Prehistory of Northeastern Africa
New Ideas and Discoveries
Studies in African Archaeology 11
Poznań Archaeological Museum 2012

Joanne M. Rowland, Mohamed Hamdan

The Holocene Evolution of the Quesna Turtle Back: Geological Evolution and Archaeological Relationships Within the Nile Delta

Introduction and background

Five seasons of fieldwork have been carried out by an Egypt Exploration Society (EES) Delta Survey project under the direction of the first author. A discrete element of this project is a renewed approach to investigations both at the SCA registered site of Quesna quarries and also on the low ground around the sand gezira (turtle back) on which the site sits. The modern town of Quesna is 65 km northwest of Cairo on the agricultural road to Alexandria, with the archaeological area c4 km to the east of this road. The results of geophysical survey and excavation on the gezira have been published elsewhere (Rowland 2008; 2007; Rowland and Zakrzewski 2008; Rowland and Strutt 2007; Rowland and Wilson 2006; Rowland and Billing 2006) and therefore only a brief explanation of the site is given here. The SCA commenced a programme of excavation at the site of Quesna throughout the 1990s, following the discovery of a brick-built mausoleum in the south of the site during sand quarrying in the area. Excavation proceeded throughout the 1990s within what transpired to be a Late Period to Ptolemaic mausoleum, with rooms stacked with burials up to six-deep. Some burials had been placed in limestone sarcophagi, others mummified and wrapped in linen. One inscribed black stone sarcophagus is now at the Egyptian Museum in Cairo (Gomaà and Hegazy 2001: 52-80). It is the inscriptions relating to an individual from Athribis on this sarcophagus that provided the link between this cemetery and ancient

Athribis in nearby modern Benha. The SCA investigations also uncovered part of a Roman cemetery and a sacred falcon necropolis. The current EES mission has renewed the investigations on the gezira with a topographic and geophysical survey and targeted test trenches, however, one of the mission's research aims is to investigate the ancient environment in the region and its implications for our understanding of the archaeology.

Similar work is being carried out by the mission across the province of Minufiyeh and one of the key aims at the outset of the project was to identify prehistoric evidence in the region, both in close proximity to Quesna and beyond. Since this presentation was made in 2007, ground survey on the western Delta fringes (2008, 2009 and 2011) has produced evidence for Palaeolithic and Neolithic material and the survey will be both intensified and extended in 2013 (Rowland et al. 2009: 427).

The Holocene evolution of the Nile Delta has been discussed in general by Butzer (1975 and 1998) and Said (1981). More detailed geological and geoarachaeological investigations have focused mainly on the northern and eastern Nile Delta (Stanley and Liyanage 1986; Coultellier & Stanley 1987; Frihy and Stanley 1987; Stanley 1989; Sneh et al. 1986; van den Brink 1986; Wit and Stralen 1988; Hamdan 2000; 2004). The present paper aims to provide a paleoenvironmental and paleoclimatic interpretation of the area around the Quesna archaeological area, based on the sedimentological, and mineralogical characteristics.

Methodology

In the region around Quesna, drill coring has been carried out since 2006 in order to obtain information relating both to the chronology of the region, but also to the ancient environment, and the latter will be the subject under discussion here. Coring has been carried out using two different sets of equipment. The Eigkelkamp hand auger is used most extensively, due to economic and time considerations and can easily reach depths of 7-8 m below surface. The handle casing drilling machine, however, is also employed selectively where cores of 10 m plus of continuous stratigraphy are required.The methodology in the field depends upon the type of coring. For hand augering, the core is photographed both before and after extraction from the auger head, any ceramic sherds, stone pieces or other archaeological materials are removed and bagged, and the sediment is then recorded, a Munsell colour reading taken, and it is then bagged for subsequent analysis. A drill core recording sheet is completed after every core section to note details as to description of the material, the stiffness, colour, presence of archaeological and environ-

