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Dating the Neolithisation process in the Middle Nile valley: a critical approach

Introduction

The early to mid-Holocene prehistory of the Middle Nile valley has been the subject of several summaries that concurrently offered thoughts about supraregional chronologies (Arkell and Ucko 1965; Wendorf 1968; Mohammed-Ali 1982; Mohammed-Ali and Khabir 2003; Sadig 2010). Parallely, the significance of a growing number of radiocarbon dates was acknowledged by transforming them into ordered lists or graphical schemes in order to visualise chronology (Green 1975; Hassan 1986). The 1970s saw the formulation of seemingly timeless pan-African concepts like the 'Aqualithic' of Sutton (1977) related to the spread of fishing and pottery production during the early Holocene, or the Khartoum Horizon Style related to the wide diffusion of 'Wavy-line' pottery decorations (Hays 1974). This was followed by the New Archaeology in the 1980s that has always been more interested in socio-economical issues (*cf.* Haaland 1996) than in the answer of historio-chronological questions. This unintentionally added to the impression that the early to mid-Holocene prehistory of the Middle Nile valley was mainly characterised by continuity with few changes, or slow shifts from one subsistence strategy to the other. Mostly this assumption of a gradual shift was based on the omnipresent admixtures of different ceramic decorations, especially in the Khartoum region, leading to the impression of their long parallel use (Caneva 1985; Mohammed-Ali 1991; Mohammed-Ali and Khabir 2003). The past decade has witnessed strong efforts dedicated to the refinement of pottery chronology for individual regions (Keding 2000; Jesse 2003; Gatto 2006a; 2006b; Fernández *et al.* 2003; Raher 2005; Garcea and Hildebrand 2009; Salvatori *et al.* 2011). At the same time, efforts of establishing an agreed lithic typochronology, especially for Nubia, have been dismissed (with only few exceptions, *cf.* Usai 2005). Replacing the fast progress done in the late 1960s (Wendorf 1968; Marks 1970), this deceleration is probably a late outcome of the early criticism of culture definitions based on lithics (Haaland 1977) as well as the unfortunate redating of the underlying Nile silt chronology (Wendorf *et al.* 1979) reminding of the pitfalls of radiocarbon dating. As a result, it has become extraordinarily difficult to link chronological concepts for Nubia with that of Central Sudan (Fig. 1) in order to unfold an all-embracing picture of the dynamics of change that affected both regions in the course of the 7^{th} to 5^{th} millennium BC (*cf.* Sadig 2010; Dittrich 2011).

Accessing the temporal structure of Holocene deposits

If neolithisation is studied in terms of a historical process, both different temporalities as well as diverging dynamics of sub-processes need to be considered (*cf.* Dittrich 2013). Hence, the chronological framework should be capable to reflect shifts within a period of time without fully collapsing if any element later turns out to be of a different age than previously thought. Radiocarbon dating is a very sensitive procedure in this respect. As radiocarbon dates for the Middle Nile valley and adjacent regions (Fig. 2) are commonly meant to act as chronological evidence, they have been the subject of a critical discussion of the dated materials, their origins and their association to individual deposits or events within the scope of a detailed study (Dittrich 2011). It seemed useful to assess the chronological information of 60 catalogued early to mid-Holocene sites (*ibid.*) for which sufficient information had been published by three methodological categories:

1. Site formation (in order to understand processes of sedimentation and transformation)
2. Radiocarbon dating (evaluation and standardised calibration of individual dates)
3. Typochronology of artefacts (in order to emphasise technological traits of pottery manufacture and lithic tool production)

The evaluation of radiocarbon could not be completed without the in-depth study of the two other issues. Especially the issue of site formation is an important methodological approach to highlight the qualities of a site as an 'archive' including

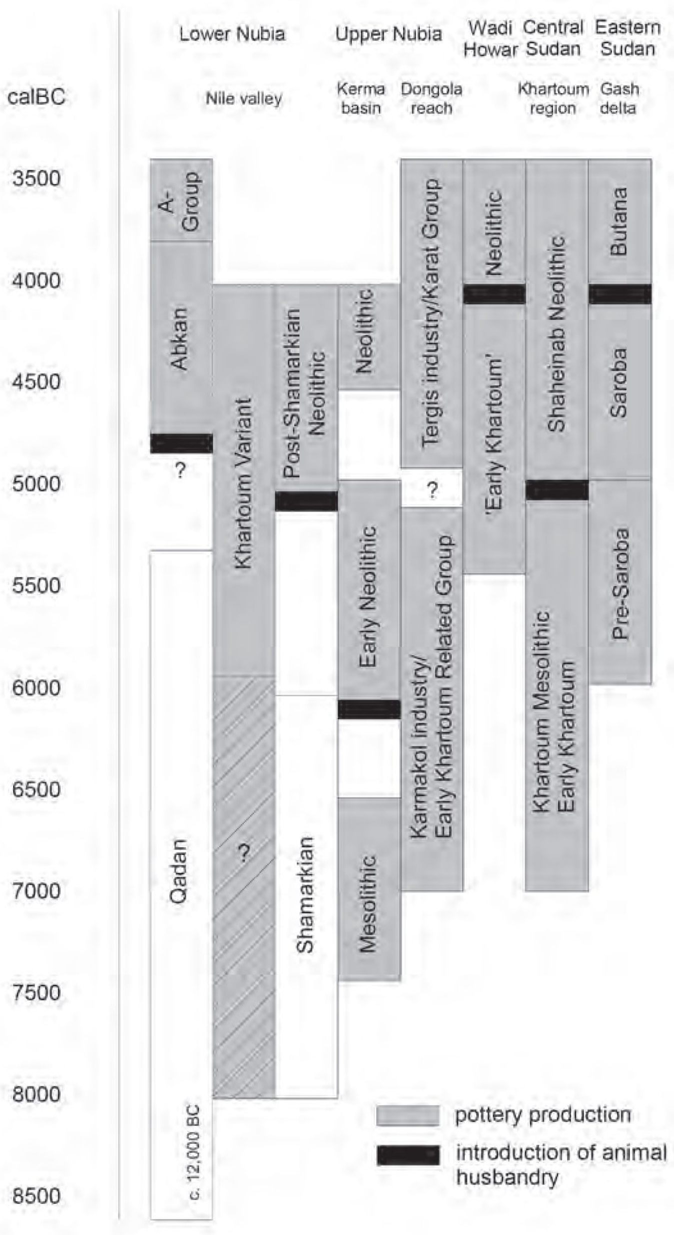

Fig. 1. Overview of chronological developments as seen from various regional perspectives therefore representing research history rather than Holocene cultural history (after Schild *et al.* 1968; Shiner 1968a; 1968b; 1968c; 1971; Marks *et al.* 1968; Arkell 1977; Hassan 1986; Honegger 2003; 2005; Jesse 2003; Usai 2005; Gatto 2006a)

various sequences of 'writing' and 'erasing' information that became later subjected to fragmentation, distortion and illegibility (Bailey 2007; Holdaway and Wandsnider 2008). In fact, stratigraphies are not to be viewed as containers of cultural history but as geological entities that may or may not preserve indices of different events such as landslides, erosion, deposition, burrowing, flooding, or previous excavating. Since the archaeological information is always part of the geological reality, such events are not easily to be separated by natural or cultural causes.

Case studies from stratigraphies in North America have especially revealed the geological nature of Holocene deposits in which the scheme of artefact distribution follows that of other sediment particles. As lithic artefacts could be refitted over long vertical distances that were equated with a long-term sedimentation (Hofman 1986), the results questioned the common practice of reading statistics as culture-chronological history. "There is, however, increasing evidence that vertical movement of buried particles, including artifacts, within and between stratigraphic units not only is common but in some sites may be pervasive" (Hofmann 1986: 163). In another case study from an early Holocene site in Colorado the absence or presence of significant artefacts could not be used as stratigraphical markers since they were widely dispersed above and below former surfaces (Surovell *et al.* 2005).

As early as in the late 1950s O. H. Myers had discussed such analytical problems for Lower Nubia while drawing on his experiences gained during the excavation of the site named Abka-9: "When a site is re-occupied sherds of the previous occupants will be lying about on the surface and these will be clearly be incorporated into the lowest level of the new occupiers… Some of these will again be moved into the level above by normal disturbance during occupation. In addition to this factor we must remember that there is always a certain amount of digging and scratching in an occupied site and this helps to account for the downward movement as well as the upward" (Myers 1958: 138f.). As humans act as sedimentological agents in geological terms (Stein 2001), also every surface site, especially in the desert regions, has been exposed to continued visitation and manipulation. Case studies from other arid zones in the world like Australia show that commonly known patterns of grouped archaeological features such as fireplaces or concentrations of lithics emerge only from the long-term (Holdaway *et al.* 2008). The chronological fixation of such sites can become extraordinarily difficult since the temporal range of reoccurring visits could be made of several thousand years (cf. the example of the Egyptian Western desert given in Dittrich 2013: fig. 1). In this respect, almost no site is to be related to just one single pe-

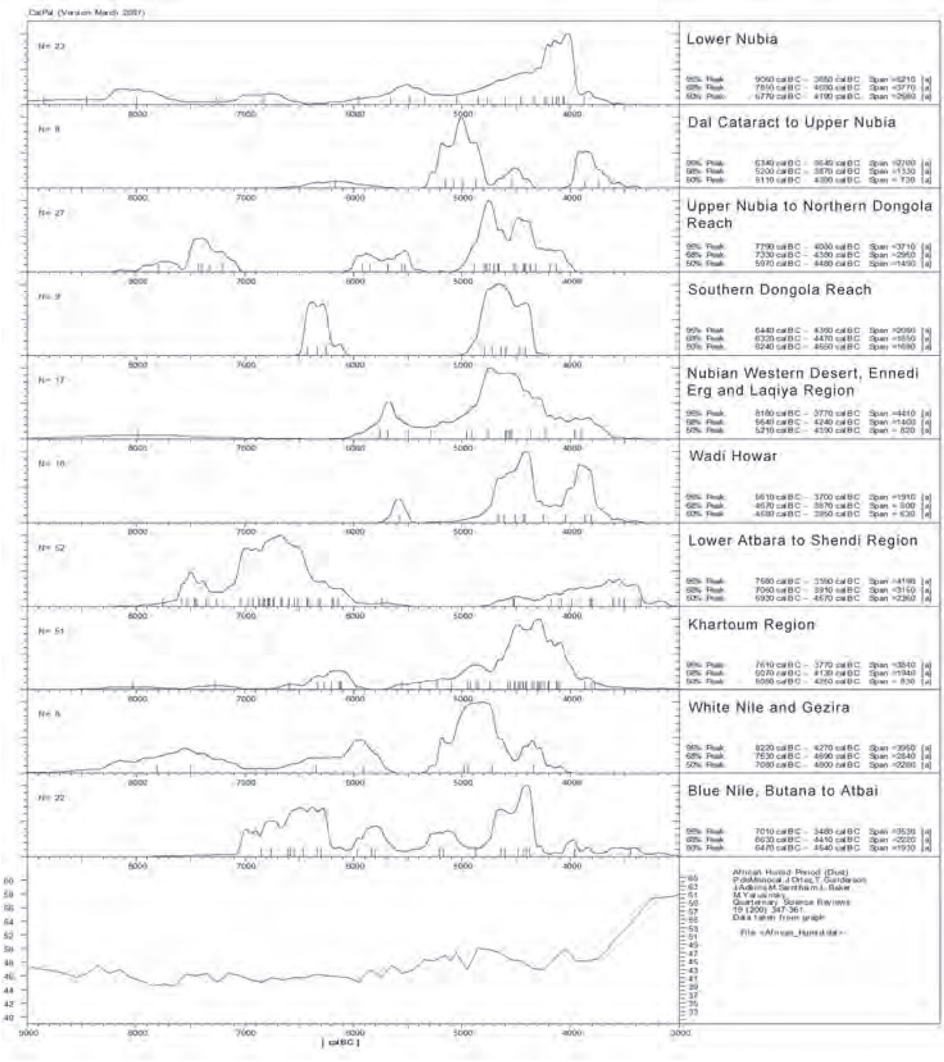

Fig. 2. Sum calibration for radiocarbon dates between 10,000 and 5000 bp for the Middle Nile valley and adjacent regions (after Dittrich 2011: fig. 3.9, list 1)

riod. Rather, a site constitutes an index to several events that vary in their temporal structure. The concept of 'palimpsest' imposed on archaeological contexts or landscapes is reconsidering such 'archival' modes of 'erasing' or eroding of information as well as 'rewriting' or redepositing of information (Bailey 2007; Holdaway and Wandsnider 2008; Olivier 2011). However, also the establishing of a chronology by relating to just one site should be viewed with caution. As each palimpsest/site has got its own temporal structure, respectively its own admixture of different traces, chronology should rather be based on multiple indexes from several localities that can be brought into a logical congruence.

Gaining stratigraphical order by Gaussian curves

As a consequence, stratigraphies have to be considered as palimpsests where the exact temporal relation between the components is not clear. Structural information might be missing, and artefacts deposited during different periods might be mixed. Chronologically, palimpsests constitute containers of disordered elements that need to be sorted by every single component unless a former systemic context of a couple of them can be verified, for instance by refitting lithic artefacts (*cf.* Hofman 1986). In this respect, it is not appropriate to state in culture-historical terms that within a given stratigraphy certain decoration types 'decrease' over time while others 'increase' in popularity though this rhetoric is frequently found throughout the cited literature.

