Short contribution on the past desert edge landscape at (Lake) Abusir, Egypt

Willem Toonen – Martin Odler – Katarína Arias – Jaromír Krejčí – Vladimír Brůna – Miroslav Bárta – Harco Willems

Abstract

A geological survey of ten boreholes was carried out at the desert edge near Abusir to investigate the location and age of former lakes. These environments are suggested to have played an important role in the symbolic landscape of ancient Egypt by connecting the realms of the living and the dead. Based on our research, it can be excluded that an Old Kingdom lake was present at the investigated zone near Abusir, as the local subsoil was dominated by colluvial, aeolian and prehistorical fluvial deposits typical for the wadi and desert edge setting. Yet, all boreholes featured a distinct layer of degraded mud brick that was interpreted as a large platform or multiple features of Old Kingdom age. Potentially, these features were tied to boat-landing places, which could imply that a lake existed at the wadi-floodplain interface, not far from the investigated zone.

Keywords

geomorphology – ritual landscape – Nile Valley – Holocene – Old Kingdom

مساهمة قصيرة عن طبيعة حافة الصحراء فى (بحيرة) أبوصير، مصر

فيليم تونين - مارتن أودلر – كاترينا أرياس – ياروмير كرتشى – ڤلاديمير برونا – ميروسلاڤ بارتا – هاركو ڤيليمس

ملخص

تم إجراء مسح جيولوجى لعشرة ثقوب (تم حفرها عن طريق استخدام البريمة)، وذلك بالحافة الصحراوية بالقرب من منطقة أبوصير للتحقق من موقع وتأريخ المكان المعروف باسم بحيرة أبوصير. حيث يُعتقد أن تلك البحيرة قد لعبت دورًا مهمًا فى المشهد الرمزى لمصر القديمة، وذلك من خلال الربط بين عوالم الأحياء والأموات. بناءً على بحثنا يمكننا استبعاد وجود بحيرة تعود لعصر الدولة القديمة فى تلك المنطقة التى تم فحصها بالقرب من أبو صير، حيث كانت تهمين على التربة الموجودة بتلك الثقوب الرواسب النهرية الغروية والإيولية المميزة لعصور ما قبل التاريخ والتى دائمًا ما توجد بالوادى والحافة الصحراوية. وعلى الرغم من ذلك، فإن جميع الآبار تتميز بطبقة من طوب اللبن المتحلل الذى تم تفسيره على أنه منصة كبيرة أو مبان تعود لعصر الدولة القديمة. من المحتمل أن تكون تلك المبانى مرتبطة بأماكن رسو المراكب، مما قد يشير إلى وجود البحيرة بحافة الوادى والسهل الفيضى لنهر النيل، فى مكان ليس بعيدًا عن المنطقة التى تم فحصها.

الكلمات الدالة

جيومورفولوجيا - طقوس الطبيعة - وادى النيل - الهولوسين - الدولة القديمة

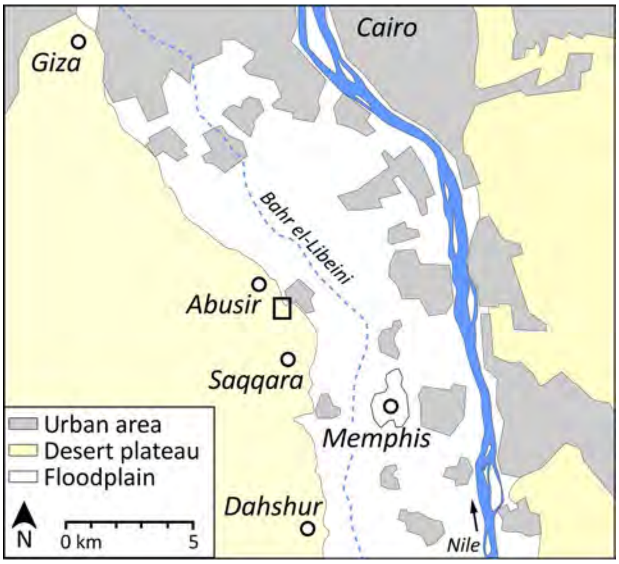

Fig. 1 Setting of the Memphite capital region. The rectangle between Abusir and Saqqara indicates the survey area (drawing W. Toonen)

