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RAINER STADELMANN GEWIDMET

Herausgegeben von  
Heike Guksch und Daniel Polz



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# Pyramid Construction

## New Evidence Discovered at Giza

ZAHY HAWASS

(Plates 2-5)

It gives me great pleasure to dedicate this new discovery at Giza to my dear friend RAINER STADELMANN. I have known him since 1969, just one year after I began my career as an Inspector of Antiquities of Egypt. When I started the excavations at Merimde Beni Salama in 1969, I invited RAINER STADELMANN and some other Egyptologists to visit the site and to consult with them on excavation techniques. Since then, our friendship has grown and we meet regularly to discuss archaeological theories and practices. As well as being an excellent scholar and expert on pyramids, RAINER STADELMANN is also a true friend who gives his opinion honestly and candidly, uninhibited by diplomatic considerations.

Even now, our archaeological adventures together continue. We recently explored the five relieving chambers above the King's Chamber in the Great Pyramid in order to examine more closely the graffiti there. A few months ago, we went down about twenty meters into a Saite tomb found by M. VERNER at Abousir and visited the newly discovered pyramid of Queen Khuit at Saqqara. He was thrilled when he viewed the newly discovered remains of a ramp at Giza, and I realized then that this paper, when written, should be dedicated to him<sup>1</sup>.

As Egyptians we are grateful to RAINER STADELMANN for his contributions to our country. Through his excellent efforts of scholarship, restoration programs and training of students, he has advanced the field of Egyptology. We hope that he will continue living in Egypt. He is considered a fellow Egyptian. To my dear friend: thank you for your tireless efforts. They are truly appreciated.

### Evidence Found at Giza Regarding Pyramid Construction

When the Overseer of All the King's Work selected the site for the pyramid, he had to establish the quarry, supply ramp, harbor, and workmen's camp. Tradition required that the site be on the west side of the Nile. More practical considerations were the location, preferably nearby, of a quarry to provide an adequate supply of limestone for the pyramid's core. A supply ramp was essential to allow the transport of stone onto the pyramid as it was built. A harbor and/or canals were needed for the transport and unloading of non-local materials. Fine white limestone for the outer casing, basalt for the temples, alabaster for statues, granite for the burial chambers and temples, and the materials necessary to construct a workmen's village were brought by this route. Each of the above elements had to be located in the natural terrain in such a way as to insure efficient flow of men and materials.

During the excavation and the site management project at the Giza Plateau, important discoveries were made connected with the building of the pyramids in general, and with the building of Khufu's pyramid in particular. The archaeological evidence found at Giza will be discussed as follows:

<sup>1</sup> I would like to thank K. NICHOLLS for editing and typing this paper. Special thanks are due to A. JONES, N. EL-MAGRABI and A. MAHMOUD for the architectural drawings, N. ABD EL-HAFIZ for the drawing of the ramp and H. EL-TAYEB for the photographs.

- I Evidence of pyramid base construction found to the east of Khufu's pyramid
- II The location of the quarry
- III The discovery of the ramp of Khufu's pyramid
- IV The discovery of the harbors of Khufu and Khafre
- V The discovery of the workmen's community at Giza.

### I Evidence of Pyramid Base Construction Found to the East of Khufu's Pyramid

Three discoveries around the subsidiary pyramids of Khufu (GIa and GIc) concern the construction of the base of the pyramids. The evidence was found during general clearing of the sand around the pyramids. G. REISNER did not excavate, nor completely clear the sand from around the base of these pyramids<sup>2</sup>.

Our excavation around the southwest side of GIc revealed the remains of a skeleton, found within a burial, inside limestone blocks, with hieroglyphic inscriptions of a person named Seshem-Nefer. The burial was of a lady aged between 50 to 60 years<sup>3</sup>. More burials were found in the area during this excavation, some dating to the Late Period. All of these burials were studied and recorded.

During the recent excavation and cleaning the following was discovered:

#### I. 1 The Pyramid Casing

The clearance of sand on the north side of the subsidiary pyramid GIa revealed the remains of part of the casing, lying in situ west of the pyramid entrance. The length of the block, made of Tura limestone, is about 30 cm. A depression on one side of the block outlines the area that once supported the casing thereby revealing its original dimensions (fig. 1, pl. 2a). Comparisons can be made between the stones in the pyramid core and the casing stones, or between the stone of the plateau (Mokatam formation), and the white fine limestone from Tura. The thickness of the casing and its construction method can also be studied.

#### I. 2 The Round Holes (fig. 1, pl. 2b)

A series of round holes about 40 cm in diameter were cut into the rock around the pyramid of Khafre. They lay about 9.50 m from its base, and were spaced about 5 m apart<sup>4</sup>. The same type of holes exist in the roof of the lower temple of Khafre, which made B. GRDSELOFF think that the holes served as sockets for the construction of the purification tent<sup>5</sup>. The same type of holes are also found on the south side of Khufu's pyramid. In our excavation we found the same type of round holes on the north and east sides of the subsidiary pyramid GIa.

