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MINERALOGICAL AND PETROGRAPHICAL INVESTIGATION OF SEDIMENTS FROM THE TELL EL FARKHA ARCHAEOLOGICAL SITE. THE NILE DELTA – EGYPT.

Badania mineralogiczno – petrograficzne osadów ze stanowiska archeologicznego Tell el-Farcha. Delta Nilu. Egipt.

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Streszczenie

W trakcie badań w pierwszym etapie skoncentrowano się na badaniach terenowych. Sporządzono generalny profil geologiczny oraz pobrano próbki konieczne do badań laboratoryjnych. W następnym etapie wykonano analizy laboratoryjne. Przy pomocy lupy binokularnej przyjrzano się drobnym frakcjom pochodzącym z rozlasowania fragmentów próbek z profilu. Potem przeprowadzono badania mineralogiczno-petrograficzne cegieł suszonych. Obejmowały one określenie składu mineralnego i ziarnowego próbek z cegieł jasnych i ciemnych. Później zajęto się badaniami antropogenicznych węgli. Celem analizy było określenie ich właściwości sorpcyjnych. Na zakończenie zaprezentowano wyniki badań, w których zawarto szkice, fotografie, mikrofotografie, tabele i diagramy oraz dokonano podsumowania badań i przedstawiono wnioski, jakie można z nich wyciągnąć. Powstanie pracy pozwoliło na rozwiązanie ciekawych problemów z pogranicza mineralogii, geologii i archeologii. Wszystkie przeprowadzone badania mają charakter nowatorski i wnoszą dużą ilość nowych i istotnych informacji pozwalających poznać stanowisko oraz aktywność ludzi przed tysiącami lat.

Słowa kluczowe: Archeologia, mineralogia, drobne frakcje, SEM, Delta Nilu, Tell el- Farcha

Abstract

The first stage focuses on field studies, during which a general geological profile was prepared and samples for laboratory tests were collected. In the next stage, laboratory analyses were conducted: with the use of binocular magnifying glasses, small fractions being the result of the slaking of fragments of the samples from the profile were examined. Then, mineralogical and petrographic examinations of dried bricks were conducted—these included determining the mineral and grainy composition of samples from light and dark bricks. Later, anthropogenic examinations of coals were conducted; the aim of the analysis was to determine their sorption properties. Finally, the results were presented, which included

sketches, photographs, microphotographs, tables, and diagrams; the research was summarized, and conclusions that could be drawn from it were demonstrated. The paper helped solve interesting problems on the border of mineralogy, geology, and archeology. All of the conducted research is innovative in nature and contributes much new and important information helping explore this site and the activities of people from thousands of years ago.

Keywords: Archaeology, mineralogy, fine fraction, SEM, Nile Delta, Tell el-Farkha

Introduction

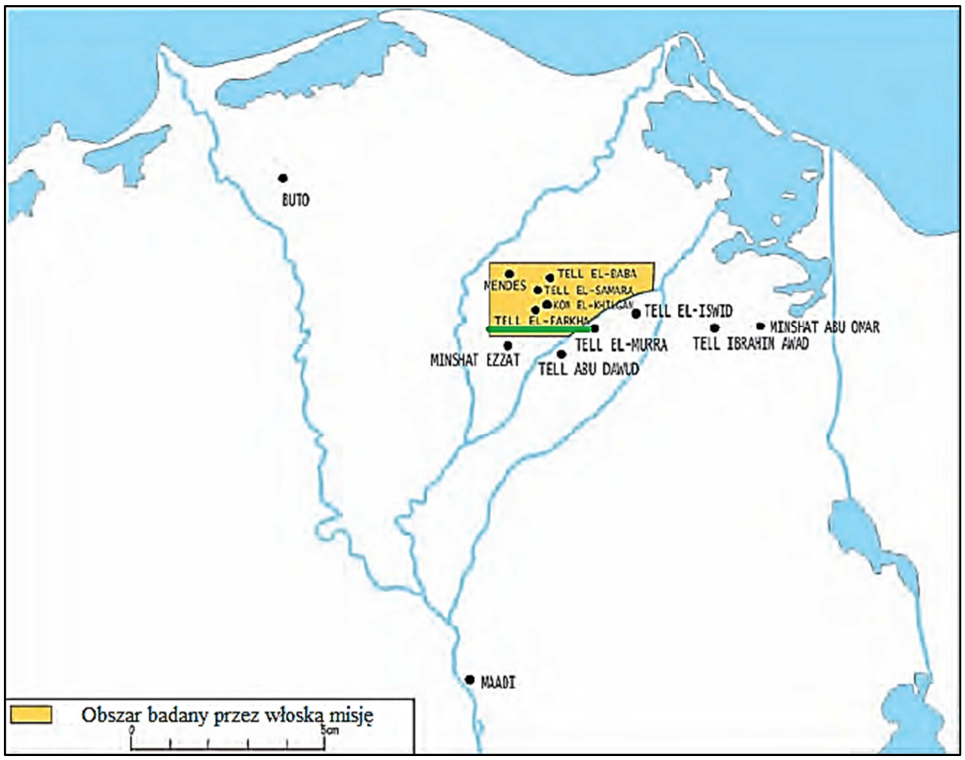
An ancient Egypt belongs to the earliest great cultures of the world, and on the grounds of the large amount of remaining buildings, items of daily using and writings, it can be observed a progression of its [an ancient Egypt's] tradition, religion and the lordship (Kemp, 2009). The first important archeologic studies were started in 1798 after the expedition of Napoleon's troops to this country. As a first person, who has interested Europeans of Egypt's treasures was the one of its [expedition's] participants – baron Vivant Denon (Gahna, 2003).

From the middle of 19th century missions from different countries started research to scale it up. It would be not easy to count all the places – among others: Giza, Saqquara, El-Kab, Thebes and so on – on which foreign archeologists were worked (Cialowicz, 1999), and also that, on which research were conducted by polish archeologic missions. These include, among others: Deir el-Bahri, known from the temples of Hatshepsut and Thutmose III (Lipinska, 1995), Tell Atrib; where the unit of marble sculptures shown Aphrodite (Mysliwiec, 1995) were found; Kom el-Dikka in Alexandria with a theatre 'saved' in 1963 (Kolataj and others, 1995), Marina el-Alamein; where is located a necropolis with the oldest and the most palatial tombs (Daszewski, 1995), Deir el-Naqlun; known from hermitages made from stone, papyruses and paintings (Godlewski, 1995); and also Tell el-Farcha; which one concerns the present PhD thesis. Archeological sites are located mainly in the Nile valley. Above all, it has a connection with dominant climate conditions. Climate changes, which began at the beginning of a middle Holocene epoch, forced people to a migration from the West Desert to the East Desert, precisely to the Nile valley (Pawlikowski, 2013). This thesis have an interdisciplinary nature and include

geological research, conducted by with a cooperation of archeologists. Already in 1960 was ascertained (Butzer, 1960), that this cooperation is essential, because during archeological excavations, the geologists help in effective understanding and interpretation of findings and allow comprehensive description of materials in each category. Presented in this thesis, compressive research of materials from the site, were designed to extend a knowledge in a range of supportive sciences for an archeology. Realize them inside signed academic cooperation of University of Science and Technology (AGH) with the Institute of Archeology at Jagiellonian University in Cracow.

Previously research of Tell el-Farkha archeological site

Tell el-Farkha site was discovered by Italian Archeological Mission, which started research of East Nile Delta in 1987. The mission was studied an area of a land over 100 hectares, where in total 31 sites were found, including among others Tell el-Farkha (from Arabic 'Chicken's Hill') (Chlodnicki, 2012; Cialowicz, 1999; Cialowicz, 2007; Cialowicz, 2008; Cialowicz and others, 2013a). This site is located on three hills (koms) – a localization of ancient colonies was determined by geomorphology of the region (Pawlikowski, 2013). The area under discussion is located in north-east Nile Delta, about 120 kilometers from the capital of Egypt – Cairo (drawing 1). The ancient colony was arisen about 5-6 thousands years ago, in before pharaonic times, and 400-500 years later became an important mercantile center on overland route, connecting Upper Egypt with Palestine (Cialowicz, 2009). In the moment when the Nile became a main way of goods transport, the colony started to decline gradually. The last inhabitants left this place about 4,6 thousands years ago, so that to appear again in modern times.



Drawing 1. *A map of Nil's Delta with a localization of Tell el-Farkha site and other pre-dynastic and early-dynastic sites (Chlodnicki, 2012, amended).*

At first, research which were conducted by Rodolfo Fattovich and Sandro Salvatori in the years 1988-1990, didn't bring interesting results. In 1995, considering financial, the Italian mission resigned from a continuation of research and agreed for it undertaking by the Polish mission.

In May 1998, research of the site were started by the Polish archeological expedition. It is leading by the professor Christopher M. Cialowicz from the Archeological Institute of Jagiellonian University in Cracow, together with a doctor Mark Chlodnicki from an Archeological Museum in Poznan, with the cooperation of Mediterranean Archeological Centre at Warsaw University. In the contrast to Italian, the Polish archeologists can show great effects of research. Due to broadly-plain method of exploitation, colony's architectural system was discovered (drawing 2).

Drawing 2. *Tell el-Farkha site. W kom – west kom, C kom – central kom, E kom – east kom (Chlodnicki, 2012)*

The Polish mission has an interdisciplinary nature. As a result of this decision, during three years of Italian's mission research and 14 seasons of Polish expedition research, at the state were working about 160 archeologists and other specialists (Chlodnicki, 2012; Cialowicz, 1999; Cialowicz, 2007; Cialowicz, 2008; Cialowicz and others, 2013).

The most important discovery was finding of one of the oldest brewery centers in the world (dated on about 3500-3350 BC) (Cialowicz, 2009). It appears that, yet in an ancient times, humanity was starting to interest in production of beer, wine, narcotics, perfumes and pigments (Michel and others, 1992; Michel and others, 1993; Hendrickx and others, 2002).

In 2001 in east kom, tombs surrounded by bricks were found. They were very feature-rich. In next seasons, another tombs from different dynasties periods were

revealing. The oldest tombs turned out as the best made and the richest. The youngest are predominantly earth tombs without furnishings.

In 2006, during archeological research, the earliest writer's palette among all found yet in Egypt was discovered.

In E kom monumental construction was discovered. It might be never unused tomb of prehistorical overlord. It consists of few rooms, and its surface is more than 400 square meters. In such buildings, called mastabas, the most important people after pharaoh were buried (Cialowicz, 2008). It rose about 5,2 thousands years ago, at the beginning of 0 dynasty. Now, it is the oldest mastaba in Egypt.

Excavation in the east kom allow to find remains after poor colony – two gold figures (of overlord and his son, together with a necklace) and flinty, ritual knives were found. The place, where they were discovered, is about 100 years older than the beginning of the Egyptian country.

Previously research of Tel el-Farkha site allow to presuppose, that colonization of Nile Delta by settlers from south, was a very complex process. The research result, that the Nagadian people didn't establish one big kingdom, which encompassed Upper Egypt. At that time, there were at least two stations competing with each other. Then overlords were competing with each other, not only for a dominion, but also for a leverage in places, where mercantile trades were leaded. Battles were fighting by the time, as one of Nagadian proto-overlord created one country by the Nile River (Cialowicz, 2008; Cialowicz, 2009).

Geography of Egypt

Human activity is very often connected with broadly defined geology of a region, so information, which it concern, form the basis of the present research.

Egypt (Arabian Republic of Egypt) lies in north-east part of Africa and encompasses more or less one-thirtieth part of total continent's surface. This country is located on the angle of three continents: Europe, Asia and Africa (Tignor, 2010). From

the north it confines by Mediterranean Sea, and from the east – Red Sea. From the north-east borders with Israel and Gaza Strip, from the south – with Republic of Sudan, and from the west – with Libya.

For the most part Egypt locates in temperate climatic zone, and less than one-fourth its surface is the southernmost from a Tropic of Cancer. This country is characterized by warm and almost rainless climate.

Sparse precipitation cause, that most of Egypt's surface overlies an arid desert. Regular and abundant supply of water is enable from the Nile. The water is distributed by narrow, artificial ditches on both sides of the river, in the area of delta and the largest oasis in Egypt.

The Nile River performs a very significant role. Technically, thanks to it Egypt comes into existence (Rawlinson, 1880; Murison, 1951). It forms not only physical traits, but also a history and an economy of this country. Thanks to the Nile River, it was possible a development of famous, ancient civilization in peace and stability.

The Nile River divided Egypt for two separate morphological regions. The east region consists from mountains and plateau, and on the south there are a lot of depressions non-concatenate with each other. Although lands located from the east of the river were created one geomorphological region, there were divided into East Desert and Sinai Peninsula, among which Gulf of Suez is located. This division was created not only for geographical considerations, but also that this regions were inhabited by different races so. Herodotus gave them names, providing about that, by who they were settled. Despite, the Greek historian mentioned Arabian Desert on the east side, and Libyan Desert on the west side.

Egypt was divided into succeeding geographical regions:

- Nile Valley and Delta;
- West Desert;
- East Desert (Arabic) and Sinai Peninsula.

Geological construction of Tell el-Farkha archeological site

Geological research at silt on Nile in Tell el-Farkha site have a long history.

Beginnings of Nile Delta are dated on the threshold of Miocene and Pliocene epoch. But, a current shape and a structure of the river were starting to appear at late Pliocene epoch, when slit were created in an old sea bay. From the end of Pliocene epoch and through all the Pleistocene epoch, different marine sediment and fluvial or eolithic slit were covered a surface of Nile Delta, created a formation from 7 to 50 meters high (average 30 meters) below the current surface.

The most interesting are fluvial slit, which are consisted of Pleistocene sand, created so-called turtle's back (Kholief and others, 1969).

It is established, that Nile Delta owes its current morphology from Holocene's slit, which are represented by Nile's clay. Their thickness is from 5 to 50 meters (Said, 1981; Chen and others, 1993).

The greatest thickness of slit is in lake Buhayrat al Nanzil. It concomitantly follows from changes of a sea level, Nile's sedimentation and subduction.

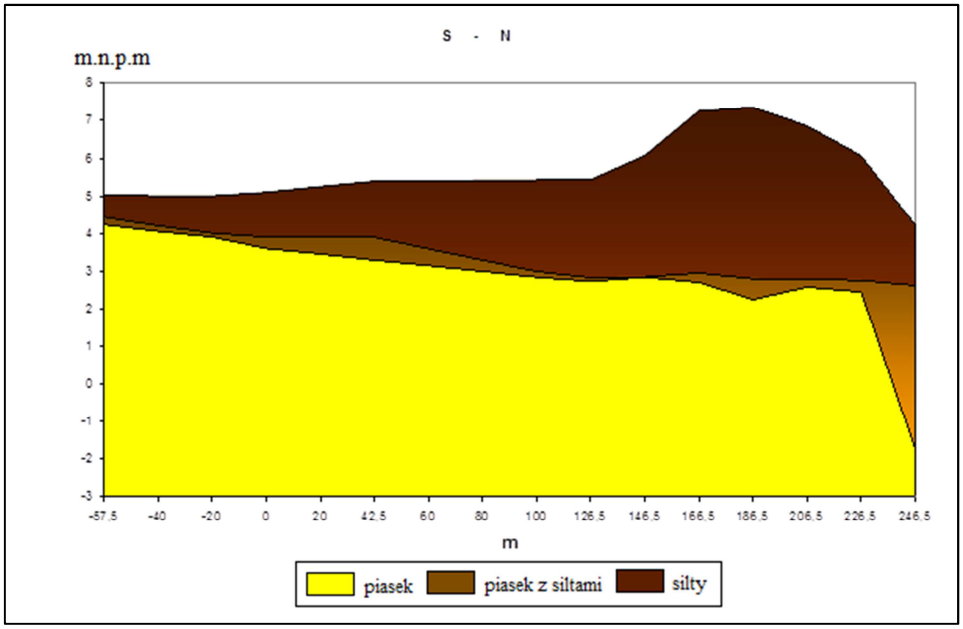
An enormous influence for geomorphology of the Nile's Delta has a nature of Nile in delta, its canals and a subsidence. In early and middle Holocene epoch, until 2550 BC Nile's Delta was dominated of few main river's canals. In damp period Sebennicki canal was dominated, but a significate role also have Menzezian and Peluzian canals (especially in east Nile Delta). In the years 1050-5 BC existed more two canals in East Delta: Damietta and Tanitian Canal.

All the hills located along watercourses, especially this from sandy- mulish slit, so-called 'gezir sand'. This places not only gave a shelter, but also provided very easy access to cornfields and pastures. Gezirs are more common in East Delta than in other Nile's Delta regions.

