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# Architecture Of The Great Pyramid Of Giza

## Concept and construction

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### Abstract

Egyptian culture of the old Kingdom was locally and regionally simple and efficient; belief was in the sky and humanism was regulated by Ma'at as the key concept in Egyptian mentality. IUNU was the capital of the black land KEMET where located "IUNU UNIVERSITY". Physics were well studied;  $\pi$  was already known; the right angle triangle of members 3, 4, and 5 with the 53° angle was in use. Supremacy was integrated on earth by multiple interpretations in architecture. The great pyramid of Giza was and still the best magnificent structure ever built on earth without having contemporary science's final word been said. Massive lime stone blocks are now arranged there in a huge massive number of about two and half million pieces; their weight could reach 6.5 million tons.

Conceptually there was a strong belief that symbolism connects hot spots on the Egyptian soil as it represented the known world, as well as the main stars were connected in multiple constellations on the dome of the observed sky. Pyramids of Giza plateau, Saqqara plateau, and Abusir plateau were all examples of that concept. Other pyramids of Iunu era were also related to the same concept.

Structurally the Giza axis coincided on the Giza plateau. Giza plateau was a part of the Moqattam plateau during the Eocene formation. Pyramids on the worked out surface of the plateau were built with the local lime stone. Pyramids' blocks were extracted, shaped and transported to its definite place within the precinct of the plateau. Chiseled pieces of stone - as waste from shaping blocks - were thrown out on the northern edge of the plateau.

Constructional perception of what and why the Khufu pyramid took that shape shows some facts; two hundred courses composed the total existed mass where each group of courses composed a layer. Each layer started with thicker course and ended in thinner ones. Higher layers got lesser courses. So far one should start thinking now why there were layers; why thicker and thinner courses existed.

In the mean time as mortar was not in use by that time, pyramids -as in Saqqara- were formed in inclined walls, as shown in the adjacent photo. Inclined walls also must have formed the whole structure of Khufu pyramid.

### Keywords

Pyramid; Old Kingdom; Egypt; Khufu; Iunu; Giza Plateau; Constallations.

## 1. Forward

Egyptian culture of the old Kingdom was locally and regionally simple and efficient; had powerful software and hardware of the time, belief was in the sky, humanism was regulated by ethical values, controlled by Ma'at as the key concept in Egyptian mentality, and supremacy was integrated on earth with the interpretation in architecture. Huge edifices with excellent aesthetical forms were well spread all over the great Nile's shores to show up the supremacy. IUNU was the capital of the black land KEMET and was its culture center; it meant the SUN CITY where located IUNU UNIVERSITY which hosted a great number of sages and scientists of the superior region of that time. By then knowledge by large was the aim of the country, Physics were well studied, the pi ( $\pi$ ) was already known, the right angle triangle of members 3, 4, and 5 with the 53° angle in use, stars in the sky were observed through the year, precise calendar of the year could be reached and many other vital items in life were established. All that magnificence of knowledge was manifested in architecture; the best known architect was HEM IUNU the responsible man for the great pyramid of Giza (fig.1).



fig.1, HEM IUNU was the super-visor for the Khufu pyramid.

Till the present moment in the field of Egyptology most of the secrets of our ancestors in building pyramids are not yet all uncovered; neither modern science did say its word with confirm. In Egypt there are really a great number of pyramids that exceeds one hundred ten pyramids, well spread over the stable soil on the western side of the Nile. They extend in existence from south until they end at Giza plateau in the north, but we did not yet include all the structural differences of our concerned thoughts in the scientific agenda. Knowing they are there, a quite good number of considerations from art historians and historians starting Herodotus from the fifth century B.C. and until nowadays, discussed how the building material was imported and layered in situ, but again, there is no any collective agreement on any idea from them.

Famous Herodotus explained in his book (is bHerodotus 2016) after his visit, that the so called "Cheops" pyramid was constructed in a period of twenty years. To do that, he explained that a ramp was designed to elevate the imported blocks of stones from the eastern side of the Nile to the pyramid base level. Then by using levers Egyptians could arrange these blocks in superimposed layers. And that is really a simple naive explanation. To drag one piece of stone that weighed around ten or twenty tons, as most of the blocks were, on a horizontal path, not to say inclined, needed between 400 or 600 individuals. If that host of people were lined up, they needed to be hypothetically ten in a row for forty rows or sixty rows which at least needed an area of six meters by forty or sixty meters, and that is illogic. What about two and half million pieces that also included forty five granite blocks of seventy tons each needed for roofing the king's room? If that hypothesis was to be considered, that means that the ramp they used must have been for four hundred meters long - or maybe one thousand meters as Herodotus said-with inclination one tenth to acquire a height of forty meters difference from the street level to the pyramid base. By that time the Nile bank was at the feet of the Sphinx and it was illogic to be used as a dock because its short distance. Even if the four hundred meters ramp was valid, it took six groups or twelve groups of pulling pieces up for one day. That means at least a period of five hundred years of hard labor needed to finish the mission of the three pyramids. If Herodotus considered the ramps discovered at the unfinished pyramid at Saqqara site was the prototype way to help constructing pyramids, one main criticism might be posed to the idea is that both sites and the building material of Giza and Saqqara are different (fig.2 and fig.3).



fig.2, part of the unfinished pyramid at Saqqara. Mud bricks as a building material were handy to transport on ramps then piled in inclined to 75° walls.

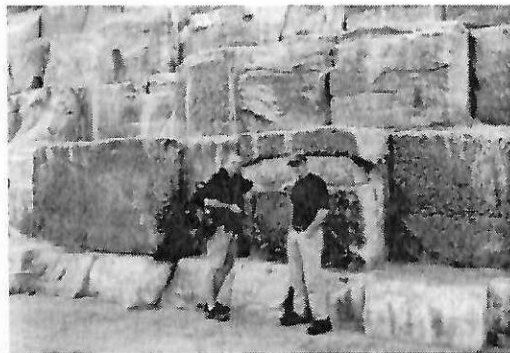


fig.3, stone courses of Khufu pyramid were of a material and scale clearly different from the unfinished pyramid.

One fact about Herodotus is that "*He is candid about acknowledging ignorance, and when versions differ he gives both*"(Herodotus 2016). We know that "facts" he mentioned in his books were after different talks and hearsays he listened were not from authorities, by the meanings we know now. So far we have to be critical to his

suggestions. But one fact should be considered as a start in the research, that is the stones that constitute the main body of the pyramid were of the local site (Ahmad Fakhry).

For a huge edifice as this, having around two and half million units of stones, structurally well spread and efficiently piled in layers to support their existence and resilience to time, an effective suitable and well thought of management must have been executed. Here another hypothesis might be considered.

Giza plateau is full of interesting morphological attractive spots to mention, and to be considered. To the west of the pyramid group, comparing to other surfaces on the plateau, there is a smooth convexity surface with a surface at level +110 m which gives the impression of being managed by man not by nature. Within the convexity there is a slight continuous depression that visually leads to unperceived valley between the second and the third pyramids to, with no doubt, drain the rain falls towards the Nile valley. Another interesting fact in the site is the presence of a 3° inclination ramp which was surely used to transport blocks from the high levels on the convexity to the lower sites; it is located to the north of the second pyramid measuring six meters wide by 200 meters long, with a longitudinal groove in the whole length. To the north of the plateau there is a huge amount of debris and remains of stone cutting and shaping procedures during the work, resulted in pieces that covered the whole northern edge of the plateau. Within the plateau there are five distinctive levels: apart from the convexity level +110m, the base of the greater pyramid is at +60 meters from sea level, the second is at +70 m, and the third pyramid is at +80m; the level at the feet of the Sphinx is at +20 where the waters of the Nile were overlooked by the Sphinx. So the puzzle that has to be looked after lies between these levels: +20, +60, +70, +80, and +110 meters. The most important fact to discuss, but not least to mention, is that the building processes in the Old Kingdome did not use any cementing material.