This can be illustrated by the example of the former difficulties with pottery decorations like 'incised wavy-line' and 'dotted wavy-line' (as defined after Arkell 1949; Caneva 1987) occurring with differing proportions at a number of Mesolithic sites in the Khartoum region. Only recently, it was stated that "the chronological index of the wavy line and dotted wavy line pottery has not as yet been fully deciphered. The archaeological evidence from the Central Nile Valley indicates that both types were present at Khartoum district sites in all layers from the beginning of the occupations" (Mohammed-Ali and Khabir 2003: 51). Fernández et al. (2003: fig. 46 and 47) even assumed that the percentages of both decorations tell about the chronological status of a whole site's inventory indicating that a high amount of 'incised wavy-line' fragments points to an earlier dating than a high amount of 'dotted wavy-line' fragments. In the following section it will be shown, however, that this parallel presence of two or more different decoration types is not a significant chronological pattern but a result of site formation. This is based on the assumption that a site has to be considered not as a container of a specific cultural order but as an archive open to anyone at any time but indexing, storing, and preserving different things differently. Furthermore it has been the common use of the insufficient method of percentage counts for pottery fragments that very much eluded their actual absolute frequencies. According to their conviction, Elamin and Mohammed-Ali (2004) presented the site of Umm Marrahi as a single phase unit whose statistics showed "a minor decrease of ca. 9% in the popularity of wavy line partly alternating with an increase of ca. 5 % in dotted wavy line" both of which observations were suggested to be negligible by

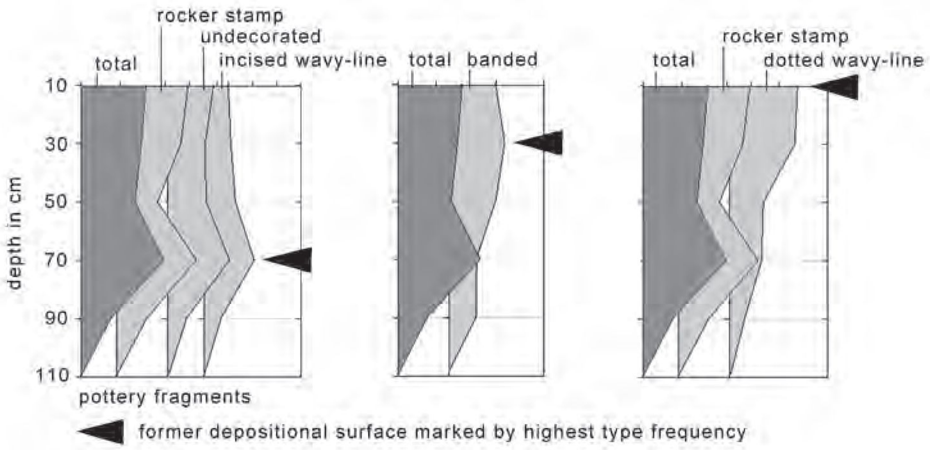

Fig. 3. Umm Marrahi. Modelling vertical frequencies of pottery decoration types out of absolute counts for levels combined to vertical ranges of 20 cm (absolute counts after Elamin and Mohammed-Ali 2004: tab. 5)

the authors. But this 'popularity' is nothing else than the distributional pattern of artefact types in a geological structure. Being originally deposited at a certain depth marked by their highest frequency, artefacts and ecofacts later spread to levels above and below by processes of transformation such as trampling, human digging, animal burrowing, water activity from inundation or rains, relocation through desiccation cracks and gravity (*cf.* Schiffer 1987; Hofman 1986).

A statistics using percentages of different types found together in artificially defined *horizontal* layers has no chronological meaning since the total of included artefacts of different age have never been used together in a single systemic context to be subsumed as a hundred percent.[1] Rather, it has to be assumed that a hundred percent of one type have been used in the same period so that the *vertical* spread of this type tells much more about the formation and subsequent transformation of the stratigraphy. Following the principles of sedimentological analysis, the vertical frequencies of every single artefact type have to be studied while switching the percentage or absolute counts from the *horizontal* to the *vertical* axis. Since Elamin and Mohammed-Ali (2004: tab. 5) have published also absolute pottery fragment counts, it is possible to model at least three depositional surfaces that are connected to different ceramic phases out of these data (Fig. 3). When Myers (1958) discussed

[1] This is one of the few points that have already been missed by Myers (1958). Percentages given for horizontal layers are still the publication standard (*cf.* Caneva 1983b; Caneva and Marks 1990; Caneva *et al.* 1993; Haaland 1995; Elamin and Mohammedi-Ali 2004; Fernández *et al.* 2003; Gatto 2006a; Salvatori *et al.* 2011)

similar observations for the stratigraphy of Abka-9 for the first time, he found it "far more interesting, indeed astonishing, …that sherds in stratified levels show a distribution curve vertically through different strata, even when the latter are well defined" (Myers 1958: 138). But, as later also Hofman (1986) and Surovell et al. (2005) observed for Holocene sediments in North America, such distributional curves of artefacts do not respect limits of layers as commonly defined in archaeology. Furthermore, Myers recognised the close relation of patterns of artefact distribution to normal (Gaussian) distribution curves: "Experiments showed that if a pot be broken on a hard even surface the sherds will be found laterally more or less according to a normal distribution curve…" (Myers 1958: 138).

The results presented here for Umm Marrahi (Fig. 3) are equally based on the Gaussian distribution (probability calculation) because statistically they can be further condensed to show that in Umm Marrahi 65.1 percent of 'incised wavy-line' were deposited in a depth between 50 to 110 cm, while 62.4 percent of 'dotted wavy-line' were deposited in a depth of 10 to 50 cm. The remaining 34.9 percent respectively 37.6 percent were relocated from the original surfaces (*cf.* full discussion in Dittrich 2011: 119ff.). This approach aims therefore mainly at the differentiation of re-located and admixed artefacts (~31.8 percent) opposing the number of artefacts still in a more or less original position (~68.2 percent) which is the ideal proportion of a Gaussian curve. This proportion can be visualized by using distributional graphs whose peaks mark the highest artefact density and therefore the level of the former depositional surface (Fig. 3). By using this procedure, different ceramic depositional phases are clearly outlined by different curves. Not necessarily is there a close connection between these curves/phases which could be interpreted in terms of a continuous occupation of the site. A partial overlap of two curves in the graph, respectively of two different decoration types, means in this respect probably nothing else than an artefact admixture, but surely not contemporaneity of both types. None of these curves shows a development from one decoration type to the other as this cultural process will not be captured by soil formation.

At this point it seems already justified to argue that the site of Umm Marrahi actually provided a rather clear sequence of two main pottery decoration concepts and that it partly solved the puzzle of their questionable chronological order. If we further state that artefacts have been spread from a former given surface than for the purpose of analysis, "it is justifiable to collapse the materials back to a single depositional surface" (Hofman 1986: 167). Therefore we can assume that the former or at least the ideal distribution pattern is a clear Gaussian curved outline for one single depositional phase. Later in this paper, three stratigraphical case studies will be used to investigate in greater detail if and how such patterns are preserved and if the Umm Marrahi sequence (Fig. 3) holds a pattern that could be generalised for the Khartoum region.

A re-examination of radiocarbon dates

The evaluation of approximately 270 radiocarbon dates between 7500 and 4000 calBC from altogether 91 individual sites in Northern and Central Sudan (Dittrich 2011: lists 1A and 2) was accomplished according to the following checklist:

1. Consistency of publication (typing or citing errors, redatings)
2. Discussion of sample material and its specific properties
3. Standardised calibration using the Intcal04 calibration curve (Fig. 2)[2]
4. Discussion of archaeological contexts and sample context
5. Primary contextual association by excavators and revised associations
6. General discussion of associated archaeological finds (Dittrich 2011: catalogue).

The last point included also a revision of the site's full spectrum of archaeological finds such as pottery, lithics, small finds, and organic remains with respect to the question if the temporalities represented by artefacts and ecofacts do find sufficient equivalence with the radiocarbon dates. As a result, for almost all of the sites it can be stated that they contained remains of more than one period though most researchers aimed at placing the whole site within a specific period. However, a site to be equated with a specific period in time is not even an exemption, for hermeneutic reasons it simply does not exist. Therefore, the temporal correlation between cultural remains and dated (organic) samples of a given site does not automatically exist but has to be established by means of scientifically agreed methods.

While discussing the quality of radiocarbon dates, the full array of possible uncertainties has to be taken into account (cf. also Hedges 1992):

1. Physical properties of sample material: isotopic fractionation, hard water effect
2. Availability of sample material during specific periods: e.g. of fresh contemporary wood in desert areas, possible modes of use or discard (e.g. old wood effect; collection of fossilised shells), possible modes of natural/geo-

2 Calibration was done using Calib 5.0 (Stuiver *et al.* 2005) for single and CalPal (Weninger *et al.* 2006) for sum calbrations. The calibration is quoted according to the range of the 1st sigma rounded to the next 50 radiocarbon years. All dates mentioned in the text are cited from Dittrich (2011: lists 2 and 1A, cf. catalogue for raw dates and full quotations).

logical deposition through bush fires, high floods (e.g. mollusk shell deposits, driftwood), incorporation of small particles from older sediments such as seeds or charcoal of species pointing to former (extinct) habitats

3. Possibility of admixtures of traces of different events through geological processes or human/animal activities such as digging and trampling, digging of soils for the construction of tumuli, processing of raw materials among them older artefacts/ecofacts, modern construction work

The secondary carbon intake of organisms such as seeds, mollusks, ostrich eggshells (Vogel et al. 2001), or bones is widely known and can be partly controlled by specific procedures of corrections that belong to the laboratory standard today.[3] Concerning the questionable suitability of composite materials like pottery (Gabasio *et al.* 1986), or sediments (Geyh *et al.* 1983) specific studies exist. As other dating materials might be often not available at least the production and publication of such dates needs a full discussion of related problems (but is regrettably missing e.g. in Gatto 2006b). In some publications the standardised quotation of radiocarbon dates as sensitive data sources and even basic information as to the dated materials and contexts are conspicuously missing (*cf.* Honegger 2003; 2005; Honegger and Jakob 2009; Reinold 2006). This practice significantly hinders the comprehension of forwarded chronological arguments, especially when these are largely drawn on radiocarbon dates and not otherwise verifiable. However, also the dating of charcoal is not without problems. Although the laboratory standard is based on charcoal and only few corrections are necessary, it is mainly the frequency of charcoal and its occurrence in stratigraphical layers that have to be questioned. Schiffer (1987) stated that charcoal as a reliable dating material becomes available from the moment when pressure is imposed on wood through wood cutting for construction work, intensified firing, or slash-and-burn practices. Presently, the origins of charcoals as found in early Holocene sediments throughout Northeastern Africa as either indices of foragers' strong impact on landscapes, or of natural agents such as bushfires and driftwood is not fully understood. Furthermore, as charcoal of recent fireplaces can be observed to be blown out or washed out within hours and secondarily deposited elsewhere, single fragments of charcoal from Holocene sediments do not constitute reliable dating samples, at least not, when viewed as evidence for contemporary human occupation.

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[3] Since the correction for isotopic fractionation was not common before 1977 six radiocarbon dates had additionally to be corrected by using the data provided with Cailb 5.0 (Stuiver *et al.* 2005; cf. Dittrich 2011: list 3).

The great number of available calibrated dates could be used for the statistical refinement of sub-phases. Based on mean standard deviation, a sequence of so-called wiggle spaces has been established (Fig. 4). This sequence illustrates that dating precision for the study area of the Middle Nile valley ranges within a time-span of 150 to 400 radiocarbon years due to the relatively high standard deviations of conventional dates. Nevertheless, wiggle spaces offer a useful framework for discussing whole clusters of dates that fall into the same wiggle such as 4350-4050 calBC. Wiggles are to be preferred to the sometimes questionable validity or even overrated precision of individual dates. In a next step, they could be turned into temporal sequences ideally to be linked to chronologically significant types of artefacts or archaeological features. As a conclusion, chronology is not so much developed from the potentially complex geological archive of a single site but from the database of temporally related traces spread over a larger region as a chronological horizon. Therefore, one could talk about the specific wiggle space of 4350-4050 calBC almost of a period of intensified human depositional activity because it is frequently matched by radiocarbon dates deriving from Neolithic settlement and burial sites. But simultaneously it reminds us of a period for which typologies for establishing chronology by other means than radiocarbon dating are largely missing.

Radiocarbon dates as evidence for cultural history?

This example leads to the discussion of the quality and significance of radiocarbon dates that is commonly missed in literature on the Middle Nile valley. In view of all available radiocarbon dates one could gain the impression that the number of dated archaeological features like fireplaces and pits, including grave pits, significantly increases only after 5050 calBC. Between 7050 calBC and 5050 calBC the repeatedly stressed association of artefacts or ecofacts to grave contexts has to be regarded with great caution because grave good rites are virtually absent during that time.

In some cases, radiocarbon dates are indicators of the long-term record of environmental changes. For instance, in Geili the peaks of high inundations are indirectly dated to 7600–7400 calBC and 6100–5750 calBC respectively by shells of *Bellamia* sp. deriving from sterile silt layers from below the Neolithic settlement (Marcolongo and Palmieri 1988; Dittrich 2011: cat. 19). Such dates are most important as they fill in gaps that are not otherwise represented by dates associated with archaeological remains in the vicinity of the Nile valley.

Discontinuities in the former availability and usage of particular resources are best encountered by the use of diverse dating materials marking as many different events as possible. It is obvious that by this methodology a specific question related to cultural history cannot be directly addressed. This multitude dating approach adds mainly to the perspective of a more general landscape archaeology that reveals its strength only by focusing on long-term changes. In this respect, there is also temporal variation in the quality of radiocarbon dates. In the present study up to 76 percent of the Mesolithic dates had to be omitted from further chronological discussion due to the uncertain status of their contextual association, while this number decreased to 12 percent for the Neolithic dates (Fig. 5; Dittrich 2011: tab. 3.13). This variation is mainly due to greater fluvial activity during earlier Holocene periods which kept the Nile valley in an unstable state of sedimentation, and a cultural shift that favoured the creation of preserving contexts such as human burials during the mid-Holocene. Presently, there is no agreed concept to consider such qualitative differences since as a rule all radiocarbon dates – while few being entirely omitted – are treated on equal terms.

The heterogenic pattern of the temporal availability or temporal absence of samples to be employed for radiocarbon dating has been interpreted in terms of continuity or discontinuity of the human occupation in specific regions of Northeastern Africa. However, is it justified to relate the absence of radiocarbon dated sequences with a supposed absence or marginalisation of human occupation? Probably not, if the dates pertain exclusively to non-human organic remains subjected to specific discontinuities of preservation as discussed above. The reconstruction of social decision-making processes is not a paramount task of radiometric dating, and there is no direct link between the manifestations each of them is based on. Therefore, the sum calibration of radiocarbon dates is not to be translated in an outline of cultural history. The same holds true when radiocarbon dates are spatially mapped as evidences of occupation. A map published by Kuper and Kröpelin (2006: fig. 3) claims that the Nile valley north of the Khartoum region has been virtually unsettled between 8500 and 5300 calBC, however, the authors did not take into account the full range of published but yet undated sites.[4] The latter prove that during the period in question the Mid-

[4] For Lower Nubia see the work in the Abka region (Myers 1958), of the Scandinavian Joint Expedition (Nordström 1972), the Combined Prehistoric Expedition (Shiner 1968a; 1968b; 1968c; Schild *et al.* 1968; Wendorf 1968), or the finds at Catfish Cave (Wendt 1966), for Upper Nubia see the work of the University of Colorado (Hewes 1966), the sites from the area of the Dal-Katarakt such as Khor Kageras (Fairbridge 1963) and Sonki East (Rudin 1980), the sites at Sai Island (Geus 2002) or in the Kerma basin (Honegger 2003), the work in the Dongola region (Shiner 1971; Marks *et al.* 1968; Reinold 2001) and in the Letti basin (Usai 1998), the sites at the Atbara confluence (Haaland and Magid 1995), or the recent work in the Fourth cataract area (e.g. Dittrich et al. 2007). *Cf.* also the summaries given by Geus (1992), Sadig (2010), and Dittrich (2011: 15-32).

