# CAHIERS DE KARNAK

13

CFEETK

Centre franco-égyptien d'étude des temples de Karnak

Cairo

2010

Centre franco-égyptien d'étude des temples de Karnak

CSA/USR 3172 du Cnrs

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Presses du Conseil Suprême des Antiquités de l'Égypte

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# GEOMORPHOLOGICAL INVESTIGATIONS IN THE WESTERN PART OF THE KARNAK TEMPLE (QUAY AND ANCIENT HARBOUR). FIRST RESULTS

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RECENT PAPERS showed an important mobility of the Nile River in the neighbourhoods of Ancient Karnak and in Upper Egypt.[1] Recent excavations realized by the Supreme Council of Antiquities in front of the first Pylon of the Amun-Ra Temple, close to the tribune, highlighted the presence of a large harbour complex, which was certainly connected to the Nile River in the past. Archaeological and architectural researches led in the late 1960s have already provided information leading to an understanding of some aspects of the harbour and its function.[2]

Few geomorphological investigations have been done to reveal the stratigraphy and the palaeoenvironmental conditions before, during and after the use of the ancient port. In doing so, it was decided to analyse stratigraphical sections and to realize several manual auger boreholes, accurately levelled using a Total station where geographic coordinates are expressed in the local grid.

The first step of this paper is to show the preliminary results of these investigations and the second step is to present the forthcoming laboratory techniques which could help obtain some accurate palaeoenvironmental reconstruction of the area and the successive displacements of the Nile River westward to Amun-Ra temple. This include sedimentological analyses: grain-size distribution using sieving method and magnetic susceptibility measurements using a Bartington MS2B dual sensor at low and high frequencies, both analyses will be done in the laboratory of the ARCE in Karnak. As well as palaeobotanic identification and radiocarbon dating (14C dating) performed on charcoal and ash samples (both analyses will be realised in the framework of a partnership developed between the CFEETK and the IFAO). Finally, the last step will consist of obtaining precise chrono-stratigraphic sequences for the "pre-ptolemaic" periods and to establish annual sedimentation rates. The extension of the project to other ancient settlements, well known for their connections to the Nile River and for the existence of harbour structures (the Theban Palladium which associate the settlements of Medamud and Tod, and Dendara; **fig. 1**), will provide a better appreciation of the river displacements from the Holocene period in Upper Egypt and their consequences on human occupation.

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[1] J.K. Hillier, J. Bunbury, A. Graham, "Monuments on a migrating Nile", *Journal of Archaeological Science* 34, 2007, p. 1011-1015 ; J. Bunbury, A. Graham, M.A. Hunter, "Stratigraphic Landscape Analysis: Charting the Holocene Movements of the Nile at Karnak through Ancient Egyptian Time", *Geoarchaeology* 23/3, 2008, p. 351-373; J. Bunbury, A. Graham, K. Strutt, *Karnak Land- and Waterscapes Survey 2008 Season*. Report for the Centre Franco-Égyptien d'Étude des Temples de Karnak. p. 16.

[2] J. Lauffray, "Abords occidentaux du premier pylône de Karnak : le Dromos, la tribune et les aménagements portuaires", *Kêmi* 21, 1971, p. 77-144 ; J. Lauffray, S. Sauneron, Cl. Traunecker, "La tribune du quai de Karnak et sa Favissa. Compte rendu des fouilles menées en 1971-1972 (2e campagne)", *Karnak* 5, 1975, p. 43-76.

