

## PYRAMIDS

Pyramids are Ancient Egyptian tombs and religious monuments of a certain geometrical shape. They have motivated scholars and, in contrast, cranky adventurers and dreamers to investigate them. Of the latter's output, I can mention: pyramid power, builders from outer space, use of artificial stone, and isolating the Great Pyramid from others. Of the former's I can mention: archaeological reports and their interpretation. Unfortunately a number of pyramids have either been partly or totally overlooked by them. It is regretted that only a few scholars from: Austria, Czechoslovakia, Egypt, England, France, Germany, and the USA are working with limited resources on some pyramids today. This short note deals with some basic facts concerning the pyramids; it is hoped that the reader will realise how much more research is needed.

Royal pyramids were built with interruptions from the Old Kingdom to the beginning of the New Kingdom, [Dynasties III-VI, VII-X?, XII-XIII, XIV?, XVII-XVIII, 28th-16th century B.C.]. By the end of that period, pyramids had been plundered to an extent that no Egyptian King built pyramids any more. Kings and queens of the New Kingdom, [Dyn. XVIII-XX, 16th-10th cent. B.C.], for future security of their resting place, were buried in rock tombs in the Valley of the kings and the queens of the Theban Necropolis. Nevertheless these tombs in turn became vulnerable. During the greater parts of the Third Intermediate and the Renaissance Periods, [Dyn. XXI-XXIV, XXVI, XXVIII-XXX, 10th-4th cent. B.C.], the royal tombs were constructed where they could best be guarded, close to the principal temple of the capital. In the meantime a Nubian King named Piankhi had invaded Egypt and established Dynasty XXV [8th cent. B.C.]. He seemed to have been impressed by the pyramids on the western desert near the old capital Memphis. He decided to adopt the pyramid shape for his tomb back home at El Kurru. The local kingdoms which followed him

built pyramid-tombs on several sites in Nubia until the 3rd cent. A.D. There is reason to believe, however, that Alexander the great and the Ptolomies, [4th-1st cent. B.C.], were buried under pyramid-tumuli in Alexandria.

It should be noted that pyramids did not cease to exist in Egypt during the period of Dyn. XVIII-XXX. The shape was already being constructed in modest dimensions over private tombs as early as the First Intermediate Period [Dyn. VII-X, 23rd cent. B.C.] and the tradition continued until the beginning of the Christian Era during Roman Rule [2nd cent. A.D.].

Ancient documents account for kings whose pyramids have hitherto not been found, and owners of some existing pyramids have not been identified. My current research on royal funerary-pyramids and religious pyramid-like monuments accounts for:

- 98 funerary-pyramids and 24 pyramid-like monuments laying between Khataana in the Eastern Delta and Elephantine in Aswan. The larger pyramids of the Memphite Necropolis, come within this group. They are found between Abu Rawash north of Giza and El Lahun east of Fayum.
- Some pyramid-tumuli of Hellenistic Rulers which have not hitherto been discovered in Alexandria.
- More than 150 pyramid-tombs in Nubia.
- As well as hundreds of private pyramid-tombs standing in ruins on many sites in Egypt and Nubia.

The pyramids of the first group could be divided into three phases: the step pyramid, the true pyramid in stone, and the true pyramid in mud brick. The pyramids which mark the beginning of these phases are: the Step Pyramid at Saggara [Dyn. III], the Red Pyramid at Dahshur [Dyn. IV], and the Brick Pyramid at El Lahun [Dyn. XII]. The middle phase could be divided in two eras: Giant

Pyramids [Dyn. IV] and Conventional Pyramids [Dyn. V-XII].

The Heliopolitan cosmogony was involved with a primeval hill named: the Benben. It came to us inscribed in several forms. The step pyramid was, indeed, a three dimensional model of one of the Benben inscription. Since later pyramid phases developed from step pyramids we may consider that all pyramids, and obelisks, derived from a common ancestor: the Benben. Thus we could claim that we know the pyramid's origin and where the shape was conceived.

My studies tell me that the first step pyramids were greatly influenced by, embankments and religious tumuli of the Archaic Period, [Dyn. I-II, 35th-29th cent. B.C.]. I believe that factors which controlled the relative dimensions of religious tumuli were applied to the newly developed monuments. These factors demanded that the height of the tumulus should not exceed the length of the semi-diameter of the base. Consequently the height of step pyramids was determined by a similar relationship to its base.

