



VISIBLE-INDUCED INFRARED LUMINESCENCE OF EGYPTIAN BLUE AND THE GREAT ONES OF MITANNI AND HATTI

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ABSTRACT

This paper discusses the use of visible-induced infrared luminescence of Egyptian blue in Egyptology and describes the approach used by the author in a photographic survey of ten Theban tombs. A short scene caption discovered in TT 239 by this method identifies the leaders of tribute bringers in this tomb as the “great ones” of Hatti and of “wretched Mitanni.” The tribute scene in TT 239 is briefly compared to other similar scenes in Eighteenth Dynasty private tombs before the Amarna period.

In recent decades, Egyptology increasingly turns to novel imaging technologies, such as 3-D and 2-D+ imaging (including reflectance transformation imaging—RTI¹ and light domes²), multispectral imaging, and digital image processing techniques, improving the visibility of inscriptions and decorations³ (the latter including principal component analysis⁴ and other enhancement methods⁵). Multispectral imaging comprises photography in spectra adjacent to the visible-light spectrum. To enhance the visibility of Egyptian texts and decorations, image capture in the near-infrared and long-wave ultraviolet spectrum is most commonly used. Multispectral photography can capture reflected images to enhance the contrast between the pigments and the background⁶ or overlay material,⁷ or it can capture luminescence images to reveal areas

with coatings that have specific photo-induced fluorescence properties (that is, they emit light in one part of the spectrum when illuminated by light from another part of the spectrum).⁸ Various organic materials such as varnishes,⁹ but also the white pigment huntite,¹⁰ exhibit exploitable ultraviolet-induced visible luminescence (that is, they emit visible light when illuminated with ultraviolet light, which is opportune, because this luminescence can be seen with the naked eye and captured by a normal camera), and the common blue pigment Egyptian blue has visible-induced infrared luminescence (VIL).

It has been known since the 1990s that the pigment Egyptian blue (cuprorivaite), widely used in ancient Egyptian—and also in ancient Near Eastern, Roman and early European—artistic production, emits near-

infrared light when illuminated with visible light.¹¹ The spectrum of this emitted infrared light peaks at about 910 nm, while the excitation peaks in the red part of the visible spectrum at about 630 nm.¹² It was further shown that modified digital photo cameras, with the infrared blocking filter removed, can capture this near-infrared emission of Egyptian blue and thus produce photographs showing the areas of ancient artifacts originally covered with Egyptian blue. In the 2000s, British Museum conservator Giovanni Verri tested the capture of visible-induced luminescence of Egyptian blue on a variety of Egyptian artifacts in London,¹³ most notably on the wall paintings from the Eighteenth Dynasty tomb chapel of Nebamun (TT E2), which are housed in the museum.¹⁴ He demonstrated that this method can detect even small amounts of Egyptian blue, which often fades and may not be visible to the naked eye.

The visible-induced infrared luminescence of Egyptian blue finds application mainly in archaeometric and conservation studies, dealing with identifying pigments on Egyptian polychrome objects, often conducted at museums' conservation departments.¹⁵ British Museum scientists have proposed a protocol for multispectral imaging including visible-induced infrared luminescence.¹⁶ The technique is also used by archaeological conservators in the field, most often to confirm the presence of the Egyptian blue in degraded polychrome decorations.¹⁷

Kathryn Piquette has demonstrated that visible-induced infrared luminescence can also improve the readability of inscriptions originally executed in Egyptian blue that have become unreadable due to its degradation.¹⁸

In November–December 2023 I conducted a short five-day visit to ten Theban tombs (tomb chapels, to be precise) from the Eighteenth Dynasty in order to record personal names and titles for the database “Persons and Names of the Middle Kingdom and Early New Kingdom.” Given the tight timeframe, the inscriptions were recorded only photographically. The working files of the database project relating to the survey are archived in an online repository.¹⁹

Verri's examination of Nebamun's wall paintings in the British Museum has already shown that inscriptions executed in Egyptian blue appear as very bright when capturing the visible-induced infrared luminescence of Egyptian blue.²⁰ Egyptian tombs of the Eighteenth Dynasty often feature

inscriptions painted in blue, and Egyptian blue was the most common blue pigment in this period.²¹ Hence, within the framework of this photographic survey, I decided to use an infrared-capable camera to complement conventional color photographs with near-infrared (NIR) and visible-induced infrared luminescence photographs. Whereas the near-infrared photography, which is reported to make readable tomb inscriptions covered by soot,²² did not bring any significant results in the tombs I visited (probably because the soot crust was too thick), the visible-induced infrared luminescence did improve the readability of inscriptions in several tombs (particularly in TT 62, TT 140, and TT 239). In this paper I would like to briefly describe my approach, show how visible-induced infrared luminescence of Egyptian blue can reveal new inscriptions even in relatively well-documented tombs (using TT 239 as an example), and discuss the new inscription from TT 239 and its accompanying scene.

In order to capture the visible-induced infrared luminescence of Egyptian blue with an infrared-capable photo camera, the object should be illuminated only with visible light and should be well shielded from near-infrared light, while the camera should be fitted with a filter that blocks all visible light, so that possibly only the weak infrared light emitted by Egyptian blue is captured by the camera. When working in tomb chapels, one must block the strongest source of infrared light—the sun. For this end, I covered the tomb entrance with an opaque black cloth (although admittedly cardboard might have been a better solution).

Several light sources have been proposed for exciting luminescence: visible-only continuous output lights, such as white LEDs²³ and red LEDs,²⁴ full-spectrum continuous output lights with IR-blocking filters, and full-spectrum flashes with IR-blocking filters.²⁵ Since the excitation of Egyptian blue luminescence peaks at about 630 nm, bright red LED lamps should theoretically be the most power-efficient light source for exciting luminescence, which is relevant when using battery-powered light. Yet there are no readily available red LED-based battery-powered photographic lights that can evenly illuminate large areas.²⁶ For the tomb survey, I used white LED continuous output lights—two affordable 28-watt Neewer 280 lamps. These battery-operated lamps proved to be barely sufficient to effectively excite luminescence of Egyptian blue; in some cases, I had to hold them 20–50 cm away from

the photographed surface. It is therefore advisable to use more powerful light sources, or possibly custom-made red LED lights.

I employed a consumer-grade mirrorless Sony $\alpha 6000$ (ILCE-6000) camera, with the UV and IR-cut filter removed by a camera conversion service, with a Samyang (Rokinon) AF 24mm f/2.8 lens and the Heliopan 5850 850nm IR longpass filter (using Schott RG 850 filter glass). VIL photographs were shot using a tripod, very long shutter speeds of 2 to 15 seconds, and moderate sensitivity (ISO 400 to ISO 800) and aperture (f/2.8 to f/5.6) settings.