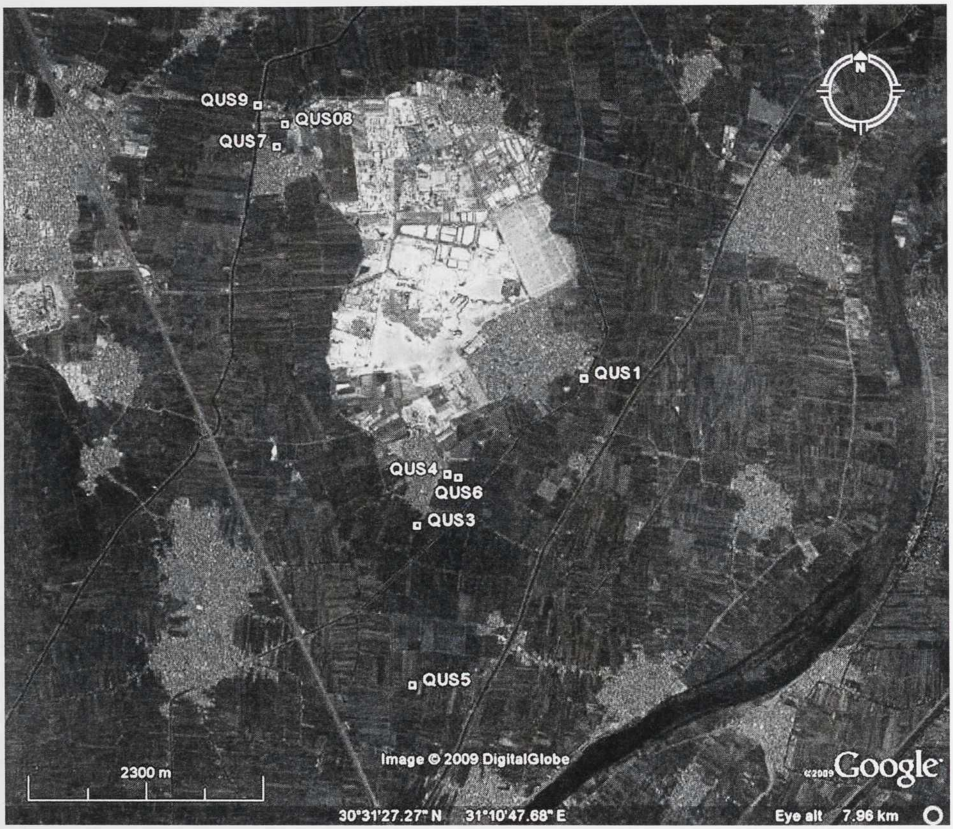

Fig.1. Location of the studied cores.

mental materials (e.g. pottery, stone, brick, charcoal, textile, shell). A different process is carried out for the handle casing drilling machine. The machine produces cores of 60 cm in length which give an uninterrupted core, as opposed to the hand auger, which produces a series of smaller, interrupted cores. On extraction of the handle-casing core, the metal casing around the core is opened lengthways and the untouched core is photographed and then examined; sedimentological observations are made on the recording form and any archaeological material recorded. The exact depths below surface at which cultural material is found can be considered and sherds, lithics, or other artefactual material, are retained for examination for typological and chronological indicators. Following collection of the sediment from both types of cores in the field, the geological samples are subjected to grain size analysis using a wet sieving technique and some selected samples are subjected to heavy mineral separation by heavy liquid (Bromoform).

The gezira at Quesna

The cemetery and sacred falcon necropolis described above were positioned on a turtle back or *gezira*. Even today, a position on top of the Quesna gezira allows for outstanding views over the surrounding countryside. In antiquity, however, without the presence of the modern brick and glue factories, the industrial estate and the modern tree cover, the site may even have been visible from as far away as Athribis. The modern day pollution must also be a consideration in site inter-visibility. The site as seen today probably gives a very different picture to that which it did even in the recent historical past. The area has been modified by sand quarrying and agriculture over the past 20 years and in addition to this, there has also been an encroachment of buildings associated with the growth of industry in the region, along the western and northern sides of the gezira. Even within the memory of the local farmers and the local SCA inspectorate, the sand *gezira* used to descend at a much more gradual gradient than today, when it sharply descends on all but the eastern side.

