Editorial

Laminated lake sediments are considered as high-resolution archives of past climatic and environmental conditions (see Renberg, 1983; Saarnisto, 1986, 1991; Sturm and Lotter, 1995; Bradbury *et al.,* 1996; Kemp, 1996; Lamoureux and Bradley, 1996; Wohlfarth *et al*., 1998; Hughen *et al.,* 2000; Brauer, 2004; Zolitschka, 2007; Wanner *et al.,* 2008; Bauer *et al.,* 2009; Francus *et al.,* 2013; Ojala *et al.,* 2013). Fossil lacustrine deposits enable to obtain an absolute chronology and an almost continuous time scale, in the case of the Holocene based mostly on radiocarbon datings (Brauer *et al.,* 1999, 2000; Lamoureux, 2001; Enters *et al.,* 2006). In some cases, stable sedimentary conditions in the lakes favor formation of undisturbed sediment sequence with annual lamination (varves) (Chu *et al.,* 2005; Tylmann *et al.,* 2012). Another advantage is a relatively high sedimentation rate estimated from 0.3 to a few millimeters per year, which gives a possibility to trace any changes in lake environment within a few months or a year (Petterson *et al.,* 1993; Valpola and Ojala, 2006) (Fig. 1). Finally, full cores of fossil lake sediments offer possibility to perform comprehensive laboratory studies which allow tracing even small environmental and climate changes, especially during the Holocene (Dean *et al.,* 1999, 2001; Elbert *et al.,* 2012; Czymzik, *et al.,* 2009; Last, 2001; Smol *et al.,* 2001; Tiljander *et al.,* 2002; Welc, 2016).

Palaeoclimatic data provided by lake sediments can be also successfully correlated with archaeological and geoarchaeological proxy, what allows to grasp relationships between subsequent phases of development and collapse of ancient cultures and civilizations in context of natural environment transformations, especially a climate change (it should be noted here, that although it seems obvious that ancient cultures were influenced by climate changes, this issue has only recently been initiated in profound multidisciplinary investigations) (see Ralska-Jasiewiczowa *et al.,* 1998; Weiss, 2000; Weiss and Bradley 2001; Zolitschka *et al*., 2003; Staubwasser, Weiss 2006; Kröpelin, 2008; Welc and Marks, 2014).

Studies of lake and paleolakes sediments are particularly significant in desert and semi-desert areas where there is usually a lack of high resolution paleoclimatic proxies. North-eastern Africa belongs to such regions. At present, Egypt and Sudan are located in a hyper arid desert zone, however past climatic conditions were significantly different from the present one. Palaeoclimatic and geoarchaeological data collected so far suggest clearly that transformations of the natural environment resulted mostly from north-south migration of the monsoon rain belt (Intertropical Convergence Zone = ITCZ) (Welc, 2016).

In effect of migration of ITCZ zone to the north, during early and middle Holocene in southern Egypt and northern Sudan numerous freshwater lakes have developed. They were identified in almost the whole area of the present Western Desert. The geological map of Egypt (1: 500,000) reveals that playa sediments filled extensive depression mostly at the foot of high cliffs, rock walls and the edge of

