaces to reveal pristine white marble of the most highly prized sculptures with soap, sponges, brushes, and even chisels [37] (pp. 137–138), [40,41]. Contemporary accounts record recipes for harsh surface treatments and oils to blend the colour of restored areas with original surfaces [42] (pp. 362–363), which necessitated the removal of surviving pigments. Set against this background of the systematic erasure of traces of polychromy from Classical sculpture and the idealisation of pristine white marble [43] (pp. 78–79), it is perhaps surprising that GLAHM.F1 was repainted in vivid colours. Indeed, there are currently no reported comparative examples of repainted Classical sculptures, with the notable exception of the “Bursa” relief, which dates considerably later to the 19th century [44], rendering our monument completely unique.

Given the diversity of visible colours ranging from light to dark brown, red, grey/black, white, pink, black, and gold (see Figures 4 and 5), it is somewhat surprising that more attention has not been paid to the surviving polychromy on this monumental inscription. Earlier writers attribute the gilding of letters to the Earl, which suggests that during his extensive travels he encountered Roman inscriptions depicted in gold. Perhaps he even saw rare examples of bronze letters cast and rivetted onto inscribed letters, some of which were then gilded [45] (pp. 15–16). There are later examples of Antiquarians replacing missing metal-cast letters during the 19th C, including on the Parthenon [45] (p. 24), so perhaps the Earl was ahead of his time.

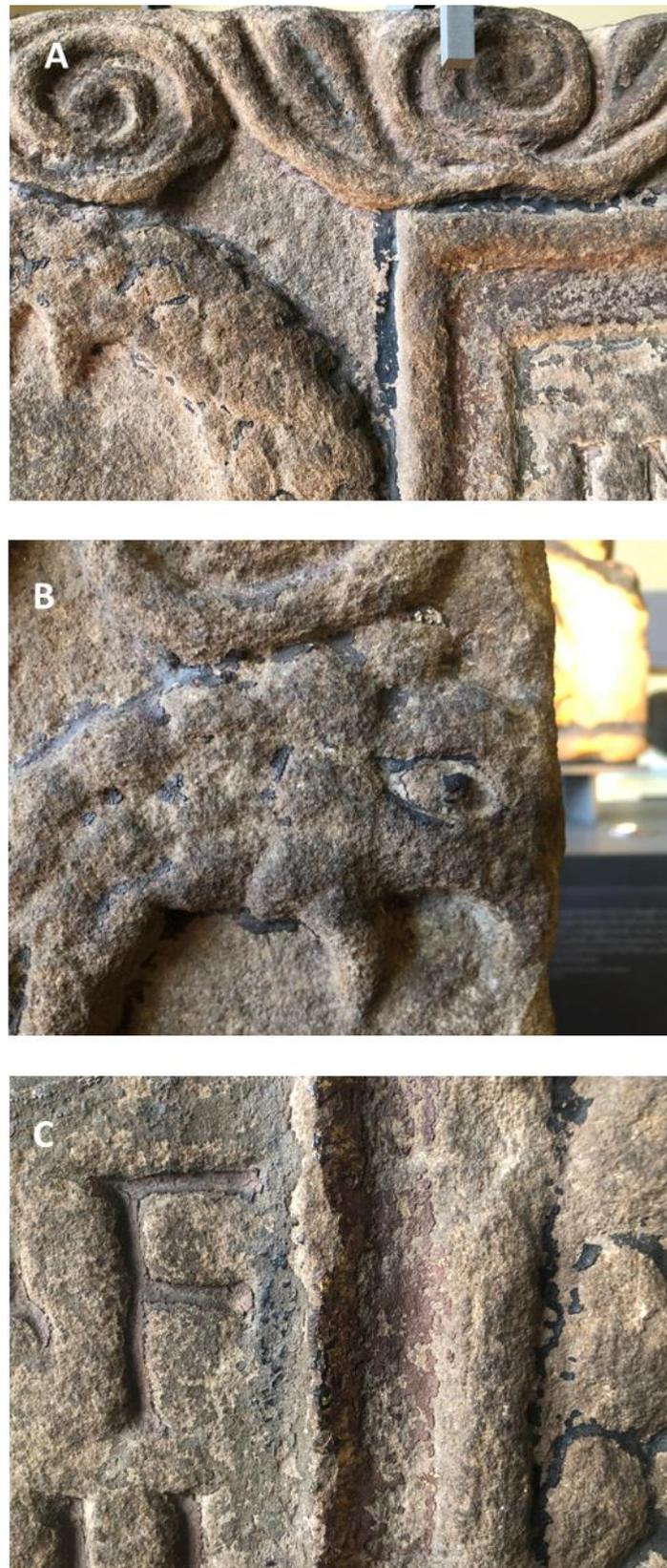


Figure 4. Coloured features—(A) Ivy tendrils, griffin body, and frames; (B) Griffin head; and (C) inscription panel with detail on sculpted frame flanked with black borders.