These holes were noted by G. GOYON, V. MARAGIOGLIO and C. RINALDI as being connected with the laying out of the pyramid<sup>6</sup>. R. STADELMANN believes that these holes could be bases for trees based on references observed in some private tomb paintings<sup>7</sup>. M. LEHNER took the view of

<sup>2</sup> REISNER, *Giza I*, 3, 16–17, 70–72, 130–136.

<sup>3</sup> The National Research Center of Egypt did the analysis of the skeleton. The Research Center's team is responsible for the analysis of all the bones found during our excavation.

<sup>4</sup> V. MARAGIOGLIO, C. RINALDI, *Architettura delle piramidi menfite V*, Rapallo 1966, 72; U. HÖLSCHER, *Das Grabdenkmal des Königs Chephren*, Leipzig 1912, 60.

<sup>5</sup> B. GRDSELOFF, *Das ägyptische Reinigungszelt*, Cairo 1941, 22–49, see also Z. HAWASS, in: *MDAIK* (forthcoming).

<sup>6</sup> G. GOYON, in: *BIFAO* 67, 1969, 73, note 3; MARAGIOGLIO, RINALDI, *Architettura V*, 66.

<sup>7</sup> Personal communication R. STADELMANN.

G. GOYON, V. MARAGIOGLIO and C. RINALDI, and added that these holes were used to lay out the base of the pyramid as a square base<sup>8</sup>.

These holes are set at regular intervals and form lines which run parallel to the sides of the pyramid. The best theory for the purpose of these holes is that they served to hold stakes that carried a line used as a reference by the builders as they laid out the base of Khufu's pyramid with blocks of limestone, or in the case of Khafre's pyramid, with granite. These fifteen-ton blocks are marked so as to define the central axis of the pyramid's faces and diagonals. There are also trenches that were probably used to hold and drain water during and after the leveling operations<sup>9</sup>.

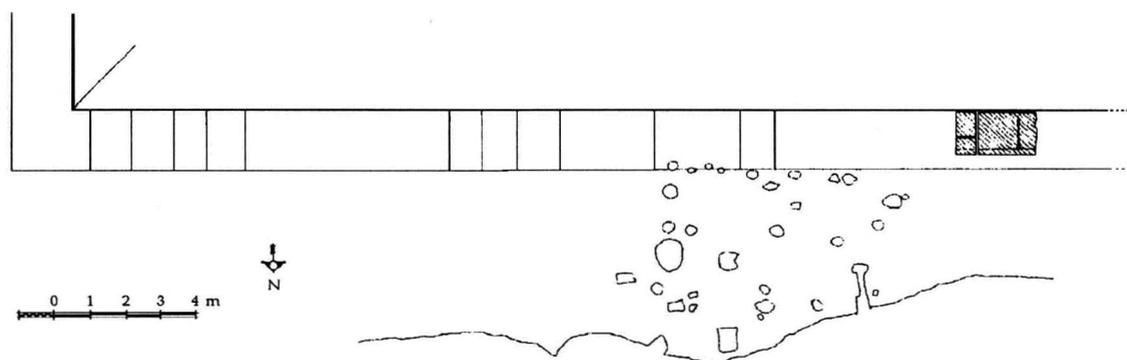


Fig. 1 Giza – Eastern Field, G1a: Casing block and round holes

### I. 3 The Perpendicular Lines

The base of the pyramid is placed on solid rock. On the south side of Khufu's pyramid, the base is seen to be part of the living rock formation rising as high as 8 meters above ground. On the north-west base of the subsidiary pyramid G1c, there are perpendicular lines. This pyramid is unfinished with only half of the lines carved into the base (fig. 2, pl. 3a). This, and the lack of a boat pit on the south side of this pyramid, suggest that Queen Henutsen may have died an early and unexpected death. We excavated the south side down to bedrock and no evidence of a finished pit was found, although the preparations for such a pit can be seen cut into the bedrock base.

## II The Location of the Quarry

The search for the location of ramps and quarries must include surveys of all four sides of the respective pyramids. M. LEHNER located the quarry of Khufu's pyramid to the south side of the pyramid base<sup>10</sup>.

The south side of Khufu's pyramid is the only side on which the quarry and the ramp could be located. The east side was not suitable as the tombs there were built in year 12 of Khufu's reign. Blocks from the quarry could not, therefore, be dragged through this area after that date, although pyramid construction continued well after year 12. There is no evidence of quarries or ramps either on the north side of the pyramid, or on the west where tombs of the officials began to be built in year 5 of

<sup>8</sup> M. LEHNER, in: *AfO* 32, 1985, 136–158.

<sup>9</sup> Z. HAWASS, in: D. SILVERMAN (ed.), *Ancient Egypt*, London 1997, 174–177; see also LEHNER, in: *AfO* 32, 1985, 136–158.

<sup>10</sup> M. LEHNER, in: *JARCE* 20, 1983; IDEM, in: *MDAIK* 41, 1985, 109–143.