The Giza plateau was, in ancient times, geologically connected to the Moqattam hill on the other side of the Nile (Gamal Hemdan 1984) (fig.4), crossing the site of what is now the capital Cairo. The top level of the Moqattam hill is now +200 m. The top level of the Giza plateau must have acquired a level hypothetically close to the Moqattam surface level, i.e. +200 m, or so. The geological formation of both sites, the Giza plateau and the Moqattam hill, is composed of a "cretaceous nucleolus amid an iocenean formation" (Gamal Hemdan 1984), an action happened when "Abu-Rawash concave cap mass was transposed upside down in the late upper cretaceous, resulting in a solid cap well exposed on the surface". Amid that process, the site was formed as hill heights along with convexes of the vallies, keeping an "axis running from the eastern North to the western South". That axis almost coincides with the axis connecting the centers of gravity of the three pyramids. "The iocenean formation of the site is mainly composed of two strata, one higher and one lower. The lower stratum is identified as denser and more homogeneous." And so far, the Nile valley bisected, after the ancient changes, that formation, one on its east and the other on its west, forming two heights overlooking it. The elevations of both sites must have stayed the same, or at least relatively the same. Here starts the hypothesis of the site management and the system of constructing the pyramids on the plateau.

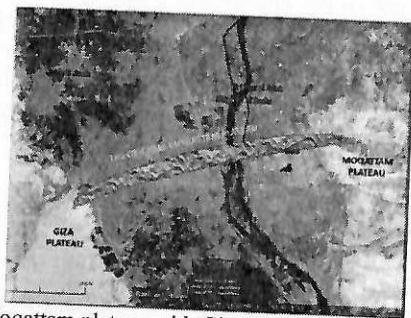


fig.4, the continuity of Moqattam plateau with Giza plateau that was before the historical split.

The fact now that the surface level of the area to the west of Khufu pyramid reaches +110m does not mean that it was the original height before its construction. Moreover as up mentioned, the other part of the formation- the Moqattam - on the east of the Nile is having an elevation +200m. Having this fact, and investigating the formation of the stones of the building material of the pyramid and the ground surface where pyramids were built, one could easily find that the former one was chosen from the upper stratum of iocenean site while the latter one is the original lower dense stratum of the iocenean which was used as a base for the structure.

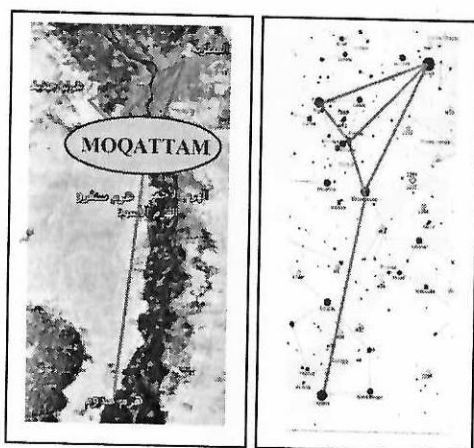


fig.5, Map including the Iunu pyramids as it was identically presenting the map of the five stars in the three constellations.

## 2- The Concept

In the IUNU era of KEMET, strong connections were considered between the visually perceived sky's components and the conceived world of power concentrated in Egypt. God was believed to be one; he dwelt unseen in the sky. He could grant a chosen woman a boy or a girl. The woman who got pregnant gave birth to a royal king or queen. Their status could have been considered sacred. As in philosophy every fact should have had the five questions to be answered: what, why, how, where, and when. By that philosophy every fact had a symbol representing it. Kingdoms had symbols over the kings' heads, the god was symbolized in the character "Khnom", Iunu was symbolized as star "Sirius" which also indicated, by its first yearly appearance in the east, the New Year and the beginning of the inundation, by that time, on the fifth of July each year. Kings' souls (Ka) were believed to leave after death to certain stars from which they return on the time of resurrection. Accordingly pyramids were symbolized and presented by stars in constellations in the sky, so maps of both these stars and the pyramids of the period are identical (fig.5)<sup>1</sup>. Iunu was presented as Sirius, Saqqara site as Betelgeuse, Khufu pyramid as Alnitak, Djedefre's as Rig, Khafre's as Ainilam, Menkaure's as Mintaka, Meydum's as Capella.

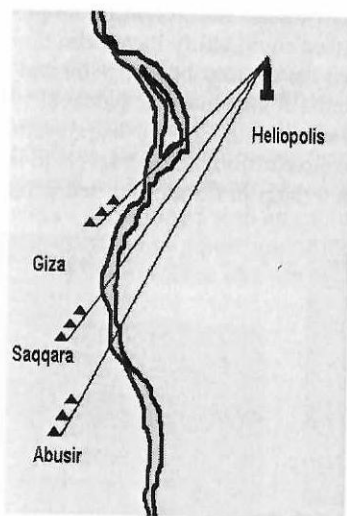


fig.6, three axes were visually connecting Capital Iunu to the sites of Giza, Saqqara, and Abusir.

In some idea (Giulio Magli 2013) there was a hypothesis telling about a visual connection between Iunu and some pyramids of the time, upon which the terms "Giza Axis", "Saqqara Axis", and "Abu Sir Axis" appeared in literature (fig.6), which the latter axis was considered the last towards south because of the existence of the citadel hill as it hindered the visual path; the visual connection of Meydum to Iunu was interrupted by the Moqattam hills (fig.7)<sup>2</sup>, though Meydum-Iunu axis took the right proportion as Capella-Sirius (fig.5). It could be concluded so far, that it was not the *visual axis* as much as it was the *value axis* that connected the pyramids to the stars.

<sup>1</sup> Author's drawing on Google and stars' maps.

<sup>2</sup> Author's drawing on Google map.



fig.7, the value axis connected pyramid Meydum to Capital Iunu.

After taking the decision of choosing sites for Snofru's pyramid- Meydum- to correspond to its related star, decision of choosing pyramids' sites for Khufu and his three successors reached the selection of the three stars in the Orion's belt. Accordingly and with respect to the proportions of distances among the corresponding stars the three pyramids' sites were chosen on Giza plateau, laid on the Giza axis that was also visually connected with Iunu.

**2.1 Structurally speaking**, the huge weight of each of the three pyramids should have had its line of stresses to safely go all the way from up down to the main crust of the earth. That is why the Giza Axis should have coincided with the axis of the geological convex formation of the Giza plateau (fig.8)<sup>3</sup>. Here one should say it was the perfect appropriate choice correlating structure, astronomy, geology, geography, and belief all together in the structure process. The group of the three pyramids' masses that could reach 13.5 million tons was distributed on the axis of the plateau (fig.9)<sup>4</sup>. In the mean time, to have the three pyramids visually well perceived from Iunu, their bases' levels acquired 10 meters difference from each other i.e. Khufu's was on +60m, Khafre's on +70 m, and Menkaure's on +80 m. By mentioning that, the sum of masses of the pyramids almost reached 13.5 million tons, it should be said that as this was the dynamic weight, the equivalent static weight in place prior to the construction was five or six times, i.e. 67.5 or 81 million tons. That was the net weight of the blocks but, if we consider the wasted rubble resulted from shaping the blocks that number could easily have been doubled i.e. around 160 million tons. If the plateau was considered as the area between the contour lines of + 60 and +80, then the area was 797692.5 square meters. That means that the height of that area could have reached level +160 meters or higher. So, that height was used as the building material in situ for the pyramid. Having that elevation of the original plateau, the logic tells the fact of transposing the huge masses extracted from the high levels to levels below, and ramps were used to roll blocks down. There is an example of such a ramp in front of the second pyramid which is a point to be discussed down.