In Tell el-Farkha site can be distinguished two types of complex:

- Gezira's sand;
- Nile's clay.

Between them there is a thick sandy-mulish transition lawyer (0-10 centimeters). A general profile of the site is below (drawing 3).



Drawing 3. *A general geological profile of Tell el-Farkha site (Pawlikowski and others, 2010, amended).*

It can be distinguished a greenish-grey layer of clay on the north and the north-east bens' slops as well as a green sand layer in the east part. A water table is between 2-2,5 meters above the current sea level.

Gezir is composed by yellow-brown sand, which is mainly consisted from quartz grains, with the addition of plagioclases, K-feldspar and heavy minerals (amphiboles, pyroxenes and others) in small amount. The size of grains is varied from 0,1 and 2 millimeters, with the prevalence of the grains' diameter 1-2 millimeters.

The quartz grains' are covered with iron oxide and sometimes with carbonates. It causes a coloring of grains from white and yellow into brown. The grains are coated, which is characteristic for a material, rolled by the wind sooner. This material probably came from Arabian Desert and from the Abyssinian Plateau.

It is possible, that the layer also consists some amount of Aeolian sands. They can be classified as roughly and finely sand derived from a river, Pleistocene epoch. It is the lowest layer of a drill core, made by professor Maciej Pawlikowski and doctor Michal Wasilewski, in the course of geological research on site and it is located on the level from 2,3 to 3,5 meters above the sea level. It can be determined a lamination of the layers in the mud.

A surface of gezira declines fiercely to the north, to a direction of a canal (Masraf Ghazãlah). Shells of mollusks founded in mud, snows that in a terminal layer of sedimentation dry climate was appeared.

In the south-west part of gezira is located a layer of a green sand, which is identical as the previous one, in terms of a structure/a composition, but it has a different color. This difference may be resulted from another terms reduction of a sedimentation or after-sedimentation system. Generally, green sands are connected with older Nile's canals, oxbow lakes or with swamps.

Gezira is covered by a sand layer, mixed with clays' thickness 5-50 centimeters. It is slighter on slopes and on the top of gezira, but beside the ground it is getting thicker. In the composition of the layer are consisted brown-grey clays, which cover all the site's surface and its neighborhoods. X-rays analyzing was shown that, Nile's clays are mainly consisted of (in 95%) smectites and illites. Marginally, there are also appeared kaolinite and some organic matter. An additive of other substances is little.

The highest clays' layer is mixed with a current waste and with a bit of sand. Research were shown (Pawlikowski and Wasilewski, 2012) that this material has been used to bricks' production (dried on a sun and burned) and ceramics. A bricks' storehouse largely depended on craftsmen, which preferred various proportions in mixtures (Emery, 2011).

Green-grey clays are created a layer on the north and the north-east ben's coast. It has from 20 centimeters to 1,5 meters thickness. This clays, alike brown-grey clays, are consisted of smectites, illites and a kaolinite. They are also consisted to 5-7%

quartz, a rutile and grains of feldspars. A color of slit is depended on sedimentation's terms.

In brown-grey clays are appeared archeological artifacts. A region rich in that elements is stretching along in sandy-clayey layer (to about 2,5 meters above the sea level) and in green-grey clays on 2,1-2,2 meters above the sea depth. The utmost depth, on which artifacts were found, is 1,5 meters above the sea level in the north part of a site. It has a connection with a close neighborhood of one Nile's canal. Yellow-brown and green sands are completely voided of archeological relics. The colonies with artifacts are considered of coals, the fragments of bones, ceramics and flinty tools (mainly regional, as well as occasionally imported from the Middle East).

Tell el-Farkha site is one of the most precious and one of the best places for a geological observations and for climate phenomenon's reconstructions. The borders of gezir is an area where an anthropogenic material was settling on natural Nile's siltiest (when a level of the Nile was low). Afterwards, on the anthropogenic layers, Nile's siltiest were settling again (when a level of the Nile was high). Geomorphological research of a site allow to a reconstruction of geological and climate phenomenon along Nile's Delta, which took a place within the last 10 thousand years (Pawlikowski, 2010).

The methods of research

Field study

A material to an essay was gathering during three expeditions to the Egypt, during which a sketches and photographical documentation were made and samples to research were preparing.

Moulding

During research on the site, geological profile of slit's layer was made and additionally charts showing a content of individual slite's components, made by on the grounds of analysis, conducted by the help of a binocular magnifier (a method discussed in the

next chapter). The profile was studied in 2012 in an E kom, on the north wall of an archeological digging (photo 1).

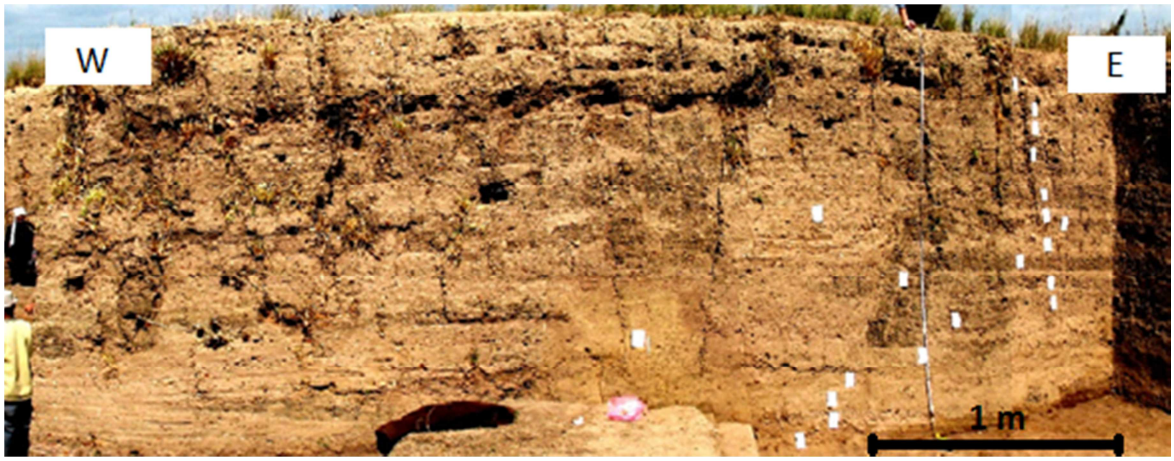


Photo 1. *An excavation's wall, on which the profile of slit's layers was made. The height of wall – 4,5 meters. White points are places of samples' charging to laboratory tests.*

Sampling

Slit and micro-relics

During a preforming of an E kom's geographical profile to laboratory tests, samples of each 20 profile layers' of slit were drawing. A weight of samples varied from 2 to 3 kilos, depending on slit's concision. In the next stage, samples were slaking in water and were sieving, in order to extract small fractions consisted in it, which has contained: a pug [1], ceramics, small coals, bones, flints, the fragments of stones, quartz and fish's bones. This elements were conducted by laboratorial research. On the grounds of diversified composition of slit, a part of samples were slaking without any problems, the second part, which contained a big amount of a mineral material, but required a firm mechanic slaking and pounded in hands. The remaining material was drained and tested by more research.

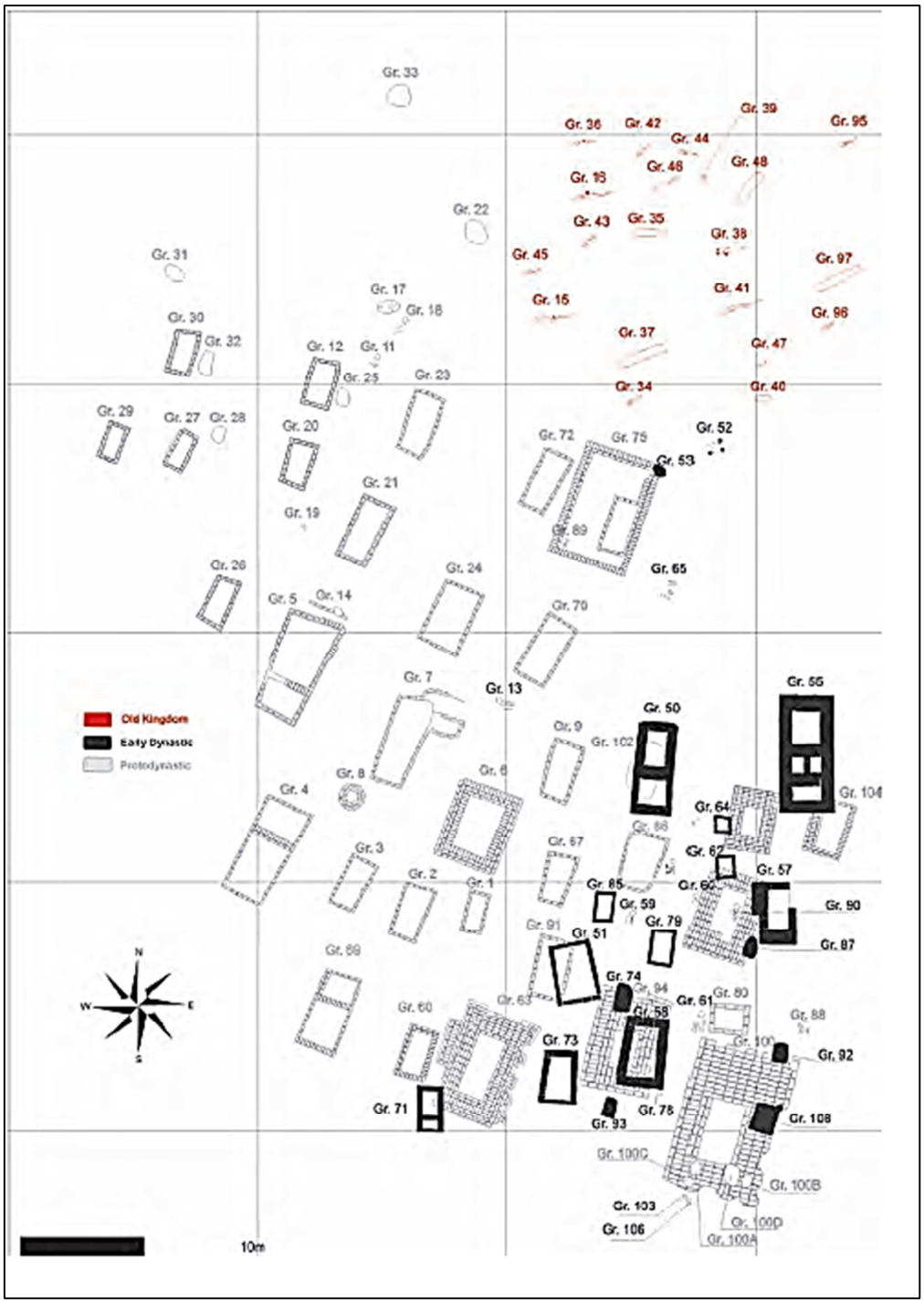
[1] An appellation 'a pug' used in thesis is concerned to the fragments of more or less destroyed, and sometimes slaking bricks. They are characterized by the presence of an intermixture of a chaff and a sand.

Bricks

Bricks were mainly used to build separation walls (Cialowicz and others, 2013), buildings and tombs. Research were focused on dried bricks, which came from a mastaba and from tombs.

At the first stage, a photographical documentation of bricks' arrangement, which have built a mastaba, was made. On the grounds of their different shades (part of bricks is brighter, another part – darker) and sizes, there were made drafts of ten walls' extracts, with different width and sense of direction. This drawings were reflected a width and a length of bricks, as well as considering of their shade. A space between bricks was filled with a mortar. After making of drafts, samples for laboratory tests were charged. It was striven to charge a sample of a light brick, a dark brick and a mortar from teach of ten drafted extracts of a wall.

At the second stage, it was focused on eight tombs (numbers 9, 63, 80, 86, 91, 94, 99 and 104), which have been found on the southeast from a mastaba. Tombs were firmly destroyed. A map shows their localization is presented below (drawing 4). Drafts of bricks and mortars, which cordoned tomb's chamber, were made. On the grounds of performing only grey bricks (darker) in tombs, there is no a division of light and dark bricks in drafts. In tombs, where it was possible, a measurement of bricks was made. Results are shown in charts and graphs.



Drawing 4. *A draft presenting a location of tombs at Tell el-Farkha site (Debowska-Ludwin, 2012).*

Others

During research fragments of animal's bones, ceramic crockery and mats, founded in tombs, were collected. This samples were destined to microbiological research.

Laboratory tests

Tests of minor fractions (an analyze with a binocular microscope)

This research have an innovative character. They brought a lot of new information with a tiny archeological material, which mainly ambulates to a slag heap.

Research of micro-relics allow to find important archeological information, in places where, it seems that there is no essential discovery at the first sight (Sherwood and others, 1995). Micro-relics are perfect source of knowledge about buildings' functions, demarcating of settlers' activity area and processes connected with a site's inception (Rosen, 1991). Research of tiny minor fractions are not so popular, for the sake of time needed to recover and analyzation them. Simms and Heath (1990) claim that, the time, we have to intend for the recover, sorting and identification of samples with micro-artifacts, amounts about two hours per sample.

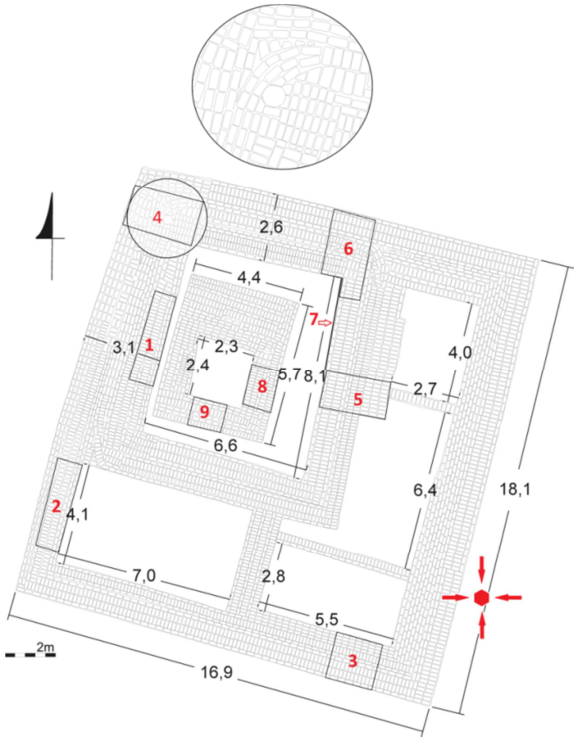
Research of minor fractions were made with the help of a stereoscope microscope (so-called 'binocular magnifier'). In them, it was focused on a material, obtained from slit's slaking samples, which were retrieved from a place, where geographical profile have been drawing. As a result of an analyze, it was determined a percentage content of such components as: a pug, ceramics, coals, bones, flints, stones' extracts, quartz, fish's bones and aggregates. Results were shown in the form of a tabular and also by the use of pie charts. A photographical documentation of minor chosen elements was made.

Mineralogical-petrographic research of dried bricks

Mineralogical-petrographic research of dried bricks from a mastaba and from tombs, consisted in making microscope mixture to research in polarized light of dried bricks and a mortar. The next stage were research by the light microscope, in passing polarized light. A Meiji microscope of Japanese production was used to it. Next, plane geometrical and granulometrial analyzes were conducted. To this end, about 500 grains in each sample were counted. Result of the calculations allow to draw up a graph of mineral and grain's composition in dried bricks. Additionally, microphotographs of brick's structure were made.

Coals' research

Anthropological research of charcoal charging from a burning layer's, connected with a fire of a total site, were made in order to determine their sorption attributes. Samples were charged in three places, next to the east side of a mastaba (drawing 5) (Cialowicz and others, 2013).



Drawing 5. *Schematic drawing of mastaba's studying (Cialowicz and others, 2013, amended). 'Centers' are marked with a red point.*

To systematize research's results, the fragments of burning slit's layer, in thesis they were described as 'center' ('center' A, 'center' B, 'center' C).

This research have an innovative character. Their aim was to check the attributes of sorption coals, i.e. checking, if coals didn't absorb metals from a mastaba's environment.

It was concentrated on three samples during research, which were charged from three 'centers' located close to each other, behind the east wall of a mastaba. Places of their retrieving is denoted on the photo (photo 2).

