SOME RECENT GEOLOGICAL DEPOSITS IN THE EGYPTIAN NILE VALLEY

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SEVERAL YEARS AGO G. W. Murray[1] contributed a discussion to the *Geographical Journal* which marked the first successful attempt to sketch the Upper Pleistocene and Holocene climatic history of Egypt in a truly modern fashion. The wealth of personal observations and intimate knowledge of the material described reflected Mr. Murray's long years of experience in Egypt, since 1941 as Director of the Topographical Survey. During the winter of 1958 the present writer collected geological data in Middle and Upper Egypt which adds in some way to our present knowledge of Postglacial climates in that country.

Although the Recent, or Holocene, deposits of Egypt form but a minute fraction of the surface area, their significance for the inhabited riverain zone is paramount. Climate and sedimentation must have played as important a role in modelling the geographical environment in ancient times as they do today. For example, it is not at all obvious that the precious Nile alluvium has been distributed and laid down at a uniform rate since the close of the Pleistocene, as is widely supposed. These Holocene deposits in the Nile Valley are of aeolian and fluviatile origin: sand dunes, nilotic mud and wadi deposits.

The aeolian deposits.—Wind-borne sediments in the valley are more or less limited to the western margins, particularly between Gebel Deshasha (near Biba) and the monastery Deir el-Miharraq by el Qusiya, a stretch of over 80 miles. These sand fields are of considerable hindrance to cultivation. Their development is both complex and interesting, so that it is regrettable that, apart from reference to their existence, little attention has ever been paid to them. Firstly one can speak of an irregular line of marginal valley dunes lying exlusively upon Nile mud to a width of one half to two miles between Deshasha and a point about three miles south of Balansura (west of Abu Qurqas). After a small interruption similar dune fields occur between Tuna el Gebel (west of Mallawi) and Dashlut (west of Dairut), and again between Nazlet Bawit (west of Sanabu) and el-Miharraq. In contrast to the dunes upon the Pleistocene gravels west of the desert margin, these are to a fair extent fixed by vegetation deriving its moisture from the ground-water. Although the fields between Deshasha and Balansura can only be classified with difficulty as generally transversal arrays running parallel to the border desert-alluvium, those between Tuna and Dashlut are developed as specific geomorphological forms. Three rows of 10 feet high transversal dunes run NNE.–SSW. while another line abuts the desert in the lee of the Pleistocene gravels. In the Meir area, between Sanabu and Qusiya, two immense longitudinal dunes of four miles in length are blown up in the lee of the steep limestone scarp running NNW.–SSE. All these dunes overlie nilotic sediments and were apparently deposited during the last few centuries.

From behind the Black Hills due west of Beni Mazar a chain of NNW.–SSE. longitudinal dunes, generally averaging one or two miles in length, extends over 30 miles across the desert surface to the nummulitic headland a little south of Balansura. These deposits have no direct continuation north-westward while they merge with the marginal valley dunes south of Minya, forming a great field of barchans north of Balansura. These fields, and the minor longitudinal leeward dunes abutting from the scarp here and there, are mobile and moving across the Pleistocene gravels.[2] It

[1] "The Egyptian climate: an historical outline." *Geogr. J.*, **117** (1951), pp. 422–34.

[2] Both the Western Desert and the marginal valley dunes are shown on the geological map of Middle Egypt (between Fashn and Qusiya) in Butzer, "Contributions to the Pleistocene geology of the Nile Valley," *Erdkunde*, **13** (1959) pp. 46–67.

appears that the barchan fields north of Balansura, which merge with marginal dunes there, are, in their present position, partly related to the sub-recent aeolian deposition on the adjacent alluvium indicated by the surface marginal dunes.

From a number of exposures between Dashlut and Tuna the marginal dunes in that area generally overlie 8 to 12 inches of Nile mud and, below that, some 6 feet of further aeolian sand. The latter rests upon alluvium and nilotic sands often attaining 6 feet, and then again upon at the very least 15 feet of wind-borne sand. The major layer of alluvium appears to be Roman.[1] In other words two layers of aeolian sand were deposited in late and post-Classical times, the Upper Younger Dunes representing the present surface deposits, the Lower Younger Dunes the upper buried ones (Fig. 1). The latter can be found under alluvium in exposures several miles west of the surface dunes, indicating greater aeolian activity in an intensified desert climate at the time. Towards the east they are also subdivided by interdigited bands of alluvium. The Older Dunes, underlying the mud of Hellenistic age, represent a long period of deposition, possibly 1000–2000 years. Several erosional surfaces invariably occur within the profiles and the base was never observed. These former

