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The Tutankhamun-Nefertiti joint burial hypothesis: a critique

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Abstract:

This article reviews and evaluates the hypothesis that Nefertiti is entombed behind the north wall of the burial chamber in KV62, the tomb of the pharaoh Tutankhamun in the Valley of the Kings. Egyptologist Dr. Nicholas Reeves first formally proposed this in print in 2015. The current article now evaluates the results of three radar surveys carried out to test the hypothesis, as well as the wider arguments put forward to both support and refute the hypothesis. Based on an analysis of all three main classes of evidence (superficial wall irregularities, circumstantial art-historical details, and hard radar data), the current study finds that the corpus of evidence stands overwhelmingly against the hypothesis. Despite this, the study also finds that the main proponents of the idea have not yet properly accepted the negative results of the investigations. Finally, this article should serve as an accurate and permanent record detailing how the project unfolded over time.

Introduction

The tomb of Tutankhamun, designated as KV62,[2] is one of the world's most famous archaeological sites. The tomb is part of the UNESCO world heritage area known as the Valley of the Kings, which the ancient Egyptians themselves called 'the field of truth' or Ta-sekhet-ma'at. It was the necropolis for many of the rulers of ancient Egypt during the 18th through 20th dynasties. Although the valley was well hidden in the mountains west of ancient Thebes (modern day Luxor) and west of the banks of the Nile River in Upper Egypt, most of the royal tombs were looted in antiquity. Tutankhamun's was one of the few that evaded detection for the reasons discussed below.

In 2015, a hypothesis was published by Egyptologist Nicholas Reeves proposing that Nefertiti remains buried behind the north wall of the main burial chamber in Tutankhamun's tomb. As Nefertiti possibly ruled as pharaoh for a period following her husband Akhenaten's death, it is indeed possible that she could have been buried in the Valley of the Kings. Following a careful analysis of the evidence, however, this article finds that the hypothesis that she is behind the north wall of the burial chamber in KV62 is incorrect. The article demonstrates why this is the case, why inaccurate conclusions were drawn early in the project, and how they continue to be drawn by the main proponents of the theory following the conclusion of investigative work to test the hypothesis.

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1 University of Glasgow, Scotland, PhD in archaeology (2013). Ancient Egyptian history tutor at the university from 2008-2013 and co-editor of the Journal of Ancient Egyptian Architecture since 2016. He also holds a degree in mechanical engineering and has been involved with GPR surveys as geographical surveyor.

2 KV refers to the Valley of the Kings. The number 62 indicates that it was one of the last of the 65 tombs found in the valley. Other tombs in the Theban necropolises carry different designations, including TT.

The 2015 hypothesis proposed that Nefertiti was already entombed behind the north wall of what is now Tutankhamun's burial chamber, with all her burial equipment and personal treasures, when the tomb was re-purposed for Tutankhamun's own burial. According to the theory, he was her successor and had died prematurely, and had no tomb of his own ready to use. The section of the tomb containing Nefertiti was closed off and hidden from sight and was never detected by Howard Carter when he excavated KV62.

Soon after the hypothesis was published, the first of three radar data collection projects carried out by three different teams commenced. At first, there appeared to be indications that organic remains and metallic objects were indeed buried in a room behind the north wall, but by the time the third team had concluded their investigations, it was clear that was no chamber or body there.[3]

In the first instance, it is important to re-iterate that the Egyptian department of Antiquities and Tourism has already accepted the results of the final scans: that there is little to no chance that Nefertiti is buried behind the north wall in the tomb. The most recent and high-quality radar survey carried out by an experienced team from the Polytechnic University of Turin concluded that: "after careful data processing, no evidence of marked discontinuities due to the passage from natural rock to artificial blocking walls were found in the radargrams. It is therefore concluded that there are no hidden chambers immediately adjacent to the Tomb of Tutankhamun".

Despite the clarity of the final conclusions of the radar surveys, the main proponents of the Nefertiti theory continue to elaborate it as if it were still legitimate. Reeves continues to embellish the hypothesis with additional hidden chambers. One prominent academic Egyptologist, the current professor of Egyptian art and architecture at UCLA, has even gone so far as to claim that there was a deliberate cover-up of the evidence for political reasons.[4]

That is clearly a problematic viewpoint and situation to arrive at, but due to the complexity of the evidence and the discussions surrounding the tomb, and the Amarna Period in general, it is difficult for the general public and non-specialists to understand the confusion regarding the scientific results. One popular magazine editor recently called for a hole to be drilled through the tomb walls to resolve the uncertainty.[5]

The radar data is not the only evidence that can be employed to support or refute the hypothesis. Evidence from inside the tomb does, in fact, suggest that it was re-purposed and re-decorated for Tutankhamun, but it does not inevitably follow that Nefertiti is, therefore, hidden behind the north wall.

In order to resolve this situation, this article sets out all of the relevant evidence and arguments to clearly demonstrate how the evidence should be analyzed and to summarize how the conclusions of the research must be understood. This article also serves as an accurate and permanent record of how the project unfolded over time.

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3 Kennedy (2016).

4 On October 16th, 2020, the Egyptologist in question wrote online that "it's quite useful to use GPR as a foil to turn Egyptologists away for political reasons". In an interview on 11th February 2021, the same Egyptologist re-iterated this point as follows: "different radar teams have been brought in opportunistically to shut down certain questions". See the online interview with C.R. Woodside here: https://youtu.be/5csfQ3PXA0Q at approximately 1 hour 30 minutes. It is regretful that no scientific article has been written by this Egyptologist to justify these claims, particularly as the person has a high media profile and their views are widely heard.