The tomb of Paenhut, TT 239, lies in the central part of the Dra Abu el-Naga necropolis.²⁷ There exists no complete publication of its inscriptions and decorations, but they still are quite well documented. The so-called tribute scenes on the southern part of the western wall in the hall (scene 3, as numbered by Porter and Moss) and on the adjacent southern wall (scene 4) are the best recorded parts of the tomb. The scenes were photographed on glass plates in 1912–1913 by the *Fremdvölker-Expedition* headed by Max Burchardt under the auspices of Eduard Meyer.²⁸ Walter Wreszinski included a photograph of scene 3 made by this expedition and a tracing of it in his *Atlas zur altägyptischen Kulturgeschichte*.²⁹ Melinda Hartwig published a close-up color photo of what now remains of scene 3.³⁰ Norman de Garis Davies and Alan H. Gardiner copied complete inscriptions of the tomb, including those accompanying the tribute scenes: one column in scene 3 and remains of a longer caption in scene 4.³¹ Based on this documentation, Silke Hallmann discussed the scenes in her monograph on New Kingdom tribute scenes.³² The present condition of the tomb is described by Mahmoud Farahat Mahmoud Ali El-Kadia, Adel Ahmed Zain El Abidine, and Mohammed Al-Bayoumi Al-Shaqra³³: the decoration of the tomb is largely lost, and especially the tribute scene is now reduced to a small fragment.

A color photo (FIG. 1), a near-infrared reflectance photo, and a visible-induced infrared luminescence photo (FIG. 2) were taken of the remaining fragment of the tribute scene. The latter photo reveals the remains of an inscription. Further image enhancement by processing the VIL image against the background of the non-VIL near-infrared image taken from the same tripod position with an LED infrared light made the inscription even clearer. The two images were aligned, and then the VIL image was divided by the non-VIL infrared image and

multiplied by its average brightness (using the Calculator Plus tool in the Fiji edition of the ImageJ image processor).³⁴ The resulting image is shown in FIGURE 3.

What seemed to be a typical case of blank inscription columns above the heads of two foreigners turns out to be a caption, originally inscribed in Egyptian blue and so heavily discolored that none of the scholars visiting this tomb recognized it. This caption is absent from the copies of inscriptions made by Gardiner and Davies; it is not mentioned by Burchardt or Wreszinski, who published descriptions of the tribute scene. The only inscription accompanying scene 3 according to Gardiner and Davies is *jn mn[h] mrj n nb t3wj jmj-r3 h3swt nbwt mhtwt P(3)-[n-hwt]* “By the efficient, beloved by the lord of the two lands, overseer of every northern foreign land Pa[en]hut” (FIG. 5). It is not seen on published photographs from the tomb and is now lost.

The previously unrecorded inscription explains who two of the three frontmost foreigners were (FIG. 4). The lower bowing figure is *wr n Ht* “the great one of Hatti”, and the upper bowing figure is the *wr n Nhrn hs hr rdj(t) j3w n nb t3wj* “the great one of the wretched Mitanni, giving praise to the lord of the two lands.”

Most scholars date TT 239 to the time of Thutmose IV–Amenhotep III. Particularly, Max Wegner substantiated the Thutmose IV date by comparing representations of Syrian foreigners to those in TT 91, which bears the name of Thutmose IV.³⁵ Hartwig explored further similarities with Theban tombs from the reigns of Thutmose IV and Amenhotep III that according to her share a common style (TT 63, 64, 74, 76, 77, 90, 91, 116, bearing the name of Thutmose IV; TT 78, 89, 201, 226, bearing the name of Amenhotep III, and TT 66, 118, 258, undated).³⁶ The depiction of Isis and Horus in scene 5 in TT 239 can be paralleled by depictions on stelae from the reign of Amenhotep III.³⁷

Wr “great one” was the common designation for representatives of foreign lands bringing tribute in private Eighteenth Dynasty tombs.³⁸ The two captioned figures in TT 239 are thus representatives of the two great West Asian powers Hatti and Mitanni, which Egypt could have been dealing with under Thutmose IV and/or early reign of Amenhotep III when Paenhut was in his office of the “overseer of every northern foreign land.”³⁹ It is well known that the coming of the great ones of Hatti and Mitanni is already attested in royal records of



FIGURE 1: TT 239, scene 3, color photograph, 2023 (from Ilin-Tomich 2024).

