

THE PYRAMIDS OF EGYPT

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RESUMEN

La Gran Pirámide de Egipto, construida aproximadamente dos mil años A.C., no es solamente un apilamiento de piedras. Es una tumba que contiene una cámara de enterramiento, pasajes, conductos de ventilación, etc. Es una proeza de la ingeniería. Fueron muchas centurias las que transcurrieron hasta que fue posible la construcción de una verdadera pirámide. Existen aproximadamente cien pirámides en Egipto. Hace 500 años que los egipcios dejaron de construir pirámides. Los Nubios, quienes ocuparon Egipto alrededor del 1000 D.C., construyeron en Meroe otras doscientas pirámides, pero de mucho menor tamaño que las de Menfis.

PALABRAS CLAVE: Pirámides, canteras, construcción, Egipto.

ABSTRACT

The Great Pyramid in Egypt built about two thousand years BC is not just a pile of stones. It is a grave containing a burial chamber, passages, and ventilation ducts, etc. It is an engineering feat. It took many centuries of experimentation till it was possible to build a true pyramid. There are about one hundred pyramids in Egypt. After about 500 years when the Egyptians stopped building pyramids, the Nubians who occupied Egypt around 1000 BC, built in Meroe another two hundred pyramids but far much smaller than those at Memphis.

KEY WORDS: Pyramids, quarrying, building, Egypt.

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INTRODUCTION

About 3150 BC, King Menes of Egypt established his capital at Memphis (Figure 1) on the west bank of the Nile 20 km south of present day Cairo. It thrived as a regional centre for commerce. The city became

known as Men-nefer meaning “enduring and beautiful”, which became Menfe in Coptic. The name Memphis is the Greek adaptation of this name. The pharaohs believed in life after death and elaborated the mastaba as their tombs (Figures 2 and 3). Mastaba is the Arabic word for stone bench.

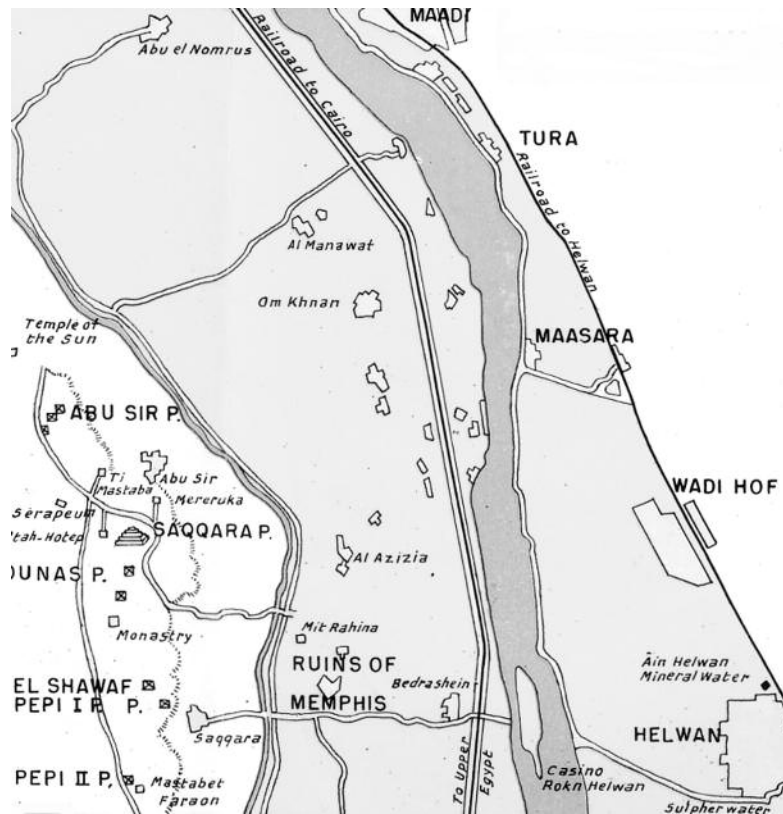


Figure 1. Location of Memphis, south of Cairo, on the west bank of the Nile (Maadi and Helwan are suburbs of Cairo).



Figure 2. Mastaba tomb.

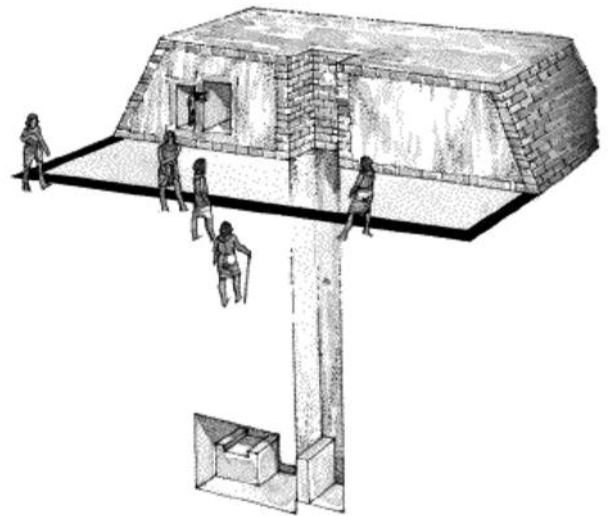


Figure 3. Mastaba tomb.