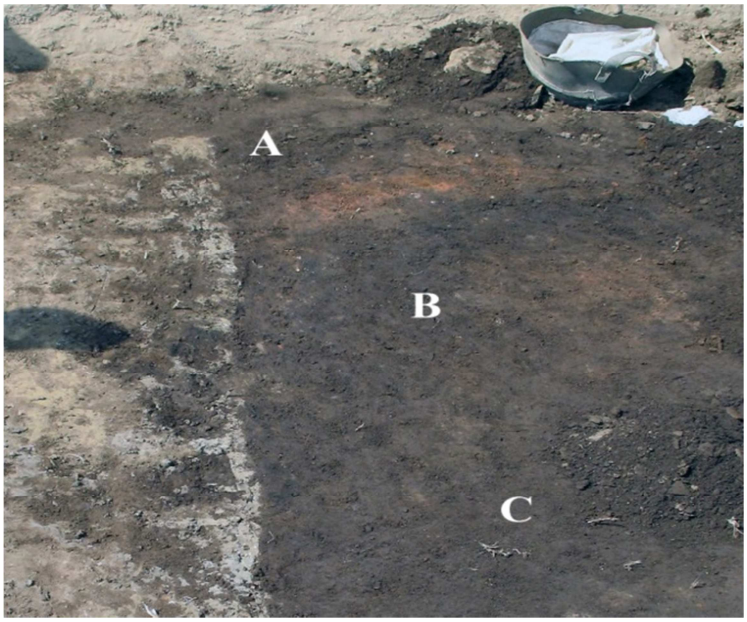


Photo 2. *Three 'centers' (A, B and C), from with samples to research were charging.*

Research were started from an observation of samples, with the help of a binocular magnifier. Next, from retrieving samples, a microscope slides were done. They helped to research in a polarized light. To that end, the light microscope XP600 Trino was utilized. At the end, an observation at scanning electron microscope (Jeol 540) with an adapter to EDS analyze. During research microphotographs were performed and a chemical composition (EDS) of carbons from 'centers' was

determined. Results of research were presented in the form of photography documentation and charts as well as graphs shown a composition of coals.

Microbiological research (a material from a tomb, geology profile, animals' bones and ceramics)

To microbiological research four samples were allocated:

1. a sample from the tomb number 94, charged from a mat (photo 3);
2. a sample charged from a repletion (photo 4);
3. a sample from a ceramic crockery (photo 5);
4. a sample charged from an interior of animal's bone (cancellous bone) (photo 6).

Photo 3. *A place of first sample's charging, from a mat in tomb number 94.*

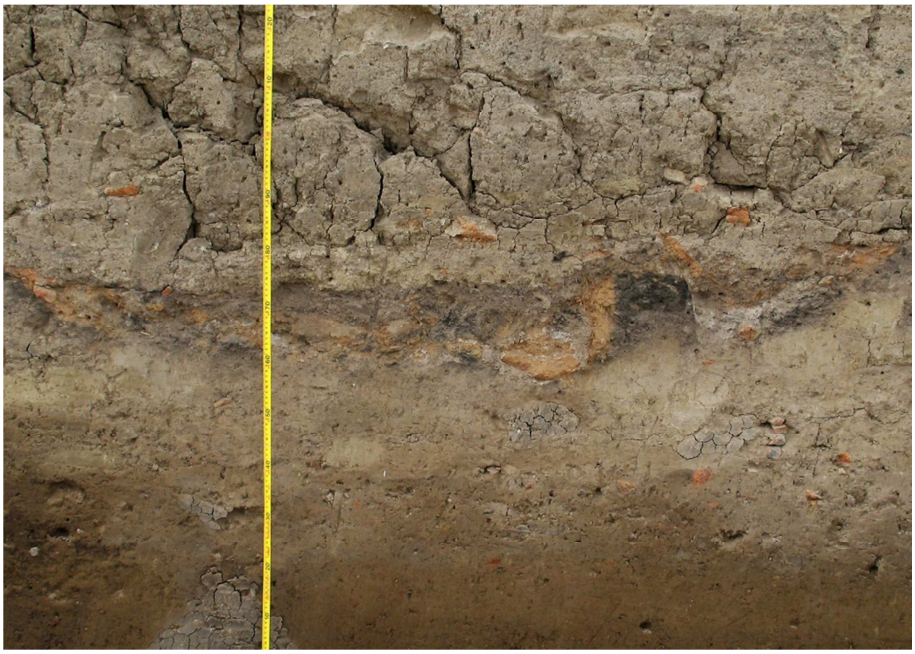


Photo 4. *A place of second sample's charging, from an old hearth. C kom. Excavation I. Wall S.*

Photo 5. *A place of third sample's charging. E kom. Ceramics.*

Photo 6. *A place of fourth sample's charging – animal's bone from a tomb. E kom.*

Photographic documentation was made in a place where samples were charged, and then microbiological symbols of performing bacteria were conducted. Results were presented in the form of charts and graphs.

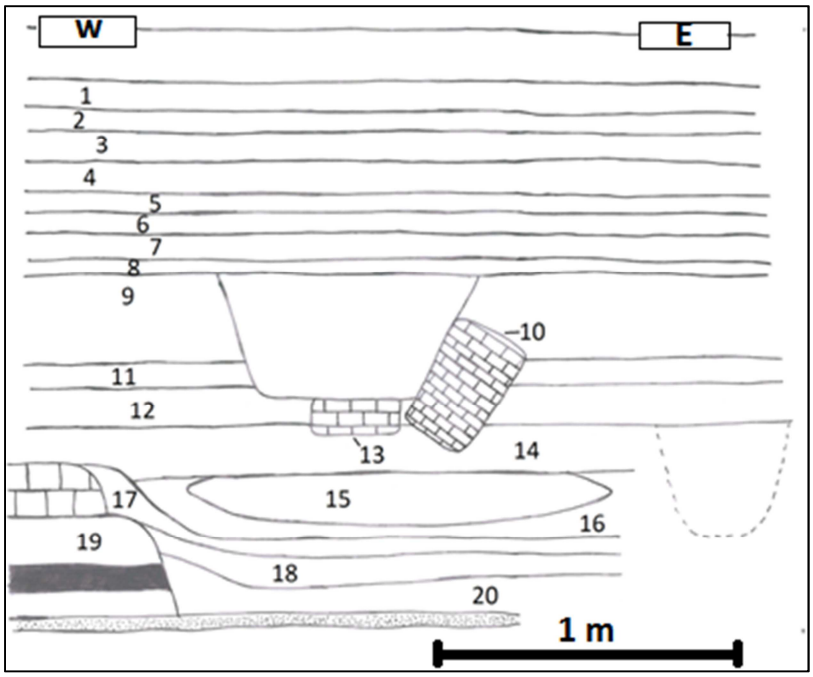
Research were performed in the Department of Environmental Microbiology and Biotechnology at the Nicolaus Copernicus' University in Torun, leaded by professor Maciej Walczak. Introductory results indicated at significant danger, follows from research of bacteria included in samples. Due to this, further research were aborted.

Research results

Geological profile (profile S; kom E) (the method of layers stripping)

Research of anthropogenic slit layers' moulding, made in kom E, on extreme wall of archeological digging (drawing 6) are shown below. After the preparing of complete profile to a reconstruction of sedimentation conditions, the method of

removable layers was used in order to visualize next stages of embedding slit in sedimentation tank.



Drawing 6. *A complete geological profile of slit's layers, made in E kom, on an extreme north wall of an excavation. The height of a profile is about 4,5 meters.*

Geological research were concentrating on the deepest profile among others, located in kom E. From it, in places marked on the north wall of archeological digging, in kom E 21 samples to research were charged.

Macroscopic observation allowed to ascertain , that all studied layers are similar to each other and sometimes it is hard to distinguish them in profiles. It was transpired that the best for observation were not recently cleaning profiles, but this, which were subjected to natural wind erosion for some time. The wind, which was blowing minor material, has shown a nature of layered slit, which become a base of their samples and other analyzes.

The first sample was gathered about 20 centimeters below sediments' alloy. Above there are modern slit, mixed with present litters. The first sampled layer is sandy-clay slit, destroyed by local birds, which are bored in an excavated hole. The second layer of a profile, like that located above it, is at places highly eroded and

consist an addition of a dark coal's dust, which caused that, it has darker shade. The third layer of a geological profile is represented by slit with a bit brighter shade, thanks to larger content of quartz, as well as in minor and in thicker fractions. The fourth layer (count from the top of a profile) has a clay-sandy nature, which impart its grey shade. The fifth layer also, has a clay-sandy nature and consists an addition of a coal's dust. The sixth layer also has an explicit anthropogenic nature. A coal's dust performed in it, except of quartz, imparts its light shade and impacts on a color of clay's materials. This layer has different macroscopic fragments of a shred, thanks to its significant shade differ from mentioned slit. It can also be observed fragments of broken ceramic crockery in it, without using of a microscope. The seventh layer is a layer consisted of light, dusty slit with an addition of a quartz. The eight layer, a bit darker from the previous one, ends a sequence of regular, horizontal, not sawing layers of a profile. It has a character of a compact weak powder, which results from a present of a mixture of anthropogenic and mineral elements. The ninth layer is definitely the thickest layer at profile, which displayed of increased human's activity in this place, at the time of its inception. It its area a hard to identification fragment in the shape of diverted trapezoid and a part of destroyed wall from dried brick were recognized. The tenth layer is a brick wall, built from dried bricks, which were made from a local Nile's slit. The eleventh layer, like the tenth layer, is intersected by a trapezoid construction and a wall from dried brick. It has an anthropogenic character and includes fragments of ceramic crockery among others. However, it is absolutely slighter, thanks to an addiction of a dust from charcoals. The twelfth layer consists of darker clay–loamy slit with an addition of anthropogenic material. It has a dusty structure. In a studied profile it is intersected by two walls, build from dried bricks. The thirteenth layer is another fragment of brick wall, which also appears in twelfth and fourteenth layer. The fourteenth layer is a layer of an average thickness, with fragments of walls appearing in three places. Only slit in brown color is fine-grain, dusty, lumpy in some places. The fiftieth layer is consisted of slit, which ectypal were filled by minor excavation in the shape of an objective. Although, an anthropogenic material is consisted in it, this light layering suggesting that it is an ectypal depression of a minor area's excavation. The sixteenth layer is sandy-dusty slit, in which limit an

objective is performed (fifteenth layer), represented by similar but a bit more loamy and thereby lumpy slit. The seventeenth layer consists of slit, which are filling almost horizontal, but in some places on other profile's walls its disturbance is observed. For example, on the east part of a profile, this slit is heaving to the top and it is based on a fragment of a wall as well as it is incising in fourteenth layer. It is suggested that its layer's origin is connected with the processes of destruction and brick wall's covering. The eighteenth layer has an origin approximate to the seventeenth layer. Petrographic, it has a dusty-sandy character and consists of considerable addiction of eolith quartz, descended from sands, which are spreading the site's objects (gezira's roof). The next layer, the nineteenth is located on the east part of geological profile and it is consisted of sandy slit, like in the previous case. In this slit, the next stagnant fragment of a wall from a dried brick was recognized. The twentieth layer is the lowest, belonging to a sequence of slit, which are heaving from the east part of a profile. It has a large amount of burning ceramics' fragments. The twenty-first layer is located below the twentieth layer. It is the oldest anthropogenic layer in this part of a site. It has a sandy character and it consists of an addiction of loamy minerals. However in it there are fragments of a burning pug. All this slit are performing on natural sands of gezira's roof, which partly have an eolith origin.

A presented method and receive results, were proving very useful to a reconstruction sedimentation's terms of anthropogenic layers and to a reconstruction of human activity at each phase of site's operation. This method, although difficult, should be spreading in archaeology.

Research results of tiny fractions from the profile (profile E; kom E)

After making analytical research of fraction's composition, assigned from flaking samples, a selection of tiny finding fragments was made (photo 7-13):

- a pug, or in other words shabby (sometimes crumbling) bricks with an addiction of a chaff and dry sand;
- ceramics represented by the fragments of broken ceramic crockery;

- coal’s dust, derived from a burn-out straw;
- animal’s bones;
- flints, specifically fragments descended from fragments of flinty tools processing;
- natural rocks, like lime stones, agates and other fragments of broken stone crockeries (diorite, calcite, alabaster, basalt);
- quartz (only natural grinding grains);
- fish-bones of elongated shape;
- an aggregate of loamy, non-crumbling minerals.

Photo 7. *Fragments of bones. Zoom 20x.*

Photo 8. *Fragments of a pug. Zoom 20x.*

Photo 9. *Coated quartz's grains. Zoom 20x.*

Photo 10. *Burnt-out fragments of pug with small coals. Zoom 20x.*

Photo 11. *Burnt-out fragments of bones and fish-bones. Zoom 20x.*

Photo 12. *Fragments of ceramics. Zoom 20x.*

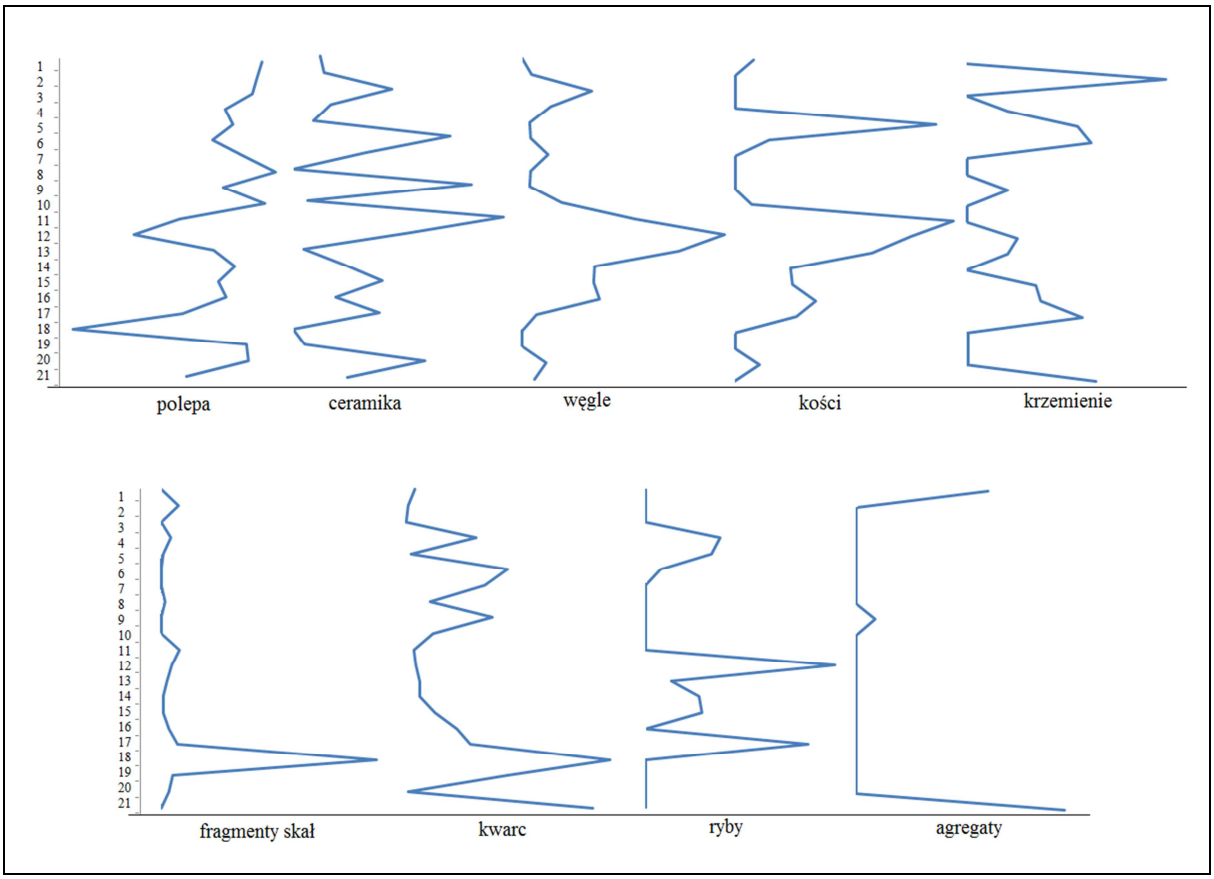
Photo 13. *Fragments of ceramics with an addition of corns. Zoom 20x.*

Research results of tiny fraction obtained from crumbling slit's samples, retrieving from a profile shown in a table (table 1). It presents a percentage content of small relics in slit. On its grounds it can be state, how anthological diversified individual layers are.

