The Great Pyramid (part 1)

A Layman's guide

Keith Hamilton 25th February 2022

A lot of people have contacted me with a request to create a guide on the Great Pyramid. I have been reluctant to do so, as the structure has frankly been done to death, and I would rather highlight the lesser known Egyptian structures. Like the young king Tutankhamun, the number of publications on the Great Pyramid is especially numerous, and would take some years of one's life, if one attempted to read them all.

I wouldn't say that it was my favourite structure in Egypt, but for many people, it's like moths to a flame. If any structure requires a government health warning, it surely belongs to the above structure; it has obsessed many people, as it has the properties of a black hole; once it catches you in its gravity, it is very difficult to escape.

The numerous books on the structure are matched by the numerous theories to explain its existence. For Egyptology, it is the tomb of the pharaoh Khufu (Greek variant-Cheops); whilst for others, it is a water pump, a power plant, a prophetic device, a geodetic marker, which encodes the dimensions of the earth etc: the list could go on. There can be little doubt that it is the most multirole building in existence if we accept all the theories assigned to it; why this should be, is a mystery in itself. It's not as if the structure stands alone, but for some reason the other giant pyramids

seem to get a pass; one can only assume their mass is not sufficient to generate the black hole effect.

Positions are clearly polarized between theorists; but generally those theorists that fall outside the narrative of Egyptology are often referred to as pyramidiots. Mark Lehner, for example, would describe the early explorer Piazzi-Smyth as a pyramidiot.[1] It is a somewhat unfortunate term, as it has the effect of discouraging people from reading the works of people so labelled. Whilst I do not subscribe to the theories of Piazzi Smyth and pyramidologists such as the Edgar's, they are to be commended for some of the clearance work, data collection and early photography of the great Pyramid. Indeed, one would wish that Egyptologists were as obsessed on the structure as alternative theorists, as then we might have better data to work from.

Certainly the Great Pyramid has been more thoroughly explored than any other pyramid; however, for the most part, the available data largely comes from old sources, and often from outside Egyptology, and there are too many blank spaces that need to be filled in. There is no hefty book one can purchase that explains every aspect of the pyramid in detail, and help fill in these blank spaces. Instead, Egyptology too often churns out what I often describe as coffee table books; these books whilst often well produced, with fine images, are too often just a compendium of pyramids, were a few pages is given to describe each pyramid.

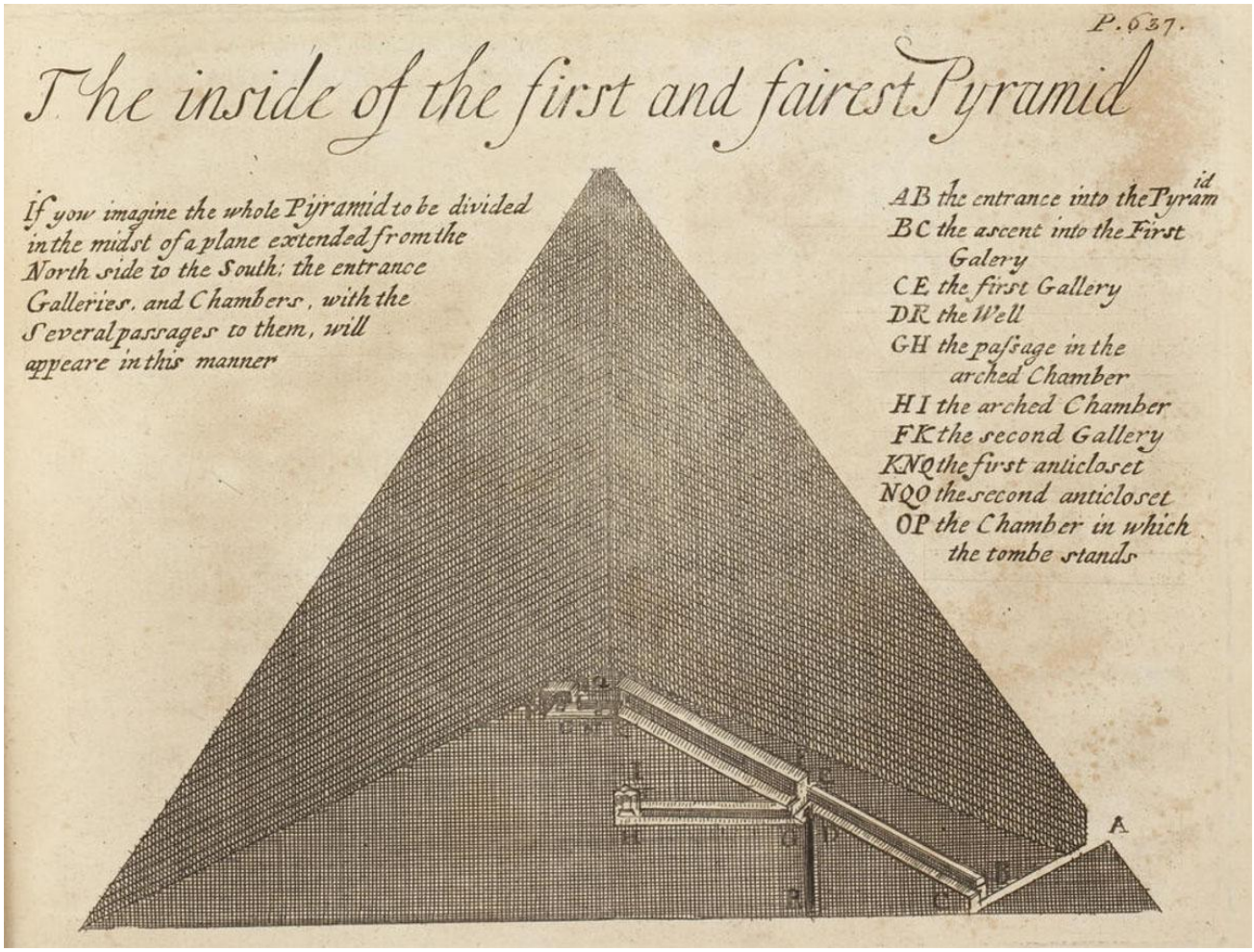
There remain too many voids in our knowledge of the Great Pyramid (and that's not including the voids picked up by the Scan Pyramids project), and in many ways the data which we hold is not unlike the sorry state which I have already described in Sneferu's giant pyramids. Whilst Egyptology has made great strides in practically every aspect of ancient Egyptian life, it appears that when it comes to architecture, the discipline has largely vacated the subject. This lack of interest has left voids too easily filled by alternative theorists, and likely this alternative interest has entrenched Egyptology's position, and reluctance to thoroughly examine these massive feats of engineering.

Given the huge amount of published information on the structure, and to keep this guide to a manageable size, it is not possible to comment on all the various authors and theories, and so I will endeavour to concentrate more on the structure itself.

Exploration

Though we have snippets of information from classical sources, such as Herodotus, Strabo etc, caution is always required on using such old sources.

[1] The Complete pyramids, 1997, page 57



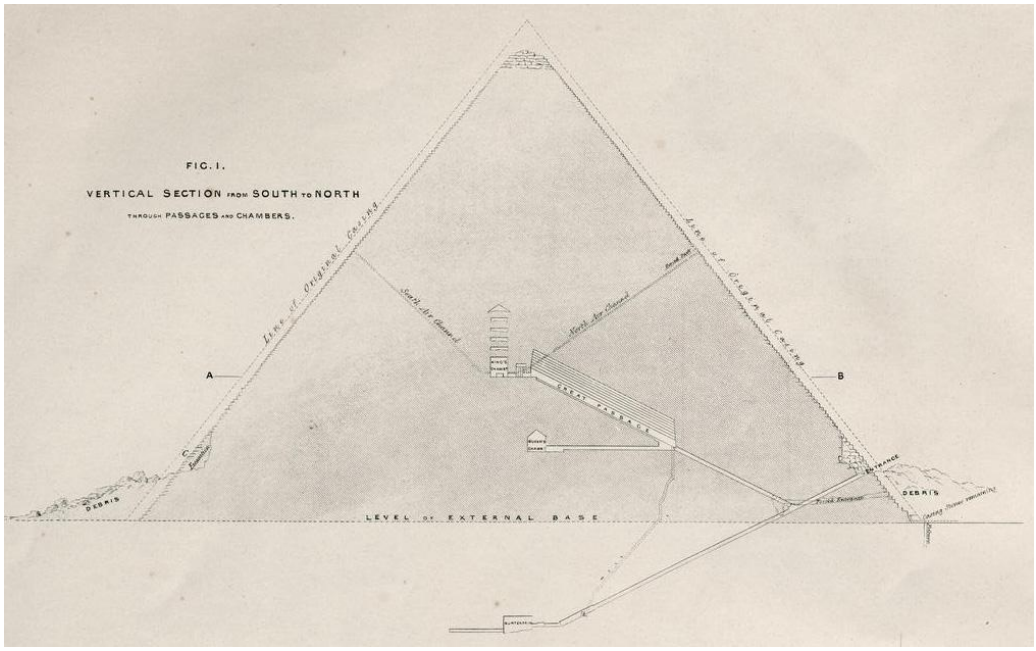
A clearer picture of the structure could be said to start from the arrival of Professor John Greaves, who would explore the structure during his tour of the Middle East from 1637-1640. His findings of the pyramids were published in his 'Pyramidographia' in 1646. The above drawing comes from his publication, and highlights what was known at that time (in common with many other early explorers the subterranean parts of the pyramid were an unknown, as the descending entrance passage and well shaft were blocked with debris). Greaves work is probably one of the first scientific attempts to record the structure. Further degradation of the structure has occurred since his time, for Greaves tells us that he and two friends climbed the pyramid to count the steps; two would record 207 steps, whilst one recorded 208;[2] today the number of steps is closer to 203 (Petrie would appear to record remnants of 203 steps).

The French Consul General for Egypt (1692-1738), Maillet, would further improve our knowledge of the structure, as would the French savants attached to Napoleon's Egypt expedition of 1798. The mystery of the subterranean parts of the

[2] Pyramidographia, 1646, page 636

pyramid would finally be resolved by Caviglia in 1817; who would finally clear the debris blocking up the descending passage, and discover the unfinished subterranean chamber, along with the end of the mysterious well shaft, which connected to the descending passage.

The next major milestone in exploration of the pyramid came courtesy of Howard-Vyse in 1835, during his tour of the Middle East. Initially he employed Caviglia but the two men quickly fell out, and Caviglia was removed from his operations. Vyse would employ the engineer John Perring, who would provide the best drawings and measurements then available (the drawing on page 1 is from Perring's Publication[3]).



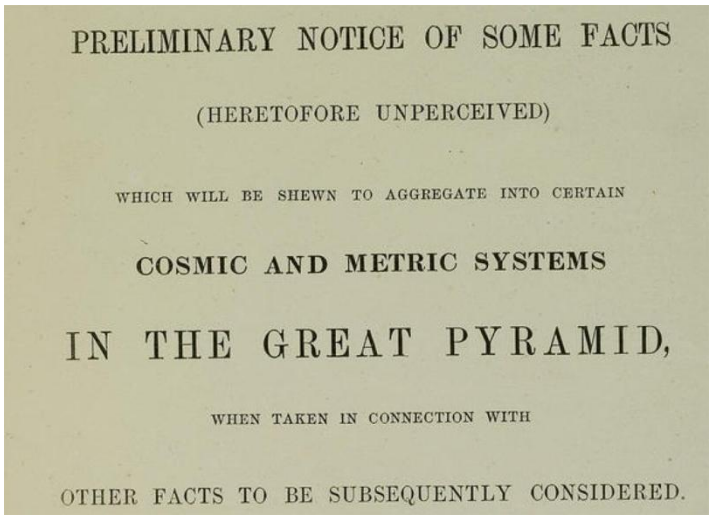
From the same publication we have Perring's cross section of the pyamid[4]. This would differ from earlier depictions, as it shows the five so-called relieving chambers above the king's chamber, along with the narrow shafts which connect to the outside of the pyramid. The lowest of these chambers had been entered by Nathaniel Davison in 1765; Vyse with the help of gunpowder would discover the remaining four chambers. The four chambers which Vyse blasted into would have been fairly well sealed and protected spaces, untouched since the construction of the pyramid. In these chamber's numerous workers markings and graffiti were found including the names of Khufu. These discoveries of Vyse are a major blow to some theorists who ascribe the structure to some lost civilisation, and so the story is told that Vyse forged Khufu's name. This forgery theory still has many supporters today; indeed, it even made the

[3] The Pyramids of Giza, from actual survey and admeasurement. Part I, The Great pyramid, plate VII
[4] Ibid, plate I, fig I

plotline for the Stargate movie in 1994. For my own part, I have no problems with the graffiti and worker's marks that Vyse found, and am more than satisfied that they are genuine; and with that said, I have probably lost half my readers, and its only page 5. Some may argue that the lowest chamber (Davison's chamber) was devoid of any markings or graffiti; though I would point out that this chamber was left open by an ancient tunnel to the top of the Grand Gallery, and that when Davison entered, it contained over a foot of bat dung. This chamber could have been a roosting spot for bats for centuries, so would it be a surprise that no markings survive here, in such an environment.

The next person of note to explore the pyramid was the Astronomer Royal for Scotland, Charles Piazzi Smyth, who along with his wife ventured to the pyramid in 1865. In part to prove the theories of John Taylor, who died in 1864; Taylor had published a controversial book entitled *'The Great Pyramid: why was it built, and who built it?'* in 1859. Before Piazzi-Smyth left for Egypt he would publish a book entitled *'Our inheritance in the Great Pyramid'* in 1864. This book would subsequently go through many editions, each bulkier than the previous. The contents of the book still have their supporters today, though it would ultimately gain him the title of pyramidiot from other quarters. Today Piazzi-Smyth is largely airbrushed from discussions on the pyramid, though there is much useful data to be found in his three volume publication, *'Life and Work at the Great Pyramid during the months of January, February, March, and April, A.D. 1865'* published in 1867.

Piazzi-Smyth's work received mixed reviews, especially in an era which was still largely coming to terms with Darwin's book published in 1859, *'The Origin of Species'.* One of the avid supporter's of Piazzi-Smyth was the father of Flinders Petrie, and indeed the young Flinders Petrie took quite an interest in Piazzi-Smyth's work.


PRELIMINARY NOTICE OF SOME FACTS

(HERETOFORE UNPERCEIVED)

WHICH WILL BE SHEWN TO AGGREGATE INTO CERTAIN

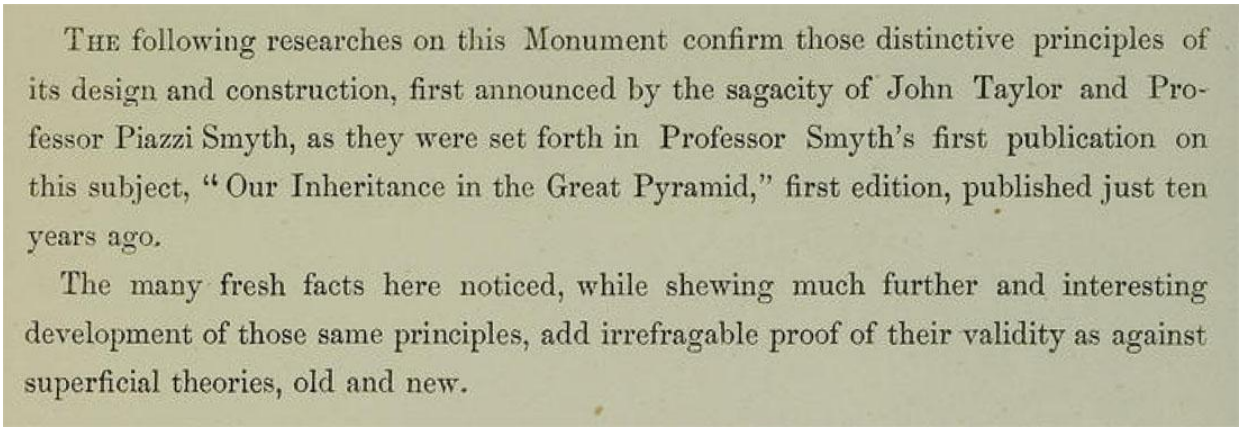
COSMIC AND METRIC SYSTEMS

IN THE GREAT PYRAMID,

WHEN TAKEN IN CONNECTION WITH

OTHER FACTS TO BE SUBSEQUENTLY CONSIDERED.

In 1874 at the age of 21, Petrie would publish his first book, whose lengthy title is shown left. This publication by Petrie is largely airbrushed from his bibliography due to its content; though his subsequent publications, *'Inductive Metrology' 1877,* and *'Stonehenge' 1880,* are not so controversial.



THE following researches on this Monument confirm those distinctive principles of its design and construction, first announced by the sagacity of John Taylor and Professor Piazzi Smyth, as they were set forth in Professor Smyth's first publication on this subject, "Our Inheritance in the Great Pyramid," first edition, published just ten years ago.

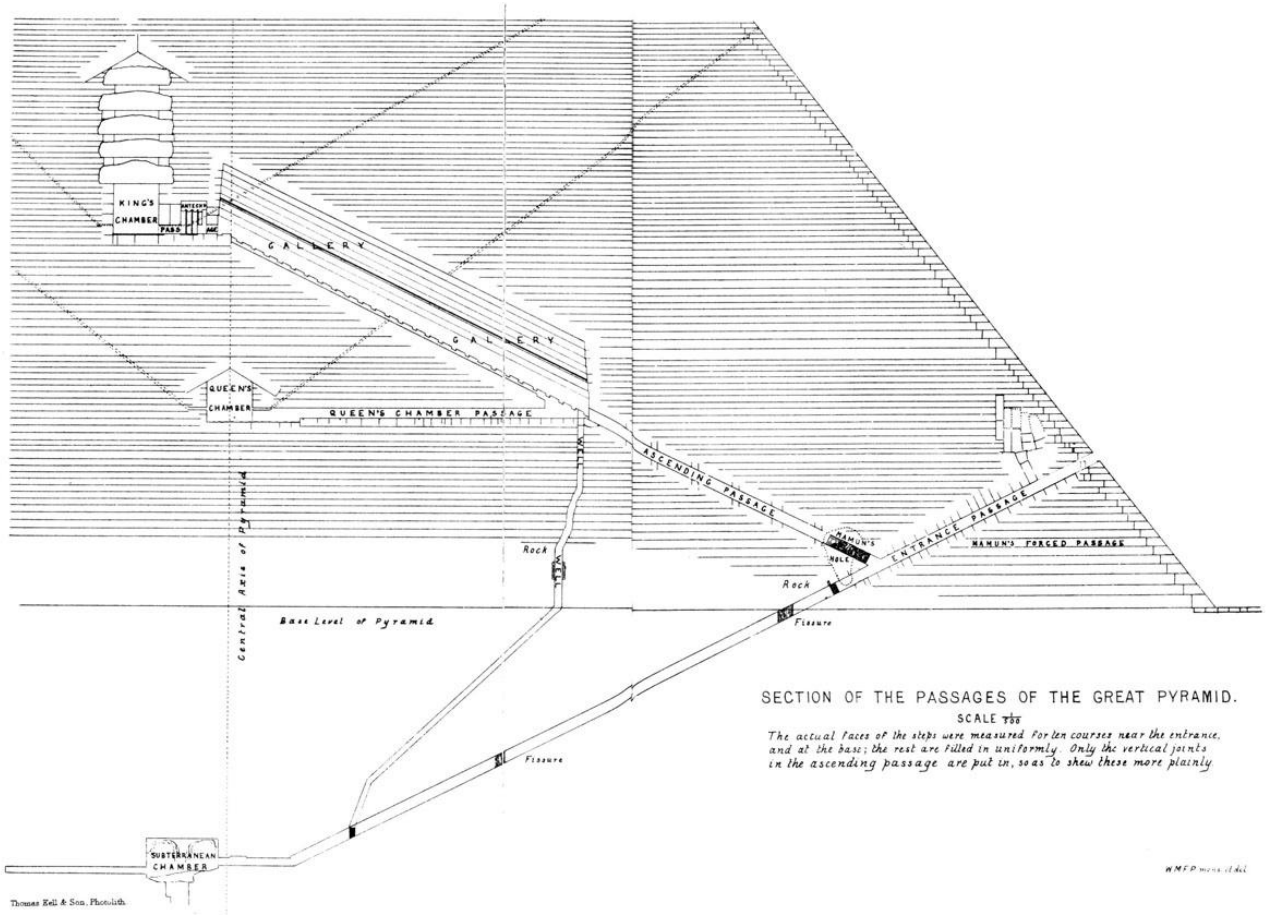
The many fresh facts here noticed, while shewing much further and interesting development of those same principles, add irrefragable proof of their validity as against superficial theories, old and new.

In Petrie's controversial 1874 book, his opening page contains the above statement; however, by 1877 disagreements between the Petrie's and Piazzi-Smyth emerged. This would ultimately lead to the Petrie's decision to travel to Egypt, and use their surveying skills to obtain superior measurements of the pyramid. In the event, only the younger Flinder's Petrie would travel to Egypt with his instruments in 1880. In some ways Petrie was the ideal candidate to survey the pyramid; his in-depth knowledge of the myriad theories which surrounded the pyramid could be readily put to the test by his fine surveying skills. He would spend two winter seasons in Egypt and publish his findings in *'The Pyramids and Temples of Gizeh'* in 1883. This publication would become the gold standard on the Great Pyramid, and still very much a primary resource today.

Petrie's work would severely damage the theories of Taylor and Piazzi-Smyth, with Piazzi-Smyth quick to rebut Petrie's findings in 1884, when he published *'New Measures of the Great Pyramid by a new measurer, described and tested by C. Piazzi Smyth'*. Petrie's experience in Egypt, would eventually lead him to be one of the founding fathers of Egyptology. Petrie would comment on how his work affected pyramid theories, he states:

"As to the results of the whole investigation, perhaps many theorists will agree with an American, who was a warm believer in Pyramid theories when he came to Gizeh. I had the pleasure of his company there for a couple of days, and at our last meal together he said to me in saddened tone, - "Well, sir! I feel as if I had been to a funeral." By all means let the old theories have a decent burial; though we should take care that in our haste none of the wounded ones are buried alive."[5]

[5] The Pyramids and Temples of Gizeh, 1883, Petrie. introduction xvi



The above section is from Petrie's publication, and if we compare this to Perring's section on page 4, we can see the addition of shafts emanating from the so called queens chamber. These shafts were discovered by Waynman Dixon in 1872, and although Petrie draws the shaft as reaching the outside of the pyramid, this can only be an educated guess at his time, by comparing to the kings chamber shafts. Only in modern times with the advent of small robotic rovers, have we been able to determine the limit and route of the queen's shafts.

Petrie's work in some ways was the last major investigation on the pyramid. In the following century pyramidologists such as the Edgars and others would carry on exploring the structure; though today such theorists would be described as pyramidiots. It was a strange era when Egyptology were content to allow such theorists to do major works and investigation inside the structure.

In the 1960's the Italian scholars Maragioglio and Rinaldi (M&R) set aside a whole volume of their work on the Great Pyramid[6], and this work along with Petrie's is mostly quoted from Egyptologists today.

Today access to the pyramid is tightly controlled, and exploration is largely by reading the above reports. Modern technology has slowly arrived at the structure, with

[6] L'Architettura Delle Piramidi Menfite, Parte IV

the most recent being the ScanPyramids project; however, much like the ScanPyramids images, our picture of the pyramid is quite fuzzy, and it is a very frustrating structure to investigate, due to the lack of clear data. More modern forensic investigation of the structure is long overdue.

The above brief history of exploration is mostly what scholars have to work from, and one of the first to try make sense out of the design of the pyramid was the German Egyptologist Ludwig Borchardt (1863-1938). He was of the view that the design of the structure was an ad-hoc affair: basically the original intention was for the king to be buried in the subterranean chamber, but that a change of plan resulted in this being abandoned for a new chamber inside the superstructure of the pyramid; in the form of the so-called queen's chamber. This in turn would give way to a new chamber in the form of the king's chamber. This somewhat chaotic sequence of events still has its supporters today, whilst for others, they see the design as a well planned unified design from the outset. For example M&R would state;

"All the above mentioned elements lead us to conclude that the hypothesis of Borchardt regarding the three projects for the funerary apartments of Cheops is not acceptable. According to us all the rooms and passages built in the Great Pyramid belong to a sole project which was studied in every detail as a whole."[7]

This sentiment appears to be shared by Zahi Hawass and Mark Lehner, who state;

"Rainer Stadelmann, however, documented a long tradition, found before and after Khufu, of a standard model of three chambers in Old Kingdom pyramids, and so other Egyptologists see the whole inner arrangement as a unified design, planned from the outset, and we agree. In fact, some evidence suggests that the Subterranean Chamber, which Khufu's workers left unfinished, was the last of the three to be created."[8]

Having reviewed the available data, and as a layman, I would tend to agree that the great pyramid was built to a unified plan, and that the unfinished subterranean chamber was created last. Ultimately, it is up to the reader to do their own diligence on the available data, which unfortunately is not as good as it could be.

We will now look at the individual components of the pyramid in greater detail. I would like to thank the many people who have assisted in providing images for this guide; suffice to say, any suggestions that I might make on the structure is not necessarily shared.

[7] Ibid, page 152
[8] Giza and the Pyramids, 2017, page 146

The Exterior

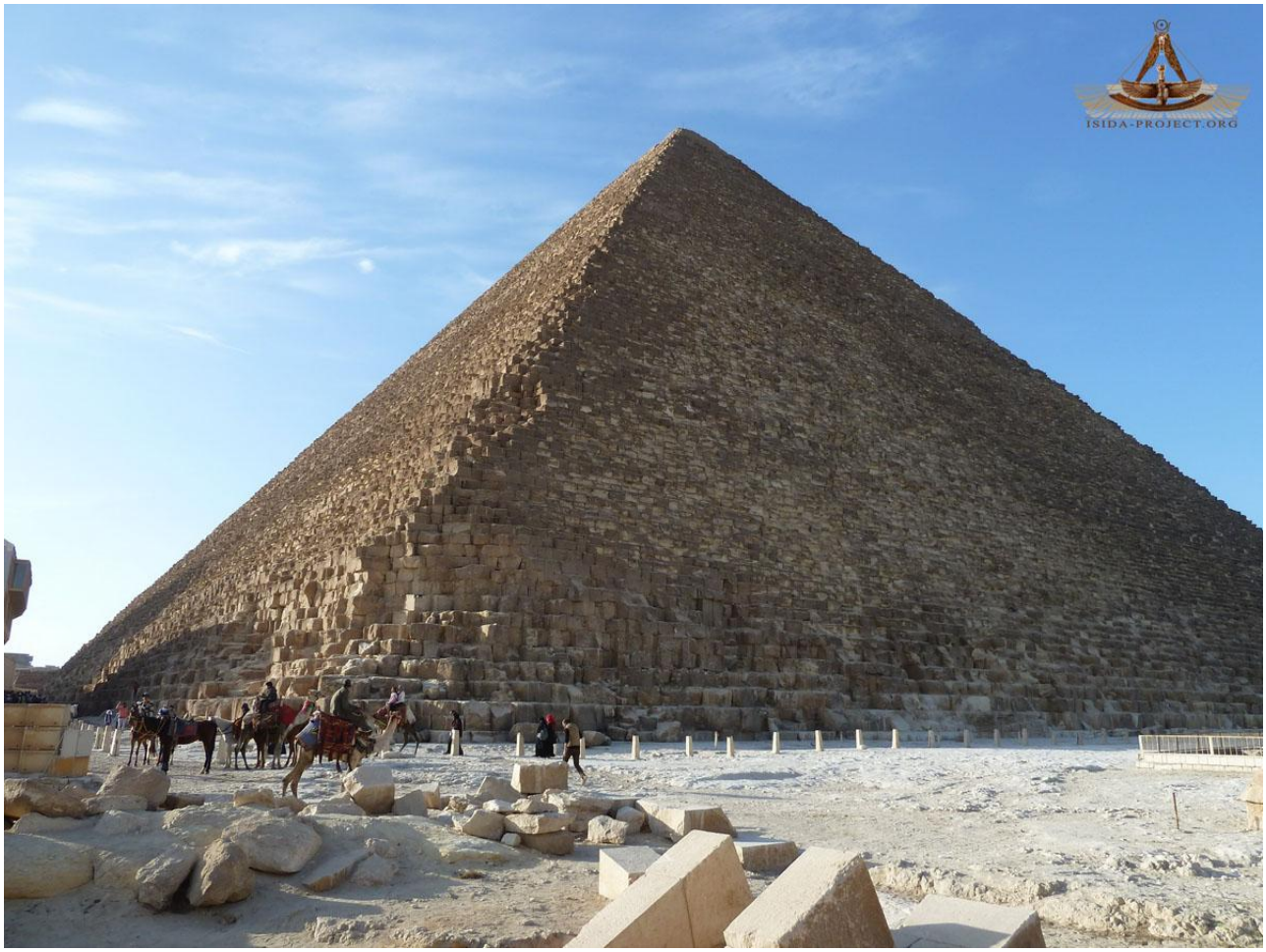


Image courtesy of Isida Project

In the above image we are looking at the south-east corner of the Great Pyramid; to the extreme left we can see part of the old boat house which used to house Khufu's boat, and in the foreground, the reconstructed entrance leading into pyramid GI-d. Today most of the debris has been removed from around the pyramid, likewise around Khafre's pyramid; though unfortunately the debris surrounding Menkaure's pyramid is yet to be cleared, and is in much the same state that the early explorers found it.

This massive pile of debris which flanked the pyramid was a major obstacle in determining the size of the structure. The French savants had uncovered the two northern corner sockets of the pyramid and an attempt was made to measure their distance. Suffice to say, distances varied significantly depending on who did the surveying. For pyramidologists the theoretical length should be 9140 inches; this was determined with a measuring rod of about 25 inches being used to mark out the base

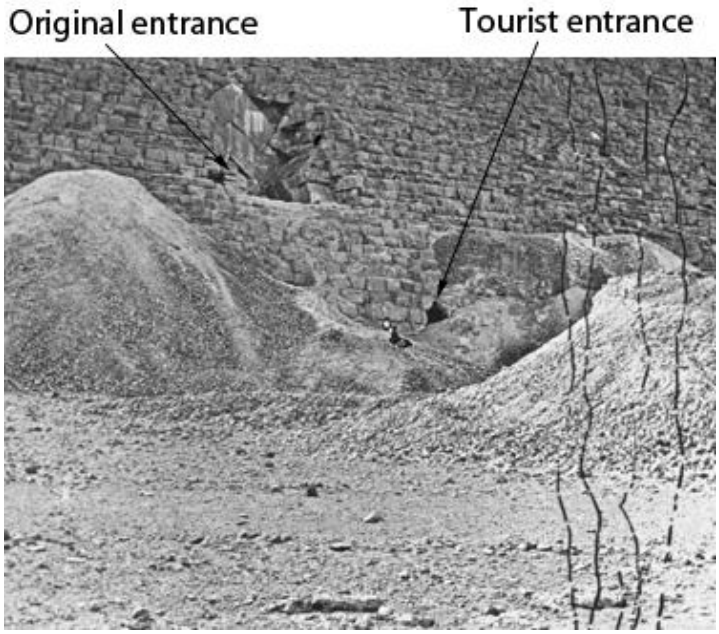
of the pyramid, and that the number of days in the year times this rod would give the length of the year (365.2422 x 25.025 = 9140 inches).[9]

In the above image taken by Piazzi-Smyth in 1865, we can better see the debris covered landscape of the Giza plateau; the Sphinx is visible middle right; whilst the large hole on the south face of the pyramid is courtesy of Howard-Vyse. Piazzi-Smyth was not equipped to excavate the mountains of debris at the base of the pyramid, but by fortunate event, on his last week at Giza he was introduced to Mr Aiton, a contractor who had some business on the Suez Canal. According to Piazzi-Smyth he had some theories on the pyramid himself and so he dispatched one of his engineers, a Mr Inglis and some men to excavate.[10] This would lead to all four corner sockets being uncovered, which Piazzi-Smyth would record and photograph. The discovery of the corner sockets alone would not be sufficient to calculate the base length, as other factors would have to be taken into account, and this puzzle would finally fall to Petrie, some 15 years later.

The corner sockets were described as in good condition; the chisel marks of the builders were still evident, and the floors of the sockets were noted as being perfectly level, though the sockets were somewhat irregular in shape.

[9] Our inheritance in the great Pyramid, 4th edition, Piazi-Smyth, 1880, page 36
[10] Life and work at the Great Pyramid, Vol I, page 524

In the above images we can see the pyramids northern corner sockets; the socket with the fallen stone resting on its floor is the northwest socket. Today these sockets are much eroded away, thanks to the tourist traffic. Piazzi-Smyth would assume that the corner casing stones would fit inside these sockets, and given the huge amount of debris cloaking the pyramid, it would seem a fair assumption, given the limits that he could achieve during his stay. Distances between the sockets varied between sources, some larger and some smaller than his theoretical 9140 inches; but he was under the impression that if it could be accurately measured it would agree to his theory.



In Piazzi-Smyth's image of the northern entrance, we can see the extent of the debris around the entrance, and at his time the debris was at the level of the forced tunnel, by which tourists enter the pyramid today. The surviving casing stones on the pavement discovered by Howard-Vyse below this spot were covered over by him to protect them, and Piazzi-Smyth could not uncover them.

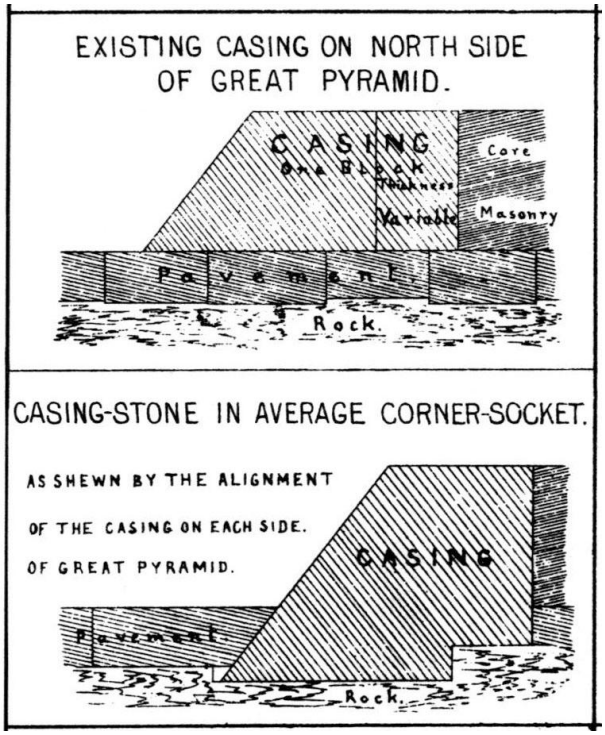
In this modern image, we can see the surviving casing stones sitting on the pyramid platform. Petrie was somewhat lucky in his excavations, for on arrival some contractor had removed the casing chips from the north face for road repairs, and exposed Vyse's casing stones along with the pavement. Moreover, years earlier, locals had significantly reduced the amount of debris around the pyramid in order to obtain building material for their villages.[11] This would greatly help Petrie and allowed him to sink numerous shafts throughout the remaining debris on all four sides, in an attempt to find further casing or pavement. Further pits and trenches were dug to find the outer edge of the pavement; in short, Petrie tells us that some 85 shafts, pits or trenches were excavated around the Great Pyramid.[12] The data obtained from these numerous excavations would allow Petrie to finally solve the base size of the pyramid. He states;

"Since the time of the first discovery of some of the sockets in 1801, it has always been supposed that they defined the original extent of the Pyramid, and various observers have measured from corner to corner of them, and thereby obtained a dimension which was—without further inquiry—put down as the length of the base of the Pyramid. But, inasmuch as the sockets are on different levels, it was assumed that the faces of the stones placed in them rose up vertically from the edge of the bottom, until they reached the pavement (whatever level that might be) from which the sloping face started upwards. Hence it was concluded that the distances of the socket corners were equal to the lengths of the Pyramid sides upon the pavement.

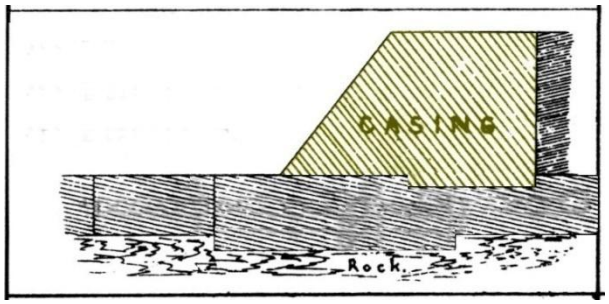
On obtaining accurate measures, however, of the relations of the sockets to the casing on each side, it was found that the sockets lay two or three feet outside the line of the casing of the Pyramid on the pavement; and also that the mean planes of the core masonry of the Pyramid were far more nearly a true square than the square of the sockets. The socket distances varying on an average 4.4 inches from the mean, and the core sides varying but 1.0 inch from their mean length; while there was also a similar superiority in the squareness of the core. This first threw doubt on the sockets representing the original base; and on comparing their distances from the centre of the Pyramid, it was seen that the deeper the level of the socket, the farther out it is from the centre. This shows then that the sockets were the limit of the casing where it

[11] The Pyramids and Temples of Gizeh. 1st edition,Page 29
[12] Ibid, page 30

ran down to the socket floors in a slope, and not where it met the pavement which was 23 to 40 inches above them. A further test of this result is by seeing whether a line which starts from one socket diagonal, and passes alternately through the points of the casing on the sides and the diagonals of the other sockets all round the Pyramid, will come back again on to the starting point, or no; for there is no necessity that it should, if it was not so planned in the construction. This line,—representing the original edge of the base,—does thus return to even 1/10 inch, or far closer than the points could be measured; and hence we have every assurance that this is the true restoration of the original outline of the Pyramid base on the pavement.[13]



From Petrie's plate VII, we can see his reconstruction of how he thought the corner casing and paving may have looked. Petrie's extensive surveying of the size of the pyramid base at pavement level, would give a mean value of 9068.8 inches; significantly less than the 9140 inches required by the pyramidologists. Moreover, even the socket sides given by Petrie, would fall short of the desired 9140 inches, with the longest socket side given as 9130.8 inches and the shortest socket side given as 9119.2 inches.[14]



We may never know the exact solution for the corner casing stone, and I have amended Petrie's corner-socket drawing to show another possible solution, of which I can think of a few. In this solution, the casing stone does not actually contact the socket floor. Instead, a large paving slab is fitted instead and on its upper surface a recess is left in which a protruding square of rock left on the underside of the casing stone would engage. Such a solution would neatly anchor the corner stone. Concerns on the fastening of corner stone's seem apparent, from the small pyramid GIII-a next to Menkaure's pyramid. Here we appear to have casing corner stone with a neat protrusion left on its underside, and its possible further stones along the arris line were similarly adapted. (GIII-a below)

[13] Pyramids and Temples of Gizeh, 2nd edition, pages 10-11 (more detail is to be found on pages 37—41 of the larger 1st edition)

[14] The Pyramids and Temples of Gizeh. 1st edition,Page 38

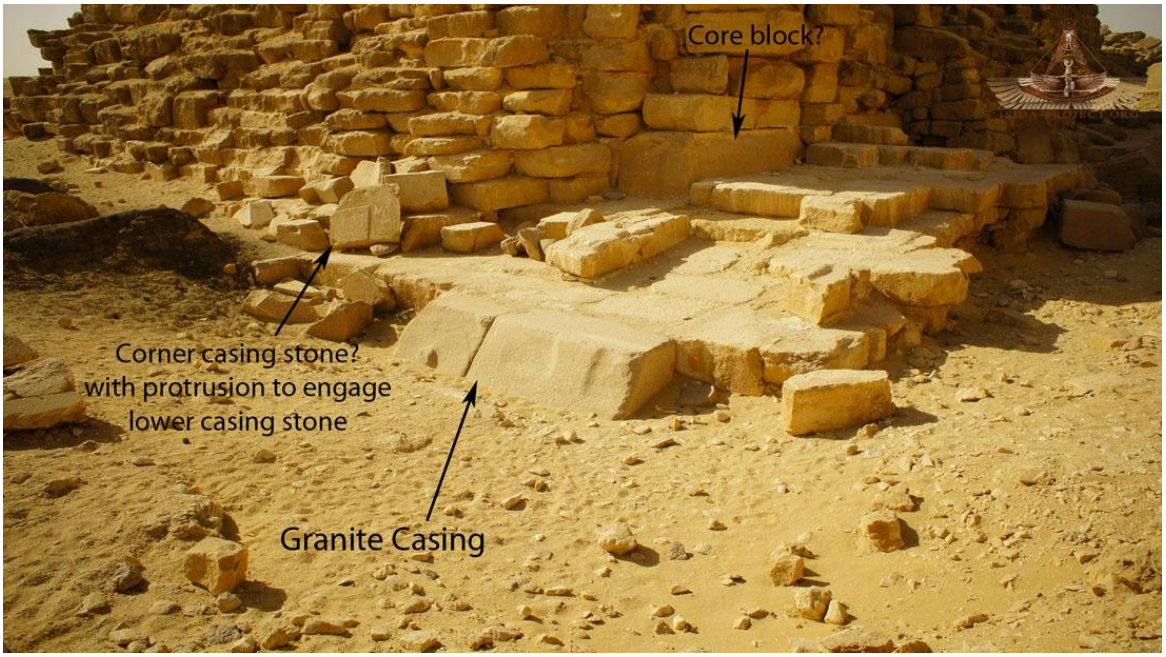


Image courtesy of Isida Project

M&R were of the opinion that the corner-sockets did not serve for anchoring the pyramid corner-edges in the rock.[15]

Image courtesy of Griffith Institute, University of Oxford

In the above image taken by Petrie, we can see the tourist entrance at top left (often referred to as al-Mamun's tunnel), and one of the casing stones at bottom right, with writing along its side, which was done by Vyse.