THE PYRAMIDS

The Old Kingdom of Egypt (2686-2181 BC) was the period of pyramid builders, i.e., the change from mastaba to pyramids. There are about on hundred pyramids in Egypt (Figure 4).

The Step Pyramid

The mastaba developed into the step pyramid. There were a series of mastabas placed one on top

of the other; each smaller than the one beneath. The first step pyramid was designed by the architect Imhotep for King Djoser *ca.* 2780 BC. This pyramid still stands today on the west bank of the Nile River at Saqqara near Memphis (Figures 5-7).

Towards a true pyramid

The construction of pyramids went through another phase of design. The bottom portion of the pyramid looked like a mastaba while the middle and

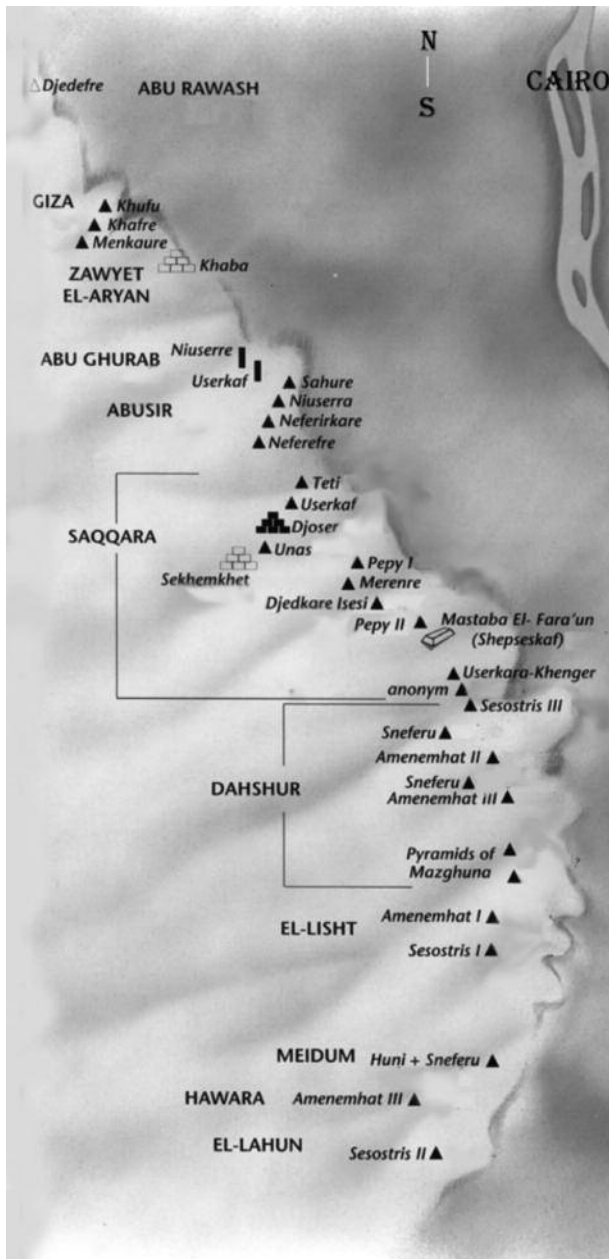


Figure 4. Map of pyramids in Giza, Saqqara, Dahshur, and Meidum west of Cairo.

upper portions resembled a true pyramid. This was the case of Meidum then Dahshur pyramids (Figure 8). Some pyramids collapsed during these trials.

Sneferu pyramids

The Pharaoh Sneferu (2613-2589 BC) father of Cheops built three pyramids:

Meidum is 80 km south of Memphis, on the west bank of the Nile just east of Fayoum (Figures 9 and 10). The Meidum pyramid was started as a Step Pyramid then modified aiming at a true pyramid but apparently it collapsed during construction. In its ruined state, the structure is 65 m high. All that remains now is a three-stepped tower rising up from a hill of debris. The Meidum pyramid was the first attempt at building a smooth-sided pyramid, and that it may have collapsed when the construction of the



Figure 5. The Step Pyramid at Saqqara built for Pharaoh Djoser.