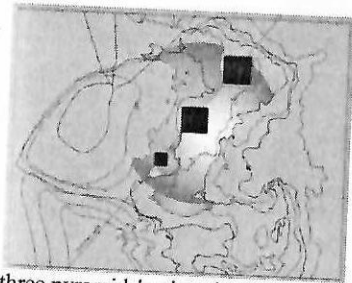


Fig.8, the three pyramids' axis coincided on both the Giza axis and the plateau axis.

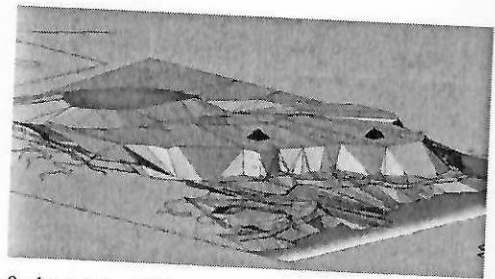


Fig.9, the original Giza plateau as imagined, while keeping the pyramids in place to show the static mass of the original geologic formation.

### 3- Site Management

As the upper Eocene stratum of the plateau was used to get blocks from; blocks were to be shaped into the suitable sizes for the building. The visible courses of the pyramid are of all different thicknesses that ranged between maximum 153 cm in the second course to minimum 46cm in the eighteenth course. Actually there is a repetitive

<sup>3</sup> Author's drawing.

<sup>4</sup> Author's drawing.

sequence of layers each of which is composed of some courses started with a thick course and ended in a thin one; there are eight of them (fig.10)<sup>5</sup>. That process was repeated until the course number 120 at a height of 90m from the base level. That means that the periodic procedure of layers firstly demanded easy way for supplying heavy blocks; when that way got tougher blocks got lesser in weight and thickness. If one considers the ramp in front of the second pyramid as the prototype for transporting blocks of stones from a high site to a lower site, then it is logic to suggest that there were eight successive ramps well distributed in site to transport blocks to the successive layers mentioned before. Courses over the height 120 m did not have the possibilities of getting heavy blocks that is why they were all around 0.5 m thickness. If that was the genius way of accumulating the mass courses of the pyramid, then comes to mind the second interesting point which is the bonding principle on which the huge mass got coherent.

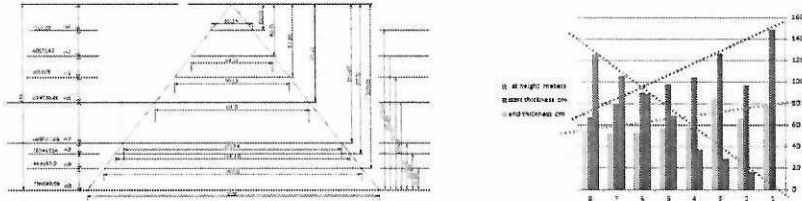


fig.10, eight layers in successive heights formed the mass of the pyramid. The blue dotted line indicates levels of layers, the brown indicates first courses' layers related, and the green indicates the last course of each layer. Dotted lines show the decrease in thicknesses as layers' courses get higher levels in the pyramid.

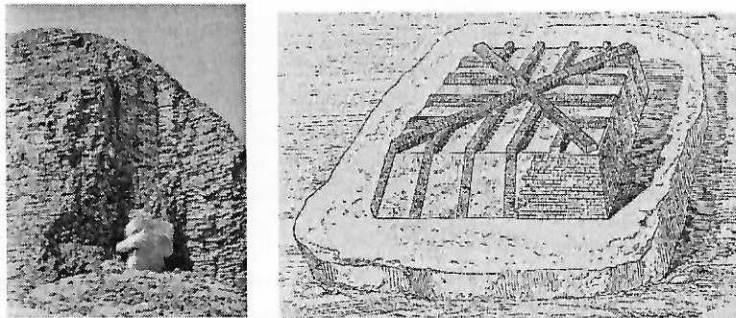


fig.12, Illahun pyramid drawing showing the main carcass with leaning walls in between.

#### 4- Structural Concept

Looking for the cementing material that was supposed to act as a bonding material between the blocks and the layers together, one can easily find nothing. Looking up for the way older pyramids used, it was found that the preceded Djoser's pyramid used a very effective and natural power that gave its shape the resilience that lasted now for 4647 years (fig.11). The genius method used was mainly to construct leaning walls in the four sides of the pyramid, the slope was directed to the center of the pyramid with an angle 75 degrees. There was no other material more than stone blocks except small pieces of stone to adjust the needed leveling of the courses. This was the system of supporting the structure all over the edifice. That was actually the system of the old Kingdome in the industry of construction.

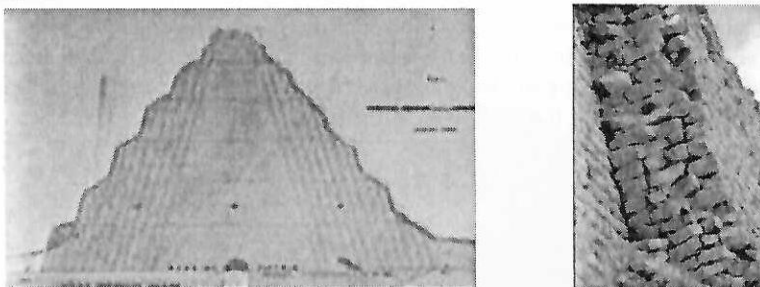


fig.11, leaning walls formed the whole structure of the Saqqara pyramid.

In an example in Illahun, although built in the twelfth dynasty by Sesostri II, the structure of its partly ruined corner shows the details of how the walls were designed. There is double wall acting as diagonal for the structure, then there are two flanking inclined masses of courses acting as the sides of the pyramid. As a key stone to prevent the structure from sliding out, blocks of heavy stones were planted around the core. A drawing (Georges Perrot

<sup>5</sup> Author's drawing.

1882) shows its design in axonometric presentation (fig.12). The structure here presents a carcass of main vertical walls in almost horizontal courses, and leaning walls flanking each of them on both sides, acting as support and filling.

Nowadays, leaning walls are used in retaining walls to support the horizontal thrust of the earth at the back. It could be on both sides of a highway. Leaning walls of loose bricks is actually the most practical, most safe and most stable condition under dynamic effects as vibrations or earthquakes. Leaning sheets of glass or leaning glass windows are best to be transported on trucks. Even leaning piles of bricks are of best case to keep until used (fig.13). All what is needed is to precisely keep inclination the same throughout the process of construction.