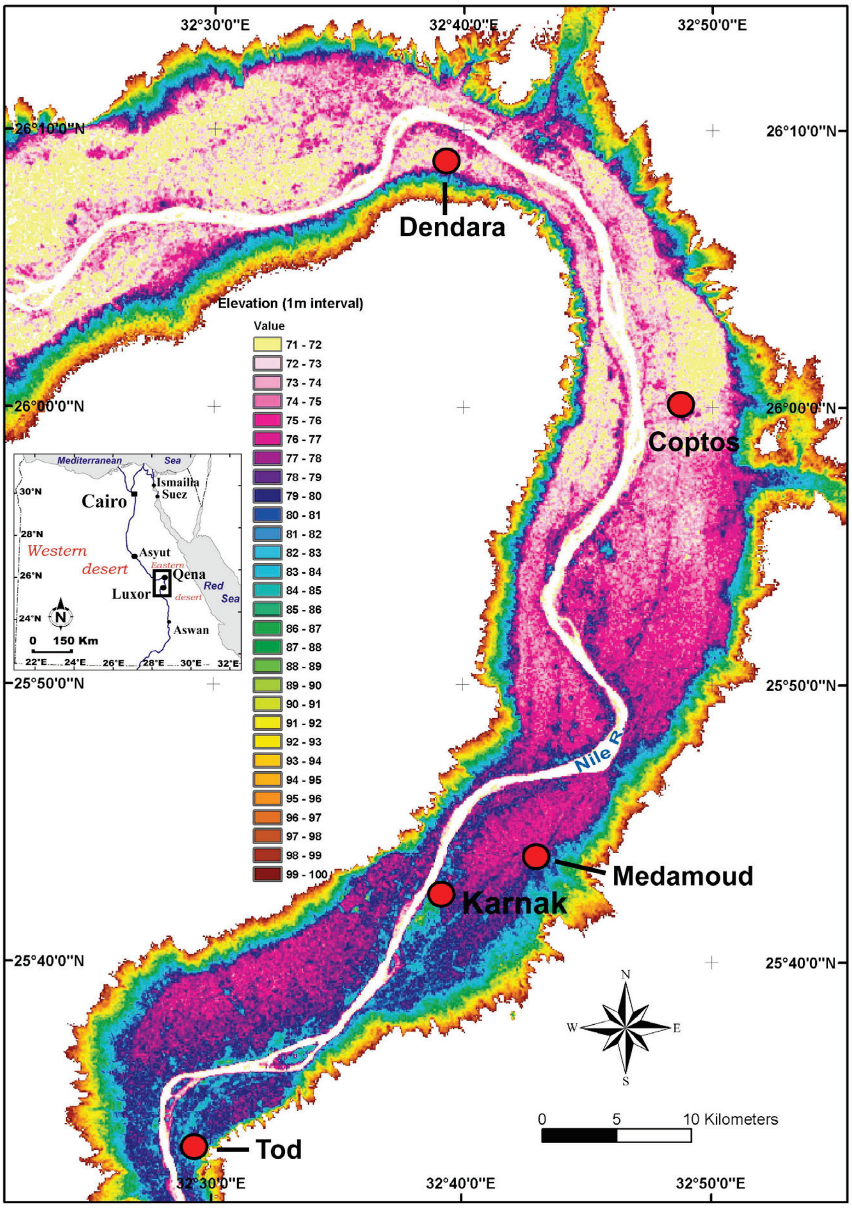


**Fig. 1.** Location map, the topographical informations (S.R.T.M. data) were computed with the help of a GIS, the projection system is expressed in U.T.M. W.G.S. 84.

## 1. Archaeological evidence of harbour infrastructures in Karnak

The first observations and investigations, close to the ancient harbour, were made at the beginning of the 19th Century, and the deepest excavations reached sediments ascribed to Roman times. Later, in the 1920s, G. Legrain focused his research on the tribune and its western face.[3] He concluded that the edifices discovered were constructed between the 19th Dynasty and Roman times. In addition, H. Chevrier excavated the area in the 1930s.[4]

The most relevant work was reported in the early 1970s;[5] this included complete archaeological, hieroglyphic and topographic studies of the tribune, the quay and the ramp. Initial investigations revealed for the first time the shape of the ramp and its dimensions (length: 18 meters; width: 9.40

[3] G. LEGRAIN, *Les temples de Karnak*, Bruxelles, 1929, p. 3-27.

[4] H. CHEVRIER, "Rapports sur les travaux de Karnak (1927-1928)", *ASAE* 28, 1928, p. 124.

[5] J. LAUFFRAY, *Kêmi* 21, 1971, p. 83.

meters; general slope: 14%; distance between the lower part of the ramp and the first pylon: 53.50 meters). J. Lauffray[6] proposed an interesting perspective view of the area surrounding the tribune where a quay built with large sandstone blocks seems to be the western limit of the temple.