Khufu's reign. The same can be said for the western tombs in regard to the length of the pyramid construction<sup>11</sup>.

On the south side of the Great Pyramid are the two boat pits which have been dated to the reign of Djedefre. The tombs built on this side are dated to the reign of Menkaure<sup>12</sup>.

According to the Egyptian pyramid complex program, the south side should contain the subsidiary pyramids. It seems that the architect of the Great Pyramid was forced to place the subsidiary pyramids on the east because the south side had to be used for the construction ramp.

The quarry must therefore be located low on the plateau, and on the south side of the Great Pyramid, and this is indeed where it is found. The quarry bears testimony to its ability to supply nicely layered stones which were suitable for the pyramid's large building blocks. As the pyramid was built, the quarry basin grew deeper and its sides aligned with those of the pyramid.

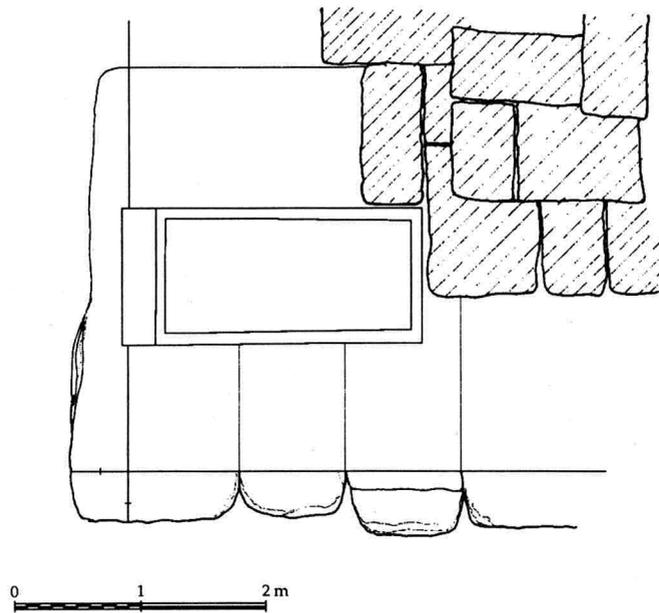


Fig. 2 Giza – Eastern Field, G1c north-west corner

### III The Discovery of the Ramp of Khufu's Pyramid

Excavation on the area south of the Great Pyramid revealed evidence of the remains of the ramp of the Great Pyramid.

#### III. 1 Previous Discussion of the Ramp

Scholars propose two theories: a straight ramp or a spiral ramp, both of which present their own problems. The first theory proposes a single large ramp sloping up against one face of the pyramid. This proposal has the advantage that all four corners and three sides of the pyramid remained clear during the construction, allowing builders to monitor and check the rise of the sides and the diagonals. Careful surveying during construction was essential; otherwise, a twist might occur and

<sup>11</sup> REISNER, *Giza I*.

<sup>12</sup> JUNKER, *Giza X*.

the diagonal lines would not meet in a point at the top. There are problems with this proposal. One is that to obtain a functionally low enough slope – one that rises 1 m every 6 m – the ramp would have to be extremely long, extending over and beyond the quarry.

The other theory posits a ramp spiraling around the pyramid in some way. The most popular form of this idea has a ramp starting at each corner thereby creating four ramps spiraling upwards and resting on the unfinished outer casing blocks for support. These blocks would be smoothed as the ramps were dismantled after the apex of the pyramid had been reached. This theory leaves most of the pyramid's face clear, for measuring purposes, during construction and the necessary double-checking of lines and corners.

The first problem with this theory is that the unfinished faces of the pyramid could not support the ramps which these theorists believe were made of mud-brick or debris. Also a spiraling ramp increases the distance over which the blocks had to be hauled and creates unnecessary strain for the team pulling each multi-ton block. It also increases the difficulty of pulling the blocks with extended ropes around the sharp corners of the pyramid's diagonals<sup>13</sup>. Another theory, proposed by M. LEHNER and R. STADELMANN, and supported by the author, is that the ramp rose from the quarry about 30 m above the pyramid's base at its southwest corner. The discovery of the ramp, southwest of the Great Pyramid proved that the last theory is the correct one.

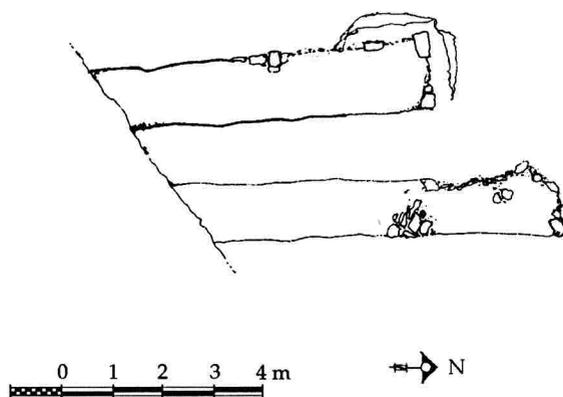


Fig. 3 Giza – Eastern Field, Pyramid of Khufu, South side:  
Plan of the ramp

### III. 2 The Discovery of the Ramp

During the work of relocating the cables of the Sound and Light Show at Giza, we were able to excavate along the course of their trenches, beginning southwest of the Great Pyramid. Also at this time we started the re-excavation of the cemetery GIS and the restoration of the tombs there.

