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GEOARCHAEOLOGY OF THE KOM EL HISN AREA: TRACING ANCIENT SITES IN THE WESTERN NILE DELTA, EGYPT

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ABSTRACT

The present location of the Old Kingdom site at Kom el Hisn used to be simply explained by the presence of sandy mounds or the so-called Gizira sand. These Gizira sands are usually described by others as Pleistocene sand of the Nile Delta. The present geoarchaeological study addresses the questions of what the landscape looked like during the Old Kingdom period at Kom el Hisn and how geoarchaeological surveys can be used to trace the actual boundaries of ancient sites with an optimum number of auger holes and drilling. Several geomorphological and sedimentological considerations are presented about the Nile Delta. The term Gizira sand is not used in the present work due to its possible misleading use in the interpretation of the geological setting of Koms or tells; the term "diluvial sediments" is used instead . The Canopic branch of the Nile and some of its distributaries in the present area are traced. Alluvial aggradation and degradation as well as the fluctuation of the sea level (.i.e., the ultimate Nile base level) as a function of time are considered for the geoarchaeological interpretation of Kom el Hisn.

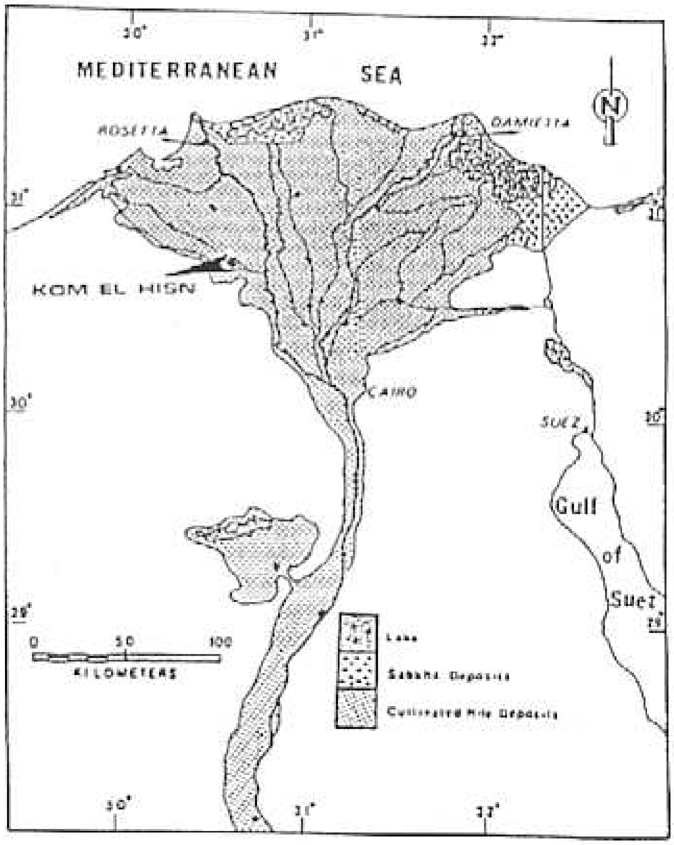
Between 3500 B.C. and 3000 B.C., the Mediterranean Sea level was higher than today and then was coupled with higher Nile floods (from 3000 B.C. to 2760 B.C.). Later, during the fifth Dynastic occupation at Kom el Hisn, the sea level was in a falling phase. It is my belief that the people of the Old Kingdom (who lived at Kom el Hisn after 2700 B.C.) took advantage of this situation by settling on these older (ca. 3000 B.C to 2700 B.C) and now higher point bars and natural levees which are located on the outer sloping margins of the diluvial yellow sand that forms the greater portion of the Kom. Also, Old Kingdom Man used the deposits from old dried out oxbow lakes as a source of raw material for mudbricks, ceramics and other building materials. The point bars and flood plains of his time would have been used for grazing and farming, respectively, while the river channel could have supported fishing and contemporary fresh water oxbow lakes, fishing fowling and the gathering of reeds.

Limitations and future prospectives of the present geoarchaeological study for Kom el Hisn and for the other Koms present in the area are discussed. At present, when there is still much to be learned, the most promising area for finding old and/or earlier archaeological sites is in the region surrounded by the area south of El Tod, the area north of El Haddien, and the area along the ancient water course of Absum el Sharqiya canal. In this region, coring at depths of 10 to 12 meters is very much needed.

TABLE OF CONTENTS

List of Figures and Tables

GEOARCHAEOLOGY OF KOM EL HISN



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Geoarchaeology of the Kom El Hisn Area: Tracing Ancient Sites in the Western Nile Delta, Egypt

While Herodotus used the Greek letter *delta* to describe the triangular mouth of the Nile river around 450 B.C., the ancient Egyptians called the Delta *Mḥw* or *T3-mḥ* which is possibly derived from *mḥw* "aquatic plants" or "flooded land"[1]. This implies that while the Greeks used a descriptive term for the triangular mouth of the Nile, the Egyptians from an early time on were concerned with physical features of the region. The Egyptians focused on the physical or floral features within the Delta, rather than on the border of the Delta on the Mediterranean Sea, despite the fact that they were well aware of the existence of the sea as well as the lands beyond it.

At the present time, the Nile river bifurcates into the Damietta and Rosetta branches just north of Cairo. The Delta stretches for about 170 km in a north-south trend and it covers an area of 22,000 km^2 (fig. 1)[2]. While this area forms less than 1/40 of the total area of Egypt, it represents 63% of the inhabited area. It also covers more than six of the most industrialized provinces in Egypt. In other words, we may now consider the Nile Delta area as constituting over half of modern Egypt, dividing the country into Bahari (northern) and Qibli (southern) regions, of which the Bahari region is one of the most important. Cairo was established here (*i.e.*, between Qibli and Bahari) as the capital of modern Egypt because of the importance of this area. The importance of the Delta seems to have started as early as 7000 years ago. For example, the major part of the

Predynastic Delta was certainly not a marshy wasteland[3]. The crown of the first Pharaoh displays the symbol of lower Egypt and the first capital of Egypt was located in this area, Manf, lying on the boundary between Lower and Upper Egypt.

In the seven millennia that elapsed since the first agricultural communities were established in the Nile Delta, Man has interacted with the Delta landscape considerably. Some of the most conspicuous results of his interactions and activities are the *KOMs* (tells) scattered across the Delta countryside, which consist of accumulated debris from hundreds of years of human occupation[4]. One of the Koms is Kom El Hisn, located on the western side of the Delta (fig.1). The midden part of the Kom is the location of a dense occupation area, present above medium sand deposits of alluvial origin. It is covered with halfa grass in some places, but over large areas is unvegetated and surrounded by cultivation. Kom El Hisn is a substantial, well-preserved, 5th dynasty settlement site with 1 to 3 meters of stratified deposits which, for the most part, are above the present water table and are unobscured by later deposits[5].

Kom El Hisn was one of the sites excavated during the summer of 1984 as a part of the Naukratis Project's continuing efforts to reconstruct and analyze patterns of human settlement in the western Delta[5]. While the Naukratis project was devoted to excavations at several late Pharaonic sites in the present area[6] (fig. 2), Robert Wenke and his crew from the University of Washington have extended their analysis of the western Delta cultures into the Old Kingdom period. The major premise of the Kom el Hisn archaeological project is that the site can give valuable information about the ecological, economic and administrative variables of ancient Egypt. These variables must be studied for a more comprehensive explanation of cultural evolution in Egypt*.

The present study is a geoarchaeological survey carried out in the summer of 1986 in the Kom el Hisn area. It deals with the reconstruction of the landscape during early Dynastic times and attempts to understand the palaeoenvironment during early Dynastic times.

The questions addressed in this geoarchaeological survey were:

1) What did the landscape look like during the Prehistoric occupation in the Western Delta, and in particular at Kom el Hisn?
2) How can such a survey be used for tracing the actual boundaries of ancient sites?, and
3) How can other archaeological sites in the present area be looked for?

These questions are quite important since much information is needed to understand the palaeoenvironment and the ecology of the only Old Kingdom settlement site in the present area.

The importance of the relation between the natural landscape and the spatial distribution of archaeological remains has been recognized by several scientists who worked in the Eastern Delta,

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* For more detailed information about the importance of the Kom el Hisn project and the results of the project's excavation in this area, please refer to R. Wenke (1985) in the Newsletter of ARCE.[5]

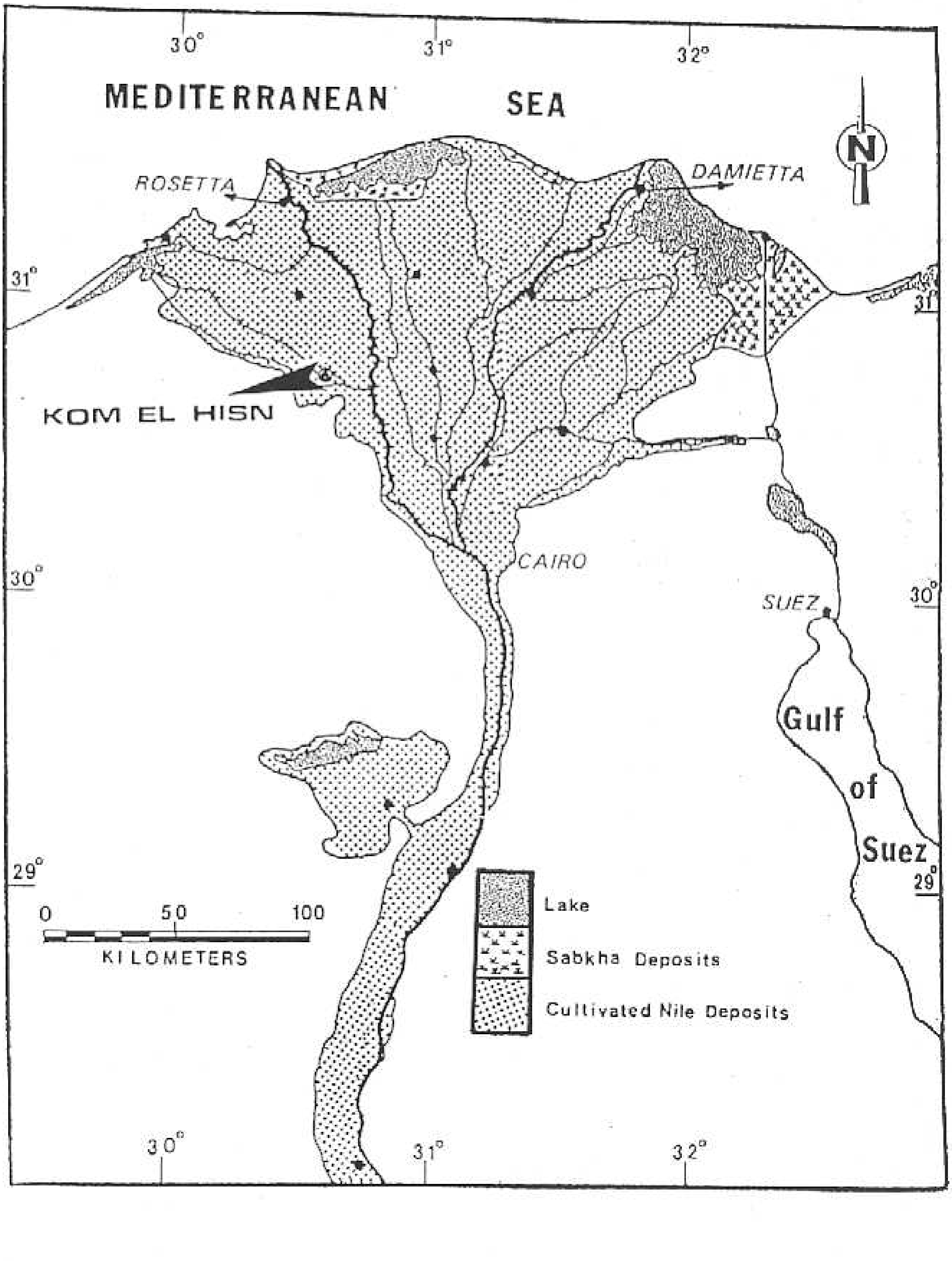
such as Bietak (1975)[7], Wasemael and Dirksz (1986)[8], Sewuster and Wasemael (1987)[9] and Wunderlich (1986).[10]

In the Nile Delta, the geological work of water courses (*i.e.*, transportation, erosion and deposition) is indeed one of the most important factors in the sculpture of the landscape. Thus, tracing ancient river courses, studying their deposits, and understanding their geological evolution as a function of time, would be quite valuable to the geoarchaeologist for determining the actual boundaries of ancient burial sites, and for developing a model that can be used for the prospecting of other archaeological sites.