For a pyramid with two crossing walls and four leaning walls on the four sides the structure was held in place. Each block in each wall had its weight acting vertically, and since the block was inclined, the acting weight was to be analyzed into two components, one along the inclined plane and the second component acted perpendicular. By that fact each and every block consolidated the pyramid by its perpendicular force acted towards the center. Here we had a solid, fixed and stable structure that proved a positive resilience to all the negative natural environmental effects. In Saqqara pyramid the inclination of all the walls in the whole edifice was  $75^\circ$  which is supposed to be the same in Khufu. From this point research could proceed in discussing the Khufu Pyramid case.



fig.13, the way to keep blocks together safe in a dynamic environment is to have them on an inclined planes.

Hem Iunu the architect must have used all the experiences he acquired from the preceding pyramids. He had lots of privileges in his job; the unique convex site, the big masses of stones that could be easily handled, and moreover there was no more possibility for another pyramid to share with him the site. As the main concept of building was to have stone blocks leaning to the inside, the rock base of the pyramid must have acquired the same Principle (fig.14)<sup>6</sup>. It is suggested that the base was divided into four triangles slightly inclined towards the center.

Thinking of the management how that huge mass of loose heavy stone blocks characterized by superimposing more than two hundred courses laid in eight complexes layers was executed, bearing in mind the usage of ramps, morphology of the site should be clear imagined. Huge heavy blocks were extracted from the same site, Giza plateau. They were much heavier than those of any previous pyramid. Previous pyramids were designed on almost horizontal terrains that needed ramps to bring small blocks up; on the contrary the three pyramids of Giza were chosen on a super high already plateau which needed another means of transporting the blocks. The genius architect was to use the upper part of the plateau to build on the lower part using ramps to bring blocks down. Blocks of the higher cracked stratum were to take shape and be adjusted to be built on the same relatively height in the pyramid, and so did with each of the eight layers; the process to be explained next.

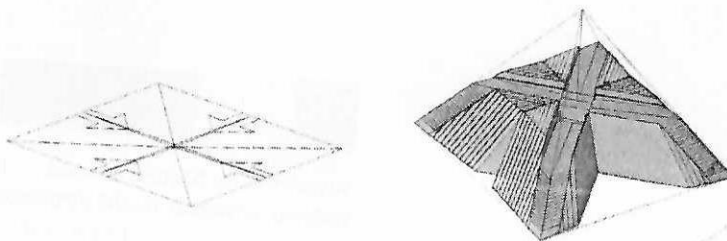


fig.14, Khufu pyramid structure composed of two crossing diagonal walls encountering eight leaning to them walls; its base was divided into four inclined planes.

<sup>6</sup> Author's drawing.



If considered the natural setting of the plateau as raised convex land, different levels must have been initiated to be eight levels corresponding to the eight layers of the pyramid; each of which to be connected with a sloping ramp to reach the south western corner of the pyramid on its related level. That corner was most probably the active corner because the other three corners were on the edge of the plateau. The concept (fig. 15)<sup>7</sup> behind that was to remove the upper part of the natural formation of the plateau, in the pyramid's site, and put it aside on the same level where it was extracted. On that site blocks were to be shaped and worked out to be ready to be sent back to its relative place in the structure. The procedure was to be repeated for each level till the lowest one.

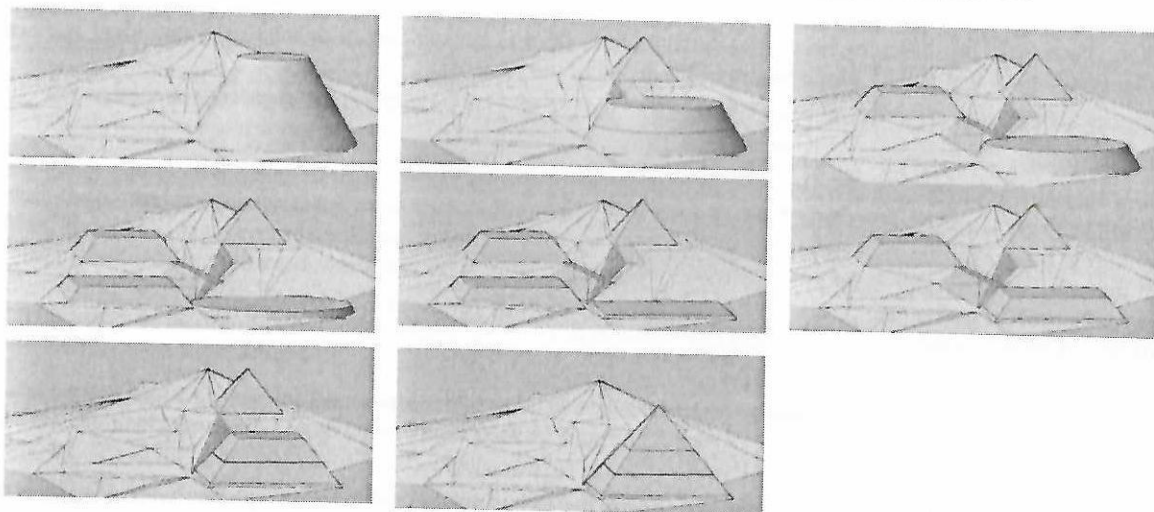


fig.15, steps in executing the concept used for the layer system in building the great pyramid of Giza.

Moving rough blocks of stones should have had ramps ready to move down from the natural site where they were cut to the working site, and then after they were already taken form in the working site they were to be rolled down the ready ramp to the pyramid in its relative place in the structure. The amount of work needed to accomplish that mission was lessening by getting higher. 30% of the pyramid volume was already acquired by the height 15 meters; 52% by 30 m.; 82% by 50 m.; 97% by 100 m., and only 3% of the total volume was embodied on the last 46 meters (M. Lehner). At level 50 meters, after almost finishing 80% of the volume, forty five red granite blocks each weighing around 70 tons were brought to be used for the composite ceiling of what is called "The King's Chamber". That massive amount of stones could not have been brought to place unless ramps were used to bring them down through the Ma'ady plateau and then to the Giza plateau then to the site. If preceding experiences in building pyramids were to be considered, this Khufu pyramid must have two diagonal crossing walls flanked by inclined to 75° walls (fig.16)<sup>8</sup>. As up mentioned, to have the principle of gravity working in bonding the stone blocks all over the building together, it is suggested that the rock base of the pyramid was divided into four triangles slightly inclined to the centre.

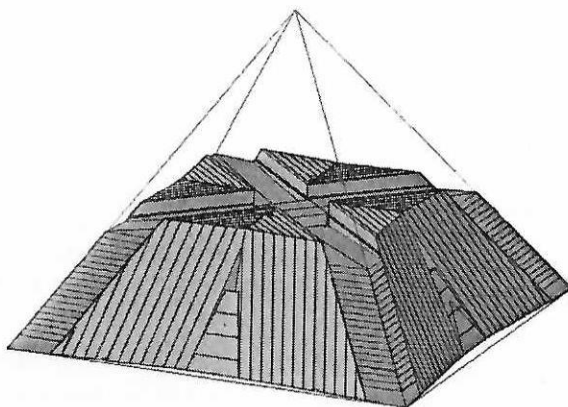


Fig. 16, drawing shows the pyramid under construction, as imagined by the author.

The blue color indicates the horizontal layers of the crossing diagonal walls. The grey color indicates the leaning walls at 75° on the crossing walls.

<sup>7</sup> Author's drawing.

<sup>8</sup> Author's drawing

That way might have kept the whole loose stone edifice compacted towards the center. The process needed the best accuracy in cutting stone, preserving the same thickness all the way for every course to maintain the overall shape as we see now. It might be worthy to mention that the highest plane on the top of the pyramid is composed of one even plane of well arranged blocks of stones of the same thickness, loaded by seven free blocks.

