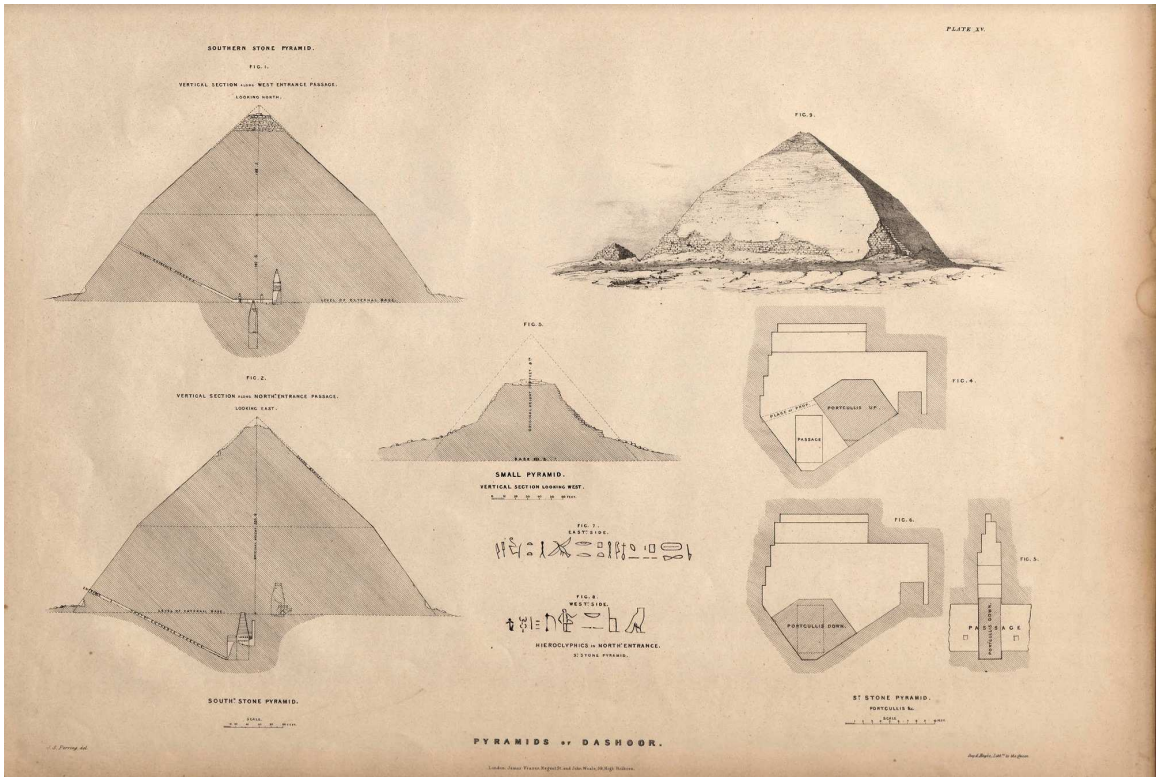
The Bent Pyramid

A Layman's Guide part 1

Keith Hamilton. 15 July 2017



Exploration.

The drawing above by Perring, who examined the Bent Pyramid in 1839, marks the beginning of modern exploration of the structure. Given the conditions and era that he worked in his work is quite remarkable; even though his description only amounts to a few pages it is quite informative. His findings were published in *"Pyramids of Gizeh Part III"*

The next person of note to explore the pyramid was some 43 years later in the form of Flinders Petrie; but because the northern passage had been blocked with debris he was only able to provide an outside survey and furnish some details on the northern passage that was accessible to him. This

limited information is shared between his *"The Pyramids and Temples of Gizeh"* and *"A season in Egypt 1887"* (The survey data is to be found in the latter)

Some 63 years pass from Petrie's time, and it is only at the close of the Second World War that serious work begins on the pyramid. The work undertaken by Hussein, along with Effendi and Varille, involved exploring the inner chambers and clearing them of the debris and the numerous small blocks of limestone that filled up a great proportion of them. (Today only the upper chamber has a sizeable amount of these blocks still left in situ) Sadly Hussein died in 1949 and valuable information for the study of the pyramid, was lost. Fakhry who took over the work in 1951 says;

"When the time came to take over the work, all his notes during four years of work had completely disappeared, and all my efforts to find them had failed. I had to depend only on the memory of some of his former assistants or workman for information"

Fakhry published his findings in a three volume work *"The Monuments of Sneferu at Dahshur"* In volume one, he provides a brief description of the interior and in the same volume Hassan's survey is published. Though his description is brief, Fakhry freely admits:

"The interior of this pyramid has been examined but I can never pretend that it has been thoroughly investigated or it does not need more researches in the future."

It is not until the 1960's that we start to get a more detailed look at the structure, thanks to the Italian architects V.Maragiolio & C.Rinaldi (M&R) who undertook a major multi-volume work describing Egyptian monuments. Their findings on the Bent pyramid are published in *"L'Architettura Delle Piramidi Menfite, Part III 1964"*. However even in this fine work there are many gaps in our knowledge of the structure.

J. Dorner, in 1986, carried out a survey that closely agrees with those parts that Petrie managed to observe and highlighted possible inaccuracies on Hassan's survey.

This briefly sums up the exploration history of the Bent pyramid and as a layperson I can only echo what Fakhry states *"I can never pretend that it*

has been thoroughly investigated," For the sad truth appears to be that the best preserved pyramid in Egypt is also the least explored. The pyramid appears to have been closed and off limits for a considerable time, possibly due to a military base in the area. Yet despite the dearth of information pertaining to the Bent Pyramid, it has not prevented Egyptology from confidently declaring that its strange form is the result of constructional failure. The evidence for this assertion is not as clear cut as some authors would make out, and in this paper I will not repeat my concerns as I have already pointed them out in my previous paper *"The Bent Pyramid: The curious case of the 60 degree pyramid"*

The first colour photographs of the pyramid's interior first appeared in 1997 by Andrew Bayuk who created the Guardians Egypt website, and gave the outside world its first tantalising glimpse of the pyramid's interior in colour. The world had to wait a further 15 years, until in 2012 the ISIDA-Project was granted access and it's their archive of pictures that provide the clearest view yet of the pyramid's interior. Once again I am indebted to ISIDA-PROJECT.ORG for their kind permission to use their images. All other 3D images are created by myself.

The Bent Pyramid and Subsidiary Pyramid

The Exterior

The Bent pyramid today retains a high percentage of its original casing stones, thanks, in no small part, to its construction method of inclining the casing stones towards its centre. Its neighbour, the Red Pyramid, thanks to its horizontal casing stones was not so lucky. On the Bent pyramid the upper casing is largely missing, possibly due to its smaller size and more horizontal positioning, Perring reports;

"The beds of the casing stones are not horizontal, but incline downwards towards the interior of the edifice, in order, probably, to obtain greater solidity, and likewise to save the materials, as less of the external faces of the stones thus laid, would require to be planed away to complete the exterior of the building. This incline, however, is not uniform, nor at right angles to the exterior, but it seems to be regulated by the shapes of the blocks; in the upper part it is generally at an angle of 3°30', and in the lower part it varies from 6°30' to 9°. The casing stones of the lower part are very large, some of the courses being 4 feet 8 inches in height; but they are often divided into two layers, and the joints at the sides, instead of being vertical, are cut to fit the adjoining stones. The courses in the upper part are seldom more than 2 feet in height"

On the casing stones Petrie commented;

"It is cased with yellowish Mokattam limestone, of the same quality as that of the second pyramid of Gizeh. This is broken away just round the bottom in most parts, also all over the top, and over a large part of the W. and S. sides; the S.W. corner being so much ruined that it can be very easily ascended. The courses at the top are 20 to 21 inches high; a reputed cartouche of King Unas on one block is merely a royal bee. The casing blocks are very deep from back to front, about 80 inches; though only 20 inches high, and about 60 wide. They are more like layers bevelled off at the edges than a coating of "slabs of stone", as such casing has been described. The joints are not quite horizontal, but dip inward a little; they are very good and close."

It is often reported that the top of the Bent pyramid is the first use of horizontal courses. It is close but not totally horizontal.

The image above, kindly provided by Lesleyanne Ryan, shows some of the surviving casing stones. Petrie was of the opinion that *"…much of the destruction has been done in the present century, and even a few years ago."* Perring mentions; *"The masonry in the lower part has also been destroyed, principally, it is said, by the late Deftarder Mohammed Bey, to get materials for his palace near Cairo."* Though I feel it is quite likely that looting of good quality stone, be it from the surrounding wall, causeway etc stretches back into antiquity.

The casing stones display numerous patches and slips of stone along joint lines, possibly to effect repairs to stones damaged by installation. There are also instances where cracks can be seen running vertically through several adjacent casing stones. These cracks have been used by proponents of the settlement theory to explain the form of the pyramid. To me, these cracks, in the scheme of this giant structure, by crude analogy, are no worse than a crack visible from, say, a window corner in our modern homes. Like at Meidum, the core stones are not laid with the care and accuracy of the casing stones, gaps existed between blocks, where mortar is absent and contact between adjacent blocks would be restricted to the high points of those

blocks. In the right circumstances, localised movement may have occurred in these core stones and the support they provided to the casing stones diminished enough to allow the propagation of cracks in the neighbouring casing stones.

Whether these casing cracks presented themselves during construction or during the intervening 4500 years is not known. The area has had seismic activity, for example the Cairo earthquake of 1992, which measured 5.9 on the Richter scale, was centred near the village of Dahshur. In the casing stones we have already described the patch repairs, though I am not aware of any repairs that have been effected to those stones with cracks. Like the rest of the pyramid a more thorough investigation is required.

As highlighted in my previous paper, I am not convinced with the idea of a 60 degree pyramid hiding under the mantle of the Bent pyramid, but have opted for the simpler solution as demonstrated in other pyramids, and that is a stepped structure and that said stepped core, like at Meidum, is firmly anchored on the bedrock. The casing phase, like at Meidum, would mostly rest on the steps and its load transmitted through the stepped core to the bedrock. Only the lower part of the casing was supported by a foundation platform on the desert surface. The PBS production called *Time Scanners,* using laser scanners, shows how successful it was. Indeed, to the ancient builders, it must have been a success for they replicated the technique at Meidum after the Bent pyramid, though using the new method of horizontal courses. At Meidum the lower part of the casing also rested on a foundation platform, laid on the desert surface, approximately 2.5 metres above the bedrock; and here too, judging by Petrie's survey of the platform level, a great success also.

The foundation platforms of both pyramids are similar, for the most part, along the sides the casing is laid on a single foundation stone and the corners are supported by more courses of foundation stone. It is possible that at the Bent pyramid the corner foundation stones might extend down to the bedrock. On the issue of the pavement level on the Bent Pyramid, Petrie says

"The Level which was intended as the apparent base, or pavement level, is fully fixed by the fine white mortared pavement which was found outside the place of the stone paving, at E.S.E and S.S.W., as well as by the pavement found in situ at the N.N.E., E.N.E., and N.W. No doubt therefore can exist on this point. At the N.W corner, which is the best preserved, there lies a large

socket block in the ground; its level is 13 inches below the pavement, part of which there still overlies it. This socket block bears a sloping bed on its upper face, as all the bedding of the courses of this pyramid is inclined inwards 5° or 10°. This bed is well dressed, having of course a slight re-entering angle along its diagonal, where the sloping bed of the north side cuts that of the west. Outside of this sloping surface it falls away slightly and runs about level, to receive a level pavement outside of the pyramid. The block is over 10 feet x 4 ½ feet, with another adjoining it, both together forming this socket bed. The slant face of the casing started directly from the edge of the sloping socket bed, and must thus have been covered over its face by the pavement to a depth of 13 inches. This is proved by the remaining block of pavement still on the socket floor, having a sloping line of dressing on its edge rising at the pyramid angle, in the plane of the casing."

Image of N.W. corner

Of the stone Pavement Petrie says *"The stone pavement projected but little from the pyramid, perhaps 20 or 30 inches; beyond that the gravel ground was dressed down to a hard face, and a thick coat of mortar, finished with a fine white surface, was laid upon it, to form an apparent continuation of the pavement. How far this extended I did not discover."*

In order to recover the intended dimensions of the Pyramid, Petrie had to work with several clues presented by the Pyramid's remains, though there were areas that he could not recover, for example; *"At the S.E. the corner is destroyed; and although I sunk several pits along the E. side, no trace of the pavement could be found. The length of the S. side and azimuth of the E. side is therefore not recovered."*

Petrie's mean of the three recovered sides was 7459 inches or 189.46 metres. Dorner's mean of four recovered sides is 189.61 metres, a close agreement. Likewise is average Azimuth, Petrie gives -9°12′; Dorner gives -10°2′, these two surveys taken a century apart are in close agreement. Unfortunately the same cannot be said for Hassan's survey, which differ significantly to the previous two, for example he provides a side length nearly a metre shorter and a bend height nearly 2 metres higher! And therefore his survey should be treated with caution.

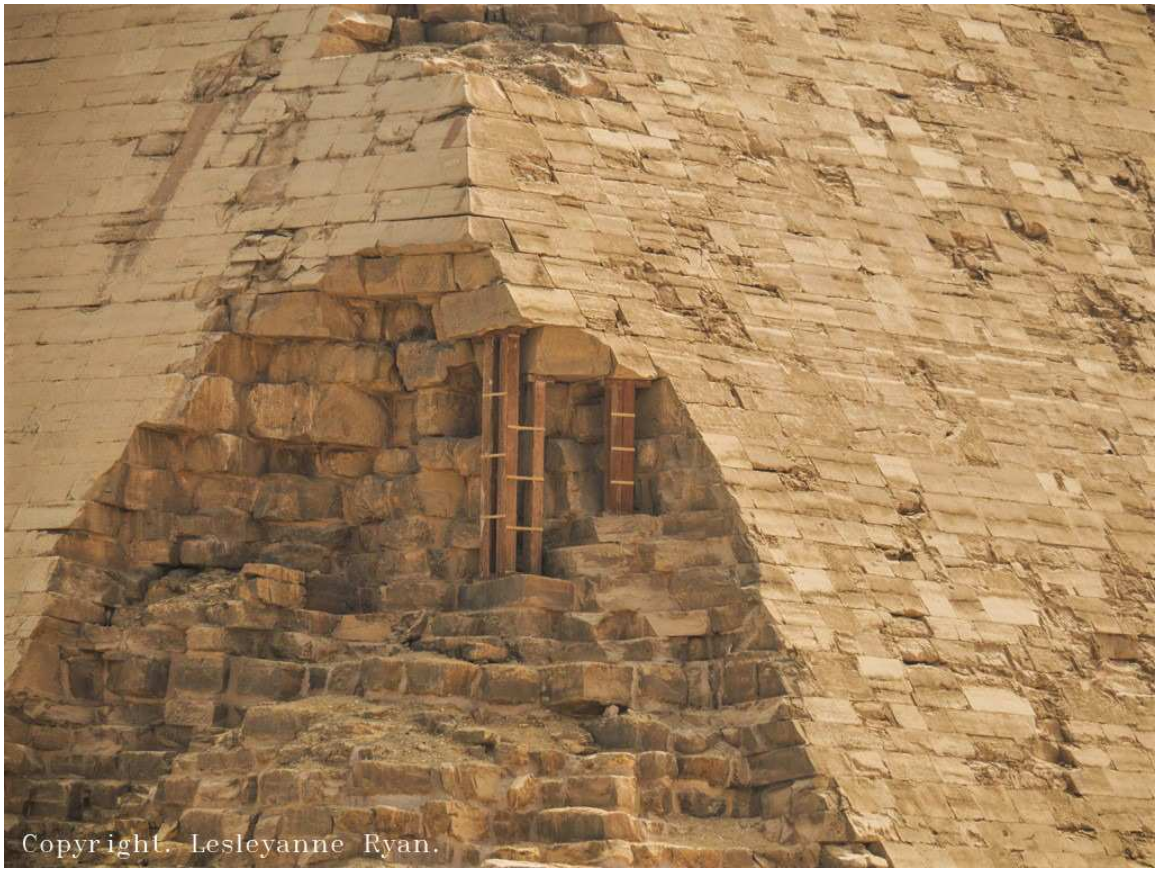
Petrie and Dorner closely agree on height, for example, lower slope vertical height in metres, P=47.17, D=47.04. Upper slope vertical height P=57.83, D=57.67. Despite the close agreement of Petrie's and Dorner's surveys, there are various interpretations of what they mean; some believe the pyramid base was intended to be 360 cubits, others believe it was intended as 362 cubits, though between competing factions there appear to be an agreement on height, with lower portion being 90 cubits and upper portion 110 cubits, for a total height of 200 cubits. Angles for the lower portion have been given as 54 to 55 degrees and upper from 43 to 44 degrees. I do not propose to discuss the various mathematical theories for the pyramid's design; the reader can undertake that research on their own and form their own opinion.

An unusual feature of the lower slope of the pyramid, which makes the measuring of its angles problematic, was noticed by Petrie, and that is that the sides display a noticeable convexity. This convexity was shown on the Time Scanners documentary, where they placed a flat plane on the pyramid sides and showed in a more visual way the convexity on all four sides. Petrie also reported that the upper slope showed a similar convexity.

This feature seems strange, and has not been given much attention. The Engineer Peter James provided an article in *Structure magazine, May 2013*, Entitled, *New theory on Egypt's Collapsing Pyramids.* As managing director of Cintec international, his first introduction to Egypt was in the aftermath of

the 1992 earthquake, where he undertook many repairs in Cairo and elsewhere. Soon afterwards he did his first pyramid restorations at the Red pyramid where a corridor was strengthened and a much bigger undertaking at Djoser's step pyramid where a large portion of the burial chamber roof had collapsed. (I have not come across any reports of damage to the Bent Pyramid as a result of this earthquake)

The author was asked for advice in securing the existing casing of the Bent Pyramid; in his article he states *"The pyramid did not appear to have any foundation movement. All of the missing cladding occurred at interfaces or changes of direction at the angles and between the ground and the cladding"* The author goes on to develop his theory of thermal expansion and states, *"Furthermore, the convex shape of the pyramid's outer casing could be caused by the stones arching between fixed points."* As a theory, I find it interesting and elements of it could benefit from more research.



The above image shows one of the damaged corners, with modern props to secure the casing.

The figures above give some semblance of the huge scale of the structure.

The North Entrance

The northern entrance is placed in the mid line of the pyramid, according to Petrie the passage axis is but .6 of an inch east of the pyramid's N-S axis. Petrie provides two heights for the beginning of the entrance floor, for

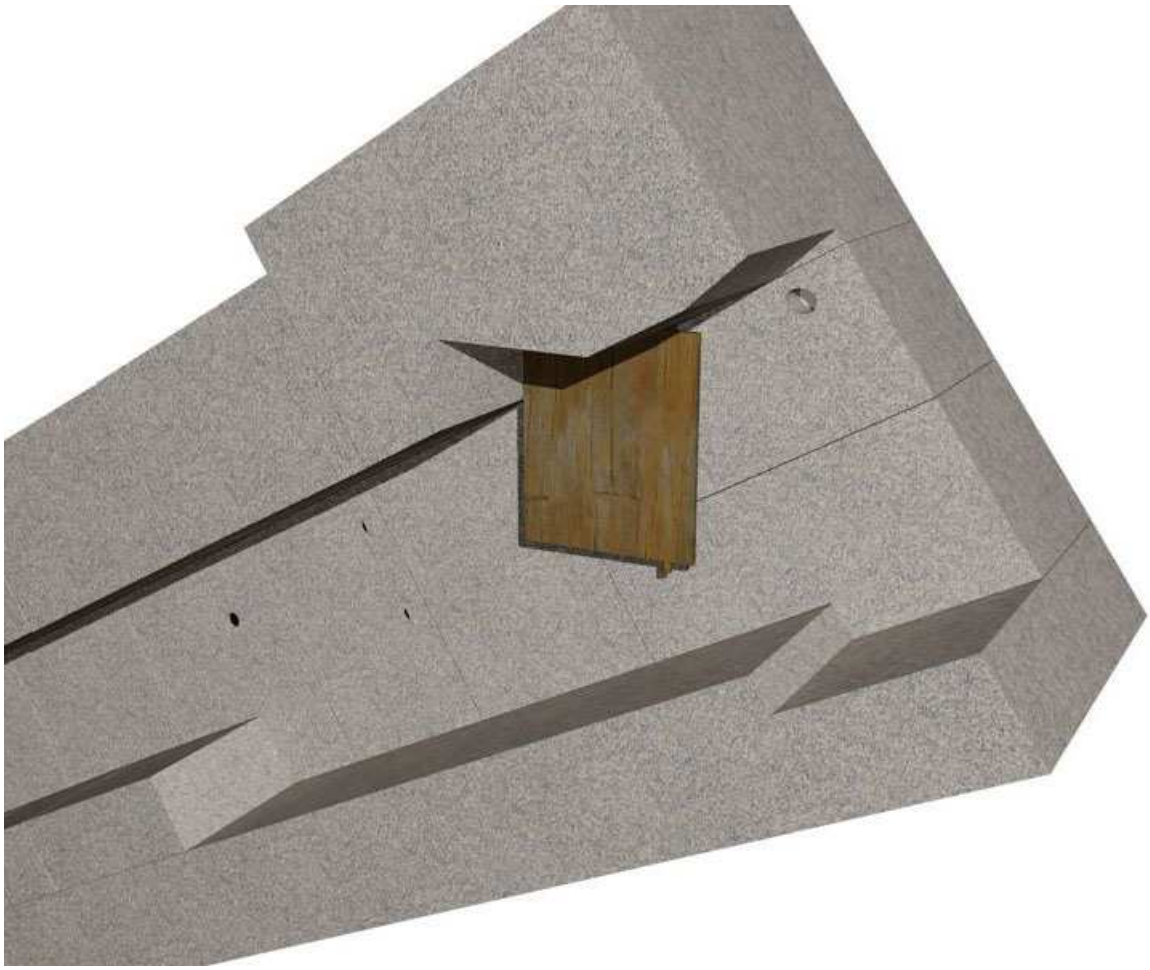
simplicity in autocad I have chosen his value for 55 degrees which gives the vertical height of the entrance floor as 11.88m from the pyramid base. (The other measure he gives of 11.96m as the casing angle by the door was 10 minutes more than the mean of the face of 55 degrees, which amounts to a 3 inch difference between measures) Petrie gives the azimuth of the passage as +13 ½ minutes east of true north.

As the pyramid has two distinct passage/chamber systems, I will deal with each separately and discuss the modifications visible in each at the end.

The northern entrance is accessed via a flight of wooden stairs; the massive lintel above the entrance is easily discernible. It measures approximately 3.18 by 1.5 metres; its depth has not been recorded by M&R.

Photo by Iverienen

Above the steel doors, and cut out of the lintel block, is the cutaway that Petrie mentions and it is about 8cm higher than the plane of the passage roof and slopes down to rejoin the ceiling plane; measured along the slope as 40cm. M&R have unusually omitted masonry joint lines for the upper passage walls from their drawings. Puchkov states that the walls from the continuous joint to the entrance are made of single blocks, though pictures of the entrance casing stones suggest two courses; this is not surprising and, like at Meidum, was probably done to disguise the entrance, though how the casing courses married with the single blocks of the passage is not recorded.



With the steel doors removed we might expect to see something like above, based on M&R's drawing TAV 11. The tapered cut above the door is visible and just below that a round hole that has a partner on the opposing wall. Petrie States;

"On either side of the passage is a hole in the wall; now very rounded and cavernous, owing to weathering; but apparently about 3 or 4 inches in

diameter, and 5 or 6 deep, originally. These two holes are just opposite one to the other, the centres being about 13 inside the pyramid, and 6 below the passage roof"

M&R's drawing shows the west hole to be 18cm deep (7 inches) and the east hole 28cm deep (11 inches) Petrie thought that these holes held bronze bearings for a stone door working on a horizontal hinge, and that the cut-out above the door was to allow the top edge of the door to rise when turning. I feel that this theory is unlikely, the different depths on the holes suggest more a temporary fitting like a wooden beam; the east wall hole being deeper, to allow a beam to be slid in at an angle, and then withdrawn to fit the shallower hole in the west wall. To this beam a rope could be attached to help workers manoeuvre up and down the passage. The roof cut-out could have been made to provide clearance and assisting in the movement of items down the passage, such as plugging blocks that may have been turned from a platform just outside the entrance. It is also to be noted that a similar cut out in the roof exists at the bottom of the western corridor.

The north corridor appears to be designed to be 3 cubits high and 2 cubits wide; into this corridor pavement blocks 1 cubit high were inserted between the walls and reduced the corridor bore to 2 by 2 cubits square. Several of the paving stones are missing, M&R state;

"The walls and ceiling of the first part of the descending corridor are in very good condition, but the floor is destroyed for a certain length. Some marks on the walls, give the original floor level also for the missing part."

It is possible that the steeper, upper, part of the northern corridor was intended to be plugged with blocks and finished with casing stones made to blend in with the surrounding casing stones; the 8cm cut-out could have been patched with a slip of stone, that is a feature of many casing blocks. This work would have been in vain, the huge lintel block and the entrance's location in the mid-plane of the pyramid along with its low height from the ground would make it an easy find for violators.

The next item of note in the upper corridor is the horizontal cut out in the roof , that Petrie thought may have held a door, he states;

"Some way within this point is a vertical hole in the roof, 6.2 to 8.2 from the west side, or 33.5 to 35.5 from the E. side of the passage; and from this hole

inwards the roof is cut away horizontally for about 32 inches. It is plain that this is intended for a door, probably made of wood by the smallness of the pivot, and working on a vertical hinge. The cut-out of the roof shows this by its length, which agrees with the width of the door required; and also by its only extending over the eastern part of the roof, up to the pivot; while W. of that, the 6 inches behind the door when opened, the roof slopes down as elsewhere. Unhappily, the floor is all torn up for 195 inches from the outside; a layer of 19 or 20 inches being missing from 36 to 195 inches, and a thicker amount of 25 inches from 36 to the outside. Hence the lower pivot hole and other details are missing. At about 130 inches down the passage are two holes on each side, one near the top and one near the bottom; they are about two inches wide and one deep, flat on the N. and curved on the S. probably they were for some fittings".