[15] L'Architettura Delle Piramidi Menfite, Parte IV, observation 2, page 96-102

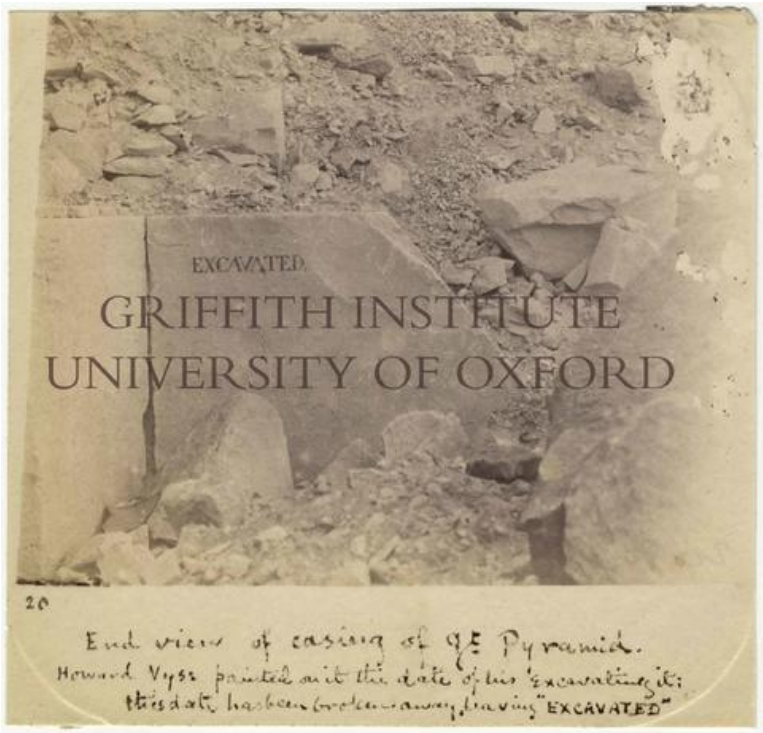


Image courtesy of Griffith Institute, University of Oxford

The above close up image shows the casing stone more clearly; the date of its excavation by Vyse has been broken off. This casing stone still survives today.

Petrie, would comment on the fine joints of these casing stones, some of which he calculated weighed as much as 16 tons.

The above image was taken by the Edgar brother's in 1909,[16] though they were pyramidologists they did much useful work. Here they have outlined the joints of the casing stones in charcoal: the stone next to the figure is the one shown on Petrie's image above. Note also the large fissure in the foreground under the pavement (noted on Perring's drawing on page 4). The Edgar's provided some of the best early photography of the pyramid, and their permission to explore the Great Pyramid was authorized by the then Director-general of Antiquities in Egypt, M.Maspero. Morton Edgar would state;

"I have permission to photograph in the interior of the pyramid by flashlight, and to take photographic pictures generally. I have also full powers to proceed without delay in the work of clearing out the debris from the Descending Passage of the Great Pyramid, and other work of a like nature."[17]

The descending passage appears to have been filled with debris with a regular monotony. Though Vyse had cleared the passage in 1837, it was largely filled again by the time Piazzi-Smyth arrived in 1865. The following exchange between Piazzi-Smyth and Alee Dobree, offers the reason why the passage was blocked below the junction of the descending and ascending passage.

"Yes, I see it is,' was the reply, 'if you mean the way up to the first ascending passage; for that is Khaliph Al Mamoon's hole, and just where it should be; but stop here for a moment, if you please, O Alee, who knowest more than any other Pyramid guide; and explain what is the meaning of this great bank of sand, blocking up so cruelly all the lower part of the entrance passage beyond this point which we have reached; and preventing any access to the subterranean chamber.'

'Why' returned he with a faint smile, and having seated himself despairingly in the Oriental manner, 'it just means what you say; precisely that and nothing more, for no one can go beyond the sand; but if they want to see the King's chamber and sarcophagus, and everything else that all the travellers come to visit, they must turn off here into Al Mamoons hole, and so go up just as I told you.'

'Pray, though,' we asked, 'who first brought the sand into the passage?'

But Alee was not well pleased with this question, and tried to parry it by asking argumentatively, 'How the travellers could ever get through the Pyramid quick enough, if they had to go down the long subterranean passage, in addition to visiting the upper galleries and the chambers there. They had not the strength enough for it too,' he said; 'and so it was for the travellers own good that the Arabs were obliged to stop up the passage completely, and show there was no hollow space beyond that; for if anything at all of a hole were left visibly open, the travellers were so troublesome in asking where that hole led to, and then insisting on being taken there.'

'What length of time.' We asked, 'has the sand-bank been in this place?'

'Oh a great many years,' answered he, 'more than he could recollect;' and then he became absorbed in philosophically examining the state of each and every one of his

[16] Great pyramid Passages, Vol 1, 1923, 2nd edition, plate XLI

[17] Ibid, page 126

toes, in a sort of earnest and kindly manner too, as if they had been so many fingers on which he was about to draw kid gloves.
'And has no tourist, during all that time ever seen, or asked by name to be shown the subterranean chamber at the bottom of this entrance passage?' we persisted in inquiring.

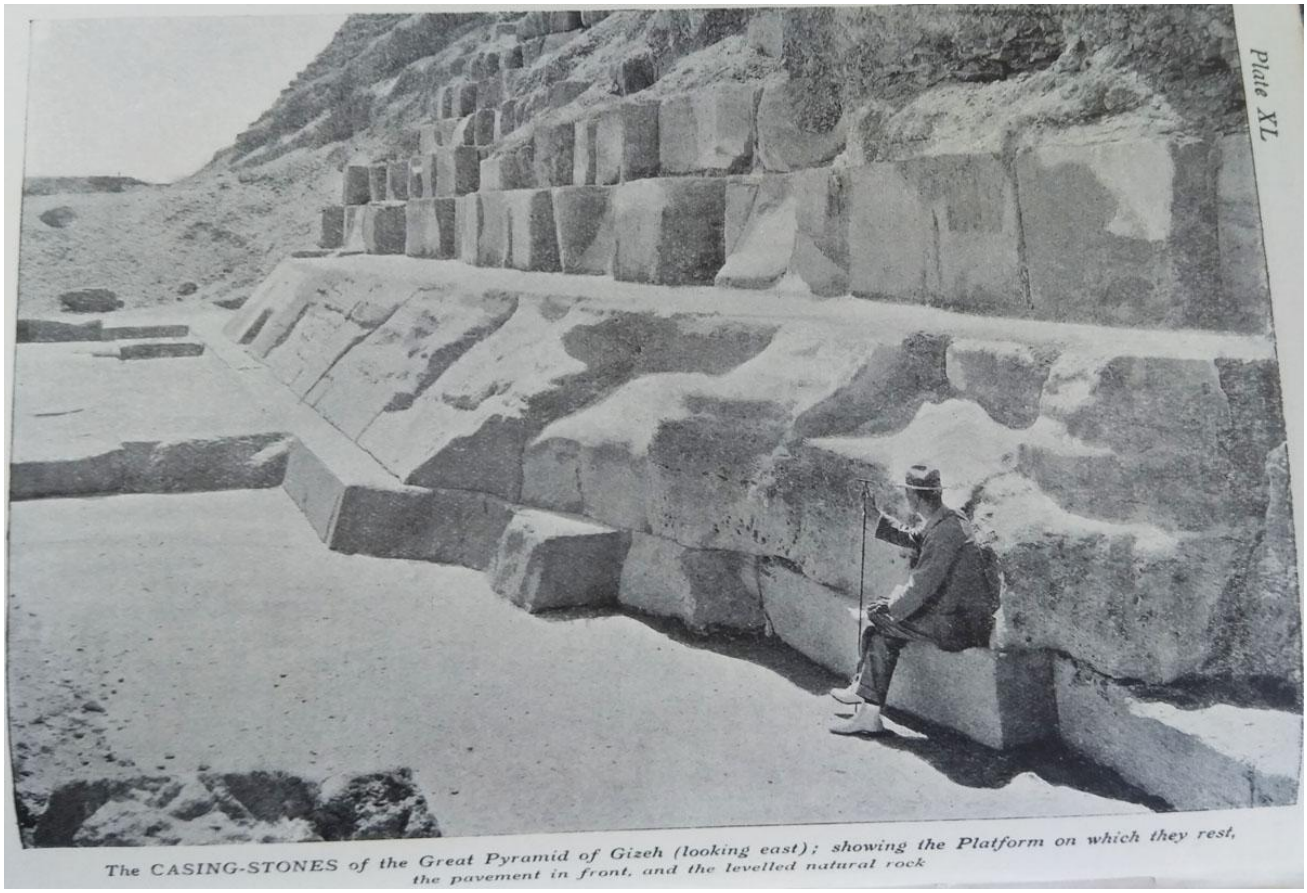
'But how are the travellers to know that any chamber is there, if they don't see it?' urged he, 'and if they don't know there is such a thing, how can they have any desire to see it? Once on a time perhaps there used to be travellers who knew all about the pyramid; but', muttered he, ruefully shaking his head, and bringing the examination of his toes to an abrupt conclusion, 'there's a great change come over all the travellers in late years. Formerly, whenever they visited the Pyramids they would stay several days, and be a long time looking carefully at every tomb; and they would talk with us Arabs about our houses and our fields, and ask us how we were getting on, and seemed to think they would like to be pyramid Arabs too; but now the travellers are always in such a hurry, and they are getting more and more in a hurry every year. One of the Arabs looking out now at the village, has only just time to cry out that travellers are coming, and immediately the Pyramid Sheikhs and all the guides run to the hill; but before they can get there the travellers are upon them, for they make their poor donkeys gallop through the sand; and the moment they arrive at the Pyramid they call out for their luncheon, never waiting for the corks to be drawn out of the bottles, but knocking their necks off on the stones and letting the pieces fall all about' and then they tell the Sheikh, "Now look sharp, old fellow, and get us three Arabs apiece to take us up to the top of the Pyramid that we may see the view, and be down quicker than anyone else; and we'll time you by our watches;" and they no sooner come down than they are on their donkeys again, and away they go over the plain to Masr, and we never see them a second time. Only a very few too of all those travellers ever go inside the pyramid; and as they don't pay any more than their friends who merely went up the outside, - the poor Arabs can't afford to let them know that there are many chambers or passages. It won't do at all to let travellers stop too long inside the Pyramid; outside it might be well enough if they liked it, but inside they are burning our candles all the time, and Arabs can't find wax-candles by digging any day in the tombs.'

'Well! That will do, Alee, for the present.' Said we, 'as to the stopping up; have the goodness to lead on now to the upper passages'.

Alee Dobree was certainly a remarkable character, and would experience a lot on the Giza plateau. Indeed, Petrie reports; "*I was happy in having Ali Gabri,* the faithful servant of Prof. Smyth, Mr. Dixon, and Mr. Gill; his knowledge of all that has been done at Gizeh during his lifetime is invaluable; and his recollections begin with working at four years old, as a tiny basket carrier, for Howard Vyse in 1837."* (* Called Ali Dobree by Prof. Smyth.)[18] According to Edgar, Alee dobree died in 1904;

[18] Pyramids and Temples of Gizeh, 2nd edition, page 3.

though the Edgar's would employ his son Hadji Ali Gabri during their work at the pyramid.



The CASING-STONES of the Great Pyramid of Gizeh (looking east); showing the Platform on which they rest, the pavement in front, and the levelled natural rock

From Edgar's plate XL we are looking east along the surviving casing stones on the north side of the pyramid. According to the Edgar's the casing stones sit on a limestone platform some 21 inches thick, whose front edge extends some 16 inches beyond the bottom edge of the casing stones. This front edge they give as being bevelled somewhat by some 2 of 3 degrees; against this face further paving would be laid.[19] (this feature can also be noted at pyramid GII-a)

The levelling of the base and accuracy of orientation to the cardinal points, along with the fine quality of the casing stones have all been noted by many, so will not need to be retold. On the manner of this pavement and the large fissure found underneath as seen in the image on page 15; Perring tells us:

"The stones composing the pavement are not rectangular, although carefully and beautifully fitted together. Under this pavement was found a fissure in the rock, which had been filled up with small stones grouted together with gravel, with a wedge-shaped course of stones fitted into the rock at the surface: this fissure was cleared to the depth of 47 feet 6 inches, and of sufficient length eastward, and westward of the

[19] Great pyramid Passages, Vol 1, 1923, 2nd edition, page 130

centre, to prove that no lower entrance into the building existed at that place, or the passage must have crossed the fissure."[20]

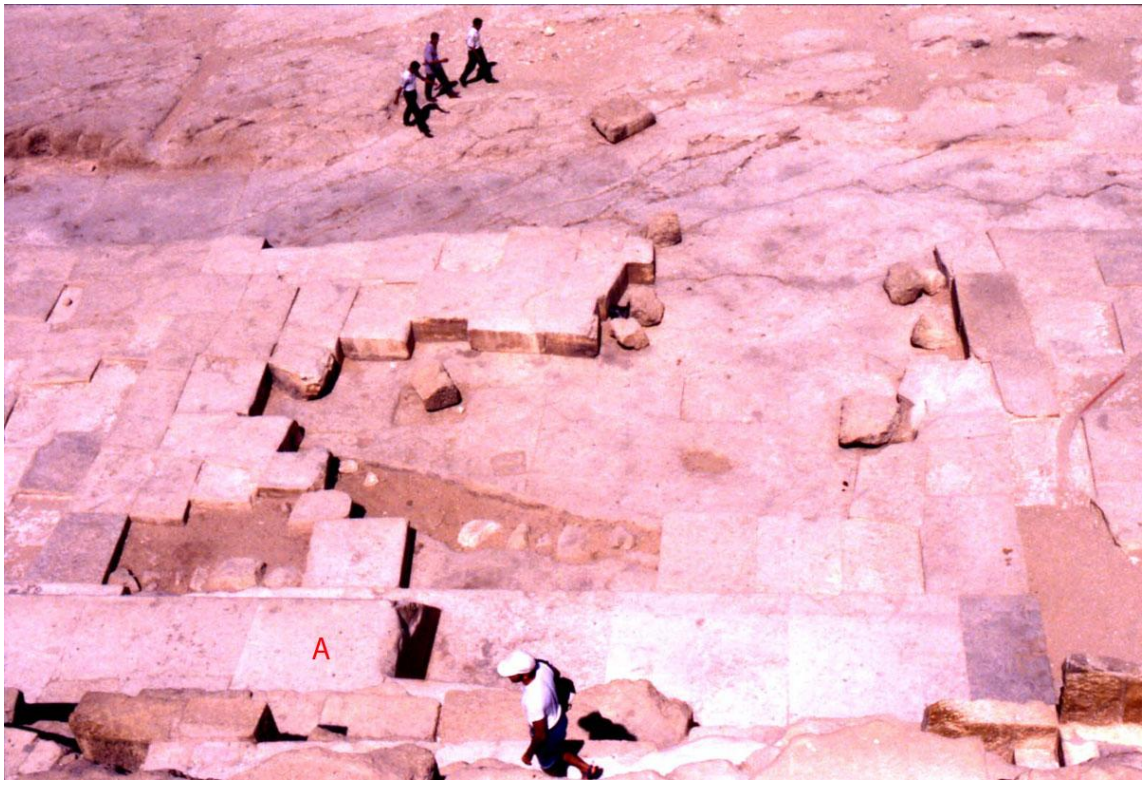


Image courtesy of J.D.Degreef

In the image above looking down from the original entrance we can see some of the remains of the pavement which surrounded the pyramid (the letter A, denotes the casing stone visible in Petrie's image. See page 14&15). Petrie was able to find the edges of the rock cut bed, which received the pavement; however, he found that no paving had been found complete up to the edge of its bed. From the measures obtained from the bed cutting from around the pyramid, he states;

From these measures it appears that there is no regularity in the width of the cutting; the distance from the casing varying 99 inches, and altering rapidly even on a single side. The fine paving may possibly have been regular, with a filling of rougher stone beyond it in parts; but if so, it cannot have exceeded 529 in width.

M&R would comment that the temenos wall which surrounded the pyramid had foundations of about 6 cubits wide, which were cut no deeper than in the court for the pavement slabs. They would suggest the base of the wall was 5 cubits, and that the distance from the wall foundations were some 10.20m to the east and north, and about

[20] The Pyramids of Giza, from actual survey and admeasurement. Part I, The Great pyramid, plate I description.

10m on the other sides. This suggested to them that the paved court may have been intended to be 20 cubits (10.5m) wide on all sides.[21]

This square, of the original base of the Great Pyramid casing on the platform, is of these dimensions :—

	Length.	Difference from Mean.	Azimuth.	Difference from Mean.
N. . .	9069.4	+ ·6	− 3′ 20″	+23″
E. . .	9067·7	− 1·1	− 3′ 57″	− 14″
S. . .	9069·5	+ ·7	− 3′ 41″	+ 2″
W. . .	9068·6	− ·2	− 3′ 54″	− 11″
Mean .	9068·8	·65	− 3′ 43″	12″

The table above is Petrie's results for the base lengths of the pyramid along with their orientation. These figures have been largely confirmed from later surveys, such as the one undertaken by J.H.Cole in 1925.[22]

Side.	Length Petrie 1880	New Determination 1925.	Difference.
	Ins.	Ins.	Ins.
North	9069·4	9065·1	− 4·3
South	9069·5	9073·0	+ 3·5
East	9067·7·	9070·5	+ 2·8
West	9068·6	9069·2	+ 0·6
Mean	9068·8	9069·4	+ 0·6

In the above table from Cole's publication we can see the minor differences between his and Petrie's base lengths; a similar picture is also to be found on the azimuth measures. In more recent times the late Glen Dash did much good work on surveying the structure, with his mean length given as 230.363m for the base of the pyramid, or 9069.4 inches.[23] The levelling and orientation of the structure is quite astonishing, and many theories have been developed as to how the builders may have achieved this feat, especially when we consider that the site is very far from level, and that it absorbs a considerable knoll of rock inside its construction, not unlike what we see at khafre's pyramid.

[21] L'Architettura Delle Piramidi Menfite, Parte IV, page 64-66
[22] Determination of the exact Size and Orientation of the Great pyramid of Giza. 1925
[23] The 2015 Survey of the Base of the great pyramid. Available on academia.edu.

Given that we have as close a base length as we are likely to achieve for the Great pyramid, we next turn to its probable height, and here Petrie used the surviving in situ casing stones, along with numerous fragments and states;[24]

> **On the whole, we probably cannot do better than take 51° 52′ ± 2′ as the nearest approximation to the mean angle of the Pyramid, allowing some weight to the South side.**
>
> **The mean base being 9068·8 ± ·5 inches, this yields a height of 5776·0 ± 7·0 inches.**

This angle is very similar to that which he gives for the Meydum pyramid. The exact size and angle of the pyramid is a very contentious subject, and numerous theories have been proposed to what the architect intended. But today it is generally accepted that the base of the pyramid was intended as 440 cubits long by 280 cubits high, and that the angle of the pyramid conforms to the Egyptian Seked of five and a half palms. The extent of mathematical knowledge at the time of the 4th dynasty when the pyramid was constructed is unknown; what little we know of Egyptain mathematics is from later rare survivors such as the Rhind Papyrus, believed to date some 1000 years after the construction of the pyramid. In this mathematical papyrus several areas of mathematics is dealt with, not least, techniques for determining the slope of pyramids. The term used is Seked, which in modern terms we could describe as a simple run and rise ratio. The Seked angle was basically determined by the horizontal displacement against the height of one cubit, which contained 7 palms; so in the case of the Great pyramid, the Seked which compares closest to the angle of the pyramid is 5.5 palms: i.e. imagine a right angle triangle whose height is 7 palms, and base is 5.5 palms.

This ratio 7:5.5, perfectly conforms to the height of 280 cubits and half base of 220 cubits, and given the limits to the data recovered from the ruins of the pyramid, along with invoking Occam's razor, it is the simplest explanation. This Seked of 5.5 either by coincidence or design also displays the PI ratio of 22/7; as the ratio of the height of the pyramid to the semi circuit of its base, i.e. 880:280 can be reduced to 22/7. This ratio was first assigned to the Great Pyramid by Taylor; though Agnew had assigned it earlier to Menkaure's pyramid.[25] This ratio has inspired further inquiry, and it now seems that every mathematical constant or irrational number can be displayed by various aspects of the structure, by numerous authors. Petrie himself was not adverse to the Egyptians knowing the ratio 22/7, and comments on the many competing mathematical theories in his work.[26]

[24] Pyramids and Temples of Gizeh, 1st edition, page 43

[25] See my Menkaure Pyramid guide

[26] Pyramids and Temples of Gizeh, 1st edition, chapter XXI. Theories compared with facts. Pages 182-207.
He would also expand on this in his 'Wisdom of the Egyptians' published in 1940, pages 29-30.

Image courtesy of Isida Project

Looking along one of the sides of the pyramid, we can see many eroded casing stones sitting on the fine limestone platform and above these the neat steps or courses of the pyramid. These neat backing stones would help support subsequent layers of fine quality Tura casing. It might be a trick of the light, but in some images it appears we have a low angled triangular shape on the core masonry, rising up to the centre of the pyramid as seen in the image above. Given the significant sloped debris which covered all four sides of the pyramid for many centuries; maybe this is a sort of tide mark, which protected the core masonry under the debris from further erosion. Another option is in my Khafre Pyramid guide, here I mentioned a smaller triangular area of what appears to be superior core masonry under its entrance passage in order to provide a good foundation for the passage. Now, if the Great pyramid was a unified design from the beginning and not a series of changes, it would be imperative that the builders ensured that the core stones were suitably well laid to support the chambers in the superstructure; concentrating mainly in the areas surrounding and underneath the chambers. For lesser areas away from the internal chambers, the laying of core masonry and its quality could be relaxed somewhat.

It is often assumed that such neat masonry as we see above, extends throughout the pyramid like neat layers of a cake; However, the core of these pyramids is not as neat as many think. For example, M&R would state on the Great Pyramid;
"In the breach more than 9 metres deep opened by Vyse at a certain height from the ground on the southern face of the pyramid is clearly noticeable that in building the inner part of the nucleus very little account was taken of following the well defined and aligned outer courses. In the inner masonry, larger, smaller and some-times very small blocks are placed side by side without any order. Rarely one can see very thin slabs laid in the masonry edgewise."[27]

Image courtesy of Isida Project

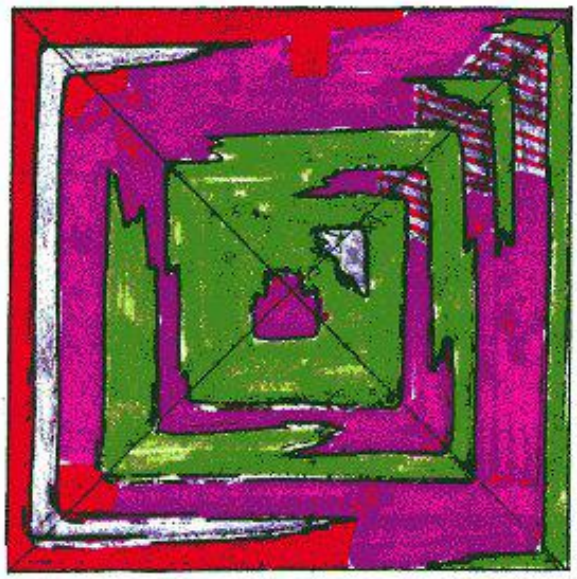
We rarely get a good look at the inner cores of pyramids, but thanks to the destructive urge of others we do get a peek. In the above image of Menkaure's pyramid we can see a large gash on its north side, and around it, the neat core stones, similar to what we see at the Great Pyramid: at the bottom of the image we can see the surviving granite casing stones.

As we get closer to this gash we see something more in agreement to the quote given by M&R above, which the reader can see in the following images overleaf. I have highlighted a small stone in red, to help the reader stitch the two images together.

[27] L'Architettura Delle Piramidi Menfite, Parte IV, page 14

Images courtesy of Isida Project

In the upper image we can see neater core stones on the exterior on right of image, and then as we go further back the quality of core stone laying is less. In the lower image we see this core stone abut against a well laid face of the internal stepped core. Though in the Great pyramid the core stone does seem to be laid better, though this is likely due to the fact that so much of the chambers was built inside the superstructure, whereas in Menkaure's and khafre's pyramids the chambers are mostly subterranean so less care was required in core construction, which in these pyramids had merely to support the fine outer casing.



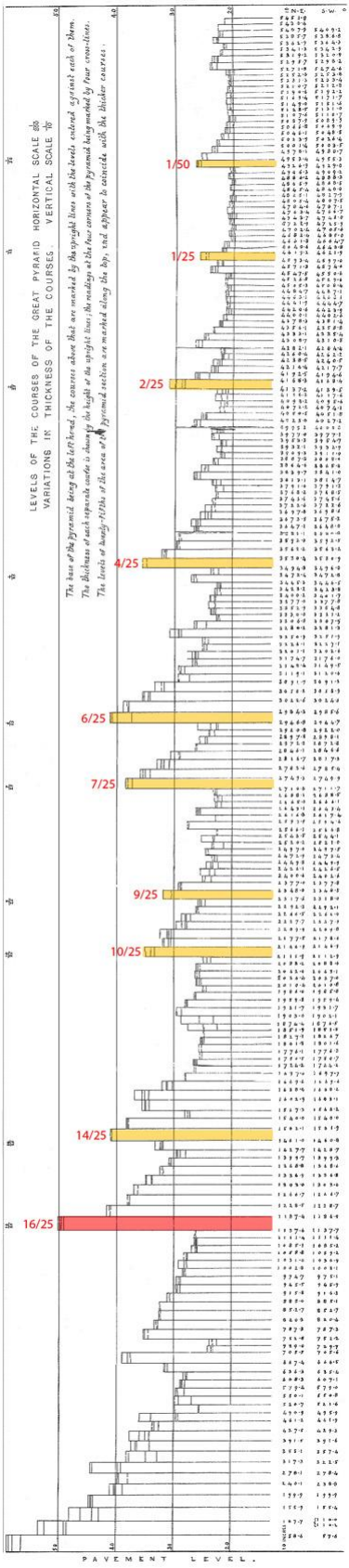
We do not know if a stepped core exists inside the Great Pyramid, but in the 1980's a gravimetric scan was done of the Great Pyramid, which resulted in the image left. This research has been used by some to suggest that a stepped core exists also inside the Great pyramid; whilst others suggest that it might prove the existence of an internal ramp, used during construction. However, given the clear evidence for stepped cores, be it in Menkaure's pyramid or the Queens' pyramids at Giza, I would tend to support a stepped core. This two phase approach to building a pyramid, i.e. a stepped core created first and then a casing phase, I have discussed elsewhere, so will not repeat it here.

Another unusual feature best observed from some aerial images is that the faces of the core masonry are slightly concave; though this concave trait does not appear to extend to the fine casing of the pyramid, as the missing casing often left marks on the foundation platform, and I have seen nothing from the surveys to suggest that the casing at base level at least, was anything but straight. Petrie would describe the feature as striking and would offer the following suggestion;

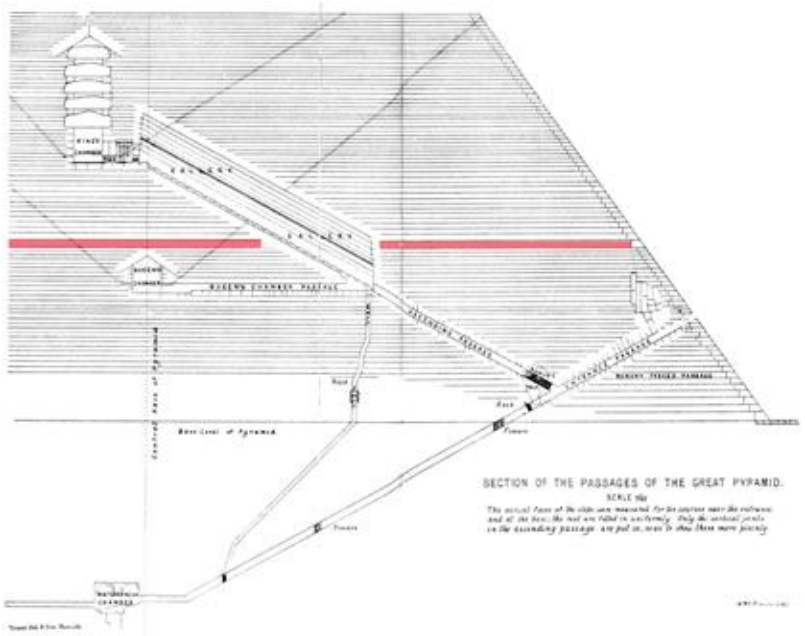
"The object of such an extra thickness down the mid-line of each face might be to put a specially fine lline of casing, carefully adjusted to the required angle on each side; and then afterwards setting all the remainder by reference to that line and the base."[28]

Another curious feature of the core masonry is the strange pattern exhibited in course thickness; here we see several thick courses which are followed by gradually smaller courses, which then meet a significantly thicker course, and then the pattern repeats. Petrie would plot this pattern on his plate VIII, which I have placed overleaf, along with highlighting some of these thicker courses.

[28] Pyramids and Temples of Gizeh, 1st edition, page 44



Petrie would record some 203 courses and their thicknesses on his plate VIII, shown left. The bottom of the plate is the largest course, with the next largest being the one above. Somewhat bizarrely, the third largest course is to be found at course 35, which I have highlighted in red; this course is located about 1/5th of the height of the pyramid.



In Petrie's plate IX above, I have highlighted the thick 35th course, just above the roof of the so called queen's chamber. This pattern Petrie would suggest was connected to the base area of the pyramid, he states;

"Beside the level of the King's Chamber signalizing where the area was a simple fraction of 1/2 of the base area, thicker courses were perhaps intentionally introduced where the area of the course was a multiple of 1/25 the base area : this system accounts for nearly all the curious examples of a thick course being suddenly brought in, with a series above it gradually diminishing until another thick course occurs."[29]

He would also say that they do not appear to have any connexion to the levels of the interior.[30]

[29] Pyramids and Temples of Gizeh, 2nd edition, page 93
[30] Pyramids and Temples of Gizeh, 1st edition, page 184

It has been suggested that the pattern may be a natural result of the quarrying sequence. It is believed that the core stones came from the nearby quarries on the plateau; whilst the fine limestone casing came from the Tura quarries on the east side of the Nile. It is suggested that quarrying along the seams of the plateau, we would be left with a divergent range of quarried stone, some thicker than others depending on the size of the natural seam from which the blocks were extracted. Whether this is the case is debateable; though I think it has to be kept in mind that the neat core backing stones, which supported the fine casing is not indicative throughout the core of the pyramid, but rather limited to the role of supporting the casing. Beyond the neat steps visible today, the core is likely more reminiscent of the irregular stone described by M&R, in Vyse's breach, as described on page 27.

So in some ways Petrie's course heights seem more limited to the neat backing stones visible today; whilst the majority of the stone which makes up the core is of a more irregular size, with large gaps filled with small stone and gypsum mortar, and somewhat disconnected from a particular quarry seam. Moreover, which stone has priority for course thickness, the fine Tura casing stone, or the poor local limestone? To me it would seem illogical that the fine casing stone was cut to match the poor backing stone; as it would be easier to shape and cut the backing stone. So if the pattern is a natural result of quarrying seams, it should be related to the Tura quarries.

The obsession by many on the Great Pyramid unfortunately means that the other 4th dynasty giant pyramids are often reduced to mere crumbs of exploration. Sadly course data on these are largely nonexistent, despite some retaining significant casing; it would be interesting to analyse these to see what patterns if any are displayed.

The original number of courses is an unknown, and some, as already mentioned have been lost since the time of Greaves. In his time he reports the upper platform as some 13 feet wide, or 156 inches; whilst in Petrie's time he gives the then size of the platform as ranging on a side form 214 to 224 inches. From Petrie's plate VIII the 203rd course top is 5451.8 inches from the base, or some 324 inches from Petrie's theoretical height for the pyramid of some 5776.0 ±7 inches. Not surprisingly, the upper courses are built of more manageable sized stone, with the top six courses ranging from 21.4 to 22.8 inches in thickness at the north east, giving a mean thickness of 22 inches. A major unknown is the size of any pyramidion; with few surviving examples, it's difficult to suggest what sized pyramidion was fitted. The reconstructed one by the Red Pyramid, is about 1m high, whilst the impressive one found by the Black Pyramid is about 1.3m (51.2 inches) high. If we added a further 12 courses of 22 inches, this would leave 60 inches (1.52m) for a pyramidion. Given the grand scale of the Great Pyramid and their skill, we could have a 3 cubit high pyramid added to these 12 courses for a total number of courses of 215 plus pyramidion: but this can only be a guessing game.

The Entrance and Descending Passage

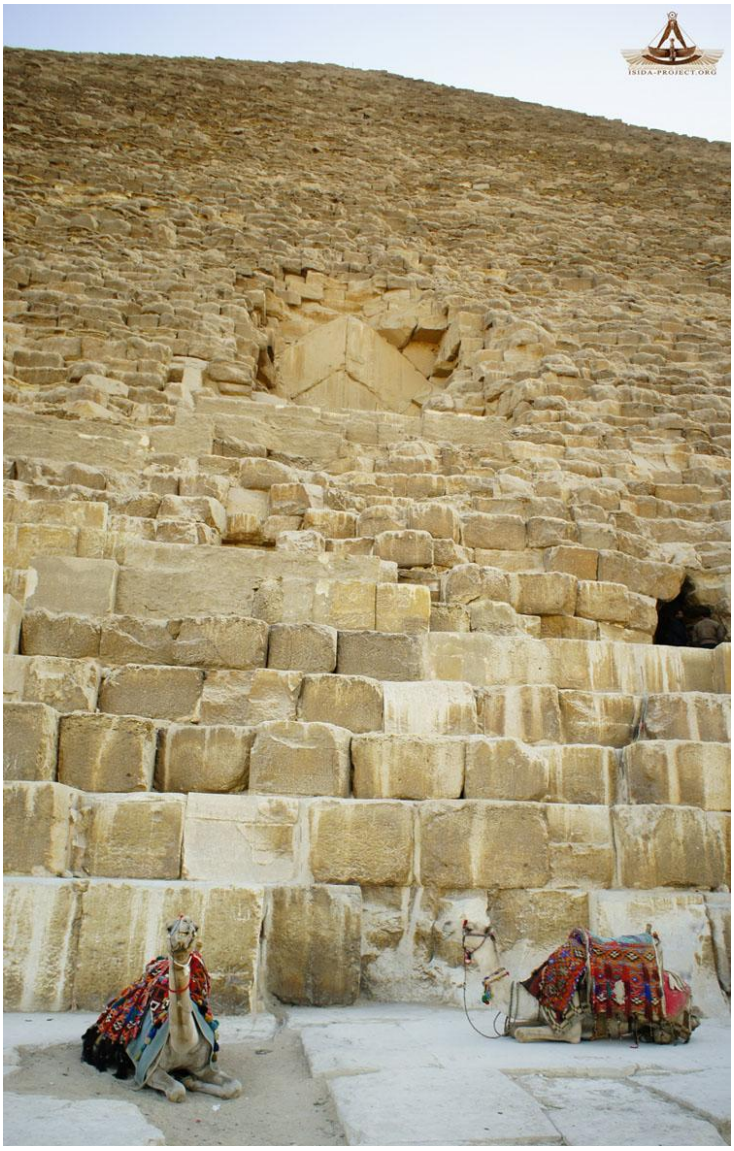


Image courtesy of Isida Project

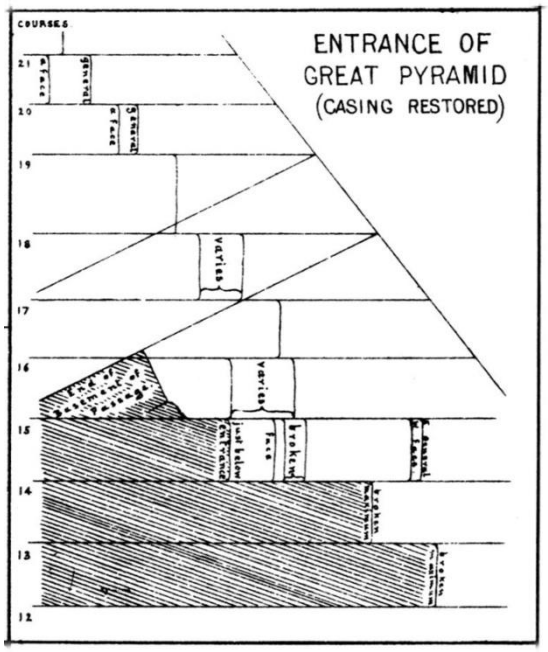
According to Petrie, with the casing restored, the original entrance would exit on the 19th course. The mean dimensions of the descending passage are given by Piazzi-Smyth as width 41.53, and perpendicular height 47.24 inches[31] (in this guide I will be using a combination of Piazzi-Smyth's and Petrie's dimensions: Petrie would state; *"Professor Smyth's vol. II. Is required for the measurements and description of the interior of the Great Pyramid."*[32]*)*

Petrie was of the opinion that the height of the passage was clearly intended to be identical to the fine granite courses which made up the walls of king's chamber.[33]

[31] Life and work at the Great Pyramid, 1867, Vol II, page 36
[32] Pyramids and Temples of gizeh, 1883, 1st edition, introduction xv.
[33] Ibid, page s 51-52

In ancient Egyptian units we are looking at a passage 2 cubits wide by 2 cubits 2 palms high (or 56 x 64 digits[34]). Even in this simple dimension one could look to find a PI connection, as 64:56 =22/7 minus 2. This passage dimension is not unique to the Great Pyramid, but can be found in several of the pyramids at Giza; moreover, it existed before the Great Pyramid, as it is to be found in his father's Red Pyramid at Dahshur.

Using the size of the passage along with its inclination and face angle of the pyramid, Petrie could calculate the height of the casing stone required at the entrance.



Petrie would state; "*On looking to the diagram of courses (PL. viii) it is seen that at the 19th course is a sudden increase of thickness, none being so large for 11 courses before it and 14 after it. And this specially enlarged course is of exactly the required height of the doorway,"*[35]

Petrie's drawing left from his plate XI, shows his reconstruction, with the casing restored. It is interesting to note the number of courses which Petrie gives either side of the entrance course; i.e. 14:11, as this ratio also gives an identical angle to a Seked of 5.5 palms.

Petrie would calculate that the original doorway would be some 668.2±.1 (16.97m) above the pavement, with the passage axis not being aligned to the pyramids N-S axis but displaced to the east by 287.0±.8 (7.29m); or some 14 cubits.

The entrance opening seems to have been protected by a series of large pent limestone beams. In so far as we know, this appears unique to the Great Pyramid[36] Petrie would suggest that some five pairs of these beams may have existed, with some of the pairs exhibiting a different angle and possibly being inclined towards the pyramid as it approach the casing. M&R would state; *"It seems irrational that this complicated relieving system was used right at the beginning of the descending corridor where there was the least vertical thrust, unless the builders feared an eventual sliding of the casing and thus an excessive weight on the architraves of (D)."* 'D' being the descending passage.

Petrie's description of this unusual feature is given overleaf.[37]

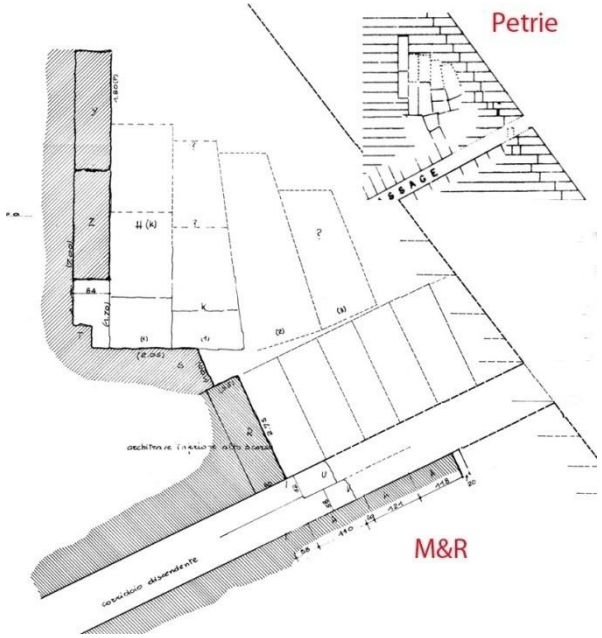
[34] 1 royal cubit, has 7 palms, with each palm having 4 digits, meaning the cubit contained 28 digits.
[35] Ibid, page 52
[36] The good condition of the Bent pyramid prevents observation. Some 5th dynasty pyramids have similar protection along their entrance passages.
[37] Ibid, page 53

These blocks are much like a slice of the side of a casing stone in their angle; but their breadth and length are about half as large again as any of the casing stones. Their mean angle from 12 measures is 50° 28′ ± 5′. The thickness of these blocks is only 33 inches, and there are no others exactly behind them, as I could see the horizontal joints of the stones running on behind them for some inches. On the faces of these blocks are many traces of the mortaring which joined to the sloping blocks next in front of them. These were placed some 70 inches lower at the top, and were not so deep vertically. By the fragment left on the E. side, the faces of these blocks were vertical. In front of these came the third pair, similar, but leaning some 7½° or 8° inwards on the face, judging by a remaining fragment. Probably a fourth and fifth pair were also placed here (see Pl. ix.); and the abutment of the fifth pair shows an angle of 70½° or 73° in place of 50°. The successive lowering of the tops, leaning the faces in, and flattening the angle of slope of the stones as they approach the outside, being apparently to prevent their coming too close to the casing.