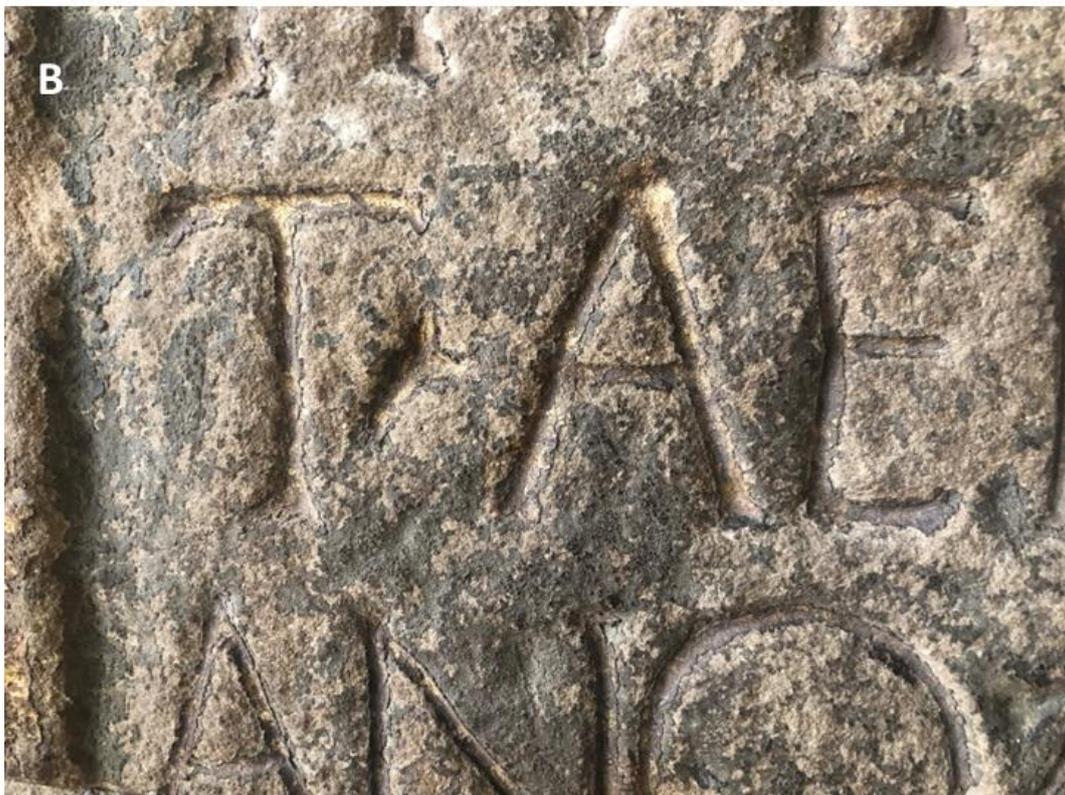


Figure 5. Gilded features—(A) Gilded frame and (B) Gilded letters with extant inscription background pigment.

4. Materials Science Methods

To identify the pigments present as well as their sequence of application and chronology, the sculpture was subjected to intensive multi-technique analysis. This has been fully reported elsewhere [10], and a forthcoming programme of SEM/EDS on samples from all features will supplement that work. It is, however, useful to provide a brief summary of the methods used and the results to place the polychromy into context and to establish the palette used to depict the features present, all of which informed its digital reconstruction here.

Portable non-invasive technologies, including portable X-Ray Fluorescence (pXRF) and in situ microphotography, were deployed to assess surface conditions and analyse the elemental composition of pigments detected on each sculpted feature in order to validate or refute historical accounts referencing their 16th-century application. These techniques were supplemented with micro-sampling, which provided invaluable information on chemical composition of the pigments and binders using SEM/EDS (Scanning Electron Microscopy/Energy Dispersive X-ray Spectroscopy) and FTIR-ATR (Fourier Transform Infrared Spectroscopy with Attenuated Total Reflectance). Samples were embedded into resin to facilitate microscopy of cross-sections and the identification of stratigraphic layers.

Following on from that work, the primary purpose of this paper is to examine the cultural context into which the sculpture sat and to present a digital reconstruction of how it may have looked in its final iteration before environmental conditions and successive episodes of curatorial intervention removed most of the surviving polychromy.

5. Summary of Scientific Analysis Results

In order to authentically reconstruct the polychromy applied to this sculptural relief, it is helpful to provide a brief summary of the results from the scientific analysis referred to above which identified the pigments present.

5.1. *Ivy Tendrils*

Carved ivy tendrils framing the top and bottom of the inscription panel retain a light-brown pigment mix of realgar possibly mixed with red lead overlying a visible light-pink layer of red ochre mixed with lead sulphate.

5.2. *Griffin Peltae*

Elongated griffin peltae flanking either side of the central inscription panel retain visible dark greyish/black resinous pigment overlying an orangey-red base layer in deep grooves. The results suggest a base of realgar and red lead or lead sulphate overlain with a shellac mixed with black pigment, probably a carbon-based black, and hints of smalt interference from other features (see below) [46–50]. The central rosette feature was decorated with a red ochre.

5.3. *Griffin Eye*

Layers identified on the peltae (above) were evidently painted across the entire griffin feature, including the eye, which was then depicted with lead sulphate possibly mixed with lead tin yellow to create the correct shade of eye white (sclera) along with a central pupil depicted with a carbon-based black pigment. Combined with the resinous layer below the white, all of these overlie a base of calcium carbonate over red lead possibly mixed with realgar. Crisp stratigraphic layers in cross-section confirm that each layer was left to fully dry before application of the next, and this is particularly visible under UV light, which shows no evidence of leaching between layers (Figure 6).