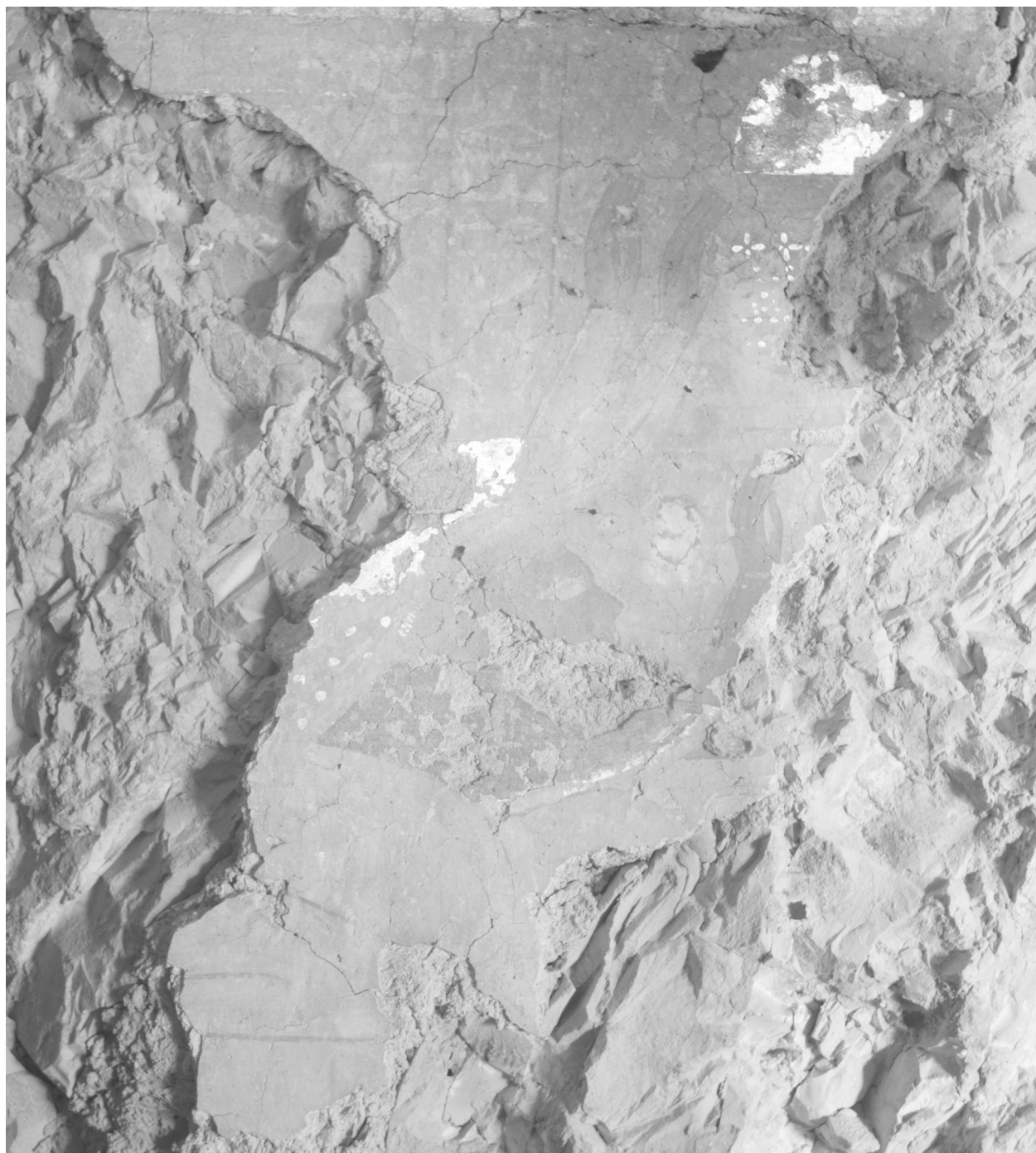


FIGURE 2: TT 239, scene 3, detail, visible-induced infrared luminescence photograph (VIL), 2023 (from Ilin-Tomich 2024).



FIGURE 3: TT 239, scene 3, detail, visible-induced infrared luminescence photograph (VIL), processed against the background of non-VIL near-infrared photograph (based on photos from Ilin-Tomich 2024).

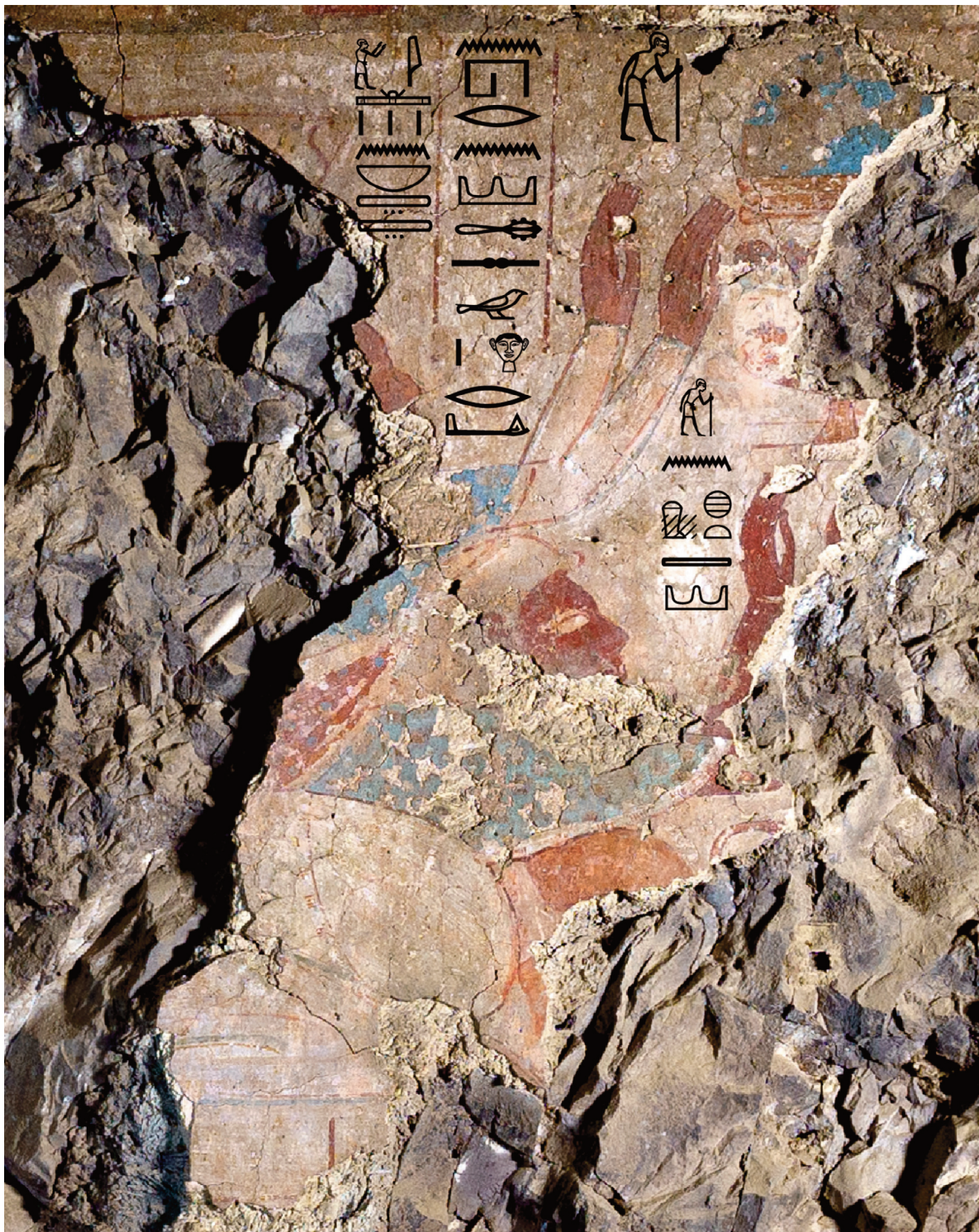


FIGURE 4: TT 239, scene 3, detail, color photograph from FIGURE 1 overlaid with a hieroglyphic rendering of the inscription visible in FIGURES 2 and 3.



FIGURE 5: TT 239, scene 3, inscription, now lost, read by Gardiner and Davies. Based on handwritten hieroglyphs in Davies MSS 11.2.42 and Gardiner MSS AHG 23.72.126-126a (both in the Griffith Institute, Oxford).

Amenhotep II,⁴⁰ and it is generally assumed that primarily diplomatic relations with both powers were maintained under Thutmose IV, manifested by the marriage of Thutmose IV to a Mitanni princess, mentioned in Amarna letter EA 29.⁴¹ It was proposed to view other depictions of Mitanni emissaries in private tombs from the time of Thutmose IV in the context of these relations.⁴²

Important is the epithet *hs* “wretched” after the name of Mitanni. In connection with a possible restoration of a Karnak offering list of Thutmose IV, proposed by Helck,⁴³ it was argued that that this epithet could not possibly be placed after the name Mitanni in the time of Thutmose IV and, more than that, at no point after Thutmose III.⁴⁴ The new evidence of TT 239 invalidates this line of argumentation.