5 Burzacott (2019), pp. 47-63.

The classes of evidence

The main classes of evidence used to evaluate the Nefertiti hypothesis can be organized and examined in order. The current article addresses the evidence in three main groups:

#	Evidence type	
1	Superficial	From the laser scans of the tomb wall surfaces (NOTE: these are not the radar scans, which can see through plaster and into rock).
2	Circumstantial	From the artistic program on the walls, and from architectural precursor tombs in the valley.
3	Geophysical	Hard scientific evidence from the radar scans.

Table 1. Classes of evidence covered in this review

Despite the disappointing results and some problematic methodology associated with the tomb in recent years, KV62 remains an excellent place to examine how scientific research can develop in real-world situations (fig. 1). Some of the best scientific archaeology has been carried out at the tomb over the years, and some of the most valuable lessons can be learned from the more problematic episodes. This article provides a chronologically ordered record of the main events that took place during the testing of the new hypothesis, so that future scholars can appreciate how the project developed over time. The conclusion of this article includes a more general evaluation of some of the more important epistemological issues that arose when considering the chain of events that took place to test the joint burial hypothesis.

Fig. 1. View to northwest looking at the entrances to KV9 and KV62, the tomb of Tutankhamun. The entrance to KV62 is several meters below that of KV9 and is hidden here by the berm walls that have been erected to protect it from flash flooding. Both tombs enter to the NW into the low mound (image courtesy of Piotr Matyia CC SA BY 3).

Background to the tomb

In 1323 B.C. a boy pharaoh called Tutankhamun died. He was a remnant of a glorious but ultimately failed 18th dynasty that had been subverted by his late father, the radical and reactionary reformer called Akhenaten (fig. 2). Tutankhamun was originally born as Tutankhaten in 1341 B.C., but he changed the theophoric part of his nomen to Amun by the time he died as pharaoh at only 18 or perhaps 19 years old. By that time, the older religious traditions had been revived and the Amarna court had returned to Thebes. Tutankhamun had reigned from c. 1332 B.C. for approximately 9 years and seems to have died unexpectedly or prematurely. He was hastily buried with all

the opulent trappings of his most decadent predecessors in a small tomb fairly low in the hidden valley where the Theban pharaohs had been interred since the beginning of the 18th dynasty.

The tomb was broken into sometime soon after it was closed off, but damage was limited, and it was subsequently re-sealed. Its position meant that it was easily covered by debris from flash flooding, and this seems to be what occurred. The tomb of Ramses V, KV9, reused by Ramses VI, was then built directly above KV62 around 80 years later, and debris from the excavation of that tomb may have further buried the entrance to KV62. Workers' huts were also built over the accumulated material, and so Tutankhamun's tomb lay hidden for more than three millennia.[6]

Thirty-two and a half centuries later, in 1922 A.D., English archaeologist Howard Carter found the tomb almost entirely intact. He had suspected that another pharaonic tomb was still hidden in the area. Despite the fact that Tutankhamun's existence had been wiped from the historical record by the ancient Egyptians themselves, the effort was not completely successful. As a remnant of the Amarna regime, he was not considered to be a legitimate pharaoh following his death. Based on the few attestations that did survive, Howard Carter guessed that his tomb was still in existence, although hidden, and he eventually found it. It took Carter eight years to meticulously extract the tomb's contents, and in the years that followed, he revealed the magnificence of the tomb's treasures to the world.

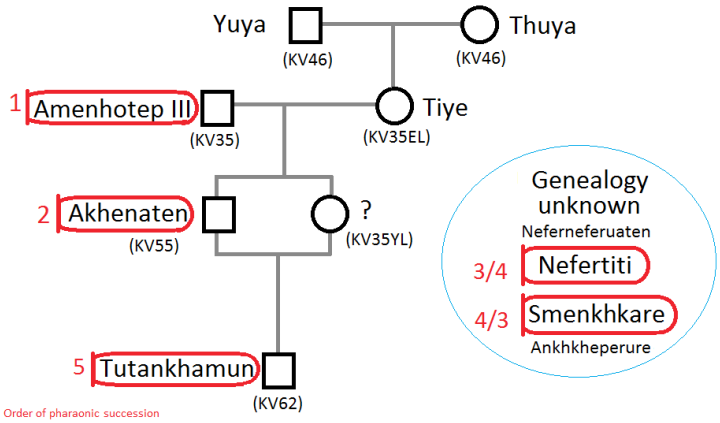

Fig. 2. Genealogy of Tutankhamun and the order of pharaonic succession over the Amarna Period. Find locations of bodies of the extended Amarna family are included where known. The order of succession is based on the most commonly accepted interpretation of the data available at present (David Ian Lightbody).

The tomb is accessed via a stairway leading down from the central wadi into the hillside on the west side of the lower valley. At the bottom of the steps is a long declining corridor leading to a tight group of four chambers, now known as the antechamber, the burial chamber, the treasury, and the annex. The entrance to the tomb was sealed when it was discovered by Carter, as was the entrance to the annex. A wall had been erected between the antechamber and the burial chamber but the door from the burial chamber to the treasury had been left open. The tomb seems to have been constructed in a rather ad-hoc fashion. The linear dimensions, for example, do not equate to whole

6 Cross (2008).

cubits or round numbers of cubits, which might indicate careful pre-planning.[7] When discovered, all of the rooms were filled with Tutankhamun's funerary equipment. The main burial chamber contained a nest of gold, box-shaped shrines containing a stone sarcophagus that in turn contained nested gold coffins, and finally the gold death mask covering the pharaoh's body.

Only the bright yellow background covering the walls of the burial chamber, the room that drew the renewed attention of Nicholas Reeves, was decorated, using an artistic technique known as fresco-secco.[8] The north wall of the main burial chamber is adorned with three painted scenes, from right (east) to left (west) showing 1: Tutankhamun's successor Ay performing the 'opening of the mouth' ritual on his mummy, 2: Tutankhamun with the goddess Nut, and 3: Tutankhamun with his ka personified and his mummy as Osiris (fig. 5).