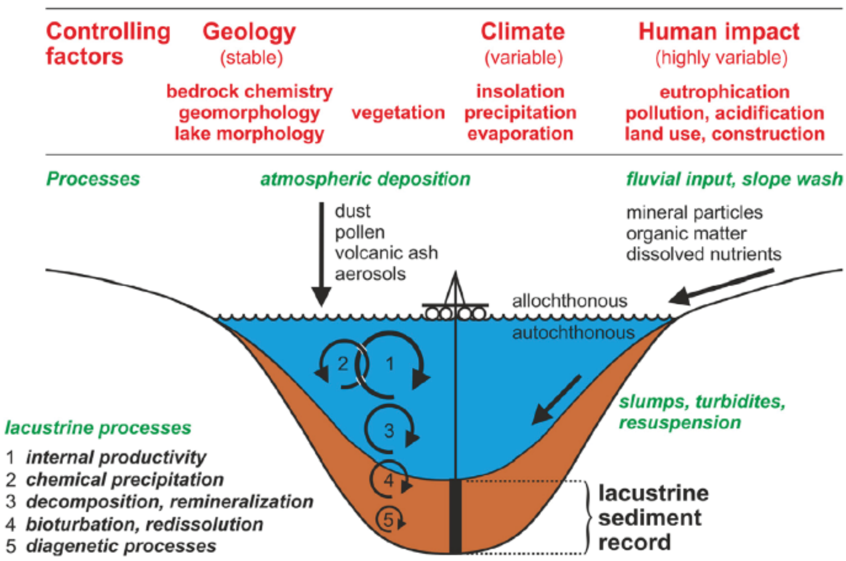

Fig. 1. Scheme depicting main controlling factors and formation process of the lake sediments (after Zolitschka *et al.*, 2015).

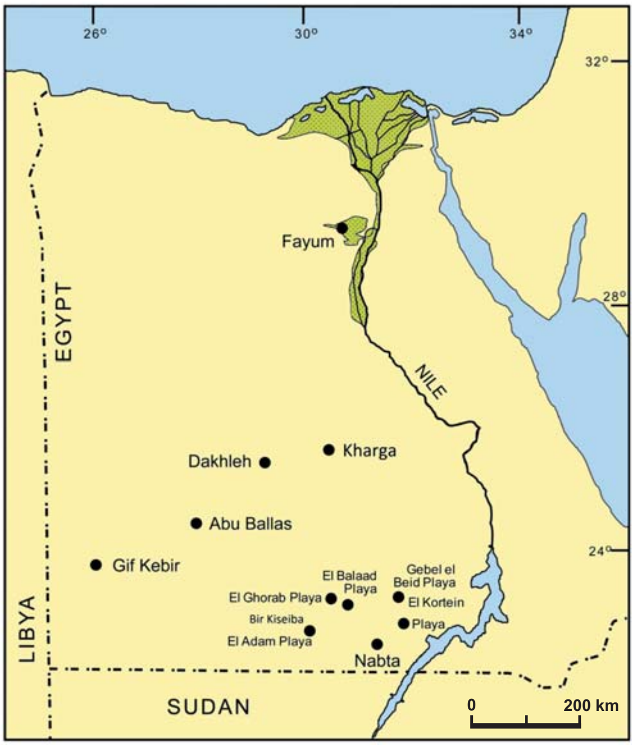

Fig. 2. Map of Egypt showing most important archaeological sites connected with plays deposits and major Oasis located on Western Desert.

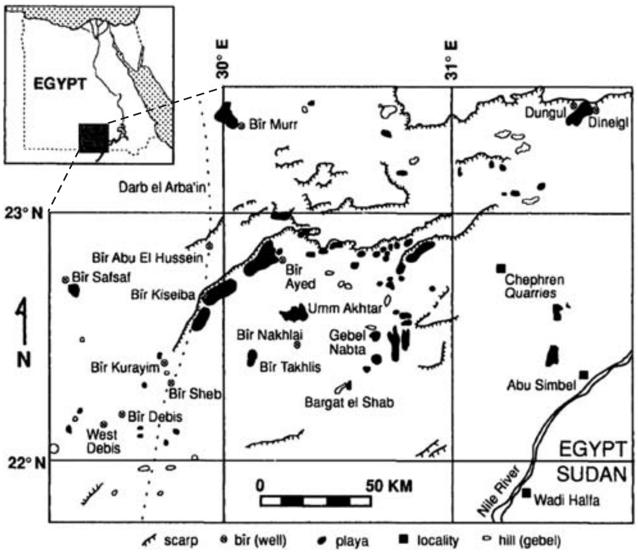

Fig. 3. Major playa preserved on south Western Desert detected by archaeological surveys and satellite data analysis (after Nicoll, 1988).

desert plateaus. In southern and central Egypt over hundreds sites with playa are still preserved (Embabi, 2004) (Fig. 3). Only in the Farafra Oasis area, geological maps and surface surveys enable to estimate a total number of such sites to be over 100 with a total surface area of approximately 500 km² (El-Rashidi, 2002).