These D holes that Petrie mentions are also to be found in the Meidum Pyramid's corridor. M&R had the following information to these D holes;

"…they are on the same plane which is perpendicular or almost perpendicular to the floor and the pair on the east wall is made along a joint"

Not noticed by Petrie is another pair of holes, noticed by M&R, of 10cm diameter whose centre is about 4.73m measured from entrance roof and 43cm below the roof.

In this view looking up towards the entrance we see the vertical joints of the single blocks mentioned by Puchkov that make the walls of the upper passage, below the continuous joint they revert back to two courses. This use of single blocks will become apparent in later pyramids.

Looking up towards the entrance with the area of so called settlement.

A view into the excavated west wall, showing the face of the continuous joint; also in view is the dressing of the roof mentioned by Petrie.

A view into the excavated east wall showing the face of the continuous joint.

These faces have an angle of approximately 60 degrees and the continuous joint runs round the walls ceiling and floor. A similar continuous joint displaying a lesser angle of 55 to 58.5 degrees exists in the western corridor; in this corridor there is no so-called settlement at this joint. To explain these

continuous joints, M&R rotated the western corridor to align with the plane of the north corridor and noticed that a line connecting the two continuous joints displayed an angle of approximately 60 degrees and such a line, if continued to the pyramid base, would display a pyramid base of approximately 300 cubits. It is thought, therefore, by Egyptologists that the pyramid was originally intended to be 60 degrees, but that a series of construction defects resulted in changes in plans and the bent form we see today. I have provided a different theory to explain these anomalies in my previous Bent Pyramid paper, "*The curious case of the 60 degree pyramid"* that I recommend the reader read.

The so called settlement at the continuous joint of some 23 cm is accepted by most as evidence of structural failure and subsidence, though I would tend to accept Petrie's view;

"The dislocation is at a remarkable place, where the roof and floor in their outward course suddenly turn up in a curve to a point 11.1 above the true line, and then dropping sharply, they begin again only 1.1 above the true line, and fully regain the old direction in 23 inches distance. This formation is not due to a settlement, for (1) a settlement of 11 inches in such solid masonry, not far from the ground, is impossible, the more so as it would need a uniform settlement of the whole of the lower part of the passage, which should quickly cease at one point, and soon after continue at an equal amount; and (2) because the roof on the upper side of the dislocation is cut away in a slope for 23 inches, 1.1 being removed at the maximum. This shows that the builders were well aware of this formation in their time; and yet that they did not wish to smooth it all out, as if it were an accident or settlement, though nothing would have been easier for them than to have removed all trace of it. This part, like the rest of this pyramid, needs far more examination."

I can only say that we are still awaiting *more examination* some 130 years later. M&R's observation of this area is very scant; they have totally omitted the different construction method of the upper corridor from the continuous joint, they provide hardly any information on the form and size of blocks that make up this area; their drawings on TAV 11 are blank, no masonry lines etc. We see from other examples of their work, that they can provide this information, such as at Meidum, and what a contrast to the entrance of Khafre's pyramid, where on TAV 7 they provide wall and roof block dimensions. Given the importance of this area and the subsequent theories

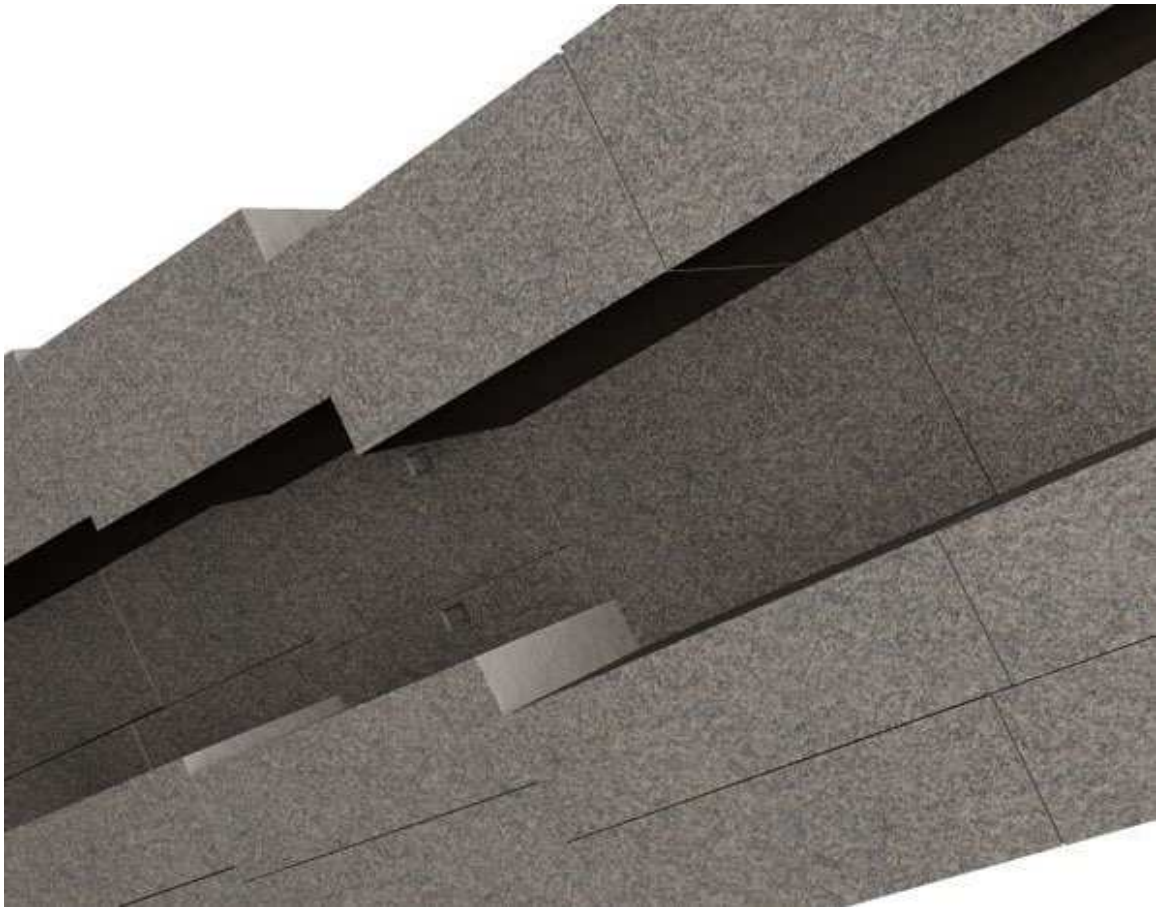
that have developed from it, one would have thought that they would have closely analysed the corridor to support their findings. Here, I feel they have taken their eye off the ball; an all too human failing, having found what they believe to be a major discovery they concentrate on items to support it to the detriment of items that run counter to their theory. In the Bent Pyramid they tend to concentrate on cracks, for example:

"The casing blocks in white limestone also have numerous cracks running vertically for many courses…. This fact confirms the deduction that the whole body of the pyramid was subjected to enormous forces probably caused by a very important settling of the masonry"

Several processes can lead to cracking; in any event, the Time Scanners study showed no settling of the masonry, and as already mentioned the engineer, Peter James, found no evidence of foundation movement.

It is informative to compare the narrative of M&R's work to that of their work in the nearby Red Pyramid. In the Red Pyramid there are some major cracks, highlighted and photographed by Massimiliano Nuzzolo in his work *"The Bent Pyramid of Snefru at Dahshur, A project failure or an intentional architectural framework"* and as already mentioned, Peter James' company was called in to strengthen the structure. Yet M&R are strangely quiet on these cracks.

The upper corridor from the continuous joint displays a steeper angle of 28°38′ and its length, measured along the roof, is given by M&R as 12.6m. Omitting the paving blocks which are inserted between the walls, the end of the upper corridor, where it meets the continuous joint, is only 5.4m above the pyramid base. As Petrie mentioned, a short distance from the ground and an area where large masonry blocks were most likely used; it is hard to see how such masonry can move such a distance and, looking at the good condition of the upper part of the corridor, the impression is that the whole upper corridor has conveniently pivoted around the entrance, an unlikely event. I have to conclude that this upper part of the corridor was purposely designed this way, and again I refer the reader to my previous paper for further details.



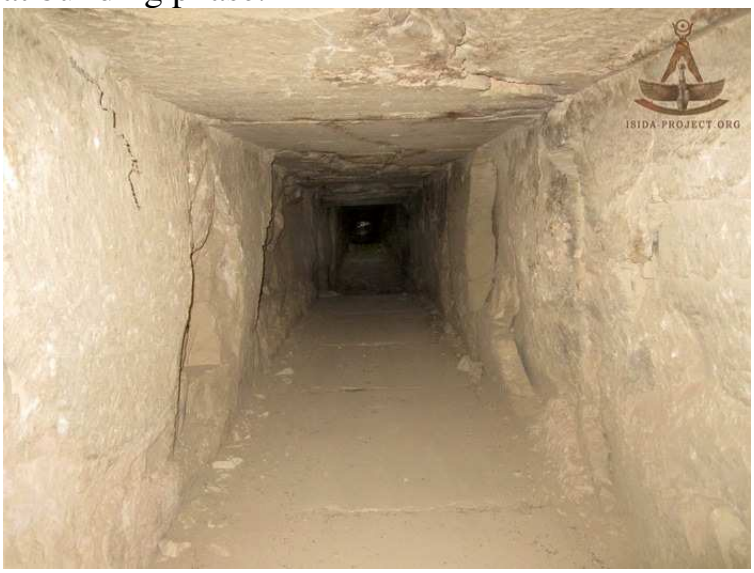
In the image above we see the upper corridor extension at the point where it meets the lower corridor. The difference between roof levels M&R give as 23cm. The square holes visible south of the continuous joint are not parallel to the continuous joint, but at an angle of 75 degrees. In my previous paper I explain how the continuous joint can be explained by marrying the new corridor extension to the face of a 75 degree step structure and that the smaller 8cm step visible south of the joint may have been intentionally made to provide a stop for a closing casing block, should the Pharaoh die during the step phase. I also suggested that the steeper extension may have been made this way in order that it could be closed with plugging blocks.

In the western corridor there is no so-called settlement at its continuous joint, but M&R report a settlement of 5cm approximately 1m south of the joint. In their TAV 13 they produce a drawing of this settlement, clearly showing a drop in the floor and roof and a perpendicular fracture, however, the reality appears different to their drawing, in that there appears to be no noticeable drop in the floor or well defined fracture. The western passage

was plugged for a large part of its length, hence the well preserved smooth floor (the northern corridor had notches chiselled out for foot support by persons unknown). The western corridor was finally cleared of plugging stones by Fakhry in his first season in 1951; a decade before M&R's arrival, and few people have had access to this structure in the intervening years since M&R, so it is unlikely that someone took it upon themselves to dress the floor smooth and remove traces of settlement. The fracture, if that is what it is, bears little resemblance also to the drawing, the damage to the walls is very similar to damage we see further down the passage.

Looking up the western corridor towards the entrance. The red line denotes the continuous joint, east of that are the square holes. The floor is well preserved and smooth and no evidence of 5cm settlement that M&R show in their TAV 13.

Looking down the western corridor, from the continuous joint; a square hole is just visible in the top left hand corner. The damage to the walls is a bit clearer and is similar to what we see further down the passage and may be related to similar processes of degradation. If there is a 5cm drop in the roof, it could have been built in, as a backstop for a casing block, should it be required in that building phase.



Further down the passage we see similar damage.

As a layperson, the problem I have with M&R's report on these joints is the clear lack of any detailed analysis. They totally omit detailed block layout, structural analysis and dimensions in these areas, we are so devoid of basic information; we basically have to take their word for it. That such flimsy evidence has been accepted as gospel surprises me and I think it comes down to the fact that there are two opposing camps when it comes to the theory of the Bent Pyramid; in one camp we have those who feel the pyramid was purposely built that way and in the other camp those who feel it is the result of settlement and failure. It is clear that in Egyptology the latter is in ascendant and therefore quite happy to accept evidence to prove their case, without too much scrutiny. So thorough is M&R's work, that Monnier & Puchkov in *"The Construction Phases of the Bent Pyramid at Dahshur A Reassessment"* state on the opposing theory;

"We will not fuel the debate more by commenting further on this matter; we consider that the architects Vito Maragioglio and Celeste Rinaldi collected enough evidence to demonstrate that the unplanned structural issues were significant. The Bent pyramid was enlarged and it led to unexpected consequences, that is to say cracks and subsidence that forced the architects to give this very non-typical shape to the building"

The power of M&R's work is so immense that Egyptology does not need to carry out further investigation to validate their claims, no modern structural analysis by structural engineers are needed; it is a closed case, the builders built it on clay and encountered no end of problems.

Yet engineers who have examined the structure appear not to follow the script of Egyptologists, for example Steve Burrows states from *Time Scanners*;

"by structural analysis this was designed like this. It hasn't failed; this is actually a great success."

I have already mentioned the engineer Peter James, and in personal correspondence with Peter he mentions;

"When I was restoring the structural integrity of the burial chamber of the Step Pyramid I was asked by the Antiquities for my views on the outer casing of the Bent Pyramid and how I could resolve the problem. The standard theory was again settlement problems although they had commissioned a

German Consultant to examine the foundations at various positions. The result was that the consultants confirmed that there was no settlement."

Are these views ever considered by Egyptologists? Apparently not, but as a layperson I must take them into account, they should not be ignored; indeed an argument could be made that they are better qualified than M&R to give an opinion on the structural integrity of the Bent Pyramid.

We will now return to the northern corridor and examine the corridor south of the continuous joint. Below the joint the walls are made of two courses and the angle is less than the northern extension, Perring gives an angle of 26° 10′, M&R provide a length along the ceiling of 78.60m for the total length of the northern corridor, with the extension taking up 12.60m, therefore 66m is given for the passage below the continuous joint, measured along the roof. Towards the end of the corridor the damage appears very similar to what we see also at Meidum.

The cavernous form that we see at Meidum is apparent in the Bent pyramid too. Monnier and Puchkov suggest that this may be due to a different type of rock used in the lower parts. It would be useful to obtain a geologists report on the rock and the processes involved that explains what we see today.

An interesting observation by M&R on the corridor is;

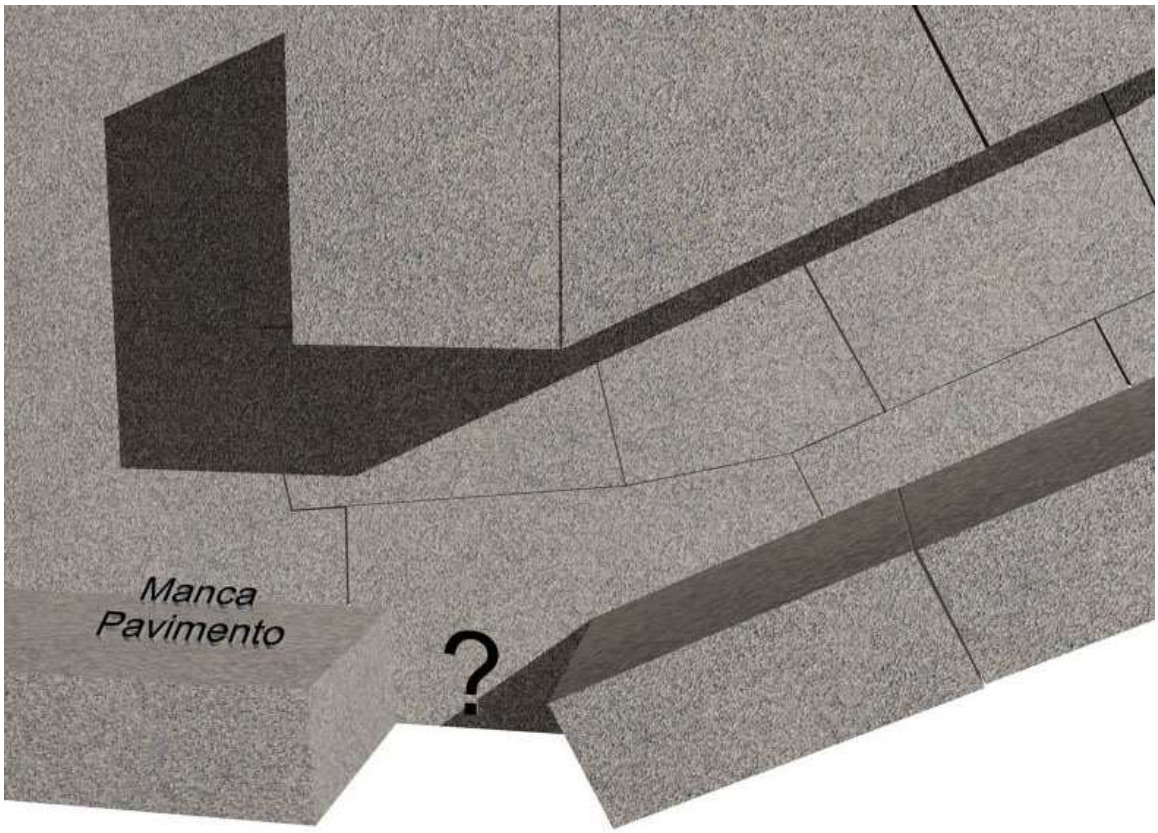
"Along the upper edge of the side walls it is possible to note that the ceiling blocks are placed like the teeth of a saw. This fact which is seldom apparent

in the lower part of the corridor, becomes almost a rule in the upper part. Due to the good state of preservation of the ceiling we were able to notice that the wall blocks were intentionally cut in the upper part in order to receive slabs and that the indentation of the saw-teeth varies from 2 to 4 cm.

We will see a similar use of this saw tooth arrangement on the ceiling slabs in Khufu's grand gallery. The extent of this arrangement in the corridors is not clear from M&R, in TAV 13 they provide a drawing suggesting that the western corridor also has this saw tooth arrangement, but in what locations of the corridor it is not clear. In Fig 15 of Monnier and Puchkov's paper a picture with the title *"Sinking of the ceiling stones in the western passage"* can also be explained as an effect given by the saw tooth pattern; like the rest of the pyramid more detailed scrutiny is required to find and map the locations of this arrangement. Though images I have of the northern extension appear to not have this saw tooth arrangement.

The end of the northern corridor is quite damaged, but M&R thought that the corridor becomes horizontal for a distance, of at least .85m along the ceiling before entering the antechamber. They were unable to examine the floor due to the presence of debris. In the area where the sloping corridor meets the horizontal they say;

"that the blocks of the side walls were cut in a special way in order to strengthen their mutual support and therefore the rigidity of the masonry in this point."

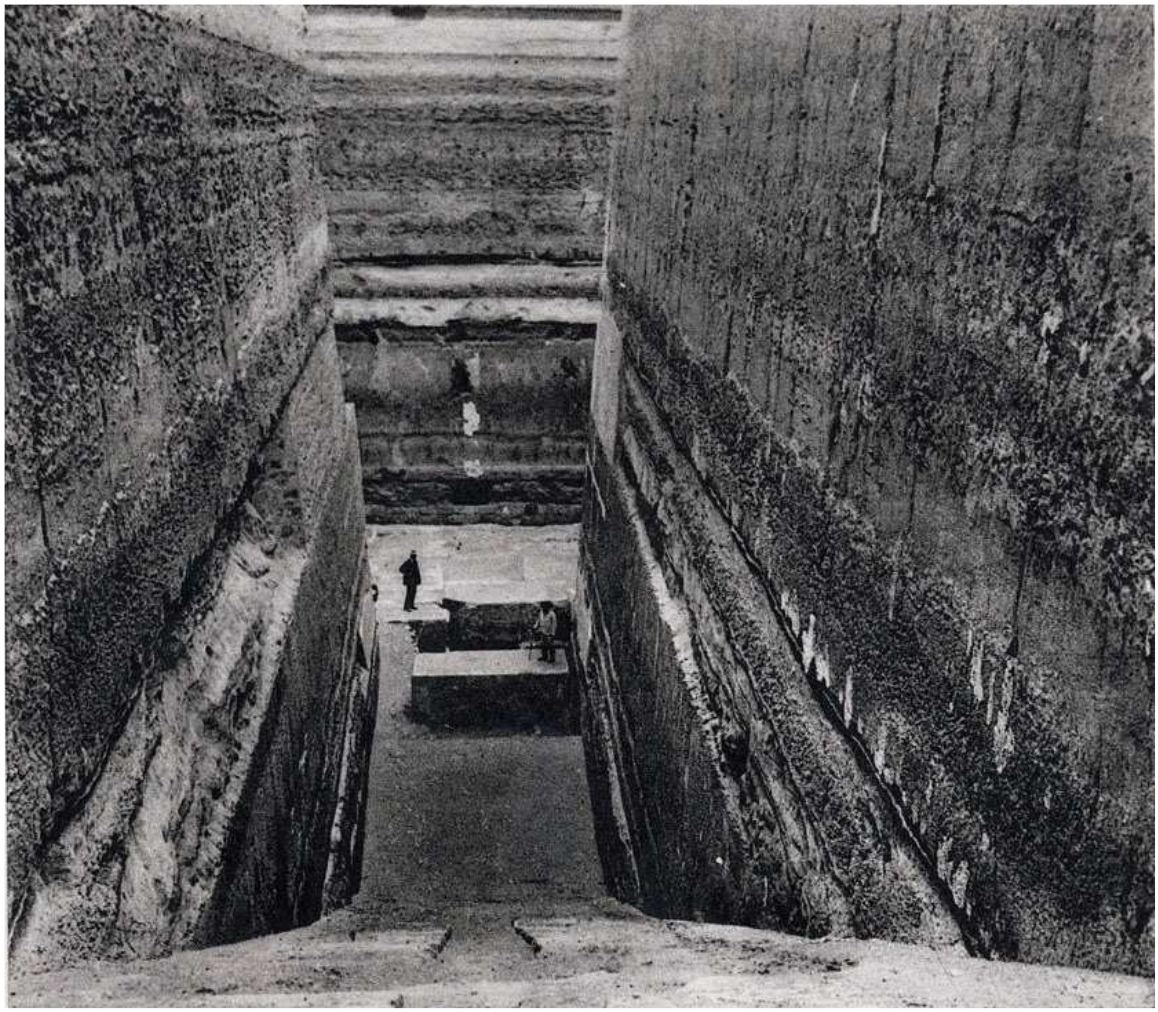


In the image above based on M&R's TAV11 we see the blocks mentioned by them. The antechamber floor M&R have no comment on apart from Manca pavimento (There is no floor) on their drawing; though the floor line on their drawing if extended north will neatly meet the paving of the sloping corridor. Because of debris M&R could not observe the small horizontal floor part of the north corridor; this is the area with the question mark. I have recently found an article by Charles Rigano who is one of the lucky few to have visited the inside of the Bent Pyramid; and in an article for *The Ostracon, Volume 13, No, 2002;* he gives his account and mentioned the following;

"At the bottom of the descending passage, the floor is cut away and the railroad tracks, on wooden planks, cross a large rough hole in the floor and emerge into the antechamber."

I mention this, for in the Meidum pyramid we have a shaft at its passage end and at the end of the Bent's western corridor we have a carefully built pit. What Rigano describes is certainly worth further investigation, as is the floor of the antechamber to find out what exactly it is.

Antechamber



The image above of the great pit at Zawiyet el-Aryan is to give the reader some idea of scale when it comes to the depth of excavation in the rock carried out at the Bent pyramid. The depth of the pit above from Lehner's Complete Pyramids is given as 21m deep; my CAD drawing using M&R's drawings and Petrie's survey gives the floor of the antechamber in the Bent Pyramid as 23.3m deep and if we assume the natural rock starts at 2.5m below the pyramid base, it would mean some 47m (sloping) of the northern corridor had to be excavated in the rock. It may have been done like above in a sloping trench for example, we may never know.

The Antechamber in the Bent pyramid is a strange chamber, it is more a continuation of the horizontal corridor but with a huge ceiling height; the width of the antechamber is the same as the corridor at 2 cubits, but its

ceiling soars to a height of some 12.60m (24 cubits). The 2 cubit width of the antechamber is closed at the top by corbelling of the east and west walls, a total of 5 corbels are used. The corbel courses vary in height, from M&R's drawings total height taken by the corbels is 3.71m (7 cubits).