In Reeves' original hypothesis it was proposed that the decoration of the north wall hid an entrance to a second and earlier burial chamber containing Nefertiti.[9] Nefertiti was the Great Royal Wife of the pharaoh Akhenaten, and it is thought likely that she ruled herself for a period immediately following Akhenaten's death, perhaps after the short reign of an intervening pharaoh called Smenkhkare.[10] As such, it is conceivable that she could have been buried in the Valley of the Kings before Tutankhamun died.

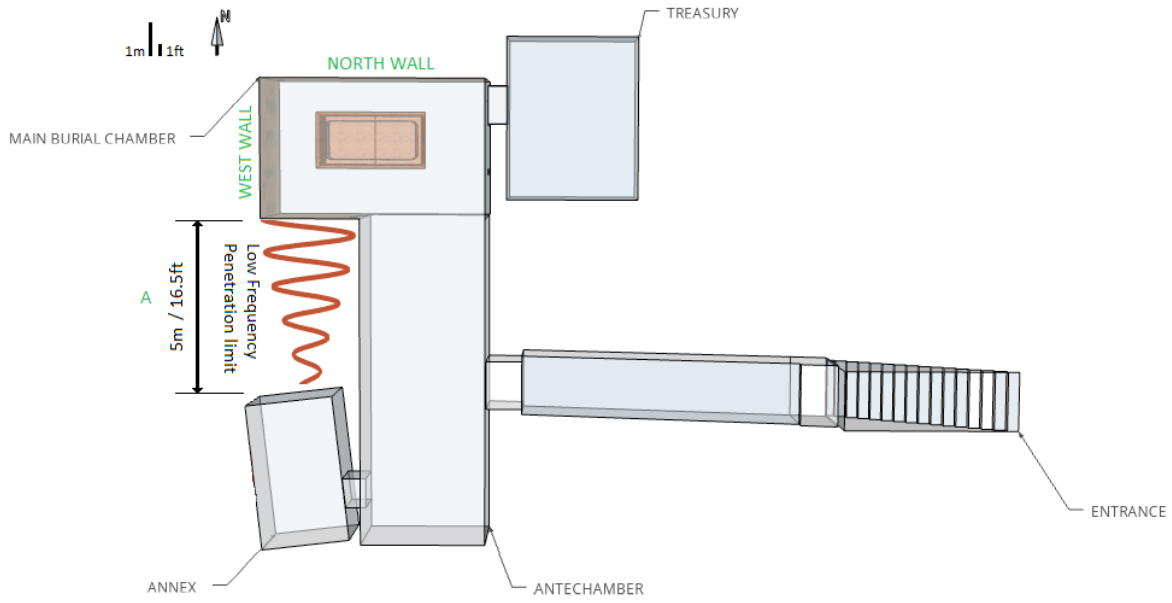

Fig. 3. Plan view of tomb KV62 of Tutankhamun showing layout and English terms used to refer to the chambers. The north wall of the burial chamber is the one that Reeves proposed hid the entrance to an earlier burial chamber containing Nefertiti. The wave form on the left represents a test carried out by the Turin team that allowed them to estimate the low frequency limits of the detection equipment operating through the rock matrix around KV62, originating within the burial chamber and aimed at the annex (model and image by Dave Lightbody CC SA BY 3).

7 Cf. Carter and Gardiner's (1917) study of the dimensioned plan of tomb of Ramses IV in the Valley of the Kings (KV2). The papyrus is now in Turin and used many whole numbers.
8 Lacovara (2017), p. 35.
9 Reeves (2015).
10 Habicht (2019).

Reeves also proposed that a second subsidiary room remained hidden behind the artwork on the west wall of the main burial chamber (fig. 4). He made both of these proposals based on a set of wall images taken by a company called Factum Arte, discussed in the following section.