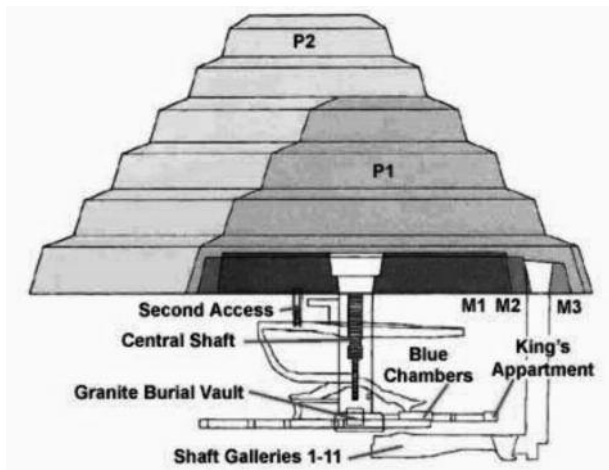


Figure 6. The Step Pyramid at Saqqara built for Pharaoh Djoser.

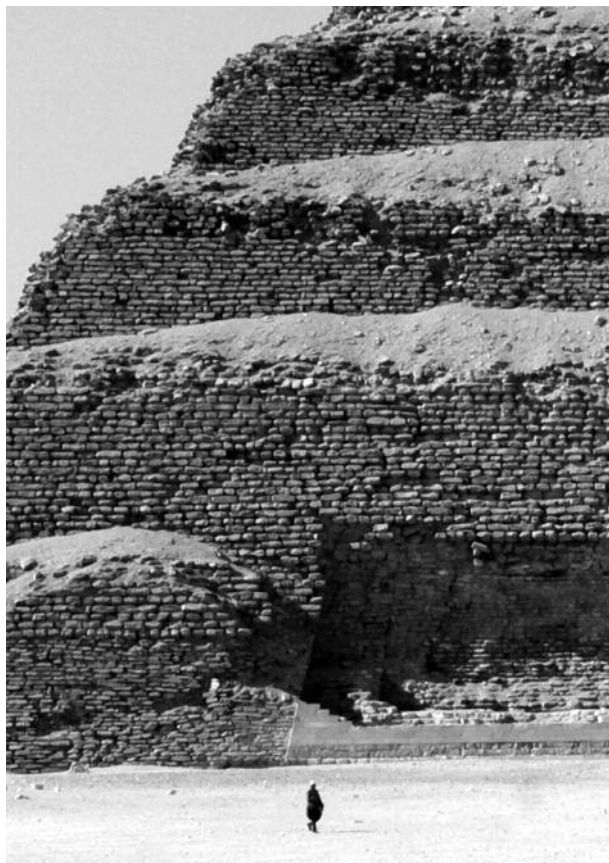


Figure 7. The Step Pyramid at Saqqara built for Pharaoh Djoser.

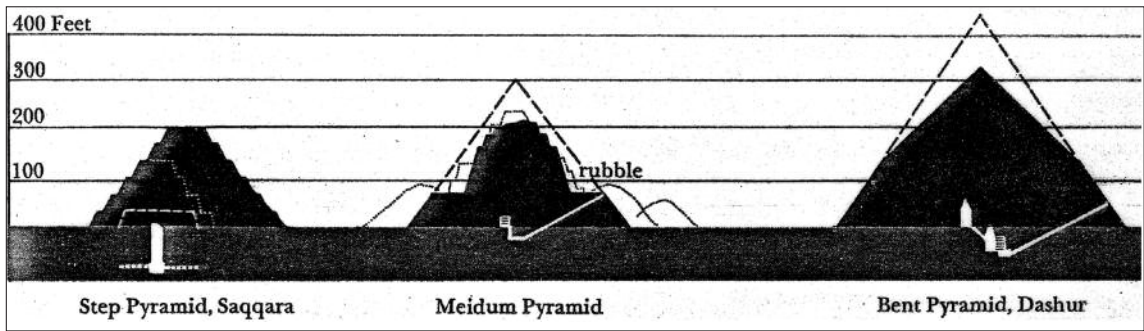


Figure 8. Saqqara, then Meidum, then the Bent Pyramid in Dahshur.

Bent Pyramid was underway (see below). The outcome of this was the change in inclination of the Bent Pyramid, and the commencement of the later Red Pyramid at an inclination known to be less susceptible to instability and therefore less susceptible to catastrophic collapse.

The Bent Pyramid at Dahshur (Figures 11-14) by Amenemhat III which is between Saqqara in the north and Meidum in the south. The collapse of the Meidum Pyramid while the Bent Pyramid was under construction was likely the reason for the change from the usual 52° to 43° inclination. This pyramid is bent because the initial angle proved too steep, and the engineers had to change it midway during construction.