After careful scrutiny of the references mentioned above, it appears that the harbour was directly connected to the Nile River. Questions arise concerning the shape of the port: it is generally thought that a basin was constructed in front of the tribune, but until now there is no evidence of such edifice and the actual archaeological excavations led by the SCA do not confirm this hypothesis.

The aim of this paper is to reconstruct the palaeoenvironmental history of the area at the foot of the tribune and of the quay. The interpretation of stratigraphic sections obtained by manual augering will allow a better understanding of the mobility of the Nile River and reveal potential lake/swamps occupation in front of the first pylon.

## 2. Preliminary results derived from stratigraphic profiles and manual auger analyses

### 2.1. Stratigraphic profiles

Five sections were precisely located (**fig. 2**) and levelled. The five stratigraphic profiles obtained have been carefully analyzed, taking into account the geomorphological features and the presence of remaining archaeological artefacts.

The stratigraphic profiles SP1, SP2 and SP3 (**fig. 3**) are located in front of the ancient harbour (at the foot of the ramp and south of the tribune) and their elevations range from 70.659 m (base of SP3) to 72.791 (top of SP1). All the sequences record fluvial sediments, ranging from clay to sand deposits. The longest section (**fig. 3**) clearly indicates fluvial dynamics: coarse sands, well bedded reveal a high energy environment. Some silt layers also occur with clay intercalations at the top, indicating the occurrence of flood events with a lower energy. In addition, the presence of sandstone (debris) beds reveals the human adaptation to these flood episodes. Indeed, debris coming from the sculpture of large sandstones blocks were deposited over the flood sediments in order to reclaim the area during a period when the harbour was not used any more: perhaps because of a Nile River migration to the west. Three samples were collected for 14C dating on SP1, on SP2 (ash layer) and on SP3 (charcoal layer).

The stratigraphic profiles SP4 and SP5 (**fig. 4**) are located between the first pylon and the ancient harbour, below the highest blocks (in elevation) which form the ramp. The elevations range from 71.529 to 73.519 meters above sea level. Due to their position (below the harbour infrastructures) the sediments are older than those from SP1, SP2 and SP3 which are contemporary with the construction of the harbour. Alluvial sequences are recorded: silts alternating with clay deposits, potsherds and charcoal are found embedded. Charcoal samples were collected from SP4, at an elevation of 72 meters, for 14C dating.

[6] J. LAUFFRAY, *Kêmi* 21, 1971, p. 84.

