On-going Investigations at the Predynastic to Early Dynastic site of Kafr Hassan Dawood:

Copper, Exchange and Tephra

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Continued analysis of material – primarily ceramic – excavated during the 1990s at the Predynastic to Early Dynastic cemetery site of Kafr Hassan Dawood (KHD) in the Wadi Tumilat has allowed seven phases of use to be identified. This process has been greatly helped by the acquisition of further archival material of the 1989 to 1995 excavations. The assigning of these phases was also aided by the dating of tephra from a layer covering First Dynasty graves; it has provided a terminus post quem for certain graves dug into this layer in the south of the site that did not have any grave goods and has also given a terminus ante quem for all the graves below this layer. Archaeometallurgical analysis of a copper bowl from grave 913 has shown that it was made of arsenical copper, which probably came from the Sinai. The large amount of copper artefacts found at KHD may indicate its function as a node on the interregional exchange network between the Sinai and the Memphite region.

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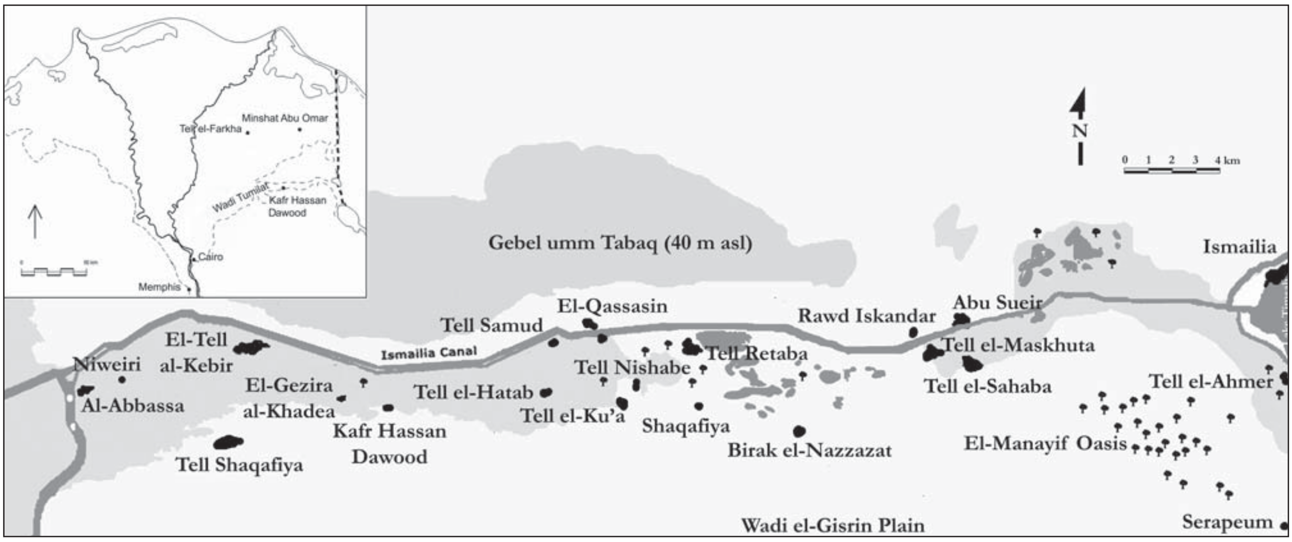
Une analyse approfondie des matériaux, principalement la céramique, recueillis au cours des années 1990 sur le cimetière pré- et protodynastique de Kafr Hassan Daoud (KHD), dans le Ouadi Toumilat, a permis d'identifier sept phases d'utilisation. Cette étude a été grandement facilitée par l'acquisition des archives des fouilles de 1989 à 1995. L'attribution de ces phases a également été confirmée par la datation d'une couche de téphra recouvrant des tombes de la 1re dynastie; il a fourni un terminus post quem *pour certaines tombes creusées dans cette couche dans le sud du site qui ne possèdent pas de mobilier funéraire et a également donné un* terminus ante quem *pour toutes les tombes en dessous de cette couche. L'analyse archéométallurgique d'un bol en cuivre provenant de la tombe 913 a montré qu'il était constitué de cuivre riche en arsenic, probablement importé du Sinaï. La grande quantité d'objets en cuivre trouvés à KHD peut indiquer que ce site était un nœud sur le réseau d'échanges interrégionaux entre le Sinaï et la région de Memphis.*

Introduction

The Predynastic to Early Dynastic site of Kafr Hassan Dawood (KHD) (3,400 to 2,750 BC) is located in the east Delta on the southern edge of the Wadi Tumilat, a natural entry and exit point into and out of Egypt from the Sinai and southern Levant (see **fig. 1**). Archaeological fieldwork was conducted at this large site covering 38.5 hectares between 1989 and 1999 (Hassan 2000; Hassan et al. 2003), although the analysis of the material is still on-going (i.e. Tassie et al. 2008; Rowland 2014a). A total of 1069 graves were excavated at this cemetery site, of which 752 date to this early period and the rest to the Late Period to Roman era.[2] This makes it the largest Predynastic to Early Dynastic cemetery site so far excavated in Lower Egypt outside of the Memphite region (Dębowska-Ludwin 2013: 80-84).

The recent acquisition and interrogation of fuller archival data pertaining to the excavations conducted from 1989 until 1995 has allowed a much greater insight into material remains from the site and made it possible to plot in greater depth the spatio-temporal development of the cemetery. The results of scientific analysis of geological and archaeological material have also produced some startling new results that shed light on the process of state formation.

Fig. 1
Map of Wadi Tumilat.



2. Initial analysis had assigned 745 graves to the Predynastic to Early Dynastic period (i.e. Hassan et al. 2003) however, further interrogation of the data has assigned seven more graves to the early period (Hassan and Tassie in prep.). Pottery analysis has also further identified the Roman occupation at the site that now continued into at least the second century AD.

Phasing of the Cemetery

Interrogation of recently acquired data, along with that already held on KHD has allowed the team to divide the site into seven chronological phases (see **tab. 1**). Although the earliest phase was only observed in test pits conducted during the 1999 season (Hassan et al. 2003), it was clear this pottery (which was not removed from the graves) was earlier than any previously encountered at the site. Only a few graves have at present been assigned to the subsequent KHD II phase (3,400 to 3,300 BC), but it is possible due to their location and that of the phase I graves that several more are located beneath the two modern cemeteries that are located directly to the north of the main excavation area.

Initial analysis suggested that the cemetery seemed to have grown from the north (KHD I ca. 3,500 BC) to the south, where the latest Second Dynasty graves are located (KHD VII ca. 2,800 to 2,750 BC). However, recent analysis of the data by Rowland (2014b; in preparation) shows that although there are phase VII graves in the south, and phase I graves are only suspected in the far north, the spatio-temporal growth the cemetery was far more complex. Rather than simply expanding south, there seems to be various zones – similar to Cemetery N7000 at Nag ed-Der (Savage 1997) – and may sup-