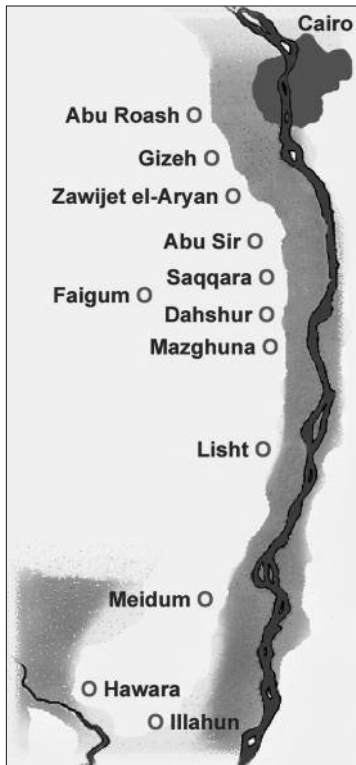


Figure 9. Location of Giza (Gizeh), Saqqara, Dahshur, Meidum, and Hawarah.

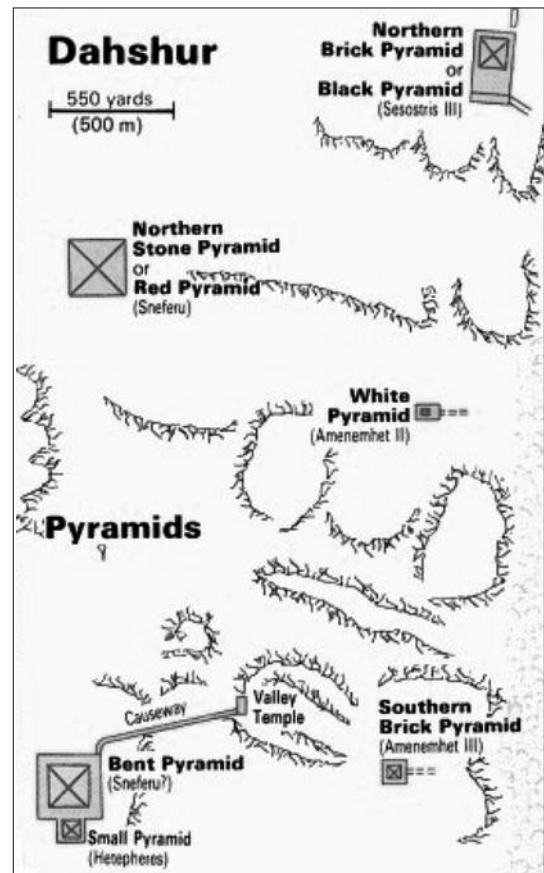


Figure 11. Pyramids in Dahshur: there are three large and two small pyramids remaining of the original eleven.

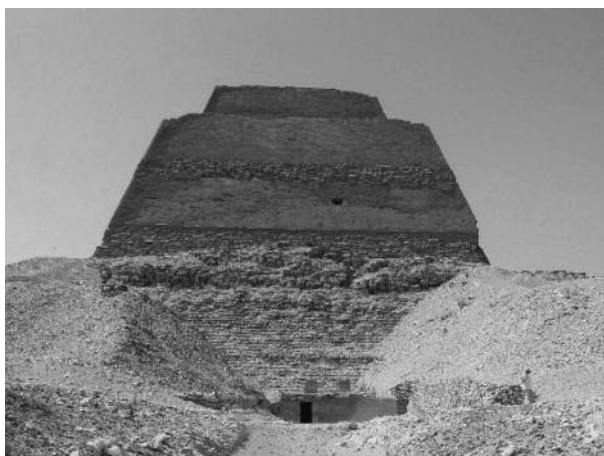


Figure 10. Meidum Pyramid.



Figure 12. View of the Dahshur pyramids.



Figure 13. Sneferu Pyramid at Dashur also called Bent Pyramid.

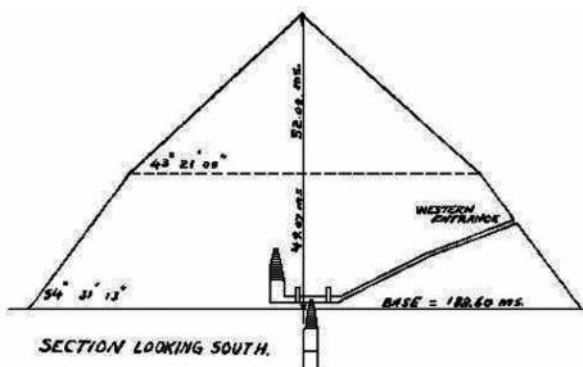


Figure 14. Sneferu Pyramid at Dashur also called Bent Pyramid.

The Red Pyramid (Figure 15) and is located about one kilometer to the north of the Bent Pyramid. It was built at the 43° angle like the upper section of the Bent Pyramid. The design may be an outcome of engineering crises experienced during the construction of the two earlier pyramids. It is 104 m high and named for the reddish hue of its stones. The Pyramid was originally cased with white limestone, but only a few of these now remain at the base. Much of the white limestone was taken later for buildings in Cairo revealing the reddish sandstone

beneath. It is also believed to be the world's first successful attempt at constructing a "true" smooth-sided pyramid.