Image courtesy of Isida project

The surviving beams are shown above; Petrie would report a grafitto on one of these dated 1476.[38]

[38] Ibid, page 53



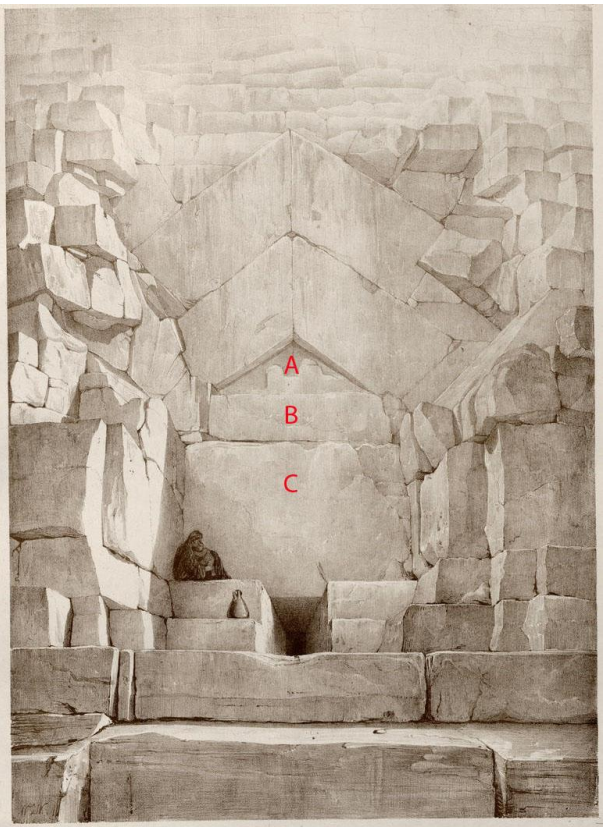
In the image left we have M&R's and Petrie's reconstruction of how the series of pent beams may have looked.[39] Ultimately the destruction is so thorough in this area, that any reconstruction of this area will always be uncertain. The last pair of beams likely only survived as it was judged uneconomical to extract them given the considerable amount of core masonry that would have to be removed to access them.

It has been suggested that these series of beams may have protected a hidden passage into the pyramid, and indeed excitement seem to rise when the Scan Pyramids detected a small void behind the surviving beams in 2016.[40] As far as I am aware, no further investigation has been done to discover what this void is.

Image courtesy of Isida Project

[39] M&R's drawing is fig 10 from TAV2, and Petrie's is part of plate IX

[40] See 'ScanPyramids-First conclusive findings with muography on khufu Pyramid' pdf. www.scanpyramids.org In this pdf they also show a modern 3d reconstruction of the series of pent beams.



The drawing left of the entrance is from Perring's plate XIII, and I have annotated the three areas, A, B, C, as per the previous image. C is one of the large ceiling stones, which form the roof of the descending passage, and these large stones are laid edgewise. Piazzi-Smyth would describe the roof stones as; *"These blocks of stone do not seem of so hard and dense a quality as those of the side walls; and these again are inferior to the floor stones; which floor, therefore, seems to have been meant to stand work."*[41]

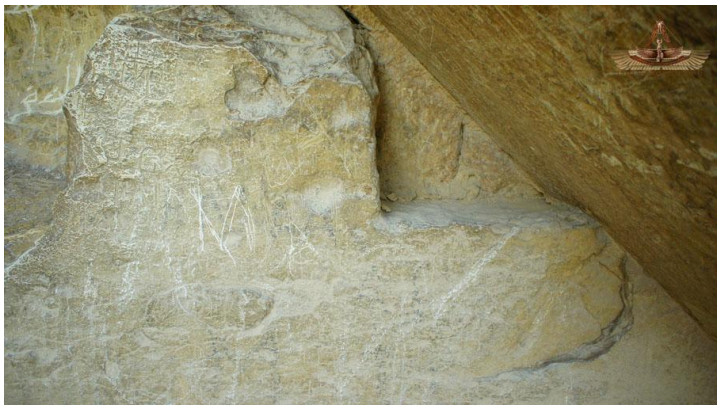
From various sources, block C appears to be 2.75m high (M&R) 38.2 to 38.7 inches thick, 0.97m (Smyth)[42], and about 3.65m wide (M&R). Such a stone amounts to around 9.7 cubic metres, and if we allow 2600kg per cubic metre for good quality limestone, we are looking at some 25 metric tonnes. It might be the case that such edgewise stones extended along the descending passage, and according to Smyth's table of roof joints[43] the thickest roof block is the 4th stone below the one above, which he gives as 66 to 66.4 inches thick (1.68m). Such a block if it maintained the width and height of C would weigh in at some 44 metric tonnes.

The limits of stone B is rather uncertain, with M&R's fig 10 suggesting that it is about 1m high, and extends back some 2m, before we reach area A. It's very difficult to grasp the masonry layout from the images available to me; ideally the whole area needs to be more forensically examined to determine masonry layout.

[41] Life and work at the Great Pyramid, 1867, Vol II, page 19.
[42] M&R's fig 10 gives the roof stone as 80cm thick. However Smyths roof joint measures, give closer to 0.97m
[43] Ibid, page 19

Image courtesy of Isida Project

Looking into area A, we can see notches have been cut out; the region marked B? might be the upper surface of the B stone, which seems to abut against area A.



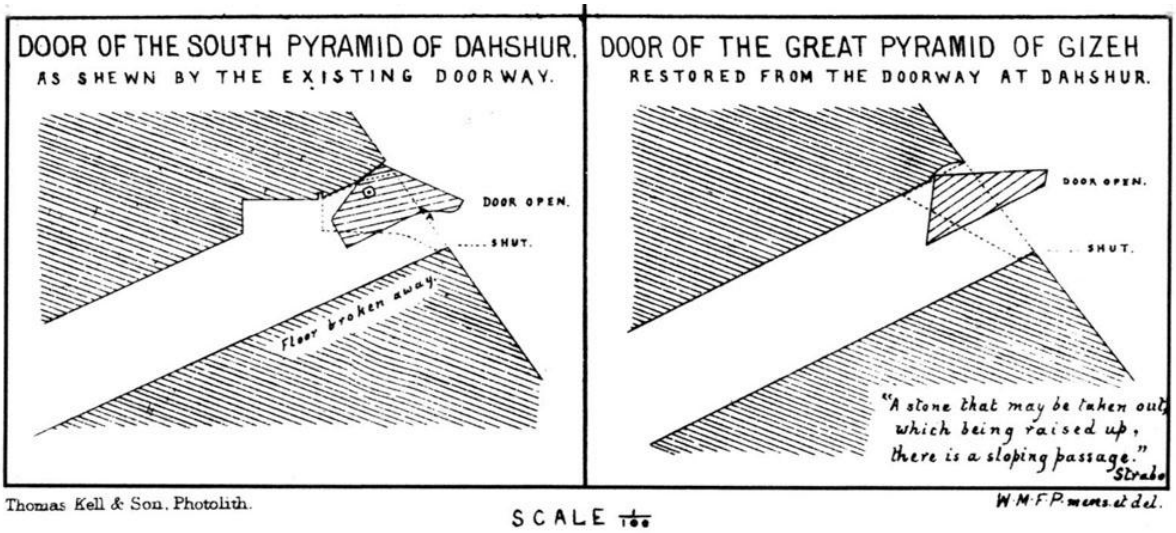
The image right is the western limit of area A, with a neat angular cut. The impression from the images is that the area with the notches is part of the same stone which continues behind the pent beams, with the front part of this stone suitably cut at its ends to receive the pent beams (though this would need to be confirmed by closer inspection; like so many areas of the pyramid, detailed data on the masonry is nonexistent). Above the stone with the notches cut out, we can see the joints of two further stones, which fill this triangular area.

One would think it an easy matter to drill a small hole through this area to further explore the Scan Pyramids void; however, pyramid exploration often moves at a glacial speed. The door discovered by Gantenbrink in 1993, in the queen's chamber southern shaft, took nearly a decade before a hole was drilled through it in 2002: so for the Scan Pyramids void, it is early days yet, as it was only discovered six years ago.

The void itself might be no more than the cave like void discovered behind the notch visible on the pyramids north east arris ridge. This notch can be seen on Perring's drawing on page 1; this ridge was the favoured route for tourists when climbing the pyramid was allowed. This notch created a welcome platform for tourists

to take a rest from their climbing; at the back of the notch was a small opening which gave access to a cave like void of about 9 square meters. This cavity labelled C2 by the Scan Pyramids project is known to be 6m deep from the edge of the pyramid, and was used to validate the performance of their muon gas detector's. Their detectors detected a possible similar sized cavity further up the ridge C1, and further investigations were planned for the other edges of the pyramid; though I have come across no further data.[44]

With the scant data available in this strange area by the entrance, it's hard to make out the reasoning for all this masonry effort. But with the little data I have, it's difficult to see a hidden passage beyond these beams, or that there is any evidence that further beams might extend further into the pyramid core, and so it seems we have an excessive amount of over engineering in the area of the pyramid entrance, which seems to have no logical explanation. The only suggestion I can make, is that some construction existed beneath this area in which the large ceiling stones could not provide the necessary protection and so an added layer of protection, in the form of these series of pent beams was required to secure the area.



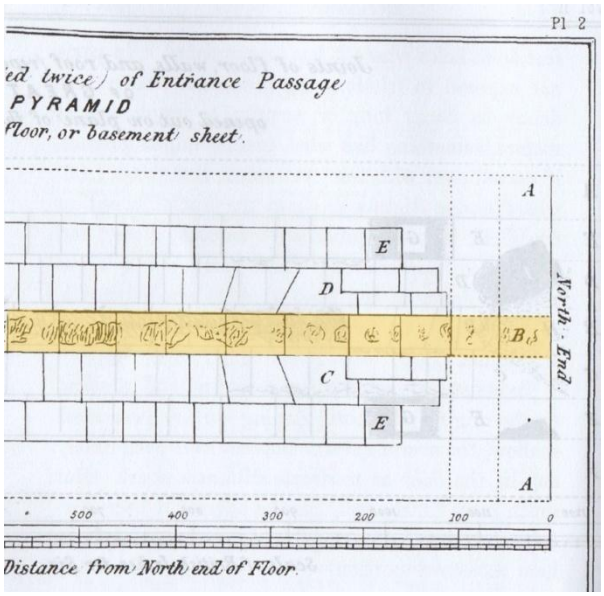
The above drawings are from Petrie's plate XI, and here he suggests a pivoting door into the Great Pyramid, based on Strabo's statement; he would also see a similar door fitted to the Bent Pyramid. In my Bent pyramid guide I questioned if such a door was fitted;[45] however, we do have evidence of a door behind the casing at the Bent pyramids north entrance. Here we can see that the roof of the passage was cut away, and surviving hinge holes in the ceiling suggested that a door pivoted into this cut away. The function of this door could be merely a practical device to secure the pyramid, pending the permanent solution of sealing the pyramid with a casing stone. It may have also served as some ritualistic door, as the king ascended to the imperishable stars to the north, as we often see the mention of doors in the later pyramid texts.

[44] See 'ScanPyramids-First conclusive findings with muography on khufu Pyramid' pdf. www.scanpyramids.org
[45] See Bent Pyramid, part 1, page 12-13

It is often assumed that Strabo's statement applied to a pivoting casing stone as shown above, but I feel it could equally apply to a door behind the casing stone. Could some symbolic door have existed behind the casing stone at the Great Pyramid? Khufu seems to have certainly gone over the top in the grandeur of his pyramid, and so it might be possible that some elaborate counterweighted stone door was constructed in the now destroyed entrance area. Such a door may have taken up a considerable part of the ceiling area of the passage, and so the large on edge stones which we see further down the passage would be unsuitable for protecting the door. The protection above this door would require a different solution, and maybe the series of pent beams was part of this solution to secure this device. Again the whole area is so destroyed it can only be guesswork.

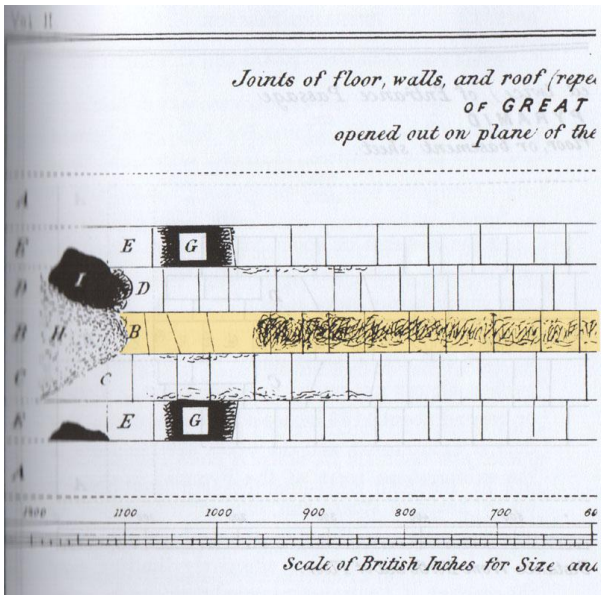
Image courtesy of Valery Senmuth

In this view we are looking down from on top of stone C; here we can see the wooden walkway and hand rails which provide sure footing into the original entrance. Either side of the walkway we can see some of the surviving wall masonry of the descending passage, which in this location consists of two courses, and is made of fine limestone; whilst either side of these wall courses we find the poorer quality core stone. To the right of the walkway we see a granite stone with two holes in it, believed to be a remnant of one of the portcullises which barred entry into the king's chamber. This granite stone sits on a broad bed of fine limestone, often termed the basement sheet, some 398 inches wide and 30 inches thick, and on which the passage wall stones also rest.



The drawing left is part of Piazzi-Smyth's plate 2 (Vol. 2). Here he shows the masonry layout of the descending passage by the entrance; I have highlighted the floor, which today is not visible due to the wooden walkway. Under this walkway are numerous holes, which have been cut into the floor: Piazzi-Smyth would state;

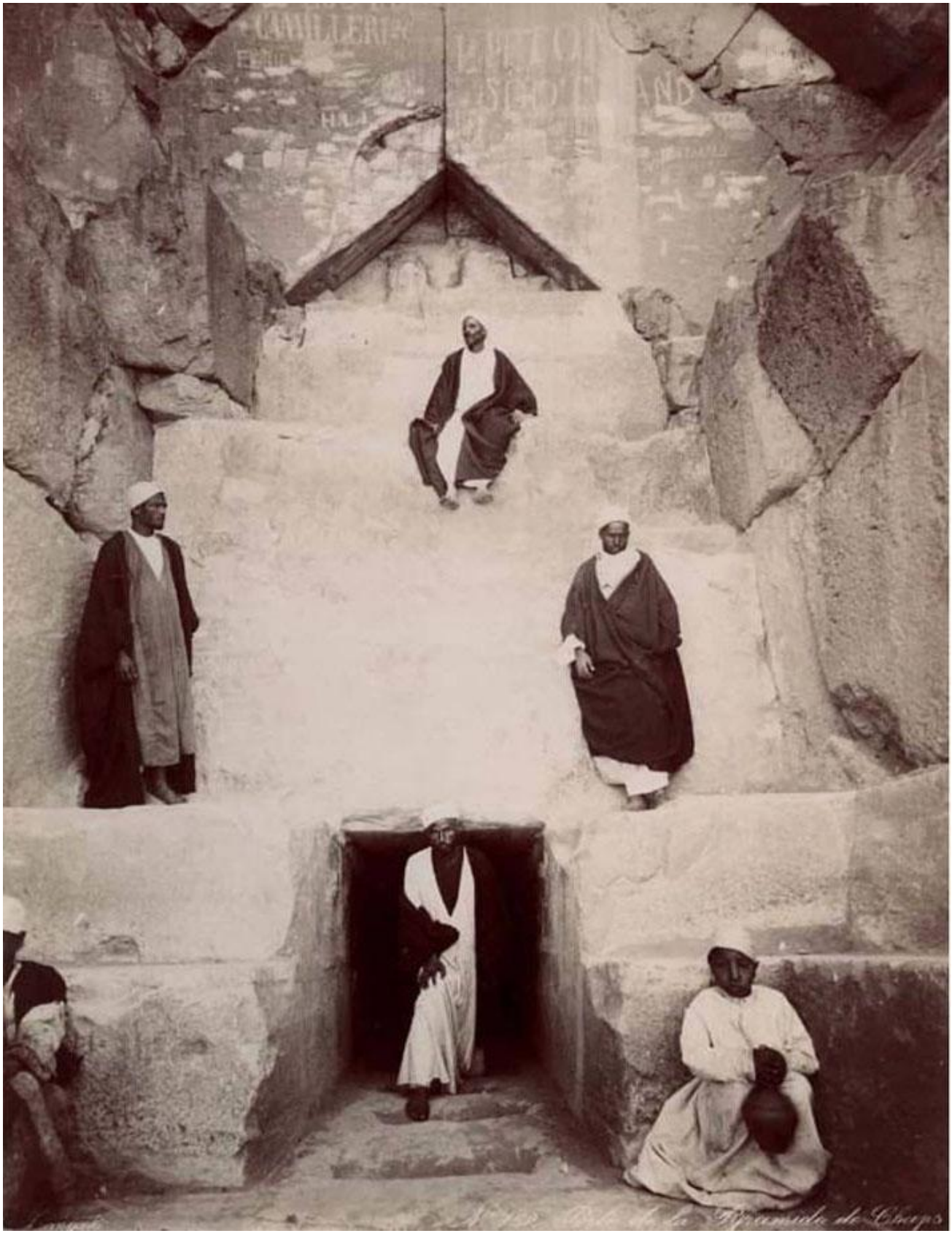
"To assist men, apparently, to ascend and descend on the originally smooth, sloping surface, occasional shallow, transverse holes or notches have been rudely cut in the floor at moderate distances apart. But much more rudely still, has the operation been performed towards the middle and lower end (of the here measured portion)[46] *of the passage, where the floor-stone is not so hard as near the beginning. For in such parts, these transverse holes, usually about two-thirds the breadth of the passage, have been lengthened out, preserving their breadth, until they meet and join each other longitudinally; and have then been deepened so as almost to form a sort of ditch, running along or through the central line of the passage floor; very rough and broken, but yet enabling the ascent and descent to be made with only little stooping."*[47]



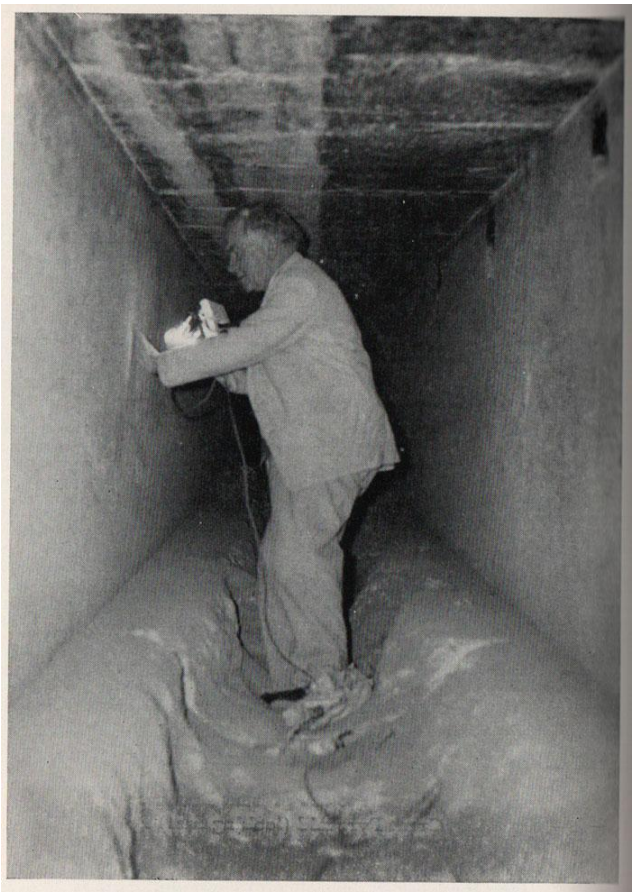
This ditch in the floor would come to an abrupt end just before the junction of the ascending passage, as shown left. Here Piazzi-Smyth noted an anomaly in the floor joints, which were extremely fine and diagonal to the axis of the passage; moreover he describes this stone as excessively hard.[48]

This stone is opposite the junction to the ascending passage, which is plugged with granite stones 'G'. 'I' is the breach in the west wall of the descending passage, which connects to the tunnel often referred to as al-Mamun's tunnel.

[46] The lower end of the descending passage was blocked with debris and he was unable to observe this portion.
[47] Life and work at the Great Pyramid, 1867, Vol II, page 14
[48] Ibid, page 15-16



In the old image above we can see some of the notches in the descending passage floor, as described by Piazzi-Smyth.



Further down the descending passage we come across the ditch in the floor. Here we see the Pyramidologist Adam Rutherford examining the joints of the passage.[49] Just visible on one of the walls are square holes near the ceiling; I could find no data on these, and Piazzi-Smyth who recorded every joint in the passage makes no mention of them. It would appear they are modern constructs, and judging from what appears to be staining on the ceiling next to the one in the foreground, they may have held oil lamps to help illuminate the passage for tourists. Similar sized holes appear also by the granite plug stone, which blocks the ascending passage; these holes too are not mentioned by Piazzi-Smyth; neither are they mentioned by Petrie or Vyse.

The cause of this damage to the floor was mentioned by Perring, who states; *"The whole of the Inclined Entrance Passage was probably closed up with blocks, which exactly fitted it, and the floor of it has been broken up in getting them out, forming what some travellers have been pleased to call steps."*[50] This suggestion of Perring's was countered by Petrie, who states;

"In the great pyramid the entrance passage is often spoken of as having been plugged up; and the holes in the floor are adduced in proof, as showing where the destroyers got under the blocks to force them out. But these holes have been cut by a person standing in the clear passage below them, and picking at the stone from the southward; as is clearly seen on examining the cutting marks. Also the floor, being not only the most awkward part to work upon, but also the hardest stone, would certainly not be attacked to loosen any plugs; but the sides or roof would rather be chosen. Again the holes are not deep enough to hold a man, though five or six feet long; and they only reach as far as Mamun's hole, and not down to the subterranean parts. Moreover, if plug blocks had been dragged out, or broken up in the passage, the walls and roof would inevitably have been bruised or broken where each block was attacked; whereas, there is no trace of such injury visible; and the triangular stone covering the plug-stones in the roof would have been broken loose before Arabic times. Besides these points, in the upper corners of the passage may be seen remains

[49] Pyramidology Book III, image between page 924-925
[50] The Pyramids of Giza, from actual survey and admeasurement. Part I, The Great pyramid, page 2

of the plaster, rubbed by the fingers into the angle; and this would have been displaced if any blocks that were cemented in had been dragged out."[51]

Petrie would state that these holes in the floor would not extend beyond Mamun's hole; however, in Petrie's time debris still covered most of the floor, and he was forced to put his measuring poles on top of the debris in order to obtain a rough measurement down to the subterranean chamber.[52]

The Edgar's however, would state; *"Now that we have cleared the Descending passage below the granite stone referred to by Professor Petrie (Plate XI), we find that the floor here is not slippery like it is elsewhere. Immediately below the granite stone there is a short length smoother than the rest. At this part we notice rough-hewn oblong footholds similar to those in the other passages."*[53]

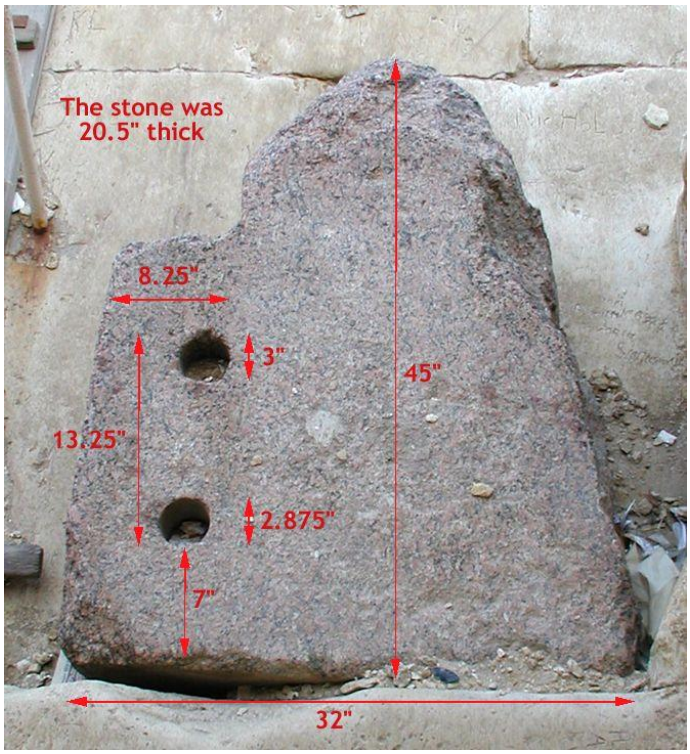
The granite stone referred to by the Edgar's and Petrie appears to be the same granite stone mentioned by Piazzi-Smyth. In the Edgar's plate LXXXIII left, this large granite block has an iron grill door affixed to it, also at bottom of image is a large limestone block. The granite block is likely part of the king's chamber portcullis system. At the top of the image we can see the end face of the plug stone which closes the ascending passage; square holes similar to those on the previous image can be seen either side of the plug stone.

This granite stone appears to have been moved at some unknown date, and might be the one which now resides outside the entrance as seen on page 35. Many early explorers have described coming across pieces of granite in various locations inside the pyramid. I am not aware of any concerted attempt to record in detail these blocks, to establish if any could be connected to one another. Petrie would describe the granite block;

"It was a slab 20.6 thick, worked on both faces, and one end, but rough broken around the other three sides; and as it lay flat on the floor, it left us 27 inches of height to pass down the passage over it. Where it came from is a complete puzzle; no granite is known in the Pyramid, except the King's Chamber, the Antechamber, and the plug blocks in the ascending passage. Of these sites the Antechamber seems to be the only place whence it could have come; and Maillet mentions having seen a large block (6 feet by 4) lying in the Antechamber, which is not to be found there now. This slab is 32 inches wide to the broken sides, 45 long to a broken end, and 20.6 thick;

[51] Pyramids and Temples of gizeh, 1883, 1st edition, page 166
[52] Ibid, page 57
[53] Great Pyramid Passages, Vol 1, 1923, page 168

and, strangely, on one side edge is part of a drill hole, which ran through the 20.6 thickness, and the side of which is 27.3 from the worked end. This might be said to be a modern hole, made for smashing it up, wherever it was in situ; but it is such a hole as none but an ancient Egyptian would have made, drilled out with a jewelled tubular drill in the regular style of the 4th dynasty; and to attribute it to any mere smashers and looters is inadmissible. What if it came out of the grooves in the Antechamber, and was placed like the granite leaf across that chamber? The grooves are an inch wider, it is true; but then the groove of the leaf is an inch wider than the leaf. If it was in then in this least unlikely place, what could be the use of a 4-inch hole right through the slab? It shows that something has been destroyed, of which we have, at present, no idea."[54]



The image left, kindly supplied by Jon Bodsworth, is very close to the dimensions given by Petrie above; however, we have two further holes in this block, not mentioned by Petrie. It might be the case that these holes were filled with compacted debris, and not readily visible to Petrie. Confusion on the granite block is to be found in M&R's work; here they provide a drawing of the block (fig 6 below) and they describe it in their text. This block has no resemblance to the one shown left, but we do not know if M&R's drawing is a reconstruction from Petrie's text. Alternatively, they may have actually saw this block, and we therefore might have another granite block unaccounted for.[55]

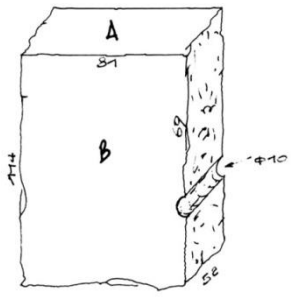


FIG. 6 BLOCCO DI GRANITO TROVATO DA PETRIE PRESSO LA BRECCIA DI AL MAMUN

[54] Pyramids and Temples of Gizeh, 1883, 1st edition, page 28

[55] L'Architettura Delle Piramidi Menfite, Parte IV, page 28, fig 6 from TAV 4

As far as I am aware, there are three granite blocks still residing in the pyramid; one in the recess of the short horizontal passage leading to the subterranean chamber, another inside the pit of the subterranean chamber (this might be the block described by the Edgars further down the descending passage, but moved into the subterranean chamber), and finally, a block is to be found inside the grotto by the well shaft: the latter two appear to have holes drilled through them. I have been unable to find any detailed data on these other pieces of granite.

Judging by the accounts of various early explorers, the descending passage appears to have not been totally cleaned out of debris. The upper masonry constructed part of the passage down to the granite block seems to have been relatively clear to enable tourists to access Mamun's hole; however, beyond this spot, the greater length of the passage, which was cut through the rock of the plateau, appears to have always contained debris, with only sufficient being removed to access the subterranean chamber. The Edgar's appear to be the first to have actually cleared the passage beyond the granite block, here they state;

"Thus we see that the floor of this descending passage has never been so thoroughly cleared, at least in modern times, as it now is. The debris which my men carried out was found to have embedded in it several small fragments of green-coloured idols. Whether or not the idols originally belonged to the Pyramid it is difficult to say. They may have been deposited in the pyramid by others than the builders."[56]

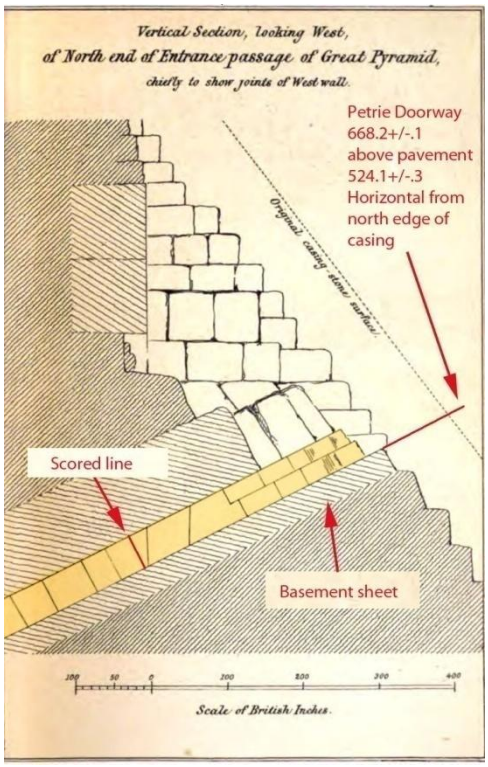
The Edgar's would also comment on how much light could reach the end of the passage. *"It is wonderful how much light enters this passage right to the lower end. Notwithstanding the fact that quite two-thirds of its height is cut off by the granite block on which the iron grill door is fixed, one evening at twenty minutes to six, when we were sitting at the junction of the Descending, and Small Horizontal, Passages, we found it possible to read the time. As Petrie's granite block intercept the rays of light along the floor and axis, we found it necessary to hold the watch close to the roof, against the flat square end of the passage. When we did so, we discerned the time without difficulty. If the granite block were removed it is probable that the light, which is very strong in Egypt, would penetrate sufficiently to enable one to read a newspaper."*[57]

If the granite block was two thirds the height of the passage, it suggests that it may have been moved after Petrie, as he describes it as laying flat on the floor. Two thirds of the perpendicular passage height is close to 32 inches; this suggests that the stone had been moved on to its edge, and it was likely askew in the passage or jammed somewhat as its width at some 45 inches, is greater than the width of the passage.

Today the passage is unobstructed, though the effect of natural light can no longer be judged as the original entrance is closed with steel doors. It is possible for

[56] Great Pyramid Passages, Vol 1, 1923, page 145-146
[57] Ibid, page

tourists to venture into the descending passage and the subterranean chamber, though this access is normally restricted to private tours, with added expense. Entrance to the above areas is through Mamun's tunnel, and illumination is courtesy of modern electricity.



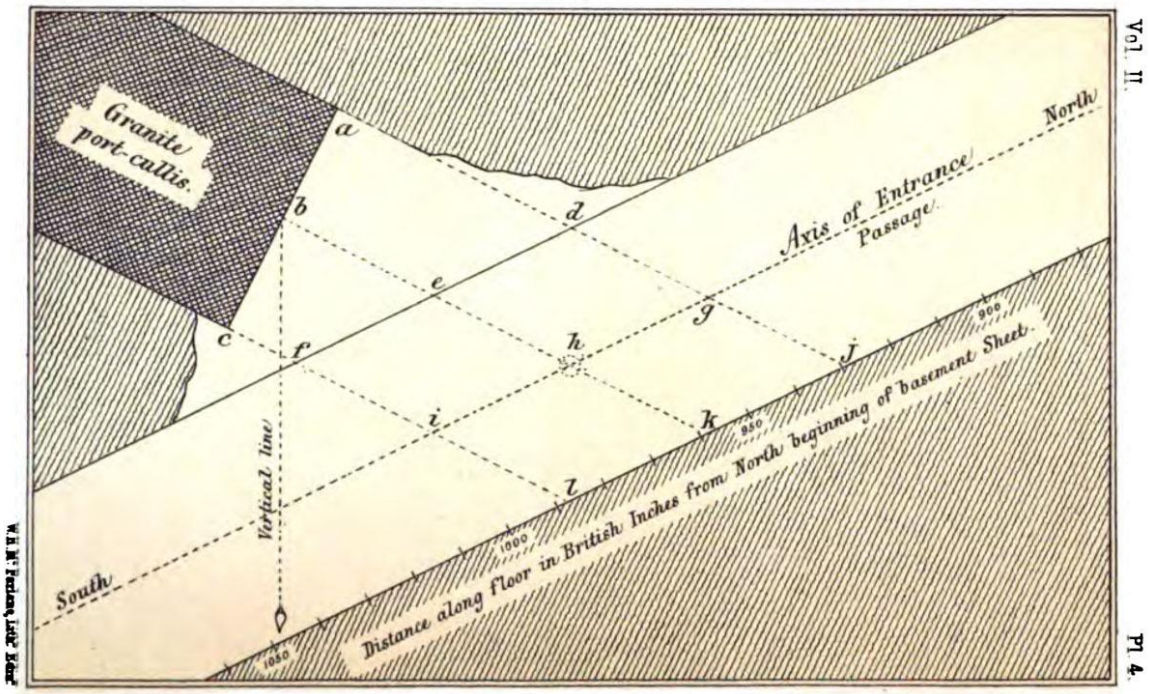
Piazzi-Smyth would spend several days on measuring all the joints in the descending passage, and produces many tables of his results. In his plate 3 left, I have highlighted the west wall of the passage, and pointed out some of the features. I have also inserted Petrie's determination of the doorway location; this he gives as 124.2 inches away from the end of the basement sheet (Piazzi-Smyth thought about 100 inches)[58]

Piazzi-Smyth's work shows that at the upper end of the passage the side walls consist of two courses; this is then followed by singular wall blocks for the remainder of the masonry part of the descending passage. The two singular wall blocks south of the two course section both have their south faces approaching vertical, and beyond this point the wall blocks are laid perpendicular to the passage. Just south of the last vertical joint we have a scored line, which is also present on the opposing east wall. Piazzi-Smyth would state;

"A few inches below, or south of the fourth joint, and nearly similarly on either side of the passage, is still to be seen a line about .08 broad and .02 deep, drawn by a powerful hand, and with a hard tool, upon the stones, and in direction of a perpendicular to the line of the passage. The line finds itself on that particular stone, whose lower or southern end is perpendicular to the passage, while its upper and northern end is approaching to the vertical; and from its (the line's) position, would enable a set-off to be obtained for the unusual angle of the northern face more accurately than from the further end of the stone, to which the line may be considered parallel, - but it is in fact rather truer in rectangularity than that, to the passage axis. The pyramid guides had not noticed these lines on either side; and quite believed, on having them pointed out, that they might have been made by the original builders; while we ourselves afterwards found traces of similar lines on the junction surfaces of fragments of casing stones, and more notably on the south-west socket of the Pyramid excavated and exposed to view by Mr Aiton in April."[59]

[58] Ibid, Vol 2, page 37
[59] Ibid, Vol 2, page 27

Petrie would give the scored line on the west wall as some 481.59 from the original doorway or 357.39 inches from the end of the basement sheet. Piazzi-Smyth did not accurately measure these scored lines, but he gives the 4th joint on west wall as 349.4 from basement sheet, and Waynman Dixon states that the scored line started at 7.55 south of this joint at the bottom, giving a total of 356.95; a similar figure to Petrie's.[60] Petrie provides no measure for the scored line on the east wall, but Piazzi-Smyth gives the joint here as 353.9, with Dixon giving the bottom of the scored line at some 4.37 below this joint for a total on this side of 358.27.



Vertical section (from North to South) shewing Junction of Entrance Passage, and First Ascending Passage, looking West.

In Piazzi-Smyth's plate 4 above, we see the junction of the descending and ascending passages. After carefully measuring this area he would provide the following measures for point 'L' above; west side 985.6, and east side 987.2, or mean of 986.4 from basement sheet. Point 'L' is the apparent intersection of the ascending passage floor with the descending passage floor, and Petrie would give this point as 1110.64 from original doorway or 986.44 from basement sheet, which agrees closely with Piazzi-Smyth's mean figure.[61] The Edgar's would measure this point of intersection with a steel tape from the basement sheet and give a value of 986.25 inches.[62]

Piazzi-Smyth was unable to measure the lower part of the descending passage, as it was blocked with debris, and Petrie states; "*For the total length of the passage, down to the subterranean rock-cut part, only a rough measurement by the 140-inch*

[60] For Piazzi-Smyth see table on page 21, Vol 2, and Dixon see, Our Inheritance in the Great pyramid, 4th edition page 471. For Petrie, see Pyramids and Temples of Gizeh, Ist edition page 55

[61] For Petrie, see his 1st edition, page 55-56, and for Smyth, see Vol 2, page 42

[62] Great pyramid passages, Vol 1, page 216

poles was made, owing to the encumbered condition of it. The poles were laid on the rubbish over the floor, and where any great difference of position was required, the ends were plumbed one over the other, and the result is probably only true within two or three inches."[63]

Petrie would give a total length for the descending passage as; *'End of sloping roof, 4143 inches'.* The Edgars would clear the passage, and brush out any debris in the corners of the passage, and even levered the granite stone to allow passage of their metal tape. They would state; *"For the first time known in history, therefore, an accurate continuous floor-measurement of the passage from end to end is now made possible".*[64] Having measured the passage seven times, they give a distance from the point of intersection 'L' to the lower square end of the passage as slightly over 3037.5 inches.[65] If we add this amount to Petrie's measure from the original entrance to point 'L' of 1110.64 inches, we obtain a total length for the floor of the descending passage of some 4148.14 inches or 105.36m (this is the amount shown on M&R's TAV 3).

How accurate Edgar's results are is uncertain, as I have not come across any more modern data to check the validity of their measures. The floor length is often thought to equate to 200 cubits, and to give a better idea of how long this passage is, it is similar to the base length of Menkaure's pyramid.

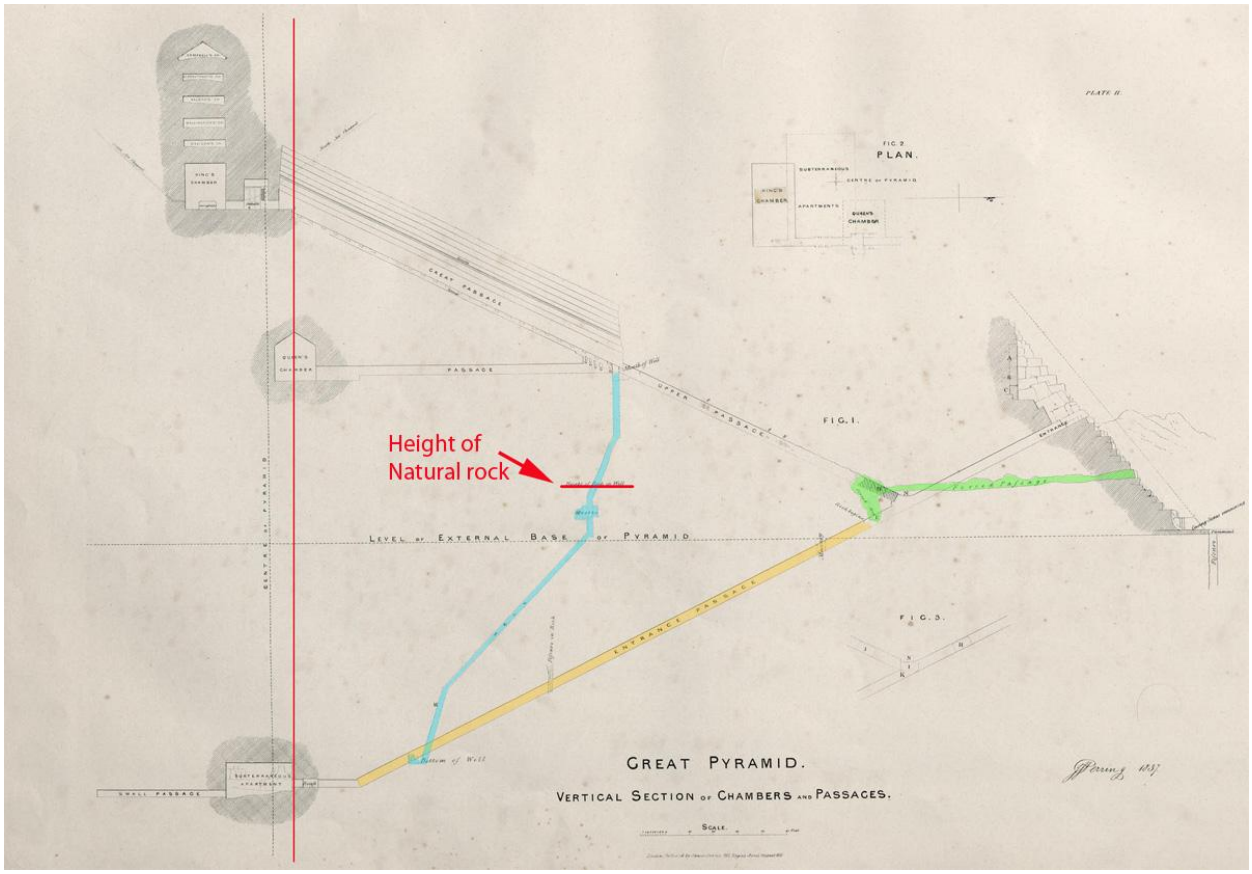
	Azimuth.	Altitude.
Mean axis of whole length . .	−3′ 44″ ± 10″	26° 31′ 23″ ± 5″ ?
Mean axis of built part alone .	−5′ 49″ ± ·7″	
Same, by offsets from 3′ 44″ axis .	−5′ 28″ ± 12″	26° 26′ 42″ ± 20″ ?
(Same by Prof. Smyth, two days −4′ 27″ and	−5′ 34″	26° 26′ 43″ ± 60″)

The average error of straightness in the built part of the passage is only $\frac{1}{50}$ inch, an amazingly minute amount in a length of 150 feet. Including the whole passage the error is under $\frac{1}{4}$ inch in the sides, and $\frac{3}{10}$ on the roof, in the whole length of 350 feet, partly built, partly cut in the rock.