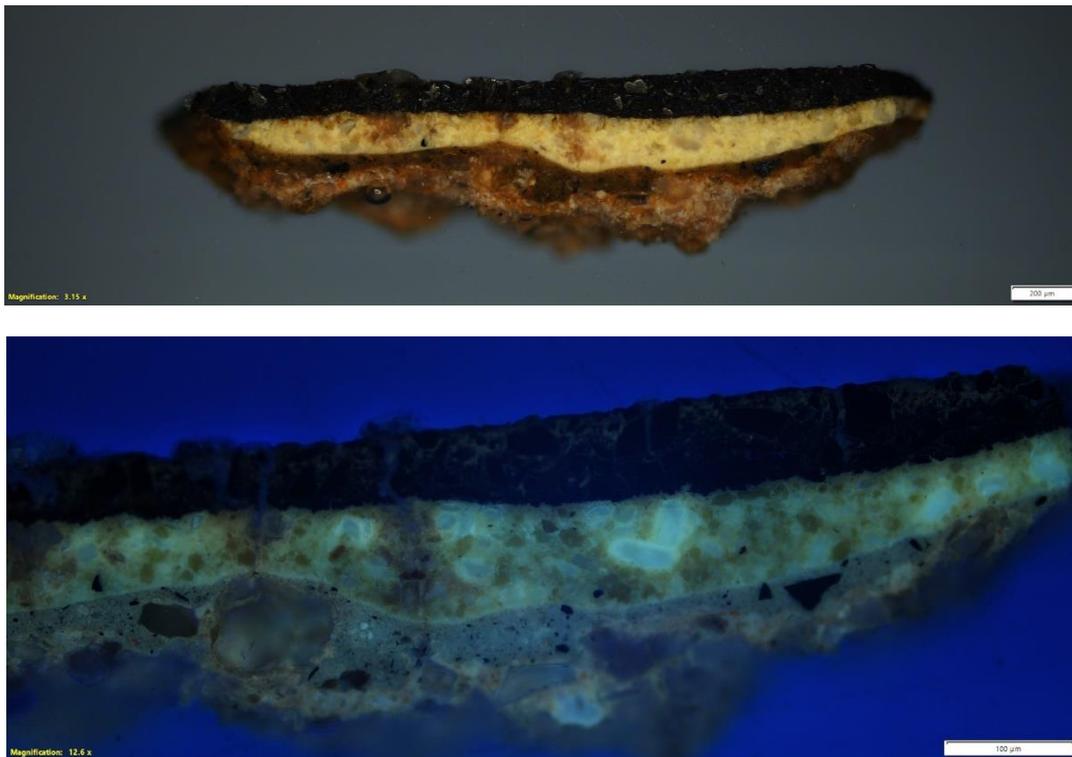


Figure 6. Cross-section of the pupil on the griffin eye pigment layers (**top**) and under UV light (**bottom**).

5.4. Inscription Panel Frame

The central inscription panel is set within a triple-ribbed carved frame that retains visible traces of a mid-brown pigment overlain with leaf gilding on several features. A grey/black pigment was painted around the exterior of the frame. Traces of an informal black border survive in areas of the carved frame interior overlying the inscription panel background. Together, these two very dark borders must have formed an extremely dramatic contrast to the gilded carved frame, which would have been exacerbated under the flickering candlelight of Dunnottar’s Great Hall. Given previous explicit reporting of there “now” being black colouring on the sculpture [20] (p. 204), these borders may even have been applied at a later date than the other pigments. Each painted feature of the frame is summarised below.

5.4.1. Exterior Frame

The grey/black external border of the carved frame is composed of three layers including a whitish/pink base mixture of lead sulphate, calcium carbonate, red lead, and traces of smalt. This was followed by a bright orangey-red mix of realgar and red lead overlain with a carbon-based black pigment on the surface.

5.4.2. Gilded Frame

Despite being perhaps the least sculpturally impressive feature on the monument, surface treatments on the gilded frame constitute the most complex and extraordinarily well articulated of all its constituent parts with at least nine layers visible in cross-section, and, again, distinctions between each are most clearly visible under UV light (Figure 7). A heavily cracked mid-brown pigment is visibly extant over large areas of the carved frame coated on the surface by gold gilding that survives less well throughout. The layers comprise a yellow-white base of calcium carbonate with lead sulphate possibly mixed with orpiment or yellow ochre providing a size below a bole. The bole consists of layers of red lead, realgar, and iron oxides sandwiched between resinous material with black inclusions below the surface gilding.