Introduction

The western fringe of the Nile Valley in the Memphite region forms an environmental boundary between the low-lying lush floodplain and the relatively high arid desert plateau (fig. 1). In the ancient past this landscape interface was also an important cultural divide; between the place where people lived in the urban zone of the capital city of Memphis and where the dead were buried at the Giza, Abusir, Saqqara and Dahshur necropoleis (Bárta 2011).

Several recent studies have focused on the reconstruction of the past landscape in this zone and its use by ancient people. Based on geoarchaeological investigations at Giza, for example, Mark Lehner (2014) suggested the existence of a river branch near the desert edge, allowing access to the Great Pyramids by boat through large harbour basins and quay structures. Reconstructions of the fluvial landscape around Memphis have similarly placed a formerly active branch of the Nile in the western part of the valley (Bunbury *et al.* 2017; Hassan *et al.* 2017), roughly where the current (partially infilled) Bahr el-Libeini canal is located (fig. 1). The presence of harbour basins at Dahshur (Alexanian *et al.* 2015), Abusir (Krejčí 2011) and Saqqara (Labrousse – Moussa 1996; Klemm *et al.* 1998), may thus suggest a similar situation as postulated for Giza with direct boat access to the valley temples (Bárta 1999). These basins may have played an important role in the supply of building materials for the construction of the pyramid complexes (Krejčí 2000). Yet, some of these basins have a relatively high elevation compared to the estimated levels of the contemporaneous floodplain (Jeffreys 2001). Moreover, a direct channel connection with the Nile River has not been proven for most of these sites, so it is also possible that access by boat was restricted to the flood season when the floodplain was inundated.

In addition to a branch of the Nile, several studies have inferred the presence of intermittent lakes on the fringe of the floodplain. These are commonly observed features in the distal part of floodplains of large, low-gradient alluvial river systems (Lewin – Ashworth 2014), such as the Nile (Willcocks 1889). A convex floodplain topography develops due to the inverse relation between flood sediment accumulation rates and the distance to the main river channel, the main source of sediment. Hence, distal locations become sediment-deprived and relatively low-lying. These zones are likely to transform into shallow lakes during wet seasons with the rise of groundwater levels above the surface and are the first extra-channel zones to become suitable for navigation.

At Abusir, Miroslav Bárta (2013) suggests a close symbolic link between the recurring presence of standing water at the desert-floodplain interface, the funerary processions that incorporate the idea of resurrection, and the frog-headed goddess Heqet, who was a symbol of rejuvenation and the annual Nile flood. Further adding to the symbolism of such lakes was that they provided an access route to the wadi systems that gave entry to the necropolis, thus making it the transitional zone between the realms of the living and the dead. According to Miroslav Verner (2017), the intermittent lakes at Abusir can be linked to lake Pedju, which is mentioned in the Pyramid Texts and connected to the cult of Sokar, the god of the dead and divine ruler of the necropolis.

As evidenced from historical documentary evidence (photographs and maps) and the pre-Aswan dam