Figure 15. The Red Pyramid in Dahshur, 104 m high.

Pyramids of Amenemhat III

Amenemhat III of the Middle Kingdom (2100-1700 BC) ruled from *ca.*1860 to *ca.*1814 BC built the so-called Black Pyramid at Dahshur but there were construction problems and this was abandoned. After 15 years he decided to build a new pyramid at Hawara near Fayoum and a temple known as the "Labyrinth" which was praised by Roman writers as a wonder of the world. The pyramid (Figure 16) was originally about 75 m high with a base 105 m long and an incline of 57° . The pyramid was made of mud brick and clay and encased in limestone. The ground level structures consist of the entrance opening into the courtyard and mortuary temple, surrounded by walls. The unstable building material allowed groundwater from the Nile to seep into the walls, causing the entire pyramid to sink and crack.

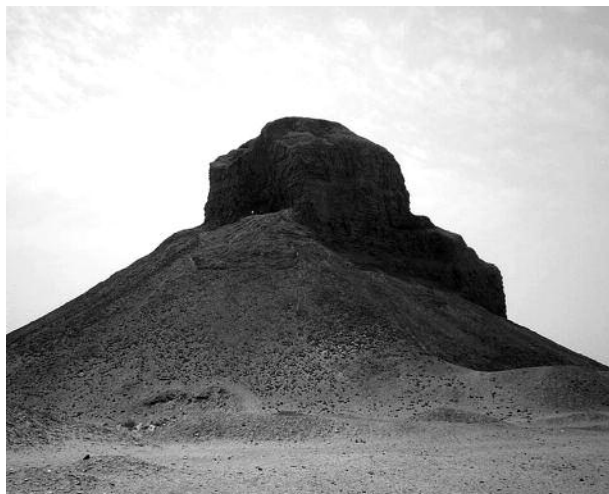


Figure 16. Pyramid of Amenemhat III.

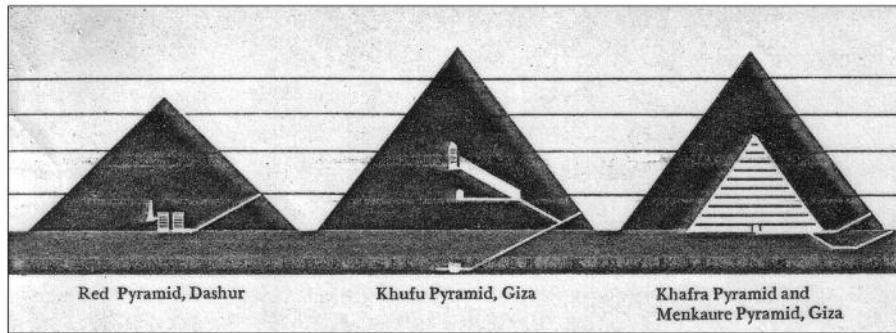


Figure 17. From the Red Pyramid at Dahshur to Khufu Pyramid at Giza.

The true pyramid

The Red Pyramid was the first real pyramid after a long experience of determining the angle of inclination for a stable structure to be 43° . Afterwards, the Khufu, Khafra, and Menkaure pyramids were built (Figure 17).

Quarrying

Quarrying and stone cutting in ancient Egypt was an unprecedented activity. The tools used for the quarrying of soft stones was perhaps made of a hard stone such as basalt or dolerite. For hard stone the excavation of open cast quarries was conducted by means of hammer stones. Once the chosen area of

rock had been roughly evened out it was probably scattered with glowing pieces of wood and then cold water was quickly poured over, so that the surface of the stone disintegrated at this point, making the block easier to extract. Iron was not yet known and copper chisels must have been used.

The largest pyramids are in Memphis (present day Giza) (Figures 18 and 19). The Great Pyramid was built by Khufu (Figure 20) of about 2.3 million large limestone blocks each weighing about 2.5 tonnes (Figure 21). The total mass of the pyramid is estimated at 5.9 million tonnes. Building this in 20 years would involve installing approximately 800 tonnes of stone or 320 block every day. The blocks were made