According to Hallmann, there are only three Eighteenth Dynasty private tombs before the Amarna period portraying representatives of Mitanni among the tribute bringers (TT 84, from the

reign of Amenhotep II, and TT 90 and TT 91, from the reign of Thutmose IV), and only one mentioning the land Hatti (TT 86, from the reign of Thutmose III). Wreszinski claimed that the tribute scene in TT 91 also depicted a Hittite below the representative of Mitanni,⁴⁵ but since the name of the land Hatti cannot be found in the available photographs and copies of texts from the tomb,⁴⁶ he must have misread, as Hallmann suggested, the damaged preposition *hft* in the line accompanying the scene for *Ht* “Hatti”.⁴⁷ Thus the inscription in TT 239 adds the fourth known representative of Mitanni and the second known representative of Hatti in pre-Amarna private tombs.

Several scholars have discussed the depiction of the Hatti representative in TT 86 (Menkheperreseneb), pointing out that the image diverges from artistic convention for depicting Hittites, which emerged later in the Amarna period or in the Nineteenth Dynasty (and it does not match the emblematic depiction of a Hittite person from the Kom el-Hettan temple of Amenhotep III,⁴⁸ either). It was a mere generic depiction of a person from Syria.⁴⁹ The newly identified depiction of a representative of Hatti in TT 239 does not differ in this respect from that in TT 86, corresponding to one of generic images of northern Levantines (Syrians), common in the period.⁵⁰ The same is true for the representatives of Mitanni in tombs of the Eighteenth Dynasty before the Amarna period. Whereas scholars recognize the iconographical type later associated with Mitanni in some uncaptioned representations in pre-Amarna tombs,⁵¹ the depictions of people explicitly labelled as originating from Mitanni are all generically Syrian, and TT 239 is no exception.

The leaders of the tribute bringers in TT 239 are arranged in a tightly packed composition (FIG. 6): one foreign leader kisses the earth, while two others kneel and raise hands in an adoration gesture right next to him, and the foremost tribute bringer stands behind them holding a large object. The postures of the three leaders, whose figures are superimposed, are visual equivalents of the common phrases *sn-t3* “kissing the earth” and *rdjt j3w* “giving praise,” and it makes perfect sense that the second phrase is now seen on a VIL photograph. One can hypothesize that the first phrase appeared in the now lost caption for the figure of the foreign leader kissing the earth, probably also giving the name of his country.

This particular composition occurs in several other

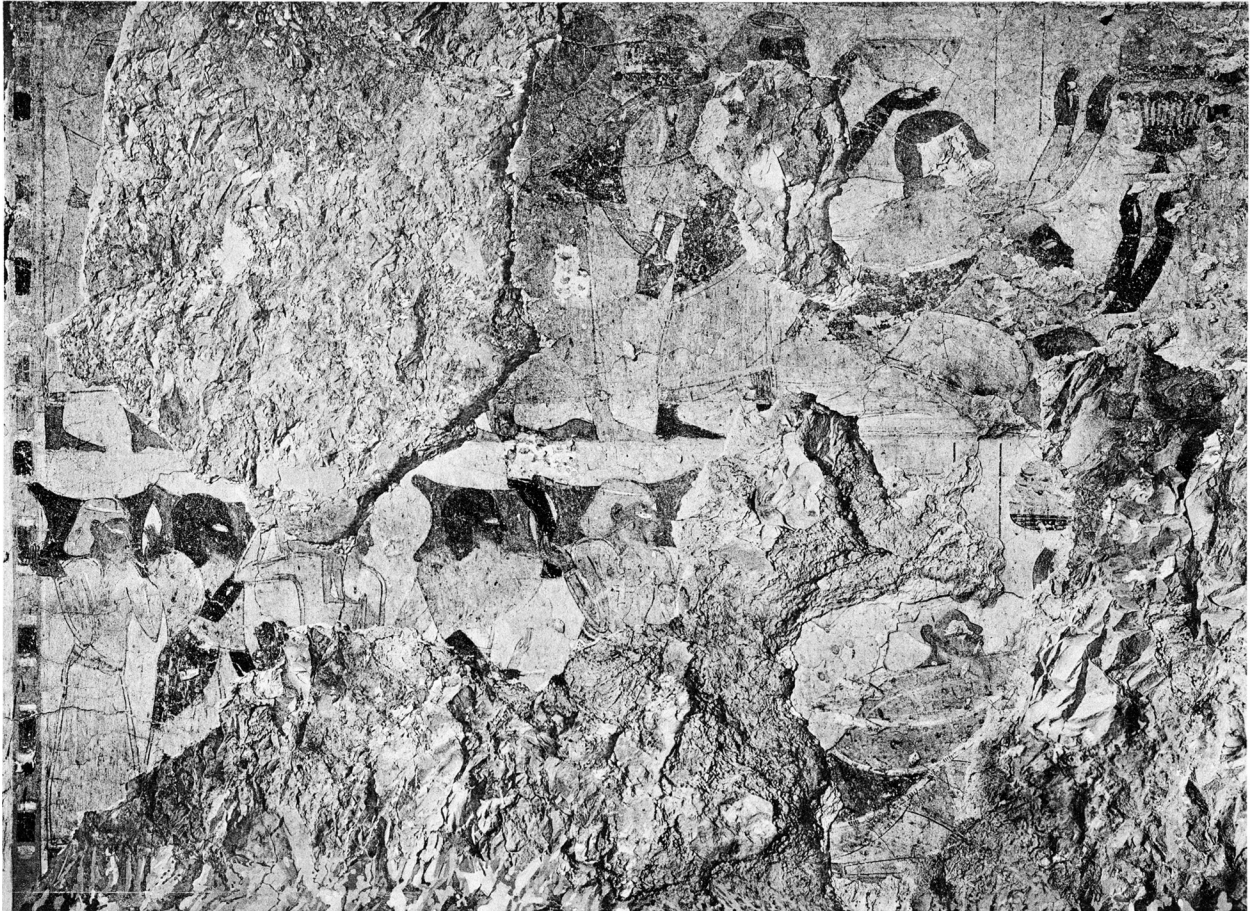


FIGURE 6: TT 239, scene 3 (from Wreszinski 1923, pl. 373).

Eighteenth Dynasty private tombs before the Amarna period. Three of them, TT 63 fragment BM EA37991⁵² (FIG. 10), TT 78 scene 8.III,⁵³ and TT 91 scene 5⁵⁴ (FIG. 7), belong to the same group of stylistically close tombs from the time of Thutmose IV and Amenhotep III, defined by Hartwig, to which also belongs TT 239. Two other examples date from the reign of Amenhotep II: TT 42 scene 5⁵⁵ (FIG. 8) and TT 85 scene 17⁵⁶ (FIG. 9). In one even earlier tomb, TT 86 scene 8,⁵⁷ from the reign of Thutmose III, an earlier version of a similar group appears with all figures still visually separated from one another rather than superimposed.