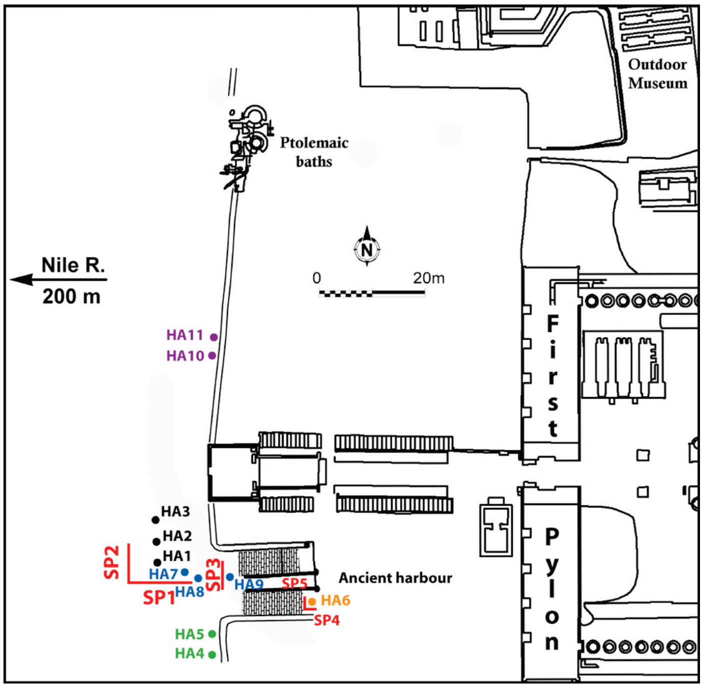


**Fig. 2.** Location map of the stratigraphical profiles (SP) and of the manual auger cores (HA).

### 2.2. Manual auger boreholes

A series of eleven manual auger boreholes, up to a maximum depth of 3.50 meters, were obtained (ten to the west and one to the east of the ramp, see **fig. 2** for exact location) and are detailed in the present paper (**fig. 5**, **6** and **7**). The equipment (Eijkelkamp) was kindly given by Yann Tristant (IFAO). Due to water table presence around 70-71 meters in absolute elevation, it was not always possible to collect sediment samples (remixing of sediments caused by water disturbance). For HA4, HA5, HA10 and HA11, the lower part of the boreholes is estimated at circa 69.20 meters, and in all cases an impenetrable structure (blocks?) was reached (**fig. 6** and **7**). Similar observations were made for HA2 and HA3 where the bottom of the boreholes is levelled at circa 68.50 meters high. J. Lauffray[7] mentioned the presence of a possible large base composed by blocks which was probably used during periods when the Nile was low. On this base, the actual discovered quay was built with sandstones blocks to prevent high levels during flood events of the Nile. Further investigations are needed to reveal the architecture of the quay. In every manual auger boreholes potsherds were found, from the top until the bottom: due to their small size, it is not yet possible to estimate their age.

Initial sediment analyses, based on texture and colour, indicate that fluvial dynamics are predominant. The sequences record alternating layers of silt and clay sediments; there is no evidence of a lake/swamps occupation.

## 3. Forthcoming laboratory analyses

### 3.1. Grain-size analysis

Approximately 250 samples, derived from stratigraphical profiles and manual augering, were collected. Subsequently they will be weighed and sieved under dry conditions (room temperature) and separated into different fractions corresponding to coarse, medium and fine sands, silts and clays. The

[7] J. LAUFFRAY, *Kêmi* 21, 1971, p. 83.

laboratory facilities provided by the American Research Centre in Egypt (ARCE) will significantly contribute obtaining rapid results for sedimentological purposes (percentages of clay, silt and sand). All samples have a weight of approximately 100 gr.

### 3.2. Magnetic susceptibility measurements

Magnetic susceptibility measurements will be made on the samples used for grain size distribution. A Bartington Instrument MS2B dual sensor will be employed at low and high frequencies in order to obtain important indications about the content of magnetic minerals in the different sediment fractions. Plastic pots of 10 $cm^3$ will contain the samples to avoid any contamination. The results will be expressed on a mass specific.

Magnetic parameters are very commonly used for geomorphological studies such as: in a fluvial context, in order to distinguish sediment contributions from different drainage basins, to “fingerprint” individual river sediment signatures[8] and to characterize human impact on slope dynamics. The relationship between grain-size distribution and magnetic properties will help to determine sediments provenance (*wadi* contribution for example).

Partnership with the University of Liverpool and the Laboratory of Environmental Magnetism (Dir. Jan Bloemendal) is planned, and well experienced scientists will be invited to analyse and to help in the interpretation of the results.

### 3.3. Palaeobotanic study and 14C dating

Around 15 charcoal and ash samples were collected from the stratigraphical sections; due to laboratory constraints, the minimum weight considered was 15 gr. All the samples, separated from the sediments were wrapped in aluminium foil for treatment during first semester of 2009. A palaeobotanic analysis of the different burnt wood species may help to characterize the type of local vegetation. In the meantime, radiocarbon dating performed on the selected samples (charcoals and ash) will give an age (14C conventional dating method) and will allow accurate reconstruction of the palaeoenvironmental evolution using chronostratigraphic sequences. Calibration will be a very important step of the research program, as well.

## 4. Other perspectives of researches from a regional standpoint

### 4.1. Study of Nile River migrations in Upper Egypt during Historical times

We propose to extend the present study focusing on the ancient harbour of Karnak to other temples presenting similar port infrastructures (**fig. 1**): Dendara to the north (*circa* 47 km), Medamud to the north-east (*circa* 5 km) and Tod to the south-east (*circa* 24 km).