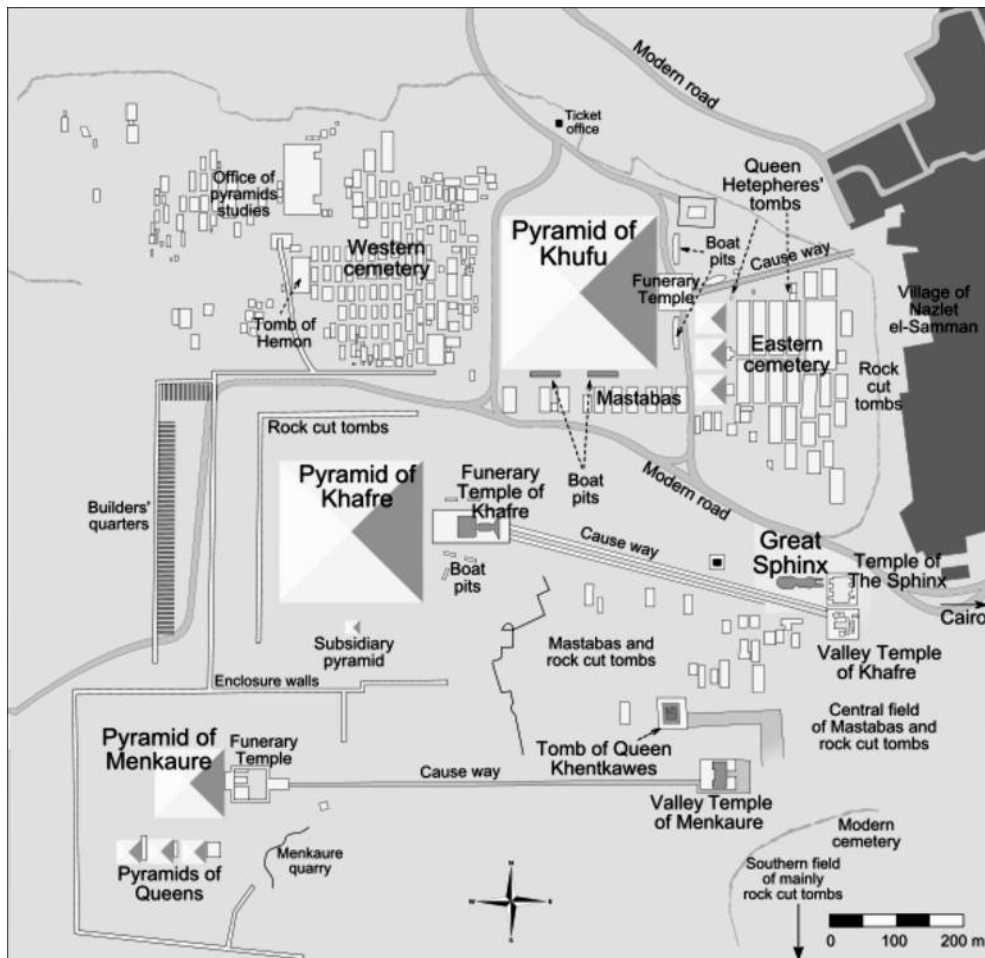


Figure 18. Map of the pyramids and Sphinx in Giza.

smooth so that they fit one on top of the other without mortar. Quarrying and moving these blocks are a great feat. The Pharaoh was buried in a chamber in the center of the pyramid. For smoothing the faces, an abrasive powder of crushed quartzite was used, with grains that were sharp-edged unlike the rounded ones of sand.

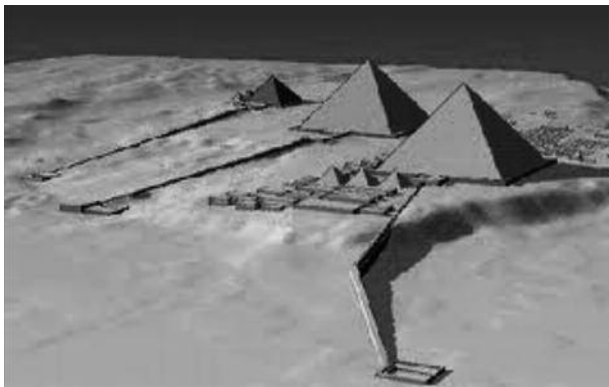


Figure 19. A drawing showing the position of the Great Pyramid.

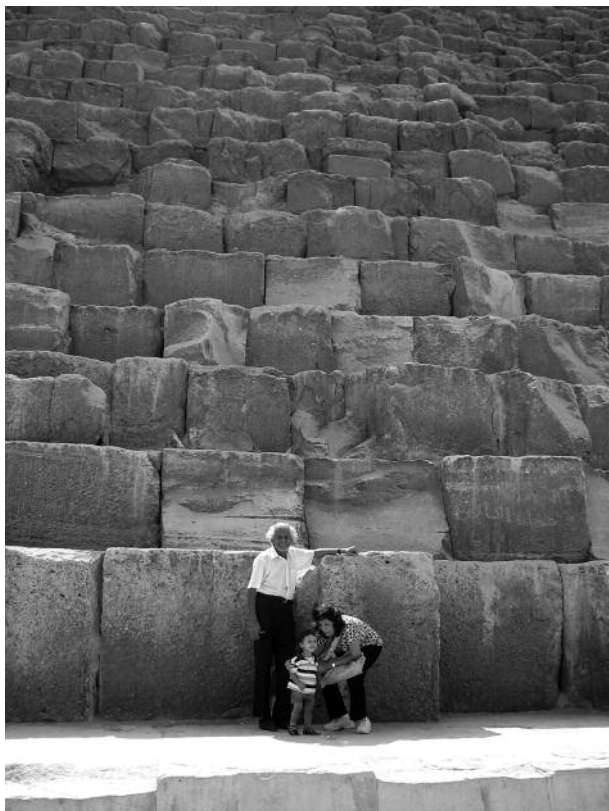


Figure 20. The author at the Great Pyramid in 2009 showing the size of the limestone blocks.