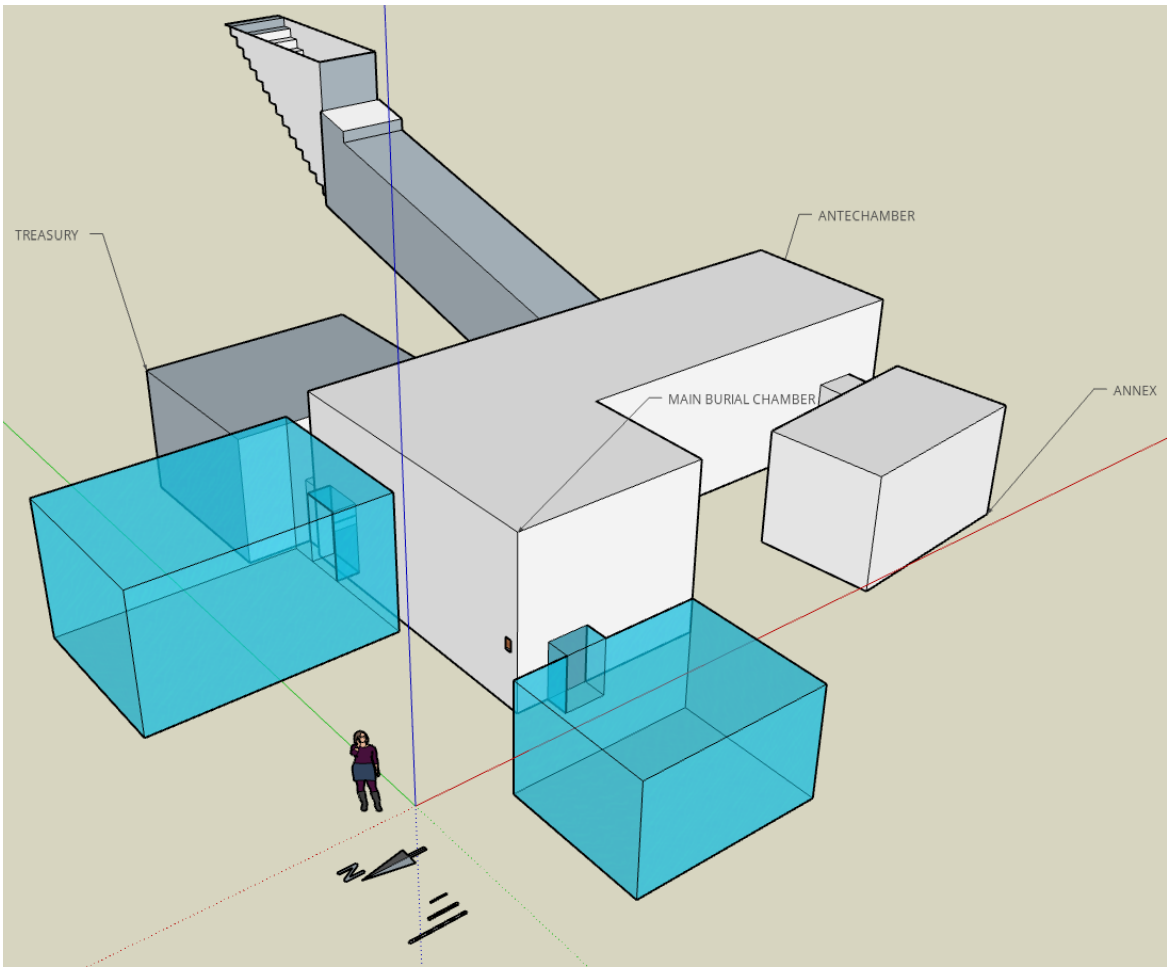

Fig. 4. Three dimensional model of tomb KV62 with blue chambers representing those originally speculated by Reeves in his 2015 hypothesis (image and model by Dave Lightbody CC SA BY 3).

Superficial evidence

Following a feasibility study in 2002, the Anglo-Spanish company Factum Arte proposed a project to construct a replica of Tutankhamun's tomb. They had already created high-quality replicas of KV34 starting in 2002, one of which was part of an international travelling museum exhibition.[11] The new project to replicate KV62 was approved in 2009 by the Supreme Council of Antiquities, and the company began work in March of that year to scan the interior of the tomb at a resolution of 600-800 DPI. The laser module they used only scanned the surfaces of the walls, albeit with very high precision. It was not a radar scanner of the types that were later used to test the 2015 hypothesis, which can see through or behind wall surfaces.

11 The current author visited this reconstruction at the National Museum of Scotland in Edinburgh and was very impressed by its quality. This was shortly after visiting the real KV34 in the Valley of the Kings.

Between 2009 and 2012, the Factum team, based in Madrid, used the laser and photographic data they had collected to manufacture a 3D facsimile of KV62. In 2012, Factum Arte had completed their reconstruction work and presented the structure to the people of Egypt on behalf of the European Union. In 2014, the full-scale replica of Tutankhamun's tomb was installed near the Valley of the Kings and opened to the public.

Factum Arte also put the laser scans and photographs online in a searchable way, making the collected data available to scholars around the world.[12]

Based on a close study of these laser scans, English Egyptologist Dr. Nicholas Reeves proposed in 2015 that Nefertiti was still buried behind the north wall of Tutankhamun's burial chamber. This hypothesis, which was published on Academia.edu as a preliminary proposal and was, therefore, not peer-reviewed, was heavily based on the information that was placed online in the laser scans. Despite the preliminary nature of Reeves' document, the news went viral in the global media.

Reeves had supposedly identified some surface features on the plaster of the walls shown in the Factum Arte laser scans that indicated the existence of structures below the surface, which he interpreted as door frames and lintels. The faint lines were, however, on the surfaces of the walls, not behind them or under the plaster or paint. What Reeves had really identified were light marks on top of the plaster and paint. It should be noted that the reason that plaster was used by the ancient Egyptians was because it was efficient at covering over irregularities on the roughly cut stone surfaces that were usually the end result of quarrying the spaces out of the bedrock with copper chisels. The features on the surface do not, therefore, necessarily reflect what is under the plaster. The linear surface features he identified could equally have been made by a worker using a flat board to spread out the plaster. Even if they could be seen on the surface, subsurface linear irregularities could be stone bedrock features left over by systematic quarrying processes rather than door jams or lintels. Those possibilities were not made clear in Reeves' paper. Overall, the alternative interpretations he put forth and the conclusions he extrapolated from them seemed to stretch credulity.

Work in the tomb by the Getty Conservation Institute (2012-2014) to study the murals was unable to establish how thick the combined layers of paint and plaster really are. They carried out careful examination of the murals as part of the wider collaborative project between the Getty Conservation Institute and the Egyptian Ministry of State for Antiquities to ensure the long-term conservation and management of the tomb of Tutankhamen.[13] During that research work they established that there were significant variations in technique used around the burial chamber and that multiple layers of paint and plaster had been applied.[14] Any theory drawing conclusions about the subsurface architecture based on features on the decorated wall surfaces is, therefore, questionable.

More problematic were phrases used in the 2015 paper, including in the abstract where Reeves wrote: "Recently published, high-resolution scans of the walls (...) reveal, beneath the plastered surfaces of the painted scenes, distinct linear traces". Similarly, on page one he wrote: "For the archaeologist these files possess a further potential to be investigated here: namely, what they might be coaxed to reveal about the architecture of the tomb beneath this decoration. The short answer seems to be: a great deal". Finally, on page five he wrote: "Close examination of these surface scans reveals, beneath the plaster, several features in shallow relief". Upon close reading of these paragraphs there seems to be some ambiguity in the mind of the writer as to what was on top of the wall surfaces and what was under them. It is possible that Reeves was exaggerating the significance

12 https://www.factumfoundation.org/pag/1548/the-facsimile-of-tutankhamuns-tomb-overview

13 Wong (2013).

14 Wong, Rickerby, Phenix, Rava, and Kamel (2012).

of the superficial evidence to convince readers that his analysis was correct, but it is also possible that he had not fully appreciated that the laser scans could not see through the top surface of the plaster at all. Either way, there were problematic aspects in the presentation of the hypothesis and the superficial evidence from the very beginning.