The plan of the project presented by the CFEETK for the next four years aims to conduct geomorphological investigations close to all of these ancient temples where harbour infrastructures were described or just observed. The large scale of study and the great amount of data collected will require a Geographic Information System approach focusing on Upper Egypt. This will include different layers such as the geological and tectonic backgrounds since it appears that in this area the

[8] M. GHILARDI, S. KUNESCH, M. STYLLAS, E. FOUACHE, “Reconstruction of Mid-Holocene sedimentary environments in the central part of the Thessaloniki Plain (Greece), based on microfaunal identification, magnetic susceptibility and grain-size analyses”, *Geomorphology* 97/3-4, 2008, p. 617-630.

course of the Nile is largely under tectonic influence and the Holocene displacements of the Mediterranean's largest river can not be attributed to just climate oscillations. Indeed, architectural studies developed in Dendara clearly show seismic events creating strong displacements of the blocks/walls.[9]

Other methods including topographical surveys of the different sites will aid in the precise levelling of the different harbours infrastructures, as well for the stratigraphical information.

Finally, combining the results coming from the geomorphological investigations and the data delivered by the GIS geodatabase, will offer the possibility of geomorphological mapping of Upper Egypt. This will include mapping the active channel course and of the relict landforms of the Nile River (meanders, ancient levees, swamps, etc.). The palaeoenvironmental reconstruction will also associate the *wadi* (intermittent tributaries of the Nile) where it is possible to better understand the climate/rainfalls changes during the Holocene period.

### 4.2. Extent of the research on Prehistoric/Neolithic Times

Actual research led by the IFAO (Coordinator of the project: Laure Pantalacci, scientist involved: Yann Tristant) on the settlement of Coptos (35 Km N/NE of Karnak, see **fig. 1** for location) will complete the reconstruction of the entire Late Pleistocene/Holocene evolution of the Nile River in Upper Egypt.

Additional stratigraphic sequences obtained with the help of manual auger boreholes and geologic trenches will give the opportunity to start laboratory analyses comprising grain-size distribution, magnetic parameters measurements and 14C dating. A complete palaeoenvironmental reconstruction of the last 20 000 years, in Upper Egypt, will allow understanding of the relationship between landscape evolution and human adaptation to the Nile River dynamics.

### 4.3. Creation of a regional atlas

The idea of integrating and associating data from different disciplines (e.g. archaeology, architecture, epigraphy, topography, geomorphology, geology and earth/geo sciences) will provide the opportunity to better understand the relationship between the human occupation of Upper Egypt and the landscape evolution. Many questions are still under consideration and we can cite some as examples: was the pharaonic civilization confronted by major "natural" catastrophes such as earthquakes, violent flood events? What was the role played by the *wadi* intermittent streams (and potential tributaries of the Nile River) in the sedimentation of the valley, and were they more active than today?

### 5. Acknowledgments

Mansour Boraik is thanked for according the permission to collaborate and to work with the SCA in front of the first pylon during the archaeological excavations.

The authors are grateful to Yann Tristant (IFAO), for letting us use his manual auger and for his precious advices.

Quentin Lebel is warmly acknowledged for his help in coring during October-November 2008, his kindness was highly appreciated, as well.

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[9] P. ZIGNANI, "Une culture sismique dans l'architecture des pharaons, de Djéser à la période gréco-romaine", *Verba manent*, *CENiM* 2, Montpellier, 2009, p. 455-467.

Antoine Marmousez and Claire Filiaggi are acknowledged for the topographic surveys realised during October-November 2008.

The Director of the IFAO, Laure Pantalacci, is personally acknowledged for her support in the research program and in facilitating the palaeobotanic and 14C analyses.

Jan Bloemendal, Director of the Laboratory of Environmental Magnetism, University of Liverpool and Keli Alberts (Chicago House, Luxor) are thanked for their fruitful comments, advices and for improving the writing style.