The largest playa are located in the southern part of the Western Desert, among others in Bir Tarfawi, Bir Sahara and Nabta Playa (Figs 2–4). Another large ensemble of fossil lake sediments has been preserved to the south of Kharga (Fig. 2) depression and along Darb Al-Arb'ain (Embabi, 2004). During last decades playa sites were extensively mapped and studied by numerous expeditions, especially in the area of Abu Ballas (Pachur and Röper, 1984), Gilf Kebir (Kröpelin, 1989), Bir Kiseiba and Nabta Playa (Wendorf and Schild, 1998; Wendorf *et al.,* 2001). (Figs 2–5). The compressive studies of archaeological sites in the context of playa sediments in Bir Tarfawi, Nabta Playa and Bir Kiseiba regions allowed a creation of the first detailed environmental change scenario and correlated it with phases of past human settlements in south-western Egypt during Holocene (Schild and Wendorf, 2001, 2013). Numerous dry and wet pulsations dating back to the Early, Middle and late Holocene were detected and placed in a proper chronological order (based on ^{14}C and TL datings). These episodes reflect stabilization of the summer mon-

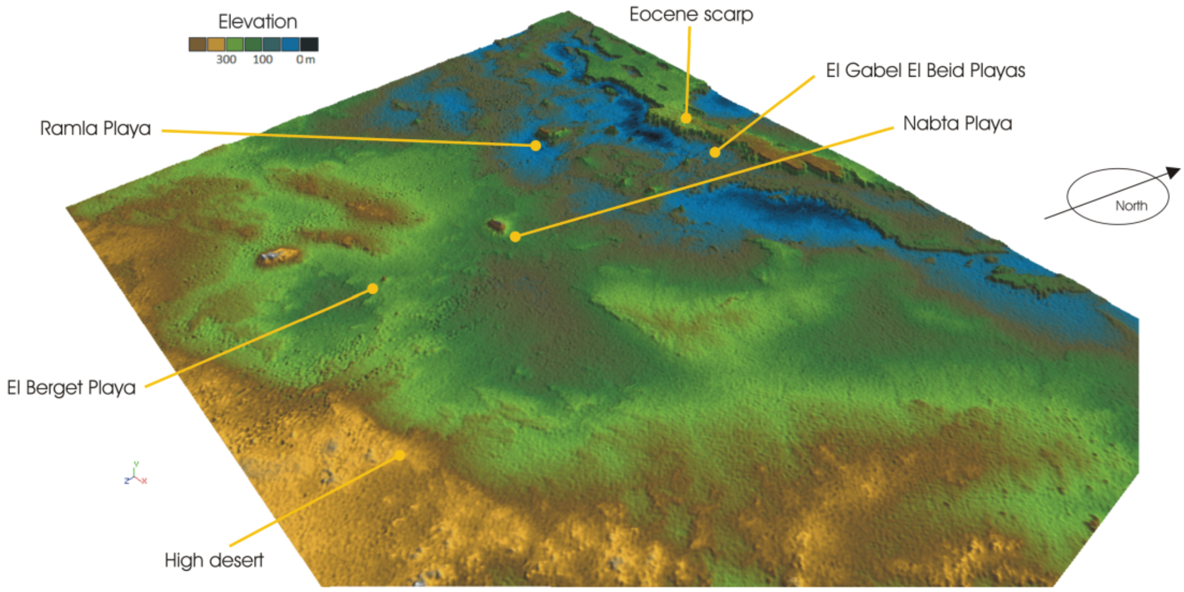

Fig. 4. Digital map – DEM, based on Landsat 8 data, showing major playa preserved on south Western Desert in Nabta Playa region (drawing F. Welc).

soon season ca. 10 ka cal BP and the gradual disappearance of the monsoon rains ca. 6 ka cal BP. However, this process was not linear, as evidenced by several short dry episodes. Finally, palaeoclimatological and geoarchaeological research in the Nabta eegion allowed distinguishing 7 wet main pulsations (summer monsoon advance to the north) (Schild and Wendorf, 2013, see table below).