Recent maps (1970s onwards) combined with the view from the top of the gezira already help to build up a clearer image of the original extent of the gezira. From these maps and from the viewpoint at the archaeological area, it is possible to see additional smaller, lower, sand islands in the landscape, islands which would in all probability originally have been a part of the Quesna gezira. Looking at the geomorphology of the site, the site can be subdivided into three main geomorphic units:

1) Quesna Turtleback, elongated Pleistocene sand hill, 25 m asl.
2) Flood plain, 10-11 m asl.
3) Damietta branch

Location of the cores

Figure 2 shows the detailed lithological characteristics of the studied cores. The cores were placed along two transects in order to gauge the original form of the gezira in a number of directions. The east–west transect began with core QUS1 to the east of the gezira with the other three cores (QUS8, 7 and 9) in this transect lying to its west (Fig. 1). Only one core was placed to the east due to the proximity of a local river branch which marks the provincial boundary for Minufiyeh. Along the north-south transect, the first core in the line is, again, QUS1, with the remainder of the cores falling to the south at the time of this analysis (QUS4, 6, 3 and 5; Fig. 1), however, during the 2008 season a number of cores were drilled in the area of

Fig. 2. Lithological description of the studied cores.
(QUS2 was drilled at Kom el-Ahmar, Minuf).

the villages of Kufur Raml, which lie to the northeast of the gezira. There are several locations around the *gezira* where, due to sand clearance for farming, sections of the gezira have been exposed, providing a chance for geological examination of the stratigraphy. Section QUS10 (Fig. 2) represents one of these, located in a sand quarry to the north of the archaeological site, where Unit 1 is exposed in the surface and represented by thin beds of matrix supporting ordered and disordered gravel and cross stratified quartzose sand, medium to coarse grained.

Lithostratigraphy and sedimentology

The Holocene sediments of the Quesna area are represented by a complex sequence of both local and Nilotic deposits. The stratigraphy comprises five sedimentary units. Each of these is made up of several types of deposits reflecting the variability of the environment of deposition during various epochs. These units show a great variability in terms of thickness and changes of facies throughout the drilled cores (Fig. 3 and Table 1).

Fig. 3b shows a detailed description of the stratigraphy of the Holocene sediments on the western side of the Quesna *gezira*, where Units 4 and 5 become thicker than those in the eastern core QUS1 (Fig., 2). Unit 3 is still well developed but becomes more silty than core QUS1 on the east of the gezira. Unit 2 is reduced in comparison to core QUS1 and it almost disappears in core QUS7.

Moving to the north-south geological cross section of the gezira, the five units identified through the drill core data are of different thicknesses and lithologies (Fig. 3a), showing much greater variation than in the east-west section and an overall dissimilarity between the sections. The contact between the Pleistocene and the Holocene sediments shows a gentler slope than that of the western and eastern sides of the gezira. Unit 2 is well developed in the two most southerly cores and virtually disappears in the northernmost two ones. Unit 3 shows reverse relation in that it disappears in the most southerly of the cores. Unit 4 is well developed in the southern cores and exists, but to a lesser extent, in the northern cores and Unit 5 exists in uniform thickness in all cores.

Unit 1

Description

Unit 1 is recorded in the base of all studied cores at depths of up to 10 m below the present flood plain surface as well as on the surface on the southern slope of the *gezira*. In the *gezira*, it is represented by very pale brown (10 YR 7/4) colour, quartzose gravely sand, poorly sorted, cross-stratified, with foresets in a 60^{0} northeast direction. Ripple lamination and thin mud drapes are also observed. Few well-rounded limestone pebbles and gravel of local origin are scattered in the lower part. On the subsurface, Unit 1 is represented by very pale brown (10YR 7/4) colour, poorly sorted, quartzose gravely sand, its upper surface is located at different levels in the drilled cores. The top part of this unit is characterised by the existence of calcareous soil (ranging in thickness from 10 to 40 cm). The soil is white (10YR 8/1), highly calcareous silty sand, with scattered sub-angular to angular quartz, limestone rock fragments and pale olive (5Y 6/3) re-worked mud

