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Pleistocene history of the Nile Valley in Egypt and Lower Nubia

Histoire de la vallée du Nil en Egypte et en Basse Nubie au Pleistocène

La série du Cénozoïque supérieur de la Vallée du Nil en Egypte et Basse Nubie comprend une suite complexe d'alluvions nilotiques et autochtones, en partie interdigitées mais pas nécessairement en phase, de même que des paléosols qui leur sont liés et des formes d'érosion.

Cette série ne peut être interprétée sans des modèles géomorphologiques modernes, et sans s'appuyer sur une recherche cartographique détaillée, des analyses micro-stratigraphiques et des études sédimentologiques. En dépit de quelques lacunes, c'est l'une des plus complètes et des plus informatives disponibles pour le Sahara, et la seule qui démontre clairement l'interférence des tendances paléoclimatiques subméditerranéennes et subsahariennes.

La première moitié du Miocène fut caractérisée par le découpage de surfaces d'érosion étendues sous des conditions semiarides. La sédimentation deltaïque et l'effondrement des couches en Basse Egypte, accompagnés du basculement des blocs dans le Graben de Kom Ombo furent suivis par le soulèvement en forme de voûte des couches de la plateforme stable d'Egypte et par le surcreusement de la Vallée du Nil qui s'approfondit (568 m au dessous du niveau de la mer au Caire, 172 m au dessous du niveau de la mer à Aswan) en réponse à l'assèchement du Bassin méditerranéen vers 8 à 5 millions d'années B.P. Le Pliocène commença par une transgression marine, comprenant des schistes glauconitiques de faciès d'estuaire ou de lagune jusqu'au Sud d'Aswan (de −172 à −35 m). L'absence d'abondants dépôts détritiques bruts implique un climat subhumide. Le reste du Pliocène vit une accumulation de faciès lagunaires, lacustres et fluviaux grossiers, suggérant des conditions subarides, s'élevant de 120 à 130 m, comprenant des *Ostrea, Pecten et Anancus* dans le nord. Ils furent suivis, en Haute Egypte, de conglomérats massifs s'élevant jusqu'à 180 m.

La série de la première moitié du Pléistocène comprend 5 phases majeures d'alluvionnement provenant du Nil et des oueds locaux, sables mêlés de graviers ou graviers bruts tous d'origine locale, indiquant un environnement semi-aride. Les phases d'alluvionnement comprennent: 1) l'étage de Gallaba (3 sous unités, 60-74 m au dessus de la plaine d'inondation actuelle avec des plateformes fluviales associées), 2) l'étage de l'oued Allaqui (+50 −55 m, avec une pédimentation de bord de vallée et plus de 100 m de dépôts, localement), 3) les sous-étages de Dihmit et d'Adindan (+40 −48 m, +40 −42 m, le premier avec une pédimentation étendue de bord de vallée; le second avec de l'Acheuléen tardif *in situ*), 4) l'étage de Dakka (+30 −35 m, avec 120 m de dépôts dont la base est à 10 m au dessus du niveau de la mer; pédimentation de bord de vallée; Acheuléen *in situ)*, et 5) l'étage de l'oued Korosko (2 sous-unités, +23 −25 m, +12 −15 m); comprend des faciès de silts – Formation de Dandara – avec des composants minéralogiques éthiopiens de même que de l'Acheuléen *in situ*. Des intervalles de creusement du Nil majeur (25-200 m d'amplitude) dans des remblais plus anciens, séparent ces unités alluviales, et au moins 2 paléosols majeurs inter-

médiaires, indiquant un climat subaride à subhumide, peuvent être identifiés: un Paleargid typique qui suit l'alluvionnement d'Adindan et un Haplargid typique subséquent à l'étage de l'oued Korosko et de Dandara.

Le Pléistocène supérieur semble commencer par les alluvions de conglomérats d'oueds en Nubie et à l'oued Kurkur, à une époque ou la plaine d'inondation du Nil était plus basse qu'actuellement. Après une nouvelle dissection, une calcification ou un concressionnement ferrugineux, l'alluviation de la Formation du Korosko inférieur commença bien avant 40 000 ans B.P. Une plaine d'inondation sableuse, en partie marécageuse, reflétait une activité d'oued accélérée, avec le complément d'un fort apport des eaux d'inondation éthiopiennes. Les dépôts de source correspondants à Kurkur semblent être contemporains du peuplement atérien. La formation de Korosko se déposa ensuite, après un creusement du Nil d'au moins 10 m, et représenta la plaine d'inondation enfoncée (+34 m en Nubie, +20 m à Kom Ombo) d'une rivière sableuse au réseau anastomosé avec des faciès mélangés du Wadi et du Nil; l'âge estimé est supérieur à 32 000-27 000 ans B.P. environ, avec des industries du Paléolithique moyen le long du Nil, et une occupation atérienne à l'oued Kurkur.

Les épisodes semi-arides du Korosko furent suivis par un climat hyperaride, l'invasion de la vallée par les dunes, et 34 m ou plus d'enfoncement du Nil. La formation suivante de Masmas représente une masse épaisse de silts d'inondation éthiopiens ayant atteint un remplissage de +33 m en Nubie mais seulement de +8 m près du Caire. C'est à la fois l'enregistrement de l'activité minimale de l'oued et les dunes interdigitiées qui impliquent un climat hyperaride en Egypte, mais la pente accusée, les chenaux de sable fréquents et le débordement sur une plaine d'inondation exceptionnellement large impliquent un substantiel débit de pointe du Nil. L'intervalle de temps estimé de 25 000-18 000 ans B.P. coïncide avec le peuplement de Khor Musan et d'Halfan (Paléolithique supérieur) en Nubie. Par la suite, les industries de la fin du Paléolithique ont proliféré sur la surface du sol stabilisée (Torrert vertisol), antérieurement à un enfoncement d'au moins 28 m ainsi qu'à l'invasion des dunes.

L'unité suivante, le Membre Darau de la Formation de Gebel Silsila représente une plaine d'inondation nilotique à 22,5 m en Nubie, à +13 m à Kom Ombo, +5 – 7,5 m à Esna-Quéna, et –5 m dans le nord de l'Egypte. Le gradient trop fort de la pente, l'apport du Soudan central de graviers de silex noir de Hudi, l'érosion des roches saines du socle à l'endroit des cataractes, les dépôts de la charge solide en relief, et les chenaux à déplacement et à bifurcation rapides, tous apportent des arguments en faveur d'inondations d'été vigoureuses et d'une grande efficacité. Un premier étage élevé, vers 17 000 ans B.P., fut accompagné d'un dépôt local accéléré et suivi par une récession mineure et une invasion de dunes ou formation vertisol. Ensuite, les sous-étages du haut-Nil à 14 500-12 500 ans B.P. coincidèrent avec un dépôt d'oued renouvelé, alors modéré. Un Nil 'sauvage', avec des inondations aberrantes d'une ampleur phénoménale, est indiqué vers 12 000-11 500 ans B.P., de multiples industries de la fin du Paléolithique, situées le long de la plaine d'inondation, furent dispersées à cette époque. Une brêve phase hyperaride suivit vers 11 500 ans B.P., avec au moins 20 m d'enfoncement du Nil, le dessèchement total de la Dépression du Fayum, et la formation du sol 'Paleorthid' calcaire.

Deux sous intervalles d'un nouvel alluvionnement nilotique à 11 200-7 700 ans B.P. et 7 300-6 000 ans B.P. représentent le Membre Arminna, Formation de Gebel Silsila, avec à nouveau une pente accusée (+15 m en Nubie, –8 m à Fayum), mais une absence dans le lit de faciès primaires et grossiers, comme pour le Nil actuel. L'activité accélérée des oueds en hiver, principalement à 11 000-8 000 ans B.P., n'était pas en phase avec les inondations d'été du Nil. Le peuplement épi-paléolithique se concentra sur la plaine d'inondation du Nil, plutôt que sur celles des oueds où un paléosol 'camborthid' subséquent indique des conditions subarides.

Après au moins 15 m d'enfoncement du Nil vers 6 000 ans B.P., la dernière plaine d'inondation non-fonctionnelle fut comblée durant les 5e et 4e millénaires avant J.C., c'est-à-dire pendant les époques Fayum 'A', Prédynastique et Groupe A. C'est le Membre Kibdi, Formation de Gebel Silsila, à +6 –7 m en Nubie, –8 m dans le Fayum. L'alluvionnement accéléré du Nil en été fut à nouveau saisonnièrement en opposition de phase avec l'activité accélérée des oueds en hiver.

11.1 INTRODUCTION

The Quaternary record of Egypt was first systematically studied by Max Blanckenhorn (1901) during many years of field work. This early framework was superseded by the comprehensive survey of K.S.Sandford for the University of Chicago Oriental Institute (Sandford & Arkell 1929, 1933, 1939; Sandford 1934). Despite a number of local studies between 1933 and 1960, and several attempts at revision of Sandford's schema of uniform geomorphic stages along the length of the Nile, a new era of fieldwork was predicated on the massive surge of research funding set into motion by the Nubian Monuments Campaign. The Nile Valley (Figure 11.1) from the Sudanese border to the Kom Ombo Plain was mapped in detail and comprehensively published by Butzer & Hansen (1968). The record of Sudanese Lower Nubia was examined by De Heinzelin (1968), while that of the Esna, Dendera and Dishna sectors of Upper Egypt, and of the northern Sudan was explored in the archaeological investigations of Wendorf & Schild (1976). Finally, the subsurface geology of the Nile and its delta has been partly elucidated as a result of deep borings related to dam construction, and water or oil exploration (see Chumakov 1967; Said 1975).

11.2 THE TERTIARY GEOMORPHIC SETTING

The extensive sedimentary plains, hill complexes, and tablelands of Egypt and the Libyan Desert owe their origin to continental, littoral and marine sedimentation of late Cretaceous to early Miocene age (Said 1962; Whiteman 1971), followed by extensive subaerial denudation during most of the Tertiary (Butzer & Hansen 1968:431ff.). The Tethys Sea covered Egypt during the early Eocene, but had receded northward to the latitude of the Fayum by late Eocene times. During the Oligocene, an ancestral Nile flowed across parts of the structural-erosional Libyan Tableland to empty into the Tethys north of the Fayum. Upwarping and faulting of the Red Sea perimeter was preceded or accompanied by widespread but localized vulcanism, probably in terminal Oligocene times. The major Kom Ombo Graben was first downfaulted at about this time, with further block tilting during the late Miocene; gravity breccias of Eocene limestone rest on or within steeply-dipping Esna Shales but are older than horizontal Pliocene strata (Butzer & Hansen 1968:23ff.; Sandford & Arkell 1933:10f.).

