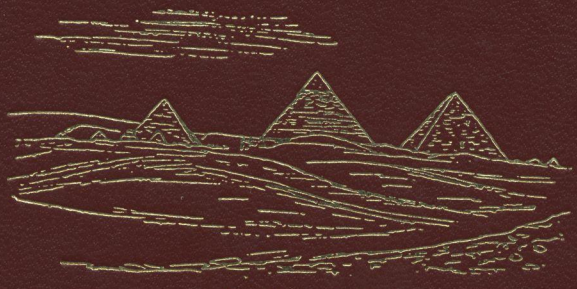
THE PYRAMIDS AND TEMPLES OF GIZEH



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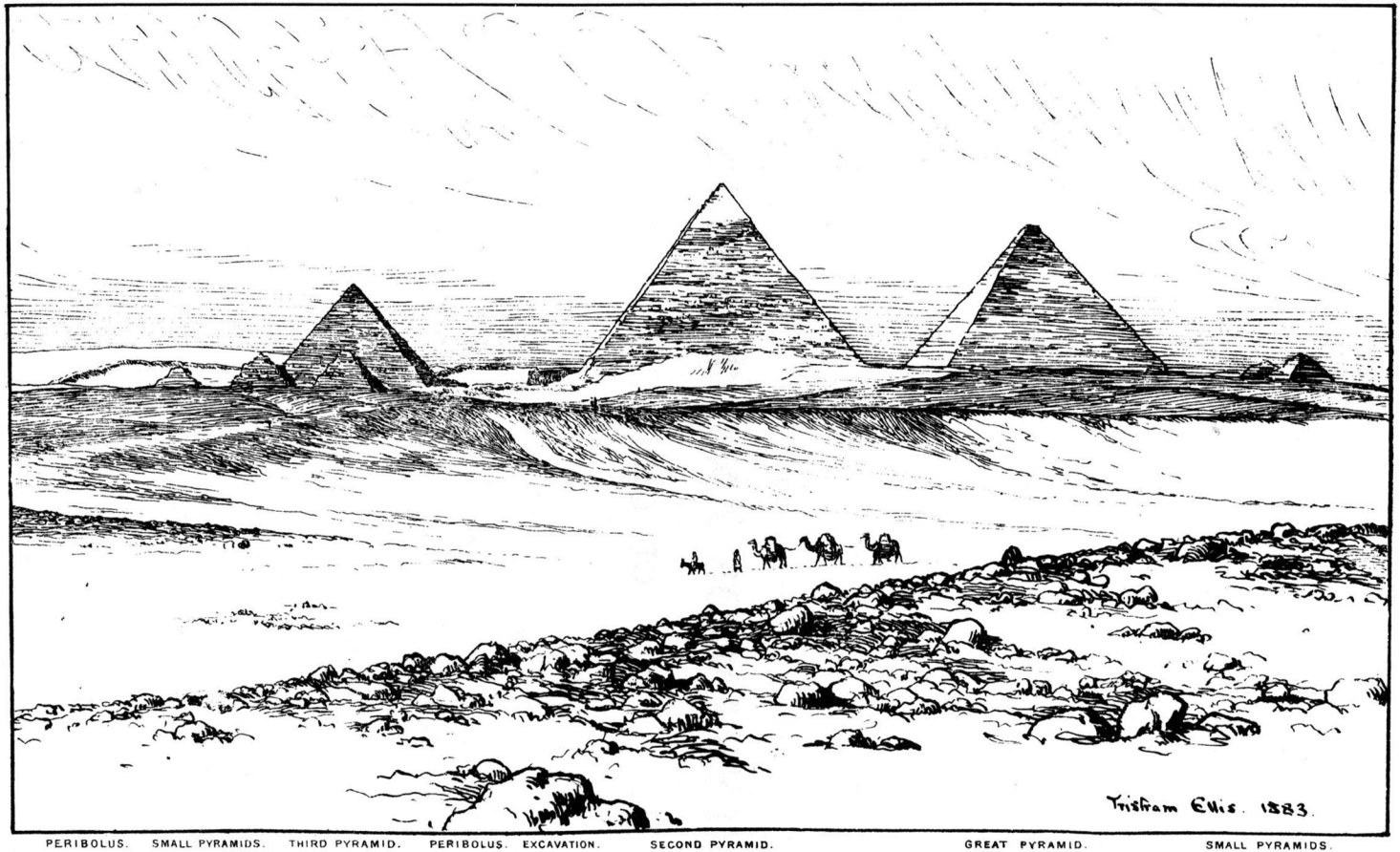

PERIBOLUS. SMALL PYRAMIDS. THIRD PYRAMID. PERIBOLUS. EXCAVATION. SECOND PYRAMID. GREAT PYRAMID. SMALL PYRAMIDS.

THE NINE PYRAMIDS OF GIZEH.

FROM THE SOUTH.

THE

PYRAMIDS AND TEMPLES

OF GIZEH.

BY

W. M. FLINDERS PETRIE,

Author of "Inductive Metrology," "Stonehenge," "Tanis," &c.

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1883.

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LIST OF PLATES.

PREFACE TO THE SECOND EDITION.

THE first edition of this work having been exhausted in a few months, the present edition makes its appearance so soon as my other researches in Egypt will allow of my attending to it. But in thus reissuing it, there did not seem any necessity to reproduce a quantity of matter which was only of technical interest to surveyors or mathematicians; or to provide again the many incidental details of accuracy which are requisite to render a scientific memoir of permanent value. Those students of the subject who really require to know how every result has been obtained, will probably be already furnished with the full edition, and, if not, can refer to it in libraries; and any critical remarks on the details of the work should be based on the original memoir, and not on this edition, which is intended for more general reading. In many cases I have summarized the results of long tables into a few lines, but nothing which could be considered readable has been omitted from this edition.

BROMLEY, KENT,
January, 1885.

W. M. F. P.

INTRODUCTION.

THE present work rests upon several different methods of inquiry, which are not often brought together; and hence different parts of its treatment appeal to different classes,—to the antiquary and the engineer,—the historian and the architect. An investigation thus based on such different subjects is not only at a disadvantage in its reception, but also in its production. And if in one part or another, specialists may object to some result or suggestion, the plea must be the difficulty of making certain how much is known, and what is believed, on subjects so far apart and so much debated.

The combination of two apparently distinct subjects, is often most fertile in results; and the mathematical and mechanical study of antiquities promises a full measure of success. The object is to get behind the workers, and to see not only their work, but their mistakes, their amounts of error, the limits of their ideas; in fine, to skirt the borders of their knowledge and abilities, so as to find their range by means of using more comprehensive methods. Modern inquiry should never rest content with saying that anything was "exact"; but always show what error in fact or in work was tolerated by the ancient worker, and was considered by him as his allowable error.

The materials of the present volume have been selected from the results of two winters' work in Egypt. Papers on other subjects, including the Domestic Remains, Brickwork, Pottery, and travellers' *graffiti*, each of which were examined with special reference to their periods, have been published by the Royal Archæological Institute. The mechanical methods and tools employed by the Egyptians were discussed at the Anthropological Institute, and are more summarily noticed here. The lesser subjects being thus disposed of, this volume only treats of one place, and that only during one period, which was the main object of research.

Though, in describing various features, reference has often been made to the publications of Colonel Howard Vyse * (for whom Mr. Perring, C.E., acted as superintendent), and of Professor C. Piazzi

* "Operations at the Pyramids," 3 vols. 1840.

Smyth,* yet it must not be supposed that this account professes at all to cover the same ground, and to give all the details that are to be found in those works. They are only referred to where necessary to connect or to explain particular points; and those volumes must be consulted by any one wishing to fully comprehend all that is known of the Pyramids. Colonel Vyse's volumes are most required for an account of the arrangements of the Second and smaller Pyramids, of the chambers in the Great Pyramid over the King's Chamber, of the negative results of excavations in the masonry, and of various mechanical details. Professor Smyth's vol. ii. is required for the measurements and description of the interior of the Great Pyramid. While the scope of the present account includes the more exact measurement of the more important parts of the Great Pyramid, of the outsides and chambers of the Second and Third Pyramids, and of the Granite Temple; also the comparison of the details of some of the later Pyramids with those at Gizeh, and various conclusions, mainly based on mechanical grounds.

The reader's knowledge of the general popular information on the subject, has been taken for granted; as that the Pyramids of Gizeh belong to the first three kings of the fourth dynasty, called Khufu, Khafra, and Menkaura, by themselves, and Cheops, Chephren, and Mycerinus, by Greek-loving Englishmen; that their epoch is variously stated by chronologers as being in the third, fourth, or fifth millennium B.C.; that the buildings are in their bulk composed of blocks of limestone, such as is found in the neighbouring districts; that the granite used in parts of the insides and outsides was brought from Syene, now Assouan; and that the buildings were erected near the edge of the limestone desert, bordering the west side of the Nile valley, about 150 feet above the inundated plain, and about 8 miles from the modern Cairo.

One or two technical usages should be defined here. All measures stated in this volume are in Imperial British inches, unless expressed otherwise; and it has not been thought necessary to repeat this every time an amount is stated; so that in all such cases inches must be understood as the medium of description. Azimuths, wherever stated, are written + or −, referring to positive or negative rotation, *i.e.*, to E. or to W., from the North point as zero. Thus, azimuth −5′, which often occurs, means 5′ west of north. Where the deviation of a line running east and west is stated to be only a few minutes + or −, it, of course, refers to its normal or perpendicular, as being that amount from true north.

The probable error of all important measurements is stated with the sign ± prefixed to it as usual. A full description of this will be

* "Life and Work at the Great Pyramid," 3 vols. 1867.

found in any modern treatise on probabilities; and a brief account of it was given in "Inductive Metrology," pp. 24–30. I will only add a short definition of it as follows:—The probable error is an amount on each side of the stated mean, within the limits of which there is as much chance of the truth lying, as beyond it; *i.e.*, it is 1 in 2 that the true result is not further from the stated mean than the amount of the probable error. Or, if any one prefers to regard the limits beyond which it is practically impossible for the true result to be, it is 22 to 1 against the truth being 3 times the amount of the probable error from the mean, 144 to 1 against its being 4 times, or 1,380 to 1 against its being as far as 5 times the amount of the probable error from the mean result stated. Thus, any extent of improbability that any one may choose to regard as practical impossibility, they may select; and remember that 4 or 5 times the probable error will mean to them the limit of possibility. Practically, it is best to state it as it always is stated, as the amount of variation which there is an equal chance of the truth exceeding or not; and any one can then consider what improbability there is in any case on hand, of the truth differing from the statement to any given extent.

It should be mentioned that the plans are all photolithographed from my drawings, in order to avoid inaccuracy or errors of copying; and thence comes any lack of technical style observable in the lettering.

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

The

Pyramids and Temples of Gizeh.

CHAPTER I.

OBJECTS AND METHODS.

THE small piece of desert plateau opposite the village of Gizeh, though less than a mile across, may well claim to be the most remarkable piece of ground in the world. There may be seen the very beginning of architecture, the most enormous piles of building ever raised, the most accurate constructions known, the finest masonry, and the employment of the most ingenious tools; whilst among all the sculpture that we know, the largest figure—the Sphinx—and also the finest example of technical skill with artistic expression—the Statue of Khafra—both belong to Gizeh. We shall look in vain for a more wonderful assemblage than the vast masses of the Pyramids, the ruddy walls and pillars of the granite temple, the titanic head of the Sphinx, the hundreds of tombs, and the shattered outlines of causeways, pavements, and walls, that cover this earliest field of man's labours.

But these remains have an additional, though passing, interest in the present day, owing to the many attempts that have been made to theorise on the motives of their origin and construction. The Great Pyramid has lent its name as a sort of by-word for paradoxes; and, as moths to a candle, so are theorisers attracted to it. The very fact that the subject was so generally familiar, and yet so little was accurately known about it, made it the more enticing; there were plenty of descriptions from which to choose, and yet most of them were so hazy that their support could be claimed for many varying theories.

Here, then, was a field which called for the resources of the present time for its due investigation; a field in which measurement and research were greatly needed, and have now been largely rewarded by the disclosures of the skill of the ancients, and the mistakes of

the moderns. The labours of the French Expedition, of Colonel Howard Vyse, of the Prussian Expedition, and of Professor Smyth, in this field are so well known that it is unnecessary to refer to them, except to explain how it happens that any further work was still needed. Though the French were active explorers, they were far from realising the accuracy of ancient work; and they had no idea of testing the errors of the ancients by outdoing them in precision. Hence they rather explored than investigated. Col. Vyse's work, carried on by Mr. Perring, was of the same nature, and no accurate measurement or triangulation was attempted by these energetic blasters and borers; their discoveries were most valuable, but their researches were always of a rough-and-ready character. The Prussian Expedition sought with ardour for inscriptions, but did not advance our knowledge of technical skill, work, or accuracy, though we owe to it the best topographical map of Gizeh. When Professor Smyth went to Gizeh he introduced different and scientific methods of inquiry in his extensive measurements, afterwards receiving the gold medal of the Royal Society of Edinburgh in recognition of his labours. But he did not attempt the heaviest work of accurate triangulation. Mr. Waynman Dixon, C.E., followed in his steps, in taking further measurements of the inside of the Great Pyramid. Mr. Gill—now Astronomer Royal at the Cape—when engaged in Egypt in the Transit Expedition of 1874, made the next step, by beginning a survey of the Great Pyramid base, in true geodetic style. This far surpassed all previous work in its accuracy, and was a noble result of the three days' labour that he and Professor Watson were able to spare for it. When I was engaged in reducing this triangulation for Mr. Gill in 1879, he impressed on me the need of completing it if I could, by continuing it round the whole pyramid, as two of the corners were only just reached by it without any check.

After preparations extending over some years, I took with me, therefore, instruments of the fullest accuracy needed for the work; probably as fine as any private instruments of the kind. The triangulation was with these performed quite independently of previous work; it was of a larger extent, including the whole hill; and it comprised an abundance of checks. The necessary excavations were carried out to discover the fiducial points of the buildings, unseen for thousands of years. The measurements previously taken were nearly all checked, by repeating them with greater accuracy, and, in most cases, more frequency; and fresh and more refined methods of measurement were adopted. The tombs around the pyramids were all measured, where they had any regularity and were accessible. The methods of workmanship were investigated, and materials were found illustrating the tools employed and the modes of using them.

To carry out this work, I settled at Gizeh in December, 1880,

and lived there till the end of May, 1881; I returned thither in the middle of October that year, and (excepting two months up the Nile, and a fortnight elsewhere), lived on there till the end of April, 1882; thus spending nine months at Gizeh. Excellent accommodation was to be had in a rock-hewn tomb, or rather three tombs joined together, formerly used by Mr. Waynman Dixon,; his door and shutters I strengthened; and fitting up shelves and a hammock bedstead, I found the place as convenient as anything that could be wished. The tombs were sheltered from the strong and hot south-west winds, and preserved an admirably uniform temperature; not varying beyond 58° to 64° F. during the winter, and only reaching 80° during three days of hot wind, which was at 96° to 100° outside.

I was happy in having Ali Gabri,* the faithful servant of Prof. Smyth, Mr. Dixon, and Mr. Gill; his knowledge of all that has been done at Gizeh during his lifetime is invaluable; and his recollections begin with working at four years old, as a tiny basket carrier, for Howard Vyse in 1837. He was a greater help in measuring than many a European would have been; and the unmechanical Arab mind had, by intelligence and training, been raised in his case far above that of his neighbours. In out-door work where I needed two pair of hands, he helped me very effectually; but the domestic cares of my narrow home rested on my own shoulders. The usual course of a day's work was much as follows:—Lighting my petroleum stove, the kettle boiled up while I had my bath; then breakfast time was a reception hour, and as I sat with the tomb door open, men and children used to look in as they passed; often a friend would stop for a chat, while I hastily brewed some extra cups of coffee in his honour, on the little stove behind the door; Ali also generally came up, and sat doubled up in the doorway, as only an Arab can fold together. After this, starting out about nine o'clock, with Ali carrying part of the instruments, I went to work on the triangulation or measurements; if triangulating, it was Ali's business to hold an umbrella so as to shade the theodolite from the sun all day—the observer took his chance; if measuring, I generally did not require assistance, and worked alone, and I always had to get on as well as I could during Ali's dinner hour. At dusk I collected the things and packed up; often the taking in of the triangulation signals was finished by moonlight, or in the dark. Then, when all was safely housed in my tomb, Ali was dismissed to his home, and about six or seven o'clock I lit my stove, and sat down to reduce observations. Dinner then began when the kettle boiled, and was spun out over an hour or two, cooking and feeding going on together. Brown ship-biscuit, tinned soups,

* Called Ali Dobree by Prof. Smyth. G is universally pronounced hard by Egyptians, soft by Arabs; thus either Gabri or Jabri, Gizeh or Jizeh, General or Jeneral, Gaz or Jaz (petroleum).

tomatoes (excellent in Egypt), tapioca, and chocolate, were found to be practically the most convenient and sustaining articles; after ten hours' work without food or drink, heavy food is not suitable; and the great interruption of moving instruments, and breaking up work for a midday meal was not admissible. Then, after washing up the dishes (for Arab ideas of cleanliness cannot be trusted), I sat down again to reducing observations, writing, etc., till about midnight. Ali's slave, Muhammed the negro, and his nephew, little Muhammed, used to come up about nine o'clock, and settle in the next tomb to sleep as guards, safely locked in. Having a supply of candle provided for them, they solaced themselves with indescribable tunes on reed pipes; often joining in duets with Abdallah, the village guard, who used to come up for a musical evening before beginning his rounds. Very often the course of work was different; sometimes all out-door work was impossible, owing to densely sand-laden winds, which blew the grit into everything—eyes, nose, ears, mouth, pockets, and watches. During the excavations I turned out earlier—about sunrise; and after setting out the men's work, returned for breakfast later on in the morning. On other occasions, when working inside the Great Pyramid, I always began in the evening, after the travellers were clean away, and then went on till midnight, with Ali nodding, or even till eight o'clock next morning; thus occasionally working twenty-four hours at a stretch, when particular opportunities presented themselves.

My best thanks are due to M. Maspero, the Director of Antiquities, for the facilities he accorded to me in all the excavations I required, kindly permitted me to work under his firman; and also for information on many points. It is much to be hoped that the liberal and European policy he has introduced may flourish, and that it may overcome the old Oriental traditions and ways that clogged the Department of Antiquities. Excepting Arab help, I worked almost entirely single-handed; but I had for a time the pleasure of the society of two artists: Mr. Arthur Melville, staying with me for a week in May, 1881, and kindly helping in a preliminary measure of my survey base, and in an accurate levelling up to the Great Pyramid entrance; and Mr. Tristram Ellis, staying with me for a fortnight in March and April, 1882, and giving me most valuable help in points where accuracy was needed, laying aside the brush to recall his former skill with theodolite and measure. Thus working together, we measured the base of survey (reading to $\frac{1}{100}$th inch) five times, in early dawn, to avoid the sunshine; we levelled up the Great Pyramid, and down again (reading to $\frac{1}{100}$th inch); took the dip of the entrance passage to the bottom of it, and gauged its straightness throughout; took the azimuth of the ascending passages round Mamun's Hole; callipered the sides of the coffer all over, at every

6 inches, and raised the coffer (weighing about 3 tons), by means of a couple of crowbars, to 8 inches above the floor, in order to measure the bottom of it. For the instrumental readings, in these cases, Mr. Ellis preferred, however, that I should be responsible, excepting where simultaneous readings were needed, as for the base length, and in Mamun's Hole. To Mr. Ellis I am also indebted for the novel view of the Pyramids, showing the nine at once, which forms the frontispiece of this work.

To Dr. Grant Bey I owe much, both for occasional help at the Pyramid, in visiting the chambers of construction, the well, etc.; and also for his unvarying kindness both in health and sickness, realizing the conventional Arab phrase, "My house is thy house." Further, I should mention the kind interest and advice of General Stone Pasha, who gave me many hints from his intimate knowledge of the country; and also the very friendly assistance of our Vice-Consul, Mr. Raph. Borg, both in procuring an order for my residence and protection at Gizeh, and in prosecuting an inquiry into a serious robbery and assault on me, committed by the unruly soldiery in October, 1881; unhappily, this inquiry was a fruitless task apparently, as the military influence was too strong in the examination.

And now I must not forget my old friend Shekh Omar, of the Pyramid village, shrewd, sharp, and handsome; nor how anxious he was to impress on me that though some people of base and grovelling notions worked for money, and not for their "good name," *he* wished to work for fame alone; and as he had no doubt I should make a big book, he hoped that I should contract with him for excavations, and give him a good name. I gratified him with one contract, but finding that it cost many times as much as hiring labourers directly, and was not sufficiently under control, the arrangement was not repeated; but I will say that I found him the most respectable man to deal with on the Pyramid hill, excepting, of course, my servant Ali Gabri, who was equally anxious about his good name, though too true a gentleman to talk much about it. The venerable Abu Talib and the loquacious Ibrahim, shekhs of the Pyramid guides, also conducted themselves properly, and Ibrahim seemed honestly genial and right-minded in his words and acts, and knew what so few Arabs do know—how not to obtrude. The rank and file of the guides—so familiar, with their little stocks of *antikas* in the corners of old red handkerchiefs—reckoned that I was free of the place, having Ali for my servant; they never gave me the least trouble, or even whispered the omnipresent word *bakhshish*, but were as friendly as possible on all occasions, many claiming a hand-shaking and a hearty greeting. My impression of a year's sojourn with Arabs is favourable to them; only it is necessary to keep the upper hand, to resist imposition with unwearied patience, to be fair, and occasionally liberal in dealings,

and to put aside Western reserve, and treat them with the same familiarity to which they are accustomed between different classes. With such intercourse I have found them a cheerful, warm-hearted, and confiding people.

The list of instruments employed was as follows:—

A* Standard scale, steel 100 inches long, divided to 1 inch.
B* Steel tape 1,200 „ „ 50 „
C Steel chain 1,000 „ „ 20 „
D Pine poles, a pair 1 inch diameter 140 „ „ 10 „
E* Pine rods, a pair 1 × 2 inches 100 „ „ 1 „
F* Pine rods, 10 of ½ × 1 „ 60 „ „ 1 „
(Jointing together into two lengths of 250 „ each.)
G* Pine rods for levelling { 3 of ½ × 2 inches 60 „ „ 1 „ ; 2 „ ½ × 1 „ 60 „ „ 1 „
H* Pine rods, 2 „ ½ × 1 in. 40 & 20 „ „ 1 „
J Box on mahogany rods, 2 of 1 × 1 25 „ „ 1/10 „
K Boxwood scale, 1·25 × ·13 12 „ „ 1/60 „
L Steel scale, 1·07 × ·04 12 „ „ 1/10 „
M* Ivory scales, 2 of 1·18 × ·08 10 „ „ 1/60 „
N* Boxwood scale, 1·18 × ·08 10 „ „ 1/60 „
O* Gun metal scale, 1·06 × ·09 6 „ „ 1/60 „
P* Ivory scale, 1·0 × ·08 1 „ „ 1/100 „
(The divisions of those marked * are all known to within 1/1000 inch.)
Q Double calipers, 72 inches long.
R Supports for catenary measurement by tape and chain.
S 10 thermometers for scale temperatures.
a Theodolite by Gambay { 10 inch circle, divisions 5′, vernier 3″ ; 7 inch circle, „ 10′, „ 10″ } telescope × 35.
b Theodolite by King { 5 inch circle, „ 30′, „ 1′ ; 5 semicircle, „ 30′, „ 1′ } telescope × 6.
c Theodolite by Troughton { 4 inch circle, „ 30′, „ 1′ ; 4 semicircle, „ 30′, „ 1′ } telescope × 8.
d Box sextant by Troughton { 1·64 inch radius, division 30′, vernier 1′.
e Hand level in brass case.
f Gun metal protractor, by Troughton, 5·9 diam., divisions 30′.
g Mahogany goniometer, 11 and 9 inch limbs.
h Queen's chamber air channel goniometer.
j Sheet steel square, 35 and 45 inches in the sides.
k Folding wooden tripod stand, old pattern.
l Rigid tripod stand, 30 inches high, octahedral.
m Rigid tripod stand, 16 „ „
n Rigid iron tripod, 12 „ „
o 12 signals, with plumb bobs.

The above were all used, most of them continually; a few other instruments were also taken out, but were not needed.

In taking lineal measurements, pairs of rods butting together, and laid down alternately, were always used instead of making marks at each length. Plumb-lines were also continually used to transfer dimensions from inaccessible parts, such as the length of a chamber

at its top; and for taking offsets to vertical faces, both in chambers and on the coffer. Thus dimensions are referred to true vertical planes by plumb-lines, and also to true horizontal planes by sighting with a theodolite. Offsets from a theodolite sight were also used to gauge the straightness of the passages. Outside the Pyramids all the measures were ascertained by triangulation from the measured base-line of the survey; the first class points being fixed with a probable error of ±·06 inch. The base of the survey was thrice measured, and is known with a probable error of ±·03 inch, or 1 in 200,000. A line of levelling was run from the N.E. corner of the Great Pyramid, to the S.E., to the S.W., up to the top, and down to the N.E. again. The difference on return was only ¼ inch, or 1″·5, on 3,000 feet distance, and 900 feet height.

In Egypt all excavations are forbidden, and a special permission is required for any such researches, the law of treasure-trove being the same as in England. Having in 1880–1 done all the triangulation of my station marks, it was requisite in 1881–2 to connect them with the ancient points of construction. For this, therefore, I needed permission to excavate, and applied to M. Maspero, the courteous and friendly director of the Department for the Conservation of Antiquities; Dr. Birch kindly favouring my request. In order to save delay and needless formalities, M. Maspero at once said that he would permit me to work under his firman, on all the points that I had indicated to him in writing; the Bulak Museum being formally represented by a reis, who would observe if anything of portable value should accidentally be discovered, though such was very unlikely and unsought for. Under this arrangement, then, I carried on excavations for about six weeks, having during most of the time about 20 men and boys engaged. The total expense was only about £18, or £22 including the reis of the Museum. He was a son of old Reis Atweh, who worked for Prof. Smyth; a very polite man, who quite understood that his presence was a formality.*

The first work that needed to be done (and that quickly, before the travellers' season set in) was to open the entrance passage of the Great Pyramid again to the lower chamber. The rubbish that had accumulated from out of Mamun's Hole was carried out of the Pyramid by a chain of five or six men in the passage. In all the work I left the men to use their familiar tools, baskets and hoes, as much as they liked, merely providing a couple of shovels, of picks and of crow-bars for any who liked to use them. I much doubt whether more work could be done for the same expense and time, by trying to force them into using Western tools without a good training.

* A notice of these excavations appeared at the time in the *Academy* of 17th December, 1881.

Crowbars were general favourites, the chisel ends wedging up and loosening the compact rubbish very easily; but a shovel and pickaxe need a much wider hole to work them in than a basket and hoe require; hence the picks were fitted with short handles, and the shovels were only used for loose sand.

A large block of granite was found lying in the passage, 20·6 thick, worked on both faces and one end, and having on one edge a part of an old Egyptian tubular drill hole, which had been cut right through the mass. What part of the Pyramid this can have come from is a puzzle; nothing like it, and no place for it, is known.

The so-called "grotto" in the well-passage, between the gallery and the subterranean part, is really a fissure in the limestone, through which the passage has been lined with small hewn stones to keep back the gravel found in the fissure.

The casing of the Great Pyramid was found *in situ* on each side but only just in the middles of the faces; the shafts were cut about 20 feet deep to reach it through the loose rubbish of chips. The casing is much hollowed out by the wind-blown sand on the S. side. The pavement was found in many parts by cutting pits and trenches, and the edge of its rock bed was uncovered.

At the Second Pyramid the raised edge of rock which was coterminous with the casing edge was uncovered, near the ends of each side; and the casing was cleared at the S.W. corner, where it remains *in situ*. The great peribolus wall, and the adjoining masons' barracks, were partly uncovered to find their outlines.

At the Third Pyramid the work is very difficult, and was abandoned by Howard Vyse, owing to its dangerousness; the blocks of granite lie in loose sand, and where a hole is made the sand runs in and the blocks fall over. They were however wedged apart so as to form a ring in which a pit could be sunk, and thus the original lower edges were uncovered. Altogether 284 shafts, pits, and trenches were made in the course of this work.

Of supervision the Arabs require a good deal to prevent their lounging, and Ali Gabri looked well after them, proving zealous and careful in the work: I, also, went out with them every morning, allotting their work for the day; then visiting them generally just before noon; and again before they left off, in the afternoon. Going thus round to six or eight places some way apart, and often stopping to direct and help the men, occupied most of the day. It is particularly necessary never to put more men on a spot than are absolutely needed to work together; generally each isolated party was only a man and one or two boys; thus there was no shirking of the individual responsibility of each man to get through his work. Every man was told what his party had to do, and if they were lazy, they were separated and allotted with good workers, where they would be closely

watched. The men were allowed to choose their work somewhat, according to their strength and capabilities; and if any man grumbled he was changed to different work, or dismissed. A very friendly spirit, with a good deal of zeal to get through tough jobs, was kept up all the time by personal attention to each man, and without any extra stimulus of bakhshish, either during or after the work.

CHAPTER II.

THE GREAT PYRAMID.

THE materials available for a discussion of the original size of the base of the Great Pyramid are:—(1) the casing *in situ* upon the pavement, in the middle of each face; (2) the rock-cut sockets at each corner; (3) the levels of the pavement and sockets; and (4) the mean planes of the present core masonry.

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

On obtaining accurate measures, however, of the relations of the sockets to the casing on each side, it was found that the sockets lay two or three feet outside the line of the casing of the Pyramid on the pavement; and also that the mean planes of the core masonry of the Pyramid were far more nearly a true square than the square of the sockets. The socket distances varying on an average 4·4 inches from the mean, and the core sides varying but 1·0 inch from their mean length; while there was also a similar superiority in the squareness of the core. This first threw doubt on the sockets representing the original base; and on comparing their distances from the centre of the Pyramid, it was seen that the deeper the level of the socket, the farther out it is from the centre. This shows then that the sockets were the limit of the casing where it ran down to the socket floors in a slope, and not where it met the pavement which was 23 to 40 inches above them. A further test of this result is by seeing whether a line which starts from one socket diagonal, and passes alternately through the points of the casing on the sides and the diagonals of the other sockets all round the Pyramid, will come

back again on to the starting point, or no; for there is no necessity that it should, if it was not so planned in the construction. This line, —representing the original edge of the base,—does thus return to even $\frac{1}{10}$ inch, or far closer than the points could be measured; and hence we have every assurance that this is the true restoration of the original outline of the Pyramid base on the pavement.

The following are the dimensions of the Great Pyramid base:—

	Base of casing.		Socket sides.		Core-plane sides	
	length.	azimuth.	length.	azimuth.	length.	azimuth.
N.	9069·4	−3′ 20″	9129·8	−3′ 20″	9002·3	−4′ 35″
E.	9067·7	−3′ 57″	9130·8	−5′ 21″	8999·4	−5′ 26″
S.	9069·5	−3′ 41″	9123·9	+1′ 15″	9001·7	−5′ 23″
W.	9068·6	−3′ 54″	9119·2	−7′ 33″	9002·5	−5′ 39″
Mean	9068·8	−3′ 43″	9125·9	−3′ 45″	9001·5	−5′ 16″
Mean difference	·6	12″	4·4	2′ 42″	1·0	20″

And it must always be remembered that this very small mean error of the casing, ·65 inch and 12″, is that found through measurements of the rock sockets, and not that of the finally adjusted, and now destroyed, casing. This also includes errors of survey, which are probably ±·3 inch, and of settling the ancient points of casing and sockets which are about ±·5 inch. So that we can only say that the original base was probably more accurate than ·65 inch in length and 12″ in angle.

The relations, then, of the core masonry, the base of the casing on the pavement, the edge of the casing in the sockets, and the socket edges, are shown in Pl. vi., to a scale of $\frac{1}{50}$. The position of the station marks is also entered. The inclinations of the various sides of sockets and casing are stated; and it is noticeable that the core masonry has a twist in the same direction on each side, showing that the orientation of the Pyramid was slightly altered between fixing the sockets and the core. The mean skew of the core to the base is 1′ 33″, and its mean azimuth − 5′ 16″ to true North. The diagram also shows graphically how much deformed is the square of the socket lines; and how the highest socket (S.W.) is nearest to the centre of the Pyramid; and the lowest socket (S.E.) is furthest out from the centre of the socket diagonals, and also from the mean planes of the core.

For ascertaining the height of the Pyramid, we have accurate levels of the courses up the N.E. and S.W. corners; and also hand measurements up all four corners. The levels were all read to $\frac{1}{100}$ inch, to avoid cumulative errors. But these levels, though important for the heights of particular courses, have scarcely any bearing on the question of the total height of the original peak of the casing of the pyramid; because we have no certain knowledge of the thickness of the casing on the upper parts.

The zero of levels that I have adopted, is a considerable flat-dressed surface of rock at the N.E. corner, which is evidently intended to be at the level of the pavement; it has the advantage of being always accessible, and almost indestructible. From this the levels around the Pyramid stand thus:—

	N.E.	E.	S.E.	S.	S.W.	W.	W.N.W.	N.W.	N.
2nd Course	+ 107·7	...	+ 105·5	...	+ 111·2	...	...	+ 106·6	+ 107·4
1st „	+ 58·6	...	...	...	+ 57·6	...	...	+ 58·0	+ 58·9
Levelled rock	0	E.N.E.	...	...	...	...	...	...	...
	− ·15	N.N.E.	...	...	...	...	...	...	...
Pavement		− 6?	...	− 5·5?	...	+ 1·1?	− 1·2?	...	+ ·
Socket	− 28·5	...	− 39·9	...	− 23·0	...		− 32·8	...

The pavement levels, excepting that on the N. side below the entrance, are not of the same accuracy as the other quantities; they were taken without an assistant, merely for the purpose of showing that it really was the pavement on which the casing was found to rest on each side. The differences of the 1st course levels, probably show most truly the real errors of level of the base of the Pyramid.

To obtain the original height of the Pyramid, we must depend on the observations of its angle. For this there are several data, as follows; the method by which the passage and air channels determine it being explained in detail further on:—

Casing stones, *in situ*, N. side, by theodolite. (To three points on top and three on base.)	51° 46′ 45″ ±	2′	7″
„ „ „ „ by goniometer and level . . .	51° 49′	1′	
„ „ „ „ by steel square and level . . .	51° 44′ 11″		23″
„ „ 5 overthrown by goniometer . .	51° 52′	2′	
„ „ 18 fragments, all sides, „ . . .	51° 53′	4′	
(All above 2 inches in shortest length.)			
N. face, by entrance passage mouth . . .	51° 53′ 20″	1′	
N. face, by air channel mouth	51° 51′ 30″		20″
N. face, mean	51° 50′ 40″	1′	5″
S. face, by air channel mouth	51° 57′ 30″		20″

The staff which was set up by the Transit of Venus party in 1874 on the top of the Pyramid, was included in my triangulation; and its place is known within ± ½ inch. From this staff, the distances to the mean planes of the core masonry of the Pyramid sides, were determined by sighting over their prominent edges, just as the positions of the mean planes were fixed at the lower corners of the faces. Hence we know the relation of the present top of the core masonry to the base of the Pyramid. The top is, rather strangely, not square, although it is so near to the original apex. This was verified carefully by an entire re-measurement as follows:—

		Mean of four readings, 1881.	Mean of three readings, 1882.	Mean of all.
Centre of Pyramid base horizontally to the	N. side	226·0 ± ·5	223·7 ± ·2	224·5 ± ·7
	E. side	214·4 ·4	213·8 ·6	214·1 ·3
	S. side	215·0 ·6	215·0 ·4	215·0 ·4
	W. side	216·4 ·5	218·7 ·5	217·6 1·0

Now, at the level of these measurements, 5407·9 at N.E., or 5409·2 at S.W., above the base, the edges of the casing (by the angles of the N. and S. side found above) will be 285·3 ± 2·7 on the North, and 301·6 on the South side, from the vertical axis of the centre. Thus there would remain for the casing thickness 60·8 ± 3 on the N., and 86·6 on the S.; with 77·6 for the mean of E. and W. Or, if the angle on the S. side were the same as on the N., the casing thickness would be 69·2 on the S. This, therefore, seems to make it more likely that the South side had about the same angle as the North.

On the whole, we probably cannot do better than take 51° 52′ ± 2′ as the nearest approximation to the mean angle of the Pyramid, allowing some weight to the South side.

The mean base being 9068·8 ± ·5 inches, this yields a height of 5776·0 ± 7·0 inches.

Several measures were taken of the thickness of the joints of the casing stones. The eastern joint of the northern casing stones is on the top ·020, ·002, ·045 wide; and on the face ·012, ·022, ·013, and ·040 wide. The next joint is on the face ·001 and ·014 wide. Hence the mean thickness of the joints there is ·020; and, therefore, the mean variation of the cutting of the stone from a straight line and from a true square, is but ·01 on length of 75 inches up the face, an amount of accuracy equal to most modern opticians' straight-edges of such a length. These joints, with an area of some 35 square feet each, were not only worked as finely as this, but cemented throughout. Though the stones were brought as close as $\frac{1}{800}$ inch, or, in fact, into contact, and the mean opening of the joint was but $\frac{1}{50}$ inch, yet the builders managed to fill the joint with cement, despite the great area of it, and the weight of the stone to be moved—some 16 tons. To merely place such stones in exact contact at the sides would be careful work; but to do so with cement in the joint seems almost impossible.

The casing is remarkably well levelled at the base; the readings on the stones of the North side, and the pavement by them being thus:—

	W. End.	Middle.	E. End.	Pavement by Casing.	Core 40 ft. E. of Casing.
Casing Front	+58·83	+58·84	+58·90	−·01	...
Casing Back	+58·84	...	+58·85	−·03	...
Core ...	...	...	...	+·02	+58·87
Pavement ...	[−·56]	[−·30]	[−·05]	·00	...

The pavement levels in brackets are on decidedly worn parts, and

hence below the normal level, as shown in the fourth column. The average variation of the casing from a level plane of + 58·85 is but ·02 ; and the difference to the core level, at the farthest part accessible in that excavation, does not exceed this. The difference of pavement level out to the rock at the N.E. corner is but ·17 on a distance of 4,200 inches, or 8″ of angle.

The works around the Pyramid, that are connected with it, are : —(1) The limestone pavement surrounding it ; (2) the basalt pavement on the E. side ; and (3) the rock trenches and cuttings on the E. side, and at the N.E. corner.

The limestone pavement was found on the N. side first by Howard Vyse, having a maximum remaining width of 402 inches ; but the edge of this part is broken and irregular, and there is mortar on the rock beyond it, showing that it has extended further. On examination I found the edge of the rock-cut bed in which it was laid, and was able to trace it in many parts. At no part has the paving been found complete up to the edge of its bed or socket, and it is not certain, therefore, how closely it fitted into it ; perhaps there was a margin, as around the casing stones in the corner sockets. The distances of the edge of this rock-cut bed, from the edge of the finished casing on the pavement (square of 9068·8) were fixed by triangulation on the N. side 619 to 529, E. side 539 to 534, S. side 530 to 536 and on the W. side 536 to 628 inches.

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

The levels of the various works around the Pyramid are as follow, taken from the pavement as zero :—

Flat rock-bed of pavement	W. of N.W. socket ...	− 23·7
„ „ „	beside N.W „ ...	− 21·6
„ „ „	N. of N.W. „ ...	− 17·0
„ „ „	N.E. of N.W. „ ...	− 15·9
„ „ „	before entrance ...	− 27·1
„ „ „	inner end of E.N.E. trench	− 26·9
Basalt pavement, E. side of it	... ...	+ 2·0
„ „	W. side, in excavation	+ 2·0

The Pyramid pavement must then have varied from 17 to 27 inches in thickness ; it was measured as 21 inches where found by Vyse.

The basalt pavement is a magnificent work, which covered more than a third of an acre. The blocks of basalt are all sawn and fitted together ; they are laid upon a bed of limestone, which is of such a fine quality that the Arabs lately destroyed a large part of the work to extract the limestone for burning. I was assured that the lime-

stone invariably occurs under every block, even though in only a thin layer. Only about a quarter of this pavement remains *in situ*, and none of it around the edges; the position of it can therefore only be settled by the edge of the rock-cut bed of it. This bed was traced by excavating around its N., E., and S. sides; but on the inner side, next to the Pyramid, no edge could be found; and considering how near it approached to the normal edge of the limestone pavement, and that it is within two inches of the same level as that, it seems most probable that it joined it, and hence the lack of any termination of its bed.