Geomorphological and Sedimentological Considerations:

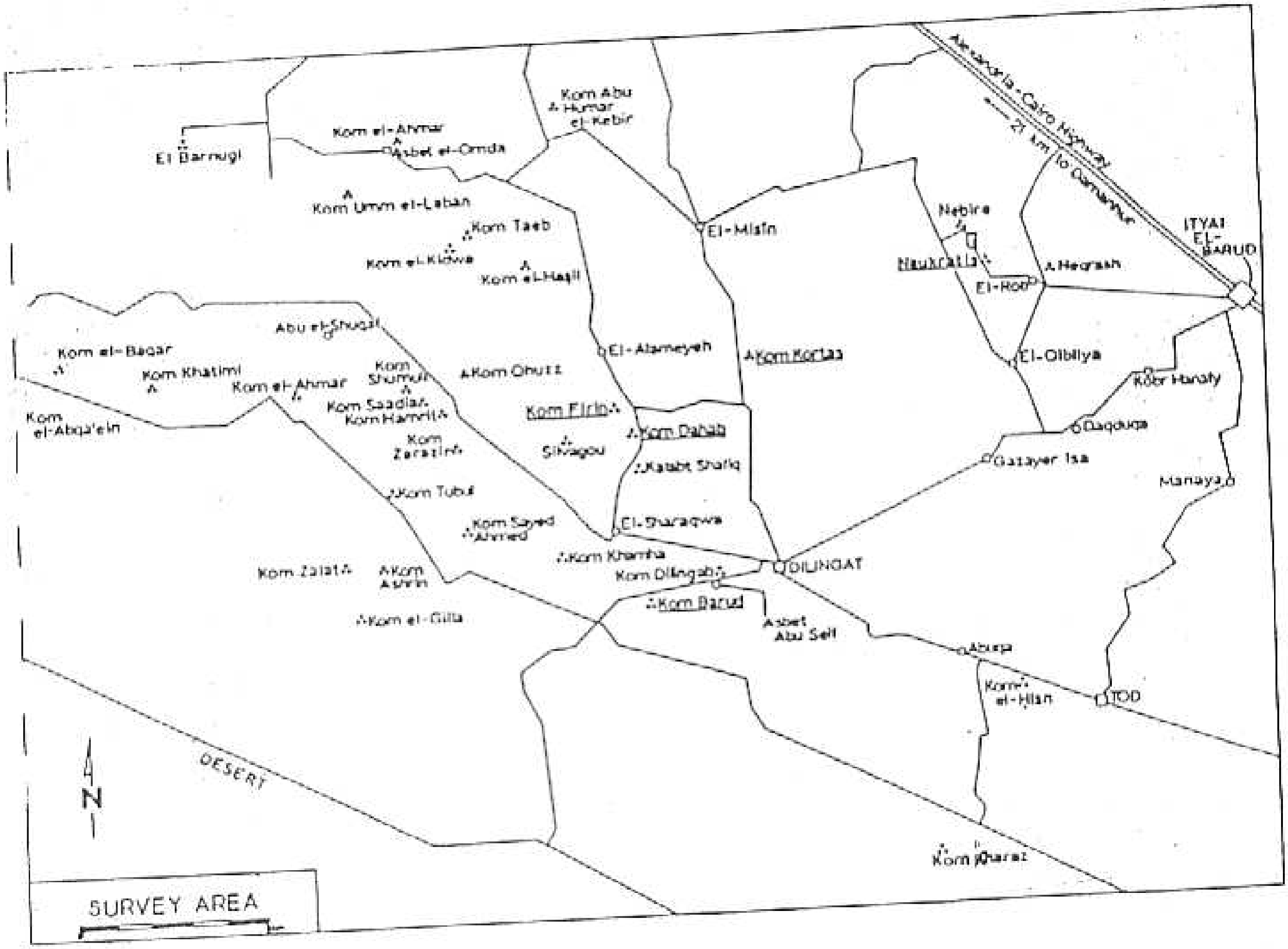
Since the morphology of the Delta is quite different from that of the valley proper, it is logical to assume that the magnitude of vertical and lateral aggradation and degradation of the Nile river would be different from that of the valley proper. In the Delta, water and sediments are able to spread out over an area at least twice the size of the area available to the valley proper, since there is no lateral constriction such as the limestone gorge of the Nile south of Cairo[11]. Moreover, a large body of Nile sediments as well as Nile water used to be carried out to the sea. In fact, several studies on the Quaternary deposits of the Eastern Mediterranean Sea have shown the significance and the locally dominant influence of the Nile river as a major contributor of sediments to the region[12]. At the same time the Nile river base level has changed with the fluctuating

Fig. 1 - Map of the Nile Delta and the lower part of the Nile Valley showing the location of Kom el Hisn.



30°
31°
32°
MEDITERRANEAN SEA
N
ROSETTA
DAMIETTA
31°
KOM EL HISN
CAIRO
30°
SUEZ
Gulf of Suez
29°
0 50 100
KILOMETERS
Lake
Sabkha Deposits
Cultivated Nile Deposits

Fig. 2 – Location map of the survey area of the Naukratis Project. After Coulson and Leonard (1981)*



AFTER COULSON AND LEONARD (1980)6

levels of the Mediterranean. These base level fluctuations in turn would have influenced the alluviation of the Delta branches. Thus, regional geomorphological and sedimentological factors as well as ancient fluctuations in the Mediterranean Sea level must all be taken into consideration when studying the geological evolution of the Delta branches as a function of time.

The Nile Delta occupies a portion of the gulf area dominated by the valley in Pliocene times. It is bounded for the most part on the eastern and western sides by gravel plains (+100 m) which merge into elevated Miocene and Pliocene sediments. These gently incline toward the northeast and northwest, respectively. The Nile branches 23 km north of Cairo in a nearly flat area that is very suitable for spreading fluviatile sediments. It slopes to the north with a very gentle gradient of 12 meters in its entire 170 km north-south trend. To the north of El Muqattam and Abu Rowash, the land grows flat and the high lands disappear. In general, the Delta is described as a widespread flat area with a very low relief ratio. Almost all of the area is highly fertile due to alternating dark brown Nile sediments of silt, clay and clayey sand[13]. However, it actually displays several contrasting geomorphic features. The contour lines are closer to each other in the southern Delta than in the northern Delta. According to Hamdan (1980), the Delta can be subdivided into three zones, separated by 7 meter and 3 meter contour lines.[14] These are the southern, the middle and the northern Delta zones.

The southern zone lies above the 7 meter contour line. It contains all of El-Minufiya, El-Qalyubia and the southern third of El-Gharbia provinces as well as some parts of El-Beheira and

El-Sharqiya provinces. It is the highest zone in the whole Delta, characterized by coarser Nile sediments when compared with the other two zones. The river gradient in this zone is about 1:7000 and is characterized by the presence of large numbers of turtle-backs. The width of this zone is narrow when compared with the other two zones.

The middle zone is surrounded by 7 meter and 3 meter contour lines. It comprises parts of El-Gharbiya, El-Daqahlia, El-Sharqiya and El-Beheira provinces. The northern boundary of this zone ends south of the coastal lakes. The region of the middle Delta generally slopes from east to west, making the level of the Damietta branch higher than that of the Rosetta branch by two meters.[3] It is usually characterized by finer sediments when compared to the southern zone. However, some turtle-backs occur in this zone. In general, it is considered to be a transitional zone between the southern and northern Delta zones.

The northern zone of the Delta is situated at an elevation less than 3 meters above sea level. It is characterized by a high relief ratio when compared to the other two zones. It also has the finest Nilotic sediments of the 3 zones. The gradient in the northern reaches of the Delta is about 1:19,000. The northern part of the Delta is a berari area with several brackish lagoons (Maryut, Idku, Burullus, Manzala) connected with the Mediterranean Sea through narrow striates. The northern Delta zone is separated from the sea by a coastal sand dune belt that stretches along the coast for about 110-120 km. The 3 meter contour line marks the maximum southern limit for lagoonal conditions ever to exist. In this zone, there are two main types of morphology. These are the coastal morphology and deltaic morphology[15]. The coastal morphology mainly consists of sand barriers created by wind and waves. The deltaic morphology mainly includes channels, levees, interdistributary basins, marshes and other small deltaic features created by the Nile discharge behind the sand barries.

In summary of the major geomorphological features of the Delta, it is possible to say that the greatest part of the Nile Delta consists of a system of Nile distributary branches in an alluvial plain with natural levees and flood basins. It is characterized by the presence of sandy islands (turtle-backs) in the southern and middle Delta zones, and a berari area in the north with several brackish lagoons, which are separated from the Mediterranean Sea by a coastal sand dune belt.

A) Turtle-Backs and Diluvial Deposits:

At the time of the formation of the river terraces in the Nile valley, the river was depositing great amounts of sand and gravel in the Mediterranean. The fluviatile sediments belonging to this river system spread into a large delta whose surface was eroded by later deltaic branches and their distributaries when the sea level dropped at the end of the Upper Paleolithic.[3,14]

The fluviatile sediments belonging to this river system* crop out along both sides of the southern part of the Delta margins, forming an important element in the landscape. In the

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*Said in 1982 refers to this river system as the Prenile.[16]

Delta, these old sediments seem to lie unconformably beneath younger Nile deposits (Nile alluvium) whose upper parts form the fertile land of the Delta.[16-18] On the basis of lithology and mineral analysis, Said correlated these sand and gravel deposits with the Prenile Qena sand in 1982.[16]

The "Prenile" flowed for a long period of time throughout most of the Middle Pleistocene and terminated around 200,000 B.P. While Ball in 1939[17] and Hamdan in 1980[14] refer to these sediments as *sub-deltaic deposits*, Attia in 1954 referred to the same sediments as *diluvial deposits*.[18] They are of light yellow color and consist mainly of coarse sand and gravels. Examination of the gravels show them to contain pebbles of quartz and flint as well as pebbles of igneous and metamorphic rocks. Biotite and iron oxides are also often present[18]. In the Delta wells, these sand and gravel deposits are of great thickness*. In the northern margin of the Delta, these deposits seem to merge into sandy strata with marine shells.

The sand and gravel deposits (or the diluvial sediments) also outcrop as isolated low mounds or "islands" in the midst of the fertile fields of the Delta, representing the higher parts of the eroded surfaces of these sediments. Archaeologists and geographers often refer to the upper parts of these sediments as "*Gizira Sand*" or "*Sand island*"[7-11,20]. Butzer has referred to these sediments as Pleistocene sands and gravels in 1976[21]. In

---

* It has a thickness of 463 meters at Mit Ghamr well #1. Petroleum geologists usually refer to these sediments as Mit Ghamr formation, defined by Rizzini *et al.* in 1978.[17]

the more easterly parts of the Delta these diluvial sediments rise through the fertile fields forming the round gravelly banks known as *turtle-backs*[22]. The inspection of old topographic maps as well as the activities of the farmers in the Delta (*i.e.*, the man-made landforms), indicate that both the elevation as well as the surface geographical distribution of the turtle-backs are constantly decreasing. This is because of the following:

a) the annual accumulation of Nile alluvium*[1]

b) the man-made leveling of the margins of the turtle-backs to expand agricultural fields,

c) the modern sand quarrying for these sediments.

The present geographical distribution of the turtle-backs, as was described by several workers, seems to be between latitudes 30° and 31°N and longitudes 31° and 32°E[2,14]. Four of them are found in the Quwaysna district, one near Faqus and five to the south of lake Manzala.

Stanley and his coworkers used on-shore and off-shore drilling as well as advanced sedimentological and laboratory techniques to (1) monitor the changes of the eastern Delta coastline position as a function of time; and (2) to recognize the geographic distribution of former Nile distributaries*[2] and their delta-mouth lobes[23-25]. In these studies, he recognized late Pleistocene coarse grained sands of fluviatile origin and of upper Nile provenance. In the northeastern part of the Nile

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*[1] However, this process has declined since the introduction of perennial irrigation and the construction of the High Dam.

*[2] Specifically, the Mendesian, Pelusiac, Tanitic and Pre-modern Damietta.

Delta, lenticular layers of silty clay were identified in this late Pleistocene sequence. They vary in thickness from a few centimeters to 8 meters[23]. On the basis of grain size and heavy mineral analysis, he considered this late Pleistocene sequence as a part of the Mit Ghamr formation. Stanley has assigned an age older than 30,000 years to these sediments. As far as I am aware, the previously mentioned date and the time period given by Said in 1981 for the Prenile sediments*1 were the only clearly assigned dates for these sediments. It is evident, that more dates are required, at least for the upper most parts of these Pleistocene sands and gravels. From now on, I will refer to the upper part of these Pleistocene sands and gravels as ***Diluvial Sediments*** for the following reasons:

1) to distinguish these sediments from Late Pleistocene sands described by Butzer (1976, p. 22)
2) to clarify that they only represent a part of the Mit Ghamr formation*2 and not all of the fluvial sand and pebbles with clay interbeds of this formation which has an estimated average thickness of 700 meters[26],
3) Although the heavy mineral analysis indicates that these sediments are of Upper Nile provenance[23] and that their sources seem to have been outside of Egypt[16,27], they are somewhat different than the proper alluvial Nile sediments. Correspondingly, the physical, geochemical and possibly the

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*1 Middle Pleistocene to 200,000 B.P. This not only includes the Prenile Qena sands but all of the Qena-Dandara complex.[16]

*2 most probably, its uppermost part.

hydrological systems responsible for the deposition of these sediments are not exactly the same than those of the <u>proper alluvial Nile sediments</u>, which derive all of their water only from the Abbyssinian Plateau (via summer floods) and the Central African sources[28,27].

4) These sediments should be <u>firmly differentiated</u> from younger Holocene (or possibly Late Pleistocene/Holocene) coarse and medium sand with mica and magnetite, which is sometimes interbedded with alluvial Nile silt and clay. These latter interbedded sediments have been frequently found in some of the boreholes described by Attia in 1954 (for example, the boring made near Mahallet Zaiyad, El Mansura, Kafr Bulin, Kafr Gharin, Kafr Migahid and many others)[18] or those boreholes described by the staff of the Research Institute for Ground Water (for example well number 270,263 and others).[30] *

5) (a) all of the geologists, archaeologists and geoarchaeologists who studied these sediments agree that these sediments are of Pleistocene age[7-23,26,31-32], (b) these Pleistocene sands and gravels seem to have been deposited by a highly vigorous and competent river system with a copious supply of water and a wide flood plain[16,27], and (c) the term <u>*diluvial*</u> refers to that period of geologic time since the appearance of man. Diluvium is an old term originally applied to the accumulation of sand and gravels believed to be the result of the Noachian deluge, but now is being applied to all

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* There will be more discussion for this reasoning later in the text.

masses that are apparently the result of powerful aqueous media[33].

Therefore I feel justified to apply this term (*i.e.*, diluvial sediments) to those sand and gravel sediments that form a part of the Mit Ghamr formation or Qena sands; and to use the conventional term (Nile alluvium) for those sediments that succeeded them and continue to the present time, regardless of whether they are the Late Pleistocene sands described by Butzer (1976, p.22) or whether they are the later coarse and medium grey and/or yellow sands that are usually interbedded with proper Holocene Nile Mud*. However, as was mentioned earlier, more dates are urgently required for these diluvial deposits. For the time being until better means of dating sand and gravel deposits are developed, it seems that the only possible way to estimate the time for the start of the deposition of these diluvial sediments, as well as the time for the start of their severe dessication, would be by monitoring and interpreting aggradational and degradational phases as a function of river flood volumes and Mediterranean sea level fluctuations with time. If we assume that changes of the relative levels of land and sea (as a base level) during the Pleistocene and Holocene period led to changes (*i.e.*, readjustment) of the level and gradient of the river in land; then one should expect a rise in the surface of stream beds and flood plains by accretion or deposition (*i.e.*,

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* It is needless to say that the first geologist to have used the term diluvial deposits for the stratigraphy of the Nile Delta is Attia in 1954.[10]

aggradation) with each rise in the sea-level; and, correspondingly, a lowering of its channel by erosion (*i.e.*, degradation) with each fall.