Circumstantial evidence

As well as the surface scans, Reeves assembled a body of circumstantial evidence to support his theory. This was derived from 1) an analysis of the artistic program on the walls of the tomb, and 2) comparison of the architecture of KV62 with the other tombs in the valley.

In his analysis of the artistic program he argued that the figures of Tutankhamun within the set of sacred scenes chosen for the north wall had originally been images of Nefertiti. According to his theory, the north wall had been reworked for Tutankhamun once the boy pharaoh had died and once the tomb had been chosen for his unexpected burial. One argument he put forward to support this was that the yellow paint on the north wall had been painted around the figures, whereas on the other walls it was used as an underlying background color and the figures were painted onto it.[15] This could possibly have indicated that figures were already on the north wall when the chamber was painted yellow for use as a burial chamber for Tutankhamun - a 'pr-nbw' or house of gold. If one follows this line of thought, then the north wall must already have been decorated and have hidden the entrance to Nefertitit's own burial chamber. As already mentioned above, however, the Getty Conservation Institute noticed other variations in techniques between the walls all around the chamber, so this difference can hardly be considered conclusive. There are other plausible explanations for this situation to have arisen, including a desire to avoid using excess yellow paint unnecessarily when decorating the larger figures on the north wall.

Many of the other specialists in the field of tomb artworks disputed Reeves' claims shortly after he had published the hypothesis. Tom Hardwick of the Houston Museum of Natural Science and Traugott Huber of the University of Zurich, both experts in the field, provided critiques and counter-arguments regarding the artistic interpretations that Reeves had made, in particular regarding the facial features of the figures. According to the theory, names identifying representations of Nefertiti and her successor Tutankhamun had been reworked to name Tutankhamun and his successor, Ay, respectively.[16] Reeves argued that the original identities of the figures could be deduced from the facial features that remained unchanged, but as Tom Hardwick put it, the problem is that "Tut looks like Tut and Ay looks like Ay, as we have always assumed".[17]

The circumstantial arguments Reeves gathered were also weakened by the many uncertainties regarding the real identities of the people involved in the Amarna era and its aftermath (fig. 2). The identities of Tutankhamun's parents have never been known with any degree of certainty, despite the fact that their bodies have been recovered.[18] DNA evidence has indicated that the bodies in KV55 and KV35 are those of Tutankhamun's parents, but they had no names with them.[19] Traditionally it has been assumed that the body from KV55 is Akhenaten, but more recent theories have suggested that the body could belong to the short lived pharaoh named Smenkhkare.[20] Similarly, it has recently been convincingly argued that Tutankhamun's mother was not Nefertiti, but a wife of

15 Reeves (2015), p. 9.
16 Reeves (2019), p. 5.
17 Hardwick (2015).
18 See Dodson (2020) for the most up-to-date and comprehensive discussion of the evidence and major hypotheses to date.
19 Hawass, Gad, Ismail *et al.* (2010).
20 Allen (2009), p. 19, footnote 67.

Akhenaten who was also his sister and a daughter of Amenhotep III.[21] Alternatively, there is still a possibility that the body KV35YL is indeed Nefertiti, but this would certainly undermine any case that she is still in KV62.

In addition, the high-status individuals involved typically bore several names during their lives, and their names sometimes changed during their lifetimes. The names were often theophoric in nature, rooted in the name of the gods they worshipped, so they often changed when the gods they worshipped changed, as was the case for Tutankhamun himself. The prosopographic evidence indicating the relationships between all those involved in the Amarna Period, and during its period of decline, remains very unclear.

Fig. 5. Image on left of northwestern corner of the burial chamber, and image on right of north wall showing figures with disproportioned heads that do not conform to the Amarna canon or the more conventional 18th dynasty canon of proportions (image on left courtesy of Editorfrommars CC BY-SA 4.0.; image on right is in the public domain).

Circumstantial evidence cannot prove a hypothesis but it can provide support for one when the various pieces can be knitted together effectively into an over-arching narrative. But here, there are too many unknowns and there is too much uncertainty to produce a compelling story.

The second body of circumstantial evidence Reeves presented was an analysis of the architectural layout of the chambers in the tomb. He argued that the other pharaonic tombs in the valley typically had four annex rooms connected to the main burial chamber, and so Tutankhamun's tomb should also have four annex rooms connected off the main burial chamber. This would mean that three rooms are still to be found.

In this case it is worth referring to the Egyptian tomb architecture from the Old Kingdom, when the great pyramid tombs of the pharaohs were first constructed. They were similarly built as a sequence of pharaonic tombs, in one specific necropolis area, over a few centuries. They similarly give the impression of conformity and repetition of design, but closer study shows that each iteration was in fact a new expression of traditional ideas. The intention was to maintain an impression of continuity, but innovations were the rule rather than the exception.

Multiple factors influenced the architectural choices made for each tomb. Because they were pharaonic tombs typically built during the lifetimes of the pharaohs, there were many theological issues

21 Hawass, Gad, Ismail *et al.* (2010), p. 641.

to consider, but there were also strict time restraints on the projects and other external factors. Economic and labor issues could impact the projects. There were often structural concerns, topographical limits, and in the Valley of the Kings, other tombs to avoid. Pharaohs often died prematurely, so plans were curtailed, or they sometimes lived much longer than expected, so extensions were added. The designs did follow earlier models, but only on an ad-hoc basis. The precursors can, therefore, be used only as a guide to what might be expected, not as proof of what is certainly there. This is particularly true for periods of disruption such as the Amarna and post-Amarna era when the architecture was certainly ad-hoc to significant extents.