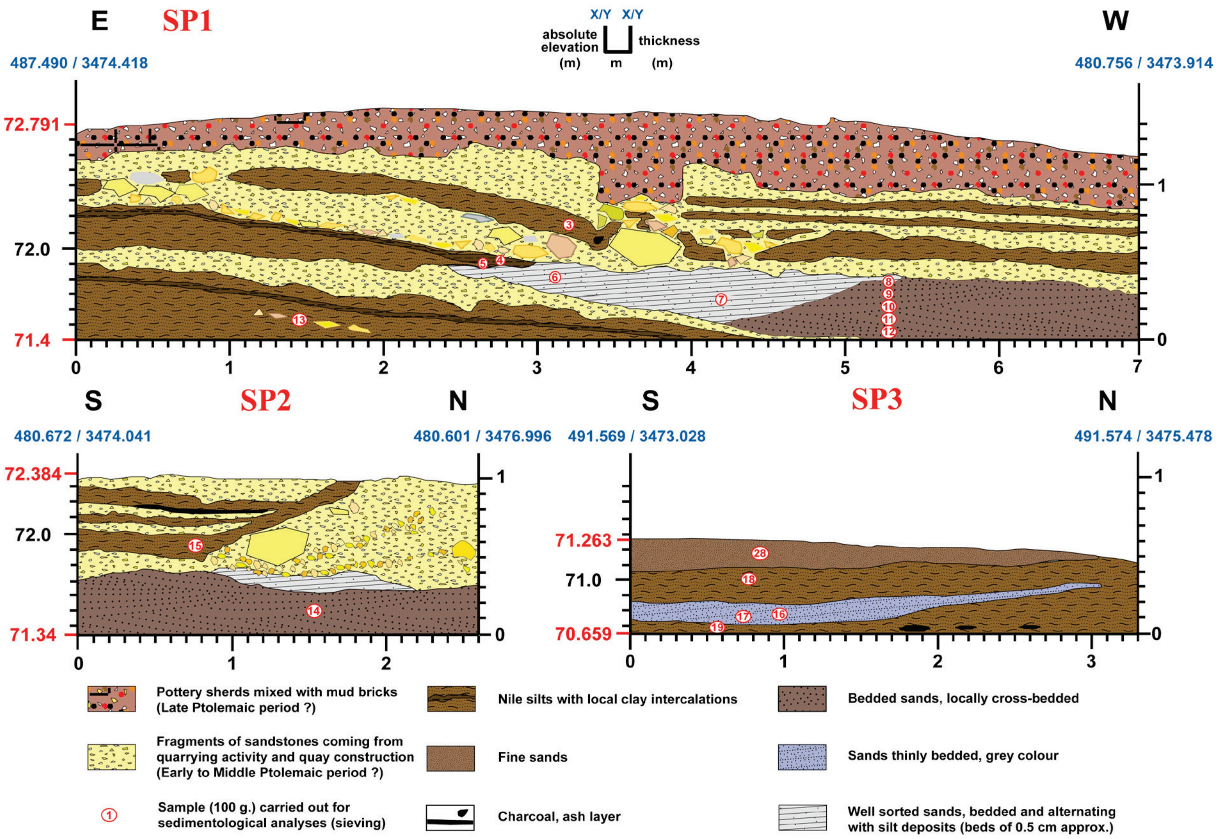


**Fig. 3.** Stratigraphical profiles SP1, SP2 and SP3.

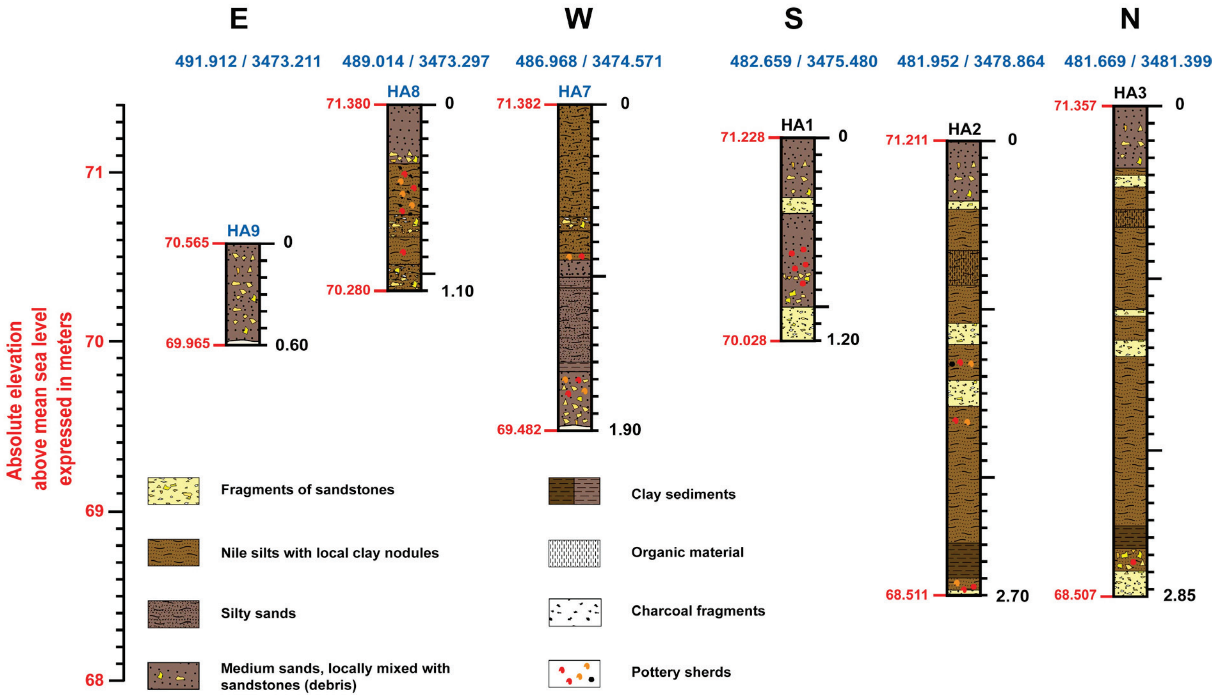