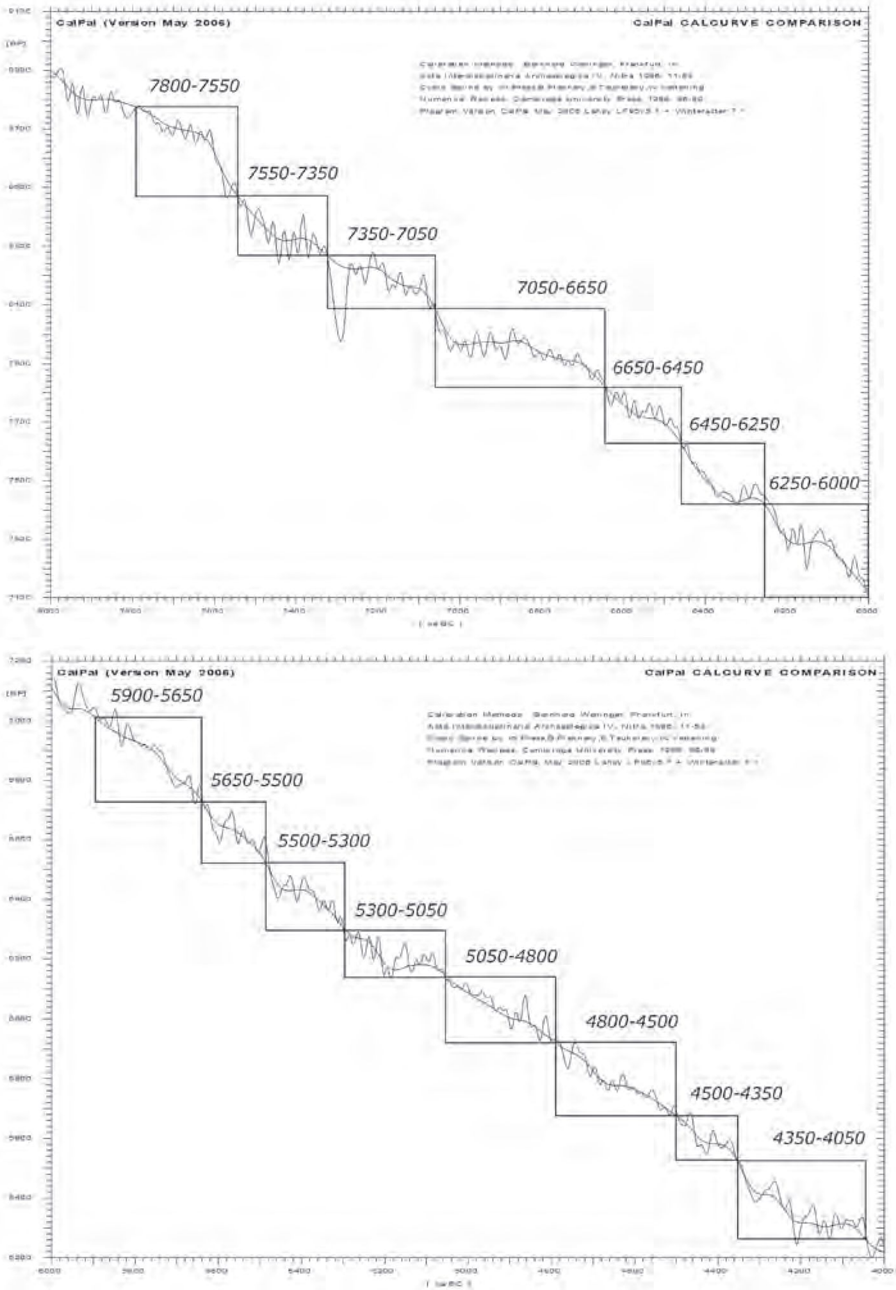


Fig. 4. Frequently matched wiggle spaces between 8000 and 4050 calBC based on IntCal curves 1998 and 2004

dle Nile valley has been constantly revisited and settled by humans. In fact, since every given point in the past is imaginable on a timescale, radiocarbon dating is not a validation if this point or a temporally related event really existed. It is just a method to fix at least a coarse-grained grid depending on the specific properties and availabilities of dating materials. For the interpretation of the cited map that shows a virtually unsettled Nile valley before the onset of the Neolithic this has serious consequences: The neolithisation of the Middle Nile valley cannot be solely thought as an eastward movement out of the deserts, a scenario favoured by Kuper and Kröpelin (2006), because such movements within the West-East oriented ecological corridors have been dictating the modes of life of forager groups well before. Furthermore, this assumption neglects that rather the neolithisation of the Middle Nile valley is both (1) an inner transformation of Mesolithic societies, and (2) a spread of ideas and domesticates along major traffic corridors such as the Nile valley and other North-South oriented routes.

In fact, the general chronological frame-working of neolithisation is made up of few indicators. Dates from 7050 calBC onwards are related to the onset of a distinctive Early Mesolithic occupation phase (Fig. 5). The statistics indicate a possible temporal break marked by the absence of dated grave contexts between 5500-4850 calBC (Fig. 5). If this is not to be attributed to the absence of datable grave goods it could indicate a period of much shorter and dispersed occupation events that are amalgamated to other more dominant palimpsests and therefore escape the archaeological attention. The beginning of the Neolithic period in the Middle Nile valley is to be fixed around 5050-4850 calBC (Rabak, Kawa R12; *cf.* Dittrich 2011: cat. 39, 28) while a dense cluster of dates around 4500-4050 calBC defines the core area of the Middle Neolithic.

Stratigraphic case study 1: Shaqadud Midden

The 3.15 m thick stratigraphy of Shaqadud-Midden has been located in a small valley in the Butana steppe leading us about 40 kilometres away from the Nile, in the vicinity of a former Holocene water pond probably once fed by a small waterfall (Fig. 6). In this micro-ecological niche the preservation of a considerable soil formation of the 6th millennium calBC provided a sufficient stratigraphical distinction between early and mid-Holocene deposits, respectively the Mesolithic and Neolithic periods. The subsequent covering of older occupational remains was explained by reoccurring landslides originating from the nearby slopes and forming a palaeosoil due to increased humidity during the mid-Holocene (Marks 1991a: 44). Two main occupational 'events' are out-

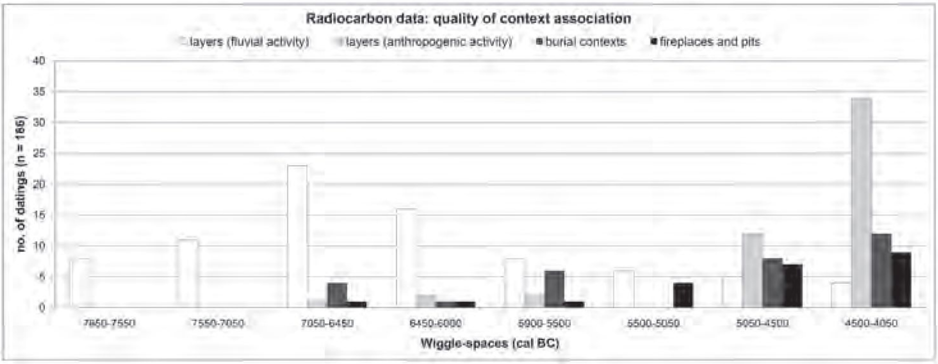


Fig. 5. Correlation between context types and radiocarbon dates for the Middle Nile valley and adjacent regions illustrating different qualities and problems of precise association

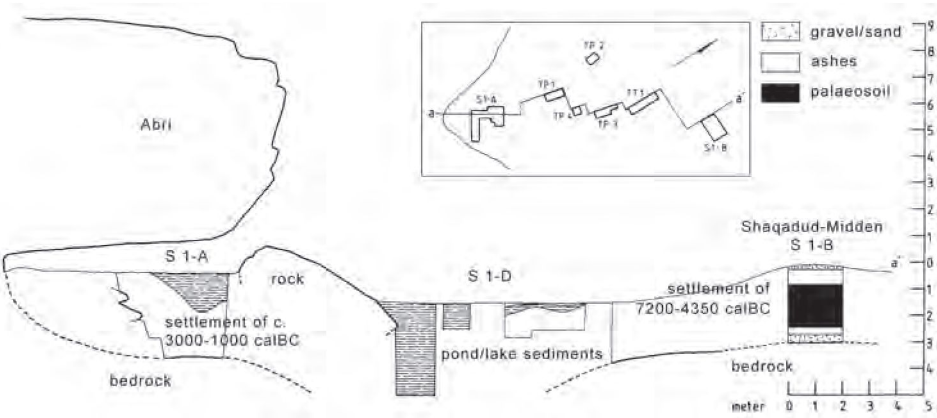


Fig. 6. Shaqadud. Schematic section through the valley and the sites S 1-A (Midden), S 1-C and S 1-D (after Marks 1991a: fig. 4-11, 4-20)

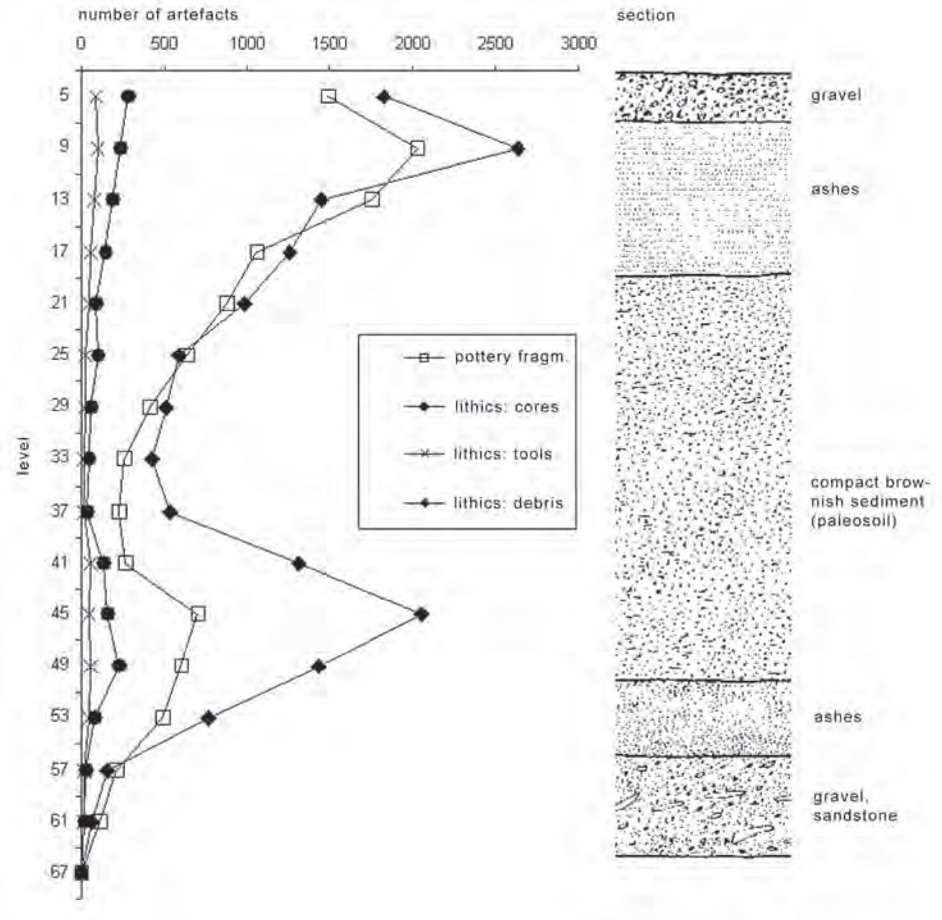


Fig. 7. Shaqadud-Midden. Vertical frequencies of pottery fragments and lithics artefacts such as cores, tools and debris (absolute counts after Mohammed-Ali 1991 and Marks 1991b; section after Marks 1991a: fig. 4-11)

lined by two peaks of high artefact frequencies corresponding more or less with two *in situ* ash layers (Fig. 7). Although these two different 'events' of intensified deposition could be roughly equated with the Mesolithic and the Neolithic occupation of the site, they constitute two palimpsests that can actually be dissolved into at least six 'events' of deposition (Fig. 8).