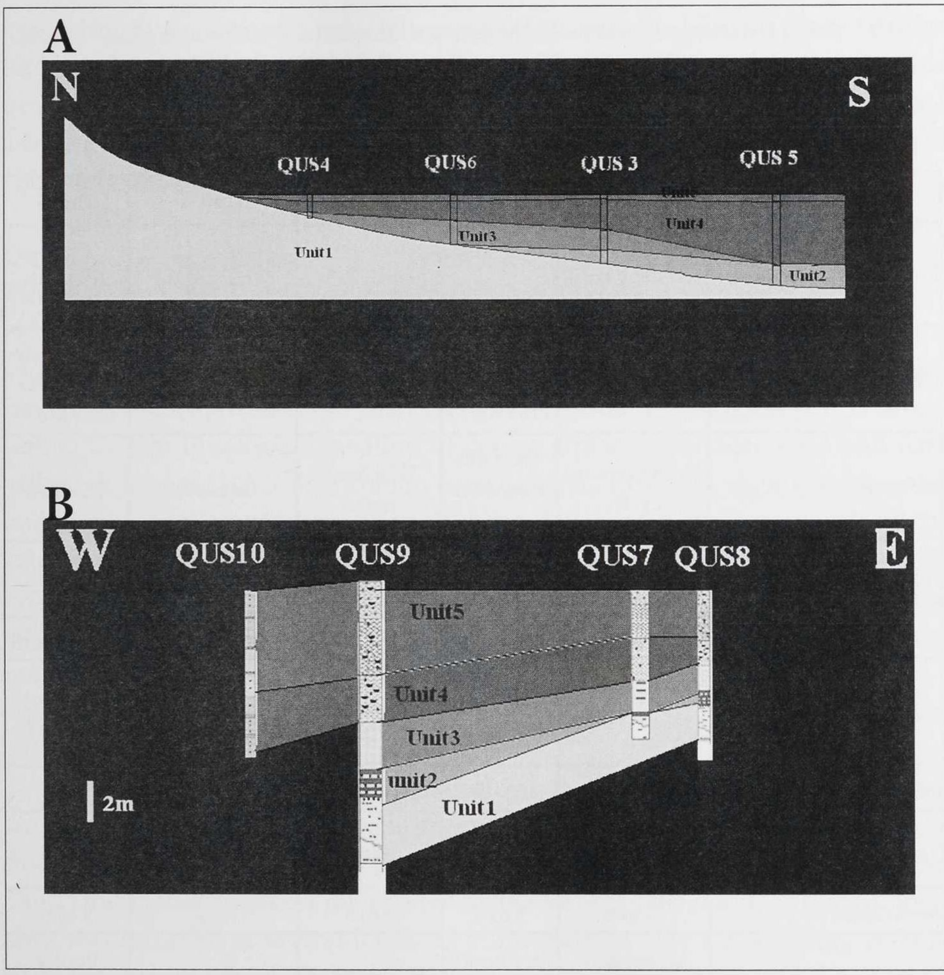

Fig.3. Stratigraphic cross section showing the distribution of the different units in the studied area (A) N-S stratigraphic cross section and (B) E-W section.

clasts. The local angular limestone clasts and the occurrence in a relatively low palaeorelief area suggest that the soil formation is related to high water influx under wetter conditions.

Interpretation

Fine and medium-grained sand is the dominant lithology for this unit, but gravel and coarse sand also occur. The abundant internal structure of the sandy facies is the planar and trough cross stratification. Both the lithology and sedimentary structures indicate that the PS has been deposited by

Table 1. A comparison between the different lithogical and sedimentological characteristics of the five units discussed above. The final row, the environment of deposition, explains how the analysis has allowed the interpretation of the units in relation to the ancient environment.