Reeves also suggested that because a right-hand turn was required to reach the burial chamber then it was clearly constructed for a female.[22] Within this argument, the tombs for males had long central sequences of rooms joined by a straight shaft, and the observation seems to make some logical sense at first sight. Some tombs in the Valley of the Queens follow a right-hand rule. On the other hand, some tombs in the Valley of the Kings originally built for men, such as KV20, which was originally built for Tuthmosis I but reused and extended by Hatshepsut,[23] and KV7, built for Ramses II, also have right turns on the way to the burial chambers.

Finally, Reeves suggested an evident change in the grid system used to draw the figures on the walls in proportion, from an Amarna-era 20-vertical-square grid to a post-Amarna-period 18-vertical-square grid.[24] This claim was based on earlier observations made by Gay Robins.[25] The 18-square grid was the more traditional of the systems probably utilized to construct murals and statues so that they looked realistic. Dylan Bickerstaffe,[26] however, has already highlighted how the artwork in KV62 does not adhere or conform to such rigorous systems. He referred to comments by Marianne Eaton-Krauss, who noted the inconsistencies in proportions that were probably the result of painters working in cramped conditions and under poor lighting after the shrines had been erected. This could have contributed to the rather mediocre quality of the paintings in general, and some anomalous proportions seen in the figures on the north wall in particular (fig. 5 right image). Their larger heads conform neither to the traditional nor the Amarna canons.[27]

A full art-historical analysis is not within the scope of this article, but it is clear that the circumstantial evidence and the arguments that drew on both the artistic program and the architectural layout for support have already been deemed unconvincing or incorrect by established experts in the field.

Hard evidence from the radar scans

This section reviews and forms a chronological record of the sequence of radar scans carried out at KV62 to test Reeves' theory, now referred to as GPR1, GPR2, and GPR3.

A year after the Egyptian revolution had ended, in June 2014, a new Minister of Antiquities called Mamdouh Eldamaty was appointed. He seems to have been keen to leverage the antiquities media to promote Egyptian tourism in the aftermath of the revolution. That may explain why the first radar scanning project to test Reeves' theory was quickly given permission to start work in KV62.

In order to test the 2015 hypothesis, the team needed to see what was under the surface and inside the walls, so a Ground Penetrating Radar (GPR) survey now referred to as GPR1 was carried out

22 Reeves (2015), p. 7.
23 Romer (1974).
24 Reeves (2015), p. 9.
25 Robins (1994).
26 Bickerstaffe (2020). See also Bickerstaffe (2021) for additional discussion of the architectural evidence.
27 Eaton-Krauss (2016), p. 115. See also Eaton-Krauss (2010), pp. 28-29 & 34; where inconsistencies of scale and proportion of figures on the north wall are illustrated.

in late 2015. Reeves' long-time colleague, Japanese scientist Hirokatsu Watanabe, used a single radar set functioning at an intermediate/low frequency of 400 MHz. A basic survey was taken running at one height along the north and west walls. The survey was not followed by formal publication of the results nor a peer-review, and it proved not to be repeatable, but at the time Reeves stated that "clearly, it does look from the radar evidence as if the tomb continues, as I have predicted". "The radar behind the north wall seems pretty clear. If I am right it is a continuation − corridor continuation − of the tomb, which will end in another burial chamber".[28]

Furthermore, the Egyptian antiquities department minister Mamdouh Eldamaty announced: "We said earlier there was a 60 percent chance there is something behind the walls. But now after the initial reading of the scans, we are saying now it's 90 percent likely there is something behind the walls". Watanabe added "There is, in fact, an empty space behind the wall based on radar, which is very accurate, there is no doubt".[29]

It should be noted here that there are known fissures running through the rock matrix around the Valley of the Kings including around KV62,[30] and some disturbances were visible in the preliminary scan printouts that were posted on notice boards at the valley on the day of the announcements. At first glance, however, it did not seem that any anomalies were visible that could have justified the conclusions that had been drawn with such confidence by the scan team themselves.

In December 2015, History Channel news reported that "preliminary results of a high-tech radar scan appear to confirm the presence of a secret chamber hidden behind the walls of King Tut's tomb". As the results had not been formally published, the author of the current article warned colleagues to be cautious about accepting the claims in the first instance.[31] In fact, the results of GPR1 were never formally published.

In March 2016, the minister of antiquities Mamdouh Eldamaty was replaced by the current minister, Khaled el-Anany. This seemed to have marked a sea-change in the approach taken by the Egyptian antiquities officials and a return to a more sober approach employing less wishful thinking.

The following month, a second round of scans now known as GPR2 was commissioned to be carried out by a National Geographic team using two radars. This time, Eric Berkenpas, an electrical engineer at National Geographic, was accompanied by Alan Turchik, a mechanical engineer.[32] They employed antennas operated at intermediate-low and intermediate-high frequencies of 400 and 900 MHz. They took 40 different scans of the walls at five different heights. They found no evidence of any void spaces. A formal report was produced, but it was only released to the Egyptian department of antiquities.

Public reports of the failure of the second survey to replicate the results of the first seem to have emerged at the second annual international Tutankhamun conference at the Grand Egyptian Museum held in Cairo over the weekend of 6th-8th May 2016. The fresh information and rumors about the tomb survey spread among the conference attendees, and the hidden chamber debate made global headlines again.