The conventional analysis of the ceramic material using percentages for horizontal layers did not show marked breaks over the whole sequence but one rather 'continuous' phase with seemingly gradual and slight changes (Caneva and Marks 1990; Mohammed-Ali 1991). Caneva and Marks (1990: 21) concluded that "a number

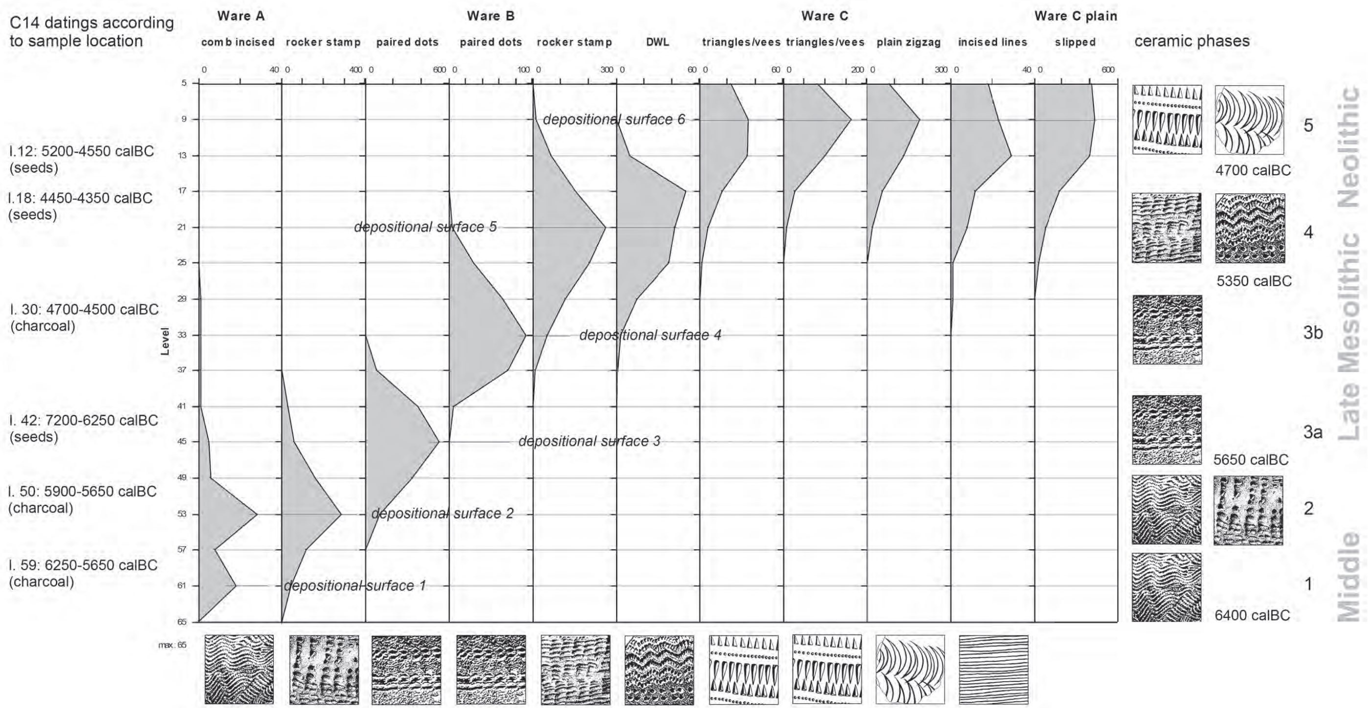


Fig. 8. Shaqadud-Midden. Stratigraphic frequencies of pottery decoration types according to ware groups and resulting Holocene ceramic sequence for the Khartoum-Butana region (absolute counts after Mohammed-Ali 1991)

of quite distinct modal ceramic assemblages can be recognized, forming ‚phases'. These however have no sharp beginnings and ends, since each develops directly out of the preceding and into the following one". However, there was no discussion of how such 'sharp beginnings' and 'ends' should look like in a soil formation subjected to geological rather than cultural processes. Accordingly, the Neolithisation of the region was seen as a gradual and slow shift from one subsistence form to the other, under the questionable premise that this supposed inert decision-making process had been captured proportionally by the rate of sedimentation.

By using the interpretation of Gaussian probability calculations, several different ceramic depositional phases are clearly outlined by different curves (Fig. 8). As mentioned above, there is no indication to interpret the partial overlapping of individual curves in terms of a continuous occupation. This overlapping is the result of soil formation and not of the supposed contemporaneity of different pottery decoration concepts. Therefore, the differently marked depositional surfaces/pottery decoration phases of Shaqadud can be seen as discrete chronological phases interrupted by distinctive discontinuities. The stratigraphy tells nothing about the exact nature of those discontinuities but it is known from comparable sites that domesticates and other Neolithic elements were common during phase 5, while the faunal remains entirely belonged to wild species during phase 4.

There is a clear chronological sequence of 'incised wavy-line', 'banded' (paired dots), 'dotted wavy-line' and Neolithic decorations. Since the 'incised wavy-line' distribution has got two different vertical peaks (Fig. 8: depositional surfaces 1 and 2), it seems probable that different sub-types have been lumped together under this concept by Mohammed-Ali (1991) and that there is indeed an older phase without a parallel occurrence of rocker stamp decoration. This is also indicated by the more precise definition of Caneva and Marks (1990: tab. 2) according to which the more recent type 'incised arches' which can be combined with rocker stamp (*cf.* Caneva 1983b) occurred from level 58 upwards but not earlier. On the other hand, it was only Mohammed-Ali (1991) who studied the ware groups for different decorations which in retrospect assured an even more plausible sequencing. In fact, the more independent technologies are statistically combined the more depositional events could be made visible. Interestingly, phases 3a and 3b (Fig. 8: depositional surfaces 3 and 4) would not have been separable on the basis of similar decorations before. But given the presence of different ware groups and significant stratigraphic frequencies, this horizon of banded decorations emerges clearly as a pronounced phase. In former studies being focussed on the supposed succession of wavy-line decoration types only, this horizon has been fully neglected and even suspended from analysis (*cf.* Jesse 2003: fig. 46). However, the occurrence of banded decorations such as paired dots (using a double pronged tool) or rocker stamp bands enclosing undecorated zones is part of a widespread horizon of the 6th millennium BC, and its stratigraphical bracketing in Shaqadud (Fig. 8) constitutes a major reference for its overall chronological position. It is the location of Shaqadud in a small valley in the Butana which led to these extraordinary conditions of preservation due to moist conditions, especially when compared to the inner Nile valley where high floods of the 6th millennium BC have transformed the remains of the banded horizon into disordered and marginal stratigraphic contexts (cf. below, Khartoum-Hospital).

Despite the presence of seven radiocarbon dates, however, the chronology of the individual phases could not be developed on the basis of their partly reversed stratigraphic order (Fig. 8). Fostered by the small size of the sample materials they had been subjected to considerable vertical movements. The dates give the range for a time average (7200-4350 calBC) in which their exact association is not known (Dittrich 2011: cat. 47). However, none of them should be excluded as suggested by the excavators (Marks 1991a) because such an exclusion unless done by the laboratory often follows subjective rather than methodological considerations. This problem was solved by using comparable dates from rather single-phase find complexes documented elsewhere in the Khartoum-Butana region (Dittrich 2011: 133f.). The dates whose samples originate from levels 12, 18 and 30 pertain mainly to the Neolithic occupation after 5000 calBC, while two other dates indicate Mesolithic date ranges around 6000–5650 calBC (level 50, 59) and before 6250 calBC. The oldest date range of 7200-6250 calBC (level 42) is confirmed by a further date of Shaqadud S 21 (6350-6250 calBC; *cf.* Dittrich 2011, cat. 46) and recent datings from Mesolithic sites in the vicinity of the White Nile (sites 16-D-4 and 16-D-5; cf. Salvatori *et al.* 2011, tab. 1, 2)[5]. Depositional surface 1 of Shaqadud-Midden might be equated with a date around 6500 calBC whereas the rocker stamping technique (Fig. 8: depositional surface 2) seems to appear only towards 6200/6000 calBC. For the dating of the depositional surface 5 the site Kabbashi A produced a comparable pure 'dotted wavy-line' inventory and a date of 5350-5000 calBC (Caneva *et al.* 1993; Dittrich 2011: cat. 24). As a most important result, phases 3a and 3b (Fig. 8) are bracketed between radiocarbon dates of 5650 and 5300 calBC placing the banded horizon chronologically in the mid of the 6th millennium BC. It is argued here that this dating is of supraregional relevance.

[5] As these dates fall in the large wiggle of 7050-6650/6450 calBC (*cf.* fig. 4), an actual date around 6700/6500 calBC seems most probable.

Despite the encouraging results for the frequencies of pottery decorations, the low statistical frequency of lithic tools, however, seemed to prevent the outline of an adequate distributional pattern of types and phases (Dittrich 2011: fig. 5.13). It was merely by the visualisation of the frequency of different core types as defined by Marks (1991b) such as single platform, unfaceted (SPUF), single platform, faceted (SPF), cortex platform (SPC), as well as discoid, flat (DF) that a stratigraphical pattern could be proven. While cores of type SPUF and SPF which are used to obtain blades and flakes were especially frequent in the range between levels 49–52, the other two types SPC and DF dominated in the range between levels 9–12. Cortex platform cores (SPC) which have no prepared platform at all are typical indicators that the so-called slicing technology has been used. The slicing technology remains one of the most distinctive Neolithic techniques in the Middle Nile valley (Kobusiewicz 1996; Dittrich 2011: 109f., fig. 4.40). According to the statistics as given by Marks (1991b, tab. 6-5), additionally five bipolar blade cores were found in the utmost levels 53 to 65. This stratigraphical pattern represents a clear shift from a blade(let) or blade-like flake oriented production requiring platform preparation to a much more careless knapping of thick segmented flakes. According to the sequenced pattern of changes in ceramic decoration and ware groups, this has probably not been a slow and gradual shift but the consequence of rather abrupt losses of older traditions.

Stratigraphic case study 2: Khartoum-Hospital and Al Qoz

Unlike Shaqadud, the early Holocene sites in the Nile valley have not been subjected to more or less continuous sedimentation, but to significant alteration between accumulation and subsequent deflation of topsoils. Additionally, sites have been frequently reoccupied or reused as is the case with Khartoum-Hospital from where burials of different periods such as early Holocene, late Prehistory to late Antiquity were reported (Arkell 1949). The 'early Holocene site' of Khartoum-Hospital was situated at the bank of the Blue Nile consisting of fluvial silts and sands above the sands and silts of the so-called late Pleistocene/early Holocene Gezira formation (Fig. 9: lower layers). As occupational debris had been discarded downward the slope according to Arkell (1947), he assumed a much higher level for the original settlement, well above the assumed high flood level (Arkell 1947: 173). However, desiccation cracks and calcification crusts which have been observed all over the excavated area including the early Holocene skeletal remains, hint to several events of flooding followed by rapid dry spells during the mid-Holocene.

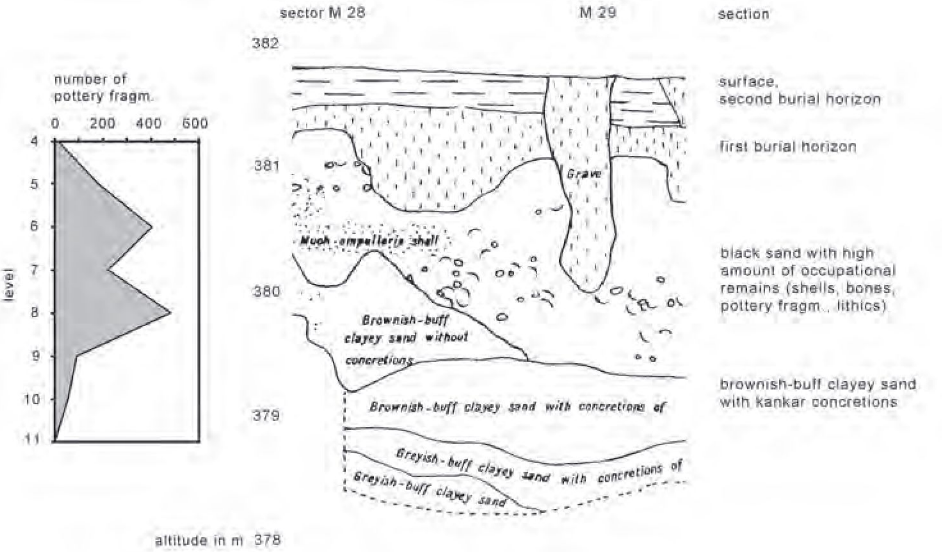


Fig. 9. Khartoum-Hospital. Vertical frequencies of pottery fragments according to the stratigraphical section in sector M28 (absolute counts and section after Arkell 1949: 96f.)

Arkell concluded that several factors of distortion had prevailed to such an extent that a chronological interpretation of his stratigraphical observations would not be possible: "It was always grey sand of varying firmness, with varying distributions of sherds, stone and shell fragments, etc., completely unstratified" (Arkell 1949: 4). Despite expressing such doubts, Arkell was trying to fix his former impression gained during excavation that at the 'discarding area' some of the debris "was undoubtedly *in situ*, as thrown on the river bank" (Arkell 1947, 172). He not only introduced the term 'Early ware' in opposition to supposedly later ceramic ware groups but also published absolute counts of potsherds according to their ware groups and stratigraphical positions. These tables have often been cited as evidence for the 'contemporaneity' of most of the ware groups as – although in varying frequencies – they mostly occurred together in the same layers (cf. Mohammed-Ali and Khabir 2003).

In the present study, the absolute counts given by Arkell (1949: 96f.) are used for re-analysis aiming at the stratigraphical separation of different ware group/decoration combinations for Arkell's sectors M26 to M30 (Dittrich 2011: 136ff.). It is of specific interest that the total amount of pottery fragments shows two different stratigraphic peaks indicating at least two different phases of deposition (Fig. 9). While using Arkell's pottery classification it was not possible, however,

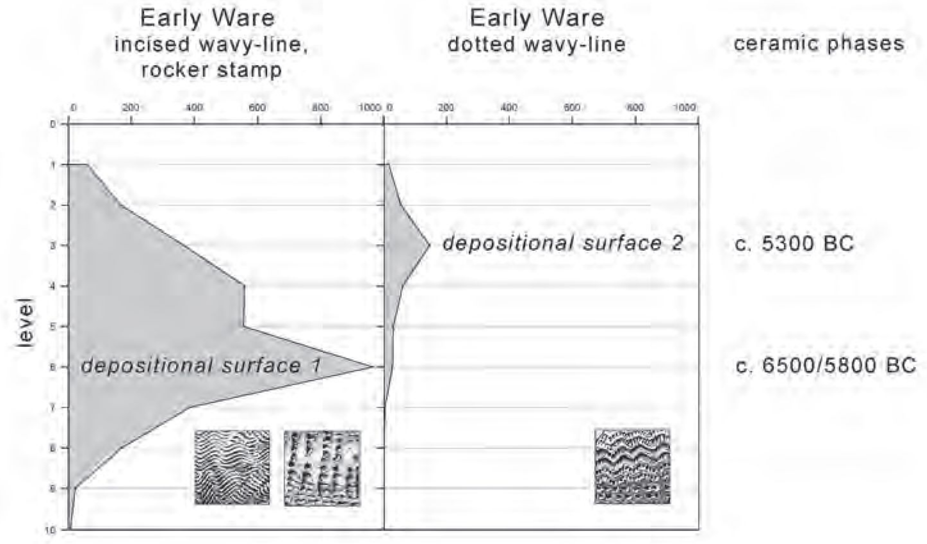


Fig. 10. Khartoum-Hospital. Cumulated vertical frequencies of pottery decoration types ‘incised wavy-line/rocker stamp’ and ‘dotted wavy-line’ for sectors M26 to M30 (levels corrected for slope, absolute counts of fragments after Arkell 1949: 96f.)