The available data for sea level fluctuations with time can be summarized as seen in tables 1 and 2. Table 1 summarizes Ball's view (1939) for the sea level fluctuations as a function of time[17], while Table 2 summarizes Butzer's view starting from 20,000 B.C. until 700 A.D.[11,21], as well as the Paleogeographic interpretation of Stanley and his workers from their recent excellent studies on the sedimentolgy of the north eastern part of the Delta.[12,23-26] With special emphasis on the relative sea-level fluctuation, these data indicate the following:

1) The principal rises in the levels of the Mediterranean Sea during the Pleistocene and the Holocene occurred between:
   - A) Middle Mousterian (30,000 to 40,000 B.P.) and late Middle Paleolithic (*i.e.*, a relative sea level rise of about 28 m)
   - B) later than 20,000 B.C. and 7000 B.C. (*i.e.*, a relative sea level rise of about 130 m).
   - C) 7000 B.C. and 3500 B.C. (*i.e.*, a relative sea level rise of about 24 m)
   - D) Later than 2200 B.C. and 1200 B.C. (*i.e.*, a relative sea level rise of about 4 m).
   - E) Later than 400 B.C. and 700 A.D. (*i.e.*, a relative sea level rise of about 2.5 meters)
2) The principal falls of the levels of the Mediterranean Sea during the Pleistocene and Holocene are those between

Table 1 – Relative Mediterranean Levels and Related Events as a Function of Time (Ball, 1939)[19]

TABLE I

RELATIVE MEDITERRANEAN-LEVELS AS A FUNCTION OF TIME

PERIOD	STAGE	APPROXIMATE LEVEL OF MEDITERRANEAN RELATIVE TO THE LAND, AS COMPARED WITH THAT OF THE PRESENT DAY (in meters)	RELATIVE DIFFERENCE FROM PRECEDING TIME PERIOD
Late Pliocene	140-m* Nile Terrace	+ 154	
			- 25
"	115-m Nile Terrace	+ 129	
			- 26
Early Pleistocene	90-m Nile Terrace	+ 103	
			- 31
"	60-M Nile Terrace	+ 72	
			- 15
"	45-m Nile Terrace	+ 57	
			- 16
Early Paleolithic	Chellean (30-m NT**)	+ 41	
			- 16
"	Acheulean (15-m NT)	+ 25	
			- 7
Middle Paleolithic	Early Mousterian (9-m NT)	+ 18	
			- 30
"	Middle Mousterian	- 12	
			+ 28
"	Late Mousterian	+ 16	
			- 3
Late Paleolithic	Early Sebilian	+ 13	
			- 10
"	Middle Sebilian	+ 3	
			- 46
"	Late Sebilian	- 43	
			+ 33
Neolithic	Early Neolithic	- 10	

* meters

** Nile Terrace

Table 2 – Relative Mediterranean Levels and Related Events as a Function of Time (Butzer, 1959, 1976)[11,21]

TABLE (2)

RELATIVE MEDITERRANEAN - LEVELS AND RELATED EVENTS AS A FUNCTION OF TIME

TIME	APPROXIMATE LEVEL RELATIVE TO THE PRESENT SEA LEVEL (in meters)	RELATIVE DIFFERENCE FROM PRECEDING TIME PERIOD	SIMULTANEOUS EVENTS IN THE NILE VALLEY AND THE DELTA
20000 B.C.	-150		
		+130	*High White Nile Floods. (10000 - 8000 B.C.)*
7000 B.C.	-20		
		+9.0	
5500 B.C.	-11		*High Nile Floods.*
		+11.0	
4000 B.C.	0.0		
		+4.0	*High Blue Nile Floods (data found at Hierakonpolis)[30]*
3500 B.C.	+4.0		
		ca. -2.0	*The Delta margin of the Delta plain is prograding northward with an average rate of ca. 10m/year[23].*
3000 B.C.	>+2.0		
		ca. -4.0	*Old Kingdom High Floods (3000 - 2760 B.C.)[21]*
2200 B.C.	-2.0		
		ca. +4.0	*Reported famines due to weak floods around 2180 - 2130 B.C.[16].* *Reported High Floods (1840 - 1775 B.C.)[14].*
1200 B.C.	>+2.0		
		ca. -4.5	*High Nile Floods (900 - 700 B.C.)*
400 B.C.	-2.5		*Herodotus described the Nile Delta.*
		+0.5	
300 B.C.	-2.0		
		0.0	
100 A.D.	-2.0		
		+2.0	
700 A.D.	0.0		

A) Early Pleistocene and Middle Mousterian (gradual decrease of about 100 meters).

B) Late Middle Pleistocene and 20,000 B.C*

C) 3500 B.C. and 2200 B.C. (*i.e.*, a relative sea level fall of about 6 m). However, recent sedimentological studies by Stanley and his coworkers clearly show that the sea level was generally rising from 3000 B.C. to 500 B.C. and at the same time the Delta plain was progressing northwards with an average seaward accretion rate of the Delta margin of about 10 meters/year[23]. This seems to be quite reasonable since Butzer has indicated high Nile floods during the 1st Dynasty (*i.e.*, 3000 to 2763 B.C.)[21]. Also, Paleoclimatic studies in the equatorial and East African lands have indicated that during the time period of the Neolithic (particularly around 3000 to 2500 B.C.), the climate in the Abyssinian plateau was considerably wetter than it is today[34]. Thus the historical records, as indicated by Butzer[21] and the paleoclimatic studies in the Abyssinian Plateau[34], favor the factor of high accretion rates as suggested by Stanley[23] over a fall in the sea level during the time period of 3000 B.C. to 2500 B.C. and then again around 2000 B.C.

D) Around 400 B.C., there was a relative sea level fall of about 4.5 m.

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* Full data are not available to me yet, but perhaps lie in the magnitude of about 100 to 150 m (?)

The previously mentioned facts, as well as the indication that the present elevation of some diluvial sediments (that are preserved in the form of turtle-backs) is about 13 meter higher than the surrounding Nile alluvium[14], makes it seem possible that these sediments may have been deposited when the base level (*i.e.*, the sea level) was at least 16 m higher than the present sea level. This suggests that these diluvial sediments started to deposit with the beginning of the sea level rise in the Middle Mousterian (*i.e.*, 30,000 to 40,000 B.P.) and this aggradational episode may have continued for at least 10,000 years. Also, the intensive dessication of these diluvial sediments must have started at least around 20,000 B.C. Until we have better means of dating and absolute dating of these sediments, 30,000 to 40,000 B.P. seems to be a likely and possible date for these sediments.

B) Alluvial Nile Sediments:

These are the sediments that rest on top of the diluvial deposits in the Delta. It is on the surfaces of these deposits that history has witnessed the dawn of civilization and the first state. They also form the fertile land which Egyptians consider as the principal everlasting source of wealth of their country.

The alluvial Nile sediments were laid down in the Delta during the Late Pleistocene/Holocene time. They are usually dark brown in color, consisting of clays, sandy clays, clayey sands, silty sand, fine sand and mud. Coarse to fine sands are sometimes interbedded with these dark brown Nilotic sediments*. These sediments form the younger part of the Neonile deposits described by Said in 1981.[16] The average thickness of the Nile mud in the whole Delta was estimated to be 9.8 to 11.96 meters[18,17]. The average from 22 borings in the northern Delta is 11.2 and from 39 borings in the southern Delta is 8.5 meters[17]. Based upon Ball's estimation for subrecent annual depositions of 1.03 mm of Nilotic mud[17], Butzer estimated that Nile silt accumulation began about 7600 B.C. in the Delta[11]. He also estimated that:

1) 60% of the Nilotic mud had been deposited before the first Dynasty.
2) Nile mud deposition was limited between 1960 B.C. and 990 B.C.
3) 20-25% of the Nilotic mud had been deposited since about 500 B.C.

In the north eastern Delta, Stanley and his coworkers have identified two important sedimentological units[23]. These are Late Pleistocene-Holocene transgressive sands and a marine Holocene silt and clay admixture.

The Late Pleistocene-Holocene sand is 2 to 10 meters thick and rich in heavy minerals that indicate a Nilotic provenance. The initiation of their deposition was estimated to be between 20,000 and 15,000 B.P. Along the coast, the fluvial sands (originally) were later transformed to cleaner sands with marine fauna as a result of reworking in nearshore and beach environments[23,24]. Also, along the coast, these sands interfinger

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* See Attia 1954, for example p. 214-216 and 278, 290, 245.[18]

(locally) with peat deposits that date from about 9000 B.P.[23] South of Lake Manzala, at a sector where the sands were not reworked by the sea, a date of about 10,000 B.P. was estimated for the upper part of these fluvial-derived grey sands[23]. It seems that it is possible to correlate these Late Pleistocene/Holocene sands in the north with the Late Pleistocene fine sands described by Butzer (1976, p. 22)[21] in the southern part of the Delta. At the same time, it is difficult to correlate these with the coarse to fine sands that sometimes intercalate with Nilotic mud, as mentioned earlier. This is so because of the following:

1) As far as I am aware, no systematic sampling of these alluvial coarse to fine sands was done. This clearly implies that sedimentological or geochemical analyses have not yet been performed.
2) While these coarse to fine sands sometimes lie directly on top of the diluvial sediments, implying that they could be Butzer's Late Pleistocene fine sands*[1], they also sometimes intercalate with the Nilotic mud; this clearly implies that they are of Holocene age.

In other words, it seems that these coarse to fine greyish yellow sands have been formed during more than one period. Since the mineralogical and size composition*[2] of their medium sand fraction seems to be similar to that of the diluvial sediments,

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*[1] See Attia 1954, p. 311, 245, 243, 206.[19]

*[2] The heavy mineral analysis for some of these sediments have been started, but results are not yet finalized.

it is logical to say that these coarse to fine greyish and or yellow sands were, at one time, a part of the less compacted portions of the diluvial deposits that were disintegrated and reworked by the water action of the Delta distributaries. They were then mixed with Nilotic sediments and redeposited as channel deposits and point bar deposits by the extinct branches of the Nile Delta and their numerous distributaries. This clearly implies and shows the necessity for studying the spatial distribution of these sediments and their importance as a key factor to tracing the ancient water courses in the Nile Delta. It is along and near to these water courses where many archaeological sites (*i.e.*, Koms and tells) were found.

C. The Nile Delta Distributaries

Several historians and geographers have indicated that the Nile Delta had more distributaries than it does now. Herodotus (450 B.C.) indicated three principal branches and four smaller ones, two of them being artificial (the Bolbitic and Bucolic branches) while Ptolomy (200 B.C.) reported six main branches. Some Arab geographers listed five branches, and others listed six or seven[2]. Figure 3 displays the Delta branches after Herodotus, Strabo and Ptolomy. However, seven branches can be easily recognized. From east to west, these are[2]:

1) the Pelusiac branch
2) the Tanitic branch
3) the Mendesian branch

4) the Bucolic branch

5) the Sebennyic branch

6) the Bolbitic branch and

7) the Canopic branch

Five branches have now disappeared and only two remain. During the time when they were all active, geological processes such as armouring, avulsion, bending, aggradation in one place and degradation in another, and much meandering were all occuring. In other words, the Delta branches and their many distributaries were never static and they were always in constant change since the start of their evolution.

In 1976 Butzer estimated that the seven or eight Delta distributaries indicated by earlier historians had only evolved during the time period of 4000 to 2000 B.C. (Butzer 1976, p. 24, 25).[21] However, Hamdan indicated that several Nile distributaries existed by the end of the Late Pleistocene and their erosional powers were quite high and laid down the transported subdeltaic deposits close to the coast[14]. In fact, Stanley and his coworkers concluded from their recent studies that the Mendesian branch did exist as early as 8000 B.P.[23]. However, there seems to be an agreement that during the Predynastic up until at least the Islamic time period, the Delta distributaries existed and the maximum extent of the coastal lagoons and marsh lands never passed the 3 meter contours line (*i.e*, they were not more than 55 km from the coast). It is along and between these Delta branches and their distributaries that archaeological settlements have been found. Thus, it is important to recognize and to investigate the relationship of

Fig. 3 - Map of the Delta and the lower part of the Nile Valley according to (A) Herodotus, (B) Strabo and (C) Ptolemy. After Ball (1942)[41]

human settlements and the natural landscape, including the water courses of the Delta.

The Canopic Branch and its Distributaries in the Kom el Hisn Area

As far as I am aware, the possibility of tracing the former courses of the river branches by means of present ground levels* in the Delta was first pointed out by Prince Omar Toussoun in 1922[35]. However, Bietak in 1975[7] and Butzer in 1960[3] and 1976[21] were the first to correlate between the natural landscape (including water courses) and the different archaeological settlements in the Delta. The same approach has been utilized for Prehistoric and Predynastic sites in Upper Egypt and proved to be quite successful[36-40].

In *"Periplus of Scylax"*, the Canopic branch of the Nile Delta was considered as the boundary between Egypt and Libya[41]. While this is incorrect, it clearly indicates the importance of the Canopic branch as an important landmark in the landscape of Egypt.

According to Herodotus, the Nile river was divided into the Canopic, Sebennytic and Pelusiac branches about 2400 years ago, at a point close to the modern village of El Warraq el Arab (about 3 km north of Cairo), which was the actual apex of the Nile Delta at that time. Starting from El Warraq, the Canopic

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* *i.e.*, by using topographic maps

branch seems to have passed around the western side of Geziret El Warraq and then took an approximate course along the modern Rosetta branch[41]. It continued along the course of the Rosetta branch as far north as the modern village of Zawyat el Bahr (fig. 4). Then it approximately followed the course of Abu Diayab el Qadima canal, passing close to the modern village of Kafr Bulin and then between the modern village of Barrim and east of the modern town of Kom Hamada; then it shifted to a N-W direction, following the coarse of Abu Diyab el Ulya canal. At this point the Canopic branch passed close to Naukratis and Niqrash, then approximately followed the coarse of Abu Diayb el Sufla canal, passing near Kom Abu Humar el Kebir (Kom # 2 in fig. 4).