As was discussed above, the only possible side for the erection of the ramp during the reign of Khufu was the south side. The ramp was constructed of limestone chips, gypsum, and a calcareous clay called *tafla*. Due to the hardness of the construction materials, any remains of the ramp after the Egyptians removed it to build the tombs of GIS should still be evident on the south side.

We started to remove sand for the erection of the Sound and Light cables north of the paved road and south of the pyramid. During the work we found a large part of the ramp used to transport the

<sup>13</sup> HAWASS, in: SILVERMAN (ed.), *Ancient Egypt*, 174–177.

stones from the quarry to the pyramid base. This part of the ramp consisted of two walls built of stone rubble and mixed with *tafla*. The area in between was filled with sand and gypsum forming the bulk of the ramp (figs 3–5, pl. 3b, 4a).

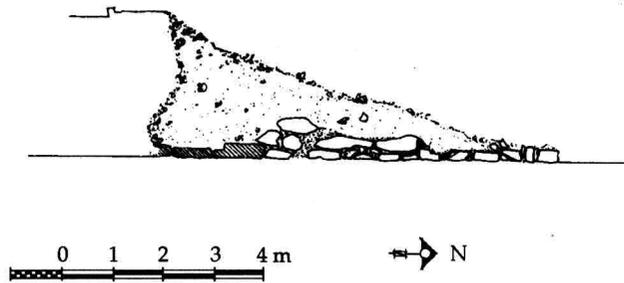


Fig. 4 Giza – Eastern Field, Pyramid of Khufu, South side:  
Elevation of the ramp

The length of the west wall is 1.40 m, built of stone rubble and *tafla*. The maximum height is 60 cm. Mud was used to consolidate the stones.

The eastern wall is located about 1.50 m to the east of the west wall. The width is 1.45 m and it is also built of stone rubble.

On the south side of the paved road, south of Khufu's pyramid, we excavated down about 2.5 m and found another part of the ramp. This part is in line with the eastern and western wall and is of similar construction. This discovery proves that the ramp led from the quarry to the southwest corner of the pyramid and was made of stone rubble and *tafla*.

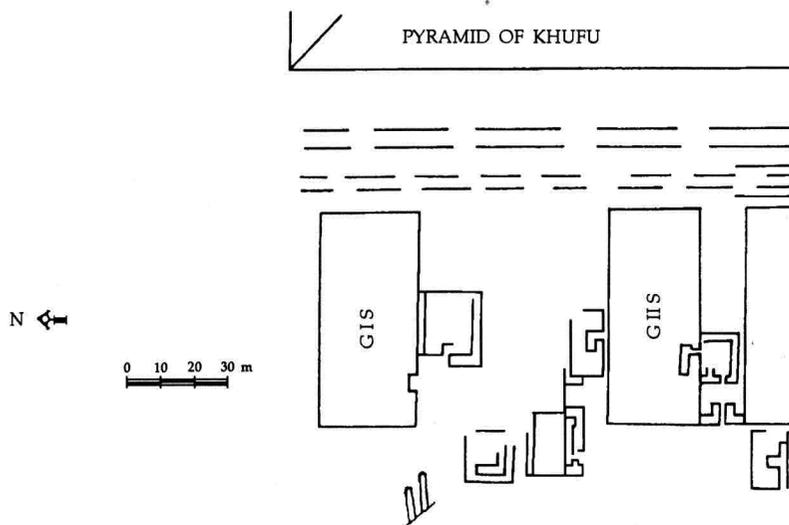


Fig. 5 Giza – Eastern Field, Pyramid of Khufu, South side:  
Remains of the ramp

The ramp rises to about 30 m above the pyramid's base at its southwest corner (fig. 6). The ramp would have leaned against the pyramid's faces as they rose, somewhat like accretion layers wrapped around the pyramid with a roadway on top. The weight of this ramp was borne by the ground around

## Pyramid Construction

the pyramid. Traffic could move along the top of this structure as both pyramid and ramp rose in tandem. The top of the pyramid could be reached with only one and one quarter turns. The slope would rise with each turn from a reasonable  $65^\circ$  for the first section, to as much as  $18^\circ$  for the last climb to the apex<sup>14</sup>.