When it comes to the grand gallery design with its spacious space that measured almost eight meters and half in height and forty seven meters in length, the architect chose to design it in a middle vertical plane between the two opposite inclined walls of the northern facade (fig.17)<sup>9</sup>. That again was the best structural choice for the grand gallery, because of the diverging horizontal thrust on both sides as a result caused by the two symmetrical inclined walls. Function of that gallery might be out of the scope of the research.

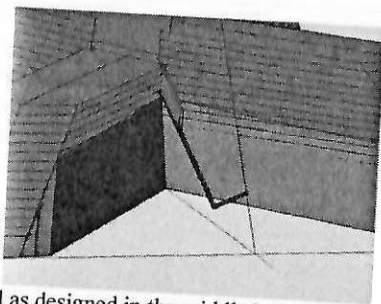


fig.17, the grand gallery in Khufu pyramid as designed in the middle between the two opposite inclined walls on both sides.

## 5- Conclusion

The three main environmental factors – the eco sphere, the techno sphere and the socio sphere - were dealt with in a complete harmony to execute one of the best wonders of the world, the Great pyramid of Giza. Ecological considerations such as geology, morphology, geography, and astrology as one third of the equation were balanced with the ultra techno sphere of the fourth dynasty, and all were controlled by the social beliefs MAAT and the behaviour of the Egyptian people. Gravity as one of the main Physics' laws was the main factor that kept the magnificent edifice in place and at that height all that elapsed time. No error work was the second factor in the building. The scientific basics were the appropriate infrastructure for the architectural aesthetics of the pyramid.

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<sup>9</sup> Author's drawing

# Tombs of the Valley of the Kings in Luxor Ecological Consideration

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## Abstract

By the eighteenth dynasty in the Egyptian Old History, funerary architecture was oriented towards a new direction in perceiving space and form, meaning and symbolizing, and pride and festivity.

As being a great city by that time, Luxor (Thebes) looked for a site that offered a similar dignified place as it was with the pyramid plateau in Giza, in the north, close to the previous Capital "IUNU". As much as the Giza plateau was worked out to receive the edifices on, the place in Thebes was chosen of highly qualified natural properties. The place was on the sacred western side of the capital of the kingdom, in a huge valley formed through the millions of years where its morphology could offer the dignity that we still feel it, the geological formation was much easier to work through, tombs architecture within it offered the possibilities to preserve the traditions and the bodies of the great kings safe.

The paper aims at declaring the environmental capabilities of the architecture form of tombs of the Kings Valley of the eighteenth and nineteenth dynasties of the Old Egypt History.

## Keywords

Old Egypt; Tombs; Kings' Valley; Religious Festivals; Eighteenth Dynasty; Nineteenth Dynasty; Geological Formation; Egyptian Art; Egyptian Beliefs; Architecture in Ancient Egypt.

## 1-THE BEGINNING IN HISTORY

"**Ta-ope**" or **tp** - meaning "head"- was the name of Thebes in the old history. It was also **Wase**, or **Wo'se** the main city of the fourth Upper Egyptian nome (province) of Wase.

The site shows how humanly valuable it was by knowing that the first evidence of the Paleolithic era in Africa – that lasted 500,000 years before known dynasties - was found there. In that glowing environment Thebes has been inhabited continuously for the last 250,000 years. It is known that high civilization to have existed from the 4th dynasty B.C onward as *the capital of "the earliest known empire in the history of mankind"*.

But late during the sixth dynasty and through 135 years (c. 2316-2181 B.C.) in the Old Kingdom the city was a minor trading post in Upper Egypt, which was controlled by local clans. In later time, Power was regained by the Theban rulers who reunified Egypt after they defeated the Herakleopolitans - who were governing the country from herakleopolis Magna<sup>1</sup> - and started to control the entire country. Thebes emerged by that time as the **capital city** of Egypt in 2035 B.C. and remained the royal city. The city began to grow more powerful under the leadership of powerful governors. Actually the high status of the city was achieved afterwards in the Middle Kingdom due to political and religious prominence. On the East Bank, beneath the modern city of Luxor, lie the remains of the ancient town that from about 1500 to 1000 BC was one of the most spectacular in Egypt, with a population of perhaps 50,000. Thebes had earned a reputation as one of the ancient world's greatest cities. By that time Memphis, at the apex of the Nile Delta, served as the headquarters of the Egypt's internal bureaucracy, but accordingly Egypt was freed from its enemies – the Hyksos that were dwelling in Avaris in the East of the delta- and acquired the state of the wealthiest and most powerful country in the ancient world, establishing Thebes as "**the queen of cities**".

The capital Thebes, by the reign of Akhenaton (1367-1350 B.C.), was moved to Akhet-Aten/ El-Amarna in Al Minya. However, after seventeen years at Akhenaten's disappear, Thebes was restored as Egypt's capital city again.

<sup>1</sup> **Heracleopolis** is the Roman name of the capital of the 20th nome of ancient Upper Egypt. The site is located approximately 15 km (9.3 mi) West of the modern city of Beni Suef, in the Beni Suef Governorate of Egypt.

As the capital Thebes was close to Nubia and the Eastern desert, with their valuable mineral resources and trade routes, it acquired a profound value in the Egyptian culture. It was a cult center and the wealthiest city of ancient Egypt at its heyday. However, the most important period in the history of Thebes was the five-century-long New Kingdom (1539-1069 B.C.), when what the ancient Egyptians called this “*model for every city*” achieved unrivalled religious, political, and architectural stature.<sup>2</sup>

## 2-THE SITE

Thebes was located along the banks of the Nile River in the middle part of Upper Egypt about 675 km south of Cairo. It was largely built on the alluvial plains of the Nile Valley which follows a great bend of the Nile (Fig.1).

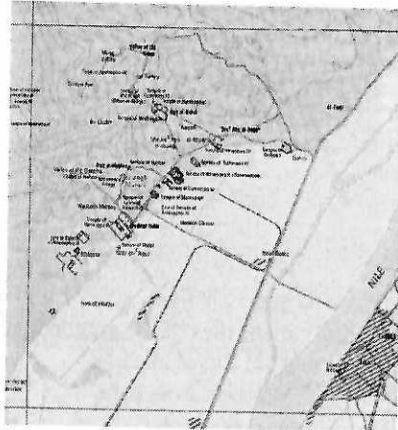


Fig.1 a- Thebes site is :Long . 32° 35'- 40' E, Lat. 25° 42'-45' N

Theban Hills in the West were culminating at the sacred 420-meter al-Qurn (Fig. 2). In the East lies the mountainous Eastern Desert with its wadis draining into the valley, significant of these wadis is Wadi Hammamat near Thebes. It was used as an overland trade route going to the Red Sea coast.

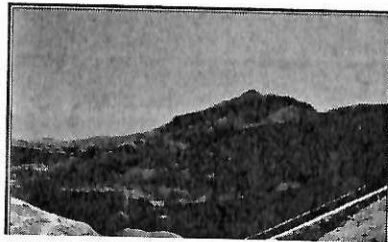


Fig. 2 Theban Hills in the West were culminating at the sacred 420-meter al-Qurn.