Almost two years later, in February 2018, a third radar survey team travelled to Luxor to carry out

28 Gamal-Gabriel (2015).

29 Knecht (2015).

30 Sambuellia *et al*. (2019), pp. 293-294.

31 Two months later when the promised results had not appeared, I wrote a long blog post Lightbody (2016) asking where and when the results would be formally published. See https://arkysite.wordpress.com/2016/02/04/nefertiti-or-noferti-ti-so-which-is-it/

32 Hessler (2016).

scans of KV62. This time the team was from the Polytechnic University of Turin and was led by Professor Francesco Porcelli. They had been commissioned to resolve the uncertainties caused by the first two conflicting surveys by carrying out GPR3. This time the team used three radar systems with multiple frequency bands ranging from low to high frequency. The low frequency radars can look further into the wall/rock, but have lower resolution. High frequency radars have higher resolution but can only see a couple of meters into the wall. High frequencies are, therefore, good for examining the surface layers and features, for example the multiple layers of plaster and paint applied over the excavated rock. The three scans at different frequencies[33] were carried out by three different scanning sub-teams, and no comparison between the results of the different scans was permitted before the independent data sets had been processed and conclusions drawn. The results of this third radar scanning project were reported in a peer-reviewed article published in the Journal of Cultural Heritage in May 2018.[34]

These scans were carefully calibrated to remove sources of interference. The team calibrated the scans by taking measurements through the rock masses between the existing rooms. They could see between the burial chamber and the treasury and so could measure how fast the radar was travelling through the rock over the known distance, and so they could measure how rapidly the radar signal was attenuating under those conditions. They were also able to determine that they could not see from the annex to the burial chamber (fig. 3 annotation A), even with the low frequency radar, so they were able to calculate the operating distance limits of their scanning equipment.

Scans of the burial chamber's north and west walls were taken in both vertical and horizontal directions with very close profile spacings. Overall, it was a very high-quality research experiment and the results were conclusive.

On the day of the publication of the project's peer-reviewed report, May 6th 2018, National Geographic reported that: "It's Official: Tut's Tomb Has No Hidden Chambers After All". "The third radar scan of the pharaoh's burial site conclusively shows that no additional mysteries lurk immediately behind its walls".[35] "A statement was released today on behalf of Mostafa Waziri, Secretary General of the Supreme Council of Antiquities, during the fourth annual international Tutankhamun conference, held at the Grand Egyptian Museum (GEM) in Giza". In the paper, the Italian team reported that "after careful data processing, no evidence of marked discontinuities due to the passage from natural rock to artificial blocking walls were found in the radargrams. It is therefore concluded that there are no hidden chambers immediately adjacent to the tomb".[36]

The Italian team added "finally, we agree with the conclusions of the second GPR survey, which did not confirm Watanabe's results… …we can conclude, with a high level of confidence, that Reeves' theory concerning the existence of hidden chambers adjacent Tutankhamun's tomb is not supported by the GPR data."[37]

To summarize the three scanning projects then, it is possible to say that the first scan was a basic quality radar scan employing one machine that showed almost nothing definitive. The results were over-interpreted to say that the data set possibly showed metallic objects, organic remains, and a void space.

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33 The three frequency bands used for GPR3 were as follows: low frequency (LF) 150–200 MHz, intermediate frequency (IF) 600–900 MHz, and high frequency (HF) 1500–3000 MHz).

34 Sambuellia *et al.* (2019).

35 Romey (2018).

36 Sambuellia *et al.* (2019), p. 288.

37 Daley (2018).

The second scanning project carried out by the National Geographic team was of significantly higher quality, employing two machines and collecting significantly more data, and it arrived at conclusions that contradicted those of the first scan. The new team concluded that there was no void space visible.

Finally, a third and calibrated set of radar scans of much higher quality using three independent systems operating at different frequencies confirmed the results of the second round of scans, and similarly concluded with a high degree of confidence that there were no voids.

Reeves did obtain data from the second round of scans and had it re-processed by an English radar expert. Ballard's analysis in Reeves' second paper[38] was reasonable. It did not arrive at any definite conclusions and confirmed that no void was found. Ballard nevertheless concluded that there was still a possible indication of a "back-filled" corridor or space behind the tomb's north wall. A particular signal at the east end of the north wall might have signified a filled corridor wall at that point, but there were no definite signals that could be securely identified as walls or corridors. The report seemed reasonable, and was certainly more circumspect with respect to the claims that were made following the conclusion of the first survey two years previously. Unfortunately, Ballard's conclusions were already superseded by the results[39] of the third set of scans by the time they were published.

More problematically, and based on his most recent paper published in October 2020, Reeves seems to have now rejected the conclusions of the radar scans entirely.[40] He now suggests that no fewer than three hidden rooms could be connected to the burial chamber.

Finally, it is important to mention data collected by a company called Terravision who recently carried out a radar scan of the exterior surface outside and to the north east of the tomb. Nature reported on 19th Feb 2020 that "radar clues reignite debate over hidden chambers" and "a new survey hints at a previously unknown space beyond Tutankhamun's burial chamber".[41] A cursory look at the Nature article and the illustrations it carried in more detail, however, reveals some issues. The article includes the phrase: "The findings − in an unpublished report, details of which have been seen by Nature". This is particularly problematic given that Nature's reputation relies on its rigorous peer-review system and open publication of data. The Nature article also included a graphic that appeared to show the radar scan projected down on to a plane level with the floor of Tutankhamun's burial chamber. Calculations for the current paper, based on the data from the Turin scans as well as the 3D model constructed for the present study, indicate that it would be impossible for a radar set to detect anything at the floor level from the surface using current technologies. The vertical height from the outside ground surface down to the floor of the burial chamber in that area must be in excess of 8 m, and so no floor level details would be visible to a surface-based radar. Portelli's calibrated survey experiments in the tomb showed that radar readings over 5 m cannot be expected through the stone matrix around KV62, and this indicates that the Nature diagram is not accurately representing the evidence collected by the Terravision team, and that wishful thinking is again impacting the processing of the data. The "feature", if it does exist, is probably much closer to the surface than is shown in the diagram. If it really is some sort of human-made structure, then it is perhaps more likely to be a tunnel leading into the hillside and passing by KV62 to the north, rather than a chamber at equal depth and associated with Tutankhamun's tomb. Again, the data has not been formally published and no raw information has been provided, so at this stage it cannot be treated as a serious proposal.