During the early and mid-Miocene, the ancestral Nile flowed along its present axis and extensive, coalescent pediment plains were cut across both the Nubian Sandstone and Basement Complex through much of Nubia, fingering into the Libyan Desert and Red Sea Hills. Three major stages, the Kurkur, Ballana and Aswan Pediplains, can be recognized, during which the land surface was reduced almost 200 m (Butzer & Hansen 1968:29ff., 210ff., 350ff.). Long intervals of semi-arid climate are implied (Table 11.1).

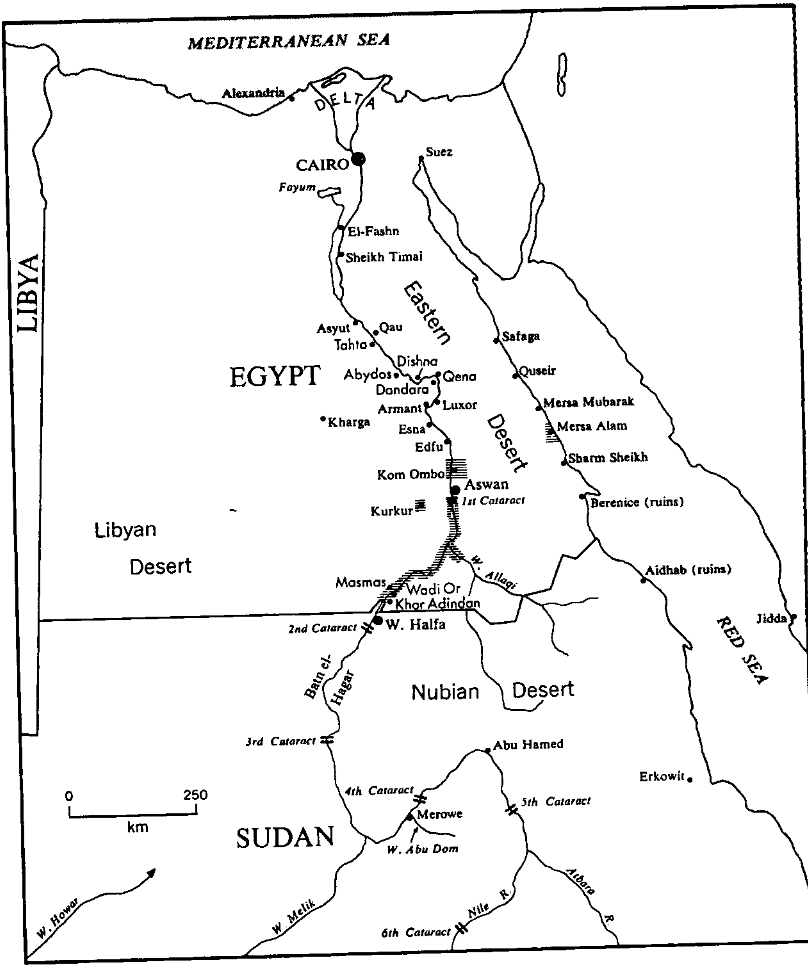

Figure 11.1 Location map of Egypt.

11.3 THE MIO-PLIOCENE OVERDEEPENED VALLEY

The Mediterranean Basin was separated from the world ocean during the late Miocene, and extensive evaporites indicate that there was no Mediterranean Sea ca. 8 to 5 million years ago (Hsü et al. 1973). Anhydrites were even deposited in parts of the Delta zone of subsidence (Said 1975). This interval saw entrenchment of the Nile into bedrock, to 568 m below modern sea level near Cairo (Said 1975) and 172 m below sea level near Aswan (Chumakov 1967). Although facilitated by fracture zones, and affected by epeirogenic impulses, this downcutting was pre-eminently a fluvial response to a phenomenally low base level.

A reconstituted Pliocene sea invaded the overdeepened Nile trench, depositing a 135 m suite of montmorillonitic clays, interbedded with sands, and rich in organic detritus, glauconite and zeolite, preserved at −172 to −35 m elevation as far south as Aswan (Chumakov 1967). The rare ostracods here suggest brackish water and estuarine conditions, with no evidence of arid zone, torrential run-off.

These early Pliocene beds are followed at Aswan by 110 m or more of thin-bedded sands, interbedded with gravels or clay lenticles (Chumakov 1967) and, near Kom Ombo, by at least 40 m of sands and gravelly sands, or shales with gypsum intercalations (Butzer & Hansen 1968:33ff). In the limestone segments of the Nile Valley between Luxor and the Fayum, there are over 60 m of calcreted quartz sands, marls with gypsum or gravelly interbeds, and chert or limestone conglomerates, showing complex horizontal as well as vertical, lenticular facies changes (Sandford & Arkell, 1933:6ff.; Sandford 1934:18ff.; Chumakov 1967). These beds, which lack fauna, include common gravity breccias or local tufa complexes adjacent to the Eocene limestones, and are best preserved within embayments of the Miocene Nile trench. Chumakov (1967) argues that the upper conglomeratic and breccioid units of the Valley of the Kings (the 'Issawia Formation' of Said 1962, 1975) which attain 180 m elevation, compared with a maximum of 120-130 m for Pliocene deposits at Cairo or Kom Ombo, may be younger than the sand unit at Aswan. However, the lowest part of this sequence ('Armant Formation', Said 1975) certainly represents a late Pliocene facies complex and must be considered coeval with the well-known marine *Ostrea-Pecten* beds, exposed northwest and southwest of Cairo to 121 m (Blackenhorn 1901; Sandford & Arkell 1939:13ff.). Of some interest is the Pliocene mastodon *Anancus osiris* recovered from the Giza Pliocene (Arambourg 1947). Overall, these late Pliocene beds suggest a degree of torrential runoff as well as abundant moisture in Egypt.

The Plateau Tufas of Kurkur and Kharga (Butzer & Hansen 1968:355ff., 515ff.) probably represent Libyan Tableland counterparts of the late Pliocene valley-margin tufas. At Kurkur they include two stratigraphic units (over 45 m), with basal clastic interbeds and occasional organic tufas in a thick body of travertine-like, laminated freshwater limestones. Deposited adjacent to a former drainage line, there are impressions of *Ficus* leaves, and a wide range of pollen, particularly of several palms and of acacia. Abundant water and a subarid or subhumid climate is suggested by all criteria.

11.4 EARLY TO MID-PLEISTOCENE ALLUVIAL HISTORY

11.4.1 *Introduction*

The Egyptian Nile alternately aggraded coarse gravels and cut down its bed into older, unconsolidated sediments during most of the Pleistocene. Similar sequences of aggradation and dissection can be verified for the larger tributary wadis, resulting in frequent development of suites of Nile or wadi terraces or both. Sandford (1934; Sandford & Arkell 1929, 1933, 1939) argued for the existence

Table 11.1 Miocene to mid-Pleistocene geomorphic evolution of the Nile Valley (Tertiary chronostratigraphy after Berggren 1972; Pleistocene after Butzer 1974a)

Stratigraphy		Phase	Phenomena
Middle Pleistocene (0.13-0.7×10^6 yr)		18	Nile dissection and wadi downcutting (at least 15 m).
		17	Pedogenesis, a red soil (typic Haplargid) with 1 m solum. Climate subarid.
		16	Nile and Wadi aggradation; Wadi Korosko substages at 23-25 m and 12-15 m above modern floodplain; includes Dandara Formation silt facies, with first Ethiopian summer-flood heavy minerals. Acheulian in situ. Climate semiarid.
		15	Nile and wadi dissection (at least 25 m).
		14	Nile and wadi aggradation (locally 120 m thick at Aswan), valley-margin pedimentation (Upper Egypt and Nubia); Dakka stage, 30-35 m above floodplain. Acheulian in situ. Climate semiarid.
		13	Major Nile downcutting (by some 135 m) to 10 m above sea level (Aswan).
		12	Major pedogenesis, a deep red soil (typic Paleargid) with 1-1.5 m B2 horizon and partial decomposition of igneous gravel to 6 m depth. Climate subhumid.
		11	Nile and wadi gravel aggradation, valley-margin pedimentation; Dihmit stage, 44-48 m above flood plain. After minor dissection, Adindan aggradation in southern Nubia at +40 to +42 m. Late Acheulian in situ. Climate semiarid.
		10	Nile and wadi dissection (at least 30 m).
Lower Pleistocene (0.7-1.8×10^6 yr)		9	Nile and wadi gravel aggradation (locally 100 m) and valley-margin pedimentation; Wadi Allaqi stage, 50-55 m above floodplain, with substages. Climate semiarid.
		8	Major downcutting of Nile (by some 200 m or more) to 55 m below sea level (Aswan).
		7	Nile and Red Sea Hill wadis aggrade Gallaba gravels, 3 substages, 60-74 m above modern floodplain (Upper Egypt), or cut fluvial platforms (Nubia). Climate semiarid.
Pliocene	Late (1.8-4×10^6 yr)	6	Marine regression in Nile trench, with sands, gypsum shales and conglomeratic marls of fluvial, lagoonal or lacustrine facies (130 m in south), superposed by massive conglomerates, in part gravity breccias (180 m); Plateau Tufas (at Kurkur and Kharga); *Ostrea-Pecten* beds, with *Anancus* (120 m, in north). Climate subarid.
	Early (4-5×10^6 yr)	5	Marine transgression into Nile trench, with glauconitic shales, of estuarine or lagoonal facies as far south as Aswan (−35 m and below). No torrential runoff; climate subhumid.
Miocene	Late Upper (5-8×10^6 yr)	4	Desiccation of Mediterranean Basin; uparching of Egyptian stable shelf; cutting of overdeepened Nile Valley (−568 m Cairo, −172 m Aswan).
	Early Upper (8-10.5×10^6 yr)	3	Deltaic sedimentation and downfaulting (Lower Egypt); block-tilting (Kom Ombo Graben); cutting of Aswan Pediplain (at 180-210 m) in Lower Nubia and Upper Egypt. Climate semiarid.
	Middle (10.5-16.5×10^6 yr)	2	Cutting of Ballana Pediplain (at 230-260 m) (Pediment II at Kurkur Oasis) in Lower Nubia. Climate semiarid.
	Lower (16.5-22.5×10^6 yr)	1	Cutting of Kurkur Pediplain (at 300-360 m) (pediment I at Kurkur Oasis) in Lower Nubia; fluvial or estuarine El-Khashab Red Beds (west of Cairo). Climate semiarid. Local vulcanism; upwarping (Red Sea Hills); downfaulting (Kom Ombo).