The length of the basalt paving from N. to S. is 2123·7 on E. to 2124·7 on W. side, but the ends are not parallel to the Pyramid sides by 15 inches; its breadth from E. to W. was 1006·6 or more, and its outside was 2148·0 to 2153·0 from the Pyramid E. side. The N. trench ends at 318·1 from the edge of this pavement, and the S. trench at 327·9. The N. trench axis is just about half-way between the Pyramid base and the outside of the pavement, being 1074 to the former and 1076 to the latter. Hence the plan of the basalt pavement seems to have been two adjacent squares of about 1,080 inches, the N. trench axis bounding them, and being equally distant about 1,080 inches from the Pyramid side.

The N. trench axis is 1085·5 to 1080·6 from the Pyramid side; and the S. trench axis similarly 1122·9 to 1125·4. The axial length of the N. trench is 2130·2, and of the S. trench 2093·7; and the length of the E.N.E. trench, outside of the basalt pavement, 2124·7. Apparently all three are intended to be the same as the length of the basalt paving itself, 2124·2.

The angles between the axes of the trenches are, S. trench to E.N.E. 104° 1′ 43″ (2×52° 0′ 52″), and E.N.E. to N.N.E. trench 51° 36′ 52″. The trenches are in most parts but roughly cut in the rock, and were evidently lined with masonry, which has been destroyed, only leaving a few scraps cemented in place. This lining would reduce the length to about 100 cubits, 2,063 inches. The forms of the ends of the trenches are given in Pl. ii.

The trial passages (see Pl. ii.) are a wholly different class of works to the preceding, being a model of the Great Pyramid passages, shortened in length, but of full size in width and height. Their mean dimensions—and mean differences from those dimensions—as against the similar parts of the Great Pyramid, are:—

26°32′	mean	difference	24′	Pyramid passage angle		26° 27′	mean	difference	·4′
41·46	,,	,,	·09	,,	,, widths	41·53	,,	,,	·07
47·37	,,	,,	·13	,,	,, heights	47·24	,,	,,	·05
23·60	,,	,,	·08	,,	ramp heights	23·86	,,	,,	·32
81·2	,,	,,	·6	,,	gallery widths	82·42	,,	,,	·44
28·63	,,	,,	·54	,,	well widths	28·2	,,	,,	·3

The details of the measurements of each part are all entered on the

section (Pl. ii.). The vertical shaft here is only analogous in size, and not in position, to the well in the Pyramid gallery; and it is the only feature which is not an exact copy of the Great Pyramid passages, *as far as we know them.* The resemblance in all other respects is striking, even around the beginning of the Queen's Chamber passage, and at the contraction to hold the plug-blocks in the ascending passage of the Pyramid. The upper part of the vertical shaft is filled with hardened stone chips; but on clearing the ground over it, I found the square mouth on the surface. The whole of these passages are very smoothly and truly cut, the mean differences in the dimensions being but little more than in the finely finished Pyramid masonry.

The original length of the entrance passage of the Great Pyramid has not hitherto been known, except by a rough allowance for the lost casing. But after seeing the entrances of the Third Pyramid, the South Pyramid of Dahshur, and the Pyramid of Medum, all of which retain their casing, there seemed scarcely a question but that the rule was for the doorway of a Pyramid to occupy the height of exactly one or two courses on the outside. That the casing courses were on the same levels as the present core courses, is not to be doubted, as they are so in the other Pyramids which retain their casing, and at the foot of the Great Pyramid.* The next step is to see if there is a course equal to the vertical height of the doorway; and, if so, where such a course occurs. Now the vertical height of the doorway on the sloping face of the Pyramid (or difference of level of its top and base) would be 37·95 if the passage mouth was the same height as the present end, or 37·78 if the passage was exactly the same as the very carefully wrought courses of the King's Chamber, with which it is clearly intended to be identical. On measuring the thickness of the courses it was seen that at the 19th course is a sudden increase of thickness, none being so large for 11 courses before it and 14 after it. And this specially enlarged course is of exactly the required height of the doorway, its measures running thus:—

By levelling at entrance 38 67, by measuring courses 37·8; by N.E. 38·1, S.E. 37·6, N.W. 37·5, S.W. 39·1.	mean. 37·94 ± ·17	37·95 or 37·78 doorway height.

* The awkward restoration of the casing that Prof. Smyth adopted (Life and Work, iii., Pl. 3) was forced on him by his mistaken assumption of the pavement level 20 inches under the truth (L. and W. ii. 137); hence by Vyse's casing stone measures he made the casing break joint with the core, in defiance of Vyse's explicit drawing of its position; and was obliged to reduce the pavement to 5 or 10 inches, in place of the 21 inches recorded by Vyse. The drawing of "backing stones," at the foot of Pl. 1, vol. iii., L. and W., is equally at fault; the casing stones which remain in the middle of the side, ending directly against the core masonry; and the core at the corners only leaving 34 inches for the casing thickness. No backing stones exist behind the casing of the Third Pyramid or the cased Dahshur Pyramid.

Here the agreement is so exact that it is far within the small uncertainties of the two dimensions. Hence, if the passage emerged at the 19th course it would exactly occupy its height (see Pl. vii.).* Besides this, it will be observed that there are two unusually small courses next over this, being the smallest that occur till reaching the 77th course. The explanation of these is clear, if the doorway came out in the 19th course; an unusually thick lintel course was needed, so two thinner courses were put in, that they might be united for obtaining extra thickness, as is done over the King's Chamber doorway. These two courses are also occasionally united in the core masonry.

The crucial test then is, supposing the passage prolonged outwards till it intersects this course, how will its end, and the face of the casing, stand to the casing stones at the foot of the Pyramid? The answer has been already given in the list of determinations of the casing angle. It requires an angle of slope of 51° 53′ 20″ ± 1′; and this is so close to the angle shown by other remains that it conclusively clenches the result to which we are led by the exact equality of the abnormal course height with the doorway height.

By a similar method the air channels give a determination of the angle of the faces. It is true that the channels did not occupy a whole course like the entrance; but as they are uniformly cut out as an inverted trough in the under side of a block which is laid on a broad bed, it is almost certain that they similarly continued to the outside, through the one—or perhaps two—stones now stripped off; and also that their floors thus started at a course level (see Pl. vii.).† If this, then, were the case (as the N. channel cannot by its position have come out in any but the 103rd course on the face, and the S. channel in any but the 104th), they would show that the casing rose on the N. face at 51° 51′ 30″, and on the S. face at 51° 57′ 30″, as before stated.

Having, then, fixed the original position of the doorway of the Pyramid, we may state that it was at 668·2 ± ·1 above the pavement of the Pyramid; 524·1 ± ·3 horizontally inside (or S. of) the N. edge of the Pyramid casing; and its middle 287·0 ± ·8 E. of the centre‡

* It should be explained that this is called the 20th course by Prof. Smyth, owing to his error about the 1st course and pavement level. His measure of it is 38 inches, and the two French measures give it as 37 and 38 inches.

† In the section of the S. air channel mouth published by Prof. Smyth, certainly "the joints are not put in from any measure," nor is any other feature of it. The passage, its bed, and top, are all about half of their true size, and the form of it is unlike anything that has been there, at least since Vyse's time.

‡ Whenever any point is described as E. of the centre of the Pyramid, it is uniformly meant that it is that amount E. of a vertical plane, parallel to the

of the Pyramid; or 3723·6 from E. side, and 4297·6 from W. side, at its level; the probable error being that of fixing the length of the sides. Thus we have the following positions in the entrance passage, reducing all to the true beginning of the floor :—

	W. Floor.	W. Wall Base.	W. Wall Top.	W. Roof.	E. Roof.	E. Wall Top.
Doorway, original	0 ±·3	0 ±·3				
End of "basement sheet"	124·2					
Station mark	127·90					
Scored line		481·59				
Floor ascending passage	1110·64					
Rock begins			1318·5	1340·1	1350·7	1347·5

For the total length of the entrance passage, down to the subterranean rock-cut part, only a rough measurement by the 140-inch poles was made, owing to the encumbered condition of it. The poles were laid on the rubbish over the floor, and where any great difference of position was required, the ends were plumbed one over the other, and the result is probably only true within two or three inches. The points noted down the course of the passage, reckoning from the original entrance (*i.e.*, the beginning of the rock on the E. side of the roof being 1350·7), are the following :—

	E.	W.
Beginning of inserted stones, filling a fissure	1,569	1,555
Joint in these stones	1,595	None.
End of these inserted stones	1,629	1,595
Sides of passage much scaled, 1 or 2 inches off, beyond here	2,750	
Fissure in rock	3,086 to 3,116	3,066 to 3,096
Mouth of passage to gallery		3,825 to 3,856
End of sloping roof (4,137 Vyse, corrected for casing)	4,143	

The azimuth and straightness of the passage were carefully measured. The azimuth down the built part was taken by reference to the triangulation, which in its turn was fixed by six observations of Polaris at elongation, from a favourable station. The azimuth to the bottom of the rock-cut passage was observed independently, by five observations of Polaris at elongation. The observations of the straightness throughout gives a check by combining these two methods, and they are thus found to agree within 19″, or just the sum of their probable errors, equal to only ·09 inch lineally on the azimuth of the built part. The results are :—

mean of the Pyramid's E. and W. sides, and which passes through the centre of the Pyramid. Similarly of similar descriptions, N., S., and W.

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

The average error of straightness in the built part of the passage is only $\frac{1}{60}$ inch, an amazingly minute amount in a length of 150 feet. Including the whole passage the error is under $\frac{1}{4}$ inch in the sides, and $\frac{3}{10}$ on the roof, in the whole length of 350 feet, partly built, partly cut in the rock.

The Subterranean chambers and passages are all cut roughly in the rock. The entrance passage has a flat end, square with its axis (within at least 1°), and out of this end a smaller horizontal passage proceeds, leaving a margin of the flat end along the top and two sides. The dimensions and distances are as follow, from the S. end of the floor of the entrance passage (as deduced from the roof, which is better preserved); and the axial positions and levels are by theodolite observations :—

	Distance from End of E. P. Floor.	Distance from Mid. Plane of Pyramid.	Width E. to W. Top.	Width E. to W. Base.	Mid from Entrance Axis, continued.	Mid. E. from Mid. Line of Pyramid.	Height. E.	Height. W.	Level above End of E. P. floor.	Level below Pyramid Pavement.
Beginning of Horizontal Passage	0	306 N.	40·8		·4 W.	286·4	48·5		0	−1181 floor
	20	...	32·9		1·0 W.	285·8	...		Top + 38·3	−1143 roof
Fissure	76 W. 91 E.	...	...		...	...	...		...	...
In Passage	121	...	32·3	32·4	...	...	...		...	...
N. Door of Side Chamber	218	88 N.	31·6	32·7	...	...	...		...	...
S. ,, ,, ,, ...	291	15 N.	31·9	33·0	...	...	...		...	...
N. Door of Large Chamber	346*	40 S.	32·0	33·3	·5 W.	286·3	35·5	36·0	Top + 38·9	−1142 roof
S. ,, ,, ,, ...	672	366 S.	29·5	29·5	1·9 W.	284·9	31 + *x*†		Top − 6·6	−1188 roof
In S. Passage	760	...	29·6	27·3	...	...	...		...	...
,, ,, ...	900	...	26·7	26·7	...	...	26·3	26·0	...	...
,, ,, ...	1040	...	28·1	29·0	...	...	28·6	27·0	...	...
,, ,, ...	1180	...	30·1	30·0	...	...	29·5	29·3	...	...
,, ,, End... ...	1318	1012 S.		26·0	9·7 W.	277·1	...		Top − 2·6	−1184 roof
Large chamber, E. wall 325·9; at 100 from W. wall 329·6?; N. wall 553·5; S. wall 554·1									Top + 125·3‡	−1056 roof
Side chamber	W. wall 69½ to 70½; N. wall 70·3; S. wall 72·3						...		Top + 40 to + 48	−1137 roof

The large chamber walls are therefore distant from the Pyramid central axis, 302·9 E. at N. wall; 299·6 E. at S. wall; 250·6 W. at N. wall; 254·5 W. at S. wall; 40 S. and 366 S. The central axis thus not passing through the chamber, but 40 inches inside the rock of the N. side.

The side chamber is an enlargement of the passage, westward and upward, as are all the chambers of the Pyramid; it is very rough and uneven, and encumbered now with large blocks of stone. The

* E. side of door-sill is at 351, and W. side 347, the wall not being fully dressed down there.

† This doorway rounds off at the top, rising 1½ inches in the 10 inches.

‡ The top is + 124·3 at N. doorway, 125·4 to 127·6 at S. doorway; the roof being cut away higher, just in the corner.

large chamber is most clearly unfinished, both in the dressing of the walls, and more especially in the excavation for the floor. The walls have an average irregularity estimated at ±·7, and projecting lumps of rock are left untouched in some parts. The roof is more irregular, estimated average variation ± 3. The floor is most irregular, at the W. end it rises at the highest to only 10 inches from the roof; and over all the western half of the chamber it is irregularly trenched with the cuttings made by workmen to dislodge blocks of the rock. It is, in fact, an interesting specimen of quarrying, but unfortunately now completely choked up, by Perring having stowed away there all the pieces of limestone taken out of his shaft in the floor. After dislodging several blocks, I crawled in over the knobs and ridges of rock, until jammed tight from chest to back in one place; and thence I pushed about one 140-inch rod, by means of the other, so as to measure the length up to the Western end. To measure along the W. side is impossible, without clearing away a large quantity of stones; and as there is no place to stack them safely without their going down the shaft, I could only measure the width at 100 from the W. end, perhaps somewhat askew. The lower—eastern—part of the floor, 140 below the roof, which is comparatively flat, is, nevertheless, very irregular and roughly trenched, quite unfinished. The best worked floor surface is just around the square shaft, 198 below the roof, and about 40 below the main part of the floor, which is 155 below roof on a knob of rock beside the shaft. The square shaft is not parallel to the chamber, but is placed nearly diagonally.* The southern passage is very rough, apparently merely a first drift-way, only just large enough to work in, intended to be afterwards enlarged, and smoothed; its sides wind 6 or 8 inches in and out.

The Ascending passage from the entrance passage is somewhat troublesome to measure, owing to the large plugs of granite that fill some 15 feet of its lower part; and also to the irregular way in which much of its floor is broken up.

The junction of the passages was not projected uncertainly over the broken part, as had been done before; but a plumb-line was hung from the W. side of the Ascending passage roof, in front of the plug-blocks; and measures vertical, perpendicular, and sloping, were taken to the plugs, the fragments of the ascending, and the top and bottom of the entrance passage. Thus the whole was knit together to a true vertical line, the place of which was fixed on the entrance floor. From the mean of these measures the floor cuts the entrance floor at 1110·64 from the doorway, both probably ±·1.

Further, the lower end of the plug-block is 74·19 from the intersection of the floors; and the upper end 50·76 from the intersection of

* Like the shaft of the tomb chamber of Ti at Sakkara; an unusual plan.

the roofs. Having thus fixed the beginning of the Ascending passage, by the point where its floor produced onwards intersects the floor of the entrance passage, we can proceed up the Ascending passage from this as a starting point. The distance past the plug-blocks being determined by levelling between points below and above them, and that from the plug-blocks to the S. end of the passage, by steel tape measure on the E. side of the floor; then, the tape being corrected for temperature and tension, the results are thus, on the sloping floor:—

	Floor, E. side.	Base of E. wall.
Junction of passage floors	0	0
Beginning of actual floor	∴59·8	...
Base of plug-blocks	74·2	...
Top of plug-blocks, present	252·7	...
„ „ „ ancient	277?	...
Gallery, plumb from wall over door	1546·5	...
29 Floor joint	1546·8	...
Wall joint and edge over door	...	1547·0

The granite plugs are kept back from slipping down by the narrowing of the lower end of the passage, to which contraction they fit. Thus at the lower, or N. end, the plug is but 38·2 wide in place of 41·6 at the upper end: the height, however, is unaltered, being at lower end 47·30 E., 47·15 mid, 47·26 W.; and at upper, or S. end, 47·3. In the trial passages the breadth is contracted from 41·6 to 38·0 and 37·5 like this, but the height is also contracted there from 47·3 to 42·3. These plug-blocks are cut out of boulder stones of red granite, and have not the faces cut sufficiently to remove the rounded outer surfaces at the corners: also the faces next each other are never very flat, being wavy about ±·3. These particulars I was able to see, by putting my head in between the rounded edges of the 2nd and 3rd blocks from the top, which are not in contact; the 2nd having jammed tight 4 inches above the 3rd. The present top one is not the original end; it is roughly broken, and there is a bit of granite still cemented to the floor some way farther South of it. From appearances there I estimated that originally the plug was 24 inches beyond its present end.

Several of the roof-blocks are girdle-blocks, being all in one piece with the walls, either wholly round the passage, or partially so. These vertical girdle-blocks are a most curious feature of this passage (first observed and measured by Mr. Waynman Dixon), and occur at intervals of 10 cubits (206·3 to 208·9 inches) in the passage, measuring along the slope. All the stones that can be examined round the plugs are partial girdle-blocks, evidently to prevent the plugs forcing the masonry apart, by being wedged into the contracted passage. Many of the stones about the blocks in Mamun's Hole are over 10 or 11 feet long; the ends are invisible, but probably they are about 15 feet over all.

The angle of slope I did not observe, as I considered that that had been settled by Prof. Smyth; but the azimuth was observed, by a chain of three theodolites, round from the entrance passage. The straightness was observed by offsets all along it, read from a telescope at the upper end of the plug-blocks, and though rough and worn the mean variation is but ·3 inch to the sides and floor.

From the mean altitude of 26° 2′ 30″, the sloping length of the passage being 1546·8, the horizontal length will be 1389·5, and the vertical height 679·7, both being corrected for difference in the offsets of the ends. The determination of the azimuth has, unhappily, a large probable error, ± 3′ (owing to bad foundation for the theodolite in Mamun's Hole); and its direction, − 4′, is so close to that of the Pyramid side, that it may be assumed parallel to that ± 3′. This, on the passage length, = 1·2 inches for the probable error of the place of the upper end of the passage, in E. to W. direction in the Pyramid.

These, added to previous amounts, give for the absolute place of the floor end at the latitude of the E. wall of the gallery (172·9+679·7) =852·6±·3 level above pavement; (1517·8+1389·5)=2907·3±·6 horizontally from N. edge of Pyramid, or 1626·8±·8 northwards from centre; and 287±1·5 for middle of passage eastward from centre of Pyramid.

The horizontal passage leading to the Queen's Chamber is the next part to be considered. This was measured with steel tape all along, and the levels of it taken with theodolite. The results for its length and levels are thus, reckoning from the mean door of the gallery at 1546·8 from beginning of ascending passage :—

	Distance from door.	Northward from Pyramid centre.		Floor level.		∴ Roof level.
Mean doorway on floor ...	0	1626·8±·8		852·6±·3		...
On flat floor	52	1575		858·4		...
Floor joint, No. 8, Smyth	312·0	1314·8	All these are ±·8	857·4	All these are ± 3	903·8
„ „ No. 16, „	623·0	1003·8		856·1		902·3
On floor	1000	627		856·2		902·4
Step in floor	1307·0	319·8		854·6 834·9		901·0
Chamber N. wall { top of door ...	1523·9	102·9		...		...
Chamber N. wall { side of door ...	1524·8	102·0		...		...
Niche, N. side	1620·7	6·1		834·4		...
Niche, first lapping ...	...	...		...		901·3
Chamber, E. apex ...	1626·5	·3		...		1080·1

The azimuth of this passage was not measured, but the beginning of it is 287±1·5 E. of the middle of the Pyramid; then for the axis of it at the end we may say the same, or 287±3, since the gallery above it only differs about two inches from that quantity.

In the Queen's Chamber it seems, from the foregoing statement, that the ridge of the roof is exactly in the mid-plane of the Pyramid, equidistant from N. and S. sides; it only varies from this plane by a less amount than the probable error of the determination.

The size of the chamber (after allowing suitably in each part for the incrustation of salt) is on an average 205·85 wide, and 226·47 long, 184·47 high on N. and S. walls, and 245·1 high to the top of the roof ridge on E. and W. walls, the mean variation being ·22 in width and ·59 in length.

In the matter of height, the courses vary a good deal; and far more care was spent on the closeness, than on the regularity of the joints. For a starting point in measurement, the general floor is hopelessly irregular, consisting plainly of rough core masonry; and furthermore, it has been built over with similar rough masonry, which was afterwards stripped down to insert the chamber walls. This is proved by there being no fewer than eight edges of sunken spaces upon it, made (according to the universal habit of pyramid builders) to let in the inequalities of the upper course into the surface of the course below it. These sunken edges are well seen in other parts of the core masonry, and their meaning here is unequivocal. But all round the chamber, and the lower part of the passage leading to it, is a footing of fine stone, at the rough floor level; this projects 1 to 4 inches from the base of the walls, apparently as if intended as a support for flooring blocks, which have never been introduced. It is to this footing or ledge that we must refer as the starting point; though what floor was ever intended to have been inserted (like the floor of the King's Chamber, which is inserted between its walls) we cannot now say.

The sloping roof blocks, calculating from the above quantities, are as follow:—

	E. end, N. side.	W. end, N. side.	E. end, S. side	W. end, S. side.
Sloping length	120·00	119·96	119·12	118·59
Angle	30°48′	30°14′	30°33′	30°10′

These roof blocks are seen—where Howard Vyse excavated beneath one at the N.W. corner—to go back 121·6 on slope, behind the wall face; this, coupled with the thickness of these blocks (which is certain, by similar examples elsewhere, to be considerable), throws the centre of gravity of each of the slabs well behind the wall face,* so that they could be placed in position without pressing one on another. Hence there is never any arch thrust so long as the blocks are intact; they act solely as cantilevers, with the capability of yielding arched support in case they should be broken.

The niche in the eastern wall of this chamber, from its supposed

* As at Sakkara, in the Pyramid of Pepi.

connection with a standard of measure, was very closely examined. Its original depth back was certainly only 41 inches at every part from the bottom upwards.

The general form of the niche was a recess 41 inches (2 cubits), deep back; 62 inches (3 cubits) wide at base, and diminishing its width by four successive overlappings of the sides (at each wall course) each of ¼ cubit wide, until at 156 high it was only 20 (1 cubit) wide, and was finally roofed across at 184 high. Thus, of the 3 cubits width of the base, one cubit was absorbed on each side by the overlappings, leaving one cubit width at the top. This cubit is the regular cubit of 20·6 inches, and there is no evidence of a cubit of 25 inches here.

The channels leading from this chamber were measured by goniometer; they are exactly like the air channels in the King's Chamber in their appearance, but were covered over the mouth by a plate of stone, left not cut through in the chamber wall; no outer end has yet been found for either of them, though searched for by Mr. Waynman Dixon, who first discovered them, and also by myself on the N. face of the Pyramid.

The N. channel is 8·6 high, and about 8 wide in the chamber wall, running horizontally for 76 inches, and then turning upwards. The S. channel is 8·8 high, and runs 80·0 to its turn upwards. The mean angles, measured between the horizontal roof and the ascending slope of the channels, are thus :—

N. Channel.				S. Channel.			
W.	Mid.	E.	Mean.	W.	Mid.	E.	Mean.
37°33′	37°25′	37°25′	37°28′	38°28′	38°20′	38°35′	38°28′

each statement being the mean of two observations, which never differed more than 6′.

Hence, if these channels were continued to the outside of the Pyramid, their floors would end on the Pyramid faces at 2641·3 above the base, and 2460·8 from the centre of the Pyramid on the N. face; and at 2679·1 above the base, and 2431·2 from the centre on the S. face. I observed something like the mouth of a hole in the 85th course on the S. face, scanning it with a telescope from below; but I was hindered from examining it closely.

Returning now to the gallery from which we diverged to the Queen's Chamber, the length of the gallery was measured like the other passages, with the steel tape.

The total length on the slope is 1883·6, or 1815·5 to the face of the great step at the southern end; and the average variation from a straight line is ·15 in the sides, and ·5 in the floor, which is somewhat curved down in the middle.

Hence the floor of the gallery intersects the S. wall at 1689·0±·5 above the pavement; at 61·7± ·8 S. of the Pyramid centre; and its

middle is 284·4 ± 2·8 E. of the Pyramid centre; reckoning the measures of length and angle continuously through from the plug-blocks upwards, so as to avoid all uncertainties of connection at the beginning of the gallery, and duly correcting for difference in offsets.

The holes cut in the ramps or benches, along the sides of the gallery (see section of them in Pl. v.), the blocks inserted in the wall over each, and the rough chopping out of a groove across each block —all these features are as yet inexplicable. One remarkable point is that the holes are alternately long and short, on both sides of the gallery; the mean of the long holes is 23·32, with an average variation of ·73, and the mean of the short holes is 20·51, with average variation ·40. Thus the horizontal length of a long hole is equal to the sloping length of a short hole, both being one cubit. This relation is true within less than half their average variations.

The roof of the gallery and its walls are not well known, owing to the difficulty of reaching them. By means of ladders, that I made jointing together, I was able to thoroughly examine both ends and parts of the sides of the gallery. The roof stones are set each at a steeper slope than the passage, in order that the lower edge of each stone should hitch like a paul into a ratchet-cut in the top of the walls; hence no stone can press on the one below it, so as to cause a cumulative pressure all down the roof; and each stone is separately upheld by the side walls across which it lies. The depth of two of these ratchet-cuts, at the S. end, I measured as 1·0 and 1·9 to 2·0.

By plumb-line measure at the S. end, the roof on the E. side is inside the floor edge (or overhangs) 20·50, and on the W. side 20·40. On the S. end (eliminating the lean) the projection is 20·9, and on N. 20·4; mean of all, 20·55, for the sum of the seven projections of the laps, or one cubit, the laps being then one palm each in breadth. Thus the laps overhang the ramps along the gallery sides, and the space between the ramps (2 cubits) is equal to the space between the walls at the top.

At the upper end of the gallery, we have already stated the S. wall to be 61·7 ± ·8 S. of the Pyramid centre; and hence the face of the great step at the head of the gallery (which descends behind both floor and ramps) is (61·7−61·3)=·4 ± ·8 S. of the Pyramid centre. It may, therefore, be taken as intended that the face of this step, and the transition from sloping to horizontal surfaces, signalizes the transit from the Northern to the Southern half of the Pyramid. This same mid-plane of the Pyramid being also signalized by the mid-plane of the Queen's Chamber, which is measured as ·3 ± ·8 N. of the Pyramid centre.

The Antechamber and its passages were measured both by steel tape and rods, in one length, from the step to the King's Chamber; and the joints and floor levels are as follow:—

	Along Floor on E. side.	Southward from centre of Pyramid ± ·9.	Level over virtual end of gallery ± ·2.	Level over pavement ± ·6.
Face of step . . .	− 61·32	·4	4·7 E. / 5·6 W.	1693·7 to 1694·6
S. wall of gallery . .	0	61·7	4·2 E.	1693·2
N. end of Antechamber .	52·02	113 7		
Joint, granite begins .	64·90	126·6	3·6 / 3·9	1692·6 / 1692·9
Granite of wall begins .	75·26	137·0		
Edge of wall groove .	91·79	153·5		
Joint of floor . . .	112·15	173·8	3·7 / 3·2	1692·7 / 1692·2
Edge of wall groove .	113·48	175·2		
" " " .	119·26	181·0		
S. end of Antechamber .	168·10	229·8		
Joint of floor . . .	198·41	260·1	2·9 / 2·8	1691·9 / 1691·8
Base of King's Ch. wall .	268·9	330·6	− ·5	1688·5
End of passage floor .	269·04	330·7	3·0	1692·0
Raised floor, King's Ch. .	269·17	330·9	3·8	1692·8

Taking the Antechamber alone, we may say that its dimensions above the granite wainscot of the sides vary from 114·07 to 117·00 in length, and 64·48 to 65·48 in width; the whole chamber is from 149·01 to 149·65 high, the ceiling being from 152·6 to 153·0 above the virtual end of the gallery floor.

In the details of the walls, the rough and coarse workmanship is astonishing, in comparison with the exquisite masonry of the casing and entrance of the Pyramid; and the great variation in the foregoing measures shows how badly pyramid masons could work.

The granite leaf which stretches across the chamber, resting in grooves cut in the granite wainscots, is not simply a flat slab of granite, but on both its upper and lower parts it has a projection on its N. side, about 1 inch thick, where it is included in the side grooves. The edge of this projection down the W. side has been marked out by a saw cut; and the whole of the granite on the inner side of this cut has been dressed away all over the face of the leaf, leaving only one patch or boss of the original surface of the block.

This boss, of which so much has been made by theorists, is merely a very rough projection, like innumerable others that may be seen; left originally for the purpose of lifting the blocks. When a building was finished these bosses were knocked away (I picked up a loose one among waste heaps at Gizeh) and the part was dressed down and polished like the rest of the stone. It is only in unimportant parts that they are left entire. This boss on the leaf is very ill-defined, being anything between 4·7 and 5·2 wide, and between 3·3 and 3·5 high on its outer face; at its junction with the block it is still less

defined, and might be reckoned anything between 7·2 and 8·2 wide, and 5·6 to 6·6 high. It projects ·94 to 1·10 from the block, according to the irregularities of the rough hammer-dressing. Anything more absurdly unsuited for a standard of measure it would be difficult to conceive. I write these remarks with a sharp plaster cast of it before me that I took in 1881. Traces of another boss remain on the W. wall of the Antechamber, above the wainscot; remains of another boss may be seen on a block in the passage to the King's Chamber; remains of 15 or 16 others in the King's Chamber; 5 others complete in the spaces above that; and many on the casing of the Third Pyramid and elsewhere.

The King's Chamber was more completely measured than any other part of the Pyramid; the distances of the walls apart, their verticality in each corner, the course heights, and the levels, were completely observed. On every side the joints of the stones have separated, and the whole chamber is shaken larger. By examining the joints all round the 2nd course, the sum of the estimated openings is, 3 joints opened on N. side, total = ·19; 1 joint on E. = ·14; 5 joints on S. = ·41; 2 joints on W. = ·38. And these quantities must be deducted from the measures, in order to get the true original lengths of the chamber. I also observed, in measuring the top near the W., that the width from N. to S. is lengthened ·3 by a crack at the S. side.

These openings or cracks are but the milder signs of the great injury that the whole chamber has sustained, probably by an earthquake, when *every* roof beam was broken across near the South side; and since which the whole of the granite ceiling (weighing some 400 tons), is upheld solely by sticking and thrusting. Not only has this wreck overtaken the chamber itself, but in every one of the spaces above it are the massive roof-beams either cracked across or torn out of the wall, more or less, at the South side; and the great Eastern and Western walls of limestone, between, and independent of which, the whole of these construction chambers are built, have sunk bodily. All these motions are yet but small—only a matter of an inch or two—but enough to wreck the theoretical strength and stability of these chambers, and to make their downfall a mere question of time and earthquakes.

Applying, then, these corrections of the opened joints to the lengths of the lower course—and also, as being the most likely correction, to the upper parts as well—we have the following values for the original lengths of the chamber, and for the error of squareness of the present corner angles.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.
Top . .	412·14	+ 4″	206·30	− 35″	411·88	+ 1′ 35″	206·04	− 1′ 4″
Mean .	412·40	− 2′ 57″	206·29	+ 2′ 20″	412·11	− 1′ 2″	205·97	+ 1′ 39″
Base. .	412·78	− 4′ 54″	206·43	+ 4′ 40″	412·53	− 4′ 5″	206·16	+ 4′ 19″

Probably the base of the chamber was the part most carefully adjusted and set out; and hence the original value of the cubit used can be most accurately recovered from that part. The four sides there yield a mean value of 20·632 ± ·004, and this is certainly the best determination of the cubit that we can hope for from the Great Pyramid.

The average variation of the thickness of the courses from their mean is ·051, the mean being 47·045 between similar joints, or including the top course, which was necessarily measured in a different way, 47·040 ± ·013.

The roofing-beams are not of "polished granite," as they have been described; on the contrary, they have rough-dressed surfaces, very fair and true so far as they go, but without any pretence to polish. Round the S.E. corner, for about five feet on each side, the joint is all daubed up with cement laid on by fingers. The crack across the Eastern roof-beam has been also daubed with cement, looking, therefore, as if it had cracked *before* the chamber was finished. At the S.W. corner, plaster is freely spread over the granite, covering about a square foot altogether.

The floor of the chamber, as is well known, is quite disconnected from the walls, and stands somewhat above the base of the lowest course. It is very irregular in its level, not only absolutely, but even in relation to the courses; its depth below the first course joint varying 2·29, from 42·94 to 40·65. This variation has been attributed to the sinking caused by excavation beneath it, but this is not the case; it has been only undermined at the W. end beneath the coffer,* and yet the floor over this undermined part is 1½ inches *higher* in relation to the first course, than it is at the S.E. corner; and along the S. side where it has not been mined it varies 1⅓ inches in relation to the first course. In these cases I refer to the first course line, as that was the builder's conception of level in the chamber, to which they would certainly refer; but if we refer instead to absolute level, the anomalies are as great and the argument is unaffected.

It appears, then, that the floor never was plane or regular; and that, in this respect, it shared the character of the very variable floor of the passage that led to the chamber, no two stones of which are on the same level. The passage floor, even out to the great step in the gallery, is also inserted between the walls, like the floor of the chamber.

There is a remarkable diagonal drafted line across the immense block of granite over the doorway; it appears not to run quite to the lower corner on the E. side; but this is doubtless due to the amount by which the block is built into the E. wall, thus cutting off the end

* I know the hole well, having been down into it more than once.

of the diagonal line. This sunken band across the stone appears to have been a true drafted straight line cut in process of working, in order to avoid any twist or wind in the dressing of the face; this method being needful as the block was too large to test by the true planes otherwise used.

The position of the King's Chamber in the Pyramid is defined thus: N. wall at base 330·6 ± ·8 S. of centre of Pyramid; S. wall 537·0 ± ·8 from centre; E. wall (284·4 ± 20·7) = 305·1 ± 3·0 E. of centre; W. wall 107·7 ± 3·0 W. of centre. Base of walls 1686·3 to 1688·5 ± ·6 above pavement; actual floor 1691·4 to 1693·7 ± ·6 above pavement; ceiling 1921·6 to 1923·7 ± ·6 above pavement.

The air channels leading from this chamber were measured on the outside of the Pyramid; the N. one varies from 30° 43′ to 32° 4′, in the outer 30 feet; and the S. one from 44° 26′ to 45° 30′, in the outer 70 feet.

The coffer in the King's Chamber is of the usual form of the earliest Egyptian sarcophagi, an approximately flat-sided box of red granite. It has the usual under-cut groove to hold the edge of a lid along the inside of the N., E., and S. sides; the W. side being cut away as low as the groove for the lid to slide over it; and having three pin-holes cut in it for the pins to fall into out of similar holes in the lid, when the lid was put on. It is not finely wrought, and cannot in this respect rival the coffer in the Second Pyramid. On the outer sides the lines of sawing may be plainly seen: horizontal on the N., a small patch horizontal on the E., vertical on the S., and nearly horizontal on the W.; showing that the masons did not hesitate at cutting a slice of granite 90 inches long, and that the jewelled bronze saw must have been probably about 9 feet long. On the N. end is a place, near the W. side, where the saw was run too deep into the granite, and was backed out again by the masons; but this fresh start they made was still too deep, and two inches lower they backed out a second time, having altogether cut out more than $\frac{1}{10}$-inch deeper than they intended. On the E. inside is a portion of a tube drill hole remaining, where they tilted the drill over into the side by not working it vertically. They tried hard to polish away all that part, and took off about $\frac{1}{10}$-inch thickness all round it; but still they had to leave the side of the hole $\frac{1}{10}$ deep, 3 long, and 1·3 wide; the bottom of it is 8 or 9 below the original top of the coffer. They made a similar error on the N. inside, but of a much less extent. There are traces of horizontal grinding lines on the W. inside.

The coffer was very thoroughly measured, offsets being taken to 388 points on the outside, to 281 points inside, or 669 in all; besides taking 281 caliper measures.

On raising the coffer no trace of lines was to be found to mark its

place on the floor, nor any lines on the floor or bottom of the coffer.

The flint pebble that had been put under the coffer is important. If any person wished at present to prop the coffer up, there are multitudes of stone chips in the Pyramid ready to hand. Therefore fetching a pebble from the outside seems to show that the coffer was first lifted at a time when no breakages had been made in the Pyramid, and there were no chips lying about. This suggests that there was some means of access to the upper chambers, which was always available by removing loose blocks without any forcing. If the stones at the top of the shaft leading from the subterranean part to the gallery had been cemented in place, they must have been smashed to break through them, or if there were granite portcullises in the Antechamber, they must also have been destroyed; and it is not likely that any person would take the trouble to fetch a large flint pebble into the innermost part of the Pyramid, if there were stone chips lying in his path.

The mean dimensions of the coffer are—

N. end thick	5·67	E. side thick	5·87	Inner depth	34·42
Inside length	78·06	Inside width	26·81	Base thick	6·89
S. end thick	5·89	W. side thick	5·82		
Outside length	89·62	Outside width	38·50	Outer height	41·31
				Ledge depth	1·70

From these data the cubic quantities may be calculated of a simple rectilineal box, omitting all notice of the attachments for the lid, employing the mean planes:—

Contents = 72,030; solid bulk = 70,500; volume over all, 142,530 cubic inches.

Or by the caliper results, instead of the mean planes, the bulk is $\frac{1}{880}$ more, and the contents probably about $\frac{1}{1000}$ less; hence the quantities would be—

Contents = 71,960; solid bulk = 70,630; volume over all, 142,590. These quantities have a probable error of only about 60 cubic inches on contents and volume, and 100 inches on the bulk. The bulk of the bottom is = 23,830; and hence one side and end is on an average = 23,335. Bulk of bottom × 3 is then = 71,490; and $\frac{3}{2}$ × bulk of sides and ends = 70,000, subject to about 100 cubic inches probable error.

All the chambers over the King's Chamber are floored with horizontal beams of granite, rough dressed on the under sides which form the ceilings, but wholly unwrought above. These successive floors are blocked apart along the N. and S. sides, by blocks of granite in the lower, and of limestone in the upper chambers, the blocks being two or three feet high, and forming the N. and S. sides

of the chambers. On the E. and W. are two immense limestone walls wholly outside of, and independent of, all the granite floors and supporting blocks. Between these great walls all the chambers stand, unbonded, and capable of yielding freely to settlement. This is exactly the construction of the Pyramid of Pepi at Sakkara, where the end walls E. and W. of the sepulchral chamber are wholly clear of the sides, and also clear of the sloping roof-beams, which are laid three layers thick; thus these end walls extend with smooth surfaces far beyond the chamber, and even beyond all the walls and roofing of it, into the general masonry of the Pyramid.

From the measurements of the lines drawn on the rough sides of the blocks, it seems that the roofing-blocks had usually a mid-line and two end lines marked on their sides as a guide in placing them; and, in case of obliteration, extra lines were provided, generally a cubit (20·6) from each end, but sometimes at other points. The horizontal lines were probably to guide the workman in cutting the straight under-sides of the beams; and it would be desirable to measure through some cracks to find their distances from the ceiling side. The flooring of the top chamber has large holes worked in it, evidently to hold the butt ends of beams which supported the sloping roof-blocks during the building.