The Valley of the Kings (Fig.3) is one of two branches of a huge West Bank wady, or valley, in the desert West of the temples at Deir al-Bahari. Wady's branches are small, steeply sided valleys with arroyos, were found throughout the limestone hills of the site. They were cut into bedrock millions of years ago by heavy rains that fell almost continuously over the North African landscape, eroding bedrock created millions of years earlier when it lay beneath a great sea called Tethys, the precursor of the Mediterranean.

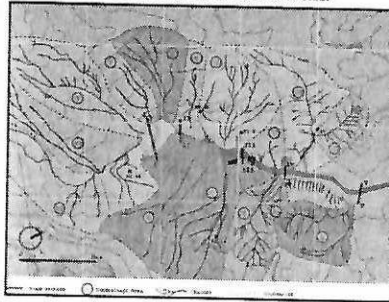


Fig.3 The valley was a basin in ancient times for a group of smaller valleys through which rains were drained.

<sup>2</sup> The information on Egyptian history is taken from a number of sources, including Sir Alan Gardiner's Egypt of the Pharaohs.

The Valley of the Kings lies now about one kilometer west of the Nile floodplain at Thebes (Fig.4). It is a small wady cut by torrential rains and erosion during several pluvial periods in the Pleistocene into a thick layer of limestone that lies within a discontinuous stratum of Esna shale. The Valley lies about 70m above the level of the River Nile (140m above mean sea level), and the immediately surrounding hills rise an average of 80m above the valley floor.

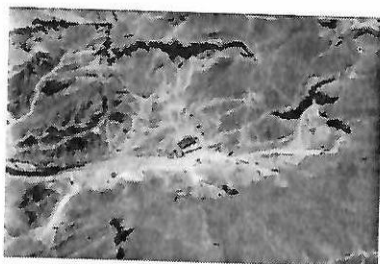


Fig. 4 Valley of the Kings lies in the West of the Nile, within a stratum composed of mainly limestone deposits from the Pleistocene era.

### 3-THE GEOLOGY

Virtually all exposed bedrock in this part of Egypt is limestone, except for small pieces of chert (silica mainly – quartz) embedded in the limestone stratum; its thickness was around 44.67 meters (Fig.5). That was – most probably- one of the reasons that caused all of the tombs to be within that soft limestone stratum. Accordingly slopes of the corridors leading to the tombs were between 2 degrees (as in tomb KV 15 of Seti II) which reached depth -6.25 m, and 39 degrees (as in tomb KV 38 of Thutmose I- (1493 -1481 BC)) which reached depth -14 m. But the deepest tomb was KV 57 of Horemheb which reached -30 m below the wady's floor. The underlying inaccessible stratum was of montmorillonite, a dangerously unstable stone also called Esna Shale (tafla in Arabic).

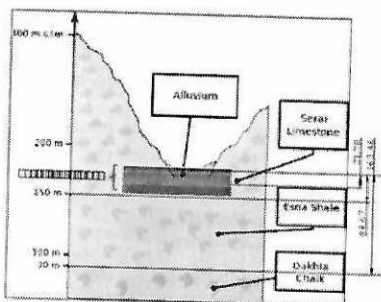


Fig. 5 Geological formation of the valley with indication of the depths limits of toms within the limestone stratum.

### 4-THE TOMB DESIGN

The second reason- the researcher proposes- was that the sun rays penetrated most of the tombs' tunnels all the way to the tombs in certain times in the morning or in the afternoon in certain days corresponding to the calendar of festivals celebrating Amun, Ptah, or Thut (Fig. 6).

EGYPTIAN CALENDAR				FESTIVAL CALENDAR VS TOMBS		TOMB # 14	
GRIGORIAN CALENDAR	DAY IN MONTH	MONTH IN YEAR	DESIKHOFF MONTH	FESTIVAL	AM SUN PENETRATION	PM SUN PENETRATION	
OCT 1	DAY 19 PHOT	MOONTH 1	ANKHET 1	WAG and THUT festival. This event was connected with the mortuary ritual of the king.	KV 2 RAMSES IV- KV 9 RAMSES V- KV 15 SETI- KV 14 THUTMOSIS I KV 38 THUTMOSIS I	KV 4 RAMSES II- KV 40 YUVA & TIYA	
MAR 10	DAY 1 BARAMBAT	MOONTH 2	PEREY 3	Festival of PTAH: day of return of the prince of the dead in the festival of ANKHET in the festival of calling heaven.			
Oct 20	DAY 10 BABA	MOONTH 2	ANKHET 2	All of the festival as 11-day festival for ANKHET in Luxor.	KV 8 HOREMHEB KV 12 THUTMOSIS III KV 10 RAMSES I KV 15 AMENOPHIS II KV 12 UNKHOUSAN	KV 3 SPHONX RAMSES II KV 55 LANOUCIAN	
Oct 23	DAY 18 BABA	MOONTH 2	ANKHET 2	Local Egyptian festival of KHNUM and ANKHET.			
19 Oct 21	DAY 27 BABA	MOONTH 2	ANKHET 2	Great 7-day local festival of ANKHET. This may be not an actual festival, but the ceremony, perhaps of the consecration of a shrine.			
Feb 27 MAR 10	DAY 10 AHSABA	MOONTH 6	PEREY 2	See 30 key date as a festival opening (central day). Identified sometimes as festival in the festival of calling heaven, and in some instances the day of bringing together of the wood-free wood from all the wood-gard at houses and carpenters in the next day. The 1st of the next month, with the ceremony of being the sacred eye as in the 1st of the next month, part of the 1st. Ideal indicator.			

Fig.6 Recorded festivals of the site of Thebes showed that there were 7 deities people were celebrating through certain times of the year. Wag, Thut, Ptah, Amun, Khnum, Anquet, and mont were celebrated within times of the Spring and Autumn.

Festivals were sort of time dedicated to celebrate deities of the national and local beliefs. More than sixty annual festivals were celebrated in Thebes. The major festivals among these according to the Edfu Geographical Text were: the Beautiful F East of Opet<sup>3</sup>, the Khoiak (Festival), Festival of I Shemu, and Festival of II Shemu. Another popular festivity was the Halloween-like Beautiful Festival of the Valley . People were used to move from the city on the East to sacred areas on the West by boats, starting with passing by Temples that were built along the edge of the cultivation of the Western side of the Nile, where they could be reached by religious processions that travelled from Karnak Temple by boat along canals cut through the fields.

**The third reason** was most probably that the site's morphology permitted the meant slopes of most of the tomb's tunnels to provide sunrays of the required day of the year to penetrate to the tombs, again according to the festivals' calendar. It shows in two examples (KV35 and KV57) that elevations of the morphology against the tunnels of each of them were considered for penetration of the sunrays (Fig. 7).

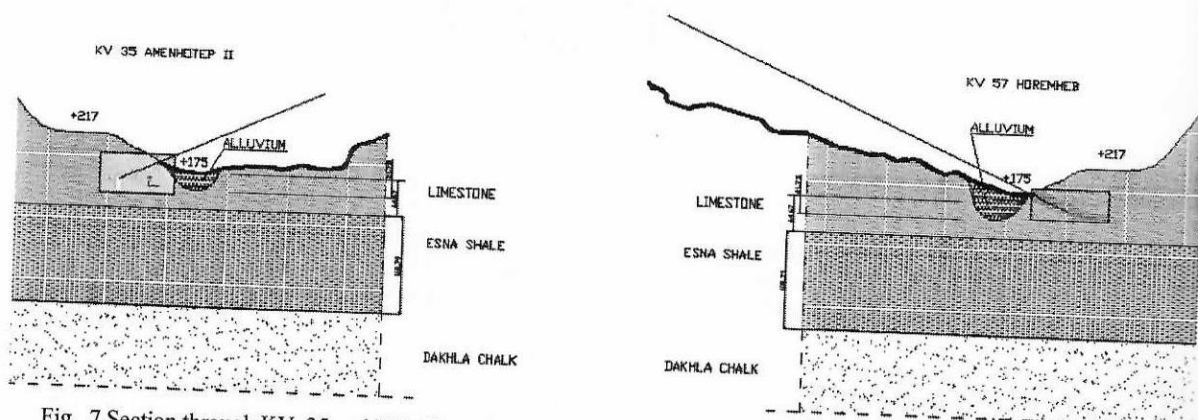


Fig. 7 Section through KV 35 and KV 57 to show how much morphology was considered in design of the corridor of tombs.