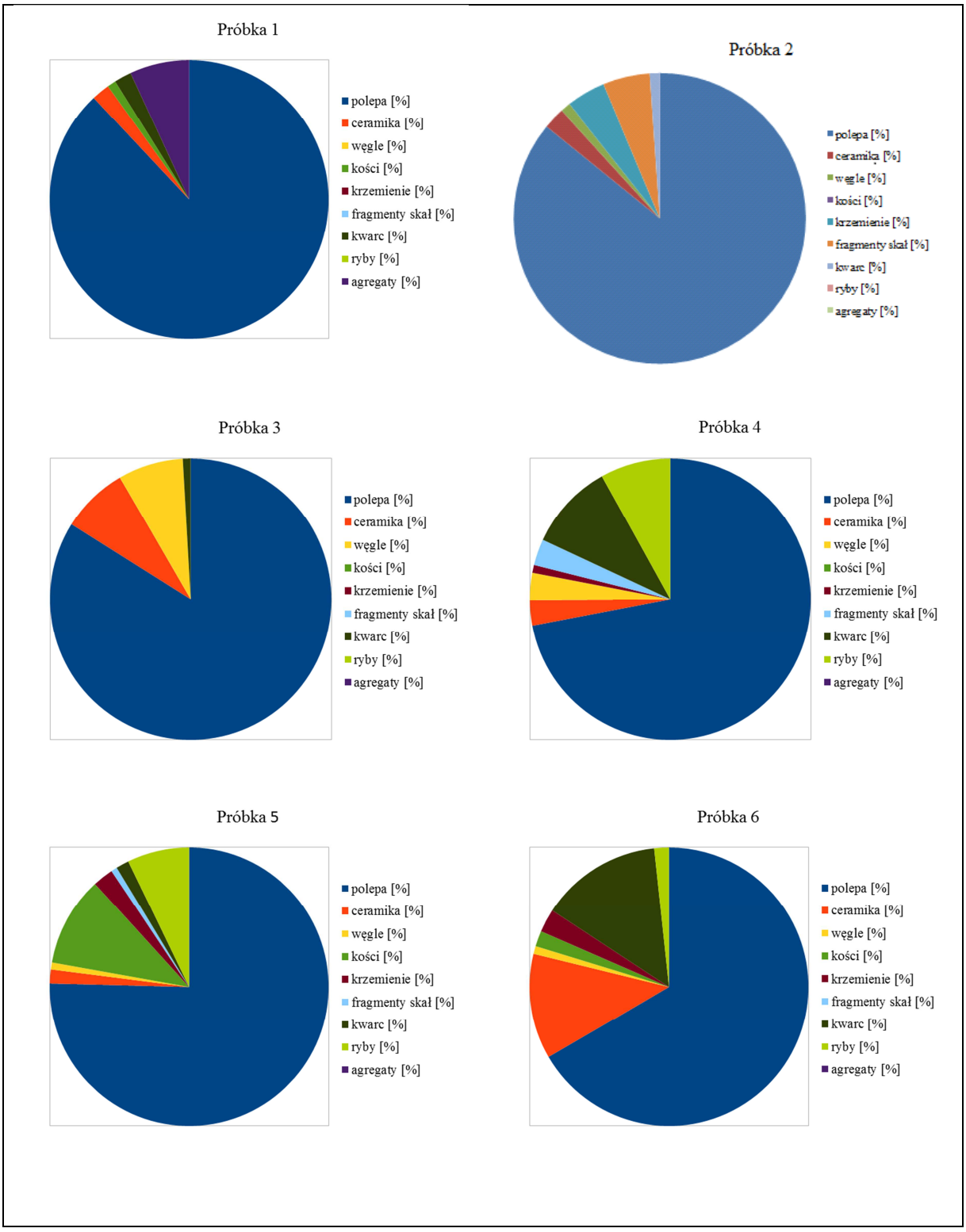
Based on a table (table 1) funicular diagrams were made (drawing 7), which shown a variability of tiny fraction's content in further slit's layers and pie charts (drawing 8-11), shown a percentage content of individual tiny archeological relics founded in soggy samples of slit.

Sample number	daub [%]	ceramics [%]	carbon [%]	bones [%]	flint [%]	rock fragments [%]	quartz [%]	fish remains [%]	aggregates [%]
1	88,0	2,1	0,0	1,0	0,0	0,0	2,0	0,0	6,9
2	85,9	2,4	1,1	0,0	4,3	5,2	1,1	0,0	0,0
3	83,9	7,7	7,5	0,0	0,0	0,0	0,9	0,0	0,0
4	72,0	2,9	3,1	0,0	0,9	3,0	10,0	8,1	0,0
5	75,4	1,6	0,8	10,4	2,4	0,7	1,5	7,2	0,0
6	66,6	12,2	0,9	1,8	2,7	0,0	14,1	1,7	0,0
7	80,4	5,6	2,8	0,0	0,0	0,0	11,2	0,0	0,0
8	93,9	0,0	1,0	0,0	0,0	1,1	4,0	0,0	0,0
9	71,4	13,8	0,8	0,0	0,9	0,0	12,1	0,0	1,0
10	89,3	1,1	4,3	0,9	0,0	0,0	4,4	0,0	0,0
11	52,7	16,3	12,2	11,3	0,0	5,6	1,9	0,0	0,0
12	32,8	9,1	21,8	9,1	1,1	3,2	2,2	20,7	0,0
13	67,0	0,8	16,9	7,1	0,9	1,8	2,7	2,8	0,0
14	76,2	3,9	7,8	2,9	0,0	0,7	2,7	5,8	0,0
15	69,4	6,9	7,7	3,0	1,5	0,7	4,6	6,2	0,0
16	72,5	3,3	8,4	4,2	1,6	2,5	7,5	0,0	0,0
17	54,0	6,7	1,6	3,2	2,5	5,0	9,3	17,7	0,0
18	6,8	0,0	0,0	0,0	0,0	65,7	27,5	0,0	0,0
19	81,4	0,9	0,0	0,0	0,0	3,6	14,1	0,0	0,0
20	82,2	10,2	2,6	1,3	0,0	2,5	1,2	0,0	0,0
21	55,4	4,2	1,4	0,0	2,8	0,0	25,3	0,0	10,9

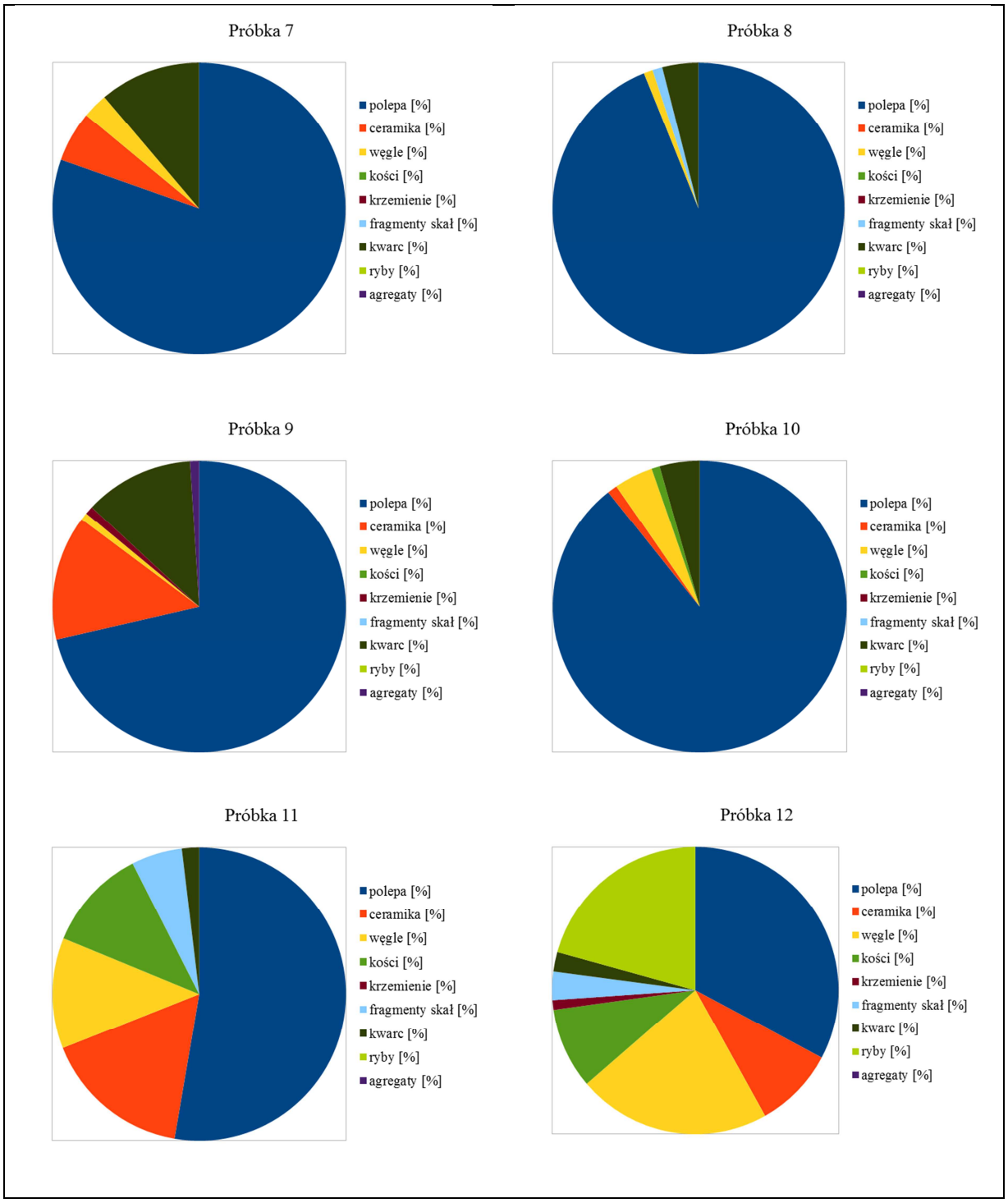
Table 1. *A percentage content of marked micro-relics and mineral components.*



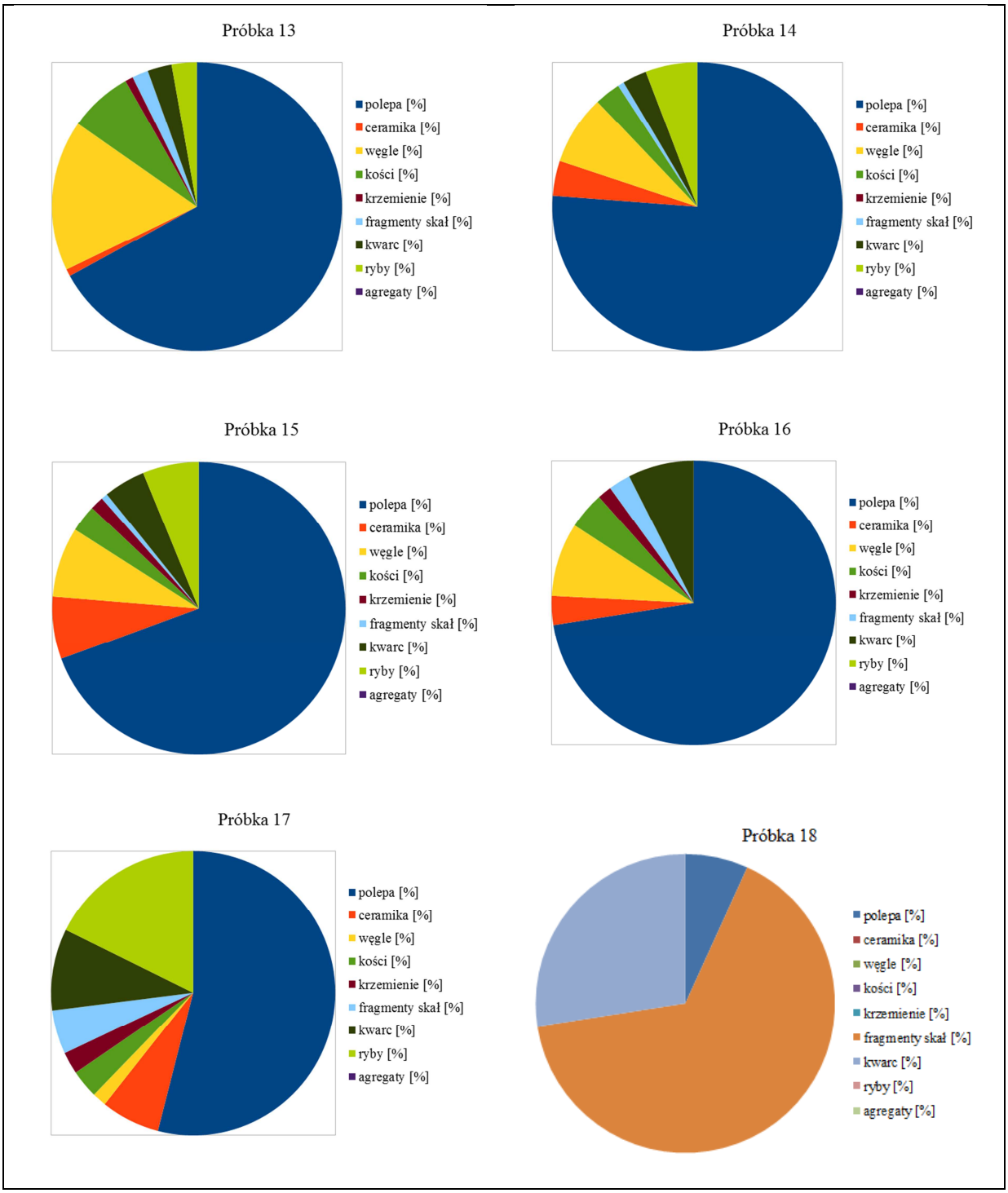
Drawing 7. *Linear diagrams showing variability of micro-relics content, in next slit's layers at studying profile. (polepa- daub, ceramika – ceramics, węgle – carbon, kości – bones, krzemienie – flint, fragmenty skał – rock fragments, kwarc – quartz, ryby – fish remains, agregaty – aggregates).*



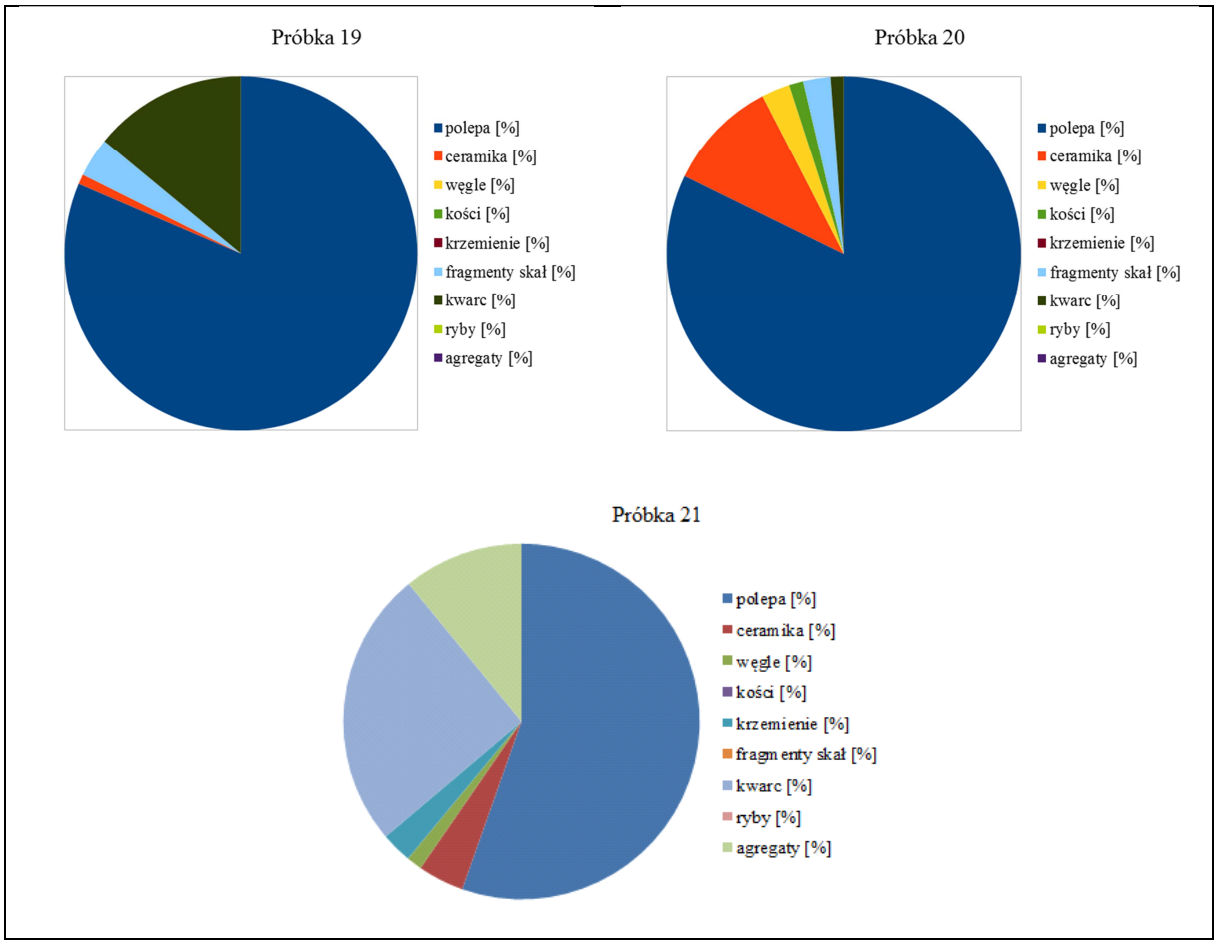
Drawing 8. *Diagrams showing a composition [%] of samples 1-6. (Próbka 1 - Sample 1, Próbka 2- Sample 2, Próbka 3- Sample 3, Próbka 4- Sample 4, Próbka 5- Sample 5, Próbka 6- Sample 6, polepa- daub, ceramika – ceramics, węgle – carbon, kości – bones, krzemienie – flint, fragmenty skał – rock fragments, kwarc – quartz, ryby – fish remains, agregaty – aggregates)*