The above data from Petrie[66] gives an idea of the accuracy and angle of the descending passage. It was clearly carefully constructed and its azimuth closely matches that of the pyramid itself. The passage axis is displaced according to Petrie, some 287 +/-.8 inches east of the pyramids N-S axis, or some 14 cubits.

[63] The Pyramids and Temples of Gizeh, 1st edition, page 57
[64] Great pyramid passages, Vol 1, page 171
[65] Ibid, oage 172
[66] The Pyramids and Temples of Gizeh, 2nd edition, page 19

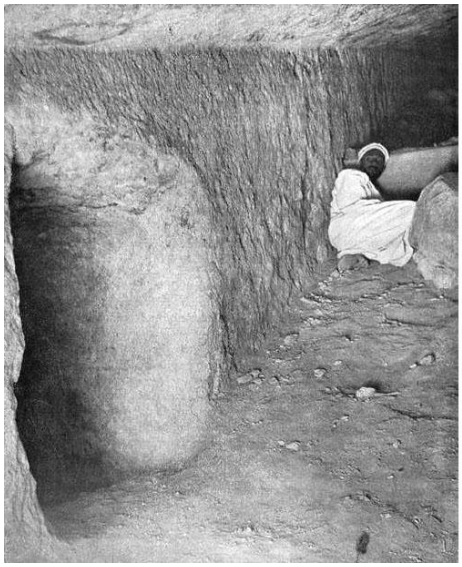
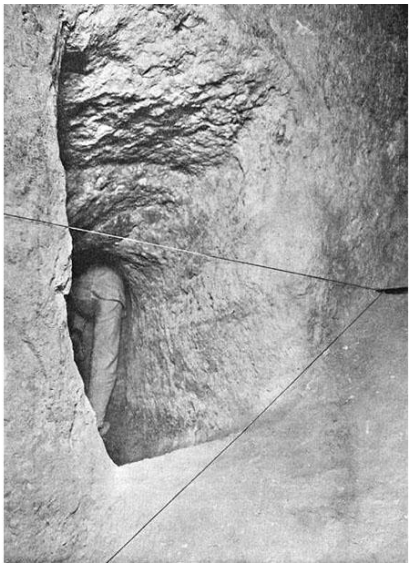
A short distance after the junction of the ascending and descending passages, the masonry portion of the descending passage soon gives way to the longer portion of the descending passage which is excavated out of the rock



I have amended and highlighted parts of Perring's section of the pyramid. The vertical red line is the pyramids E-W axis as determined by Petrie; Perring shows his further south. The yellow portion of the descending passage is that portion which is excavated out of the rock. The green portion is Mamun's tunnel, whilst the blue is the route of the well shaft; this shaft shows that a significant knoll of rock is incorporated into the pyramid, and indeed the rock start of the descending passage is above the pyramid base.

Also just visible in Perring's drawing are natural fissures which run through the rock-cut descending passage. According to the Edgars's, the upper fissure retained its masonry filling, described as evenly dressed. Another large fissure, further down the passage, was also filled with masonry; though in this location only the masonry in the floor survived, the masonry fill of the walls and ceiling had been removed at some unknown time: this fissure would make a convenient resting place for the Edgar's as it allowed one to stand upright; indeed, they describe having a tea break inside it.[67]

[67] Great pyramid passages, Vol 1, page 191-192

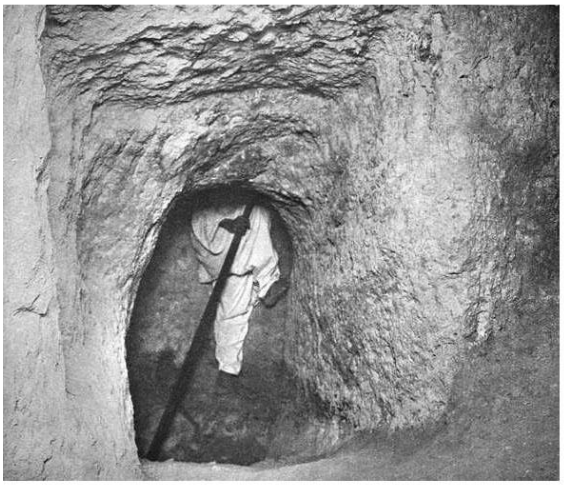
Towards the end of the descending passage a somewhat irregular opening on the west wall gives access to the bottom of the well shaft. The above images taken by the Edgar's has the left image looking up the passage, with the well shaft doorway on left: A granite stone can be seen, below and to the right of the person sitting on the floor of the descending passage; this block is described as having two drill holes in it. Above the person can be seen a board fitted across the passage by a previous excavator to hold back debris; this was removed and cleared by the Edgar's. The right image is the best frontal view of the well shaft opening given the narrow width of the descending passage. The floor of the well shaft opening, slopes downwards somewhat for a short distance in a north-west direction and meets the start of the vertical shaft; one can just make out the legs of one of the Edgar brother's below the shaft.

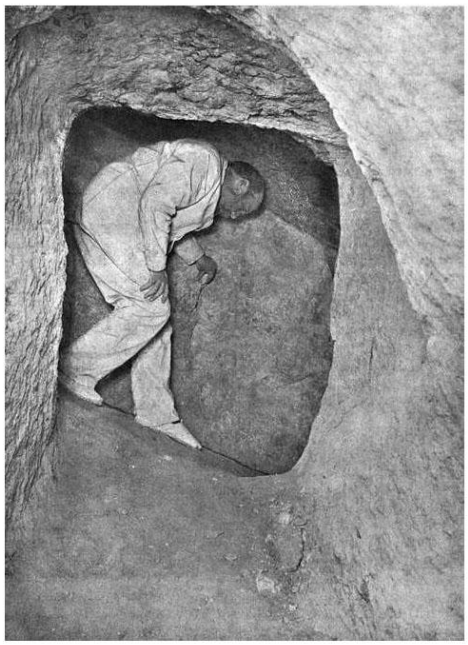
Further detail on the above granite block and others are mentioned by the Edgar's; after describing a large block with two drilled holes to be found in the grotto, they state: *"There are similar granite stones elsewhere in the Great Pyramid. Three lie on the floor of the Descending Passage. One of these, the largest, was discovered by Professor Flinders Petrie, a little below the junction of the First Ascending Passage. It is across the top of this stone, as mentioned before, that the iron grill-door is fixed. It has five worked surfaces, and the remains of one drill-hole four inches in diameter. Another lies on the floor of the Descending Passage a little above the opening of the lower end of the Well. Like the one in the Grotto there are two drill-holes in it.*

This second stone now lies below the Well opening. On the day our men began to clear the debris from the Descending Passage, they had uncovered a third but smaller granite stone, which lay on the floor a little below the iron grill-door. Taking away too much of the supporting debris, this stone began to move, and quickly gathering impetus on that steep floor, it plunged down the 200 feet or more of the passage and crashed with great force into the granite stone with the two drill-holes, knocking it to the bottom. Nevertheless, no damage was done to either of the blocks. As these two stones now prevented entrance to the Small Horizontal Passage leading

to the Pit, I had them removed a few feet up the passage, and laid against the east wall, taking care so to place the larger block that the drill-holes might be examined readily by interested visitors."[68]

In this statement we can add further confusion to the granite stone with the grill door, in that the Edgar's say it had five worked surfaces. The Edgar's would also report several small granite pieces in the pit.

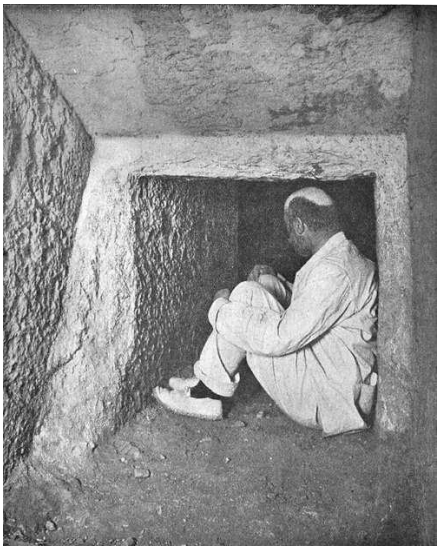




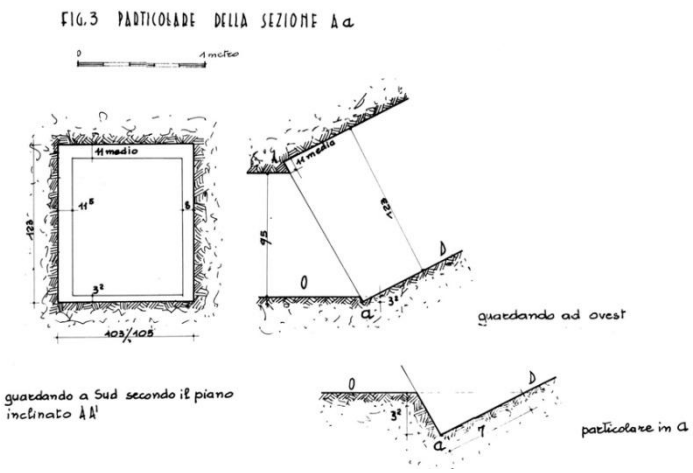
Further images of the Well shaft opening by the Edgar's. The left image is from the floor of the descending passage looking down the short inclined passage to the bottom of the well shaft. The figure at the bottom of the shaft is holding a pole to help indicate the upward direction of the shaft. The right image is taken from the bottom of the well shaft, looking up to the descending passage; where one of the Edgar's is stooped on the floor of the descending passage.

The end of the descending passage terminates in a flat end, with neatly cut corners and perpendicular to the slope of the passage. Out of this flat termination of the descending passage a horizontal passage was cut, and in the image right we can see one of the Edgar's sitting inside this passage. Petrie would measure the margin left by this passage on the flat end of the descending passage, but only along the top and sides, as the floor was still encumbered with debris.

The Edgar's on clearing the debris would discover a margin left at the bottom of the flat end.



[68] Ibid, page 362-363



The Edgar's images are not so clear in this area, but M&R's fig 3 from their TAV 4, gives a clearer picture of the flat end, showing the margin along the bottom.

To conclude this section on the descending passage I will add some more modern images of the passage.

Image courtesy of Jon Bodsworth

Looking up the masonry constructed part of the descending passage towards the modern steel doors, which have a skylight above them. The modern foot boards hide the damage done to the passage floor.

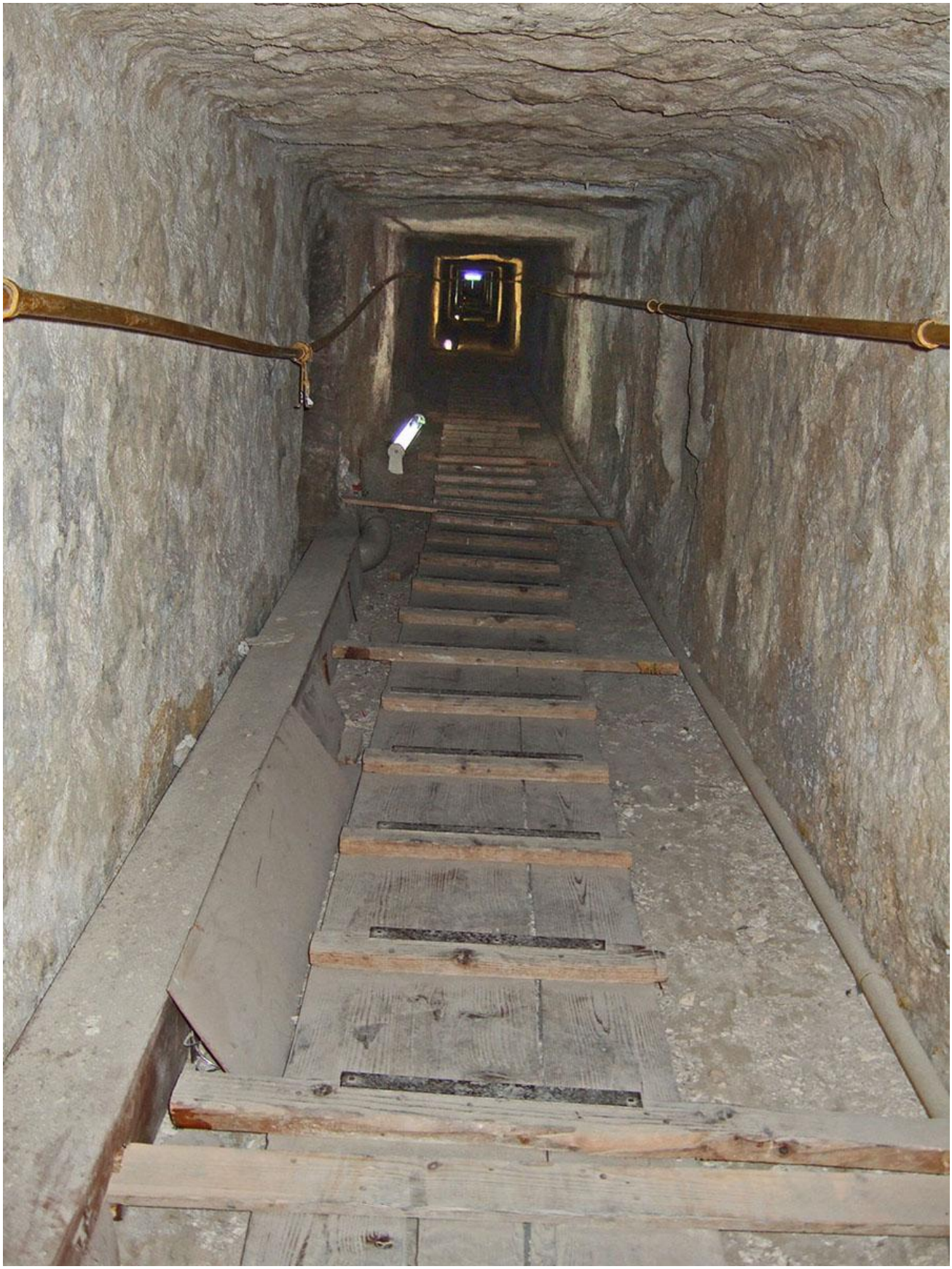


Image courtesy of Jon Bodsworth

The previous image is taken from the bottom of the descending passage, and one can see the well shaft opening on the left. The skylight is still visible, and in some early accounts, I have read of people who visited the pyramid at night, and state that they could observe stars from the bottom of the passage.

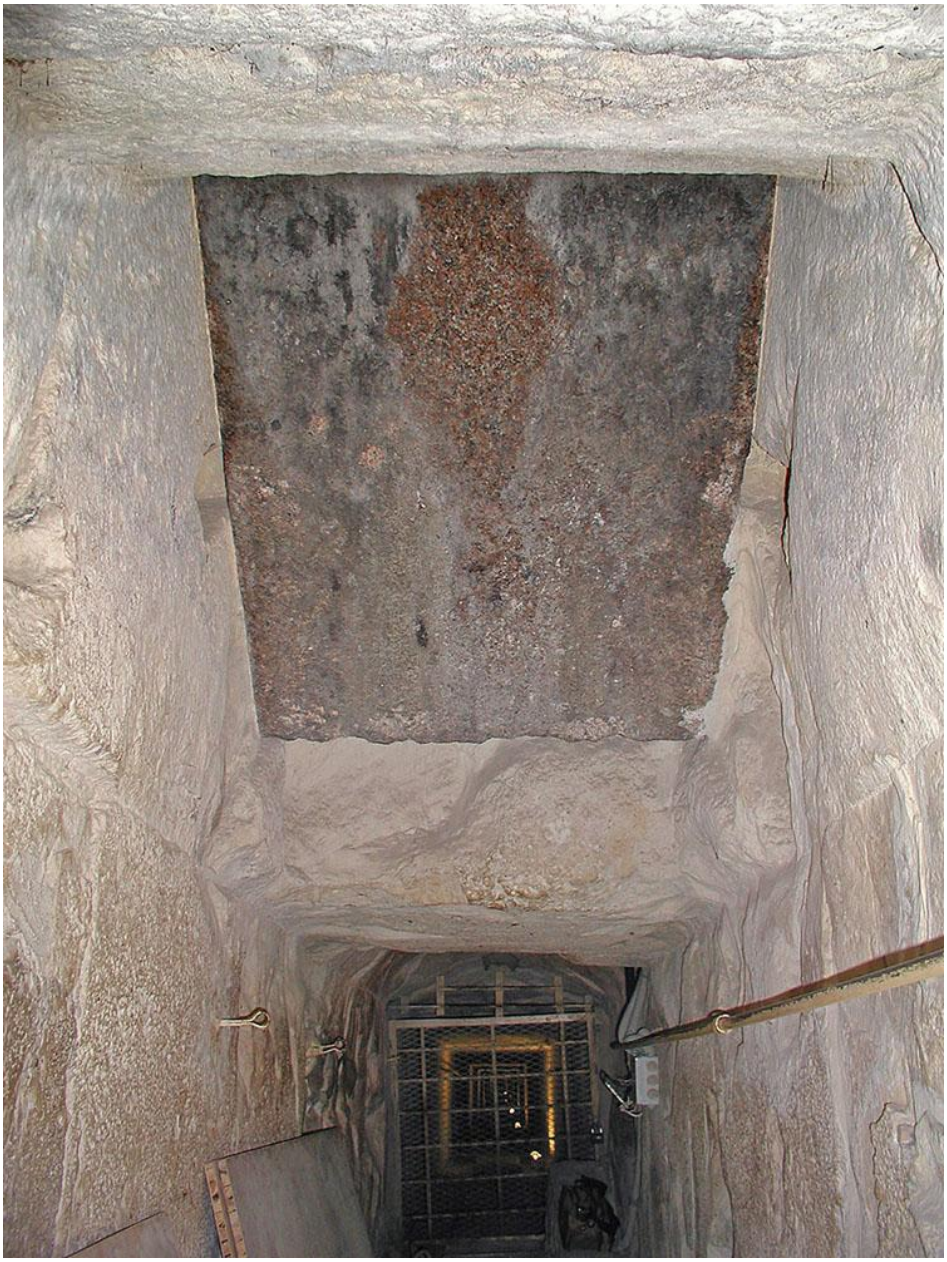


Image courtesy of Jon Bodsworth

Looking down the descending passage, we can see the granite plug which seals of the ascending passage. The modern steel door replaces the door which was mounted on the granite block; to the right of this is the breach to Mamun's hole, which bypasses the security of the granite plug stones. Note the square holes either side of the granite plug stone.

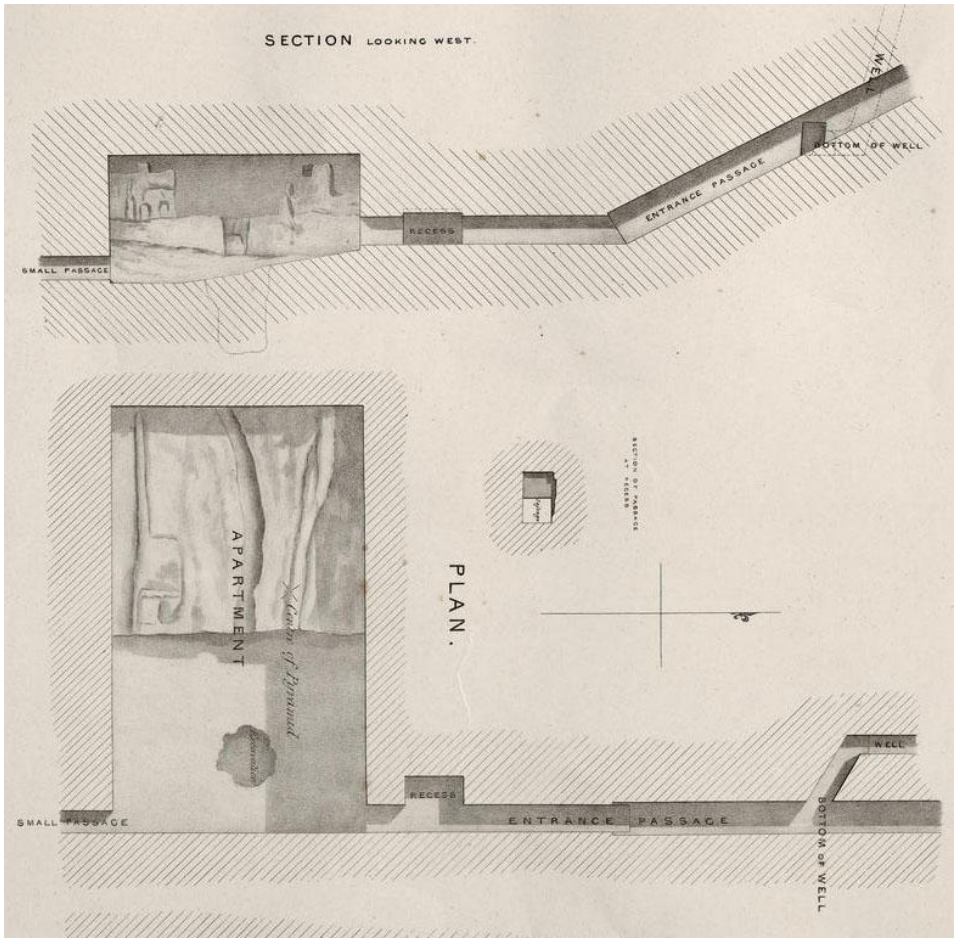
Image courtesy of Jon Bodsworth

Looking down the descending passage, with the well shaft entrance on the right. In the top left we can see the margin of rock left at the end of the descending passage, and the commencement of the horizontal passage which leads to the subterranean pit.

In the image left we can see the scored line on the eastern passage wall, with an unknown graffiti just below the line: graffiti enlarged on right..

Image courtesy of Larry Pahl

The Subterranean Chamber



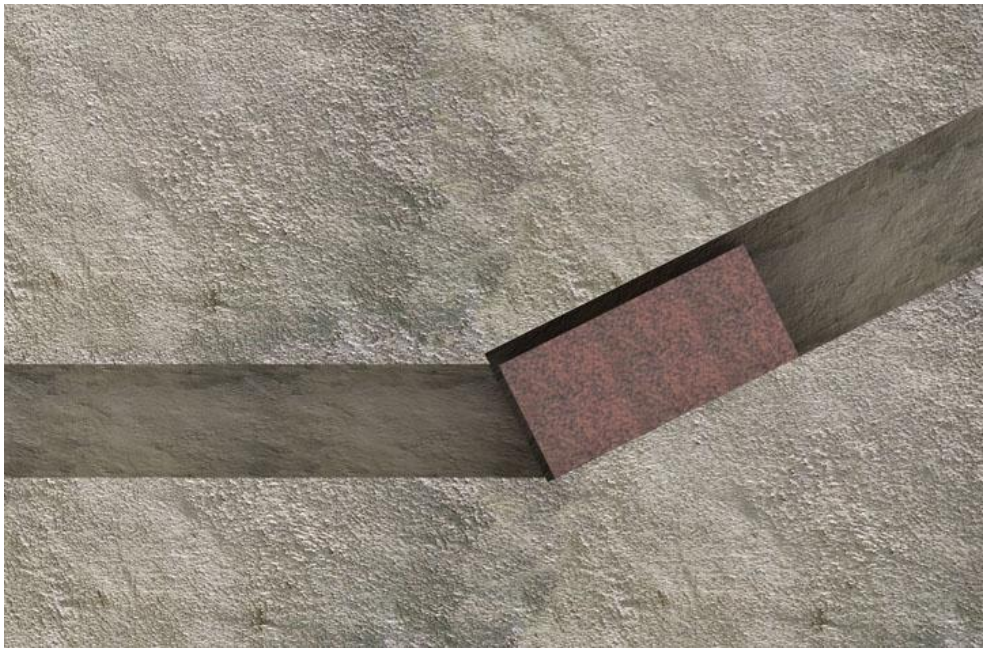
The above plan and section of the subterranean chamber is from Perring's plate IX. Theories have been developed to try and explain this chamber, with the most cited being that it was the intended original burial chamber of the king, but a change of plan to locate the burial chamber in the superstructure led to the abandonment of the subterranean chamber. As previously mentioned on page 8, Lehner and Hawass state that some evidence suggests that the above unfinished chamber was the last to be constructed, which if true, would have major implications for alternative theories. Unfortunately they provide no evidence for their conclusion, other than the so-called trial passages east of the pyramid, which also lack a subterranean chamber.

My own view on this chamber, would agree to some extent with those who see this chamber as being constructed last; however, as a layman, I will be somewhat controversial in suggesting that the subterranean chamber is not contemporary to the Great Pyramid, but rather a later intrusive addition. In short, the long descending passage was always designed as a neat dead end, which was subsequently cut through by some later usurper. It might seem strange to create a blind passage, but even under the impressive Hawara pyramid, we have a well constructed blind passage, which Petrie describes as being filled up with solid stone; whilst the other passages remained unfilled. Moreover, this blind passage was significantly wider than the others, which

would have required additional work on the ceiling beams; in all, a lot of work for a passage with no apparent function.[69]

The actual design of the subterranean chamber also appears odd in the context of 4th dynasty architecture; an analogy might be what the antique furniture trade call a marriage: i.e. when two pieces of furniture from different era's and manufacturer are joined together, to create a piece for better resale value. The pyramid before the Great Pyramid is the mighty impressive Red Pyramid at Dahshur; by base length it is the second largest pyramid, being only 20 cubits less than Khufu's, or some 10.5m. This fine pyramid has successfully placed all its chambers inside the superstructure, and it has no subterranean features; so it would seem strange that Khufu's vision for his massive pile of stone, would extend to a less imaginative rock cut chamber; which was subsequently abandoned, for a more imaginative and highly elaborate design that we might expect from the outset of the project.

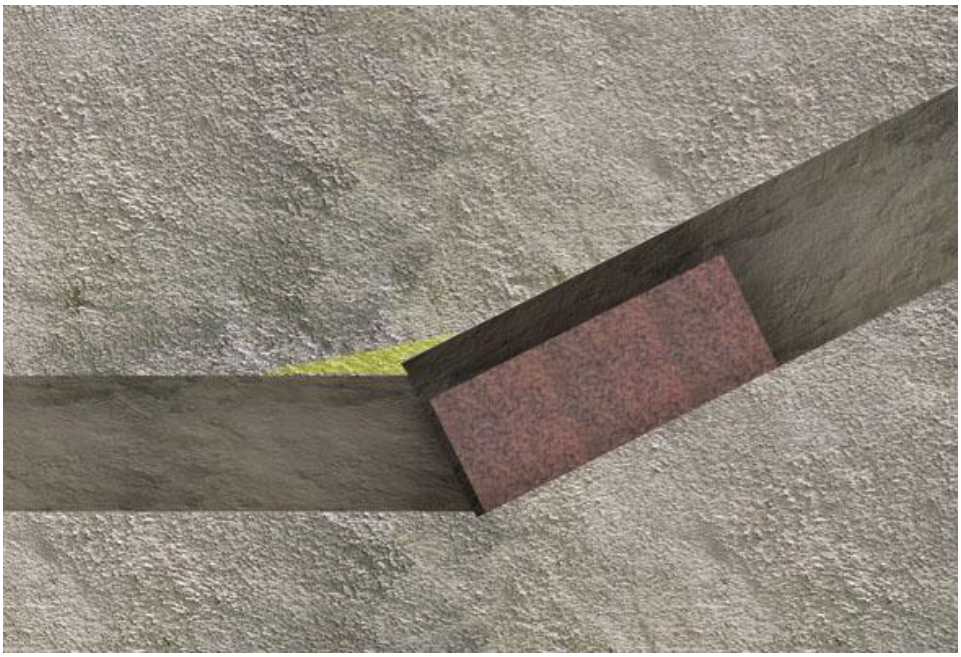
Basic problems emerge at the junction of the descending passage and horizontal passage that leads to the subterranean chamber, in that as currently configured, we can only hope that Khufu was a small man, as it's hard to see any impressive stone sarcophagus making its way into the rock cut chamber.



In the above image I have placed the sarcophagus found inside the king's chamber at the bottom of the descending passage, and the problem is easily apparent, in that how do we move the sarcophagus onto the floor of the horizontal passage? There is simply no turning room, unless extensive cutting is made at the junction, this would remove the margin at the passage end, which some have suggested was left for restraining plug stones. It's not that Khufu's sarcophagus is especially large; Khafre's is longer by some 14 inches, and wider by some 3.5 inches, though shorter in height by some 3.2

[69] For more information see my Hawara guide.

inches (the sarcophagus in the image above is just the box, the lid would have to be brought in separately). The horizontal passage has a height ranging from 91 to 95 cm (35.8-37.4 inches: M&R TAV 4), so box would have to be around 35 inches high for clearance along the passage. The passage width is around 85cm (33.46 inches), so we could allow the box around 32 inches width for clearance.



Even with the box reduced to dimensions to fit the horizontal passage, cutting would still be required at the junction to allow the turn. The simplest solution might be to remove some of the ceiling as highlighted above, or cut into the floor and extend the incline of the descending passage enough so the box could be levered up and so avoid the ceiling. It all comes across as a poor design, and a small sarcophagus for so mighty a king.

It would seem likely that these giant pyramids were all violated at the end of the Old Kingdom, in the First Intermediate Period. Any later usurper, who cared to use the structure, would likely understand the various functions and symbolism of Khufu's design; whereas today from a distance of some 4500 years, we modern humans can only guess and theorize what was in the mind of the architects. The usurper may have well understood the purpose of the blind descending passage, and took care to leave a margin at its end, to denote its original limit and retain its magical importance. Clearly the new subterranean addition to the structure was not completed; possibly through the early demise or overthrow of the usurper; but what was completed is a sizeable effort hacked out of the rock, and which would have taken a considerable time.

The time taken to create this chamber would have little effect on exterior building activities, which could be advanced unimpeded. Given the depth of the chamber, and the arduous toil of the work, the number of workers would be limited due to space restrictions and available air. During this time if we assume that the chamber is contemporary and Khufu's first plan, the superstructure would continue to

rise as work continued in the deep bowels of the plateau. Given the close proximity of the descending and ascending passage junction to the natural rock, it might be expected that the superstructure would have risen somewhat above the rocky outcrop as the slow laborious work of excavating the chamber continued. If this was the case, then when the decision was taken to abandon the subterranean chamber and build in the superstructure, we might expect that the new ascending passage was cut through pre-existing laid core masonry; and indeed, this is often the view of Egyptology. For example I.E.S. Edwards would state;

"At the time when the decision was made to alter the original project and to substitute a burial-chamber in the body of the pyramid for the one under construction in the rock, the superstructure had already been built to a height of several feet. A hole was therefore cut in the masonry-roof of the earlier Descending Corridor at a point about 60 feet from the entrance and a new Ascending Corridor was hewn upwards through the core."[70]

However, as we will see when we examine this new junction in the ceiling of the descending passage that things are not as simple as they first appear, and instead the masonry in this location appears purposely made for the new passage, and not cut through core masonry. This would put another question mark on the provenance of the subterranean chamber. If Khufu had created the subterranean chamber, why not finish it? He could have easily left a handful of workers to continue the chamber, if only to provide a ruse to attract robbers: leaving it in its unfinished state would only raise the suspicion of robbers. Moreover, it is a bit of an eyesore on a finely finished substructure, which would hardly tax the resources of Khufu to tidy up.

Even simple issues like the footholds cut into the floor of the descending passage have the ability to raise questions. According to Piazzi-Smyth the damage to the descending passage floor ceases under the granite plug of the ascending passage; from here the floor is uninjured, with the footholds according to the Edgar's commencing again just below Mamun's hole in the passage wall: why is this? It would seem unlikely that some special hard limestone existed that could defy attack. Indeed, why do we even find footholds down to the subterranean chamber, as it is often thought that such cuttings were made later by others. What need is there for these footholds down to the subterranean chamber; violators would soon discover an unfinished chamber of little interest, so why waste energy cutting footholds down to it. One could argue that the footholds are contemporary and were created by Khufu's workmen to assist in transiting the passage, and yet this seems unlikely as good surviving examples from the Old Kingdom suggest that the floors were left smooth, and a good example of this can be found in the western passage of the Bent Pyramid. This western passage was plugged with stones, which were only removed in modern times, and here we can see the good condition of the floor.

[70] The Pyramids of Egypt, New ed, 1986, page 109

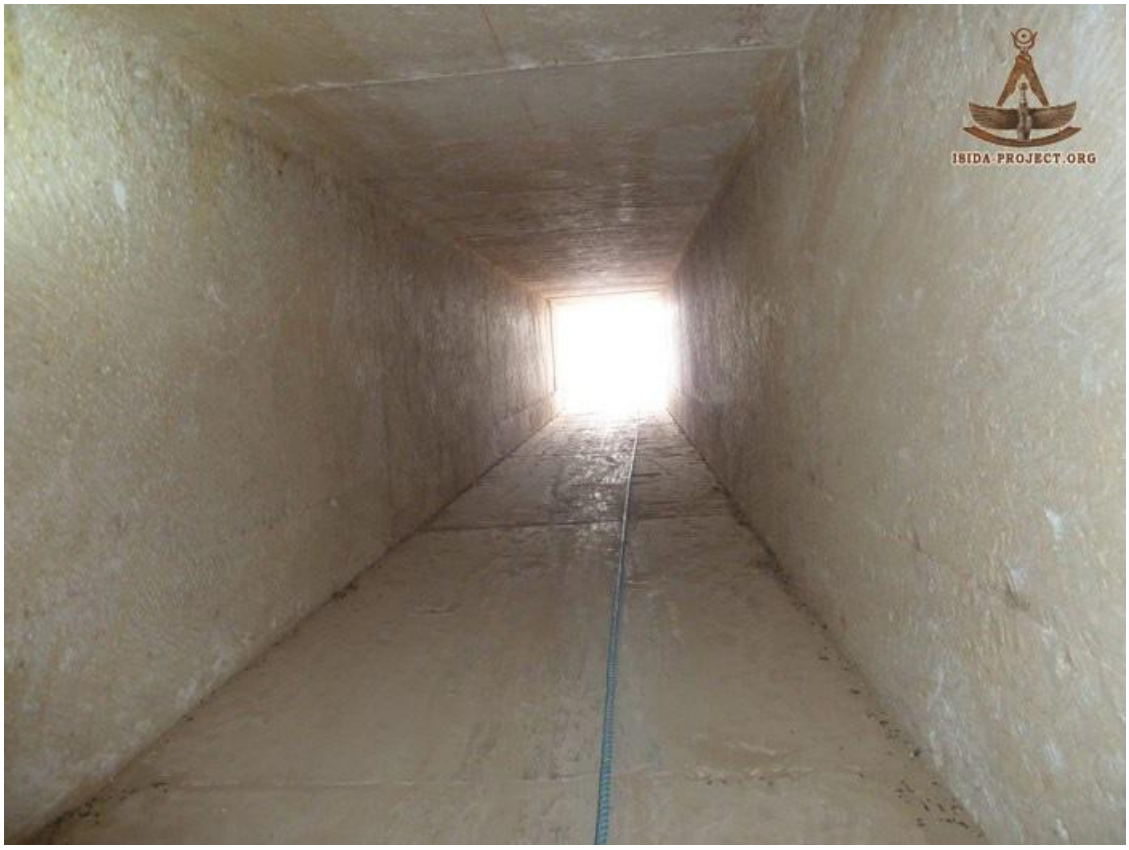
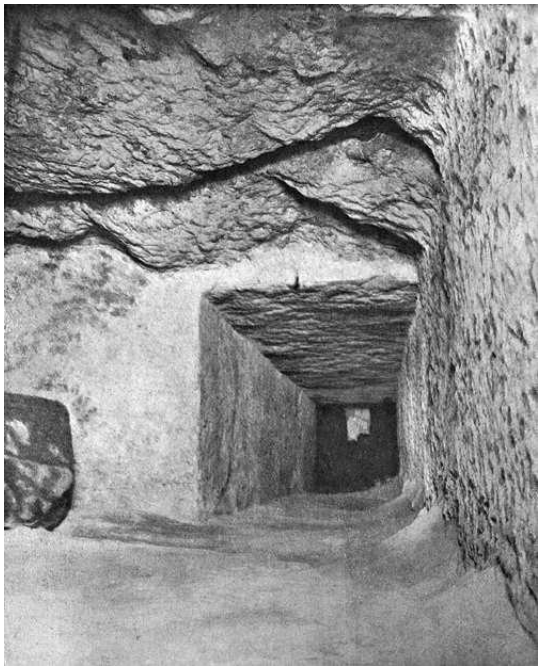


Image courtesy of the Isida Project

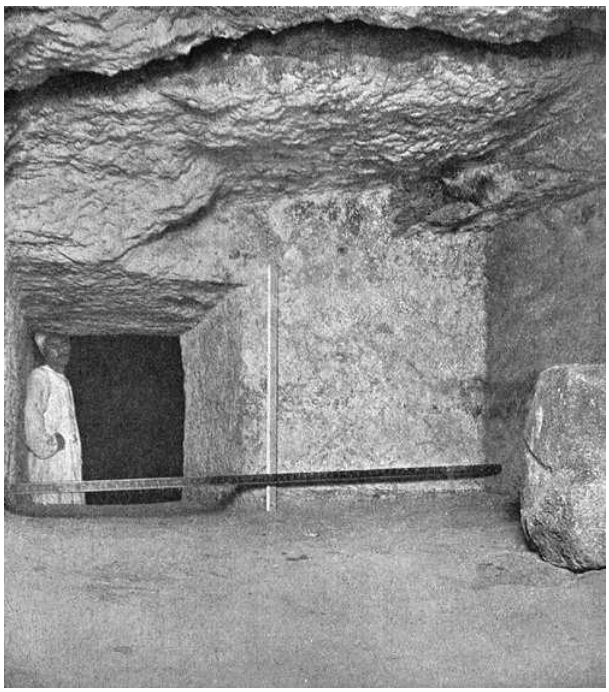
In the above image we can see the good condition of the passage floor in the Bent pyramids western passage. Today a rope assists those lucky enough to gain access, and likely such assistance was offered to workers during its construction. So how do we explain the cuttings in the descending passage of the Great Pyramid and the gap in the floor where the cuttings restart? The hole in the descending passage west wall which connects to the tunnel cut through the structure is often attributed to al-Mamun, and yet the evidence for such an attribution is very tentative; indeed, the accuracy of this tunnel is very similar to the accuracy of a similar tunnel cut through Khafre's pyramid, and both tunnellers were either very lucky or knew exactly where they were going to bypass the security features. The fact that both tunnels start near the middle of the pyramid faces, whilst the entrance passages were displaced to the east has been used by some to suggest that the robbers did not know the location of the entrances, but this is unlikely. We see that in the construction of passages and chambers that the builders surrounded the structures in good quality limestone to a good depth: we see a good example of this in the tunnel cut into the niche in the queen's chamber. The tunnellers would be aware of this and hence would offset any tunnel to avoid cutting through this harder and more compact stone, and this is why we likely see both tunnels turn to the east at their ends, after they have bypassed the security features. Of course the myth exists that the tunnellers turned east in the Great Pyramid after hearing a concealing stone in the ceiling of the descending passage fall, and alerting the tunneller's: though strangely, no such myth explains the turn in Khafre's pyramid.

These tunnels are major works in their own right, and would take some considerable time and so unlikely to be the work of a few robbers working at night; but more likely they were sanctioned by some ruler, possibly during the First Intermediate Period. After the pyramid was violated this tunnel may have had another function for a usurper in helping them construct the subterranean chamber, in that it provided a short cut to aid removal of debris extracted from the subterranean chamber, and possibly the footholds were cut in the lower portion of the descending passage then, and why they terminated at Mamun's hole. (In the Middle Kingdom pyramids, the problem of transit on inclined passages was largely solved by creating steps down the centre of the passage, and leaving smooth ramps either side of the steps).



Returning now to the subterranean chamber, the view left, taken by the Edgar's is from the south end of the horizontal passage; in the background a person can be seen standing on the inclined floor of the descending passage. To the left we can see one of the granite stones in the recess (this stone displays no holes, but has a groove visible. This groove may be part of the violator's process in breaking up the block; Perring would cut groves into the portcullis in Khafre's pyramid in an attempt to break it up. but failed.) The recess has a very irregular ceiling, and Petrie reports that a fissure also runs through it.

Edgars view right, is looking south from inside the horizontal passage; the recess along with the granite block can be seen on the right, whilst the figure in the background stands on the irregular floor of the chamber.
In the image overleaf, we have a modern image of this granite block, which still resides in the side recess.