	Unit 1	Unit 2	Unit 3	Unit 4	Unit5
Location	QUS sand hill, and the base of all cores	QUS 3, 5, 8, 9	QUS 3, 7, 8, 9	QUS 1, 3, 4, 5, 6, 7, 8, 9	All cores
Colour	Light yellowish grey(10YR8/4)	Dull yello-wish brown (10YR5/3)	10yr3/3	Light brownish grey (10YR6/1)	Dull yellow-ish brown (10YR5/3)
Structure	Fining upward cycles	Sand-silt intercala-tions	Thin lami-nated	Massive	Massive
Boundaries	Sharp erosive	Grada-tional	Gradational	Sharp contact	Sharp ero-sive
Stiffness	Friable	Slightly stiff	Soft	Slightly stiff	Slightly stiff
Carbonate	Non	Low (Less than 5%)	Low to Mod-erate (3-7%)	Moderately (5-10%)	Moderately (5-10%)
Organic mater	<0.5%	2.2-4%	1-1.8%	1-5%	4-5%
Texture	Gravely sand	Sand and silt	Sand	Silt and sand	Silt
Mean size (Φ)	-5 to 0	3 to 5	2 to 3	1-5	3 to 6
Sorting	Moderately sorted	Very poorly sorted	Poorly sorted	Poorly sorted	Poorly sorted
Skewness	Fine skewed	Coarse Skewed	Fine Skewed	Coarse Skewed	Fine skewed
Deposition processes	Rolled and traction	Slope wash and Sus-pension	rolling and suspension	Traction	Suspension
Environment of deposi-tion	Braided chan-nel	Margin of flood plain with re-depo-sition of Pleistocene sand	Levee envi-ronment	Laterally aggrad-ing meander channel in flood plain	Flood plain

aggrading river channels migrating laterally across the alluvial plane (Bridge and Leeder 1979). Based on their mineralogy, lithology and stratigraphic position, these deposits are correlated with Qena sand, in Upper Egypt (Said 1981) and Sath Ghorab Formation of Late Pleistocene age in Middle Egypt (Hamdan 1992).

Unit 2

Description

This unit is recovered in some drilled cores, such as cores QUS3 and 5 to the south of Quesna Turtleback, and core QUS9 to the west. In general, the thickness increases southward to more than 200 cm at QUS5. Lithologically, it is represented by two lithologies; medium to coarse grained quartzose sand and dark yellowish brown (10YR 4/4) colour, hard massive, silty clay, slightly calcareous, and highly gypsiferous where fine acicular and columnar gypsum crystals fill the fractures and joints, especially in the upper two metres. This unit is non-fossiliferous, however, poorly preserved root casts are recorded in certain horizons. The unit also contains fine-grained calcareous concretions with thin black manganese cortex and yellowish ochre coat.

Interpretation

Sedimentologically, Unit 2 may indicate no flood surge but instead sheet wash from higher ground which began to prograde several hundred metres onto the flood plain with little attrition by overflow. So, the sedimentation of the Upper Sand Unit is therefore best interpreted by the waning Nile flood. This hydrologic shift was recorded at several localities at the Eastern Nile Delta during 7000 to 6500 BP. (Butzer 1998). The present study suggests the existence of a distributary channel which passed very close to the turtle back sand hill. The friable sand of the turtle back was re-worked in the flood basin by the high water flood, as well as by wind deflation.

The heavy mineral assemblage of the sediments of Unit 2 is represented in decreasing order of abundance by opaques, amphiboles, pyroxenes, epidotes, micas as well as metamorphic minerals and metastable minerals. It is obvious from the lithological and mineralogical studies that there is a great similarity between the sediments of Unit 2 and the sand of the Turtleback sand. This unit may be correlated with fan-like deposits in the south of the site of Minshat Abu Omar, Eastern Nile Delta (Andres and Wunderlich 1991).

Unit 3

Description

This unit is recorded in the southern and the western cores. In the north-south transect cores it is recovered in cores QUS6 and 3 with constant thickness (2 m) and very little thickness to the north at core QUS4, completely disappearing at core QUS5 in the south. In the western cores, it is recovered in the three cores (QUS7-9) with constant thickness. It is represented by a light yellowish brown (10YR 7/4) colour, fine-grained micaceous quartzose sand, with occasional pebbly horizons at different levels.

Interpretation

Unit 3 is formed of coarse siliclastic sediments which indicate a high energy environment. The fining upward nature of the sand as well as the decrease in the thickness of the layers probably indicates the deposition of a levee environment of a meander channel. The heavy mineral assemblages are dominated with opaques, pyroxene, amphiboles as well as low percentage of metamorphic minerals. These mineralogical characteristics probably indicate that these sediments were derived from East African sources.