Date	Upper Egypt	KHD	Other Delta Sites
3,060 – 2,613 BC	**Early Dynastic**		
2,686–2,613			Buto VI, Mendes Unit 1, Tell el-Farkha VII, Tell Ibrahim Awad 3
2,800–2,686	Naqada IIID$_2$-IIID$_3$	KHD VII	Buto V, MAO IV, Mendes Unit 1, Tell el-Farkha VI, Tell Iswid (Phase C), Tell Ibrahim Awad 4
2,930-2,800	Naqada IIID$_1$	KHD VI	Buto IV, MAO IV, Mendes Unit 1, Tell el-Farkha VI, Tell Iswid (Phase C), Tell Ibrahim Awad 5a
3,060–2,930	Naqada IIIC$_2$	KHD Vb	Buto IV, MAO IIIc, Mendes Unit 1, Saïs III, Tell el-Farkha VI, Tell Iswid (Phase C), Tell Ibrahim Awad 5b
	Naqada IIIC$_1$	KHDVa	Buto IV, MAO IIIc, Mendes Unit 1, Saïs III, Tell el-Farkha V, Tell Iswid (Phase C), Tell Ibrahim Awad 5b
3,300 – 3,060 BC	**Protodynastic**		
3,200–3,060	Naqada IIIB- IIIC$_1$	KHD IV	Buto IIIf, KeK 3, MAO IIIb, Mendes Unit 2, Saïs III, Tell el-Farkha IV-V, Tell Iswid (Phase B), Tell Ibrahim Awad 6
3,300–3,200	Naqada IIIA$_1$-A$_2$	KHD III	Buto IIIb-e, MAO IIIa, Mendes Unit 2, Saïs III, Tell el-Farkha III-IV, Tell Iswid strata VII (Phase B), Tell Ibrahim Awad 6
3,900 – 3,300 BC	**Predynastic**		
3,350–3,300	Naqada IID$_2$	KHD IIb	Buto IIIa, MAO II, Mendes Unit 3, Saïs III, Tell el-Farkha II
3,400–3,350	Naqada IID$_1$	KHD IIa	Buto IIIa, MAO Ib, Saïs III, Tell el-Farkha I, Tell Iswid strata IV-VI (Phase A)
3,500-3,400	Naqada IIC	KHD I?	Buto IIb, KeK 2, MAO Ia, Saïs III, Tell el-Farkha I, Tell el-Iswid strata I-III (Phase A), Tell Ibrahim Awad 7
3,600–3,500	Naqada IIB		Buto IIa, Saïs IIIa
3,700–3,600	Naqada IIA		Late Maadi, Buto I-IIa, Digla II, Heliopolis, Kek 1, Saïs III
3,800-3,700	Naqada IC Naqada IB		Early Maadi, Buto Ib, Digla I
3,900–3,800	Naqada IA		Buto Ia

Tab. 1
Chronology.

Fig. 2
Plan of SE Area of KHD.

port a theory that the cemetery was a central burial place of several different, but possibly dependent communities/settlements.

Although the associated early settlement(s) has not been excavated, a series of drill-cores suggest that it lies to the northeast of the cemetery, in the Upper Mud Unit. Hamdan (2003: 225) identified at least three horizons with anthropogenic remains (potsherds and lithics). These artefacts were found at 0.40 to 0.80 m, 1.20 to 1.90 m, 2.30 to 2.70 m and 3.90 to 4.0 m below surface. The highest remains were those from the later period of occupation whereas, the lower three correspond to the Predynastic to Early Dynastic occupation phases, with the lowest seeming to corroborate a KHD I phase of occupation. However, in 2013 the local Canal Zone Inspectorate excavated three hearths to the northwest of the cemetery, but did not find any associated pottery or submit any charcoal for radiocarbon dating.

Running in a south-north direction through the cemetery, lying just to the west of the two largest graves – grave 913 and grave 970 – is an artificial palaeo-water channel 10.0 metres wide and 1.50 m deep (**fig. 2**). This channel comprises both fluvial and colluvial sediments, including a gravel, sand and silt complex, with two contexts (204) and (208), consisting mainly of freshwater mollusc shells and (205) and (207) being mainly gravel. In the top layer (206) in the central part of this palaeo-water channel was found a layer of fine grained quartz, clayey minerals and evidence of agriculture in the form of burnt phytoliths of wheat and a lesser amount of barley, along with phytoliths of wild grass husks and quite

Fig. 3
Grave 967.

a bit of sedge, some belonging to the genus *Cyperus* sp. (Hamden 2003; Rosen pers comm 1999). Tephra had also blown into this layer of the channel from the Agnano Monte-Spina eruption in the Campi Flegrei caldera of southern Italy; the date of this eruption that produced the tephra is 2878-2576 Cal BC (Victoria Smith pers comm 2009). A few of the Early Dynastic graves were dug into this layer (206) of the palaeo-channel (i.e. grave 967 located to the south of grave 970) therefore, making them later than the tephra (see **fig. 3**). As artefacts are generally not associated with these flexed burials – in a stratigraphically higher layer than the First Dynasty graves – a tentative mid to late Second Dynasty date is probable for these graves and then the abandonment of the site.

The site's main phases of occupation and socioeconomic growth appear to have been from KHD IV to KHD VI (3,200 to 2,800 BC), a period in which the population grew and enjoyed their most prosperous period. Given the relative dates of the latest Early Dynastic graves (Second Dynasty) and the absolute date from the tephra, it may be that the settlement at Kafr Hassan Dawood was one of those that suffered the consequences of the significant drop in the average height of the annual inundation after the end of the First Dynasty (Bell 1970). The amount of water in the western Wadi Tumilat may have been drastically reduced, and as such environmental factors may also have played a part in the downfall of the community at KHD. As only a few graves are dated to this period, and these are generally poorly furnished with grave goods, it therefore seems that life at KHD became increasingly difficult from the end of the First Dynasty. As such, it seems that the size of the community that remained at KHD reduced during these hard times of the early Second Dynasty, soon these people too seem to have relocated elsewhere, as indicated by the few people that were buried during the mid to late Second Dynasty. The community at KHD could also have been affected by the political changes under Peribsen and Khasekhemwy (Wilkinson 1999: 69, 77-79), which may have resulted in a change in the interregional exchange networks (Hassan 2000).

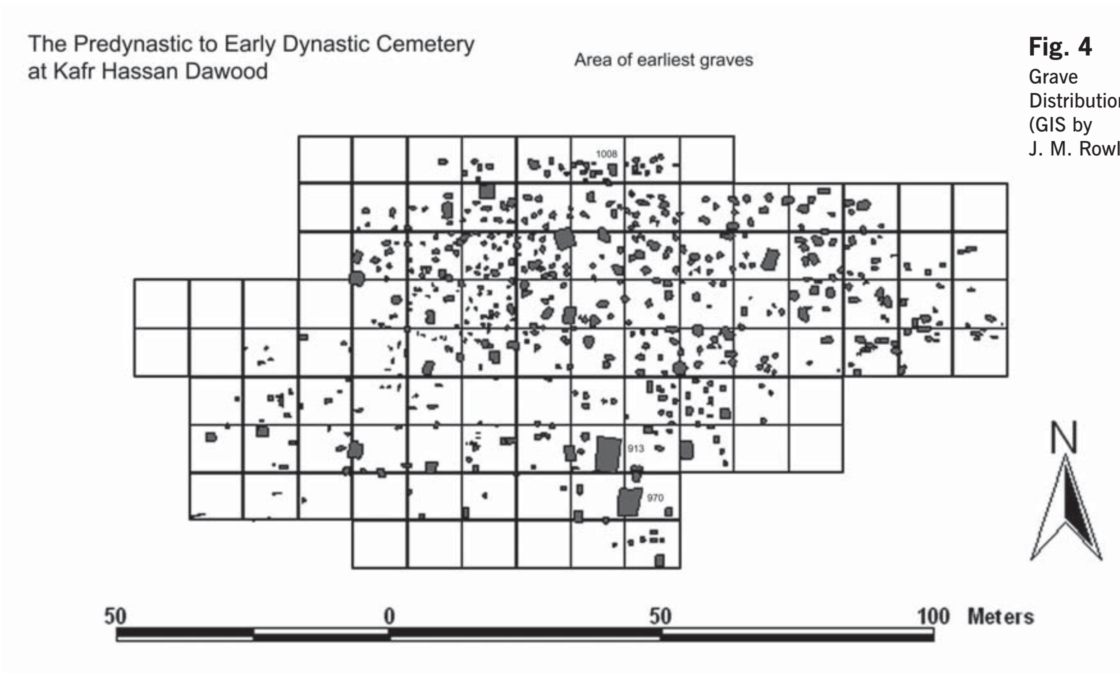


Fig. 4
Grave Distribution (GIS by J. M. Rowland).