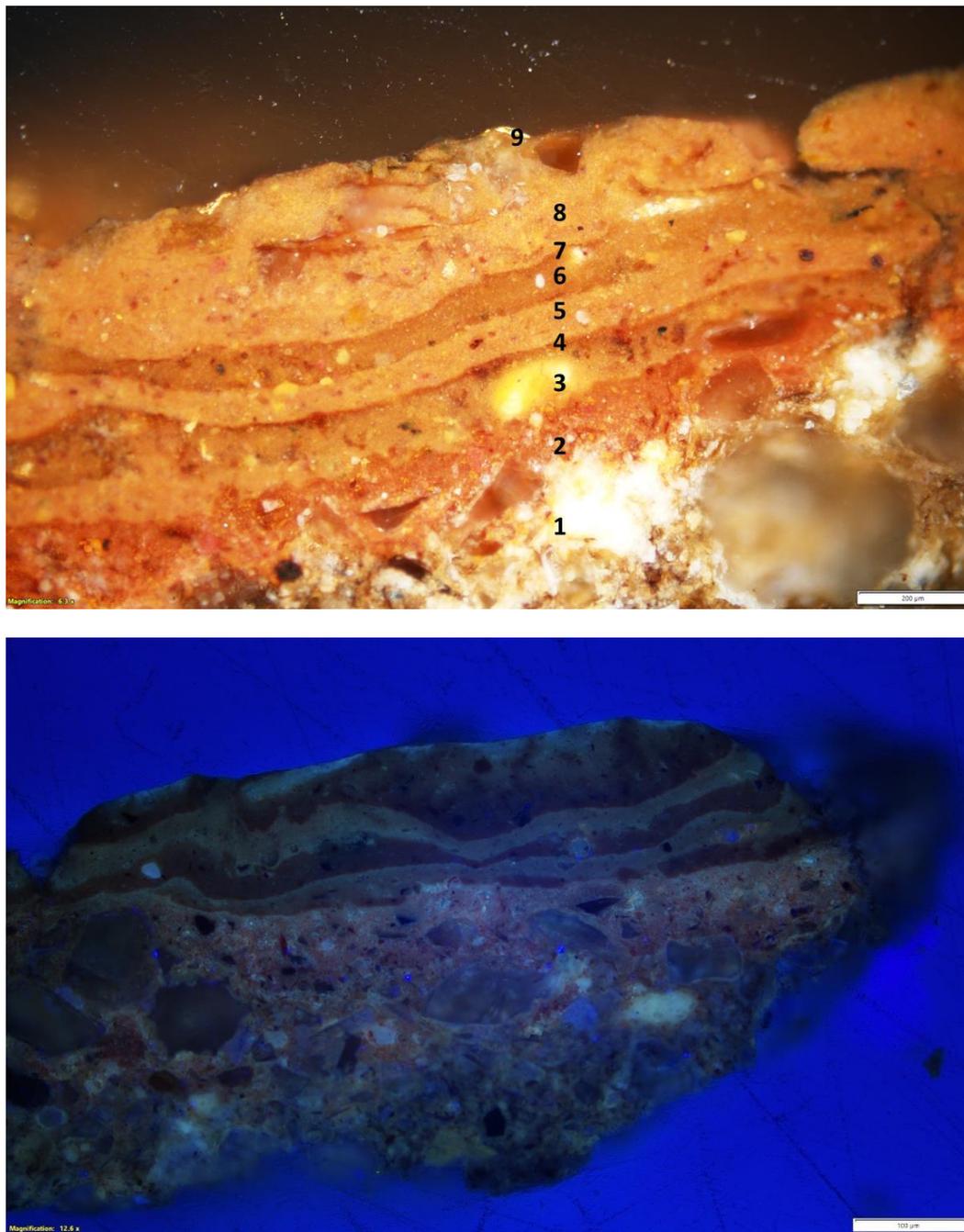


Figure 7. Cross-section of gilded inscription frame pigment layers numbered from 1–9 (**top**) and under UV light (**bottom**).

These preparatory layers were evidently applied to provide a warm tone to the gold, a common practice on frames gilded during the Renaissance, especially during the 15–17th centuries by German artisans [51–56].

5.4.3. Informal Border Inside Inscription Panel Frame

A sticky black, probably carbon-based, material containing natural wax was painted on the interior of the frame forming an informal border overlying pigment covering the inscription panel background, which caused interference with the pXRF readings since the instrument does not distinguish between layers and instead provides cumulative analysis of elements present in the sample [48] (pp. 136–137).

5.5. Inscription Panel Background

As the central feature of this Distance Sculpture, the inscription panel is pivotal to the monument's performance and reception to any audience, especially to those capable of deciphering the highly formulaic pattern of the abbreviated Latin text. As such, it is reasonable to expect it to be decorated in a manner that demands attention to the message conveyed.

The pigment here differs greatly in character, both visibly and structurally, to the others present. From a distance, this surface could be mistaken for flaking natural stone, but close inspection reveals a deliberately applied heavily cracked and degraded surface layer that has survived fragmentarily, perhaps accelerated through successive cleaning episodes [11]. The colour is greyish brown, which lacks the slight shine evident in other pigments and is comprised of a brown-grey raised surface with dispersed particles of blue and red inclusions. Critically, this is evidently the final layer of colour applied to the panel. Given its status as a chronological marker, this pigment demands more detailed consideration here (Figure 8).



Figure 8. Cross-section of inscription background pigment.