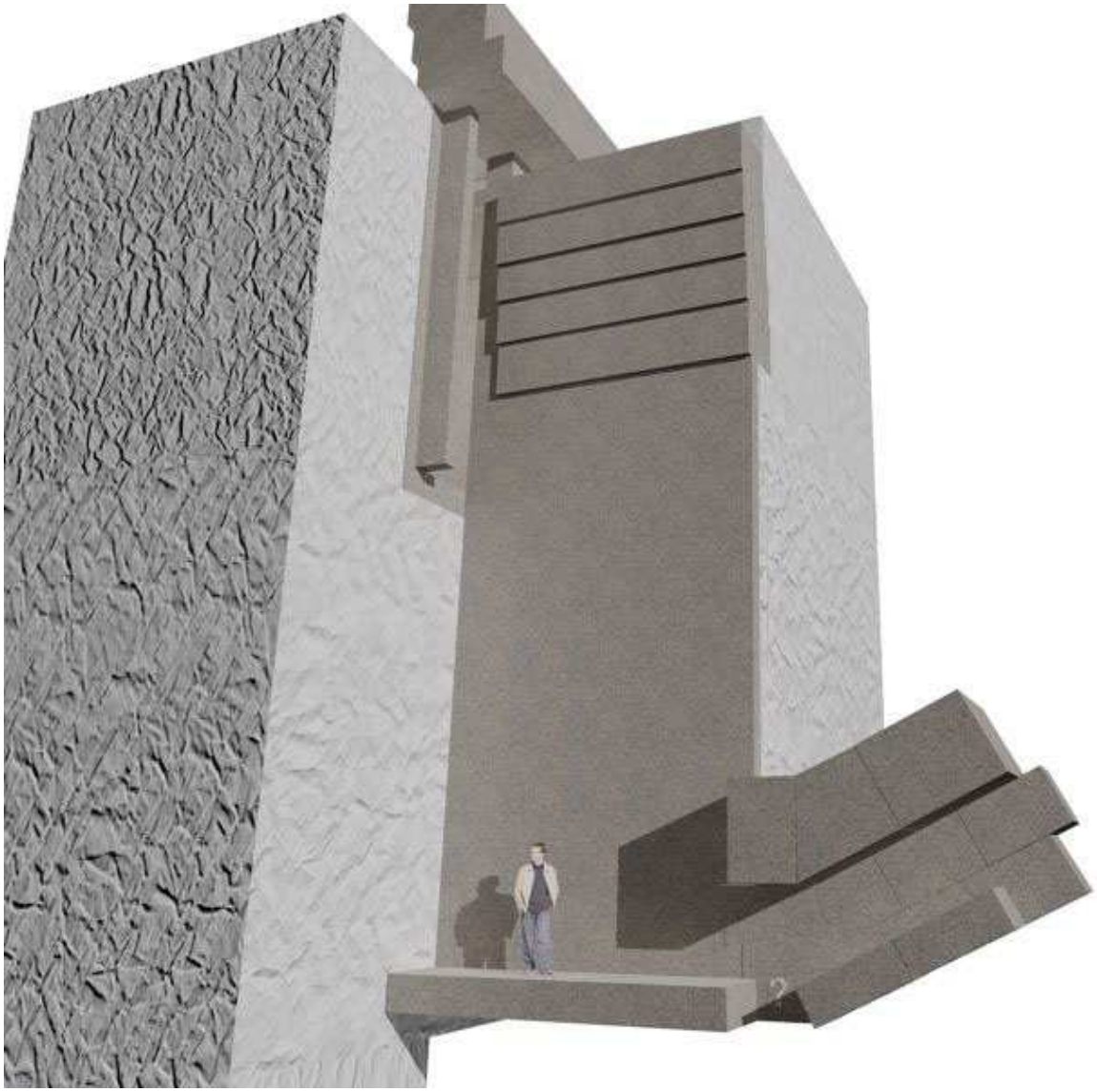
The short horizontal passage leading to the antechamber from the northern corridor appears to have a height of approx 1.2m (2 cubits 2 palms) its N-S length .85m added to antechamber length of 4.90m, gives a total from the sloping corridor end to the south rock wall of the antechamber of 5.75m (11 cubits). This vertical rock wall is aligned with the north wall of the lower chamber; from M&R's drawing this wall at the entrance between the antechamber and lower chamber is .52m (1 cubit) thick, if this wall continued down and lined the rock wall face with 1 cubit blocks, it would reduce the corridor end distance to 10 cubits. The height of the rock face is given as approximately 6.75m and the height from the ceiling of the horizontal passage to the pavement level of the lower chamber is 5.99m which makes the vertical height of the horizontal corridor 1/5th of this height.

The scheme for the corbelling and entrance from the antechamber into the lower chamber, appears to be a doorway 2 cubits wide by 3 cubits high and from this point each of the 5 corbels protrudes 1 palm, until the ceiling is reached with a gap of 4 palms or 30cm.

There are some issues with M&R's drawings, be it errors or dimensions that do not agree to the scale of the drawing, an example that is in their drawing TAV 11, has the top of the chimney as 1.60m N-S, but by scale rule it is 1.40m. It just highlights the need for a more modern and accurate survey to be carried out.

In my previous paper I suggested that the east and west walls of the antechamber were tiled with thick tiles, a technique we see present at Meidum; this would allow the corbels of the antechamber to direct their stress directly to the natural rock. Less excavation is required and the descending passage masonry if trenched in the rock would be well buttressed at its end. I also suggested that the same process was used in the upper chamber, this suggestion appears confirmed by the following statement from Rigano's article, where he describes the lower chamber;

"The chamber walls are not bedrock but are made of nicely laid limestone blocks. A section of the west wall is missing and the limestone lining can be seen to be about 1 foot thick"



In the image above, we have a section view of the antechamber, showing the possible layout as described in the text. The masonry pillar east of the doorway to the lower chamber, is the thickness of the lower chambers north wall at the door, this would have merged into the lining of the antechamber's east wall; the bottom of this pillar is level with the pavement of the lower chamber. The form of the original entrance to the lower chamber is not clear due to the damage inflicted upon it, during the modification phase, when the small blocks were brought into the chamber. It may have been a simple rectangular 3x2 cubit rectangular doorway, with the corbels hid behind the 1

cubit thick masonry that borders the doorway; then when the stone staircase was introduced, it was needed to heightened the doorway and modify some of the antechamber corbels at their southern end, to provide clearance for the stairway. The south wall of the antechamber is a vertical face of rock and it may have been tiled, at the base of this rock wall an excavation has been carried out, possibly by violators, up to 2m in length. The north wall of the antechamber is probably made of large blocks that span the gap of the excavated shaft that holds the antechamber.

Today the end of the descending corridor meets the modern stairs that provide access to the lower chamber; the same stairs prohibit us from viewing the south rock wall of the antechamber.

Could this be the natural rock and missing tiling?

The walls of the antechamber are well preserved where they were protected by the stone staircase.

Looking up towards the entrance into the lower chamber.

The steps enter the lower chamber.

Photo by Ivrienen.

In this earlier image, with somewhat less secure steps, we can make out the southern rock wall of the antechamber.

From the floor of the lower chamber we see the damage to the top of the entrance, its original form may never be known.

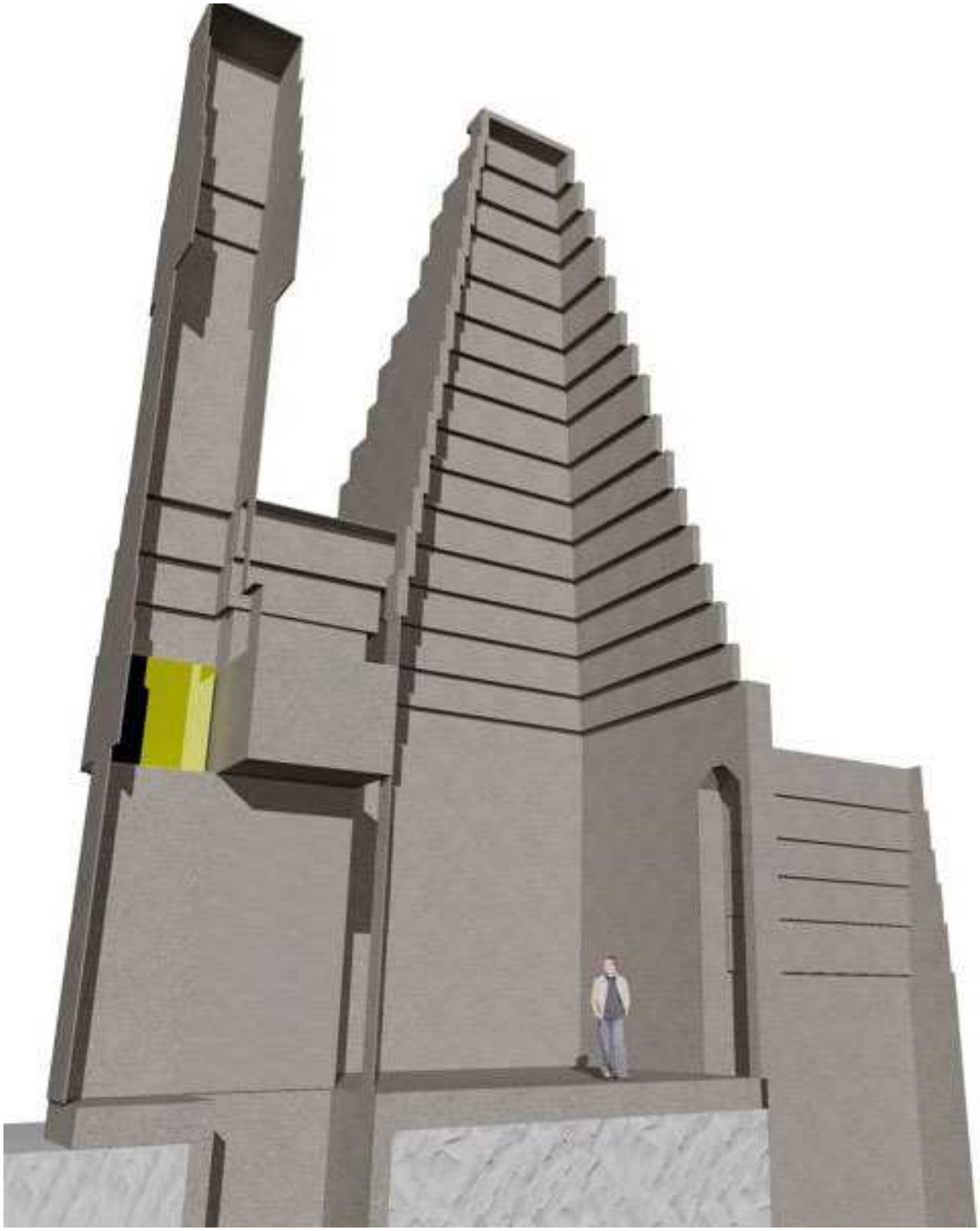
The Lower Chamber.

The entrance to the lower chamber via the antechamber is in the north east corner; the doorway itself is offset from the east wall by 25cm (1/2 cubit). The floor plan of the chamber is 4.96m E-W and 6.30m N-S (9½ x 12 cubits); this means that 8 by 12 cubits of the chamber is placed east of the pyramids N-S axis; a similar situation is seen at the main chamber in Meidum where we see the major part of the chamber residing in the east. The rock floor of the chamber is approximately 6.75m above the antechamber floor, or some 16.55m below the pyramid base, a still considerable depth in the rock; on top of this rock floor a pavement was fitted, M&R give a thickness of 37cm at one point.

The height of the chamber is 17.30m (33 cubits) from the paved floor; the height of the 15 corbels that present themselves on all four walls is 11.24m, leaving 6.06m for the height of the chamber walls. Though the lower chamber has the smaller floor area of 9.5 x 12 cubits compared to the upper chamber of 10 x 15 cubits it is the tallest chamber by virtue of its higher chamber walls which are significantly higher; 6.06m to first corbel in lower chamber and only 3.33m to first corbel in upper chamber; height of lower chamber is given as 17.30m and upper chamber as 16.50m. This difference maybe due to the different construction methods applied in each chamber. If research is ever undertaken, we might find that the corbel ceiling of the lower chamber rests directly on the rock, with the chamber walls mostly tiled, except for those openings such as doorways and chimney which may have had more traditional masonry used; the chamber height in this method would not be a concern. In comparison the upper chamber is in the superstructure of the pyramid and built entirely of masonry, here they may have shown a bit of caution to chamber wall height.

The corbels in the chamber protrude more than the antechamber; here it appears to be 2 palms on all four walls. Another doorway appears opposite the entrance on the south wall, this leads to the chimney; this doorway is given as slightly narrower at 90cm and a height to the large lintel block of 3.93m (7.5cubits) an area of small mortared blocks about 55cm high appears below the lintel for the whole width of the doorway, which has the appearance of a repair or strengthening of the lintel by persons unknown. Above the chimney doorway we have what has been termed the window, a corbelled space that also connects straight through to the chimney. This corbelled space starts above the large lintel block, whose height is 1.5m

high; the window is 80cm wide at its base and its corbels run through 3 courses and narrow to 30cm at the top; the windows combined height being 2.20m.



The lower chamber, entrance in north east corner via antechamber; in south wall another entrance is under the lintel block that leads to a deep vertical shaft and the base of the chimney.

Looking along well preserved east wall

looking along east wall towards entrance to chimney, note traces of red plaster on the walls.

View along north wall, entrance is to the right.

Looking along south wall with chimney entrance on left, blocked by rubble wall. The stone facing on wall looks like tiling?

Closer view of what appears to be thick tiling.

Looking up at the ceiling along the east wall, the entrance into the corbelled window can be seen on the right.

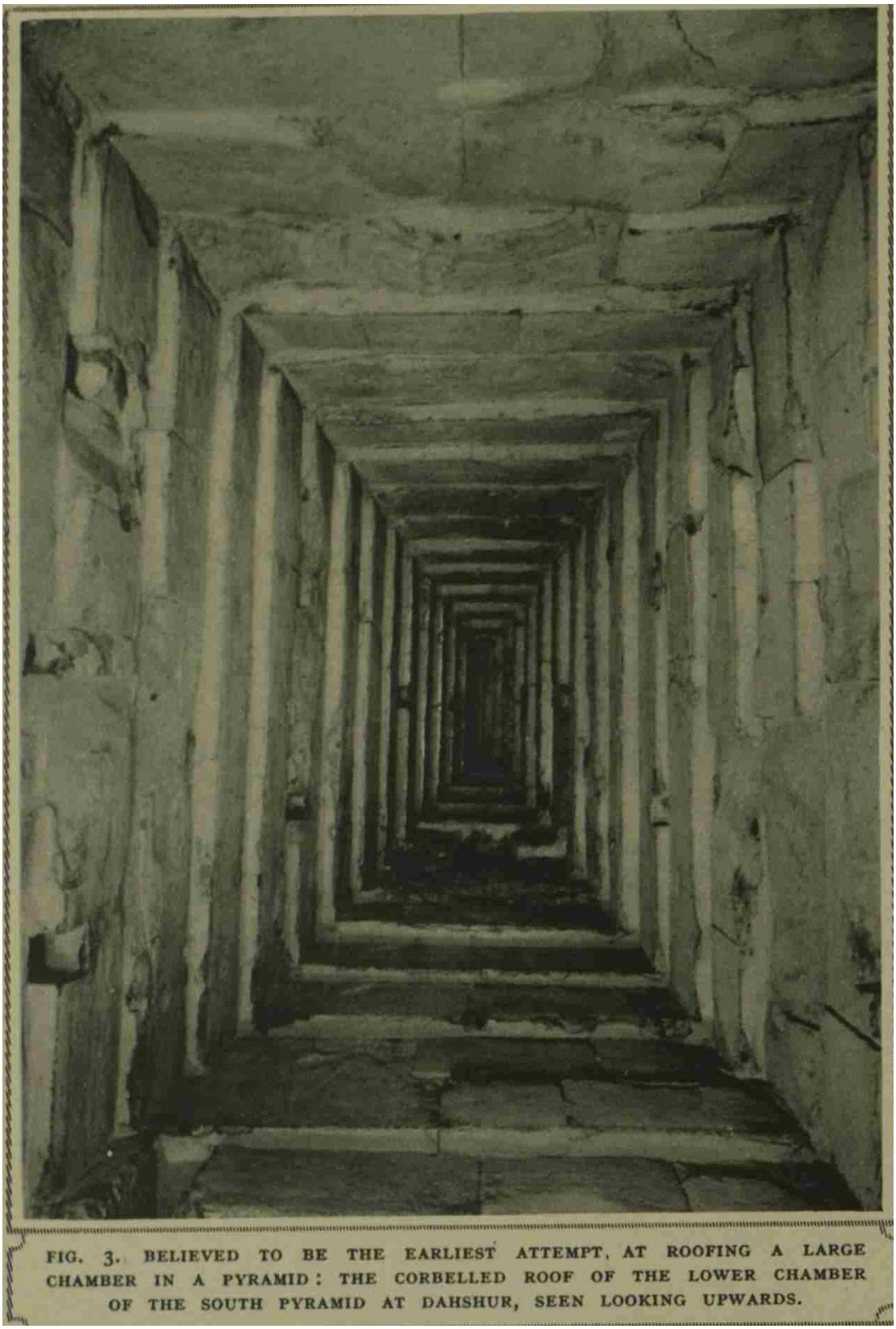


FIG. 3. BELIEVED TO BE THE EARLIEST ATTEMPT AT ROOFING A LARGE CHAMBER IN A PYRAMID: THE CORBELLED ROOF OF THE LOWER CHAMBER OF THE SOUTH PYRAMID AT DAHSHUR, SEEN LOOKING UPWARDS.

Image from *Illustrated London news, March 22, 1947,* note some of the neat cut out notches on the corbels.

Close up view of the upper corbels.

The vertical shaft

Before we get to the chimney a curious feature was discovered by Hussein; as his notes have been lost to us, a contemporary report by Garnon Williams published in *Illustrated London News* 1947 and based on information by M.Hussein, is the best we can hope for. In this article, the following is said;

"On examination it was noticed that the walls of the recess for the shaft were smooth to a height of 6ft. which exactly equalled the depth of this recess. As a preliminary step the paving-stones were lifted, revealing the native rock of the hillside. However, the evidence of the smooth walls of the recess and the relative height and depth of the smooth portions indicated that there was a probability of the solid rock not being as solid as it at first sight appeared, since there was room for the rock to be rotated about one end to reveal a shaft. The "solid" rock was then cut out and was revealed as a larger piece of stone cut from the hillside which had been used as a cover and so inserted that the joints with the solid rock were covered by the surrounding masonry. Below this stone was a layer of soft rock of the same type as a similar stratum in the hillside; when this layer (8in. thick) had been cut through, hewn stone slabs set in soft mortar were revealed(fig 5). The way to the tomb now appeared clear, more especially as this shaft was on the axis of the pyramid; however, after 18ft. of this masonry had been lifted, the bottom of the pit was reached, where slight traces of incense were found."

But has the bottom of the shaft been reached? The article above was published in March 1947 and 18ft equates to 5.5m, to this I have added .37m for paving(which M&R give at one point for lower chamber paving thickness) and have doubled the 8inches as the thickness of upper layer is not given, therefore .40m is added for a total of 6.25m from the pavement surface. This can only be a guess, as to where this 18ft was taken from is not clear.

In Fakhry's work (Vol 1, pg 47) he says of this shaft;

"In 1948 there was an attempt to clean it ***but its bottom had not been reached.*** *According to the workman, they descended to a depth of about 8 metres and found good masonry work on all sides. It was refilled afterwards. The purpose of its construction is not clear unless it was meant to indicate*

the centre of the pyramid, but I have no explanation why it was made so deep"

Where the 8 metres was measured from like the previous article is unclear; now Fakhry's first season at the Bent did not start until 1951 and he himself admits he had to rely on the memory of Hussein's former assistants and workman. I feel there is enough of an ambiguity here to reopen this shaft and determine its true construction and clarify why Fakhry thought that its bottom had not been reached.

The description by Garnon Williams, suggests that a clever method of concealing this shaft was attempted, in his article, he says of the pavement that covered the lower chamber;

"This pavement had been cut in several places by robbers in their efforts to find the entrance to the tomb chamber."

The builders who built the shaft would have been aware that violators, would lift paving slabs in the hope of discovering some find of importance; therefore it would make sense that a piece of natural rock should be used under the paving to disguise and protect this shaft, and it appears to have worked as it took some 4500 years to be discovered. This method of deception and concealment is all the more reason why I think this shaft should be revisited.

The position of this deep shaft appears to be directly below the large lintel block, which in turn is relieved by the corbelled window.

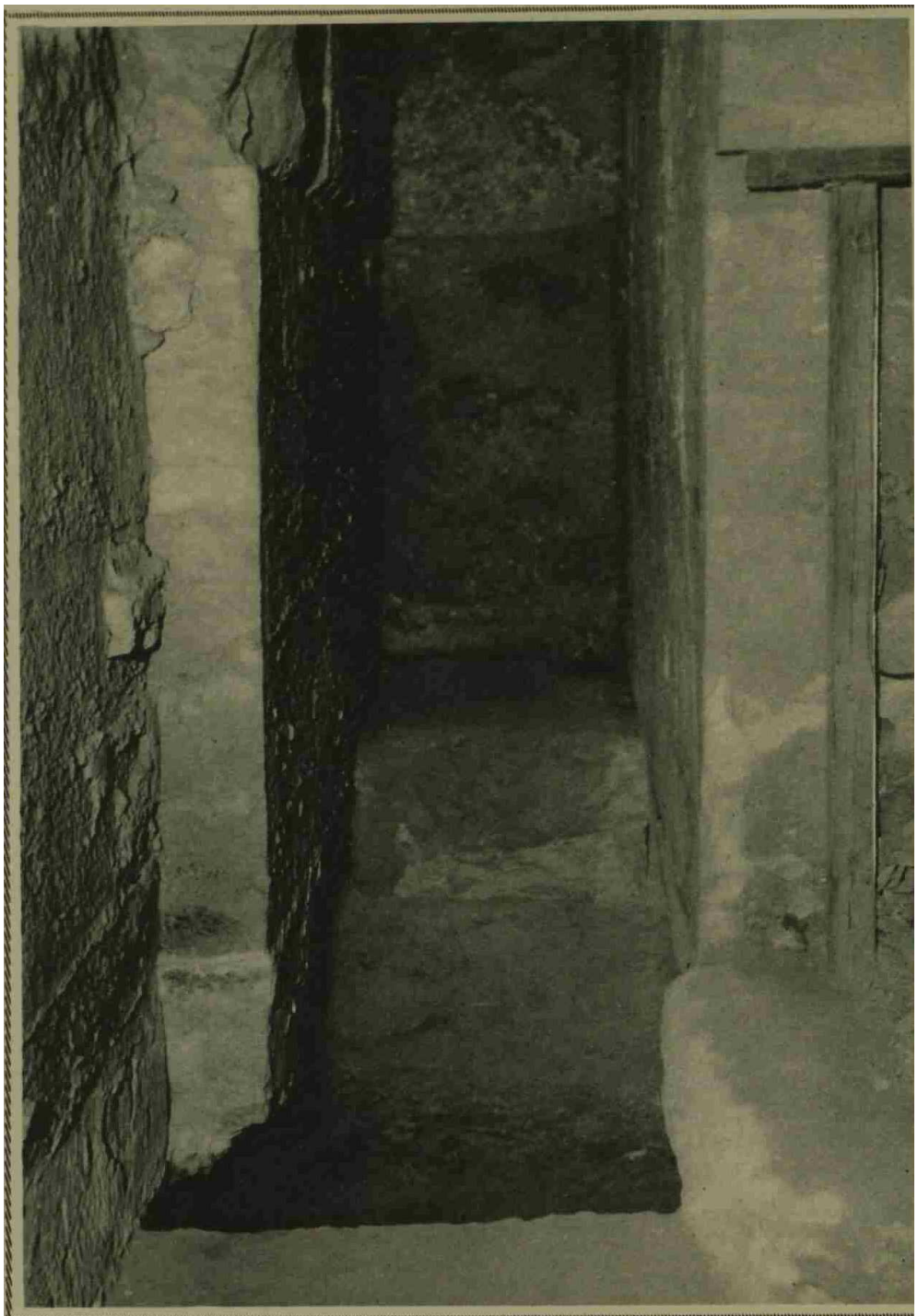


FIG. 4. THE RECESS OF THE LOWER CHAMBER OF THE PYRAMID, IN WHICH WAS CUNNINGLY CONCEALED THE ENTRY FROM THE SHAFT TO THE PIT. THE SMOOTHED WALLS GAVE THE CLUE FOR THE DISCOVERY.

Looking from inside the lower chamber towards the chimney, the wooden prop that appears to support some wall tiling, was in M&R's drawing, today it is no longer there.

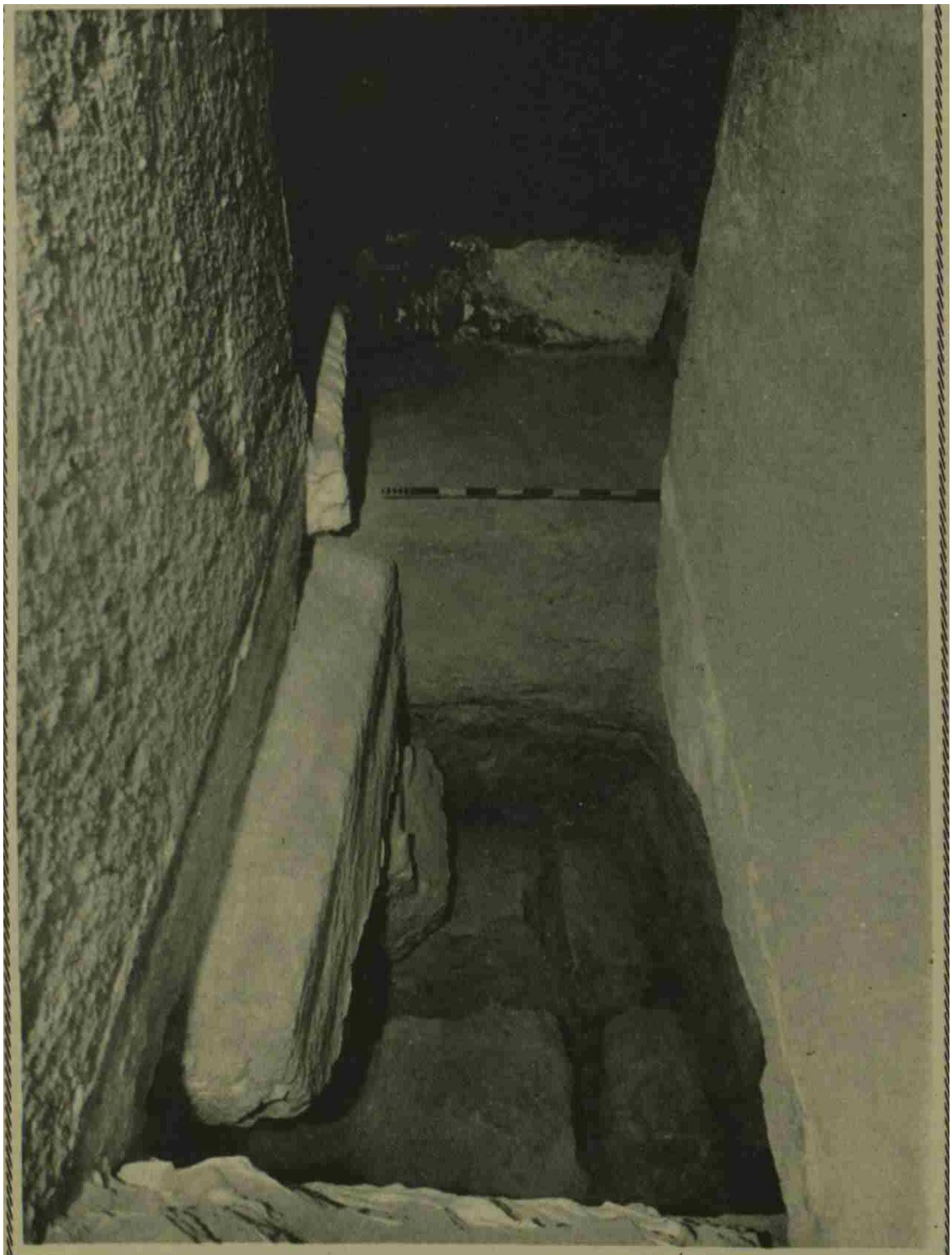


FIG. 5. A RUSE OF THOUSANDS OF YEARS AGO UNCOVERED: THE SLAB OF APPARENTLY "TRUE ROCK" (SEE TEXT AND FIG. 4) APPEARS LEFT CENTRE, AND BELOW, THE MASONRY IN MORTAR, WHICH BLOCKED ENTRY TO THE PIT.