Analysis of Graves 913 and 970

The majority of graves at KHD were simple oval pit graves (e.g. grave 967), although sub-rectangular pit graves occurred, as did larger oval pit graves, such as grave 1008, and medium-sized mud-lined graves, such as grave 955 and grave 956 and a few oval pottery coffins, such as in grave 1025 (Hassan et al. 2008; Rowland 2007; van Wetering & Tassie 2003). In the south of the site two large rectangular mud-lined graves (6.0 m north-south by 4.0 m east-west and 1.1 m deep) were discovered: grave 913 and grave 970 (see **fig. 4**). Grave 913 was discovered by the local Canal Zone Inspectorate under the directorship of Mohammed Selim el-Hangouri in early 1995, before the lead

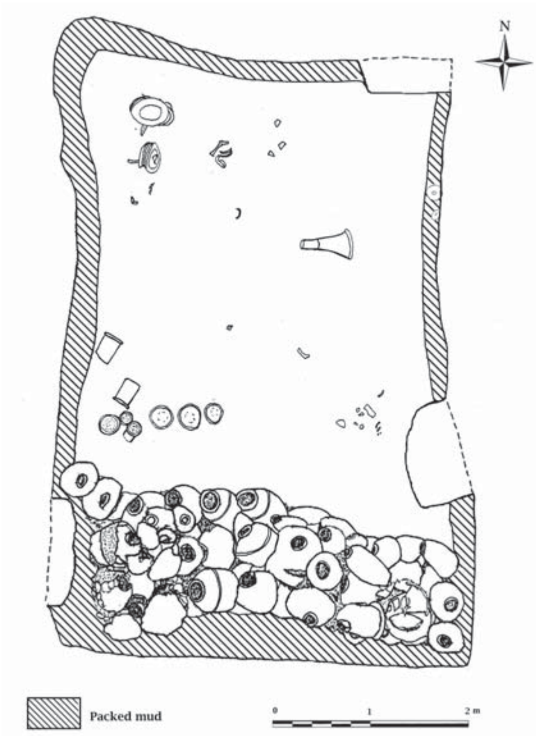


Fig. 5
Grave 970.

Fig. 6
Pottery wine jars (Grave 970).

author was asked by the SCA to take over the directorship later that year (Hassan et al. 2003). Grave 970 was discovered in summer 1996 and excavated by the Supreme Council of Antiquities/University College London Mission over the course of the next two seasons (see **fig. 5 & 6**). An ancient robbers' trench was discovered in the east side of grave 970, directly over the area where the body of the tomb-owner would have been placed. However, grave 913 appears to have largely, but not totally escaped the attentions of the grave robbers (see **fig. 7 & 8**). In autumn 1999 members of the SCA/UCL Mission studied, recorded and analysed all the material excavated from grave 913. Due to the robbing of grave 970, there is a large difference in the amount of grave goods recorded from the two tombs, although it can be assumed that 970 (84 objects) originally had a similar amount of grave goods to 913 (207 objects) as well as those objects that were robbed from both graves (see **fig. 9 & 10** for some of the types of grave goods found in grave 913). Apart from grave 974, a rectangular mud-lined 'grave' that held no body just pottery and fragments of a quern, located just to the west of 970, only simple pit graves surrounded these two large burials. The building of the substructures of both these graves seems to have first consisted of digging an initial grave pit, then lining the floor of this pit with clean very light yellow sand. This rectangular grave pit was then lined with mud. The numerous grave goods where then placed within specific zones, with the large storage jars, beer jars, cooking pot stand, cooking pot and lid being placed in the southern most zone(s) (see Tassie 2010 for the cooking pot ensemble). In the central western zone were stone vessels and small ceramic jars, whereas in the north-western zone were stacks of rough ware dishes, bowls, plates and oval bread moulds, a pressure flaked chert knife and the remains of animal bones that appeared to be that of a bovid (see **fig. 5 & 7**). In the north-eastern zone were only a few medium-sized ceramic vessels, such as beer jars. In the central eastern zone – the burial chamber – the body in grave 970 had been removed and discarded by the grave robbers, but in grave 913 part of the skeleton was found *in situ*, albeit in a poor state of preservation, lying on its left side in the flexed position with the head pointing west, facing north-east. Around the body of the tomb-owner were placed numerous stone vessels, some being very

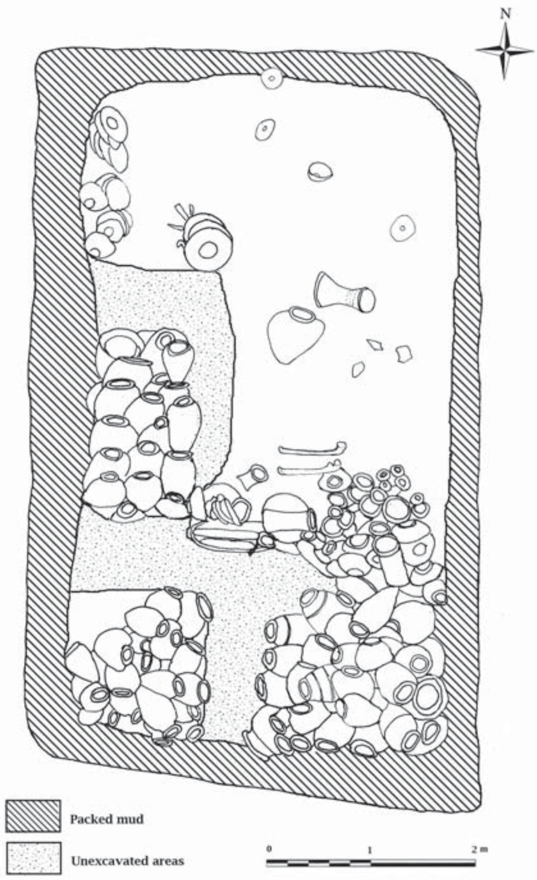


Fig. 7
Grave 913.

Fig. 8
Grave 913
looking west.

