TRACING THE CANOPIC BRANCH AT SCHEDIA AREA: A CONTRIBUTION OF BOREHOLES DATA AND FACIES ANALYSIS.

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1. INTRODUCTION

At least seven distributaries flowed across the Nile Delta and discharged in the Mediterranean at various times during the Middle to Late Holocene **(Said, 1981)**. During the past millennium flow in most Nile distributaries diminished and only Damiatta (formerly Bucolic) and Rosetta (formerly Bolbitine) are active at present. The position of the former branches has been determined by historical, geographic, archaeological, remote sensing, sedimentological, geophysical evidences **(Toussoun, 1922&1926; Sestini, 1976; Brink, 1987; De Wit and van Stralen, 1988, El Fattah and Frihey, 1988; Chen et al, 1994, Stanley and Warne, 1993, Frihy et al, 1994; El Gamili et al, 1994, Stanley et al, 2001; Ghazala, 2001, Stanley et al, 2004, El-Shahat et. al, 2005, Ghazala, et. el. 2005).**

The historic records by Greek, Roman, Byzantine and Arab scholars provide valuable information that help to interpret the evolution of the Canopic branch including the time when this major distributaries become a relict feature. Summarizing available documents, **Toussoun (1922, 1926)** suggests that the Canopic branch was the largest of the distributary channels at the time of the Greeks (as of the 7^{th}-6^{th} century B.C.) and remained active until the 1^{st} millennium A.D.

In general field evidence of the defunct branches is not clearly obvious. Precise mapping of some ancient distributaries of the Nile Delta is difficult because of lateral shifting of channels, subsequent development of an extensive irrigation and canal system, and drainage of marchlands and lagoons **(Arbouille and Stanley, 1991)**. However traces of the Canopic branch were detected inland from the coast, including the south margin of Idku lagoon, by areal photography **(UNDP/UNESCO, 1978** and **satellite imagery (IWACO, 1989)**. A series of low hills (Koms) are still preserved in the northwestern Nile Delta. These were attributed as remnant point bars related to the flow paths of the Canopic branch. In a recent study, **Stanley et al (2004)** examined the evolution of the Canopic branch at the Nile Delta margin in Abu Qir bay. Information from historic documents, integrated with data from geographical, geological and archaeological exploration in Abu Qir bay, indicates that the Canopic branch was active from 4000 B.C to the end of the 1st millennium A.D. **El Gamili et al (1994)** applied the geoelectrical resistivity technique to map the southern part of the defunct Canopic branch, south of Damanhour. He found a considerable agreement between the interpretations of the geoelectrical resistivity data and the geographical and historical recodes of the Canopic branch.

2. OBJECTIVES

In the Nile delta most of the Quaternary startigraphic units are now buried below the modern flood plain mud which covers the entire delta and its fringes. The detailed drilling provides the best mean to identify the principle lithofacies and recognize their aerial and vertical distribution. However, the sedimentological analysis of the subsurface samples must be supplemented by rhizoliths and floral analysis, radiocarbon dating and archaeological reports.

In this context, it is hoped to determine some of the buried geomorphic units and their mutual relation with the defunct Canopic branch that flowed in Schedia area during the Holocene. It is also hoped to reveal the landscape evolution during the Holocene time and its impacts on distribution of ancient settlements especially during Greek, Roman, Byzantine periods.