Having that many attestations of one and the same scene it is difficult to reconstruct the tradition of this vivid composition. Shelley Wachsmann favored the

idea of pattern books used by the artists for creating tribute scenes rather than copying directly from earlier tombs.⁵⁸ The Egyptological concept of pattern books has since come under severe criticism in general⁵⁹ and in application to tribute scenes.⁶⁰ Recent studies on intericonicity in the Eighteenth Dynasty Theban necropolis have suggested various other ways of how scenes could be transmitted in Theban tombs.⁶¹

One well-described mechanism was intentional adaptation of tomb decoration schemes and single decorative features from tombs of predecessors holding the same offices as the tomb owner.⁶² The relation between the owners of TT 239 from the reign of Thutmose IV and of TT 42 from the reign of Amenhotep II fits perfectly into this pattern, for they

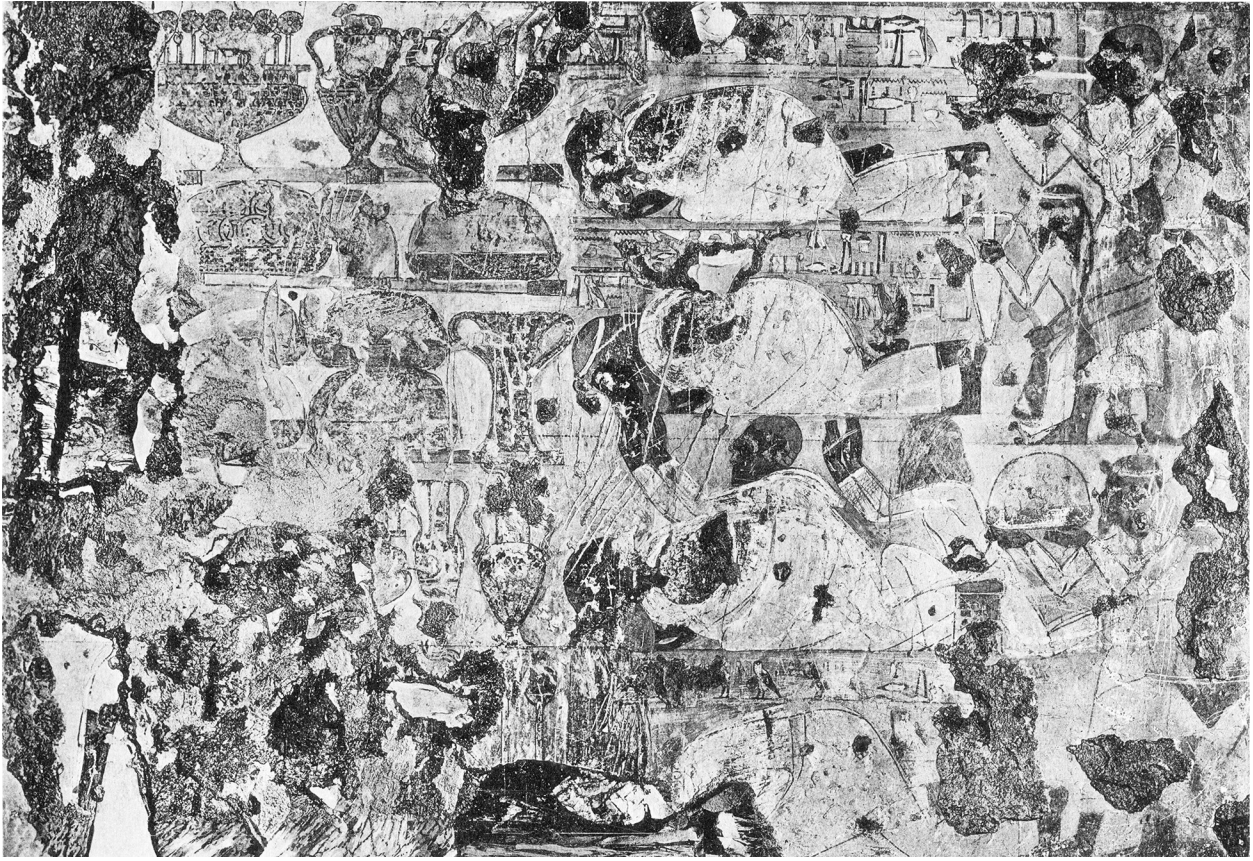


FIGURE 7: TT 91, scene 5 (from Wreszinski 1923, pl. 290).

both were overseers of northern foreign lands, and whereby TT 42 was much larger than the decorated part of TT 239, as already pointed out by other researchers,⁶³ they share the same arrangement of tribute scenes on two adjacent walls—the small left wall and far left wall of the hall. The scenes on the small left wall (scene 4 in TT 42⁶⁴ and scene 2 in TT 239⁶⁵) seem to have in common only that they are both tribute scenes and feature a figure bringing a large broad vase, whereas TT 42 has neither Syrian emissaries bringing horses nor Nubian emissaries—the only remains of decoration in TT 239 documented by Max Burchardt's expedition. The far left walls (scene 5 in TT 42 and scene 3 in TT 239) have much more in common, including the composition in question. TT 42 shows, from right to left: the king on the throne, the figure of the tomb owner, foreign vases, emissaries, and tribute bringers. The figure of the king was destroyed in TT 239 by the

time when Davies and Gardiner described the tomb, and it is as well unclear whether the tomb owner was depicted between the king and the emissaries, but the rest of the scene is generally similar to TT 42, differing in details: Syrians bring other tributes, have other clothes and hairstyles, and are arranged much more densely, owing to the lack of space. It thus appears quite plausible that the group of three representatives of foreign lands kissing earth and giving praise in the tomb of Paenhut TT 239 was directly copied from the tomb of his predecessor in office TT 42.