Drawing 9. *Diagrams showing a composition [%] of samples 7-12. (Próbka 7- Sample 7, Próbka 8- Sample 8, Próbka 9 - Sample 9, Próbka 10- Sample 10, Próbka 11- Sample 11, Próbka 12- Sample 12, polepa- daub, ceramika – ceramics, węgle – carbon, kości – bones, krzemienie – flint, fragmenty skał – rock fragments, kwarc – quartz, ryby – fish remains, agregaty – aggregates)*



Drawing 10. *Diagrams showing a composition [%] of samples 13-18. (Próbka 13- Sample 13, Próbka 14- Sample 14, Próbka 15 - Sample 15, Próbka 16- Sample 16, Próbka 17- Sample 17, Próbka 18- Sample 18, polepa- daub, ceramika – ceramics, węgle – carbon, kości – bones, krzemienie – flint, fragmenty skał – rock fragments, kwarc – quartz, ryby – fish remains, agregaty – aggregates)*



Drawing 11. *Diagrams showing a composition [%] of samples 19-21. (Próbka 19- Sample 19, Próbka 20- Sample 20, Próbka 21 - Sample 21, polepa- daub, ceramika – ceramics, węgle – carbon, kości – bones, krzemienie – flint, fragmenty skał – rock fragments, kwarc – quartz, ryby – fish remains, agregaty – aggregates)*

Based on an analyze of research results, it can be ascertain that the main component of almost all samples (besides one – number 18) is a pug. It comprises between 32,8 to 93,9% volume of observed samples. Different situation occurs only in the case of the sample number 18, where a pug comprises only 3,6% of volume. Its main components are fragments of rocks (65,7%). Other components appearing in variable proportions. Their amount don't exhibit any rule and arise from a different composition of a material which was accumulating during sedimentation.

Ingredients of tiny fractions informs about fish catching (fish bones), flinty tools processing (flinty shell) or also processing of things from a stone (sharp-edged bits of rocks).

All determined components, indicating for a change of the same place within a flowing of time, so with a development and next phase of settlement on exanimated site.

Analyzing linear graphs of variability occurrence of individual micro-relics in geological profile, it can be ascertain, that in lower layers are more amount of fish bones, flints and coated quartz grains'; in the middle part of a profile there are more amount of fish bones, coal's dust and bones; and in the upper part of the profile there are fragments of flint, fish bones, bones and pebbles of quartz.

A forgoing variability of appearing individual micro-artifact in profile, is proving that in individual periods of site's functioning its function has changed.

Research result of dried bricks

Research result of dried bricks from tombs

Mineralogical research of dried bricks weren't undertake on a broad range in Egyptian archeological site, especially in necropolis. They are essential, because a dried brick is a main building material in Egypt. Presented research are proving of bricks' diversity, in respect of their mineral and grains' composition. They showing for an evolution of making this building material in the time of site's functioning.

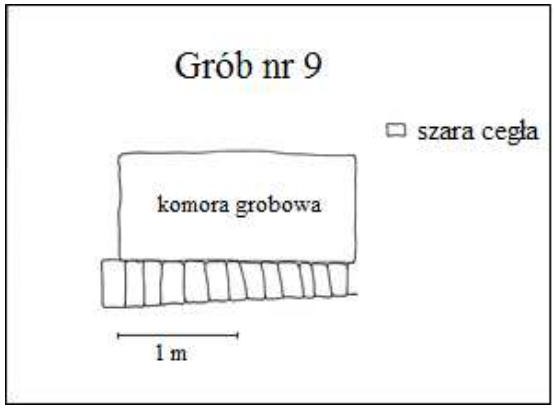
Research results were shown in the form of a collation for each tomb according to a scheme: tomb's name, photo and the draft of bricks' arrangement, which surrounding
a tomb's chamber. In the case of tombs, in which enough amount of bricks were preserved, a measurement of their length, width and thickness was made. Next,

mineralogical research's result was collated (a mineral and grainy composition of bricks). At the end, microphotographs made on chosen cut were presented.

Tomb number 9

Below a photography (photo 14) showing a tomb just after digging it in site is presented. It can be observed, that ceramics jugs are in it. On the draft from a right site (drawing 12) variability in bricks' size is illustrating.

Photo 14. *A photo of a tomb with a content, just after digging.*



Drawing 12. *A draft of bricks along one of the edges (made three seasons after digging).(Grób 9- tomb 9, komora grobowa- tomb chamber, szara cegła- gray brick)*

Tomb number 63

Below a photography (photo 15) showing a tomb just after digging it in site is presented. Next to it there is a sketch (drawing 13). On the grounds of a heavy destruction of a tomb and using of a large amount of a mortar, in case of tomb number 63, it succeed to identify one brick (it was not measure).

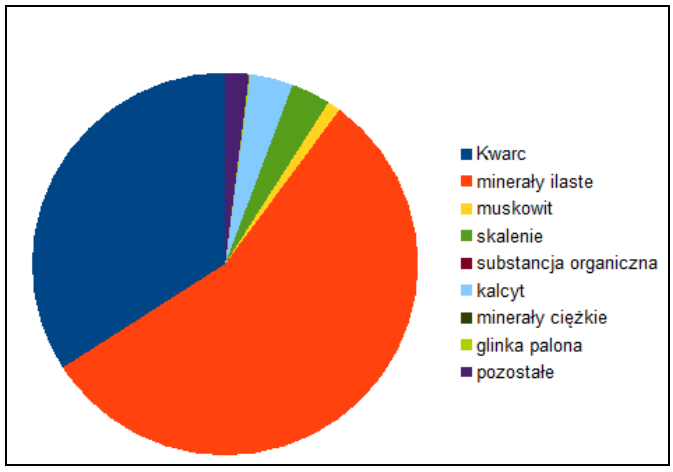
Photo 15. *A photo of a tomb, just after it digging.*

Drawing 13. *A draft of a tomb, three seasons after digging. One brick and a mortar were observed. (Grób 63- tomb 63, komora grobowa- tomb chamber, szara cegła- gray brick)*

Below research results of brick's mineral composition from a tomb number 63 is presented in the form of a table (table 2) and a graph (drawing 14).

component	contents
quartz	34,1
clay minerals	55,8
muscovite	1,1
feldspars	3,3
organic subst.	0
calcite	3
heavy minerals	0
burned clay	0,1
other	2

Table 2. *Mineral composition [%] of a brick from the tomb number 63.*

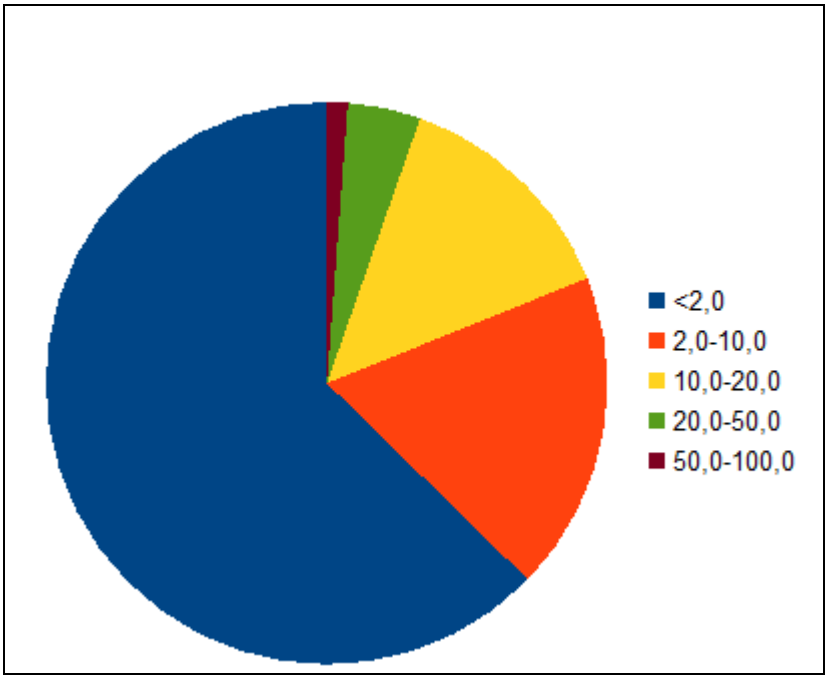


Drawing 14. *A diagram of brick's mineral composition, from the tomb number 63. (kwarc- quartz, minerały ilaste- clay minerals, muskowit – muscovite, skalenie – feldspars, substancja organiczna – organic subst., kalcyt – calcite, minerały ciężkie – heavy minerals, glinka palona – burned clay, pozostałe – other)*

The next stage of research was to ascertain a composition of grain in a brick from the tomb. Research results are presented in the form of a table (table 3) and a graph illustrating it (drawing 15).

Size of grains (µm)	contents
< 2	62,7
2–10	18,4
10–20	13,5
20–50	4,2
50–100	1,2

Table 3. *Grains' composition [%] of brick from the tomb number 63.*



Drawing 15. *A diagram of brick's grain composition in the tomb number 63.*

Tomb number 80

Below a photography (photo 16) showing a tomb just after it digging is presented. We are observing a very poor furnishings in it. Next to the photography there is its sketch (drawing 16). After three seasons from digging, it succeed to find only two bricks. To research samples from each were charged.

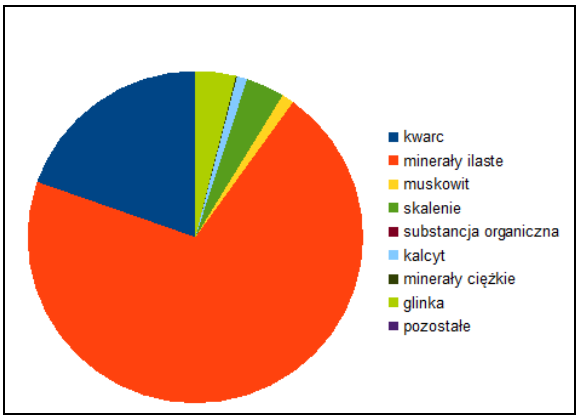
Photo 16. *A photo of a tomb, just after digging.*

Drawing 16. *A draft of a tomb, three seasons after digging. Two bricks in north circle were observed. (Grób 80 – tomb 80, komora grobowa- tomb chamber, szara cegła- gray brick)*

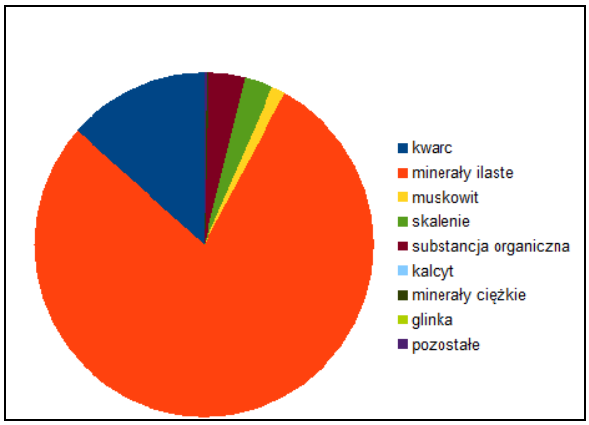
The material to research, descended from two bricks was analyzed in terms of mineralogy. It transpired, that even through both of them are located next to each other, they have different mineral and grainy composition. Below research results are shown in the form of tables (tables 4-5) and graphs (drawings 17-20).

component	contents	
	first sample	second sample
quartz	19,6	13,5
clay minerals	70,5	78,7
muscovite	1,2	1,3
feldspars	3,7	2,7
organic subst.	0	3,5
calcite	1	0
heavy minerals	0,1	0,2
burned clay	3,9	0
other	0	0,2

Table 4. *Brick's mineral composition [%] in the tomb number 80.*



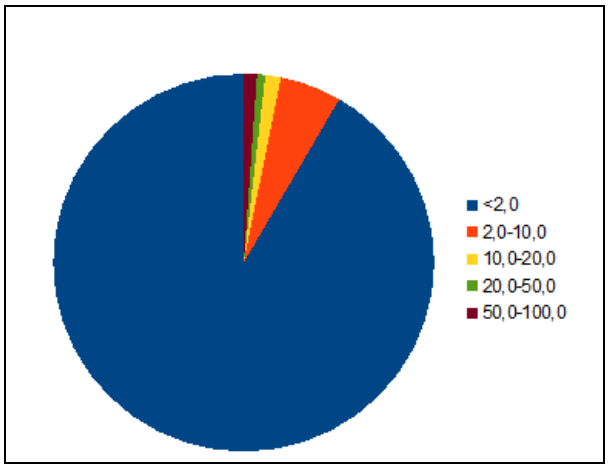
Drawing 17. *A diagram of the first brick's mineral composition from the tomb number 80. (kwarc- quartz, minerały ilaste- clay minerals, muskowit – muscovite, skalenie – feldspars, substancja organiczna – organic subst., kalcyt – calcite, minerały ciężkie – heavy minerals, glinka palona – burned clay, pozostałe – other)*



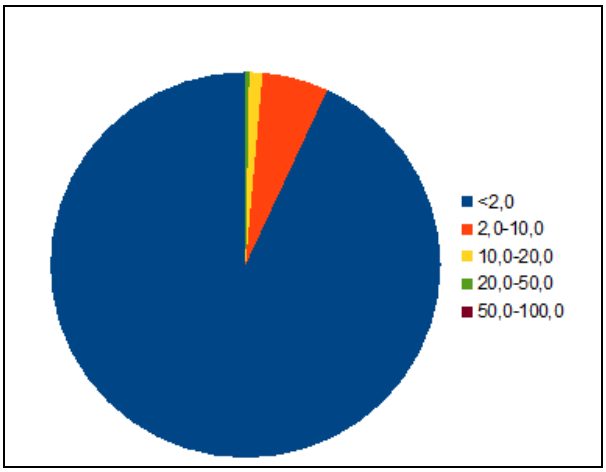
Drawing 18. *A diagram of the second brick's mineral composition from the tomb number 80. (kwarc- quartz, minerały ilaste- clay minerals, muskowit – muscovite, skalenie – feldspars, substancja organiczna – organic subst., kalcyt – calcite, minerały ciężkie – heavy minerals, glinka palona – burned clay, pozostałe – other)*

Size of grains (µm)	**contents**	
	first sample	**second sample**
< 2	91	93,1
2–10	5,2	5,5
10–20	1,3	1,1
20–50	0,7	0,3
50–100	1,1	0

Table 5. *Samples grains' composition [%] of two bricks in the tomb number 80.*



Drawing 19. *A diagram of the first brick's composition in the tomb number 80.*

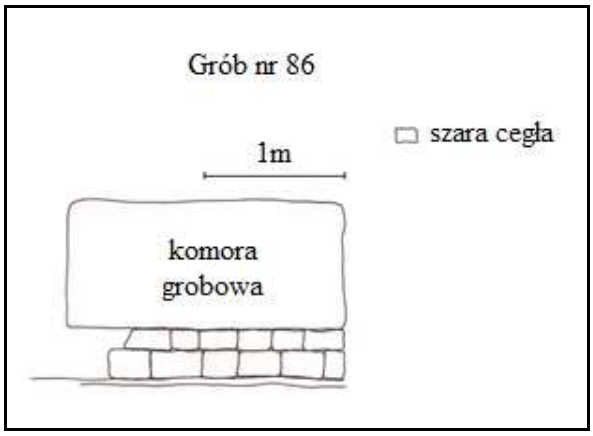


Drawing 20. *A diagram of the second brick's composition in the tomb number 80.*

Tomb number 86

Below a photograph (photo 17) of the tomb after exhumation is pres. The tomb has a wide, not regular brick circle. Three seasons after the exhumation, when a draft of tomb was being done (drawing 21), as a result of natural process of brick's destroying, they only protected on the south part of the tomb.