It should be emphasized that vast majority of the playa sections which has been preserved on the Western Desert in Egypt are very fragmentary and have numerous gaps due to long-term erosion and deflation. This situation created a need for continuous and undisturbed column of lacustrine sediments from Egypt, covering the entire period of the Holocene. Therefore, in 2013 the Nile Climate Change

Date	Name of climatic informal unit	Climate	Depositional environment	Past human activity	Archaeology
Younger Dryas	Pre-El Adam phase	Hypothetical arid phase	Eolian activity.	Desert abandoned by humans.	
Ca. 11.2–9.9 cal. ka BP	El Adam interphase	Humid	Emergence of photogenic dunes followed by sandy playas. Contracted desert.		Early Neolithic
Ca. 9.9–9.5 cal. ka BP	Post El Adam phase	Arid	Interstratified eolian sand bed in playa deposits.	Desert abandoned by humans.	Middle Neolithic
Ca. 9.5–9.1 cal. ka BP	El Ghorab interphase	Humid	Silty and sandy playa were deposited. Contracted desert.	No houses remains or storage pits were found in Nabta Playa region.	
Ca. 9.1–8.9 cal. ka BP	Post El Ghorab phase	Arid	Eolian erosion in El Adam Playa. Eolian sand deposition between El Ghorab and Nabta. Contracted desert.	No human presence on desert.	
Ca. 8.9–8.1 cal. ka BP	El Nabta / El Jerar interphase	Humid – local climatic optimum in Nabta region.	Maximum of local precipitation, reduced silt deposition due to vegetation cover, small permanent lakes, extensive semi-sedentary settlements. Dry savanna with desert and semi-desert animals predominated.	Oval huts with storage pits and big settlements appeared in Nabta Playa region with association of dotted wavy line decorated pottery. Human existence on desert throughout the year. Most probably sorgo was cultivated in Nabta region.	
Ca. 8.1–7.9 cal. ka BP	Post El Jerar phase	Arid – 8.2 ka event	Sharp reduction of the vegetation, increased eolian erosion, violent seasonal rains, intensive clastic deposition in playa basins.	No human presence on desert.	
Ca. 7.9–7.5 cal. ka BP	Ru`at El Ghanam interphase	Humid	Development of phytogenic dunes, local rains resulting in surface washes.	Sheep, goat and domestic caprovids appeared in Nabta region. Large, bell – shaped storage pits and abundant grinding stones are very frequent kind of findings in Nabta area. Houses are round in outline often with slabed-lined walls.	
Ca. 7.5–7.4 cal. ka BP	Post - Ru`at El Ghanam phase	Arid	Massive eolian erosion.	No human presence on desert.	
Ca. 7.4–6.6 cal. ka BP	Ru`at El Baquar interphase	Humid	Alluvial deposits in wadis and closed basins.	In the Nabta Playa area cult and ceremonial installations appeared, among them most important is so called “calendar circle”, which may have had astronomical functions. Cult of cattle is also widespread in Nabta region.	Late Neolithic
Ca. 6.6–6.5 cal. ka BP	Post-late Neolithic Arid phase	Arid	Deflational basins.	Sparse human occupation on desert.	
Ca. 6.5–5.5 cal. ka BP	Bunat El Asnam interphase	Humid	Seasonal rains and alluvial washes.		
Ca. 5.5–4.7 cal. ka BP	Post-Neolithic arid phase	Arid	Sparse human occupation on desert.		
Ca. 4.7–4.3 cal. ka BP	Hyper arid phase	Arid	Hyper arid desert.		
Ca. 4.3–3.3 cal. Ka BP	Humid interphase	Relatively humid	Rare local rains.		

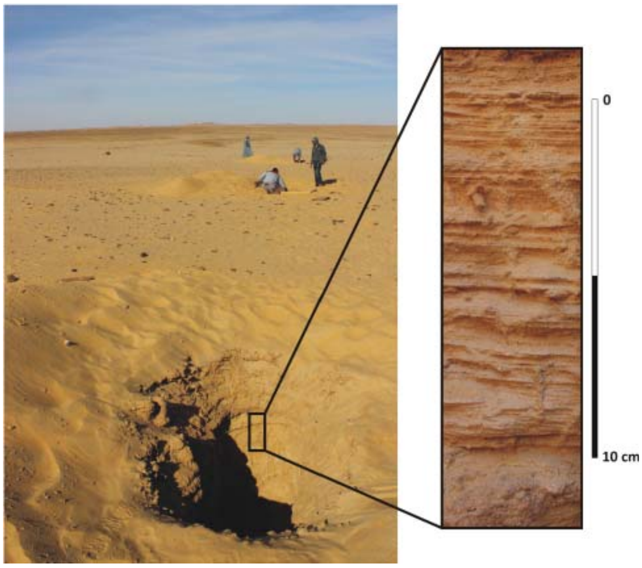

Fig. 5. Early Holocne silty – sand laminated lake sediments studied in El Berget area, south of Nabta Playa (photo F. Welc).