The Chimney

After the deep shaft we arrive at the base of the chimney; the chimney has two entrances, one via the doorway in the south wall of the lower chamber and via the corbelled window. The total height of the chimney is given as 15.27m (29 cubits).

The E-W dimension of the shaft excluding the two corbelled spaces is the same as the horizontal passage leading to it, at .90m. The N-W dimension is not so clear, M&R show 1.6m in their drawing TAV11, but I think they have made an error here, using a scale rule on their drawing it is about 1.4m from the top of the window and below the window it widens to just over 1.5m, or the distance from the south end of the large lintel block to the shafts south wall; which appears to be confirmed when you take the dimensions from the neighbouring architecture into account. This widening from approximately 1.4 to 1.5m is caused by a corbelled step at the window. This first corbel of the window coincides with the first corbel of the lower chamber. The bottom of the window, which is the top surface of the large lintel block appears to align with the top of the antechamber roof. On the window M&R say;

"Its width is reduced by means of two narrowings corresponding to the overhangs of the western wall. The lower part of the window is not dressed but left in the rough, as though a block was missing or the masonry cut in order to increase the height of the window. Originally it must have been only 1.40m high and, in the lower part, 0.64m wide:"

In the image on page 45 we see two yellow blocks, standing on edge, that are thought to be a tilting portcullis, that would close and rest on a ledge present on the opposing wall of 30cm. The blocks themselves, stood on a ledge of about 75cm. The two portcullis chambers are near identical and just mirror each other; the vertical height of the lower chamber before the corbel is about 1.5m; the upper chamber varies slightly in that the wall with the block is about 1.7m high and reverts back to 1.5m on the opposing wall. The widest part of these chambers where the blocks reside in is 1.97m E-W. Today we have one block still residing in the lower portcullis chamber against the west wall of the shaft, on the upper chamber M&R say;

"On the east wall, there are clear traces of a block about 1.55m high which stood on the floor and was symmetrical to the rough one we saw against the west wall of the lower small room"

The top of the chimney is covered by two stones and the joint line between them is clearly visible. I am not aware if any further investigation has been carried out to ascertain if any continuance of the shaft is present after these stones. The bottom of the shaft, against the south wall is quite damaged; M&R thought a probable trial digging by violators. It would be worth revisiting this damage, to determine the masonry make up of the south wall

and the presence of any natural rock. The top of the chimney ends at a level close to the pyramid base (In my model using M&R's dimensions attached to the external survey of Petrie it is 86cm below the base line; in reality a modern survey of the structure is desperately needed to clarify many discrepancies)

The Scheme for the chimney could be that the height from the floor to the first portcullis chamber be 7.5 cubits, then total height of chamber including corbels 7 cubits, followed by 5.5 cubits to start of next chamber, whose height to the closing roof stones be 9 cubits, for a total of 29 cubits.

The position of the chimney means that the vertical axis of the pyramid falls within its boundary; Perring and Hassan confirmed this, however M&R say, *"According to our survey it is slightly shifted to the north of the axis"* and in their drawings by scale rule, as they do not give a dimension, the south wall of the chimney is up to 1 metre north of the axis. I created two CAD drawings, one using M&R's drawings who incorporated Hassan's survey, and one using Petrie's external survey; in both models the vertical axis fell within the boundary of the chimney. With Hassan the axis falls virtually down the middle of the chimney; with Petrie's whose survey closely agrees with Dorner's the axis moves about 60cm further south and close to the south wall of the shaft, about 14cm. Where M&R have gone wrong on their hand drawings is hard to say; but it appears that the original drawing by Perring with the axis close to the chimney south wall, still holds true, pending an accurate survey of the structure.

The function of the chimney is not altogether clear, the view held by Monnier & Puchkov for example;

"By comparing the internal arrangements of the Meidum pyramid and the bent pyramid, it is clear that the 'chimney' of the lower layout of the Bent pyramid was undoubtedly planned as a route to reach a burial chamber."

In the same paper when dealing with the hypothesis of Varille and Legon;

"The hypothesis that this profile could symbolize an expression of a duality is credited to Alexandre Varille who found in the person of John A.Legon his most fervent follower.

This theory would be convincing-indeed, Sneferu built two pyramids at Dahshur, the Bent pyramid has two entrances and two internal layouts- if

evidence of structural collapse and modifications had not been found inside the building. This theory is also contradicted by the fact that the burial chamber of the lower layout was never built (cf.supra)."

Here in Monnier & Puchkov's statement there is no ambiguity, the chimney was "*undoubtedly planned"* and *"by the fact that the burial chamber of the lower layout was never built"* M&R had looked at this possibility in their observations 18;

"the chimney was part of an initial plan which was then changed. In the original plan the chimney could have only led to a crypt built higher up, but always in correspondence with the chimney itself (see Meydum). In this case the small rooms acted as a blocking system by means of overturning portcullises. The displacement of the crypt, due to a variation in plan, would have been the reason for interrupting the construction of the chimney and the subsequent closing at its present height. This assumption, however, does not explain the reason why the builders preferred to build the whole western descending corridor with its two portcullises. Instead they could have joined the crypt (even though shifted with respect to the original plan) with the chimney by means of a passage properly built for this purpose or cut out in the already existing masonry.

The builders at first had no intention whatsoever to connect the two apartments. In fact when they were obliged to connect them a passage was cut in an entirely different part and not through the chimney, even if it ran nearby. The two apartments were planned as separate entities and therefore the chimney did not enter into the plans as a connecting passage. All considered, it has been impossible for us to support this hypothesis with what is noticeable today"

The lower apartment was constructed deep in the rock, and it is unlikely that any structural problems would have arisen so early on, to cause the chimney to be abandoned if it was a route to a burial chamber. Also the close proximity of the upper passage system and chamber to the ground suggests that the two constructions were in a similar timeframe. M&R thought, *"Therefore in this pyramid the two apartments were planned from the very beginning even if we cannot understand why."*

Comparing the internal arrangements with those in Meidum, it seems clear that there is little resemblance, other than construction techniques such as the possible tiling of walls and step structure. In my Meidum paper I

demonstrated the possible portcullis method in the vertical shaft; a formidable obstacle compared to the stones we see in the chimney. But to me the chimneys close proximity to the lower chamber, suggests that it was not a route to a burial chamber; in the Meidum pyramid, a much smaller chamber, we see a separation from the last antechamber to the south wall of its vertical shaft of over 4.5 metres, In the Red pyramid the passage from the last antechamber to the upper chamber provides a separation distance of 7.37m (14 cubits) to a chamber of 8 X 16 cubits (The Bents upper chamber is 10 X 15 cubits).

The Separation distance between the lower chamber and the south wall of the chimney is only 3.45m (or 1.95 to north wall of chimney). The upper burial chamber if we take the analogy from Meidum would mean the chimney entering the north-east corner of the proposed burial chamber, the height of this proposed burial chamber is unknown; but given the current height of the chimney, it is clear that it would have to be built entirely of masonry, and that such wall blocks would be a considerable size to support the corbel ceiling. In my view the proposed burial chamber construction is far too close to the corbelled ceiling of the lower chamber and I do not believe the ancient Egyptian builders would choose such a course; but rather they would choose a sensible separation distance.

This then suggests that the chimney held a different role and its position under the apex of the pyramid is most likely intentional, be it for ritual purposes or more practical matters, or both. John Romer in his *Great Pyramid* book suggested the following idea for the chimney;

"this small shaft would have enabled the pyramid-makers to keep a sheltered plumb line at the pyramids dead centre- a most desirable reference point as the pyramid rose higher and the multiple lines and edges of a stepped pyramid were no longer available to aid in checking the architecture of the rising pyramid. Such a shaft would be the first of many similar vertical controls set up inside the early pyramids. Today, however, after the slow movement of its stonework, the Chimney no longer stands at the centre of the pyramid."

Whatever the function of the chimney, its close attachment to the lower chamber, suggests it is intricately linked to it and that both chamber/passage systems were carefully planned from the outset.

Looking at the lower chambers south wall, we see the doorway leading to the chimney and the small window above the doorway. Just above the doorway we can just make out what appears to be a repair to strengthen the lintel stone. Below, looking upwards, with the repair in the foreground.

Looking north from the chimney, we see the back of the repair below the large lintel stone; this repair appears to be shown in Perring's plate XVI, fig 4.

Looking up the chimney we see the window enter from the left. Below, we see the window enter chimney north wall, and left, part of the vertical block.

Above the lintel stone in the lower chamber, M&R say *"The lower part of the window is not dressed but left in the rough, as though a block was missing or the masonry cut in order to increase the height of the window. Originally it must have been only 1,40m high and in the lower part, 0.64m wide"*

From the rear of the window, chimney side, the corbels appear more defined, it would seem unlikely that originally the window was smaller as M&R describe. It may be possible that originally a plate of stone was left on the lower block, lower chamber side, and the rest of the window walled up above this plate to disguise the window from the lower chamber side. This would make sense, for if the window was left open; the first portcullis block in the chimney could be easily bypassed. In the Queens chamber in the Great pyramid, we see how a plate of stone was left to disguise the shaft entrances.

The top of the chimney, here we see the join between the two stones that close the top of the chimney.

The Western Corridor.

We shall now take a look at the western chamber/corridor system; the western corridor is a considerable distance above the base, Hassan gives 33.32m and Dorner 32.76m. Unlike the north corridor which has the pyramid N-S axis running through its axis, the western corridor axis is displaced some 13.70m (26 cubits) south of the pyramids E-W axis.

In the image above we see the western corridor entrance, the bar and rope is inserted into one of the pair of D holes that run parallel to the casing slope and about 27-28 cm from the face. M&R say;

"At the entrance there are two corresponding pairs of D-shaped holes, more or less deformed: one of the holes is filled up with mortar."

In the image above we can see the joint line for the two courses of stone that make up the corridor walls and inserted between them a paving block a cubit thick; this paving block runs to the face and is cut to the slope of the face.

The western entrance was discovered by Perring in October 1839 and we have to wait some 112 years later, when at 10 in the morning on the 5th of April 1951 the last stone was removed from the western corridor.

In the distorted view of the western entrance above, we see what the entrance is like in its current form. There appears to be no attempt of clever concealment that we see present on the E3 phase entrance at Meidum; the yellow block is the paving stone, whose end face would be cut to match the slope of the pyramid, above this a closure stone would be set. Above the entrance is a large lintel stone, such a closing arrangement would be conspicuous. Perring appears to have found it easy enough, and in his day he gives it a height of 29.8m; likewise early violators who knew of a western entrance would have little problem in finding it, and maybe they did, but did not require its opening. Fakhry's statement of;

"The passage was completely blocked up with plug stones, and the exterior stone of the casing fitted so exactly, and did not differ from the surrounding stones, that it was impossible to detect the presence of any opening in the surface of the pyramid."

From the remains we see today, the entrance did differ from the surrounding stones, and sufficiently enough for Perring to find it without much difficulty.

The western corridor is similar to the northern corridor in that they both possess two distinct slopes; in the western corridor from the entrance we have a steeper slope of 30°9′ to begin with and after a certain distance it reduces to 24°17′ to the corridors end, these angles are provided by M.Hassan. M&R state the following on the length of the western corridor;

"Hassan Mustafa says that the length of the corridor is 64.63m, but in his section he draws it as about 67.50m long: we measured it as 67.66m."
The first minor point to note in this statement is that M.Hassan gives the lengths in his survey as 42.62m for the lower part of the passage with the reduced slope, and the steeper part of the passage as 21.81m; which gives a total of 64.43m, some 20cm less than M&R quote him, likely a typo mistake. Hassan's survey can be found in Fakhry's volume 1 or A.S.A.E LII 1954.

But now we enter a whole world of confusion for this corridor, for in A.S.A.E LI 1951 Fakhry says;

*"We continued the clearance of the passage, and it was found that after a distance of **40.45m** the angle of the passage changed and ascended, and it continued for a further **27.28m**."*

The highlighted measures by Fakhry provide a length for the passage of **67.73m**, close to M&R's **67.66m** but some 3.3m more than Hassan's **64.43**.
In M&R's work they talk of their own controls, which they sometimes used to check the work of previous explorers, we see it's use in the north corridor where they measured along the roof, due in no small part to the way Hassan had recorded this corridor; Hassan strangely ignored the two slopes of the north corridor and simply gave a length of the north corridor as 79.53m and an angle of 25°24′. Today we still largely rely on Perring's angles for the north corridor.

M&R have obviously used some control on the western corridor also, otherwise how would they discover the discrepancy in Hassan's length; further they provide measures along the corridor of interesting observations that previous explorers had omitted. In their work M&R say;

"For 21.81m from the entrance, the inclination of the passage is 30°09 'then it becomes 24°17' with no other variation down to the end."

Here the change of slope they give as 21.81m, exactly the same value given by Hassan, but did they check this value? The continuous joint they give as 10.63m from the entrance, a similar distance and they would arrive at the change of slope, but here Fakhry suggests the change of slope to be a further 5.5m along the corridor.

In the course of my research I contacted John Legon, and it is he, who first brought my attention to this discrepancy in the measures of the western corridor. M.Hassan had used a closed traverse for his survey and the readings for this traverse are available in table 1 of Hassan's survey, for any surveyors who care to check. John states the following;

"It turns out that the distances in the west passage as shown by the lengths of line in this traverse can be reconciled with Fakhry's statement of the passage lengths as 40.45 & 27.28, but curiously not with the passage lengths as stated by Mustapha."

In my CAD model using M&R's drawings, the western chamber floor is 3.63m above base, yet in their drawings they show it as 3.2m; if I amend my model and use Fakhry's measure, the chamber floor is lowered to 3.1m above base, closer to the 3.2m of M&R. This confusion found in the western corridor and elsewhere, only highlights the need for a modern survey to try and reconcile the current mess that we see in the pyramid.

The Continuous Joint.

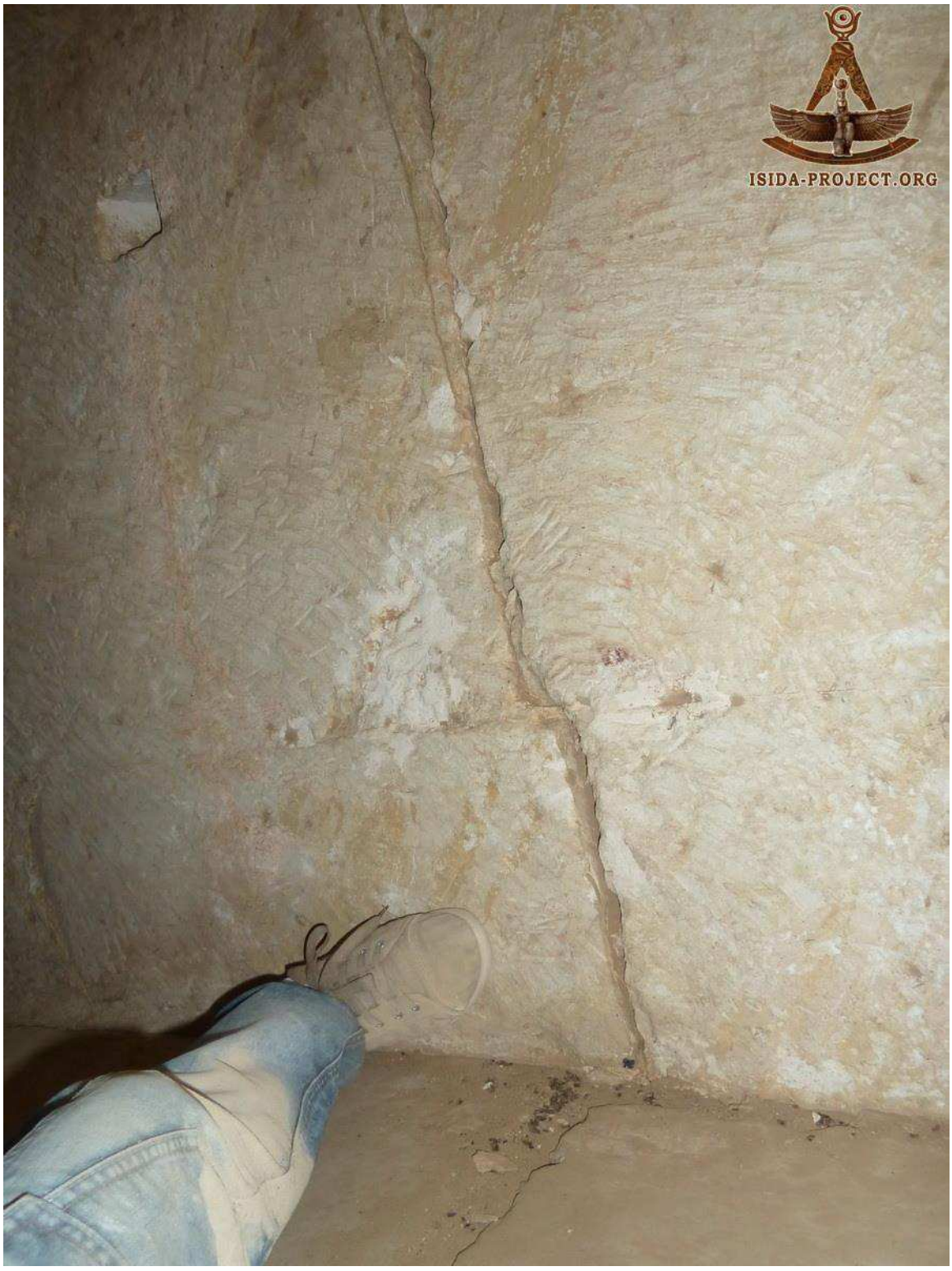
At a distance of 10.63m from the entrance we arrive at the continuous joint, similar to the one found in the north corridor, but here we find no so-called settlement at this joint. Below this joint a small rectangular hole is to be found near the ceiling, this hole 10cm wide by 7cm high, is 30cm from the continuous joint and 60cm above the wall course joint. Below this M&R say

"At about one metre from the joint there is a big fracture in the walls…In correspondence to the fracture there is a dislocation very similar to the one we noted in the north corridor, but here the sinking is only 5cm."

This 5cm settlement and fracture, they draw in fig 4 on TAV 13, in this drawing they draw a 5cm settlement on both the roof and the floor, moreover, this settlement they show also on the wall course joint.

The above image from M&R's TAV13, showing the continuous joint, the rectangular hole and the so-called 5cm settlement, along with a perpendicular fracture that connects the settlement in the roof and the floor. Also of note is how they show the wall course joint to be also displaced by 5cm; even the wall joint by the continuous joint is drawn higher than its western neighbour. The problem with this drawing by M&R is that it appears not to reflect, what we see, in the pictures of this area.

First, the floor of the corridor displays no settlement, it is smooth and level, and second, the wall course joints also appear level throughout this area. The perpendicular fracture and settlement of the roof is also called into question. I have to call into question the motive of M&R when they created this fig 4. We will now look at some of the images of this area.



The continuous joint on the south wall, note how the wall course joints either side of the continuous joint are aligned and not displaced; rectangular hole is also visible, top left.

The continuous joint on the north wall.

The continuous joint running along the ceiling, note red line defining axis of passage.

The floor of the corridor is smooth; no settlement is visible on the floor, we should expect the floor to be smooth and level as the corridor was plugged for a considerable part of its length. The red line denotes the continuous joint. The walls are damaged, similar to lower parts of the corridor, but whether the perpendicular fracture that M&R mention, exists, will required further scrutiny.

Looking down the corridor from the continuous joint; rectangular hole is in top left corner. Here we get a better view of the wall and ceiling damage. Along both walls we can see the wall course joint appear to run straight down the corridor with no sign of any settlement or noticeable break in the line. It follows that if the wall course joints and floor are level, it calls into question the 5cm settlement in the ceiling and if it to exists. Clearly the whole area is in better need of scrutiny to determine if M&R's fig 4 is based on fact, or their imagination.

I am not denying that cracks exists in the corridors, but they also exist in other pyramids be it at Meidum or the Red pyramid; it's the interpretation of them that concerns me, in the Bent they are used to bolster the theory of settlement, in other pyramids similar cracks and degradation processes are ignored: are we looking at a double standard?

Contrast the well preserved beginning of the western corridor, to that found at the lower part of the western corridor. The lower part is a bit reminiscent of Petrie's description of the lower part of the Meidum pyramid, where the passage was practically blocked with sheets of stone that appear to have exfoliated of the corridors surfaces.

This degradation process is not well understood and I have not come across any report that gives a detailed explanation for what we find. In Meidum it has been suggested that as the lower part of the passage is built in the rock; moisture from the surrounding natural rock has caused salt crystals to form in the passages and over time causing sheets of stone to exfoliate. In the western corridor however, it is built in the superstructure away from the ground; maybe moisture laden air sinks to the lower parts, but how, when the corridor was mostly plugged, but we have the mysterious current of air, first noticed by Perring that rushed through the structure, even when the corridor was plugged for most its length. Obviously more research is required to understand the degradation processes we see.

The next items of interest in the western corridor as described by M&R;

"The floor is missing for 6.35m at a point 54.60m from the entrance and it was probably removed by ancient violators when they attempted to open the corridor. About 55m down the corridor, on the south wall there is a vertical groove which goes from the floor to the ceiling. Always in the south wall, at a point 57.80m from the entrance, is a shaped niche, 1.62m wide, in which were located two vertical wooden beams (already mentioned by Perring). The western beam has disappeared, but its traces are still visible, and there is the stump of the eastern one. No notches to facilitate transit were cut in the corridor pavement, as can be seen in the remaining part of the floor."

There appears to be some confusion in the above statement, in respect of the groove at 55m. This groove should be 40 cm east of the missing paving, but this is not shown in their drawing. What are shown on their drawings are dashed lines at 50.20m, with the caption *Traccie di chiusura* (Closure traces); another caption just west of these dashed lines says, *Traccie di inserimentodi una chiusura lignea (traces of inserts a wooden closure)*. M&R also show the dashed lines running across the floor. This might be the groove they talk about in the text; google translate suggests traces of a wooden door: is this groove something similar to what we see in the Meidum corridor? Yet again more scrutiny is required on this groove.

At the end of the western corridor M&R say;

"The ceiling was cut to a lesser inclination and shows a step. The last floor slab is missing, but we noticed that the slab was inserted between the walls with a clearance of 2-3cm. for each side. Underneath there is a small pit,

whose east edge coincides with the point where the sloping corridor becomes horizontal. The pit walls are well dressed, even if they show the marks of chisel strokes, and the bottom is well defined."

This pit was not mentioned by others; in Perring's day if open, the pit could have been covered with debris, but Fakhry's omission of this pit is puzzling, unless it was covered with a slab in his day, and subsequently uncovered at a later date by persons unknown. We do not now if this pit was covered or open, or even partly covered. It may have had a similar function to the pit at Meidum, but it is strange that its existence was not reported until M&R's investigation. It may have been noticed by Fakhry, but he simply failed to report on it; in his three volume work at Dahshur, he provides scant information on the interior of the pyramid, a mere four pages of text is given over to the description of the interior. Clearly his interests laid elsewhere and this is confirmed in his book *'The Pyramids'*, where he says;

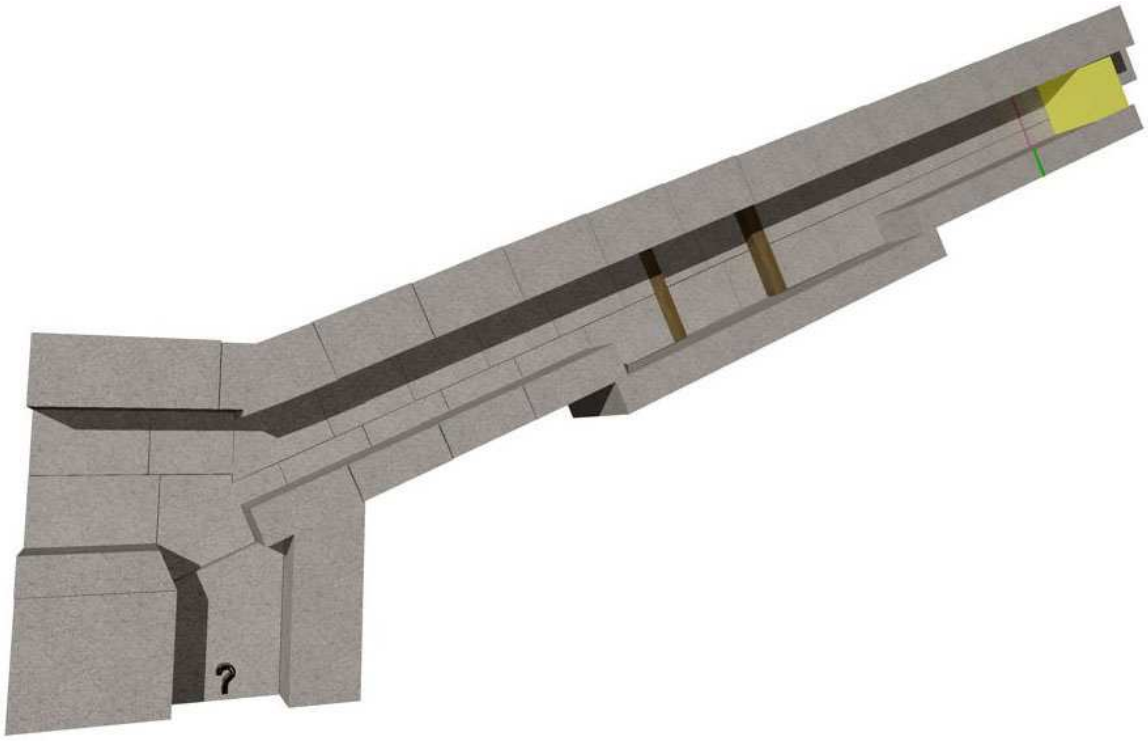
"From the beginning of my work there, I felt that it was more important to examine the area around the pyramid than its interior"

Fakhry also omits the recess and beams in the corridor south wall, first mentioned by Perring; the hole in the floor of the northern passage mentioned by Charles Rigano; any sign of settlement in the western corridor etc. As his statement above shows, his priorities lay elsewhere, confirmed by the following statement from his volume 1;

"During the four seasons which I spent digging at Dahshur, my work inside the pyramid was limited to the opening of the western entrance only; I did not try to dismantle more stones from any chamber although there were tempting reasons to continue"

But even in this one area of clearing the western corridor, he describes very little, important information on the plug blocks are omitted, there is no indication of their size and the clearance provided for their insertion, or photographs; he merely says in volume 1;

"It was filled with blocks having the same size as the passage which were plastered from the western side, the blocks being inserted from the western entrance, and every one of them was plastered all around it before inserting the next stone until they reached the casing."