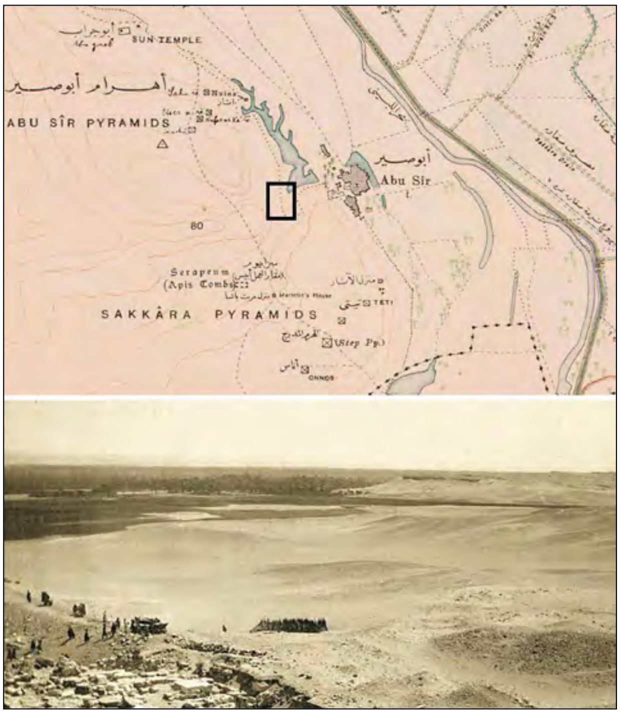

Fig. 2 Historical evidence for Lake Abusir. Upper frame: Survey Department of Egypt map of 1910 (revised edition, 1917) showing the presence of lakes at the floodplain margin near Abusir and Saqqara – research area indicated by the black rectangle. Lower frame: historical photograph (compiled by W. Toonen, after Bárta 2013: fig. 6)

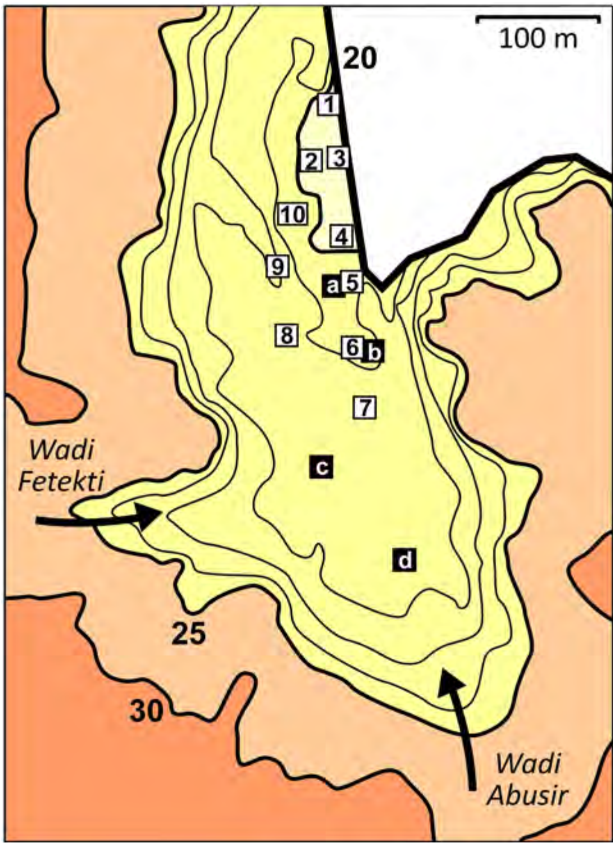

Fig. 3 Elevation map of the research area. Black boxes indicate the locations of trenches dug and studied by Cílek *et al.* (2012). White boxes indicate the location of boreholes (this study). Thick black lines indicate 5 m elevation index contour lines; between 20–25 m above sea level, also 1 m intermediate contours are shown (thin black lines). The white area lies outside the research concession (drawing W. Toonen, after Cílek *et al.* 2012: fig. 2)

memories of the local population (Bárta 2013), the desert-floodplain interface at Abusir indeed featured intermittent lakes during the flood season in (sub)recent times (fig. 2). One of the earliest modern maps of the area by Karl Richard Lepsius depicts a lake in the area (Bárta – Brůna 2006). Currently, the existence of a lake at Abusir in the ancient past is only indirectly supported by biological and archaeological evidence. Lake-dwelling faunal remains found locally in Fifth to Sixth Dynasty burials (2494–2181 BC) and contemporary mud brick platforms (Bárta 2013; Cílek *et al.* 2012; Odler *et al.* 2013) that were tentatively interpreted as boat landing facilities at the desert edge seem to support the textual indications for the existence of a Lake Abusir during the late Old Kingdom period. Direct evidence from sedimentary and dating information to demonstrate the age, location and extent of Lake Abusir is, however, largely missing or even concluded to be non-existent based on previous geological surveys (*cf.* Jeffreys 2001). Following the assumed presence of a river channel in the western part of the Nile Valley during the Old Kingdom, it may even be questioned whether a convex floodplain topography was present in which intermittent lakes could develop at Abusir.