of a repetitive terrace sequence of essentially constant gradient throughout Egypt and Lower Nubia. The three highest, at relative elevations of 80-100, 60-75 and 45-50 m, were believed to be Plio-Pleistocene and pre-Paleolithic. Two further terraces at 30 and 15 m, and a discontinuous feature at 22 m, were shown to include Acheulian artifacts. Several younger and lower features from 9 m above to well below modern floodplain were attributed to the time span represented by the Middle and Late Palaeolithic. Sandford attributed these supposedly synchronous terrace units to readjustments of the Nile River in response to eustatic fluctuations of Mediterranean base level. Subsequent work has shown that at least the older terraces north of the Asyut area cannot be directly linked with those in Upper Egypt and Nubia (Butzer 1959). Furthermore, even in southern Egypt the scheme does not stand up in detail in any one area nor in terms of its coherence (Butzer & Hansen 1968), although Sandford's field observations were basically sound.

11.4.2 *Lower Nubia*

The Pleistocene deposits and erosional features of a 277 km long, 3 km wide stretch of Egyptian Nubia has been mapped at 1:41 500 (Butzer & Hansen 1968: Figures K1-K10), and a generalized, 1:300 000 map is available for the adjacent Sudanese sector, north of the Second Cataract (L.Daels in De Heinzelin 1968).

Fluvial platforms, partly mantled by sheets of gravel, are well developed along more open stretches of the valley. These platforms are frequently continued, after a marked inflection, by inclined pediment surfaces of ferricreted sandstone, veneered with lateral wash. The major wadis of the east bank commonly have thick alluvial deposits along their lower courses. Deposits range from quartz sands with fine to medium-grade quartz pebbles (Nile facies upstream of major wadi confluences), to sandstone and ferricrete sandstone rubbles (near west bank wadis), to coarse-to-cobble-grade igneous, metamorphic and quartz gravel (downstream of and within major east bank wadis). This complex of wadi and autochthonous Nile gravels represents a bed-load facies lacking in suspended sediments, and for the most part moderately weathered. It is not surprising that subsaharan components are difficult to trace. Nonetheless fluvial platforms and conglomerates can be followed across the Basement Complex rocks of the Batn el-Hagar (Maley 1969, 1970; also satellite photography), well into Upper Nubia.

The Nile and the major wadis are not visibly overdeepened south of about Kalabsha. Episodes of downcutting did in fact involve a degree of bedrock incision, while terrace aggradation was accompanied by extensive bedrock planation. The resulting erosional forms are developed with some regularity and assist in linking isolated gravel exposures. Furthermore, the existing structural framework of Nubia (Butzer & Hansen 1968:20ff., Figure 5-1) does not influence terrace elevations in longitudinal profile. These features assist in geomorphic correlation of the alluvial sequences from one sector of the river to the next.

However, the alluvial components show more horizontal than vertical differentiation; paleosols, although prominent, are little differentiated; and alluvial terraces are almost generally eroded or deflated, if not veneered with wash or eolian sands. Finally, there is no fauna whatsoever. These difficulties in dealing with the early to mid-Pleistocene record apply to all of Egypt, and render intraregional correlation difficult and any external correlations tenuous.

Bearing these caveats in mind, the following sequence of alluvial stages can be recognized in Egyptian Nubia (Butzer & Hansen 1968: chapter 5 and maps) (Figure 11.2):

1. Wadi Allaqi stage, +50 – 55 m, probably with two substages. Major lateral pedimentation; deep (B2 horizons 1-1.5 m), red paleosol – a typic Paleargid (according to Soil Survey Staff 1975 classification);
2. Dihmit stage, + 44 – 48 m. Major lateral pedimentation; deep, red paleosol (Paleargid);
3. Adindan stage, +40 – 42 m. Poorly represented in tributaries and absent north of Dakka; deep, red paleosol (Paleargid);
4. Dakka stage, +30 – 35 m, with possible lower substage. Moderate (B2 + B3 horizons 1 m) red paleosol – a typic Haplargid;
5. Wadi Korosko stage, +23 – 25 m, with lower substages recorded by several extensive Nile-cut platforms or localized wadi gravels; bedrock cutting of auxiliary Nile channels; moderate, red paleosol (Haplargid).

A datum to this sequence is provided by the Wadi Floor Conglomerate, a unit of up to 6 m of fine-to-cobble grade, cemented gravels that postdates weathering of the previous gravels as well as long-term subsequent dissection. It is projected to below modern floodplain, providing a convenient mid/late Pleistocene boundary in southern Nubia (Butzer & Hansen 1968:282ff.).

Sandford & Arkell (1933:26, 31) recovered Acheulian artifacts from Dakka stage gravels at Tumas and from a 15 m wadi gravel north of Wadi Halfa. Kleindienst (1972) describes evolved Acheulian found in situ within the Adindan-stage Nile gravels at the mouth of Wadi Or, but records no Acheulian surface sites on top of deposits of the Dakka and Wadi Korosko stages. Finally, Chmielewski (1968) excavated two rich, late Acheulian sites from wadisediments probably projected to the Wadi Korosko-stage Nile floodplain, at Arkin, in the northernmost Sudan.

Two or three major gravel stages are found west of the Nile in Sudanese Lower Nubia, but these have not been differentiated by De Heinzelin (1968; see also comments by Maley 1970), who labels them 'Pre-Nile Group' or 'Dabarosa Formation'. Although zigzag faults bound several pedimented sandstone blocks along the Egyptian-Sudanese border, in at least one instance gravel terraces traverse such a fault without evidence of disturbance (Butzer & Hansen 1968:232ff.). Nonetheless, faulting has affected the oldest conglomerates south of the Second Cataract (Maley 1970).

11.4.3 *Aswan, Kom Ombo Plain and Edfu*

An excellent sequence of thick alluvial gravels, partly exposed by deep bores around the Aswan Dam, is present near the southern end of the Miocene Nile trench. The oldest deposits post-dating the late Pliocene fluvio-lagoonal beds

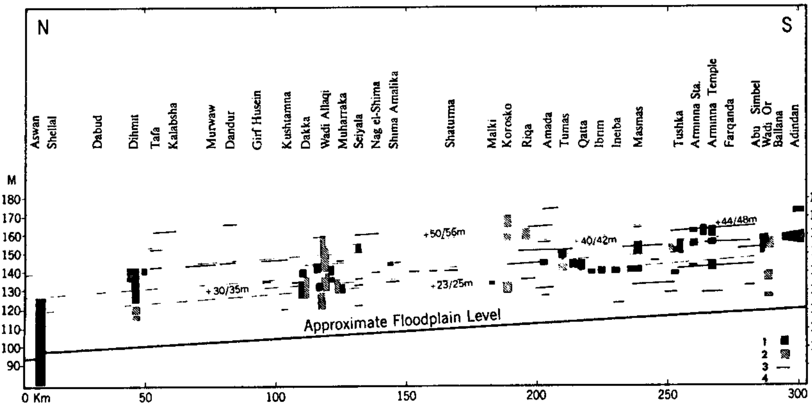

Figure 11.2 Early to mid-Pleistocene Nile and related Wadi gravels in southern Egypt. 1: autochthonous Nile gravels; 2: wadi gravels; 3: rock-cut fluvial platforms; 4: longitudinal profiles of major stages. After Butzer & Hansen (1968: Fig. 5-9), with permission of the University of Wisconsin Press (copyright).

are those of the Gallaba stage. Three fluvial substages are represented at +60 to 74 m (163 m maximum elevation) in a huge sweep of wadi gravels emanating from the Red Sea Hills via a series of braided channels (Butzer & Hansen 1968: chapter 2). This is the 'Villafranchian' 'Kubaniya suite' of Chumakov (1967), which cannot be readily correlated with the substantially higher Issawia gravels and breccias in the Luxor area. Subsequently, the Nile re-excavated its old trench to −55 m, and then deposited at least 75 m of fresh gravelly sand with clayey lenticles, the early Pleistocene 'Kundi suite' of Chumakov (1967).

The subsequent gravel terrace sequence of the Kom Ombo Plain has been mapped at 1:100 000 (Butzer & Hansen 1968: Figure 2-12) and can be correlated with that of Nubia by gradient projection: HT (High Terrace) I, +51 to 54 m, multiple Nile channels, Paleargid soil, Adindan stage; HT II, +40 to 43 m, multiple Nile channels, Paleargid soil, Dihmit stage; MT (Middle Terrace), +34 m, Haplargid soil, Dakka stage; and LT (Low Terrace) I and II, +22 m and +15 m, Haplargid soil, Wadi Korosko substages (Butzer & Hansen 1968: Table 2-2 and p. 265). Elevations of gravels and rock-cut platforms on the bedrock margins and within the graben are at identical levels, precluding Pleistocene faulting or downwarping. At Shellal, an alternative Nile bedrock channel is filled with 120 m of Dakka-stage gravelly sands (Chumakov 1967), indicating a major period of downcutting almost to sea level between the Dihmit and Dakka stages. This long erosional interval may or may not coincide with the protracted period of intensive biochemical weathering that significantly altered the Adindan and Dihmit gravels (Butzer & Hansen 1968: 52ff., 252ff., 490ff.).

East of Edfu, Wadi Abbad has several prominent alluvial terraces: deeply weathered 'High Terraces' at +52 to 54 m and +42 m and a moderately weathered 'Middle Terrace' at +34 m; typical 'Low Terraces' are only preserved upstream (Butzer & Hansen 1968: 63f.). Said (1975) describes a section from a late substage of the Gallaba gravels ('Idfu Formation'), south of Edfu, where the wadi components found west of Kom Ombo have been replaced by a typical autochthonous Nile facies of gravelly quartz sands; Said incorrectly correlates his isolated outcrop with the sum total of Pleistocene gravel terraces in Nubia and all high gravels northwards to Cairo.