After following Abu Diyab el Sufla canal, the Canopic branch approximately followed the present course of El Khataba canal, passing close to Hermopolis Parvce (east of Damanhur) to its conjunction with the Mahmudiya canal on to the village of Birket el Ghitas[41]. Then it bent northward and ended just to the east of the Abuqir peninsula at a point close to an old fort called El Tabia el Hamra, about 10 km south east of Abu Qir[41].

From the course of the Canopic branch just mentioned above and from the inspection of fig. 4 as well as old topographic maps and from field studies, the following should be pointed out:

1) The course of the Canopic branch as described between latitude 30° 45' to 31° N seems to be correct considering the fact that former natural water courses exhibit many irregularities and much meandering along its course.[14,35,41]

2) The present distance between Kom el Hisn and the former course

Fig. 4 – Map of the Kom el Hisn area showing the location of the different Koms (30 Koms) and modern villages with respect to the modern Rosetta branch, irrigation canals and preserved freshwater ponds as they were mapped by the Survey of Egypt in 1929.

of the Canopic branch (as described in 450 B.C.) is less than 6 km.

3) The area between Abu Diyab el Ulya canal, Kom el Hisn and to the northeast of the modern village of El Haddein now exhibits a north-south gradient of 1:11000 and an east-west gradient of 1:5500 (fig. 5).

This suggests that the natural water flow around this area (*i.e.*, around Kom el Hisn) would occur in two main directions. These are mainly a west-north-west direction and a north-south direction. This was indeed the case, as all of the water courses that display irregularities and much meandering follow in these two directions. These water courses are Absum el Sharqiya canal and parts of Farhash canal (fig. 4), as well as minor drainage canals such as Misqet Absum and Misqet el Magnuna, that are located a few hundred meters away from the Old Kingdom site of Kom el Hisn (fig. 5). These observations clearly suggest that the above mentioned canals and misqets (small irrigation channels) are flowing approximately along ancient water courses, that were at one time or another close to the Old Kingdom site of Kom el Hisn (such as Absum el Sharqiya canal, Misqet Absum and Misquet el Magnuna) or close to the New Kingdom cemetery (such as part of the Farhash canal)*.

4) While the Canopic branch and several other ancient water courses have been identified to be close to Kom el Hisn, there

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* The irregular parts of Farhash canal are now about 3.5 km away from the New Kingdom cemetery.

Fig. 5 – Topographic map of the El Tod area as inferred from the 1 to 25,000 map of Khirbita, sheet number 89/570 produced by the Survey of Egypt in 1924.

is no geological proof for the following:

a) That all of these ancient water courses (including the Canopic branch itself) were (4500 years ago) at the same distance from Kom el Hisn as they are today.

b) That all of these ancient water courses (*i.e.*, the distributaries of the Canopic branch) did exist at the same time. In other words, there is no evidence to indicate that all of these distributaries are contemporaries of each other or that all did exist together in the 5th Dynasty.

5) The area between Kom el Hisn and El Tod is characterized by the presence of several*[1] fresh water ponds (fig. 5) where natural reeds and grasses are growing. They are quite shallow in depth. The larger ponds (mostly the 5 largest ones) display a crescent-like shape*[2]. The same situation exists in several other localities, particularly to the north-west of Kom el Hisn. It is interesting to note that all of the ponds surrounding Absum el Gharbiya had almost disappeared by the summer of 1986. What is left of the largest pond*[3] near this village is now a small pond about 70 m x 7 m in size (fig. 6). The disappearance of these ponds is due to constant local attempts to expand the cultivated land or gain more land for housing at the expense of these ponds.

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*[1] A total of 13 fresh water ponds according to the Egyptian Survey map of Khirbita from 1924.

*[2] It should be realized that these ponds are quite different in origin and environment from the coastal marshes that are located in the northern Delta.

*[3] In 1924 the dimensions of this pond were about 500 m x 85 m.

Fig. 6 – A photograph taken in 1986 showing the remains of one of the fresh water ponds in the Kom el Hisn area (specifically north east of Ezbet Sulinam Buraiyik).

REMAINS OF FRESH WATER PONDS

However, for a better understanding of the nature of the landscape during the Old Kingdom period of Kom el Hisn, it is clear that although identification of ancient water courses is useful, it is not sufficient for answering the first question addressed in the present work (see pg. 3). In other words, the actual time course of the ancient water flows in history can not be determined from this information alone. More geological and geoarchaeological studies are needed.

The Geological Setting of the Kom el Hisn Area

Kom el Hisn is situated on a low mound that rises 2 to 3 meters higher than the surrounding cultivated land. The mound itself is mostly unvegetated and measures about 760 meters in a north south direction and about 475 meters in its maximum width. Several elevated areas and depressions are scattered within this mound (fig. 7)*. Most of these features, if not all, are artificial and have been formed as a result of earlier excavations. Some of the depressions are now filled with water due to the rise of the water table, particularly at times when farmers are irrigating their surrounding rice fields.

Along the southern border of the mound Griffith presented a sketch of a 116 m by 64 m brick temple wall and identified three statues of Ramesses II associated with this structure. One of these statues is a red granite statue of Ramesses II standing and

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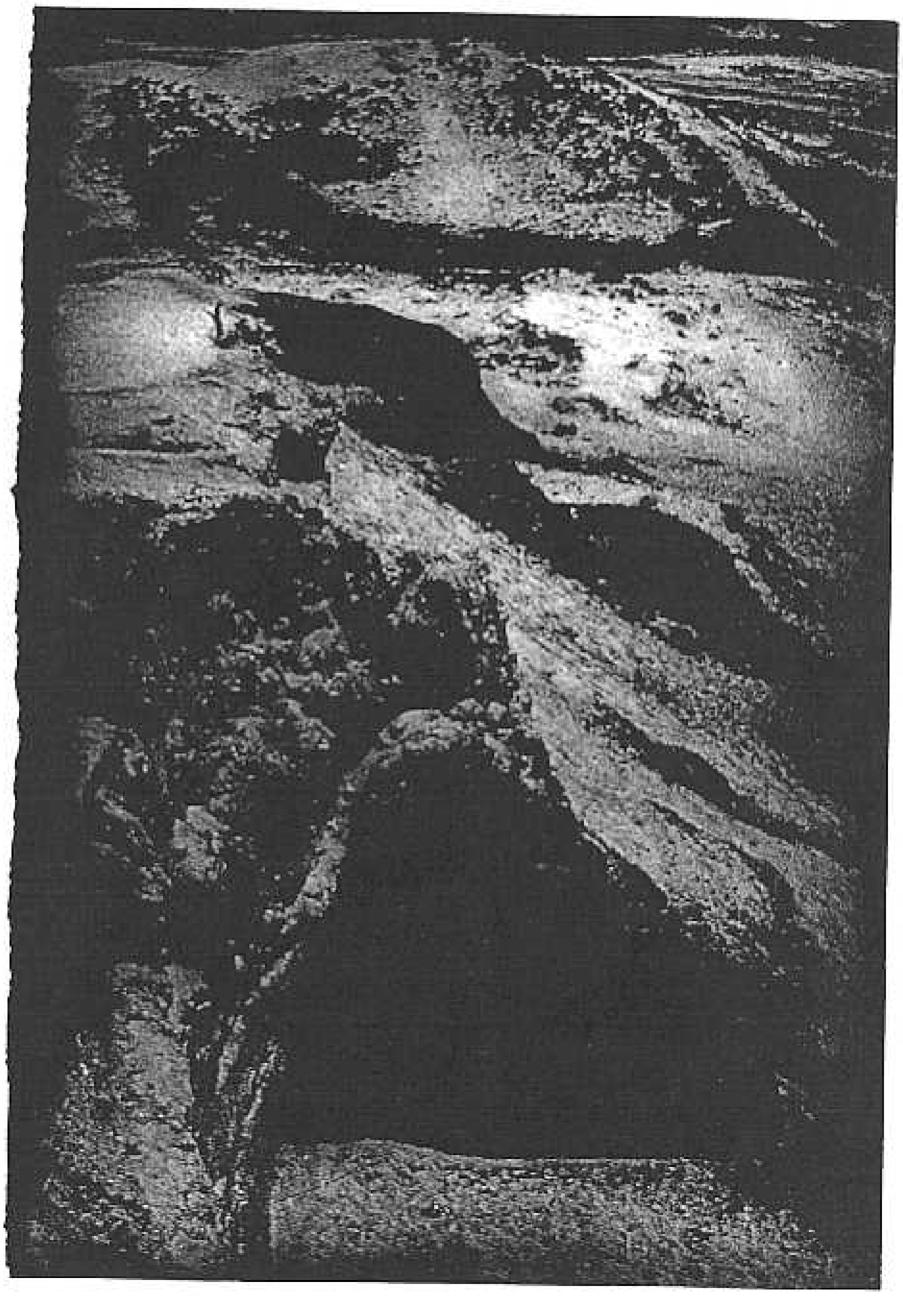
* Fig. 7 is a topographic map of Kom el Hisn. The italic numbers indicate the location of some of the cores dug in the area. The elevations and the contour lines were measured and processed on the computer by Mr. Paul Buck.

Fig. 7 - Preliminary topographic map of Kom el Hisn showing the location of the auger holes dug in the 1986 field season (in *ittalic* numbers).



MUD BRICK WALL STANDING AGAINST THE SANDY SEDIMENTS AT KOM FIRIN

Fig. 17 – A photograph (taken in 1986) showing the mudbrick wall standing against the sandy sediments at Kom Firin.

at Kom el Hisn. In the meantime, the topographic map with the scale of 1 to 25,000 indicates that all of the Koms are surrounded by either ancient water courses or old oxbow lakes. While interpretation of the geoarchaeology of all of the Koms is not finalized yet, it is possible to make the following points:

1) At *Kom el Kharaz*, a Graeco-Roman site is found on the southwestern part of a sandy mound whose surface is covered by a large number of ceramic sherds[8]. This sandy mound seems to be a stabilized sand dune of Pre-Neolithic age[16]. Geological samples were taken from the sandy sediments for sedimentological analysis. While according to the 1 to 25,000 scale topographic map from 1924 the Kom was mapped to lie on the boundary between desert and Delta, an old oxbow lake was found about 1 km to the east of the site. The existence of this lake was confirmed in the field. While the entire surface of the present area is covered by dune sands, an auger hole dug on top of the old oxbow lake recovered Nilotic mud and clay at a depth of about 1 – 1.25 meters. Although presently there are no morphological features on the surface that would indicate the presence of ancient Nile water courses, the Nile clay recovered by augering clearly implies the presence of ancient water courses to the east of the site that now are covered by dune sand sediments.

2) *Kom Firin and Kom el Dahab*

Kom Firin (about 1600 m by 800 m) received Greek influences during the seventh century B.C.[6]. Petrie observed a citadel structure with a large wall that is constructed of unbaked mudbricks in the center of the Kom. In some places there are gathering of reeds.

Thus it seems that while the digging of canals and construction of dikes for controlling the discharge of Nile waters has been practiced since the early Dynastic period, Man was still not able to entirely control the flood waters with these methods. Consequently, the Nile was free to overflow its banks to scour out fresh channels in the Delta during every high flood, becoming more irregular. The flood water then was free to return to its channel as the water level fell, and was not yet artificially retained for some 40 days on the land until the later method of controlled basin irrigation came into practice. Thus, it is logical to assume that Man of the Old Kingdom time adapted his life style to the changes of the Nile flood volume and its base level fluctuations.

Geoarchaeological Survey of other Koms

The geoarchaeological survey of the 1986 field season also included several other Koms that are located in the present area. These are Kom el Kharaz, Kom el Barud, Kom el Dahab, Kom Firin, Kom el Hadid, and Naukratis (fig. 7). One of the aims for surveying these Koms was to determine the relationship between the present landscape and the spatial distribution of settlements during the Late period to Roman period and to compare this with Kom el Hisn. Data was surveyed from boreholes dug near these Koms by the Geological Survey and the Research Institue for Ground Water. Diluvial sediments were not expected to be exposed on the surface or to be present at shallow depths, as is the case been several other Old Kingdom sites just immediately above the high parts of the diluvial sediments that were possibly removed by erosion or were highly dispersed by later human activities[4,7-11]. As far as I know, no archaeological artifacts were found on the top surface of the diluvial sediments in this area.

Thus, considering the geomorphological and sedimentological facts mentioned earlier it seems that during the Old Kingdom occupation of Kom el Hisn (during the 5th Dynasty) the sea level was in a falling phase*. Before this phase the sea level had been much higher (at or around 3000 B.C.) and then was coupled with higher Nile floods (from 3000 B.C. to 2760 B.C.). This means that this aggradational phase was at a level which was higher than that during the time of occupation. It is my belief that the people of the Old Kingdom took advantage of this situation by settling on these older (ca. 3000 to 2700 B.C.) and now higher point bars and natural levees, which are located on the outer sloping margins of the diluvial yellow sand that forms the greater portion of the Kom (mound). Also, Old Kingdom Man used the deposits from old dried out oxbow lakes (mostly clays) as a source of raw material for mudbricks, ceramics and other building materials. The point bars and flood plains of his time would have been used for grazing and farming, respectively, while the river channel could have supported fishing and the comtemporary fresh water oxbow lakes fishing, fowling and the

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* see Table 2

deposits on the southern border of Kom el Hisn were differentiated and characterized. From a general sedimentological point of view, the different alluvial sediments can be grouped into two main types. These are the river channel deposits and the flood plain deposits. It is clear that in the majority of auger holes the river channel deposits and flood plain deposits interchange variably. This leads me to the only possible conclusion that lateral migration of nearby ancient water streams was quite active. Moreover, upon tracing the continuation of the river channel deposits from core # 4 to core # 15 (*i.e.*, from point E to W to H in figure 7) at the elevation of 2.5 to 4 meters above sea level, it became evident that the river channel deposits constitute the majority of that level along the line E-W-H with little exception in core # 14 and 17. In other words, this may imply (with the inspection of figures 12, 13, 16 and 7) that there is a continuous extension of channel river deposits along the line of E to core # 13 to core # 16 to point H, that might indicate the presence of an ancient point bar or a channel bar. Also, it seems most interesting to note, that we have found a large concentration of archaeological materials that may correspond to the same Old Kingdom site that Dr. Wenke and his crew are studying just less than a meter away. All of these archaeological materials are associated with Nile alluvial sediments. Thus, the present geological setting of these archaeological materials found close to core # 15 (or point H) consists of old river channel deposits. However, this does not necessarily mean that all of the Old Kingdom settlement sites were restricted to old river channel deposits. There may have