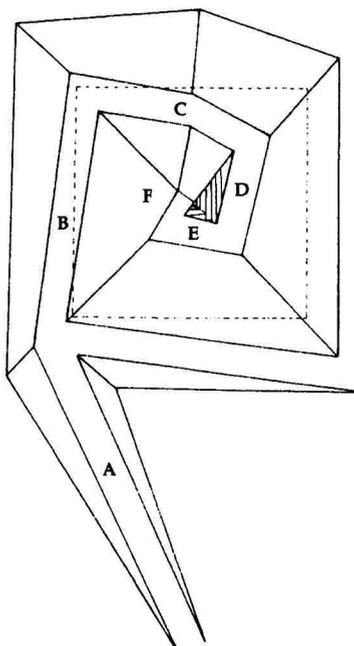


Fig. 6 Giza – Pyramid of Khufu:  
Location and construction of the ramp

### IV The Discovery of the Harbors of Khufu and Khafre

During periods of pyramid construction harbors and canals were used to deliver casing stones of fine white limestone from Tura, and granite from Aswan. Alabaster was imported from Hatnub for the construction of the temples and statues of the King<sup>15</sup>. Food was transported from far-off estates for the workers and the officials in charge of overseeing the construction. The river route could also have been used by workers not living at the workmen's village.

Our excavations in front of the Sphinx temple in 1980 proved the existence of the harbor of Khafre's pyramid. We opened a square in this area east of the Sphinx Temple. A core drilling was done about 68 m east of the same temple. The drilling went down about 20 m and hit granite. Further east there is a drop-off in the bedrock which could indicate the existence of a harbor in this area.

During the construction of new apartment buildings on the east side of Zaghoul Street, 650 m south of Pyramids Road in Nazlet es-Samman, a wall was uncovered built of a foundation of

<sup>14</sup> LEHNER, in: *AfO* 32, 1985, 136–158; IDEM, in: *MDAIK* 41, 1985, 129–132, figs 5–7; R. STADELMANN, *Die großen Pyramiden von Giza*, Graz 1990, 266–269, figs 172–173; HAWASS, in: SILVERMAN (ed.), *Ancient Egypt*, 40–43.

<sup>15</sup> G. GOYON, in: *RdE* 23, 1971, 137–8.

limestone blocks, about 4 m wide, with an upper course of basalt slabs, 3–5 m across. This could be the foundation of a wall of an old canal or harbor (pl. 4b)<sup>16</sup>.

## V The Discovery of the Workmen's Community at Giza: The Pyramid Builders

There are four archaeological discoveries at Giza connected with the pyramid builders:

1. The institution area
2. The workmen's camp (a settlement)
3. The lower cemetery
4. The upper cemetery.

### V. 1 The Institution Area

Two bakeries found southeast of the "Wall of the Crow" measure about 5.25 m in length and 2.5 to 2.6 m in width. Inside the entrance of each bakery lay a pile of broken bread pots discarded after the last batch of bread was removed. M. LEHNER found, according to paleobotanical evidence recovered from the site, that Egyptian cereal grains included barley, which has no gluten, and emmer, which has a small amount of gluten. The volume of the bread molds found in this area indicate that this must have been a leavened bread.

The expedition found another area thought to be for fish processing. This is suggested by the presence of troughs and benches which could have been used for drying, smoking, salting and storing fish, at least for a short term, perhaps in jars for which were found lids and stands<sup>17</sup>.

### V. 2 The Workmen's Camp

In 1990, the Egyptian government began the construction of the sewage system in the village of Nazlet es-Samman, and other villages nearby, in cooperation with AMBRIC. Here, the remains of an ancient settlement were uncovered, extending over 3 km under the village streets. The sequence of occupation at this site began with mudbrick buildings laid out over natural desert sand, followed by their destruction, the leveling of the remains with a layer containing very dense pockets of pottery, bone, charcoal, and layers of ash, and finally, a second series of mudbrick buildings covered with ashy rubbish thickly filled with pottery.

The location of the settlement to the east of the tombs and the institution area suggests that this site could be the workmen's camp<sup>18</sup>.

### V. 3 The Lower Cemetery (pl. 5a)

This cemetery lies on the low desert, south of the Sphinx. The tombs found here are built of mudbrick with chunks of limestone, granite and basalt. Their shapes vary from pyramid, step-pyramid, mastaba, bee-hive, and small mounds of mudbrick. Statues were found in front of the tombs and

<sup>16</sup> For full details of this discovery, see Z. HAWASS, in: C. BERGER, B. MATHIEU (eds.), *Études sur l'Ancien Empire et la nécropole de Saqqâra*, Fs J.-P. Lauer, Montpellier 1997, *Orientalia Monspeliensia* 9, 245–256.

<sup>17</sup> A. CHAZAN, M. LEHNER, in: *Paleorient* 16/2, Paris 1990, 21–35; Z. HAWASS, M. LEHNER, in: *Archaeology* 50,1, Jan./Feb. 1997, 31–38.

<sup>18</sup> Z. HAWASS, in: M. BIETAK (ed.), *Haus und Palast im Alten Ägypten, Untersuchungen des ÖAI* 14, DÖAW 14, 1996, 53–67; Z. HAWASS, M. JONES, *Old Kingdom Settlement Found at Giza* (forthcoming).

inside niches. Also hieroglyphic inscriptions were found written on false doors bearing titles such as *shd jr js*, and *hrp jr js*<sup>19</sup>.