General summary of the positions inside the Great Pyramid:

	Horizontally.			Vertically.
	From N. Base.	From Centre.	E. from Centre.	Above Pavement.
Beginning of entrance	524·1± ·3	N. 4010·0± ·3	mid. 287·0± ·8	+ 668·2± ·1
S. end of entrance passage . . .	4228· ±2·	N. 306· ±2·	mid. 286·4±1·	−1181· ±1·
S. end of N. subterranean passage	4574· ±2·	S. 40· ±2·	mid. 286·3±1·	−1178· ±1·
Subterranean Chamber, centre . .	4737· ±2·	S. 203· ±2·	mid. 25·9±2·	−1056· ±2· roof
N. end of S. subterranean passage	4900· ±2·	S. 366· ±2·	mid. 284·9±1·	−1219· ±1·5
S. end ,, ,, ,,	5546· ±3·	S. 1012· ±3·	mid. 277·1	−1213· ±2·
Beginning Ascending ,,	1517·8± ·3	N. 3016·3± ·3	mid. 286·6± ·8	+ 179·9± ·2
End of ,, ,,	2907·3± ·8	N. 1626·8± ·8	mid. 287· ±1·5	+ 852·6± ·3
Queen's Chamber, N.E. corner .	4402·1± ·8	N. 102·0± ·8	side 308· ±3·	+ 834·4± ·4
,, ,, mid. W. roof .	4533·8± ·8	N. ·3± ·8	side 72· ±3·	+1078·7± ·6 roof
Gallery, virtual S. end, floor . .	4595·8± ·9	S. 61·7± ·9	mid. 284·4±3·	+1689·0± ·5
Gallery, top of step face	4534·5± ·9	S. ·4± ·9	mid. 284·4±3·	+1694·1± ·7
Antechamber, N. end, floor . . .	4647·8± ·9	S. 113·7± ·9	same?	+1692·6± ·6
,, S. ,, roof . . .	4763·9± ·9	S. 229·8± ·9	same?	+1841·5± ·6 roof
King's Chamber, floor at door . .	4865·0± ·9	S. 330·9± ·9	mid. same?	+1692·8± ·6
,, ,, N.E. wall base .	4864·7± ·9	S. 330·6± ·9	side 305·0±3·	+1688·5± ·6
,, ,, roof				+1921·6± ·6
				to 1923·7± ·6

CHAPTER III.

THE SECOND AND THIRD PYRAMIDS.

THE casing of the Second Pyramid is different in its arrangement from that of the Great Pyramid, as already mentioned. The lowest two courses of the casing are of granite, very well preserved where it is not altogether removed. In order to avoid the risk of working an acute angle for the lower edge of the bottom course, the builders made the face drop down for some depth vertically from the edge of the slope, building the pavement against the vertical face. Thus no edge of the block was sharper than a right angle, and the two outer edges top and bottom were considerably over a right angle, and therefore not liable to injury. But by so arranging it they required the vertical foot of the casing to be as high as the pavement thickness, or else to be raised; and as the pavement must not be too thin, for fear of cracking, and also as they did not wish to be limited to the exact amount of surplus that formed the vertical foot; they therefore cut the rock to support the casing-blocks at a higher level than that for the pavement bed.

The lengths of the sides are—N. 8471·9, E. 8475·2, S. 8476·9, and W. 8475·5; thus the mean is 8474·9, and the azimuth $-5'\ 26''$, with mean error of only 1·5 inch, and $33''$ of angle.

But beside this there is the casing still remaining on the upper part of the Pyramid, which differs from the diagonals of this base only ·7 inch on the average.

The mean angle of the casing is $53°\ 10' \pm 4'$, and hence the height will be $5{,}664 \pm 13$ inches.

The lowest course of casing was of granite, and is $41{\cdot}52 \pm {\cdot}05$ high, vertically, from the top to the base of its slope, and its vertical face below that 11 high, as measured at the S.W. The upper part of the Pyramid was cased with Mokattam limestone, of a rather different quality from that of the Great Pyramid; it is grayer, harder, more splintery, and of not such a regular and certain fracture.

Where some foundation stones had been removed, low down under the S.E. socket, a coin of Sultan Hasan, 1347–1361, was found in clearing the sand in 1881. As the mosque of this Sultan is said to

have been built with stones from the Pyramids, this coin rather suggests that some stones were removed for that purpose from the base of the Second Pyramid. The casing in general, however, was said to be still in its place in the time of Palerma, 1581, and of Albinus, 1591; though in Sandy's view, 1611, only the present cap of casing is shown.

The lower part of the Pyramid core, all round, is of rock; unmoved, but hewn into shape; higher on the W. and lower on the E. side. Above this lie two or three courses of huge blocks of Gizeh rock, much larger than those brought from the Mokattam quarries on the E. bank.

The pavement around the Pyramid was sunk slightly in the rock, and the edges of its bed were found near the N.W. corner. They were 528·8 and 527·9 distant from Pyramid base on the N., and 530·9 on the W. side. This is just about the same as the most usual breadth of the Great Pyramid pavement bed. Vyse reports finding 432 inches breadth of paving still in existence.

The whole site of the Pyramid is artificially levelled; it is cut into the sloping rock of the hill-side, deeply on the W., and less along the N.; it is built up at the N.E. to support the pavement, by a platform of immense blocks; and at the S.E. the rock falls rapidly away, and has probably also been built over, in order to level it up for the pavement.

Within this lowered area are rows of grooves and cross grooves cut in the rock, which is thus divided up into squares. These are the remains of the trenches by which the workmen cut out the whole of this space.

Around the N., W., and S. sides of the Pyramid and its area is a large peribolus wall. This wall differs in its character on each side, and does not seem to have been planned with any uniformity. On the N. side it is a wide substructure of very large blocks, rather rudely hewn, and bearing cubit marks and numbers on the backs. Its original height cannot be easily settled; probably 20 feet would be below the mark. On its S. face this wall is much less finished, and has been banked up to the top of the broad part by a vast heap of chips, which have been kept in position by building retaining walls in them. Two of these retaining walls that I partly uncovered, were of rough broken stone, neatly put together, and mud plastered on the S. faces.

Exactly from the end of this great wall, there turns off a much narrower wall, which runs parallel with the W. side of the Pyramid. This W. wall is 70 wide at the top. It is built of rough scraps and blocks of limestone, neatly fitted together with a smooth face; and was probably 6 or 8 feet high when complete. The intention seems to have been to place it as far from the edge of the area as is the N.

wall. The azimuth of this W. wall is + 38′ from the Pyramid azimuth, and it runs on till it joins the wall of the Third Pyramid.

The true peribolus wall of the Second Pyramid, on the S. side, is only a short piece, 500 feet long, which appears to have been incomplete when the Third Pyramid walls were begun; since it was merged into the latter by an elbow wall, instead of being uniformly finished. It is a fine piece of work as far as it goes, and was apparently intended to be at the same distance from the Pyramid as is the great North wall.

Beyond the western peribolus wall there lie the large barracks of the workmen. These have been hitherto considered merely as lines of stone rubbish, or masons' waste heaps; and though Vyse cut through one part, he merely says that the ridges "were found to be composed of stones and sand, and their origin was not discovered" (vol. ii. p. 88). But on looking closely at them I observed the sharply defined edges of walls; and as soon as these were begun to be cleared, the ruined tops of the walls were seen, the spaces being filled with blown sand.

These galleries are built of rough pieces of limestone (somewhat like the W. peribolus wall), bedded in mud, and faced with hard mud, or mud and lime; the floors of the galleries are also of hard mud. Their length was variable, about 90 feet; their width 113 inches, with entrances 85 inches wide. There are in all 91 galleries; which make an aggregate of over a mile and a half of gallery length, 9½ feet wide, and 7 feet high. Such a vast amount of accommodation seems only attributable to the workmen's barracks. The work is just suitable for such a purpose; strong and useful, and with about as much elaboration as an Egyptian would put into work that had to last in daily use for one or two generations. The extent of the galleries is also very reasonable. Supposing the men had a fair allowance of room (more than in some works at present) the whole barrack would hold about 4,000 men; and such would not be an unlikely number for the permanent staff of masons and their attendants employed on a pyramid. There is no probability of the walls being later than the Second Pyramid, because (1) they are arranged square with it; (2) at a part of the hill which would be out of the way for any other work; and (3) they are built of exactly the same style as the adjoining western peribolus wall and the retaining walls.

The doorway of the Second Pyramid is lost, along with the casing; and the granite blocks of the passage end irregularly. The position of the passage was fixed from a station mark near it; its axis is 490·3 E. of the middle of the N. face. Its azimuth was already observed by Prof. Smyth, as −5′ 37″; which is almost exactly the mean azimuth of the sides, as by my triangulation they are −5′ 26″, with a mean difference of 33″.

The entrance passage is entirely of rough dressed granite, none of it polished; like the work of the King's Chamber ceiling and the Antechamber, and not like the King's Chamber walls in the Great Pyramid. The flaws in it are made good with plaster, much of which is to be seen on the first roof-stone, and all along the side of the roof, sometimes half-way across it. This was laid on with a board or trowel, and afterwards painted red, like the plastering in the Granite Temple.

This passage varies from 47·13 to 47·44 in height, and 41·08 to 41·62 in width.

At the bottom of the slope, the roof has a half-round drum or roll across it, like the "roller" over all the tomb doors. From this the passage goes southward horizontally (see Pl. iv.), with a granite portcullis slab across it, sliding in vertical grooves. Beyond that the passage is 70·38 to 71·53 high, and 41·30 to 41·78 wide. The intention in the 71 inch height seems to be to make it half as high again as the ordinary passage: $71{\cdot}06 \times \frac{2}{3} = 47{\cdot}38 \pm {\cdot}09$; and the other passage is $47{\cdot}29 \pm {\cdot}03$.

The great chamber is entirely cut in the rock, excepting the pointed gable roof, which is built of limestone beams, like that of the Queen's Chamber in the Great Pyramid. Stone has been let into the walls to make good defects; and the whole surface was stuccoed. The floor is partly of rock and partly paved; the paving is of fine limestone 9 to 14 inches thick, except around the coffer at the W. end, where it is of deep granite blocks. The coffer is of the usual form, like that in the Great Pyramid, but was let into the floor up to the level of its sliding lid. The floor was lamentably torn up by Perring in search of other chambers, and the stones are now piled up all over the E. wall. The chamber is,

195·8 on E., 195·9 on W.; 557·9 on N., 557·4 on S.;
206·4 high at N.W.; 206·3 and 206·5 (?) at S.W.

Vyse gives 38 inches for the gable roof rise (though measuring the height from the wall base instead of the floor), and this gives 244·4 for the height of the ends.

The coffer is well polished, not only inside but all over the outside; even though it was nearly all bedded into the floor, with blocks plastered against it. The bottom is left rough, and shows that it was sawn and afterwards dressed down to the intended height; but in sawing it the saw was run too deep and then backed out; it was, therefore, not dressed down all over the bottom, the worst part of the sawing being cut ·20 deeper than the dressed part. This is the only error of workmanship in the whole of it; it is polished all over the sides in and out, and is not left with the saw lines visible on it like the Great Pyramid coffer. The finish is about the same as o

the walls of the King's Chamber, and the horizontal polishing lines can be seen inside the N. end.

The lid is lying on the floor of the chamber, unbroken; it was slid on to the coffer, and held by a projection on its base, which fitted into undercut grooves. When finally slid into place, two pins (probably of bronze) dropped down out of holes in the lid, into corresponding holes in the W. side of the coffer.

The designers were evidently afraid, however, of the coffer being turned over, so as to let the pins drop back into the lid; they therefore sunk the coffer into the floor. To make it still safer they put resin in the pin-holes, where it may still be seen; then the pins, being ready heated, were put into the holes in the lid, which was quickly closed; thus the pins sank ½ inch to 1 inch, melting their way into the resin, and probably forcing it up their sides. This process made sure that there could be no way of getting the lid off without breaking it, and the design answered perfectly; the lid never was drawn off. On one side of the groove in the coffer may be seen a little scrap of cement. This shows that the lid was cemented on in the grooves, and that it never was slid back, or it must have rubbed off such a fragile scrap. This cementing on of the lid was also of use to prevent any shake; so that the labour of wrenching it off, and bruising the undercutting to pieces by wriggling and jogging it up and down, must have been enormous. This seems, however, to have been the way of forcing it, as the undercutting is much broken, and the cement in the groove, and the melted-in pins, make it impossible to suppose any other mode of removing the lid. There is a good deal of crystallized salt on the inside of the coffer.

The mean size of the coffer was measured—outside, length 103·68, width 41·97, height 38·12; inside, length 84·73, width 26·69, depth 29·59; mean variation of work ·04 inch. Lid 103·7 × 42·0 × 9·9.

This coffer being 42·0 inches wide, can never have been taken through the passages, as the upper passage is only 41·3 wide, and the lower is 41·2 and 41·6. Hence it must have been put into the chamber before the roofing was laid over it, and so before the Pyramid was built upon that.

The lower chamber (see Pl. iv.) is roughly cut in the rock, and is of no particular interest; a recess in the passage opposite its doorway shows that a coffer (about 40 × 105) was intended to be turned round into it. The granite portcullis in the lower passage shows great skill in moving masses, as it would need 40 or 60 men to lift it; yet it has been moved, and raised into place, in a narrow passage, where only a few men could possibly reach it.

The Third Pyramid has never been quite finished. Its granite casing blocks are left in probably the same condition that they were

sent from Assouan, with their outer faces in the rough,* but smoothly dressed down, and polished toward the edge on the joint surfaces. This line of polish is well defined on its outer edge, the stone being quite rough outside it, and sinking away sharply from it. This is important for estimating the intended plane of finish. The limestone casing which covered the upper part of the Pyramid was finished off like that of the other Pyramids; as may be seen by the worked faces, in the heaps of chips left by the Arab destroyers. But the pavement seems most probably never to have been placed around the Pyramid; Perring found nothing but a substructure of rough megalithic blocks, with wide joints, and concluded that it was to be covered with finer work. On uncovering the granite casing, not only did I find no paving there, but the casing foot is quite in the rough, so that no pavement could be fitted to it; and none underlies it, as the granite rests on rough limestone.

It is most likely that the face was intended, when finished, to end in a vertical foot; and this would be covered by the pavement to be afterwards added.

The intended base of this Pyramid was probably then a double cubit below the first joint, as in the Second Pyramid, leaving the first course visible for the same height as those above it. At this level then the sides averaged 4153·6, with a mean error of ·3·0; and the orientation was + 14′ 3″, with a mean error of 1′ 50.″

For the angle of the Pyramid the data are rather divergent; the stones *in situ* are very irregular, and the courses are not level. Probably it was 51° 0′ ± 10′, which yields a height of 2564 ± 15 for the Pyramid.

The granite probably ceased at the level of 645·2, *i.e.*, including the lower 16 courses. The reasons for this are: (1) the highest remaining fragments of granite (mere back ends of casing stones) are at the same level on each of the sides; (2) the course next over this is thicker than any other course of the whole Pyramid, and is followed by a course thinner than any that underlie it; (3) Diodorus states that the casing was of black stone up to the 15th course, and like the other Pyramids above that level. Now, by the stumps of the stones the granite must have come to the 16th, and probably the lowest course was covered with sand in his day; but it is unlikely

* One writer has described them as "rusticated," as if the roughness was a prepared feature; and another has attributed all the rounded irregularity of the stones to their weathering away since they were built. To say nothing, however, of innumerable cut holes in the outer surface, left for lifting the blocks, no weathering would add to a stone a part above its original face. I had the pleasure of showing these details to an Engineer officer, experienced in Indian granite works, and he perfectly concurred as to the method of leaving an excess of stone on the face, to prevent injury to the block in transit.

(unless we credit him with loose errors like modern guide books*) that the casing went much higher.

This being settled, it is worth notice that the granite just covered one quarter of the height of the Pyramid, the total height being $4 \times 641 \pm 4$. Conversely this may be taken as giving a determination of the original total height, perhaps more accurately than by the varying angles of the casing, thus:—

645·2 (±·5 (?) for uncertainty of paving) $\times 4 = 2580{\cdot}8 \pm 2{\cdot}$
And this yields an angle of 51° 10′ 30″± 1′ 20″.

The casing, though partly attacked in the 12th and 13th centuries, does not seem to have been removed in the time of Belon (1548), or of Villamont (1589), who describe it as perfect, and without steps.

The peribolus walls around the Third Pyramid (see Pl. i.) are all built of unhewn stone, neatly laid with mud mortar, like the walls of the barrack galleries of the Second Pyramid. They are, however, irregular in their position, some being nearly square and parallel with the Pyramid, and the others on the South being very different. They were all fixed in the survey by triangulation, with more accuracy than the wall-surface can be defined; and they seem to have been laid out piecemeal, in round numbers of cubits, without any regular plan.

The temple on the E. side of this Pyramid appears to have been the most perfect that was visible at Gizeh in 1755; and Fourmont mentions four pillars as then standing in it. It has now lost all its casing (used by the Mamelukes for houses at Gizeh), and merely the core blocks remain, weathered away in some parts so as to have fallen over. The marks where the walls have been cut, to fit in the backs of lining blocks, show that it was cased (probably with granite) like the temple of the Second Pyramid and the Granite Temple.

The causeway is just the width between the entrance passage walls; it is built of large blocks, and raised, probably, 20 or 30 feet above the plain, though the sides are now much hidden by sand. It ran down the hill for about 800 feet from the temple; but it had no connection with the other causeway, situated half a mile further E. in the plain below, though they are often confounded together. The lower causeway is not in the line of the upper, nor parallel to it;

* In one of the most scientific of guide books it is said that the Third Pyramid cannot be ascended (it is easier than the Great Pyramid); and that it was "covered with *slabs* of *polished* granite, and the upper part with *rough stones*"! or, making matters worse still, "in the case of the Third Pyramid the *whole* surface was to be, as it were, *veneered with slabs* of granite"! showing that the writer had never realised the proportions of a casing stone. But descriptions of the Pyramids are usually replete with extraordinary mistakes—"granite" for "limestone," "height" for "width," etc.

and it only ran up to the quarries in the limestone hill, which is such a striking feature in the neighbourhood.

There was a considerable village of Græco-Roman age around the Third Pyramid. A great amount of crude brick and pottery lies on the S.E.; crude brick is also found on the causeway, and is mentioned by Vyse as found on the pavement at the N. side.

The entrance is in the fourth course, or from 165·3 to 202·1 vertically above the base; it is in the middle of the face, unlike that of either of the larger Pyramids. The centre of it is 2078·9 from the E. side of the Pyramid; and though we do not know the exact length of the N. face, yet this is precisely half the length of the S. face.

The azimuth of the passage is + 13′ 16″, which is just between the varying azimuths of the Pyramid sides.

The granite close around the doorway has been dressed down to pretty nearly its final surface, but there is no trace of decoration or inscription.* The edges of the doorway are much broken away, so that no remains of any means of closing it can be traced.

The entrance passage is built of granite, until it enters the rock, in which it is afterwards cut; and all the chambers of this Pyramid are entirely hewn in the rock.

Just beyond the foot of the slope of the passage, it opens into the first chamber (153·8 × 124·9), of which both the sides and the ends are decorated with the panel ornament so universal in the earliest tombs, but not used before in a pyramid.

The horizontal passage beyond this has evidently been excavated from the South outwards; whenever the excavators ran wrong (and they did so several times) the false cut goes deeper towards the N., and then ends abruptly when the error was seen. Also the direction of the pickmark points to its outward working. How the men got inside the rock to begin with, is plain from a second passage which runs above this; and which opens into the second chamber blankly, without any means of getting to the chamber floor, except by a ladder or other help. This upper passage runs through the rock up to the masonry, and was cut from the North inwards. The second chamber is 559·8 × 152·0. This is not, however, the chamber that contained the coffer, though it has a recess apparently intended to hold a coffer. Out of the middle of its floor a sloping passage descends westwards, turns horizontal, and then comes into the E. side of the granite-lined sepulchral chamber. There are some remarkable holes cut in the walls, apparently to hold the ends of rollers, over which ropes were run in lowering the coffer; these holes were not cut by Perring, as he engraves them in his plates.

* The name of Menkaura, recorded by Diodorus as being on the N. side of this Pyramid, was probably cut in the bold characters of the early kingdom upon the limestone above the granite, easily visible, but safe from idle mischief.

The granite chamber is hewn in the rock with a flat ceiling like the other chambers. The granite lining and floor of it is built in; and in order to introduce the roof-blocks a hole is cut from the end of the second chamber, into the top of the lower chamber. The roofing is not by beams, as in the King's Chamber, nor by cantilevers, as in the Queen's Chamber of the Great Pyramid; but by sloping blocks resting one against the other with a thrust, the essential principle of an arch. The under-sides of these blocks are cut into a barrel or hemi-cylindrical roof, like passages in tombs of the early period. The introduction of these massive blocks through such a small space, and the placing them in such a confined position, is a good piece of work.

This granite chamber is not at all as regular in form as it is in appearance, as its length varies from 258·8 to 260·7; width, 103·2 to 104·0. Its height is 105·7 at side, and 135·0 in middle.

Beside the first, second, and granite chambers, there is a chamber containing six loculi: this is entered by a flight of steps turning out of the passage to the granite chamber. These steps are by far the earliest known in any building or excavation: they are six in number, and their breadths are from 10·5 to 12 inches, averaging 11·3. This loculus chamber was doubtless intended to contain coffins, judging by the sizes of the recesses. The chamber is 75 × 208, and irregular.

From all the details it seems that the Third Pyramid was first begun no larger than some of the small Pyramids on the same hill. That it had a passage descending as usual, with a large lintel block over it; and running horizontally in the rock, into a rock-cut chamber, whose roof was 74·1 above the passage floor. That after this was made, the builders, for some reason, determined on enlarging the Pyramid before it was cased, and on deepening the chamber. They accordingly cut a fresh passage, from the new floor level of the chamber, working this passage from the inside outward. They not only deepened the chamber, but also cut the sloping passage to the lower, granite-lined, coffer chamber; for the granite lining could not be put in until the second chamber had been deepened to its present extent; so the granite chamber must be part of the second design, or is perhaps in itself a third design. The old entrance passage was then built over on the outside, and the greater part of its height blocked up. The blocking that remains is clearly ancient, as it consists of large blocks wedged in by chips, and worn by passing over the tops. On one block is a saw cut, 6 inches deep in part, running vertically on the face; this cut must therefore have been made by the Pyramid builders, before they used the block for filling the passage.

The orientation of the Great Pyramid is about 4′ West of North; a difference very perceptible, and so much larger than the errors of setting out the form (which average 12″), that such a divergence

might be wondered at. When, however, it is seen that the passage, which was probably set out by a different observation, nearly agrees in this divergence, it seems unlikely to be a mere mistake. And when, further, the Second Pyramid sides, and also its passages, all diverge similarly to the W. of North, the presumption of some change in the position of the North point itself, seems strongly indicated. The Third and lesser Pyramids are so inferior in work, that they ought not to interfere with the determination from the accurate remains; they would, however, scarcely affect the mean deviation if included with the better data. The azimuths of the two large Pyramids are thus:—

Great Pyramid,	casing sides	. . .	$-3'\ 43'' \pm 6''$
„	„ core	„ . . .	$-5'\ 16'' \pm 10''$
Second	„ casing	„ . . .	$-5'\ 26'' \pm 16''$
„	„ passage (Smyth)	. . .	$-5'\ 37'' \pm 10''$ (?)
Great	„	„	$-5'\ 49'' \pm 7''$

In considering these results, the difference of the casing and core azimuths of the Great Pyramid shows that probably a re-determination of the N. was made after the core was finished; and it must be remembered that the orientation would be far more difficult to fix after, than during, the construction; as a high face of masonry, for a plumb-line, would not be available. The passages of the Great and Second Pyramids are the most valuable elements; as, being so nearly at the polar altitude, a very short plumb-line would transfer the observations to the fixed plane. Considering, then, that the Great Pyramid core agrees with the passages far closer than does the casing, the inference seems to be that the casing was fixed by a re-determination of N., by the men who finished the building. These men had not the facilities of the earlier workers; and are shown, by the inferiority of the later work in the Pyramid, to have been far less careful. Hence the casing may probably be left out of consideration, in view of the close agreement of the four other determinations, one of which—the passage—was laid out by the most skilful workmen of the Great Pyramid, with their utmost regularity, the mean variation of the built part being but $\frac{1}{50}$ inch.

The simple mean of the last four data is $-5'\ 32'' \pm 6''$; their divergences being just what would be expected from their intrinsic, probable errors. The passages are, however, probably far the most accurate lines in their execution; and as the Second Pyramid is inferior in its workmanship, $-5'\ 45'' \pm 5''$ might be well taken as the result from them alone. On the whole, considering the various values of the data, $-5'\ 40'' \pm 10''$ may be taken as a safe statement of the suggested place of the pole, at the epoch of the Pyramid builders.

There are, however, two checks on the supposition of such a change in the pole: the observations of any change in later times,

and the existence of an adequate cause for the change. Now, the best latitude observations at Greenwich, those on Polaris—least affected by erroneous refractions—appear to show a latitude of 51° 28′ 38·58″ during 7 years, 1840–7; 38·30″ during 10 years, 1851–61; 38·22″ during 3 years, 1862–5; and 38·30″ during 8 years, 1868–76;* or on an average a decrease of ·28″ latitude in 28 years, or 1·0″ per century. But Maskelyne's discussion in the last century yielded 39·7″, for mean epoch 1761. This implies a decrease of 1·38″ per century, agreeing as closely as could be expected with the change in recent observations. A similar decrease of latitude of 1″ per century has been detected in the observations at Pulkova by Nyren.

Hence, in 4,000 to 6,000 years—the age of the Pyramids by different chronologers—the change of Greenwich latitude would amount to just about 1′. Thus, as far as observation can lead us, it seems to show a shift of the earth's axis in longitude 0° to a fifth of the extent shown in longitude 121° by the Pyramid orientations; and therefore a change of the same order, and not improbable in its extent.

As to the adequacy of a cause for such a change, it is hopeless, in our ignorance of the exact amount and velocity of the ocean currents at different depths, for us to strike a balance of them, and see how much motion is outstanding to affect the axis of rotation. But we can at least see what sort of proportion the required effective current would bear to the whole of the currents. Assuming a change of place of the axis amounting to 1′ in 1,000 years, it seems that a ring of water circulating around the earth, across the Poles, at 1 mile per hour, and only 4 square miles in section, would suffice to cause such a change. This is an amount of unbalanced, or outstanding, current which is quite imperceptible in the balancing effects of the various ocean currents; and therefore amply accounted for by existing and known causes, even apart from atmospheric currents.

Thus the apparent change in the axis of rotation shown by the orientation of the Pyramids, is of the same order as a change actually observed. It is also far within the changes likely to be produced by known causes, and the uniform deviation is otherwise unaccountable in its origin. Hence it appears that it may legitimately be accepted as a determination of a factor which is of the highest interest, and which is most difficult to observe in any ordinary period.†

* See diagram in Mr. Christie's paper: Mem. Ast. Soc., xlv.

† Careful re-determinations of the meridians fixed in the beginning of the Ordnance Survey might be of value; as (according to the Pyramids) a change of 5″ might be expected in their azimuths.

CHAPTER IV.

THE GRANITE TEMPLE, AND OTHER REMAINS.

THE Granite Temple stands near the Sphinx, at the foot of the hill of Gizeh; and is directly connected with the Second Pyramid, by means of a causeway which leads from its entrance, straight up to the entrance of the temple of that Pyramid.

This causeway was a grand work, about 15 feet wide and over quarter of a mile long. The rock has been uniformly cut down to a sloping bed, on which has been laid apparently two layers of fine white limestone. The rock looks at first as if it were all masonry, owing to every stone that was placed on it having been more or less let into its surface, just like the building of the Pyramid courses one on the other. All the paving has been torn up, and only a few blocks are left lying about: these have a shallow drain cut in them, apparently on the upper side of the lower layer of paving. This causeway was only discovered two or three years ago; though Professor Smyth, as far back as 1865, had mentioned that the entrance of the Granite Temple pointed to the Second Pyramid, and had thence argued for a connection between them.

The direction selected for this causeway is not due E. from the temple of the Second Pyramid; and it is therefore not square with the Pyramids, nor with the Granite Temple, which is similarly oriented. For this divergence from the nearly universal orientation of other constructions here, there seems good reason in the fact of a very suitable ridge of rock running in this direction, with a sharp fall away on each side of it. Hence, unless an enormous mass of masonry had been built up, to fill a valley that runs due E. of the Second Pyramid, there was no means of making the causeway square with the other constructions. This causeway may have been regarded as a Via Sacra; for on both sides of it the rock is closely perforated with the large shafts of rock tombs, over which chapels were probably built, bordering the causeway.

The two temples which this causeway connects—the upper one, in front of the Second Pyramid, and the lower one, or Granite Temple—are closely alike in their character; and the temple of the Third Pyramid seems to have been similar to them. Both of them were

built with a core of megalithic blocks of limestone, ranging in their weight to over a hundred tons each; and these were cased over by massive blocks of granite or of alabaster. The upper temple has been far more destroyed than the lower; only a few blocks of its polished granite remain, and its ruins are half buried in heaps of chips of alabaster,* limestone, and granite. It had a sloping ascent, like the lower temple, probably to a court over the roof of its chambers; and innumerable fragments of polished diorite statues, beside alabaster vases and inscribed ornaments, are mixed together in the rubbish, evidently derived from the destruction of statues like those of Khafra, which were found dashed into the well in the lower temple.

The lower temple, or Granite Temple, which has also been called the Temple of the Sphinx, was apparently a free-standing building, like the upper temple. This is not the view of some who have seen it, and who suppose that it is a rock-excavated work, lined with granite, at least in the lower parts, for the upper half is manifestly built. But Mariette (Rev. Pol. et Lit. 6 Dec., 1879) expressly says that it is all built; and he describes the outer surfaces as being smooth, and "ornamented with long grooves, vertical and horizontal, skilfully crossed," which seems to imply a design like the lattice-work pattern of the early tombs. As far as the outside can be now seen, to about fifteen feet above the base, it is built of megalithic blocks; and in the inside a rough chamber, to which an entrance has been forced, shows the hidden construction; and here it is all built of immense blocks of limestone, resting on a bed of rock at the base level of the temple. Again, just outside it, on the N.E., is an enclosure of crude brick and rough stone, lately cleared, and there the rock is at about the level of the base of the temple. It seems most probable, therefore, that it is entirely built; though possibly heaped round with stones and sand on the outside, like the tombs on the S. of the Great Pyramid, and at Medum. Until the outside shall be cleared, and the construction put beyond doubt, the evidence points to this resembling the upper temple in every respect.

The arrangement of the Granite Temple will be seen from the plan, Pl. iii. The causeway from the upper temple runs downs the hill, in a straight line, into the passage which slopes down into the great hall. The pillars in this hall are all monoliths of dark red granite, like that of the walls; they are 41 inches (2 cubits) square, and 174·2 high, weighing, therefore, about 13 tons each. The two larger pillars, placed at the junction of the two parts of the hall, to support three beams each, are 58 inches wide, and weigh over 18 tons each. All these pillars support beams of granite, which are likewise

* This is carbonate of lime, in crystalline nodular sheets; and is called Oriental alabaster, by the wide use of that word for both sulphate and carbonate.

41 inches square in the double colonnade, and 47·8 to 48·4 deep in the single colonnade, where their span is greater. The shorter spans are 128, and the longer 145 inches; so that the beams are not as heavy as the columns, the two sizes being 9½ and 12½ tons. Six of these beams, or a third of the whole, are now missing. The Arabs say that they were found lying dislodged in the temple; and that Mariette, when clearing up the place to exhibit (at the festivities of the opening of the Suez Canal), had them blasted to pieces by soldiers. This seemed scarcely credible, although very similar stories are reported of that Conservator of Antiquities; but among the quantities of broken granite, which is built into a rude wall to keep back the sand, I found many pieces with polished surfaces like the beams in question, and with distinct blast-holes cut in them, quite different in character from the holes drilled anciently. This ugly story, therefore, seems confirmed.

Besides this great hall, with the colonnades 222·4 inches high, there is another hall to the east of it, which has been much higher; and from each end of the eastern hall is a doorway, one now blocked up, the other leading to a chamber. Out of the great hall a doorway, in the N.W. corner, leads to a set of six loculi; these are formed in three deep recesses, each separated in two by a shelf of granite. These recesses still have their roofs on, and are dark except for the light from the doorway, and from a ventilator. The lower part of the walls of each recess is formed of granite, resting on the rock floor; this is 61·6 to 61·7 high. Above this is the granite shelf, 28 thick, which extends the whole length of the recess. In the southern recess this shelf is nearly all of one block 176 × over 72 × 28. Upon this shelf, over the lower recesses, are placed two walls of alabaster, dividing the upper three loculi; both walls are irregularly a few inches southward of the lower walls. The extraordinary length of these loculi—over 19 feet—seems strange; especially as the turn to the side loculi would prevent any coffin larger than 30 × 76 inches being taken in unless it were tipped about to get the benefit of the cubic diagonal. The doorway is only 80·45 high, so that nothing over 80 inches long could be taken in on end.

On the S. side of the short passage leading to these loculi, a stone has been removed from the wall, and by climbing in, a curious irregular chamber is reached, evidently never intended to be seen. It is entirely in the rough, the N. and part of the W. side being merely the backs of the granite blocks of the hall and passage; these are irregular, in and out, but nevertheless very well dressed, flat and true in most parts. The rest of this chamber is of rough core masonry, just like the core of the upper temple, and the floor is of rock, with a step down across it (broken line in plan) about the middle of the chamber. The base of the S.W. corner of the chamber

is entirely in one block, the lower or sunken part of the rock floor being levelled up by a base plane cut in the block, and the S. and W. sides being two vertical planes in the same block, so that it forms a hollow corner all in one piece. On the S.E. the chamber is bounded by a rough wall of stone scraps built in when it was recently opened. In the chamber were found, it is said, several common mummies; perhaps of late date, like those I found in the E.N.E. rock trench.

The history of the opening of this secret chamber seems to have been that in destroying the temple, for the sake of building stones, the pillagers began at the S.E. and S.W. corners; here they pulled stones away until they opened into this chamber, and then, finding a granite wall on one side of it, they dragged out the smallest block, and so broke through into the passage. A clearance of the outside of the temple is needed, however, to settle this as well as other questions.

Another covered chamber also exists, branching from the entrance passage; this is built of alabaster and granite. Opposite the entrance to it is a doorway, leading to an inclined passage, which was the ascent up to the former roof of the great hall. This passage is of alabaster, and the upper doorway of granite.

The whole of the area above the great hall appears to have been at one level, and to have formed a large uncovered court, surrounded by high walls. That it was not subdivided into chambers would appear from the character of the facing of the wall, which remains in one corner over the six loculi. This wall is of fine limestone, and not of granite or alabaster, which were used in covered parts of the building; and it has a considerable batter, unlike the walls of the halls or chambers below, and only resembling the external walls of tombs. Each feature shows, therefore, that it was open to the sky. As no temples more complete than this are known, except those built one to three thousand years later, it is unsafe to argue by analogy; but still there is no case, I believe, of a second storey to a temple; and smaller temples over the large one (as at Dendera) are of the character of additions built in a court on the roof, and not upper storeys as parts of a whole design.

The ventilators are a peculiar feature of the building, though somewhat like those to be seen in the tombs. They were formed by sloping slits along the top edge of the walls, a few inches wide, and usually 41 inches long. Only one remains perfect, that opening out of the chamber of loculi; this slit opens into a rectangular shaft, which rises to some way above the roof, and there opens with a square mouth of alabaster on the face of the upper court wall. The mouth is on the same side of the shaft as the slit; and hence the only light entering is reflected from the side of the shaft. The

slits cut for these ventilators exist all along the Western part of the great hall, and are marked on the walls in the plan.

The Eastern hall appears to have been formerly much higher, probably as high as the smaller chamber on the N. of it, which rises several feet above it. The signs of this are the absence of ventilating slits along the present tops of its walls, and the two large recesses at each end of it, which are now less than half their original height. What these recesses originally were like may be seen by a similar recess in the small chamber at the N. end. Here is a large recess in the W. wall, quite rectangular, and free from any ornament, like all the other parts; it is roofed across by a deep lintel, the whole being of the same red granite as the rest of the walls.

What may have been the use of these recesses, is an inquiry which seems to be solved by the other question, as to where were the original sites of the diorite statues, so many of which were found thrown into the well in the Eastern hall. These statues must have had some appropriate place in this hall, and no sign appears of any pedestals upon which they could have stood. We might look, then, on such niches or recesses in the walls as the original sites of the great diorite figure of Khafra, of his lesser statues, and of the equally valuable (though sadly neglected) cynocephalus apes of Tahuti, carved in grey granite and green basalt, which now lie scattered about the building. These recesses at the end of the Eastern hall are 80·9 (S.) and 85·5 (N.) in width; that in the north chamber is not accessible.

The workmanship of the building in general, though fine looking, is not at all equal to that of the Great Pyramid. The granite blocks are fitted together anyhow, so long as their joints are horizontal, and somewhat upright; and in some cases even a re-entering angle is cut in one stone to receive the corner of another. The walls are also far from vertical, or square with each other in plan. The Eastern hall is longer on the present top than at the bottom by 7·2 on E. and 9·7 on W. side, the difference being nearly all due to a very perceptible batter of the S. end. It is also wider at the top than the bottom, by 4·1 on N. end and 2·9 on S. end. The orientation of it is fairly close; for, judging by the noonday gun of Cairo, it is + 16′ or − 12′ from true N. by two different days' observations. The irregularity of the walls discouraged me from using polestar observations for it, the difference of width of the ends being equal to 10′ on the length. All the dimensions marked on the plan are as measured at the base, except the Western part of the great hall, which is much buried in the sand.

The building is peculiar in the fitting of the corners; not only are the courses bedded alternately one over the other up a corner, as in the Great Pyramid, but each course goes an inch or two

round the corner; the angle being actually cut out in each stone. This may be very probably explained by what we see in the granite casing of the Third Pyramid; there the face was left rough, to be dressed down after building. If, then, the faces of these blocks were left with a small excess on them, and dressed down afterwards, that would make each block turn the corner in the way described.

All the doorways seem to have been fitted with double valve doors: the doorway to the loculi is the best to examine. There the pivot-holes cut in the granite lintel by a jewelled tube drill are plainly to be seen; with the stump of the core left by the drill, still sticking in the southern hole. On the floor beneath these there is, not another hole, but a highly polished piece of black basalt, quite flat, and free from scratches. It is difficult to see what was the use of such a stone, or how the doors were worked.

This Granite Temple, then, appears to have been a mass of masonry, probably cased externally with fine limestone; and measuring about 140 feet in each direction, and 40 feet high. This contained a hall about 60 feet long, 12 wide, and 30 feet or more in height, with a large recess at each end containing a statue. These recesses were high up above the doors which led into lesser chambers, also containing statues, and from which outer doorways may have led. Besides this hall there was the great hall, entered by a doorway over 8 feet wide and 14 feet high, and dimly lighted by its ventilators; one part of this was 81 feet long, 22 wide, and 19 feet high, the roof supported by six massive pillars; while the remainder was 55 feet long, 33 wide, and 18½ high, with its roof supported by ten of the same monolithic pillars. There were also six loculi, each 19 feet long, in one of the side chambers. Over all this was the open-air court on the top, reached by a sloping passage of alabaster, and cased with fine white limestone; its area about 80 feet by 100 feet, and the walls around it over 15 feet high. From the great ceiled halls of dark red granite—with their ranks of square monoliths, and vistas as much as 100 feet in length, all dimly seen by the light reflected through the openings along the roof—the main passage led out in one straight line, up the wide dazzling white causeway, for more than a quarter of a mile; thus entering the similar temple that stood before Khafra's Pyramid, richly furnished with statues, bowls, and vases engraved with his royal name and titles.

The date of the Granite Temple has been so positively asserted to be earlier than the fourth dynasty, that it may seem rash to dispute the point. Recent discoveries, however, strongly show that it was really not built before the reign of Khafra, in the fourth dynasty.

The main argument for its earlier date is the mention of the "Temple of the Sphinx," in the celebrated tablet discovered at Gizeh.

But I found that the building to which this tablet belonged was of the twenty-first dynasty; and, as will be seen in the "Historical Notes," this tablet is either a refurbished and altered copy of an older inscription, or more probably an entire invention. In no case, however, would it be certain that the Granite Temple was the identical temple of the Sphinx, rather than the temple of Isis, or that of Osiris, which are also mentioned; and there may easily have been other temples in the neighbourhood, whose foundations are as unknown now as the whole Granite Temple was a generation ago. The whole reasoning turns on the supposition that a building which is near the Sphinx, though not known to be in any way connected with it, is yet necessarily identical with a temple of the Sphinx, mentioned on a tablet which has internal evidences of being untrustworthy, and which was written about a couple of thousand years after the time mentioned upon it.