Interestingly, TT 42 must not have been the only early inspiration for the tribute scene in TT 239. Four men in the second register of scene 3 in TT 239 are carrying metal ingots on their shoulders—this offering is otherwise unattested in tombs from the time of Thutmose IV and Amenhotep III. Pre-Amarna attestations of this motif in private tombs all

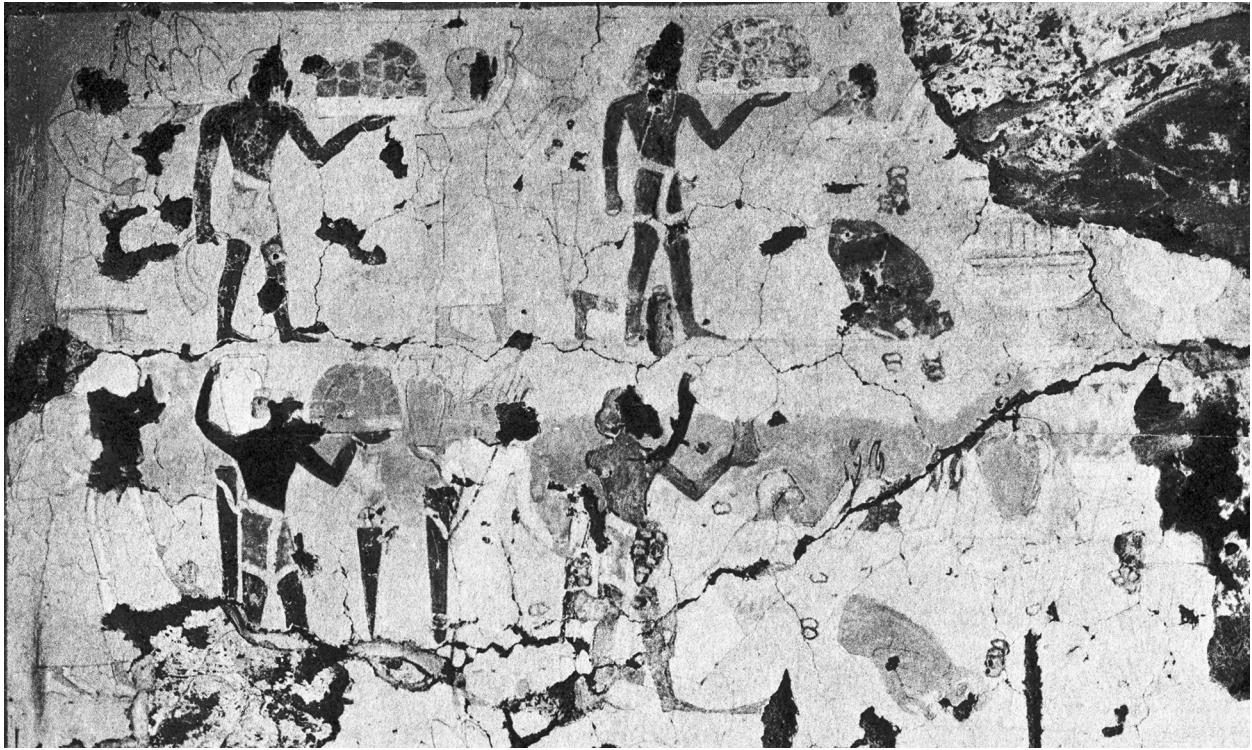


FIGURE 8: TT 42, scene 5, detail (from Wreszinski 1923, pl. 88a).

date from the reigns of Thutmose III and Amenhotep II: TT 17, TT 39, TT 100, TT 119, TT 131, TT 256, and TT 276.⁶⁶ One of these tombs beside TT 42 probably could have served as another source of inspiration for the artists behind TT 239.

A further untypical feature of this scene is the fifth man situated between two pairs of ingot-bringers in the second register bearing a naked child on his shoulder—a posture otherwise unattested for men.⁶⁷

As concerns the tombs contemporary to TT 239, the analyses by Melinda Hartwig and earlier by Max Wegner⁶⁸ highlight particular similarities existing between the tribute scenes in TT 239 (FIG. 6) and TT 91 (FIG. 7). Scenes in both tombs are labelled as depictions of the great ones of Mitanni and share common costumes and hair styles. Hartwig pointed out that both tombs share the same strong outline defining the hands in the adoration gesture, which she compares to depictions of hands in Amenhotep III's palace at Malkata.⁶⁹ Thus, the occurrence of the same group of foreign representatives in TT 239 and

TT 91 could be a case of scenes being shared across different tombs decorated by the same artist(s).⁷⁰

To what extent it could also be true for other tombs belonging to the group of private tombs from the reigns of Thutmose IV and Amenhotep III, defined by Hartwig, remains questionable. In the case of TT 63 (FIG. 10) there seem to be more reasons to consider its tribute scene directly influenced by another tomb from the reign of Amenhotep II, TT 85 (FIG. 9).⁷¹ Although the male owners of the two tombs do not appear to be connected and the two Sheikh Abd el-Qurna tombs are not particularly close to each other, both tombs prominently feature royal nurses—the owners' wives. These two tombs feature similar depictions of the foremost offering bringer leading a child by the hand, shown behind after the discussed group of foreign representatives. They also exhibit a similar rendering of costumes. In addition, the two tombs have other common elements, such as the jackals on the false door⁷² and depiction of a nurse with a royal child sitting on the lap.⁷³