Units 4 and 5

These units are recovered in all drilled cores, but with pronounced variation in thickness and lithology (Figs. 2 and 3). In general, the thickness increases away from the Quesna turtleback sand (Fig. 1). Lithologically, it is represented by a dark yellowish brown (10 YR 4/4) colour, hard massive, silty clay, slightly calcareous, and highly gypsiferous where fine acicular and columnar gypsum crystals fill the fractures and joints, especially in the upper two metres. This unit is non-fossiliferous, however, poorly preserved root casts are recorded in certain horizons. The unit also contains fine-grained calcareous concretions with a thin black manganese cortex and yellowish ochre coat.

Description

These units represent the main unit of the studied cores and are recovered in all cores. In the southern cores, Unit 4 it shows great thickness in the core QUS5 and much less thickness at core QUS4. In general, it is represented by about 2 m thick, pale brown (10YR 6/3), hard, heterogeneous, sandy silt, sometimes gravely, and calcareous. The sand grains are represented by sub-rounded to sub-angular quartz, rounded basement rock fragment and mica flakes. Calcareous nodules and concretions, as well as calcified root casts are abundant and concentrated in certain horizons. Along these horizons black Mn_2O_3 coat the carbonate nodules and yellow ochre fills the microfractures. Fresh water molluscan shells, represented mainly by gastropod tests are observed. Most of these shells are broken. Unit 5 mainly covers the whole studied area and represented by Nile silt rich in Roman pottery. It is highly calcareous and rich in calcified root casts and carbonate nodules.

Interpretation

The massive nature and the grain size is dominated by fine-grained clastics (>50% clay), which may indicate that this unit was deposited from suspended water in a rather low energy environment (flood plain). The abundant clay content and the relatively low CaCO3 content probably indicates that they were deposited in a back swamp environment with relatively low evaporation. Poor vegetation cover prevailed during their deposition as indicated by the frequent amount of calcified root casts. The existence of fine-grained micaceous sand lenses within this unit favours its interpretation as levee or crevasse splay deposits.

The heavy mineral assemblages of both Units 4 and 5 are similar and indicate East African sources.

Geological Evolution

Fig. 4 explains the geological evolution of the area under study. This area, as part of the Nile Delta, was occupied by braided channels where Unit 1 was deposited as a bedload deposit and probably point bar. The heavy mineral assemblage of this indicates that this river originated in central Africa. During the time of the Late Pleistocene, there was a drop in sea level to about –100 m below the present level. As a result of this drop, a deep erosion prevailed over the whole Nile Delta and as a result of this a deep incision and sub-aerial erosion of the Pleistocene deposits occurred. The surface of the site was littered by low ridges which were separated by small depressions (furrows). This period is marked in almost all of the cores by relatively high calcareous soil.

Unit 2 is characterised by two lithologies, coarse grained sand and silt which were deposited by a river which were originated from an equatorial African source. The correlation of the core indicates the existence of a distributary channel which passed very close to the turtle back sand hill. The friable sand of the turtle back was re-worked in the flood basin by the high water flood, as well as by wind deflation.

Unit 3 is characterised by fine grained quartzose sand and silty sand, the heavy assemblage of which indicates a mixed source between Ethiopian and central African sources. The top of this unit is marked with soil of a reddish colour with patinated lag gravel which probably indicates a low flood level. During the time of deposition of Unit 3 there was an eastward migration of the distributary channel