In this paper, we report the findings of the spring 2019 coring campaign at Abusir. The main aims were to search for the local desert-floodplain interface during the Old Kingdom, and to look for direct sedimentary evidence for Lake Abusir in the form of lake deposits. Our survey focused on the relatively low and wet zone, as indicated by sparse vegetation and mud-crack features, that forms the transition between Wadi Fetekti's outlet point and the Nile floodplain (fig. 3). At this location, Václav Cílek *et al.* (2012) identified floral and faunal remains of aquatic species in local deposits and sedimentary indications for ponding, from which they concluded that an intermittent Lake Abusir could have existed in the ancient past.

Methods

Ten boreholes were drilled in the local depression that has been associated with Lake Abusir (fig. 3). They were placed as a scatter around the survey trenches of Cílek *et al.* (2012) to extend the zone of observation around the mud brick platforms (fig. 4), inferred as lake-side archaeological structures, and to potentially identify lacustrine deposits. These must according to Cílek *et al.* (2012) either be located in the deeper subsoil or to the northeast – downslope into the floodplain region. The area of investigation was bounded by the Abusir concession perimeter wall, which prevented a more extensive regional survey.

An Eijkelkamp percussion augering kit with 1–2 m window gauge samplers was used to extract sediments down to a maximum depth of 4 m below the present surface; locally ranging between 19.5–21.5 m above mean sea level (+msl). Although the equipment technically allowed us to penetrate the subsoil down to *ca.* 12 m depth, local groundwater-saturated coarse sands at depths larger than 4 m could not be contained in the sampler. Sedimentary information, such as texture, colour, sorting, mineralogy, and the occurrence of organic macrofossils were logged in the field, following standardised soil classification methodologies (USDA

Fig. 4 Excavation trench b (location in fig. 3) showing mud brick structures and a layer of degraded mud brick similar to Unit C (after Bárta 2013: fig. 4)