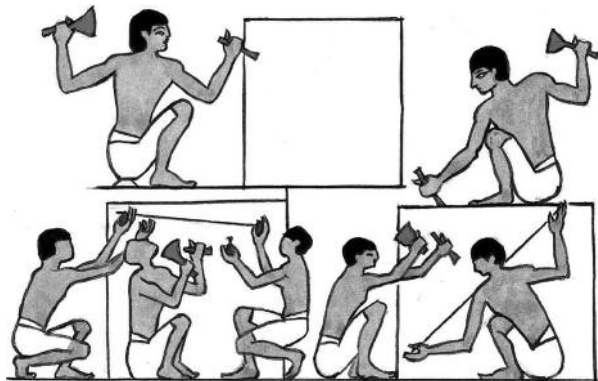


Figure 21. An ancient Egyptian wall painting showing masons cutting stones to a precise size.

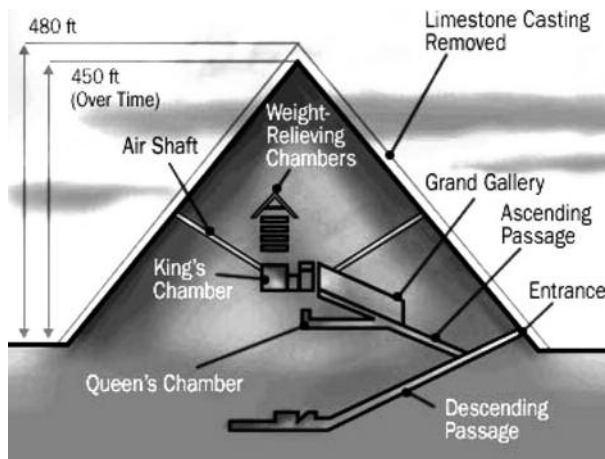


Figure 22. Cross section through the Great Pyramid. Total height 146 m (480 feet).

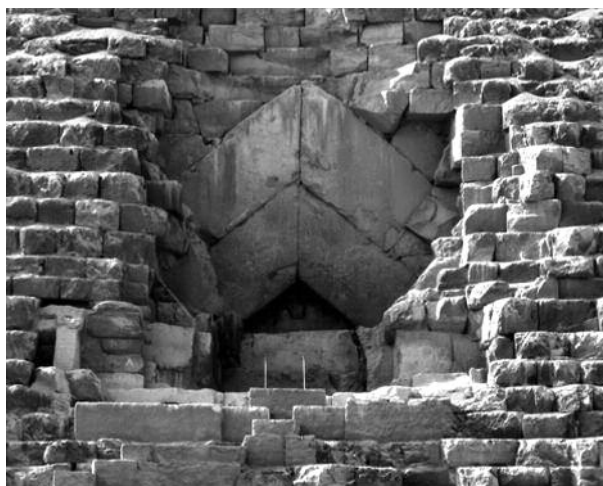


Figure 23. Entrance of the Great Pyramid.

The Great Pyramid is not just a pile of stones, it is a grave containing a burial chamber, passages, and ventilation ducts, etc. (Figures 22-24). It is an engi-

neering feat. The burial chamber was made of Aswan granite (Figure 25) while the sarcophagus was carved from a massive block (Figure 26).



Figure 24. Inside the Great Pyramid.