to reach a finer resolution of more than these two depositional surfaces (Dittrich 2011: fig. 5.17-18). Many inconsistencies visible in the resulting plots can be attributed to Arkell’s imprecise classification scheme lumping ‘incised wavy-line’, ‘rocker stamp’, ‘dotted wavy-line’ and other decorations such as finger nail impressions together in just one group named ‘Early ware’ as well as to omnipresent disturbances by the later digging of grave pits. However, as the vertical stratigraphic frequency method as outlined above takes into account the translocation and reworking of a certain amount of material (up to roughly 31.8 percent), the two main vertical peaks have to be considered as a significant pattern. These peaks are even more pronounced when the decoration types ‘Early ware: incised wavy-line/rocker stamp’ and ‘Early ware: dotted wavy-line’ are plotted (Fig. 10). In sector M26 the first corresponds to a depth of 120 to 140 cm (depositional surface 1) while the second occurs primarily at a lower depth of 60 to 80 cm (depositional surface 2). The interim space of roughly 40 to 60 cm of silt deposition due to repeated inundations is marking the discontinuity between the two main phases (Fig. 11). Assuming a sedimentation rate of 0.5 mm per annum (Marcolongo and Palmieri 1988, 45), a period of 800 to 1200 years would separate both of

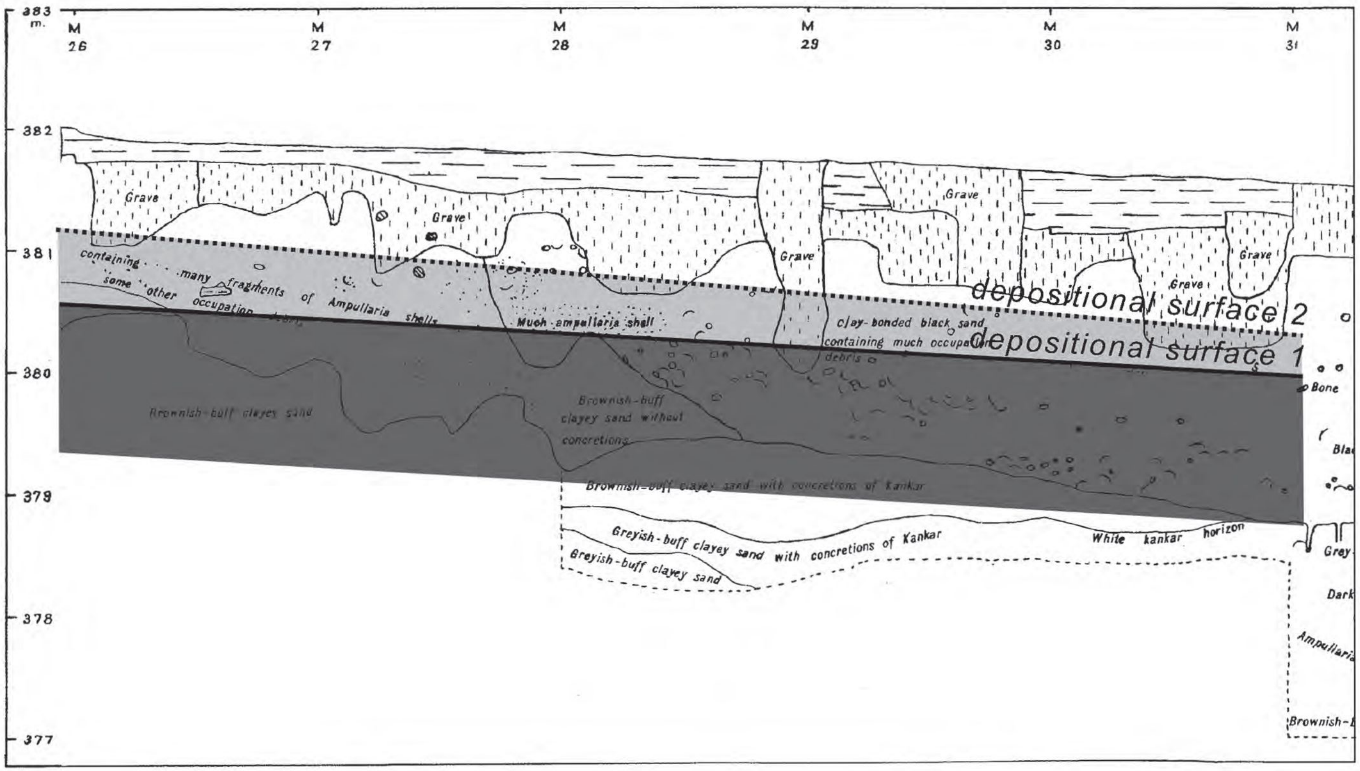


Fig. 11. Khartoum-Hospital. Projection of the highest frequencies of pottery decoration types 'incised wavy-line/rocker stamp' (depositional surface 1, continuous line) and 'dotted wavy-line' (depositional surface 2, dotted line) onto the section indicating at least two separate phases of deposition (section after Arkell 1949, 96f.)

the former depositional surfaces. As the 'dotted wavy-line' horizon (depositional surface 2) has been chronologically fixed to 5300-5000 calBC by the dating of Kabbashi A (Caneva et al. 1993), this would roughly indicate a time-span of 6550-5800 calBC for the older depositional surface 1 (Fig. 10, 11).

Due to low frequencies the exact position of Arkell's 'brown ware' with banded decorations and his 'imitation basketwork ware' decorated with both rocker stamp arranged to bands as well as 'dotted wavy-line' type B is not clear but has most probably to be located between the two main peaks. However, the more recent depositional peak of 'dotted wavy-line patterns' is further matched by a frequency peak of 'crude black fracture ware' (Dittrich 2011: fig. 5.17 and 5.18), a chaff-tempered ware to be associated with 'dotted wavy-line' type C and cord-impressed or cord-roulette patterns. In such an admixed stratigraphy like Khartoum-Hospital it is the single object that forms the smallest systemic context in the sense of an archaeological context indicating contemporaneity. Arkell was aware of this fact while stating that "no single sherd was found with both the [Incised] Wavy Line and this imitation basketwork decoration on it. It would appear therefore that these decorations were not used at the same time" (Arkell 1949: 88).

As a conclusion it can be stated that the stratigraphy of Khartoum-Hospital bore a similar chronological sequence as Shaqadud-Midden but was much more compressed due to heavy deflation and truncation of silts during the course of the 6th millennium BC. The differing history of geological site formation can therefore not act as evidence for a differing cultural sequence.

Also the site of Al Qoz showed traces of disturbance due to the construction of postmeroitic tumuli and later road construction work (Arkell 1953: 97). As a surprise the silts and sands must have contained the sought-after Mesolithic-Neolithic sequence which had become clear from the presence of at least two respective ceramic traditions. Despite the great expectations, such a sequence could not be developed from the mixed occurrences of the types throughout the section. Arkell again tried to describe his impression in stating that „the maximum of the Gouge Culture sherds occurs above the maximum of the Wavy Line sherds, with the maximum of Dotted Wavy Line sherds between them" (Arkell 1953: 101). Using again the Gaussian probability statistics, this impression is only partly right regarding the clear sequential spacing between the highest frequencies of the Mesolithic 'Wavy-Line' and the Neolithic 'Gouge Culture' (Fig. 12). However, the 'dotted wavy-line' peak occurs at the same level as the Neolithic decorations' peak indicating that at the find spot no substantial soil formation took place between the Late Mesolithic and the Neolithic period. Both depositional surfaces must

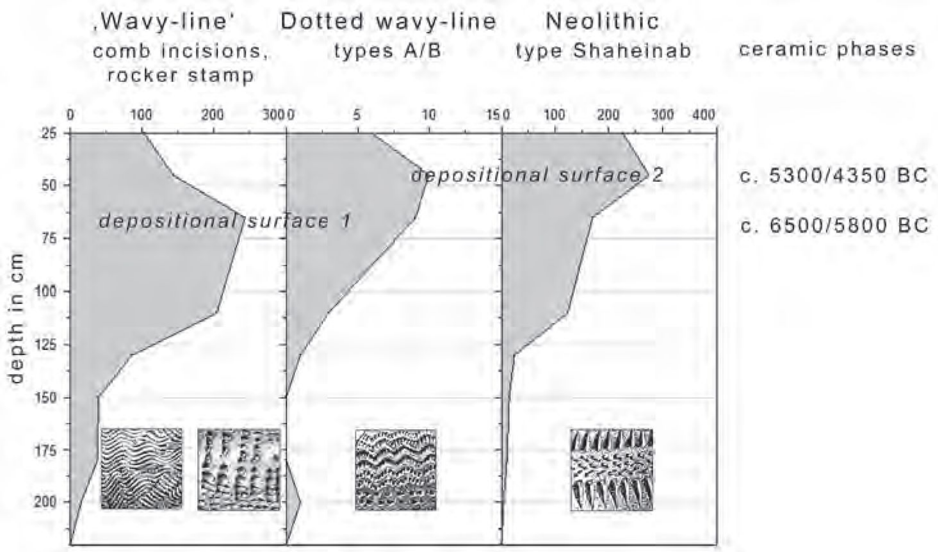


Fig. 12. Al Qoz. Vertical frequencies of pottery decoration types 'incised wavy-line/rocker stamp', 'dotted wavy-line' and Shaheinab Neolithic types for sector P40 (absolute counts after Arkell 1953, 98; level 85 omitted)

have collapsed back to the same level. Nevertheless, the stratigraphy of Al Qoz confirms the considerable distance between 'incised wavy-line' and 'dotted wavy-line' patterns as it has been also demonstrated for Umm Marrahi, Shaqadud-Midden, and Khartoum-Hospital before (see above, fig. 3, 8, 10).

Stratigraphic case study 3: Saggai-1

As a third example, the stratigraphy of Saggai-1 is discussed here because it exposes one of the major problems Holocene archaeology in the Nile valley has to deal with. The sedimentological analysis confirmed the observation that the site was located partly within a gravel accumulation (Fig. 13) that had been formed by a wadi fan discharging into the main Nile (Palmieri 1983). Gravel reached large proportions of up to 35 percent (in a depth of 20 to 30 cm) and 75 percent (in a depth of 70 to 80 cm) in sector F 6 (16). Most of the pebble stones originated from the hinterlands and had been washed down by the wadi (Palmieri 1983).

The number of artefacts excavated from the site was unusually high, amounting to several thousand pottery fragments per 20 x 20 m sector (Caneva 1983b). While Mesolithic finds were covered by calcified crusts due to desiccation processes the so-called 'intrusions' (mainly unstudied Late Neolithic material) could be distinguished by their fresh appearance (Caneva 1983b). The latter made up large proportions of 20 to 30 percent. However, since the results of the sedimentological study (Palmieri 1983) and of the statistical analysis of artefacts (Caneva 1983b; Caneva and Zarattini 1983) have not been properly brought together, the stratigraphy was continued to be viewed archaeologically as a sequence of culture-historical significance (Caneva 1983a).

The vertical artefact frequency method has been applied here to illustrate the almost complete absence of stratigraphy (Fig. 14; *cf.* Dittrich 2011: 145ff.). One of the main arguments for this view is that the 'intrusions' of later date showed their highest frequency at the same level as any Mesolithic decoration type. Also the total amount of pottery fragments marked only one single peak (Fig. 13). Furthermore, unclassified pottery fragments, including rolled or worn pieces, amounted to more than 50 percent per layer indicating that the finds were not in their original position. As the upper layers contained a marked fluvial gravel accumulation, a contemporary occupational event seems not very probable. Rather, most of the finds seem to be relocated and deposited due to fluvial activity as were the pebbles for which a secondary deposit was already assumed by Palmieri (1983). Concerning the 'Mesolithic' lithics studied according to the sequence, there is no mention how they were distinguished from the Late Neolithic ones during analysis (Caneva and Zarattini 1983) which does not qualify them in sum as representative for the Mesolithic period.

It was only in a depth of 70 cm in sector F6 (16) that intact Mesolithic burials have been found and that an original surface could be located (Caneva 1983a). Although the four radiocarbon dates which give a range of 6400-6000 calBC might be linked to the burial phase, very few artefacts originated from these lower layers (Fig. 13). Therefore, it cannot be excluded that the dated *Pila* sp. shells, especially those from the upper layers, have been part of the secondary deposit. If the major events that led to the formation of the site are reconstructed, a picture emerges in which flooding, human occupation, and wadi activity form several discontinuous strands (Table 1). The time periods of artefact use and of artefact (re)deposition are diverging to a great extent. This reveals another problem of our present understanding of a site: It is no more appropriate to call Saggai-1 a Mesolithic site because at the same moment it is also a palaeo-environmental, a Late Neolithic, and a Meroitic site, and the Mesolithic components have been transformed and relocated differently in every subsequent period. It is crucial to understand such processes of formation and transformation before artefacts can be interpreted chronologically. The example of Saggai-1 shows that these processes are not only to be considered theoretically or discussed in a geological chapter but to be included in the finds' analysis and considered by methodological approaches.