The step pyramid was ingeniously planed by Imhotep, the famous architect, as accretion layers around a central squared core. I believe that his idea was influenced by contemporary embankments. The step pyramids' cores and layers were built sloping at their outer sides in accordance with a horizontal displacement of one unit to a plumb line drop of four units. Blocks of stone had to be laid inclined inwards to maintain that slope. This method provided additional stability to the step pyramids. The outer facings of step pyramids were created by building or dressing visible layers projecting upwards with, Tura Limestone. In step pyramids one can see that existing skills of brick laying were applied to stone masonry: stone blocks weighing 50-200 kilograms were arranged in heads, stretchers, and ends. Thus we can claim that the origins and principals of relative dimensions, architectural composition, and methods of laying stones of step pyramids

are known to us.

Architects of subsequent pyramid phases maintained the same controls over their height. In the new shapes, the height was checked by the slope of the pyramid side. I found this angle to be of the same value as the 'angle of repose'. Any heaped material sloping at the 'angle of repose' will not be dispersed by the gravity of the earth. Various values for that slope were discovered for true pyramids. At the earliest true pyramid in stone, Era of Giant Pyramids, the height did not to exceed half the base length (it looked blunt and flattened) this relationship was the result of a side angle of  $45^{\circ}$  seen at the Red Pyramid of Dahshur. Progressively the height was increased without exceeding half the length of the diagonal of the base (the usual pyramid shape). This height was controlled by a side angle of  $53^{\circ}$  seen at the Second Pyramid at Giza. Early in the Era of Giant Pyramids appeared the first bent pyramid. During the Era of Conventional Pyramids the side angle of 14 of queens' and subsidiary pyramids was increases beyond the 'angle of repose' until in a few cases the height became equal to the base length, resulting from a side angle of  $64^{\circ}$ . An example is seen at the pyramid of queen Udjepten at southern Saqqara [Dyn. VI]. It should be noted that these pyramids were small and could be looked upon as exceptions.

The builders modified stone laying disciplins several times, in all cases the blocks were arranged horizontally. During the Era of the Giant Pyramids we observe that blocks weighing 2.5 tons were used in the pyramid superstructures and some of their foundation blocks exceed 400 tons. In the Era of Conventional Pyramids stone blocks became smaller and smaller reaching the size of chippings. Finally the building material of the latest phase of true pyramids became mud brick.

The architectural composition of bent and true pyramids in some

cases maintained the step pyramid form imbedded within them. The tradition was not altered, it was preserved, while new forms were added to older ones. In other cases the true pyramid was a simple composition of courses over each other. A late architectural composition was by building cross walls along the axis and diagonals of the pyramid base, and filling in pockets.

Apart from what has been mentioned above we know the layouts of the substructures of most pyramids. Some information has been discovered concerning rituals in the pyramid temples. Thus we can claim that we understand relative dimensions, methods of laying stone blocks, and the architectural composition of bent and true pyramids.

We have always admired the ancient architects, surveyors, and astronomers for perfectly leveling, exactly orientating and precisely achieving the correct pyramid shape. We can imagine that significant motives stood behind such achievements and admirable methods were employed to keep the project going. One can imagine that transportation of great quantities of various kinds of stone and metal from quarries and mines was by caravan and river craft and that cedar wood was brought by many ships from overseas. We surmise that an efficient administration was appointed. Feeding, clothing, and housing armies of skilled and unskilled workers had to be handled. But we know nothing about reference plans used during the building process. We have never convincingly imagined how the blocks were raised to the building level at the pyramid site.

I hope that the reader has acquired a true impression of our state of knowledge. A full understanding of pyramids is not within our reach at present. There are other aspects where further research becomes necessary: why did one king own 6 pyramids, what were the functions of subsidiary pyramids, why do some pyramid substructures contain miniature corridors, why do some pyramids include

more than one burial chamber, and very important is a study of the social history of the pyramid builders. As we admit such lack of knowledge, interesting answers by fantasy rather than fact are being published everyday, such answers should not be taken very seriously.

When you deal with one pyramid you should remember that it is a link in a long chain of development. You have to think in simple terms as the Ancient Egyptians did. Please note that the pyramids existing today were designed and built to last eternally but curiosity and greed are responsible for their present state.

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