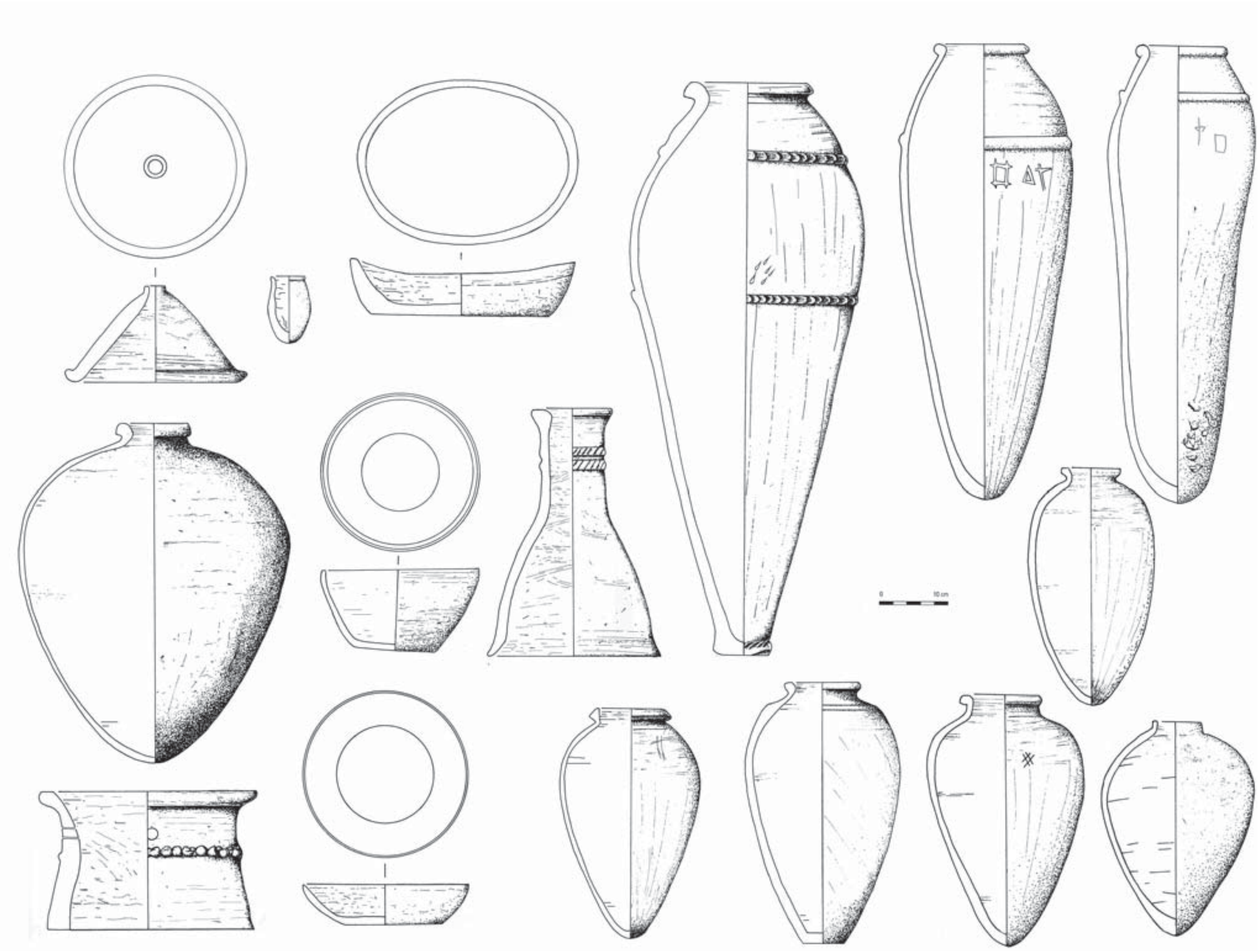


Fig. 9
KHD V – 913.

fine made of stone such as red jasper (grave 970), a potstand, jewellery (beads, bracelets) and in the case of grave 913, a copper bowl and an adze (see **fig. 7 & 10**). Many of the stone vessels and some of the pottery ones had been stolen in grave 970, but enough remained to indicate that the general zoning of objects was similar to that of 913. The whole grave then had mud poured into it and over the grave goods and the body, and this gave the effect of compartmentalising the grave. Originally they each had a superstructure consisting of a large mound or tumulus made of a mixture of sand, grit and mud. On the east side of the tumulus over grave 970 was an offering place where several small rough ware offering dishes had been placed. On the south of 970 was also a ramp-like structure context (201) made of packed mud (see **fig. 2**).

These two graves are the largest and most richly endowed graves in the cemetery, possibly belonging to two local chiefs or administrators placed at the site by the newly

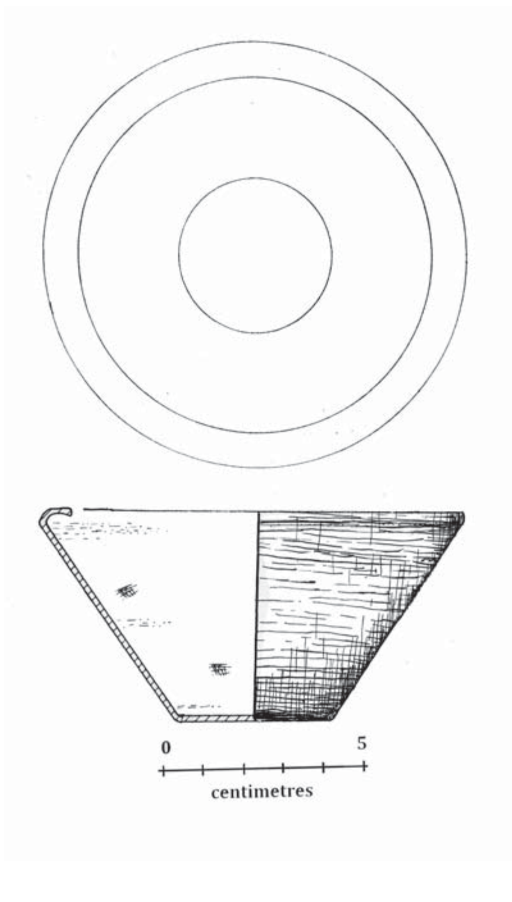


Fig. 10
KHD3080.

formed Egyptian state (Rowland 2014a; Tassie et al. 2008: 205). Although these graves contained numerous objects, many of these were repetitions, such as numerous examples of beer jars, storage jars and tall cylindrical beakers of Egyptian alabaster and plates and dishes of siltstone. This practice of putting fewer fine wares in the grave had already started in the second half of the Naqada II period. By Naqada III most large graves in Egypt contained a greater number of objects but less variety of forms. This practice has been related to the increasing importance of storage of offerings and vestiges of complex burial rites (Wengrow 2006: 72-98). Some of these funerary rites seem to have included a funerary feast, and the offerings of bread, beer and animal products found within the graves may indicate that the remnants of this feast were perhaps shared with and presented to the deceased for their first meal in the afterlife (Tassie 2010). The variety of objects placed within these two graves at KHD seems to have been restricted and the individuality of grave offerings seems to have only been expressed in the red jasper stone vessel (KHD2100) in grave 970 and the metal bowl (KHD3080) and possibly adze (KHD3254) in 913. These two tombs, grave 913 dating to KHD Va (Naqada IIIC1), and grave 970 dating to KHD Vb (Naqada IIIC2) represent the most prosperous period of activity at the site.

Copper Objects at Kafr Hassan Dawood

Compared to other contemporary east Delta sites - such as Tell el-Farkha (38 objects from both the settlement and cemetery) – Kafr Hassan Dawood has a higher than average amount of copper objects (3.6% of the graves contained copper objects), with 75 single objects[3] coming from 27 different graves (Czarnowicz 2012; Tassie & van Wetering 2003; Rowland 2014; van Wetering & Tassie 2003). The type of objects at KHD included adzes, an amulet, awls, beads, bowls, a bracelet, chisels, dishes, fishhooks, harpoons, knives, mirrors, needles, a spear, and wire. The majority of these objects are tools, with only the bowls, dishes, mirror and jewellery items being of a more personal and decorative nature. Although generally only single copper objects were found in graves, such as a copper adze, several graves at KHD contained numerous copper objects, such as grave 142, grave 298, grave 371 and grave 529. Gold also occurred at KHD, with two small gold cups, or more likely sheet gold covers of handles or staffs of office (that did not survive, but may have been made of wood or ivory) being discovered in grave 73 along with a copper awl, nine ceramic vessels and two stone vessels (Hassan & Tassie et al. in prep). However, Minshat Abu Omar (MAO) has a similar amount of objects (70 from 422 graves, although 24% of these objects came from only 2% of the graves, the largest and most richly furnished), but many of these seem to be of a more decorative nature. As with KHD the copper objects constitute between 2 to 3% of the total grave good assemblage, but at MAO the copper assemblage includes such items as saws, chisels, harpoons, axes, oval adzes, bracelets, needles, beads, and very occasionally vessels, varying from deep bucket-like bowls to flat dishes with a small rim. Several remarkable papyrus flower-shaped copper objects, which may have been encasings for horizontal beams (now decomposed) of a bed or catafalque, were also found (Kroeper 1988; 1996; 2004; Kroeper & Wildung 1985; 1994; 2000). The major difference between the two sites is that Minshat Abu Omar generally seems to have more richly furnished large graves with more elaborate architecture than KHD, and seems to have been the burial place of a wealthier community (van Wetering & Tassie 2003).

The question arises whether KHD was a node in the interregional exchange network, with the majority of the copper pass-

3. Although 52 copper objects were recorded in Tassie & van Wetering (2003), further analysis has been able to split groups of copper objects originally recorded as one piece.

ing through on its way to the Memphite region and the royal residences? The high amount of copper at KHD may be because the site was located on one of the natural entry and exit points into and out of Egypt from the Sinai and ultimately the southern Levant: the Wadi Tumilat. A road existed that extended from the Wadi Tumilat, east of Lake Timsah running parallel to its northern counterpart, the Ways of Horus, but located 20-30 km to the south of this coastal route. It turned south past the limestone escarpment and upon reaching its eastward extent in the Sinai turned north to the region of Beersheva and other Canaanite sites. Several finds of contemporary Egyptian pottery have been made on this road. This seems to have been the southern route for objects coming from the south Sinai, whereas MAO was located on the northern exchange route for objects coming from the Levant across the northern part of the Sinai and Uruk colonies possibly via ships down the east Mediterranean coast (Hendrickx & Bavay 2002: 73-75). The copper at KHD, as will be discussed below, probably originated in the Sinai. The likely source for the majority of the copper found at Tell el-Farkha is also the Sinai (Rehren & Pernicka 2014), which may indicate that the copper passing through KHD supplied other areas of the Delta as well as the Memphite region.