Acheulian artifacts were recovered from within as well as on top of +15 to +34 m gravels at several sites between Kom Ombo and Edfu (Sandford & Arkell 1933:28, 32ff.; Butzer & Hansen 1968:157; Vermeersch 1972).

11.4.4 *Upper Egypt: Luxor to Asyut*

The state of information on earlier Pleistocene deposits north of Edfu is generally rudimentary or exploratory, and does not merit extensive discussion. West of Luxor, Coque (1972) describes pediments cut into late Pliocene(?) deposits and projected to floodplain levels of +50 to 60 m, +35 to 40 m, and +15 to 20 m. The surficial deposits of the highest pediment were originally mantled by a duricrust of pink, calcareous silt embedding local rubble (brocatelli), in effect a calcreted red paleosol. The lowest of these pediments, which shows moderate reddish weathering, has alluvial counterparts in the wadis east of Luxor (Butzer 1959).

At the mouth of Wadi Qena there are extensive alluvial terraces of gravelly, well-stratified sands at +34 m and +23 m, as well as fragments of higher wadi floodplains at +70 m and +51 m (Butzer & Hansen 1968:64f.). Sections in a Nile counterpart of the +23 m wadi terrace at Dandara have been studied by C.V.Haynes (in Wendorf & Schild 1976:95ff.). This is a sand-silt, in part marly, over 20 m thick and with a moderate red paleosol (? Haplargid) on top, under gravelly wash or compact sands with Acheulian artifacts. An interbedded terminal tufa has a C^{14} date of greater than 39 000 B.P. Defined as the Dandara Formation, this unit can be readily correlated with the Wadi Korosko stage further south. It is clearly distinct from the similar facies of the Upper Pleistocene Korosko Formation (Butzer & Hansen 1968) by virtue of its minimum radiocarbon age, its paleosol, its Acheulian context, and its clay minerals (contrast F.A.Hassan, in Wendorf & Schild 1976: Figure E-1, with Butzer & Hansen 1968: Figure D-1), although its pyroxene-epidote index is comparable (Hassan 1976). The Dandara Formation is a valid stratigraphic unit of variable facies and lithology that could be used to define the Wadi Korosko stage. However, Said (1975) indiscriminately applies the name to thick (250-1 000 m or more), suballuvial sands in northern Egypt and beneath the Delta, which in fact have a different mineralogy (see Hassan 1976: Appendix 2). In this connection, there is as yet no valid 'Qena Formation' (a small body of surface sands embanked against the Dandara Formation in the type area, see Wendorf & Schild 1976: Figure 53). A similar sequence to that at Dandara, but with better exposures, is currently being studied by Vermeersch et al. (in press). An important, although secondary Acheulian industry is found in a +10 m rubefied wadi terrace resting on both thick sands and nilotic silts.

Alluvial terraces are well developed in the mouth of Wadi Asyut, and along the floodplain margins northwest and southeast of that city. Former floodplain levels at +70 m, +44 to 52 m, +25 to 30 m, and +12 to 15 m can be identified (Butzer 1959).

11.4.5 *Middle and Lower Egypt*

A sequence of high gravel terraces runs along the western edge of the floodplain from Minia to the west-central Delta, and patches of gravelly alluvium are also found along the east bank between the Fayum and Wadi Tumilat (Sandford & Arkell 1929, 1939; Butzer 1959). All of these terraces have red paleosols, and they include Nile facies of gravelly sands as well as local facies of wadi rubble (east bank) or reworked Tertiary gravels (west bank). Their relationship to the suballuvial sands of northern Egypt (Said 1975) is obscure. These terrace suites are typically found at +80 to 95 m, +60 to 65 m, and +25 to 35 m (Sandford & Arkell 1939: Figure 11); higher gravels may be present adjacent to the Fayum. The large variations in elevation are at least partly due to extensive erosion. Proper interpretation must await detailed mapping and study. These northern terraces are separated from those around Asyut and further south by a break of 80 km, and they may well be unrelated. A glacial-eustatic framework (see Butzer 1960) is possible, but not demonstrated, in that relative level of the +25 to 35 m terrace complex appears to decrease upstream, where terrace subdivisions at +22 to 32 m and +10 to 18 m can be identified south of the Fayum.

11.4.6 *Discussion*

The early to mid-Pleistocene evolution of the Nile Valley in Upper Egypt and Lower Nubia is summarized in Table 11.1. No attempt is made to incorporate the gravel terraces and suballuvial sands of northern Egypt into this scheme. The Adindan, Dakka and Dandara (Wadi Korosko) stages are all associated with evolved Acheulian artifacts, which in subsaharan Africa are older than 200 000 but probably younger than 500 000 years (see Butzer & Cooke, in press); this is the basis for assigning a Middle Pleistocene age for geomorphic phases 10 to 18 (Table 11.1). By exclusion, phases 7 to 9 represent the Lower Pleistocene.

The protracted periods of bedrock planation and long-distance, high-competence transport of coarse bed-load deposits recorded by the successive periods of aggradation (see Butzer 1976c: section 8-6) are interpreted to represent a substantially wetter, but seasonal and semiarid climate (Butzer & Hansen 1968:78ff., 226ff., 439ff.). The major red paleosol has argillic subsurface horizons with over 35% clay fraction, with kaolinite dominant, and is of rotlehm type, qualifying as a Paleargid. It implies a degree of geomorphic stability and a subhumid climate. The later red paleosol has montmorillonitic clays and an argillic horizon with intermediate clay levels and qualifies as an Haplargid. A subarid climate is suggested.

Almost all of the Pleistocene gravel-sand units can be attributed to regional runoff from the Red Sea Hills, feeding the Nile via a series of major east bank wadis. As late as the Dakka stage, these bed-load deposits essentially lack the pyroxenes characteristic of heavy mineral suites derived from Ethiopia by the modern, summer flood regime (see Chumakov 1967; Hassan 1976). The Dandara Formation provides the first evidence for large-scale influx of subsaharan, nilotic suspended sediment into Egypt (Hassan 1976). This does not preclude earlier summer floods from Ethiopia (Butzer & Hansen 1968:79, 435), but it does indicate that regional runoff was decreasing in significance, and that subsaharan discharge had for the first time assumed relative prominence in Egypt. Such an interpretation finds support in the presence of Ethiopian pollen (*Podocarpus gracilior;* tropical Ericaceae; Acanthaceae; Pedaliaceae) and spores (tropical ferns) in Calabrian marine deposits downcurrent of the Nile (Maley 1969).

11.5 LATE PLEISTOCENE TO HOLOCENE NILOTIC HISTORY

11.5.1 *General*

The geomorphic evolution of the Nile Valley until the late Middle Pleistocene was dominated by local hydrographic dynamism, with major wadis supplying the bulk of the run-off and sediment redistribution by the Nile. The Dandara Formation records the beginning of a gradual shift to the more familiar summer-flood regime, probably no later than 200 000 B.P. An arbitrary but convenient datum for the base of the Upper Pleistocene is provided in southern Lower Nubia by the Wadi Floor Conglomerate, which predates three major lithostratigraphic units that serve as distinctive markers through most of southern Egypt (Figure 11.3).

11.5.2 *Lower Nubia and the Kom Ombo Plain*

11.5.2.1 *Wadi Floor Conglomerate.* Some 5 or 6 m of well-rounded cobble conglomerates may overlie the potholed, bedrock floors of Nubian wadis. They imply a local base level at or below modern floodplain, and record a last episode of high wadi competence in valleys now transporting little coarser than sand-grade particles. This Wadi Floor Conglomerate was indurated by calcareous or ferruginous cements, but not rubefied, prior to renewed erosion (potholing) and accumulation of the quasi-nilotic Korosko formation (Butzer & Hansen 1968: 282ff.). In the Kom Ombo region, the Wadi Floor Conglomerate may be present well below modern floodplain.

11.5.2.2 *Korosko Formation.* Resting on top of the Wadi Floor Conglomerate is a complex of white to light brownish grey marls, sands and sandy gravels, extensively discoloured by limonitic mottling (Butzer & Hansen 1968:87ff., 266ff.). Facies range from valley-margin, subaqueous lime muds, intercalated with wadi sands or gravels, to fluvial, calcareous sands. Locally, root casts and rootlet impressions are conspicuous, recording a floodplain vegetation of grasses and shrubs. Evaporite interbeds (halite) are common near the eastern edge of the Kom Ombo Plain. In the mouths of the smaller wadis, local stream detritus normally interdigitates sharply with marly nilotic materials, indicating winter wadi discharge onto a dry floodplain, although a few ponds persisted where wadi sands were washed into standing waters. The overall facies arrangement suggests a braided stream complex along the Nile axis. An abundance of sorted sands along the west bank (Butzer & Hansen 1968:241, Figure 6-10) further indicates fluvial reworking of eolian sands (occasionally identified as dunes by De Heinzelin 1968, in default of sediment and clay mineral analyses).

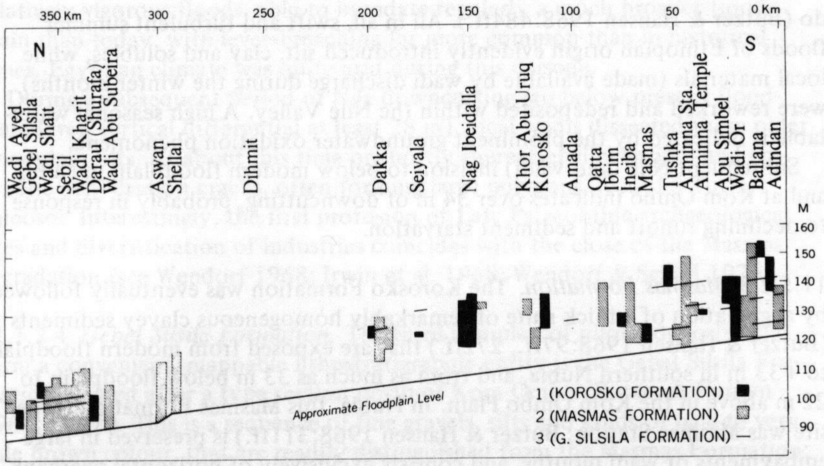

Figure 11.3 Late Pleistocene to Holocene nilotic deposits in southern Egypt. Vertical range of sediments is shown for the Korosko and Masmas formations, but maximum outcrop elevations (only) are shown for the several members of the Gebel Silsila Formation. After Butzer & Hansen (1968: Fig. 6-1), with permission of the University of Wisconsin Press (copyright).