38 Reeves and Ballard (2019).
39 Ballard reinterpreted both the NGS and Turin data but preferred the NGS for his more detailed analysis.
40 Reeves (2020), p. 26.
41 Marchand (2020).

Discussion

It is clear that none of the three classes of evidence covered here provides compelling support for Reeves's theory. The superficial evidence is undermined by what is known about the structure and the use of plaster wall coverings and decoration. The circumstantial conclusions from the artworks have already been questioned by many experts in the field. In the case of the radar scans, it is possible to go further and to say that the evidence taken as a whole clearly contradicts the theory.

Taking a wider view of the whole project that encompasses politics, tourism, academic funding issues, and the media, it seems likely that the combined pressures of these factors compelled the Egyptologists involved to make some statements that were not entirely supported by the science or evidence. The political environment in Egypt at that time may be the most significant factor to take into account, as the government was focused on consolidating the new regime after the end of the revolution. The livelihoods of those working in the tourist industry depend to some extent on the perpetual generation of interesting and positive news about the country, so it is understandable that there was considerable pressure to arrive at positive conclusions that could be shared with the media. In that political climate any negative findings or contrary views could be misconstrued as intended to undermine the new Egyptian government and its new positive messaging. As such, a free scientific exchange of ideas, including contrary viewpoints, may have been difficult. A comparable scenario and similar outcome can be seen with the 'ScanPyramids' project that operated over roughly the same time period, and which arrived at conclusions that were also premature, were probably exaggerated, and were certainly presented as a great success.[42] In that case, however, there is no doubt that the raw data revealed new features. The problems here were more likely due to misinterpretations of the observed features on the muon scans rather than the invention of results.

While the reasons for wanting to arrive at positive outcomes are understandable, the ends certainly do not justify the means if the conclusions drawn are in fact false. If the indirect result of this period of research is a loss of confidence in particular scientific techniques and in the scientific method per se then the cost was surely too high.

The Egyptian Department of Antiquities and Tourism seems to have understood that a sea change was taking place in mid-2016, and it seems to have consciously turned its focus back to more traditional archaeology and a more sober scientific approach. Zahi Hawass maintains his colorful and hyperbolic narratives in 2021,[43] but it is surely now time for Reeves and the western academics who have promoted his narrative to accept the hard facts regarding KV62. That could be their greatest legacy to Egyptology.

Given the high profile of the site, and its status as one of those where younger and amateur global audiences are exposed to scientific archaeology in action, it is imperative that the scientific process is followed rigorously to its end. The global audience should be allowed to see that scientific instruments can and do provide reliable answers and conclusions when utilized properly. At the end of the day, negative findings are not negative at all; they simply demonstrate that there is nothing present when a hypothesis is tested. As such, they improve our understanding of the archaeology and by extension the history of the site and the era under investigation. They are indeed useful and should be accepted.

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42 Lightbody (2018).

43 The Guardian newspaper reported on Thursday 8th April 2021 that Zahi Hawass had announced that a 3,000-year-old 'lost golden city' of ancient Egypt had been discovered: "Experts say Aten is the largest such city ever found and one of the most important finds since unearthing Tutankhamun's tomb".

Conclusions

In 2015, a hypothesis was published proposing that Nefertiti was buried behind the north wall of Tutankhamun's tomb. Over the next three years, the north and west walls of the burial chamber were scanned with radar systems operated by three different teams. The final results of the scans showed that the hypothesis was not valid and that there were no signs of backfilled corridors, doorways, or open chambers behind the plastered and painted wall surfaces. The other circumstantial evidence brought in to support the claims was also not compelling.

The reasons that false conclusions were drawn with such certainty early in the project seem to have been due to a combination of methodological faults and a shared momentum to arrive at positive conclusions. The early claims were most probably the result of the politicized, media-dominated, and financially concerned environment in which the project was undertaken, which was far from ideal.

The scientific method is a logical machine for making discoveries. It can be successfully used in archaeology, but to produce valid new knowledge it must be applied properly. Lessons can be learned from the recent KV62 investigations that should help future project teams identify potential pitfalls. The main lessons learned include some familiar rules and are as follows:

1. A hypothesis, once tested and found wanting, must be altered to incorporate the new body of evidence, if possible.
2. The result of an experiment to test a hypothesis should be repeatable before it can be accepted.
3. Results should be presented for open peer-review in a way that authentically represents the data collected.
4. 3D simulations and illustrations are not reality. If these tools and representations are used for scientific publications, then care should be taken to faithfully represent the scientific data.
5. Archaeologists and Egyptologists applying the scientific method must make efforts to resist the influences of external factors in order to allow impartial interpretation of data.

In conclusion, while GPR machines can see through walls, the more difficult task in Egyptology seems to be seeing through the smoke and mirrors that often cloud issues at high profile sites. Only the rigorous application of logic, impartial analysis, and the peer-review process can ensure success in these situations.

At a general level, more efforts must be made to bridge the gaps between the amateur readers, skilled students, and experienced scholars and scientists. The eyes of the world will be on KV62 during the centenary of its re-discovery in 2022. At that time, the next generation of archaeologists and Egyptologists will benefit from seeing that the scientific method has been applied properly and successfully, both via the latest electronic technologies and by using traditional analytical, peer-review, and publication processes.

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Further reading

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The Theban Mapping Project website: www.Thebanmappingproject.com

The Journal of Ancient Egyptian Architecture: www.egyptian-architecture.com

Factum Arte project and scans: https://www.factumfoundation.org

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