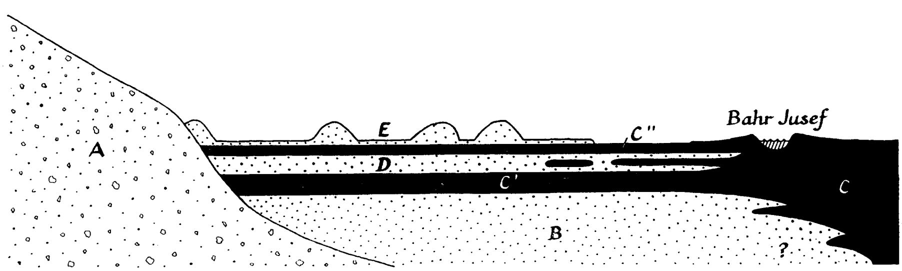

Fig. 1. Idealized profile of the Marginal Valley Dune generations in western Middle Egypt (between Dashlut and Tuna el Gebel: A. Pleistocene gravels; B. Older Dunes; C. Holocene alluvium, C' Roman age, C'' Islamic age; D. Lower Younger Dunes, locally subdivided (later Roman to early Islamic); E. Upper Younger Dunes (modern)

dunes also extended well west of the surface ones and likewise imply greater aeolian activity in pre-Hellenistic times. A lower limit can be deduced from evidence at the site of Hieraconpolis in Upper Egypt. There a Predynastic cemetery in Palaeolithic silts was later wind-eroded, exposing the burials while the silts and foreign sand were laid down in false-bedded deposits covering 2,500,000 sq. ft. a little in the lee. Other indications would indicate that slightly more abundant rains occurred from Neolithic right down to Vth Dynasty times,[2] so that an estimation of 2350–500 B.C. for the period of formation of the Lower Dunes would not seem unreasonable.

Another Recent phase of accelerated aeolian activity can be deduced from the work of Miss Caton-Thompson and Miss Gardner[3] in the Fayum depression, where

[1] Dr. W. Kaiser identified numerous pottery sherds at one section in the main alluvium horizon and base of the overlying sand as Roman. This contained brown rilled and a coarse red ware. The archaeological material will be published, along with a geological description by the writer, in *Mitt. deut. Archäol. Inst. Cairo*, **17** (1959).

[2] Butzer, K. W., "Das ökologische Problem der neolithischen Felsbilder der östlichen Sahara." *Abhl. Akad. Wiss. Liter. (Mainz), Math.-Naturw. Kl.* 1958*a*, 20–49, Nr. 1; "Quaternary stratigraphy and climate in the Near East." *Bonner Geogr. Abhl.*, 1958*b*.

[3] Caton-Thompson G. and E. W. Gardner, "Recent work on the problem of Lake Moeris," *Geogr. J.*, **73** (1929), pp. 20–60; also *Bull. Inst. d'Egypte*, **19** (1937), pp. 243–303. It may be noted that the sand lenticle found by K. S. Sandford and A. J. Arkell ('Paleolithic Man and the Nile Valley in Nubia and Upper Egypt,' Oriental Inst. Publ., University of Chicago, 1933, p. 47) in the Sebilian Silts at Armant indicates similar arid spells in Upper Pleistocene times.

desiccation and severe wind-scour followed upon the Middle Sebilian and before the recreation of the pre-Neolithic lake at 206 feet R.L. With radio-carbon dates of 4440 and 4144 B.C. for the early Neolithic lake, it may be that the previous arid phase ended about 5000 B.C.

The valley alluvium.—The deposition of Nile mud is generally believed to have begun after the Upper Pleistocene degradation of the Nile Valley, when the river bed rose in response to the early Postglacial rise in eustatic sea level. The silts deposited before this in Upper Levalloisian and Lower Sebilian times are, however, fine, slightly sandy deposits from annual floods of Blue Nile provenance, only a little different from modern alluvium. It seems that the subsequent Nile degradation only interrupted further deposition until the river gradient was less steep. As can be seen from numerous bore-hole profiles, the earliest aggradation corresponding to a rising base level of erosion was not nilotic mud but mica-bearing, fine gravel and sands which lie 10 to 30 feet thick below the alluvium in Middle and Upper Egypt.[1] This presumably post-Sebilian filling is certainly post-Upper Levalloisian as the high percentage of Blue Nile minerals (*e.g.* pyroxenes) never occurs in earlier deposits.