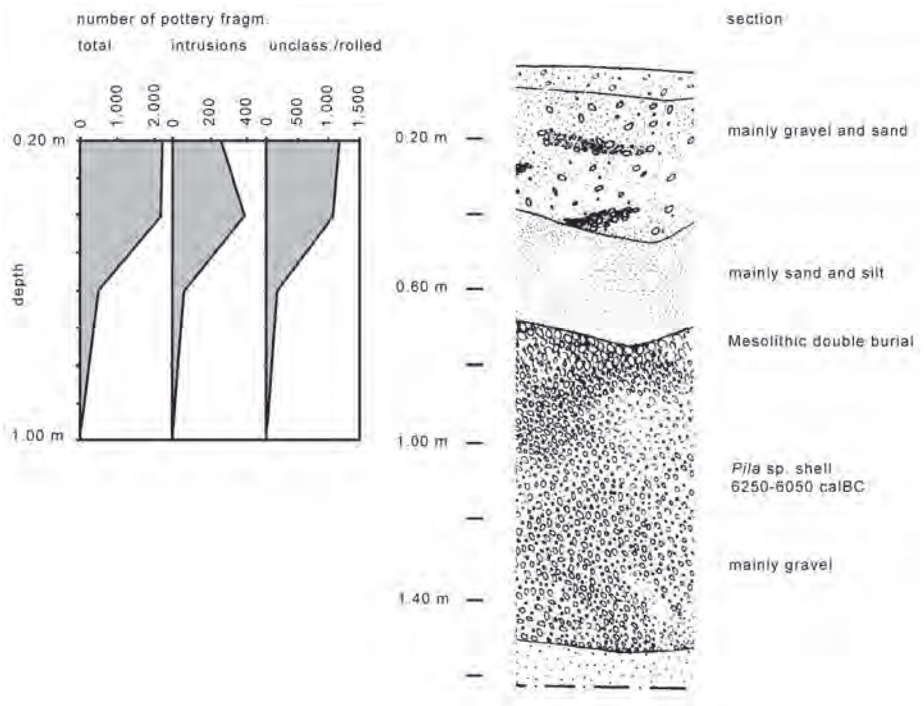


Fig. 13. Saggai 1. Vertical frequencies of pottery fragments according to the stratigraphical section in sector F6 (16) (absolute counts and section after Caneva 1983a, fig. 6; Caneva 1983b, tab. 1)

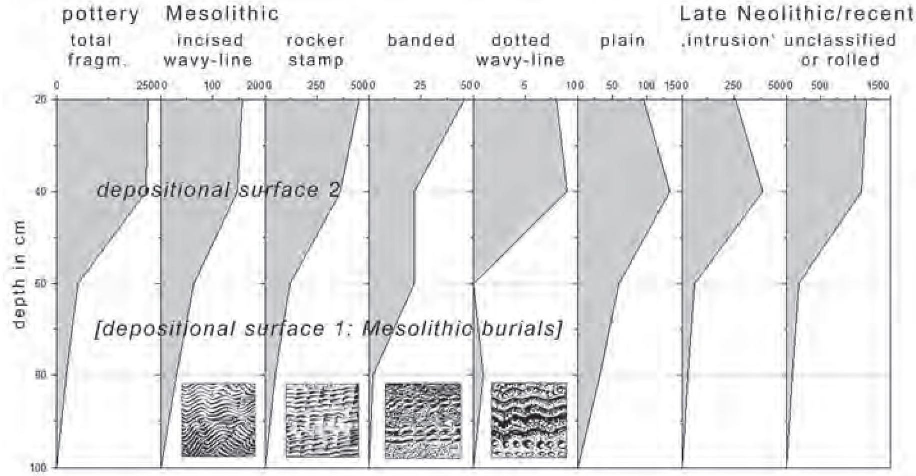


Fig. 14. Saggai 1. Vertical frequencies of pottery decoration types 'incised wavy-line', 'rocker stamp', 'banded' and 'dotted wavy-line' compared to that of 'intrusive' and 'unclassified/rolled' fragments indicating the absence of a sufficient stratigraphy (absolute counts after Caneva 1983b, tab. 1)

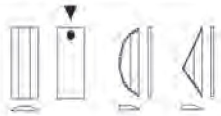
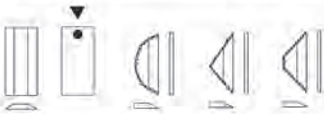
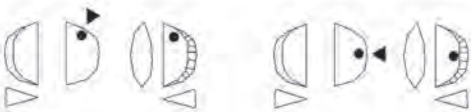
A similar phenomenon that was not fully addressed by the excavators before could be demonstrated for the sites of Sarurab-I (Mohammed-Ali 1982; Dittrich 2011: 144f.) as well as of Mahalab (Fernández et al. 2003; Dittrich 2011: 153ff.). In Sarurab-I all Holocene depositional phases had been later collapsed back to one level. This was mainly due to erosional processes or perhaps to the formation of a secondary deposit through a nearby wadi. The temporal relations of different pottery decoration types in terms of contemporaneity or sequencing could not be established by the documentary of this site. Furthermore for the adjacent site Sarurab-II no material has been published that would match the two charcoal dates of 8800-8450 calBC from the same site. In contrast to the opinion expressed by the excavators (Khabir 1987), most probably a natural cause for the embedding of charcoal has to be considered. This and a further shell date of 8300-7800 calBC originating from the stratigraphy of Umm Marrahi (Elamin and Mohammed-Ali 2004) should not be quoted anymore in connection to the 'Early Khartoum' complex. It would be of interest indeed if these dates could be once connected to a previously overlooked Epipalaeolithic tradition.

The site of Mahalab producing three radiocarbon dates between 6700-5750 calBC was situated at the fringe of a Wadi. Therefore, the sediments contained large amounts of sand and gravel reaching together nearly 85 percent (Lario *et al.* 1997; Fernández *et al.* 2003: 208). As had to be assumed for Saggai-1, especially the large amounts of gravel indicate that every artefact and ecofact of the same size and weight as the gravel particles could have been brought to the site and deposited there the same way as the gravel. According to Surovell *et al.* (2005), artefact analysis should include artefact size, weight, orientation, matched refittings, and degrees of abrasion to be plotted with increasing or decreasing values against the level of the former depositional surface. For the above mentioned sites, the quotation of just the radiocarbon dates would completely ignore the absence of former surfaces and the doubtful presence of secondary artefact deposits.

Redefining typochronology: from lunates to segments

As a counterpoint to the radiocarbon dating method, again more use might be made of the typological method. Mixed inventories deriving from palimpsests should be temporally accessible solely on the basis of significant techniques used for manufacturing stone tools and/or decorating pottery (*chaîne opératoire*). For establishing chronological horizons for the Middle Nile valley it seems not appropriate to separate the two main material sources, pottery and lithics, from each other for analysis. Though the technologies of both might not

Table 1. Saggai 1. Typochronological scheme for the production of lunate-shaped insertion tools (after Dittrich 2011: fig. 4.32)

group	blank product and tool shaping techniques	tool typology	related tools
1	 blade/bladelet, breaking/notching techniques, back retouch	thin-necked elongated backed points (also bipointed bladelets, arch-backed points)	truncations, backed points, scalene triangles
2	 bladelet, breaking/notching techniques, back retouch	thin-necked lunates (variant: reshaped lunate with burin blow)	truncations, isosceles triangles and trapezes
3	 flake with thick (cortex) back, struck from single platform core, back retouch (variant: partly backed)	thick-necked lunate (variants: s-shaped lunate, partly backed lunate)	
4	 segmented flake with cortex back, struck from cortex platform core (variants: side-blow segmented flake, macrolithic segment), back retouch	thick-necked segment (also crescent flake, 'orange wedge')	borers made from segmented flakes, large backed knives (Neolithic), side-blow flakes

seem to be related in any respect, it is only the combination of several chronologically significant types that ascertain the temporal status of archaeological contexts under discussion here.

While the study of ceramics receives much of the attention attributed to the study area of the Middle Nile valley, the exact temporal relation to certain types of lithic tools or production modes remains often unknown. There are some studies where the corresponding lithics are not even considered for chronological discussion (Honegger 2003; 2005; Gatto 2006a; 2006b; Garcea and Hildebrand 2009) adding to the paradox that some of the supposed early Holocene 'ceramic cultures' have to get by without the presence of an early Holocene lithic production scheme. However, while such schemes had been thoroughly studied for Nubia before (Schild *et al.* 1968; Shiner 1968a; 1968b; 1968c; Marks 1970; Nordström 1972), their application has later been questioned. Namely Haaland criticised that the members of the Combined Prehistory Expedition had tried to "reconstruct culture history in terms of migration, diffusion or invention" on the basis of lithic analysis (Haaland 1977: 1). On the contrary, she came to the conclusion that geographical patterns of the spread of lithic tools have not so much to do with the (ethnic) identity of people who used them. The differences "in occurrence …should rather be sought in differences in the activities carried out by the people…" (Haaland 1977: 15). Therefore, the idea has to be abandoned that single tools or tools' percentages could act as chrono-cultural evidence. This is of even more true when it is considered that the composition of lithic inventories is subjected to the geological reality as outlined above. Concurrently, the large amount of debris should begin to form a class of artefacts worth of study because it consists of numerous traits for different practices of stone knapping and use. In this respect, the shape of tools is still significant if the shaping is investigated as a specific mode of production and if tool shapes had also emblematic meanings among the prehistoric communities. As with pottery decorations it is rather their actual making (*chaîne opératoire*) that is bound to specific chrono-cultural traditions.

For prehistoric research done in the Middle Nile valley it is striking that the large group of insertion tools has received so little attention as to their precise definition.[6] A great corpus of labels pertaining to the lunular shape such as microliths, lunates, arch-backed pieces/bladelets, bi-pointed backed bladelets, backed points, segments, crescents, 'orange wedges' exists throughout the literature without mentioning that these tools could have been made by using quite different technologies. As a general chronological scheme it is suggested here that Early and Middle Mesolithic lunates or microlithic backed points have been obtained mainly from bladelets or blade-like flakes committed to a blade-oriented tradition (Table 2: groups 1 and 2). Around 6500 calBC a succession from elongated backed points/scalene triangles to lunates/isosceles triangles could be postulated although the triangle tradition is not very pronounced in the Khartoum area due to the use of quartz (*cf.* Dittrich 2011: 167f.). On the opposite, Neolithic segments or crescents were struck as flakes or even as segmented flakes while using the slicing technology (Table 2: group 4; *cf.* Kobusiewicz 1996). Their necks are thick and their cutting edges are often not straight as they would be if the blank had been a blade(let). Between these two main

6 In contrast to the discussion of their probable function (*cf.* Honegger 2008).

Table 2. Typochronological scheme for sub-types of the 'dotted wavy-line' horizon (after Dittrich 2011: fig. 4.15-22)

type	technique	composition	tool shape and use	regions	fabric	associated lithic industry	dating [BC]
A	comb-like tool, single fan-like impressions with regular change of rotation point			Khartoum-Butana region, Gezira, Dongola Reach, Wadi Howar	temper: anorganic, shell, organic (rare)	macrolithic flaking industry (quartz, chert, rhyolite), broad lunates/ segments	5300–5000
B	comb-like tool, parallel single impressions arranged to waved bands			Khartoum-Butana region, Gezira, Dongola reach, Wadi Howar	temper: anorganic, shell, organic (rare)	macrolithic flaking industry (quartz, chert, rhyolite), broad lunates/ segments	5300–5000
C	comb-like tool/roulette, single fan-like impressions or rolling along guiding line, interlacing motifs by fast change of tool position			Wadi Howar, Khartoum-Butana region, Gezira, Dongola reach	organic temper	mainly flaking industry	5100–4700 ?
D1	three-toothed tool or comb, rocker stamp arranged to waved bands (also incised variants)			Lower and Upper Nubia	anorganic temper, mica (rare)	flaking industry ?	5300–5000 ?
D2	three-toothed tool, single impressions (also incised variants), archs or interlacing motifs by fast change of tool position			Lower and Upper Nubia	anorganic temper, mica (rare)	flaking industry ?	5300–5000 ?
E	double-pronged tool, rotating fan-like impressions, simple impressions or incisions			Khartoum-Butana region, Wadi Howar	fine anorganic and organic temper, surfaces burnished	Neolithic flaking industry (quartz, chert, rhyolite), adzes, gouges	4700–4000
F	comb-like tool, single impressions using a guidance grid (return technique)			Khartoum-Butana-Region (Sahara)	fine anorganic temper, surfaces burnished	Neolithic flaking industry	4500–4000

technologies, there belongs a third one using cortex backed blade-like flakes as blanks (Table 2: group 3). This technology was especially frequent in the middle layers of Shaqadud-Midden (Marks 1991b) representing a Late Mesolithic tradition to be dated to the second half of the 6^{th} millennium BC together with the banded horizon as a popular pottery decoration concept. The chronological transitions between each of these different traditions stand for discontinuities affecting communities on a supra-regional scale. In that way, the transition to slicing technology is associated to the lasting adoption of other Neolithic elements such as macrolithic tool types and practices of surface modifications.

The 'dotted-wavy-line' horizon: types and transition

The 'dotted wavy-line' (DWL) horizon is one of the most frequently discussed Holocene phenomena for Sub-Saharan Africa (Jesse 2003), while the proposed chronology ranges between 10,000 and 2000 bp (Jesse 2003; 2010). To break up the monolithic appearance of this phenomenon six technological variants, namely types DWL-A to F, have been defined for the study area of the Middle Nile valley and Nubia (Table 3; Dittrich 2011: 94-99). Each type shows close affinities to other contemporary decoration techniques such as rocker stamp banded decorations (types DWL-A, DWL-B), the Laqiya decoration as discussed in Jesse (2003: 154f.) (type DWL-C), banded decorations without the use of rocker stamp such as incised bands or archs (type DWL-D), Neolithic line application techniques as summarised by Dittrich (2011, 100) (type DWL-E), and the Neolithic return technique as described by Caneva (1987) (DWL-F). The application of types DWL-A and B, and especially of type DWL-C appears sometimes very similar to that of cord (roulette) impressions or cord roulette rolling (*cf.* Arkell 1949: pl. 75, 76, 78). In these cases, the significant decoration is often related to a black fracture fabric that contains organic temper such as chaffed grass.[7] It would seem interesting to study the supraregional appearance of such wares in more detail, as the chaff could be an indirect hint to the presence of dung of domesticated animals.

Most importantly, since the six varieties of DWL decorations transcend the Mesolithic-Neolithic dichotomy they could be used to assure the typochronological precision of the transitional process. They further form a suitable base for the study of mid-Holocene social networks and their mediating role in the process of Neolithisation, although it must be stressed that they sometimes occur in low frequencies or are even absent in favour of other less significant decorations. The types DWL-A and B are chronologically fixed by two dates of Kabbashi A to 5350-5000 calBC (Caneva *et al.* 1993; Dittrich 2011: cat. 34). Type DWL-F occurs in the top Neolithic layers of the Shaqdud-Midden sequence (Mohammed-Ali 1991: fig. 5-3a) whose depositional surface 6 is to be dated to c. 4700-4000 calBC. Type DWL-C is most probably to be connected with the oldest date of Conical

[7] Cf. also Arkell's 'imitation basketwork ware' and 'crude black fracture ware' (Arkell 1949), Clark's 'Naima ware' (Clark 1989), the organic temper wares of Multaga-3 (Gatto 2006b) or of the Early Khartoum Related Group/Karmakol industry of the Dongola reach (Marks et al. 1968; Shiner 1971; Usai 1998).