The argument, on the other hand, for the Granite Temple being of the fourth dynasty, is drawn from its own construction, and is, therefore, contemporary evidence. The great causeway from the temple runs askew to the orientation of the temple and Pyramids; and the adequate reason for this is the presence of a ridge of rock running along in that direction. But the entrance passage, which is built all in one mass with the temple, and is certainly contemporary with it, is also skewed exactly as the causeway. This shows that the causeway cannot have been designed after the temple, since there must be a strong reason for building one part of an oriented structure askew to the rest of it. If the causeway, then, is as old as the temple, what could be the meaning of running a causeway up to a bare hill-top, if no temple or Pyramid existed there? more especially as all other causeways and approaches run east instead of west. The only adequate reason for this arrangement is the pre-existence of the Second Pyramid and its upper temple, before the causeway and lower temple. The same conclusion is arrived at when we consider the other Pyramid causeways, and see that the causeway of the temple was (in the cases of the Great and Third Pyramids) doubtless the causeway by which the materials were brought during the building. If the Granite Temple existed before the causeway, and so blocked the end of it, there would be no way of taking the stones up for building the Second Pyramid. The lower end of the causeway must have opened freely on to the plain, until the completion of the Pyramid and upper temple.

Thus the arrangements of the buildings themselves point clearly to the following order of design. First, the Pyramid of Khafra; second, the temple built symmetrically in front of that Pyramid; third, the causeway, leading askew from that temple down a ridge of rock; and fourth, the Granite Temple at the foot of the causeway, with its entrance passage skewed into line with the causeway, though

the rest of the temple was oriented, like everything else in the neighbourhood.

The fact that the only dateable remains found in the Granite Temple were statues of Khafra also shows that it is of his period; since the idea of his appropriating an earlier building is very unlikely.

Such, then, is the contemporary evidence on the age of this building, given by the causeway and passage.

There are, at Gizeh, remains of various other great buildings of the Pyramid period, as well as the Granite Temple (or rather the lower Granite Temple of Khafra) and the upper temple by the Second Pyramid.

On the east side of the Great Pyramid a large building existed, of which but little can be found to show its nature. The great basalt paving, about 90 feet by 180 feet, has been described already, and a great platform of this sort must have been part of some large work. The superstructure, now destroyed, appears to have been lined with granite, like the temples of Khafra; many large pieces of polished granite are to be seen lying on the S. side of the basalt paving; and on the E. side, in the inner end of the E.N.E. trench, is a block with two adjacent faces, and a third worked surface on it is precisely like that of the holes for the pivot blocks of the doors in the Granite Temple. Again, when excavating on the basalt pavement, at the middle of it, I found several large hewn blocks of granite, mixed up with the blocks of basalt which lie all torn up there. By the basalt paving I also picked up several flat pieces of diorite; some polished, and others rough-dressed as for cementing in a building. To understand somewhat more of the nature of this part, the whole site of the basalt paving and around it should be cleared of sand and chips, and all pieces of granite and diorite carefully noted down.

The great rock-cut trenches on the E. of the Great Pyramid have every appearance of having been lined with fine stone; not only in each of them are blocks inserted with plaster, and other plaster remaining, but the surfaces are very irregular, and certainly not final; and in most parts the characteristic recessing is to be seen, cut out to hold the irregular backs of the lining blocks, as they were fitted one by one, exactly as in both of the granite-lined temples of Khafra. This recessing can never occur from any cause, except the actual fitting in of the irregularities of the individual blocks of lining; and it must always show, not only that a lining was intended, but that it was also fitted in. Again, the irregular, but flat, ledges on many parts (such as around the inner end of the S. trench, and along the sides of the E.N.E. trench) are exactly what would be made for fitting blocks of lining. Now the width of the inner end of the S. trench is only 134 inches, and that of the E.N.E. trench 170, and its outer end 150; and lining blocks can hardly be reckoned at less than 30 inches thick,

considering the height was 20 feet; hence these trenches must have been narrowed to long vertical slits or crevasses about 5 or 6 feet wide, 20 feet deep, and 160 feet long, lined with costly polished stone.

Of the smaller trenches, the N.N.E. is partly built, and was almost certainly, by its form, position, and wear, a drain to carry off the washing of the basalt pavement, or possibly for some sacrificial arrangement; the other slight trench, at the N.E. corner of the Pyramid, has a uniform fall, as if for a drain.

On the E. side of the Great Pyramid, among the rubbish near the smaller Pyramids, I found two pieces of the casing of a pyramid, each unique. These are now in the British Museum. One is a piece of a basalt casing stone, with three worked faces, *i.e.*, two outer faces of a pyramid, and the horizontal joint below them; being, in fact, a bottom corner of a ridge casing stone. The fragment is about 7 inches high on the faces, and 5 inches wide along the base. The joint surface is beautifully worked, by pick-dressing slightly ground; being seldom over $\frac{1}{10}$ inch from a true plane, and generally much less. The angle of slope must have been 50° 9′ ± 5′, as determined by the angle of meeting of the faces; but the joint dipped down 1° 18′, so that the angle of the block is 52° 27′. From this it seems probable that one of the smaller Pyramids had arris lines of basalt down each corner, to prevent wear and weathering; the general casing of all of these Pyramids was certainly limestone; as I picked up pieces (with the angle of slope) by each of them.

The other remarkable piece of casing is a bottom corner, with an upright joint, of a diorite casing stone. The idea, even of arris lines being cased with a stone so valuable and difficult to work, is almost incredible; but this chip, some four inches long on the face, and one inch on the joint, cut to the regular angle (*i.e.*, 52° 30′ ± 10′), seems to admit of no other explanation.

It therefore appears as if the small Pyramids of the family of Khufu were adorned with the protection of edges of the hardest and toughest stones, which embraced the faces of polished white limestone; an architectural effect quite new to our ideas.

The use of diorite at Gizeh is worthy of study; it is far from a common stone, and was generally reserved for statues, no building stones of it being known *in situ*. Hence, wherever it is found, it is both unmistakable and important. Of wrought and finished diorite, I found opposite the N. face of the Great Pyramid two pieces; each with three faces meeting at right angles, two faces rough-dressed and cemented, and the other face fine ground. These must have belonged to some building work in diorite; and probably belonging to the same were two angle pieces with both faces polished, and two plane chips, both polished. Beside these, in the same place, were many pieces of diorite with slight saw cuts in them, ½ to 2 inches deep, and

hammer-dressed surfaces ; and also innumerable chips of diorite lying about. All these pieces are solely found lying on the surface, and never within the sloping stratification of the ancient Pyramid masons' rubbish. They seem exactly as if some small construction, or object, in diorite, had been smashed up in one spot ; but there are no foundations or traces of a building on the bare rock, for hundreds of feet on either side of it. The site of these fragments is exactly opposite the entrance to the Great Pyramid. Now, Greaves (in 1638) mentions a tradition that the niche in the Queen's Chamber was the place for an idol ; and it would be a very suitable recess to hold a great diorite statue like that of Khafra, which probably stood in a recess in the Granite Temple. If, then, such a statue and its pedestal had been broken up, and carried out of the Pyramid, and finally chipped to pieces at the edge of the hill,—with the same intensity of hatred that is shown in the destruction of the other statues at the temple of the Second Pyramid, at Abu Roash, at Sakkara, and elsewhere,—this would account for the corners of built blocks found here, which might be parts of the pedestal ; for the rough pieces, which might be the backs of the blocks ; for the various pieces of polished diorite ; for the quantity of diorite chips ; and for some pieces of diorite statues, and other dressed fragments, found a couple of hundred feet to the westward. There is no place so likely for the diorite to be brought from, as from the Great Pyramid ; since this site is the part of the hill edge nearest to the entrance, but not near to any other place. Unhappily, there has been such a large amount of quarrying and replacing in the Queen's Chamber, and so much rubbish from there has been distributed elsewhere, that it is vain to look for any diorite chips still remaining there.

The exact position of all wrought fragments of diorite, should be carefully noted when they are found ; as by this means many suggestions may be obtained as to objects that are now entirely destroyed.

CHAPTER V.

NOTES ON OTHER PYRAMIDS.

SOME of the other pyramids that I have examined have such important bearings on those of Gizeh, that it will not be out of place to give some notes here upon their construction, though they have been mostly described by Vyse and Perring, to whose account this must only be considered supplementary.

Beginning at the north, the first Pyramid is at Abu Roash, five miles N. of Gizeh. It is situated on the top of a striking hill of white limestone, a culminating point of the Libyan Desert, which is seen from far in the Nile Valley. This hill is deeply scored by water-courses which wind through it; and its Nile face rises at a steep slope of 35°. The wild and desolate valleys of it were used for interment by the ancient Egyptians; as outside a cave, now partly fallen in, I found fragments of bronze, and of a very large, thin, translucent alabaster bowl. On this hill there are apparently the remains of two Pyramids, but of one of them nothing much can be stated without excavations. Of the other, the general appearance is a large pit cut in the rock, with a passage leading down to it; about ten courses of limestone around it, and a great quantity of broken stones heaped about it, making a mass some 300 feet square and 40 feet high. Beyond this are heaps of granite chips lying in a line all round the Pyramid, and most abundant just in front of the entrance. Leading away northward from the Pyramid is a causeway, nearly a mile long, and in some parts 40 feet high, running down to the plain.

The rock-cut pit and passage were originally lined with fine Mokattam limestone, which, it is said, was stripped out in the time of Mohammed Ali by a mudir. Since Vyse's time some more masonry is gone; and this Pyramid (perhaps the most ancient in existence) is being quarried during high Nile at the rate of 300 camel-loads a day, I was told.

The pit is now about 30 feet N. to S., by 70 feet E. to W., and about 30 feet high, besides the depth of a large quantity of broken stone in it, beneath which Vyse found the pavement. The passage is about 18 feet wide. The sides have a batter of about 1 in 30. The entrance passages of Pyramids are in no case over about 40

inches wide; if such was the case here, then the lining must have been 7 feet thick. Now, looking at the rock-pit, this would imply a chamber about 16 feet by 56 feet (or probably 17 feet, *i.e.*, 10 cubits, in width), the length of it being, perhaps, divided in separate chambers; and what makes this the more likely is that, by this thickness of lining, the sloping roof-beams would lie on it and act as cantilevers without any thrust, just as they do at Gizeh and Sakkara. Perring considered that there were traces of superposed ceilings and spaces, like those over the King's Chamber at Gizeh; and such a covering seems very likely. Roughly observed, by the noon-day gun of Cairo the rock-cut passage is only 20′ W. of N.; this, at least, shows it to be as well oriented as could be expected in a mere rock cutting which was to be afterwards lined.

An important question about this Pyramid is, whether it was ever finished. It has been often written of by Vyse and others as being unfinished; and the rude stone hammers met with here have been classed as implements left by the workmen. We now know, however, that jewelled saws and drills were the tools used by Pyramid builders; and the rough stone hammers are of exactly the types belonging to the rude remains of Ptolemaic times. These, therefore, more probably tell of destruction rather than of construction. The great heaps of granite all round the Pyramid show that it has been cased with granite; and as it is always believed that no casing was put on a Pyramid until the core was entirely finished, this is evidence of the completion of the Pyramid. The far larger heaps of granite in front of the entrance, show that it has been lined in part with granite. Now, all these heaps, like the hammers, tell of destruction, for throughout them broken pieces of worked surfaces of granite may be seen, some with two planes meeting; and also many blocks which have cleavage holes in them, are too large to be masons' waste, and too small for casing blocks, but exactly such as would result from cutting up the casing. The large amount of masonry carried away is shown by the depth of 6 or 8 feet of chips lying on the top of the remaining courses; so that the objection that there is not sufficient bulk here for the Pyramid to have been complete, is put to rest at all respects by the remains of what has been destroyed.

Whether the body of the king was actually placed in the Pyramid or no, is a point of less consequence compared with the fact of finding pieces of granite coffer, and of diorite statue. The pieces of the granite coffer, which I observed in the rubbish which had been carried out of the inside, are some of them curved; belonging, therefore, to a modified box-coffin, partially suited to the figure. One curved piece of coffer is 8·1 thick, and a plane piece is 10·2 thick. Besides this I found fragments of the diorite statue, including several pieces of the figure, and one piece of the throne. This throne had borne an

inscription arranged exactly like that on Khafra's large statue, and of the same scale; the fragment found reads, ". . . . nub (Ramen . . . .)," showing that the king's name was MEN . . . . RA. Altogether, eight pieces of the polished surface and quantities of unwrought chips, were picked up; and beside these I also found chips of basalt (one wrought), and several scraps of Mokattam limestone. Everything here has been smashed with great care; the wrought granite had been mainly burnt and powdered; and the surfaces of the statue were bruised to pieces before it was broken up; the block with the piece of cartouche on it had been used as a hammer, having a groove cut round it to hold a cord by which it was swung. Exploration here would be most desirable, to recover more of these remains, considering how much was found without any aid in a couple of casual visits. For the remarks on the builder, see the Historical Notes.

The recently opened Pyramid of Pepi of the sixth dynasty, at Sakkara, is very interesting as showing many details of construction. The first description of it that was published was one that I sent to Dr. Birch, and which was communicated by him to the Society of Biblical Archæology, in April, 1881, with seven plates of inscription which I copied one day. The chamber is of the form of the Queen's Chamber in the Great Pyramid; the beams of the gable roof rest $\frac{3}{5}$ on the side wall, and project $\frac{2}{5}$ over the chamber; thus they were completely cantilevers, and were quite free from arch thrust until they were broken. The roof is not merely formed of one set of these deep beams on edge, but of three successive layers of beams, or complete roofs, one over another in contact. Yet the destroyers have forced a way through all the beams, and broken them up, so that many of them are upheld by merely the thrust of the fragments against each other. Like the spaces over the King's Chamber in the Great Pyramid, the E. and W. walls of this chamber are wholly independent of the N. and S. sides and of the roofing-beams, the great end walls extending into the masonry of the Pyramid past the building of the rest of the chamber.

The coffer itself is of black basalt, of the plain box-shape; slightly curved, with about 2 inches swell in the sides, to fit the body. The lid slid on from the W.; and to support it a sort of side-board of masonry appears to have been built up between the W. wall and the coffer, from off which the lid could be slid over the coffer. The coffer has only one band of inscription, which is along the E. side; this is only the name Ra-meri and usual brief titles. The form of the box is remarkably massive, the sides being over a foot thick, and the bottom 20 inches, although it was only 2 feet wide inside. Yet it has been broken up by cutting rows of grooves in it, and banging it to pieces; one end being even broken off through the 12 inches thick-

ness of the sides. Its dimensions are 106·5 × 48·6 × 44·7 high, and inside 82 (?) × 24·3 × 24·8 deep.

Beside this coffer there is a square box of granite sunk in the floor; it is 28·1 × 27·9 across the inside, and the sides are 6·2 thick; thus outside it would be 40·4. There is a covering slab, quite flat, and without pin holes or fastenings, 41·2 square and 9·0 thick.

The general bulk of this Pyramid is of very poor work; merely retaining walls of rough broken stones, filled up with loose rubble shot in. This appears to be the usual construction under the sixth dynasty. On a block of the W. wall of the chamber, where it was covered over by the roof-beams, is a painted slab. It is of the style of tomb decoration, with figures variously engaged, and brief inscriptions. But it is very rough, and has been built in as a common building stone and slopped over with mortar. It therefore seems probable that we have here the first example yet known of a learner's work; great quantities of such must have been done by an artist, before he could be entrusted with the execution of the bold, clear drawing for decorating a tomb.

The Great Pyramid of Dahshur is of fine work, about equal to that of the Second Pyramid of Gizeh; and it was cased with fine white Mokattam limestone like that on the Great Pyramid of Gizeh. The entrance passage of limestone has never been polished, but is about equal in work to the fine hammer-dressing of the granite passage of the Second Pyramid. The passage is 41·3 wide, and 47·5 high; the fine stone of the floor is two courses deep, but does not go very far under the sides. The first chamber has 11 overlappings, like those of the Great Pyramid gallery, and the work of it is much like that; it measures:

N. 143·9, S. 142·8, E. 328·5, W. 330·0, N. door 41·2, S. door 41·1.

The passage to the second chamber is 124·6 long; and the second chamber 103·0 wide, with a doorway 41·2 wide. The dimensions were evidently in the usual cubits: 329·2 ÷ 16 = 20·57, 143·4 ÷ 7 = 20·49, 124·6 ÷ 6 = 20·73, 103·0 ÷ 5 = 20·60, 41·1 to 41·2 ÷ 2 = 20·6. In the chamber are many ox-bones; some in bitumen, and therefore probably ancient. The passage is much polished, as by continual passing, and some animal has a lair in the inner chamber; I did not disturb it, being unarmed and miles from any help; and a pair of hyænas with a family might have proved awkward acquaintances.

The Southern or Blunted Pyramid of Dahshur is in many respects the most interesting of any existing, as the greater part of its casing still remains, with good and close joints. It is so out of the way, that the tide of Arab pillage (which only stripped the Gizeh Pyramids in the last few centuries) has but lately reached it; and much of the destruction has been done in the present century, and even a few

years ago. It is also remarkable for containing two hieroglyphic scribbles of visitors, the only examples of such known in the Pyramids; and a curious Greek drawing, of a beast of the pug-dog type. 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 most valuable part of the remaining casing is that of the doorway, as it shows the arrangement for closing the Pyramid (see Pl. vii.). 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.* From the point above these holes, the roof slopes upward more steeply to the outside, being cut away; the joint of the passage side, however, continues in a straight line. This formation of the passage seems exactly adapted for a stone door working on a horizontal hinge; the holes being for the bronze bearings of the pivot, and the cut-out of the roof being to allow the top edge of the door to rise when turning it on its hinge.

Some way within this point is a vertical hole in the roof, 6·2 to 8·2 from the W. 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 of wood by the smallness of the pivot, and working on a vertical hinge. The cut-out in 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. 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.

The form of the outer stone door may be roughly estimated by the requirements and limitations of the case. A plain flat slab is what would probably first occur to the observer; but such a slab, which must be 20 inches thick by the position of the pivots, would need a pull varying from 700 to 1,500 lbs. to lift it up, which could hardly be applied in such a position; also it would leave a gap 13

* The sides of the holes are 11 to 15½ on E., 11 to 16·2 on W.; the tops and bottoms are 4 to 8½ on E., 2 to 8 on W.

inches wide at the top edge when shut. Considering the various data, we may conclude that the door must have been thinned at the lower edge to permit of a person getting in without needing to tilt it so much as to require a great amount cut away at the top edge, and probably the mass would be extended to the S. of the pivot, so as to bring the centre of gravity more nearly under the pivot, and thus make the door easier to open. Thus the conditions almost limit the form of the door to that shown in open shade on the diagram (Pl. vii.); the closed position of it being outlined by dots. The pull required to open such a door by the lower edge would vary from $2\frac{1}{2}$ cwt. at the beginning, to 5 cwt. when fully open; and it could be easily kept open by a rod put across the mouth of the passage at A. Thus, when lifted, there would be an opening about 15 inches high and 41 wide, for $4\frac{1}{2}$ feet long under the block, which would leave access to the lock of the wooden door inside. For the further discussion of this, and the confirmatory passages of Strabo and an Arabic author, see the Architectural Ideas, Chapter VII.

The general work of this Pyramid is about equal to that of the Larger Pyramid of Dahshur, and like that of the Gizeh Pyramids; it is entirely of a superior class to that of the sixth dynasty Pyramids of Sakkara.

The Pyramids which have been described above are all true Pyramids; though they are often confounded all in one class with the Mastaba-Pyramids* of Medum† and Sakkara (the Step-Pyramid), which are really of a different class, distinct in their system and construction. The Mastabas are nearly all built at an angle of 76°, or a rise of 4 on a base of 1, and the usual Pyramid angle of about 52° is well known. The two are wholly distinct, and the examples of them do not merge one into the other. And it may further be stated that there are no true Step-Pyramids. Those commonly so called (at Gizeh, for instance) are merely in process of destruction, showing the successive working platforms of the building, which rise far steeper than the Mastaba-angle; and of one of the most step-like of all (the middle small one by the Great Pyramid), sloping casing may still be picked up around it, and found *in situ* under the rubbish. There are only two of the so-called Pyramids that were not cased in a slope without re-entering angles; these are the two Mastaba-Pyramids of Sakkara and Medum, which really consist of superposed Mastabas, with the characteristic angle of 76°.

* *Mastaba* is the native Arabic name (adopted by antiquarians) for the sloping sided tombs, of about 76° angle, and 10 to 20 feet height.

† This name has always been variable. In the third dynasty it is *Metun;* Mariette, from some hieroglyphic source, spells it *Metum* or *Meri-tum;* Abu Abdallah Muhammed (*ante*, 1400 A.D.) writes *Meidoun;* modern Arabs say *Medum.*

The tower-like appearance of the Medum Pyramid is only due to the lower steps having been broken away. Not only may the places where the steps joined the existing surface be seen, but the lower part of each step-face may be found standing in the rubbish at the base (see F. F. in Pl. iv., drawn from a photograph). An historical proof of the existence of the steps formed by these lower faces is given by Abu Abdallah Muhammed, quoted by Makrisi (circ. 1400 A.D.),* who mentions a Pyramid built in *five* terraces, and called "Meidoun." Both of these Mastaba-Pyramids are also peculiar as having been repeatedly enlarged. In no case have successive enlargements been found in a true Pyramid;† but both of these structures have been several times finished, each time with a close-jointed, polished casing of the finest white limestone; and then, after each completion, it has been again enlarged by another coat of rough masonry and another fine casing outside of the former casing. This explains how readily the Medum Pyramid was stripped into a towering form; there were the older polished casings inside it; as soon as the later coats were stripped off, the older surface was revealed again.

The Step-Pyramid of Sakkara is of poorer work, but on just the same principle as that of Medum; and in this case the additions have been very one-sided, since on the South two finished fine casings may be seen far inside it, only about a third of the distance from the present middle to the W. side (see F. F., Pl. iv.).

* See Vyse, ii. 354.

† Even the Third Pyramid of Gizeh, the size of which has been increased from that of the first design, has not been enlarged over a finished casing, but merely modified in the course of its building.

CHAPTER VI.

HISTORICAL NOTES.

IN considering the arrangements of the early monuments, the questions of the invariability of the climate, and the state of the ground when they were built, become of interest. Was the sand as encroaching then as now? And did the builders anticipate the half-buried state of many monuments?

In considering these questions we must first glance at the general course of Egyptian climate. The country has undoubtedly been gradually drying up. The prodigious water-worn ravines in the cliffs of the Nile valley show this; and there are remarkable evidences of the Nile having been habitually some 50 feet above its present level, thus filling up the whole valley at all times of the year. At many points of the Nile valley, particularly at Tehneh, the cliffs are all water-worn in holes, exactly in the manner of solution under water; while above this action, over about 50 feet level, the cliffs are worn by aerial denudation in a wholly different manner: also the lower part projects forward as a foot, in front of the upper part, the action by water being apparently much slower than that in air, and tending to prevent aerial denudation afterwards.

Besides this, at the foot of the cliffs, particularly at Beni Hassan, wherever the scour of the current was less, or ravines debouched into the main valley, large banks of *débris* have been formed, showing the former power and height of the stream. That it was fed by local rains throughout its course is seen by the deep gorges in the cliffs, often a mile long, and ending in dried-up waterfalls. In the history of the Faium the same drying up is seen; that district appears to have been originally a large lake, which has been gradually reduced, partly artificially, until it is now not a tenth of its former size.

It therefore appears certain that the general change has been one of desiccation; and the inquiry to be made is, if there be any evidence to show whether this change has been continuing in historic times.

Rain was certainly known in Lower Egypt in the Pyramid times, though there is but one evidence of it in the monuments; the water-

spout carved in stone, leading from the roof of one of the tombs of the fifth dynasty at Gizeh, is a proof that such a feature was known, and perhaps in common use on the mud-brick houses. Nevertheless, the rain can hardly have been much commoner then than now, or more signs of its action on the tombs would remain. In Greek times the rain appears to have been just as rare as it is now, or even rarer, in Upper Egypt. Herodotus says that the last that fell at Thebes was two centuries before his time, under Psamtik, and then only in drops. Now, in 1882, Mr. Tristram Ellis, while at Negadeh, just below Thebes, expected rain one day, but he was told that none had been seen there for 45 years. So there does not appear to have been appreciable climatic change in the Thebaid during the last two thousand years. The pits in the Tombs of the Kings, sometimes supposed to have been intended to arrest any storm-flooding, may as likely have been to arrest or hinder intruders; or may be sepulchral pits abandoned, owing to the changes and amplifications of the plans. Again, it may be observed that neither rain, nor any sign of rain, is shown in the paintings of the tombs; no wide hats, no umbrellas, no dripping cattle, are ever represented. Mud-brick tombs, covered with stucco, still remain from the third or fourth dynasty, when they were built without any apparent fear of their dissolution.

On the whole, the rain-fall does not appear to have perceptibly changed during historic times.

The Nile, though so much higher in pre-historic or geologic times, as just mentioned, does not seem to have sunk at all, in Middle or Lower Egypt, in historic times; though above the cataracts it has fallen some twenty or thirty feet. Below the cataracts, on the contrary, it has actually risen, owing to silting up; for many of the deepest tomb-shafts at Gizeh have now several feet of water in them at high Nile, and can only be entered just before the inundation. Also the thickness of mud over the remains both at Memphis and Karnak shows, not only the great amount of deposit, but also how much the river must have risen for it to lay down mud so many feet above the old level of deposit.

The rise due to silting up proceeds, then, much faster than any slight diminution of the river which may take place.

The amount of the sand, then, cannot be affected by any variation in moisture; and on looking back it seems very doubtful if there has been any change in it. The sand over the Serapeum might be supposed to have increased, as it has buried the Sphinxes there. But these are of Greek work, and were only erected shortly before the time of Strabo; and he, nevertheless, mentions them as being nearly buried in his day, though doubtless some attempt was made then to keep them cleared. Before this, in the dream of Tahutmes IV., the Sphinx at Gizeh appears to have been buried very much as at present.

And on looking to the remains of the early dynasties at Gizeh and elsewhere, their buried state seems rather to be due to artificial changes accumulating the sand than to any great increase in the general amount of sand.

The usual way in which the sand is moved is by a few high winds in the course of the year. These tear over the ground, as opaque as a London fog, bearing just as much sand as their whirling will support; and as soon as any obstacle checks their velocity, the surplus of sand is dropped, and thus accumulates. Now the tombs are either rock-hewn, in which case a face of rock is artificially scarped for the fronts, or else they are built on the surface. In either case an eddy is formed in the wind, and this will cause quantities of sand to be thrown down during a sand-storm. Again, the erection of the Pyramids would be sufficient to interrupt the steady blow of the wind by causing numerous oblique currents, and would so produce an increase of wind-borne sand in the neighbourhood. Whatever cause checks the velocity of the wind is sure to lead the sand to accumulate; the Arabs know this well, and plant frail rows of reeds (even spaced apart) around their gardens bordering the desert; these make the wind drop the sand, so as to form a bank outside them, and thus keep the enclosures clear.

The general conclusion as to the climate, then, seems to be that there has been no appreciable change in rain-fall, river-flow, or sand-blow during historic times.

The builder of the Pyramid of Abu Roash and his epoch have hitherto been quite unknown; but now that we have obtained part of the builder's name (MEN . . . . RA) on the fragment of diorite throne that I found there, we have some clue to the age. The Pyramid of Menkaura of the fourth dynasty is well known already at Gizeh; and the workmanship of the Pyramid at Abu Roash excludes it from the period of the rubble Pyramids of the sixth dynasty at Sakkara, and of the mud-brick Pyramids of the eleventh and twelfth dynasties at Thebes and Howara. Thus Menkara and Ra-mentu-hotep are out of the question, and it is almost certain that we must look either to some king of the second or third dynasties not found in the lists, or to a second Menkaura, successor to Menkaura of the fourth dynasty.

The work of this Pyramid suggests that of the fourth dynasty. The Pyramid of Khufu at Gizeh had no granite outside it; that of Khafra had one or two courses of granite; that of Menkaura had nearly half its surface covered with granite casing; thus there is a progressive use of granite by these successive kings; and at Abu Roash the Pyramid was entirely cased with granite, and therefore next in order of work after that of Menkaura of Gizeh. And this is all the stronger evidence, because no other examples of granite casing

on a Pyramid are known.* Again, the diorite statue at Abu Roash was apparently like that of Khafra in size, material, and inscription, which also tends to fix this Pyramid to the fourth dynasty.

The builder of the Great Pyramid of Gizeh is well known. Khufu (Grecianized as Kheopa † and Soufis,‡ and Anglo-Grecianized as Cheops) is named both by historians and by his cartouches, which are found as quarry-marks on the building stones.

Khafra § has, on the strength of the historians, been considered by most writers as the builder of the Second Pyramid; but there was, till lately, no monumental evidence on this point. About three years ago, however, the great causeway was discovered which led from the lower granite temple, where the statues of Khafra were found, to the upper temple by the Second Pyramid. A closer connection of Khafra with this upper temple, I was happy enough to find while there; from the heaps of chips in the temple, I obtained (without excavating) a piece of white magnesite, steel-hard, with part of the cartouche and standard of Khafra, exquisitely cut; and also a piece of alabaster with the cartouche alone. The finding of these cartouche fragments gives the clearest monumental proof that has yet been obtained of the Second Pyramid belonging to Khafra. It may be mentioned here that I also picked up at Gizeh a piece of diorite bowl inscribed ". . nofru"; perhaps, therefore, of Senofru; and another piece with the standard of Khufu.

The attribution of the Third Pyramid to Men-ka-u-ra, the successor of Khafra, is disputed; and the reasons for doubting his sole ownership appear to be as follows. First, that the Pyramid has certainly been altered from its first design in the inside, and also, perhaps, on the outside; secondly, that there appear to have been two coffers in it; thirdly, that Diodorus says that Menkaura died before it was finished; and, fourthly, that Manetho attributes it to Nitakerti, the queen in whom the sixth dynasty became extinct, and who is supposed to be identical with the Men-ka-ra of the lists of Abydos.

The change of design in this Pyramid does not seem, however, to have been due to a later reign; but to have occurred, like some after-thoughts in the Great Pyramid, while it was in course of construction, as has been already pointed out in the description of this Pyramid. Looking at the historical side of the question, this Pyramid (as all writers are agreed) cannot be earlier than the Pyramids of Khufu and Khafra, by reason of its inferiority of position; the poorer site was accepted for it, in a way that clearly stamps it as being later.

* Excepting some on the anomalous little Pyramid at Riga, of the fifth dynasty.

† Herodotus. ‡ Manetho.

§ Here, again, Herodotus retains the final vowel, though adding a nasal in Khefrena.

But the basalt coffer that was found in the lowest chamber, is that of the first builder—Menkaura of the fourth, and not of Menkara of the sixth dynasty. Thus, by the spelling, the latest occupant of the Pyramid was the same king that we have already seen must be the earliest builder of it; so that any double origin, or later appropriation of it, is thus contradicted.

The evidence from the character of the work is entirely in favour of its being of the fourth, and not of the sixth dynasty. The panel ornament both in the first chamber and on the coffer (which is like that of tombs of the fourth),—the absence of any stone-cut inscriptions, such as cover the walls of the pyramids of the sixth dynasty,—the use of granite for the lower casing, and for the lining of a passage and chamber,—the position of the Pyramid in relation to the others,—the peribolus of the Pyramid of Khafra being unfinished when the Third Pyramid peribolus was being built,—and the absence of any remains of the sixth dynasty in the neighbourhood,—all these characteristic features point clearly to the dynasty, and even to the reign, of Menkaura successor to Khafra.

The evidence of Manetho is not quite certain in the mere extracts that we possess; he only mentions that Nitakerti built "the Third Pyramid," without saying where it was; and it is only a presumption that it refers to the same group as "the largest Pyramid," which he mentions twenty reigns earlier. It might have referred in the full original text to one of the Sakkara groups, where we should naturally look for works of the sixth dynasty.

Diodorus Siculus, though saying that Menkaura died before the Pyramid was finished, yet expressly states that he was a son of Khufu. The unfinished state of the granite casing, and absence of pavement, exactly accord with the premature death of the king.

Thus the four reasons for doubting the earlier date of this Pyramid are reversed or neutralized on examining the details; excepting the testimony of Manetho. The choice then lies between—on the one hand, Manetho being misunderstood, or in error by confounding Menkaura and Menkara; or, on the other hand, ignoring the spelling of the names,—the character of the construction and decoration,—the situation of the Pyramid,—the connections of the peribolus,—the date of the neighbouring tombs,—and the testimony of Herodotus and Diodorus.

Regarding the age of the brick Pyramids, it is well known that such were built in the eleventh dynasty by the Antef kings at Thebes; and probably in the twelfth dynasty by Amenemhat III. at Howara, by the side of the labyrinth in which that king's name is found. This shows that as a class they belong to the times after the stone Pyramids, and thus gives a general clue to age of those at Dahshur. Unhappily, Perring only found the end of a cartouche in his digging

there, with " . . . kau " upon it. This mere fragment, however, is of value, as there is no king in the lists whose name ends in "kau" until the eighth dynasty; excepting Ramenkau, whose Pyramid is the Third of Gizeh, and Hormenkau, whose Pyramid is believed to be at Sakkara, by the slab bearing his figure being found there in the Serapeum. It is not till the end of the eighth dynasty, when there occur three names ending in "kau," that we meet then with any name that can be applied to the S. brick Pyramid of Dahshur. The style of work of the fragments found along with the cartouche is also clearly of about this date; they are not in the style of any dynasty before the seventh, nor in that of the twelfth or later periods; but they most resemble a tomb of the eleventh dynasty at Kom Ahmar (lat. 28° 5′). Hence, by the fragment of the name,—by the character of the work,—and by the material used,—there seems little doubt but that the brick Pyramids of Dahshur belong to the dark and troubled period between the sixth and eleventh dynasties ; and that they may probably be assigned to the end of the eighth dynasty.

The celebrated tablet containing a reference to the Sphinx requires some notice here of its age and history. While I was at Gizeh, the official excavations by the authorities disclosed some fresh parts of the temple in which this tablet was found, with the cartouche of Pisebkhanu of the twenty-first dynasty: he is represented wearing the crown of Lower Egypt. This, then, gives the date of the temple; and the character of all the work agrees well with the style of this epoch.

Now the question of the critical value of the little tablet that mentions the Sphinx, turns on the choice of three hypotheses. 1st, That it is the original tablet of the age of Khufu, preserved through at least 1500 years (or, according to Mariette, double that time), and built into the temple of Pisebkhanu. 2nd, That it is a copy of such a tablet, more or less exact. 3rd, That it is an unhistorical inscription written for the decoration and honouring of the temple of this usurping dynasty. And it should be noted that it does not profess to be contemporary with Khufu, or even to be a copy of an early record. The style of the engraving is quite unlike the work of the Old Kingdom ; in place of the finely rounded and delicate forms in low relief, and the bold, handsome execution, of the time of Khufu, this insignificant-looking tablet is cut in scratchy intaglio, worse than any of the poorest tomb-decorations of the early times, and looking like nothing but a degradation of the work of the decadence of the twentieth dynasty. Most authorities now agree that it cannot be contemporary with Khufu. Is it, then, an exact copy of any earlier tablet? This can only be judged by its matter, and on looking at the figures represented on it, it will be seen that they are such as are not found on early monuments; they comprise Osiris, Isis and Horus,

Isis Selk, Khem, Bast (?), the human-headed uræus, and the sacred bark. Of these, scarcely one can be found on any monument, public or private, of the Old Kingdom; not all of these figures could be matched under the twelfth dynasty; even the monuments of the eighteenth and perhaps nineteenth dynasties do not often show such an assemblage together; and it would be an entire novelty to find such a company on any stele that Khufu could have seen. In the inscription itself, moreover, Osiris is repeatedly called "Neb Rustau," or, "lord of the abodes of the dead" (Brugsch): this title is one that does not occur in any of the dozen of inscribed tombs of the Old Kingdom that are visible at Gizeh; but it is found repeatedly in this temple, built by Pisebkhanu in the twenty-first dynasty, from which this tablet came. Also, though Pyramids are often mentioned in early inscriptions, Isis is never connected with any of them, and her name is hardly ever found in Pyramid times; so that the title of "Patroness of the Pyramid" seems (like "Mother of the Gods," also found there on the tablet) to be as late an invention as "Neb Rustau."

Thus, by all that can be so clearly seen of the well-marked styles and characteristics of the different periods of Egyptian art and religion, and by the titles here used, this tablet is relegated to the third hypothesis, and stands as an invented inscription designed for the decoration of the temple. This relieves us from an apparent anachronism, as no trace of a Sphinx in statuary, tablets, or inscription, is to be found until the twelfth dynasty; and such a form was not common until after that. It would seem, therefore, to be an Asiatic idea, akin to the human-headed lions, bulls, and dragons of Assyria and Babylonia. In any case, the allusions to the Sphinx in this tablet were merely topographical, and might be struck out or inserted without altering the sense of it; hence, even if it were a refurbished copy of an older inscription, it would not be of critical value in relation to the age of the Sphinx unless its rigorous accuracy and freedom from additions could be proved.

Though the age of the foundation of buildings is always examined, yet the date of their destruction is often of greater historical importance. The many erasures of the names of Set, of Amen, of Hatasu, and others, show very important changes, and the mode in which many of the remains have been destroyed is also very suggestive. The Pyramid of Pepi shows one of the most striking examples of spiteful violence that may be found. Such destruction is commonly attributed to the Persians, or the Hyksos; but the details seem to show violence of an earlier date. In the passage of this Pyramid, the name Ra-meri is chopped out in almost every place, without the rest of the inscription being attacked. This shows a personal spite, beyond the mere destructiveness of an invader, and

which can hardly be accounted for even by the Hyksos conquest. Again, not content with tearing the body out of its wrappings, the massive and tough basalt coffer was raised on stones, lines of cleaving-holes cut in it, a fire burnt beneath it, and, with the utmost violence, it was split asunder; yet the religious inscriptions on the wall beside it are uninjured. Such care in destruction is more than would be produced by a general hatred to a conquered race.

Again, at Gizeh, the diorite statues in the lower granite temple have been dashed down from their niches, and thrown into the well; but in the upper granite temple, by the Second Pyramid, the destruction is far more laborious and elaborate; the statues are broken into small chips; a single toe, or half a hieroglyph, is almost as much as can be found in one piece; the diorite and alabaster vessels are broken in shivers; and an imperfect cartouche is the greatest prize obtainable from the ruins.

Again, at Abu Roash, the king's diorite statue was not only broken up, but the surfaces were bruised to powder, and a block of the tough diorite was grooved round by chipping, so as to hold a rope by which it could be swung to and fro, until even the ends of it were shivered, and it was finally cracked in two. The granite coffer was burnt, and mostly ground to powder; while stray chips of basalt show that some other object existed which is quite unknown.

All this vehemence of destruction, this patient, hard-working vengeance, can scarcely be attributed to an age, or a people, which only knew of the kings as historical names. It is to the dark period of the seventh to the eleventh dynasties that we must rather look for the destroyers of the Old Kingdom monuments. The fourth, fifth, and sixth dynasties were one continuous and peaceful succession; and when that was broken up, apparently by civil war and rival dynasties, it would be highly probable that such personal spite, and intelligent wrath, would be shown by embittered revolutionists. A modern parallel to this vengeance was seen in the careful and painstaking clearance of the bodies of the French kings out of Saint-Denis, and the fate allotted to their monuments, in 1790; the latter were only saved from annihilation by the strenuous claim of Lenoir and others on behalf of the museum.*

* See the *Procès-verbal* in "Monographie de l'Eglise de Saint-Denis," par le Bon. De Guilhermy. 1848.

CHAPTER VII.

ARCHITECTURAL IDEAS OF THE PYRAMID BUILDERS.

IN this chapter the more general principles, common to all the pyramids, will be considered ; leaving the points which are peculiar to the Great Pyramid, to be discussed in the History of the Great Pyramid and its design.

The characteristic Mastaba-angle, and the nature of Mastaba-Pyramids and true Pyramids, have been already stated. The design of the various slopes that are met with, appears to be always a simple relation of the vertical and horizontal distance, agreeing with the method of stating the slope in the mathematical papyrus of Aahmes.

It seems clear that the rule for slopes in designing, was to set back the face an integral number of cubits, on a height of an integral number. The use of angles of 4 on 3 (which has hypothenuse 5) in the Second Pyramid, and 20 on 21 (which has hypothenuse 29) in the N. Pyramid of Dahshur, seems to suggest that the square of the hypothenuse being equal to the squares of the two sides may have been known ; particularly as we shall see that the use of squared quantities is strongly indicated in the Great Pyramid.