#### V. 4 The Upper Cemetery (pl. 5b)

As we excavated the Lower Cemetery towards the south, we came upon a ramp that ran west, straight up the steep slope of the desert cliff for more than 23 m. It led us to a second cemetery, at a higher level, close to the top of the Maadi formation ridge. This is the cemetery of the artisans.

The tombs, so far numbering 43, are larger and more elaborate than those of the Lower Cemetery. Many of them are completely rock-cut or have a stone facade built in front of the cliff face. Others are built of limestone and mudbrick in the mastaba style. The size and location of these upper tombs is indicative of the higher status of those buried here. As in the Lower Cemetery, the skeletons were found in shafts, between 0.5 to 1 m underground, and mostly in a fetal position.

Many titles were preserved: The "overseer of the side of the pyramid", and the "overseer of the craftsmen" are two of the most important.

The above archaeological sites are separated from the pyramids to the north by a large enclosure wall, known as the Heit el-Ghorab (Wall of the Crow) which is built of stones as large as those in the pyramids. This wall extends eastward from the south side of the wadi.

The wall seems to have been planned as both a main entrance to the Giza Necropolis, and as a separation between the sacred precinct of the pyramid complex and the workmen's cemetery.

#### The King's Palace

R. STADELMANN believes that the royal residence, and the administrative court of the country were permanently located at Giza. He feels that the building of the pyramid complex was of primary importance requiring the cooperation of the entire population throughout the year. Based on text of the Abousir Papyri, he connects the palace of Isesi, which is said to have stood on the *š* (lake) of the King, with the title *hntj-š*, which is a common mortuary title at Giza. Thus he argues that Isesi's palace was at his pyramid site<sup>20</sup>.

M. LEHNER agrees with R. STADELMANN and reconstructs a huge palace south of the Lower Temple of Khufu and northeast of the Sphinx. He bases its measurements on the palace of Isesi, and supposes that it would be surrounded by an enclosure wall with recessed paneling in addition to large estates with groves of trees, lakes or pools, and vineyards<sup>21</sup>.

There is more evidence, in my opinion, to support this theory and also to propose that the King ruled from the pyramid site. If this is true then it can be postulated that Memphis, rather than being the political capital of Egypt, was to the Egyptians a holy site for the temple of Ptah. It follows then that the Kings' palaces were located not in Memphis, but along the Kings' pyramid sites from Abou Rawash in the North to Meidum in the South.

<sup>19</sup> Z. HAWASS, in: *Archaeology*, 50, 1, Jan./Feb. 1997, 39–43; IDEM, in: *Kunst des Alten Reiches, Symposium Kairo 1991*, SDAIK 28, 1995, 91–95, 97–101.

<sup>20</sup> R. STADELMANN, in: *RdE* 33, 1981, 77; and E. WINTERS argument against this theory, E. WINTER, in: *WZKM* 54, 1957, 222–233.

<sup>21</sup> LEHNER, in: *MDAIK* 41, 1985, 139–140.

A survey and excavation of the British expedition at North Saqqara found evidence of the archaic capital *Jnb-ḥd* near the tombs of the First and Second Dynasties<sup>22</sup>.

The discovery of the extensive Old Kingdom settlement at Giza suggests that the administration town was there, and that the limestone blocks found south of the lower temple of Khufu could be a remnant of the King's palace. This evidence suggests that the location of *It-tꜣwy* is at Lisht, close to the pyramid of Amenemhet III.

We found pottery food trays from Upper Egypt in the Old Kingdom settlement, supporting the theory that households in Upper and Lower Egypt participated, not only with labor, but with food supplies to further the advancement of the national project. It is known that the King celebrated with his people the completion of the pyramid complex<sup>23</sup>. Since the building of a royal pyramid was a national project, the King would have had to live nearby to command and control effectively the continuing unification of the population in the accomplishment of the project.

I therefore propose, based on the aforementioned evidence, that the palaces of the Kings were located near their pyramids and therefore, that Giza was the capital of Egypt during the reigns of Khufu, Khafre and Menkaure.

<sup>22</sup> H. S. SMITH, D. G. JEFFREYS, in: *JEA* 64, 1978, 10–21; H. S. SMITH, D. G. JEFFREYS, J. MALEK, in: *JEA* 69, 1983, 30–42; IDEM, in: *JEA* 70, 1984, 23–32; H. S. SMITH, D. G. JEFFREYS, in: *JEA* 71, 1985, 5–11; D. G. JEFFREYS, *The Survey of Memphis I*, London 1985.