In the image above we have a section of the lower corridor, the pit is about 1.36m E-W, .51m N-S, leaving a significant ledge of 21 to 23cm either side of the pit to support a paving slab, the depth measured on the east wall is 1.48m, though possibly deeper as M&R leave a question mark on their drawing. Further up the corridor we come to the area of missing paving and it is in this area that we find the beams about 27cm wide and the south wall recessed about 25cm, this recess including the width of the beams is about 2.47m. The beams and recess appear to travel the full two course height of the corridor walls and not commence from the paving surface.

The yellow block at about 18.30m from the corridor end, was the position of existing plug blocks in Perring's day. The red line, slightly east of that is the groove or *closure traces in M&R's drawing,* and the green line east of that is the location that the mummified bat was found, Fakhry states;

"the box which contained the mummy of a bat was put in the passage at a distance of about 2 metres from the end of the removed blocks and was covered with plaster"

Fakhry quotes the end of the plug block as 18.30m which agrees with Perring's 60 feet from the passage end; the box was 2m from this plug block.

Were Fakhry got this information is unclear as the box was discovered in 1947 and Hussein had further cleared the corridor to a length of 32 metres before Fakhry took charge in 1951. In 1948 Dr A.Batrawi did an article (A.S.A.E., XLVIII 1948) *A small mummy from the pyramid of Dahshur;* in the box where found the remains of a bat and what was thought to be an owl along with five skulls of the same mammalian type. On its discovery Batrawi says;

"About the end of 1947, a small wooden box, containing a small mummy was discovered under a certain stone in the floor of a built-up corridor within the structure of the pyramid"

The mummy itself is not contemporary to the pyramid but believed to be from the Ptolemaic Period. In connection with this, Egyptian text was found on the walls of the north corridor about 2.7m from the entrance; Fakhry thought that they were from 26th dynasty and the Ptolmaic period. A picture that Fakhry describes as a crudely drawn lion was also present nearby.

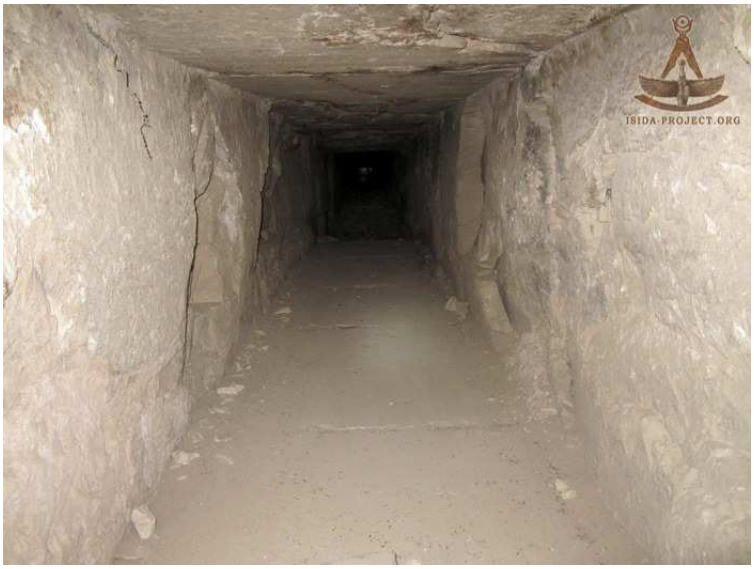
ANOTHER CLUE IN AN EGYPTOLOGICAL "DETECTIVE STORY": A TINY COFFIN CONTAINING A MUMMY BEARING A HAWK SYMBOL, RECENTLY DISCOVERED IN A DAHSHUR PYRAMID.
In our issues of March 22 and April 4 of last year we described the excavations in progress into the heart of the blunt pyramid at Dahshur and the exciting possibility that still, somewhere concealed in this mass of masonry, lay the undisturbed burial of a Pharaoh, probably Snefru. To date of writing the mystery is not yet solved, but it is reported that M. Abd Essallam M. Husein, who is in charge of the excavations, has uncovered the 20-in.-long miniature coffin we show here.

The image on page 69 shows the 20 inch long box that held the mummified contents described in Batrawi's report. This image was published in the Illustrated London News, Jan 3, 1948. The image seems at odds with Batrawi's and Fakhry's description; the impression is of a box that has been walled up in some rough rubble wall, with mortar/plaster.

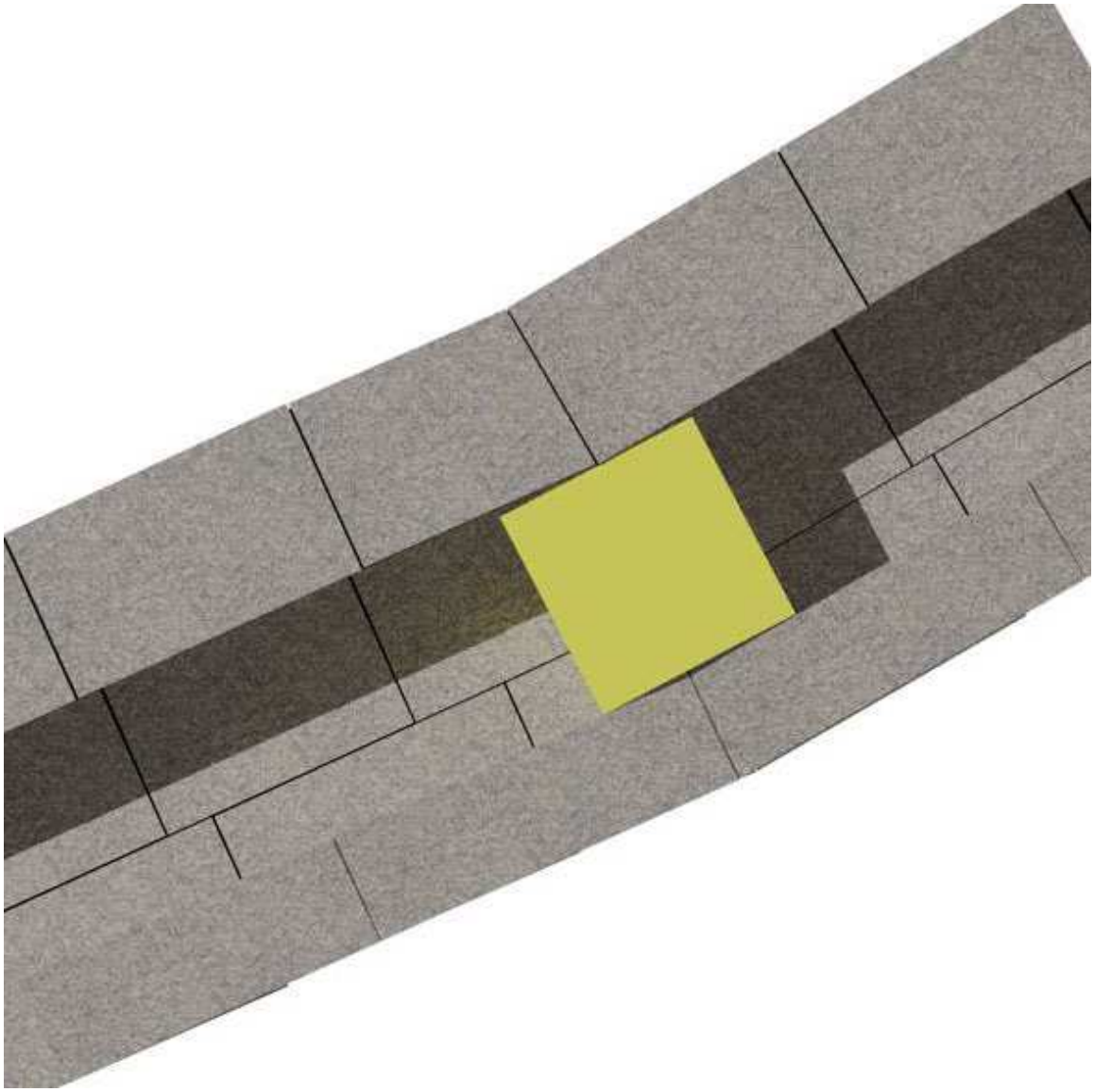
Though Hussein's notes are lost to us, apparently his photographs survived, some have been published in Fakhry's work and in newspaper articles and I assume some have not been published. It would be a worthwhile project for someone with more resources than I, to try track them down and preserve this important record.

Pit in western corridor.

Looking down into the pit, a faint red line denoting axis can be seen on one of the blocks.



View up western corridor from the pit.



In the above image I have placed a plugging block at the junction of the western corridor where the angles change. To the left of the plug the angle as given by Hassan is 24°17′ to the right the angle is given as 30° 9′. The masonry makeup at this change of angle I have not seen as recorded, so we do not know if any adaptation was done to the junction to allow plug blocks to pass. In the image above the height of the block would have to be reduced in order for it to turn pass the junction or they could have dressed away the ceiling to provide clearance. We also have to take into account the 5cm settlement mentioned by M&R, if it exists; also to be considered is the saw tooth pattern of the roof blocks and how they encroached into the corridor. It's such a pity that Fakhry could not record these plug stones and corridor in more detail, I feel an opportunity has been lost to record in detail how they

plugged the corridor. The only other description of the plug stones is from Perring, who says;

"The greater part of it was closed up with large blocks, which had only been removed for about 60 feet at the lower end. The entrance on the outside of the pyramid was so well concealed as to have escaped the closest examination, and the blocks within it appeared to have been fitted with the greatest accuracy."

From the two descriptions of Fakhry and Perring, it appears the plug stones were single blocks, that were quite accurate to the bore of the passage that they slid down; but sadly because no proper recording of these plug stones was done, we do not know what tolerance was given to the plugs to allow them to slide down freely. From the descriptions it appears to be a small tolerance, and if so, can we discount any settlement in this corridor? Or if settlement occurred it was after the event of closure.

Fakhry's description of the plaster on the western side of the plug stones is also not that clear, is it likely that someone went done a slippery slope and plastered each plug in turn, or were baskets of liquid plaster/mortar poured down the passage as lubricant, which the descending block gathered up on its descent and depositing it on the west face of the block it abutted against.

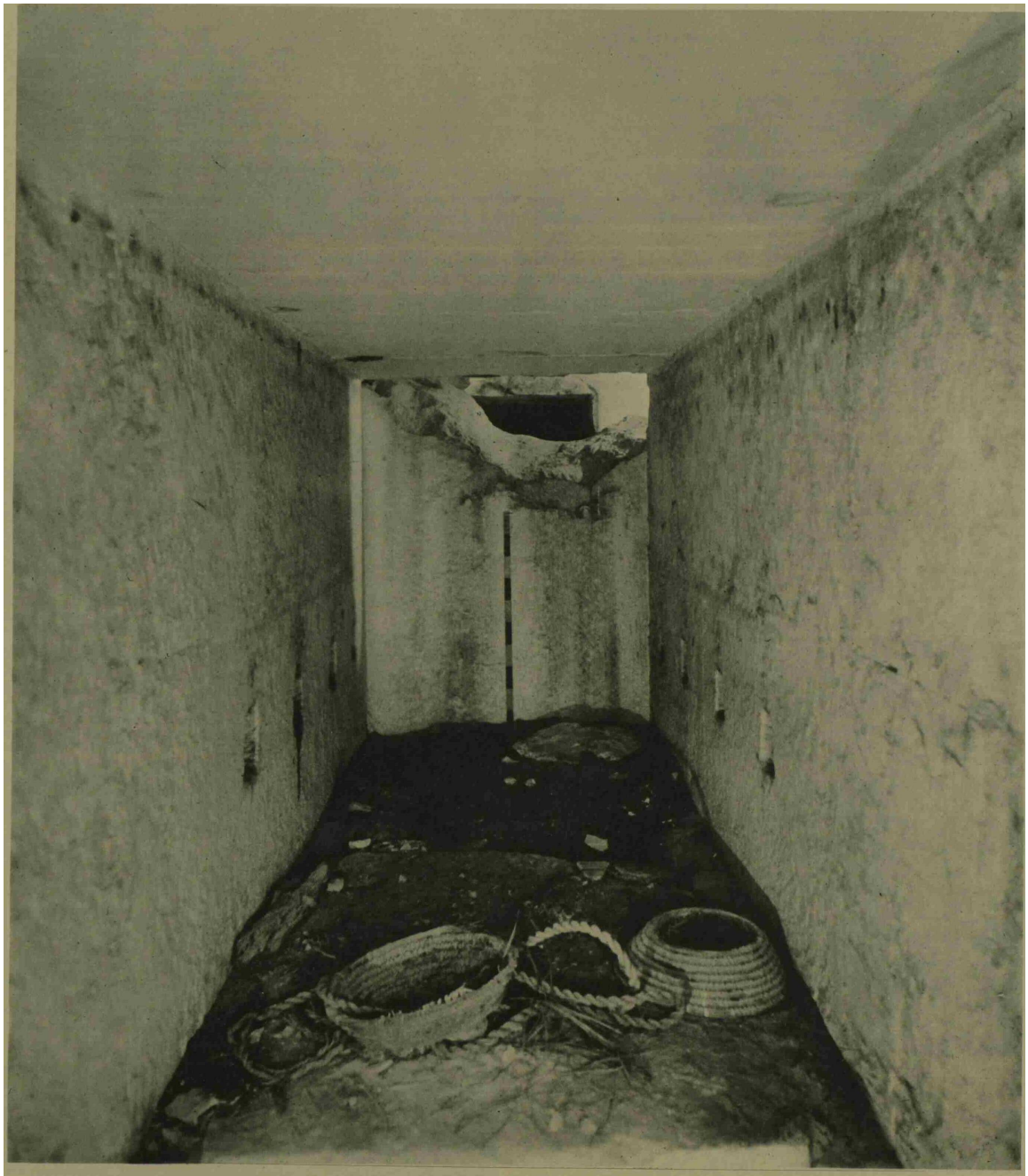
It is generally assumed that the passage was plugged to its end, Fakhry says;

"The portcullis was broken by tomb robbers at its upper north corner in ancient times and a large part of the blocks filling the entrance to a distance of about 18.30m was also removed;"

Solid limestone weighs approximately 2600kg (2.6 tonnes or 2.86 US tons) a cubic metre. If we take the empty corridor as 18x1x1m and the missing paving as 6x1x.5m, we have about 21 cubic metres of excavated plug stones and paving removed, or 54.6 tonnes (60 US tons) of material removed; not a small undertaking. So it is all the more surprising that all this material was passed through a small breach made on top of the portcullis block, barely large enough for a person to crawl through; surely nothing could be easier than for violators to smash through this portcullis block and make their job a lot simpler.

To me this calls into question if this lower 18m was plugged with blocks and it's interesting to note, that in Perring's day, the plugging stopped

just short of the grooved line. Alternatively the corridor was plugged for its entirety, but that the western portcullis was not lowered at this time. Therefore early violators had easy access to clear the lower part of the corridor; maybe later, possibly in the Saite period, during the introduction of the mummy box, they choose to utilise the portcullis.



WHERE THE MOST INTERESTING EGYPTIAN DISCOVERIES OF RECENT YEARS ARE NOW BEING MADE: IN THE HEART OF THE PYRAMID OF SNEFRU, SHOWING THE FORCED PORTCULLIS, AND THE BASKETS AND ROPE ABANDONED THOUSANDS OF YEARS AGO BY ROBBERS WHO FAILED TO FIND THE STILL UNDISCOVERED TREASURE.

Our picture was taken in the heart of the southern stone pyramid at Dahshur ...

Image of portcullis, from the Illustrated London news, March 22, 1947.

Generally in Egyptology there is an assumption that a lot of what we see inside the Bent pyramid is contemporary with the construction and reign of Sneferu; but I feel that we should always be open to the idea that usurpation and modifications to the structure, could have been carried out in various periods of Egyptian history. It is most likely that all these great pyramids of the old kingdom were violated early on, possibly in the chaos that ensued, during the collapse of the Old Kingdom.

The Horizontal Corridor.

The horizontal corridor connects the bottom of the descending western corridor to the upper chamber, and included within its boundary are two portcullises and a vertical shaft. M&R give the length of this corridor, measured along the ceiling as 20.03m (Perring gives 65ft 6 inches or 19.96m). The width of the corridor for the most part mirrors the descending corridor of about 1m, though it widens after the western portcullis block to 1.25m for a distance of 3.80m, then reduces again to 1.12m for a further distance of about 2.36m. The height of the corridor from the paved floor is from 1.59 to 1.63m; so apart from the wider area next to the shaft, the horizontal corridor appears to mirror the dimensions of the descending corridors, minus their paving, at 2x3 cubits and the walls consist of two courses.

At 2.43m measured along the ceiling we arrive at the first portcullis block and corbelled space that housed the block in the open position; this is the only portcullis block that was lowered, the eastern portcullis remains stored in its housing. The width of these corbelled spaces is not clear from M&R's TAV 13, in their fig 1; they suggest a width of 78cm for the western housing and 82cm for the eastern housing. The distance from the eastern housing to the upper chamber in fig 1 they give as 16.82m, however in fig 2, they give 16.76m. These two drawings provide two widths for the eastern housing of 80 and 82cm.

On the ISIDA website they took some images of the eastern portcullis and housing, along with measures.

Eastern portcullis in stored position

Width of eastern housing and width of actual portcullis block suggest a clearance of about 6cm.

On the next page, we have the drawing made by Perring of the portcullis block and its corbelled housing. The two portcullises are nearly identical, except for the fact that they mirror each other across the passage, i.e. the western portcullis was designed to slide down from north to south; and the eastern portcullis was designed to slide down from south to north.

The floor of the corridor was cut into, in order to receive the lower part of the block. It does appear a somewhat complex design, given that a simple vertical portcullis could perform the same function.

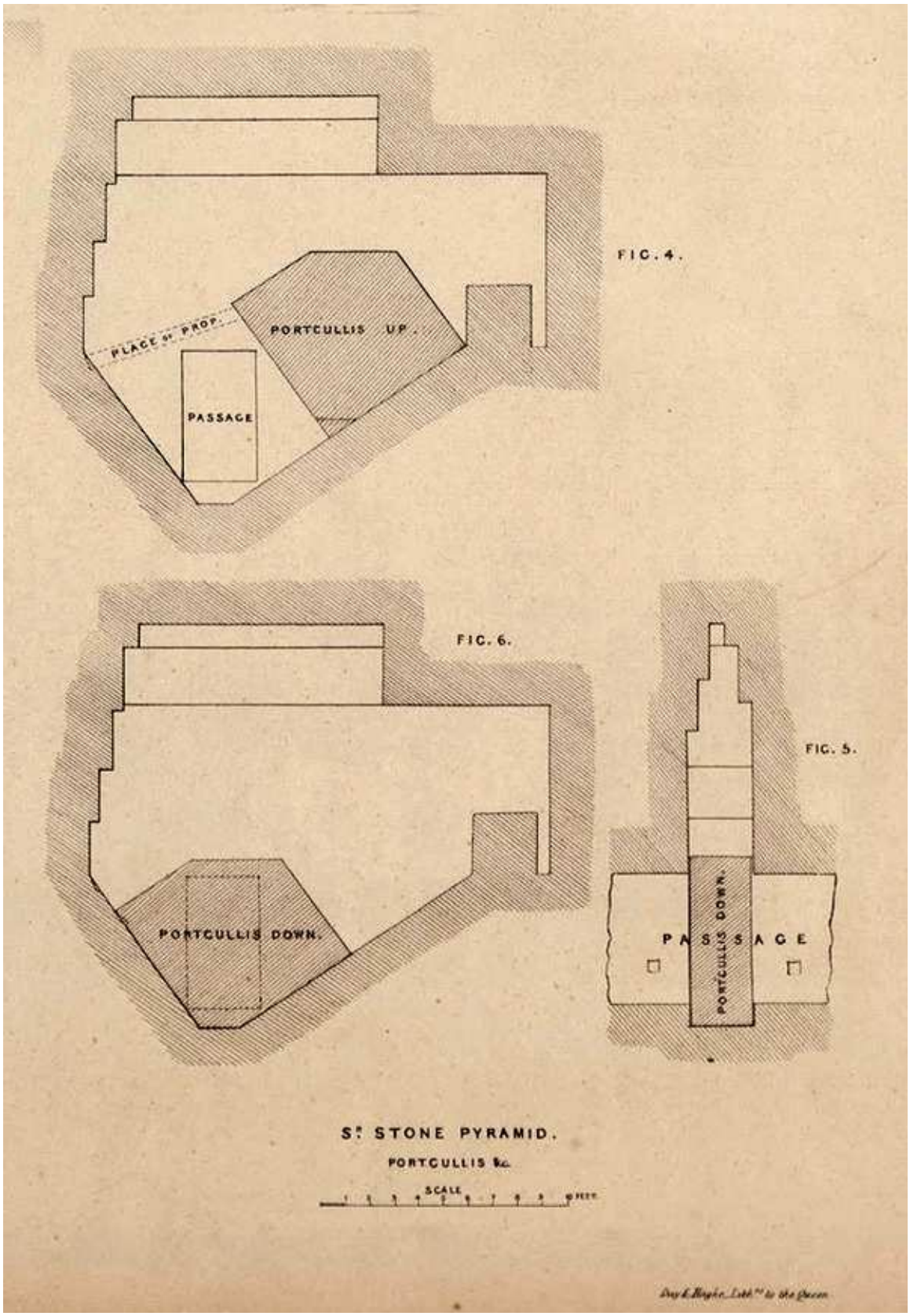


FIG. 4.
PLACE of PROP.
PORTCULLIS UP.
PASSAGE
FIG. 6.
PORTCULLIS DOWN.
FIG. 5.
PASSAGE
PORTCULLIS DOWN.
S.t STONE PYRAMID.
PORTCULLIS &c.
SCALE
Day & Haghe Lith.rs to the Queen

The lowered western portcullis, the neat cutting of the block was done by Hussein in order to improve access. Note also the cutting in the corridor floor, the square holes and ledges in the walls. At this point the horizontal corridor is 1.25m wide.

Views looking up into the western portcullis housing, the square block in Perring's drawing is visible to the right.

It is not exactly clear how the portcullis was stored in its housing, M&R mention "*there are holes and cuts where some small beams had been fixed"* In one of their drawings it appears that the square block at the back of the housing acted as a back stop, which was the limit of the portcullises upward travel and that the block was restrained from sliding down by a beam in a slotted hole that caught the top edge of the block. Its possible that on closure, the portcullis block was somehow levered, taking the pressure of the holding beam, so that it could be removed from the slotted hole and allow the block to slide down.

We now come to the sealing of the portcullis block. Perring says;

"The portcullis must have been let down when both of the entrance-passages were open, as it had been plastered on both sides."

Fakhry states; "*The portcullis was plastered on both sides, which proves that the labourers who did this were able to leave the pyramid through the winding passage and the northern entrance."*

(The winding passage is a connecting passage that was cut through pre-existing masonry, connecting the lower chamber to the horizontal corridor)

M&R state; *"Perring says, and both Fakhry and our exploration confirm his statement, that this portcullis had been sealed with mortar on both sides"*

These observations have mainly been taken to mean that access to the portcullis had to have been available from both entrances. But there appears to be some ambiguity in these statements, what exactly do the authors mean, when they say plastered on both sides? Looking at photographs it is hard to discern the presence of plaster/mortar; what we see, appears to be a nice block of dressed limestone. Thankfully we have another witness in Charles Rigano who describes the portcullis block thus;

"A robbers hole in the upper right corner of the portcullis was enlarged by Hussein to a rectangular space about 3 feet high to provide easy access to the western passage and to the western entrance at its end. ***The portcullis was sealed with mortar around the edges on both sides*** *indicating that the north and west entrances were open when the portcullis was lowered,"*

This last observation, highlighted above, suggests that mortar was only visible on the edges on both sides of the block; but does this mean that both entrances had to be opened when it was lowered? I would suggest not.