Project (NCCP) was initiated, founded by the National Science Centre (DEC-2012/05/B/ST10/00558, ID: 185179, OPUS, ST10) (Marks *et al.*, 2016, 2017; Welc, 2016). The main objective of the project was a reconstruction of the Holocene climate fluctuations in Egypt based on research of lacustrine sediments from Nile Delta and especially from the Faiyum Oasis. At present time, the Faiyum occupies a natural depression modeled by deflation during the late Pleistocene. In its northern part there is the shallow and hyper-saline Qarun Lake, a relic of a vast Holocene freshwater reservoir (Figs 6–8). Without any doubt the injection of the Nile water into the depression in the Early Holocene was due to reactivation of a summer monsoon in the Ethiopian Highlands. At that time a vast lake developed in a central part of the Faiyum Oasis. During the annual floods the river water fed the lake, favouring deposition of mineral-organic sediments. These deposits constitute a unique archive of late Quaternary palaeoclimatic data for the northern (lower) part of the Nile Basin. The dynamics of hydrological and climate changes in the Nile Basin are

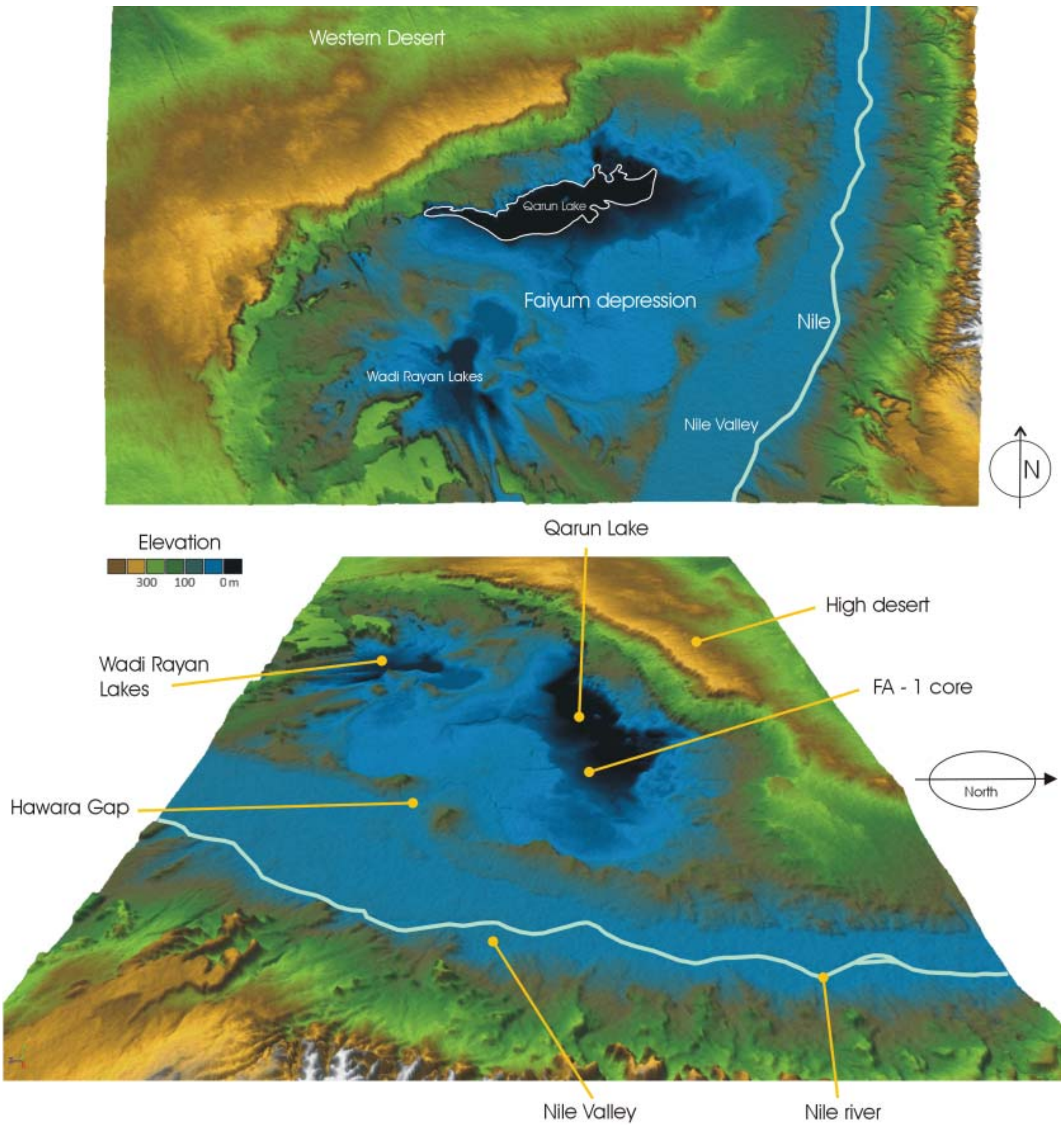

Fig. 6. Digital map – DEM, based on Landsat 8 data, showing Faiyum depression and Qarun Lake preserved in its northern part (drawing F. Welc).

Fig. 7. Photos showing drilling of the core FA-1 on the southern shore of Lake Qarun and general view of the Lake form its southern shore (photo F. Welc).

reflected in the lithological and geochemical characteristics of the sediments deposited in the Faiyum, because freshwater filling of the depression have changed concordantly with fluctuations of the Nile waters, which in turn resulted from varying intensity of the Indian monsoon reaching Ethiopian Highland (Welc, 2016).