3. METHODOLGY

To achieve the pervious aims, it is recommended to drill about 30 shallow boreholes around the archaeological sites of Kom El-Gizah, Kom El-Hammam and Kom El-Nashwah. Accordingly, twenty eight boreholes were recovered in the working area **(Fig.1)**. The chosen sites of the drilled boreholes were carefully selected according to the available geological, geophysical and archeological information that are related to the Canopic branch and associated paleotopography. These boreholes were drilled during three field expeditions in May 2005 with varying depth generally from 8 to 12m below the ground surface, except H10 which was stopped at depth of about 4.5m probably due to presence of large buried limestone block. The drilling sites are arranged along 5 transects; generally perpendicular to the inferred course of the defunct Canopic branch. Three transects are located to the east of the present Kanubiya canal and extending nearly in the NE-SW direction; from south to north are a-a', b-b', and c-c'. The other two transects, d-d' and e-e', are located to west of the Kanubiya Canal and extend nearly in the N-S direction. The separation between the boreholes ranges from 50 to >150 m interval according to the field accessibility and previous knowledge about the area.

For each borehole, the subsurface samples were taken at depth interval of 0.5 m and rapidly examined in the filed and carefully preserved. A total of 480 subsurface samples were taken for further sedimentological analysis.

Facies interpretation is mainly based on the analysis of the more obvious attributes as sediments color, gross lithology, mineral composition, rhizoliths and floral contents. Pottery and burnt brick fragments were recorded wherever present. In addition, the sand fraction (>63 m) was examined by binocular microscope **(c.f. Frihy and Stanley, 1988, Loizeau and Stanley, 1993).** The mineralogical components include the recognition of light and heavy minerals, mica, gypsum, rock fragments, sand aggregates (cemented by carbonates) , carbonate nodules, calcareous and hemattic rich rhizoliths, calceretee lumps (quartz sand cemented by displacive micrite) and calcerete grains (micrite aggregates. The faunal components are mainly pelecypodes, gastropods, undifferentiated shell fragments, ostracods (dominated by Cyprideae) and bone fragments of small vertebrates. The floral elements are represented by carbonized plant remains including stems and seeds) and charaophyte oogonia, Exotic components include oolites, pellets echinoderm spines and plates. These components are reworked from the limestone fragments; frequently encountered in the overbank mud, lacustrine and lagoon facies. These limestone fragments are abundant near archaeological sites. The petrography of the limestone fragments suggests their derivation from the carbonate of Abu Sir Ridge. Full descriptions of each borehole along the five transect and its characteristics are represented in **Figures (2 -7),** for more details see also **Tables 1 – 28**. Moreover, **Plates (1& 2)** show some identified components recognized in subsurface samples, under the binocular microscope.

4. SEDIMENTARY FACIES

Various lithofacies units were distinguished on the basis of the previous petrologic components. A brief description and interpretation of each lithofaices is given below. The predominant lithofacies of the Holocene sequence in the area includes the channel sand bar, overbank sediments, lacustrine and lagoon deposits. The Holocene sequence is underlain by calacerete and rhizoliths sands with an unconformity surface. Full description of these facies is given below.

4.1. Overbank mud

The facies consists of dark brown soft compact clay, silty clay, clayey silt and sand silt. Thickness of this unit varies from 3 to10m. The overbank mud grades laterally into lacustrine and lagoonal facies; underlain by channel bar sand or older lagoonal sediments. Fossils are generally rare; represented by reworked shell fragments, ostracods, vertebrate fragments and some charcoal. The sand fraction of the overbank mud consists of fine quartz and some mica. In some samples the sand fraction is mainly carbonate nodules, calcareous and hematite cylindrical rhizoliths. Locally there is limestone fragments derived from the limestone of Abu Sir Ridge (example H10). These samples contain oolites, pellets, benthonic foraminifera, echinoderm fragments. Without a previous background information on the petrography of the limestone of Abu Sir Ridge misinterpretation may be reached**.**

4.2. Channel bar sand

This facies consists of friable yellowish grey, reddish brown and greenish grey fine-medium quartz sand. Fossils are very rare: include abraded shell fragments and some bone fragments of small vertebrates. The facies is encountered in most of the examined boreholes; grades upward into overbank mud or lacustrine clay. & some boreholes, the channel bar sand is overlain by silt, sand silt and clay with abundant black plant debris (H5, H6, H7, H8, H17 and H18). This refers to stagnant conditions; probably related to a phase of channel deactivation. Small pottery fragments have been recognized in the channel bar sand at several intervals. The channel sand of H7 (between depth intervals 9-12m) is particularly very rich in large pottery fragments (~10 cm) in addition to abundant large oysters. The presence of oysters which have a marine affinity with fluviatile sand is puzzling. However, it possible that the oysters were carried to site by humans for unknown reasons. The presence of the oysters and large pottery fragments with the fluviatile sands at a depth of 9-12m below the present ground surface refers to probable harbor site.