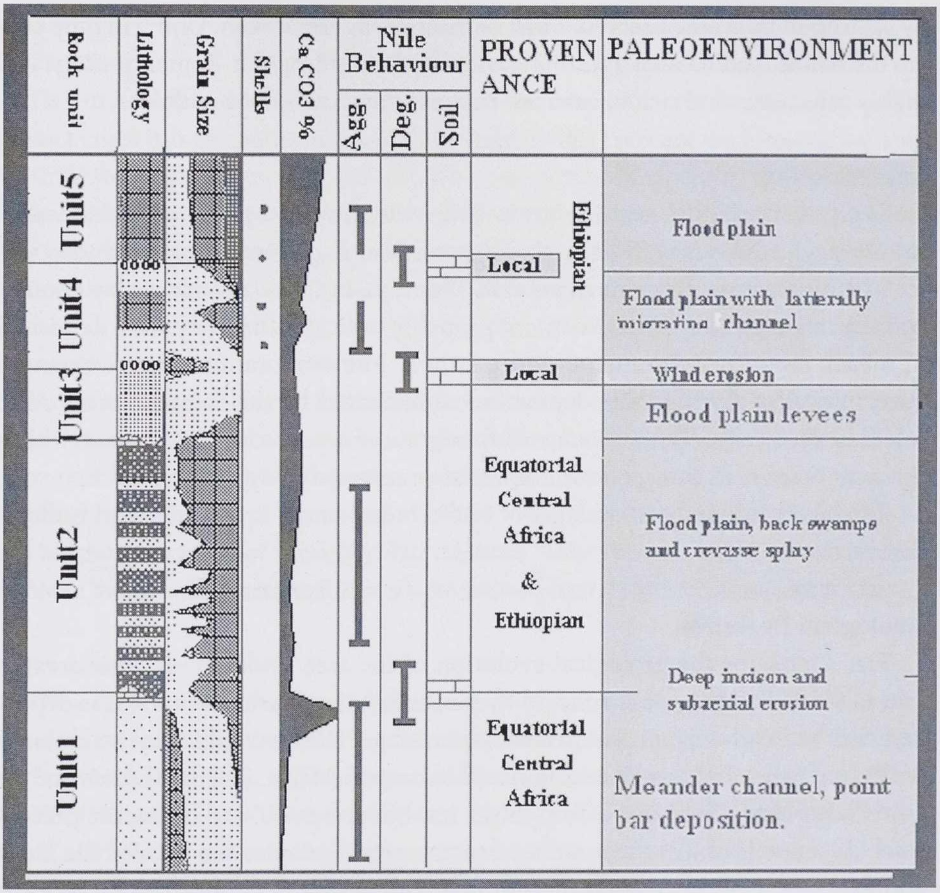

Fig. 4. Geological model for the Holocene evolution of Quesna area.

and the foot slopes and nearby areas were occupied by the flood basin which was covered with levees and back swamp pools.

Unit 4 consists of two lithologies which indicate deposition in a flood plain basin with a migrating channel close to the Quesna sand hill. The heavy mineral assemblage indicates that the river responsible for the deposition of Unit 4 is of Ethiopian origin. The top is marked with reddish colour soil.

During the time of deposition of Units 4 and 5, the site was occupied by the flood basin with probably a subsidiary distributary channel, which intercalated with the flood plain silt.

During the 2000 season, geophysical survey was conducted on the low ground around the Quesna gezira for the first time, both using magnetometry and resistivity. Although no archaeological structures were determined, the method proved successful as an additional means of providing information as to the subsurface of the Pleistocene gezira and (Rowland et al. 2009).

REFERENCES

ANDRES W. and J. WUNDERLICH. 1986. Untersuchungen zur Paläogeographie des westlichen Nildeltas im Holozän. *Marbung/Lahn: Marburger Geograpische Schriften* 100: 117-131.

ANDRES W. and J. WUNDERLICH. 1991. Late Pleistocene and Holocene Evolution of the Eastern Nile Delta and Comparisons with the Western Delta. In: H. Brückner, U. Radtke (eds), *Von der Nordsee bis zum Indischen Ozean*: 121-130. Erkundliches Wissen 105. Franz Steiner Verlag.

BRIDGE J. S. and M. R. LEADER. 1979. A simulation model of alluvial stratigraphy. *Sedimentology* 26: 617-644.

BRINK, V.D. 1986. A geoarchaeological survey in the north Eastern Delta, Egypt. *Mitteilungen des Deutschen Archäologischen Instituts Abteilung Kairo* 43: 7-31.

BUTZER, K. W. 1975. Delta. *Lexikon der Agyptologie* vol.1: 1043-1052.

BUTZER, K. W. 1998. Late Quaternary Problems of the Egyptian Nile: Stratigraphy, Environments, Prehistory. *Paleorient* 23(2): 151-173.

COUTELLIER, V. and D. J. STAŃLEY. 1987. Late Quaternary stratigraphy and paleogeography of the Eastern Nile Delta, Egypt. *Marine Geology* 77: 257-275.

FRIHY, O. E. and D. J. STANLEY. 1987. Quartz grains surface texture and depositional interpretations, Nile Delta region, Egypt. *Marine Geology* 77: 247-255.