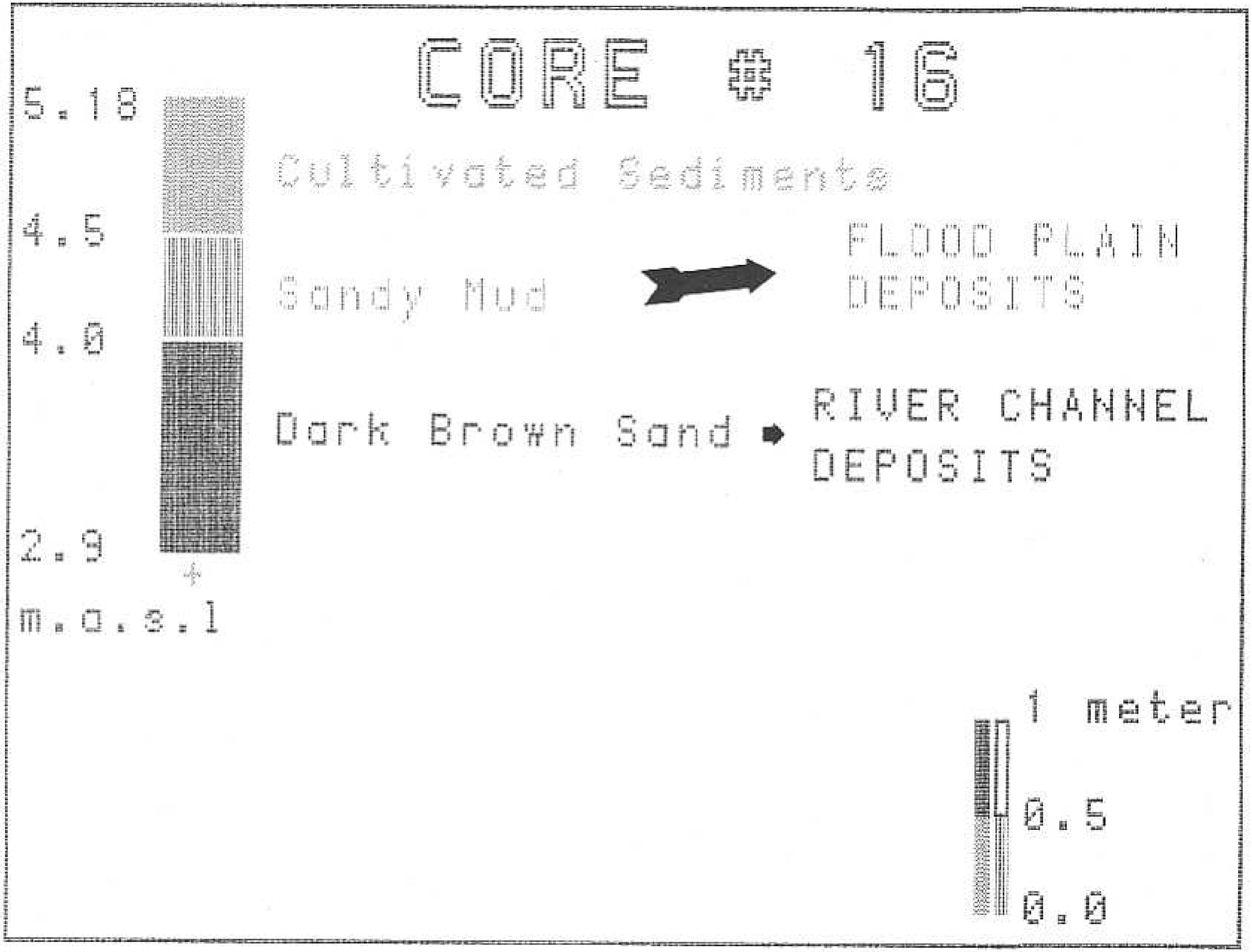
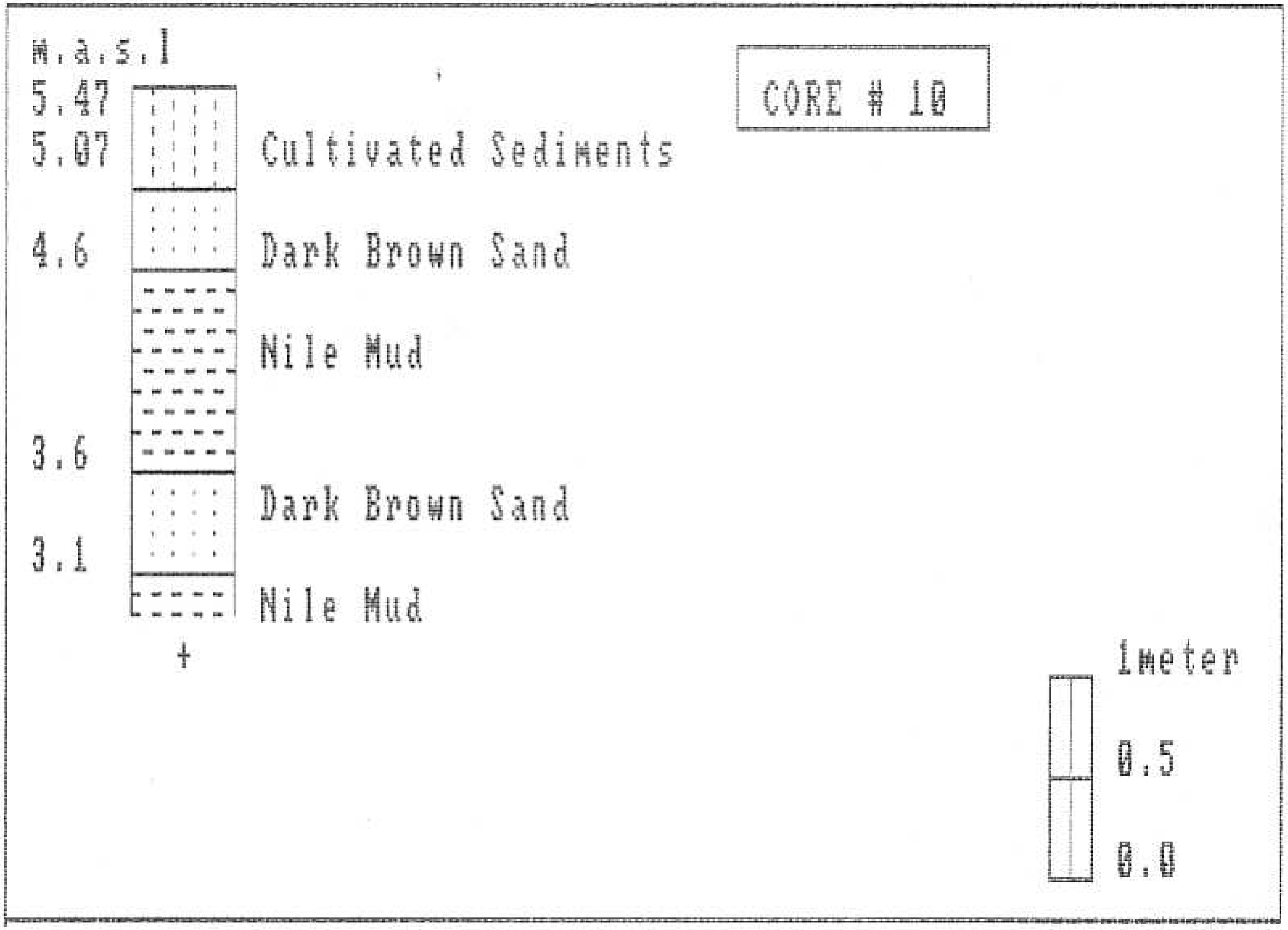
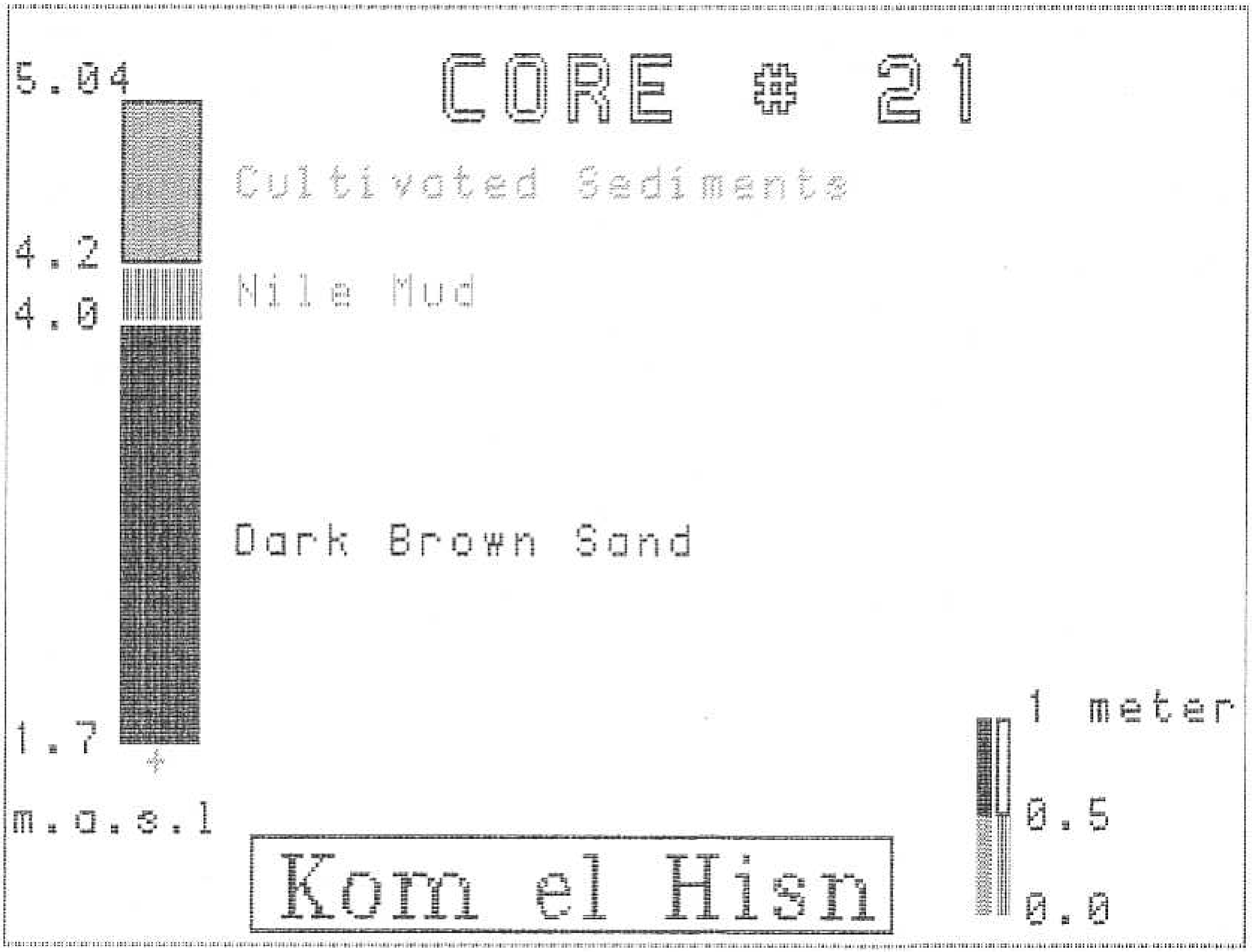

CORE # 16
5.18
4.5
4.0
2.9
m.a.s.l
Cultivated Sediments
Sandy Mud
FLOOD PLAIN DEPOSITS
Dark Brown Sand
RIVER CHANNEL DEPOSITS
1 meter
0.5
0.0

Fig. 16 - The lithological log of core # 16 at Kom el Hisn.



m.a.s.l
5.47
5.07
Cultivated Sediments
4.6
Dark Brown Sand
Nile Mud
3.6
Dark Brown Sand
3.1
Nile Mud
CORE # 10
1meter
0.5
0.0

Fig. 15 - The lithological log of core # 10 at Kom el Hisn.



CORE # 21
5.04
Cultivated Sediments
4.2
Nile Mud
4.0
Dark Brown Sand
1.7
m.a.s.l
Kom el Hisn
1 meter
0.5
0.0

Fig. 14 - The lithological log of core # 21 at Kom el Hisn.