The Korosko Formation (type area at New Korosko near Kom Ombo; Butzer & Hansen 1968:124f.), culminates as a graded floodplain deposit, dropping from +34 m near the Sudanese border to +20 m on the Kom Ombo Plain. Its base is everywhere found below modern floodplain. Two members, separated by considerable downcutting, can be verified in Wadi Or (Butzer & Hansen 1968:271, 296ff), where the lower, silty unit attains +11 m (top eroded) and was dissected to bedrock prior to accumulation of the upper, sandy unit to +22 m (top eroded). This upper member, generally represented in Nubia and at Kom Ombo, has a minimum radiocarbon date of 27 250 B.P. Aggradation of perhaps 50 m of deposit, separated by at least 10 m of erosion, presumably required tens of millennia overall. An early Upper Pleistocene age range seems indicated.

Mammalian faunas are absent from the Korosko Formation, but mollusca are found in marly, low-energy deposits of the Kom Ombo Plain. Most common are *Planorbis, Valvata* and *Bulinus,* all snails preferring stagnant or slowly-moving waters, with occasional *Lymnaea* and *Corbicula* (Butzer & Hansen 1968: 510). Artifacts are rare, but some large and unpatinated flakes in situ in Wadi Or may imply penecontemporaneous Middle Paleolithic occupation of the area (Butzer & Hansen 1968:272, 301).

The heavy minerals of the Korosko Formation have high pyroxene counts, and pyroxene/epidote ratios only slightly lower than those of modern Blue Nile-Atbara flood silts (Butzer & Hansen 1968:467ff.; Hassan 1976). The clay mineralogy is pre-eminently that of montmorillonite and interlayered illite/mica, with secondary but distinct maxima of kaolinite; the latter may indicate a higher component of White Nile drainage than subsequent nilotic formations do (Butzer & Hansen 1968:484ff.). All in all, swift and turbulent summer floods of Ethiopian origin evidently introduced silt, clay and solubles, while local materials (made available by wadi discharge during the winter months) were reworked and redeposited within the Nile Valley. A high seasonal water-table is indicated by the prominent groundwater oxidation phenomena.

Subsequent Nile (and wadi) incision to below modern floodplain in Nubia and at Kom Ombo indicates over 34 m of downcutting, probably in response to declining runoff and sediment starvation.

11.5.2.3 *Masmas Formation.* The Korosko Formation was eventually followed by aggradation of a thick suite of remarkably homogeneous clayey sediments (Butzer & Hansen 1968:97ff., 272ff.) that are exposed from modern floodplain to +33 m in southern Nubia, and from as much as 33 m below floodplain to 22 m above in the Kom Ombo Plain. In Nubia, this Masmas Formation (type site was Masmas Station; Butzer & Hansen 1968:311ff.) is preserved in large embayments or wadi mouths, and consists exclusively of horizontal overbank deposits, i.e. flood silts and local sand splays, varying in texture from clayey sand to clayey silt, with carbonates increasing away from the river. In the Kom Ombo Plain the Masmas Formation is prominently developed and ranges in facies from marly beds or massive, slickensided clayey silts to sandy deposits in clearly defined channel fills. Colours range from brown to dark greyish brown, and structure is strong, blocky to prismatic, depending on clay content. Terminal networks of deep (1.5 m) polygonal cracks, filled with younger wash or evaporites, are characteristic and indicate a floodplain vertisol (Torrert). Intercalated wadi deposits are rare and reflect minimal discharge from the Egyptian tributaries.

The Masmas Formation represents a continuous sequence of periodic Nile aggradations, over 50 m thick. Excellent channel sections near Kom Ombo indicate meandering primary and secondary channels, with coarse levee deposits and root drip, interdigitated with extensive sand splays. Flood silts are the dominant facies, however, with reducing backswamps verified at the eastern end of the plain by sulfide-rich silts with *Planorbis*, *Valvata* and *Bulinus*. In Sudanese Nubia the Masmas Formation is identical with the Dibeira-Jer (ex-Khor Musa) Formation (De Heinzelin 1968), which has a (revised) radiocarbon date of 20 900 B.P. (WSU-203) in its uppermost part and underlies younger deposits with a basal date of 18 800 B.P. Terminal dates of 18 300 and 17 000 B.P. obtained on marls of the Kom Ombo Plain are probably contaminated by younger carbonates and too young. A mid-Upper Pleistocene date of ca. 25 000-18 000 B.P. seems a reasonable estimate on available evidence.

There is next to no mammalian fauna in the Masmas unit, and archeological associations are rare and essentially confined to Sudanese Nubia. They include the Levalloisian flake industry known as Khor Musan (see Wendorf 1968) as well as the first of several microlithic, blade industries of Late Palaeolithic type, the Halfan, found in terminal Masmas beds (Irwin et al. 1968).

The heavy minerals and clays indicate that the Masmas deposits are typical summer flood residues, perhaps with a slightly greater White Nile component (Butzer & Hansen 1968:470f., 484ff.; Hassan 1976). They record a period of relatively vigorous floods, able to inundate regularly a much broader floodplain than today, with levee-breaching far more common than in historical times. Egyptian climate was quite arid during this episode.

During a subsequent period of Nile downcutting (to below present floodplain level, vertical differential at least 28 m), local wadis dissected these older floodplain silts. At about this time or shortly thereafter slickensides and epigenetic dehydration cracks, often forming large polygons, record a Torrert paleosol. Interestingly, the first profusion of Late Palaeolithic archaeological sites and diversification of industries coincides with the close of the Masmas aggradation (see Wendorf 1968; Irwin et al. 1968; Wendorf & Schild 1976).

11.5.2.4 *Gebel Silsila Formation.* The third complex of nilotic deposits that form a convenient, mappable lithostratigraphic entity is the Gebel Silsila Formation, named after a type section north of Kom Ombo (Butzer & Hansen 1968:132ff.). This is a sequence of fine gravels, silts and sands of pale to very pale brown colour, that are readily distinguished from the Masmas Formation; they àre lighter, sandier, rarely clayey, poorly structured, and often lenticular, with gravelly interbeds. This episode includes three major phases of nilotic aggradation, separated by effective downcutting, so that subdivisions, the Darau (oldest), Arminna, and Kibdi (youngest) members, are necessary. The facies of these members are more or less identical, so that field mapping must be based on ancillary geomorphic criteria. For these reasons, a single formation is maintained by the rules of stratigraphic nomenclature, which considers formations as lithostratigraphic units suitable for extensive field mapping.
The disposition of the members is as follows:

a. Darau Member. These deposits exceed 18 m in thickness, and attain +22.5 m in southern Nubia, +13 m at Kom Ombo, with an oversteepened gradient of 1.17 in 10 000 (compared with 0.94 today). Due to this gradient, the younger members are mainly suballuvial north of about Kalabsha, and several channel stages of the Darau Member only are recorded on the Kom Ombo Plain: +11 to 13 m (ca. 17 000-14 500 B.P., 4 radiocarbon dates), +9 to 10 m (ca. 14 500-13 000 B.P., 10 radiocarbon dates), and +8 m (ca. 12 500 B.P., 1 date). Finally, there was an episode of at least several centuries, shortly after 12 000 B.P., during which Nile floods sporadically attained +22 m at Kom Ombo and +30 m at the Sudanese frontier, i.e. 8 to 9 m above the general floodplain of the time. No terraces were created, but clayey flood silts (up to 3 m maximum thickness) were laid down in sheltered areas beyond the active floodplain. This dramatic episode of a 'wild' Nile must reflect unusual climatic anomalies in subsaharan Africa. Post-Darau floodplain dissection amounted to at least 7 m in Nubia and 9 m near Kom Ombo.

b. Arminna Member. These deposits are at +15 m in southern Nubia, where they date to 11 200-8 000 B.P., but at only +4 m year Edfu ('El-Kab Formation'; Vermeersch 1972, 1976), where they date to ca. 8 400-7 700 B.P. There are fewer bed-load deposits in the Arminna than in the Darau Member, except where Darau beds have been eroded and reworked. Maximum thickness recorded is 12 m, and subsequent dissection was at least 15 m.

c. Kibdi Member. Related deposits at +6 to 7 m in southern Nubia are poorly dated but culminated in the 4th millennium B.C. They comprise flood silts or gravel lags reworked from older beds, and were dissected when flood levels declined significantly at the beginning of the Dynastic era (Bell 1970).

The Darau and Arminna-Kibdi members of Butzer & Hansen (1968) compare reasonably well with the Sahaba and Arkin formations of De Heinzelin (1968) and must be considered as equivalent and essentially interchangeable units on either side of the Egyptian-Sudanese boundary (despite revisionist views expressed by Wendorf & Schild 1976:273ff.). Within the Sahaba, De Heinzelin (1968) additionally recognizes a minor recession accompanied by vertisol formation. His inter-formational 'regressional' units, the Ballana and Birbet 'formations', are eolian deposits that valuably complement the nilotic record along the wind-sensitive western margins of the valley. They evidently provide different information than the multiple fluvial units interdigitated along the wadi-sensitive eastern margins, as described further below.

The Darau Member at Kom Ombo, and the Darau-Sahaba and Arminna-Arkin in Southern Nubia include a host of Late Palaeolithic sites (see various authors in Wendorf 1968; Irwin et al. 1968; Smith 1968, 1976; Phillips & Butzer 1975). A-group materials are found in the Kibdi. The Darau unit has provided a considerable faunal inventory, generally associated with archaeological occurrences. A range of habitat-specific riverine, bush, and grassland mammals are represented, modern except for the buffalo *Homoioceras*, but conspicuously lacking certain Ethiopian forms: elephant, rhino and giraffe (Churcher 1972; Gautier 1968; C.A.Reed & P.F.Turnbull, unpublished). A remarkable avian fauna, including many seasonal migrants, is also present (Churcher 1972). The molluscan faunas of Sudanese Nubia are described by Martin (1968).