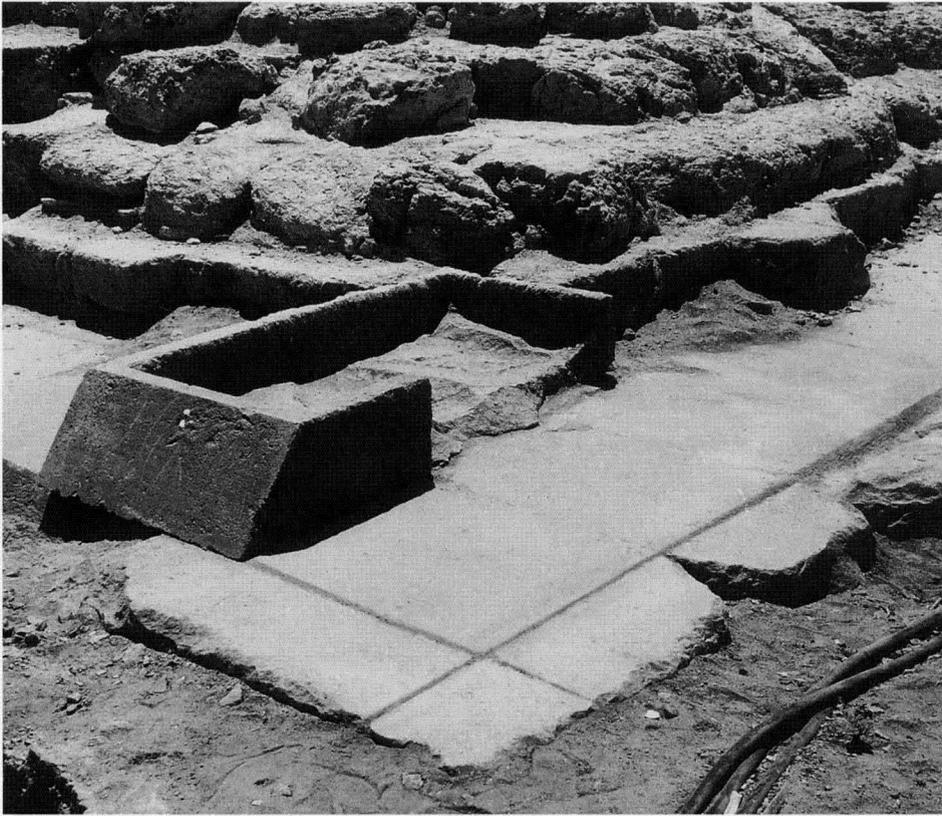
<sup>23</sup> See the scenes of dragging the pyramidion and the *hnr* shown on blocks found in Abousir, Z. HAWASS, M. VERNER, in: *MDAIK* 52, 1996, 177–186.



a Giza, Eastern Field, G1a, North side: casing block in situ



b Giza, Eastern Field, G1a, North side: round holes



a Giza, Eastern Field, G1c: North-west corner



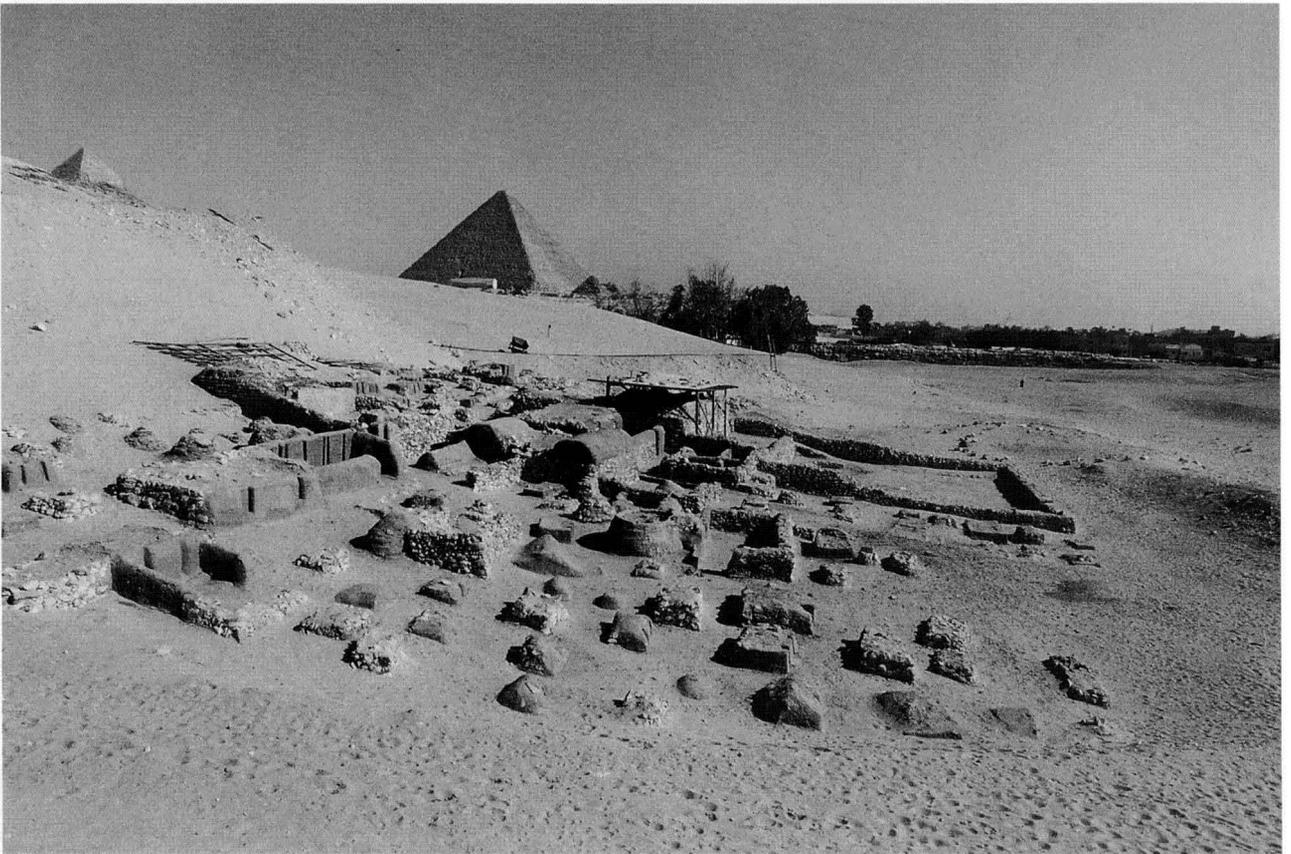
b Giza, Eastern Field, G1c: South-east corner and remains of ramp