Taken together, the analytical results confirmed this blue to be smalt [10,57,58]. Commonly used from the late 15th–early 18th centuries, smalt is a vibrant blue derived from a potash silicate glass coloured with cobalt and often substituted for more expensive pigments [59] (p. 952), [60]. The colour is, however, unstable due to a combination of similarities in refractive properties of drying oils and smalt, migration of cobalt ions into oils, and leaching of potassium from unstable potash glasses used as flux during manufacture [61] (p. 351). As a result, smalt used in paintings from this period is known to discolour to brown or grey [62] (p. 1428) probably as a result of low potassium concentrations [59] (p. 956). This could explain the grey-brown colour of the panel, while the cracked surface is likely the result of this pigment's sensitivity to humidity [61] (p. 352) with a dry environment resulting in shrinkage and cracking of the structure severing contact between the glass pigment particles, surface, and binder resulting

in blanching and cracking [58]. This process may have been exacerbated by the monument's curation in a warm, dry museum environment.

Some artists in the early 17th century mixed smalt with other pigments to darken colours and aid surface drying (some of which are not detectable with pXRF [63] (pp. 2–18)) to produce a more textured and darker paint while reducing the characteristic translucency of smalt and aiding surface drying. These siccativ qualities were most likely the artist's primary motivation for its inclusion in some layers [63] (pp. 2–18). Different grades of smalt were historically sold, with the best quality originating from Flanders during the 16th century, largely because of the Netherlands' strong control over the cobalt trade [50]. More finely ground smalt produces a paler colour [58], which would have served the artist painting our sculpture well if they were attempting to replicate the lighter blues surviving on Roman frescoes, which they may have been exposed to during the Grand Tour [23,24]. This can be tested by comparing FTIR spectra with Raman spectra to determine intentionality in the use of lighter blue or whether discolouration occurred through degradation [58,64]. Given the date of application and the status of its owner, our smalt is likely to have been high grade, as indicated by the surviving splash of bold blue in one area. It was mixed with a wax, probably beeswax—a common 17th century practice, to create high-gloss surfaces emulating lapis lazuli [65]. Immediately below this surface was a layer of red lead, which overlaid orpiment or realgar mixed with calcium carbonate.

5.6. Inscribed Letters

The letters retain a visible reddish pigment with a waxy structure deriving from a proteinaceous source with resin (possibly shellac), and gold gilding survives on some areas of the lettering. The combined results confirm a base layer of lead sulphate mixed with calcium carbonate and possibly small amounts of red lead. Thereafter, the smalt discussed above was painted across the entire inscription panel, including the letters, which were then painted with a thin layer of orpiment before being overlain with realgar followed by an iron-oxide, realgar, and red lead mixture acting as a preparatory bole for the gilded surface.

This stratigraphy is clearly defined in cross-section, and the complex mix of particles from the constituent parts of the pigment recipes in each layer are strikingly evident under UV light (Figure 9).

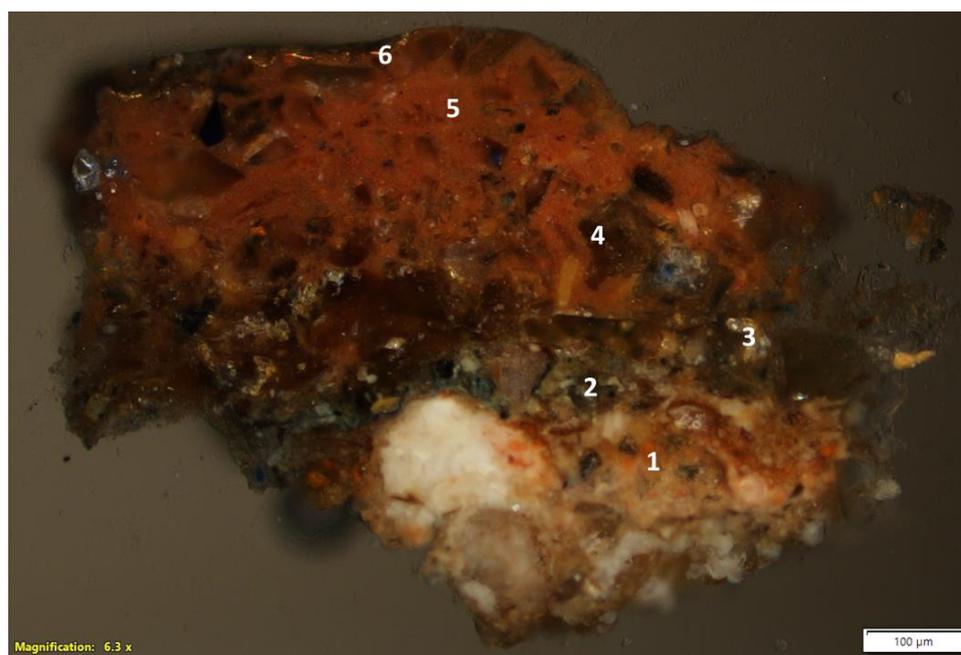


Figure 9. Cont.