11.5.2.5 *Interpretation of the Gebel Silsila Formation.* The Darau Member of the Gebel Silsila Formation pertains to channel and levee environments of a rather more vigorous and competent Nile. Horizontal flood silts are rare; instead, former shoals of bed gravels or sands interfinger with laterally embanked topset and backset strata. Coarser grade bed loads and a striking incidence of shifting or braided channels indicate greater competence and rapid sedimentation rates. Relative proportions of clay minerals and heavy minerals are, for the first time, almost identical to those of today.

However, the gravels are marked by an influx of exotic flint, chert, chalcedony, agate, jasper and carnelian – most of which are totally absent from older deposits, and are derived in good part from the Hudi Chert outcrops in the central Sudan. Flushing of chalcedony, agate and carnelian pebbles through local Sudanese wadis into the Nile, and from there northwards along the length of the Egyptian Nile valley, requires not only abundant runoff in the central Sudan but an unusually great, if periodic, Nile flood competence – one that transports little coarser than pea-sized gravel today.

This image of a high-competence Nile is supported by the presence of abundant medium-grade pebbles of granite, aplitic feldspar and schist at Kom Ombo, that were derived from vigorous erosion of the Basement Complex rocks between Aswan and Kalabsha. The argument is completed by the surge of unworn quartz sand grains that appears both at Kom Ombo and in Nubia simultaneously with the Hudi Chert gravels, indicating fresh erosion of the cataract floors (Butzer & Hansen 1968:111f., 330f., 478). The vigorous Darau floods remain difficult to explain in terms of the complex climatic zonation of the Nile Basin in Upper Nubia, Ethiopia, and the White Nile drainage components, on the one hand, and the question of peak discharge versus overall flood volume, on the other.

It is unlikely that fresh Sudanese gravel components were introduced to Egypt during the Arminna and Kibdi stages, when most gravel was deposited as lags or in shoals embanked against eroded Darau silts. This implies less vigorous floods than during the Darau substage. The brief periods of effective dissection before 11 200 and again after 7 900 B.P., like that after 3 000 B.C., can best be related to rapidly declining flood discharge and sharply reduced sediment load. However De Heinzelin's (1968: Figure 5) 'Nile high-water curve' does not provide an estimate of Nile discharge but, instead, records changing, absolute floodplain elevations.

11.5.3 *Upper Egypt: Edfu to Dishna*

The Masmas Formation, as a distinctive lithological entity, can be traced along the western margins of the Nile from 13 km south of Edfu (at +18 m, possibly overlying Korosko Formation; see Sandford & Arkell 1933:45f.), past Edfu-Hierakonpolis (+15 m; Butzer 1961) and Armant (+7.5 m, interbedded with eolian sand; Sandford & Arkell 1933:47) to south of Luxor (+6 m). Typical exposures of the Gebel Silsila Formation are not found in this area.

However, near Esna, Wendorf & Schild (1976:43ff., Table 15, Appendices) have developed an informative sequence of younger flood silts, pond deposits, and dunes of terminal Pleistocene age that are situated on top of typical Masmas outcrops, locally at +5 m. A massive unit of dunes is interbedded with the top of the heavy Masmas silts, with the earliest occupation on top of these dunes (Site E71K1) dated 18 020 B.P. At El-Saayda (El-Kilh), between Esna and Edfu, a series of occupations on top of the Masmas silts (here interbedded with eolian lenticles as at Armant) are dated 16 950-17 800 B.P. (Wendorf & Schild 1976:27ff.), leaving no doubt about a firm correlation of the Masmas litho units in this area with those at Kom Ombo and points further south. The dunes are not exactly dated: site E71K1 suggests they were blown up during the period of Nile dissection ca. 18 000-17 000 B.P., whereas at E71K9X a similar (identical?) dune rests on pond deposits dated at 16 830 B.P. that in turn rest on an eroded surface of Masmas silt. Since no geological mapping was undertaken by Wendorf & Schild (1976), and since the sum total of granulometric work consists of thirteen sand-sieve analyses (Appendices C and F), this stratigraphic problem must remain unresolved. It is possible, however, that E71K9X records seepage from a high Nile stand coeval with the earliest phase (Channel A) of the Darau Member.

Above a possible paleosol, a sequence of pond deposits with interesting diatom floras was laid down within the interdunal swales near Esna, in response to lateral seepage, from Nile floods at some 7 m above modern floodplain (see Wendorf & Schild 1976: Figures 37 and 49), mainly prior to 12 690 B.P. Nilotic silts shortly thereafter overwhelmed the area to about +7.5 m. Correlation with the terminal units of the Darau Member at Kom Ombo is reasonable.

Further north, near Dandara, the post-Masmas dunes are represented under late Darau silts (+5 m) that have a basal date of 12 500 B.P. (C.V.Haynes in Wendorf & Schild 1976:102ff.). Across the river, near El-Makhadma, nilotic sands (+4 m) with mollusca are dated ca. 13 380 B.P. (Wendorf & Schild 1976: 113ff.) and rest on slope wash that locally mantles possible Masmas silts. Finally at Dishna there is an interesting sequence of interdigitated Nile silts (no elevation given), pond deposits, and wadi detritus, unfortunately lacking in radiocarbon dates (Wendorf & Schild 1976:121ff.). Potential parallels with interdigitated Darau silts and wadi formations at Kom Ombo remain to be explored.

The complex post-Masmas deposits recorded between Esna and Dishna complement the Darau time-stratigraphic record at Kom Ombo, but the lack of stratigraphic and radiometric precision at present limits their utility in defining useful subdivisions for the Darau. Most importantly, perhaps, the Esna-Dishna sector provides a sequence of Late Palaeolithic archaeological sites.

Recent work in northern Upper Egypt by Vermeersch et al. (1977) promises to fill major lacunae. At several sites near Abydos, Middle Palaeolithic industries with Levallois technique but very few retouched tools were recovered from wadi terraces or fans. At Nazlet Khatir, near Tahta, a mint workshop assemblage was located in mixed wadi-nilotic gravels that overlie calcareous silts recalling the Korosko Formation.

11.5.4 *Middle and Lower Egypt*

After another spatial break, the next deposits of late Pleistocene aspect downstream are found 5 m and more below the modern floodplain at Qau (with an interesting mammalian fauna), Sheikh Timai, and El-Fashn (Sandford 1934: 86ff., 95). The presence of agate pebbles in a gravelly sand facies suggests the Gebel Silsila Formation. The sporadic +7 to 9 m fine gravel terraces adjacent to the Fayum and near the head of the Nile Delta (Sandford & Arkell 1939: 54ff., 79f.; Caton-Thompson 1946) are difficult to relate to southern Egypt but are partially clarified within the Fayum Depression (see below). It is probable that the thick body of micaceous sands intercalated between the modern flood silts and the older gravelly sands beneath the Nile Delta (Butzer 1974b) relate to the Gebel Silsila Formation, and that they fill a deep delta valley cut in response to the maximum of the Last Glacial eustatic regression.

The nilotic component of the shelf and deep-sea sediments off the Nile Delta is difficult to interpret, since such off-shore accumulations are affected by base level changes, shoreline distance, alluvial gradients in Lower Egypt, nilotic sediment composition, mean Nile volume, and peak discharge. Stanley & Maldonado (1977) identify three late Pleistocene cyclothems dating ca. 58 000-28 000 B.P., 28 000-17 000 B.P., and 17 000 B.P. to present, in reasonably close analogy to the Korosko, Masmas, and Gebel Silsila formations. Maximum sedimentation rates along the submarine Nile cone, suggestive of above-average suspended sediment transport and summer flood discharge, are indicated ca. 28 000-23 000 B.P. and 17 000-5 700 B.P., coincident with the terminal Korosko or early Masmas on the one hand, and the Gebel Silsila on the other.

11.5.5 *Fayum Depression*

The Fayum Depression provides a low-level adjunct to the Nile Valley recording many late Pleistocene to Holocene events otherwise obscure in northern Egypt. The behaviour of the fluctuating lakes within the basin depends on Nile floodplain level and possible blocking sediment at the Nile-Fayum entrance.

A number of beaches developed along the eastern and south-eastern margins of the basin have artifacts, primarily worn, and can be correlated altimetrically with features in the adjacent Nile Valley. A beach at 34 m above sea (not lake) level matches the +8 m fine gravel terrace along the Nile, and both have Middle Palaeolithic implements (Sandford & Arkell 1929:37ff.; Sandford 1934:92ff.; Caton-Thompson, Gardner & Huzayyin 1937; Caton-Thompson 1946). Two lower beaches at 28 m and 22.5 m have Late Palaeolithic implements and may correlate with agate-pebble sands (Gebel Silsila Formation) below Nile floodplain. The related molluscan assemblage of the Idwa Bank has been described by Gardner (1932). These older features deserve further study.

The Holocene record of the northern Fayum has been substantially clarified by recent work (see Wendorf & Schild 1976:155ff.). Older diatomites and lacustrine sands, presumably related to the Idwa stage, were desiccated at some time prior to 8 100 B.P., when a Nile-fed lake was recreated and soon reached 17 m. After a recession to below 12 m another high lake phase attained 24 m about 7 140 B.P., then falling to below 9 m. Subsequent high stages of 17-20 m date in the main part to the 5th and 6th millennia B.C. and the early Old Kingdom. These lake fluctuations within the Fayum provide critical data on Nile behaviour during the late Arminna time span. In combination with Vermeersch's (1972, 1976) El-Kab dates in Upper Egypt, they infer two subdivisions of the Arminna, with high Nile levels ca. 11 200-7 700 and 7 300-6 000 B.P.

11.6 LATE PLEISTOCENE TO HOLOCENE WADI HISTORY

Although the late Pleistocene Nile was governed by hydrographic events in the Sudan and Ethiopia, the role of the Egyptian tributaries is critical to proper evaluation of the regional setting. Furthermore, since no systematic information is available on wadi behaviour north of the Kom Ombo Plain during this time span (see Butzer 1959), it is useful to draw in complementary information from Wadi Kurkur, to the west of Aswan, and from the Red Sea littoral, east of Edfu. These data allow a more representative picture to be presented by way of conclusion.