Whereas 20 Levantine ceramic vessels and five objects of lapis lazuli have been found at MAO (Kroeper 1989; Hendrickx & Bavay 2002), only five Levantine vessels have so far been identified at KHD. This seems to indicate that KHD was not a major site in the exchange network with the Levant and had little sustained contact with that region. Although some of the inhabitants of KHD consumed both wine and oils – goods often associated with the Levant – the finished products may have come from other areas of Egypt in exchange for copper (Hendrickx & Bavay 2002: 74). It thus appears that KHD acted as a place of transit between Memphis and the Sinai and also between the Sinai and other sites in the Nile Delta.

The earliest evidence of Egyptian state mining activity in the Sinai has traditionally been placed in the Third Dynasty, attested by the inscriptions of Netjerikhet and Sekhemkhet in the Wadi Maghara (Abdel-Motelib et al. 2012: 19). However, the discovery of inscriptions showing the *serekhs* of Iry-hor, Ka and an unknown kinglet from the Protodynastic period, along with those of Narmer and Djer of the First Dynasty, and that of Nebra of the Second Dynasty in the Wadi Ameyra suggest that mining activities were being conducted earlier than originally thought (Tallet & Laisney 2012). Inscriptions from the reign of King Den have also been discovered in Wadi el-Humur, documenting expeditions sent to a specific area of south-western Sinai, ca. 20-30 km to the east of the modern coastal cities of Abu Zenima and Abu Rodeis (Resk Ibrahim & Tallet 2009). Although Egyptian miners may have been working the copper mines in south Sinai just prior to the First Dynasty, Pfeiffer (2013) and Abdel-Motelib et al. (2012) could find no solid evidence for copper working by the Egyptian state in the Sinai during this period. However, much of the evidence of copper working - such as wind powered smelting furnaces and slag - is loosely dated to the Early Bronze Age. These recently discovered Protodynastic and Early Dynastic inscriptions in the Sinai seem to correlate with the major period of copper finds at KHD (Naqada IIIB to IIID1, see Rowland 2014a: 283), a site that also contains *serekhs* of Ka and Narmer (Tassie et al. 2008). At least prior to Ka - and also probably after - certain individuals from KHD may have exchanged copper for agricultural produce with the people of the Timnian cultural unit; herder-gatherers that lived in the Sinai and seem to have practiced small-scale mining activities (Rothenberg 1979: 150-151).

Analysis of the Copper Bowl from Grave 913

Although a larger sample of the metal objects would have been desirable, only a small fragment of the bowl KHD3080 was made available for analysis with the kind permission of Prof. Gaballa Ali Gaballa (see **fig. 10**) due to Egypt's strict cultural heritage laws. In order to maximise the amount

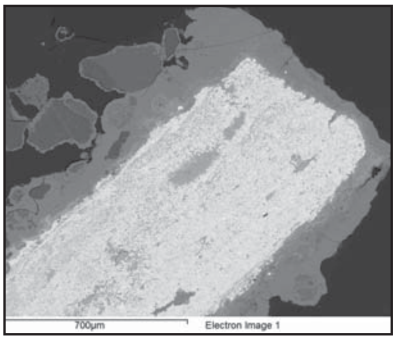


Fig. 11 • Backscatter electron image of the copper bowl from KHD. Light grey is the original metal, now corroded to copper oxide. Dark grey is the surrounding corrosion crust comprising copper salts formed from the combination of copper ions leached from the metal and material from the surrounding environment. Darker grey are sand particles. The contrast is set to a high level to underline the difference between the original outline of the artefact and the surrounding corrosion products.

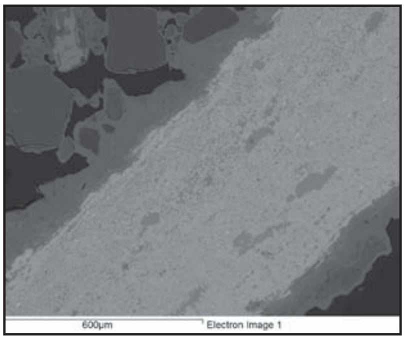


Fig. 12 Backscatter electron image of the copper bowl from KHD. The contrast in this image is set differently to the previous one in order to highlight the tiny elongated lead-rich particles within the body of the corroded metal (bright white specks).

of information from this fragment one part of it was mounted for metallographic and micro-analytical investigation, while another part was submitted for chemical and isotopic analysis by personnel from the Curt-Engelhorn-Zentrum für Archäometrie in Mannheim.

The metallographic cross section shows the metal to be completely corroded and embedded in corrosion products including some sand grains from the surrounding sediment (**fig. 11**). No sound metal is preserved in the sample, and the corrosion products appear to have obliterated all original metallographic structure, apart from a generic elongation of the overall structure parallel to the sides of the bowl. This latter feature indicates a certain degree of hammering and deformation of the original metal, which in the cross section had a thickness of between 0.5 and 0.7 mm.

Large area analyses using an Oxford Instrument energy dispersive spectrometer with INCA software found around 12 to 14 wt% oxygen, 1 to 2 wt% chlorine, 1 to 3 wt% arsenic, and the balance copper. Small areas in the corroded metal are rich in both oxygen (c 25 wt%) and chlorine (c 15 wt%), and contain about 1 wt% nickel in addition to the dominant copper; these areas appear darker grey and better polished (**fig. 12**).

Embedded in the corroded metal are numerous tiny bright elongated particles; they consist of c 55 wt% lead, c 12 to 13 wt% each arsenic and copper and c 15 wt% oxygen. The composition, being relatively rich in nickel and lead, clearly points to smelted copper as the source of this material rather than re-melted native copper. The shape of the lead inclusions indicates the deformation of the metal when it was hammered to form the bowl.

Further chemical analysis of the fragment sent to the Curt-Engelhorn-Zentrum für Archäometrie in Mannheim was done by energy-dispersive XRF, using the method described by Lutz and Pernicka (1996), while the lead isotope abundance ratios were determined by multiple-collector inductively-coupled plasma mass spectrometry (MC-ICP-MS) following dissolution of the sample in a mixture of HCl and HNO_3. Bearing in mind that the XRF instrument does not register oxygen and normalises the analytical results to 100 wt% metal content, the composition found (**tab. 2**) is consistent with the SEM-EDS analyses and offers further information about elements present at concentrations below the detection limit of the SEM-EDS system, such as antimony and silver.

Despite its badly corroded state it is possible to state with confidence that the metal was arsenical copper, with a relatively high content of nickel. Such compositions are thought to be the result of the smelting of a naturally arsenic- and nickel-containing ore and not actively alloyed (Pernicka 1990: 48). Active alloying, that is the intentional

Tab. 2 Composition of the bowl KHD3080 as determined by ED-XRF, in weight percent. Note that the method does not determine oxygen even though the metal is fully corroded, and normalises the results to 100 wt% metal content.

Sample	Cu	As	Sb	Fe	Co	Ni	Ag	Pb
KHD3080 bowl	97	2	0.04	0.07	<0.01	0.12	0.02	0.14

addition of an arsenic-rich substance to pure copper, would require a much more advanced metallurgical understanding than can be assumed for this early period. Furthermore, there is no reason to assume such alloying, since these low levels of arsenic, not typically exceeding 2 wt% and often being less than 1 wt%, have only very limited effect on the properties of the metal (Northover 1989). Finally, many secondary copper ores contain naturally such low arsenic contents, which would during smelting lead to arsenical copper (Tylecote 1976).