Photo 17. *A photo of a tomb, just after digging, with clearly marked bricks, encompass tomb's chamber*

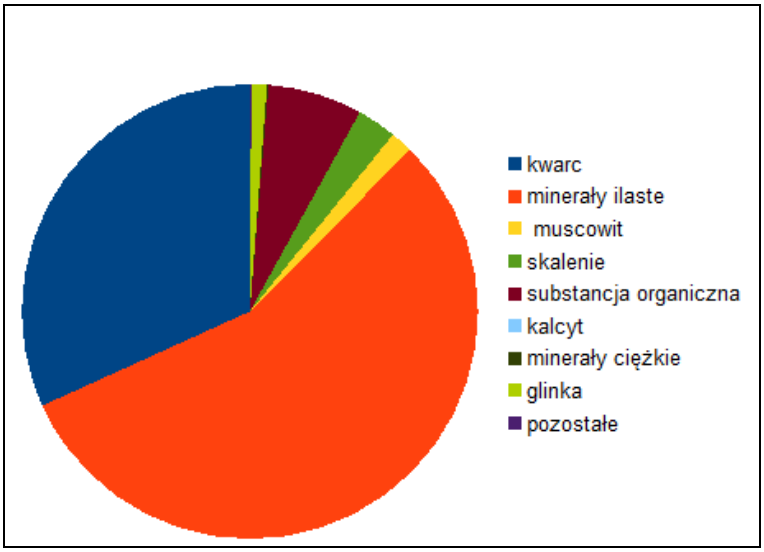


Drawing 21. *A draft of a tomb, three seasons after digging. Well-preserved bricks in it south part were observed. (Grób 86- tomb 86, komora grobowa- tomb chamber, szara cegła- gray brick)*

Below research results of brick's mineral composition from the tomb number 86 are presenting. Data are tabulated (table 6) and an adequate graph (drawing 22).

component	contents
quartz	31,8
clay minerals	55,8
muscovite	1,6
feldspars	2,8
organic subst.	6,7
calcite	0
heavy minerals	0,1
burned clay	1,1
other	0,1

Table 6. *Brick's mineral composition [%] in the tomb number 86.*

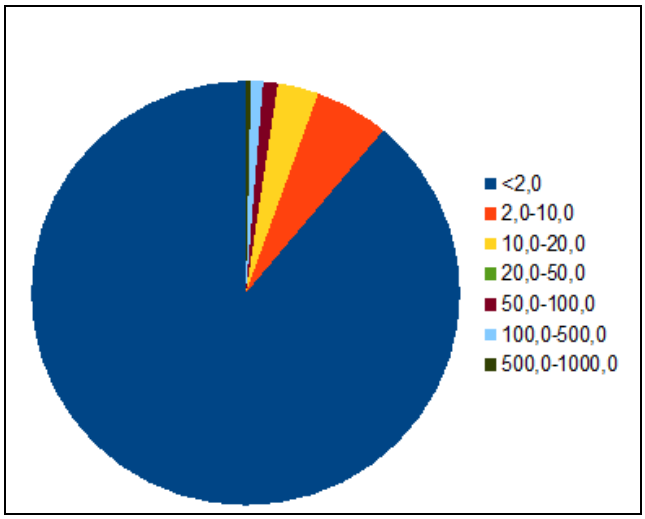


Drawing 22. *A diagram of brick's mineral composition in the tomb number 86. (kwarc- quartz, minerały ilaste- clay minerals, muskowit – muscovite, skalenie – feldspars, substancja organiczna – organic subst., kalcyt – calcite, minerały ciężkie – heavy minerals, glinka palona – burned clay, pozostałe – other)*

Research of bricks' grainy composition from the tomb number 86 were performed, and results were presented in the form of a table (table 7) and a graph (drawing 23).

Size of grains (µm)	contents
< 2	88,9
2–10	5,6
10–20	3,1
20–50	0
50–100	1,1
100–500	0,9
500–1000	0,4

Table 7. *Brick's grains composition [%]in the tomb number 86.*



Drawing 23. *A diagram of brick's grain composition in the tomb number 86.*

Tomb number 91

In the tomb a very rich furnishings was observed. In a case of bricks, only three turned out to be observe in the north-east part, above tomb's chamber. Below a photography of the tomb and its furnishings (photo 18) and a draft with marked bricks (drawing 24) are presenting.

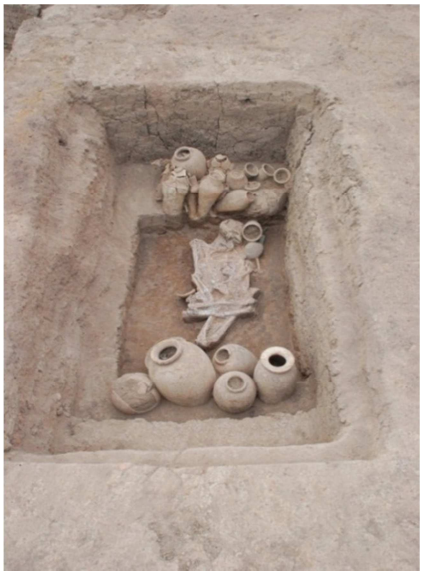
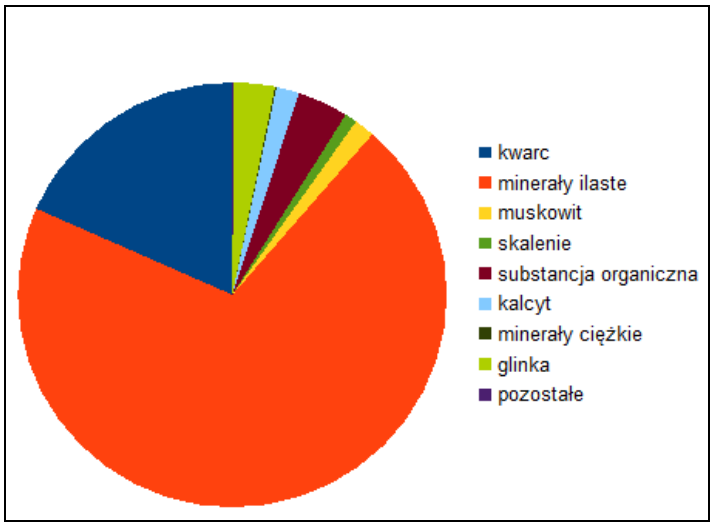


Photo 18. *A photo of the tomb number 91 with ceramics crockery and a skeleton, just after it digging*

Drawing 24. *A draft of the tomb number 91, three seasons after it digging. (Grób 91- tomb 91, komora grobowa- tomb chamber, szara cegła- gray brick)*

component	contents
quartz	17,8
clay minerals	68,2
muscovite	1,5
feldspars	0,9
organic subst.	3,7
calcite	1,7
heavy minerals	0,1
burned clay	3
other	0,1

Table 8. *Brick's mineral composition [%] in the tomb number 91.*

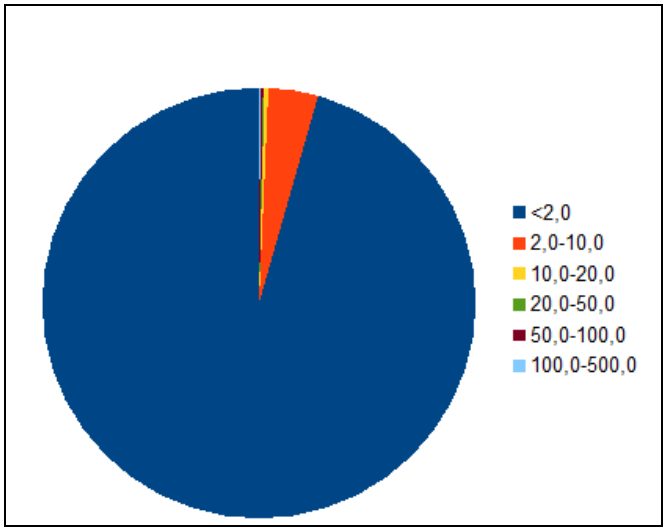


Drawing 25. *A diagram of brick's mineral composition in the tomb number 91. (kwarc- quartz, minerały ilaste- clay minerals, muskowit – muscovite,*

Considering to the fact that only three bricks were preserved, there was no measurement of them. Samples to laboratory tests were charging in order to analyze their mineral and grainy composition. Results were collated in the form of a tables (tables 8-9) and graphs (drawings 25-26).

Size of grains (µm)	contents
< 2	95,6
2–10	3,7
10–20	0,3
20–50	0,1
50–100	0,2
100–500	0,1

Table 9. *Brick's grains composition [%] in the tomb number 91.*

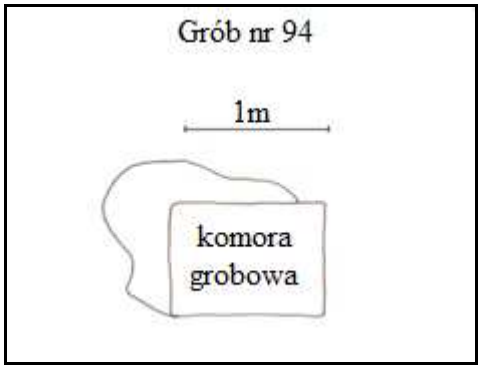


Drawing 26. *A diagram of brick's mineral composition in the tomb number 91.*

Tomb number 94

Below a photography of the tomb just after an exploitation is presenting (photo 19). It had a clear marked cross of bricks, which cordoned tomb's chamber. Three years after the exploitation, when a draft were creating (drawing 27), as a result of natural destroying in the tomb couldn't be observe any complete brick.

Photo 19. *A photo of the tomb number 94, just after digging from clearly marked bricks, encompass tomb's chamber.*

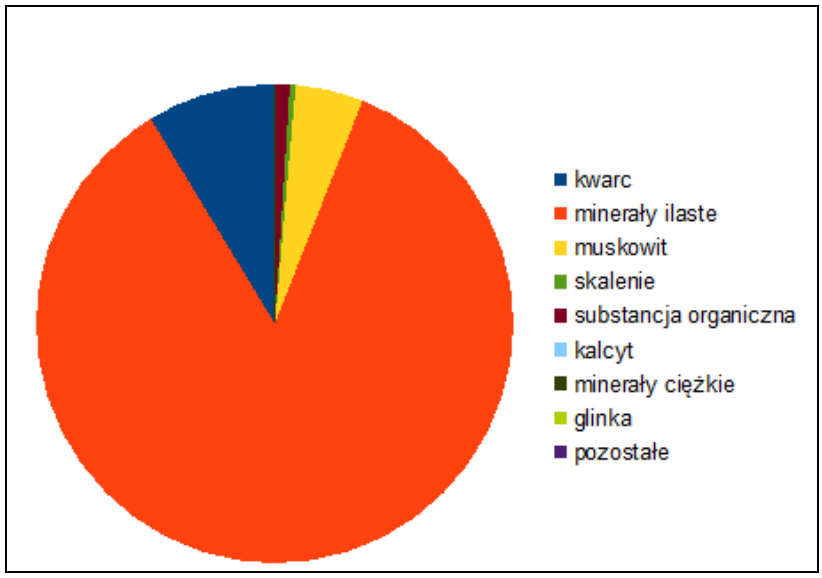


Drawing 27. *A draft of the tomb number 94, three seasons after it (Grób 94- tomb 94, komora grobowa- tomb chamber, szara cegła- gray brick)*

From one fragment of a brick, a sample for research was charged. It turned out that, like in the case of the rest of tombs, in the composition loamy minerals are dominating. It is a local Nile's slit. Below a detailed research results are presenting (tables 10-11, drawings 28-28).

component	contents
quartz	8,7
clay minerals	85,3
muscovite	4,6
feldspars	0,4
organic subst.	0,9
calcite	0
heavy minerals	0,1
burned clay	0
other	0

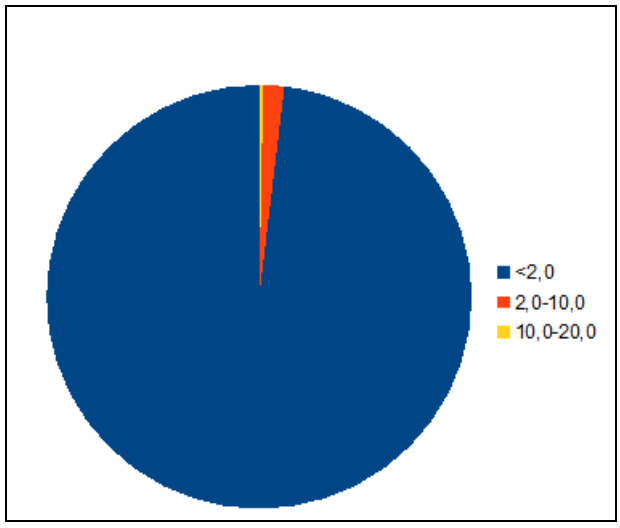
Table 10. *Bricks' mineral composition [%] in the tomb number 94.*



Drawing 28. *A diagram of brick's mineral composition in the tomb number 94. (kwarc- quartz, minerały ilaste- clay minerals, muskowit – muscovite, skalenie – feldspars, substancja organiczna – organic subst., kalcyt – calcite, minerały ciężkie – heavy minerals, glinka palona – burned clay, pozostałe – other)*

Size of grains (µm)	contents
< 2	98,1
2–10	1,6
10–20	0,3

Table 11. *Brick's grain composition [%]in the tomb number 94.*

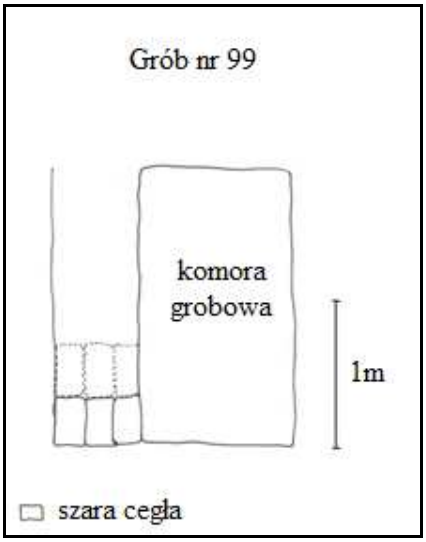


Drawing 29. *A diagram of brick's grains composition in the tomb number 94.*

Tomb number 99

In tomb number 99, during draft's creating (drawing 30) it was manage to observe only a few bricks. Below a photo is also presenting (photo 20), which was made just after its digging.