Table 3. Scheme of successive events or processes that produced discontinuity between sedimentation and the age of (re)deposited artefacts (after Dittrich 2011: fig. 2.7, tab. 5.15; sedimentological data after Palmieri 1983)

stratigraphy depth in m/ sedimentology	primary formation processes	temporality	impact by human occupation	deposition of artefacts/ecofacts	finds/structures and date of deposition
0–0,40	deflation 		phase 3: occupation on top of formation after closing	vertical translocation within older sediments, redeposition through digging	tumuli [c. 500 BC–500 AD]
0–0,40 gravel 35 % sand 45 % silt/clay 20 %	gravel deposition through wadi activity 	short-term events	–	secondary deposits	Mesolithic, Late Mesolithic and Late Neolithic finds (mixed) [after 3000 BC]
0,40–0,60	truncation by erosion 	periodical events	phase 2: occupation on top of formation and in interim stages after desiccation	translocation through desiccation cracks	[c. 5300–3000 BC]
0,40–0,60 gravel 17 % sand 41 % silt/clay 42 %	silt deposition by inundantion and in ephemeral lakes 	periodical events		mainly non-destructive covering	[c. 6000–4000 BC]
0,70–0,80			phase 1: occupation on top of formation after closing	vertical translocation within older sediments	Mesolithic finds and burials 6400–6000 calBC
0,70–0,80 gravel 75 % sand 13 % silt/clay 12 %	gravel deposition by Nile palaeochannel or wadi 	long-term and short-term events	–	secondary deposits	fossilised shells Late Pleistocene

Hill starting from 4850/4700 calBC (Keding 2000; Jesse 2003; cf. Dittrich 2011: cat. 12), and type DWL-D could be chronologically indexed by dates ranging from 5400-5200 calBC for the Egyptian site E-79-4 in the Bir Kiseiba area (Kobusiewicz 1984) to 5050-4850 calBC for the site 8-B-10C at Sai Island (Garcea and Hildebrand 2009). Jesse (2003: fig. 39.3) provided a good example where elements of DWL-D and DWL-B as well as a rim decoration executed by simple strokes were combined on the same vessel originating from Rahib Wells 80/73 in the Wadi Howar, proving a further chronological relationship for the two DWL types. However, even for a study area extended into large parts of Northern Africa no typological traits for the DWL decoration concept predating 5400/5300 calBC can be confirmed given the fact that the data base available through publications is overwhelmingly formed of only loosely associated finds and dates (Jesse 2010; *cf.* critical discussion in Dittrich 2011: 192-209).

The chronology of Neolithisation in the Khartoum-Butana region

As shown above, for the Khartoum-Butana region the chronology can be mainly established by means of the stratigraphy of Shaqadud-Midden while the early periods of the 7th millennium BC are meanwhile thoroughly studied and dated in the White Nile region (Salvatori *et al.* 2011). The growing frequency of radiocarbon dates from 7050/6650 calBC onwards marks the onset of a distinctive Early Mesolithic occupation phase (7050–6250 calBC) succeeded by the Middle Mesolithic (6250–5650 calBC) and the Late Mesolithic (5650–5050 calBC) phases (Fig. 15). The division of Early Neolithic (5050–4800 calBC) and Middle Neolithic (4800–4000 calBC) has been modified here from Hassan (1986).[8]

Still a preceding Mesolithic phase without pottery production has to be taken into consideration. The sequence of chronologically significant decoration concepts consists of 'incised wavy-line' executed by area-wide and often irregular comb incisions, the appearance of which is not necessarily to be regarded in the sense of a decoration (Fig. 15). Arch-shaped incisions occur as a more recent development, sometimes already combined with the irregular application of the rocker stamp technique which is to be attested from 6250/6000 calBC onwards. Between 5650 and 5350 calBC Mesolithic banded decorations using rocker stamp and simple impression technique were introduced. The characteristic 'dotted wavy-line' types A and B are to be dated around 5350–5000 calBC as the most recent Mesolithic ceramic tradition, beside the re-appearance of area-wide rocker stamp decorations. The latter also mark the transition to Neolithic decoration techniques that follow immediately afterwards and throughout their whole sequence always comprise a significant if not exclusive proportion of rocker stamp. The type DWL-C and the related Laqiya decoration are possibly to be placed at the beginning of the Neolithic period (Keding 2000), while the types DWL-E and DWL-F are certainly to be dated to the Middle Neolithic.

The stone tool production techniques show a significant trend from blade technology which occasionally resembles rather a flaking technology in the Khartoum region due to the use of quartz as a raw material towards a pure flaking

[8] Though the actual transition might be more precisely placed at 4700/4600 calBC which is masked, however, by the long wiggle of 4800-4500 calBC (fig. 4).

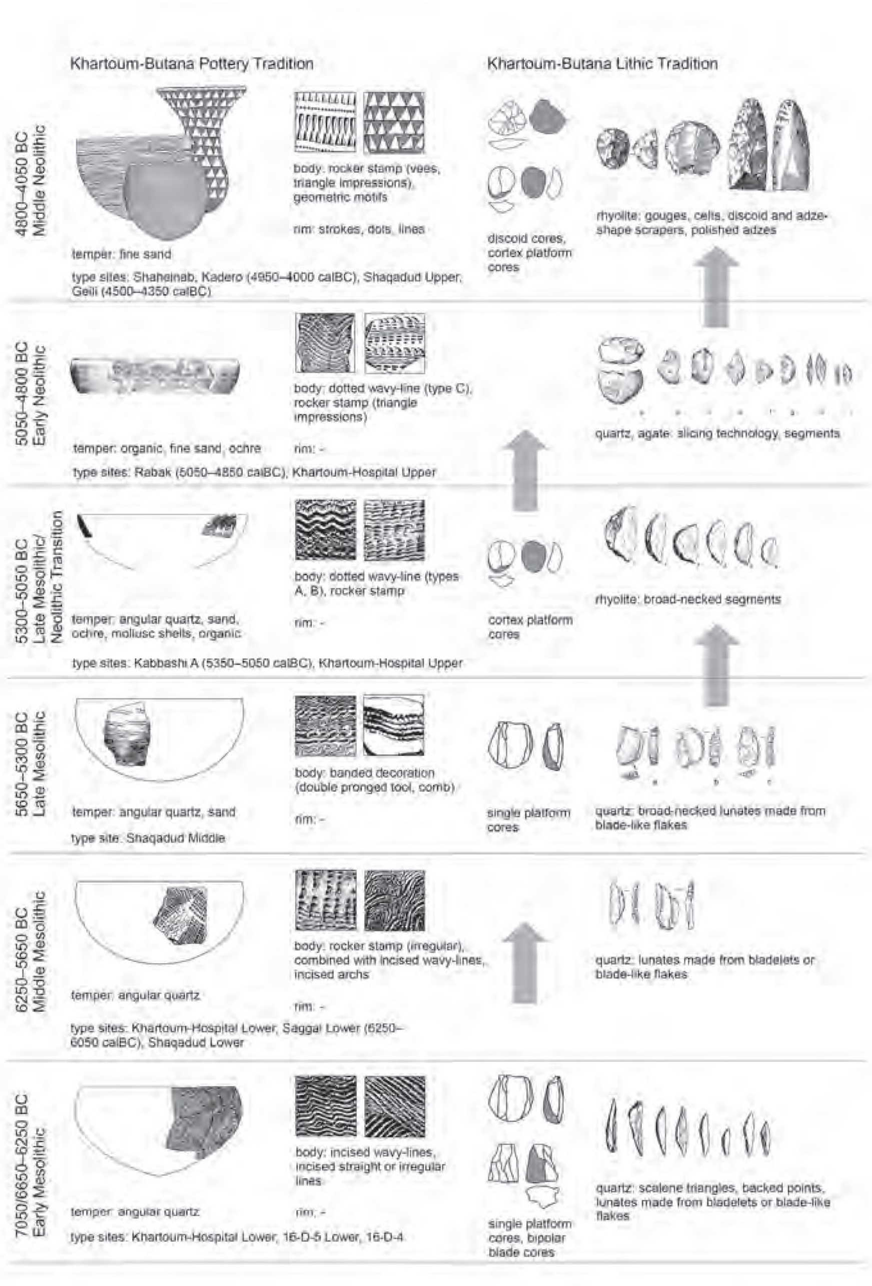


Fig. 15. Typochronological scheme for the Khartoum-Butana region between 7050 to 4050 calBC (arrows indicate continuation of the lithic technology to next period)

technology. The replacement of geometric microliths by thick-necked cutting inserts (segments) points to technological discontinuities starting around the mid of the 6th millennium BC and causing an irreversible modification of the stone tool inventory after 5000 calBC.

The chronology of neolithisation in Nubia

It is of interest here how the chronological scheme for Central Sudan can be correlated with that of Nubia. Although, in the North and in the South there existed at least two different Mesolithic traditions partly overlapping in the area of the Atbara junction, they share common elements as the arrangement of ornaments into banded decoration zones. As banded decorations of similar types appear widely in the literature[9] they could be subsumed as a temporal horizon. However, despite the conviction expressed in recent works (*cf.* Gatto 2006a; 2006b; Honegger 2003), it is not clear whether in Nubia a ceramic tradition existed parallel to the Mesolithic comb incision phase of Central Sudan (c. 7000-6000 calBC) as undoubtedly associated finds and dates are lacking. The Combined Prehistory Expedition had assigned most of the studied sites in Lower Nubia to a preceramic time-period, but missed to offer a concept for a probable 'ceramic' or Late Mesolithic and even for a ceramic Neolithic whose pottery finds were hardly mentioned (Wendorf 1968).

While acknowledging that even after more than 60 years following their publication, statistical data is still accessible due to the attention and the interest of the excavators, it has to be regretted that the methods used by Arkell (1949; 1953) and also by Myers (1958) have not found acceptance for work done in Nubia after 1960. The statistical discussion of stratified finds is virtually absent in the literature on Nubia and regions as far south as the Atbara junction, especially for sites that were claimed to be of chronological significance such as Dibeira West (Schild *et al.* 1968), Aneibis, Al Damer and Abu Darbein (Haaland and Magid 1995), Barga (Honegger 2005), or Wadi al Arab (Honegger and Jakob 2009). It is difficult to believe that each of these multi-period sites showed stratigraphical congruence as it was suggested by the excavators by superficially linking ecofacts used for radiometric dating, artefacts and other ecofacts (acting as evidence such as bones of domesticated cattle) without a methodological discussion.

The chronology of Lower Nubia has still to be partly established by the horizontal stratigraphy of Dibeira West (Fig. 16) although it must be much more clearly stated than in the original publication (Schild *et al.* 1968) that artefacts from the five distinguished sites DIW-1A and B, DIW-50, DIW-51, and DIW-53 had been

9 *Cf.* Rudin 1980: pl. 27.6-7, 31, 33; Haaland 1995: fig.2, 15b; Honegger 2003: fig. 6; Honegger and Jakob 2009: fig. 7; Dittrich *et al.* 2007: fig. 1.

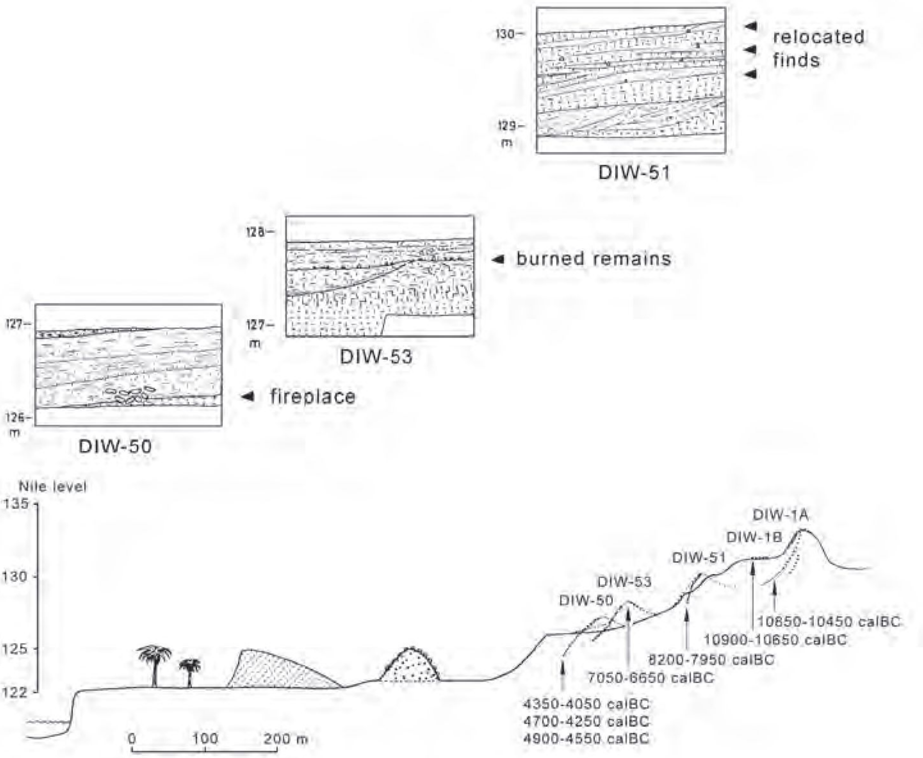


Fig. 16. Dibeira West. Relative levels of find concentrations embedded in silts and horizontal stratigraphy for the sites DIW-50, DIW-51, DIW-53 and DIW-1 (sections after de Heinzelin 1968, fig. 42-44; Schild *et al.* 1968, fig. 1-3)

mixed.[10] In fact, they tended to be eroded and washed down from the upper to the lower sites and furthermore incorporated into silt layers accumulating at a much later point in time. No stratigraphical statistics are available. It seems therefore to be the only appropriate method to view all these sites together as one palimpsest.[11] The ranges of the radiocarbon dates mark a Late Palaeolithic phase (11th millennium calBC), an Epipalaeolithic phase (8200-7950 calBC), a Mesolithic phase (7050-6650 calBC) and a Neolithic phase (4900-4050 calBC) which hint to repeated visits and manipulations of this spot (Dittrich 2011: cat. 16-18).

10 Also the possibility of geological dating according to silt accumulation stages (de Heinzelin 1968) has been overestimated and has caused much confusion especially regarding the heterogenic pattern of Holocene deposits (cf. Wendorf et al. 1979).

11 The concepts of Shamarkian and Post-Shamarkian Neolithic as defined by Schild et al. (1968) are highly questionable in their chronological relation when it is taken into consideration that the more recent site simply contained admixtures of older washed down artefacts (cf. Haaland 1977).

Mesolithic artefact types are mainly to be extracted from the inventories of DIW-51 and DIW-53, while Neolithic finds though being frequent and dated at DIW-50 were present at all of the mentioned sites (cf. discussion in Dittrich 2011: 165-168). Most interestingly, the characteristics of the Mesolithic facies (e.g. no associated pottery, great variety of microliths, use of blade and microburin technology) show great similarities to that of the Upper Capsian as it was acknowledged already by Schild *et al.* (1968), while the Neolithic facies contained typical macrolithic tools (e.g. adzes, scrapers) as well as imported tools made of Egyptian chert (including side-blow flakes, surface retouched tools). Both traditions can independently be confirmed by chronologies from outside the working area (for the Capsian cf. Rahmani 2003; 2004; for the Badarian *cf.* Holmes 1988; 1996). Therefore, they can be connected to date ranges of 7050-6650 calBC and 4900-4050 calBC, respectively, deriving from the sequence of Dibeira West itself.