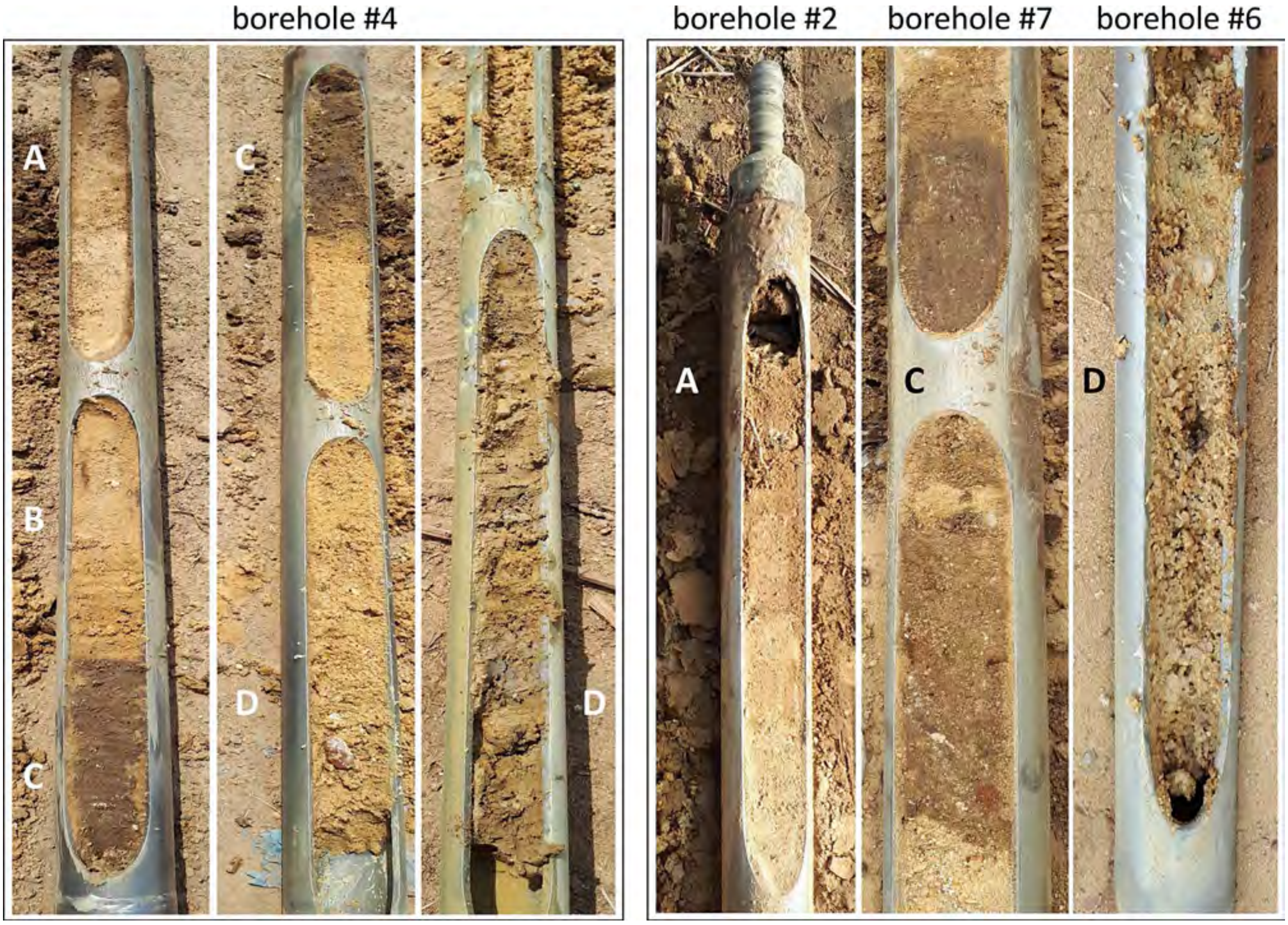

Fig. 5 Photographs of boreholes with an indication of the identified sedimentary units. Each metal window represents a 50 cm long interval of sediments (photos W. Toonen, J. Krejčí)

2017). Ceramic fragments were retrieved and studied for dating purposes. A Leica TCR805 geodetic total station was used for recording local surface elevations.

Results

All cores in the research area shared an overall similar stratigraphy with four main sedimentary units, from top to bottom; (A) the fine-grained sandy top soil layer; (B) yellow-coloured fine-grained sands; (C) a distinct layer of fine-grained grey clay-loams; and (D) poorly sorted coarse sands and gravels with occasionally also poorly sorted compact beige loams intercalated (fig. 5).

Unit A

This unit was encountered at all borehole locations and was exposed at the current surface. The thickness varied between *ca.* 40–70 cm, although it was found to be considerably thicker at borehole no. 10 with 120 cm. The texture of the moderately to poorly sorted quartz-rich sands varied between *ca.* 80–150 µm. The lower part of the unit usually contained more loams, occurring in vaguely developed cm-thick bands. The upper few centimetres, at the modern surface, contained large amounts of *halfa* grass remains and was either very dry and dusty or consisted of compacted mud crack crusts of clay-loam that formed after recent precipitation events. A weakly-developed A-horizon was present in the top of the soil, marked by its pale brown-grey colour compared to more yellow-brown in the lower part of this unit (fig. 5). Throughout the unit, low quantities (<5%) of quartz, limestone and flint pebbles were found with a maximum diameter of 10 mm. Although occasional mm-sized specks of ceramics and charcoal were present, no suitable dating material could be retrieved from this unit.