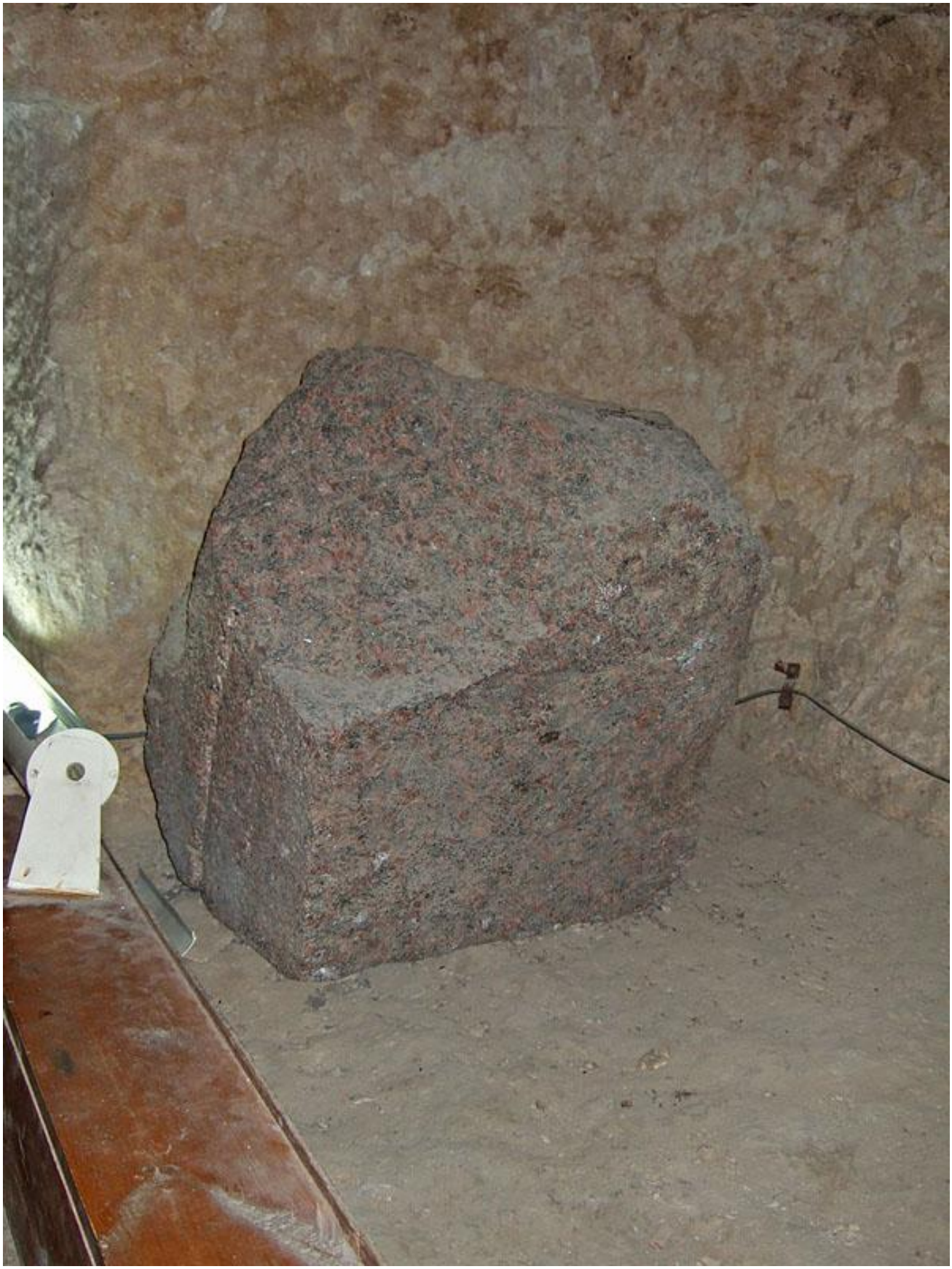
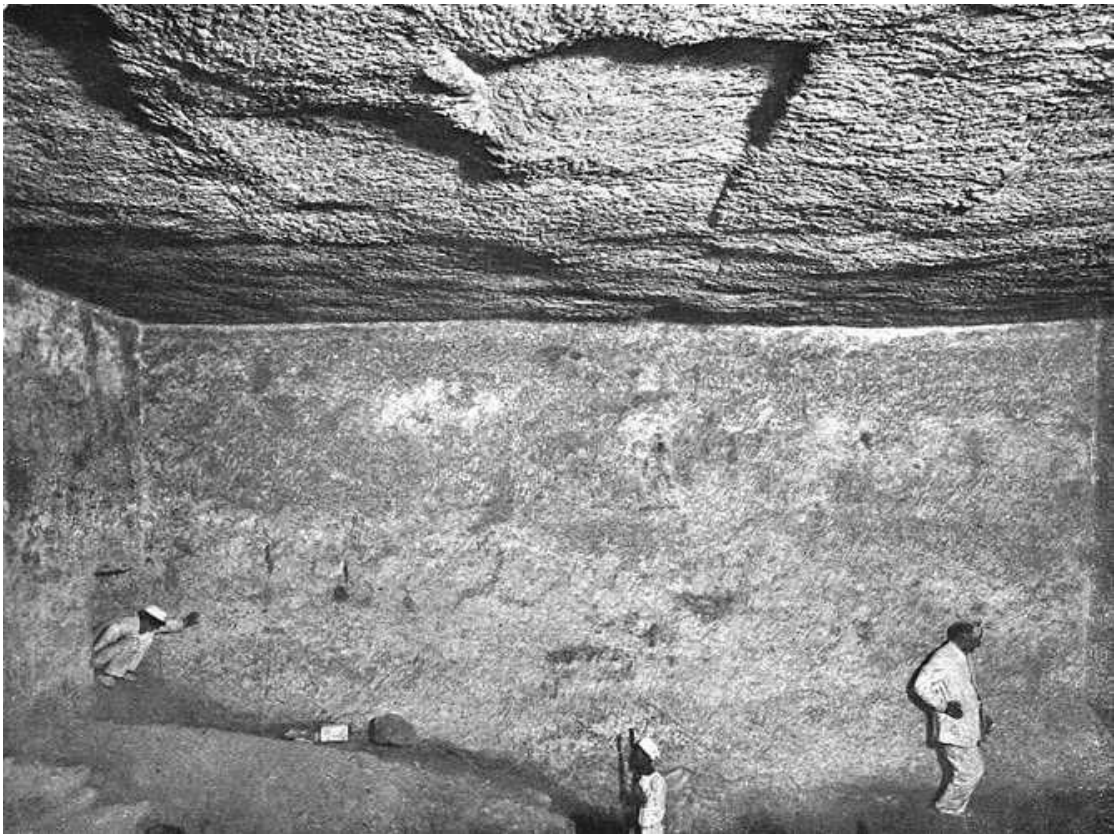
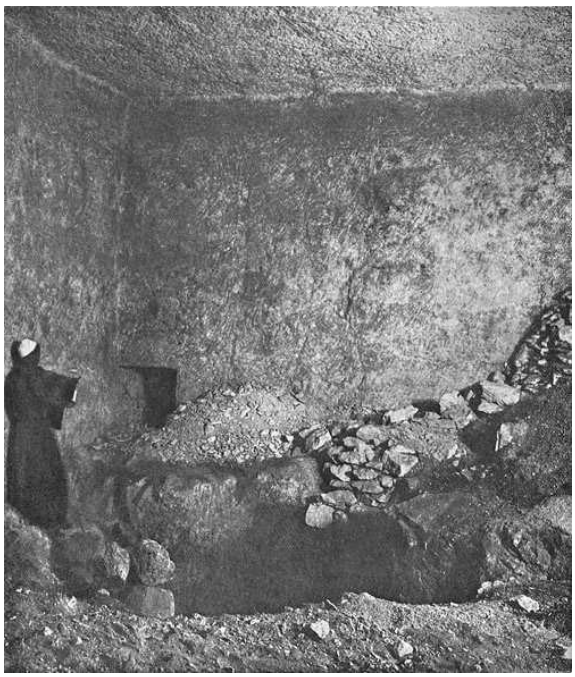


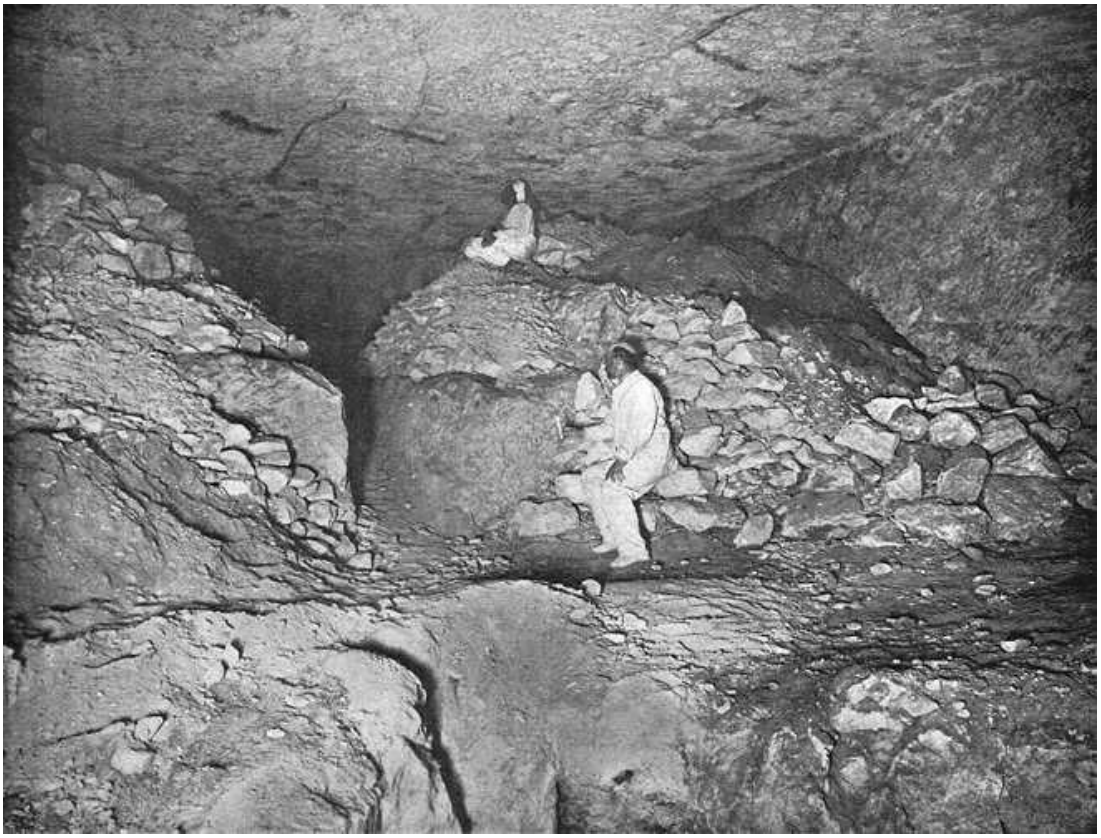
Image courtesy of Jon Bodsworth



In the above image by the Edgar's, we are looking at the east wall of the subterranean chamber; the figure on the left is emerging from the horizontal passage, whilst one of the Edgar's looks down at the opening for the blind passage which starts in the south east corner; the figure in the middle stands by the edge of the pit. According to Petrie the north wall of the chamber is some 40 inches south of the pyramids E-W axis.



This Edgar image is looking at the entrance to the blind passage found in the south east corner; this passage is at a lower level than the horizontal passage, with the roof of the blind passage being nearly aligned with the floor of the horizontal passage. In the foreground can be seen the cutting for the pit. The blind passage would extend further south for over 16m and it has a kink in its route to the southeast; starting some 11m from the door for a distance of some 1.8m before straightening south again.



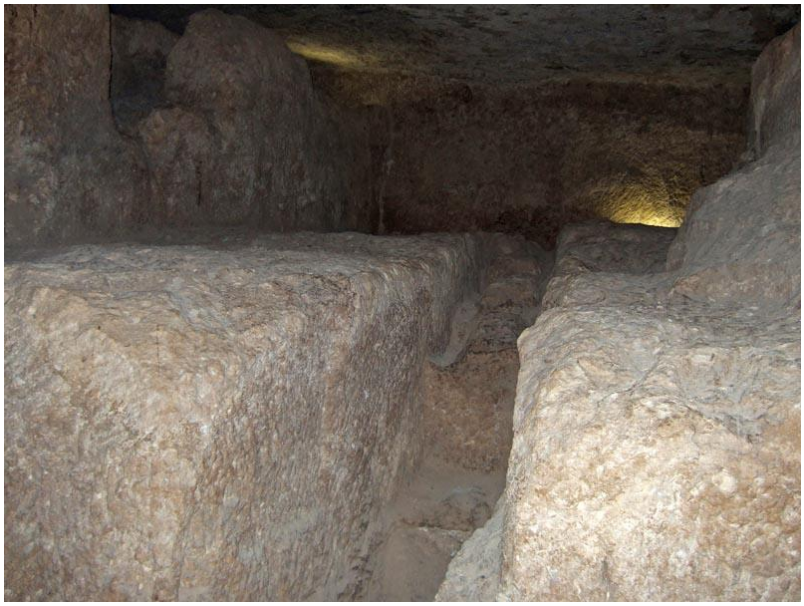
This view by the Edgar's is looking into the northwest corner of the chamber, with the pit opening in the foreground. A lot of debris is to be seen, some of which might be from Perring's excavation in the pit.

In the above Edgar image we appear to have the start of another passage or niche at the top of the west wall, which is close to the chambers north wall, which is visible behind the figure, this cutting would only extend into the west wall by some 45cm.

Image courtesy of Jon Bodsworth

This modern view looking into the chambers southwest corner shows the chamber clear of debris, and here we can see a significant amount of rock left in the western end of the chamber, when the decision was made to abandon the project. I have highlighted the niche shown in the previous image to give a rough idea of its location. The excavation process appears to start from the ceiling level, cutting downwards leaving vertical thin walls of rock between cells, which would be later removed. It must have been back breaking work, and one must surely feel sorry for the poor individual who picked the short straw to work in the blind passage. The railings now surround the pit, as certain tour groups are now allowed to visit the chamber.

The chamber itself is an impressive size, though clearly still in the rough, it measures just over 14m E-W and around 8.3m N-S

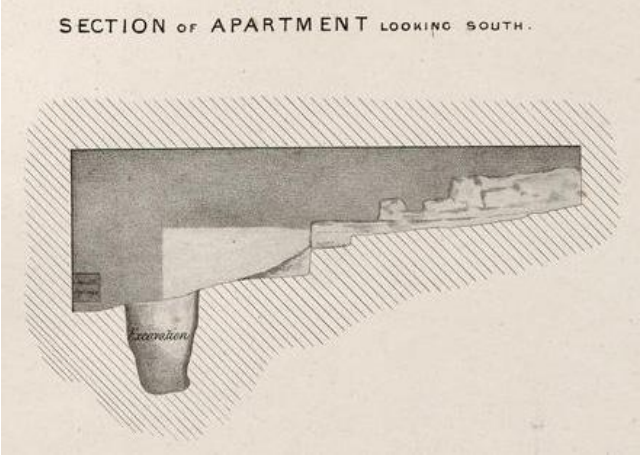


ahl *Image courtesy of Jon Bodsworth*

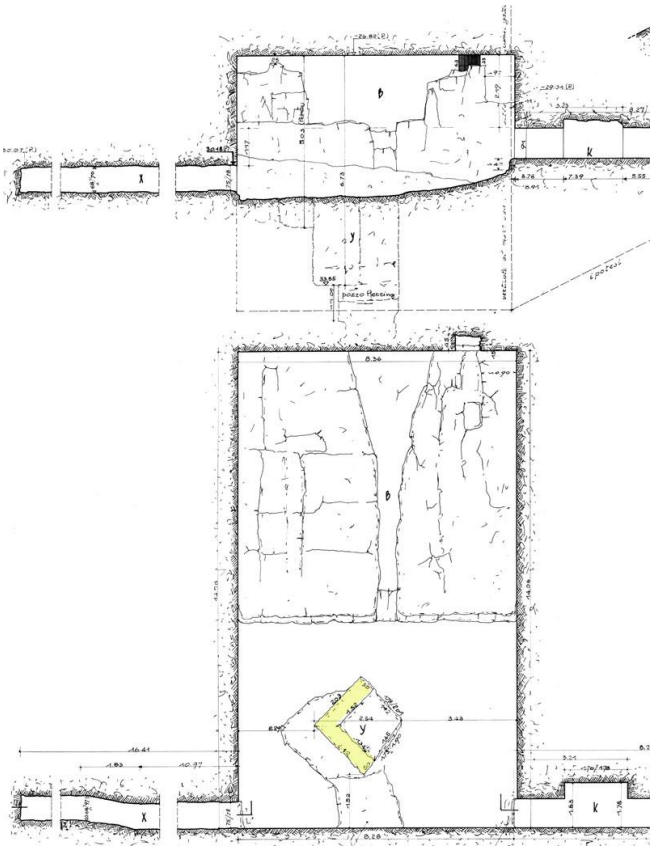
Approximately down the middle of this uncut rock massif, a channel has been cut, as shown left.

On the next page we have an image looking down inside the pit. The block inside the pit appears to be the granite black described by the Edgars, with two holes through it, and visible in the image on page 46.

Image courtesy of Larry Pahl



As we can see from Perring's E-W section of the chamber, the floor is quite irregular; Petrie would report that the best worked floor surface is to be found around the square shaft inside the pit. This he gives as some 198 inches (5.03m) below the roof. This squarish shaft extends down some 67 inches, where a ledge some 20 inches wide is encountered on two sides of the shaft.



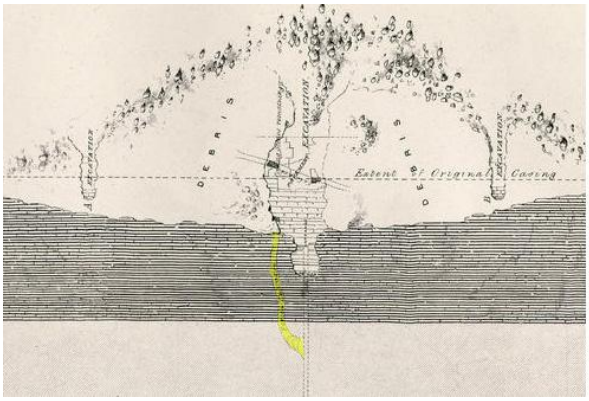
Part of M&R's TAV 4 is shown left and I have highlighted the ledge in the plan view; the granite block rests on one of these ledges. This ledge reduces the shaft size, with sides varying from 53 to 60 inches. From this point Petrie states;

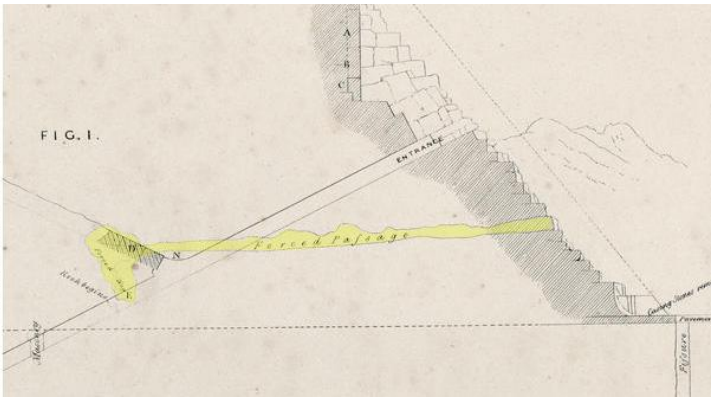
"The original depth of the smaller shaft I could not see, it was apparently about 40 inches according to Vyse, when Perring sunk his round shaft down in the bottom of the ancient square shaft. This hole in the dimly-lighted chamber, about 30 feet deep (with water in it after heavy rains have rushed down the entrance passage), and with a very irregular and wide opening, makes measurement about here somewhat unpleasant."[71]

The whole chamber is a strange design, from the small passage which basically prevents a sarcophagus such as we find in the king's chamber from fitting; though an option might be to create a sarcophagus made from plates of stone such as found inside the White pyramid. It has been taken for granted that this chamber is contemporary to Khufu, but as a layman and playing devil's advocate, I would urge caution on the provenance of this chamber. Certainly the unfinished nature of the chamber should provide numerous chisel and pick marks, how do these compare to other 4th dynasty constructions on the plateau; given that metallurgy and tool design, would develop over Egyptian history.

[71] The Puyramids and Temples of Gizeh, 1st edition, page 60

Al-Mamun's Tunnel





The above drawings are parts of Perring's drawings; the left is a plan view of the tunnel from the north face of the pyramid; whilst the right image is a vertical section of the tunnel.

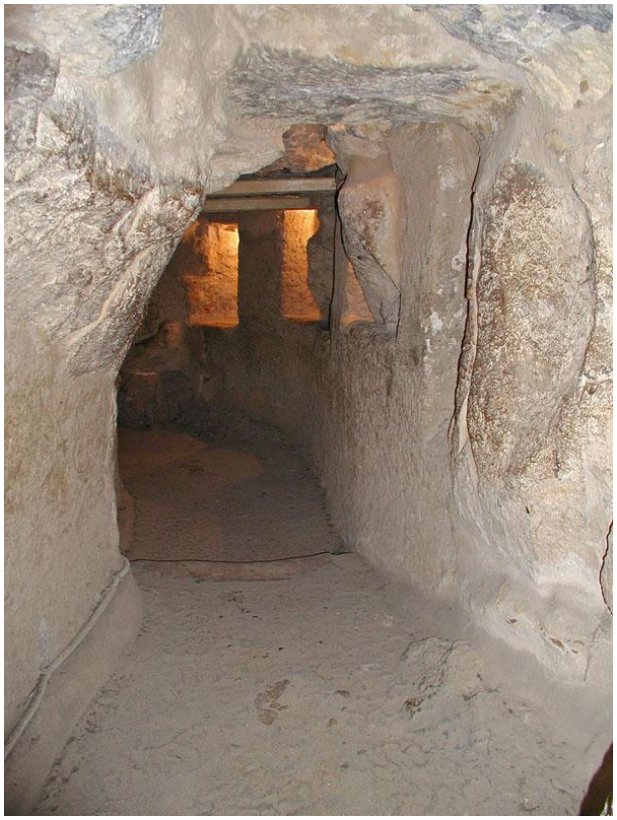


Image courtesy of Jon Bodsworth

In the image left we are approaching the end of the tunnel as it curves to the east and the granite plugs of the ascending passage. The original size of the tunnel is likely lost to us, as modifications have been made to it overtime. A possible enlargement may have been undertaken by Ibrahim Pasha in 1584, where Prosper Alpinus reports that the entrance to the pyramid was enlarged *"so that a man could stand upright in it."*[72] Of course the pyramid has two entrances, and so we do not know to which he refers, the tunnel or original entrance. One can hardly stand upright in the descending passage, even today, unless we assign the holes and trench cut in the floor of the passage as being down to the Pasha: even though Alee Dobree assigned this crime to Vyse.

In their work M&R would state; *"The actual pyramid entrance consists of the breach made by ancient violators. It has now been enlarged in order to facilitate entry."*[73] It

[72] Giza and the Pyramids, 2017, page 88
[73] L'Architettura Delle Piramidi Menfite, Parte IV, page 22

can be difficult sometimes to differentiate what is original and what modifications may have been done by authorities, as such work is often poorly recorded if at all.

The accuracy of the tunnel is quite remarkable, as is the one in Khafre's pyramid; the fact that both are displaced from the original entrance can be explained by avoiding the better quality masonry which surrounds the passages and chambers, and cutting through the lesser quality core stone. On the actual core stone arrangement of the tunnel I have been unable to find any data on block sizes and layout. The story that Mamun created this tunnel is so wide spread and repeated in numerous books, that it has slowly morphed into a fact; however, research undertaken by Michael Cooperson make a compelling case that Mamun did not create this tunnel: he states;

"From these reports, it is clear that the caliph found a pyramid with a tunnel already bored into it—perhaps the same pyramid, and the same tunnel, described by his clerical guest, Denis of Tell Mahre: "we noticed a fissure in one of them." But the tunnel was blocked, and so "great efforts and protracted toil" were expanded to clear it."[74]

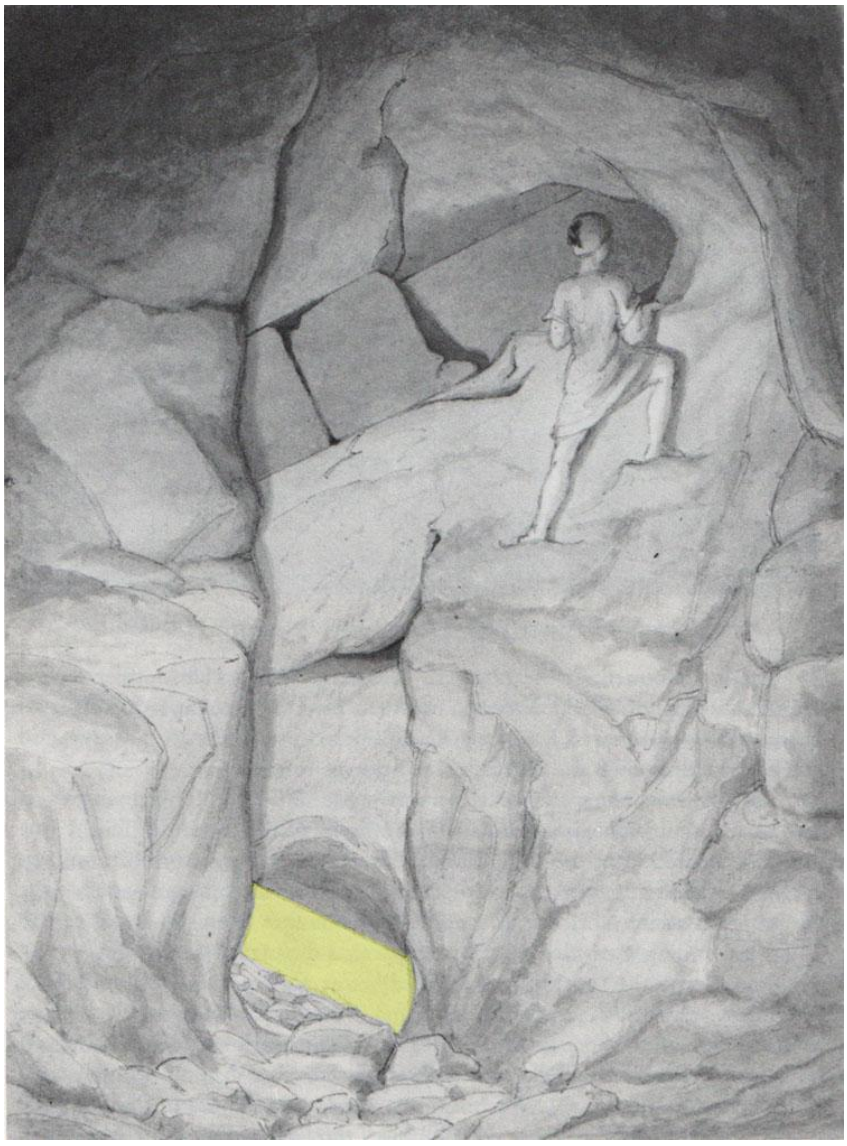
In Mamun's era the Great Pyramid would largely have retained its fine casing, and it's highly likely that the original entrance was known; especially if we believe earlier accounts from sources like Strabo. If the tunnel pre-existed Mamun and was blocked, the blockage is unlikely to be debris from the pyramid whose casing would be relatively intact. The answer to such blockage may go back to Saite times, when efforts to restore the pyramids are evident, as displayed in Menkaure's pyramid. As part of their restoration on the Great Pyramid they could have filled this tunnel; though it would be difficult to conceal the scar left on the pyramid casing, which may have attracted Mamun many centuries later.

To explain the curve of the tunnel to the east, a story has developed that a stone in the ceiling of the descending passage, which concealed the granite plug was dislodged during Mamun's tunnelling, and having heard it fall, they directed the passage to the sound. But how realistic is this story? There are several metres of masonry for the sound to travel, and would such a falling stone give a distinct enough sound to reach and direct the tunnellers? I have been in a few dungeons, whose walls are not as thick, and assured by the guides that no amount of horrible noise could be detected from outside.

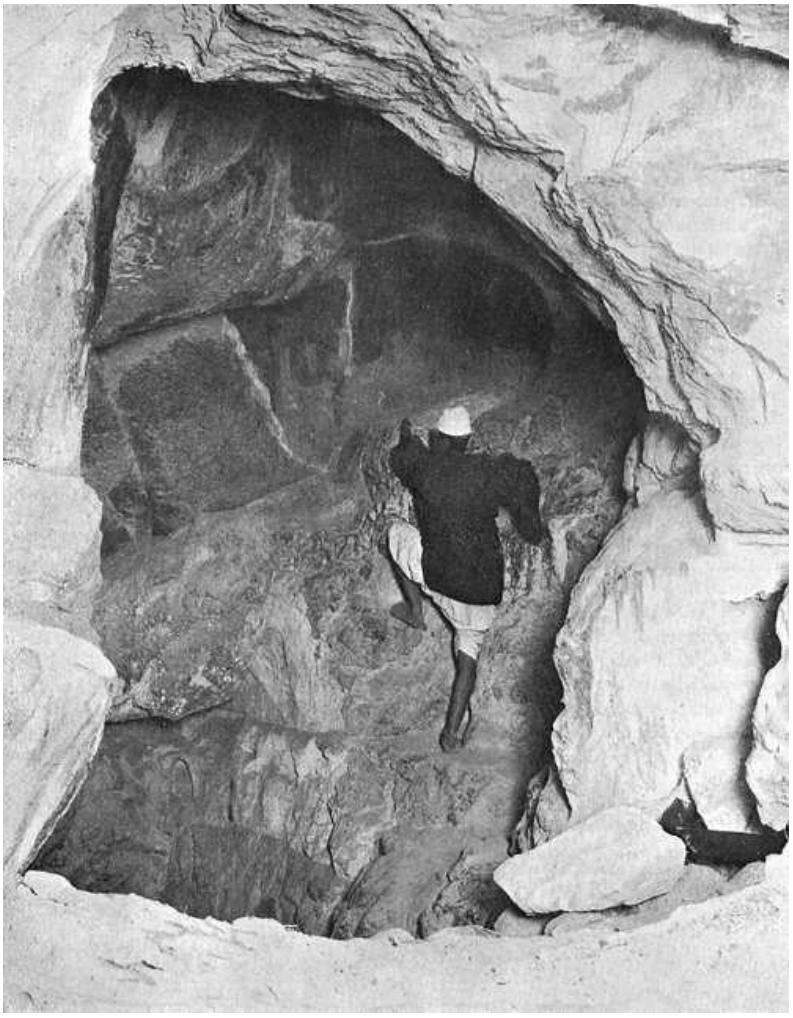
Even if we accept that the tunnel might have been created by the original violators; what was its function? The accuracy of the tunnel suggests knowledge of the interior, and if this is so, then surely they knew the location of the original entrance. Here the permutations can be many; for example, was the tunnel created to break in, or created to remove items? If the original entrance was known, and no plug stones barred entry to the descending passage, the robbers could go to the descending and ascending passage junction and bypass the granite plugs by creating a hole in the

[74] Early Abbasis Antiquarinism, Al-Mamun and the pyramid of Cheops, page 204. See also, Al-Mamun the pyramids and Hieroglyphs. Both available at Cooperson's academia.edu page.

western side of the descending passage, and tunnelling up to bypass the plugs and break into the ascending passage. In this scenario the hole in the descending passage would come before the tunnel. Many scenarios can be imagined, but it's hard to come to any definitive conclusion. If the tunnel was found in its original condition without any later modifications being inflicted upon it, we might be able to look for tool marks in the passage which might give a direction of tunnelling.



In the above drawing by E.W.Lane in around 1826, we have a view which would greet the visitor at the end of the tunnel. The figure looks into the ascending passage, with the granite plug stones showing on their left. From the floor of the tunnel a cutting goes down to a breach into the descending passage; the highlighted area is part of the descending passages east wall. A considerable amount of stone has been cut, which would entail a lot of debris to dispose of, and likely this hole in the floor would be a convenient rubbish chute, as all and sundry was fired down the descending passage.



The above image by the Edgar's is from a similar viewpoint. They would create better footholds in the area in order to better access the ascending passage; they would also state; *"We directed our men to enlarge and roughen the notches on the floor of the First Ascending Passage; for we found this passage too slippery to be traversed with safety."*[75]

Today this area has been made safer for tourists, with steps being created to help one access both passages; railings have also been installed, along with a gate to close access down to the descending passage. The extensive damage in this area makes it extremely difficult to determine masonry layout in this area; moreover, restoration repairs would obscure some joints.

[75] Great Pyramid Passages, Vol 1, 1923, page 205.

Image courtesy of Jon Bodsworth

In this more modern view we can see the steps to assist tourists, along with some restoration to the masonry. Wooden footboards are installed on the floor of the ascending passage, and these would obscure the notches on the floor, which the Edgar's enlarged. The fractured end of the last granite plug can be seen, it has electrical cables looping around it.

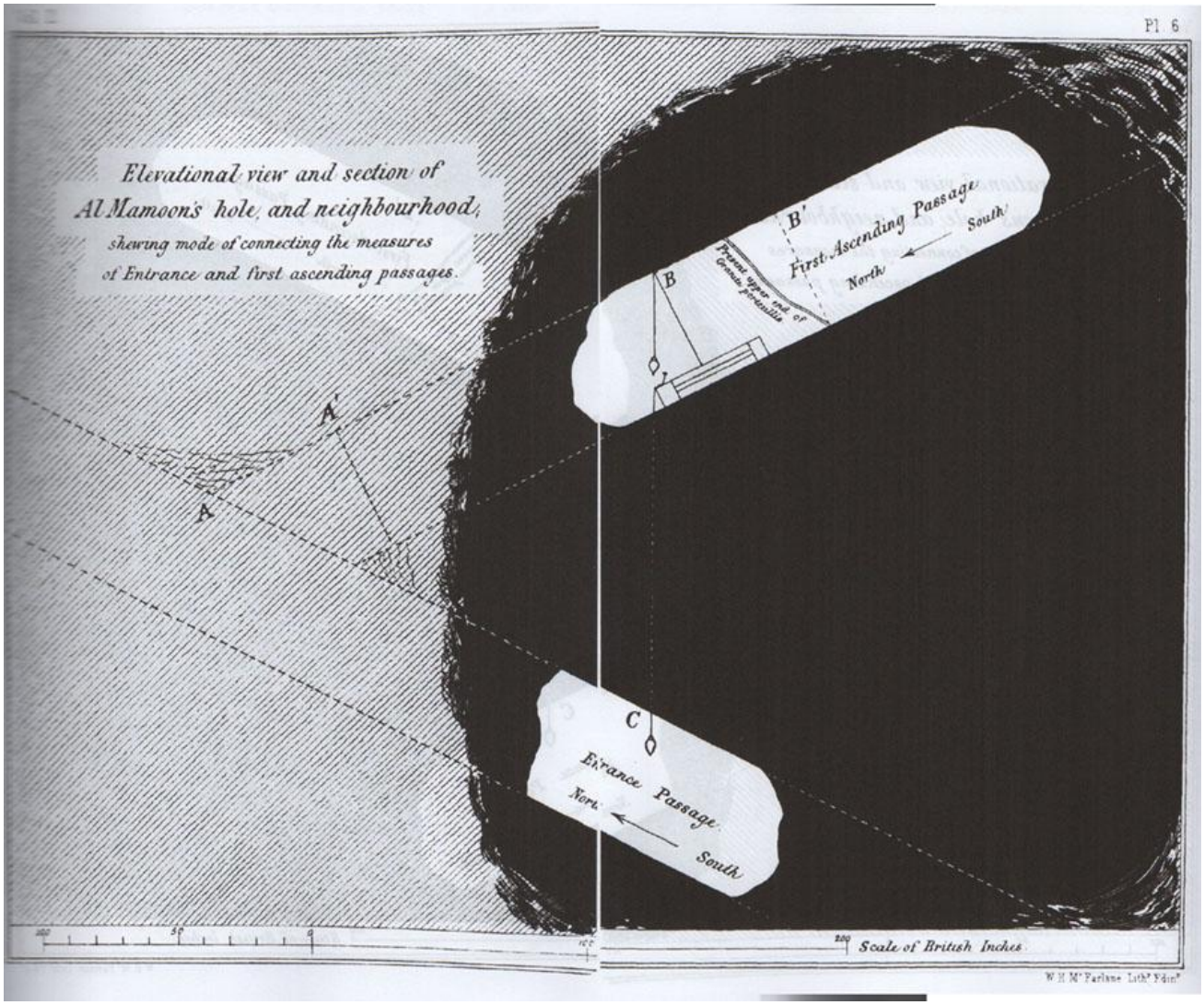
Image courtesy of Jon Bodsworth

From a similar viewpoint to the last image, we are looking down the hole into the descending passage, now made easy with the steps and railings. This hole has been cut through a portion of the ceiling and west wall of the descending passage; the east wall of the passage can be seen along with the wooden footboards which cover the floor: a new gate replaces the old one which was affixed to a granite block.

In the image overleaf we are sitting on the floor of the descending passage under the granite plug, looking down as some tourists make their way up from the subterranean chamber. The gate is open and to the right of it we can see the steps leading into the hole

Image courtesy of Larry Pahl

The Ascending/Descending passage Junction & Ascending passage



The above plate 6 shows the solution that Piazzi-Smyth adopted in order to connect the measures of the two passages. Due to the damage inflicted in the area he would use two plumb lines; the shorter from point B (edge of plug stone) and then from this a longer plumb line was used: this second line was attached to a long horizontal arm connected to a square along the base of the plug; this was necessarily to avoid the protruding masonry on the side of the hole, and this plumb line would hang through the ceiling of the descending passage to give him point C.

The start of the ascending passage is blocked by three granite plug stones, with the uppermost plug showing signs of damage. It is not known if any further plugs filled the passage; it has been suggested that the initial plugs may have been of granite with the remainder being of limestone, and so the violator's cut around the harder granite and then cut the limestone plugs out of the passage. Though it sounds like a risky operation trying to cut out limestone plugs in a steep passage, and risk being crushed.

The lowest granite plug is tapered, as is the lower end of the ascending passage to prevent the plug from crashing into the descending passage. The tapering only occurs in the walls of the passage, with the height of the passage being unchanged. According to Piazzi-Smyth the mean width on the face of the tapered plug is 38.14 inches, whilst its height is 46.72 inches.[76] Petrie would add;

"The granite plugs are kept back from slipping down by the narrowing of the lower end of the passage, to which contraction they fit. Thus at the lower, or N. end, the plug is but 38.2 wide in place of 41.6 at the upper end: the height, however, is unaltered, being at lower end 47.30 E., 47.15 mid, 47.26 W. ; and at upper, or S. end, 47.3. In the trial passages the breadth is contracted from 41.6 to 38.0 and 37.5 like this, but the height is also contracted there from 47.3 to 42.3. These plug-blocks are cut out of boulder stones of red granite, and have not the faces cut sufficiently to remove the rounded outer surfaces at the corners : also the faces next each other are never very flat, being wavy about +/-.3. These particulars I was able to see, by putting my head in between the rounded edges of the 2nd and 3rd blocks from the top, which are not in contact; the 2nd having jammed tight 4 inches above the 3rd. The present top one is not the original end; it is roughly broken, and there is a bit of granite still cemented to the floor some way farther South of it. From appearances there I estimated that originally the plug was 24 inches beyond its present end."[77]

The ascending passage conforms to the same design scheme as the descending passage in being 2 cubits wide by 2 cubits 2 palms high. The ascending passage itself is much injured; Piazzi-Smyth states: *"The walls and roof of the passage are composed of a very much softer stone, as Professor Greaves remarked in his day; and they are decayed and exfoliated away to a lamentable degree, chiefly towards the lower end, so as quite to give all that part of the passage a rounded and cavernous character, which was not clearly mentioned by Professor Greaves, and is serious if it has occurred since his visit. Towards the upper end of the passage, the original surfaces of roof and walls begin to appear again; but a considerable portion of the roof is cracked longitudinally along the middle."*[78]

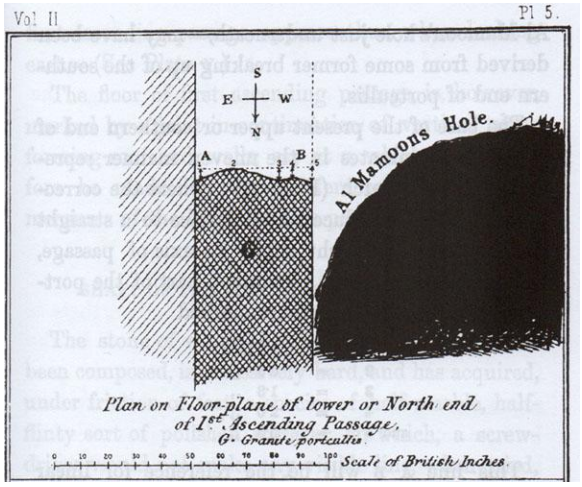
I had come across an early account were the guides are said to have cut into the ascending passage in the hope of making it wider, and speeding up the tourist traffic. With the descending passage and well shaft filled with debris, the ruse was to hurry the tourists along to the queen's chamber only and omitting the journey to the king's chamber: time is money as they say.

[76] Life and Work, Vol 2, page 42
[77] Pyramids and Temples of Gizeh, 1st ed, page 63-64
[78] Life and Work, Vol 2, page 46-47

Image courtesy of Jon Bodsworth

In the above view we are looking along the ascending passage, which highlights the damage and difficulty in obtaining measurements. In Piazzi-Smyth's table of measures for the breadth and height of the passage, his measures start from line AB, an imaginary line that crosses the passage along the fractured end of the uppermost plug stone.

The line AB is shown right, and from his table the breadth here is 41.6 and perpendicular height 47.3; though these are not of the passage, for the attached note states;
"*These measures are rather of the portcullis block, close fitting into the original passage at this point: and showing what that must have been.*"[79]
This width of the plug stone agrees with the width Petrie gives in his statement above.



[79] Life and Work, Vol 2, page 51

Piazzi-Smyth could only obtain measures for the height and width of the passage at its better preserved south end, as it approached the grand gallery; here he provides two width measures ranging from 42.1 to 42.2, and four height measures ranging from 47.5 to 47.7. If we accept Piazzi-Smyth's and Petrie's dimensions for a plug stone of width 41.6 x 47.3, we have a passage clearance of half an inch (1.27cm) for the width and only 0.2 inch for height (5mm), which appears worryingly tight.