No discussion of the sizes of the Pyramids can lead us to the ideas involved in their design, unless it is first settled whether they were each completely planned at their beginnings, or each carried forward as far as the life of the builder permitted. This last idea, which may be called the "theory of accretion," would show that the size of each Pyramid was solely due to a series of accidental events ; and that no foreseen design can be expected in the external dimensions, or in their relations to the inside. As several names have been associated with this theory, it will be best to avoid them all ; and treat it on its own merits impersonally, like all other theories mentioned in this work.

We will first, then, consider the questions that have been put forward on Pyramid building, and the applicability of the theory of accretion to each of them, and after that notice some of the other points bearing on this theory.

(1) How does it happen that the Pyramids are of such different sizes? The theory of accretion answers that each king continued building his Pyramid until his death, and hence the Pyramids differ in size because the reigns differed in length. When, however, we see that the lengths of the reigns are not in proportion to the bulk of the respective Pyramids, this apparent explanation merely resolves itself into saying, that because two quantities vary they must be connected. On comparing the lengths of the reigns with the sizes of those Pyramids whose builders we know, the disproportion is such that Khufu, for instance, must have built the Great Pyramid fifteen times as fast as Raenuser built the Middle Pyramid of Abusir; or else Raenuser built for only $\frac{1}{15}$th of his reign; either alternative prevents any conclusion being drawn as to inequalities in time producing inequalities in the sizes of the Pyramids.

(2) How could later kings be content with smaller Pyramids after Khufu and Khafra had built the two largest? This question the accretion theory cannot explain; for many of the later kings lived nearly as long as Khufu and Khafra (one even much longer), without producing anything comparable in size. When we look at the mournful declension in the designs of Pyramid building, from the beauty of the fourth down to the rubble and mud of the sixth dynasty, the falling off in size as well as quality is merely part of the same failure.

(3) How is the fact to be accounted for that an unfinished Pyramid is never met with? In the same work in which this question is asked, it is said of one of the Abusir Pyramids, that it "seems never to have been completed"; and of the South Stone Pyramid of Dahshur, "The whole pyramid was probably intended to have the same slope as the apex, but the lower part was never completed." This question is only another form of No. 5.

(4) How could Khufu have known that his reign would be long enough to enable him to carry out such a vast design? However this may be, he certainly worked far more quickly than any other king, and the arrangement of the interior of his Pyramid, as we shall see below, proves that it was all, or nearly all, designed at first.

(5) If a builder of a great pyramid had died early, how could his successor have finished the work, and built his own pyramid at the same time? First, we have no proof that a successor did not appropriate the work to himself, or share it with the founder; and, secondly, no other kings worked at a half, or perhaps a tenth, of the rate that Khufu and Khafra worked, or with anything like the same fineness; and hence any king might easily have had two pyramids on hand at once, his father's and his own.

The accretion theory, then, though not actually condemned by the application of these questions which are adduced in its support,

is at least far from being the "one entirely satisfactory answer" to them, as it has been claimed to be. And the supposed proof of it, from the successive coats of the Mastaba-Pyramids of Medum and Sakkara, is, in the first place, brought from works that are not true Pyramids; and, in the second place, shows that the buildings quoted were completely finished and cased many times over, probably by successive kings, and not merely accreted in the rough, until the final casing was applied. A confirmation claimed for this theory is "the ascertained fact that the more nearly the interior of the pyramid is approached, the more careful does the construction become, while the outer crusts are more and more roughly and hastily executed." This is certainly not true in many, perhaps most, cases. The Pyramids of Sakkara, as far as they have been opened, show quite as fine work in the outer casing as anywhere else; and the rubble of the inside is equally bad throughout. The Great Pyramid of Gizeh shows far finer work in the outermost parts of the passage, casing, and pavement, than in most, or perhaps all, of the inside; and the Second Pyramid is similar. In a great part of the pyramids we know nothing of the comparative excellence of the work of different parts, comparing fine work with fine work, and core with core masonry.

Now, if the accretion theory were true, it ought to be of the greatest value when applied to the largest Pyramids; for these are the most difficult to account for, and their extraordinary size is the main feature appealed to in support of the theory.

Let it then be critically applied to the Great Pyramid of Gizeh, the largest known (see Pl. iv.). First, it must be noticed that the centre of the Pyramid cannot have been much shifted by accretion on one side of it, as all the chambers are near the middle; and if any shift of its axis were due to this, the accretion must have been on the N. side, as two chambers are S. of the middle. Trying, therefore, how small a Pyramid might have been begun, let it be taken at A: if a Pyramid existed of this size, it would be completely anomalous, and unlike anything known; it would have (1) a horizontal passage, (2) opening near the top of it; (3) a chamber close to the top of the Pyramid; and (4) an entrance to the lower chamber far outside the Pyramid. Each of these peculiarities condemns it as impossible. The next larger size that would not leave chambers half exposed on the outside of the building, would be at B. With this size there would be the anomalies of (1) two entrances on one face; (2) one sloping upwards; (3) a great hall and a chamber close to the outside, and near the top of the Pyramid. Each of these points condemns such a design as un-Egyptian, and unlike any other known pyramid, no matter how small. The least size, then, that could possibly be supposed to be the first design would be at C, as it is clear that any lesser design would leave impossible anomalies in the arrangements. Thus it is plain that

the accretion theory breaks down in its application to any size under 600 feet for the Great Pyramid; and if we are thus compelled by its arrangements to acknowledge a primary design of a base of 600 feet (which is larger than nineteen-twentieths of the other pyramids), what need is there of a theory of accretion to account for its being 750 feet?

Next let this theory be applied to the Second Pyramid of Gizeh, which is only exceeded in size by that we have discussed above (see Pl. iv.). Here the chamber is practically central, and the axis of the Pyramid cannot therefore have been much shifted by one-sided accretion. Supposing that it was designed of any size less than A, there would then be the anomalous features of (1) an entrance on the ground level; and (2) a secondary entrance far out from the Pyramid. These features are unknown in any other pyramid, large or small, and the need of them thus condemns, as practically impossible, any design of less size than about 500 feet. Here, then, the accretion theory breaks down, as in the Great Pyramid design.

The summing up on this theory then is, that every argument brought forward in its support is either inconclusive, or false in examples; and that on applying it critically to the two cases in which it is most needed, and which have been mainly adduced to support it, it is completely contradicted by the essential formation of the pyramids. If we are then forced to accept the fact of gigantic primary designs for the largest pyramids, where is there any need of a theory to account for the far smaller designs, of very inferior workmanship, seen in the other pyramids? That some of the lesser and ruder pyramids (as the Third of Gizeh, which is ninth in order of size) may have been enlarged, is not unlikely; but such enlargement was an accident of increased ambition, and not a general law of construction; and it has nothing to do with the great designs, so magnificently carried out in the largest pyramids.

A theory which has obtained much belief, is that of the passages of each pyramid having been plugged up after the interment of the builder. But there is no evidence for this, and the passages of the pyramids show no trace of continuous plugging; nor indeed any plugging beyond the closing of the mouths of some passages, merely to prevent their being detected; on the contrary, there are incidental proofs, in the mortaring, etc., that no general plugging was ever introduced or extracted.

The possibility of the Pyramids having had movable doors has been quite overlooked in modern times, owing to the general belief that the passages were plugged up. Of course, if a passage was filled up solid, there could not have been any door to it; but as we have seen that there is no evidence of such plugging, doors may have existed. And as we shall further see that there is very substantial

evidence of the former existence of doors, we have, therefore, equally valid proofs of the non-existence of any plugging.

The traces of a stone flap door, or turning block, in the mouth of the South Pyramid of Dahshur, have been already described, as well as the signs of a wooden door behind that. Such a formation of the passage mouth is unmistakable in its purpose; but after drawing conclusions from that doorway, it was a most satisfactory proof of the generality of such doors, to observe the following passage from Strabo on the Great Pyramid. "The Greater (Pyramid), a little way up one side, has a stone that may be taken out (*ἐξαιρεσιμον, exemptilem*), which being raised up (*ἀρθεντος, sublato*) there is a sloping passage to the foundations." This sentence is most singularly descriptive of opening a flap door; first, the stone is taken out, or lifted outwards from the face; and then, being thus raised up, the passage is opened. The two different words exactly express the change in the apparent motion, first outwards and then upwards; and they show remarkable accuracy and precision in their use. Besides this description, there is another statement that the Pyramids of Gizeh had doors, in an Arabic MS., quoted by Vyse; this was written in 850 A.D., and, therefore, only twenty or thirty years after Mamun had forced his way into the Great Pyramid, and thus re-discovered the real entrance.

The mechanical proofs of the existence of a door to the Great Pyramid are of some weight, though only circumstantial, and not direct evidence like that of the above authors. No one can doubt that the entrance must have been closed, and closed so as not to attract attention at the time when the Arabs made their forced passage, about a hundred feet long, through the solid masonry. Moreover, it is certain that the entrance was not covered then by rubbish: (1) because the Arabic hole is some way below it, and the ground-level at the time of the forcing is seen plainly in the rubbish heap; (2) because the rubbish heap, which is even now much below the original doorway, is composed of broken casing, and the casing was not yet broken up at the time of forcing the passage. Therefore the doorway must have been so finely closed that the various accidental chippings and weathering on all the general surface of the casing completely masked any wear or cracks that there might be around the entrance; and so invisible was the door then, that, standing on the heap from which they forced their hole, the Arabs could not see anything to excite their suspicion on the surface only 35 feet above them; they therefore plunged into the task of tearing out the stone piecemeal, in hopes of meeting with something in the inside. Yet we know from Strabo that the Romans had free access to the passage, though he says that it was kept a secret in his time. No extractable plug or block, weighing necessarily some tons, would have

been replaced by every visitor until the Arab times, especially without there being any shelf or place to rest it on while it was removed.*

The restoration of a door shown in Pl. vii., would agree to these various historical requirements, and be in harmony with the arrangement at Dahshur; such a block would only need a pull of 2½ cwt. on first taking it outwards, and 4 cwt. to lift it upwards to its final position; it would leave no external opening; it would also allow just half of the passage to be quite clear; and from the passage being halved in its height by two courses at the beginning, such an opening is the most likely. Though the general form is thus indicated, the details are of course conjectural.

To sum up. A self-replacing door, which left no external mark, is absolutely required by the fact of the Arabs having forced a passage. Only a flap door, or a diagonal-sliding portcullis slab, can satisfy this requirement. A flap door is unequivocally shown to have been used at Dahshur. And Strabo's description of the entrance agrees with such a door, and with no other. Such is the evidence for the closing of the Pyramids by doors; equally proving also the absence of any plugging up of the entrance passages.

* Exactly the same reasoning applies to the Second Pyramid. Diodorus Siculus mentions the foot-holes up to its entrance, and Herodotus correctly describes the form of its passages; and yet the Arabs forced a large passage in it, in entire ignorance of the real entrance, which must, therefore, have had a door like the Great Pyramid.

CHAPTER VIII.

THE MECHANICAL METHODS OF THE PYRAMID BUILDERS.

THE methods employed by the Egyptians in cutting the hard stones which they so frequently worked, have long remained undetermined. Various suggestions have been made, some very impracticable; but no actual proofs of the tools employed, or the manner of using them, have been obtained. From the examples of work which I was able to collect at Gizeh, and from various fixed objects of which I took casts, the solution of the questions so often asked seems now to have been found.

The typical method of working hard stones—such as granite, diorite, basalt, etc.—was by means of bronze tools; these were set with cutting points, far harder than the quartz which was operated on. The material of these cutting points is yet undetermined; but only five substances are possible—beryl, topaz, chrysoberyl, corundum or sapphire, and diamond. The character of the work would certainly seem to point to diamond as being the cutting jewel; and only the considerations of its rarity in general, and its absence from Egypt, interfere with this conclusion, and render the tough uncrystallized corundum the more likely material.

Many nations, both savage and civilized, are in the habit of cutting hard materials by means of a soft substance (as copper, wood, horn, etc.), with a hard powder supplied to it; the powder sticks in the basis employed, and this being scraped over the stone to be cut, so wears it away. Many persons have therefore very readily assumed (as I myself did at first) that this method must necessarily have been that used by the Egyptians; and that it would suffice to produce all the examples now collected. Such, however, is far from being the case; though no doubt in alabaster, and other soft stones, this method was employed.

That the Egyptians were acquainted with a cutting jewel far harder than quartz, and that they used this jewel as a sharp-pointed graver, is put beyond doubt by the diorite bowls with inscriptions of the fourth dynasty, of which I found fragments at Gizeh; as well as the scratches on polished granite of Ptolemaic age at San. The hieroglyphs are incised, with a very free-cutting point; they are not

scraped nor ground out, but are ploughed through the diorite, with rough edges to the line. As the lines are only $\frac{1}{150}$ inch wide (the figures being about ·2 long), it is evident that the cutting point must have been much harder than quartz ; and tough enough not to splinter when so fine an edge was being employed, probably only $\frac{1}{200}$ inch wide. Parallel lines are graved only $\frac{1}{30}$ inch apart from centre to centre.

We therefore need have no hesitation in allowing that the graving out of lines in hard stones by jewel points, was a well-known art. And when we find on the surfaces of the saw-cuts in diorite, grooves as deep as $\frac{1}{100}$ inch, it appears far more likely that such were produced by fixed jewel points in the saw, than by any fortuitous rubbing about of a loose powder. And when, further, it is seen that these deep grooves are almost always regular and uniform in depth, and equidistant, their production by the successive cuts of the jewel teeth of a saw appears to be beyond question. The best examples of equidistance are the specimens of basalt No. 4 (Pl. viii.), and of diorite No. 12 ; in these the fluctuations are no more than such as always occur in the use of a saw by hand-power, whether worked in wood or in soft stone.

On the granite core, broken from a drill-hole (No. 7), other features appear, which also can only be explained by the use of fixed jewel points. Firstly, the grooves which run around it form a regular spiral, with no more interruption or waviness than is necessarily produced by the variations in the component crystals ; this spiral is truly symmetrical with the axis of the core. In one part a groove can be traced, with scarcely an interruption, for a length of four turns. Secondly, the grooves are as deep in the quartz as in the adjacent felspar, and even rather deeper. If these were in any way produced by loose powder, they would be shallower in the harder substance—quartz ; whereas a fixed jewel point would be compelled to plough to the same depth in all the components ; and further, inasmuch as the quartz stands out slightly beyond the felspar (owing to the latter being worn by general rubbing), the groove was thus left even less in depth on the felspar than on the quartz. Thus, even if specimens with similarly deep grooves would be produced by a loose powder, the special features of this core would still show that fixed cutting points were the means here employed.

That the blades of the saws were of bronze, we know from the green staining on the sides of saw cuts, and on grains of sand left in a saw cut.

The forms of the tools were straight saws, circular saws, tubular drills, and lathes.

The straight saws varied from ·03 to ·2 inch thick, according to the work ; the largest were 8 feet or more in length, as the cuts run

lengthways on the Great Pyramid coffer, which is 7 feet 6 in. long. The examples of saw cuts figured in Pl. viii. are as follow. No. 1, from the end of the Great Pyramid coffer of granite, showing where the saw cut was run too deep into the stuff twice over, and backed out again. No. 2, a piece of syenite, picked up at Memphis; showing cuts on four faces of it, and the breadth of the saw by a cut across the top of it. This probably was a waste piece from cutting out a statue in the rough. No. 3, a piece of basalt, showing a saw cut run askew, and abandoned, with the sawing dust and sand left in it; a fragment from the sawing of the great basalt pavement on the East of the Great Pyramid. No. 4, another piece from the same pavement, showing regular and well-defined lines. No. 5, a slice of basalt from the same place, sawn on both sides, and nearly sawn in two. No. 6, a slice of diorite bearing equidistant and regular grooves of circular arcs, parallel to one another; these grooves have been nearly polished out by crossed grinding, but still are visible. The only feasible explanation of this piece is that it was produced by a circular saw. The main examples of sawing at Gizeh are the blocks of the great basalt pavement, and the coffers of the Great, Second, and Third Pyramids,—the latter, unhappily, now lost.

Next the Egyptians adapted their sawing principle into a circular, instead of a rectilinear form, curving the blade round into a tube, which drilled out a circular groove by its rotation; thus, by breaking away the cores left in the middle of such grooves, they were able to hollow out large holes with a minimum of labour. These tubular drills vary from $\frac{1}{4}$ inch to 5 inches diameter, and from $\frac{1}{50}$ to $\frac{1}{6}$ inch thick. The smallest hole yet found in granite is 2 inches diameter, all the lesser holes being in limestone or alabaster, which was probably worked merely with tube and sand. A peculiar feature of these cores is that they are always tapered, and the holes are always enlarged towards the top. In the soft stones cut merely with loose powder, such a result would naturally be produced simply by the dead weight on the drill head, which forced it into the stone, not being truly balanced, and so always pulling the drill over to one side; as it rotated, this would grind off material from both the core and the hole. But in the granite core, No. 7, such an explanation is insufficient, since the deep cutting grooves are scored out quite as strongly in the tapered end as elsewhere; and if the taper was merely produced by rubbing of powder, they would have been polished away, and certainly could not be equally deep in quartz as in felspar. Hence we are driven to the conclusion that auxiliary cutting points were inserted along the side, as well as around the edge of the tube drill; as no granite or diorite cores are known under two inches diameter, there would be no impossibility in setting such stones, working either through a hole in the opposite side of the drill, or by

setting a stone in a hole cut through the drill, and leaving it to project both inside and outside the tube. Then a preponderance of the top weight to any side would tilt the drill so as to wear down the groove wider and wider, and thus enable the drill and the dust to be the more easily withdrawn from the groove. The examples of tube drilling on Pl. viii. are as follow:—No. 7, core in granite, found at Gizeh. No. 8, section of cast of a pivot hole in a lintel of the granite temple at Gizeh; here the core, being of tough hornblende, could not be entirely broken out, and remains to a length of ·8 inch. No. 9, alabaster mortar, broken in course of manufacture, showing the core in place; found at Kom Ahmar (lat. 28° 5′), by Prof. Sayce, who kindly gave it to me to illustrate this subject. No. 10, the smallest core yet known, in alabaster; this I owe to Dr. Grant Bey, who found it with others at Memphis. No. 11, marble eye for inlaying, with two tube drill-holes, one within the other; showing the thickness of the small drills. No. 12, part of the side of a drill-hole in diorite, from Gizeh, remarkable for the depth and regularity of the grooves in it. No. 13, piece of limestone from Gizeh, showing how closely holes were placed together in removing material by drilling; the angle of junction shows that the groove of one hole just overlapped the groove of another, probably without touching the core of the adjacent hole; thus the minimum of labour was required. The examples of tube drilling on a large scale are the great granite coffers, which were hollowed out by cutting rows of tube drill-holes just meeting, and then breaking out the cores and intermediate pieces; the traces of this work may be seen in the inside of the Great Pyramid coffer, where two drill-holes have been run too deeply into the sides; and on a fragment of a granite coffer with a similar error of work on it, which I picked up at Gizeh. At El Bersheh (lat. 27° 42′) there is a still larger example, where a platform of limestone rock has been dressed down, by cutting it away with tube drills about 18 inches diameter; the circular grooves occasionally intersecting, prove that it was done merely to remove the rock.

The principle of rotating the tool was, for smaller objects, abandoned in favour of rotating the work; and the lathe appears to have been as familiar an instrument in the fourth dynasty, as it is in modern workshops. The diorite bowls and vases of the Old Kingdom are frequently met with, and show great technical skill. One piece found at Gizeh, No. 14, shows that the method employed was true turning, and not any process of grinding, since the bowl has been knocked off of its centring, recentred imperfectly, and the old turning not quite turned out; thus there are two surfaces belonging to different centrings, and meeting in a cusp. Such an appearance could not be produced by any grinding or rubbing process which pressed on the surface. Another detail is shown by fragment No. 15;

here the curves of the bowl are spherical, and must have therefore been cut by a tool sweeping an arc from a fixed centre while the bowl rotated. This centre or hinging of the tool was in the axis of the lathe for the general surface of the bowl, right up to the edge of it; but as a lip was wanted, the centring of the tool was shifted, but with exactly the same radius of its arc, and a fresh cut made to leave a lip to the bowl. That this was certainly not a chance result of hand-work is shown, not only by the exact circularity of the curves, and their equality, but also by the cusp left where they meet. This has not been at all rounded off, as would certainly be the case in hand-work, and it is a clear proof of the rigidly mechanical method of striking the curves.

Hand graving tools were also used for working on the irregular surfaces of statuary; as may be well seen on the diorite statue of Khafra found at Gizeh, and now at Bulak.

The amount of pressure, shown by the rapidity with which the drills and saws pierced through the hard stones, is very surprising; probably a load of at least a ton or two was placed on the 4-inch drills cutting in granite. On the granite core, No. 7, the spiral of the cut sinks 1 inch in the circumference of 6 inches, or 1 in 60, a rate of ploughing out of the quartz and felspar which is astonishing. Yet these grooves cannot be due to the mere scratching produced in withdrawing the drill, as has been suggested, since there would be about $\frac{1}{10}$ inch thick of dust between the drill and the core at that part; thus there could be scarcely any pressure applied sideways, and the point of contact of the drill and granite could not travel around the granite however the drill might be turned about. Hence these rapid spiral grooves cannot be ascribed to anything but the descent of the drill into the granite under enormous pressure; unless, indeed, we suppose a separate rymering tool to have been employed alternately with the drill for enlarging the groove, for which there is no adequate evidence.

That no remains of these saws or tubular drills have yet been found is to be expected, since we have not yet found even waste specimens of work to a tenth of the amount that a single tool would produce; and the tools, instead of being thrown away like the waste, would be most carefully guarded. Again, even of common masons' chisels, there are probably not a dozen known; and yet they would be far commoner than jewelled tools, and also more likely to be lost, or to be buried with the workmen. The great saws and drills of the Pyramid workers would be royal property, and it would, perhaps, cost a man his life if he lost one; while the bronze would be remelted, and the jewels reset, when the tools became worn, so that no worn-out tools would be thrown away.

Of the various other details of mechanical work, mention is made in different parts of this volume. The red marking of the masons'

lines; the use of testing-planes in working surfaces; the use of drafted diagonals; the character of the fine joints; the accuracy of levelling; the fitting of the courses one on the other; the arrangement of the courses on the ground before building; the lugs left for lifting the stones; the method of raising the stones; the labour system employed on the Egyptian monuments; and the use of plaster. A general statement of all these mechanical questions, with fuller details of some of the specimens and examples of work, will be found in a paper on the "Mechanical Methods of the Egyptians," in the *Anthropological Journal* for 1883.

CHAPTER IX.

A SKETCH OF THE HISTORY AND DESIGN OF THE GREAT PYRAMID.

AT the close of the period of the third dynasty, the hill of Gizeh was a bare stretch of desert ground, overlooking the Nile valley. In ages long before this dawn of living history,* that valley had been deeply scored out in the great tract of limestone rocks through which it passes; scored by the deep and rushing stream† which filled the whole width of it from cliff to cliff. This stream was fed along its course by cataracts, dashing down through gorges on either side of it; and thus forming a series of cascades, which continually ate further back into the cliffs of the great river.‡ The present stream, meandering slowly in a channel washed out amid its mud flats, and covering its ancient limits with a few inches or feet of water but once a year, would seem a mere ditch if compared with its former grandeur.

In the days when the fourth dynasty arose, these changes were long past; and the valley would probably seem as familiar now to Prince Merhet, Semnefer the architect, and the rest of the court of Khufu, as it did in the days of their power. Above the then growing city of Memphis rose the low hills and cliffs of the desert on the Libyan side; and one of the higher parts of the edge of the desert, a bare wind-blown rise of hill, attracted the attention of Khufu for the site of his great monument. It is certainly the finest site for miles on either side of it; and probably the happiness of the blessed West in contrast to the filthy East, and the nearness to the capital, Memphis, induced him to build here, even though the materials had to be brought from the higher and more commanding cliffs of the eastern bank.

It may seem strange that the site chosen was not rather further

* See Climatic Changes.

† See the banks of scoured *débris* at Beni Hassan.

‡ See the cliffs at Masara, Tehneh, Girgeh, Thebes, etc.; and particularly the gorge south of Beni Hassan, which ends in high waterfalls, with deep basins scooped out at the feet of them.

from the edge of the cliff, and thus on a higher part of the rock. But the principle in the early days seems to have been to place the tomb as near to the home as possible; the tomb was looked on with pride and satisfaction; it was the place where a man would be periodically remembered and honoured by his descendants; it was—as Aseskaf called his pyramid—the "cool place," or "place of refreshing," where the body would rest in peace until revivified; a character of the deep rock-hewn chambers most pleasing in such a climate. Hence we find the tombs clustered as thickly as possible, where they actually look on the valley at Gizeh; and scattered less closely where but little of the sacred stream could be seen; and similarly Khufu placed his Pyramid on a slight rise of rock, as close to the edge of the cliff as possible.

To understand the purpose of the erection of the Pyramids, it should be observed that each has a temple on the eastern side of it. Of the temples of the Second and Third Pyramids, the ruins still remain; and of the temple of the Great Pyramid, the basalt pavement and numerous blocks of granite show its site. That Khufu's temple is more destroyed than the others is easily accounted for by the causeway of it being larger and more accessible from the plain than are the causeways of the temples of Khafra and Menkaura; hence it would naturally be the first attacked by the spoilers. When in all the tombs of the Pyramid age, we see that the kings are called the Great Gods ("nuter aa"), and had more priests than any of the original deities, it is easy to understand the relationship of a sumptuous temple to each of the royal Pyramids. The worship of the deified king was carried on in the temple, looking toward the Pyramid which stood on the west of it (the "blessed West," the land of souls); just as private individuals worshipped their ancestors in the family tombs, looking toward the "false doors," which are placed on the west side of the tomb, and which represent the entrances to the hidden sepulchres.

It has always been assumed that only the finer stone, used for the casing and passages, was brought from the eastern cliffs, and that the bulk of the masonry was quarried in the neighbourhood. But no quarryings exist on the western side in the least adequate to yield the bulk of either of the greater Pyramids;* and the limestone of the western hills is different in its character from that of the Pyramid masonry, which resembles the qualities usually quarried on the eastern shore. It seems, therefore, that the whole of the stones were quarried in the cliffs of Turra and Masara, and brought across to the selected site.

* I have repeatedly examined the edge of the desert from Abu Roash to Dahshur, and walked over all the district behind the Pyramids for several miles in each direction; some very slight quarrying just behind the barracks at the Second Pyramid is all that I have seen, beyond mere tomb excavations.

The great amount of labour involved in quarrying and transporting such a mass of masonry as even the casing, has always been a cause of astonishment. But an expression in the traditions reported by Herodotus, and a consideration of the internal economy of the country in the present day, seem to explain it. In describing the transport of the stones, Herodotus expressly states that 100,000 men worked at one time, "each party during three months;" now the inundation lasts rather more than three months in the present day, and during that time the inhabitants are almost idle, the land is covered with water, the cattle are fed on dry fodder, and wander on the barren desert; but few hands are needed to regulate the flow of water into the dammed-up basins of the country, and the greater part of the population turn willingly to any employment they can get, or dream away their time in some cool shade. Here, then, is the explanation of the vast amount of labour extracted from a country of limited area. It was during the three months of the inundation that the idle hands were set to all the mere routine of unskilled labour; and while the Nile was at its full height, rafts were busily employed in floating over the masses of hewn stone, from the causeways at the quarries, across the five miles' width of waters, to the Pyramid causeway, about seven miles further down the stream. It is noticeable that the period of three months is only mentioned in connection with the removal of the stones, and not with the actual quarrying or building; on these labours probably a large staff of skilled masons was always employed, though they were helped on by an abundance of unskilled labour, for the heavy work of lifting and transport, during the three months when the general population was out of work.

The actual course of work, then, during the building of the Pyramid, would have been somewhat as follows:—At the end of July, when the Nile had fairly risen, the levy of 100,000 men would assemble to the work. Not more than eight men could well work together on an average block of stone of 40 cubic feet, or 2½ tons; and the levies would probably be divided into working parties of about that number. If, then, each of these parties brought over 10 average blocks of stone in their three months' labour—taking a fortnight to bring them down the causeways at the quarries, a day or two of good wind to take them across the stream, six weeks to carry them up the Pyramid causeway, and four weeks to raise them to the required place on the Pyramid—they would easily accomplish their task in the three months of high Nile. They would thus be at liberty to return to their own occupations in the beginning of November, when the land was again accessible.

Of course the actual distribution of labour would be more specialized; but this outline will show that such a scale of work would suffice for the complete building of the Great Pyramid in twenty years, as

stated by Herodotus.* We thus see that the whole of the material, and not merely the casing, could readily be obtained from the eastern shore; and that the levies need not have been employed during more than the three months when all ordinary labour was suspended.

Besides these hosts of unskilled hands, there must have been a smaller body of masons permanently employed in quarrying the stone, and in trimming it at the Pyramid. And it is likely that a year's supply of stone would be kept on hand at the Pyramid, on which the masons would work; and so the three months' supply of labourers would put up the stones which had been trimmed and arranged during the nine months previously, while other labourers were engaged bringing over a supply for the masons' work of the ensuing nine months.

This system of employing all the unskilled labour of the country on public work, when the lands were inundated, private labour was impossible, and the Nile was in the fittest state for transport, is almost certain to have been followed in all the great works of the Egyptians; and the peculiarity of the country may go far toward explaining their capacity for executing vast public works.

What the number of skilled masons was we may well guess from the accommodation provided for them in the barracks behind the Second Pyramid. These barracks were used by the workmen of Khafra; but those of Khufu must have been equally numerous, and have occupied a similar space, if not, indeed, these identical dwellings. These barracks would hold 3,600 or 4,000 men easily; and as about 120,000 average blocks were required to be prepared every year, this would be only one block of stone prepared in a month by a party of four men, which would probably be the number of masons working together. Hence this accommodation is really more than enough; and most likely a good deal of lifting and building work would be going on throughout the year, beside the great supply of labour during the inundation.

Thus we see that the traditional accounts that we have of the means employed in building the Great Pyramid, require conditions of labour-supply which are quite practicable in such a land, which would not be ruinous to the prosperity of the country, or oppressive to the people, and which would amply and easily suffice for the execution of the whole work.

The site being chosen, it was carefully levelled, and the lengths of the sides were set out with great exactitude. How the angles were made square within 12″ average error is difficult to see; the rock rising up irregularly in steps inside the masonry, to some 25 feet

* The Great Pyramid contained about 2,300,000 stones, averaging 50×50×28 inches, or 2½ tons each. If 8 men brought 10 stones, 100,000 would bring 125,000 stones each season, or the total number in less than 20 years.

high, would render accurate diagonal measurements very difficult; unless, indeed, narrow trenches or passages were cut from corner to corner to measure through.

The setting out of the orientation of the sides would not be so difficult. If a pile of masonry some 50 feet high was built up with a vertical side from North to South, a plumb-line could be hung from its top, and observations could be made, to find the places on the ground from which the pole-star was seen to transit behind the line at the elongations, twelve hours apart. The mean of these positions would be due South of the plumb-line, and about 100 feet distant from it; on this scale 15″ of angle would be about $\frac{1}{10}$ inch, and therefore quite perceptible.

From several indications it seems that the masons planned the casing, and some at least of the core masonry also, course by course on the ground. For on all the casing, and on the core on which the casing fitted, there are lines drawn on the horizontal surfaces, showing where each stone was to be placed on those below it. If the stones were merely trimmed to fit each other as the building went on, there would be no need to have so carefully marked the place of each block in this particular way; and it shows that they were probably planned and fitted together on the ground below. Another indication of very careful and elaborate planning on the ground is in the topmost space over the King's Chamber; there the roofing-beams were numbered, and marked for the north or south sides; and though it might be thought that it could be of no consequence in what order they were placed, yet all their details were evidently schemed before they were delivered to the builders' hands. This care in arranging all the work agrees strikingly with the great employment of unskilled labourers during two or three months at a time, as they would then raise all the stones which the masons had worked and stored ready for use since the preceding season.

The means employed for raising such masses of stone is not shown to us in any representations. For the ordinary blocks, of a few tons each, it would be very feasible to employ the method of resting them on two piles of wooden slabs, and rocking them up alternately to one side and the other by a spar under the block, thus heightening the piles alternately and so raising the stone. This would also agree with the mysterious description of a machine made of short pieces of wood—a description which is difficult otherwise to realize. This method would also be applicable to the largest masses that we know of in the Pyramid, the 56 roofing-beams of the King's Chamber and the spaces above it. These average 320 × 52 × 73 inches, or 700 cubic feet each; weighing, therefore, 54 tons, some larger, some less. No simple system but that of rocking would enable men to raise such a mass with only the help of crowbars; if

such a block was put on two supports, say 30 inches apart, only 5 tons would have to be lifted at once, and this would be easily done by 10 men with crowbars. Six such parties might raise the whole of these blocks in one year.

That sheet iron was employed we know, from the fragment found by Howard Vyse in the masonry of the south air channel; and though some doubt has been thrown on the piece, merely from its rarity, yet the vouchers for it are very precise; and it has a cast of a nummulite on the rust of it, proving it to have been buried for ages beside a block of nummulitic limestone, and therefore to be certainly ancient. No reasonable doubt can therefore exist about its being really a genuine piece used by the Pyramid masons; and probably such pieces were required to prevent crowbars biting into the stones, and to ease the action of the rollers.

The tools employed have been described in the chapter on the mechanical methods; they comprised bronze saws over eight feet long, set with jewels, tubular drills similarly set with jewels, and circular saws. These were employed on the granite work, and perhaps saws of a less costly nature on the limestone. The casing blocks were dressed by very fine picking or adzing. The system of using true planes smeared with ochre, for testing the work, shows with what nicety they examined their work, and what care was taken to ensure its accuracy and truth.

The masons' waste chips were thrown away over the cliffs, on both the north and south of the Pyramid; and they form banks extending about 100 yards outwards from the original edge of the rock, and reaching from top to bottom of the cliffs; taking them altogether, they are probably equal in bulk to more than half of the Pyramid. This rubbish is all stratified at the angle of rest, about 40°; and the different qualities of it thrown away on different days may be clearly seen. In one part there will be a layer of large chips, up to the size of a hand; a little above that a lot of fine dust and sweepings; above that perhaps more large chips, and here and there a layer of desert flints and sand, showing when a piece of desert ground had been cleared to get more space for working. Among all this rubbish are pieces of the workmen's water jars and food vessels, of which I collected a hundred or more fragments, mixed with chips of wood, bits of charcoal, and even a piece of string, which had probably been used in patching up a rubbish basket. All these were obtained from pits which had been lately made in the oldest part of the heap, close to the edge of the cliff, and beyond which a thickness of some dozens of yards of waste had been shot out; there is thus a certainty that these remains show us the true masons' waste and rubbish, as thrown away by the builders, and stretching out from the cliff in lines of "tip," like a modern half-finished embankment.

By means of this bank of waste, the space around the Pyramid was largely increased in appearance, though it was not solid ground for building; and the tops of the rubbish heaps were smoothly levelled down in the nearer parts, so that their junction to the rock can hardly be traced.

During the course of building there was evidently a great change in the style of the work; a change, however, belonging more to the builders than to the masons. The pavement, lower casing, and entrance passage are exquisitely wrought; in fact, the means employed for placing and cementing the blocks of soft limestone, weighing a dozen to twenty tons each, with such hair-like joints, are almost inconceivable at present; and the accuracy of the levelling is marvellous. But in the higher parts, the gallery, for instance, is far from such excellence; and the upper part of it is very skew and irregular, the ramp surface being tilted more than an inch in a width of 20 inches. In the Antechamber the granite has never been dressed down flat, and defective stones are employed; where the limestone was very bad, it was roughly plastered over, and many parts are strangely rough. In the King's Chamber the masonry is very fine, both in its accuracy of fitting and in the squareness and equal height of all the blocks; but the builders were altogether wrong in their levels, and tilted the whole chamber over to one corner, so that their courses are $2\frac{1}{4}$ inches higher at the N.E. than at the S.W., a difference much greater than that in the whole base of the Pyramid. An error like this, in putting together such a magnificent piece of work, is astonishing; for the walls are composed of nearly $\frac{1}{10}$ of a mile length of granite blocks about 4 feet high, and probably as thick, all of which are gauged to the same height, with an average variation of only $\frac{1}{20}$ of an inch. As it would be difficult to suppose any architect allowing such errors of building, after so closely restricting the variations of masons' work, it strongly suggests that the granite had been prepared for the chamber long before it was built, and that the supervision was less strict as the work went on, owing to more hurry and less care, or owing to the death of the man who had really directed the superfine accuracy of the earlier work.

Beside these signs of carelessness, there are several points in which work that has been intended has never been carried out. The stone was left in the rough where it was liable to damage, and was to be finished off after it was safe from injury. Over the N. doorway of the gallery the stone is left roughly in excess; and in the Queen's Chamber the vertical edge of the doorway is left with an excess of an inch or more, and as a guide a short bit was drafted to the true surface at the top and bottom of each stone. From these points we see that not only was the work hurried about the middle, but that some parts never received the finishing strokes.

The plan of the passages was certainly altered once, and perhaps oftener, during the course of building. The shaft, or "well," leading from the N. end of the gallery down to the subterranean parts, was either not contemplated at first, or else was forgotten in the course of building; the proof of this is that it has been cut through the masonry after the courses were completed. On examining the shaft, it is found to be irregularly tortuous through the masonry, and without any arrangement of the blocks to suit it; while in more than one place a corner of a block may be seen left in the irregular curved side of the shaft, all the rest of the block having disappeared in cutting the shaft. This is a conclusive point, since it would never have been so built at first. A similar feature is at the mouth of the passage, in the gallery. Here the sides of the mouth are very well cut, quite as good work as the dressing of the gallery walls; but on the S. side there is a vertical joint in the gallery side, only 5·3 inches from the mouth. Now, great care is always taken in the Pyramid to put large stones at a corner, and it is quite inconceivable that a Pyramid builder would put a mere slip 5·3 thick beside the opening to a passage. It evidently shows that the passage mouth was cut out after the building was finished in that part. It is clear, then, that the whole of this shaft is an additional feature to the first plan.

Another evidence of altered plans is in the Queen's Chamber floor. This is not merely left in the rough core, but it has actually had another course of the rough core masonry built, or at least fitted, on to it; and this upper course has been removed, or omitted, in order to build the chamber there. Of the Subterranean Chamber, all that can be said is that it is wholly unfinished, and hardly more than sketched out; so that a change of plan with regard to that also seems proved, since it was the part first begun.

Having now pointed out various mechanical considerations on the history of the building, we will consider the history of the closing of the Pyramid.

There can be no doubt that the entrance passage was left clear and accessible, the door closing it on the outside against mere chance curiosity, but being readily swung on its pivots when regularly opened. The upper passages, however, were well concealed, though they had probably been surreptitiously entered before the Arabic forcing.

It has often been said that the Queen's Chamber was intended to contain the blocks for plugging the ascending passage, until they were required to be let down. But there is an absolute impossibility in this theory; the blocks are 47·3 × 41·6 in section, while the Queen's Chamber passage is but 46·2 × 40·6, or too small in both dimensions to allow the blocks to pass. Hence the blocks must have stood in

the gallery until they were wanted, since they could never be got upwards through the ascending passage, as that is but 38·2 at the lower end, and the existing plugs are 41·6 wide above that. Neither could the plugs be brought up the well shaft, as that is but 28· square; nor out of the King's Chamber, as the passage is but 43·6 high. Now, though it is most likely that there never were many plug-blocks, yet the existing ones land us in a further conclusion. The broken end of the upper block, and a chip of granite still remaining cemented to the floor of the passage a little above that, show that it was probably 24 inches longer than it is now, judging by marks on the passage. Thus the total length of plug-blocks would be about 203 inches, or very probably 206 inches, or 10 cubits, like so many lengths marked out in that passage. Now, the flat part of the Queen's Chamber passage floor within the gallery, on which blocks might be placed, is but 176 long; and the whole distance, from the N. wall of the gallery to the vertical cut down, is but 199·4: so in no way could 203 inches of blocks stand on the horizontal floor, and certainly any passage through the gallery door would be impossible, to say nothing of the difficulty of pushing such blocks along a rough floor, so as to tip them down the passage. Thus the plug-blocks cannot have stood in any place except on the sloping floor of the gallery.

For them, then, to be slid down the passage, it was necessary that the opening to the Queen's Chamber should be completely covered with a continuous floor. The traces of this floor may still be seen, in the holes for beams of stone, across the passage; and in fragments of stone and cement still sticking on the floor of the Queen's Chamber passage at that point. It is certain, then, that the Queen's Chamber was closed and concealed before the ascending passage was closed.