Unit B

No sharp sedimentary boundary was observed between Unit A on top and Unit B below. Unit B was mainly distinguished from Unit A by colour and texture (fig. 5); yellow-brown and 100–300 µm, respectively. Unit B was found in every borehole, with a thickness ranging between 40–110 cm. The moderately to poorly sorted sands were very rich in well-rounded quartz grains. The upper generally finer-grained part of the unit occasionally held loamy laminations, small chunks of grey Nile clay-loam and shell fragments – in agreement with the finds of Cílek *et al.* (2012). The lower part of the unit was marked by a few pieces of flint and gypsum, and a gradual increase in small quartz gravel (2–5%; max. 5 mm) with a polished surface, which has resulted from abrasion by saltating desert sand grains.

Unit C

Unit C consisted of a 20–50 cm thick layer of dark brown-grey clay-loams (50 µm). Varying amounts of yellow-brown sands of Unit B were admixed to the clay-loams. Admixed sands were both found as *ca.* 1 cm thick laminations and present as dispersed quartz grains found throughout the matrix, creating a very poorly sorted texture. Old Kingdom ceramic fragments and many small charcoal flecks were found in the upper part of this unit. Both the upper and lower sedimentary boundaries with other units were abrupt.

Unit D

Unit D formed the basal part of all boreholes; usually starting at *ca.* 1.5–2 m below the surface and continuing until the maximum coring depth. Both coarse, poorly sorted sands and poorly sorted compact loams were grouped in this unit - the latter was not present at every borehole (fig. 6). The texture of the (pale) light yellow-brown sands ranged between 500–1000 µm in the top (*ca.* 2–3 m depth) and coarsened down into quartz-rich gravel (matrix 3 mm; fig. 5). Together with this coarsening down, an increase in rounded desert-polished quartz and angular flint pebbles was seen; going from a few percent in the top section to over 20% below 3 m depth. Small quantities of limestone, pieces of gypsum and chunks of brown-grey loams were also found. At various boreholes, the gravelly sands abruptly changed into compacted loams, with a weathered appearance; its distinct kaki brown colour was marked by flecks of green and pale grey (fig. 5). The sorting of these loams, referred to as *tafla* by the workmen, was extremely poor with large quantities of sands and pieces of flint admixed.

Interpretation of depositional environments

The sedimentary sequence as found in the ten boreholes largely matches the results of Cílek *et al.* (2012). Units A and B are probably derived from the same source material, considering the similarity in quartz-dominated mineralogy and the lack of a sharp transition between both. The relatively fine-grained texture of the sands, the rounded and polished appearance of grains, and the brown-yellowish colour suggest that these units were predominantly formed by aeolian transport; most likely drift sands that were derived from the higher parts of the plateau and that accumulated on the lee-side of the local hills and cover(ed) most of the Old Kingdom (and later) archaeology. Loamy laminations and the occasional presence of gravel-sized clasts indicates that there also must have been input from the local wadi systems and hillslopes: the sediments mobilised during rainstorm events. In general, these sediments are derived from the same source material as the aeolian drift sands, explaining their overall similar appearance, albeit with a much poorer sorting and larger range in texture, spreading from loams to coarse sands.