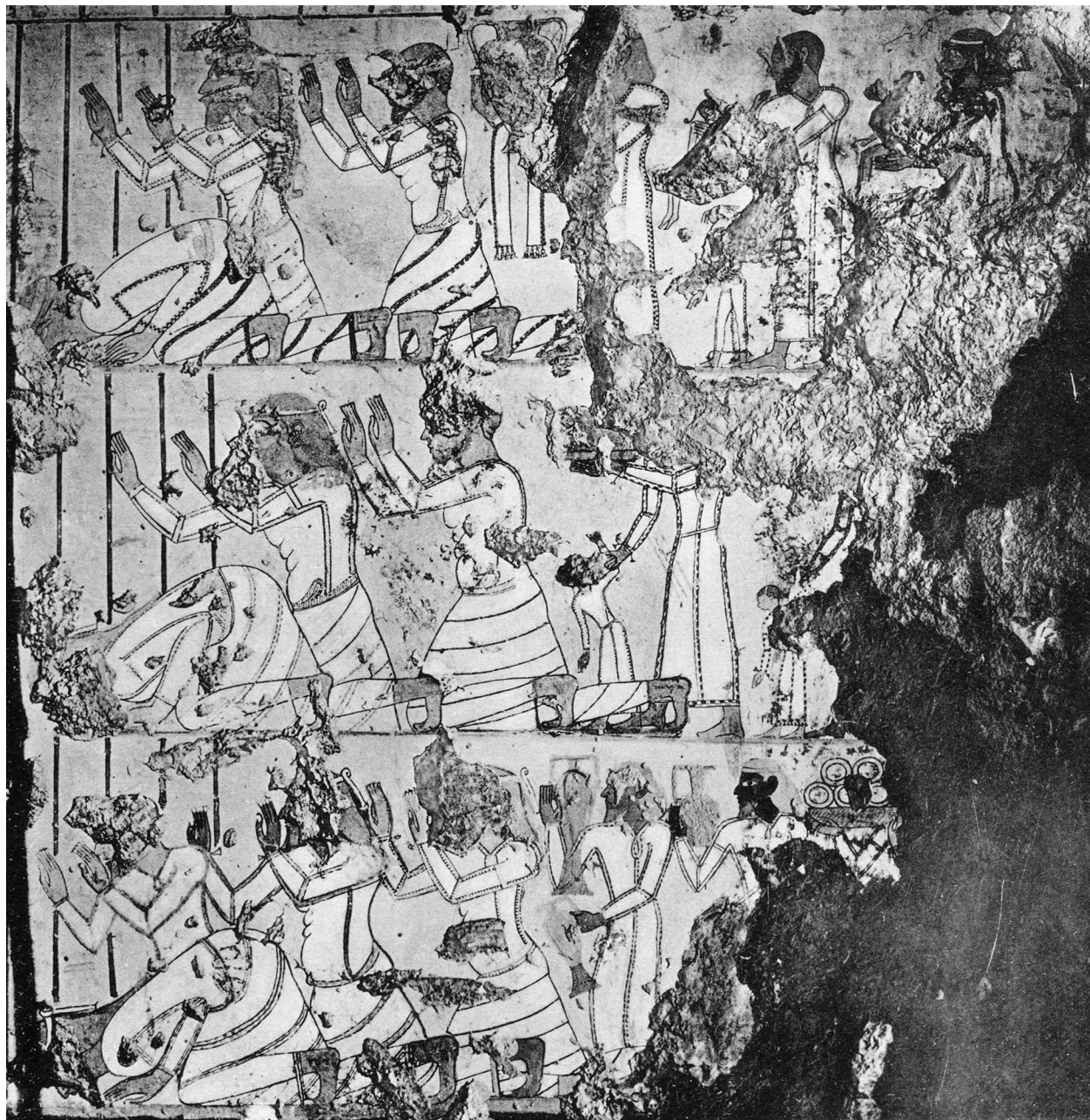


FIGURE 9: TT 85, scene 17 (from Wreszinski 1923, pl. 4a).



FIGURE 10: TT 63, fragment British Museum EA37991 (© by The Trustees of the British Museum; all rights reserved).

The two phrases *sn-t3* “kissing the earth” and *rdjt j3w* “giving praise,” to which the discussed group of foreign representatives kissing earth and raising hands in praise to the king visually corresponds, and of which only *rdjt j3w* is preserved in TT 239, do occur as captions to the group in some of the other tombs. Tomb TT 86 from the reign of Thutmose III already features the phrase *rdjt j3w n nb t3w sn-t3 n nfr-nfr jn wrw nw t3 nb ...* “Giving praise to the lord of the two lands, kissing earth for the fair god by the great ones of every land ...” next to the scene.⁷⁴ Similarly, tomb TT 85 from the reign of Amenhotep II, which already features superimposed figures of foreign represen-

tatives, has the phrase *rdjt j3w n nb t3wj sn-t3 n H^c-m-[W3st ...]* “Giving praise to the lord of the two lands, kissing earth for the One-who-appears-in-[Thebes (Horus name of Thutmose III)...]” in the same position.⁷⁵ Among the attestations of the group from the reigns of Thutmose IV and Amenhotep III, a similar phrase appears as a caption above the scene in TT 91: ... *sn-t3 n nb t3wj wr sp-2 hft [j]w[t]=sn hr jnw=sn n nb t3wj* “... kissing earth for the lord of two lands very fervently upon [co]mi[ng] with their tributes to the lord of the two lands.”⁷⁶ It can thus be said that the caption newly read in TT 239 was one of the standard captions for this group transmitted

along with it, even if not attested or not preserved in TT 42. The phrases also occur as captions for figures of foreigners in similar postures that do not belong to the discussed group but are represented in other contexts.⁷⁷

Although graphic compositions and accompanying formulae could be passed from one tomb to another, it does not necessarily mean that the names of specific foreign lands occurring in tombs were also borrowed from older tombs. One could easily adapt the same composition to depict emissaries of other foreign lands, all the more so that the images of northern tribute bringers in the discussed tombs were rather generic. Thus, whereas the mentions of the great ones of Hatti and Mitanni in TT 239 should not necessarily reflect a historical state visit or diplomatic mission during Paenhot's time as the overseer of every northern foreign, the fact that scenes in his tomb stand in close relationship with other similar scenes in earlier and contemporaneous tombs alone does not affect the possible historicity of these scenes.

Many Theban tombs of the Eighteenth Dynasty were left unfinished, and therefore blank lines and columns prepared for inscriptions are a common sight in these tombs. With this short contribution I would like to raise the question: how many of these blank writing spaces might actually contain inscriptions in degraded Egyptian blue, invisible even to the most trained naked eye, as in in TT 239 scene 3? Capturing the infrared luminescence of Egyptian blue requires no special equipment, just an LED light, an ordinary photo camera converted for infrared photography and a screw-in IR-transmitting filter, blocking visible light. It can improve the visibility of features painted in Egyptian blue. I would advocate the adoption of this cheap and easy method of documentation not only by archaeometrists and conservators but also by colleagues documenting inscriptions and decoration.