However, the symptomatic lack of dates to the late 7th millennium and to the 6th millennium BC at the same site has caused some confusion that was responded by assigning other site inventories to differently defined concepts such as the Khartoum Variant (Neolithic) (Shiner 1968c; Nordström 1972), the Qadan (Shiner 1968a), or a 'miscellaneous' facies (Shiner 1968b). Marks (1970) avoided the attachment of such cultural terms but studied site inventories as if representing cultural units, too. Recently it has been attempted to additionally define early 'evolutionary' lines especially for the Khartoum Variant (Neolithic) that have been based on speculative radiocarbon date-artefact associations from the Egyptian Western desert (Usai 2005; Gatto 2006a). But it seems more appropriate to accept a Nubian Mesolithic on the basis of an Upper Capsian tradition for the Early Holocene and to split up all the former 'culture' definitions by their different chrono-typological components (see also critics of Haaland 1977). As it has been shown elsewhere, the Qadan is an epistemological conglomerate based on mixed finds from palimpsests that were commonly present at deflated Lower Nubian Nile terraces (Dittrich 2011: 168-172). It mostly consists of a Late Mesolithic production of blade-like flakes and segmented flakes transformed by backing retouch into broad necked lunates. This tradition finds its closest chronological parallels within the Shaqadud-Midden stratigraphy (middle and upper layers, see above). Other Qadan components comprise Middle Palaeolithic Levallois cores and flakes, as well as a high amount of 'pointes Levallois accidentelle' (as defined by Rahmani 2003: fig. 206) that have been mistaken as unretouched points by Shiner (1968a) but that normally would be excluded from tool analysis (see critics of Marks 1970: 412). It can be assumed in general that there has been a transition from blade to flake production with the sequence of geometric microliths/blade technology, lunates/ blade or blade-like flake technology to segments/slicing technology in Nubia (Fig. 17). There is a constant lack in present studies to link this typological change in lithic technology to the Nubian pottery tradition. However, both specific traits in ceramics and in lithics, are to be seen as chrono-cultural units.

The Nubian Mesolithic pottery tradition is presumably to be paralleled no earlier than with Late Mesolithic banded decorations of the Khartoum region (5650-5300 calBC; Fig. 17). Technologically it is less characterised by the application of the rocker stamp technique as known from other regions but more importantly by impressions of a double pronged tool arranged to two-rowed bands which should not be confused with the Neolithic 'alternately pivoting stamp' which is related to the return technique (*cf.* Caneva 1987). These Mesolithic two-rowed bands are typical decorations preceding any type of Nubian 'dotted wavy-line' (e.g. DWL-D). This becomes obvious from DWL inventories such as Sai Island 8-B-10C (Garcea and Hildebrand 2009) and Abka-428 (Nordström 1972) where two-rowed bands have mostly disappeared and from banded inventories where DWL decorations are still lacking such as Umm Klait 3-Q-73 (Dittrich *et al.* 2007). Other kinds of impressions were produced by combs with three or four teeth which could be arranged into bands, or into the 'dotted wavy-line' type D. As the latter can be combined by simple strokes incised below the rim, this tradition is to be seen as starting point for the rim decoration becoming especially frequent throughout the Neolithic period.

This Nubian Late Mesolithic pottery tradition is followed by the Nubian Neolithic tradition (Fig. 17) characterised not only by various rim decorations such as dotted or herringbone patterns (*cf.* Nordström 1972: pl. 121; Gatto 2006a: pl. 1), but also by simple comb impressions and rocker stamp fillings (ibid.; Salvatori et al. 2008, fig. 16.30), or by impressions of double pronged tools arranged to 'alternately pivoting stamps' where dotted lines are impressed once more thereby acting as a guidance line (*cf.* Nordström 1972: pl. 123.12). As the sequence of dated grave inventories of Kawa R12 (Salvatori et al. 2008; Dittrich 2011: cat. 28) indicates there has been a growing regional variation from 4700 calBC onwards with only few elements assuring chrono-supraregional relationships such as the occurrence of the herringbone pattern (*cf.* discussion in Dittrich 2011: 175-178, 182-184). Yet the resemblance of herringbone rim decorations and horizontal rows impressed by the 'alternately pivoting stamp' technique within the Neolithic of Capsian tradition as found at Hassi Mouilah/Algeria (Camps 1974: fig. 90) and dated to 4700-4350 calBC could hardly be overlooked.

Presently, there is no agreement on the overall chronological position for the Nubian pottery tradition but it is suggested here, that the stratigraphical position of banded decorations as outlined for Shaqadud-Midden, the close affinity to the succeeding 'dotted wavy-line' tradition which is in fact just a banded variety as well as the revised radiocarbon dates put forward here, support a chronological fixation starting in the mid of 6th millennium BC and covering the 5th millennium BC. It cannot be ruled out that the application of banded decoration is the result of an outside stimulation (e.g. Yarmoukian) that would make a concerted onset in the mid of 6th millennium BC even more probable. A similar effect could be present in the distributional pattern of the Neolithic herringbone patterns.

This general dating would also neutralise the questionable chronological position of the corresponding lithic inventories whose frequent macrolithic and flake-oriented components clearly speak for a later dating within the Mesolithic sequence or, even more probable, a Neolithic date after 5000 calBC. From this point of view an early Holocene date for the Khartoum Variant as suggested by Gatto (2006a) and Usai (2005) can be ruled out. In fact, the Khartoum Variant is an epistemological mixture of Late Mesolithic and Neolithic pottery and lithic traditions that have been found together at sites such as Abka-9 (Myers 1958; Dittrich 2011: cat. 1) and Abka-428 (Nordström 1972; Dittrich 2011: cat. 2) due to similar spatial preferences during the period of 5300 to 4000 calBC. The same phenomenon has been observed in the Khartoum area where low frequencies of 'dotted wavy-line' pottery that were always distinguishable by its different fabric occurred at Neolithic settlement sites such as Shaheinab (Arkell 1953), Shaqadud-Midden/upper layers (Mohammed-Ali 1991), or Sheikh el Amin (Fernández et al. 2003). In Sheikh al Amin the outside position of 'dotted wavy-line' pottery (415 fragments) could be statistically underlined by a correspondence analysis (out of 56,761 fragments, *cf.* Fernández *et al.* 2003: 314, fig. 52). Kabbashi A seems to remain the only site where it was not mixed with later or earlier elements so that this can be seen as rare exception (Caneva et al. 1993). To avoid further terminological confusion it is suggested here to give up problematic terms such as Khartoum Variant and Qadan for Lower Nubia in favour of terms like Nubian Epipalaeolithic (9800-7350 calBC), Early Nubian Mesolithic (7350-6450 calBC), Nubian Middle Mesolithic (6450-5650 calBC), Nubian Late Mesolithic (5650-5300 calBC), Late Mesolithic/Early Neolithic Transition (5300-4800 calBC) and Nubian Middle Neolithic (4800-4050 calBC) (Fig. 17).

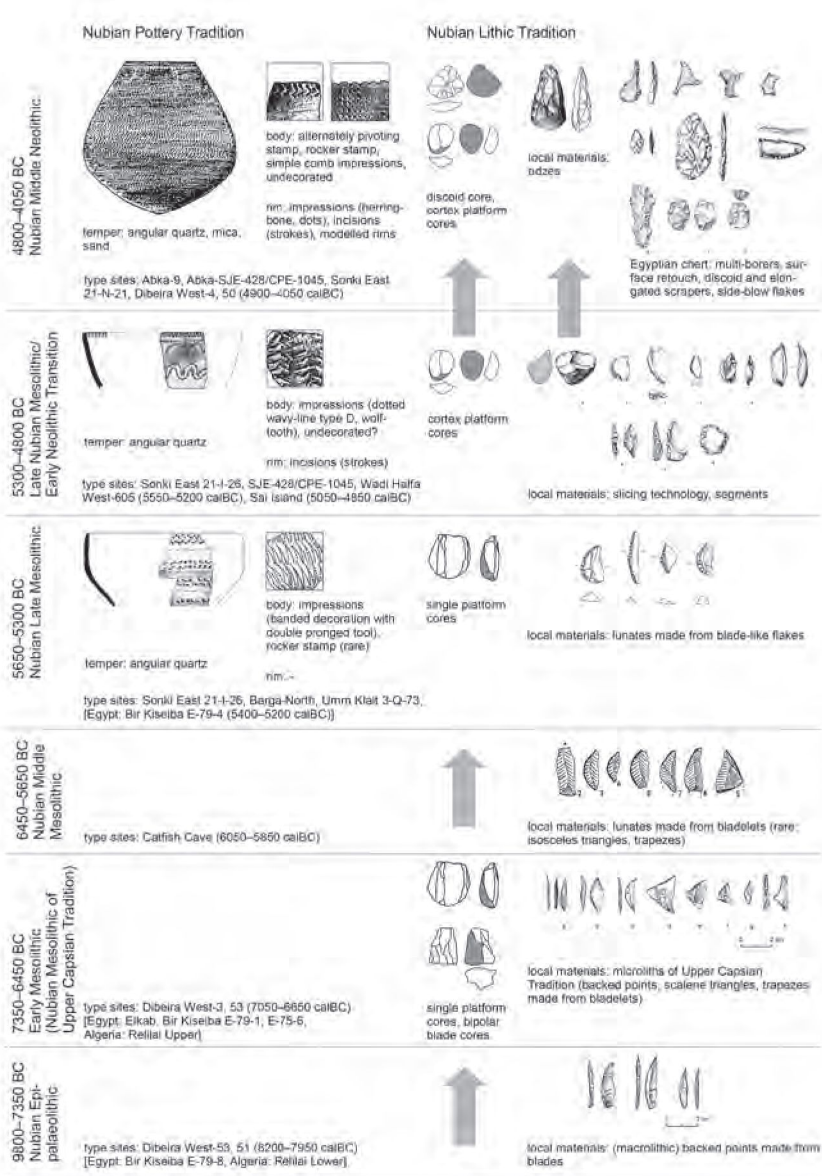


Fig. 17. Typochronological scheme for Nubia between 9800 to 4050 calBC (arrows indicate continuation of the lithic technology to next period)

Conclusions

The chronology of the Neolithisation process remains an arbitrary systematisation when based on various geological, statistical, or material information such as radiocarbon dating, stratigraphy, and typology. Therefore, chronology forming an incomplete index to past periods is not necessarily related to the full range of cultural history. Also it is inclined to make extensive use of generalisations. Although by chronology we are able to distinguish phases of continuities or discontinuities, it tells not so much about the nature of socio-cultural changes that have to be studied differently within a wider ethno-sociological and historical frame-work. In the first place, the advent of domesticates signifies a social transformation that it is also marked by the appearance of a changed burial rite and of a network of imported materials charged with prestigious meaning (Krzyżaniak 1991).

For a general chronological time-frame it is suggested here to use so called wiggle spaces as markers for time periods that are frequently matched by radiocarbon dates (Fig. 4). However, radiocarbon dates should not be employed as evidence for past events because they are always related to organic materials of former living organisms with specific properties. Clearly, the procedure of linking a radiocarbon date and a whole site or a site's complete inventory seems not a sufficient procedure anymore.

Also the definition of cultures, or industries based on potentially mixed assemblages should be rejected. On the contrary, questions of taphonomy, of formation and subsequent transformation of archaeological sites and therefore of the long-term human interest in reshaping landscapes and environments will probably receive growing attention. The concept of palimpsests acknowledges that such mixed archaeological assemblages are part of the present geological reality. The description of this geological reality requires the use of specific methods such as artefact/ecofact frequency analysis, statistics using Gaussian normal distribution curves, or sedimentological studies. However, also single finds do not so much act as evidence for past cultural events that commonly escape the archaeological method and are rather to be studied within historical conceptions.

From the viewpoint of preferred raw materials as cultural markers three traditions for the Middle Nile valley can be defined. In Central Sudan the late Pleistocene to early Holocene alluvial plains are settled by the bearers of a lithic tool production based on quartz (Khartoum Mesolithic tradition), while at the Atbara junction the lithic tradition is based on chert from the hinterland (Atbara Mesolithic tradition). In Northern Sudan the existing Epipalaeolithic flint tradition is replaced by a Mesolithic tradition with similarities to the Capsian (Nubian Mesolithic of Capsian tradition). The respective pottery traditions of these regions show, however, chronologically different onsets. The Mesolithic comb incisions of the Khartoum-Butana region previously classified imprecisely together with other decorations as 'Early Khartoum' or 'Wavy-line' pottery (see critics of Jesse 2003) constitute – as a revision of Arkell's work – still the most substantial evidence of an 'early' pottery production for the African continent. The three regions are not only linked by a marked break in the lithic technology with a shift from a blade-oriented to a flake-oriented industry but also by the distribution of local varieties of pottery decoration concepts such as banded decorations (from 5650 calBC onwards) as well as sub-types of 'dotted wavy-line' (from 5350 calBC onwards). The following transition to the 5th millennium BC is not so much related to a profound change of pottery decoration concepts but of fabrics that start to contain a wider range of temper ingredients among them organic materials that are probably linked to animal husbandry.

As the 'dotted wavy-line' horizon overlaps the Mesolithic-Neolithic transition the question could be asked if this network carried the capability to spread ideas of farming as well as domesticated species. Is it possibly comparable or partly identical to a second network that spread macrolithic tool shapes and surface retouch as a signifying technology (Shirai 2006; Riemer 2007)? Or, is it rather associated to the Middle Neolithic network that spread imported raw materials like Red Sea shells, malachite, amazonite, or cornelian and mediated the idea of figurines and ritual vessels such as calceiform beakers (Krzyżaniak 1991)? The main difference between these networks lies in their spatial orientation: The first two networks are oriented along East-West, and respectively West-East routes as it is characteristically for forager groups moving within the ecological corridors of vegetation zones. However, the third one purposely crosses these ecological borders from North to South and vice versa being responsible for the incorporation of exotic domesticates along the axis of the Nile valley. With this, we see several different spatial reference systems the temporal overlapping and adjustment of which is what is to be subsumed as the process of neolithisation.

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