Some author's have suggested that these plug stones must have been fitted in Situ, and could not have been slid down from the grand gallery. For example; *"A French professor of Architecture, J. Bruchet, who went to the spot to verify and measure, and who published an illustrated book on the subject in Aix-en-Provence in 1966, agrees with Davidson, that the granite plugs could not have been slid down the Ascending passage: he believes they were put in place at the moment of construction, when the Pyramid was still a truncated body."*[80]

Another example is to be found in the work of Gilles Dormion and Jean-Patrice Goidin; here they state; *"Finally, lets return to the element of this passage that intrigues us the most: the three plug blocks that we imagined for a long time stored in the Grand Gallery before being pushed or pulled into the passage. We checked the passage section: in one place it is narrower than the plugs by 1.5cm; the plug blocks were therefore most likely placed there during construction, they apparently could not have been stored or moved."*[81]

To circumvent this, they suggested a second entrance into the pyramid, under the chevron's by the entrance, which would lead to a hidden chamber, north of the king's chamber (other's have also proposed a hidden passage under the chevron's leading to further hidden chambers). However, Dormion would publish a later publication on the Great Pyramid in which the clearance for the plug stone is not mentioned, and neither is the hidden passage and chamber.[82] There is nothing in Piazzi-Smyth's table of measures for the ascending passage to show a smaller dimension than the granite plug, and neither do the above author's indicate where this point is.[83] The considerably damaged portion of the passage shows that the width would vary from 55 to 61 inches, with the height varying from 50 to 59 inches.

However, as we will soon see when we examine the grand gallery, we do have some clearance issues to contend with.

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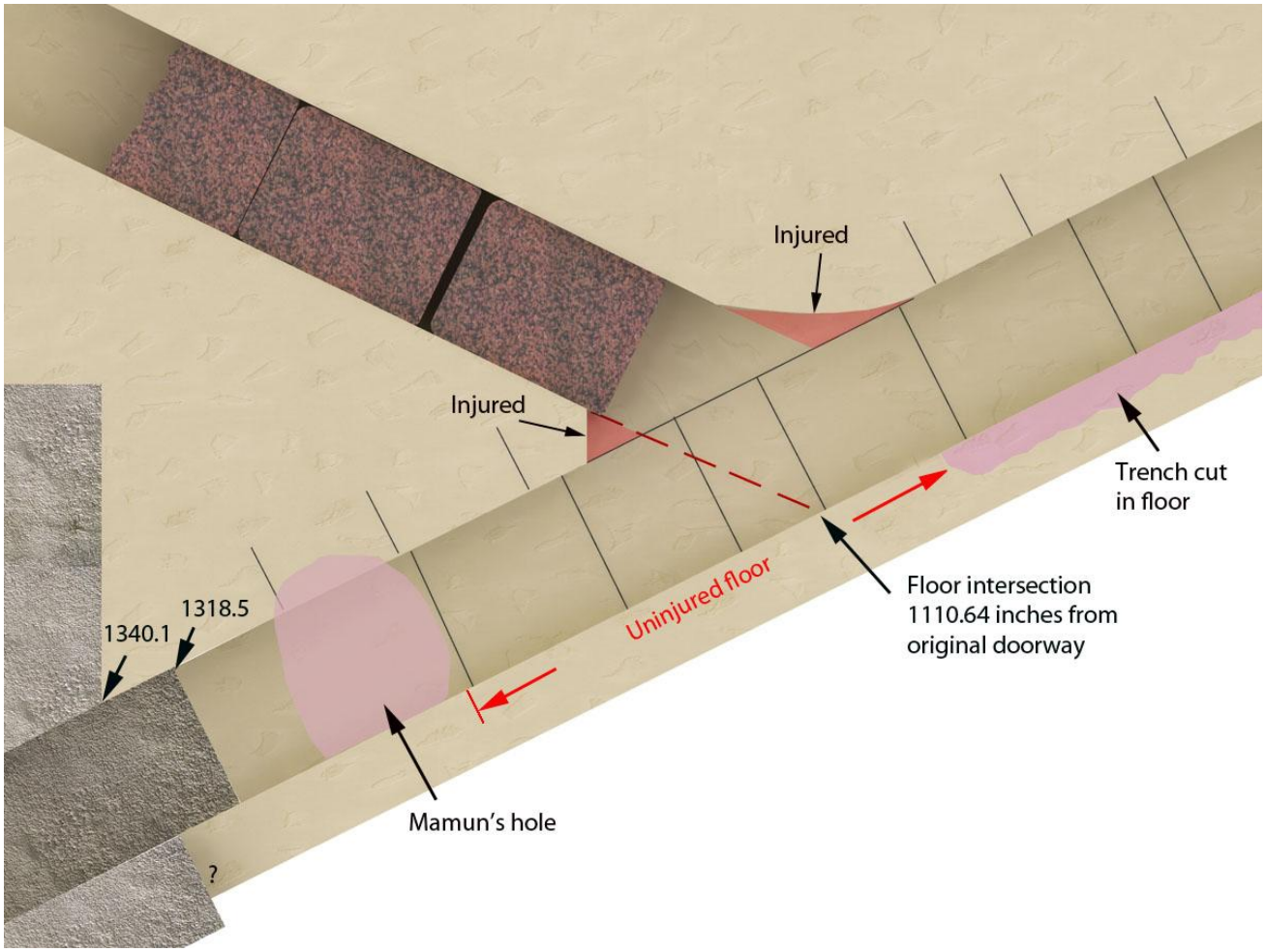
[80] This example is from the book, 'Secrets of the Great Pyramid' by Peter Tompkins, page 251. David Davidson, was a structural engineer who did not believe that a half inch clearance was sufficient; he would later become a proponent of pyramidology. J. Bruchet, would publish 'Nouvelles recherché sur la Grande Pyramide. La destination du Monument a travers les imperatives architecturaux de la distribution interne'. Aix-en-Provence 1966. I have been unable to source a copy of this work.

[81] Kheops: Nouvelle Enquete, propositions Preliminaires, 1986, page 40

[82] La Chambre de Cheops, Analyse architectural. Gilles Dormion, 2004

[83] Piazzi-Smyth would give a width of only 41.4 at floor joint 1, immediately south of the upper plug stone; but this was inferred from markings on the wall and floor, and so is not conclusive.

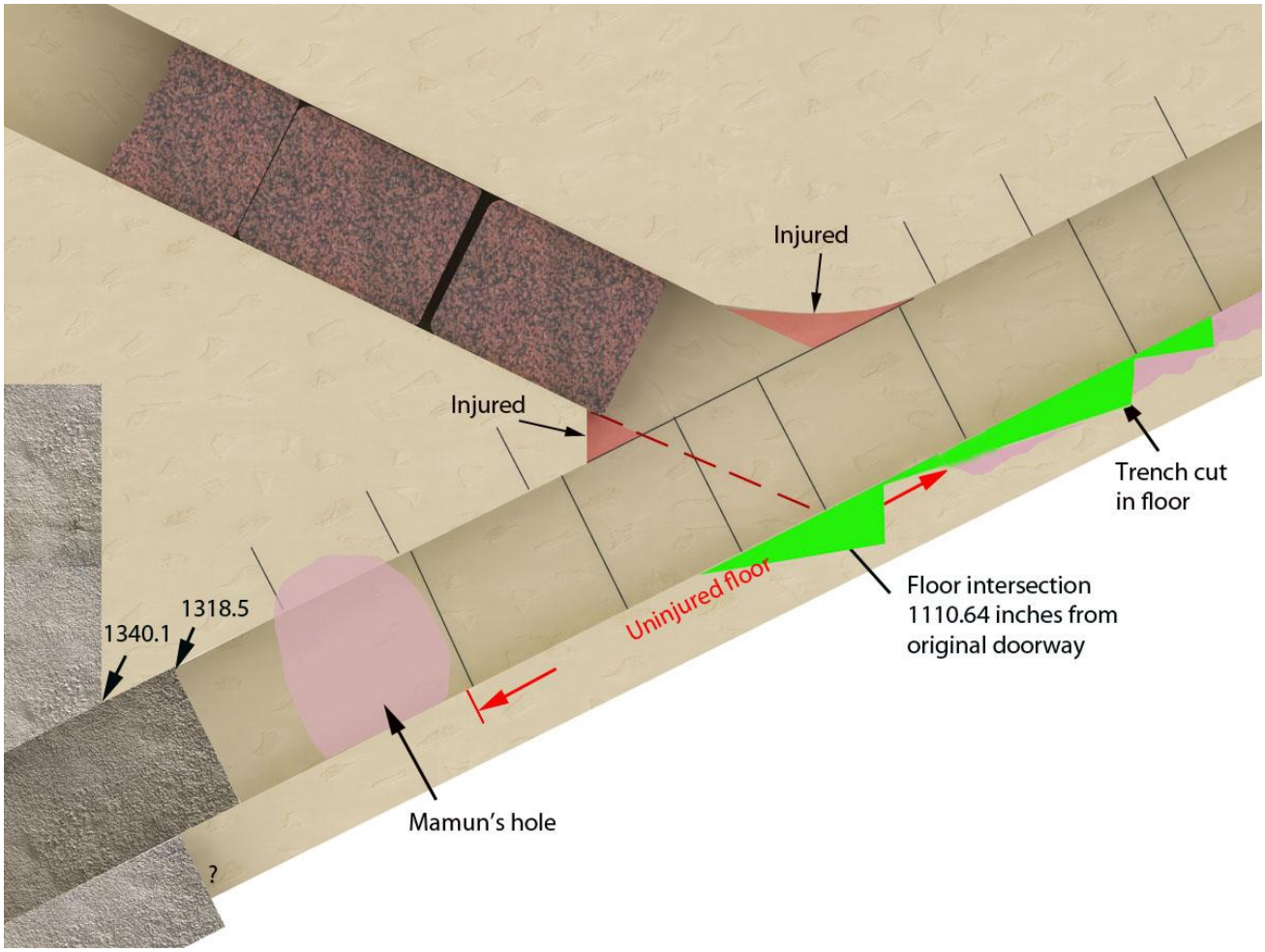


The above image gives us a rough idea of the junction area and locations of some of the features. The floor intersection point is the value given by Petrie, as are the other two dimensions which denote the cessation of masonry at top of west wall and roof. The data for this area is incomplete, and so the cessation of floor masonry is uncertain due to the debris encountered by Petrie and Piazzi-Smyth. The trench in the floor stops some distance from Mamun's hole; indeed, Piazzi-Smyth states that the floor was uninjured from 940 to 1065[84] (his measures are from the basement sheet, whereas Petrie's are from the original door, which he gives as 124 further out: if we add 124 to Piazzi-Smyth's figure then the uninjured floor is from 1064 to 1189). The uninjured floor may extend further, but debris and the granite block would prevent further inquiry; all we know is that shortly after the granite block with the gate, the Edgar's tells us that the footholds start again for the remainder of the descending passage.

The uninjured nature of the floor is confirmed by the Edgar's for they state; *"At this place the floor of the Descending Passage is composed of such hard limestone, that the traffic and vandalism of centuries have made little impression on it. For a length of about ten feet the surface is so smooth that to walk on it is impossible, unless one is wearing rubber shoes, or has bare or stockinged feet, and even then the support afforded by the side walls may not be disdained. Visitors who are wearing boots and*

[84] Life and Work, Vol 2, page 15

have no one to assist them, have to sit on their heels at this part, and slide down till their further descent is arrested by a fragmentary block of limestone. This block rests against a large fractured granite stone, which is tightly wedged across the floor of the passage."[85]



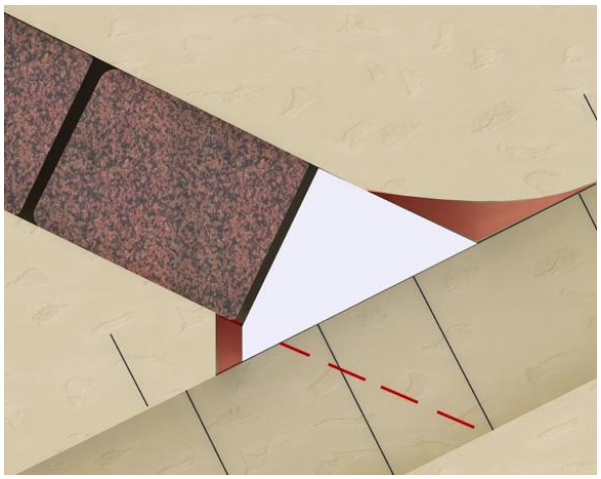
Confusion exists in this area, for the author A.Pochan shows distinct steps in the floor were previous authors above have declared it uninjured. I have overlaid the steps coloured green above; indeed, Dormion in his work shows these steps in his drawing, though he appears to have not seen them, as he states the steps have been filled in.[86] I have no idea what Pochan imagines he saw in this area, but it clearly conflicts with the earlier explorers and so I am minded to dismiss it, until sometime when the wooden boards can be lifted from the floor and a closer examination can be made of the floor. The example above highlights the difficulty in studying the Great Pyramid, as we simply have no reliable modern data on the structure to clarify matters.

In the ceiling of the descending passage we have two injured areas where the ascending passage starts; I have highlighted the areas were the floor and ceiling of the

[85] Great Pyramid passages, Vol1, page 57-59

[86] See L'enigne de la grande pyramid.1971, Pochan, page 222, and Dormion in Le Chambre de Cheops, 2004, plan No6, page 284-285.

ascending passage would intercept the ceiling of the descending passage. The floor portion is triangular in shape, and it seems unlikely that a thin edge, easily damaged would be left at the wall top (Piazzi-Smyth would report that the distance from the bottom edge of the plug stone to intercept with the ceiling line of the descending passage was 14.1 inches); instead a blunt end to better protect this end should be expected. The ceiling portion has a more curved appearance, and the masonry here could have reflected the highlighted area originally, and simply been damaged over the centuries. Alternatively, this area may have been left chamfered to provide extra turning room for larger items on route to the upper chambers; though such items have to contend with the width restriction at the start of the ascending passage of about 38 inches which holds the granite plug: for example, the sarcophagus has a width of 38.50 which prevents its passage.



The story is often told that the noise of a falling stone which would have concealed the ascending passage alerted Mamun's men; however, the evidence for such a stone is singularly absent. Some have suggested a prismatic shaped stone such as in the image left, but the logic of such a stone seems to rule it out. A stone such as this could weigh as much as two metric tonnes, and given the narrow confines of the passage, were few men could work; we have the problem of how such a stone was lifted into position. Moreover, there is no obvious mechanism in how such a block was secured in place, other than by the properties of mortar, which seems unlikely; surely the architect could design a more secure method of concealing the passage.

M&R along with others have rightly questioned the existence of such a concealing stone; M&R would state:

"For technical reasons, we do not find the hypothesis according to which an appropriately cut limestone block was inserted in the point where corridor (A) started in the ceiling of (D) (in order to block and disguise the opening) convincing at all. In this case, the workmen would have had to use a very thin slab and also make grooves or supports in the walls to hold up the slab before mortaring it in. Even admitting that the limestone edge between the ceiling of (D) and the floor of (A) had been left in situ (and not cut away as all indications here make one believe), a quite large block could not have been easily inserted and then mortared into the opening. Besides, to leave a ceiling block without any support was not a practice of the Egyptians and to our knowledge no examples exist elsewhere of a similar disposition."[87]

[87] L'Architettura Delle Piramidi Menfite, Parte IV, page 110-112

M&R would suggest that after the closing of the ascending passage that the descending passage would be filled with limestone plugs from the junction to the entrance, they did not think that the entirety of the descending passage would be filled with plug stones.

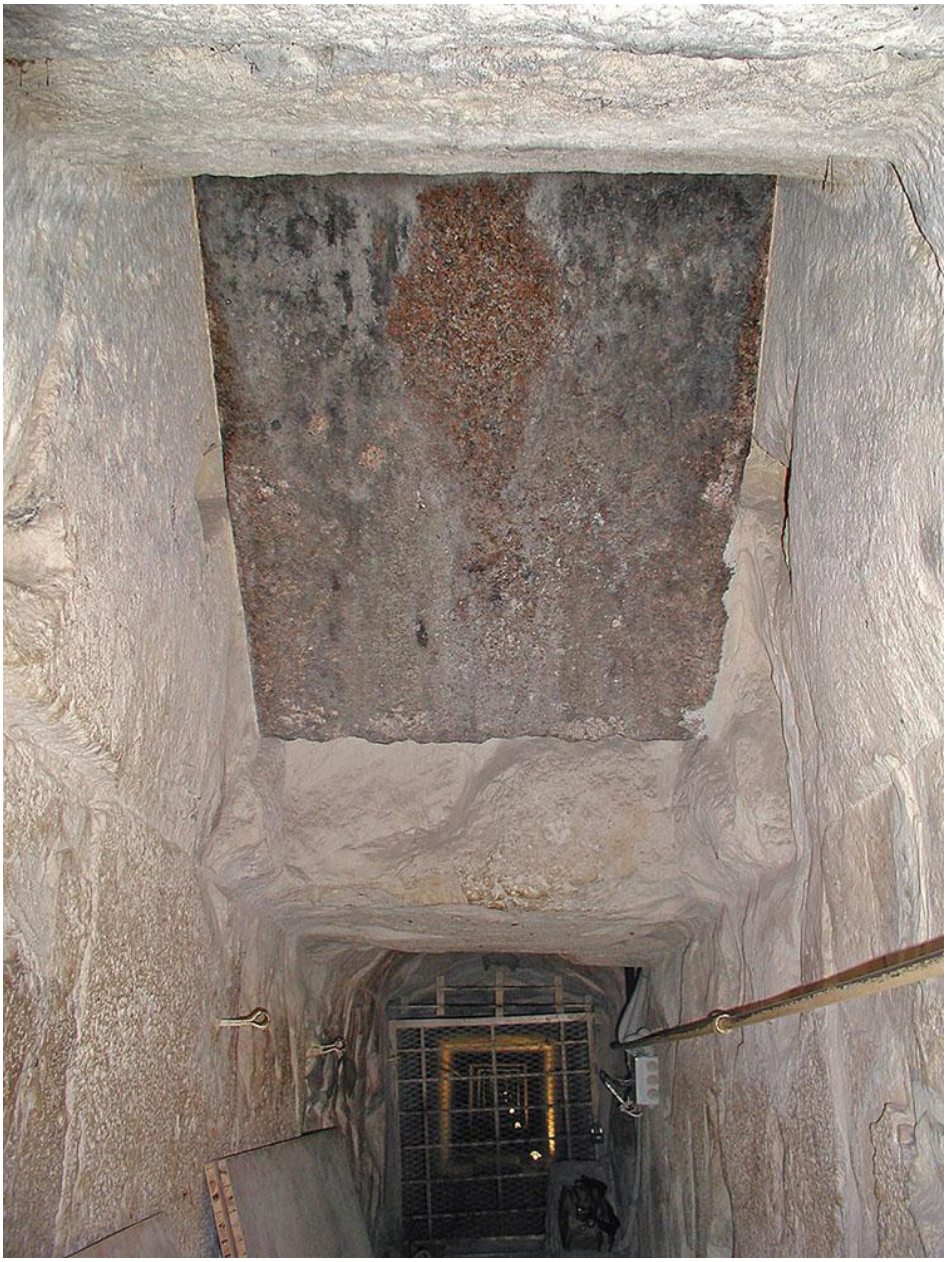


Image courtesy of Jon Bodsworth

In the above image we can make out the top of the descending passage walls and ceiling line. The plug at some 38 inches wide is some 3.5 inches narrower than the descending passage; but did this narrowing of the ascending passage continue down to the ceiling line of the descending passage? If it did, then any concealing stone would leave two joints in the ceiling to alert robbers. I could find no measurement data on this area, but images suggest that the ascending passage walls are narrower; though damage in the area makes it difficult to come to a definitive conclusion: though in

Dormion's plan No 6, it suggests that the walls are narrower. If one wanted to conceal the ascending passage then the simplest solution would be to leave a shelf on top of each wall of the descending passage, with one shelf larger and deeper than the other, in order to introduce a thin plate of stone at an angle and then raise it up the other end and withdraw it onto the opposing shelf. Two such slabs could neatly conceal the passage and a more realistic challenge for the builders given the narrow confines of the passage. If a prismatic stone existed, might we not see mortar traces in the area which appear absent; though much restoration has been done inside the pyramid, which may have removed such traces.

M&R's suggestion that the descending passage may have only been plugged down to the junction of the ascending and descending passages, might find some support in the so called trial passages.

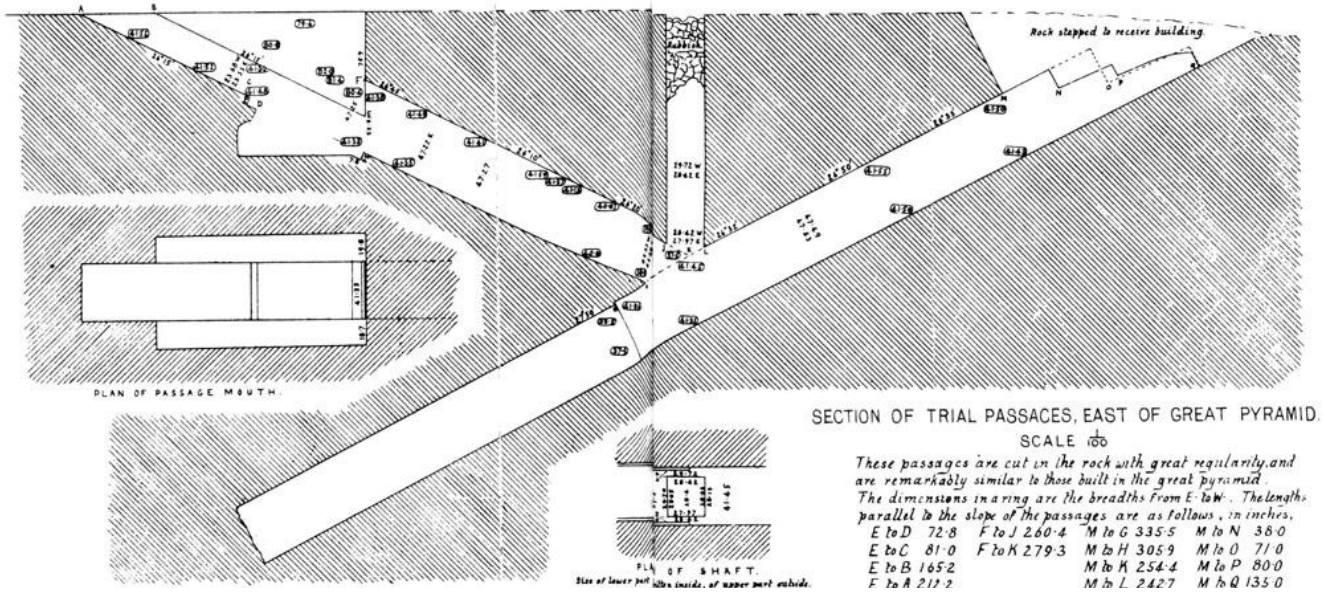


Image courtesy of J.D.Degreef

In Petrie's drawing of the trial passages above, we can see that the bore of the descending passage has been reduced just below the junction, and this margin can just be made out on the image left, which is looking down the descending passage of the trial passages. Such a feature would make an ideal stop for any plug stones; did such a feature once exist inside the Great pyramid?

No such feature is known inside the Great Pyramid; but could such a feature be removed at a later date? For example, if the subterranean chamber was a later intrusion, it wouldn't be much extra work to remove this feature or variant of it.

Given that the evidence for any concealing stone is lacking it would seem sensible to plug up the upper part of the descending passage; but against this we have Petrie's belief that no plugging was fitted, due to the good condition of the passage. In modern times plug stones have been removed in the Bent pyramids western passage, and as the image on page 56 shows, the passage is in good condition; of course the modern authorities took care in their removal: something we would not expect from robbers. That said, we do not know who might have removed the plugging and what instruction they gave to their workers; random robbers would hardly show care, but a ruler might instruct care, especially if they had eyes on reusing the structure.

Image courtesy of Jon Bodsworth

Another modern clearance of plug stones is to be found at the so called serdab next to GII-a; here three plug stones can be seen lined up next to the serdab entrance. According to M&R these plugs were not fixed with mortar, nor were traces found on the floor which could have acted as lubricant.[88]

[88] L'Architettura Delle Piramidi Menfite, Parte V, page 92

The modern excavators simply removed these plugs by cutting an oblique hole at 45 degrees into the end of the plug and fixed a hook, by which they then simply winched the plugs out of the passage. So I think caution is required as to whether plug stones were fitted in the descending passage; the possibility cannot be ruled out. The original violators may have well known the exact layout and security of the pyramid and simply opted to tunnel around it; especially if they knew that the descending passage, like in the trial passages simply led to a dead end. Any plugs in the descending passage may have simply sat there for some considerable time after the violation, and removed by a later party.

When it comes to the three granite plugs which reside in the ascending passage today, I could find no definitive data on their dimensions, other than those previously stated by Petrie and Piazzi-Smyth. The lengths of the two uninjured plugs is a bit of a mystery, and it is somewhat strange that this basic data has not been collected, as it can have important implications for the storage of such plugs in the grand gallery. Mark Lehner in an article that touched on storage of the plugs in the grand gallery, provided lengths of each plug, beginning with the lowest tapered plug as 1.75m, then middle plug as 1.60m, and the damaged last plug restored as 1.65m.[89] However, these dimensions are taken by scale rule from M&R's fig 1 on TAV 4. M&R provide no dimensions, so we do not know how accurate this drawing is. We can add further confusion to the subject, by examining Dormion's Plan No.6, where the tapered plug is given a length of 1.57m; whilst the middle plug is given as 1.67m.

Petrie and Piazzi-Smyth give a total length for the three plugs as 178.5 & 178.8 inches respectively, and Piazzi-Smyth gives the broken plug a length of some 48.5 inches; this therefore leaves us 178.5-48.5=130 inches for the two uninjured plugs and to this we subtract the 4 inch gap between them for a total of 126 inches or 3.20m for the two plugs: this compares to Dormion's 1.57+1.67=3.24m: this suggests that Dormion's figures could well be correct, though Lehner's total of 3.35m seems too large.

The first detailed description of the ascending passage is from Greaves, who states;

"The pavement of this rises with a gentle acclivity, consisting of smooth and polished marble, and were not smeared with filth, appearing of a white and alabaster colour: the sides and roof, as Titus Livinius Burretinus, a Venetian, an ingenious young man, who accompanied me thither, observ'd, was of impolished stone, not so hard and compact as that on the pavement, but more soft and tender: the breadth almost five feet, and about the same quantity the height, if he have not mistaken. He likewise discovered some irregularity in the breadth, it opening a little wider in some places than in others; but this inequality could not be discerned by the eye, but only by

[89] Niches, Slots, Grooves and Stains: Internal Frameworks in the Khufu Pyramid? Stationen Beitrage zur Kulturgeschichte Agyptens, Rainer Stadelmann Gewidmet, page 105

measuring it with a careful hand. By my observation with a line, this gallery contained in length an hundred and ten feet."[90]

It is often difficult to decipher these old reports, but if the reported 5 feet width and height of the passage is correct, it rather suggests that the damage we see today, was also visible in Greaves time. The limestone of the floor is also reported by Piazzi-Smyth as quite hard, he states;

"The stone of which the floor of this passage has been composed, is excessively hard, and has acquired, under friction of feet, a species of half-marble, half-flinty sort of polished surface; on which, a screwdriver would not make any visible line, when tried, to mark the end of a measuring-rod, - obliging a black-lead pencil to be used for that purpose."[91]

Piazzi-Smyth would also report the notches cut in the floor, which were subsequently enlarged by the Edgar's; today the tourist is assisted with modern wooden footboards. According to Dormion, a team of engineers from Cairo University performed hardness tests on the masonry of the passage using Schmidt's hammer and found that the masonry for this passage was not as high a quality as that used in the other passages.[92] That said, the masonry for the passage is often quoted as being constructed of fine limestone; for example, in Dormion's earlier work, he states: *"It is built of fine white Turah limestone along its entire length, with the exception of a belt block, located shortly after the granite plugs in local yellow limestone"*[93]

The masonry makeup of the ascending passage has been a bit of a mystery, and one of the first to notice its strange layout was Perring, who states; *"In some places in this Passage, the courses of stone are laid horizontally, with vertical joints; but in every other instance in the pyramids, the beds and joints are parallel, and perpendicular to the incline of the passages."*[94] Likewise Piazzi-Smyth would state; *"The walls show sometimes vertical, and sometimes perpendicular-to-passage, joints, and these are now and then confusedly interfered with by parts of horizontal courses of masonry."*[95]

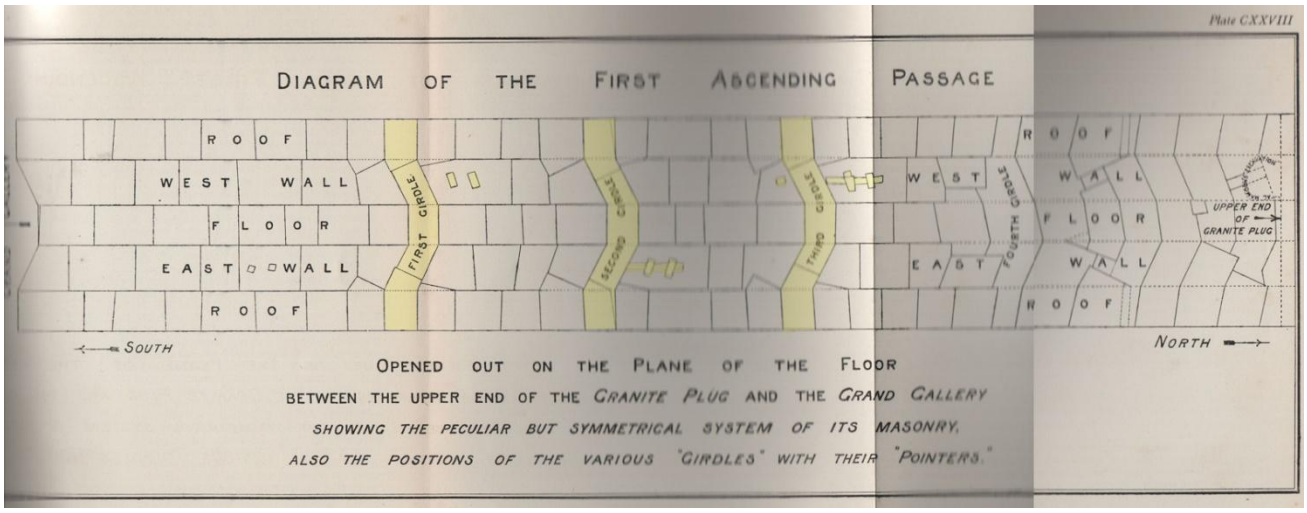
Conditions for observing this passage were not ideal, and Piazzi-Smyth complained that *'there is not a particle of daylight; candles had to be employed, and as they will not stand, but slip, and slide right away on the steep floor.'* More detail on the masonry would have to await the arrival of Waynman Dixon in 1872; Piazzi-Smyth would write of Dixon's findings in one of his later editions, he states:

[90] Pyramidographia, page 639
[91] Life and Work, Vol 2, page 46
[92] La Chambre de Cheops, 2004, page 87
[93] Kheops: Nouvelle Enquete, propositions Preliminaires, 1986, page 38
[94] The Pyramids of Giza, from actual survey and admeasurement. Part I, The Great pyramid, page 2
[95] Life and Work, Vol 2, page 47

"My examination of that passage in 1865 was confined to little more than its angle of slope and its floor length, joint by joint, on the floor alone. This was partly on account of the bewildering varieties of the wall jointing, as they appeared to my non-engineering eyes on a cursory examination. But Mr. Waynman Dixon, in 1872, applying himself long and steadily to this special task, and mapping down everything measurable, presently perceived a most admirable order pervading the apparent disorder, and tending also to hyper-excellent Masonic construction. For the chief discovery was, that at stated intervals the smaller blocks forming elsewhere separately portions of the walls, floor, and ceiling of the passage, were replaced by great transverse plates of stone, with the whole of the passage's hollow, or square bore cut clean through them; wherefore, at those places, the said plates formed walls, floor, and ceiling, all in one piece.[96]

These plates of stones have been commonly referred to as girdle stones, though a clearer picture of the passage would have to await the arrival of the Edgar's, who attempted to create a drawing of the passages masonry; they state:

"For several days Jack and I have been measuring the masonry of the First Ascending Passage. It is difficult work, and very tiring. In some places it is almost impossible to locate the joints between the stones, and these joints run in different directions. The system of masonry of this passage is very odd, quite unlike any of the other passages."[97]



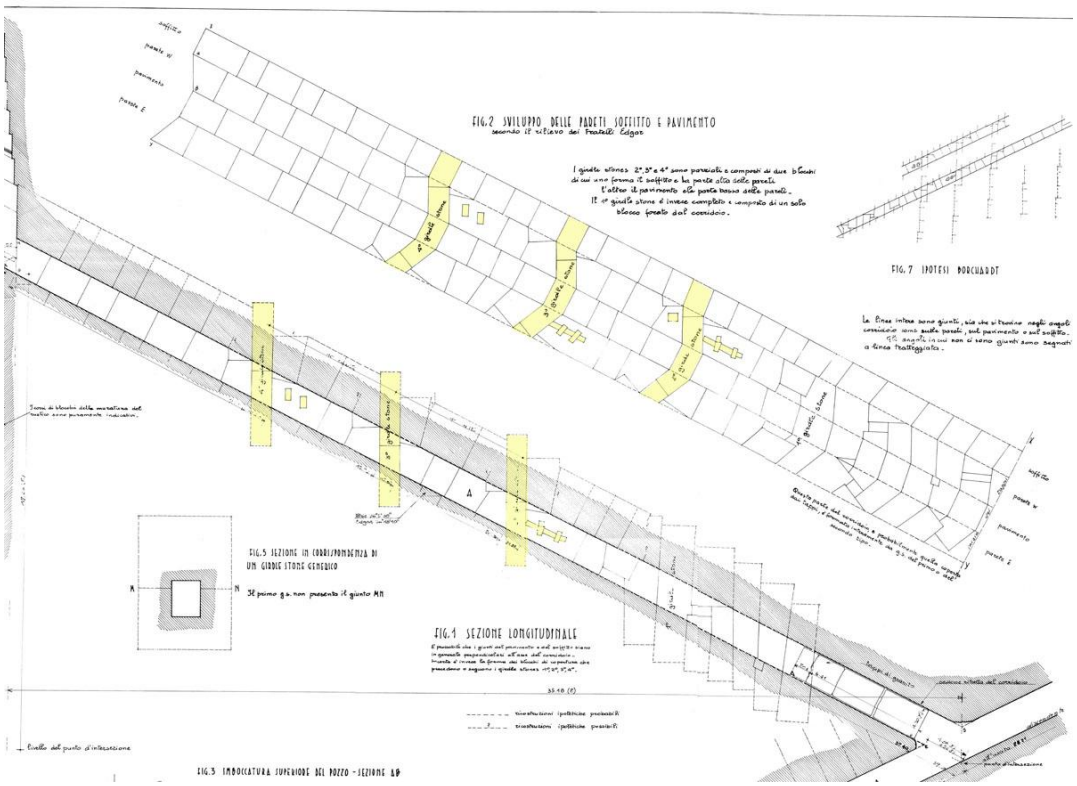
In Edgar's plate above, I have highlighted the standalone girdle stones, and the inset masonry next to them, which the Edgar's term 'Pointers'. The first of these girdle stones, judging from Dixon's measures appears to be placed some 20 cubits from the south end or grand gallery, with the next two girdles spaced 10 cubits apart. As we approach the granite plugs at the north end we then appear to have a continuous series

[96] Piazzi-Smyth- The Great Pyramid, its secrets and mysteries revealed, 1978, page 431 (this book is a reprint of Piazzi-Smyth's 'Our Inheritance 4th edition' : Dixon's measures are on page 432

[97] Great Pyramid passages, Vol1, page 271

of girdle stones, which are difficult to follow due to the damage inflicted in this area, though Petrie would state; *"All the stones that can be examined round the plugs are partial girdle-blocks, evidently to prevent the plugs forcing the masonry apart, by being wedged into the contracted passage. Many of the stones about the blocks in Mamun's hole are over 10 or 11 feet long; the ends are invisible, but probably they are about 15 feet over all."*[98]

According to the Edgar's the first three girdles from the south end consist of two stones, the lowest stone forming the floor and most of the walls, whilst the upper stone forms the ceiling and the top of the walls; they would also comment that the stones were not set horizontally on top of each other, but at an angle. The continuous section of girdles at the north end, like the previous three are placed vertical, and the Edgar's state that some of these are formed from a single stone.[99] They also comment on the distinctive 4th girdle, which displays no less than six distinct joint lines with the stones above it. The three standalone girdles all had partial girdle stones either side, which formed the ceiling and part of the upper walls; likely to add further support to these girdles.



M&R would adapt the Edgar's drawing into their TAV 5, part of which is shown above, and I have highlighted the first three girdles. How accurate the Edgar's drawing is, is open to debate, given the difficult conditions. M&R would cite a few

[98] The Pyramids and Temples of Gizeh, 1st edition, page 64
[99] Great Pyramid passages, Vol1, page 283

inaccuracies, and point out that no drawing exists showing the part of the passage taken up by the granite plugs.[100] Despite the good work by the Edgar's the whole passage could benefit from a more modern forensic examination; though it does seem clear that the masonry of this passage was methodically planned, and not the ad-hoc result of cutting through rough core masonry, as has sometimes been suggested. Indeed, M&R would state;

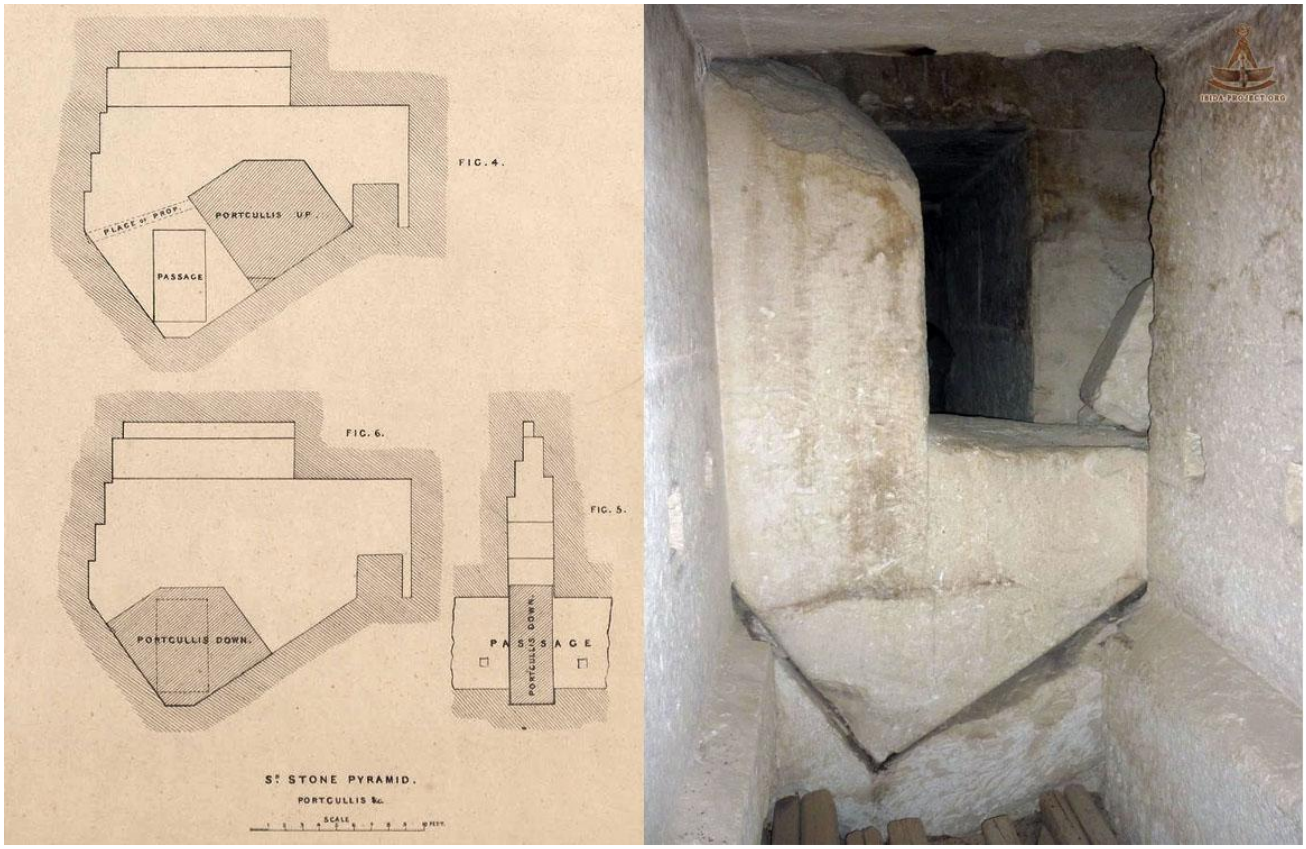
"Therefore the lower part of (A) was not cut out from normal masonry, but from peculiar blocks which were laid with the definite scope of hewing the corridor through them. We repeat, corridor (A) was not cut through a part of the rough nucleus already in situ, as Borchardt thinks, but the nucleus itself was built in a special way in order to allow the making of the ascending corridor."[101]

The whole passage has been carefully constructed, and often with sizeable blocks; again M&R state: "*The joints between the various blocks are very thin. From the northern part of the so called Ma'amun's hole, one can see that some blocks, at the corridor beginning, are at least 4.50 m. long."*[102] From the data we hold, it appears that the lower end of the ascending passage was a continuous section of girdle stones, which created a strong section to contain the plug stones and anchor the passage to the surrounding core masonry; whilst the standalone girdles likely helped dissipate some of the sliding masonry forces for the remainder of the passage.