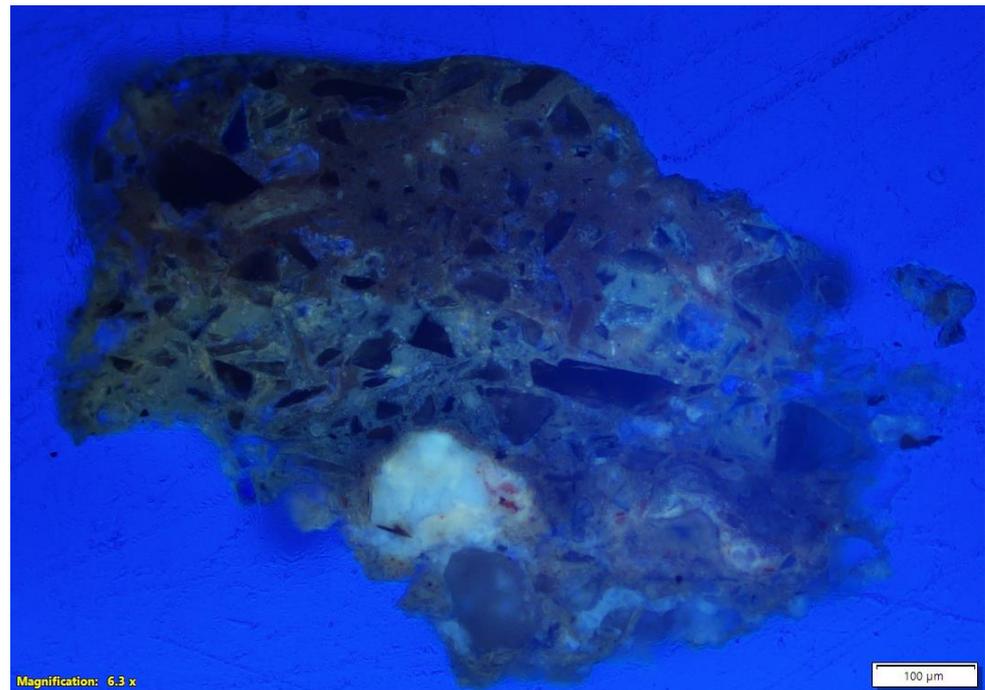


Figure 9. Cross-section of letter pigment layers numbered from 1–6 (**top**) and under UV light (**bottom**).

5.7. Artillery Damage

There are several areas of damage to the surface of the inscription panel (Figure 10) previously only referred to as “pockmarks” [11] (p. 73). The pXRF readings from these features closely mirror those of the ground sandstone along with extremely lowered readings of calcium, chlorine, and sulphur with elevated magnesium in one reading. This, combined with their obliterating of underlying features, including parts of the gilded inscription panel frame and letters along with their associated pigments, confirm that the damage must have occurred *after* the final episode of painting.



Figure 10. Probable artillery damage—(A) double indentation at bottom of gilded frame, (B) centre left above “V” of AVG, and (C) top of gilded frame.

The fresher and lighter colour of these indentations in comparison to the original surface of the sandstone (Figure 11), impacted by taphonomic processes, verifies this as the most recent, and critical, episode in the sculpture's trajectory. The source of this damage has never been previously addressed, but it is here proposed that the pristine surface and absence of any evidence for pigments [10] combined with the regularity and circular shape of the features must derive from damage inflicted by artillery fired into the castle when the sculpture was still embedded into the walls during Cromwell's siege to steal the Scottish Crown Jewels (the "Honours of Scotland") temporarily kept safe at Dunnottar [18] (pp. 87–88). Therefore, we can confidently confirm a *terminus ante quem* for the application of polychromy of 1652.

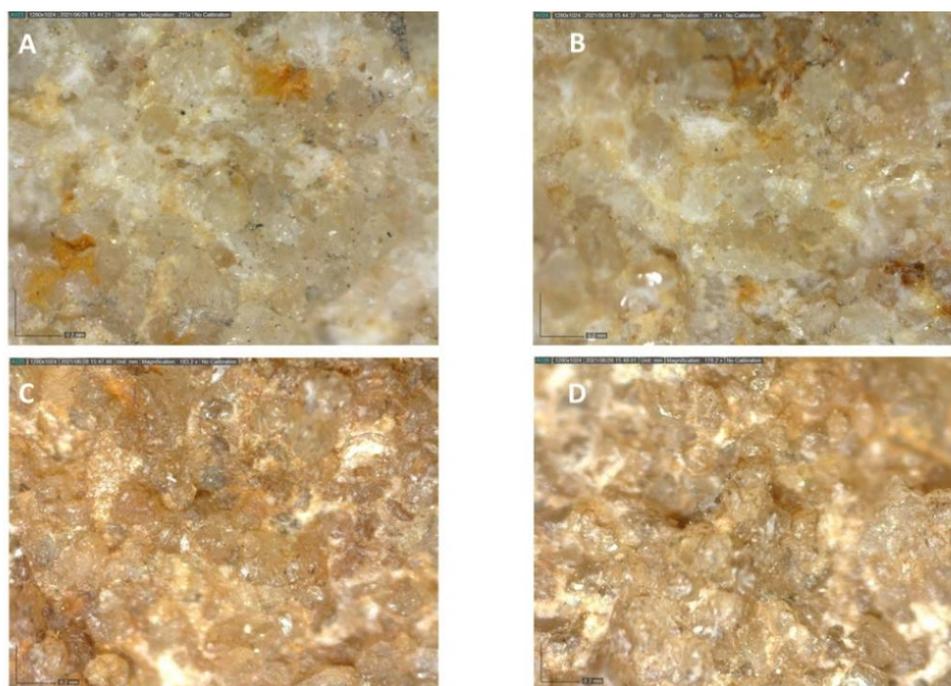


Figure 11. Top—in situ microscopic surface of probable artillery damage—(A) in the "V" of AVG, (B) (bottom of gilded frame). Bottom—background sandstone surface—(C) centre of left side and (D) bottom of left side.