Photo 20. *A photo of the tomb number 99, just after it digging.*

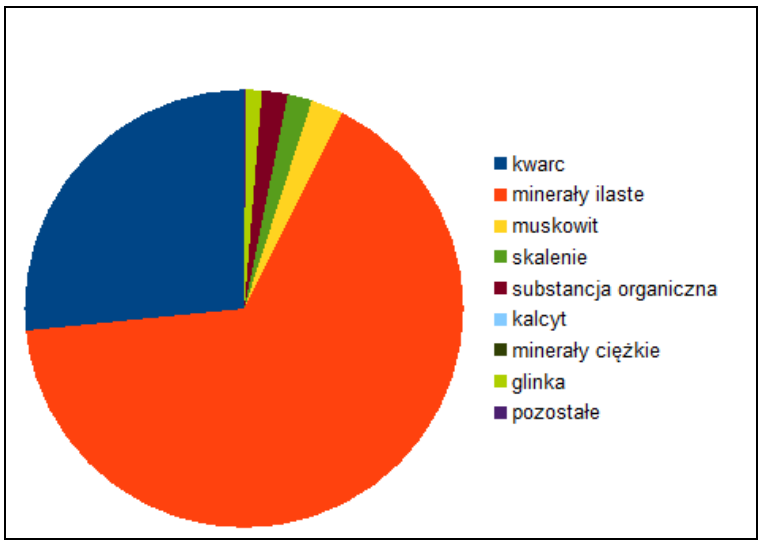


Drawing 30. *A draft of the tomb number 94, three seasons after it digging with marked bricks. (Grób 94- tomb 94, komora grobowa- tomb chamber, szara cegła- gray brick)*

During mineralogical research, it turned out that in a composition of bricks from tomb number 99, except from Nile's slit it is also a sizeable amount of quartz sand. Research results are presenting below (tables 12-13, drawings 31-32).

component	contents
quartz	26,6
clay minerals	66
muscovite	2,4
feldspars	1,8
organic subst.	1,9
calcite	0
heavy minerals	0
burned clay	1,2
other	0,1

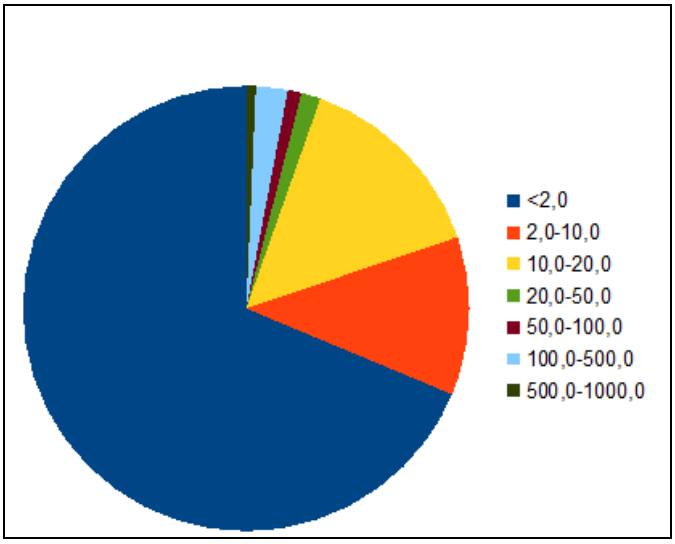
Table 12. *Brick's mineral composition [%] in the tomb number 99.*



Drawing 31. *A diagram of brick's mineral composition in the tomb number 99. (kwarc- quartz, minerały ilaste- clay minerals, muskowit – muscovite, skalenie – feldspars, substancja organiczna – organic subst., kalcyt – calcite, minerały ciężkie – heavy minerals, glinka palona – burned clay, pozostałe – other)*

Size of grains (µm)	contents [%]
< 2	68,7
2–10	11,5
10–20	14,4
20–50	1,4
50–100	1
100–500	2,3
500–1000	0,7

Table 13. *Brick's grains composition [%] in the tomb number 99.*

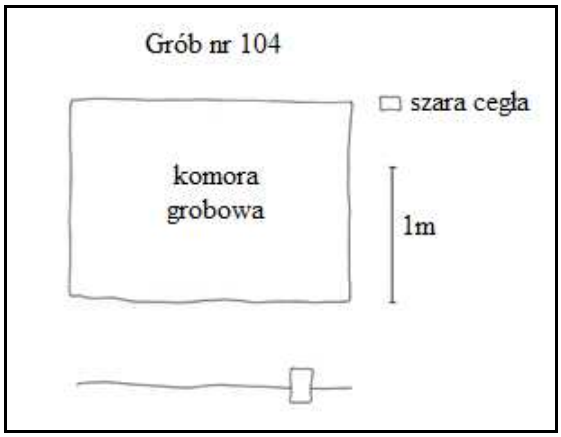


Drawing 32. *A diagram of brick's grains composition in the tomb number 99*

Tomb number 104

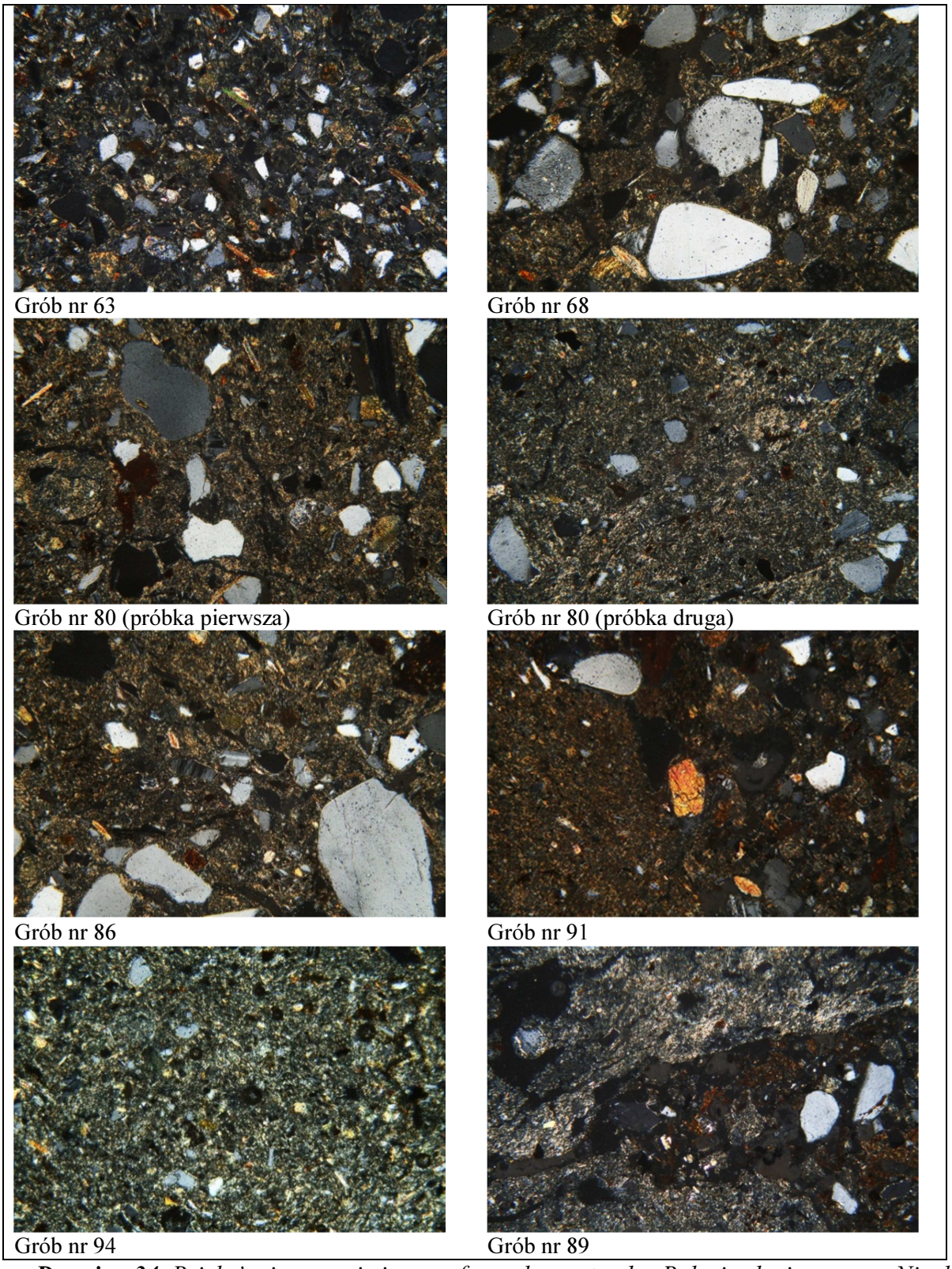
Below there is a photography of a tomb (photo 21) and its draft (drawing 33). In the tomb number 104, it succeed to observe a rest of bricks' circle.

Photo 21. *A photo of the tomb number 104, just after digging.*



Drawing 33. *A draft of the tomb number 104, three seasons after it digging, with one marked brick. (Grób 104- tomb 104, komora grobowa- tomb chamber, szara cegła- gray brick)*

During laboratory research a microscopic tests in polarized light were made. Below a microscope images (drawing 34) of bricks from studied tombs are presenting.



Drawing 34. *Bricks' microscopic images from chosen tombs. Polarized microscope, Nicol prisms are crossing, zoom 120x.*

Research results of dried bricks from tombs indicated that their main components are loamy minerals represented by clay minerals and smectites. Their

content in bricks is varying between 55,8 to 85,3%. It is so called Nile's slit, which performing locally. The second important element is quartz, which content is from 8,7 to 34,1%. On the grounds of a high content of Nile's slit, bricks are made from grains of fraction below 2 centimeters. Their sharing in samples amounted from 62 to 95,6% even.

On brick's microphotographs light sharp-edged grains of quartz were observed, adding in different proportions to Nile's slit. A sample's microphotograph from a tomb number 63 is presenting loamy minerals, on which backdrop tiny sharp-edged grains of quartz and single muscovite's lamina are occurring. The sample's microphotograph from a tomb 68 is presenting Nile's slit, on which backdrop huge over-coating quartz's grains and a bit slighter, in an oblong shape. In the sample number 68 there are at most quartz among all making cuts. There are also single muscovite's lamina. The sample's microphotography from the tomb number 80 (the first sample) is presenting loamy minerals, on which backdrop there are grains of quartz in irregular shapes. One big quartz's grain of not-regular shape and single muscovite's lamina can also be observed. The sample's microphotography from the tomb number 80 (the second sample) is presenting Nile's slit, on which backdrop, single quart's grains of irregular shapes. Based on two above sample's microphotographs from the tomb number 80 (the first and the second samples), it can be stated that, despite bricks comes from the same tomb, they have a different recipe. It can suggested, that they were made in another workshops or in another distance of time. Sample's microphotograph from the tomb number 86 is presenting loamy minerals, on which backdrop quartz's grains of different fraction are appearing. Smaller grains have very irregular shapes. The biggest grain is more well-rounded. On sample's microphotography from a tomb number 91 there is Nile's slit, on which backdrop sharp-edged quartz's grains of an average size are appearing. Sample's microphotography from the tomb number 94 is showing almost merely loamy minerals. Tiny quartz's grains are appearing occasionally and they have limited measurements and irregular shapes. Sample's microphotography from the tomb number 89 is presenting Nile's slit on which backdrop there are sharp-edged quartz's grains and single muscovite's lamina.

According to a fact that, from the eight chosen tombs, five (86, 91, 94, 99, 104) are about 100 years older than three others, a comparison of mineral and grainy composition in point of chronological reasons was made. It came out however, that mineral composition in each testing bricks, is variable and it can't be observed any rule here, in a recipe for bricks from tombs older and younger. Only that, which point out an attention is a present of little material's addiction of fraction above 100 μm in older tombs. Generally, both of bricks from older and younger tombs are consisting mainly of a material below 2 μm (loamy fraction).

Dimensions of bricks from tombs in Tell el-Farkha are very approximate. It was proved, that an average length of brick is 28 centimeters, and an average width is 15 centimeters. Differences in lengths and widths of bricks don't cross 2 centimeters. The thickness of bricks is constant and it amounts 8-9 centimeters.

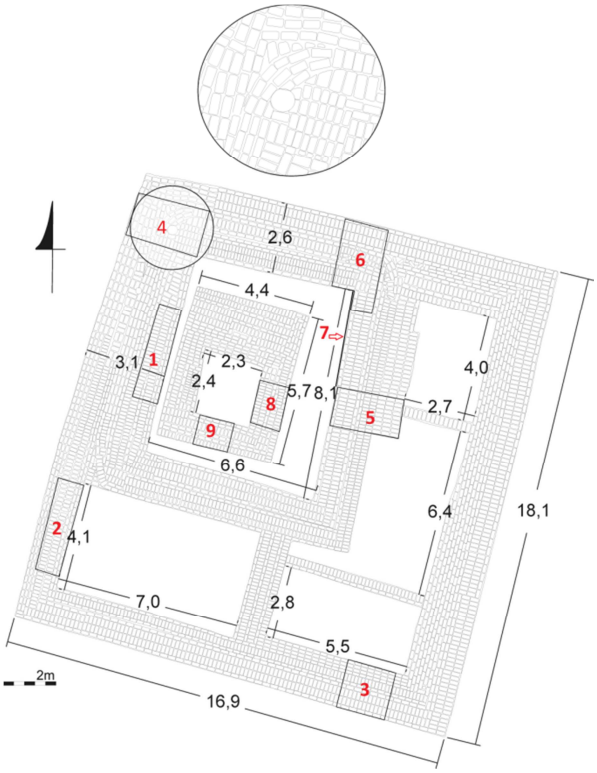
Summing up research results, it can be ascertain, that the tombs in particular periods of a society's functioning, they were built in different ways and they didn't have a constant, clearly defined recipe.

Mineral and grainy composition of bricks indicating that they were occasionally made, due to a need of human burial, so it is observed a significant diversity among them.

Research result of dried bricks from a mastaba

During research an analyze of dried bricks' morphology and mineralogy-petrography analyze of samples charged from bricks located in mastaba's walls was made. Below there is a scheme of mastaba and adjacent rooms (drawing 35) (Cialowicz and others, 2013).

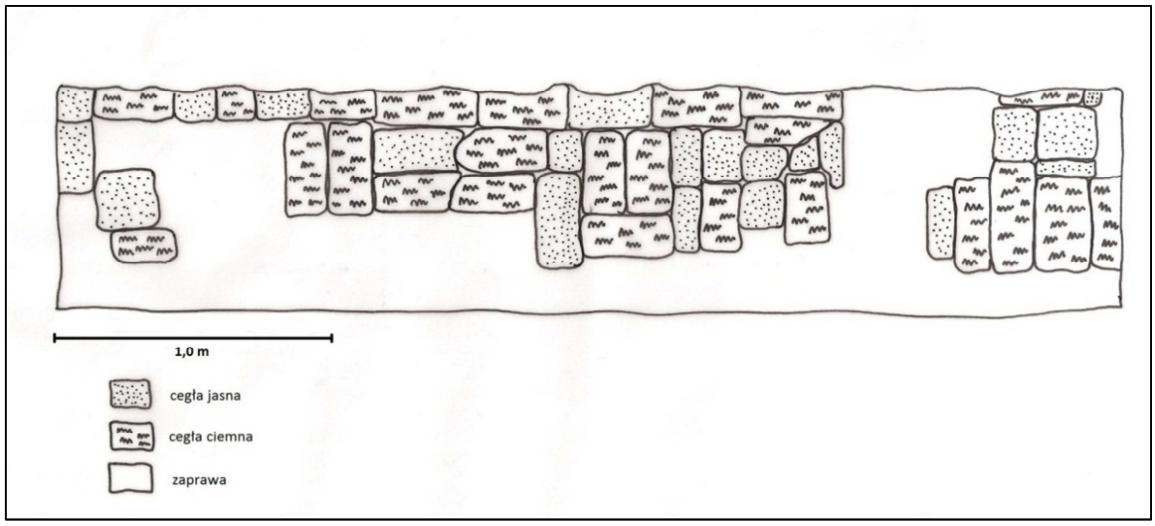
Research results were presenting in succession for each wall's fragment by the scheme: a number indicated a place of sample's charging, a draft of wall's structure.



Drawing 35. *Mastaba's plan. With red are marked places, in where drafts were made and samples were charging (Cialowicz and others, 2013, amended).*

FIRST FRAGMENT OF A WALL (M1)

Below a draft (drawing 36) of the first fragment of mastaba's wall is presenting, with a consideration of light and dark bricks.

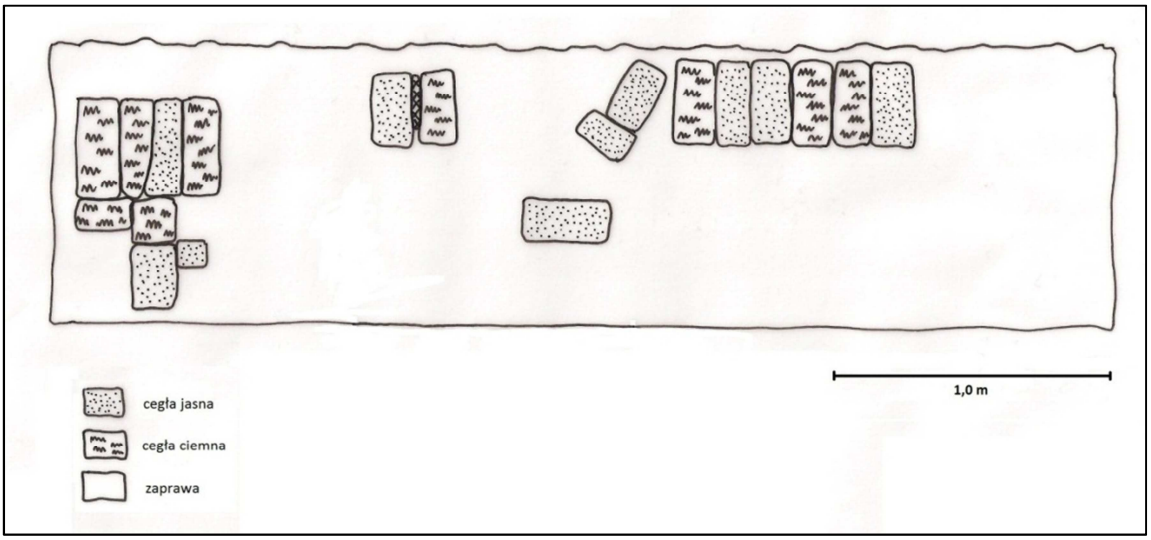


Drawing 36. *A draft of bricks' arrangement (plan) from the first fragment of a wall. (Cegła jasna- light brick, cegła ciemna – dark brick, zaprawa- daub)*

An analyze of bricks and their arrangement, suggested that there are both light bricks, as well as dark bricks here. A proportion of light to dark is about 33% : 67%. Both kinds of bricks were measured. Their dimensions were very approximate.