Unit A and particularly Unit B show some indications for periodic wetness over a considerable period in the recent past. Cílek *et al.* (2012) found microscopic

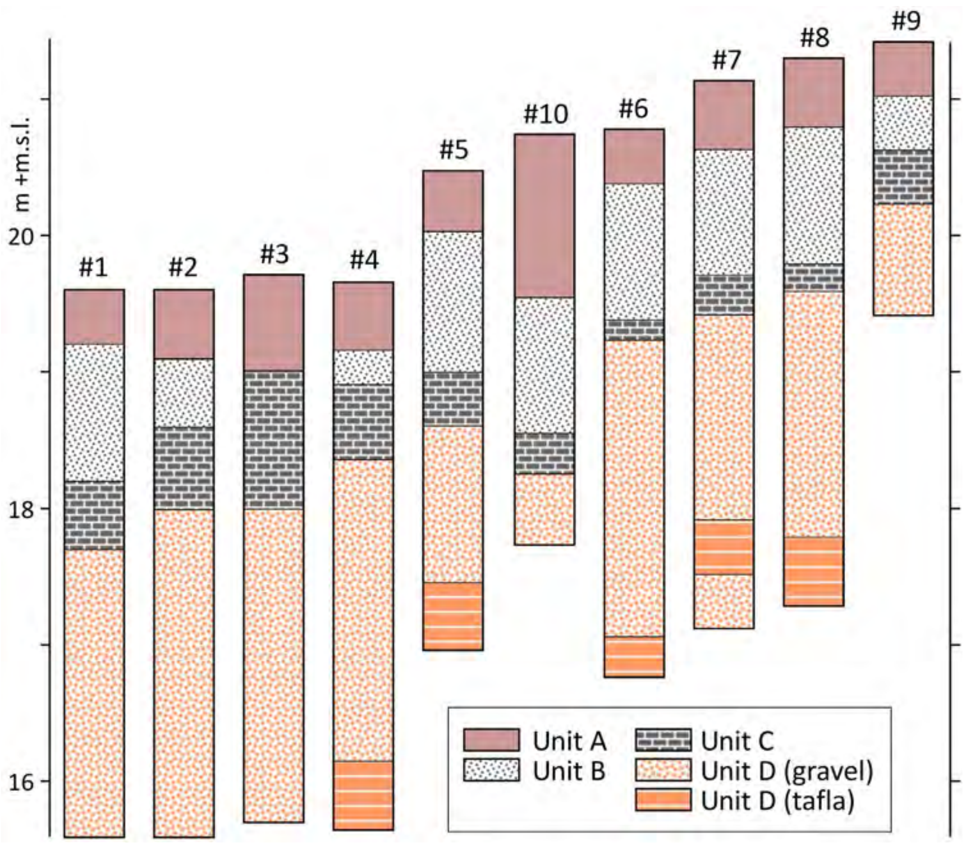

Fig. 6 Borehole stratigraphies, aligned from low (northeast) on the left to high on the right (southwest) (drawing W. Toonen)

evidence for the formation of so-called takyric horizons and the formation of gypsum salts, which they attributed to repeated wetness and desiccation. Based on the lack of additional sediment that might be expected to be introduced by flooding from the Nile, the source of water was most likely precipitation that caused local pooling and/or a rise in groundwater levels during Nile flood seasons. The prior is still occurring, evidenced by the presence of recently formed mud cracks on flat zones. The latter fits well with historical observations in the region (fig. 2).

Based on the borehole information, Unit C largely consists of typical Nile clay-loams. In a natural situation this would imply that there was depositional onlap onto the relatively high desert edge during the Old Kingdom period. Given estimated Old Kingdom floodplain surface elevations of 13–14 m +msl in the Memphite region (overview in Lehner 2009), this would require flood levels rising at least 5 m to reach the elevation of Unit C. It is assumed that regular floods reached 1–2 m above the floodplain, while extreme events with an amplitude of 4–5 m would have been extremely rare (*cf.* Seidlmayer 2001; Toonen *et al.* 2019). To produce the thickness of Unit C would require a multi-centennial period of recurring floods, taking into account the generally assumed long-term average floodplain deposition rates in the region of a few millimetres per year (overview in Lehner 2009). To our knowledge no ancient textual sources or existing study of the regional hydroclimate and Nile flood regime refers to such an anomalous period of extreme floods. Instead, the late Old Kingdom is often associated with aridification and a decline in Nile flood amplitudes (Butzer 1984; Seidlmayer 2001; Welc – Marks 2001; Stanley *et al.* 2003). Therefore, this layer of clay-loam was probably deposited by humans, and represents a layer of degraded mud bricks, similar to the observations in local archaeological trenches (fig. 4) (Bárta 2013). Pottery fragments and charcoal specks are much more abundantly present than in the other sedimentary units. A human impact also fits the extremely poor sorting of the clays with admixtures of sands – a mixture that would be rare to occur in a natural setting but that is common for mud bricks (Spencer 1979; Kemp 2000; *cf.* mud bricks used in Raneferef's mortuary temple in Abusir: Krejčí 2006).