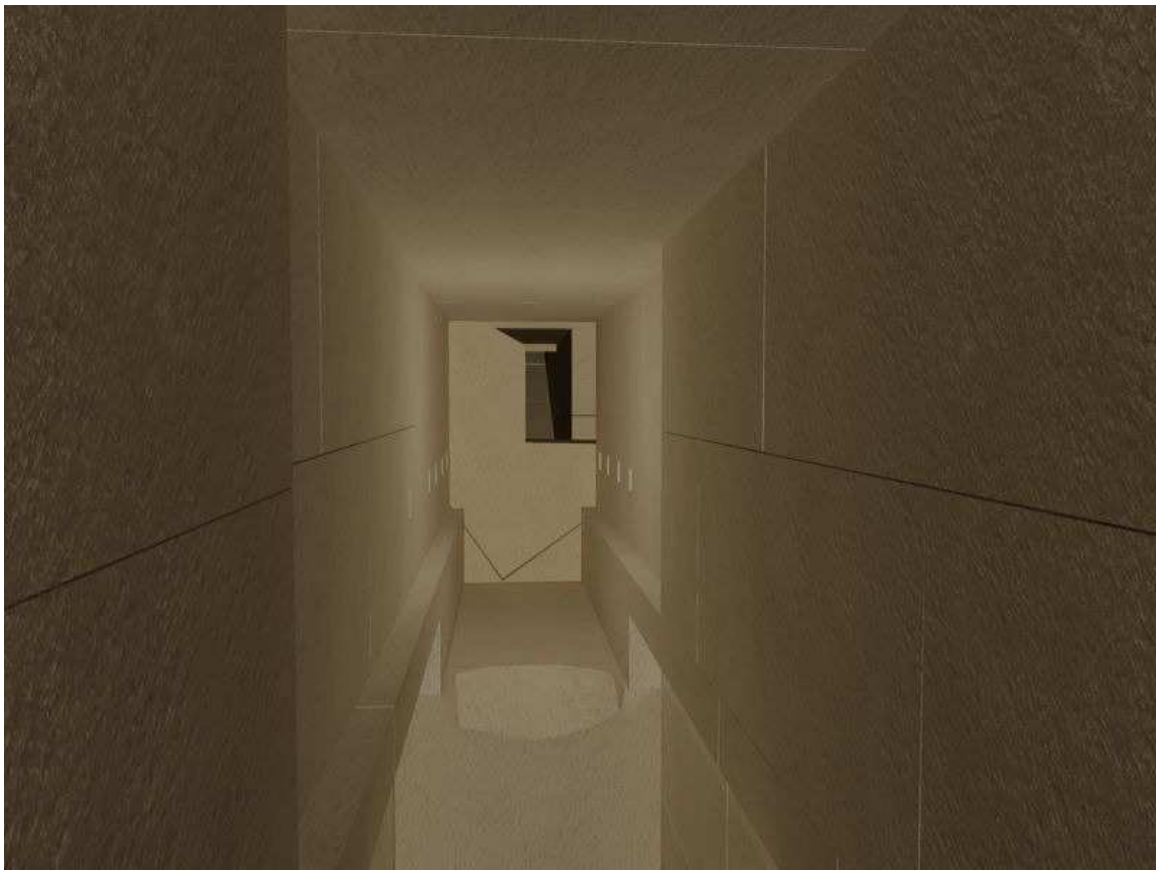
In my Meidum paper, I suggested how the portcullis block in the vertical shaft, may have been mortared in place, and that this might explain the defined line of tiles remaining in the shaft. It would seem that here in the Bent pyramid, the portcullis was likewise mortared in place. Simply lowering the portcullis without mortar, ran the risk that it could be prised and levered enough to allow violators access. It follows therefore that before the portcullis was lowered, the cut in the floor, walls, recess etc would be liberally covered in mortar. The portcullis when lowered would then be securely mortared all round and this mortar would be displaced by the mass of the block, causing mortar to ooze along the edges.

This scenario can explain the observations we see today, and I feel it is a valid alternative; it also means that both entrances did not need to be open.

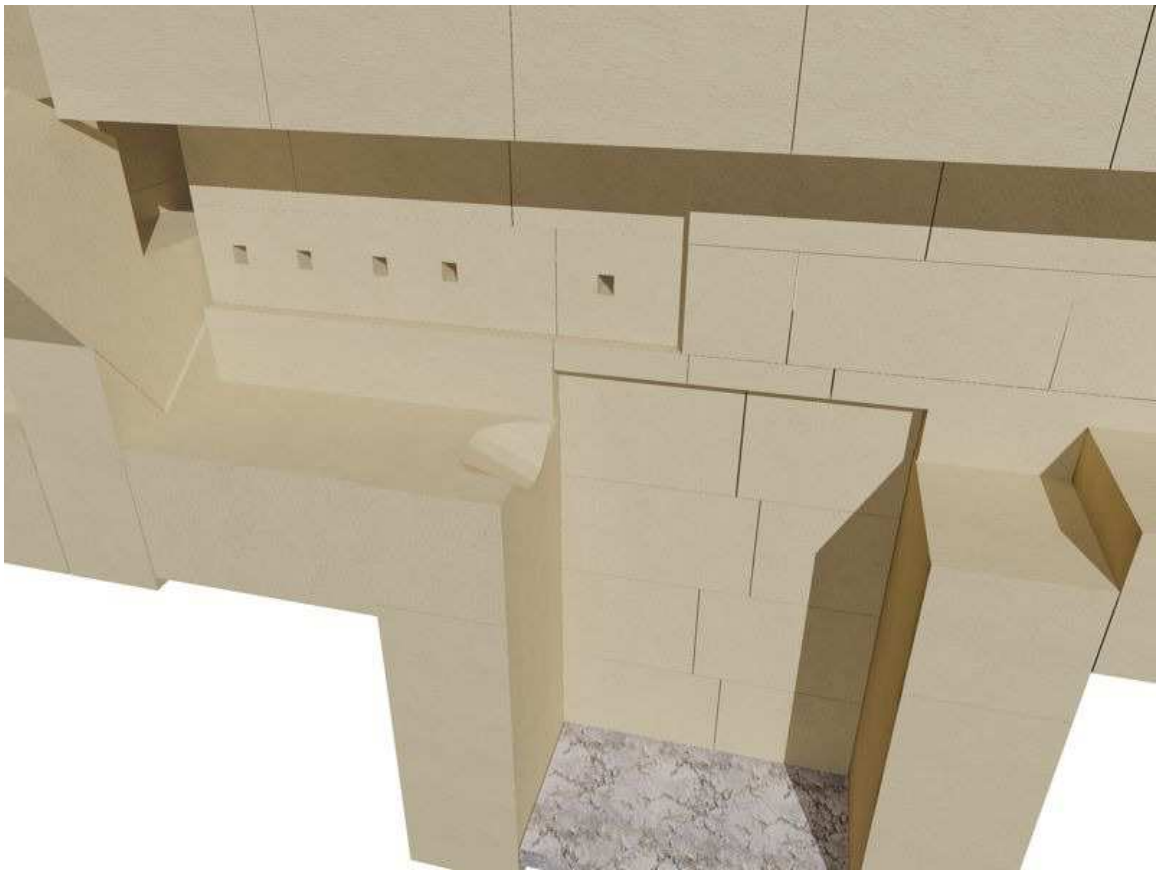
Eastern portcullis supported by modern beams.

Immediately after the western portcullis we enter the widest part of the horizontal corridor at 1.25m, this width continues according to M&R's drawing, for a distance of 3.80m (using hole measures, M&R also provide a distance of 3.87m using different points) from the portcullis, wherein the north wall of the corridor is then placed south by 13cm, which will bring it inline with the corridor walls west of the portcullis block. At this point the corridor becomes 1.12m wide for a further distance of 2.43m, wherein the south corridor wall is placed 12cm north, thereby bringing this wall in line with the corridor wall west of the portcullis and from this point the corridor reverts back to 1.0m wide.

In the image below we see how the corridor widens at the portcullis, and then reduces, by the repositioning of the north wall and further on in the left foreground, it is reduced again by the repositioning of the south wall. This strange area of the corridor includes the deep vertical shaft; this shaft starts at 2.86m or 2.92m from the western portcullis (two measures are given from M&R's drawing, why they differ so much is not clear) The east-west distance of the shaft is 2.64m (5cubits), its width is 1.44m and therefore wider than the corridor above (It appears the pit in the lower chamber also



displays this feature) the depth is believed to be around 4m.



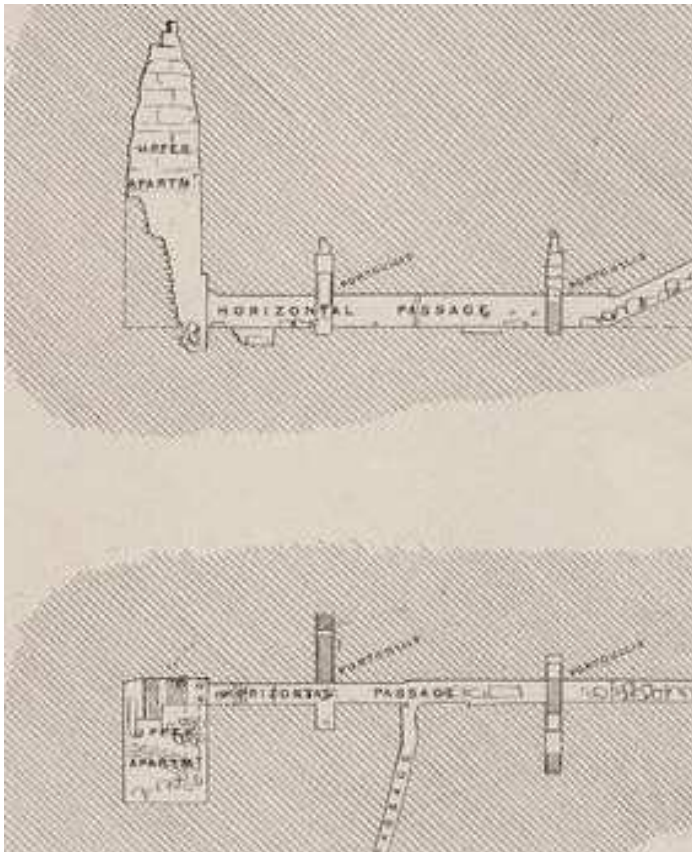
In the section above, we get a clearer view of the shaft and the five pairs of rectangular holes that are present in the widest part of the corridor. The centre of these holes, running from the portcullis are 34cm, 56cm, 63cm 56cm, 130cm and then 41cm to the repositioning of the north wall, for a total of 3.80m. M&R say the holes are 12cm wide and 15cm high. The depth of the holes is not known with certainty, M&R just say *"not very deep",* their drawing suggest about 15cm deep (Fakhry says, *"There are five at each side, the first of these holes at the south wall is 12x15cms, and is at a distance of 26cms from the portcullis; the other holes measure 15x18cms, they were very probably made during the operation of lowering the portcullis in its place").* The position of the bottom edge of the holes is 42cm above the ledge.

On top of the shafts west wall, there is a noticeable rounding of its edge, which appears not to exist on the opposite wall. The paving is missing from this area and may have been 1 cubit thick, with the paving level being aligned with the ledges. The impression one gets is that all these features are

in connection with the shaft. Fakhry's suggestion that the holes had a connection with the portcullis is unlikely as no such holes exist at the eastern portcullis.

The shaft was discovered by Hussein, Fakhry says;

"According to the labourers who were working in the pyramid at that time, Abdulsalam decided to remove the blocks on the floor of the passage when he noticed the existence of a large quantity of plaster in the corner at that place, and the removal of these blocks led to the discovery of this blind shaft."



In the drawing above by Perring it's interesting to see a rectangular depression in his drawing that corresponds to the location of the shaft and that the paving is largely intact surrounding it. Fakhry goes on to describe the shaft thus;

"When the blocks of the floor were removed there was found under them a very carefully built shaft which measures 2.65m x 1.46m and which descended to a depth of 4 metres approximately and was built on the mother

rock. It does not communicate with any other part of the pyramid and was filled with rough blocks of a yellowish kind of hard limestone which was different from all the other kinds of stones used in the construction of all the other parts of the pyramid."

Obviously there is something very strange about this shaft and can we be sure that we have reached the mother rock at 4m; we have seen the clever deception at play in the shaft attached to the lower chamber, could something similar, be at play in this shaft too? According to M&R the upper chamber floor is 3.2m above the pyramid base, and the corridor paving is at the same level; M&R give the depth of the shaft around 4m from the pavement level, therefore the mother rock would begin at 80cm below pyramid base at this point.

According to Dorner's plans the bedrock begins more that 2.5m below pyramid base, though we cannot assume the site was level, the great pyramid is built on a rocky knoll. The only area of interest nearby that might help, is the connecting tunnel between the lower and upper constructions. The floor of this tunnel starts in the south corbel ceiling of the lower chamber, according to M&R some 3.4m below pyramid base; from M&R's drawings over half this tunnel, approx 11m is under the 4m mark (shaft bottom), after this the tunnel continues its incline and breaches the north wall of the corridor approximately 90cm east of the shaft. All reports of this tunnel suggest that it was cut through pre-existing masonry; there is no indication of bedrock in its course. This seems strange given Fakhry's view that mother bedrock was found some 2.6m higher than the tunnel entrance.

From the description of the lower chamber, it appears the ceiling is supported by the natural rock, and the walls tiled, the chimney likewise could be a lined shaft, (An examination of the tunnel forced in the chimney south wall should tell us better how the shaft was built) This would suggest that the natural rock begins a short distance south of the chimney and that this rock, would most likely be left to help support the western passage/chamber system. It's all highly tentative how they best utilized the natural rock in their construction and more research is required, but could the mother rock mentioned by Fakhry be a clever deception, like the false rock in the lower chamber shaft; given the strange features that surround this shaft, I feel it would be worth further investigation.

Looking at the west wall of the shaft with its top edge rounded.

The width of the shaft undercuts the walls.

Looking towards portcullis and repositioning of north wall right.

View looking east, wooden planks cover shaft.

View from tunnel entrance showing thickness of paving stones.

View from tunnel entrance with shaft to the right.

M&R's drawing of this corridor is misleading; the missing paving is represented by a dashed line and they suggest a thickness of 23cm to the underlying masonry. This dashed line and underlying masonry 23cm below is drawn from the western portcullis to just east of the tunnel entrance on their TAV13, but as can be seen from the images it is much thicker, the top image on page 89, were the paving stops just east of the tunnel entrance, is clearly more than 23cm. M&R appear to have confused the height of the ledge that is undercut by the wider shaft, as they give that height as 23cm, but it is clear that the underlying masonry that the paving lay on was much lower.

On the rectangular holes M&R say;

"The holes seem to have contained some small beams which were probably inside a blocking masonry built here; they could have been something like the beams—with ends inserted into the walls—which can be seen in the upper part of the masonry massif in the crypt"

Confusion reigns on these holes, M&R's drawing gives a height for the 4th hole from the portcullis as 15cm and the width of the second hole from the portcullis as 12cm, when according to Fakhry they should be 15 x 18cm, with only the hole nearest the portcullis being 12 x 15cm.

So what are we to make of the strange features in this area of the horizontal corridor? Clearly a detailed study of the masonry in this area is needed, in order to provide clues to the phases of construction. With so little information I can only guess at a possible scenario. If the reader visits guardians.net they can see the photographs took by Andrew Bayuk, he has a clear image of the shaft without the wooden beams; the top of the west wall of the shaft as previously mentioned, appears modified, like its been scalloped out. Was this a feature purposely made to aid ropes in lowering a heavy item into the shaft? Whatever the depth of this shaft turns out to be, it seems clear that it was designed and incorporated early in the scheme of this pyramid. It may even be possible that something large was introduced into this shaft, while the corridor walls were only partially built. The ledges we see today may have supported planks to create a platform that bridged the corridor allowing workers to supervise lowering operations, while the ropes did their work in the space beneath the platform.

Could the rectangular holes in the walls be available at this time? The rectangular nature of the holes, with their height being more than their width, suggests that beams of a similar width were inserted, with the extra height of the holes, providing clearance for the beams to be inserted at an angle and then withdrawn to slide into the hole in the opposite wall. These may have been round beams with ropes guided around them, basically a sort of rigging effect for added control during lowering; but these walls and holes may not have been available. It could be that something heavy was lowered into the shaft at an early phase, without the walls or partially built walls; the corridor would be completed, paving stones inserted, except for the shaft, which would be left open. Maybe the rectangular holes were a feature to be used when the pyramid was closed; beams inserted in these holes may have lowered something of importance into an earlier placed item. The shaft would then be filled with blocks, maybe some deceptively to look like natural rock and then paving stones finally placed on top, to blend in with the rest of the corridor floor.

The above can only be a rough guess as to the features found in this area of the corridor; but to me there are obvious similarities to both vertical shafts, in the lower chamber shaft, Fakhry says they give up at a depth of 8m; I definitely think a closer inspection of this shaft and its surroundings is needed.

Moving on from the shaft in an eastward direction, at about 72cm we have the start of the repositioning of the south corridor wall, and unlike the north wall, the edge is not perpendicular to the wall but inclined for about 23cm. Whether this was intentional is not known; its close proximity to the connecting tunnel entrance might have caused it to be modified. Perring says of the tunnel entrance in the corridor;

"The right hand corner of the upper end had been rounded, and a small recess had been cut out on the opposite side of the horizontal passage, apparently for the conveyance of a long solid body into the lower apartment."

From this point the corridor reverts back to a 1m width; the next item we come to is the eastern portcullis, still stored in its recess. The distance between portcullises from M&R's drawings is either 10.72m or 10.67m; after this portcullis, the corridor continues for a further 5.28m (10 cubits) and then enters into the upper chambers south west corner. In the floor of the

corridor, an excavation has been made about 1.3m to 2.25m from the chamber entrance. In the image below from the Illustrated London News. March 22, 1947, looking east, we see the tunnel entering in the north wall.

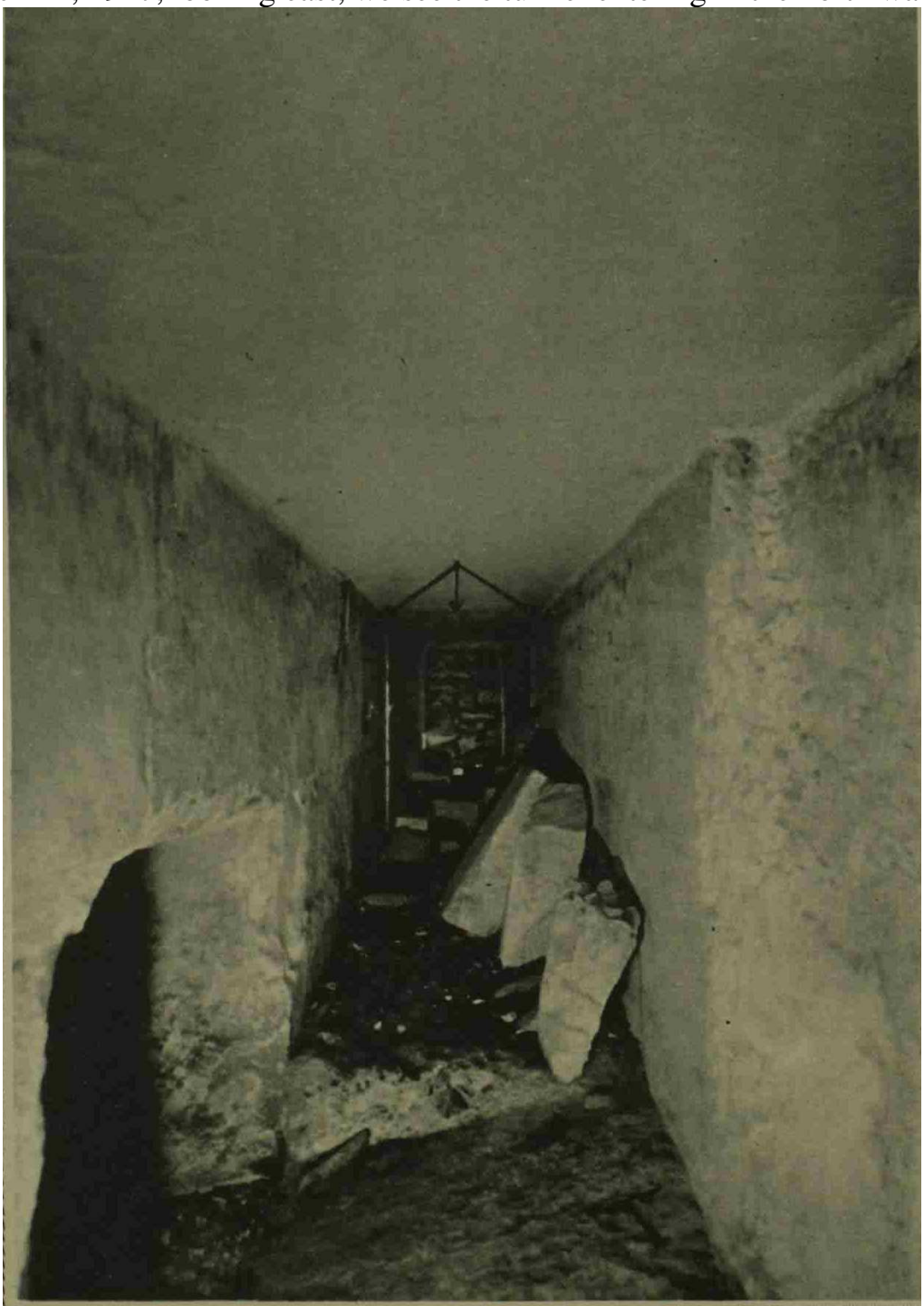


FIG. 6. LEADING TO THE UPPER CHAMBER: THE UPPER PASSAGE, WITH (LEFT, FOREGROUND) THE FORCED ENTRY FROM THE LOWER CHAMBER SYSTEM, AND (ARROWED) THE SLOT WHICH CARRIED THE PORTCULLIS STONE.

We also see the repositioning of the south wall. The tunnel entrance floor is not aligned with the pavement surface, but below, as if an error had been made, which is not surprising as M&R say of this tunnel;

"From an accurate examination of the passage, it seems to have been cut out from north to south. There are no visible elements indicating that the gallery was started at both ends"

This apparent error probably necessitated the removing of the paving stone and altering the south wall, for access, as suggested by Perring.

View from inside the tunnel entrance looking at the corridor's south wall.

View looking west.

Before leaving the horizontal corridor, it is worth reading the following statement from Fakhry;

"On some of the windy days, there can be heard inside the pyramid, and especially in the horizontal corridor between the two portculli at the end of the ramp of the western entrance, a noise which continues for almost ten seconds. This occurred several times and the only explanation is that there is still some communication with the exterior and probably an undiscovered part of the interior of this pyramid still exists"

This appears to be connected with the strange draft that Perring reported. In Perring's time the northern corridor;

"was only accessible to the length of 140 feet, and it had evidently been closed up intentionally, because stones detached from the upper part would have rolled over the mouth of the entrance; and because Mr. Perring removed out of it large blocks, and stones of ten or twelve pounds weight, like those which are to be found in the adjacent desert. The removal of these obstructions was commenced on September 20th; but it could only be continued at intervals in consequence of the want of air, which on the 15th of October had nearly occasioned the work to be abandoned, when a rush of fresh air down the passage, consequent upon an opening being effected into the interior apartments, enabled the men to proceed, and in a few minutes to complete the operation."

In a footnote to the above statement, it states;

"Mr Perring states that this current of air continued for two days, so that the lights could with difficulty be kept on. It would therefore appear that the apartments must have had some other communication with the outward air."

It might be a useful experiment to seal the western corridor, and try and recreate the conditions Perring and Fakhry describe; and maybe introduce coloured smoke into the passages. It might be that relieving spaces similar to Meidum are present above the corridors and that on certain windy days and wind direction, enough of a draw is created, through gaps in masonry to give the above observations.

View looking east, with portcullis in stored position; the ladder in the background, leads to the top of the masonry massif, that was built inside the upper chamber.

The Upper Chamber

The upper chamber may have looked like the previous image, before the modifications that have been carried out in it. Though the corridor leading to it is in an east-west direction, the chambers long axis follows that of the lower chamber being in a north-south direction; the floor dimensions are 7.97m by 5.26m (which may have been 15x10cubits). The height of the chamber is given as 16.50m. The wall height to the first corbel is less than the lower chamber at 3.21m or 3.33m (there is confusion here in M&R's TAV 12&13; In TAV 12 fig 5, they appear to give the height of the vertical wooden beams as 3.20m and the corbel as 3.33m. However in TAV 13, fig 1, they suggest the corbel starts at 3.21m). These vertical beams do not come into contact with the corbel, but exhibit a gap, that they show in their drawings.

In the image above, we can just make out two beams, under the corbel, the left one appears to have a considerable gap which appears to be filled with mortar. The walls of the chamber also appear to have been dressed down to create a channel for the beam to sit in.

In the image above we see another pair of beams, the right one exhibiting mortar in the space, and the walls appear to have been channelled for the beams. In some images the chamber walls appear well finished and in others slightly rough. M&R were unable to determine if this was rough work or caused by corrosion and stone flaking.

The ceiling of the upper chamber appears to have had 16 corbels, one more than the lower chamber, today it is a scene of destruction

The floor of the chamber, made visible by the removal of the northern part of the masonry massif, is in good condition; made of sizeable blocks that appear to have a smaller L-shaped stone at their centre, which Fakhry calls a keystone.

We will leave this chamber for now and return to it later and look at these modifications in more detail.

The Modifications

The modifications for the Bent pyramid primarily concern the introduction of numerous small blocks of masonry, into the antechamber, lower chamber and upper chamber and possibly connected with these are the wooden beams. Generally these modifications are assumed to be contemporary to the structure; for example Monnier and Puchkov in their paper, see these modifications as a result of changes in plans and settlement issues. They believe that an original 157 meter pyramid of 60 degrees was planned and that *"The internal arrangement was restricted to the lower apartments. The 'chimney' must have been installed for a burial chamber which was never built"* This chimney *"was without doubt initially intended to lead to a burial chamber. Contrary to a widely held viewpoint then, the lower chamber does not seem to be such a burial chamber, but merely an antechamber.* They go on to say, *"The architect probably judged that the 'chimney' was too perilous to allow access to the funeral procession, and so an alternative arrangement had to be found."*

I have already dealt with the chimney and my reasons why I feel it was not intended for a burial chamber that was never built; but the idea that the whole lower system was abandoned because the chimney was too perilous makes no sense. This lower system required a huge amount of work and planning to create, the builders knew exactly what they were creating, they were not some novices, who would stand back and look at their work and say, that doesn't seem to work right, lets just scrap everything and make a whole new chamber system.

Monnier and Puchkov go on to suggest that the lower apartments where abandoned and the upper system of chambers and passages was started, they say chambers which is strange, as we only have the one upper chamber, which they seem to be content on, yet for the lower chamber they expect two chambers as they describe the lower chamber as an antechamber as the real chamber was to be accessed through the chimney; yet on the upper passage system they don't require a large antechamber.