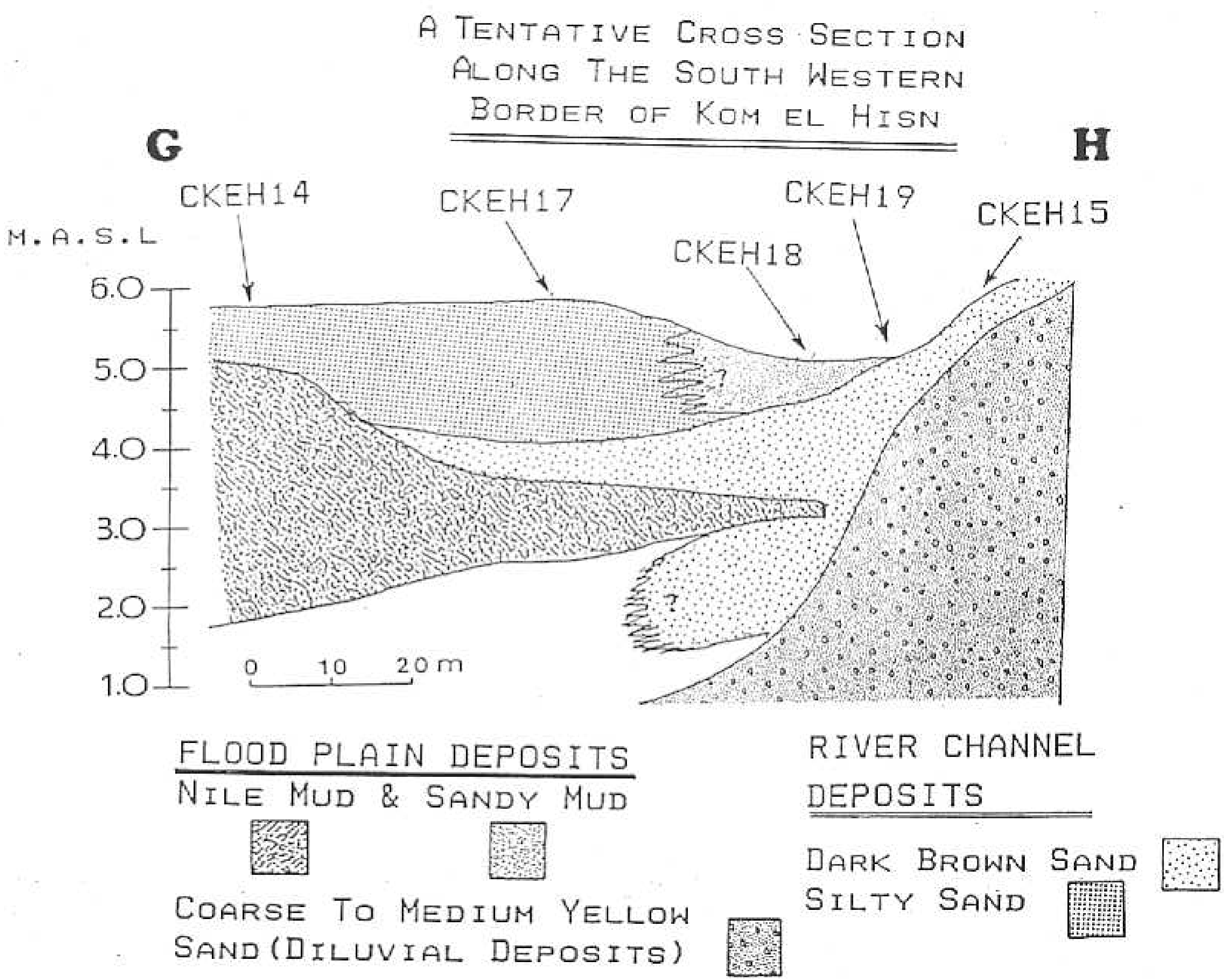

A Tentative Cross Section
Along The South Western
Border of Kom el Hisn
G
H
CKEH14
CKEH17
CKEH18
CKEH19
CKEH15
M.A.S.L
6.0
5.0
4.0
3.0
2.0
1.0
0
10
20m
?
?
Flood Plain Deposits
Nile Mud & Sandy Mud
Coarse To Medium Yellow
Sand (Diluvial Deposits)
River Channel
Deposits
Dark Brown Sand
Silty Sand

Fig. 12 - A tentative east-west cross section along the southern border of Kom el Hisn.

It is over 80 cm thick, sorted, the grains are of fine sand size with some muds. Rounded quartz grains, mica flakes and dark minerals such as magnetites are observed.

4.2 – 4.0 m Very dark grayish brown (10YR3/2) Nile mud. 20 cm in thickness with some mica flakes and very fine sands. Well sorted. With some carbonate content and several reddish ceramic pieces.

4.0 – 1.7 m Brown to dark brown (10YR4/3) sand. The grains are basically in the fine sand range with some medium grains (mainly quartz) subrounded and spherical to subprismoidal. Quartz, magnetite and other black grains, mica flakes and some reddish ceramic pieces are observed. The base of this unit was not reached because of continual collapsing of the sands.

The lithological log for this auger is shown in figure 14. The sandy facies of this auger belongs to river channel deposits while the finer facies (*i.e.*, the Nile mud) belongs to flood plain deposits. The lithological logs for two of the other auger holes (cores # 10 and 16) are also shown in figures 15 and 16. With information from figures 12 to 16 and the lithological description of all the auger holes the different Nile alluvial

Kingdom site. Three of the four possible ancient water courses are also located to the south of the site. Therfore, most of the cores were dug along the southern border of the site, with their locations and numbers shown in fig. 7.

Cores were drilled with a manual auger to a maximum depth of a little less than 6 meters below the surface. The depth of each sample was measured in relation to the ground level and was subsequently correlated with the sea level. Each auger cut produced a sample 10 to 20 cm in length with a diameter of about 10 to 15 cm.[40] Ceramic artifacts and lithics were immediately separated from the sediments, which were described and inspected on the spot as well as later on in the lab. Whenever the auger hole collapsed*, the sample was discarded and a new one was taken after clearing out the hole. Casing of holes was frequently used to prevent collapsing. Twenty one auger holes were dug.

Some of the logs of these auger holes were utilized for constructing tentative cross sections along the southern and the south western borders of the Old Kingdom site of Kom el Hisn (see figs. 12 and 13). Below is an example of the description of one of these auger holes, core # 21. This auger hole was dug into the Nile alluvial sediments present on the outer side of the low mound. The ground surface elevation at this auger hole is about 5 meters above sea level.

Elevation in meters above sea level	Description
5.04 - 4.2 m	Dark Grayish brown (10YR4/2) muddy sand.

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* Mainly due to the presence of sandy sediments and ground water.

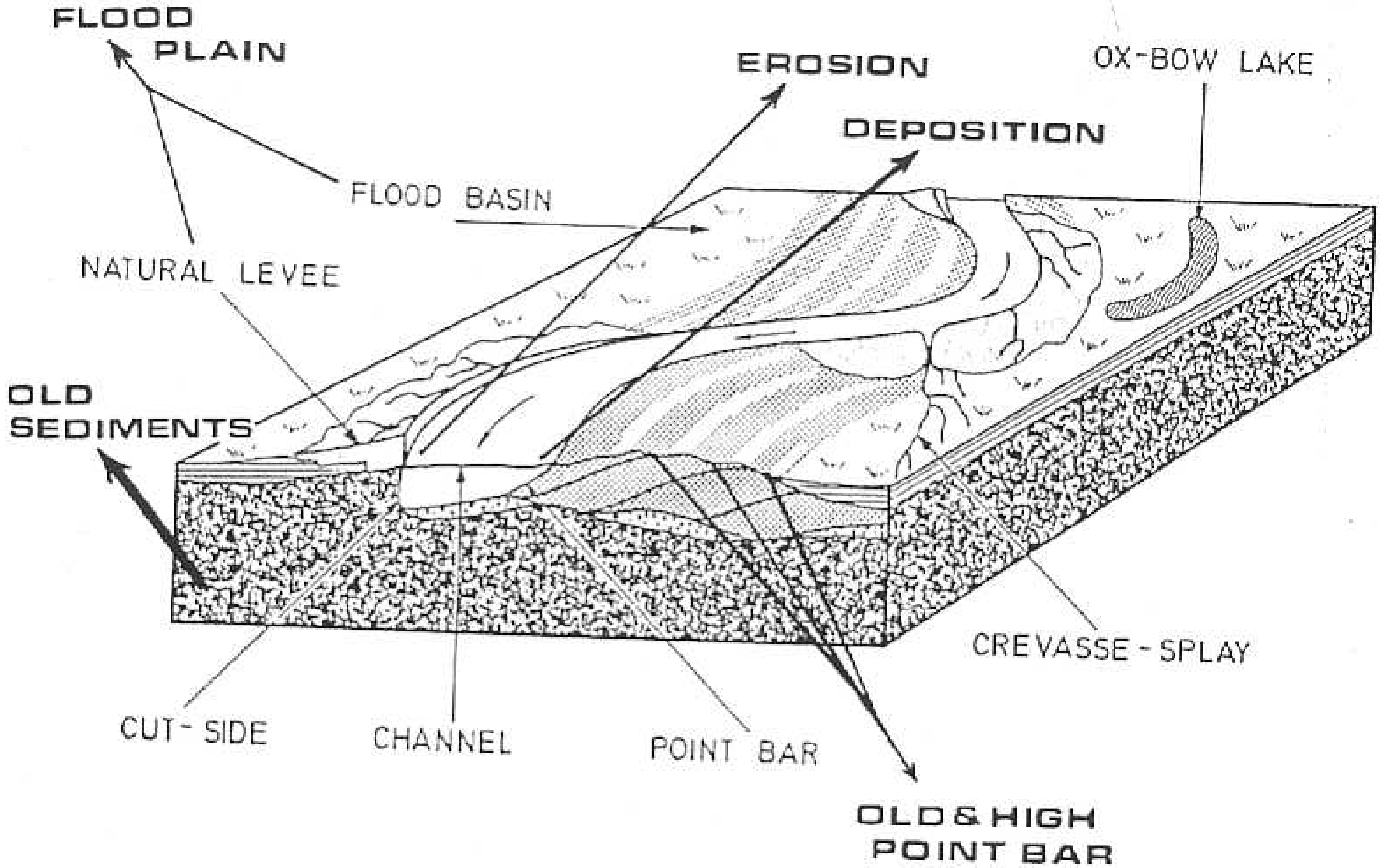
FLOOD PLAIN
EROSION
OX-BOW LAKE
DEPOSITION
FLOOD BASIN
NATURAL LEVEE
OLD SEDIMENTS
CREVASSE - SPLAY
CUT - SIDE
CHANNEL
POINT BAR
OLD & HIGH POINT BAR

Fig. 11 - A block diagram showing the morphological elements of a meandering river type.

(modified after Reineck and Singh, 1980, fig. 379)[43] block diagram showing the morphological elements of a meandering river type that most probably formed important parts in the landscape during the Old Kingdom occupation of the southern border of the Kom el Hisn mound. Also, it should be realized that the channel lag deposits never make thick layers and they are invariably discontinuous[43]. The shape and size of point bars vary with the size of the channel and its discharge[43-46]. In smaller streams, point bars are simple depositional features that are located on the convex sides of the meandering channels [43-46].

6) If we assume that the Nile base level was in a falling phase due to the gradual falling of the Mediterranean Sea level, then the stream meandering wave length, including amplitude as well as channel width and depth, would have to readjust itself to the new lower base level. The channel would have become deeper and a new, narrow flood plain would have formed at a lower level, leaving behind fresh water oxbow lakes, old higher point bars and old higher natural levees.

With all of these points mentioned above in mind, coring during the 1986 field season was performed to

a) study the stratigraphic relationship between the alluvial and diluvial Nile sediments, and

b) differentiate the alluvial Nile sediments into flood plain deposits and river channel deposits, so that their spatial distributions could be traced throughout the study area.

All of the crescent shaped fresh water ponds shown in fig. 5 (probable remains of oxbow lakes) are located south of the Old and gathering weeds and reeds.

5) Sediments deposited by river systems have been classified in different ways*1. Reineck and Singh in 1980 subdivided the fluvial deposits into three major groups. These are channel deposits, bank deposits and flood basin deposits. However, from the geomorphological and sedimentological considerations discussed earlier, it is clear that the Delta branches exhibited active and frequent lateral accretion and lateral migration. Thus Nile alluvial deposits in the Delta can only be differentiated into flood plain deposits and channel deposits. The term flood plain deposits is proposed to indicate the fine grained sediments deposited during overback flow[43] (*i.e.*, during high floods). In the present case, they are represented by the alluvial clays, mud and sandy mud. The term channel deposits is proposed for sediment deposits formed mainly from the activity of the river channels. They include channel lag deposits, point bar deposits, channel bar deposits, and channel fill deposits[43]. Regarding the active lateral migration of the former Canopic branch and its distributaries, it should be realized that point bars would constitute the major depositional features produced as a result of channel action[43,44] and that the processes of braiding and meandering are interrelated*2. Figure 11 is a

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*1 While sedimentologists differentiate sediments based on sedimentological features and primary structures, geomorphologists distinguish the sediments in terms of vertical and lateral accretion.

*2 For more discussions about channel patterns and bars refer to ref. 43, p. 258 - 274 and ref. 44, p. 20 - 38.

point in time the sea level gradually increased so that at the time of Rameses II (1290 - 1223 B.C.) and Seti II (1211 - 1195 B.C.) it was again +2 m higher than its present level.

3) In 1984, a step-trench was dug at the highest point of the Old Kingdom site. Several meters of deposits belonging to the first few centuries A.D. were found. These deposits directly overly intact walls and other features of the Old Kingdom settlement, which appears to extend westward under the comtemporary Ezbet Suliman Shalabi[8] *[1].

4) Certain conditions (landscape requirements) should exist for development of an agricultural community. Some of these requirements were nicely described by Butzer (1959, p. 48)[11]*[2] and by J. Wilson (1951, p. 24).[42]

In summary, the landform of an Old Kingdom site in the Delta such as Kom el Hisn should provide a high ground or old natural high levees or point bars for permanent housing that would not be destroyed by the high floods of the Old Kingdom period; should provide raw materials for building and ceramic production; should contain a flood plain for farming in its basin and for herding and grazing cattle, sheep and others; and should have fresh water marshes for fishing, fowling and

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*[1] Ezbet Suliman Shalabi is not shown in fig. 7 but lies approximately a few meters north of core #13

*2 Butzer writes: *"From the very beginning Man could build his abode upon the levees or upon the desert edge, and after the flood had receded, throw his crop seeds upon the wet mud of the basin floors or graze his cattle and other herds upon the lush vegetation of grass, herbs, brush and young shoots. When the water rose again the harvest had been gathered in and the livestock could pasture upon the levees or on the desert margins of the alluvium."*[11]

Nile Delta was aggradating throughout the Holocene (Said 1981, p. 75-76).[16] This seems to be the case in the present area. In the absence of outcrops then, hand augering became necessary not only to permit studying the stratigraphy of the Nile alluvial sediments, but also to investigate the important question of what the geoarchaeological setting of the Old Kingdom settlement site was like. In order to study the setting of the settlement site by intensive coring, it was first necessary to determine exactly in what localities to start coring and digging. The determination of optimum coring localities was based on interpreting the previously mentioned geology, geomorphology and archaeology of the western Delta in terms of a hypothetical model for the environment of this settlement site and its surroundings during the Old Kingdom period.

To establish this model, several points were taken into consideration:

1) The Canopic branch* existed during the Old Kindgdom period and in general, this period was characterized by high Nile floods (see Table 2).

2) The level of the Mediterranean Sea was about +2 meters or more higher around 3000 B.C. and about -2 meters lower around 2200 B.C. (Butzer 1976, p.36)[21] than today's level. Thus, between early Dynastic time (ca. 3000 B.C.) and the end of the sixth Dynasty (ca. 2150 B.C.), the base level of the Delta branches was gradually decreasing in absolute elevation. At a later

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* and possibly several other arms or distributaries from this branch.

reworked sediments are present, and d) it is presently located near to a major water course. This case is representative of Nikla el Inab, Kafr Ghirin and El Wafaiya.