**Fig. 4.** Stratigraphical profiles SP4 and SP5.

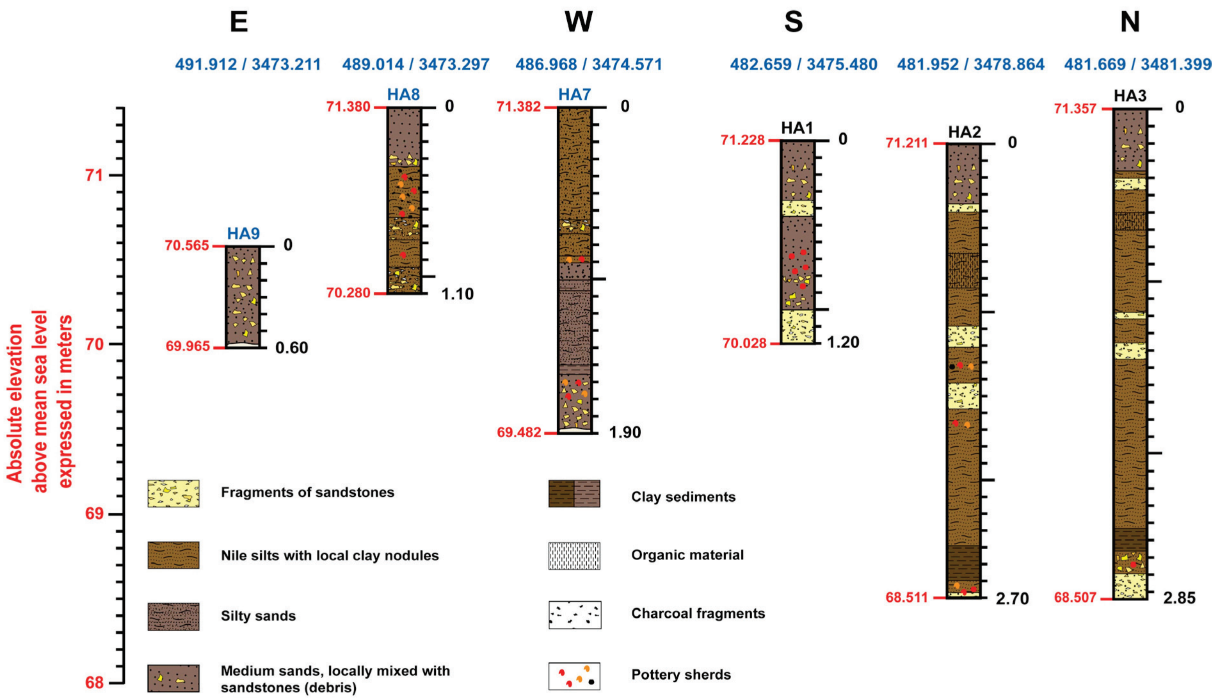


**Fig. 5.** Core profiles of HA1, HA2, HA3, HA7, HA8 and HA9.