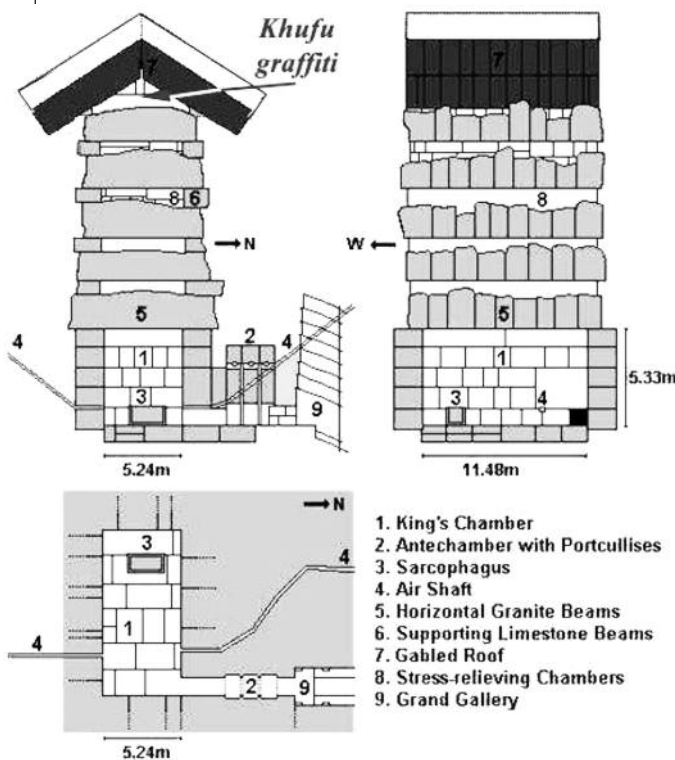


Figure 25. Details of the burying chamber.



Figure 26. Khufu carved granite sarcophagus.

Herodotus and the pyramids

The Greek historian Herodotus (484-425 BC) visited Egypt at a time when the Great Pyramid was already very ancient. From an Egyptian priest, through an interpreter, he gathered accounts of the erection of the Pyramid. He mentioned that hundred thousand men laboured constantly, and were relieved every three months by others. It took ten years to make the causeway for the conveyance of the stones. The pyramid itself was built in twenty years and was built entirely of polished stone, fitted together with the utmost care. There was an inscription in Egyptian characters on the pyramid which records the quantity of radishes, onions, and garlic consumed by the labourers who constructed it.

NUBIAN PYRAMIDS

Around 1000 BC, following the collapse of the New Kingdom of Egypt (1555-1090 BC), the Nubian kingdom of Kush emerged as a great power in the south on the Nile. Sudanese kings conquered and ruled Egypt. They seized Thebes and eventually the Nile Delta. By about 300 BC the center of the kingdom had shifted south to the Meroe (Figure 27). The Egyptian influence made a great impression, and during the later Sudanese Kingdom approximately in the period between 300 BC-300 AD. This was shown into a pyramid-building revival, which saw more than two hundred pyramids constructed in the vicinity of the capital city. The pyramids were built to house the bodies of their kings and queens (Figures 28-30) but were much smaller than the pyramids in Giza being only 6 to 30 m high. All of these pyramids tombs were built on the west bank of the Nile and were plundered in ancient times. Many pyramids are in a poor state of preservation or buried by desert sands. Prior to the building these pyramids, there had been no pyramid construction in Egypt for more than 500 years.

EPILOGUE

The pyramids of Egypt were admired by ancient writers and well documented by modern archaeologists. Many books and many articles were written about them with suggestions describing how they were built. They developed from a step pyramid to a bend pyramid till finally a true pyramid was designed and built. In spite of this, the readers of today do not grasp the genius of the engineers who designed and built them two thousand years BC for a trivial cause like burying a king. But, for the ancient Egyptians this was not trivial. The Pharaoh was a god worth such tomb and such effort - - he will live after death. In a sense, this is absolutely true. Is it not a fact that Pharaohs are living with us today in museums? Is it not true that Tut Ank Amoun, for example, who died in 1323 BC, has been travelling in recent years all over the world displaying his magnificent

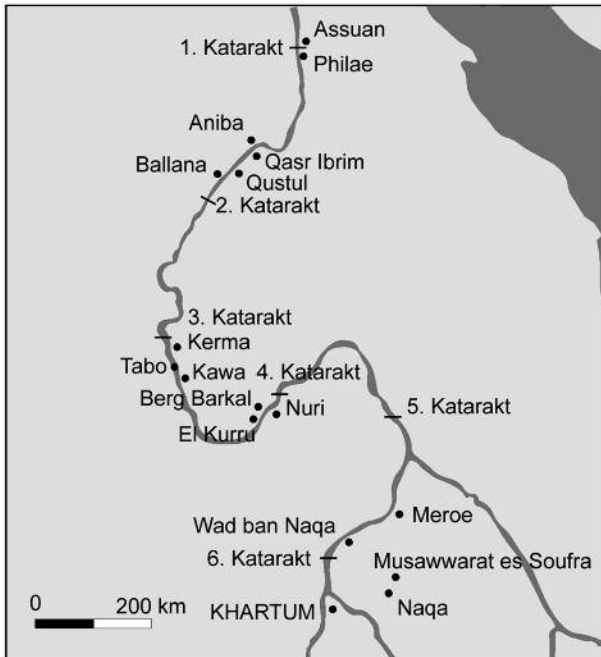


Figure 27. Location of Meroe in Nuba south of Egypt (the present Sudan).



Figure 28. Nubian pyramids.



Figure 29. Nubian pyramids.



Figure 30. Nubian pyramids.

belongings, and the modern tourist goes to Egypt to see the pyramids built four thousand years ago?

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