Geoarchaeological

The Geological Setting of the Kom el Hisn Area: Results and Discussion

The Old Kingdom site of Kom el Hisn is located on the southern border of the low mound and between two modern Ezbets. These are Ezbet Suliman Shalabi in the west and Ezbet Ali el Magnun in the east. The archaeological materials of the Old Kingdom settlement form stratified deposits 1 to 3 meters thick, that, for the most part, are located above the present water table and are unobscured by later deposits[8]. The exposed surface geological sediments in this area are alluvial Nile sediments that vary in thickness from 1 to more than 6 meters. These alluvial Nile sediments mainly consist of Nilotic dark brown sand, silty sand, sandy mud and clays. The alluvial Nile sediments lie on top of fine to medium yellow sands. In the present area, these yellow sands are sterile and for most of the year are barely located above the current water table. Most probably they belong to the diluvial sediments, that are exposed on the surface at a distance of less than 200 meters to the north of the study area. These yellow sands also have been recovered from one of the archaeological test pits (P. Buck, personal communication).

According to Said, it would be most unlikely to find outcrops of alluvial Nile deposits within the Delta, since the

TABLE 3

Borehole Name	Surface Elevation	Top of diluvial deposits surface*	Thickness of alluvial sediments in meters	Top of medium sand horizons*	Thickness of alluvial medium sand horizons
El Tod	6.24	4.24	2	-	-
El Haddein	6.57	-1.43	8	-	-
El Dilingat	6	-12	18	-8(?)**	4
Qamha	5.2	-14.8	20	-(?)	-
Kafr Bulin	7.8	-10.2	18	3.8	8
Nikla el Inab	6.38	-18.6	25	3.4 & -14.6	1 & 4
Kafr Ghirin	8.0	-18.0	26	-1	7
El Wafaiya	5.9	-21.1	27	-14.0	7

* Elevations are in meters with respect to the present sea level

** The lithological description is not definitive enough to be certain that these are late Pleistocene/Holocene yellow Sand.

Table 3 - Elevation Parameters as inferred from bore holes dug by the Geological Survey of Egypt and the Research Institute for Ground Water

meters below the ground.

Although the number of boreholes is limited in this area, the data availabe from them can be correlated with the present sea level in a meaningful way (Table 3). Based upon figures 7 - 10 and Table 3, the present area can be tentatively described in terms of three cases.

<u>In the first case</u>, a) the top surface of the diluvial sediments is exposed or at a shallow depth (*i.e*, not more than 4 meters below sea level), b) the alluvial sediments are thin (*i.e.*, not more than 10 meters thick), c) there is an absence of reworked diluvial sediments such as the coarse to medium sand mentioned above , and d) the area is located near possible ancient water ways as identified by high irregularities in present-day canals and/or the existance of ancient fresh water ponds. This case is representative of Kom el Hisn, El Tod and El Haddien.

<u>In the second case</u>, a) the top of the diluvial sediments is at a shallow to moderately deep depth (not deeper than 15 meters below the sea level), b) the alluvial sediments are not very thick (*i.e.*, not thicker than 20 meters), c) reworked diluvial sediments may possibly be present , and d) it is located near ancient water courses and/or fresh water ponds. This case is representative of Kafr Bulin, El Dilingat and to a lesser extent Qamha.

<u>In the third case</u>, a) the top of the diluvial sediments occurs at great depth (deeper than 20 meters), b) the thickness of the alluvial deposits is more than 20 meters, c)

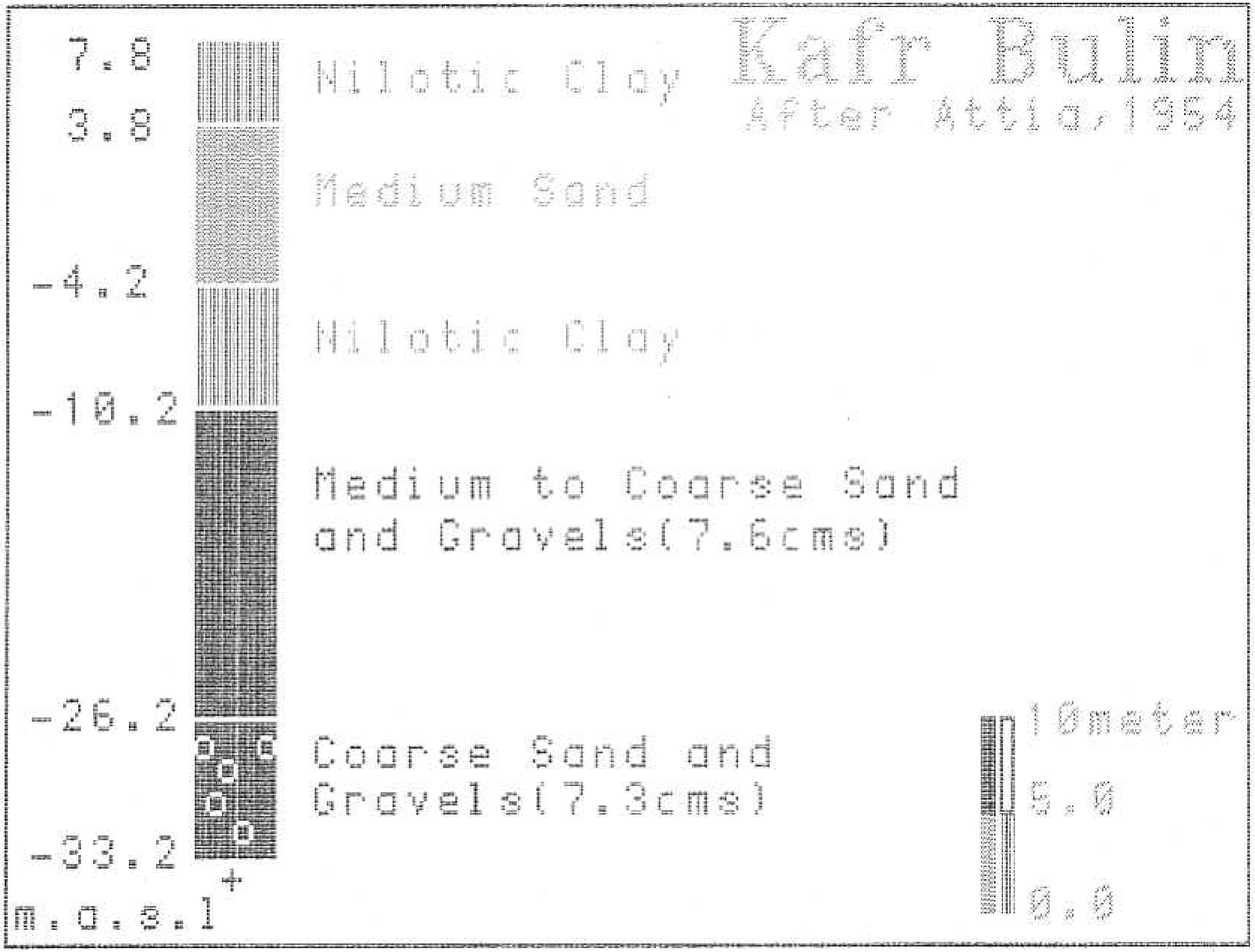
Kafr Bulin
After Attia,1954
7.8
3.8
-4.2
-10.2
-26.2
-33.2
m.a.s.l
Nilotic Clay
Medium Sand
Nilotic Clay
Medium to Coarse Sand
and Gravels(7.6cms)
Coarse Sand and
Gravels(7.3cms)
10meter
5.0
0.0

Fig. 10 - Lithological log of Kafr Bulin bore hole.
(Data are taken from Attia, 1954)[18]

boreholes inspected here*[1] is 18 meters. This is different than Attia's measurements (1954)[10] for the whole Delta (25.6 meters).

3) In 5 of the boreholes made in the study area, the lithological characteristics of the alluvial Nile sediments were not uniform (for example, see fig. 10). These sediments can be subdivided into two main size types: 1) the Nilotic fine sand to silty sand and mud and clays, and b) the medium sand with mica and magnetite. The preliminary heavy mineral analysis of these size types clearly indicates that these sediments were derived from Nile sources and were deposited by the former Delta distributaries. However, the second size type*[2], seems to be similar to the older diluvial sediments. In other words, the possibility exists that these medium sands were (originally) yellow medium sand grains in the diluvial deposits. They were then later eroded from the diluvial sediments by water action and were retransported and redeposited (*i.e.* reworked) by ancient water courses in the Delta.

4) The top surface of the diluvial sediments in the present area is irregular and uneven (see fig. 9). The sediments form the present ground surface at Kom el Hisn, while at El Wafaiya, which is less than four kilometers south of Kom el Hisn, the top surface of the diluvial sediments lies as deep as 27

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*[1] These are shown in figures 8 and 9.

*[2] No samples were available for this medium sand from any of these boreholes.

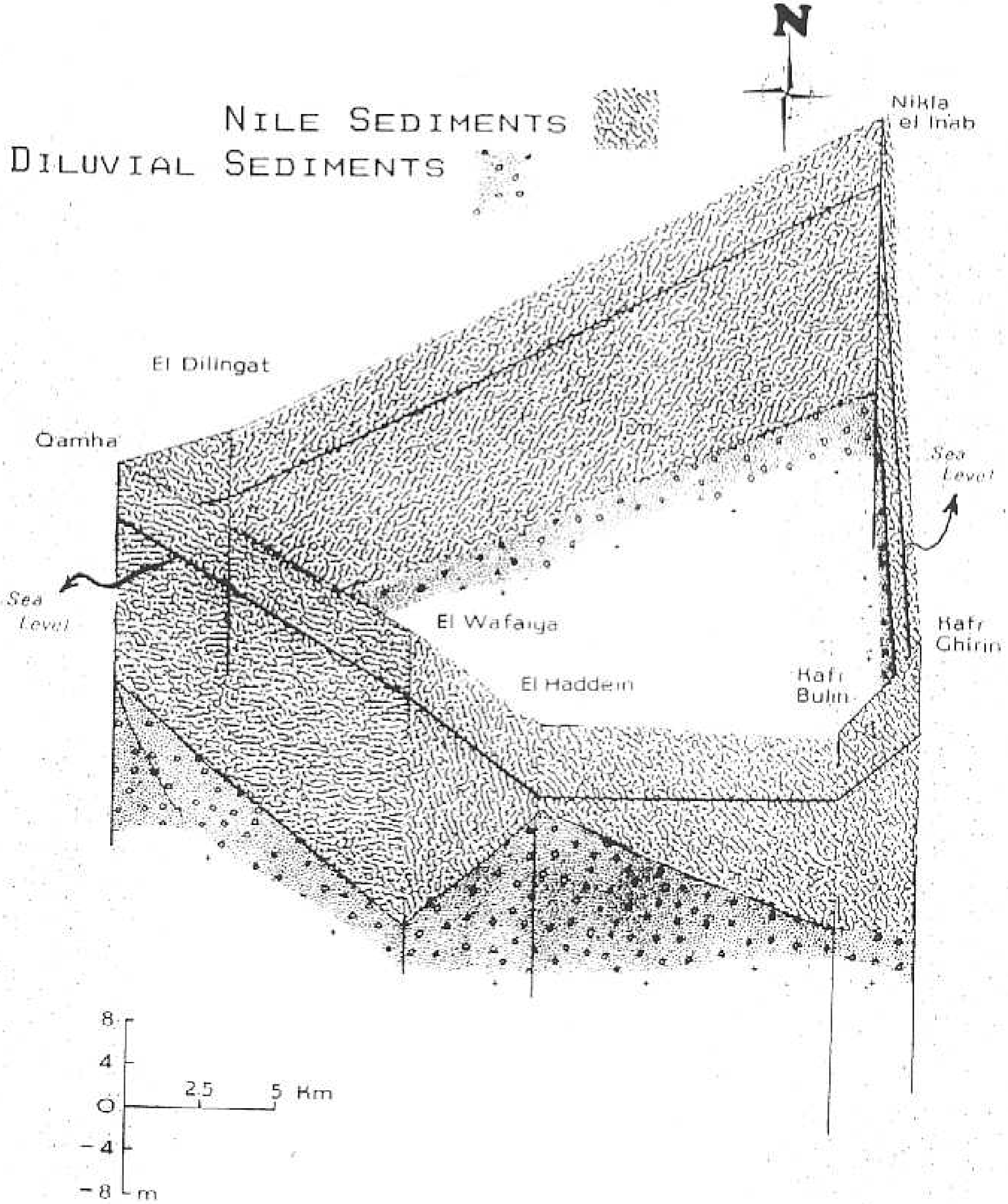
NILE SEDIMENTS
DILUVIAL SEDIMENTS
N
Nikla el Inab
El Dilingat
Qamha
Sea Level
Sea Level
El Wafaiya
El Haddein
Kafr Ghirin
Kafr Bulin
8
4
0
-4
-8 m
2.5
5 Km

Fig. 9 – A panel diagram showing the distribution of alluvial Nile sediments and diluvial sediments with respect to the current sea level in the present area (Data are taken from Attia, 1954[18] and Research Institute for Groundwater, 1987[30])