11.6.1 *Lower Nubia and the Kom Ombo Plain*

Subsequent to the Wadi Floor Conglomerate of Nubia, several phases of accele-

Table 11.2 Late Pleistocene and Holocene geomorphic evolution of the Nile Valley

Phase	Phenomena
14	Historical records of declining flood levels (with floodplain readjustment) 3 000-2 800 B.C., catastrophic low floods 2 250-1 950 B.C., repeated excessive floods 1 840-1 770 B.C., declining floods 1 180-1 130 B.C., increasing again A.D. 600-1000. Egyptian climate generally hyperarid.
13	Aggradation of Kibdi Member, Gebel Silsila Formation; +6 to +7 m in Nubia, sub-alluvial north of Aswan, 17-20 m lake in Fayum; mainly Ethiopian flood silts, indicating higher Nile sedimentation rates with steeper floodplain. Active slope denudation and accelerated wadi activity reflecting winter rains (Shaturma Formation, Member I); 5th and 4th millennia B.C. Fayum A, Predynastic and A-Group. Climate arid but slightly wetter.
12	Nile and wadi dissection (at least 15 m), ca. 5 000 B.C. (6 000 B.P.).
11	Aggradation of Arminna Member, Gebel Silsila Formation; +15 m in Nubia, +4 m at Edfu, suballuvial in north, and 17-24 m lake levels in Fayum. Two phases 11 200-7 700 B.P. and 7 300-6 000 B.P., separated by regression; mainly Ethiopian flood silts, indicating higher Nile sedimentation rates with steeper Nile floodplain. Accelerated wadi activity before 8 000 B.P. reflecting winter rains (Sinqari Member, Ineiba Formation); paleosol (Omda soil: Camborthid) later. Epi-Paleolithic settlement (Arkinian, Shamarkian). Climate arid to subarid.
10	Nile and wadi dissection (at least 20 m) and total desiccation of Fayum Depression ca. 11 500 B.P. Climate hyperarid.
9	Aggradation of Darau Member, Gebel Silsila Formation; +22.5 m in Nubia, +13 m at Kom Ombo, +7.5 m at Esna, +5 m at Dandara, suballuvial (−5 m) in Middle Egypt and under Delta, and 22.5-28 m lakes in Fayum. Oversteepened gradient, Ethiopian flood silts, influx of Hudi gravel from central Sudan, fresh bedrock erosion in cataract areas, prominent bed-load deposits and rapidly shifting, bifurcating channels, all indicate vigorous, high-competence summer floods. First high stage ca. 17 000 B.P. accompanied by accelerated wadi activity (Malki Member, Ineiba Formation); followed by minor Nile recession, with dune invasion of Esna floodplain, vertisol in Sudanese Nubia; several high substages 14 500-12 500 B.P. coeval with moderate wadi activity; culminated by 'wild' Nile ca. 12 000-11 500 B.P. and development of calcareous paleosol (Adda Soil: Paleorthid). Late Palaeolithic settlement (including Halfan, Idfuan, Sebilian, Affian, Sebekian, Qadan, Silsilian and Isnan). Climate mainly arid but slightly wetter.
8	Nile and wadi dissection at least 28 m, considerably more in northern Egypt); dune fields invade floodplain at Esna and in western Nubian valley; formation of vertisol (Torrert) on old floodplain. About 18 000-17 500 B.P. Late Paleolithic settlement (Khor Musan, Halfan, Idfuan, Fakhurian, Ballanan). Climate hyperarid.
7	Aggradation of Masmas Formation; +33 m Nubia, +22 m Kom Ombo, +18 m Edfu, +7.5 m Armant, probably +8 m Cairo and related 34 m Fayum lake. Mainly Ethiopian flood silts, inundating an unusually broad floodplain, with frequent sand splays and an oversteepened gradient in the south, all infer substantial Nile peak discharge. Minimal local wadi activity and interdigitated dunes in western valley. Estimated age 25 000-18 000 B.P. Late Palaeolithic settlement (Sudanese Nubia only: Khor Musan, Halfan). Climate hyperarid.
6	Nile and wadi dissection (at least 34 m); dunes in western Nubian valley. Climate hyperarid.
5	Aggradation of Korosko Formation, upper member; +34 m Nubia, +20 m Kom Ombo, not yet verified north of Edfu, indicating oversteepened Nile gradient. Strong Ethiopian flood component; braided channel, sandy, in part ponded floodplain margins; much accelerated activity of high-competence local wadis, declining later. Wadi Tufa IV at Kurkur. Estimated age >32 000-27 000 B.P. Middle Palaeolithic (Nubia), Aterian (Kurkur) settlement. Climate semiarid.

Table 11.2 (continued)

Phase	Phenomena
4	Nile and wadi dissection (at least 10 m).
3	Aggradation of Korosko Formation, lower member; strong influx of Ethiopian flood waters; sandy, in part ponded floodplain; accelerated wadi activity. Wadi IIIc at Kurkur (Aterian settlement?). Age >40 000 B.P. Climate arid.
2	Wadi dissection (at least 6 m), followed or preceded by calcification or ferricretion.
1	Aggradation of Wadi Floor Conglomerate (Nubia) and Wadi Tufa IIIa/b (Kurkur). Nile below modern floodplain. Climate semiarid to subarid.

rated wadi activity can be recognized in southern Egypt (see Butzer & Hansen 1968: chapters 3 and 6):

a) The upper member of the Korosko Formation is everywhere interdigitated with gravels or sands reflecting active wadi discharge. On the Kom Ombo Plain, where only the upper two-thirds of this unit appear to be exposed, there is a systematic upward fining from sandy gravel at the base, to gravelly marl, to marl at the top, arguing for a diminution of wadi activity with time. In Nubia, where basal contacts are better preserved, the initial deposits rarely include gravel, but a major influx of wadi clasts can be localized in the second quarter of the unit, with a gradual decrease in wadi competence thereafter The mixed nilotic-wadi deposits of the Korosko Formation in fact grade upstream into well-defined alluvial terraces, e.g. in Wadi Or, that appear to be related to extensive mantles of alluvial or colluvial wash on pediments and piedmonts adjacent to the wadi floors. These observations consequently allow stratigraphic definition of a significant 'pluvial' event in the hill country of southern Egypt.

b) The Masmas Formation and the preceding interval of Nile dissection provide minimal evidence for wadi activity. Runoff in the desert hills was no greater than it is today.

c) The Gebel Silsila Formation, a nilotic unit, is matched by a significant body of variable wadi deposits, that has been described, defined and mapped as the Ineiba (two members, Malki and Sinqari; ca. 17 500-8 000 B.P.) and Shaturma (two members, the second being subrecent wash; late prehistoric to historic) formations.

The Malki unit is broadly coeval with the Darau substage, with which it interfingers in Nubia. However, a single radiocarbon date of 17 400 B.P. at Kom Ombo, where alluviation was not a response to oscillations of local base level, suggests that wadi aggradation may have even begun at the eastern margin of the old Masmas silt plain a few centuries before the branches of the Darau Nile had built up a new, broader floodplain to the west. The Malki Member at Kom Ombo consists of a light brown, laminated clayey silt, with prismatic tendencies and frequent slickensides, local evaporites, and abundant rootlet impressions. Thickness exceeds 9 m. Now forming a +4 to 6 m wadi terrace, these deposits represent suspended sediment carried to the edge of the Kom Ombo Plain by the largest watercourses of the Red Sea Hills. Local detritus is confined to lenses near the base of the sequence, and indicates little rainfall within the Nile Valley proper. In the smaller Nubian wadis the lithostratigraphic equivalent comprises local sands with basal gravel intercalations, also suggesting maximum runoff early in this phase. Aggradation at Kom Ombo had ceased prior to the 'wild' Nile interval after 12 000 B.P., deposits of which are not overlapped by Malki silts east of Kom Ombo. At approximately this time, calcification of the Malki deposits indicates pedogenesis, a semidesert soil of Paleorthid type (Adda Soil Zone). The wadi interbeds at Dishna (see Wendorf & Schild 1968: 121ff.) appear to be equivalent to the Malki unit.

After some 4-12 m of wadi cutting east of Kom Ombo, a light yellowish brown, well stratified, partly current-bedded, silty fine sand or coarse sand was deposited with interbeds of coarse gravel or silt, and a maximum thickness of 8-11 m. Large vertical and horizontal root drip is common and suggests shrub growth and some trees, while proliferations of *Zootecus insularis* and *Pupoides coenopictus* snails imply abundant vegetation. This is the Sinqari Member, and it argues for a period of frequent winter rains. A similar impression obtains in Nubia, where it is interdigitated with the Arminna Member in Khor Abindan (Butzer & Hansen 1968: Figure 6-9) and Wadi Or. The equivalent Nubian facies comprises sand with thick basal gravels and *Zootecus* proliferations. The latter, from the upper half of this fill, provided a date of 8 890 B.P. and indicate correlation with the first half of the Arminna substage. Subsequently, partial decalcification, rubefaction, and kaolinitic clay formation record the 30-100 cm cambic horizon of a Camborthid paleosol (Omda Soil Zone). These reddish semidesert soil profiles provide useful stratigraphic markers. They also indicate a period of subarid conditions with biochemical weathering and repeated, fairly gentle rains. This pedogenesis must be younger than 8 000 B.P. but older than the Shaturma Formation; it may be coeval with the late Arminna stage ca. 7 000 B.P.

The Shaturma Formation, Member I, was deposited following 1-6 m of dissection. These are light brown, well stratified silty sands or sandy silts, interbedded with gravel lenses and averaging less than 2 m thick east of Kom Ombo. Laterally these beds grade into sheets of coarse piedmont colluvium that are ubiquitous in the wadi systems of the eastern deserts. In fact, in Nubia this unit is mainly represented by such colluvial mantles, which rest on top of the Omda Soil, or grade directly into shallow rubble terraces. Organic vestiges are rare, but abundant late prehistoric occupation in Wadi Kharit immediately postdates most of the Shaturma sands. A related date of 4 660 B.P. suggests termination by about 3 100 B.C., i.e. a broad contemporaneity with the Kibdi substage. Member II of the Shaturma Formation represents a minor wadi infilling, probably of Islamic age, e.g. in Wadi Qena, where an 11th century A.D. date is available (Butzer 1974c).