The function of the inset stones is also a bit of a mystery, and I could find no detailed data on these. They do tend to alternate between east and west walls, and some of them can be seen on Perring's drawing, where he states; "*In the Upper Passage, at a. b. c, Fig. 1, holes have been cut, which are now filled up, for the insertion of levers or beams to raise the Sarcophagus: on the opposite side there have also been holes, but they did not correspond with the others*."[103] This explanation is questionable, as the sarcophagus as previously shown cannot pass the junction, but their close proximity to the standalone girdles suggests a connection to these girdles. It is also to be noted that these inset stones according to the drawings seem to appear on some of the largest wall blocks to be found in the passage, with each being below the girdle. In Dormion's fig 16, these three large blocks are of similar size, ranging from 2.50 to 2.52m in length (girdle thickness range from 83 to 87 cm); his fig 16 also confirms the Edgar's observation that the upper girdle rests on the lower at an angle, and he shows that the middle girdle slopes down from east to west; whilst the girdles either side slope upwards from east to west (i.e. the inset stones are always on the highest side of the lower girdle).[104] This inclined nature would lead Dormion to propose that these standalone girdle stones were originally housings for portcullises in

[100] L'Architettura Delle Piramidi Menfite, Parte V, page 32
[101] Ibid, aoge 116
[102] Ibid, oage 34
[103] The Pyramids of Giza, from actual survey and admeasurement. Part I, The Great pyramid, page 2
[104] La Chambre de Cheops, 2004, page 97

the manner which we see fitted to the horizontal passage of the Bent Pyramid. In the Bent pyramid the two portcullises slid down an inclined ramp across the passage, providing an awkward barrier for thieves.



In the image above we have Perring's drawing of one of the portcullises and its housing; whilst the photo right is of the westernmost portcullis, which has had its robber's breach enlarged to aid in clearance of debris. Dormion would suggest that a similar portcullis operation was originally intended in the Great Pyramid in the area of our three standalone portcullises, with the inset stones holding a release mechanism; but that this portcullis method was abandoned in favour of granite plugs being slid down the ascending passage.[105]

Like Perring's explanation, I do find this explanation questionable, as the three standalone girdles would surely be built long after the lower end of the passage, which clearly has been purposely built to contain plug stones from the outset, and this suggests to me that only plug stones were the original design for sealing the passage. Ultimately the lack of data on this passage is a real hindrance in trying to understand its curious features.

Though it has often been reported that the ascending passage was cut through pre-existing core masonry, due to a change of plan in the abandonment of the subterranean chamber; it is clear that this is not the case; for cutting through pre-existing core masonry, we only have to look at Mamnun's tunnel for an example of

[105] Ibid, pages 96-105

that. And yet, we do appear to have evidence that the lower end of the ascending passage was cut through; for example the Edgar's state:

"The whole of the passage from the fourth Girdle down to the upper end of the Granite Plug is much dilapidated, extensive exfoliation having taken place on walls, roof and floor. Accurate measuring at this part is therefore almost impossible. However, we tried our best to get the exact positions of all the joints by stretching lines tightly along the four angles formed by the walls with the roof and floor, and taking off-sets to these lines from the various joints. Indications in the masonry forming the roof at this dilapidated part, show that the stones which form the Girdles here were built in solid, end to end, after which the bore of the passage was cut through them. Above the fourth Girdle, however, there can be no doubt that the passage was constructed in the usual way, i.e., that the floor was laid, the walls erected at the proper distance apart on the floor, and the roof-stones then placed on top of the wall-stones. Nevertheless, it is quite probable that the stones forming the three upper Girdles were built in entire, and the bore of the passage cut through them in situ."[106]

The description given by the Edgar's above is exactly how I would envisage the method used by the builders to create this passage. To the modern mindset it may seem strange to lay large blocks of stone first and then cut the passage through them; but this is the sort of thing that the ancient Egyptians would do. Many may be aware of the magical stones often pointed out by tour guides in various structures which appear to turn a corner; but this is merely the result of a large block being laid and then cut back to the required dimension, and leaving this strange artefact; and it mattered not if the material was of a hard stone such as granite. Sometimes it would be easier to lay a wall and cut out a window or door later, and it's likely we see something similar in the ascending passage; here at its lower end, large plates of stone were carefully laid and bonded into the surrounding core masonry; once done, the passage would be cut through this section, taking care to leave a tapered section to restrain the granite plug.

Granted that the available data on this passage is not ideal, but to me it comes across as carefully planned and not the result of some change of plan; moreover, given the junctions close proximity to the natural rock, I would suspect that it was commenced early, which might cause conflict with the subterranean chamber; which came first? As we recall, Lehner and Hawass, now suggest that the subterranean chamber was built last.[107]

When it comes to the length of the ascending passage and its angle, these were both troublesome areas to calculate for both Piazzi-Smyth and Petrie; Petrie would state;

[106] Great Pyramid passages, Vol1, page 284
[107] Giza and the Pyramids, 2017, page 146

"The angle of slope I did not observe, as I considered that that had been settled by Prof. Smyth; but the azimuth was observed, by a chain of three theodolites, round from the entrance passage." He would further add: "*From the mean altitude of 26° 2' 30", the sloping length of the passage being 1546.8, the horizontal length will be 1389.5, and the vertical height 679.7, both being corrected for difference in the offsets of the ends. The determination of the azimuth has, unhappily, a large probable error,+/- 3' (owing to bad foundation for the theodolite in Mamun's Hole); and its direction, -4', is so close to that of the Pyramid side, that it may be assumed parallel to that +/- 3'."*[108]

It would seem strange that all the attention in measuring the pyramid is largely concentrated on measuring its exterior dimensions, whilst the interior has been somewhat neglected. Given the advance in technology, such as laser scanning for example, we really should have more modern data to work from other than that provided by Piazzi-Smyth and Petrie; especially given the difficulty measuring around obstacles such as the granite plugs. For example, Petrie would report that Piazzi-Smyth's length for the ascending passage was some 3 inches shorter, and Petrie would put this down to the fact that Piazzi-Smyth used rod measures whereas Petrie would use tape.

The above measures provided by Petrie are not entirely of the physical floor of the ascending passage, but include the distance to the apparent intersection of the descending passage floor; to obtain the actual floor length we subtract 59.8 inches, and this gives us 1487 inches for the floor of the ascending passage or 72 cubits.[109] The angle determination is made difficult by virtue of the granite plugs, and indeed in his original plans Piazzi-Smyth states; *"To remove altogether, or pierce a three-inch observing hole straight through the centre of, the granite portcullis at the beginning of the first ascending passage."*[110] The angle of the descending passage is often quoted as being intended to reflect a simple gradient of 1:2, and indeed the measured angle is very close to this simple gradient; however, the ascending passage, though often suggested as being intended to be the same gradient is nearly half a degree out, and this is often explained as building tolerance. To quantify the difference a ½ gradient would make to the ascending passage, it would add nearly 12 inches to the vertical height given by Petrie above, and shorten the horizontal distance by some 6 inches.

[108] Pyramids and temples of Gizeh, 2nd edition page 22
[109] Pyramids and temples of Gizeh, 1st edition page 62-63
[110] Life and Work, Vol 1, page 8

The Grand Gallery

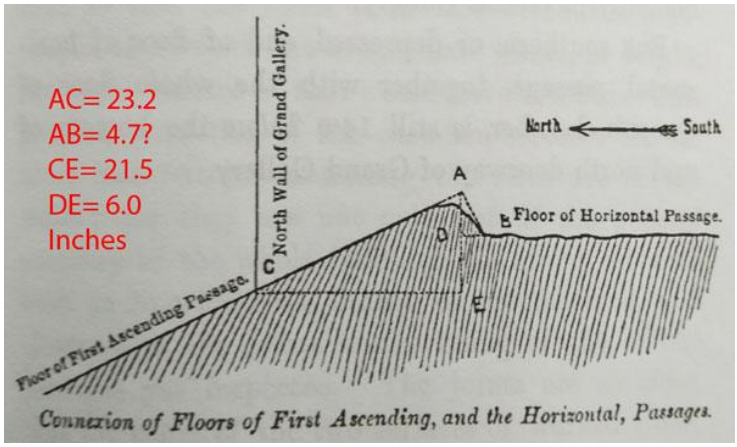
Image courtesy of Jon Bodsworth

The grand gallery is surely one of the more perplexing spaces inside the pyramid; the effort to create it would rival and possibly surpass the construction of the king's

chamber, and yet this vast space is often quoted as being a storage ramp for plugging stones, which when released would trundle down and fill the ascending passage, and thereafter leave a huge empty space of fine masonry with no other apparent role. It seems to defy logic that such a large and difficult undertaking was built merely to contain plug stones, and given the length of the grand gallery we would certainly expect more than the three granite plugs which we see today. Of course the explanation is given that the remaining plugs behind the granite ones would be conveniently made of limestone, and these were simply broken up by the violators: but would this be the method? Anyone hacking at these plugs surely ran the risk of being crushed by the mass of the plugs bearing down on them; why not bypass the plugs by cutting into the soft limestone of the passage walls?

In recent years the ScanPyramids project has detected what appears to be a large void above the grand gallery, which appears to run the length of it; though it is not sure if this anomaly is horizontal or parallel to the gallery. Given the size of the gallery this void may simply be a relieving space made of pent beams to divert the overlying masonry around the gallery. If such is the case, it further increases the complexity in the creation of the grand gallery, and all for the storage of plug stones. Why not simply plug the upper end of the descending passage, and fit a series of portcullises in the ascending passage, and fit a concealing stone in the ceiling of the ascending and descending passage junction?

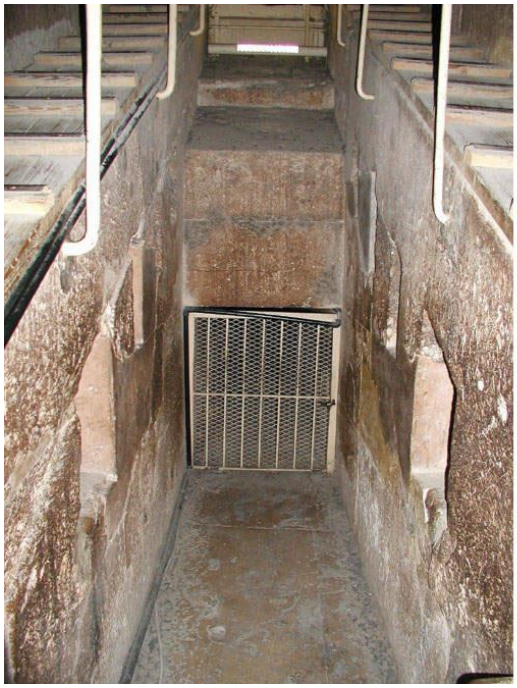
As we will see, there are many illogical features of the grand gallery that defy explanation. As we enter the grand gallery from the ascending passage we find that the floor of the ascending passage continues for a distance into the grand gallery.

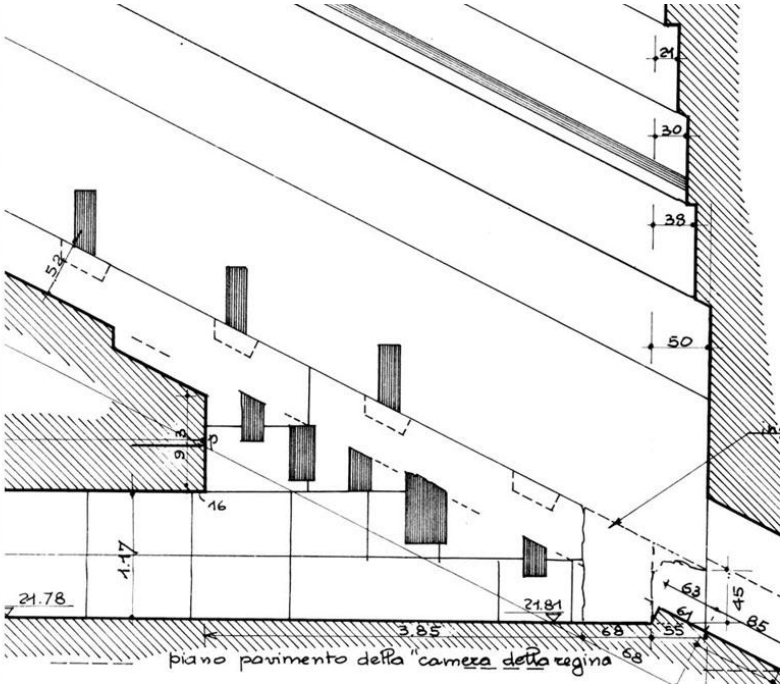


Connexion of Floors of First Ascending, and the Horizontal, Passages.

In Piazzi-Smyth's drawing left, I have placed his dimensions for the portion of flooring which extends into the grand gallery (he would report that the measures are not very accurate due to the broken state of the upper corner).[111] He would observe that the horizontal passage floor which led to the queen's chamber, was some 6 inches higher than the end of the ascending passage at the north wall of the gallery, and this added to the vertical height of the horizontal passage of 47 inches, agreed with the vertical height of the ascending passage. So it appears as if the architect has kept the top of both doorways at the same level. It is thought that the end surface AB would receive the ends of wooden beams which would bridge the gap in the floor of the gallery, allowing the plug stones to descend over this gap

[111] Life and work, Vol 2, page 60-61





In the photo above, courtesy of Jon Bodsworth, we are looking south with the ascending passage behind the viewer; whilst the drawing right is part of M&R's TAV6, showing the sizeable area which had to be bridged. In the photo we can see the gate which closes off the horizontal passage which leads to the queen's chamber, and above the gate we can see the start of the gallery floor, which has a cut out at its end, which is thought to have received the platform that bridged the gap, and that said platform was supported by cross beams inserted into the side walls, the holes of some of them can be seen in the photo.

This floor maintains the 2 cubit width, as does the queen's passage; but either side of the gallery floor we have two ramps which run from the north wall of the gallery and terminate against what is often termed the great step at the south end. This step according to Petrie's calculations is vertically aligned with the apex of the queen's chamber and denotes the pyramids E-W axis. The ramps are 1 cubit wide, which gives the width of the gallery as 4 cubits. The length of the ramps, which is effectively the sloping floor length from the north wall to the great step is given by Petrie as 1815.5 inches or 88 cubits[112] This 88 cubits would equate to 1/5th of the pyramids base length, and if we add this to the 72 cubits of the ascending passage and 200 for the descending passage, we get a total of 360 cubits: could the sloping passages denote the Egyptian year?

Along the top of each ramp we have numerous holes cut into them, as can be seen on the image on page 89, and above these inset stones have been placed, except for the two sets of holes at the north end: these holes also display a strange pattern, which will be discussed later. The width of the gallery diminishes from 4 cubits at its

[112] Piazzi-Smyth, would give two values, east 1813.9, west 1815.6, Vol 2 page 78

base to 2 cubits at the ceiling; this is achieved by a series of 7 corbels on the east and west walls diminishing by a palm, such that the uppermost corbel is vertically aligned with the ramps, and bringing the ceiling width in line with the floor width. Both the north and south walls of the gallery are corbelled, which is a departure from The Red pyramid, where only the long side walls were corbelled; though in the Bent pyramid all four walls are corbelled. The south wall also displays 7 corbels; however, the north wall differs, M&R state;

"The north end wall is interesting for the size of the blocks in it, and there are only six corbels as the lowest one was never built. Here, the total distance the corbels jut out from the base of the wall is 50 cms.: the lower faces of the 1st and 4th corbel are inclined, whereas those of the 2nd, 3rd, and 5th are horizontal. In 1837 Col Vyse made a hole in this wall and in so doing almost completely destroyed the uppermost corbel."[113] (The south wall faces are all reported as horizontal)

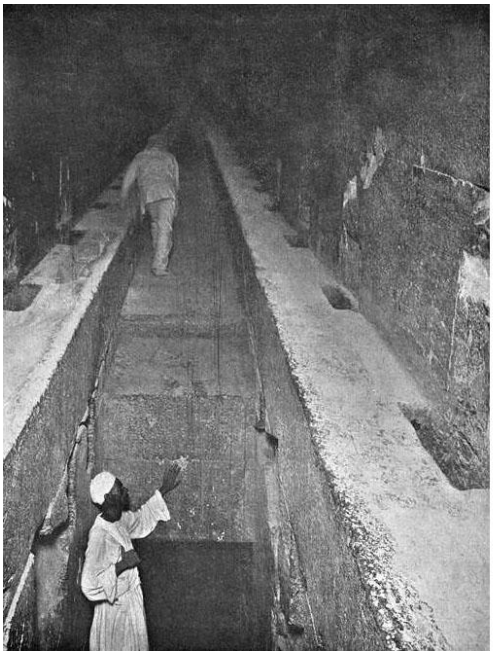
Another unusual feature is a groove which runs along the length of the east and west walls; it can be seen on M&R's drawing above, and is found on the face of the third corbel. It is a shallow groove, of which M&R state;

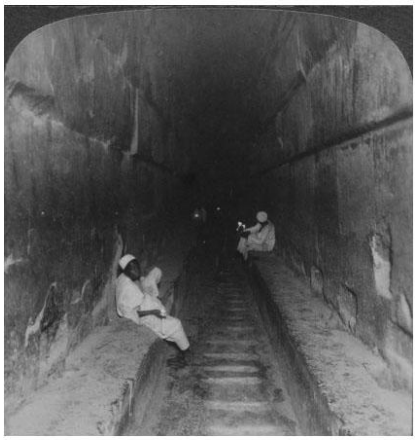
"A rough groove runs in each side wall for the entire length of the gallery and exactly it is found on the face of the 3rd corbel and 13 cms. above its lower edge. It is 15 cms. high and, on the average, a little more than 2 cms. deep. The upper edge of the groove is often badly defined and chipped, while the lower one is missing in several points as the listel between the groove and the lower edge of the corbel is often broken. It was certainly made after the dressing of the walls as indicated by the chisel or pick-hammer strokes. According to Petrie, who took his information from Piazzi Smyth, the lower edge of the 3rd corbel is 4.22 m. from the floor, the lower edge of the groove, 4.37 m. and the upper edge 4.55 m. (measurements taken vertically and not at right angles to the gallery slope). The result is that the lower edge of the groove is at a point about half way up the gallery walls".[114]

The height of the gallery was difficult to determine due to the nature of the ceiling which Piazzi-Smyth states consisted of 36 slabs, (possibly 40)[115] which have all been set into the side walls at an angle, and it is thought that this was done to reduce the sliding forces bearing down on the north wall. The ceiling slabs appear to have been set into ratchet type cuts in the walls, with the walls themselves likely varying in thickness and being bonded into the core masonry, and thus reduce their pressure on the north wall of the gallery. The north wall masonry is reported to have been built of particularly large blocks, and again this seems designed to resist any sliding forces.

[113] L'Architettura Delle Piramidi Menfite, Parte IV, page 36
[114] Ibid, page 38
[115] In an update to Petrie's 2nd edition, published in 1990, Hawass on page 103 states that 40 slabs formed the roof, and that many were in critical condition that required stainless steel bar implants and grouting.

Piazzi-Smyth would take with him to Egypt some 27 boxes of instruments, including a particularly large one to measure the height of the galley; needless to say the nature of the roof provided a wide range of measures, with the mean being given as 339.5 inches (8.62m); this being the vertical height. Data on the grand gallery is hard to come by, and we are mostly reliant on the tables of measures provided by Piazzi-Smyth and in his work, he provides two tables giving measures for the *'side-overlappings'* of the east and west walls at both south and north ends of the gallery.[116] The tables are limited in accuracy and some estimates are necessarily given, but they are at right angles to the incline of the ramps. But from this data, the first corbel seems to start at 3 cubits perpendicular from the top of the ramp; with the top of the ramp itself being 1 cubit above the gallery floor, The masonry to the first corbel is of two courses, and likely 1.5 cubits each, wherein the remaining 7 corbels would each appear to be 1.5 cubits high. This would give a perpendicular total height from the gallery floor of 14.5 cubits. To the base of the third corbel, would by this scheme, be 7 cubits (1+3+1.5+1.5), and as the bottom of the groove is 13cm above the base of the corbel, i.e. ¼ cubit, then the bottom of the groove is 7.25 cubits above the gallery floor, or exactly half the perpendicular height of this scheme. That said, the measures are uncertain and more modern surveys are required to rule other possibilities in or out.





In the above left image taken by the Edgar's, we can see one of the Edgar's walking on the gallery floor, assisted by the slots cut into the floor, which can be better seen in the earlier image right, circa 1904. Today a modern wooden walkway obscure these features.

[116] Tables on pages 89-91, in Life and Work, Vol 2.

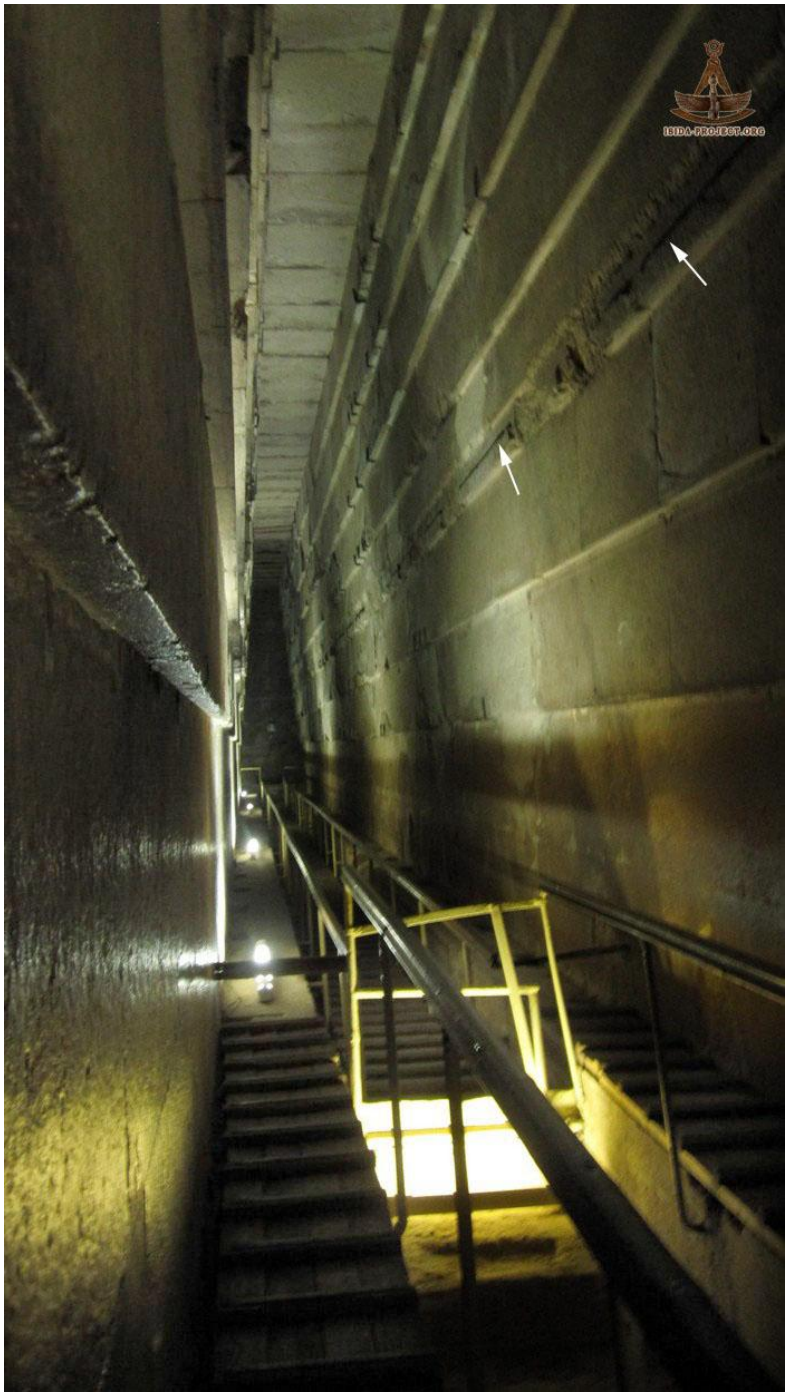


Image courtesy of Isida Project

In the above image we are looking up the grand gallery; today the visitor has secure wooden boards to walk on along with handrails. The arrows point to the lower edge of the groove in the third corbel, which is in better shape than the upper edge of the groove which is badly damaged. The function of this groove is a mystery, but it is strange that the upper edge of the groove is significantly more damaged than the lower; the only thing I can suggest is that wooden panels once slid into these grooves, creating a false ceiling. At this height in the gallery, the corbels reduce the width by the groove to 3 cubits 1 palm (1.65m), and given the height of the groove of about 15cm, the panels should be stiff enough to bridge this gap, in such a shallow groove.

If such a ceiling existed would it be decorated? If a decorated ceiling existed, it might explain why the upper edge is damaged, in order to extract the panels without damaging the decorated side, and of course such panels would have to be of a size to extract via the ascending passage and Mamun's tunnel.

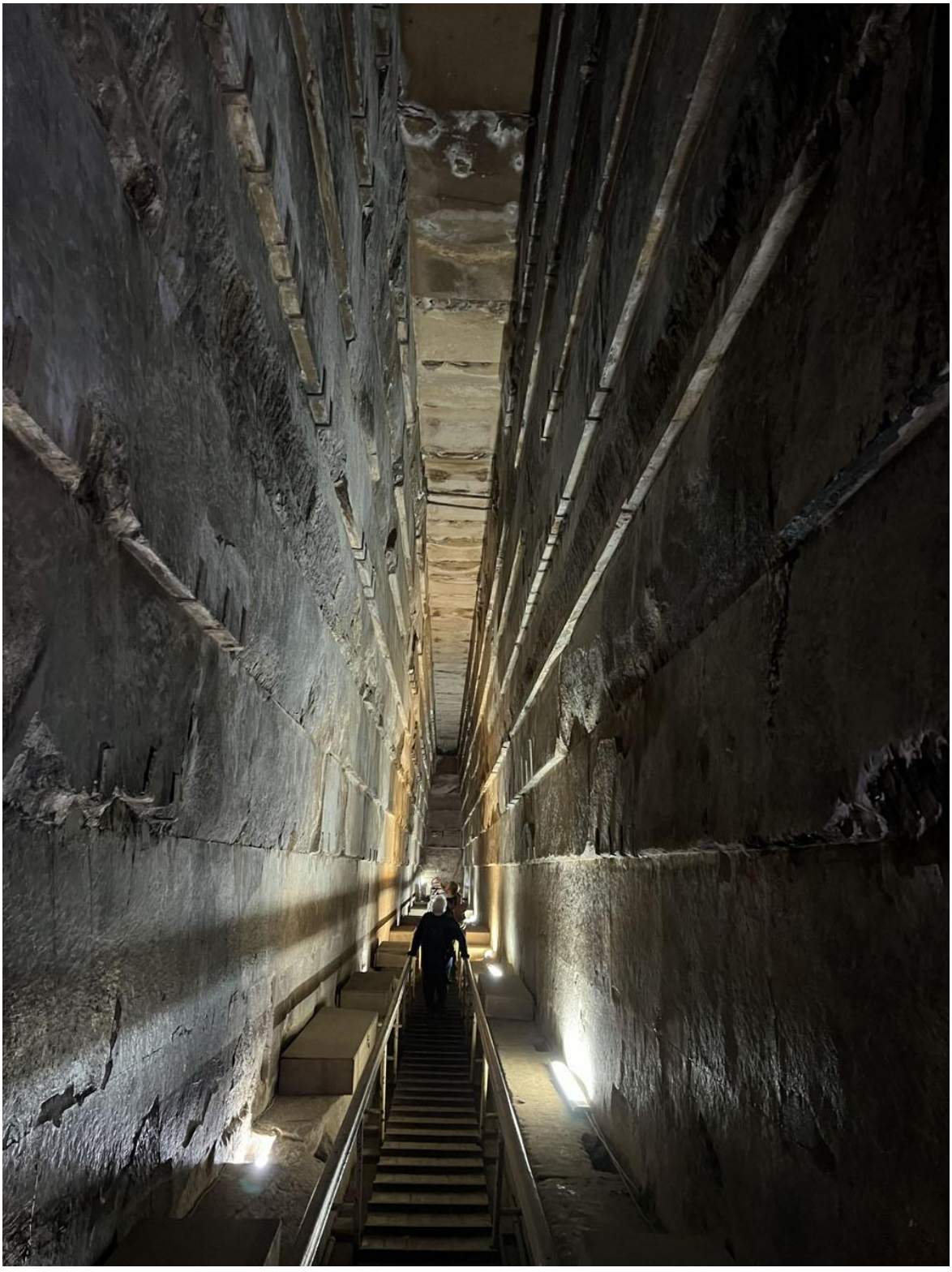


Image courtesy of Larry Pahl

The above image is looking down the grand gallery; the wooden boxes sitting on top of the ramps are connected to the ScanPyramids project. A significant amount of repair work has been done in modern times and many metal clamps can be seen under the corbels. The condition of the masonry is certainly not in the condition that we see inside the Red Pyramid, and it's likely that originally the grand gallery was just as fine as we see inside the Red; which has been largely protected from human visitation. Indeed the jointing of the masonry is excellent, as George Hart would highlight; *"Yet in this vast area of masonry you cannot find even less than a millimetre of space between the joins of the limestone blocks"*[117]

Image courtesy of Larry Pahl

At the upper end of the grand gallery we can see how the ramps abut against the great step; the left image was taken by the Edgar's and shows the damage to the step, whilst the right image highlights the modern repairs (one of the ramp holes is just visible in the lower right hand corner). The great step is some 4 cubits wide and extends back 3 cubits, where we meet the doorway, which gives access to the antechamber, which contained the granite portcullises. The breaking up of these portcullises likely attributed to the damage that we see; especially if granite fragments were carelessly hurled down the gallery, taking bites out of the limestone as it went. As well as the 27 holes which exist in each ramp, we find two holes cut into the southern corners of the step, giving a total of 28 holes on each side of the gallery.

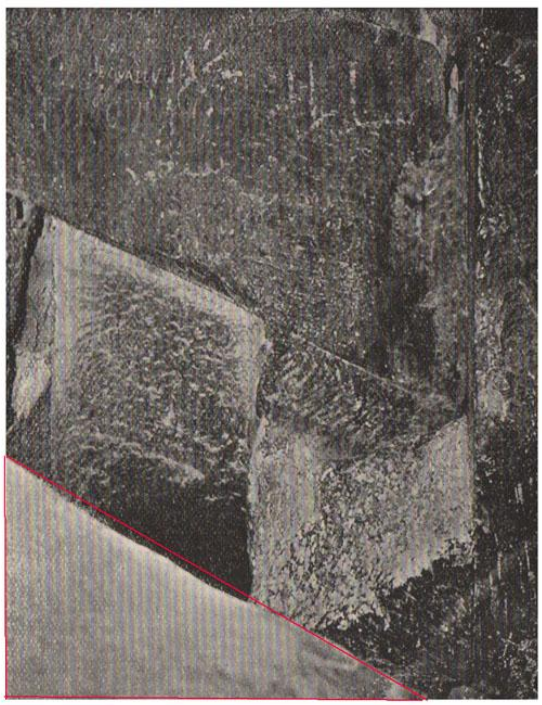
[117] Pharaohs and Pyramids, 1991, page 93

Image courtesy of Jon Bodsworth

Looking up the east wall from the great step we can see an opening by the ceiling, which was entered in modern times by Davison; this opening leads to a tunnel about 7.35m long which enters the space above the king's chamber. Unfortunately data on this tunnel in respect of the masonry composition of its route I could not find; for example, does the tunnel offer any clues to the width of the ceiling slabs etc. Also in the above view we can see the groove in the third corbel, with well preserved lower edge and damaged upper edge.

Image courtesy of Jon Bodsworth

At the lower end of the grand gallery at the base of the west wall, near to the ascending passage doorway, we have the opening to the well shaft, which is closed off. The Edgar's images below give an idea of what hides behind the grill; in the left image I have highlighted the ascending passage doorway; whilst the right image was taken from on top of the east ramp in a different direction: the bounded area is the top of the east ramp. A large piece of the west ramp, between the well shaft and gallery north wall has been broken away.



We will know look at the holes made in the ramps and the strange pattern that they exhibit. Piazzi-Smyth would state;

"These holes are cut in the ramps, next the wall, rather rudely, and have their edges now much broken. Their upper and lower, or north and south sides, are cut nearly vertical, certainly far from at right angles to the general incline of the Gallery; the depth of the holes (vertical) varies from eight to eleven inches, probably as influenced by hardened dirt. Their number,-including one at the south-east inside corner, and another at the south-west inside corner, of the upper horizontal surface of the great step at the upper and south end of the Gallery,-is, twenty-eight on either side.

Of these, all, except the two on the great step, and the two lowest or northernmost on either side (i.e. four at the north end) have a piece of stone let into the wall vertically over their middle; the height of such inserted piece being usually18., and breadth 13.; while the depth or thickness in one particular case where a neighbouring fracture enables it to be seen, is about 10. inches. The holes on either ramp are always opposite, or nearly so, to each other."[118]

Piazzi-Smyth thankfully provides tables of dimensions and locations of these holes for both ramps; though Petrie provides no such data. Petrie would state;

"The holes cut in the ramps or benches, along the sides of the gallery (see section of them in PI. ix.), the blocks inserted in the wall over each, and the rough chopping out of a groove across each block—all these features are as yet inexplicable. One remarkable point is that the holes are alternately long and short, on both sides of the gallery; the mean of the long holes is 23.32, with an average variation of .73, and the mean of the short holes is 20.51, with average variation .40. Thus the horizontal length of a long hole is equal to the sloping length of a short hole, both being one cubit. This relation is true within less than half their average variations."[119]

The range of measures for both long and short holes is quite marked; for example, in Piazzi-Smyth's table for the east ramp a long hole can have a length from a low of 21.5, to a high of 25 inches, with the mean of the 14 long holes coming out at 23.33 inches.[120] The short holes have a narrower range from 19.5 to 20.9 inches, with a mean of the 13 holes as 20.26 inches (the 14th short hole is on the great step). The 13 holes on the west ramp display a mean of 20.7 inches, whilst the long holes have a mean of 23.32 inches. Piazzi-Smyth only took these measures once, and ideally a more modern survey is required on these holes and spacing's. According to Piazzi-Smyth, the first long hole starts from the north wall of the gallery, i.e. the north wall is zero, and this long hole on the east side is some 23.0 inches long (A similar hole is thought to have also started on the west side, but the ramp here is mostly destroyed). After this hole, a

[118] Life and Work, Vol 2. Pages 78-79
[119] The Pyramids and Temples of Gizeh; 1st ed, page 72
[120] Life and Work, Vol 2. Table on Page 80

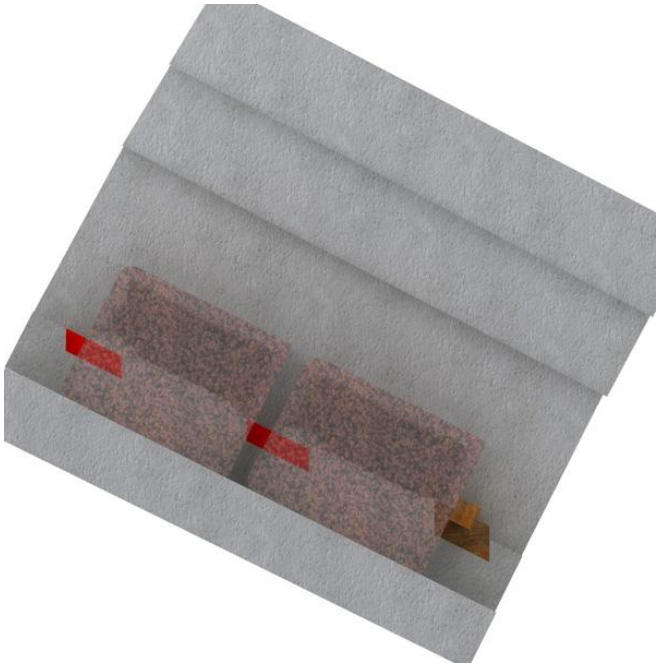
space of 2 cubits (41.9 inches) is left, wherein we meet our first short hole (19.7), and after this we have another space of two cubits (41.8) until our next long hole. It is at this long hole on both sides of the gallery that the inset stones begin (no stones are found above the first two holes or above the holes on the great step; this means that there is only 25 inset stones on each side of the gallery. From this hole, the spacing's between holes are larger than the previous 2 cubits; these larger spacing's range from a low of 44.6 to a high of 48.5, with a mean of 46.2 inches (west wall mean is 46 inches). It's difficult to conclude any particular design scheme to explain this strange spacing and hole lengths, but one would have thought that some careful planning was made before the cuttings were made. Petrie's statement that "*Thus the horizontal length of a long hole is equal to the sloping length of a short hole,"* is certainly a possibility, and we can maybe put this to the test. Let us assume that the ramp length is 88 cubits of 20.63 inches or 1815.44 inches; we can see that the initial two spacing's are 2 cubits: a total of 82.52 inches. These spacing's are double the length of a short hole of 1 cubit; so let us assume that the larger spacing's are intended to be the double of a long hole. In this exercise we obtain the following:

2 short spacing's = 82.52
24 long spacing's = 1107.12
14 long holes = 322.91
13 short holes = 268.19
Total = 1780.74 inches

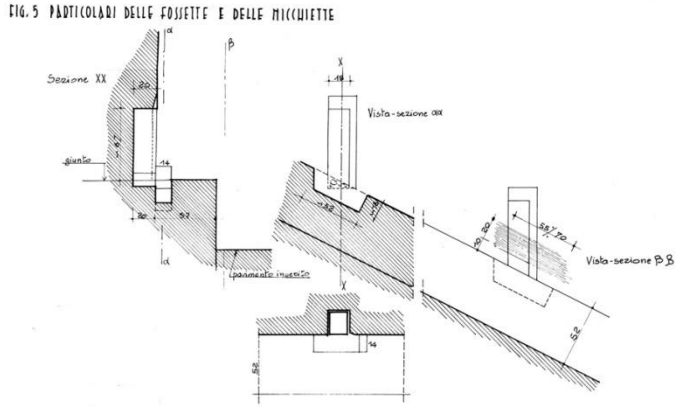
This total of 1780.74 inches is in effect the south end of the last hole on the ramp; Petrie does not give a measure for this, just the ramp length of 1815.5 inches, though Piazzi-Smyth gives the distance in his tables as 1781.7 east ramp & 1782.9 west ramp. This scheme is the closest to the available data, and indeed there are other candidates; for example, we could take the larger spacing as being intended to be 2&1/4 cubits, with the long holes half of this, which would give a total of 1789.68.

This pattern of holes is quite strange, and generally they are often thought to have held cross beams to restrain plug stones on the floor of the gallery; though it doesn't quite explain the four holes at the north end of the gallery, which are above the bridging gap; or the last hole, which is only some 33 inches (0.84m) from the face of the great step; not much of a plug stone could be restrained there, as any plug stone here, would be taller than its length and simply topple over. Or the 2 holes in the great step.

Indeed, realistically we only have 22 spaces between these holes, where plugs could be stored on the gallery floor (I assume none would be stored on the bridging platform). Dormion gives a length of 1.67m for the longest granite plug (65.75) inches, which is longer than our spacing between holes of some 46 inches; therefore the plug stone will have to encroach into some of the neighbouring holes.



One suggestion is that cross beams would restrain the stored plugs, as shown left; here wooden blocks are fitted into the ramp holes, which have a cut out on their upper side to receive a wooden cross beam. However, such an arrangement seems to have insufficient space for the plug stones, which we see fitted in the ascending passage. In the image left I have used the shorter dimensions given by Dormion, with the lower plug being 1.67m long. This is very close to the centre axis distance between holes, which is around 1.72m, and if we allow a cross beam of say 20cm width, then realistically the plug stones under the above design, should be no longer than 1.50m long.



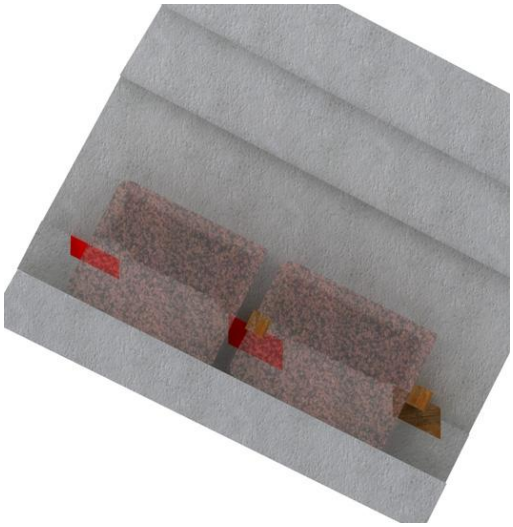
To add further confusion to these ramp holes, we have M&R's fig 5 from their TAV6, shown left. Here you will note that the north face of the hole is perpendicular to the incline of the ramp; indeed, M&R say of these holes: *"Their bottoms are parallel to the ramp slope and inside they are very rough. It is necessary to point out that their inside north faces are more or less at right angles to the bench slope whereas their southern faces are sensibly vertical: therefore they are shorter at the bottom than at the top."*[121] Here we have yet another example of confusion which is endemic to the pyramid; leaving the reader to ponder, who are we to trust? We recall Piazzi-Smyth's statement, were he comments; "*Their upper and lower, or north and south sides, are cut nearly vertical, certainly far from at right angles to the general incline of the Gallery".* In my reconstruction above I have opted for the vertical option, and this option is the view that Dormion shows in his work, and indeed in his work he states that the sides are vertical.[122] Having looked through the available images to me, it seems clear that Piazzi-Smyth and Dormion are more likely to be correct, and that M&R's statement above is incorrect.

[121] L'Architettura Delle Piramidi Menfite, Parte IV, page 38
[122] La Chambre de Cheops, 2004, page 163, fig 32

Image courtesy of Larry Pahl

The images I hold rather suggests that the north face is vertical, and in the image above I have extended the perpendicular joint line of the wall block; if the north face of the hole was supposed to be perpendicular, should it not be parallel to this line? All the images I hold are similar to above (though many are obscured with the ScanPyramids boxes). So it's difficult to understand M&R's statement; maybe some holes are as they describe and some are as Dormion describe; only a detailed forensic examination of all the holes can clear this anomaly up.

According to Piazzi-Smyth's tables the east-west width of the holes can range from a low of 5.5 to a high of 6.5 inches on west ramp, and 6.0 to 7.0 on east ramp. The depth of the holes is uncertain due to debris; though the deepest hole recorded in the tables was 12 inches vertically, whilst 13 others range from 10 to 11.5 inches deep.