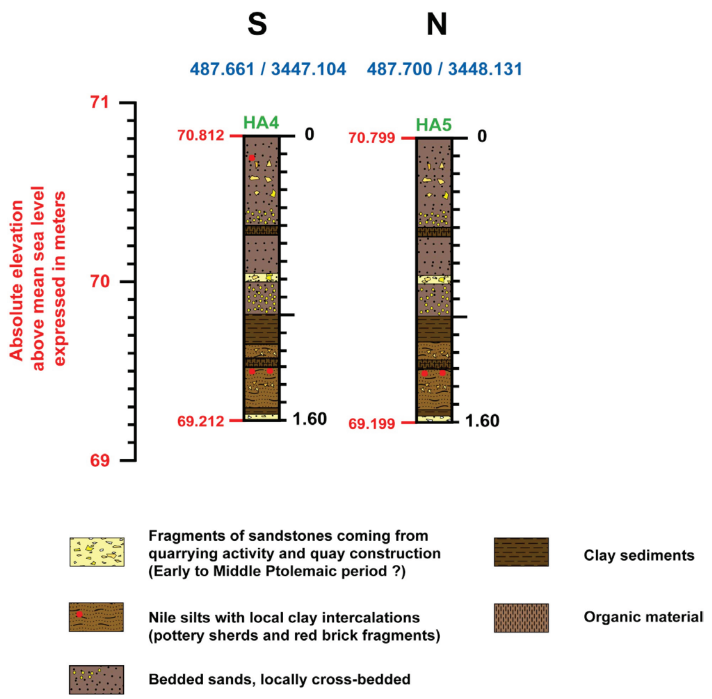


**Fig. 6.** Core profiles of HA4 and HA5.

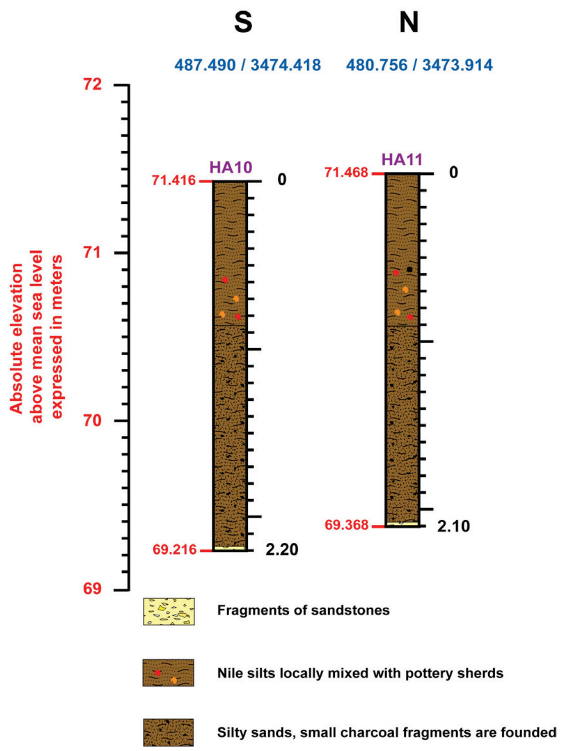


**Fig. 7.** Core profiles of HA10 and HA11.