Today the alluvium of the central valley averages 32 feet between Cairo and Minya, 28 feet between Minya and Qena, and 22 feet between Qena and Aswan. The late John Ball [2] calculated an annual deposition of 0·0405 inches of mud for the basin lands of the valley before the Aswan dam came into operation. Assuming a steady rate of deposition the present alluvium dates back to about 4600 B.C. in the southern part and to 7600 B.C. in the northern part of the valley. This would be understandable as a gradual response to a rising sea level first noticeable in the Delta and progressing slowly upstream.[3] The calculated mud rise comes very close to the archaeologically estimated rise of 4 inches in the basin lands of the valley. However, it would be presumptuous to assume that neither the sea level (and the base level of erosion) nor the Blue Nile flood volume fluctuated a little in the course of the last 7 millennia. In an earlier paper it was suggested that the sea level reached a maximum of +12 feet (*c.* 3300–3000 B.C.) dropping to a stand at +6 feet (*c.* 2500–1500 B.C.), and probably attaining a stand at below modern sea level in Graeco-Roman times.[4] Similarly A. J. Arkell [5] could show that the Blue Nile flood level was at least 12 feet higher in Mesolithic Khartoum (*c.* 4000 B.C.), while the annual fluctuations of the Islamic era are well known. It therefore appears likely that the rate of deposition was very much higher before 3000 B.C. than it is today, something confirmed archaeologically as three-fifths of the alluvium were already deposited during some 4000 years before Old Kingdom times. For example, G. W. Murray kindly informed the writer that 3m. of mud were deposited at Hieraconpolis before the reign of Pepi II (*c.* 2250 B.C.), compared with only 2m. since that date.[6]

[1] See the bore-profiles given by Sandford, 'Paleolithic Man and the Nile Valley in Upper and Middle Egypt,' Oriental Inst. Publ. 18, Chicago 1934, pp. 103–4; also Sandford's Fig. 25.

[2] Contributions to 'The geography of Egypt,' Cairo, 1939, p. 163 *et seq.*

[3] Recent radio-carbon dating by the Cambridge Laboratory confirms a rise in world sea level by 150 feet between 8750 and 3500 B.C. (H. Godwin, R. P. Suggate and E. H. Willis, "Radio-carbon dating of the eustatic rise in ocean level." *Nature*, **181** (1958), pp. 1518–19).

[4] Butzer, K. W., "The 2m. raised beach near El Alamein, Egypt." *Actos*, V. Congreso INQUA, Madrid-Barcelona (1957), in print; also 1958*b*, *op. cit.* pp. 37–8.

[5] 'Early Khartum,' Oxford, 1949, pp. 109–10.

[6] There has been considerable speculation about a so-called 20m. aggradation at Maadi in Neolithic times (*cf.* I. Rizkana, "Centres of settlement in prehistoric Egypt in the area between Helwan and Heliopolis," *Bull. Inst. Desert*, **2**, 2 (1952), pp. 117–30. The writer (1958*b*, *op. cit.*, pp. 66–7) has already given grounds why the mineralogical statistics could just as well be cited as evidence in favour of a Middle Palaeolithic dating. He has also had opportunity to examine the greater part of the prehistoric sites of Egypt without, however, having found a trace of evidence in favour of Neolithic mud deposition higher than the present flood level. G. W. Murray has likewise communicated to the author that further such evidence

From the alluvial deposits in Middle Egypt it appears as if sedimentation was accelerated during the first few centuries of our era, which was possibly due, in part, to the rise to present sea level beginning about the same time. The 6 feet of mud dating from this time (Fig. 1) took at the most 600 years to form, judging from the uniform pottery sherds occurring throughout the datable section near Tuna el Gebel. But 6 feet would theoretically require some 1800 years deposition, so that the rate of sedimentation must have been three times as great as today in Hellenistic times. This figure may be distorted a little, due to the lateral shifts of the Bahr Jusef which are indicated by the fluviatile sands, rich in organic matter, to be seen in countless buried alluvium sections in western Middle Egypt. Whether these shifts were natural, *i.e.* due to stronger floods inducing stronger meandering of this Nile arm, or due to human interference, is uncertain. There are also geomorphological indications that the Bahr Jusef flowed directly east of the desert gravels in classical times, something closely reflected in the flourishing conditions of human settlement in the western valley at the time. Graeco-Roman, and apparently only remains of this age, are scattered profusely upon the low desert surface wherever one goes. This also fits in with the aeolian activity in preceding and subsequent times. It should be pointed out, however, that pottery sherds can "slip down" through a layer of seasonally viscous Nile mud in the course of time, so that Roman sherds found throughout a horizon may only date the uppermost part.