5.8. The Palette

It is now possible to provide a palette of the pigments present on GLAHM.F1 (Table 1) and identify inherent complexities in their mixtures and application that have hitherto been unexplored for repainted Classical statuary, with the notable exceptions of a more recent widespread museum practice of repainting Roman inscriptions in red paint and the Bursa relief. The Bursa relief is a fragment of a Roman marble sarcophagus lid that was repainted in the 19th century, as confirmed by the recent discovery of synthetic Prussian blue and chromate yellow pigments [44], a full four centuries later than our sandstone Distance Sculpture from Scotland.

The palette consists of white, reds, blacks, blue, yellow, and gold, which eloquently reflects contemporary tastes for colours applied to architectural features, statuary [66], and framed paintings gilded in gold and flanked by black [55,67] combined with the antiquarian penchant for the collection and display of Classical sculpture [68]. The high level of expertise of the craftsman who decorated the sculpture is indisputable given the masterful application of appropriately mixed pigments, siccative agents, priming layers, surface treatments, and gilding and the confidence evident in ensuring that each layer was fully set to avoid cross-contamination through leeching before the application of subsequent layers. The stratigraphic sequence of polychromy for each feature was confirmed and corroborated

through the combination of the analytical techniques, particularly light microscopy and SEM/EDS of cross-sections.

Table 1. Palette of Pigments on GLAHM.F1.

Pigment	Chemical Formula	Feature
Lead Sulphate	PbSO ₄	Ivy tendril; Griffin Groove?; Griffin eye; External border of carved inscription frame; Carved inscription frame; Letters
Lead Tin Yellow	Pb ₂ SnO ₄	Griffin eye white (sclera)
Red Lead	Dilead(II) lead(IV) oxide: Pb ₃ O ₄	Ivy tendril; Griffin groove; Griffin eye; Flat area beside griffin; External border of carved inscription frame; Carved inscription frame; Inscription panel background; Letters
Realgar?	Arsenic(II) sulfide, As ₄ S ₄	Ivy tendril?; Griffin groove; Griffin eye; Flat area beside griffin; External border of carved inscription frame; Carved inscription frame; Inscription background; Letters
Red Ochre	Iron(III) oxide chromophore (Fe ₂ O ₃ + clay + silica)	Ivy tendril; Griffin rosette petal; Carved inscription frame; Letters
Carbon Black	Carbon	Griffin eye (pupil); Griffin groove; External border of carved inscription frame; Carved inscription frame
Smalt	Cobalt(II) silicate CoO. <i>n</i> SiO ₂	Carved inscription frame; Inscription panel background; Letters
Gold Gilding	Au	Carved inscription frame; Letters
Orpiment	Arsenic(III) sulfide, As ₂ S ₃	Carved inscription frame; Inscription background?; Letters

6. Digital Reconstruction

The colour scheme articulated on the sculpture aligns with contemporary decorative practice in Scottish stately homes [69], [70] (pp. 2–14), [71], [72] (pp. 199), such as the spectacularly well-preserved timber-panelled ceiling of the Long Gallery at Pinkie House in Musselburgh (Figure 12). Commissioned in 1613 by the Earl of Dunfermline (Alexander Seton), the ceiling is dominated by bold blue (thought to be azurite) features set within gilded frames highlighting inner images, gilded Latin text, and iconic Homeric and other scenes framed with gilding and black boundaries.

This practice is paralleled with Renaissance relief sculptural tradition merging polychromed features with gilded inscribed letters against dark/black backgrounds on, for example, coats of arms [73] (pp. 31–32) and exquisitely sculpted funerary architecture blending polychromy, gilding, and composite stones dominated by red, black, and gold [74] (pp. 12–13), [66].

Set against this background, our inscribed sculpted relief would not have looked out of place embedded into the walls of a nobleman's 16th-century castle. Indeed, it could feasibly have been a pivotal feature driving contemporary practice, containing, as it did, the primary constituent parts of inscribed Latin text, Classical decorative detail, and mythical zoomorphic creatures. The results confirm that, in their original condition, the pigments and surface treatments applied during the Renaissance would have lent a striking quality to the existing carved features.

This detailed review, supported by the results of scientific analysis, has now made it possible for the first time to authentically digitally reconstruct the sculpture, including

ambient light that would have been cast upon it from flickering candlelight in Dunnottar's Great Hall (Figure 13).



Figure 12. Pinkie House ceiling decorated in the early 17th century, images © Crown, Historic Environment Scotland, used with permission.



Figure 13. GLAHM.F1 digitally reconstructed (© the author, rendered in collaboration with Laura Whyte).

7. Discussion and Conclusions

Exploratory pXRF analysis of this monumental inscription in 2013 [6] hinted at the presence of pigments dating to the 16th–17th century, given their elemental composition, particularly the very high lead content and gilding consistent with that period [75] as opposed to haematite or goethite browns more common to the Roman artists' palette [76]. That validated the decision to undertake a comprehensive programme of analysis to strip back the layers and reveal the archaeology and hidden history behind the monument's polychromy.