GOMAÀ, F. and E. HEGAZY. 2001. *Die Neuendeckte Nekropole vaon Athribis*. Ägypten und Altes Testament Band 48. Wiesbaden, Harrassowitz in Kommission.

HAMDAN, M. A. 1992. *Pliocene and Quaternary sediments of Beni Suef-East Faiyum area and their relationship to the geologic evolution of the River Nile*. Unpublished Ph.D. thesis Cairo University.

HAMDAN, M. A. 2000. Late Quaternary Geology and Geoarchaeology of Kafr Hassan Dawwod, East Nile Delta. In: Z. Hawass, L. Pinch Brook (eds), *Egyptology at the Dawn of the Twenty-first Century: Proceedings of the Eight International Congress of Egyptologists. Cairo*, vol. 1: 221-228. Cairo, New York. The American University in Cairo Press.

HAMDAN, M. A. 2004. Geomorphic evolution of the Kafr Hassan Dawood predynastic site, East Nile Delta Egypt. *First conference of the Geomorphology of the Western Desert*. Cairo. Abstract.

HOROWITZ, A. 1979. *The Quaternary of Israel*. New York. Academic Press.

ROWLAND, J. M. 2007. The Delta Survey: Minufiyeh Province, 2006-2007. *Journal of Egyptian Archaeology* 93: 65-77

ROWLAND, J. M. 2008. The Ptolemaic-Roman Cemetery at the Quesna Archaeological Area. *Journal of Egyptian Archaeology* 94: 69-93.

ROWLAND, J. M. and N. BILLING. 2006. The EES Delta Survey (Minufiyeh) 2005. *Egyptian Archaeology* 28: 3-6.

ROWLAND, J. M., EDINBOROUGH, K., PHILLIPPS, R. in press. The Delta Survey: Minufiyeh Province, 2008-9. *Journal of Egyptian Archaeology* 95 (2009).

ROWLAND, J. M. and K. STRUTT. 2007 Minufyeh: the geophysical survey at Quesna. *Egyptian Archaeology* 30: 4-6.

ROWLAND, J. and P. WILSON. 2006. The EES Delta Survey – Report for 2004-2005. *Journal of Egyptian Archaeology* 92: 1-13.

ROWLAND, J. M. and S. R. ZAKRZEWSKI. 2008. Quesna: The Ptolemaic and Roman cemetery. *Egyptian Archaeology* 32: 1-3

SAID, R. 1981. *The geological Evolution of the River Nile*. Berlin. Springer.

SNEH, A., WEISSBROD, T., EHRLICH, A., HOROWITZ, A., MOSHKOWITZ, S., ROSENFELD, A. 1986. Holocene evolution of the northeastern corner of the Nile Delta. *Quaternary Research* 26: 194-206.

STANLEY, D. J. 1989. Sediments transport on the coast and shelf between the Nile Delta and Israel margin as determined by heavy mineral. *Journal of Coastal Research* 5(4): 813-828.

STANLEY, D. J. and A. N. LIYANAGE. 1986. Clay mineral variation in the Northeast Nile Delta, as influenced by depositional processes. *Marine Geology* 73: 263-283.

STANLEY, D. J. and A. G. WARNE. 1993. Nile Delta, recent geological evolution and human impact. *Science* 260: 628-634.

WIT, H. E. 1992 . The evolution of the Eastern Nile Delta as a factor in the development of Human culture. In: L. Krzyżaniak, M. Kobusiewicz, J. Alexander (eds), *Environmental change and human culture in the Nile Basin and Northern Africa until the second millenium B.C.*: 305-320. Studies in African Archaeology 4. Poznań. Poznań Archaeological Museum.

WIT, H. E. and L. V. STRALEN. 1988. *Geoarchaeology and ancient distributaries in the Eastern Nile Delta*. Report of the Laboratory of Physical Geography and Soil Science 34. Amsterdam . University of Amsterdam.

WUNDERLICH J. and J. ANDRES. 1991. Late Pleistocene and Holocene evolution of the Western Nile Delta and implications for its future development. In: H. Brückner, U. Radtke (eds), *Von der Nordsee bis zum Indischen Ozean*. Stuttgart. Franz Steiner Verlag.