The lead isotope abundance ratios of the bowl fragment are given in **table 3**; given the relatively high lead content of the sample and the observation that this lead is concentrated within the original material of the bowl, and not in the corrosion products, it is safe to assume that these abundance ratios reliably reflect the original metal itself, and not contamination during burial. The low values for all reported ratios indicate that the lead in this sample is highly radiogenic, that is strongly affected by lead isotopes formed from the decay of uranium and thorium in the ore body. The metal is unlikely to have been produced in the immediate vicinity of the site, where no ore deposits are known or to be expected. However, major copper sources with archaeological evidence for very early metal production are known further to the east, firstly in the Sinai and then in Faynan and Timna along the Arabah Valley. The most appropriate comparison data for our values are found in a recent paper by Abdel Motelib et al. (2012); according to this the bowl matches the lead isotope abundance ratios of both the ore deposits of Faynan/Timna and those from the Sinai Peninsula. Unfortunately, all these areas and deposits have copper ore and slag samples with such highly radiogenic lead, and an assignment of the metal sample to one or the other of these possible sources solely on the basis of their lead isotope ratios is therefore not immediately possible. Closer inspection of the data shows that the KHD metal is only just outside the documented range of lead isotope compositions for the Faynan area (**fig. 13**), but well within the spread of the various sources in the Sinai

2.0232	Pb^{208} to Pb^{206}
0.8137	Pb^{207} to Pb^{206}
0.05204	Pb^{204} to Pb^{206}

Tab. 3
Lead isotope abundance ratios of the bowl KHD3080.

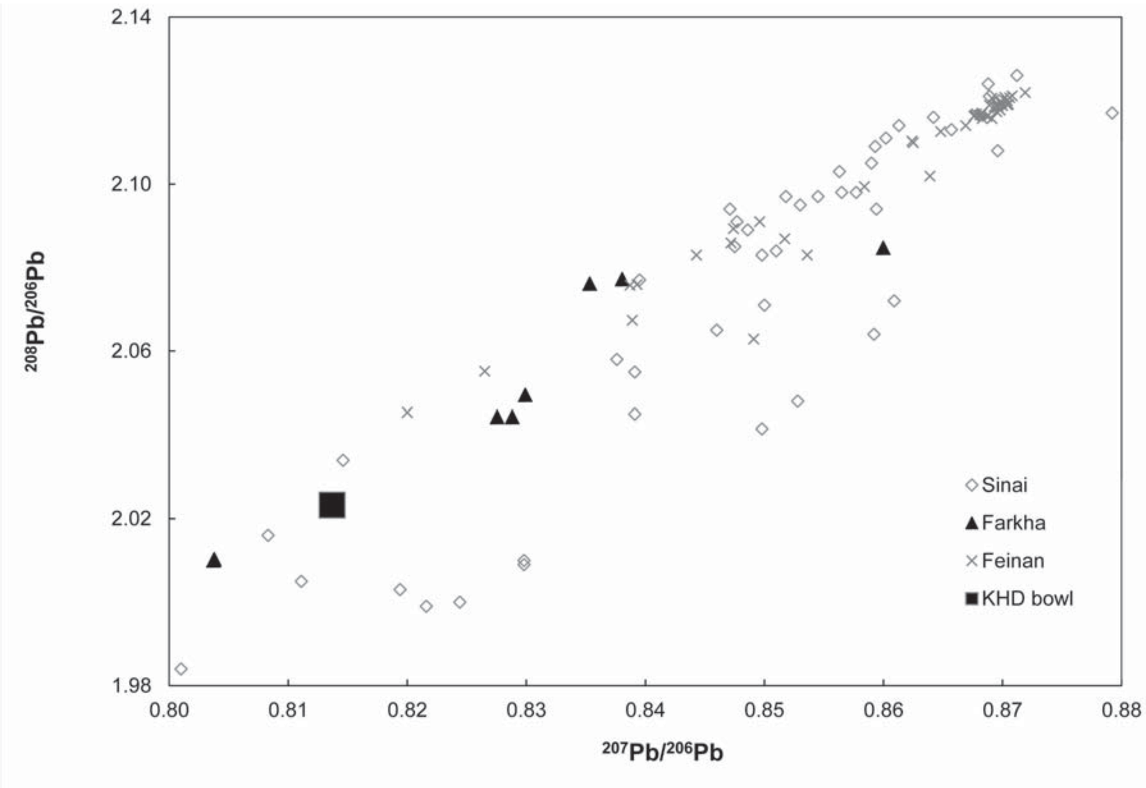
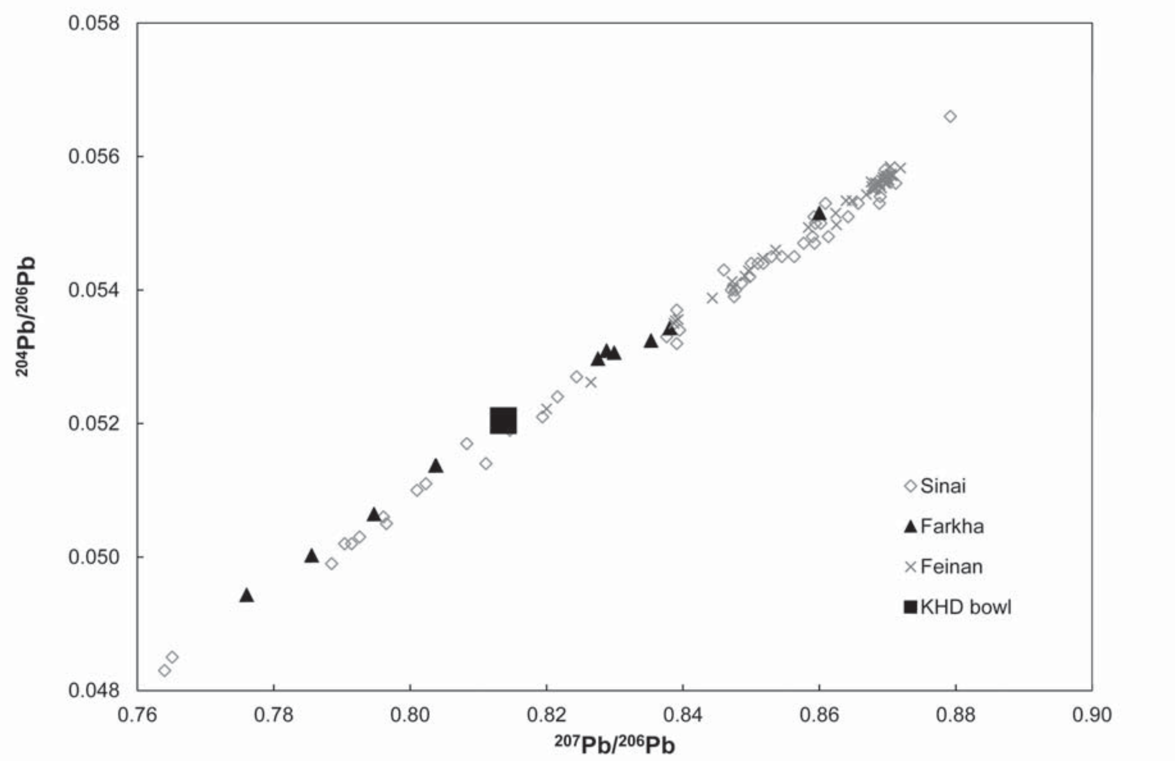


Fig. 13
Lead isotope abundance ratios for the KHD object (square), 6 of the 13 Tell el-Farkha objects (triangles) compared to data for copper and copper ore from Jordan (crosses) and the Sinai (chevrons). There is no clear discrimination between the two ore regions, although the KHD square in the lower left corner indicates the radiogenic signature of the metal.