The source of that consideration that the sun penetrates the tomb comes in the "Book of the Dead" which says: *"I have opened the caves of Hapi. I have freed the path for the Aten. I have dragged Sokar on his sledge."*

That meant that Earth should be opened for the King's body to be hosted by Osiris in the underworld; by dragging his sarcophagus accompanied by Horus along with the sun Ra' to the far point down in Earth. It is the whole story of bringing the king to the safe condition, from the environmental point of view, very well hidden in a perfect condition and very well preserved and ready for the resurrection.

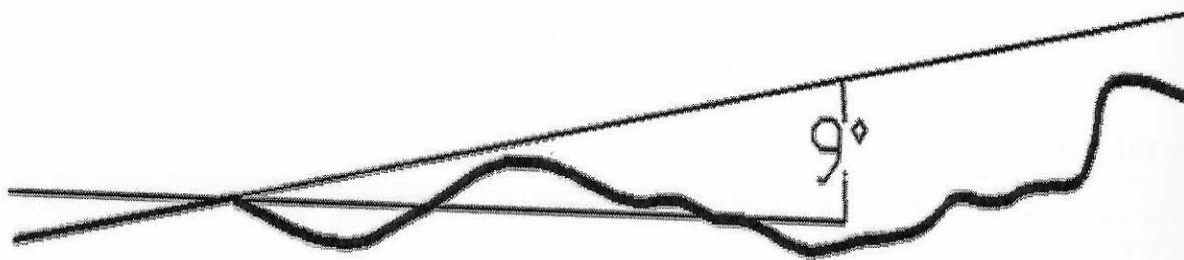


Fig. 8 - Section through the tomb of KV 14 tawsret and the the topography against it. Section shows how it receives sunrays of the beginning of March at 6.30 am, celebrating festival for "ptah" & "amun". Author drawing

Here the fact should be mentioned that the majority of toms were designed to receive morning sunrays (Fig.8), less to receive it in the afternoon, and the rest were oriented north not for a perceived to the author reason; it may need a further investigation.

<sup>3</sup> The festival was celebrated in the second month of Akhet, the season of the flooding of the Nile.

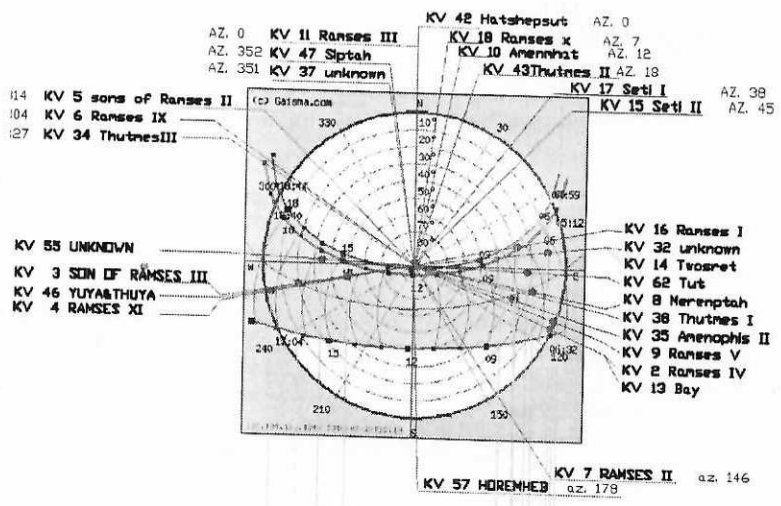


Fig. 9 On the Luxor chart of sun path diagram tombs entrances are classified into the four natural orientations. Those to the East and to the West mostly receive sun rays in certain times according to their inclinations. Entrances oriented north, they only received reflected sun rays. The rest oriented south, do not receive direct sun but, might received light from some stars as was the case in the old Kingdome .

The twenty eight tombs' orientations and slopes were plotted on a Luxor sun path diagram to investigate the relations to the real time of sun movements on the sky (Fig.9). Ten tombs were oriented to the morning East sun; four were to the West, two to the South, and nine to the north. But three were to the North West. Those oriented to the East and West had the sun penetrated in times corresponding to the calendar as mentioned above.

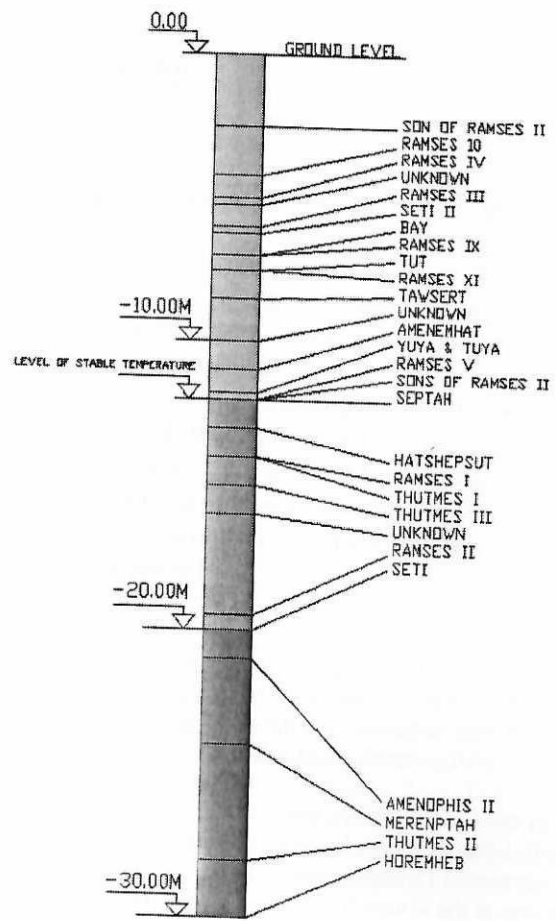


Fig.10 underground temperature lessens by getting deeper inside untill level -12.00 m. which is considered the level of the stable temperature, where no oscillations happens in temperature, day / night, summer / winter; deeper than 12 m , temperature gets higher. The Author

The fourth reason that affected- from the researcher's point of view- the depths of the majority (seventeen tombs out of the twenty eight) of the tombs to be within the upper 12 meters is that beside the fact that depths were all within the lime stone stratum, and never exceeded that depth (Fig.10), depths of burial chambers were in three levels according to the depth temperature. Down to a depth of twelve meters, where stability of temperature occurs through seasons and day 24 hours, temperature associates with the surface temperature. Below the stable temperature level, it gets warmer, and then it becomes hotter.