But we are met then by an extraordinary idea, that all access to the King's Chamber after its completion must have been by climbing over the plug-blocks, as they lay in the gallery, or by walking up the ramps on either side of them. Yet, as it is a physical impossibility for the blocks to have been lying in any other place before they were let down, we are shut up to this view.

The coffer cannot have been put into the Pyramid after the King's Chamber was finished, as it is nearly an inch wider than the beginning of the ascending passage.

The only conclusion, then, is that the coffer was placed in the King's Chamber before the roof was put on; that if Khufu was finally buried in it (and not in some more secret place), then the inner coffin, and any procession accompanying it, must have gone up the gallery, on the narrow-side ramps or benches, past the plug-blocks four feet high standing between them; that before or after this the

Queen's Chamber was blocked up; then the plug-blocks were slid down the ascending passage; and, finally, the workmen retired by the well shaft down to the entrance passage, closing the way by a plug of stone not cemented in place, and probably removable at will. Finally, the lower mouth of the well shaft was closed, probably by a plugging-block not cemented in; and then visitors of later times crawled in under the outer flap-door in the casing, the stone that could be "lifted out," and so went down to the empty and unfinished Subterranean Chamber in the rock.

It may be an open question whether the Queen's Chamber* was not the sepulchre of Khnumu-Khufu, the co-regent of Khufu. Edrisi, in his accurate and observant account of the Pyramid (1236 A.D.), mentions an empty vessel in the Queen's Chamber; and that this was not a confused notion of the coffer now known, is proved by his saying that in the King's Chamber "an empty vessel is seen here similar to the former." Whether any fragments of a coffer remained there, among the great quantity of stone excavated from the floor and niche, it is almost hopeless to inquire, since that rubbish is now all shot away into various holes and spaces. Caviglia, however, did not find a coffer when clearing the chamber, but fragments might have been easily overlooked.

When, then, was the Pyramid first violated? Probably by the same hands that so ruthlessly destroyed the statues and temples of Khafra, and the Pyramids of Abu Roash, Abusir, and Sakkara. That is to say, probably during the civil wars of the seventh to the tenth dynasties. At that time the secret opening of the Pyramid, by which the workmen retired, would still be known; and while that was the case, and before any forced openings had been made, the coffer was lifted up to see if any hidden passage existed beneath it; then probably was its lid broken off, and the body of the great builder treated to the spite of his enemies. Then also may the Queen's Chamber—the *serdab* † of the Pyramid—have been forced open, and the diorite statue torn from its grand niche, broken up, pedestal and all, and carried out to be smashed to chips, and scattered on the hill opposite the Pyramid door, so that no one should ever restore it. This is more of a guess than an inference; and yet a guess, so far harmonious with what we know of other monuments, that it perhaps deserves to be used as a working hypothesis.

In classical times we know from Strabo [illegible] at the subterranean parts were readily accessible; though the supposed proof adduced by

* These names, King's and Queen's, were given by the Arabs, in conformity with their custom of making the tombs or niches for men flat-topped, and those for women with a sloping gable roof.

† Serdab is the Arabic name for the secret hollow in tombs in which the statue was placed.

Caviglia, from I A″ M E R (M E joined) which he found smoked on the roof of the Subterranean Chamber, has nothing to do with the question; if he had noted the graffiti around the entrance of the Pyramid, he would have found IA^{c} MERCATOR 1563 (M E joined), which completely explains the smoked letters.

With regard to the many records of inscriptions on the outside of the Pyramid, a few words are necessary. From the time of Herodotus down to the 15th century, inscriptions are continually mentioned, and their great abundance is described with astonishment by travellers. This has led to the supposition that the builders had left records inscribed on the outside, although not a letter is to be found on the inside. But against the possibility of this view, it must be remembered that no early inscriptions are found on the casing remaining at the Great Pyramid, nor on any of the innumerable fragments of those stones, nor on the remaining casing of the Second Pyramid, nor on that of the Third Pyramid, nor on the casing of the South Pyramid of Dahshur, nor on the casing of the Pyramid of Medum, nor on occasional blocks uncovered at the Sakkara Pyramids. In fact, not a single example of hieroglyphs has ever been seen on any casing, nor on any fragments of casing. The truth then about these numberless inscriptions appears to be that they were all travellers' graffiti. Strabo says that the characters were like old Greek, but were not readable; this points to Phœnician or Cypriote graffiti. The accounts of the inscriptions given by the Arabs also show that they were mere graffiti; Abu Masher Jafer (before 886 A.D.) mentions Mosannad (*i.e.*, Himyaritic) letters; Ibn Khordadbeh (10th cent.) also mentions Musnad letters; Masudi (11th cent.) describes them as being in various different languages; Ibn Haukal (11th cent.) says they were in Greek; Abu Mothaffer (*alias* Sibt Al Jauzi, died 1250 A.D.) gives the fullest account, mentioning seven sorts of writing: (1) Greek, (2) Arabic, (3) Syriac, (4) Musnadic, (5) Himyaritic (or Hiritic or Hebrew in different MSS.), (6) Rumi, (7) Persian. William of Baldensel (1336 A.D.) mentions Latin; and Cyriacus (1440 A.D.) mentions Phœnician. Whether these travellers all understood exactly what they were talking about may be doubted; but at least none of them describe hieroglyphs, such as they must have been familiar with on all the tombs and other monuments; and they agree in the great diversity of the languages inscribed. The earlier travellers also do not describe such a great number of inscriptions as do the Arabic writers; suggesting that the greater part recorded in later times were due to Roman and Coptic graffiti.

Now among the hundreds of pieces of casing stones that I have looked over, very few traces of inscription were to be seen; this was, however, to be expected, considering that the pieces nearly all belonged to the upper casing stones, out of the reach of mere travellers.

Three examples of single letters were found—two Greek and one unknown; and on the W. side, in one of the excavations, a piece was discovered bearing three graffiti, one large one attracting lesser scribblers, as in modern times. The earliest inscription was probably of Ptolemy X., showing portions of the letters ΠΤΟ.....Cω Τ.....; the next was a Romano-Greek of a certain ΜΑΡΚΙΟC Κ.....; and over that an Arab had roughly hammered in .....m a j..... This is the only example of continuous inscriptions yet found, and it belonged to one of the lowest courses; it is now in the Bulak Museum. Thus, all the fragments and the descriptions point to the existence of a large body of graffiti, but do not give any evidence of original hieroglyphic inscriptions.

When one considers the large number of graffiti which are to be seen on every ancient building of importance, it seems almost impossible but that the Great Pyramid—one of the most renowned and visited of all—should not have been similarly covered with ancient scribbles, like the host of modern names which have been put upon it since the casing was removed.* The statues of Ramessu II., at Abu Simbel, bear quantities of Greek graffiti—in fact, some of the earliest Greek inscriptions known—besides Phœnician and Roman; the top of the temple of Khonsu at Karnak is crowded with the outlines of visitors' feet, with their names and particulars appended, in hieroglyphic, demotic, and Greek; the inscriptions on the colossi of Amenhotep III. ("the Memnons") at Thebes, and on the Sphinx at Gizeh, are well known; the long scribbles in demotic on the temple walls at Thebes have lately been examined; the corridors of Abydos bear early Greek graffiti; the passage of the S. Pyramid of Dahshur has two hieroglyphic graffiti, besides Greek; and there is scarcely any monument of importance in Egypt but what shows the scribbling propensities of mankind; be they Egyptians, Phœnicians, Greeks, Romans, or the worst sinners of modern times—Hellenes and Americans.

The history of the destruction of the Pyramids really begins with the Arabs. They first, under Khalif Mamun, forced the great hole through the masonry, from the outside to the part commonly called Mamun's Hole, at the beginning of the ascending passage. Had it not been for their shaking of the masonry, which let fall the stone that concealed the plug-blocks, perhaps the upper chambers would have remained yet unknown. Hearing the stone drop, they turned aside their southward progress, and burrowing some twenty feet eastwards they broke into the entrance passage, and found the fallen stone; here they saw that it had covered the beginning of another passage, and so they forced out of their hole a continuation

* Described and figured in "Archæological Journal," 1883.

southward and upward to get behind the granite plug; finding they only hit the side of the plug-blocks, they tracked along them in the softer limestone, until they reached the upper end, and then they rushed freely up the hitherto unused passage. Probably they found the plug at the top of the well not replaced, after the earlier destroyers; and so got down the well and forced out its lower closing, which must have been in position for the Greeks and Romans not to have been aware of the passage. Such, from the statements of historians, and the details of the place, seems to have been the history of the attack on the interior of the Great Pyramid.

After the time of Mamun the exterior was used as a quarry; the casing was apparently stripped off by Sultan Hasan for his mosque in 1356, since he is said to have brought the stone hence, and William of Baldensel* in 1336 mentions both the large Pyramids as being "de maximis lapidibus et politis." It was also Hasan, or a near successor of his, who stripped the Second Pyramid; as I found a coin of his deep down in the S.E. foundation. The top was not much denuded in the 17th century; Lambert (Trois Relations de l'Ægypte) in 1630 mentions 12 stones as forming the top of the core, and says that the platform was 20 spans wide; by his span measures of the coffer, this would be 230 inches; among these 12 stones was "une qui surpasse en largeur et longueur la croyance des hommes." Greaves in 1638 found 9 stones, and reports two as missing. Thevenot in 1667 reports 12 stones; but as he understood Arabic well, he probably accepted a statement of what had been there thirty years before. Other stones of the top and edges of the core were thrown down at intervals, until the beginning of the present century, as is evident from the weathering marks, and the dates of the graffiti.

Having now sketched out its history, it is desirable not to close this account of the Great Pyramid, without summing up those theories of its design which seem most likely, and which are consistent one with the other. In the following sketch, then, no theory will be mentioned which is not well within the facts of the case, and no dimensions will be required to do double duty for two theories which do not coincide. It is possible that some parts may have been made intentionally varying in size, in order to include two different relations to other parts; but such is scarcely provable; and in a general statement like the following, it is better to omit some things that may be true, than it is to include a number of dubious theories which are not supported by a system of coincidences in different parts of the structure. And if some judge that this summary includes too much, and others think that it states too little, it must

* Canisius, "Thesaurus Monumentum," iv. 342.

be remembered that the materials for forming an opinion are impartially provided in the previous chapters of this work.

For the whole form the π proportion (height is the radius of a circle = circumference of Pyramid) has been very generally accepted of late years, and is a relation strongly confirmed by the presence of the numbers 7 and 22 in the number of cubits in height and base respectively; 7 : 22 being one of the best known approximations to π. With these numbers (or some slight fractional correction on the 22) the designer adopted 7 of a length of 20 double cubits for the height; and 22 of this length for the half-circuit. The profile used for the work being thus 14 rise on 11 base.

The form and size being thus fixed, the floor of the main chamber of the building—the King's Chamber—was placed at the level where the vertical section of the Pyramid was halved, where the area of the horizontal section was half that of the base, where the diagonal from corner to corner was equal to the length of the base, and where the width of the face was equal to half the diagonal of the base.*

The Queen's Chamber was placed at half this height above the base; and exactly in the middle of the Pyramid from N. to S.

Beside the level of the King's Chamber signalizing where the area was a simple fraction of $\frac{1}{2}$ of the base area, thicker courses were perhaps intentionally introduced where the area of the course was a multiple of $\frac{1}{2\frac{1}{6}}$ the base area: this system accounts for nearly all the curious examples of a thick course being suddenly brought in, with a series above it gradually diminishing until another thick course occurs.

The angle of slope of the entrance passage is 1 rise on 2 base; and the other passages are near the same angle, probably modified in order to bring the chambers to the required levels.

The length of the entrance passage, the ascending passage, the antechamber passages, and perhaps the Queen's Chamber passage, are all in round numbers of cubits; while the gallery length (horizontal) is equal to the vertical height of its end above the base, which is determined by the King's Chamber being at the level of half the Pyramid area.

The height and width of the passages, gallery, and ramps are all determined by the form of the end of the King's Chamber, of which the passages are $\frac{1}{6}$, the gallery $\frac{2}{6}$, and the ramps $\frac{1}{10}$ the size in each direction.

* The employment of square measure, which appears to furnish the best solution of the Pyramid design, is singularly parallel to the use of square measure mentioned in the "Sulvasutras"; from those writings it appears that Hindu geometry in its origin sprung from the religious ideas of the building of altars, differing in form but equal in area. (See Prof. Thibaut in the Second "International Congress of Orientalists.")

The King's Chamber walls are determined by the same π proportion which rules the exterior of the Pyramid; the circuit of the side of the chamber being equal to a circle described by its width as a radius; and further, the length of the side of the chamber is equal to diameter of its circuit. Thus the circuit of the side has its radius at right angles across the chamber, and its diameter the length of the side along the chamber.

But the floor of the chamber is raised above the base of the walls; a peculiar arrangement for which some reason must have existed. It gives, in fact, two heights; the wall height we have just seen is required for the π proportion; and the actual height from the floor agrees to another system, which is found to run throughout all the chambers. After the attention shown to square measure in the various levels of the Pyramid, it is not surprising to find something of the same kind in the chambers. Though the idea of making the squares of the lineal dimensions of a chamber to be integral areas, may seem peculiar, yet the beauty of thus making all the diagonals of a chamber to be on one uniform system with its direct dimensions, would be perhaps a sufficient inducement to lead the builders to its adoption. Practically it is the only consistent and uniform theory which is applicable to all the chambers and coffer, and even to the Second Pyramid chamber. By this theory, then, the squares of the dimensions of the King's Chamber, the Queen's Chamber, the Antechamber, and the Subterranean Chamber, are all even numbers of square cubits, and nearly all multiples of 10. From this it necessarily follows that the squares of all the diagonals of the sides of these chambers, and their cubic diagonals, are likewise multiples of 10 square cubits; and the King's and Queen's Chambers are so arranged that the cubic diagonals are in even hundreds of square cubits, or multiples of 10 cubits squared.

For the coffer it is hard to say what theory is most likely; its irregularities of form and faults of cutting, are such that many theories are included in its variations; and certainly no theory of very great complexity or refinement can be expected. Taking most of its dimensions at their maximum, they agree closely with the same theory as that which is applicable to the chambers; for when squared they are all even multiples of a square fifth of a cubit. That the cubit was divided decimally in the fourth dynasty we know; and as this theory is also the only one applicable to all the chambers, there is very strong ground for adopting it here. There is no other theory applicable to every lineal dimension of the coffer; but having found the π proportion in the form of the Pyramid, and in the King's Chamber, there is some ground for supposing that it was intended also in the coffer, on just $\frac{1}{8}$th the scale of the chamber; the difference between the requirements of this theory and that of the squares is

only $\frac{1}{1000}$. Consistently also with the above theories, the outer length at an extreme maximum, may have been $\frac{1}{100}$ of the length of the Pyramid base; and as the inner length of the Second Pyramid coffer has the same relation to its Pyramid, this is rendered the more likely. Finally, it is not impossible that some rough relation of the cubic bulk and contents may have been aimed at, along with the foregoing designs; and the lineal dimensions required above, being nearly all maximum dimensions of the actual coffer, renders it more likely that some other object was in view. In any case the cubic relations were not very exactly attained, and it would have been impossible to run them closer by merely sawing the granite, somewhat skew, somewhat curved, and somewhat too deeply, without any adjustment afterwards by polishing. A design for the coffer which should include more than one idea, would not be unlikely in the Great Pyramid; that structure being so remarkable for the care and precision shown in the arrangement of its chambers, and particularly for the accuracy of the chamber in which the coffer is enshrined.

Such is the outline of what may be considered the tolerably safe theories of the origination of the Great Pyramid; others may by some further discovery be shown to have been intended, but most of these will probably bear the test of time, and certainly bear the test of exact measurement.

Pyramids and Temples of Gizeh.

BY

W. M. FLINDERS PETRIE.

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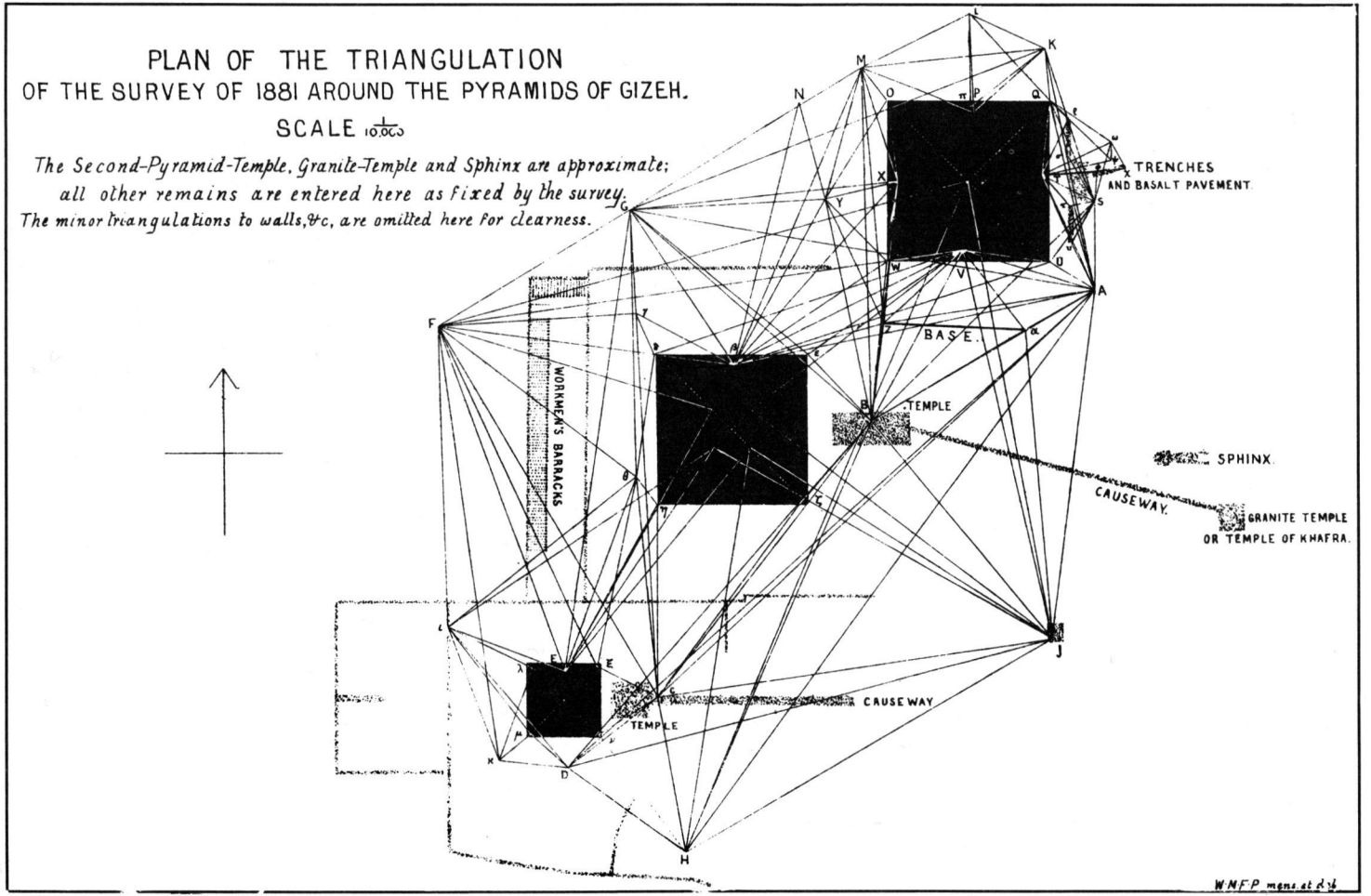
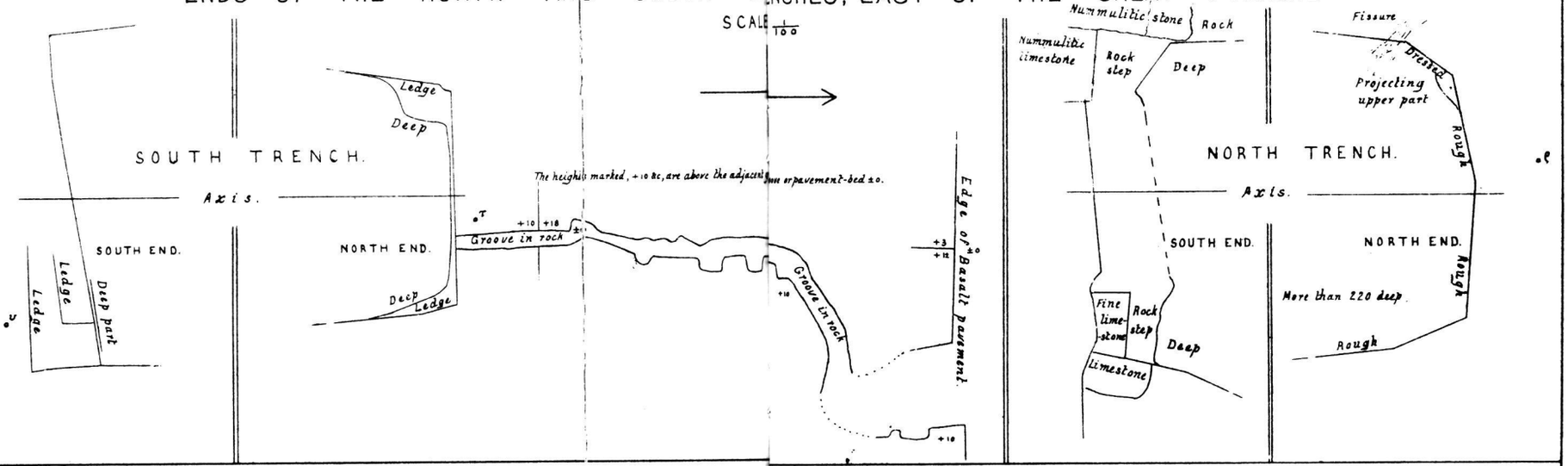
*** These announcements and press extracts are published during the Author's absence in Egypt, and without his knowledge in detail.

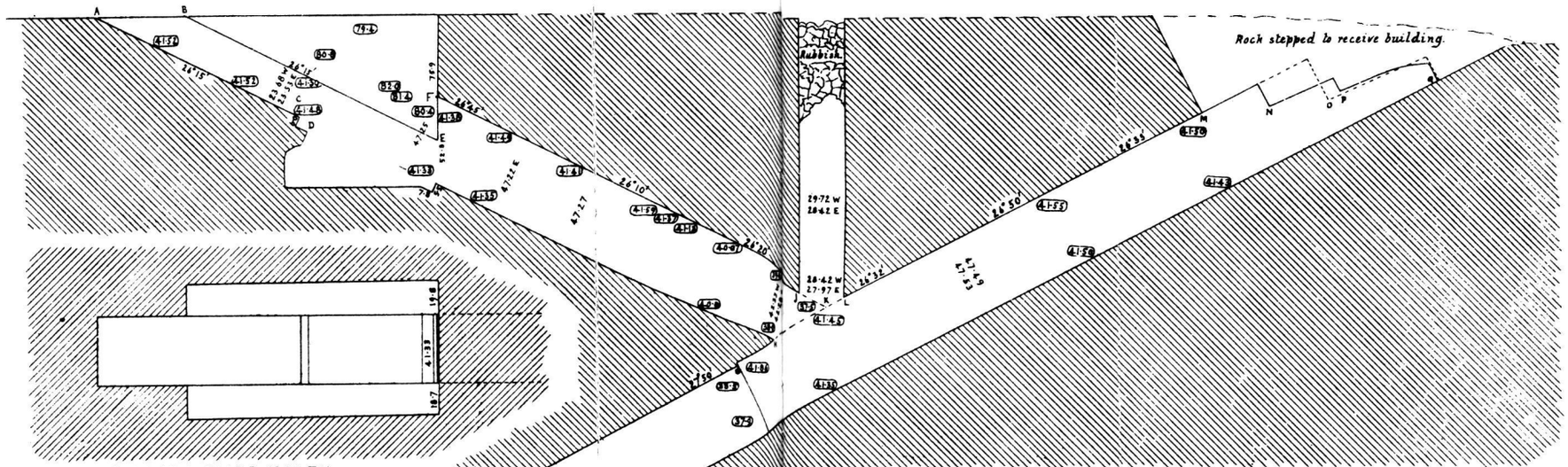


Thomas Kell & Son, Photolith.

ENDS OF THE NORTH AND SOUTH TRENCHES, EAST OF THE GREAT PYRAMID.

SCALE $\frac{1}{100}$





SECTION OF TRIAL PASSAGES, EAST OF GREAT PYRAMID.

SCALE $\frac{1}{100}$

These passages are cut in the rock with great regularity, and are remarkably similar to those built in the great pyramid. The dimensions in a ring are the breadths from E to W. The lengths parallel to the slope of the passages are as follows, in inches,

E to D 72·8	F to J 260·4	M to G 335·5	M to N 38·0
E to C 81·0	F to K 279·3	M to H 305·9	M to O 71·0
E to B 165·2		M to K 254·4	M to P 80·0
E to A 212·2		M to L 242·7	M to Q 135·0

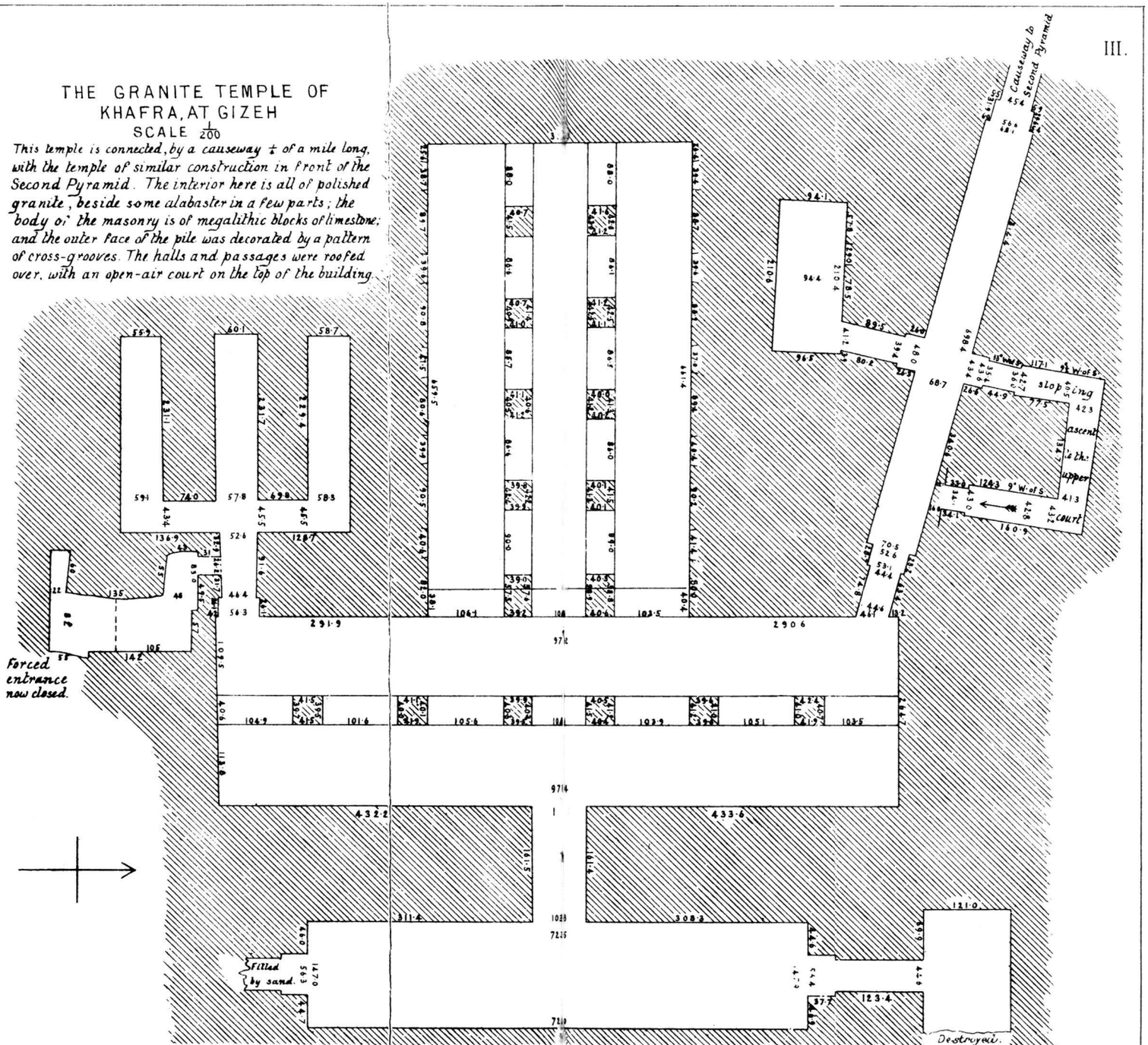
Thomas Kell & Son. Photolith.

W.M.F.P. measd. & dr.

THE GRANITE TEMPLE OF KHAFRA, AT GIZEH

SCALE $\frac{1}{200}$

This temple is connected, by a causeway ¼ of a mile long, with the temple of similar construction in front of the Second Pyramid. The interior here is all of polished granite, beside some alabaster in a few parts; the body of the masonry is of megalithic blocks of limestone; and the outer face of the pile was decorated by a pattern of cross-grooves. The halls and passages were roofed over, with an open-air court on the top of the building.



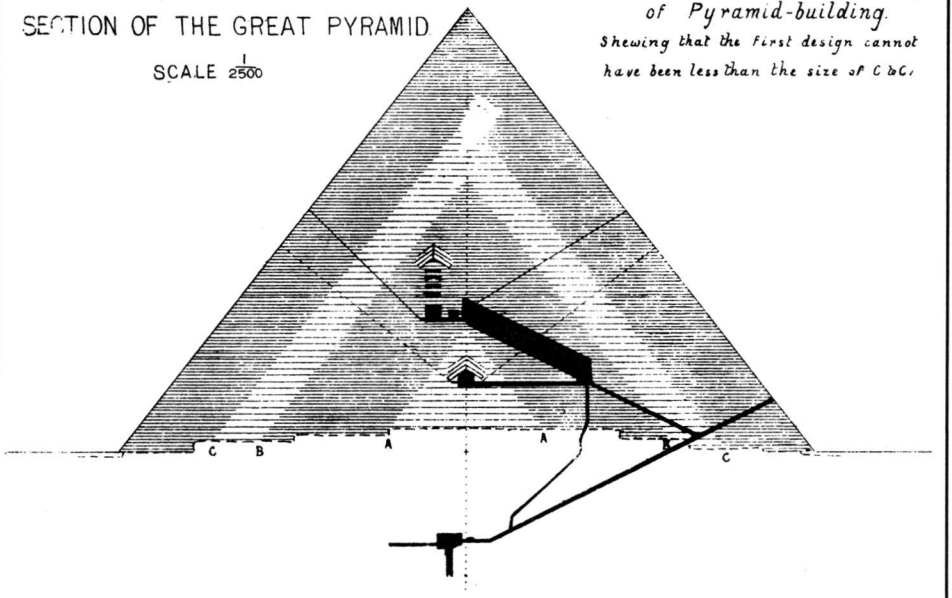
Thomas Kell & Son, Photolith.

A test of the accretion theory of Pyramid-building.

Shewing that the first design cannot have been less than the size of C to C.

SECTION OF THE GREAT PYRAMID

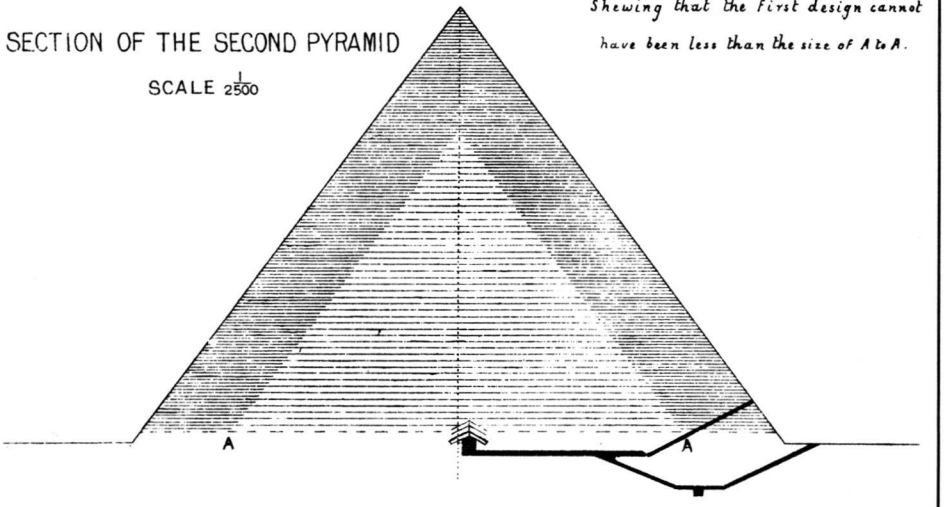
SCALE $\frac{1}{2500}$



Shewing that the first design cannot have been less than the size of A to A.

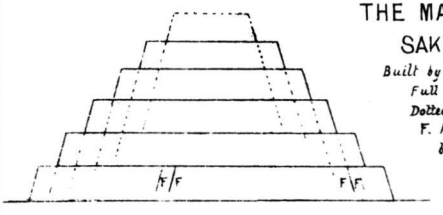
SECTION OF THE SECOND PYRAMID

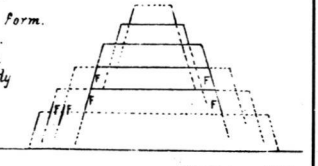
SCALE $\frac{1}{2500}$



THE MASTABA-PYRAMIDS OF SAKKARA AND MEDUN

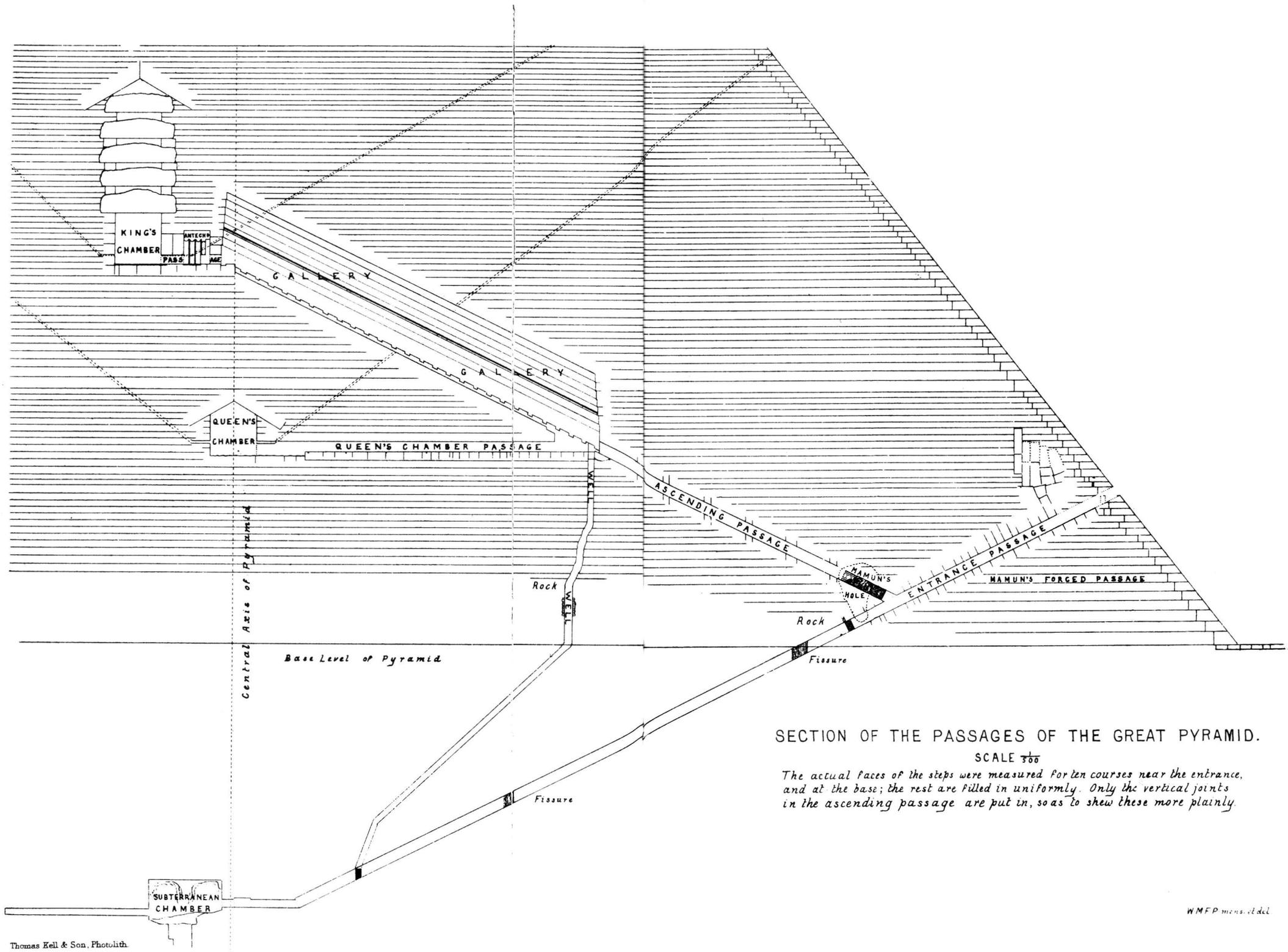
Built by accretion on a mastaba form.
Full lines. parts now visible.
Dotted lines. filled in by analogy.
F. Finished casing subsequently built over. Scale $\frac{1}{2500}$





W.M.F.F. mens. et del.

Thomas Kell & Son. Photolith.



SECTION OF THE PASSAGES OF THE GREAT PYRAMID.

SCALE $\frac{1}{500}$

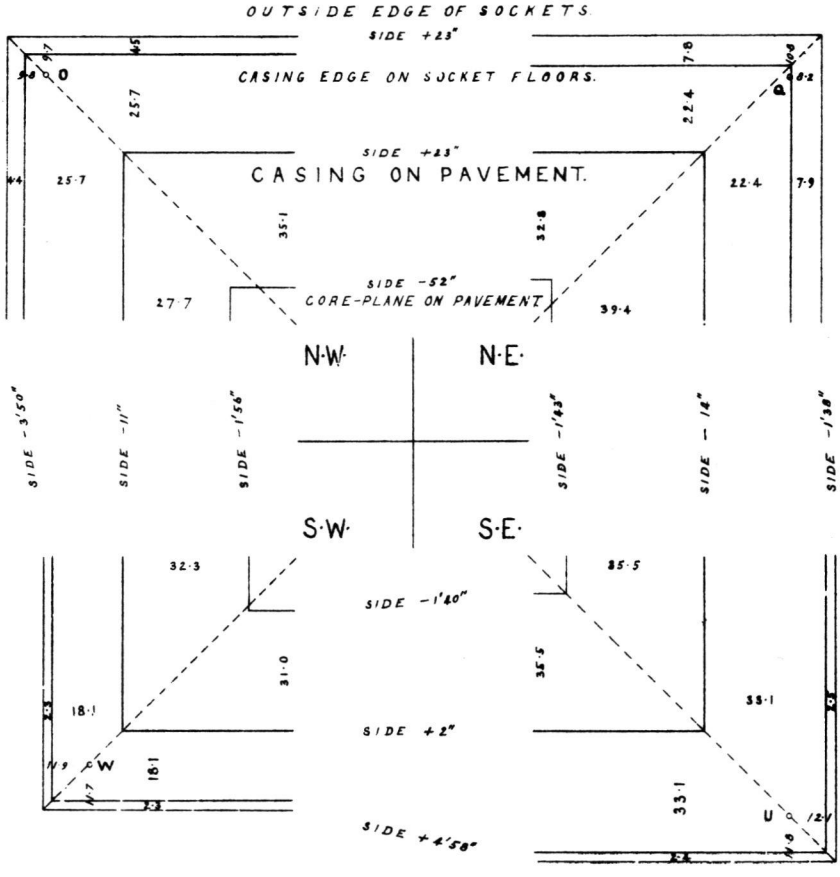
The actual faces of the steps were measured for ten courses near the entrance, and at the base; the rest are filled in uniformly. Only the vertical joints in the ascending passage are put in, so as to shew these more plainly.

W.M.F.P. mens. et del.

Thomas Kell & Son, Photolith.