In general, greater Nile discharge of Ethiopian origin coincided with accelerated wadi activity in the Egyptian deserts between 17 500 and 4 600 B.P. Particularly informative is a section in Khor Adindan that shows dark Nile flood silts of the Kibdi unit interdigitated – but along sharp, minor disconformities – with reddish sands of the Shaturma Formation (Butzer & Hansen 1968: Figure 6-7 and 288ff.): local winter spates and summer Nile floods were seasonally out of phase. An identical interdigitation of Arminna flood silts and Ineiba (Sinqari) wadi sands is verified 300 m upstream (Butzer & Hansen 1968: Figure

6-8 and 6-9). In other words, accelerated late Pleistocene to Holocene wadi activity in Egypt can be largely, if not entirely, attributed to winter rains, and not to a simple, northward extension of the sporadic summer shower activity evident in Sudanese Nubia today. Nonetheless, the local alluvial and paleosol record suggests a persistence of essentially arid conditions throughout this time span. Despite their obvious ecological significance, the amplitude of the moister intervals should not be overestimated and they generally were brief and, even so, punctuated by recurrent interludes of hyperarid climate.

11.6.2 *The Kurkur oasis*

In the upper reaches of Wadi Kurkur, above and just below the great Libyan limestone cuesta, a sequence of alluvial and spring-fed subaqueous deposits was mapped and studied in detail by Butzer & Hansen (1968: chapter 7). This succession provides a unique record of Pleistocene palaeoclimates at a different scale than the Nile Valley alluvial units. Subsequent to the Pliocene Plateau Tufa, four complexes of clastic and marl-tufa deposits developed within the Oasis valleys and as fans below the escarpment.

The two oldest of these now form inverted topographies, due to erosion of less indurated lateral sediments and accompanying bedrock denudation. In Nubia, indurated wadi deposits that are older than the Wadi Floor Conglomerate frequently show comparable inverted topographies, suggesting that these oldest Kurkur units, Wadi Tufas I and II, are of early to mid-Pleistocene age. Subsequent events can be outlined briefly:

a. Tufa IIIa. 5 m of rounded gravel, sulphide marls and silts with lenticles of plant tufas, stratified, partly current-bedded; freshwater snails (*Melanoides*) common, terrestrial snails (*Zootecus*) rare. The related +6 to 7 m escarpment fan-terrace includes water transported limestone blocks. Radiocarbon age 'greater than 39 900 years'. Rare, presumably reworked Acheulian handaxes.

b. Tufa IIIb. 5 m of tufa-travertines, plant tufas, and calcified montmorillonitic clays; complex, lenticular stratification related to fossil spring vents amid pools and tufa cascades; abundant *Melanoides* and some *Pupoides,* with pockets of plant impressions, including *Ficus.* Followed by 6-10 m of wadi downcutting.

c. Tufa IIIc. 6 m of montmorillonitic marls, in part sulphide rich, in part mottled by limonite; rich in aquatic snails and interbedded with lenticles of organic tufas; grade downstream into calcified alluvium derived from older eolian sands. The marl facies includes two planorbids, *Segmentina, Bulinus* and *Lymnaea,* suggestive of stagnant water and abundant decaying vegetation, as well as a terrestrial snail, *Lamellaxis.* Radiocarbon date 'greater than 39 900 years'. Undiagnostic flakes found within the sandy facies may indicate contemporaneity with the abundant, rich surface sites of the Aterian industry (Barbara Sivertsen, personal communication). Followed by 6-9 m of wadi downcutting.

d. Tufa IV. 3 m of calcreted subangular gravel, sand and marl, in part with sulphides, in part with evaporites; land snails (*Zootecus, Pupoides*) common, but no aquatic genera, suggesting less water than the Tufa III complex; only a minor fan-terrace (+3 m) formed below the escarpment. Radiocarbon date of 31 800 B.P. Occasional unworn artifacts in situ record last episode of major prehistoric occupation (Aterian) in area. Followed by wadi dissection and one or more episodes of sheetwash, with redistribution of reddish wash derived from now destroyed paleosols.

In terms of general interpretation, Tufa IIIa indicates episodic, torrential stream flow at the height of the rainy season, with subsequent deposition of marls in stagnant valley pools; as this stage advanced, such stream-bed ponding grew more important in the oasis. There was little fluvial activity during the Tufa IIIb stage, when discharge was probably distributed more evenly during the year, fed by waters from 'mound springs' during the dry season and so creating a wide variety of calcareous deposits along the well-vegetated valley floor. Following a drier spell with erosion, Tufa IIIc represents another phase of valley-floor spring ponding, but of more restricted extent. After yet another dry erosional hemicycle, Tufa IV represents a brief return to conditions approximating those responsible for Tufa IIIa, but somewhat less wet.

Tufa IV was contemporary with the upper member of the Korosko Formation in the nearby Nile Valley, and represents a logical geomorphic parallel. Tufa IIIc may record the lower member, Korosko Formation, while Tufa IIIa/b provides a good parallel for the Wadi Floor Conglomerate. The Kurkur sequence consequently demonstrates that the early Upper Pleistocene 'pluvial' intervals of Egypt were considerably more effective and presumably both longer and wetter than those of the terminal Pleistocene and Holocene. A similar pattern emerges in the lower-lying segments of the Libyan Desert, with access to artesian water resources (see Wendorf et al. 1976).

11.6.3 *The Red Sea littoral*

An independent geomorphologic record of late Pleistocene stream activity is provided by the Red Sea littoral, near Mersa Alam. Here dated, tectonically undisturbed, high beaches allow stratigraphic correlation with alluvial deposits or episodes of fill-cutting (Butzer & Hansen 1968: chapter 8). The sequence is:

a. +10 m coral reef (coralline limestone). ? Early Last Interglacial transgression. Minimal wadi activity.

b. +6 m coral reef (calcarenite and coral), with Th^{230}/U^{234} dates of 80 000 B.P. ± 8 000 years (on reef shell) and 110 000 B.P. ± 10 000 years (on shell from older beach gravels back of the reef). Mid-Last Interglacial transgression. Minimal wadi activity.

c. +8.5 m gravel bars and estuarine gravels, indicating accelerated wadi activity.

d. Regressive oscillation.

e. +3.5 m coral reef (calcarenite, some coral). Late Last Interglacial transgression. Minimal wadi activity.

f. Regressive oscillation with wadi dissection.

g. Alluviation of coarse gravels of 'Middle Terrace', indicating 'pluvial' conditions with increased stream competence. Basal beds appear to be contemporary with estuarine conglomerate at modern high-water, while later fluvial sediments extend to below modern sea level. Early Last Glacial regression.

h. Dissection of alluvium and calcification (Paleorthid paleosol).

i. Alluviation of 'Low Terrace', again indicating a 'pluvial' climate. Gravels indicate an oversteepened gradient at coast, and deposits extend to below modern sea level. Contemporary with early or mid-Last Glacial regression.

j. Long-term dissection of coastal deposits to well below modern sea level during late Last Glacial regression. During Holocene times sea level returned to its present mark, drowning the lowermost wadis, since post-Pleistocene wadi activity has been minimal.

This stratigraphic sequence, although by no means as readily interpreted as that of the Mediterranean Basin (see Butzer 1975b), clearly shows that in south-eastern Egypt the last 'pluvial' episodes of the later Pleistocene are broadly contemporary with the first half of the Last Glacial regression. However, part of the Last Interglacial experienced a climate about as arid as that of today. The Mersa Alam evidence further shows that there was a moister interval during the late, Last Interglacial while the last half of the major glacial-eustatic regression was comparatively dry. This emphasizes that pluvial-glacial or pluvial-interglacial correlations are gross oversimplifications of a rather more complex pattern of events.

Significantly, as at Kurkur, terminal Pleistocene and Holocene moisture fluctuations were not significant enough to leave a geomorphic imprint on the hyperarid Red Sea littoral. Only speculative correlations can be offered with Kom Ombo, Nubia and the Kurkur Oasis. In relative stratigraphic terms and assuming that major geomorphic trends are simultaneous, the 'Low Terrace' may be equivalent to the upper Korosko Formation and Tufa IV, the 'Middle Terrace' to the Wadi Floor Conglomerate and Tufa IIIa/b. If this is indeed so, the entire late Pleistocene sequence of southern Egypt discussed here is younger than 75 000 B.P.

11.6.4 *Late Pleistocene to Holocene overview*

The previous stratigraphic, thematic, and regional information is collated and reviewed in Table 11.2. It provides both a record of palaeoclimatic trends in Egypt, presumably all related to the winter rainfall belt, and a history of the Nile flood regime.

By African standards, the details are remarkably good. Comparison of the Egyptian events with those of higher latitudes are beyond the purpose of this paper, but the data base speaks for itself and provides invaluable information for a proper understanding of the dynamic climatology of the Mediterranean Basin during the late Pleistocene and early Holocene (see also Butzer 1975a, 1975b).

Equally so, the Egyptian nilotic record has major import for an understanding of the subsaharan Nile Basin. It raises more questions than it provides answers, pointing to obvious areas in Ethiopia and the Sudan that require equally searching investigation. Despite several obvious correlations and some superficial resemblances with the subsaharan lake history (see Butzer et al. 1972; Butzer 1976a, 1976b:30ff.), the Nile record would also seem to pose some contradictions. It is essential that interpretations of the East African evidence relevant to the Nile Basin be consonant with the basic Nile flood history documented in Egypt.

11.7 THE HISTORICAL NILE

The saga of the Nile during the course of the Pharaonic era has been recently studied by Butzer (1976b:27ff.), and it would be redundant to review the information here. However, in broad outline (Table 11.2), flood levels declined significantly between 3 000 and 2 800 B.C., representing an overall reduction in volume of 25-30 % (see Bell 1970). Concomitant downcutting appears to have initiated the modern floodplain downstream of Wadi Halfa. A period of catastrophically low floods characterized the interval 2 250-1 950 B.C., with improved floods thereafter. Excessive floods are documented 1 840-1 770 B.C., recurring every two to five years with peak discharge three times that of the ten greatest floods of the 19th century A.D. (see Bell 1975). Average levels remained high thereafter, but declined strongly 1 180-1 130 B.C., and then levelled off until a last interval of generally higher levels about 600-1000 A.D. Broad comparability with hydrographic trends in the subsaharan Nile Basin is evident (Butzer 1976b: Figure 5).

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