The authors then go on to suggest that the upper chamber floor was raised twice, before the enlargement of the pyramid, why this was done they do not say, but they do say *"It is certainly not due to structural problems"*. The beams in the chamber they explain as, *"The Lebanon cedar framework is only found in the upper chamber, and preceded the stone filling in the*

chronology of the construction phases. Its existence can be explained by the fact that the walls of the room, like the corbelled courses, had to be supported for the few months or years which were required to raise them"

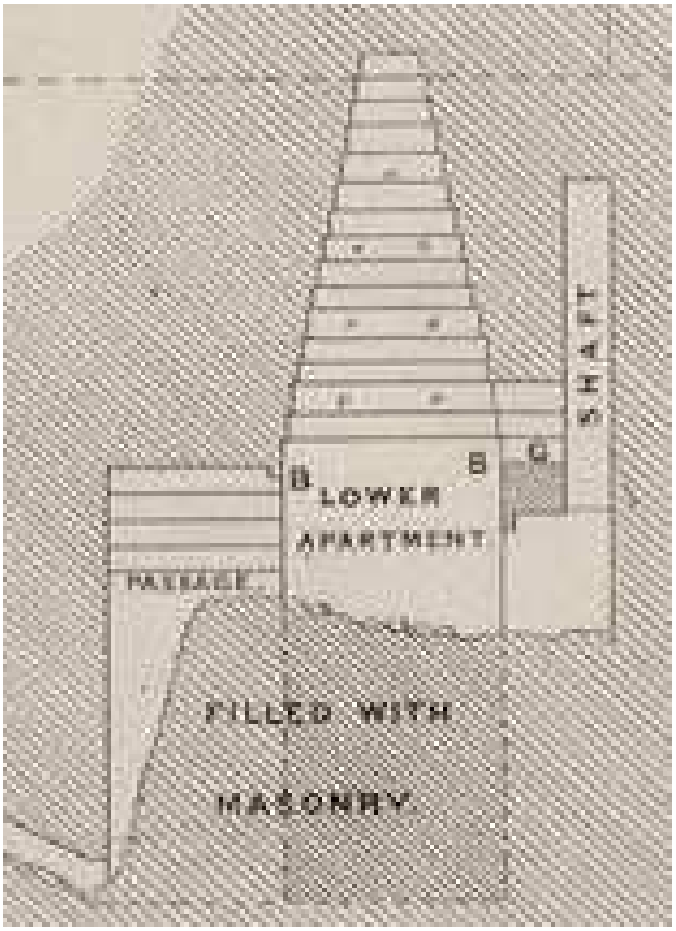
This idea of shoring the chamber walls makes little sense to me, these walls appear to be made of large horizontal blocks, from Hassan's and M&R's drawings, the two blocks at the end of the corridor on the north wall, have a length of about 2.3m and 1.25m, width unknown as it is covered by the massif masonry; we should expect sizeable blocks in the walls to support the large corbelled ceiling, the corbelled blocks themselves probably extended to a good depth, as given the modification done to them, the roof is still structurally sound. These large heavy wall blocks along with the corbel blocks, surely need no supporting yet the authors say *"the stoutness of the poles and their arrangement suggest that it was intended to counter lateral pressure on the walls and thus provide support until the floor had been built up."*

The two chamber systems are in close proximity to each other and likely all made in horizontal courses, this central core containing the chambers would most likely be constructed first and in horizontal courses; Charles Rigano, observed in the connecting tunnel, cut through pre-existing masonry, and found that the passage blocks were laid horizontally. It is likely these chambers in this core was completed early, before surrounding masonry of any great quantity was laid around them, whether there was inclined layers like at Meidum is not known, we only know that the outer casing is inclined.

Images of the beams appear to show that the finished walls have been chased down before the beams were inserted, possibly to prevent sideway movement of the beams. The impression is that these beams were inserted after the chamber was built, possibly as a scaffold for the massif itself. Whether beams existed in the lower chamber is not known, Fakhry says of the lower chamber *"We find in both the east and south walls the circular holes in which logs of cedar were put, but it is rather difficult to say if these logs existed in this chamber (embedded in the stone square blocks) a similar construction of cedar wood logs as the one discovered in the Upper Chamber in the year 1947."*

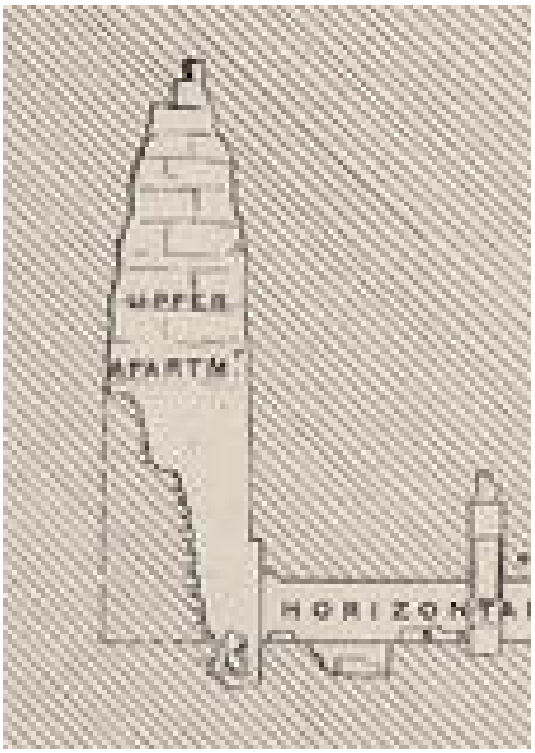
Perring's description of the lower chamber, *"It had been filled up with masonry of small squared stones, to a level with the top of the passage, which had also been in like manner built up. This masonry had been*

partially removed, but it probably now conceals a sarcophagus, or the entrance to a secret apartment."



In the drawing above by Perring, we see the level of small square blocks in his day; from his statement and drawing it seems he was unaware of the lower chambers floor, but assumed it to be at the same level as the antechamber's floor, and that the space was filled with blocks. We can see from this drawing that the lower chamber is mostly empty of the blocks, the original level of these blocks in the lower chamber is not known, Fakhry thought they reached up to the first corbel, M&R think they reached the sill of the window leading to the chimney; though M&R report that traces of mortar are present on the walls up to the height of the first corbel.

Also in this early drawing, he draws the supporting masonry under the lintel stone; M&R in their drawing suggest that the supporting masonry runs under the full length of the lintel block.



Perring's drawing of the upper chamber showing the massif of small stone blocks.

We will now look at some of the holes in the lower chamber, M&R say;

"In the overhangs of the east and west walls we have noticed a quantity of holes, almost all of them mutually corresponding on the two opposite walls: they were evidently lodgings for crossing beams. Some pairs of holes have a circular section and others a square section: a few holes have no correspondent on the opposite wall or the holes opposite them were filled up with mortar"

It is interesting to note that Perring appears to show some holes in the ceiling of the lower chamber, which may be the ones we see on page 39.

In the following selection of images of the lower chamber from ISIDA, it is not possible to give the exact location of the holes.

Circular impressions on corbel blocks

Close-up of circular depression

Hole filled with mortar?

Examples of square holes

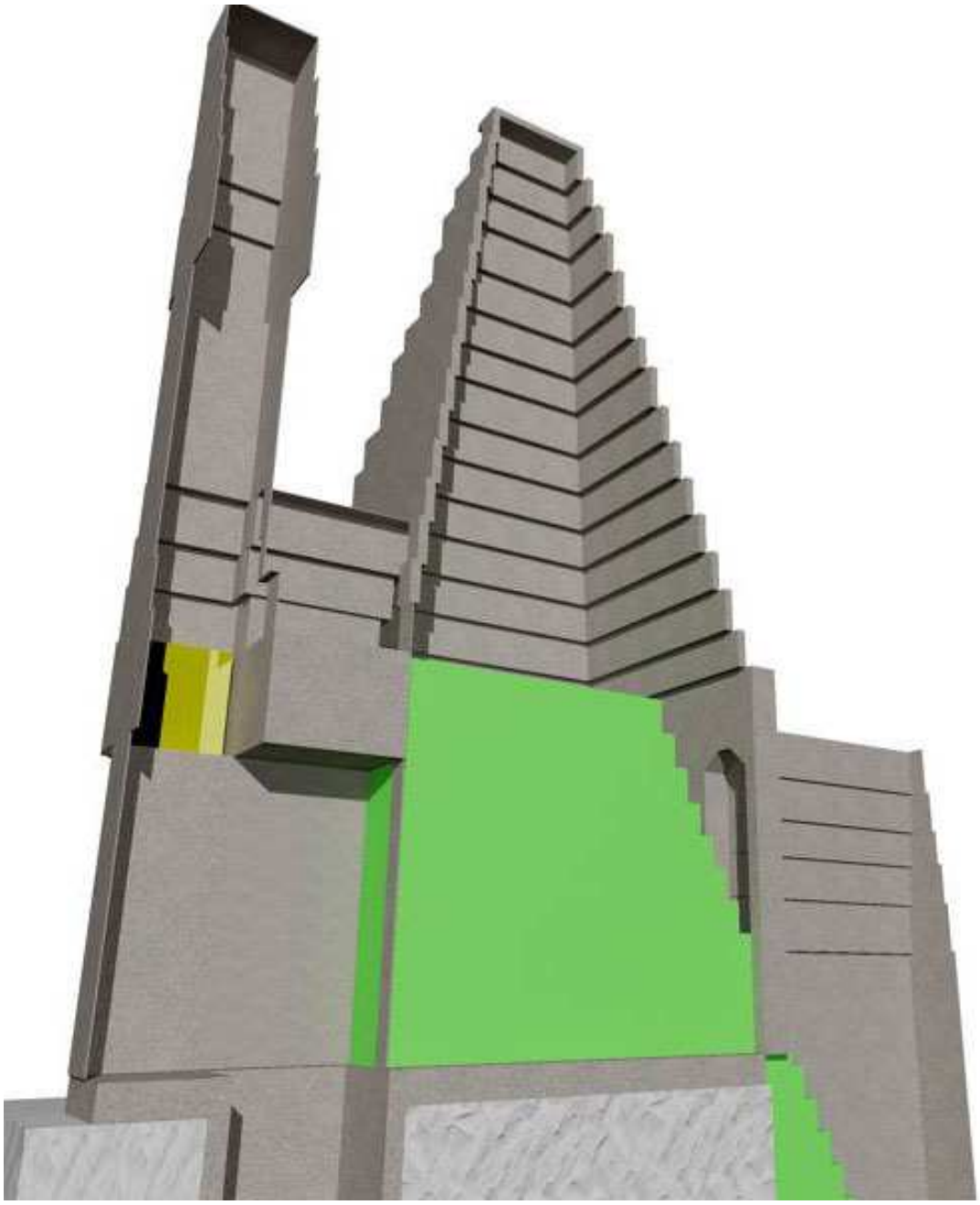
In the image above we seem to have circular impressions on one side and rectangular on the other,

There are so many holes and depressions throughout the lower chamber that they really all need to be catalogued, measured and exact locations given if we are to stand any chance of understanding their roles in this chamber.

The small blocks found in the antechamber are thought to have been used as a staircase up to the lower chamber, with risers of about 50cm and treads of 20.25cm, M&R state;

"The outline of the steps is particularly clear starting at about 1.50m from the floor of the antechamber. It is possible to see 11 steps which belonged to the middle part of the staircase and one which was probably the last step before entering the chamber"

It is thought that this staircase was carried on through the masonry structure in the lower chamber. M&R noted that the angle of this staircase if carried on would coincide with the entrance to the tunnel in the ceiling of the chamber.



Above we have a possible outline of what the staircase from the antechamber into the lower chamber may have looked like, this might explain the unusual shape we see to the chamber entrance, as it would have to be enlarged to allow the passage of people and goods.

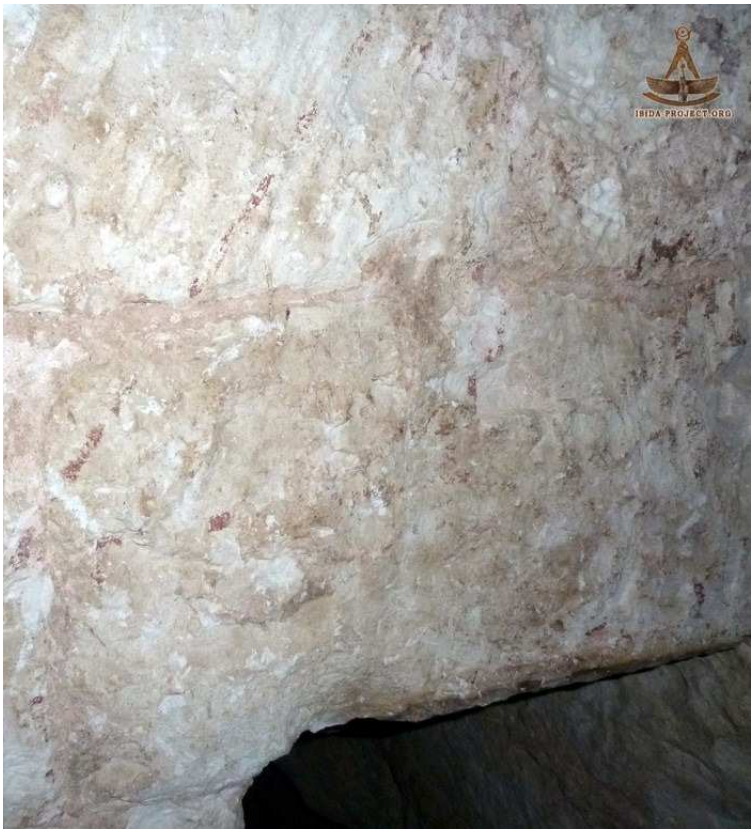
We will now take a look at some of the surviving masonry massif in the upper chamber.

Looking west from inside the upper chamber, the large block over the door has an angled cut and it has been suggested that this was modified to aid access to the massif. Like in the lower chamber, the entrance is offset from the wall by 27cm. The masonry massif can be seen on the right and is aligned with the corridors north wall.

In this view further back and taken from a modern ladder leading to the top of the massif, we get a better view of the south wall of the massif. These blocks are well squared and laid with mortar. Whether this construction method was used elsewhere is not clear, the loss of Hussein's notes is a severe blow on the blocks found in the other chambers; we can only hope that some old photographs may emerge that can help.

In this view a person lays by a hole that leads to an excavation under the nassif, which heads in a northward direction for over 2m and about .9m deep below chamber floor level and about 1m above floor level; the excavation believed to be by violators, only extends into the massif a short distance, the greater part is in the floor of the chamber Note the round hole in the massif wall and what appears to be a circular depression opposite in chambers south wall. In this excavation was found the only cartouche of Sneferu inside the pyramid, below floor level and painted upside down on the side of a block.

Looking down into the excavation under the massif and below, image of the excavation under the massif looking north.



Why this spot was chosen for excavation is not known, but it's interesting to see faint traces of red lines visible near it.

These blocks contain many mason and graffiti marks and some lines cross blocks, suggesting that these were made after the blocks were laid. Some drawings and photographs of these markings are in Fakhry's volume 1, no further information is given on them other than Fakhry's statement; *"Needless to say, all these quarry marks and graffiti which were embedded in the masonry are from the same period i.e. from Sneferu's reign, the time of construction of this pyramid."* On plate VI image A. there is a good picture of the stone blocks removed from the pyramid, piled in a large heap outside the north entrance.

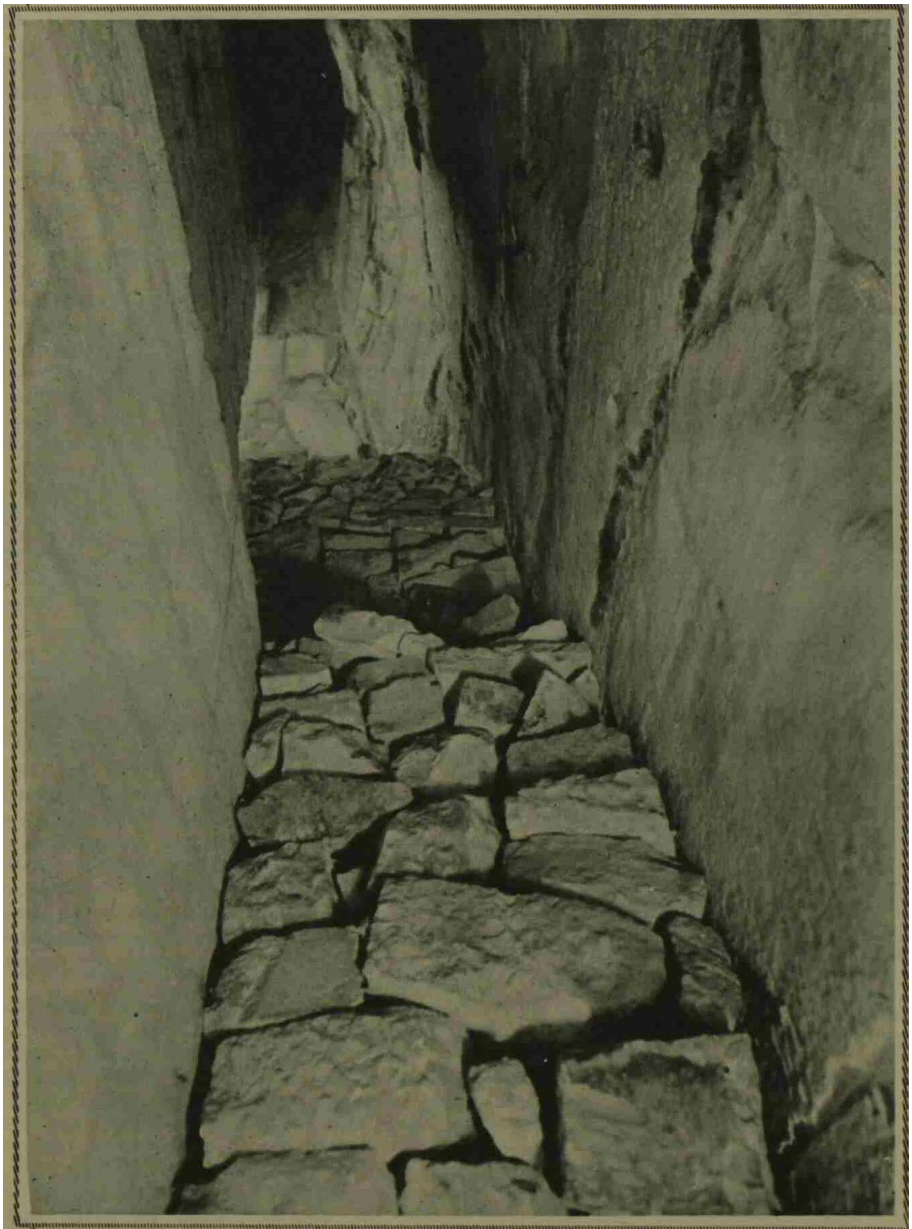


FIG. 9. LOOKING UP INSIDE THE UPPER CHAMBER OF THE PYRAMID: (RIGHT) THE WALL OF THE CHAMBER; (LEFT) THE INTERIOR BOX-LIKE STRUCTURE; AND (CENTRE) THE PACKED STONE WITH WHICH NEARLY ALL THE CHAMBER WAS FILLED.

All these stones removed are not the same, for example the image in the previous page from the Illustrated London News demonstrates two distinct types in the upper chamber. This view taken from the entrance with the well squared and mortared blocks of the massif's south wall to the left, upper chamber wall to the right and between them an apparent ramp made of shapeless and dry laid blocks, possibly made to afford access to the top of the massif. This rubble slope seems so out of place here, under this pile of loose stone that fills the gap between the massif and chamber wall, we do find well fitted and mortared blocks in the south east corner, forming what looks like a shaft and in this shaft another excavation has been made in the chambers south wall.

M&R thought that the presence of this well laid masonry could have been part of a staircase. *"Even though we did not find any traces, we think that there was a staircase in the southern part...It started at the level of the exit of the horizontal corridor and terminated at the level of P2* (This is first raised floor level 3.46m above original chamber floor) *afterwards it was prolonged to the level of P3."* (P3 is the second raised floor level, 6.54m above chamber floor) It is thought that this staircase necessitated the inclined cut in the stone above the entrance to improve access.

With the rubble ramp removed, we see the modern ladders and platform that provide access to the top of the massif.

Looking up the massif south wall, ladder to the right and the presence of two holes.

This view looking west, massif to right, chambers west wall in front and south wall left, note hole in south wall that appears to be paired with the hole in the massif wall.

Looking down the so-called shaft that looks like it has been made by massif blocks, an excavation can be seen in the chambers south wall and a circular hole is visible on the chambers east wall.

Looking into the excavation made in south east corner. A more detailed examination of this area is required to determine its true make up.

This view looking down from on top of the massif, we see the area cleared of stone blocks by Hussein, what we have left is the wooden beams. The horizontal beams span the distance between the east and west walls and from the drawings it appears that two of these beams were inserted, between each pair of vertical beams on the east and west walls; the uppermost beams are placed just below floor level of P2 while the lowermost beams are around 1.4m above the chamber floor. We can also see some of the original paving of P2 on top of the horizontal beams. Against the north wall we see three vertical beams that appear to have no function, maybe horizontal beams ran from them into the massif masonry, that have since been removed, during the dismantling of the massif; a closer examination of these beams would be useful to see if there is any witness marks on them.

The remnants of beams higher up on the east and west walls are in the area of P3 extension, but they could have been used in construction of P2, for example the hoisting of materials for the upper parts of P2. They appear to be located midway between the two floor levels of P2 & P3, currently we have two pairs, but like the beams below more may be buried in the remaining massif. Did these upper beams span the chamber? They have the appearance of being cut through, but when? Given the loss of Hussein's notes it might be beneficial to further remove some of the upper massif and see if an intact beam exists.

In this image we have a closer look at the remnants of the upper beams and if you look above we have two circular depressions; and like the lower chamber a thorough investigation is required to locate and catalogue all these holes etc, if we are to stand any chance of determining what has been going on in this chamber.

Here we see the horizontal beam abut against the vertical beam, how it is fixed is not known; it may have been banged in to create an interference fit.

In this view, the walls appear to be chased in for the beams and the gap between the corbel and beams filled with mortar.

Views from inside the massif

Blocks resting on chamber floor and good condition corbels

This picture is of the chamber floor and were the can is, should be the L-shaped keystone that Fakhry mentions, the area appears much damaged when you compare it to the pictures in Fakhry's plate XV.

Looking through the beams at the damaged ceiling.

A lone beam sits towards the top of the ceiling

A faint glimpse of surviving corbelling exists at the top

The damage is quite extensive

Views of plaster repairs


View of what is thought to be remnants of P3 floor level

The upper chamber is a very difficult chamber to describe and while the images from ISIDA are helpful, they often raise more questions. For some reason the chamber floor was raised (P2) to a height of 3.46m and some corbels appear to be cut back above this new floor, but not all, as can be seen in the picture on page 122. Then a higher new floor was decided upon (P3) at a height of 6.54m; it is thought that corbels were cut back above this floor to create a rectangular chamber for a certain height, wherein the remaining corbels progressed along their normal path to the ceiling top. Monnier and Puchkov provide some good drawings in their work as how the chamber may have progressed.

Cutting into the corbels deeply as they may have done is not advisable, an undercut corbel is losing support from below and gaining more stress from above; over time cracks could develop, causing parts of this corbel to break free, which in turn undermines the corbel above and so the cycle repeats itself.(The depth of the corbels into the walls is unknown, some possibly shorter than others) Given the 4.5 thousand years since its build, earthquakes and natural degradation processes of the limestone, maybe what we see in the ceiling above is the cumulative result of undermining the corbels, by raising the floor. If the floor had not been raised, in all probability what we might have seen today is a ceiling in as good a condition as we see in the lower chamber. Why they should raise the floors is a mystery, where the

chamber walls are visible through the clearance of the massif, they are in good condition; there is no sign of any structural problems that would necessitate the raising of the floor, not once but twice.

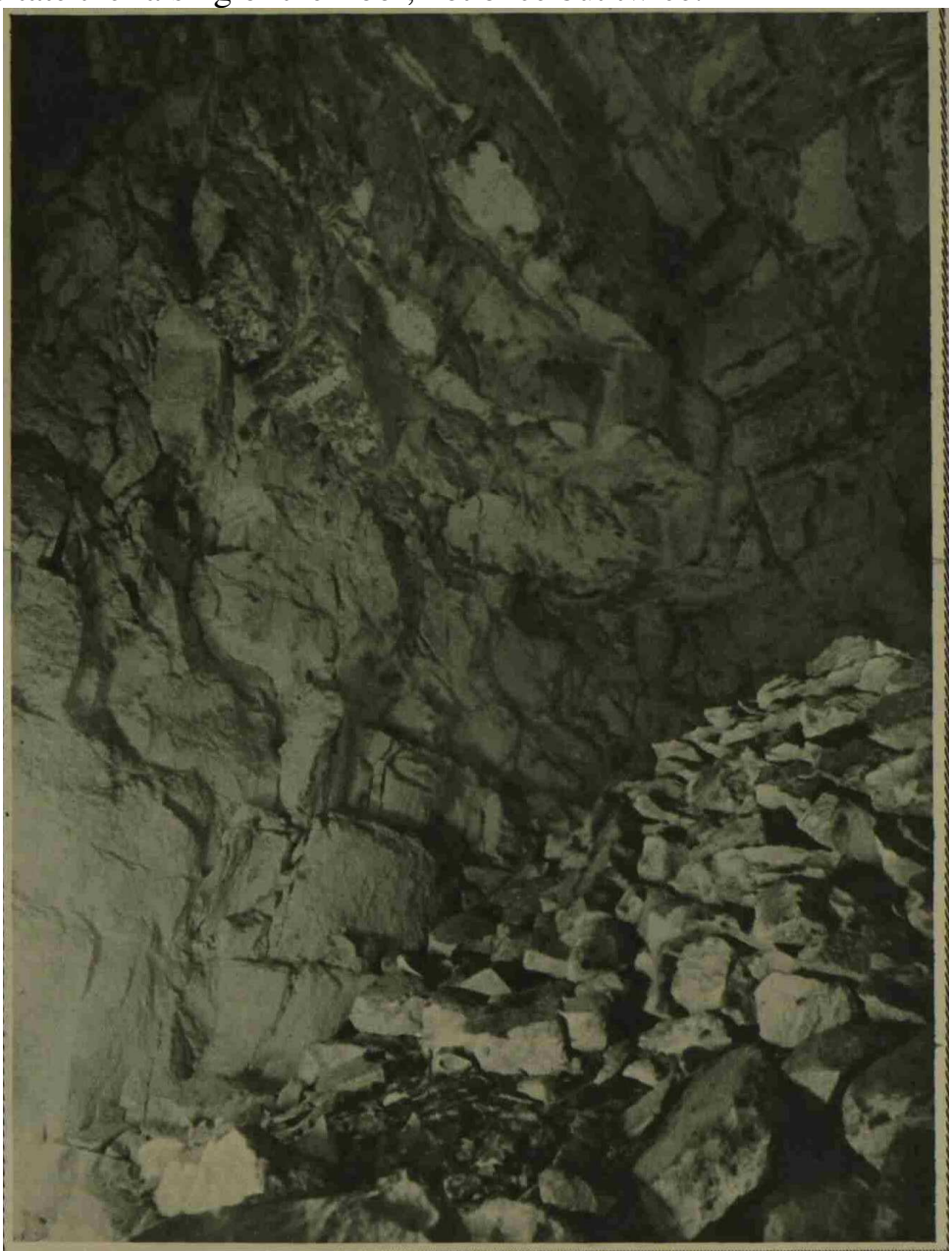


FIG. 8. THE ROOF OF THE UPPER CHAMBER OF THE PYRAMID, APPARENTLY CORBELLED AND CUT TO A ROUGH CURVF : THE CHAMBER WAS FILLED WITH STONE (FOREGROUND) WHICH MASKED AN INTERIOR BOX-LIKE STRUCTURE.