4.3. Lacustrine Clays

This facies has a limited areal distribution, encountered in surface samples of boreholes H1, H2, H3 and H4. The facies grades laterally into overbank mud. It is underlain by overbank mud or channel bar sand. The lacustrine clays are characterized by common Cyprideae ostracods, fresh water snail (*Planorbis*) and charophyte oogonia and some bone fragments of small vertebrates. The facies contains abundant lenticular gypsum suggesting the desiccation of the former lake. Subsequent pedogenesis is indicated by the presence of abundant carbonate nodules and cylindrical rhizoliths. More detailed studies including further drilling program are important to determine the proper areal extension of the former lakes in the study area.

4.4. Lagoonal facies (fluvially influenced)

This facies is restricted to the area south of Kom El Nashwah. It was encountered in the boreholes H20, H21, H24, H25 and H26. The facies (up to 5m thick) comprises different lithologies between brown clay, silt, sandy silt and fine-medium sand. Lenticular gypsum aggregates are frequently encountered. The facies grade laterally into overbank mud and is separated from the underlying calcrete or calcreted sand by an unconformity surface.

The fossils of the lagoonal facies are broadly similar to those encountered in the lacustrine facies. However ostracods are more abundant in the lagoonal facies. The areal extension of the lagoonal facies in the study area deserves further sampling and field work.

4.5. Calcrete and calcreted sand facies

Complete gradation exists between calcrete and calcreted sand facies. Calcrete lumps (quartz sand cemented by displasive micrite) and micrite aggregates are relatively common in the calcrete compared with the calcreted sand. Both rock types are beige to pale yellow in color. The dertrital fraction includes medium to coarse quartz and rare pebbles, commonly stained by carbonates. The fossils include abraded shell fragments, ostracods and sometimes whole gastropods. Gypsum is frequently encountered.

Calcrete and calcreted sand are restricted to the boreholes drilled south of Kom El Nashwah (H20-H28). They grade laterally into overbank mud. Calcrete and calcreted sand grade upward into overbank mud (H23, H27 and H28) or into lagoonal sediments (H20, H21, H22, H24, H25 and H26). Calcrete and calcreted sand may represent the oldest sediment encountered in the study area. They are separated from the overlying sediments by an unconformity surface. Their age cannot be accurately determined.

5. BOREHOLE TRANSECTS

5.1. Transects a-a' (H7, H8, H9, H10, H11, H12, H13)

This transects **(Fig. 8)** is located south of Kom El Gizah. The penetration depth varies from 8-12 m below the ground surface, except H10 which was stopped at depth of about 4.5m due to the presence of buried limestone block. The overbank Holocene Nile mud ranges from 4 to 9 m. This unit comprises two units; the upper brown mud and the bluish to greenish black humic mud which is recorded only in H7, and H8. The channel bar facies is recoded only in H7, H8 and H9 with increasing depth westward. Lagoonal facies is only recorded in H11, H12 and H13. This transect suggests the presence of the relatively deep depression within which deposition of the bluish black humic mud took place.

5.2. Transect b-b' (Boreholes H6, H5, H1, H2, H3 and, H4).

This transect **(Fig.9)** is located between Kom El-Gizah and Kom El Nashwah. The penetration depth varies from 6m to 12 m. Three facies are observed along this transect. The upper is characterized by lacustrine sediments except H6 which is dominated by the overbank mud. The lake deposits are underlain by the overbank Nile mud which increases in thickness from 2 m to 8 m westward. The channel bar sediments, range form fine to medium or coarse sand. This transect suggests the presence of the relatively deep and narrow depression within which deposition of the alluvial sediments.