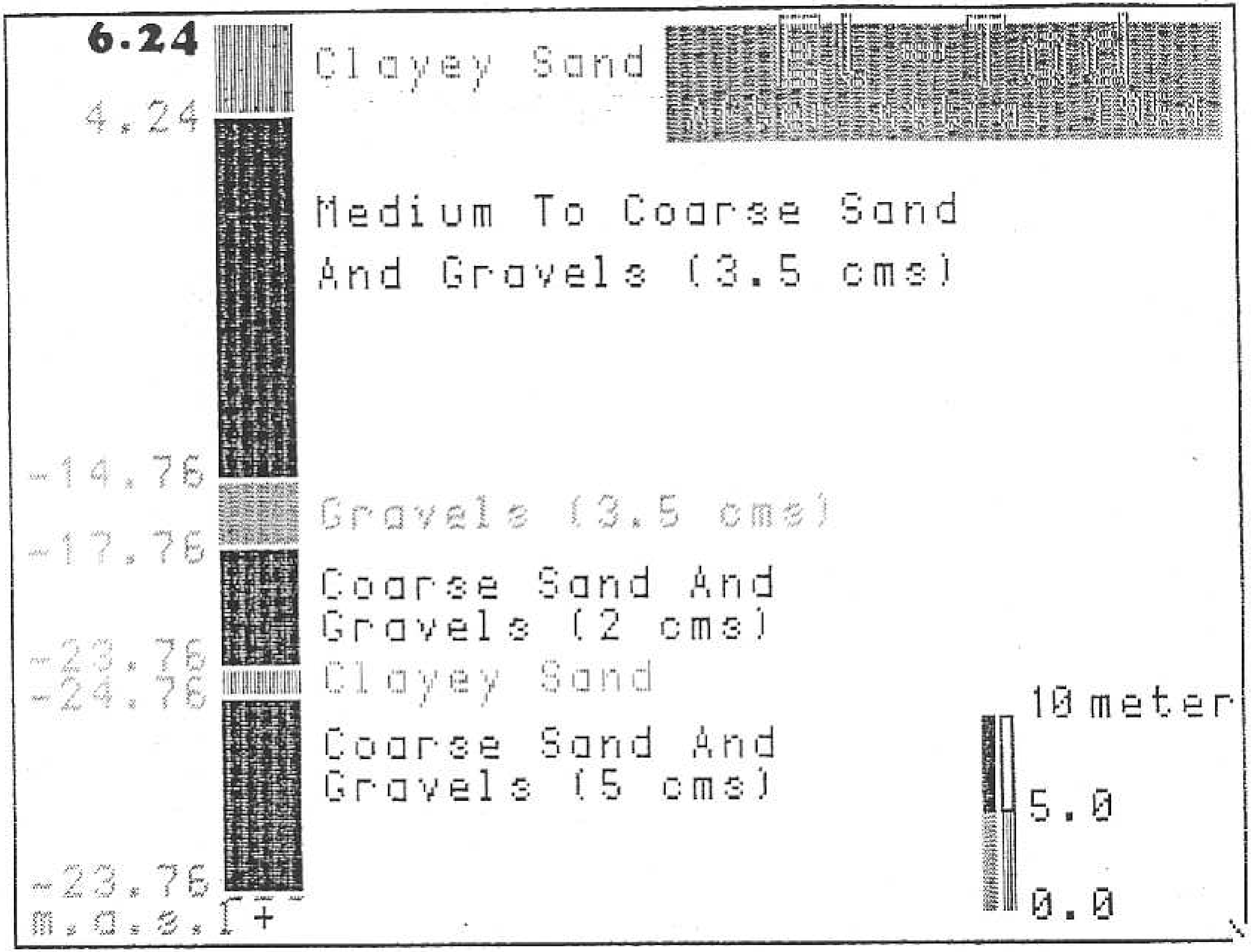
6.24
Clayey Sand
4.24
Medium To Coarse Sand
And Gravels (3.5 cms)
-14.76
Gravels (3.5 cms)
-17.76
Coarse Sand And
Gravels (2 cms)
-23.76
Clayey Sand
-24.76
Coarse Sand And
Gravels (5 cms)
-23.76
m.a.s.l
10 meter
5.0
0.0

Fig. 8 - Lithological log of El Tod bore hole.
(Data are taken from Attia, 1954)[10]

and the lithological description of the borehole is shown in fig. 8. This figure clearly shows that:

1) The diluvial sediments located to the south east of Kom el Hisn (*i.e.*, near the largest meandering of the Absum el Sharqiya canal) lie very close to the surface (4.24 m.a.s.l.).
2) The diluvial sediments in the present area are not only composed of coarse grained sediments but also of finer grained sediments, such as clayey sand. They are about one meter in thickness.
3) The thickness of the Nile alluvial sediments is only two meters and consists of clayey sand.

From the description of different boreholes made around the Kom el Hisn area (such as those of El Wafaiya, El Haddein, Kafr Bulin, Kafr Ghirin, El Dilingat and Qamha), it was clear that the top surface of the diluvial sediments is not found at a constant depth (either with respect to the gound surface or to the present sea level). Although contour mapping of the top surface of the diluvial deposits is not possible in the present area due to insufficient numbers of deep boreholes, the construction of a panel diagram is possible (see fig. 9).

The following observations can be made from the lithological characteristics of the boreholes and from figure 9:

1) All of the boreholes pass through the alluvial Nile sediments but are not deep enough to reach the bottom of the diluvial sediments.
2) The average thickness of the alluvial deposits found in the 9

alteration of fine to very fine sands. Near the top of these trenches, the sands become finer and display a wavy-like structure. Also, close to the surface, they become characterized by several carbonate mottles. Nilotic snails were also found on or close to the surface. The same sedimentological and mineralogical features described above were found in several other places in the mound. However, the majority of these sediments display a medium to coarse sand grain size* and the color varies from 10YR7/6 to 10YR7/8 (yellow sands). The coarse to medium sand grains are subangular to subrounded in shape with occasional interspersed coarser quartz grains that vary in size from very coarse sand to medium pebbles. No ceramic sherds were found in these sediments.

Several boreholes were sunk near the Kom el Hisn area by the Geological Survey of Egypt (Attia, 1954)[18] by the Research Institute for Underground Water in their continuing effort to evaluate the water resources under the Delta.[30] The stratigraphic logs for these boreholes may be quite useful for the present research since they would help to understand the nature and the distribution of the different types of sediments of this area. Perhaps one of the most important boreholes that would significantly enhance our understanding of the geoarchaeological setting of Kom el Hisn is the borehole south of El Tod (less than 3 km from the Old Kingdom site of Kom el Hisn). The ground surface elevation at that borehole is 6.24 m.a.s.l.

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* Mr. Paul Buck has performed the grain size analysis on several samples of these diluvial sediments.

holding one or two inscribed staves or standards[◊].

Starting in 1943, Hamada, El Amir and Farid excavated the northern border of the mound for three seasons. Just in the first season they uncovered an overwhelming number of tombs (over 175 tombs)[◊], including the tomb of Khesu-Wer "Prophet of Hathor"[◊]. According to Coulson, the majority of the tombs date to the latter part of the first intermediate period[◊] (*i.e.*, to around 2000 B.C.). However, several of the tombs at Kom el Hisn that were excavated by Hamada and Farid were also dated to the New Kingdom (1551–1070 B.C.)[◊]. The different excavations at the northern border of the low mound clearly indicate its long and rich history.

Since 1984, Wenke and his coworkers have been excavating the southern border of the mound, where they discovered an Old Kingdom settlement site* that occupies a large area of this mound. The mound itself is composed of medium to coarse yellow (10YR7/6) sand that belongs to the diluvial sediments. Three trenches were studied along the undisturbed eastern side of the mound, basically showing that the exposed diluvial sediments in these trenches consist mainly of fine to very fine sand, of a very pale brown color (10YR7/4) to a brownish yellow color (10YR6/8). The sand grains are mostly composed of quartz and small dark grains (consisting mainly of magnetite, amphiboles, pyroxenes and some Fe mica minerals). The sediments are basically horizontal and some stratification is observed with

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* The only 5th Dynasty settlement site ever found in the western Delta (R. Wenke, personal communication).

modern cuts in the fortified mudbrick walls to a depth of over 12 meters below its summit[6] (fig. 17). Overlying this structure are found fine to medium sands that are higly mixed with Nilotic mud, which probably represents collapsed mudbricks. At the bottom of this structure (*i.e.*, at the ground floor and in the holes dug by the locals) yellow fine to medium sand is found. Petrie reported that the citadel structure is situated on an artificial sand mound[6]. In other words, he is saying that the entire 12 meters of sand sediments are artificial. However, recent geological investigations have questioned the artificial nature of these sandy sediments[47]. It is now believed that most of the sandy sediments developed at Kom Firin might be related to geyser action from the Late Middle Pleistocene[47]. Kom Firin is bordered on the south and west by two ancient lakes. The small lake seems to be the remnant of an old oxbow lake, while the origin of the large one is still under laboratory investigation (fig. 18). The latter has a high salt content with thin evaporative sediments and possibly a high concentration of iron salts[47].

Kom el Dahab lies about 500 meters south east of Kom Firin and just north of a large fresh water lake. The Kom is small in size (*ca.* 8,000 m^2) and it does not seem to be overlying the same sandy sediments found at Kom Firin. No auger holes were dug at this Kom and the geological materials from it are quite limited. Ceramic sherds (possibly belonging to the Roman period)[6] were found to extend into the cultivated areas

Fig. 18 – A photograph (taken in 1986) showing the preserved lake that is located west of Kom Firin.

PRESERVED ANCIENT LAKE WEST OF KOM FIRIN and along the small banks of the irrigation ditches.

3) *Kom el Barud*

This Kom is located about 1 km south east of the modern village of Qamha (fig. 7). The top surface of the diluvial deposits at Qamha was recorded at a depth of 20 meters below the ground surface (see table 3). The site is marked by a low sandy area, roughly oval in shape and surrounded by cultivated fields. The exception is to the southern border, where there is an old lake measuring about 300 meters in length. The surface is fairly well covered with ceramic sherds that date back to the Roman period*. Also, two Hellenistic black-glazed body sherds were found, indicating the presence of activity at Kom Barud in the Ptolemaic time*. Four auger holes and a test pit were dug in this Kom. The lithological characeristics of these auger holes and the test pit revealed that the Kom is located on top of yellow (10YR7/6) fine sands that vary in thickness from 60 cm to about a meter in thickness. These sands are sterile except at their lower boundary where some ceramic fragments were recovered (?). These yellow sands certainly do not belong to the diluvial sediments. They are of Holocene age. Further laboratory work is needed on the depositional environment of these sediments.

Limitations and Future Perspectives: Concluding Remarks

The present geoarchaeological survey was able to propose some new thoughts about the nature of the landscape during the Old Kingdom period site of Kom el Hisn and has played an important role in expanding the dimensions of this site through tracing ancient river channel deposits. The information gained from augering along the southern border of the site, the areal study of the nature and distribution of the diluvial sediments as well as the inspection of old topographic maps were also helpful for establishing our approaches to the preliminary survey of the other Koms. However, the study of the present area was limited in getting more detailed information by several factors. These limitations are:

1) Due to time considerations, the number of auger holes dug in the 1986 season were limited to just 21 auger holes. It is clear from figures 7, 9 and 11 to 13 that more coring is required. Although the auger holes that were dug did give good ideas as to how the southern border looked like in the past, more coring is definitely needed at higher density over wider areas to provide definitive proof of the interpretations made.

2) The present method for augering (*i.e.*, by manual auger) not only takes time, but also does not permit an exact measurement of the total thickness of the Nile alluvial deposits or of the nature of the diluvial sediments underneath. In other words, while the thickness of the alluvial deposits in the Kom el Hisn area is estimated to be not more than 10 meters*, the manual auger can dig to a maximum depth of 6 to 7 meters only. In some cases it is not possible to dig deeper than 3 meters below the ground surface due to the presence of loose sandy

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* based on Table 3

deposits and/or high ground water levels and the resultant continuous collapse of the auger hole. However, measuring the thickness of the Nile alluvial sediments as well as identifying their sedimentological characteristics at Kom el Hisn are quite important because it was shown that a) during the Old Kingdom period Man was settling on the older point bar sediments (*i.e.*, those that were formed before 3000 B.C.) and b) 60% of the Nile sediments were deposited before the first Dynasty[11]. Thus, if in a particular spot we assume a 9 meter thick full aggrading sequence of Nile alluvium, then the Old Kingdom archaeological material would be expected to be found at a depth of more than 3.5 meters. Perhaps, older material is even deeper down. However, the manual augering may not easily reach such depths because of loose Nilotic sandy deposits and high ground water in some locations. Also, without knowing the average thickness of the Nile alluvial sediments in the present area, an estimate for the rate of sedimentation in that part of the Delta would be very difficult.

3) In the present study I have taken several geomorphological and sedimentological factors* into consideration before interpreting the geoarchaeological setting of the site. However, one of the important sedimentological factors that was not considered until now is the rate of subsidence of the Nile Delta. Not much work has been done on this factor

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* such as base level fluctuations and flood volumes as a function of time as well as several other factors mentioned earlier in the text.

el Hisn, the following prospectives and recommendations can be made:

1) Based upon the interpretation given earlier about the areal distribution of the top surface of the diluvial deposits and the nature of the Nile alluvial sediments above the diluvial deposits as well as the surface morphology of the present area, more intensive augering is very much required in the area between south of El Tod and north of El Haddein in an attempt to locate early Dynastic (or even Predynastic) sites (see figs. 4 and 5).

2) A geological map of the surface deposits present at and around the Kom el Hisn site should be prepared.

3) More detailed research is needed on the geological and the archaeological nature of the 30 Koms located in the present area (see fig. 4) in an attempt to determine the spatial relationship of these Koms with ancient water courses as a function of time. I believe that this would greatly enhance our understanding of the lateral migration and the history of the ancient water courses in the area and their effects on human settlements.

4) More detailed stratigraphic, sedimentological and chemical studies on the sand deposits of Kom Firin, Kom Barud and Kom el Kharaz are very much needed. The study of these sediments will enable us to have a better understanding of the geological nature of these medium to coarse sand sediments upon which most of the Koms are located.

5) Investigation of the top surface of the diluvial sediments

using geophysical techniques* is required in an attempt to map and pinpoint all of the areas where diluvial deposits are located at shallow depths, since these are the most probable localities for finding early Dynastic (and possibly Predynastic) sites.

6) The grain size analysis and heavy mineral analysis of these sediments should be continued and expanded and the results correlated with earlier work. This would greatly help us in improving our knowledge of the Late Pleistocene/Holocene stratigraphy of the Nile Delta and possibly to correlate the different types of sediments (in particular the sand deposits and the reworked yellow sands) present in the area.

7) Radiocarbon dating should be performed on any suitable material found in the ancient point bar or oxbow lake sediments in an attempt to establish a temporal relationship between the meandering of the Canopic branch (and its distributaries) and the Old Kingdom settlements. In this way the different sedimentological features, the ancient water courses as well as the old surfaces of human occupation could be correlated and tied together.

8) More field work is recommended, including deeper augering or drilling (at least up to 12 meters in depth) in order to measure the thickness of the alluvial deposits in the present area and ultimately to try to construct a paleotopographic map

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* The equipment for the different geophysical techniques is available at Cairo University and Prof. Dr. Iglal el Rifai has kindly agreed to using it under her supervision.

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