It is rare to find examples of Roman sculpture subjected to later painting given the established Antiquarian practice of scrubbing away of residual surface treatments to expose the pristine stone surface below, usually white marble [40,41]. Indeed, although a small number of unpublished examples of reliefs with post-antique colouration are known [77] (pp. 3–4, 8), our Scottish sculpture is unparalleled insofar as the only other reported example of a Roman relief sculpture is a fragment from a marble funerary relief from Bursa Archaeological Museum in Turkey. The "Bursa Relief" presents with visible polychromy (Figure 14) that is evidently a later intervention dating to the 19th century with a Prussian blue background to the sculpted portrait relief emulating the colours of "Fayum" portraits in the same way the artist working on our Scottish sculpture did three centuries previously [44].

Non-invasive technologies have proven robust in providing invaluable data for identifying surface treatments on our monument. Because of the unique context for this particular sculpted relief and the historically documented application of pigments, the decision to extract microsamples proved invaluable for supplementing the pXRF analysis through FTIR, SEM/EDS, and cross-sections. The latter was critical for determining stratigraphic sequencing of pigmented layers identified with precision through SEM/EDS. In the absence of microsamples of the Bursa relief, it was not possible to determine whether the

more recent repainting overlays originally applied Roman pigments [44] (p. 177). Unlike the “wet-on-wet” painting technique deployed on the Bursa relief that caused leeching of pigments on sculpted features, on GLAHM.F1, cross-sections support in situ microscopic examination confirming that painted layers were left to dry fully before application of subsequent layers.



Figure 14. The “Bursa Relief” (image © Dick Osseman, used with permission).

A red-lead base layer is evident on several features, perhaps because its fast-drying properties made it an attractive mixer for other pigments and as an undercoat [78] (p. 48), and the siccative properties of smalt would have complemented this as a pivotal component of accelerating the drying process between layers. Indeed, a detailed survey of 15th and 16th-century Netherlandish and French artists revealed the practice of applying an orange priming layer onto paintings, consisting of lead white, red lead, and zinc sulphate followed by a layer of smalt and lead white, then a pink layer of lead white, red lake, and smalt then red lake and smalt [50]. The building of these coloured layers had a definable impact on the hues achievable, and that practice of thin layers is abundantly evident on several painted features on this sculpture, particularly the gilded frame with at least eight definable layers underlying the gold-gilded surface.

Taken together, the clear definition and articulation of every depicted feature combined with the expertise evident in the articulation of artwork verifies the work of a highly skilled artisan with an intimate appreciation of the inherent properties of their chosen materials, with all of which being appropriately sourced and utilised for the task.

Most of the pigments detected could easily originate from a 2nd-century Roman source, including red lead, realgar/orpiment, ochre, carbon-based black, and gold gilding. However, the combination of analytical techniques excludes that possibility for others since lead sulphate and smalt were not available before the 13th–14th centuries. This confirms that the latest episode of painting must have taken place during the Renaissance period and no later than 1652, given the artillery damage likely inflicted during Cromwell’s siege. Thus, we can confidently assign the visibly extant polychromy to the mid-late 16th century under the direction of George, the Fifth Earl Marischal since it was observed around 1603 [15] (p. 699).

We can, perhaps, take our interpretations one step further to speculate on the artist deploying their skills. Rembrandt is known to have favoured building up multiple layers commencing with orange-red ochre in an oil priming layer interspersed with thin resinous layers, which effectively sealed in those below, preserving the vibrancy of their colours [79] (p. 126). This is a practice common to earlier 16th-century Netherlandish artists, detailed above [20], and particularly visible in the gilded frame, which may indicate the hand of an artist trained in the Dutch tradition or, perhaps less likely, the German School [80].

All that said, some differences in preparatory treatments and base layers on some features is at odds with a single episode of application, and it is quite possible that original Roman pigments remain preserved below these later layers. Indeed, the detection of copper in the panel background is challenging to explain since it is not attributed to smalt, and thus it may derive from azurite mixed with the smalt, which was common practice for Dutch painters during the Renaissance [81]. Alternatively, it may originate from azurite from an earlier Roman application or, perhaps less likely, Egyptian blue. A forthcoming programme of research will undertake intensive targeted SEM/EDS mapping across samples from all features to determine whether any evidence for original Roman polychromy survives.

The digitally reconstructed polychromy merits explicit reference here. The sumptuously gilded inscribed letters and sculpted frame contrasting vividly with the vibrant blue emulating precious lapis lazuli flanked with less colourful, but well-articulated, sculpted decorative components creates a majestic and enigmatic display. The dramatic colouration has a transformative impact reminiscent of Renaissance polychromy opus sectile work and very much in the style of the 16th–17th century rather than the Roman decorative tradition. This powerful digital reconstruction visually represents a Renaissance reinterpretation of what could otherwise be described as an aesthetically modest monument, which was transformed into a showpiece artefact decorated in colourful contemporary fashion and fit for display on the walls of a high-status castle set within an equally enigmatic and majestic setting off the north-east coast of Scotland. The spectacular colours are representative of the high esteem and materiality of the artefact, place, and people associated with it who were undoubtedly reflecting contemporary connections with, and aspirations to emulate, Roman imperial power.

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