THE RELATIVE POSITION OF THE SOCKET-EDGES, CASING, AND CORE-MASONRY, AT THE CORNERS OF THE GREAT PYRAMID

SCALE $\frac{1}{50}$

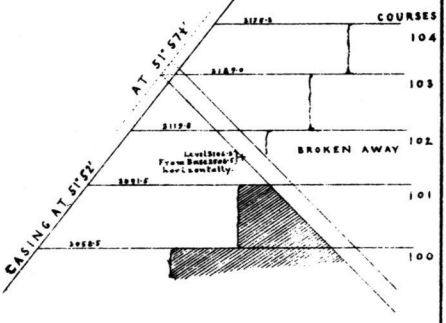


The azimuths of the sides stated are from the mean azimuth of the casing on pavement, which is −3′ 43″, ie. W. of N.
The station-marks O·Q·U·and W. are marked in position.

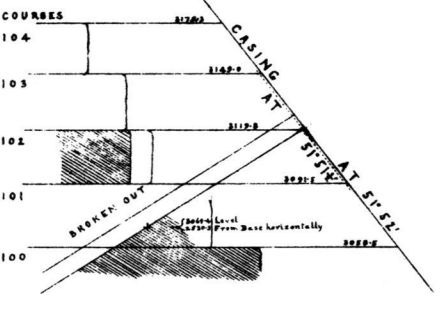
W.M.F.P. mens. et del.

Taunton Kell & Son, Photolith.

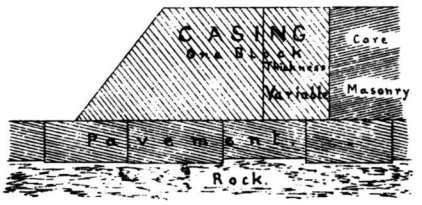
SOUTH AIR CHANNEL MOUTH OF GREAT PYRAMID (CASING RESTORED)



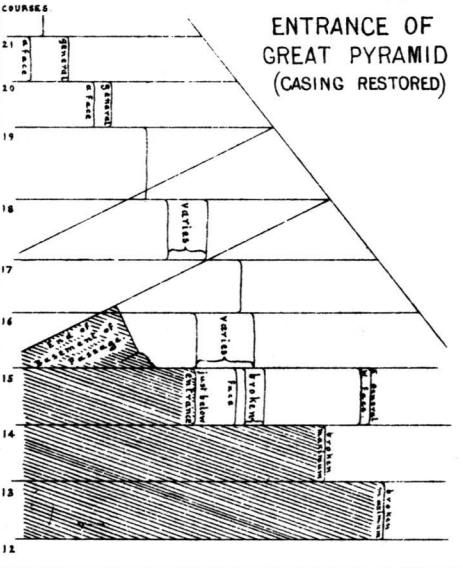
NORTH AIR CHANNEL MOUTH OF GREAT PYRAMID (CASING RESTORED)



EXISTING CASING ON NORTH SIDE OF GREAT PYRAMID.

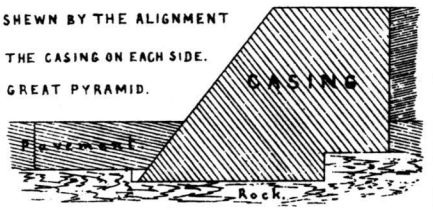


ENTRANCE OF GREAT PYRAMID (CASING RESTORED)



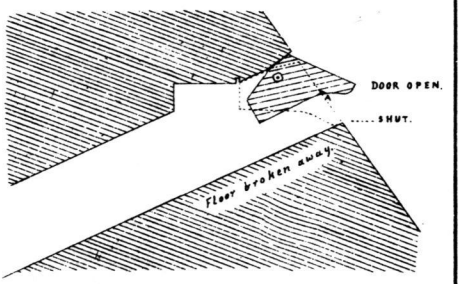
CASING-STONE IN AVERAGE CORNER-SOCKET.

AS SHEWN BY THE ALIGNMENT OF THE CASING ON EACH SIDE. OF GREAT PYRAMID.



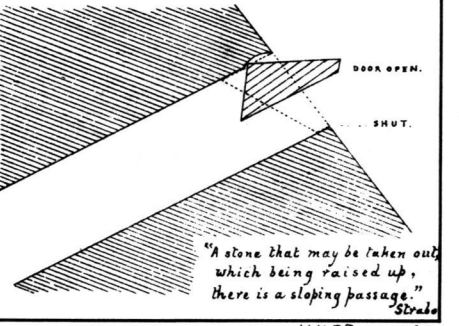
DOOR OF THE SOUTH PYRAMID OF DAHSHUR.

AS SHEWN BY THE EXISTING DOORWAY.



DOOR OF THE GREAT PYRAMID OF GIZEH

RESTORED FROM THE DOORWAY AT DAHSHUR.



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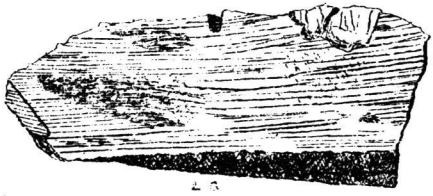
SCALE $\frac{1}{100}$

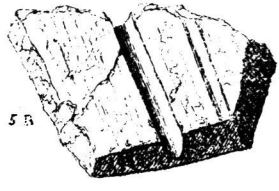
W.M.F.P. mens. et del.

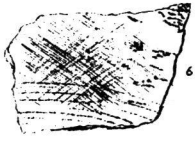

1 G

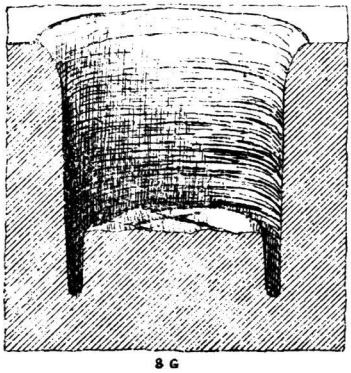

2 G


3 B


4 B

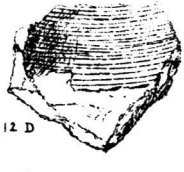

5 B


6 D


8 G

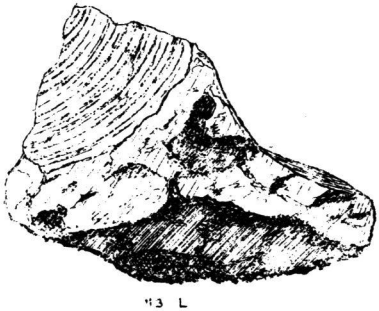

7 G

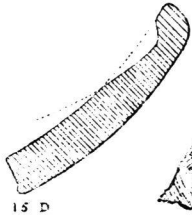

9 A

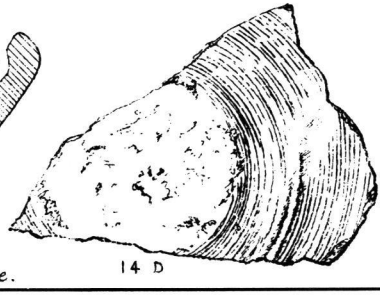

12 D


10 A


11 A


13 L


15 D


14 D

All half actual size.

A. Alabaster. B. Basalt. D Diorite. G. Granite. L. Limestone.

W.M.F.P.

THE PYRAMIDS AND TEMPLES OF EGYPT
AN UPDATE

DR. ZAHI HAWASS

Director General of Giza and Saqqara

Between December 1880 and May 1881 Sir William Matthews Flinders Petrie conducted the first scientific excavations on the Giza Plateau. Known as the father of modern Egyptology, Petrie documented his study in his book, *The Pyramids and the Temples of Gizeh*. Since that time, much more work has been accomplished at the site, relating both to the individual monuments e.g., pyramids, temples, mastabas and relating to the surrounding Old Kingdom community. Nevertheless, however, Petrie's work on the Giza Plateau is still considered as an accurate and important archaeological investigation and a basic reference for the site. It is with this in mind that *The Pyramids and Temples of Gizeh* is being republished.

This publication will begin with a summary of information gathered subsequent to the initial printing. This summary will be divided into three parts. Each part will contain an introductory background piece and conclude with a presentation of the new findings. The bibliographical references should be used where detailed information about the work of scholars mentioned in the text is desired.

PART ONE

I. *PETRIE'S WORK AT THE PYRAMID COMPLEX OF KHUFU*

The Pyramid Complex of Khufu, (Cheops), the first king to build his funerary monument at Giza, stands at the northern end of the Giza Plateau. His father Sneferu, the First King of Dynasty IV, built his pyramids in Dahshur, and possibly at Meidum.[1]

The Pyramid of Khufu, known popularly as the Great Pyramid, is in good condition and, although it has lost almost all of its casing blocks, stands nearly to its original height. The temples which were a part of the total pyramid complex, however, have all but disappeared.

The name of Khufu's pyramid was "Horizon of Khufu." The complex is also identified as belonging to Khufu through quarry inscriptions found on the relieving blocks above the king's burial chamber inside the pyramid and by later historical tradition.[2] There is no evidence that the cult of Khufu was maintained during the Middle or the New Kingdoms; however, the cult was revived in the 26th Dynasty, known as the Saite Period.

Petrie's work inside the Great Pyramid and at the other pyramids at Giza, concentrated on taking measurements of the structures. These measurements were so accurate that even today they are still used by many Egyptologists. At the same time with the advance of scientific practices more detailed information has been extracted. The base of the Great Pyramid was resurveyed by Cole in 1926, by J. Dorner and by Lehner and Goodman in 1984. Recently, Maragioglio and Rinaldi[3] did a visual survey of the pyramids of Giza and took measurements of many elements inside the Great Pyramid. They also discussed many theories presented by other Egyptologists including Borchardt and Lauer. Additionally, Goyon studied

the Great Pyramid of Khufu and produced an important book on that structure and its possible methods of construction.[4] The work of these scholars increased the amount of data that was available from pyramid research.

Petrie, in addition, considered the interior design changes of the Great Pyramid. He attributed them primarily to architectural reasons. Borchardt saw the three different chambers as an indication of two changes in planning the location of the king's burial place. However, that line of thinking has been altered by later observations that tend to connect a religious motivation to the structural anomalies of the burial chambers inside the Great Pyramid. Thereby, it may be concluded that the physical structure would reflect the dictates of a religious revolution.

At all times, the king was thought to be the reincarnation on earth of Horus, the Son of Ra. When the king died, he was believed to become Ra, the sun god and Osiris, king of the dead. I believe that Khufu changed this cult and became identified with Ra during his lifetime. Stadelmann suggested this idea because the name of Khufu's pyramid "Horizon of Khufu," as noted above, indicates that Khufu is placed with Ra, whose natural location is on the horizon.[5] Furthermore, he notes that Djedefra and Khafra, the sons and immediate successors of Khufu, were the first kings to bear the title "Sons of Ra" suggesting that their father, Khufu, was Ra.

More support for this idea in my opinion, is the enlargement of the upper temple of Khufu and the abandonment of the ritual pyramid, the same satellite pyramid that sits beside the larger Old Kingdom pyramids. Khufu changed his cult around Year 5 of his reign, then he enlarged his temple to accommodate the new cult. As a separate supporting point for the theory, the kings of the Old Kingdom who had a pyramid were probably buried beneath it, with the exception of Khufu, who was buried high up in the actual pyramid. Sneferu, the father of Khufu, was thought to have been buried at ground level with no particular significance attributed to the positioning.

The first burial chamber of Khufu is located underneath the pyramid and was left unfinished. Next, the Overseer Of All The Works of Khufu moved the king's burial chamber up further within the pyramid to what is known as the queen's chamber. But for reasons I believe are connected to the cult change made by Khufu, the burial chamber, which contains the sarcophagus, was moved even higher up into the pyramid.

There are several other points which, taken together, support this theory. For instance, the pyramid shape is clearly related to the ben-ben, the symbol of the sun god. This ben-ben was thought to be the true pyramid; the normal burial chamber was placed under the pyramid, i.e., the ben-ben from Dynasty III, (except for that of Khufu). A burial chamber within the ben-ben would identify the king with Ra, because the god and the king would be on the horizon as one.[6] Khufu also did not build any temples for any other god in Egypt. If Khufu was Ra, there would be no need to honor other deities than himself. Even the only statuette identified as Khufu was not found inside a Fourth Dynasty Temple at Abydos.[7] It seems from

negative evidence that Khufu abandoned his ritual pyramid and instead altered his upper or mortuary temple to include the function of the ritual pyramid. Another architectural distinction that indicates a dramatic change in the meaning of the pyramid layout is that Khufu's and Khafra's pyramids are the only pyramids in the Old Kingdom which have five boat pits. Through analytical observations these boat pits are assumed to relate to the religious changes attributed to Khufu.

Petrie said that the destruction of the pyramids began with the Arabs. He believed that Khalif Mamoun in the 9th Century A.D. was the earliest invader of the pyramid with his forced entry hacked through the exterior masonry. However, recently Egyptologists have actually found evidence that links acts of destruction of the pyramids to the First Intermediate Period and the Middle Kingdom, almost 2,500 years before the Arab invasion. Blocks from the lower or valley temple and the pyramid temple of Khufu were reused in the pyramid of Amenemhet I at Lisht.[8] This inclusion in the Middle Kingdom pyramid of Khufu's blocks proves that the dismantling of the Great Pyramid began before or during the Middle kingdom.

I believe that the beginning of the destruction of the pyramids of Khufu and Khafra happened during the First Intermediate Period. Khufu made himself the premier god Ra during his lifetime and his son Khafra followed him in that change. This concept of king as Ra disrupted Egyptian religion and violated the idea of Maat, the embodiment of cosmic order. Generally, Egyptian religion followed a standard program. The study of the wall reliefs, statuary, objects in the temple magazines, architectural components and the personnel of the cult in the pyramid complex, show that each element represents aspects of a basically unified program. In my opinion, during the First Intermediate Period, the Egyptians took revenge on Khufu and Khafra for their disturbance of Maat. This revenge resulted in the destruction of their monuments. The evidence from the lower (valley) temple of Khafra supports the hypothesis that the monuments on Giza were destroyed at the end of the Old Kingdom. The temple was certainly plundered and most of the statuary was smashed, a sign of revenge rather than robbery. However, the careful burial of the magnificent diorite statue of Khafra found in a pit inside the valley temple and today displayed in the Cairo Museum, suggests an attempt was made to protect it from plunderers. This pit in which it was buried must date to after the 4th Dynasty, as it has no function in the original plan of the temple.

Petrie discussed, in addition, the preparation of the Giza Plateau for building the pyramids, as have many other scholars since his time. But the subject is still a matter of debate. Egyptologists who investigated the building of the pyramid are Fakhry,[9] Edwards,[10] Stadelmann, Maragioglio and Rinaldi, Goyon and Lehner.[11] The most important point that should be mentioned here pertains to the preparation of the site as set out first by Maragioglio and Rinaldi[12] who noted regularly spaced holes around the Great Pyramid. Then, Goyon and Lehner expanded upon the former work by describing holes, 40 cm to 60 cm in diameter, which were cut in the base

rock around the pyramid. Some of these were filled with mortar.[13] It was suggested that they had to do with the laying out of the pyramid, i.e., the leveling of the pyramid base.[14]

Within the king's chamber of the Great Pyramid are found the so-called air channels. Two similar channels are incorporated also in the queen's chamber, but their openings were never cut through the walls of the chamber when they were thickened. One of the two air shafts in the king's chamber is located on the central axis of the southern face of the pyramid and faces the east-west axis of the two boats that were buried on the southern side of the Great Pyramid. Scholars first suggested that these air channels were for ventilation,[15] but Badawy believed that the channels provided a passage for the king's spirit to ascend to the astral regions.[16]

This latter explanation of the function of the air channels appears to be reasonable; thus the king would have traveled through the northern channel to join the northern stars. However, in my opinion, the southern channel in the king's chamber would have been provided for Khufu as Ra to travel to the day and night boats located south of the Great Pyramid. These channels occur only in the pyramids of Khufu and Khafra, which are also the only two pyramids to be associated with five boat pits, thus the connection between the channels and the boat pits is strengthened.

In 1986, a French team conducted an investigation inside the Great Pyramid. First, they did a non-destructive survey using the microgravimetric technique. They claimed that there were cavities located on the right side of the so-called queen's chamber corridor. The Egyptian Antiquities Organization gave permission to the French team to drill holes in this area to find evidence of these cavities. The results of this work remain ambiguous.[17]

Waseda University in Japan, applied to work at Giza just after they heard the news of the French team's hypothesis. The request was approved and they began work in January 13, 1987 under the direction of Sakuji Yoshimura. The expressed purpose of this investigation was to locate previously undiscovered passages and hollows in the pyramids and to explore relics that are buried under the ground around the pyramids.[18] The Japanese team also used the non-destructive electromagnetic wave method of exploration. In their work at the Giza Plateau, the Japanese team expanded the manipulation of radar to see how it could be applied to the ground and materials of Egypt. The Japanese focused on interior testing of the Great Pyramid. The first sounding took place within the passage leading to the Queen's Chamber. They claimed to have located a hollow about 1.5 m. under the passage that extended downward around 2.5 m. to 3.0 m. This location is the same area in which the French team did the drilling. The Japanese could not precisely identify the bottom cavity fill, but thought it contained sand.

The second area of Japanese investigation was the queen's chamber itself, within which they found evidence of another cavity in the western part of the northern wall.

The third area of investigation was the king's chamber, where they

found no anomalies or holes picked up by their magnetic devices. The king's chamber is granite and was thereby determined as solid as much of the pyramid's limestone core.[19]

The Japanese team's investigation also extended south of the Great Pyramid to the boat museum and the second boat pit. The Japanese team found a passage located around 3 m. and 5 m. underground which may extend beneath the Great Pyramid.

The last site investigated by the Japanese was the Sanctuary of the Sphinx. The three areas that were targeted were:

A. South of the Sphinx
B. North of the Sphinx
C. In front of the Two Paws of the Sphinx

The results were:

A. South of the Sphinx
   The Japanese indicated the existence of a hollow 2.5 m. to 3 m. underground. And, they found indications of a groove on the Sphinx body that extends beneath the Sphinx.
B. North of the Sphinx
   The Japanese found another groove similar to the southern one which may indicate that maybe there is a tunnel underneath the Sphinx connecting the south and north grooves.
C. In Front of the Two Paws of the Sphinx
   The Japanese found another hollow space about 1 m. to 2 m. below surface. Again, they believe that it may extend underneath the Sphinx.

The conclusion of the Japanese work suggests that the sanctuary of the Sphinx contains more cavities below the Sphinx than were previously known.

The combined data collected by the recent research at Giza resulted in the indications that there is/are:

1. Hollows located under the Sphinx as yet, not identified;
2. Cavities running from north to south underneath the Sphinx;
3. A tunnel south of the pyramid of Khufu; and
4. A wooden boat inside the second pit of Khufu. Except for the second wooden boat by the Khufu pyramid the results are ambiguous and somewhat speculative.

From August 1988 until May 1989, the Antiquities Department at Giza closed the Great Pyramid in order to restore the interior.

The reasons for closing the Great Pyramid were:

A. No restoration had been done inside the Great Pyramid since it was opened in 1836 by Howard Vyse.
B. There had been a salt accumulation of about 1 cm. thickness over the surfaces of the queen's chambers and the grand gallery.
D. About 500 different spots within the Great Pyramid had become weak and detached.
E. The original subterranean burial chamber was prepared to be

opened for visitors for the first time, as was the original entrance into the pyramid.

F. In order to control visitor circulation within the pyramid, a television monitoring system was to be installed.

During the months that the Great Pyramid was closed, the following was accomplished:

1.

Soot (black spots) was removed from the ascending passage which leads to the second burial chamber or queen's chamber by a solution composed of alcohol and water, i.e. 1:1 in equal parts. Then some of the areas were cleaned by using a concentration of acetone. In addition, the salts which covered the walls and the roof of this passage were cleaned by mechanical means. Weak parts were consolidated to protect the walls of this passage from detachment by using special mortar derived from sands and araldite.

2.

In the second burial chamber or the queen's chamber:

a. The crystallized salts which covered the walls and the roof of this chamber were first removed by mechanical cleaning. Then wet poultices from paper-paste were applied in three stages. Ten days elapsed between the application of each of these treatments.
b. Soot (black spots) was removed as described above and a watered down ammonia-solution was applied to the surfaces, followed by a rinsing with distilled water.
c. The walls were consolidated after removing the salts and soot by a solution composed of paraloid-1372 with acetone 5%.
d. The deteriorating parts of walls were restored by applying a suitable mortar composed of three parts sand, two parts lime powder, and one part kaolin.

3.

The restoration work in the grand gallery consisted of:

a. Removing the salts and soot and, consolidating the weak blocks.
b. Registering all the blocks in the grand gallery and recording by drawing and photographs, the actual condition of each block before restoration. Where possible the loosened blocks were grouted and reattached. In the grand gallery, a total of 239 blocks were examined and worked with on the right wall; 245 were examined and worked with on the left wall. Fourteen blocks were examined and worked with on the northern and southern walls and 16 of the 40 slabs that formed the roof were examined. The roof slabs were in

critical condition and required stainless steel bar implants as well as grouting.

4.

The third burial chamber or the king's chamber restoration followed that of the other areas previously described. That is:

a. Soot (or black spots) was removed by using alcohol, an ammonia and water solution in equal parts and rinsing with distilled water;
b. The walls and the roof of this chamber were cleaned through using water and neutral-soaps, then rinsing with distilled water; and
c. Grease was cleaned off the granite walls by mechanical methods.

5.

The descending passage which leads to the first burial chamber, although not previously open to the public, presented similar restoration problems as the parts of the Great Pyramid to which access was unrestricted. That is:

a. The salts which covered the walls and the roof of this passage had to be removed by using mechanical methods without using any wet-poultice in order to avoid increases in humidity inside the first burial chamber.
b. The weak parts of the walls had to be consolidated by using a solution composed of paraloid-1372 with acetone 5%.
c. The cracks and the slight detachments of the walls were repaired by using linen, sand and araldit. Where appropriate, the cracks were filled by using a special mortar composed of three parts sand, two parts lime-powder, and one part kaolin.

One important structural improvement that was made in the descending passage, was the installation of iron supports to buttress the large limestone roof of the passage. The passage was thereby strengthened sufficiently to accommodate tourists.

6.

A new limestone staircase was built in the middle of the northern side of the Great Pyramid, a short distance from the staircase used in order to reach the Mamun's entrance. This new staircase leads to the original entrance of the Great Pyramid. It was made to facilitate visiting the inside of the Great Pyramid. It will be used as the exit. The first staircase which leads to the Mamun's entrance will be used for the entrance.

7.

The lighting system inside the Great Pyramid was entirely altered by the installation of indirectly lighting sodium lamps. The old lamps that had

been randomly placed on the walls, were removed. These new sodium lamps dramatically improved the quality of the lighting in the interior passages and chambers. The old electrical cable was replaced by a new one, and all the wires were changed to accommodate the new system.

8.

A television monitoring system was introduced in order to control the circulation of visitors inside the Great Pyramid. Five highly sensitive television cameras were placed inside the interior passages and chambers, i.e. the grand gallery, the second burial-chamber, the third burial-chamber.

The work of interior restoration of the Great Pyramid was laborious. It was conducted by the staff from the Egyptian Antiquities Organization. The result is that the monument is in the best preserved state since its opening. Furthermore, it is more accessible to tourists, can be more easily viewed and policed and has more chambers open.

II. *PETRIE'S WORK OUTSIDE THE GREAT PYRAMID OF KHUFU*

In his initial work at the Giza Plateau, Sir Flinders Petrie investigated:

1. The Surrounding Limestone Court and the Temenos Wall.
2. The Basalt Pavement on the East Side of the Pyramid, i.e. the Funerary Temple.
3. The Trial Passages.
4. The Rock Trenches and Cuttings, including the Boat Pits, on the East and South Sides and at the Northeast Corner.

These are the most important exterior features that Petrie discussed. I will introduce here the terms that Petrie used to explain these archaeological remains, and I will also provide the terms applied recently to the same features.

1.
The Surrounding Limestone Court and the Temenos Wall

The Great Pyramid was surrounded on all four sides by a temenos wall, remains of which are visible today primarily on the eastern and northern sides,[20] with slight traces of the wall on the western and southern sides of the Great Pyramid.[21] This wall is about 10.20 m. from the base of the pyramid to the east and north and 10.0 m. from the pyramid to the south and west.

Between this wall and the base of the pyramid, the limestone pavement of the pyramid court mentioned by Petrie, is still visible.[22] This pavement is composed of Tura,* rather than local limestone. The slabs are laid

* Tura is a site located on the west bank of the Nile. It was considered the Royal Quarry by Ancient Egyptians. Its rocks are of fine white limestone. These rocks were used to case the pyramids.

in irregular but finely fitted patterns. They are in place in patches to the east, west and north of the pyramid. Modern construction to the south has covered any traces of the court.

The bedding of the wall in the natural rock can be seen on the east side, where it is about 3.15 m. to 3.60 m. wide.[23]

The court surrounding the pyramid seems to have been isolated by the wall from the outside. To reach the court, it was necessary to pass through the upper temple. This restricted access may indicate that the court was accessible only to officials and people who were responsible for carrying out the king's cult in the pyramid complex. Thus it would appear that the court was connected with the cult of the king, and that the Temenos wall was built to isolate the court from the populace not associated with perpetuation of the king's cult.

2.
The Funerary Temple*

Very little of the funerary temple of Khufu remains today. The entire temple was quarried away, probably in the Middle Kingdom and later. A shaft that represents either a Saite tomb or a Roman well was dug into the center of the western part of the temple area, completely destroying the plan of that area.

The first excavations of the temple area after these of Petrie were carried out by Hassan.[24] Various reconstructions of the temple have been suggested most notably by Lauer,[25] Ricke,[26] Maragioglio and Rinaldi[27] and Stadelmann.[28]

The physical evidence found in Khufu's temple combined with parallels to other Old Kingdom temples suggests the following reconstruction of the western part of Khufu's temple: A long hall, running north-south and containing five statue niches, was reached through a door in the westernmost pillared recess of the courtyard. Four of the five niches may have contained a statue of Khufu, each perhaps identified by one specific name from Khufu's titulary. Each statue was assigned a specific priest to perform ceremonies in front of it. The fifth niche could have contained a statue of the goddess Hathor, probably served by her priests known to be in residence at Giza. Hathor is goddess of women, the tree goddess and the sky goddess. She is called the royal mother and linked with the king's life. Her cult in the Old Kingdom was important at Memphis, especially at Giza. I believe that the pyramid complex at Giza was dedicated to the worship of the divine triad, the sun god Ra, the goddess Hathor and the falcon god Horus. The king is equated with both Ra and Horus. Hathor represents both the wife of the living king and the mother of his successor. This can be seen through much evidence at Giza, e.g., Menkaura triad; titles of Priestesses at Giza; name of southern entrance of the valley temple of Chephren, etc.

* See Temple Plan

There were magazines in the masonry to the north and south of this hall. An east-west passage along the inside of the north wall of the temple led from the colonnaded court to the courtyard east of the pyramid. In this courtyard there may have stood an altar flanked by two stelae on a platform against the east face of the pyramid.

Wall reliefs from Khufu's pyramid complex have been found in two locations:

I. Fragments of reliefs have been found at Giza beside the funerary temple, causeway and queens' pyramids.[29] These scenes pertain to the *Sed* festival. The *Sed* festival is a subject that begins to show up on the wall reliefs in the Old Kingdom temples and it continues therefrom during the entire span of Egyptian history. The term is translated in a Greek text as jubilee. The king celebrates this jubilee every 30 years after his succession in order to renew his power and strength. The exact meaning and significance of this festival is still a subject of debate among scholars. Because of their provenience, it is generally assumed that all these fragments were originally part of scenes in the funerary temple.

II. Fragments of reliefs have also been found re-used at the pyramid of Amenemhet I of Lisht.[30] The subjects of these reliefs are: funerary estates, foreign captives, representations of ships, animals, and the *Sed* festival. Goedicke assigned these blocks to the upper and lower temples on the basis of their parallel placements in other Old Kingdom wall reliefs.[31]

There is another relief fragment belonging to the pyramid complex of Khufu. A fragment with a scene of the *Sed* festival depicting a white hippopotamus was found built into the wall of a staircase inside Bab-el-Futtuh, one of the old Islamic gates of Cairo.

Herodotus described the causeway of Khufu as one carved with figures.[32] It appears that the program of wall reliefs was used throughout the Khufu pyramid complex. It is the first time that the program of the wall reliefs was installed on a complex-wide basis. In the time of Sneferu, Khufu's father, the whole program occurred only in the lower temple. In Dynasties 5 and 6, the program was fully developed in its final form.

3.
The Trial Passages

To the east of the Great Pyramid, Petrie found passages cut into the rock floor that are very similar to the passages inside the Great Pyramid. These he called "trial passages", thinking they were a trial run for making the actual pyramid passage. The trial passages are just north of the causeway of Khufu beside the tomb of Hetepheres I.[33] They lie 87.50 m. from the eastern base of Khufu's pyramid and 43.50 m. north of the east-west axis. The passages are oriented north to south, the rock was cut carefully and well squared, and some parts were encased with mortar.[34]

The passages have a total length of 22 m. and a total vertical depth of 10 m. At the north end there is an opening in the bedrock when is cut in steps. This becomes a sloping passage 1.05 m. wide and 1.20 m. high, which continues at an angle of 260°3'. From the north entrance of this passage, a second passage, of almost identical cross-sectional dimensions, begins. This second passage ascends southward at approximately the same angle as that by which the first passage descends. At 5.8 m. from its beginning, this second passage reaches the surface of the bedrock and widens into a corridor which is open to the sky. A square shaft, about 0.72 m. in width, was cut vertically from the surface of the bedrock to the point where the two passages meet.[35]

About 6 m. west of the trial passages and parallel to them is a long and narrow trench considered the third trial passage.[36] This runs parallel to the other passages, and is almost exactly equal in width to the vertical shaft in the trial passages. Its southern end is well-cut but its northern end was left rough. It measures 0.15 m. deep at the north end and 0.43 m, deep at the south end. This narrow trench is 0.71 m. wide and 7.35 m. long.[37] Lehner believes that it has some connection with the trial passages.[38]

The function of these trial passages has been debated by scholars since their discovery by Perring and Vyse, who believed that they were part of the substructure of the fourth queen's pyramid which was left without a superstructure.[39] They offer as evidence for this view the fact that these passages lie on the same north-south axis as Khufu's queens' pyramids designated by Reisner as GI-a, b, and c. They also note that the rock around the north entrance to the passages was leveled, indicating that there was a superstructure planned.[40]

Petrie, who examined and mapped these passages, noted the similarity of these passages to the passages inside the Great Pyramid. He suggested that the trial passages functioned as a model for the Great Pyramid's interior structure. Petrie found that "the trial passages" had the same height and width as the passages in the pyramids but were shorter in length. The only feature that differs in the two primary sets of passages is the vertical shaft, which he did not recognize as appearing in the pyramid. According to Maragioglio and Rinaldi, the trial passages reproduce the following features of the Great Pyramid passages: the descending corridor, the ascending corridor, the northern end of the grand gallery with the lateral benches, and one middle horizontal corridor, which is only roughly outlined.[41] A final point of evidence that these passages were models of the interior of the Great Pyramid for Maragioglio and Rinaldi is the fact that the rock was leveled on the sides of the north opening, which they interpret as an indication of the point where a passage built in masonry continued hewn in the rock.[42]

In connection with the "passages as models" theory, Lehner brings up the story of Khufu and the magician from the Westcar Papyrus in possible support.[43] This story tells of Khufu's attempts to discover the number of secret chambers of the god Thoth so that he could model his tomb after them.[44] Lehner, however, also lists several objections to the theory that

these are model passages: flaws in the sides of the passages would not have been filled with plaster if they were not meant to be used; the lower part of the ascending passage narrows as if to provide a resting place for plugging blocks, which implies a superstructure and a burial; the north opening of the descending passage is cut in steps as if to provide a place for the masonry of a superstructure; and the narrow trench appears to mark the north-south axis of a pyramid.[45] On the basis of these points, he reconstructs a pyramid over the area. This pyramid would have been either comparable in size to the queens' pyramids GI-a, b, c, or twice as large as these pyramids, and would have lain on their north-south axis.[46] The upper temple, the causeway, and the fifth boat pit were cut into the area of this hypothetical pyramid, indicating that it was never built.

Lehner suggests that this pyramid might have been planned as a satellite, or ritual pyramid for Khufu. He thinks that it might have been planned to be twice as large as the eventual queens' pyramids, and assumes that it was abandoned for topographical reasons.[47] Lehner believes that the cuttings referred to as the trial passages were cut as the substructure of a ritual pyramid for Khufu; and that the three queens' pyramids were planned at the same time.[48] According to his hypothesis, this pyramid was never completed, probably due to the expansion of the upper temple and the change in route of the causeway.[49] At this point, he writes, the queen's pyramid GI-a was taken over as the ritual pyramid. He chooses this pyramid because of its proximity to Khufu's upper temple and the absence of any traces of a mortuary temple associated with it.[50]

Lehner's reconstruction of a pyramid in this area is reasonable and fits the evidence well. However, it is unlikely that this pyramid was meant to be a ritual pyramid for Khufu.

It is not at all certain that Khufu had a ritual pyramid in his complex; there is certainly no obvious feature which can be assigned this function, as the three subsidiary pyramids in Khufu's complex are generally considered to be queens' pyramids. Thus, it is necessary first to look elsewhere for the site of a possible ritual pyramid.

The biggest difficulty with Lehner's theory is that it would have put the ritual pyramid on the east side of Khufu's pyramid, rather than to the south. Earlier prototypes of Old Kingdom ritual pyramids indicate that they should be to the south of the main pyramid. In fact, the structures in the complexes of Khafra and Menkaura that could be interpreted as ritual pyramids lie to the south of their main pyramids. Lehner responds that this eastern location was a topographical necessity, since the ramp from the quarry to the pyramid site would, have occupied the south side of the pyramid during its building period.[51] But, my opinion is that if it was important for the ritual pyramid to be to the south of the main pyramid, Khufu would have planned it and then built it after the ramp was removed. Lehner alternatively suggests that this location could be a product of the period of experimentation that was occurring at the time when the pyramid was being built.[52] Supporting Lehner's hypothesis is the fact that many of the ritual

pyramids have interiors which copy the interiors of the main pyramids with which they are associated.[53]

Of the functions suggested earlier for the "trial passages", all seem equally possible—the most likely appears to me to be that they are models for the passages inside the Great Pyramid.

As for the theory that queen's pyramid GI-a was taken over as the ritual pyramid when the layout of the eastern field was changed, there is little evidence. Lehner's assumption that there was no chapel on GI-a's east face is far from certain. Maragioglio and Rinaldi believe that there is enough evidence in the area to reconstruct a chapel there.[54] It is also possible that this chapel was deliberately removed in the time of Khufu.[55] The presence of one of Khufu's boat pits argues against identification of queen's pyramid GI-a as a ritual pyramid because no known ritual pyramid is associated with a boat pit. This boat pit might have been built in conjunction with GI-a before its hypothetical conversion to use as a ritual pyramid. However, if this was the case, it should have been filled up rather than left functional.

Also arguing against Lehner's theory that GI-a was taken over as the ritual pyramid are two important points. First, if the function of queen's pyramid GI-a was transferred to queen's pyramid GI-b, this would have started a chain of events eventually resulting in the lack of a tomb for some important personage. The layout of the interior apartments was significant, and should have resembled as closely as possible the internal apartments of the main pyramid.[56] Thus, GI-a could not have fulfilled the function of a ritual pyramid properly.

If all three subsidiary pyramids were for queens and the ritual pyramid[57] and the "trial passages" are dismissed as sites of the ritual pyramid, the possibility that Khufu did not have a ritual pyramid must be considered.

The function of the ritual pyramids is not known, and has been debated at length. The most frequently cited possible functions are: symbolic burials for the king as ruler of Upper and Lower Egypt;[58] tombs for the viscera;[59] tombs for crowns;[60] burials of placentas;[61] burials for the king's ka;[62] temporary storage of the body;[63] solar symbols;[64] and dummy tombs connected with the *Sed* festival.[65]

The Third Dynasty pyramid complex of Djoser is one about which much information has been derived. The reliefs in the panels in Djoser's Southern Tomb present the king wearing the White crown of Upper Egypt and running holding a staff and a mace. These scenes can be interpreted as representation of the *Sed* festival.[66] Given this antecedent it is likely that the Southern Tomb of Djoser and the subsequent ritual tombs likewise to the south of the main pyramid, are associated with the *Sed* festival.

Scenes of the *Sed* festival are well represented in the decorated blocks from the upper temple of Khufu. These blocks show the *Sed* ceremony enacted in the presence of various deities. Such scenes before deities occur for the first time in these reliefs.[67] Thus the *Sed* festival is obviously important in Khufu's complex.

But does this mean that a *Sed* ritual or subsidiary pyramid was neces-

sary? Since the aforementioned scenes were in the upper temple, perhaps the function of the upper temple was enhanced to include the function of the ritual pyramid, thereby rendering the actual existence of a ritual pyramid unnecessary. So it is possible that, due to the changes in cult and experimentations with the layout of the complexes during Khufu's reign, a ritual pyramid was never planned. If one was to insist that a ritual pyramid was planned, then the "trial passages" are its most likely location. For Khufu, however, the upper temple may have been modified to include the function of the ritual pyramid, if a change in cult during his reign did not dispense with the need for such a structure.

4.
The Rock Trenches and Cuttings, i.e. Boat Pits, on the South and East Side and at the Northeast Corner of the Great Pyramid

Five boat pits have been identified in the pyramid complex of Khufu. Two of these lie to the south of the pyramid and are oriented east-west, parallel to its southern face. Three of these lie to the east of the pyramid, two of which are oriented north-south, parallel to its face and the third of which is parallel to the causeway at a point several meters from the eastern wall of the upper temple. These pits are cut into the rock of the plateau. The easternmost of the southern pits was found to contain a full-size wooden boat.[68] The second southern pit also has a boat in it although it remains to be excavated.

The three eastern boat pits were mapped in 1843 by Lepsius.[69] At the time of Lepsius' survey, these pits were filled with sand and other debris.[70] Petrie excavated these boat pits but referred to them as trenches without giving any indication of their function. Reisner cleaned the boat pit by the causeway and Hassan re-excavated all three eastern pits.[71]

In 1954, while excavating the southern side of the Great Pyramid between the base of the pyramid and the southern mastabas, Kamal El-Mallakh found the two southern boat pits. These two pits are separated by a north-south wall of rocks which lies on the north-south axis of the pyramid. The eastern pit was opened and found to contain a large wooden boat; the western is as yet unexcavated,[72] but also contains what appears to be a similar large wooden boat.

Boat Pit #1

As noted above, this pit lies south of Khufu's pyramid. It is at present covered by 40 slabs of limestone laid side by side.

A team from the National Geographic Society and the Egyptian Antiquities Organization discovered by means of drilling and video camera observation that the pit contains a disassembled boat similar to the one found in 1954. The initial investigative work was done in 1987 and all the photo-

graphs, air samples and other measurements were made via a 3.5 inch diameter hole drilled through 63 inches of rock. The drill used in the National Geographic project was fitted with a special air lock. The air lock enabled the team to collect air samples, monitor equipment and take pictures of the interior all without altering the chamber or its environment.

Once the chamber was breached, a probe was inserted to test the atmosphere. Air was pumped out through a stainless-steel tube into six sterilized vacuum flasks on the surface. But as Peter Tans, a research scientist the University of Colorado at Boulder stated, "It is unlikely that the air in the pit remained unchanged for 4,600 years."

The hole for the air samples eventually was resealed with a mixture of plaster and stone chips and capped by a limestone plug to blend with the original blocks.

The most important result of the probe was the finding that the disassembled boat in the second pit is similar to the one which is in display now. Neither boat has a sail. The project was under the supervision of the National Geographic Illustrations Editor, Elie S. Rogers and Claude E. (Pete) Petrone with the cooperation of Farouk El-Baz and the Egyptian Antiquities Organization.[73]

Boat Pit #2

This pit lies to the east of pit #1. When excavated in 1954, it was found to be covered by 41 slabs of limestone, some of which bore quarry marks in red and black ink. These limestone slabs were resting on a ledge around the upper edge of the pit. Each block weighs about 15 tons and varies slightly in length, the largest being about 4.80 m. long. The three westernmost of these stone slabs were much smaller than the others; these have been interpreted as keystones. Small pieces of limestone were left between the blocks to keep them in their proper place.[74] Square holes were cut in the area of the upper part of the southern and northern sides of the pit to make the final adjustments of the blocks easier. A very fine liquid plaster was used to fill the interstices between the blocks so that the pit was isolated from any change in climate and protected from rain and insects.