Debris from the roof resting on the massif floor, from the Illustrated london News, it may be a slow process as Fakhry states *"However, during the last twelve years no fragments of it have fallen."* Into this mix, we may also have violators causing damage, was the loose stone ramp quarried from the

ceiling, the ramp seems out of place, and was it made from a mixture of debris and fresh stone from the ceiling?

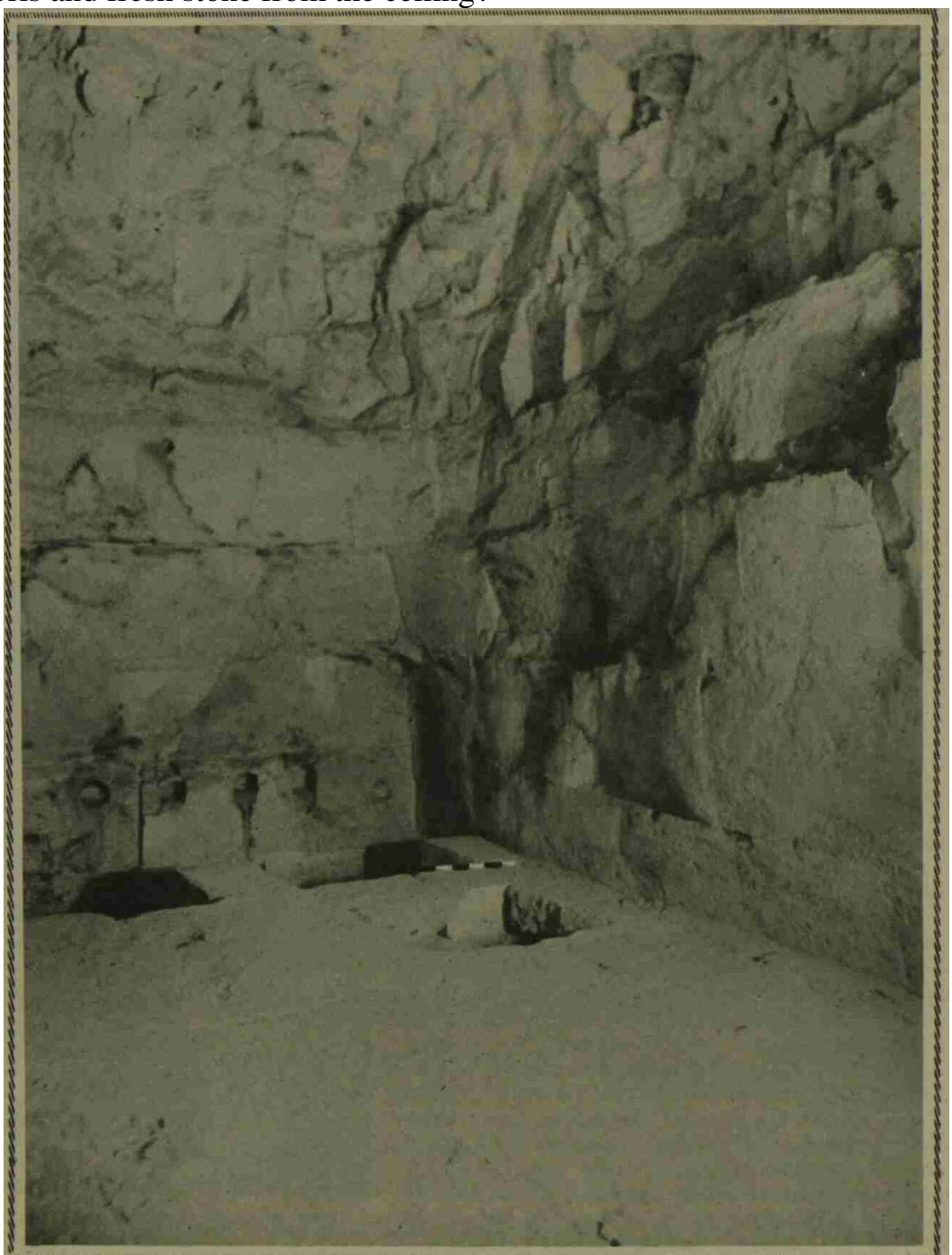


FIG. 10. INSIDE THE UPPER CHAMBER AND ON TOP OF THE INTERIOR BOX-STRUCTURE: IN FRONT OF THE SCALE CAN BE SEEN AN ATTEMPT BY ANCIENT TOMB-ROBBERS TO BREAK INTO THE BOX.

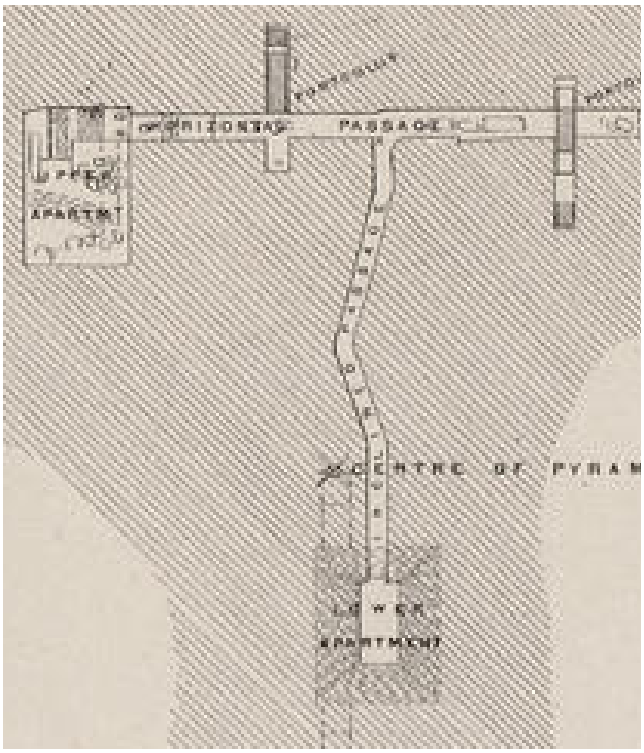
Again from the Illustrated london News we see the floor of the massif and further attempts by violators.

We now turn our attention to the connecting tunnel, cut through pre-existing masonry, which emerges into the horizontal corridor. According to Monnier and Puchkov, concerns over settlement caused the architect to abandon the western corridor and plug the corridor with blocks in an attempt to strengthen the masonry; as this route was no longer available a new route had to be found to the upper chamber and so the connecting tunnel was decided upon. I have several issues against this idea, not least the idea of settlement attributed to this corridor and here Fakhry has done us no favours by not properly recording the plugs in the corridor, no pictures or measurements, his attentions were elsewhere.

But even if this scenario was decided upon, would it not make more sense to dig the connecting tunnel from both directions, was the closure of the western corridor so urgent, that it could not wait until the connecting tunnel was made. Digging from both ends would be quicker, the entrance into the horizontal corridor could be carefully chosen with respect to the already laid masonry so has not to structurally undermine it; surely if they were so concerned about settlement, the last thing you would think they would do was dig a blind tunnel from the lower chamber, with little regard as to where it would break into the corridor.

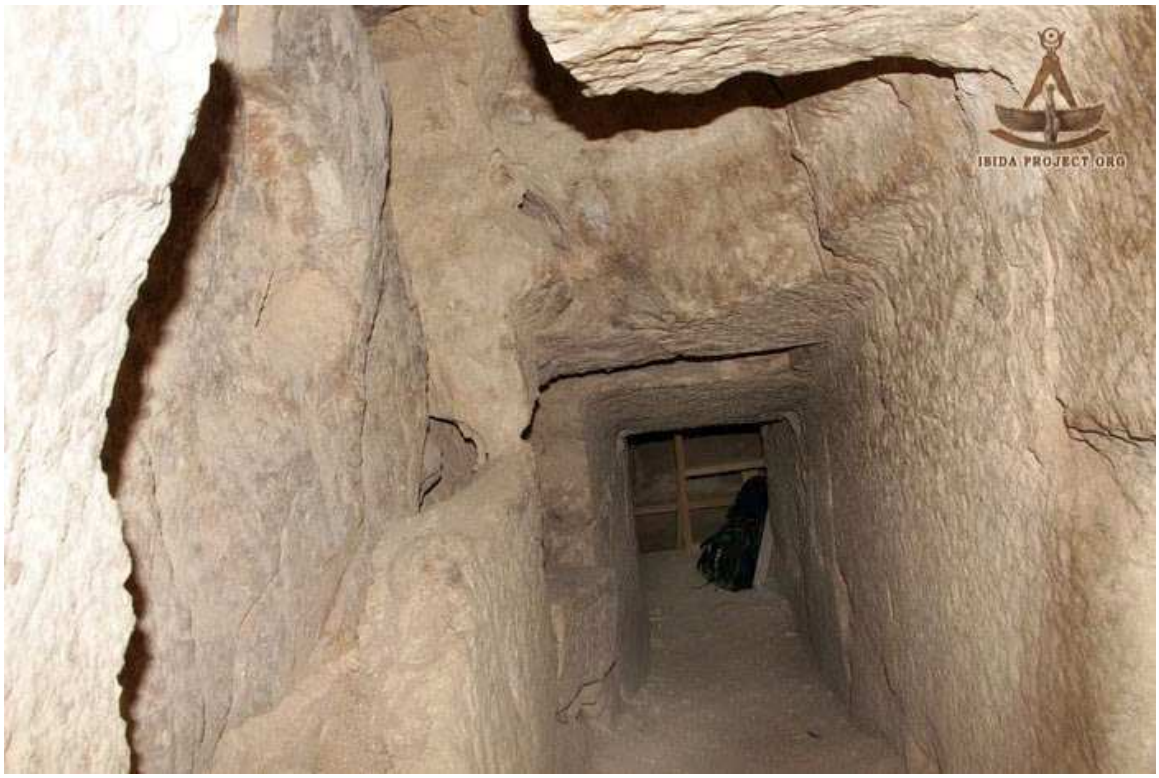
The floor of the tunnel starts some 12.60m above the lower chamber floor, and the entrance mouth is 92cm by 74cm, this entrance has been cut through the entire height of the 10th corbel and some 23cm of the top of the corbel below. Positioned in the centre of its corbel, the spot may have been chosen as the best compromise in height proximity to the western corridor and space between the adjacent ceiling corbels that would allow items of a certain size in or out. In Perring's time a papyrus rope was hanging from this entrance.

The route of the tunnel appears to exhibit a steady incline up towards the western corridor, its route is not straight, Perring says, *"This cutting, 61 feet 8 inches in length, was not straight nor regularly formed, but was slightly inclined upwards."* M&R say *"It is not straight but bends first eastwards, then westwards and again southwards, therefore its outlet is almost exactly south of the entrance. It is about 18.80m long and slopes constantly upwards: its average dimensions are 0.74m in width and 0.92m in height."* This 18.80m equates exactly to Perring's measure so maybe they have used it, also Fakhry gives the entrance opening as 0.74m x 0.92m. The drawings of the tunnel in Fakhry's volume 1, do not match those of Perring or M&R, though Hassan's survey drawings in the same volume do.



The drawing above by Perring shows the route from the lower chamber to the horizontal corridor. Why this route deviated is not known, Fakhry thought, *"it is possible that it was cut in this way to make it safer for those who used it because if it were cut straight it would be a source of danger if any one lost his hold."* It may also be a method for the tunnellers to protect themselves from falling masonry, after all they were digging blind into already laid masonry, the risk would exist that some masonry could be dislodged and tumble down the tunnel, possibly even into the lower chamber itself. This bend in the tunnel could possibly slow or arrest any wayward masonry that should try to escape. Whatever its reason, they were fairly confident as to the tunnels final destination, the chamber layout was obviously well known to them, the exit into the horizontal tunnel appears to coincide with the bottom of the corridor wall courses, though below the thick paving stones, not a bad result.

In this image we are looking into the entrance of the tunnel. The 10th corbel is completely cut through for a width of 74cm; the top of the corbel below has also been cut through to a depth of 23cm. It would be beneficial for the joints to be carefully examined in this area, this tunnel affords us the chance to see how they laid the corbels, their depth back into the wall and supporting masonry behind, this can help us better assess the damage to the upper chamber ceiling. A tunnel was cut into the niche of the Queens Chamber in the Great Pyramid; this went through some 7m of well dressed and squared limestone blocks and was followed by the usual nucleus masonry which where roughly dressed.



In the image above we are looking down the tunnel to the entrance and the scaffold in the lower chamber

In this image we turn around and face south, the cutting in the wall to the right is the cutting we see in the left of the top image. Here we see the tunnel veer to the east.

The following images I am unable to locate in the tunnel.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ISIDA-PROJECT.ORG

In the image above, location unknown inside the tunnel, we see rough masonry with generous use of mortar to fill the spaces. Below we see the tunnel exit, and again close examination of the masonry needs to be done.

Trying to make sense of it all

Trying to knit these disparate features together to make some sense is very difficult; we basically know very little about the structure, it still awaits proper investigation, but from what little information we have, I get the feeling that these modifications may be the result of later intrusive activities. We have seen the strange insertion of the mummy box in the western corridor, possibly Saite era (26th dynasty), during the Saite era, there appears to be an old kingdom revival and interest in these structures, as evidenced by the coffin box found in Menkaure's pyramid, Mark Lehner from his *Complete Pyramids book* states;

"The sarcophagus contained a mystery – a wooden coffin inscribed for Menkaure as though it was the coffin in which he was laid to rest. But its style dates it to the Saite period at the very earliest. Radiocarbon dating has proved that the human bones found in the upper chamber date to the Christian period. Recent radiocarbon dating of mummy parts from Djoser's burial vault show them to be much later than the 3rd Dynasty, while female bones from under the step pyramid date centuries earlier than Djoser. Such findings suggest that burial practices in pyramids were more complex than we can appreciate."

It is highly likely that all these pyramids were violated in the Old Kingdom; some may have been usurped or restored in the same era or in different periods of Egyptian history, multiple times even. These huge structures would always attract plenty of interest; some of this interest might be benevolent to the structure, while some interest was more geared towards looting.

In the case of the Bent pyramid there appear to be many examples of so-called robber excavations, one in particular is of interest; at the base of the southern rock wall of the antechamber we have an excavation that goes back about 2m and is about 1.5m high, M&R say;

"The beginning of a digging is visible in the rock of the lower part of the south side of the antechamber: in all probability it was not made by thieves and might therefore be original"

M&R are not so reluctant to comment on excavations that have been made elsewhere such as the one found against the south wall of the chimney in which they say of this digging "*probably due to a trial digging of violators."*

Their reluctance in assigning the antechamber digging to thieves is obvious, as it would disturb the narrative that is generally accepted for this structure, for if this digging in the antechamber was done by thieves, it would pre-date the installation of the stone staircase; or put another way, the pyramid had already been violated.

A similar situation may exist in the lower chamber, Fakhry says of this chamber, *"The lower chamber was filled with small square blocks up to the corbellment line, which were partly removed by treasure hunters in ancient times and partly by Perring, while the remainder were completely removed between 1946-48"* It is clear from Perring's report (which Fakhry describes as *"the work of Perring on this pyramid remained until 1946 the main source of information"*) that he never saw the chamber floor and that he believed it was full of these blocks down to the antechamber floor and that it might conceal a sarcophagus. So the following statement by P.A.J. Garnons Williams in the Illustrated London News. March 22, 1947, is interesting;

"The first problem which confronted the excavators was to clear completely the passage and the lower chamber of the stone packed into them. This work revealed a pavement of large limestone blocks which covered the lower chamber and the floor of the shaft. ***This pavement had been cut in several places by robbers in their efforts to find the entrance to the tomb chamber.****"*

The highlighted part is clearly interesting, as again it might suggest that the structure was violated prior to the installation of the stone blocks. In the lower chamber there is damage to the walls, noted by Perring, *"because most of the faulty places have been covered over with plaster".* If the lower chamber is mostly tiled as I suspect, they would be more susceptible to injury by violators or 4.5 thousand years of natural degradation; the plastering repairs need not be contemporary to the structure but a later repair. The small nature of the blocks introduced into the chambers, could be a practical and manageable size that could be introduced, given that the pyramid had already been completed. A scenario could be envisioned were either through repair or usurpation, it was deemed that the plaster repairs to the walls where not sufficient, and so the floor was raised, the room filled

with blocks to hide the walls and the staircase added in the antechamber to provide access to the new chamber floor, necessitating the enlargement of the chamber door. Maybe it was thought to replicate this in the upper chamber, even though these walls appear in good condition, where they are visible.

The wooden scaffold in the upper chamber appears to be more related to the building of the massif, and the size of these beams could not have been brought up through the tunnel but only through the western corridor, which means the passage must have been free of plugs at this time. No one knows were Sneferu is buried, Egyptologists believe he built three large pyramids (Though I have my doubts on Meidum) and some believe he was buried in the Red pyramid. Possibly this pyramid was not intended for use by Sneferu, if this was the case, why plug the western corridor and if the intention was to always plug this corridor what was the point of the portcullises, surely 67m of plugged corridor was sufficient deterrence. Maybe the original plan was just to use the portcullises and an entrance closing stone, the western entrance being deemed high enough to be out of reach and detection, while in the north corridor the new steeper extension was designed to be plugged down to the continuous joint, to deter thieves who could easily find this entrance being so close to the ground.

How this pyramid was left security wise if Sneferu did not require it, is unknown, it could have been left with simple wooden doors at the entrances or single closing stones; the portcullises in the horizontal corridor would be left open, a pyramid in storage while the Red pyramid was constructed and awaiting Sneferu's decision. If Sneferu decided to use a different structure, what would become of the Bent pyramid? Regardless of how the pyramid was left, it would still attract the attention of violators and damage would ensue; possibly repairs were effected to the structure as a result, or the structure usurped. The new constructions made by the blocks found in both passage systems was built, the portcullises left open, and in place the western corridor was better secured by plugging its length. If the structure was usurped and a new burial introduced into the upper chamber, the P3 floor level would hold less equipment due to its reduced size, and maybe the horizontal corridor was used for storing equipment, which may explain why the eastern portcullis was not used. The function of the lower chamber is not clear, but it's probable the northern corridor was plugged in the upper extension.

Violators would return, maybe even state sponsored, more likely they knew the exact layout and security features of the structure, its possible some where involved in its construction. They were not going to waste time hacking through some 67m of plugged western corridor; their route would be through the north entrance to violate the lower chamber and then hack their way through 19m of masonry to break into the horizontal corridor and violate the upper chamber. The tunnel was accurate; they knew where they were going, just as the violators knew, when they tunnelled into mastaba17 at Meidum.

Having arrived on top of the massif, some 6.5m above the original chamber floor, was a heavy object of some value required to be removed. Was the solution to create a rubble ramp down the gap that existed between the massif and the chambers south wall? Violators would not go to the trouble of introducing large quantities of stone into the pyramid from outside to build a ramp, when above them they found a likely quarry in the form of the ceiling above them; this could be the source of the stone that built the ramp and the cause for the strange damage we see today. This stone has long been cleared away and presumed dumped somewhere along with the removed massif blocks; it would be useful if it could be found and examined, to see if fragments of the corbel edges can be found.

Having brought the item down the rubble ramp (could the inclined cutting above the doorway be made at this time?), its journey would continue along the horizontal corridor and to the next obstacle, the tunnel entrance in the north wall and here Perring notes how a corner of the entrance had been rounded and a small recess cut on the opposite side of the horizontal corridor *"apparently for the conveyance of a long solid body into the lower apartment"*

When this possible sequence of events took place is not known, possibly in the Old Kingdom, we have to take into account the quarry markings and graffiti found on some of these blocks which Fakhry says is from Sneferu's reign. How he makes this determination is not clear, Sneferu's name does not appear on any of the small blocks and has the style of quarry markings etc changed much over the period of the Old Kingdom. It's likely our knowledge of hieroglyphs and markings of this period is more advanced than in Fakhry's day and these blocks should be revisited with a more forensic eye to see if they can shed more light. We also need to take into account the possibility that any usurper doing these modifications would

have no problems in utilizing any pre-existing building in the vicinity, which could provide an easy source of building materials; The Pyramid of Amenemhet I (12th Dynasty) comes to mind here and the reuse of blocks with relief from earlier Old Kingdom structures. But in all likelihood I feel it was probably more likely done in the Old Kingdom.

It is very likely people have been in and out of the structure throughout Egyptian history, the mummy box is interesting as it provides a narrow timeframe as to its intrusion, why is a mystery as is the strange cutting nearby in the south wall that held two wooden beams and partial removal of the paving; can we imagine a Saite period burial in this area perhaps? And lowering of the western portcullis to protect it, which in turn was violated later by breaching the top corner of the portcullis. It might seem a strange place for a burial, but then again, someone chose to be buried in the passage of the Meidum pyramid temple with the entrance walled up.

I feel it is unwise to assume everything we see in the Bent pyramid is contemporary to Sneferu, like a Russian doll; there could be many layers of occupation.

Conclusion

This paper is an amateur layman's attempt to try and explain the strange features we see in the Bent pyramid, no doubt there will be error's, but given the scant information on this structure a lot of speculation has to be made. Pending a thorough exploration of the structure any theory, including the position held by Egyptology on this pyramid can only be a theory. Under no terms could this pyramid be described as thoroughly investigated; Perring's work was the primary resource up to 1946, Hussein's work is lost to us apart from some photographs and newspaper articles, Fakhry's interest lay elsewhere and the one job he was tasked with, the clearing of the western corridor, was poorly done. M&R's work is the more detailed source and though I am an admirer of their work, there are areas I have difficulty in agreeing with, primarily this would be to do with the issue of settlement and its effects. I have to take into account the views of engineers and how it affects the standard narrative that Egyptology holds today; this narrative I have discussed in my previous paper and in completing this paper there is nothing new to change my mind on the issue of settlement.

The issue of settlement has bedevilled this structure since Perring first used the term and it has been used regularly to form theories on how the structure achieved its form. M&R's opinion is accepted as fact, it requires no further scrutiny; but to me it is just another unproven theory. Their discovery of a 60 degree pyramid is again an unproven theory (I don't doubt that the Egyptians had the technical ability to build such an angle, that they chose not to, throughout their history is telling), these continuous joints that lead to the 60 degree pyramid can be explained by the use of a step structure, which we do have evidence of in other pyramids. (Again this is detailed in my previous paper)

The settlement drawn by M&R in the western corridor I have already questioned, likewise the large so-called settlement in the northern corridor is given scant analysis in their work and drawings; the idea that it could be built that way is dismissed as is Petrie's suspicions when he first described it. Having found a so-called 60 degree pyramid, maybe it suited them that this was settlement, the silly builders had gone and piled tons of masonry against a 60 degree slip plane, something was surely going to give.

My conclusion having looked at what little evidence we have, is that both chambers and passage systems where most likely planned from the very beginning; I see no need to invent the bogyman of settlement to explain its design, or 60 degree pyramids, but rather a successful build and would concur with one of the world's finest structural engineers, Steve Burrows, who on conclusion of his research on the Bent Pyramid, says *"by structural analysis this was designed like this. It hasn't failed; this is actually a great success"*

In my previous paper I mentioned how I felt that *the illusory truth effect* best explains how we have arrived at the narrative provided by Egyptologists; this is not surprising given the poor level of exploration afforded to the structure. There is a plethora of books by Egyptologists, where a few pages is given over for each pyramid, generally, especially in the case of the Bent pyramid it just repeats what the previous generation had to say; this is not surprising given that possibly a lot of these authors have not been inside the structure; it appears closed and off limits for a considerable time.

But I feel there is a greater malaise at work when it comes to the discipline of Egyptology and that is that they appear indifferent to the pyramids themselves; one gets the impression that they don't like pyramids. When one

compares the large amount of work and excavation done at the Valley temple, which I have no problem with, it has produced great results; but then I have to ask myself why there is not the same level of activity and scrutiny afforded to the Bent pyramid itself. One only has to read Fakhry's 3 volume work to see where the interest and priority lies; this indifference is not unique to the Bent pyramid but sadly appears widespread. Maybe pyramids are not nice environments to work in but the work and proper scrutiny needs to be done.

To me the real mystery of the Bent pyramid is why it has never been properly explored; here we have one of the greatest structures built in the ancient world and no one appears interested in it. Our exploration of it is derisory, we have no accurate internal survey of it, can anyone say with accuracy where the bend in the western corridor begins or the location of the chimney etc; in short, it is one almighty mess. Where exactly is the detailed forensic research on this structure? I don't think I am unreasonable in asking Egyptology why has there not been any detailed forensic exploration of this structure. In truth we know little more than in Perring's day, the recent scan pyramids project tells us little; what is needed is a detailed exploration to determine the makeup of this structure, for example is the antechamber and lower chamber walls tiled? So much work remains to be done, if we are to stand any chance of understanding this structure.

Sadly I feel the interest in Egyptology is not there to examine the Bent pyramid and I have little doubt that this state of affairs will remain for many years to come.

The remainder of the Bent pyramid complex will be discussed in Part 2.