The Lower Younger Dunes are occasionally intercalated with a mud layer containing numerous sand lenses in its upper part, suggesting a westward shift of the Bahr Jusef in early post-Classical times. Arab authors mention the Bahr Jusef arm as beginning north of Asyut in 871, 1245 and 1441 but in 871, 900 and 1153 Ibn abd el Hakim, Ibn Serapiun and Idrisi respectively state that the Nile arm begins at Soul (Sohag). Ibn Khaldun in 1405 merely repeats Idrisi. From the continuous canal still running between Sohag and west of Dairut at the time of the French Survey (1799–1801) it appears that this former alternative branch ran somewhat west of the present Bahr Jusef.[1] This would give a ninth–twelfth century date for the "Branche de Sohag" and the brief interruption of the Lower Younger Dunes.

Somewhere in more recent times the 8–12 inches of alluvium everywhere covering the Lower Younger Dunes were deposited, apparently during a period of higher floods. In 1441 the Bahr Jusef source was already given as Dairut el Cherif as it has been ever since the eighteenth century. But el Zahiri in 1467 and the seventeenth century map of P. Vander (Amsterdam) both show the river arm commencing at Menha or Mounha, a now unknown site between Manfalut and Asyut. It appears that this arm likewise ran to Meir and along the Hod el Dalgawi drain to join the present Bahr Jusef at el Badraman, also west of the present river. Even since 1800 the Bahr Jusef has shifted a few miles eastward between Maghagha and Lahun. The Upper Younger Dunes apparently moved across the fifteenth–seventeenth century alluvium once more after A.D. 1700. For the Islamic era it is more or less certain that the Bahr Jusef shifts were natural and due to stronger or weaker Nile floods as the accounts of Nabulsi (1245) would have us suspect. These would be a reflection of rainfall fluctuations in the Blue Nile basin.

Local fluviatile deposits.—Lastly the wadi and other local deposits of the Nile Valley deserve mention. These are, of course, intimately associated with periods of more frequent occasional rains, either in the hilly country or as a southward shift of the etesian rainfall belt. For the Neolithic and Predynastic period G. W. Murray and the writer have already given detailed descriptions of the various indicators of a slightly

is also unknown to him. In view of the somewhat incomplete and unconvincing publication of the Maadi-Turah bores, we incline to consider the assumption unwarranted until better supporting data are available.

[1] These features, as well as the now abandoned canals west of Dairut, are shown on the geological map, referred to in footnote 2, p. 75.

moister "subpluvial" climate.[1] It may be of interest here to discuss the question of classical or later rainier periods.

Despite careful search and study of countless Roman ruins in the valley it was not possible to find any indication whatever of more frequent rains at that time. However there are suggestions for a moister period in post-Classical times, which may well coincide with historical evidence of a moist interval in Asia Minor during the ninth to tenth centuries.[2] Thus, the Middle Eocene limestone debris left after the demolition and requarrying of a limestone building at Oxyrhynchos (El-Bahnasa) is cemented to a depth of 6 inches by dissolved lime and bands of crystalline gypsum. Such a resistant breccia as this requires more than air moisture for formation, implying some rainfall after the requarrying of the building stones, probably in early Islamic times. At Acoris (Tehna) some 5 feet of well stratified and well assorted fine material were deposited behind a brick barrier after the abandonment of the city in Coptic or early Arab times. Such deposits are not brought down by present spates which carry a heterogeneous mass of rubble with them. Similarly at Hebenu, former capital of the 16th Upper Egyptian Nome, similar thick deposits were laid down in a small depression in front of an irrigation dam, after the abandonment of this part of the town in post-Coptic times. Scanty as the evidence is, it does suggest a brief interval with some rains, possibly contemporary with the brief cessation of aeolian activity and with the moist interval in Asia Minor about A.D. 900.

Summary and conclusions.—Summarizing the geological deposits and associated climates of the Holocene it seems possible to add somewhat in detail to that first successful study by G. W. Murray. The dating remains very approximate of course.

?16,000–5000 B.C. Arid with intensified aeolian activity. Probably a brief interruption about 9000 B.C.

5000–2350 B.C. Moister than today ("Neolithic subpluvial").

2350–500 B.C. Arid with intensified aeolian activity. Older Dunes in Middle Egypt.

500 B.C.–A.D. 300. Accelerated deposition of Nile mud. Higher floods. Locally arid.

A.D. 300–800. Arid with intensified aeolian activity. Lower Younger Dunes (I).

800–1200. Higher Nile floods. Locally slightly moister at first.

1200–1450. Arid. Lower Younger Dunes (II).

1450–1700. Higher Nile floods.

Since 1700. Recent (Upper Younger) Dunes in Middle Egypt and present-day conditions.

[1] Murray G. W. (1951), *op. cit.*; K. W. Butzer, 1958*a*, 1958*b*, *op. cit.*

[2] Butzer, K. W., "Der Umweltsfaktor der grossen arabischen Expansion." Saeculum, *Jhbh. f. Universalgeschichte* **8** (1957), pp. 359–71.