Fig. 14
Lead isotope abundance ratios for the KHD object (square), 10 of the 13 Tell el-Farkha objects (triangles) compared to data for copper and copper ore from Jordan (crosses) and the Sinai (chevrons). There is no clear discrimination between the two ore regions, except for the shorter range of data from Jordan which do not have $^{207}Pb/^{206}Pb$ values lower than 0.82, while the KHD metal, Sinai ores and the Farkha metal extend to much lower values.



(**fig. 14**). The relatively high content of arsenic and lead also points more likely to an origin from the Sinai than from the Arabah Valley deposits; this is, however, only an indicative assignment.

Overall, the sample from the bowl from KHD joins a growing body of analytical data from this early period of metallurgy, such as the copper artefacts from Tell el-Farkha (**fig. 13 & 14**; Rehren & Pernicka 2014). The metal assemblage from KHD shares a number of similarities with the Tell Farkha material, such as an emphasis on tools and fishing implements, the presence of some items of jewellery, and the high silver content of some finds (see below). Unfortunately, due to the highly radiogenic nature of the lead isotope ratios in the analysed sample and the nature of lead isotope analyses in general it is not possible to positively suggest a particular origin for the copper metal used to produce the bowl from KHD. A source in the Sinai peninsula is likely, but an origin from the major ore deposits in Timna and Faynan is theoretically possible as well, even though less likely on the basis of the chemical composition (Segal et al. 2002: 8-10).

Metal Working at KHD

It is unfortunate that the settlement at KHD is located under a modern lake, which was formed by the local villagers in 1997. It is now very difficult to ascertain whether metalworking was being conducted at the site, although as the majority of objects were tools, some form of metalworking, if only sharpening was probably being conducted at KHD. Although smelting of copper was probably not undertaken at KHD, casting of objects as well as hammering is a possibility. Comparing the copper objects at KHD with those analysed from Tell el-Farkha (Rehren & Pernicka 2014), it is likely that the thicker objects, such as the adzes and harpoons were cast. However, the needles, fishhooks, wire, and copper bowl would have probably been hammered into their final shape, after initial casting of a blank or rough-out.

Many of the objects were covered by an upper layer of hard green crystalline corrosion dominated by copper hydro-carbonates and possibly chlorides, and incorporating various amounts of sediment particles

Fig. 15 • KHD3076.

(Sutherland 2009). Beneath this layer on the thicker artefacts, such as the adzes, chisels and harpoons was a dark red layer of predominantly cuprite, which indicates the position of the original surface of the artefact, but also extends into its body as corrosion progresses. Several of the objects were cleaned to this surface, although several have the green surface layer only having the sediment removed, either because they are still awaiting further conservation treatment, or because they were so thin as to have been completely mineralised and not preserving even the cuprite layer; these include the copper bowl and needles. In the case of some of the larger adzes metal was preserved beneath the cuprite layer.

Microscopic examination of the five needles or rods (KHD3075) from grave 1027 revealed them to be completely mineralised, very brittle and extensively broken. Three of them had differently-styled heads (Tassie 2003). Some areas of the surfaces were covered by preserved organic remains that appeared to be associated and may have consisted of a reed or rush-like material into which they may have been inserted or wrapped. These needles, measuring approximately 70 mm in length appeared to have a significant silver content (Sutherland 2009: 269). This correlates well with the rods found at Tell el-Farkha that also had significant quantities of silver (Rehren & Pernicka 2014: 246). The intentionally broken copper adze from grave 1041 (KHD3076) has a flared tip, suggesting that it had been used rather than fashioned into this style (Rowland 2014a). Most of the underside and some areas of the upper surface of this adze (**fig. 15**) were covered by preserved organic remains, which appeared to take the form of deteriorated leather. Striations present in the remains that ran over the edges suggest that the object may have been wrapped or folded in a leather sheath (Sutherland 2009).

Concluding Remarks

The research undertaken at the site of Kafr Hassan Dawood during the 1990s and the continued analysis of data from this important Predynastic to Early Dynastic site, particularly in light of new scientific advances, is proving invaluable in understanding the origins and functioning of the early Egyptian state. Further archaeometallurgical research on early copper from Egypt and at the sources in the Sinai and elsewhere, such as that undertaken by Abdel Motelib *et al.* (2012) may in future enable a more likely and precise source to be identified for the arsenical copper from KHD.

The evidence taken as a whole suggests that KHD was located at a significant location on the interregional copper exchange network just prior to and during the First Dynasty, when the ruling segment of this community could command the resources to build large tombs. This major period of occupation corresponds to the founding of Memphis and relocation of the royal residence from Upper to Lower Egypt. However, in the Second Dynasty KHD seems to have lost its role in this interregional exchange network, probably due to worsening environmental conditions in the Wadi Tumilat and possibly changes in the central government, as indicated by the poorly furnished graves of this latter period. Although farming activities were the main reason for most sites to exist, these activities may have been increasingly hard to undertake at KHD after the end of the First Dynasty. The building of the artificial water channel may have been an attempt to bring more water to the site, but if this water source also dried up the community would have been forced to move. The site was then abandoned until its reoccupation in the Late Period.

It is hoped that the continued analysis of the large amount of data generated from the excavations at KHD will further help in understanding the socioeconomic processes at work during this period in the south-east Delta. The analysis of this data has also highlighted the need to return to the site to undertake further excavation and research to answer several outstanding questions, not least the exact date of the graves located in the north of the cemetery.

Bibliography

Abdel-Motelib, A.; Bode, M.; Hartmann, R.; Hartung, U.; Hauptmann A. & Pfeiffer, K., 2012. Archaeometallurgical expeditions to the Sinai Peninsula and the Eastern Desert of Egypt (2006, 2008). *Metalla (Bochum)*, 19(1/2): 3-54.

Bell, B., 1970. The oldest records of the Nile floods. *Geographical Journal*, 136: 569-73.

Czarnowicz, M., 2012. Copper tools [in:] Chłodnicki, M.; Ciałowicz, K.M. & Mączyńska, A. (eds), *Tell el-Farkha I. Excavations 1998-2011.* Poznań-Kraków: 345-355.

Dębowska-Ludwin, J., 2013. *Early Burial Customs in Northern Egypt: Evidence from the Pre-, Proto-, and Early Dynastic Periods.* BAR International Series 2571. Oxford.

Hamdan, M.A., 2003. Late Quaternary Geology and Geoarchaeology of Kafr Hassan Dawood, East Delta [in:] Hawass, Z. & Pinch Brook, L. (eds), *Egyptology at the Dawn of the Twenty-first Century: Proceedings of the 8th International Congress of Egyptologists, Cairo 2000. Volume 1: Archaeology.* Cairo: 221-228.

Hassan, F.A., 2000. Kafr Hassan Dawood. *Egyptian Archaeology*, 16: 37-39.

Hassan, F.A.; Tassie, G.J.; El-Senoussi, A.; Kjølby, A.; van Wetering, J.; Sharp, D. & Calcoen, B., 2008. Corpus of pottery from the Protodynastic to Early Dynastic cemetery at Kafr Hassan Dawood, Wadi Tumilat, East Delta, Egypt [in:] Midant-Reynes, B. & Tristant, Y. (eds); Hendrickx, S. & Rowland, J. (ass.), *Egypt at its Origins 2: Proceedings of the International Conference "Origin of the State. Predynastic and Early Dynastic Egypt", Toulouse (France), 5th-8th September 2005*. Orientalia Lovaniensia Analecta 172. Leuven – Paris – Dudley: 41-60.

Hassan, F.A.; Tassie, G.J.; Tucker, T.L.; Rowland, J.M. & van Wetering, J.F.L., 2003. Social dynamics at the late Predynastic to Early Dynastic site of Kafr Hassan Dawood, East Delta, Egypt. *Archéo-Nil*, 13: 37-45.

Hassan, F.A. & Tassie, G.J., with the assistance of Tucker, T.L.; Rowland, J.M.; Senoussi, A.; van Wetering, J.; Calcoen, B.; Hillson, S. and Hamden, M., in preparation. *Kafr Hassan Dawood. Volume 7: Interpretation of the Predynastic to Early Dynastic Cemetery in the East Delta, Egypt*. London.