The pit itself is rectangular in shape and measures 32.5 m. in length. Its sides are vertical. Traces on the sides and bottom show that they were dressed with copper chisels.

Among the quarry inscriptions found on many of the roofing blocks were 18 cartouches of Djedefra, Khufu's son and successor, showing that he was responsible for the funeral of his father and the burial of this boat.[75] On the southern side of the wall of the pit were found signs in red ink that list measurements which as yet have not been studied.[76]

Inside the pit were laid the dismantled pieces of a very large wooden boat. On top of the wood was a layer of mats and ropes, an instrument made of flint, and some small white pieces of plaster. The prow of the boat, a wooden column topped by a round wooden disk, was found in the extreme

west of the pit. This column was connected to two long wooden pieces which extended along the bottom of the pit. In the middle of the pit was a rhomboidal board, painted white and consisting of two separate pieces. At the east end of the pit was the stern post. Most of the wooden parts had been tied together with various knots. Signs had been inscribed on the wooden pieces in red ink, these are thought to be technical terms connected with the building of the boat. Also found inside the pit were other items including: twelve oars, each of which was made of a single piece of wood; fifty-eight poles; three cylindrical columns; and five doors. In total, there were thirteen layers of material consisting of 651 artifacts ranging in size from 10 cm. to 23 m.[77]

The rebuilt boat displayed in the Giza Boat Museum measures about 43.4 m. long and 5.9 m. wide in the beam. The woods used in its construction were cedar and acacia.

Nour concluded, based on the fine traces of white color found on the surface of the wood and the lack of any traces of water marks on the sides of the boat, that the vessel had never been used.[78] But other scholars believe that traces on the gangplank indicate that the boat was actually used on the Nile.

Boat Pit #3

This boat pit was one of three found on the eastern side of the Great Pyramid, south of the upper temple of Khufu.[79] It measures 51.50 m. long, 7 m. wide and about 8 m. deep. One ledge can be seen in the north end, and Petrie's drawing indicates a second ledge lower than the first. These two ledges would have held stone blocks. Some of the mortar that was apparently used to hold the blocks in place was preserved. When Petrie found this boat pit (which he called a trench), a few of the covering blocks were still *in situ* along the west edge and some of the limestone paving was left on the bottom. At its initial inspection the pit contained debris which was subsequently removed.

Hassan believes that this pit was never covered, since the great width of the pit would have been impossible to span without pillars.[80] Maragioglio and Rinaldi feel that it was covered by a layer of rubble, or by a pavement made of slabs.[81] Hassan suggests that the presence of a shallow cutting in the bottom of the pit represented the original presence of a rectangular cabin amid ships and further states that this cutting may have formed a bedding to support casing stones. Cerny and Hassan report that the prow end of the pit was oriented to the south.[82] However, Thomas states that the prow end of the pit was oriented to the north.[82]

Boat Pit #4

This second boat pit located to the east of the Great Pyramid and on the northern side of the upper temple of Khufu, is filled with debris and

hidden by the nearby roadway.[83] The pit is about 35.05 m. from the central east-west axis of the complex. It was cut vertically into the rock; the north side is dressed, and the rest was left rough. Remains of mortar appear in the rock wall and Hassan believes that it was never roofed.[84] According to Cerny and Hassan, the prow of the pit faces north; Thomas says that it faces south. As with many points in Egyptology, a clear conclusion of fact remains to be determined.

From the debris that was inside the boat pit come various artifacts. One was a fragment of limestone with a word written in hieroglyphs. This fragment Hassan reconstructs as part of the name of Khufu's pyramid. Also found was a fragment of a red pot, a fragment of limestone with the heiroglyph of *ankh* on it, and a fragment of a granite statue.[85] The inscriptions and the statue fragments may originally have come from Khufu's temple. That means that the fragments would have been deposited in the boat pit at a time later than Khufu, possibly later than the Old Kingdom.

Boat Pit #5

This third boat pit located on the east side of the Great Pyramid lies parallel to the causeway of Khufu. The pit is oriented east to west, with the prow shape at the east end. The overall impression is that the pit is shaped like a cradle. The prow represents the curtained bow post and is vertical. Hassan correlates this shape with a type of a boat found in the Archaic Period.86 The pit measures 45.50 m. in length and 3.75 m. in maximum width. A stairway containing 18 steps was found inside and Maragioglio and Rinaldi found holes cut in the sides of the pit which they interpret as sockets for small transverse beams.

Reisner discovered cordage and pieces of gilded wood inside the pit, indicating that a boat had once been inside. The stairs were filled with masonry. It is difficult to tell whether or not the pit was originally roofed.[87]

The building history of these five boat pits can be understood based on their layout. It is thought that the three boat pits found on the east side of the Great Pyramid were cut during the time of Khufu and that the two southern pits were built during or after the reign of Djedefre. That the southern pits were built during or after the reign of Djedefre is derived from the discovery of cartouches containing his name in pit No. 2. This was probably because the southern side of Khufu's pyramid was occupied during his lifetime by the main ramp which led from the quarry east of Khafra's pyramid to the base of Khufu's pyramid.[88]

The function of the boat pits around Khufu's pyramid is a matter of debate among scholars. In the Old Kingdom, boat pits around the pyramids were some of the most important elements of the pyramid complex. These pits may have contained funerary boats used to transport the body of the king to the sacred places of the god Osiris and to bring the body to the cemetery; or they could have contained types of solar boats that the king

might have used for his journey with the sun god, Ra; or they could have contained boats of the king used to accompany the sun god on his voyage across the sky.

There are three main schools of thought concerning the function of the type of boats found in pits numbered 1 and 2. The first, propounded by Cerny, is that four of Khufu's boats were ritual boats for carrying the king to the four cardinal points, and that the fifth in front of the mortuary temple, was the boat in which the body of the king was transported to Giza.[89] The second school, originally expressed by Emery in reference to a 1st Dynasty mastaba at Saqqara, and then adopted by Hassan, believes that the boats were solar boats and carried the king or the god Ra through the heaven.[90] The third explanation expounded principally by Abu Bakr, suggests that all the boats were originally used in the king's lifetime for pilgrimages and other ceremonies, including funerary activities.[91]

It would seem possible to argue that two of the eastern boat pits are for the king as Horus. Their axis were directed north to south because the king as Horus had power that extended south and north, i.e. the Upper (southern) and Lower (northern) land of Egypt. That the three eastern boat pits were different in function from the two southern boat pits is indicated by their shapes. The three eastern boat pits were cut to resemble boats, contrasting with the southern pits, which are simply rectangular in shape.

The location of these eastern pits near the upper temple suggests that they were connected with the living king whose activities are recorded in the reliefs of the upper temple, which perhaps to some degree corresponded to his palace as the living or "Horus" ruler. As to the two southern boat pits, they could not have been for funerary boats for the following reasons:

1. Traces of sawdust were found by the pits which indicates the boats were constructed next to the pyramids;
2. The oars of the boat are too heavy to be used in navigating the boat;
3. There is no scientific evidence that the boat had been used in the water; and
4. A set of funerary boats would require that one have a sail for traveling north to south and the other would have oars for traveling south to north. Neither of the boats has a sail. This fact was corroborated by the photos taken by the National Geographic of the second boat pit. They did not show any evidence of a sail in the second pit. Instead, perhaps the boats are solar boats used by Khufu as the sun god Ra. In one he would travel across the day sky, and in the other across the night sky.

The fifth boat pit by the causeway could have been connected with Hathor because the pyramid complex was dedicated to the triad, Ra the sun god; Horus (the king); and the goddess Hathor who represents both the wife of the living king and the mother of his successor. This triad is the one worshiped in the pyramid complex.[92]

III. *THE TOPOGRAPHICAL MAP AND MODERN ARCHAEOLOGY AT GIZA*

1. The Topographical Map

Petrie, in his original publication, explained that the Prussian expedition under Lepsius had produced the best topographical map of Giza to date. That map was the basis for his work at Giza between 1880 and 1881.

Recently, Mark Lehner, the Director of the Giza Plateau Mapping Project began a much needed update of the topographical recording of Giza. The primary objective of the work in its first two seasons was the completion of a survey control network for the production of a 1:500 map in several sheets of the entire site. The next step calls for aerial stereo-photography for which flight lines and ground targets must be surveyed.[93] Lehner's work at Giza produced a detailed working model of the layout of the Giza Plateau in the 4th Dynasty (ca. 2650 B.C.) during the construction of the Khufu pyramid. The model has been expanded to include the pyramid building projects of Khafra and Menkura and the final stages in the development of the Giza Necropolis. The Center of Remote Sensing of the National Academy of Scientific Research in Cairo has already begun aerial stereo-photography for inclusion in the mapping project.

2. Modern Archaeology at Giza

The royal cemetery of the Giza Plateau is one of the best excavated, documented and studied of the royal pyramid sites.

Egyptology, which began in the 19th century was focused mainly on the pyramids themselves and on the Sphinx. The major parts of the necropolis were cleared by several expeditions working mostly in the first part of the present century. The western cemetery connected with the Great Pyramid was excavated by Junker (1929-55), Reisner (1942), Fisher (1924), Steindorf, Schiaparelli (whose concession for the northern part of the field was transferred to Reisner in 1905), and later, Abu Bakr.[9495] The eastern cemetery was excavated mostly by Reisner. And, many of the decorated tombs he recorded have been published recently by Simpson and others on behalf of the Boston Museum of Fine Arts.[96] The Egyptian Service des Antiquities cleared some of the rock-cut tombs.[97]

The Sphinx was excavated by Caviglio in 1816, Mariette in 1853,[98] Maspero in 1889 and finally by Baraize from 1923 until 1936.[99] Baraize cleared most of the Sphinx temple, but his work was not published. Hassan devoted a volume to the Sphinx after he continued the excavations to the north and east. Hassan also excavated the major part of the central field cemeteries to the east-southeast of the Khafra pyramid and ended his work at Giza by clearing the area at the eastern base of the Great Pyramid.[100]

The temples of the Khafra pyramid were cleared by Mariette in 1853 and Holscher in 1912.[101] Those of Menkaura's pyramids were excavated by Reisner in 1931.[102]

Excavations also were carried out at the eastern edge of the Giza Plateau and near the northeast corner of the Sphinx by the author in cooperation with Mark Lehner in 1978 and 1980.[103] In 1978 the work involved two sites. First, there was an excavation northeast of the Sphinx and across the modern road, at the foot of the cliff which terminated the eastern cemetery field of Khufu.[104] The site is marked by a high mound in front of the modern village of Nazlet-el-Samman. The second site investigated in 1978 was at the northeast corner of the Sphinx,in front of the Amenhotep II temple. This mudbrick temple was built in the sanctuary of the Sphinx and became a focus for the pilgrims.

In 1980, we excavated 30 m. in front of the Sphinx Temple, and in front of the sound and light theater.

In the "south field" were the archaic tombs excavated by Covington and Petrie, who also excavated a poorly known Old Kingdom cemetery in the east-facing ridge of this area. The Saite and later tombs in the far south of the southern field were excavated by Petrie and by Abu Bakr for the Service des Antiquities.[105]

Saleh excavated a site about 73 m. south of the cemetery of Menkaura, which he called an industrial community.[106] Other evidence of ancient settlements was found in 1971-75 east of Menkaura's pyramid; just behind the sandy plain and the main wadi, not far from the large boundary wall lying 200 m. south of the Sphinx.[107] Finally, Goyon and Messiha did sondage for the causeway and the valley temple of Khufu in the narrow streets of Nazlet el-Samaan, the town below the edge of the Giza Plateau.[108]

PART TWO

PETRIE'S WORK AT THE PYRAMID COMPLEX OF KHAFRA

Petrie's work at the pyramid complex of Khafra focused on:

I. The Pyramid;
II. The Large Peribolus Wall Around the Northwest and South Sides of the Pyramid, i.e. The Temenos Walls;
III. Petrie's "Workmen's Barracks";
IV. The Granite Temple or the Sphinx Temple, i.e. The Valley Temple; and,
V. The Sphinx.

I. THE PYRAMID

Subsequent to Petrie's publication, the most important research on the second pyramid complex are the excavations of Holscher and the survey of Maragioglio and Rinaldi.[109] The actual restoration and conservation of the burial chamber and the interior passages of the pyramid of Khafra was conducted by the Department of Antiquities' Giza Inpsectorate between 1985 and 1987. The restoration and conservation efforts were similar to the ones discussed above for Khufu. They included:

1. Crystallized salts which covered the walls and the roof of the burial chamber and the inner corridors were first removed by mechanical cleaning, then by using a wet poultice. The poultice was made from paper-paste and applied in three stages. Ten days were allowed to elapse between each application.

2. Soot (black spots) was removed by a solution composed of alcohol and water (1:1 in equal parts). Afterwards, a watered down ammonia solution was used followed by a rinsing with distilled water.

3. The wall cracks and slight detachments were corrected by using an adhesive of linen, sand and araldit. Cracks were also treated by using a special mortar compound of three parts sand, two parts lime powder and one part kaolin.

4. Deep cracks were grouted and each block reconnected by using stainless steel bars.

5. The walls and roof of the burial chamber were cleaned with water and neutral soaps. Then they were rinsed with distilled water.

6. The greasy material, and soot (black spots) on the granite sarcophagus were cleaned first by using mechanical methods, then by using alcohol, followed by an ammonia and water solution in equal parts, and a distilled water final rinse.

As with Khufu's pyramid, a closed circuit television monitoring system was installed in Khafra's pyramid in order to control visitor circulation. Highly sensitive television cameras were fixed inside the interior passages and chambers. The lighting system inside the second pyramid was completely replaced by the installation of indirect low heat sodium lamps. These

new sodium lamps were consciously arranged to provide the maximum incandescence.

II. *THE LARGE PERIBOLUS WALL AROUND THE NORTHWEST AND SOUTH SIDES OF THE PYRAMID, i.e. THE TEMENOS WALLS*

The pyramid of Khafra is surrounded by two enclosure walls separated by a 10 m. high terrace on the northeast. The inner wall lies about 10.1 m. from the east, north, and south faces and 10.47 m. from the west face of the pyramid. Its thickness varies from 3.25 m. to 3.60 m.

Remains of the outer enclosure temenos wall have been found along the north, south and west sides of the pyramid. It is built on the higher original ground of the Plateau, except in the southeast corner, where large blocks of limestone form its foundation.[110] The temenos wall runs parallel to the inner wall of the pyramid court. Its length from east to west (on the south side) is 338 m., and it lies at a distance of 128.1 m. from the base of the pyramid, or 69.42 m. from the inner wall. The outer temenos wall on the west and south ranges from 7.60 m. to 8.75 m. in thickness.

The north segment of outer enclosure wall consists of large, undressed blocks, bounding the south side of the western cemetery of Khufu's Pyramid. According to Petrie, the thickness of the north wall varies from 7.60 m. to 8.75 m. On top of this a thinner wall was built but few traces of this now remain. Petrie found the south face of the outer enclosure wall covered by rubble in which perpendicular retaining walls had been built. These walls are the rubble from a great construction embankment left in place by the ancient builders. The modern along the north side of the Khufu pyramid road now runs over the top of this embankment.[111]

The west portion of the outer enclosure wall is slightly thinner than the north wall, and stood about 2 m. high when Petrie discovered it. It is built of small blocks of limestone and rubble; the outer face is very smooth. Of the south wall, Petrie found only a 152 m. long stump. Maragioglio and Rinaldi think that this wall was left unfinished by Khafra, as it was later connected to the temenos wall of Menkaura's complex by an elbow.[112]

The floor of the courtyard that spans the area between the pyramid and the inner temenos wall is made like the Khufu pavement of white limestone cut in slabs of different shapes and sizes and laid directly onto the rock of the Plateau. A long ramp led from the northwest corner of the corridor surrounding the open court to the terrace on which the pyramid stood. A series of round holes about 40 cm. in diameter were cut into the rock around the pyramid, about 4.50 m. from its base, and spaced about 5 m. apart. This type of hole is also found in Khufu's complex, and is thought in each case to be connected with the laying out and leveling of the pyramid.[113]

Edwards believes that the position of the ramp from the northeast corner leading to the terrace of the pyramid indicates that people who were not allowed to enter the upper temple were permitted access to the pyramid

enclosure. He adds that this stone ramp sealed the pyramid entrance after the funeral of the king, since the inner wall would have ruled out any other means of approach.[114] The subsidiary pyramid and a serdab lie on the south between the two enclosure walls of the pyramid.[115]

III. *PETRIE'S "WORKMEN'S BARRACKS"*

During his 1880–1881 excavation seasons at the Giza Plateau, Sir Flinders Petrie uncovered a series of structures located west of the outer enclosure wall of the pyramid of Khafra. He interpreted the groups of rooms which he found as a city for the workers who labored in the pyramid complex.

Maragioglio and Rinaldi did further analysis of this structure and found that the structures consisted of long narrow rooms, backing onto a square courtyard. The walls are of rough blocks of limestone cased with mud plaster, and measure, on an average 1.30 m. thick. The roofs were of mudbrick, mats, beams, and argillaceous mud, and the floors were plastered with mud.[116]

Petrie only excavated a small part of the galleries. He estimated that there were about 91 rooms, housing 400 men, at that location. Of that number, 73 rooms run east-west and measured about 26.90 m. long, 3.17 m. wide, and 2.13 m. high. The other 18 rooms run north-south and were larger than those in the first group. The entrance to the rooms measure from 2.28 m. to 2.54 m. wide. Maragioglio and Rinaldi believed each room represented an entire house or building. The rooms end to the east in wide limestone columns.[117]

Holscher, working with the data collected by Petrie, calculated that there should have been 111 rooms, housing around 5,500 men.[118]

Petrie dated these structures to the reign of Khafra mainly on the strength of their orientation relative to his pyramid. Also supporting this date is the fact that although this part of the site is removed from the actual construction area, the construction techniques of the rooms are similar to the basic wall style of the temenos wall surrounding Khafre's pyramid.[119]

Several types of artifacts were found in the area of these rooms. Most prevalent are Old Kingdom pottery sherds, large pieces of quartzite, and damaged blocks of granite, some weighing up to 30 tons. Also found were fragments of Old Kingdom statues of alabaster and diorite especially in the 4th Dynasty style. One fragment of a lifesize statue is mentioned as being an unusual type, but no further details were given.

Petrie, in his analysis of the function of these rooms, dismisses the idea that these structures were built to house priests. He cites the poor quality of the materials and construction used, the large size of the complex, and the location of the site, to rule out this possibility. Petrie further wrote that they could not be storerooms, as they were too far away from the pyramid and too large for that purpose. He concluded that the rooms repre-

sent workmen's barracks, and suggests that they housed the men who built Khafra's pyramid and complex.

Most Egyptologists have simply accepted this explanation. However, Maragioglio and Rinaldi suggest that these rooms could have been used for storage of objects used in the maintenance of Khafra's cult in his upper and lower temples. They compare these structures to the Middle Kingdom houses of Kahun, which is a known pyramid city. This grouping is adjacent to the Middle Kingdom pyramid at Lahun. Maragioglio and Rinaldi conclude that there is little similarity between the two sites. In addition, they do not see the size and number of these rooms as proof against their identification as storerooms, comparing these structures with cult storerooms dating from the New Kingdom in the Ramesseum.[120]

Lehner discusses an alternative hypotheses to Petrie and Maragioglio and Rinaldi. He suggests that the structures were most likely cult storerooms. He points out the fact that no settlement debris, such as ash, bones, charcoal and/or fiber had been found in the area as proof of its use as a workmen's village.[121] However, it is important to note that very little of the site has been uncovered and that the excavations carried out were not systematic, thus settlement debris may have been overlooked or may remain to be discovered.

A final theory suggests that these rooms could have been used to store food for the people working in the pyramid complex.[122] That these rooms were used for the storage of cult objects and food seems appropriate. The construction of the houses, with mud-plastered floors, vaulted roofs, and no windows, is more appropriate for storerooms than residences. The discovery of diorite and alabaster statue fragments supports the thesis that objects for the king's cult were stored here, as such statuary was needed in this cult. Some of the rooms might even have been workshops where the statuary was made. According to textual evidence from the time of Khafra,[123] a great deal of food was necessary to sustain the building crews in the higher desert. The vaulted ceilings of the rooms would have aided preservation of the food. This location would also have been chosen for reasons of security and ease of administration. Again, the lack of systematic excavation could account for the absence of food debris.

However, it is probable that the structure labeled "workmen's barracks" by Petrie actually represents a part of the workshop of Khafra. Lehner states that, "The kind of stones with which the walls are constructed and the fact that to the east and west of the galleries there is only the natural desert surface showing, may suggest that they were built very early in the Khafra project."[124]

Therefore, I propose that this area was the workshop of Khafra and that it was built early in Khafra's reign. I believe that it was established to produce tools and artifacts for the workmen and then used to produce cult objects and food to maintain the cult of the deceased king. A clear definition of the rooms and their purpose remains to be determined by further scientific research.

The artifacts of alabaster, diorite, and quartzite found in the rooms are typically materials for statuary. And, these were the stone remnants found in Khafra's lower temple, which suggests that the rooms can be identified with Khafra's workshop. There are no other remains that could be connected with Khafra's workshop around his pyramid. It is possible that these structures were placed west of Khafra's pyramid for topographical reasons.

In January and February of 1989, an excavation was begun in the area of the "storerooms" under the direction of Mark Lehner and the author.

On the basis of the lines of stone rubble showing on the surface from the deterioration of the walls, we could count 73 galleries attached to the west wall. We wanted an idea of these galleries at their entrance, center and back end. It was impossible to excavate all the galleries. It was agreed that a thorough investigation of only one or two rooms would not give an idea of the whole area. We chose to excavate 4 m. × 5 m. squares, selected randomly. The selection was done to assure that some of the squares would give an exposure of the entrances, some of the center, and some of the back interiors. So far we have excavated 10 of these squares, i.e. two at the entrances, two in the middle, two at the back end, one on the outside of the back wall and three at places where the patterning of the walls looked different from the usual gallery arrangement.

The tops of the walls of the galleries were found close to or at the surface, as already indicated by the patterns of stones showing on the surface. The interiors of these galleries are filled with clean mud-blown sand. This sand blew in over a long period as indicated by lines of dry soil—very thin in the sand. Many snail shells were found in the sand. This means that at one time plants upon which snails live, eg. camel thorn, grew over the area. The floors of the galleries are, for the most part clean, made of compacted mud. It looks as though they were cleaned out in ancient times. However, bits of material remain.

We have found a few pieces of malachite ore, and feldspar. There are also a great number of quartzite, diorite, basalt, and granite fragments in these areas. Tiny bits of copper have been recovered from the floors. The legs of a small royal limestone statute and two small broken figurines of the king and a lion have been found, as well as several small flint tools. All this seems to indicate that the galleries were for storing tools, products and materials used in the production of crafts. Perhaps the 80 m. of open ground in front of the galleries was where the craft work took place. However, sample analysis has to be done for this excavation to determine more information about the site.

IV. *THE GRANITE TEMPLE OR THE SPHINX TEMPLE i.e. THE VALLEY OR LOWER TEMPLE*

The granite temple was discovered in 1853 by Auguste Mariette and then described in detail by Petrie, who believed it was the temple of the

Sphinx. The temple was re-excavated completely by Holscher in 1909–1910 and identified as the lower or the valley temple of Khafra at this time.[125]

The temple stands to a height of 12.5–13.0 m. It was built of local limestone and cased with granite. In the interior are huge pillars of red granite and floors of alabaster.[126] There is a drop in the rock of the Giza Plateau just before the western entrance to the temple. Thus, about one half of the height of the western facade was built against the vertical rock face. It has been suggested that there was a granite-paved path, 75 cm. wide, between the western facade and the rock face, but there is neither evidence nor space for such a path.

The temple is connected directly with the eastern end of the causeway. The corridor of the causeway ends at the western entrance to the temple which is located in the northern corner of its western wall. A rock-cut passage along its northern side separates the lower temple from the Sphinx temple.

The valley temple faces east, and there may have been a canal oriented north-south running in front of it. To the east of the temple is an 8.40 m. wide platform which was originally paved with slabs of limestone. Two doorways built of local limestone cased with polished red granite were placed symmetrically in the east wall. These doorways were approached by short ramps leading from two paved roads. The function of the roads is not known, but it has been suggested that they were connected with the harbor or canal that may have been in front of the temple. The roads were used during the construction of the pyramid complex and then later during the funeral or for other religious purposes.

In the center of the valley temple's eastern face, Holscher found a platform with a square hole in each corner which he interpreted as the base of a shrine or kiosk with four pillars. Holscher reconstructed the shrine with two eastern doors and the inscription of the names and titles of Khafra around the doors. He postulates a raised platform in front of the temple on which offerings to the king might have been placed during certain feasts. It is likely that a statue of Khafra was placed inside this shrine.[127]

Large granite blocks remain in the temple facade before the eastern entrances. Beside the north door was the inscription "Beloved of Bastet, Giving Life." This represents the first mention of this goddess in the funerary complexes of Giza. Beside the south door was inscribed "Beloved of Hathor." The name of the latter goddess occurs often in the titles of women buried in the Giza Plateau from the time of Khufu, through the end of the Old Kingdom. The titulary of Khafra may have been inscribed around these doorways. This would show that he was not considered a god but rather as the king "Horus." There are shallow trenches on each side of each entrance. These trenches are in the form of semicircles on the north and straight on the other three sides of the entrance. Holscher suggests that these trenches mark the placement of statues of sphinxes which would have flanked the entrances.[128]

Holscher thought that there should be a wall surrounding the two

sphinxes and the kiosk, but could find no traces of such a structure. A wall, however, would have prevented access to those people unaffiliated with the activities of the temple, but who would have come to make offerings for the cult of the king. It is more likely that the temple facade, with the kiosk and sphinxes, was meant to be unobstructed to impress those who came to pay tribute to their deceased ruler. At the southwest end of the temple facade is a wash stand which was probably connected with the purification tent or the ceremonies carried out in the temple.[129] The two eastern entrances are generally agreed to represent the two lands of Upper and Lower Egypt. This suggestion is supported by the names of the goddesses written above the doorways.

As mentioned above, an inscription by the north door contains the name of Bastet, who was associated with a site in the Delta called Tel Basta in the Old Kingdom. This then should be the door for Lower Egypt. The name of the goddess Hathor, the principal goddess of Denderah in Upper Egypt from the Old Kingdom onwards, is found by the southern entrance, indicating that this is the door for Upper Egypt. One might then reconstruct these statues of the king along the east facade, one by the north entrance in the Red Crown of Lower Egypt, one by the south entrance in the White Crown of Upper Egypt and one in the kiosk in the Double Crown, of the united Upper and Lower Egypt.[130]

There are also several interesting structures on the south side of the lower temple. First are the remains of a building surrounded on the west and south by blocks of local limestone. The building has a foundation of the same material topped by mud-brick walls. It appears to have been a storehouse. Since the blocks on the west side rest on the granite casing of the temple, it is probable that this building dates to a later period.

Holscher found traces of a masonry forepart on the south side of the valley temple about 2.20 m. wide which was directed to the south and apparently held a two leaf door which opened to the west. The function of this structure is not known, and it is of an uncertain date.

As mentioned above, an exit from the north end of the west wall of the valley temple connects directly with Khafra's causeway. No traces of a door were found between the causeway and the valley temple. In the west facade were found the holes for two gutters which would have served to drain rainwater from the roof.[131]

The Sphinx Temple

The sphinx temple north of the valley temple was excavated by Baraize and Hassan in 1935–1936. Its plan is completely different from the plans of the other Old Kingdom temples on the Giza Plateau.[132]

Ricke and Schott, who studied the function of the temple, believe that the eastern set of stepped recesses are for a ritual to the rising sun, and that the western recesses are for the setting sun. They think that the twenty-four pillars around the hall (six on each side) represent the twelve

hours of the day and the twelve hours of the night, and that the four pillars in front of the two innermost recesses represent the arms and legs of the goddess Nut. Ricke and Schott believe that the open court is connected with a solar cult or a temple of Ra. This open court is similar to the courts of the upper temple of Khufu and Khafra.[133]

The location of this temple in front of the Sphinx' paws and its anomalous layout suggests that it was not a temple dedicated to the funerary cult of one of the kings buried at Giza, but was instead built to house the cult connected with the Sphinx.

V. *THE SPHINX*

Maspero was the first to describe the Sphinx as a representation of Khafra with the body of a lion and suggested that it functioned as a guardian of the Giza Plateau.[134] Based on the inventory stela found in the temple of Isis attached to Khufu's northern subsidiary pyramid, GI-c, Brugsch dated the Sphinx to before the time of Khufu.[135] If this inscription is to be believed, the Isis temple, the Sphinx, and the Sphinx temple antedate Khufu. However, the stela is thought to date from the late period and since it is certain that the Isis temple was built long after the 4th Dynasty, it seems appropriate to regard this text with caution. Some believe that it is a copy of an earlier text, although it is not explicitly labeled as such.

Stadelmann concluded that the Sphinx was carved in the time of Khufu to represent that king as a guardian figure. He argues that the Sphinx was not carved from standing rock. Stadelmann believes that the plan of the Sphinx goes back to Khufu's time. He states that the Sphinx is not a cult object of the Sphinx temple and does not lie on its axis. Furthermore, he adds that the Sphinx as a form of the sun god is known only from the New Kingdom and its name Hor-em-akhet "Horus in the Horizon" is used alone only in that period.

In supporting his dating of the Sphinx, Stadelmann suggests that the Sphinx temple was built by Khufu. He does not believe that it was built by Khafra, as its building style and technique differ from those used in Khafra's valley temple. He believes that the Valley temple was built on an axis parallel to the preexisting sphinx temple.[136]

As mentioned previously, Stadelmann thinks that Khufu may have considered himself the incarnation of Ra. Therefore, he argues that Khufu built this sun temple on the eastern border of his pyramid site, where it could be identified as the place where the sun rose and set. Thus, the Sphinx would be the guardian of the Horizon of Khufu.

Although the evidence discussed above supports the hypothesis that Khufu could represent Ra, Stadelmann's arguments for dating the Sphinx and the Sphinx temple to the time of Khufu are not convincing. Most scholars agree to date the Sphinx to the time of Khafra, based on its location near and the similarity of its temple to Khafra's valley temple.

Hassan cites the existence of a drainage trench running down the northern side of the causeway leading from the valley temple to the upper temple, which appears to divide Khufu's pyramid complex from that of Khafra's, as proof that the Sphinx was carved after the causeway of Khafra.[137] More evidence showing that the Sphinx should be dated to Khafra is cited by Lehner. He states that: ". . . the Khafra causeway is founded upon a bridge of bedrock separating this quarry from the quarry in the west part of the central field. It seems unlikely that Khufu would have reserved this rock for his successor's causeway, and so the more northerly quarry may have been exploited by Khafra."[138]

Fakhry points to similarities between the face of the Sphinx and the faces of statues of Khafra.[139] Also corroborating the dating of the Sphinx to the time of Khafra is the Old Kingdom quarry in which it stands, and the one most likely used by Khafra. The quarry would not have been used by Khufu since he used the quarry located north of the Great Pyramid and east of Khafra's pyramid. The existence of the tomb of Kahmerernebti I, one of Khafra's queens, proves that the quarry was used by the end of Khafra's reign; therefore, Khafra is the most likely king to have used it.

PART THREE

THE PYRAMID COMPLEX OF MENKAURA

The pyramid complex of Menkaura differs from the complexes of Khufu and Khafra in many ways. It was not finished during the reign of Menkaura, but was instead completed by his son and successor, Shepseskaf. Other architectural additions were made during the 5th and 6th Dynasties. And, intact artifacts from various periods were found in the upper and lower temples and the chapels of the subsidiary pyramids.

Petrie discussed the various components of the Menkaura pyramid complex, such as the pyramid, the upper temple and subsidiary pyramids. Vyse conducted excavations in the upper temple in 1837 and Reisner began his systematic excavations in the area of the third pyramid in 1906.[140]

The lower temple of Menkaura lies southwest of Khafra's lower temple, near the modern cemetery for the village of Nazlet el-Samman. It was completely covered by sand until 1908, when it was excavated by Reisner. The temple is well preserved and its development over the course of the Old Kingdom can be traced. It appears that, as in the upper temple, the foundations and several courses of some of the walls of the lower temple, were laid in limestone by Menkaura. The temple was then finished in mud-brick by Shepseskaf according to Menkaura's original plan. At some point, apparently the end of the 5th Dynasty, the western part of the temple, which was completely of mud-brick, was destroyed by a flood. A new temple was built above the ruins of the old and it is thought that this occurred at the beginning of the 6th Dynasty. The Menkaura cult was maintained in the temple through the 6th Dynasty reign of Pepi II.[141]

There are other important structures found around the pyramid complex of Menkaura, such as:

I. The Lower Temple Settlement
II. The Ante-Temple, and
III. The Purification Tent and Other Structures.

I. THE LOWER TEMPLE SETTLEMENT

The lower temple settlement consist of Old Kingdom houses found in the central court and in the area just east of Menkaura's lower temple. These houses were built of mud brick and some of the rooms had stone thresholds and wooden roofs. The decree of Pepi II, found in the vestibule of the ante-temple, indicates that these houses belonged to the pyramid city of Menkaura.

Reisner believes that the city inside the temple was first built in the time of Shepseskaf and then occupied by priests throughout the remainder of the Old Kingdom.[142]

II. *THE ANTE-TEMPLE*

The area of the so-called ante-temple which adjoins the east side of the lower temple was excavated in part by Hassan and in part by Reisner.

Reisner excavated about 7.5 m. to the south of the lower temple and found some houses that he assigned to the pyramid city of the lower temple. Hassan excavated about 10 m. on the north side of this area and found a small temple that he labeled the valley temple of Queen Khentkawes.

The structure uncovered by Hassan is built against Menkaura's lower temple. It is entered from the north and consists of a square room with four pillars and several odd shaped chambers.[143]

It is now generally accepted that this area has no connection to Khentkawes, but instead forms an ante-temple to the lower temple of Menkaura, probably of 5th or 6th Dynasty date. The artifacts found inside support this identification, as they are very similar to the objects found inside the lower temple. The connection is further strengthened by the existence of the paved path leading from the eastern entrance of the lower temple to the southern entrance of the ante-temple and built after the 4th Dynasty.[144]

III. *THE PURIFICATION TENT AND OTHER STRUCTURES*

An unusual structure is located by the northeast corner of Menkaura's lower temple. It was labeled the purification tent by Hassan. This structure is made of mudbrick. It is rectangular in form and measures about 6.05 m. east to west and 3.10 m. north to south. There is a platform of mudbrick against the middle of the south wall and a small bench lies beside this platform. A drain was cut into the rock of the floor of the so-called purification tent. This runs for about 7.20 m. and connects with the basin north of the building. The purification tent was covered with limestone slabs.[145] The second structure found in the area is a large rectangular basin which is connected to the purification tent by the aforementioned drain. Hassan also indicated that there was a wall located west of the platform of the lower temple.

About 73 m. south of the causeway of Menkaura, Saleh discovered a very interesting structure that is not paralleled in any other Old Kingdom pyramid complex. This construction consists of a long, narrow wall foundation in the shape of a reversed "L" and a second, shorter foundation northwest of the first. The two foundations were built of stone rubble mixed with mortar. Saleh labels these "foundation embankments" and suggests that they were part of ramps used to transport blocks to building sites.[146]

The pottery found in the area dates the "foundation embankments" to the Old Kingdom. This dating is supported by similar embankments found near Khufu's pyramid as well as blocks of granite and alabaster found in the area, which are typical Old Kingdom materials.

It seems most likely that the foundation embankments are associated with Menkaura's cult. This is indicated by its proximity to Menkaura's causeway, and the construction techniques used in the building, including the thickness of the wall and the size of the bricks, which parallel the techniques used in the pyramid city of Menkaura.

Conclusion

As can be gathered from this preface to the reprinting of Petrie's *The Pyramids and Temples of Gizeh*, Egyptology and for that matter, archaeology, are evolving fields of work. New discoveries cause rethinking of previous conclusions. But all elements work together for the development of a clearer picture of the history of mankind. Some contributions, however, are seminal. . . Such as the contributions of Sir Williams Matthew Flinders Petrie.

NOTES

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141. For more details of the temple plan, see Reisner, *Mycerinus*, p. 34 ff.; Maragioglio and Rinaldi, *L'Architettura*, VI.

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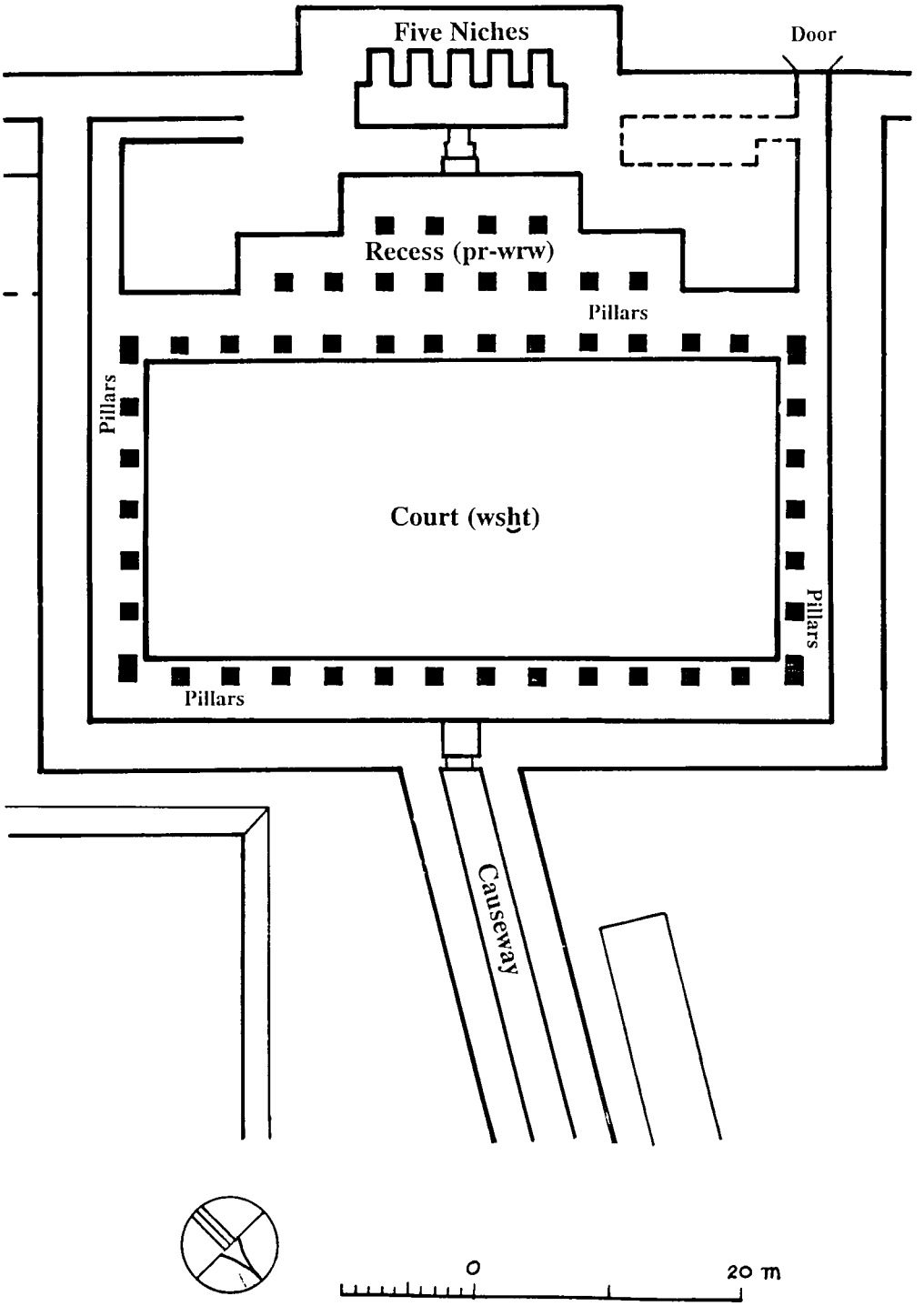
an Altar and Two Stela



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