Correlation of high-resolution palaeoclimatic data from the Fayum Nile Delta and those from the Western Desert will be one of the most important scientific challenges in the future. It will allow to create a coherent scenario of climate change with the background of past human settlement transformations in North-East Africa, especially for area of Egypt and Sudan. In order to initiate discussions on this topic in Warsaw has been organized in 2016 Fourth Geoarchaeological Conference, entitled *Late Pleistocene and Holocene climatostratigraphy of Northeastern Africa reflected in lake sediments and geoarchaeological data.* The Conference was devoted among others the issues connected with playa sediments preserved in Egypt and Sudan with background of past human settlement. The meeting was held in Institute of Archaeology Cardinal Stefan Wyszynski University in Warsaw (8–9th April, 2016) under scientific patronage of the International Commission of the Later Prehistory of Northeastern Africa, Committee on Quaternary Research of the Polish Academy of Sciences and National Committee of INQUA. The main goal of the conference was to initiate discussion concerning development of uniform climatostratigraphic subdivision for the area of Northeastern Africa in Late Pleistocene and Holocene, based on wide range of geoarchaeological data. Submitted papers presented results of field and laboratory research of the lacustrine sediments form Egypt and Sudan,

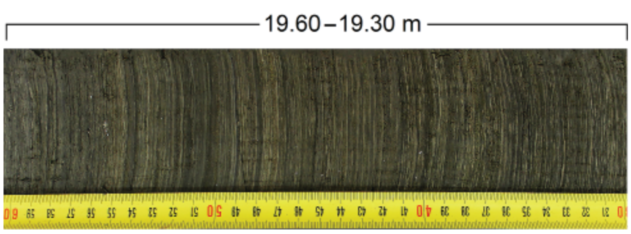

Fig. 8. Laminated fragment of the core FA-1, dated to the early Holocene (photo F. Welc).

carried out with a broad range of methodologies including sedimentological, palaeobotanical and others. Paper were presented by specialists actively involved in interdisciplinary archaeological projects in Northeastern Africa from Poland, Czech Republic, Germany, UK, Egypt and United States. The most interesting presentations are presented in this volume of *Studia Quaternaria*.

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