I have amended the middle hole to the greater depth recorded by Piazzi-Smyth. Generally in M&R's drawing they give a perpendicular depth of the hole at around 18cm and Dormion's drawing shows 17cm; however, Piazzi-Smyth's deepest hole would have a perpendicular depth of some 27 cm. It might sound nit picking, but if we are ever to understand the function of these holes, we need accurate data to work with; how can one of the most explored buildings on the planet, be so devoid of basic accurate data?

Mark lehner, would touch on the features and problems of the grand gallery in an article entitled 'Niches, Slots, Grooves and Stains: Internal Frameworks in the Khufu Pyramid?'. In this article, one of his footnotes would state; *"My observations are so far based on published sources, and not measurement and survey of the actual features. Also we assume complete uniformity in the description of an ideal ensemble (fig 1). This "typical ensemble" should be checked against the actual variability shown by each niche, notch and cutting."*[123]

It is in this article that he gives the granite plugs as 1.75m and 1.60m, and the holes in his fig 2 conform to that described by M&R, and not that of Dormion. As a layman, it is indicative of the mess which I have already described in the Bent Pyramid and elsewhere; how can we hope to understand something if we don't even know what we are looking at. Gone are the days when pyramidologists such as the Edgar's could explore and research the structure; today research is tightly controlled, and so we are all hamstrung, awaiting accurate data, that only Egyptology can provide. Unfortunately, there is no sign that Egyptology will collate such data. Lehner's article highlights some of the problems of the grand gallery, and his footnote at least acknowledges the need to check the data; so it's very frustrating that we are still awaiting accurate data on the grand gallery, especially since Lehner's article was published in 1998

Above 25 of the holes we have inset stones, set vertically in niches; one can just make out the outline in the image on the previous page; unfortunately modern restoration repairs often obscure the outline and bevelled edges of the niches. Across these stones and the wall we often see a shallow band of rough chisel marks (see M&R's fig 5 on page 101); according to M&R all the inset stones exhibit this feature except for the northernmost inset stone on each wall. The bevelled edges are reported to be found on the top and northern edges of the niche only, and after the insertion of the inset stones, were carefully mortared over. The function of these niches and inset stones is another mystery of the grand gallery that defies a coherent explanation.

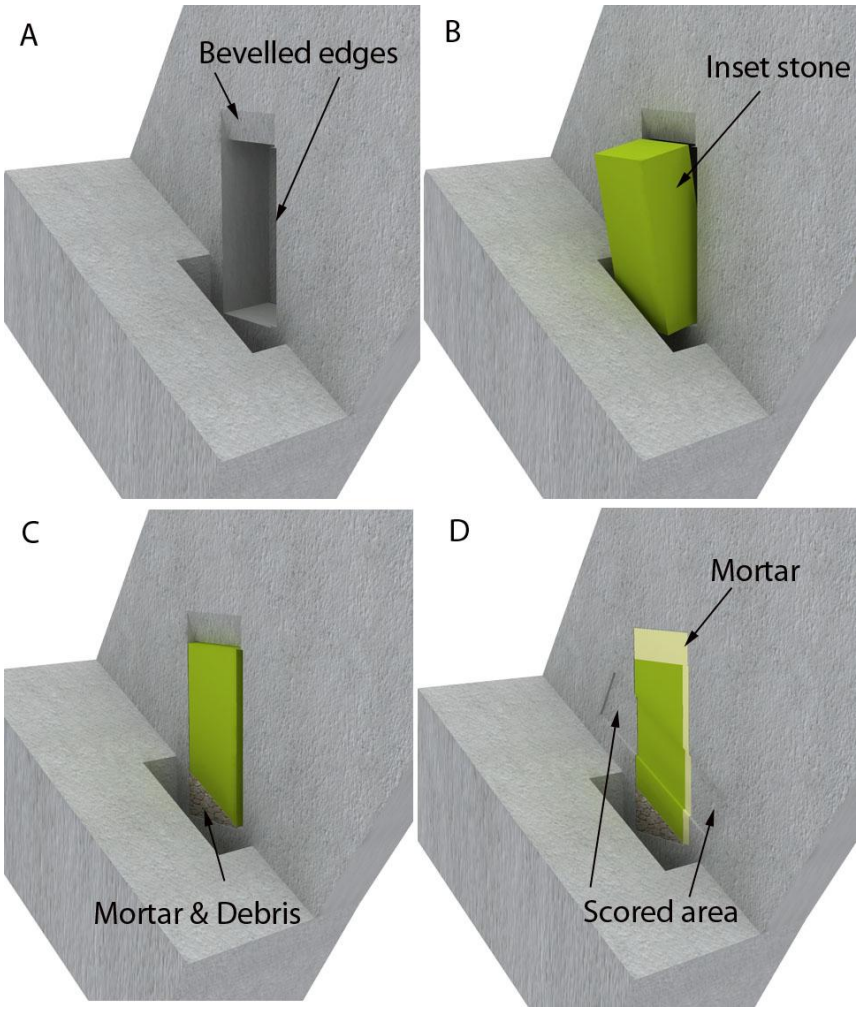
In the image overleaf we can see inside one of these niches above a ramp hole on the west wall. We can see the bevelled edge on the upper edge, which is sometimes described as around 75 degrees; according to M&R the niches were well dressed in the inside. They further report that the floor of the niche is horizontal and don't follow the incline of the ramp; this results in the southern floor being some 10-13cms below the top of the ramp, with the northern floor some 3cms below the top of the ramp. The inset stones themselves are not rectangular to fit this space, but have their lower edge parallel to the ramp, with the triangular space left beneath filled with mortar and limestone chips.

[123] Niches, Slots, Grooves and Stains: Internal Frameworks in the Khufu Pyramid? Stationen Beitrage zur Kulturgeschichte Agyptens, Rainer Stadelmann Gewidmet, 1998, page 105

Image courtesy of Jon Bodsworth

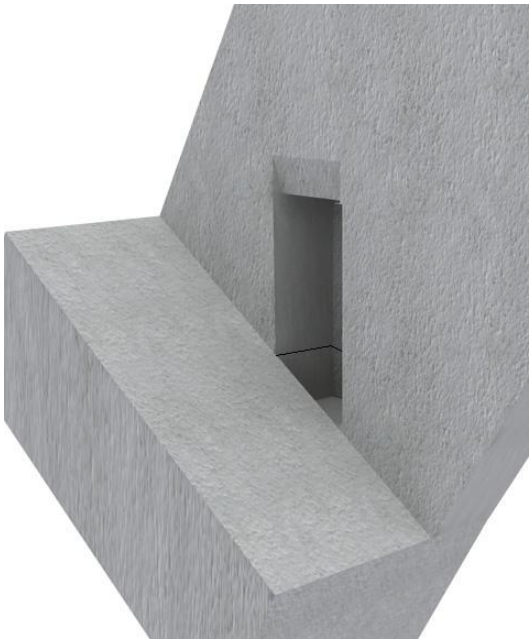
Not surprisingly, the size of the inset stones varies depending on the author; M&R give 18cm wide, 67 cm high, and 20cm deep: whilst Dormion gives 27-32 cm wide, 60 cm high (at tall north end) and 22 cm deep.[124] From the images I have, M&R again seem to be incorrect, as their 18cm amounts to only a 7 inch width, which is clearly at odds with the images.

Again, accurate data on these inset stones is lacking, and it's hard to comment on them, like so much of the grand gallery; but it's strange that the inset stones bottom was inclined to the slope of the ramp, necessitating the space below to be filled with mortar and debris. The depth of the niche at some 8.5 inches, is only 2.5 inches wider than the ramp hole, and I suspect that a rectangular block could easily be fitted into the rectangular niche at an angle. To check, I created a 3d model on the available data, and was able to insert a rectangular inset stone, by leading the bottom of the stone in first at an angle by using the space made available by the ramp hole. This was done with minimal clearance, and the bevelled upper edge of the niche helps in this experiment.



The image left gives a rough idea of the features. In 'A' we see the rectangular niche empty with the bevelled edges. In 'B' I found I could insert a rectangular inset stone into the niche; but this is not what we find. Instead, what we find is 'C', here the inset stone has its lower edge cut to conform to the incline of the ramp, with the space below filled with mortar and debris. Finally in 'D' the bevelled edges were filled with mortar, and a rough scored area 1 to 2 cm deep (according to Dormion's fig 32) some 50-60cm long by 20cm high, and about 10cm above the ramp, was chiselled across the features.

[124] For M&R see fig 5, and for Dormion fig 32, on page 163 of his work.



Granted, we have no accurate data on these features, but if detailed examination of these features shows that a rectangular inset stone could have been fitted, via the ramp hole, the next question to ask, is why did they not do so? One answer might be that when the inset stones were fitted, the ramp holes at that time did not exist, as shown in the image left. This scenario might explain why the inset stones lower edge was cut to the incline of the ramp, and the space below filled with debris and mortar.

The laying of the masonry of the grand gallery is also uncertain, Though M&R would comment that the ramps extend beyond the wall masonry; *"We have ascertained that the bench blocks generally penetrate beyond the side walls by observing the following particulars: the opening of the service shaft, small breaks in the lower edge of the side walls, and specially from the rectangular holes cut out in the benches where it is possible to see that the joints between some of the blocks continue under the side walls of the gallery."*[125]

The permutations to explain these features are many, and only a detailed examination of them will help reduce the possibilities and hopefully provide an answer to their function.

One suggestion by Dormion, is that the niches originally anchored a scaffold for the grand gallery during its construction, and when completed, the niches were sealed with the inset stones. Then later during construction of the pyramid, when cracks in the ceiling beams of the king's chamber appeared, it was decided to shore up the grand gallery, by creating new holes in the ramps, and creating a wooden frame, as shown left. One beam would be inserted into a hole, whilst another would be lashed to it and abut against the top of the ramp.

[125] L'Architettura Delle Piramidi Menfite, Parte IV, page 36

The rope lashings according to Dormion would explain the shallow scored area above the hole to allow passage of the rope behind the beam. These scored areas from images I have, vary greatly, some appear about an inch deep, whilst others appear to be a shallow scratch, and of course the northernmost inset hole on each wall, have no scored areas at all; the same applies for the holes without inset stones, north of these: why are these except? Indeed, would there be need for such a feature? Possibly, if the beams were vertical against the wall; but such beams would be angled away from the wall, to avoid the overhanging corbels and connect to the area of the groove in the third corbel. The E-W width of the holes is but 6 inches, and this would likely be reduced in the timbers as they would have to be inserted at an angle, and no bevelling is reported on the outer edges of the ramp holes to assist timber insertion.

We could ask why was it necessary for the bottom of the ramp holes to be inclined and not horizontal, and what benefit was there in having the holes alternatively long and short. Indeed, does such a design shore up anything, it doesn't come across as a very competent solution, and would such a solution be needed anyway? The Egyptians had lots of experience with corbelling, with its pinnacle being in the Red Pyramid, where the corbelled chambers are wider and taller, and still in excellent condition. It's a sound design, and while cracks in the Kings chamber would cause alarm; especially in a design not tried before, would they be concerned about the grand gallery, which is still in remarkable condition today.

The theories on the grand gallery are many, be it Borchardt's suggestion that the plug stones were stored on a platform in the groove of the third corbel to allow an unimpeded route for the funerary procession; or a series of stepped wooden platforms to hold the plug stones as shown in Lehner's fig 2.[126] Another interesting study on the grand gallery was carried out by Luca Miatello,[127] but really, we are all just groping around in the dark for a solution; when really what we should be doing is forensically examining these features, so that people have some reliable data that we can work with.

In fact, further confusion can easily be thrown into the mix; for example, Bardot and Darmon report that some of these niches in the grand gallery are fake; being only inscribed markings.[128] Or we could look to the work of J.P.Lepre, who states; *"In regard to the series of inset stones located along the Gallery's east and west lower-*

[126] Niches, Slots, Grooves and Stains: Internal Frameworks in the Khufu Pyramid? Stationen Beitrage zur Kulturgeschichte Agyptens, Rainer Stadelmann Gewidmet 1998, page 105

[127] Examining the Grand Gallery in the Pyramid of Khufu and its Features, PalArch's Journal of Archaeology of Egypt/Egyptology, 7(6) 2010.

[128] La grande pyramide de Kheops: nouvelle decouverte. 2006, pages 82-91

wall sections, the author noticed that all the inset stones on the east wall, except for one (vertical) set, were in a slightly slanted position from true vertical: and that all of the others on the west wall, except for one (slanted) set, were in a true vertical position. The twenty-sixth set on the east wall is on the vertical, and the thirteenth set on the west wall is slanted. This discrepancy between the east and west wall sections is slight; however, it is readily noticeable upon close scrutiny and measurement."[129]

These are but two examples, whether they are true or not is anyone's guess, and unfortunately this scene is replicated throughout the pyramid, as the researcher is reliant on old reports and conflicting views: sadly this state of affairs is likely to continue, until some modern scientific method is undertaken to provide us with accurate data.

Image courtesy of Larry Pahl

I was lucky enough to obtain a Lidar scan of the gallery, which highlighted the features on the west wall quite well; but unfortunately, the east wall is not so clear. In the west wall one inset stone appeared to stick out, and this is shown on the left image above; the right image is for comparison and is a neighbouring stone, and the form we normally see in the gallery, with the top edge horizontal. This unusual stone is the 8th inset stone from north end, or above the 10th ramp hole, so does not conform to Lepre's 13th. In Photoshop I selected the neighbouring inset stones on the scan and slid them along the gallery, and overlaid it above the unusual 8th stone, and this suggested that the 8th stone is in the wrong position; could this be the slanted stone that Lepre refers to? Unfortunately, modern restoration and repairs make it very difficult to ascertain the outlines of so many features, and so everything is uncertain.

As previously mentioned, views are held by some, that the plug stones could not have been stored in the gallery; Indeed, Pochan would envisage a side chamber by the ascending/descending passage for the three plugs; though as correctly pointed out by

[129] A Comprehensive Illustrated Guide, 1990, page 83

Dormion, the evidence for such a feature is clearly not there.[130]

However, there is evidence that the granite plug stones could not have been slid down from the gallery, though neither Piazzi-Smyth nor Petrie picked it up on their measurements. Piazzi-Smyth would create a table of measures of the breadth between ramps at various distances along the length of the gallery. These measures led Piazzi-Smyth to the following statement;

"These measures show without doubt that the Grand gallery is broader towards middle and upper or southern end than at the lower or northern end; and this prevails equally with the breadth between, and that above, the ramps"[131]

This observation has largely been forgotten, but it has a bearing on our granite plugs, for as we recall, both authors give the width of the granite plug as 41.6 inches, and yet according to Piazzi-Smyth's tables, the lower 222 inches of the grand gallery is too narrow for our granite plug to pass. The breadths in this area of which he gives six are all narrower than 41.6; indeed, the narrowest recorded measure at 185 from north wall is given as only 40.8: here the breadth between the ramps is .8 of an inch less than the recorded width of the granite plug. Petrie does not show as much data, but at 150 from north wall, the width appears to be 41,[132] (Smyth would give 41 at 152) so as it stands the recorded measures show a conflict. I had brought up this conundrum some 22 years ago in an article for the 'Giza the Truth website',[133] along with some issues concerning the bridging platform, which any plugs would have to slide over.

A year later, during correspondence with John Legon, the plugs came up in discussion, and he kindly informed me that he had measured the upper plug: his notes were; *"This plug fits tightly into the passage roof and east side, and is closely jointed with the plug below. Width of upper plug, by sighting to west side, base 1.045m, upper middle 1.040m, middle by using straight edge 1.030 or 1.035m. Perpendicular height of plug 1.185m."* Converting to inches, by sighting is 41.14 to 40.95 inches, straight edge 40.55 to 40.75 inches, and perpendicular height 46.65 inches. If we accept the straight edge measures, then it's feasible for the plug stone to traverse the narrow end of the gallery. Of course these measures should ideally be confirmed, along with the other two plugs.

[130] Pochan's drawing and scheme is on page 40 of his, L'enigme de la grande pyramide, 1971
[131] Life and work, Vol 2, page 82
[132] The Pyramids and Temples of Gizeh, 1st ed, page 71
[133] www.ianlawton.com/pc2.html

Image courtesy of Jon Bodsworth

In the above image we can see the damaged upper granite plug; being the upper plug it has suffered most to human activity; the better preservation of the middle plug should provide a more accurate measure. I can only say that the jury is out on this problem; given that there is over a century between measures, could further damage have occured to the upper plug to affect the later measures? Certainly its possible that Piazzi-Smyth has made an error, and the 41.6 measure also given by Petrie, may not have even been observed by him, but that he just accepted this measure from Smyth.

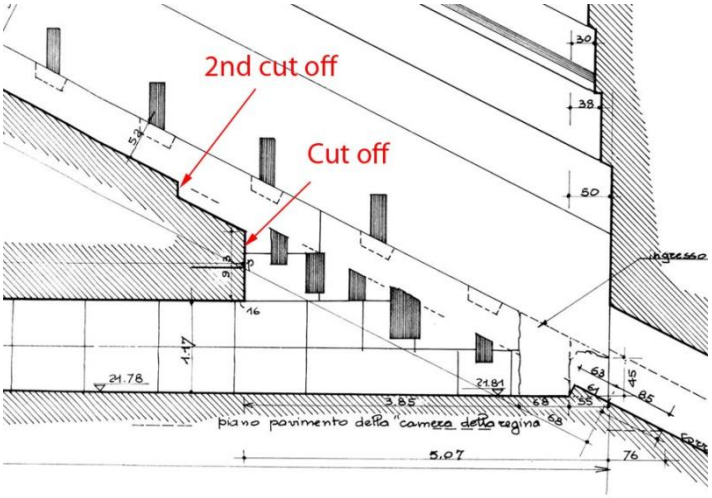
Other issues surrounding these plugs is whether they are mortared in, and yet again, there appears to be no consensus, some say yes, others no, take your pick. Surely it is an easy matter to find out, by examining the faces between the plugs above and around them; we also have the 4 inch gap between two of them, what was found here? If lubricate was laid on the floor, we might expect it to gather inside this gap.Clearly the plugs had to come from somewhere, and pending some accurate data on them, I am minded to accept that they must have come from the gallery, as there is no other logical place for them; moreover, the floor of the ascending passage in contrast to the rest of the passage is made from a much harder limestone as reported previously by Piazzi-Smyth; this in itself suggests that something was to be slid down it: if the plugs were built in, as some have suggested, why prepare a hard floor?

The next issue to address is the bridging platform at the lower end of the gallery, by which the plug stones would have to traverse over, and even here all is not clear cut.

Image courtesy of Jon Bodsworth

In the above image we are looking at the lower end of the gallery, the doorway to the ascending passage is visible. Today the visitor after emerging from the ascending passage, climbs onto the footboards placed on top of the ramps; these boards hide the ramp holes, and according to the Edgar's they report that footholds had been cut into the top of them. The features surrounding the inset stones are practically obscured by modern repairs; indeed, the lidar scan for this east wall hardly shows these features.

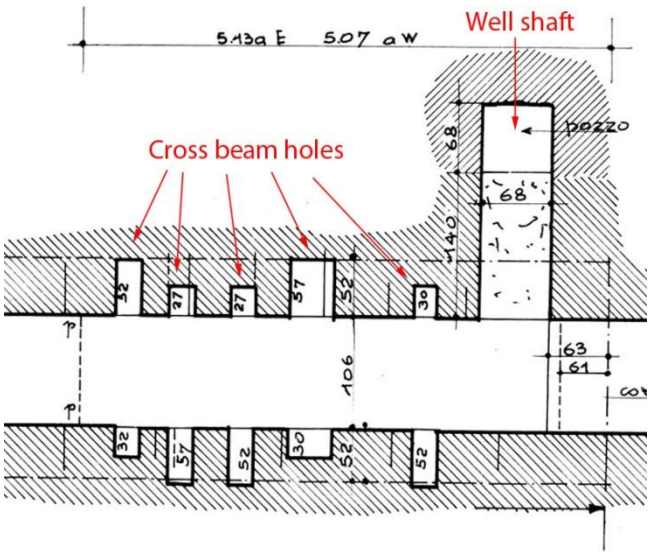
The space between the ramps at this end would have been bridged by a platform, which is believed to be supported by cross beams inserted into the holes arrowed above. These pairs of holes have one side deeper than the other, this is to allow a beam to be inserted at an angle, lowered to horizontal, and then withdrawn into the opposing hole on the other side. Again, we are reliant on Piazzi-Smyth for the data in this area, which allows one to create an accurate model; as he is the only one to provide detailed measures of the holes and their locations.



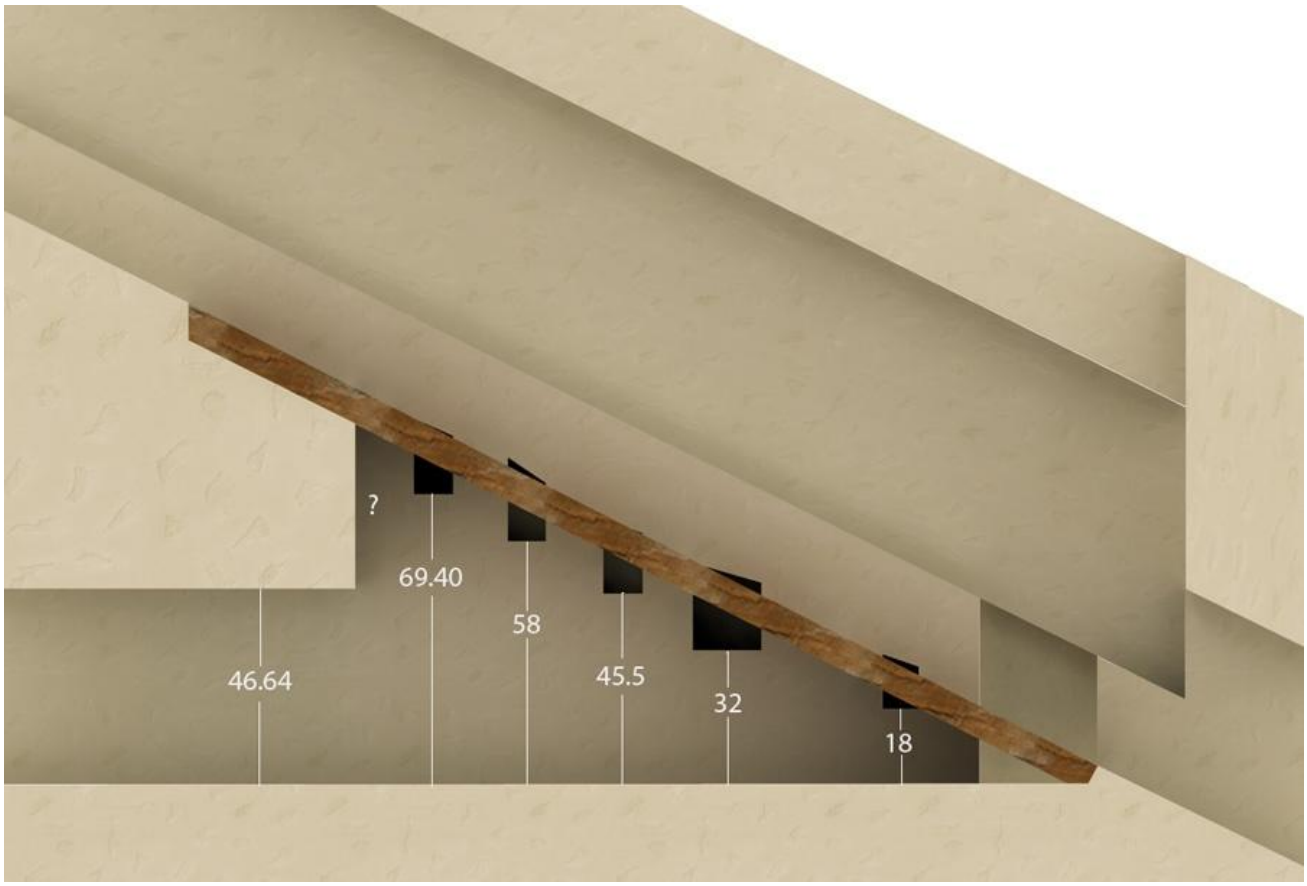
In the drawing left we have part of M&R's TAV6, showing the lower end of the gallery west side; here we see the corresponding holes cut in the wall to receive cross beams. The holes vary greatly in size, and it is noticeable that their upper edges are inclined to the slope of the gallery, and aligned with the floor of the gallery and not at the lower level of the floor cut out, which we might expect. Piazzi-Smyth would give an inclined length from the gallery's north wall to the face of the cut-out as computed as 222.4 (Petrie gives 223.7) Smyth's horizontal distance from north wall to vertical face of cut off is 199.4 (M&R's 5.07m equates to 199.6 inches). The inclined distance to the second cut off is given as 40.5 & 40.8 (Petrie gives 40.1), with the depth cut into the floor given as 9 inches. It is thought that a wooden platform would be inserted in this floor cut out, with its north end abutting against the face of the extended ascending passage floor, with the platform being supported by the cross beams.

Image courtesy of Jon Bodsworth

Looking south, we can see the cut out on the floor of the grand gallery, and the cross beam holes on either side of the area to be bridged. Well planed lengths of wood would fit into this cut out, with the upper surface flush with the gallery floor, to provide a smooth transition for our plugging stones. However, we have the strange situation where the cross beam holes appear to be in the wrong location; when logic suggests that they should be set lower in the wall, such that their inclined upper edges align with the floor of the cut out, and not that of the gallery.

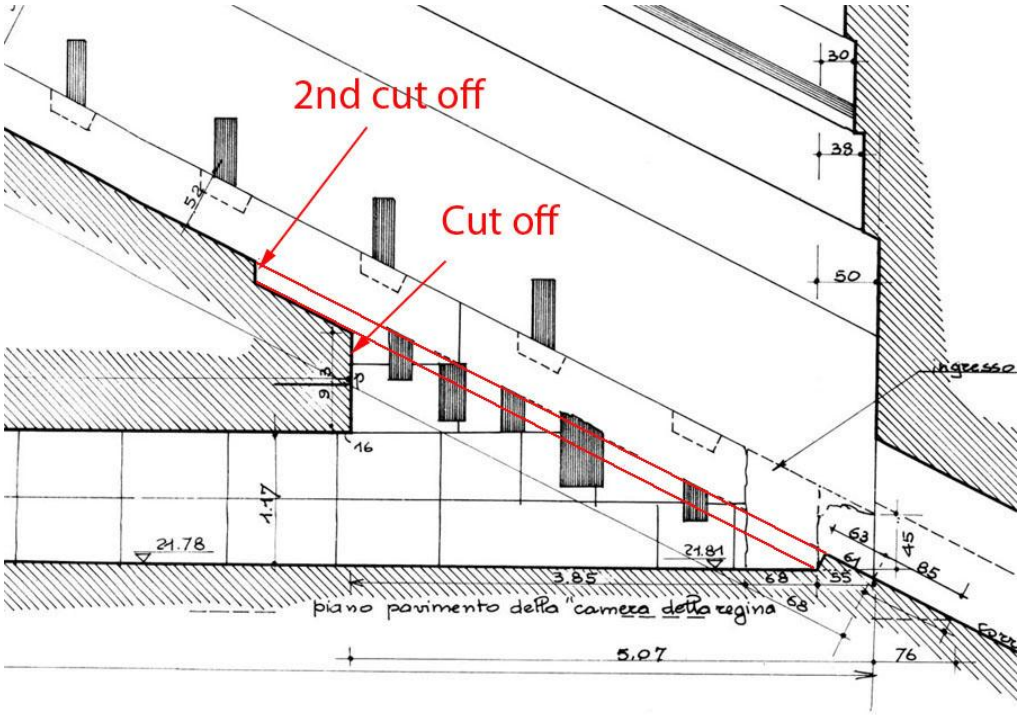


M&R's plan of the cross beam holes is shown left, and here we can see how the depths of the holes differ to aid in the insertion of the cross beams. However, the insertion of such beams is not an easy matter, given the narrow confines of the gallery walls; one could hardly bring them in horizontally, standing on the level floor which leads to the queen's chamber, and rotate them into the holes; instead, they would have to take advantage of any cubic diagonal, so that each end of the beam had suitable and equal purchase in each hole.



Using Piazzi-Smyth's tables we obtain a reconstruction of the crossbeam holes above, and as we can see, there are a few issues for our cross beams, especially the northernmost hole, which appears superfluous. The measures in inches are from the floor. There are a few inconsistencies in Smyth's measures; for example, the vertical height of the cut off (? Above) is given as 39.7: however, M&R show 93cm (36.6 inches). Dormion in his drawings 8 & 10, show 101cm (39.76 inches), which agrees

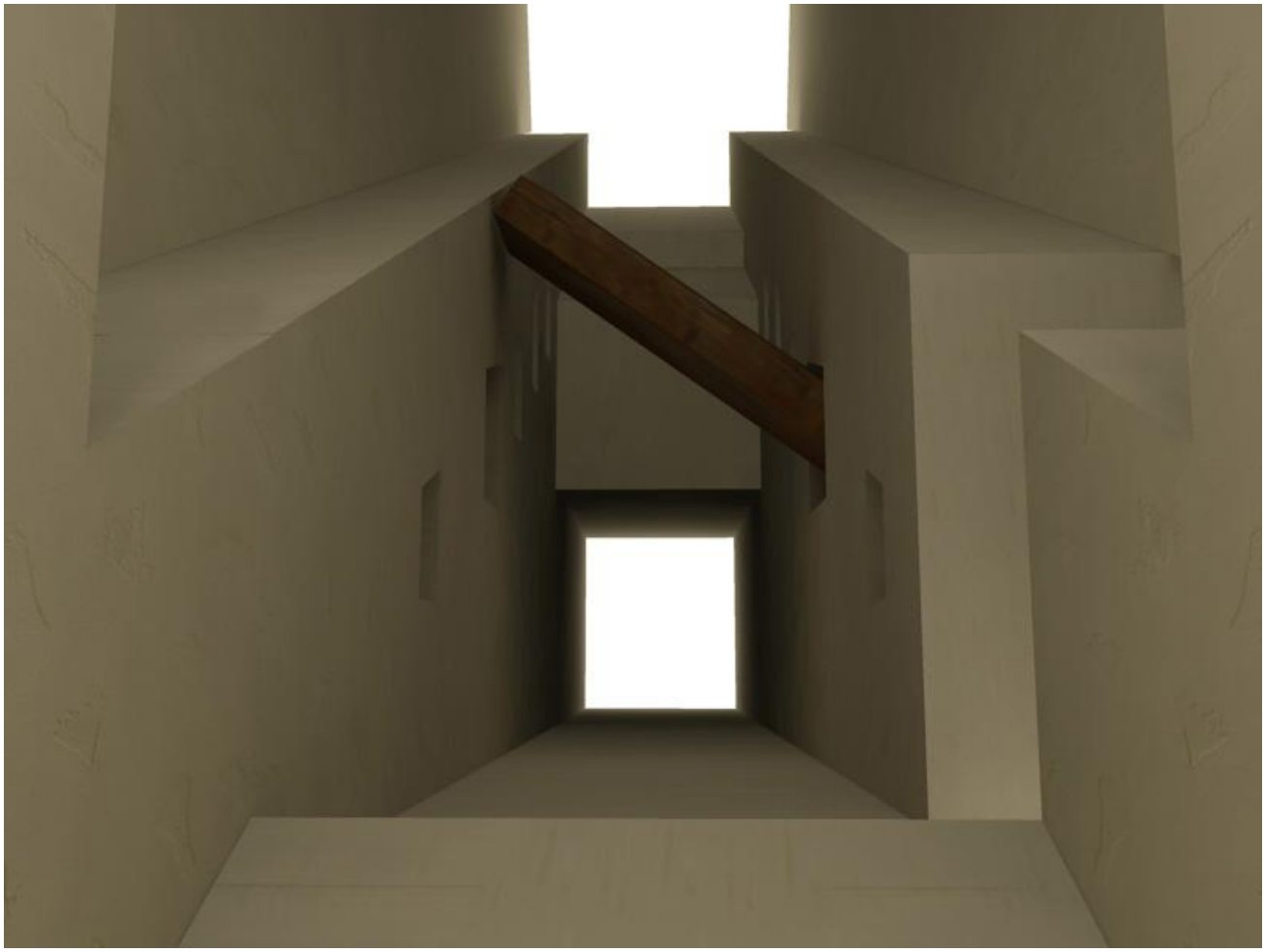
with Smyth; indeed, Dormion shows two measures for this face; the lower 56.5cm to joint line, visible on image on page 122, and 44.5cm for the upper portion.[134] Other issues have also to be taken into account such as the angle of the gallery, which Smyth gives as steeper than the ascending passage, 26º 18' (Petrie–mean axis of 26º 16' 40"). Ideally the whole area needs a modern survey, but the reconstruction is not a million miles away.



Placing the platform outline on M&R's drawing shows a similar result. An interesting point would be the missing ramp hole against the gallery north wall, and even here the location of the well shaft opening is uncertain. Smyth would give horizontal distance from gallery north wall to north side of well as 21.3 inches;[135] whilst M&R in their plan on the previous page suggest 63cm or 24.8 inches (they show a similar measure above: inclined length?). Now according to Smyth the first hole which is still intact on the east ramp (though not visible today due to the footboards) was a long hole of 23 inches; this means that if Smyth's horizontal distance of 21.3 is correct, then this would leave an inclined length for our hole of just over 23 inches. This means that a hole here would have no south end to it; i.e. it would be left open. Some have suggested that a closing stone would have concealed the well shaft opening, if this was the case (though it's difficult to see how such a stone would be fitted) then this stone would effectively form the south end of our ramp hole. A ramp hole with no south end could explain the damage to the ramp in this area; as a tumbling piece of granite portcullis could easily catch this weak corner and shear it off.

[134] La Chambre de Cheops, 2004, page 288-289, and 292-293. Dormion's figures are difficult to make out, even with a magnifying glass.
[135] Smyths tables for Grand Gallery, are in Vol 2, pages 68-91. Petrie would give well as 21.8 from north wall.

The positioning of the cross beam holes is hardly supportive of a platform, which would have to contend with granite plugs of some 5 metric tonnes.



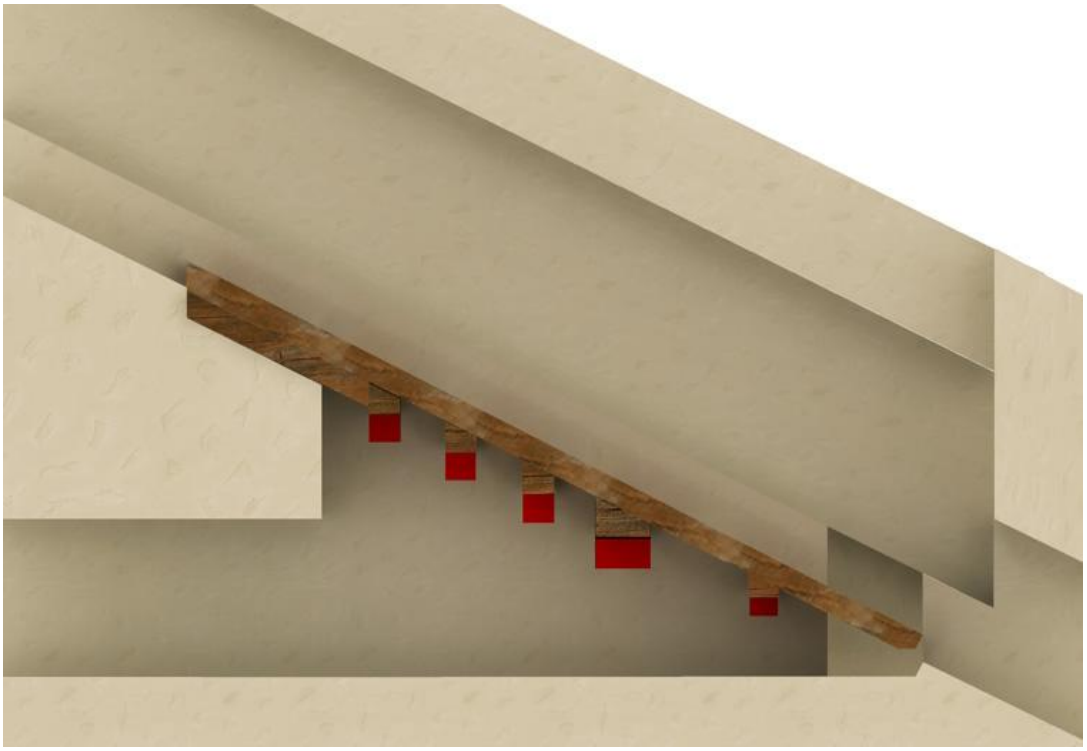
In the image above I picked the largest hole, and tried to ascertain what size of beam could be inserted at an angle. The holes with the short depths vary from 9.5 to 11 inches, whilst the long depths vary from 19 to 23 inches. However, we have yet another anomaly in the smallest northern hole, here Smyth gives the long hole as 15.5 inches; though in M&R's plan (see page 113) they give a depth of 52cm or 20.47 inches. One would suspect M&R's value to be correct in order to insert a beam, but it's yet another example of inconsistency in data.

Clearly no beam could be the exact dimensions of the hole; its height would have to be reduced to provide insertion clearance. In the example above, I managed to insert a beam some 61 inches long, whose southern side was 10 inches high, with the top side of the beam following the incline of the hole. This makes the height of the beam about half that of the hole. The series of five holes could have been placed lower, such that their upper edges were in line with the lower cut-out on the gallery floor, and the beams could still be fitted, so why do we find them at what appears an illogical higher level, with the result that one of them is redundant?

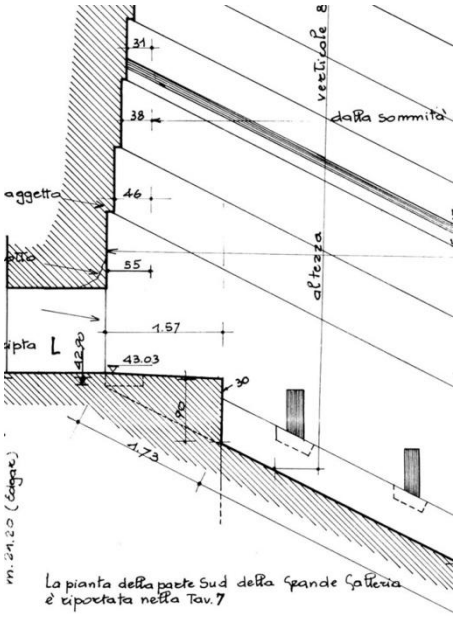
The complexities of the grand gallery are many, and sadly our data on it is extremely poor; so pending some accurate exploration and data, it appears a hopeless case Clearly, the floor of the gallery gives all the impression of a slipway, but was it all set aside for plug stones? The amount of work to create the gallery is immense, and in some ways it seems that the expenditure in building it rivalled or excelled the king's chamber, and all for the sake of plug stones! Something doesn't seem right; could this massive space have a dual role perhaps?

It might be the case that the only plug stones that issued from the gallery are the three we currently see today, and if this was the case, what else could have sat in this long slipway? Boats have always played an important role in Egyptian funerary custom, and so I wonder if perhaps Khufu outshone his rivals by actually interring a boat inside his pyramid? Previously in other guides, I mentioned the possibility that boats may have been interred in the Osireion and in the cenotaph of Senwosret III at Abydos, so I think it might be a possibility in the Great Pyramid. It might explain Piazzi-Smyth's observation that the gallery narrows at its north end, as if to protect something valuable from crashing of the end of the cut out.

One possible way to explain these holes is that they had a dual function, i.e. they held beams in two different positions; so in one position the northernmost hole could be used, whilst in the other it would be covered with the bridging platform for the limited number of plug stones. In plug stone function, the northern end of the platform could have been supported by a wooden frame on the floor, and it's interesting to note that the largest hole is the next one up. Once the plug stones have safely traversed down the ascending passage, the platform is raised to its higher level as shown below.



Here the cross beams are raised to the highest position in the hole, and held there by packing underneath, highlighted in red. In the lower floor cut out, another piece of timber is connected to the underside of the platform, and this abuts against the upper cross beam to prevent the whole assembly sliding down the ascending passage. Once complete, the valuable boat would be slid down and abut against the raised platform and secure it for eternity. The boat may have sat under a decorated false ceiling, which was installed in the groove of the third corbelled.



At the south end of the gallery the floor of the gallery stops at the great step; though Petrie reports that if the floor was continued it would intercept the south wall of the gallery at 61.7 +/- .8 south of the pyramid centre, or three cubits. This would give a total length of the grand gallery as some 1883.6 (Smyth would give 1882.6 East and 1883.0 West).

The top of the step has two short holes (1 cubit), and it is notable that the depth of these holes is much less than those on the ramps, and seem to be a quarter cubit deep, as if to align with the virtual floor of the gallery. The face of the step appears to denote the east-west axis of the pyramid, and has the appearance of a landing platform, for our boat. The step at some 4 cubits wide and 3 cubits deep, would of course display the 3-4-5 triangle. An interesting observation in this area was made by Petrie, he states;

"The ramps along the sides, where they join this great step, are very irregular. Their top surfaces slope away downwards toward the side walls; thus the E. Ramp top varies from 13.30 to 12.18 below the step from E. to W., and the W. Ramp top from 12.82 to 12.2 (?) from W. To E. At present, moreover, the ends of the ramps are parted away from the face of the step by .30 on E. and .44 on W., an amount which has been duly subtracted from my length measures of the gallery. Beside this, the top of the step itself, though, straight, is far from level, the W. Side being about 1.0 higher than the E. side. And the sloping floor seems to be also out of level by an equal amount in the opposite direction; since on the half width of the step (i.e., between the ramps) the height of the step face is 34.92 or 35.0 on E., and 35.80 or 35.85 on W."[136]

In order to keep the guide to a manageable size, this is the end of part 1; hopefully, part II will be in the near future.

[136] The Pyramids and Temples of Gizeh, 1st ed, page 75