5.3. Transect c-c' (Boreholes H19, H18, H14, H15 and H16)

This transect **(Fig.10)** is approximately located west of Kom El Nashwah. The general penetration is about 10 m. Only two facies are observed along this transect. The upper ones is dominated by the overbank mud followed by the channel bar units. The overbank mud is consists of brown mud and underlain by greenish grey mud.. The overbank mud increases in thickness from 5 m to more than 10 at H19. This transect also suggests the presence of the relatively deep and broad depression within which deposition of the alluvium sediments took place.

5.4. Transect d-d' (Boreholes H23, H22, H21, H20, and H19).

This transect **(Fig.11)** is located south of kom El Nashwah and the penetration depth varies from 8m to 10 m. Three units are observed along this transect. The top overbank unit is only recorded in H23 and H19 with a thickness 7 and 9 m respectively. The overlbank mud overlies the young lagoonal unit which in turn is underlaine by is characterized by calceterd sand and calcrete. The channel bar unit is absent along this transect. This transect suggests the presence of a narrow depression within which the overbank Nile mud was deposited. The site of H23 suggests a possible location of a subsidiary canal (Alexandria canal) which had its water and sediments from the Canopic branch

5.5. Transect e-e' (Boreholes H28, H27, H26, H25 and H24).

This transect **(Fig.12)** is located between kom El Nashwah and Kom el Sherif, extending north south. The penetration depth varies from 8m to 10 m. This transect is nearly similar to the transect 4. Three units are observed along this transect. The overbank unit is only recorded in H28 and H27 with a thickness 7 and 5 m, respectively. The young lagoonal unit is exposed at the surface in H26, H25 and H24 and attains. The lower the unit is ca is caharcterized by calceterd sands and calcrete. The cahnnel bar unit is also absent along this transect. This transect suggests the presence a narrow depression within which the overbank Nile mud were deposited i.e. the site of H28 suggests also a possible location of a subsidiary canal (Alexandria canal) which had its water and sediments from the Canopic branch

6. TRACING THE DEFUNCT CANPOIC BRANCH

The defunct river distributaries, lagoons and lakes are considered to be of great importance from the geological point of view as they are responsible for temporal and spatial distribution of the lithofacies units. The vertical and lateral distribution of the different lithofacies refers to the probable location of the defunct Canopic branch.

The tentative delineation of the Canopic is based on mapping the channel fills which consists of sand and silty sands those grades upwards into clayey silt and slity clay. The fining upward sequence denotes a change from active flow to abandoned fluvial conditions. The approximate Canpoic width is about 150. It is noticed that the Canopic path was controlled by presence of the surfacial lake and lagoonal water bodies (fluvially influenced) that were dominated during its late stage.

Consequently, on the bases of all integrated results, we are strongly suggested that the possible location of the channel path is nearly coinciding present day El-Kanubyia Canal **(Fig. 13)**. The possible course of Alexandria Canal and two options of the harbor site are also suggested. The course of Canopic channel suggested by Bergmann **and Heinzelmann (2003) (Fig.13),** is located further northeast of the present suggestion.

7. RECOMMENDATIONS

Based on the above results, it is highly recommended to drill additional boreholes to fill the gaps between the different transects, especially towards the eastern side of El-Kanubiya Canal (south and north of Kom El-Hamam). About 15 additional boreholes are recommended.

The sedimentological analysis of the subsurface samples must be supplemented by additional geological studies including faunal and floral analysis and radiocarbon age dating of some representative samples.

Integration of geological and archaeological studies is essential to delineate the proper course and duration of the Canopic branch at Schedia area..

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