Hendrickx, S. & Bavay, L., 2002. The relative chronological position of Egyptian Predynastic and Early Dynastic tombs with objects imported from the Near East and the nature of interregional contacts [in:] van den Brink, E.C.M. & Levy, T.E. (eds), *Egypt and the Levant. Interrelations from the 4th Through the Early 3rd Millennium B.C.E.* London - New York: 58-80.

Kroeper, K., 1988. The excavations of the Munich East-Delta Expedition in Minshat Abu Omar [in:] van den Brink, E. C. M. (ed.), *The Archaeology of the Nile Delta. Problems and Priorities.* Amsterdam: 11-46.

Kroeper, K., 1989. Palestinian ceramic imports in pre- and protohistoric Egypt [in:] Miroschedji, P. de (ed.), *L'urbanisation de la Palestine a l'âge du Bronze ancien.* BAR International Series 527. Oxford: 407-422.

Kroeper, K., 1996. Minshat Abu Omar: Burials with palettes [in:] Spencer, J. (ed.), *Aspects of Early Egypt*. London: 79-81.

Kroeper, K., 2004. Minshat Abu Omar. Aspects of the analysis of a cemetery [in:] Hendrickx, S.; Friedman, R.F.; Ciałowicz, K.M. & Chlodnicki, M. (eds), *Egypt at its Origins. Studies in Memory of Barbara Adams. Proceedings of the International Conference "Origin of the State, Predynastic and Early Dynastic Egypt", Krakow 2002*. Orientalia Lovaniensia Analecta 138, Leuven – Paris – Dudley: 859-880.

Kroeper, K. & Wildung, D., 1985. *Minshat Abu Omar. Münchner Ostdelta Expedition. Vorbericht 1978-1984.* Schriften aus der Ägyptischen Sammlung 3. Munich.

Kroeper, K. & Wildung, D., 1994. *Minshat Abu Omar. Ein vor- und frühgeschichtlicher Friedhof im Nildelta I. Gräber 1-114.* Mainz am Rhein.

Kroeper, K. & Wildung, D., 2000. *Minshat Abu Omar. Ein vor- und frühgeschichtlicher Friedhof im Nildelta II. Gräber 115-210.* Mainz am Rhein.

Lutz, J. & Pernicka, E., 1996. Energy dispersive X-ray florescence analysis of ancient copper alloys: empirical values for precision and accuracy. *Archaeometry* 38(2): 313-323.

Northover, J. P., 1989. Properties and use of arsenic-copper alloys [in:] A. Hauptmann, E. Pernicka and G.A. Wagner (eds), *Old World Archaeometallurgy*. Der Anschnitt, Beih. 7. Bochum: 111-118.

Pfeiffer, K., 2013. *Neue Untersuchungen zur Archäometallurgie des Sinai. Die Entwicklungsgeschichte der Innovation "Kupfermetallurgie"*. Studien aus den Forschungsclustern des Deutschen Archäologischen Instituts 11. Rahden/Westf.

Rehren, Th. & Pernicka, E., 2014. First data on the nature and origin of the metalwork from Tell el-Farkha [in:] Mączyńska, A. (ed.), *The Nile Delta as a Centre of Cultural Interactions Between Upper Egypt and the Southern Levant in the 4th Millennium BC*. Poznań: 253-268.

Resk Ibrahim, M. & Tallet, P., 2009. King Den in south Sinai: the earliest monumental rock inscriptions of the Pharaonic period. *Archéo-Nil*, 19: 179–84.

Rothenberg, B., 1979. *Sinai: Pharaohs, Miners, Pilgrims and Soldiers*. Berne.

Rowland, J.M., 2007. Death and the origins of Egypt: mortuary variability as an indicator of socio-political change during the late Predynastic to Early Dynastic Period [in:] Goyon, J.-C. & Cardin, C. (eds), *Proceedings of the Ninth International Congress of Egyptologists.* Orientalia Lovaniensia Analecta 150, Leuven – Paris – Dudley: 1629-1643.

Rowland, J.M., 2014a. Interregional exchange: The evidence from Kafr Hassan Dawood, East Delta [in:] Mączyńska, A. (ed.), *The Nile Delta as a Centre of Cultural Interactions Between Upper Egypt and the Southern Levant in the 4th Millennium BC.* Poznań: 269-297.

Rowland, J.M., 2014b. Times of change: investigating change in the late 3rd/early 4th millennium BCE through the burials at Kafr Hassan Dawood, Eastern Nile Delta [in:] Midant-Reynes, B. & Tristant, Y. (eds.), *Origins 5. Cairo, 13-18 April 2015.Fifth international conference of Predynastic and Early Dynastic studies. Abstracts of papers*. Cairo: 101-102.

Rowland, J.M., in preparation. *Social Transformation in the Delta from the Terminal Predynastic to the Early Dynastic Period: A Comparative Study*.

Segal, I., Kamenski, A. & Merkel, J., 2002. The Cave of the Sandal, Ketef Jericho: new evidence from recent Chalcolithic copper finds. *Iams*, 22: 7-10.

Savage, S.H., 1997. Descent group competition and economic strategies in Predynastic Egypt. *Journal of Anthropological Archaeology*, 16: 226-268.

Sutherland, A., 2009. Field conservation at Kafr Hassan Dawood, Wadi Tumilat, East Delta, Egypt [in:] Hassan, F. A., Tassie, G. J., De Trafford, A., Owens, L. S. & van Wetering, J. (eds), *Managing Egypt's Cultural Heritage: Proceedings of the First Egyptian Cultural Heritage Organisation Conference on: Egyptian Cultural Heritage Management*. London: 266-280.

Tallet, P. & Laisney, D., 2012. Iry-hor et Narmer au Sud-Sinaï (Ouadi ʿAmeyra): Un complément à la chronologie des expédition minières égyptiennes, *Bulletin de l'Institut Français d'Archéologie Orientale*, 112: 381-398.

Tassie, G.J., 2003. Identifying the practice of tattooing in ancient Egypt and Nubia. *Papers from the Institute of Archaeology*, 14: 85-101.

Tassie, G.J., 2010. Funerary feasts and the function of early offering-dishes. *Cahiers Caribéens d'Égyptologie*, 13-14: 61-72.

Tassie, G.J.; Hassan, F.A.; van Wetering, J. & Calcoen, B., 2008. Potmarks from the Protodynastic to Early Dynastic cemetery at Kafr Hassan Dawood, Wadi Tumilat, East

Delta, Egypt [in:] Midant-Reynes, B. & Tristant, Y. (eds), Hendrickx, S. & Rowland, J. (ass.), *Egypt at its Origins 2: Proceedings of the International Conference "Origin of the State. Predynastic and Early Dynastic Egypt", Toulouse (France), 5th-8th September 2005*. Orientalia Lovaniensia Analecta 172, Leuven – Paris – Dudley: 203-236.

Tassie, G.J. & van Wetering, J.F.L., 2003. Early cemeteries of the East Delta: Kafr Hassan Dawood, Minshat Abu Omar, and Tell Ibrahim Awad [in:] Hawass, Z. & Pinch Brook, L. (eds), *Egyptology at the Dawn of the Twenty-first Century: Proceedings of the 8th International Congress of Egyptologists, Cairo 2000. Volume 1: Archaeology.* Cairo: 499-507.

Tylecote, R.F., 1976. *A History of Metallurgy*, London.

van Wetering, J. & Tassie, G.J., 2003. Socio-political hierarchy of First Dynasty sites: A ranking of East Delta cemeteries based on grave architecture [in:] Eyma, A. K. & Bennett, C. J. (eds), *A Delta-Man in Yebu*. Occasional Volume of the Egyptologists' Electronic Forum, No. 1. USA: 123-146.

Wengrow, D., 2006. *The Archaeology of Early Egypt: Social Transformation in North East Africa, 10,000 to 2,650 BC*. Cambridge World Archaeology Series. Cambridge.

Wilkinson, T.A.H., 1999. *Early Dynastic Egypt*. London