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NOTES

- ¹ Piquette 2016.
- ² Van der Perre, Hameeuw, and Boschloos 2016.
- ³ Pieke 2020, 134–135; Hameeuw, Van der Perre, and Boschloos 2023.
- ⁴ Used in DStretch plugin (Harman 2020;) see also Evans and Mourad 2018.
- ⁵ Used in Hierax software package (Atanasiu 2021).
- ⁶ As when photographing papyri in the near-infrared spectrum to increase the contrast between black ink and the papyrus. Not only single reflectance images can improve the legibility of texts, but also the application of image enhancement software to stacks reflectance images taken in different parts of the spectrum. See Van der Perre et al. 2016a.
- ⁷ As when using near infrared to penetrate soot covering texts and decoration (see note 22 below) or to reveal overpainted texts and decoration.
- ⁸ Dyer, Verri, and Cupitt 2013.
- ⁹ Den Doncker and Tavier 2018.
- ¹⁰ Hartwig 2023, 92.
- ¹¹ Ajò et al. 1996, 42–43 fig. 7c; Pozza et al. 2000.
- ¹² Accorsi et al. 2009; see also Kakoulli et al. 2017; new data on excitation in the short-wave ultraviolet spectrum (around 250 nm) (Binet et al. 2021) are arguably of limited practical value for Egyptology, because of safety considerations associated with short-wave UV light sources. Verri (2009b, 1015) highlights the fact that visible light of any colour excites luminescence in Egyptian blue.
- ¹³ Verri 2009a; 2009b; Verri et al. 2010.
- ¹⁴ Verri 2008.
- ¹⁵ Bracci et al. 2015; Armstrong 2015; Coppola et al. 2017, 132–133; Abdrabou et al. 2018; Nicola, Musso, and Petacchi 2019; Abdrabou et al. 2022; Medina Sánchez 2019; Smith 2022, 206–207.
- ¹⁶ Dyer, Verri, and Cupitt 2013; Dyer and Sotiropoulou 2017.
- ¹⁷ Hallmann, Rickerby, and Shekede 2021; Coulon et al. 2021, 386–388; Fulcher 2022, 40.
- ¹⁸ Piquette 2018, 100–102.
- ¹⁹ Ilin-Tomich 2024.
- ²⁰ Verri 2008.
- ²¹ Harsányi et al. 2001; Vandenabeele et al. 2009; Abd El Aal 2011; Abd El-Tawab and El-Hassan 2021; Mancini and Sedikk 2023; Hartwig 2023, 92.
- ²² Díaz-Iglesias Llanos et al. 2022, 40–41; Repole and Shirley 2024.
- ²³ Dyer, Verri, and Cupitt 2013, 86–90.
- ²⁴ Verri 2009b; Dyer and Sotiropoulou 2017.
- ²⁵ Armstrong 2015.
- ²⁶ Vallet et al. (2022, 78) used four-color LED architectural lighting fixtures in red mode as the light sources for exciting the Egyptian blue luminescence. This equipment appears to be too powerful to run on batteries. Widely available red LED torchlights can be helpful for identifying rests of Egyptian blue, because they provide a narrowly focused beam of very bright red light, allowing the detection of Egyptian blue at short shutter speeds and without dimming background light. I tested a 620–630 nm red torchlight UltraFire H-R3 with three LEDs. It excites IR luminescence of Egyptian blue detectable at a shutter speed of 1/40 second both on a specimen painted with synthetic Egyptian blue (Kremer Pigmente #10060) and on Egyptian artifacts in the Liebieghaus museum in Frankfurt.
- ²⁷ Porter and Moss 1960, 330; Kampp 1996, 516.
- ²⁸ Description: Meyer 1913, 797; photos: 1973, nos. 621–622, 726–727.
- ²⁹ Wreszinski 1923, pl. 373, which is a combination of Meyer 1973, pls. 726 and 727.
- ³⁰ Hartwig 2004, pl. 10.1; she also reproduces Wreszinski's line drawing (2004, 244 fig. 44).
- ³¹ Davies MSS 11.2.42 and Gardiner MSS AHG 23.72.126–126a (both in the Griffith institute, Oxford).
- ³² S. Hallmann 2006, 84–87.
- ³³ El-Kadia, Zain El Abidine, and Al-Shaqra 2022; see also Brandt 2016, 2: 142–145; pls. 33–34.
- ³⁴ Schindelin et al. 2012.
- ³⁵ Wegner 1933, 131.
- ³⁶ Hartwig 2004, particularly, 31–33.

- 37 Radwan 1975.
- 38 For an overview of other *wr* “great ones” in Eighteenth Dynasty tombs, see Matic’ 2022, 76.
- 39 For this title and its other bearers during the Eighteenth Dynasty, see: Murnane 1997; Hirsch 2006.
- 40 Helck 1955, 17:1309.13–20; Bryan 1991, 336; Morris 2005, 132.
- 41 Bryan 1991, 336–339; Morris 2005, 132–136.
- 42 Bryan 2000, 79; Kahn 2011, 138.
- 43 Helck 1957, 19:1554.17.
- 44 Bryan 1991, 338–339; followed by Morris 2005, 133.
- 45 Wreszinski 1923, pl. 290; 1935, pl. 46; followed by Helck 1977; Sakurai, Kondo, and Yoshimura 1988, pl. 74; Darnell 1991, 113.
- 46 Helck 1957, 19:1597–1599 (524); Wilkinson MSS V, 150 (Bodleian Library, Oxford); Davies MSS, 11.1.110 (Griffith Institute archive); Das Digitale Schott-Archiv 6789–6806, 8322–8325; Meyer 1973, pls. 758–761.
- 47 S. Hallmann 2006, 83 n. 577; the word *hft* was still intact when copied by Champollion 1844, 839.
- 48 Sourouzian et al. 2007, 329–330, pl. 37(c).
- 49 Helck 1971, 328; Wachsmann 1987, 8; Schulman 1988, 57–58; Darnell 1991, 113; Oosthoek 1992, 338; S. Hallmann 2006, 29, 261–262, 270–271.
- 50 S. Hallmann 2006, 86.
- 51 Helck 1971, 330, referring to TT 120 and TT 226.
- 52 Dziobek and Abdel Raziq 1990, pl. 3 (d), 33; British Museum, n.d.
- 53 Porter and Moss 1960, 153–154; Brack and Brack 1980, pls. 47, 49; Wreszinski 1923, pl. 247; the bowing figures above the prostrate figure were already lost by the time of Champollion (1835, pl. CLVIII), yet it is clear that the leg bent at the knee and one of the heels must belong to a figure bowing in adoration.
- 54 Porter and Moss 1960, 187; Wreszinski 1923, pl. 290; Meyer 1973, pls. 758–760; Schott archive photos 6804–6805; Kozloff Brodkey 1977a, 1977b.
- 55 Porter and Moss 1960, 82; Nina de Garis Davies and Davies 1933, pl. XXXIV; Baud 1935, pl. VI; Wreszinski 1923, pl. 88 (a); Meyer 1973, pl. 802.
- 56 Porter and Moss 1960, 172; Wreszinski 1923, pl. 4 (a); Norman de Garis Davies 1934; Kozloff Brodkey 1977c.
- 57 Porter and Moss 1960, 177–178; Nina de Garis Davies and Davies 1933, pl. IV; Wreszinski 1923, pls. 273–275.
- 58 Wachsmann 1987, 12–25; Wachsmann (1987, 40) admitted exceptions from this rule.
- 59 Schenkel 1996, 148–150.
- 60 S. Hallmann 2006, 9.
- 61 Merzeban 2014; Laboury 2017.
- 62 Den Doncker 2017.
- 63 S. Hallmann 2006, 85 n. 585, 87; Feucht 1990, 184 n. 22 also pointed out that these two tombs had tribute scenes on the same two adjacent walls.
- 64 Porter and Moss 1960, 82.
- 65 Porter and Moss 1960, 330.
- 66 According to index in S. Hallmann 2006, 353; see also Wachsmann 1987, 50–53.
- 67 Compare other Eighteenth Dynasty scenes featuring foreigners bringing children in Matic’ 2015; TT 239 is not taken into account in that paper, which features no other examples of men bringing children on their shoulders.
- 68 Wegner 1933, 131.
- 69 Hartwig 2004, 33.
- 70 Devillers 2018; Merzeban 2014.
- 71 So already Polański 2000, 202.
- 72 Hermann 1940, 39; Brandt 2016, 2: 46.
- 73 TT 85: Gathy 2012, pl. 29 (2). Reconstructed in TT 63 based on the preserved caption: Dziobek and Abdel Raziq 1990, 67–68, text 20c.
- 74 Nina de Garis Davies and Davies 1933, pl. IV.
- 75 Norman de Garis Davies 1934, pl. XXV.
- 76 Champollion 1844, 839.
- 77 S. Hallmann 2006, 295.