The sediments of Unit D are derived from the local hillslopes and wadi systems. Unit D has a similar slope to the modern surface, indicating that the overall topography of the research area has not changed dramatically in the last millennia, albeit in the past with coarser deposits at the surface and slightly lower elevations above the present sea level. Based on the coarseness and mineralogy of the hillslope deposits, they are most likely derived from the quartz-rich Pleistocene fluvial terraces that flank the Holocene Nile Valley (Mahmoud – Hamdan 2002). The layers of *tafla* and pebbles of flint, limestone and gypsum are derived from the regional limestone/marl geology and were transported during activation of the wadi system during episodic rainfall events. The coarseness and thickness of Unit D compared to Unit A and B indicates that such events were of a considerably larger magnitude (and frequency) than the wadi activations of the last millennia. Given the inferred Old Kingdom age of Unit C, which is located on top of Unit D, this period of increased rainstorm activity presumably relates to the last phase of the African Humid Period (deMenocal *et al.* 2000; Woodward *et al.* 2015).

Conclusion

Based on the borehole information, it can be concluded that the observations from Cílek *et al.* (2012) and Bárta (2013) apply to a much larger zone. The same stratigraphy, with remnants of mud brick buried below deposits of a mixed aeolian and wadi/colluvial origin that contain evidence for the repeated pooling of water and desiccation, continues at lower elevations of the desert edge along the outlet of the local wadi system.

The current survey was not able to produce direct sedimentary evidence for the existence of a lake during the Old Kingdom. Only in the topsoil is there evidence to suggest the periodic existence of standing water, without a direct input of water and sediment from the Nile River. These observations align with historical observations of pooling water, but do not allow us to infer a lacustrine environment for the ancient past (*cf.* Jeffreys 2001). Firstly, because the 4 m deep boreholes reached pre-Old Kingdom deposits without finding evidence for the existence of a lake: instead, typical wadi outwash deposits were found with coarse gravel and layers of *tafla*. This rules out the possibility that a desert-floodplain interface with intermittent lakes could have existed in the investigated zone. Secondly, Unit C was dated to the Old-Kingdom and is located at 18–20 m +msl, which is significantly higher than the contemporaneous floodplain, estimated to have been positioned at 13–14 m +msl. Even extreme floods seem unlikely to have reached such high elevations or been able to induce local ponding by the rise of groundwater levels. Based on the assumed Old Kingdom Nile Valley floodplain levels at much lower elevations than the present surface, the low desert would likely have protruded laterally further into the valley, assuming a continuation of the same slope. Hence, our best guess for the location of the desert-floodplain interface with an Old Kingdom Lake Abusir would be to the northeast of the current survey, beneath the outskirts of the modern town of Abusir.

The spread of Unit C is particularly interesting, as it has been associated with a mud brick feature or a zone of structures spread across the wadi mouth, following the natural topography. Bárta (2013) raised the suggestion that such features could be related to boat-landing facilities, and if the 300 m wide zone of investigation indeed represents human activity at the waterfront, this could be an indicator for the nearby presence of a lake that was suitable for navigation at least during part of the year. At Giza, Old Kingdom waterfront terraces and the so-called "Workers Town" were found around 15–16 +msl, which roughly coheres with the elevations of the mud brick structures at Abusir, considering the Nile Valley gradient and the position of our survey slightly higher up the desert edge.

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