Seventeen tombs were among the first level, i.e. to the depth 12 meters. Seven were in the next layer; four were in the hotter/ deepest one. Tomb of Ramses II was the nearer to the valley ground surface; Horemheb's tomb was the deepest.

A list of the twenty eight most important tombs is shown in (Fig.11) that declares the specific characteristic features of each of them from five different considerations: death time of the king, tracks leading to the burial chamber, inclination of the entrances' corridors, tunnels' azimuths, and depth of each one of them.

THE ROYAL VALLEY TOMBS						
KV	NAME	DEATH	TRACK	ALT.	AZ	DEPTH.m
2	RAMSES IV	1147	1	4	114	3
3	SON RAMSES III		2	19	208	2.5
4	RAMSES XI	1009	1	6	248	7.5
5	SONS RAMSES II		8	10	314	12
6	RAMSES IX	1108	3	14	304	7
7	RAMSES II	1213	6	26	148	19.5
8	MERENPTAH	1303	6	17	101	13-24
9	RAMSES V	1143	1	6	111	12
10	AMENEMHAT	1200	3	8	12	11
11	RAMSES III	1153	2	9	0	6
13	BAY		1	8	114	7
14	TAWSEBT	1185	8	9	83	18.5
15	SETI II	1194	3	2	45	8.25
16	RAMSES I	1294	2	26	78	14
17	SETI I	1279	5	38	98	20
18	RAMSES X	1099	1	6	7	4.2
32	UNKNOWN	0	4	31	83	16
34	THUTMES III	1456	3	30-48	327	15
35	AMENOPHIS II	1392	4	17	108	21
37	UNKNOWN	0	2	39	351	5.25
38	THUTMES I	1481	3	39-50	103-121	14
42	HATSHEPSUT	1458	2	38	0	13
43	THUTMES II	1479	3	33	18	28
46	YUYA & THUYA		4	42	48	11.8
47	SEPTAH	1188	1	22	362	12
55	AKHENATEN	1335	3	33	272	18
57	HOREMHEB	1295	7	34	178	20.30
62	TUT	1325	2	37	92	7.5

Fig. 11 List of the twenty most important tombs in the valley indicated by their kings with their dates of death, tunnels' form, their inclinations, their orientations to North, and their burial chambers' depths in the ground.

Color  indicates east orientation.  
 Color  indicates farthest depth.  
 Color  indicates medium depth.  
 Color  indicates nearest depth.

The Author

Of the twenty eight tombs three tombs from the eighth dynasty were in each layer; from the nineteenth dynasty five tombs were in the first layer, three in the second, and one in the third; the six tombs from the twentieth dynasty were all in the first layer. One can here conclude that the privilege of having the tomb being in the first layer - which one can consider it the best environmentally conditioned - acquired enough care from the architects.

Distribution of the tombs within the Valley did not follow a definite policy but one factor was decisive and that was about placing the Eighteenth Dynasty tombs by almost at the end of the valley which was the higher level of the wady's floor; those of the nineteenth Dynasty around them. Tombs of the Twentieth Dynasty almost were at the beginning the wady which was at the lowest level of the wady's floor. That policy might show that there was not a collective thought about the orientation or about the tunnel inclination, or even a collective idea about the one deity to celebrate, since they were all at multi orientations and multi inclinations. Run off of rain water was much considered in the eighteenth Dynasty that the twentieth Dynasty.



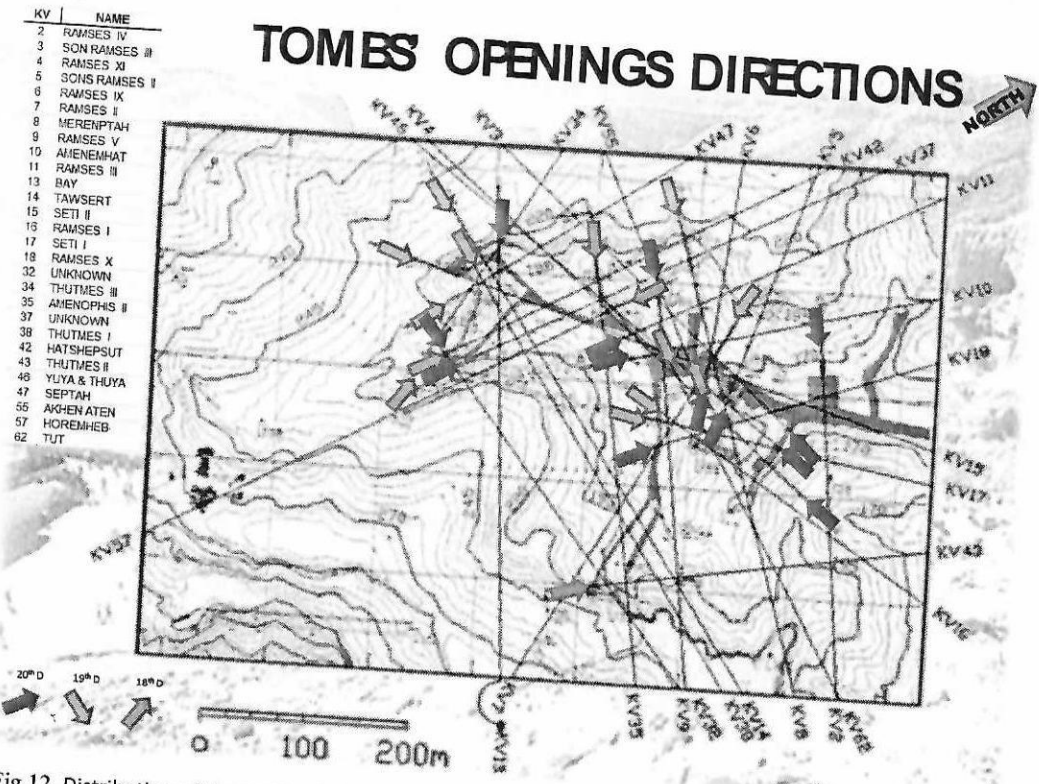


Fig.12. Distribution of the tombs within the Valley did not follow a definite policy. Run off of rain water was much considered in the eighteenth Dynasty than the twentieth Dynasty.

**5- Conclusion**

Tombs of the Valley of the Kings were environmentally designed. It means that the site was carefully chosen by its natural geological formation characteristics that it was mainly the lime stone; soft enough to be carved in and been painted to last through ages until nowadays. As the site experienced rain running off through ages, maybe it was meant to be one stage of the process of design. Tombs' entrances were all accessible from the ground of the valley. One tomb entrance, that is KV 62 of Tut Ankh Amon's tomb, was once concealed by deposits after been finished and sealed, caused by rain runoff, until it was discovered in the last century; maybe it was intended through time of construction to be hidden later on. But surely they were accessible for people to celebrate their deceased kings in the national festivals.

Slopes of the passages of most of the tunnels had inclinations permitting the Eastern early sun, and in some others Western late sun, to reach the burial chambers in due time related to their festivals. Depths' levels of most of the burial chambers inside earth did not reach the limit where "The Thermal Equilibrium" happened. Thermal equilibrium is "a stable situation in which forces cancel one another"<sup>4</sup>. Four tombs' chambers exceeded the -20 meters depth for no clear reason; they were tombs of each of AmenhotebII, Merenptah, ThotmoseII, and Horemheb. Even that tomb of Horemheb was the deepest where it reached -30m; but research could not reach a convincing answer for having the burial chamber in that theoretically higher temperature.

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<sup>4</sup> <https://www.thefreedictionary.com>

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