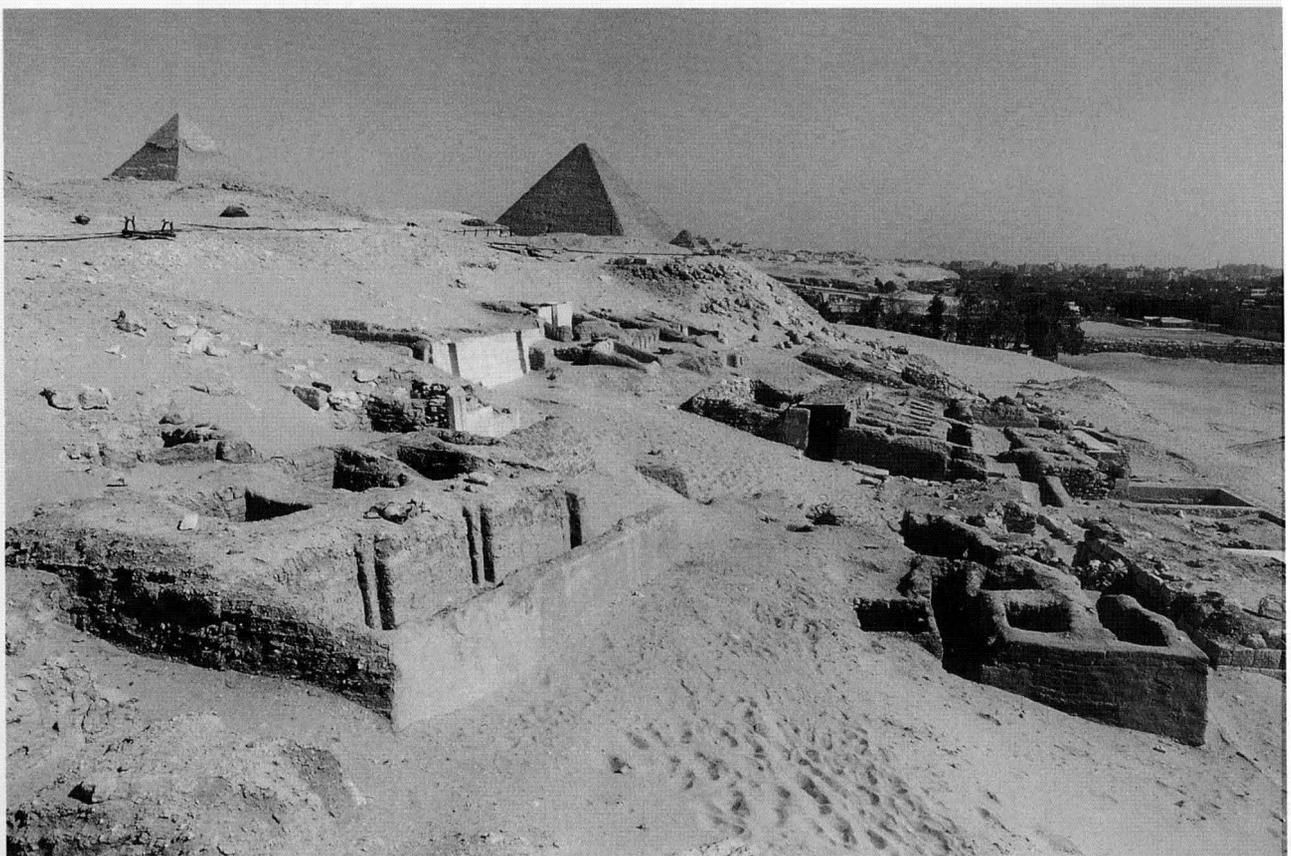
a Giza, Eastern Field, G1c: South-east corner and remains of ramp, detail



b Giza, Nazlet es-Samman: Remains of the harbour



a Giza: The lower cemetery



b Giza: The upper cemetery