SECOND FRAGMENT OF A WALL (M2)

Below a draft (drawing 37) of the second fragment of mastaba's wall is presenting, with a consideration of light and dark bricks.

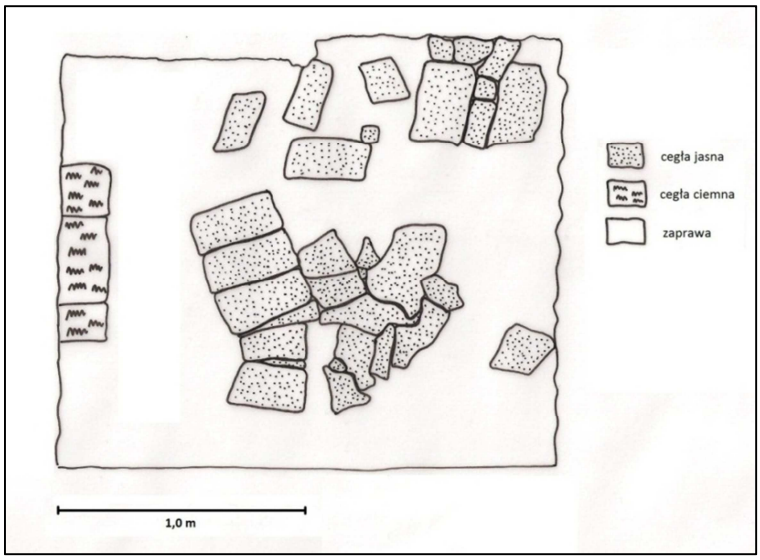


Drawing 37. *A draft of bricks' arrangement (plan) from the second fragment of a wall. (Cegła jasna- light brick, cegła ciemna – dark brick, zaprawa- daub)*

In the second fragment of the wall a length and a width of bricks were measured. It transpired that, dimensions are approximate to that in wall M1. With the arrangement of bricks, it was deduced, that likewise in the case of first fragment of the wall, a proportion of light bricks to dark bricks is 33% : 67%.

THIRD FRAGMENT OF A WALL (M3)

Below a draft (drawing 38) of the third fragment of mastaba's wall is presenting, with a consideration of light and dark bricks.

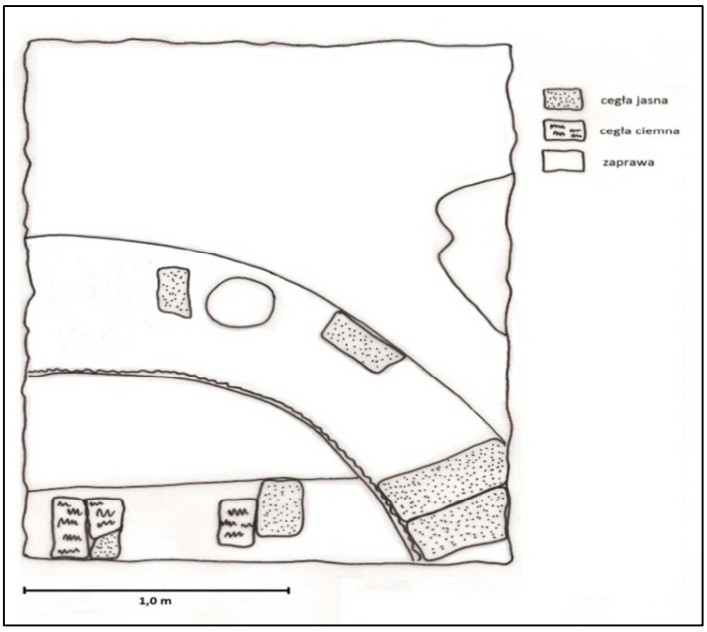


Drawing 38. *A draft of bricks' arrangement (plan) from the third fragment of a wall. (Cegła jasna- light brick, cegła ciemna – dark brick, zaprawa- daub)*

After performing an analyze of the third wall's fragment, it was deduced, that a proportion of light bricks to dark bricks significantly departs from this parameter, in the case of two previous studied walls. Here, light bricks significantly are dominating.

FOURTH FRAGMENT OF A WALL (M4)

Below a draft (drawing 39) of the fourth fragment of mastaba's wall is presenting, with a consideration of light and dark bricks.

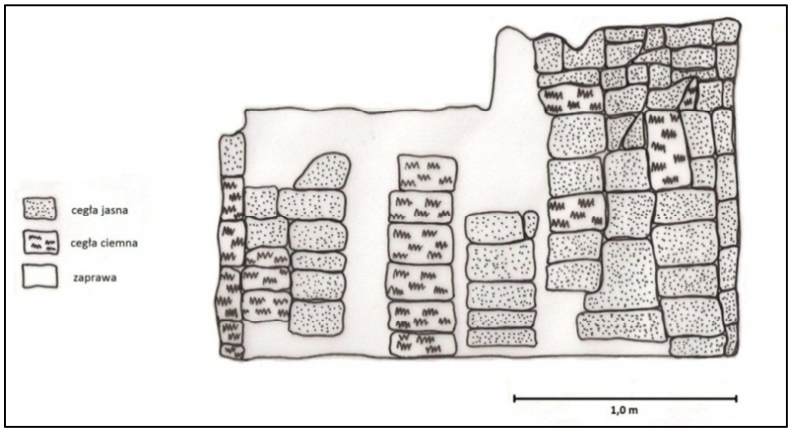


Drawing 39. *A draft of bricks' arrangement (plan) from the fourth fragment of a wall. (Cegła jasna- light brick, cegła ciemna – dark brick, zaprawa- daub)*

Analyzing an arrangement of bricks in the wall M4, it can be stated, that it is a mastaba's corner. In the case of this wall's fragment, only a measurement of light bricks was made, which dimensions were transpired approximate to bricks' dimension from different fragments of walls.

FIFTH FRAGMENT OF A WALL (M5)

Below a draft (drawing 40) of the fifth fragment of mastaba's wall is presenting, with a consideration of light and dark bricks.

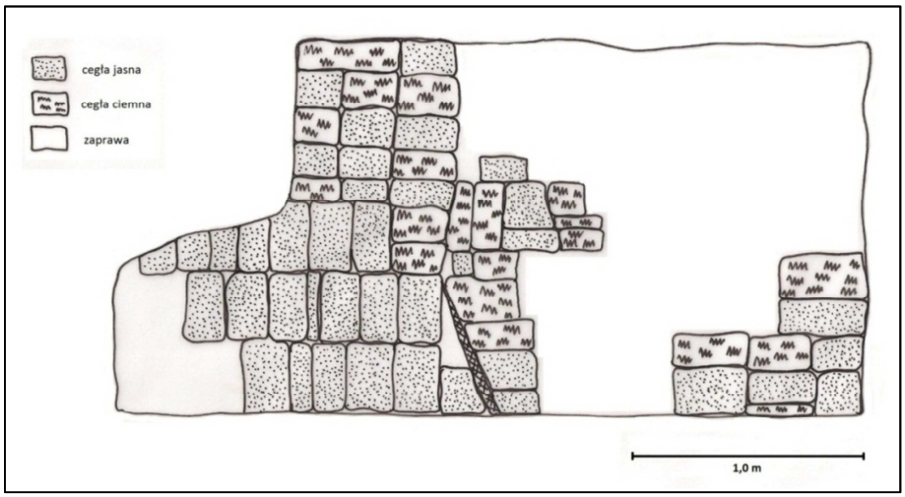


Drawing 40. *A draft of the fifth wall's fragment. (Cegła jasna- light brick, cegła ciemna – dark brick, zaprawa- daub)*

After making an analyze of the fifth fragment of the wall, it was stated that, it consists of three walls: outside, central and inside. In the outside wall light bricks, as well as dark bricks were observed. A proportion of light to dark is 23% : 77%. In the central and inside wall are only light bricks.

SIXTH FRAGMENT OF A WALL (M6)

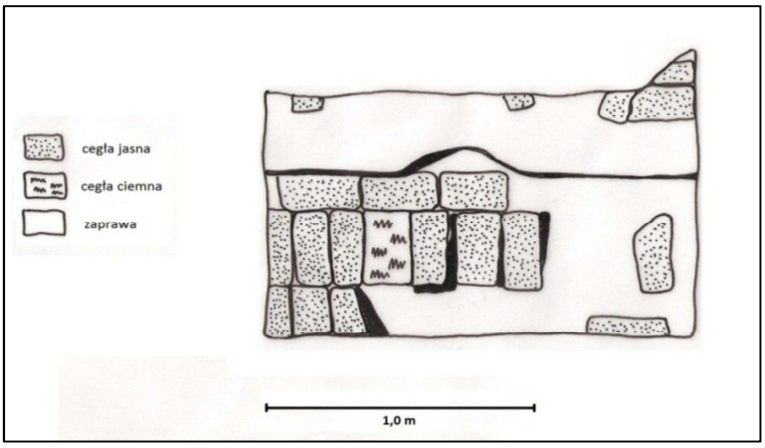
An arrangement of bricks (drawing 41) in the wall, at the place marked M6 pointing that, it consists of two walls abutting to each other: A and B. The wall A consists of light bricks, but the wall B consists of light bricks as well as dark bricks. During measurement, a division considering a color weren't consider. The bricks' dimensions transpired approximate again.



Drawing 41. *A draft of the sixth wall's fragment. (Cegła jasna- light brick, cegła ciemna – dark brick, zaprawa- daub)*

EIGHT FRAGMENT OF A WALL (M8)

From a draft (drawing 42) it results that, a wall M8 consists of two walls: outside wall (A), consists of dark bricks and inside wall (B), consists of light bricks.



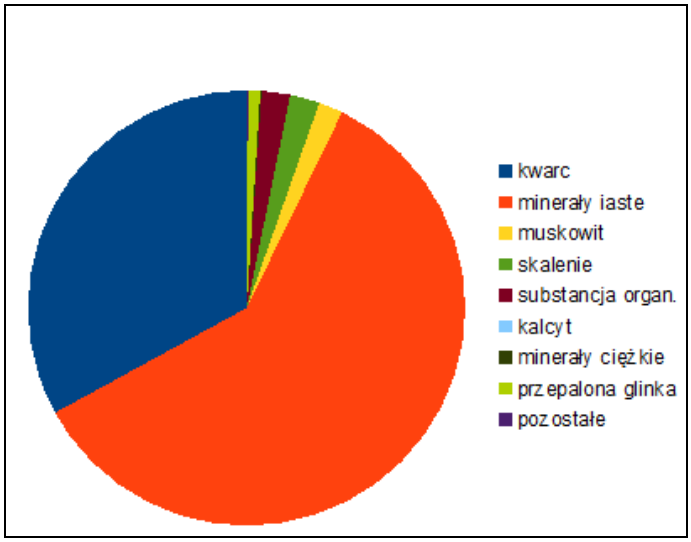
Drawing 42. *A draft of the eight wall's fragment in the point M8. (Cegła jasna- light brick, cegła ciemna – dark brick, zaprawa- daub)*

From research, it results that bricks from a mastaba like dried bricks from tombs, have very regular dimensions. Their average length is 28 centimeters, and their width is about 15 centimeters.

At the end of dried bricks' research, a mineral composition analyze of three of them was performed (from walls 1, 5 and 8). One light and two dark bricks were probed. This research results is presenting below, in the form of tables (tables 14-16) and on the graphs (drawings 43-46).

component	contents
quartz	33
clay minerals	59,8
muscovite	1,8
feldspars	2,2
organic subst.	2,1
calcite	0
heavy minerals	0,1
burned clay	0,9
other	0,1

Table 14. *Light brick's mineral composition from the wall M1.*



Drawing 43. *A diagram of brick's mineral composition from the wall M1. (kwarc- quartz, minerały ilaste- clay minerals, muskowit – muscovite, skalenie – feldspars, substancja organiczna – organic subst., kalcyt – calcite, minerały ciężkie – heavy minerals, glinka palona – burned clay, pozostałe – other)*

component	contents
quartz	20
clay minerals	22,8
muscovite	1,5
feldspars	0,7
organic subst.	3,3
calcite	0
heavy minerals	0,1
burned clay	2,1
other	0,1

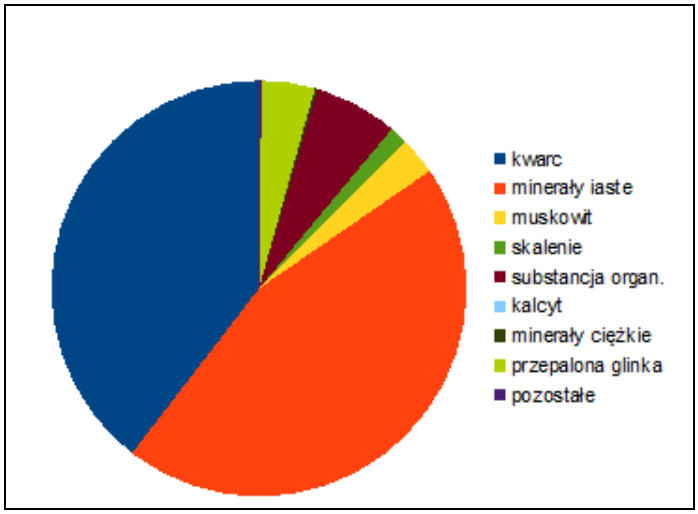
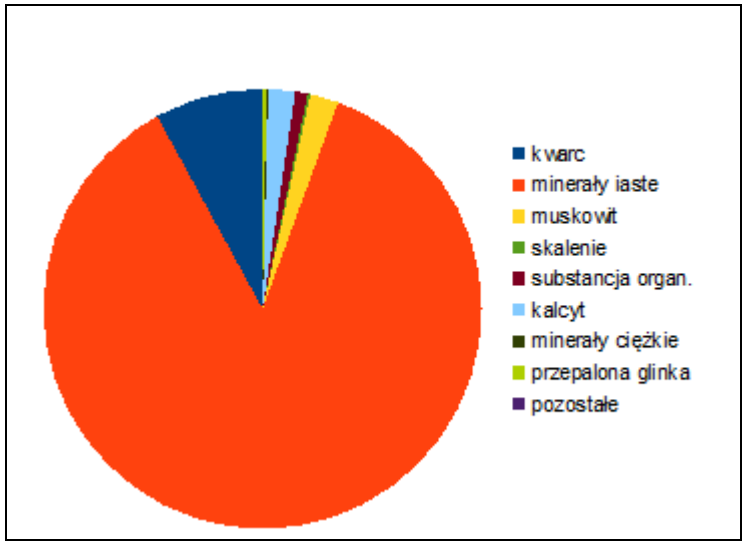


Table 15. *Dark brick's mineral composition from the wall M5.*

component	contents [%]
quartz	8
clay minerals	86,4
muscovite	2,1
feldspars	0,2
organic subst.	0,9
calcite	2
heavy minerals	0,1
burned clay	0,3
other	0

Table 16. *Dark brick's mineral composition from the wall M8.*

Drawing 44. *A diagram of brick's mineral composition from the wall M5. (kwarc- quartz, minerały ilaste- clay minerals, muskowit – muscovite, skalenie – feldspars, substancja organiczna – organic subst., kalcyt – calcite, minerały ciężkie – heavy minerals, glinka palona – burned clay, pozostałe – other)*



Drawing 45. *A diagram of brick's mineral composition from the wall M8. (kwarc- quartz, minerały ilaste- clay minerals, muskowit – muscovite, skalenie – feldspars, substancja organiczna – organic subst., kalcyt – calcite, minerały ciężkie – heavy minerals, glinka palona – burned clay, pozostałe – other)*

Analyzing mineral composition's research results from a mastaba, it was ascertained, that like in a case of dried bricks from tombs, their main components are loamy minerals. Their content is varying from 22,8 to 86,4%. The second main component is a quartz (content from 8 and 33%).

A comparison of (grey) brick's mineral composition, descended from tombs and older from them mastaba, proving their variable recipe or bricks' transformation in

different workshops, as well as both. In this analyze also didn't prove similarities in individual groups (bricks from mastaba's walls, bricks from older tombs, bricks from younger tombs). On the grounds of only one light brick charging, based on it we can't rate how its mineral content may impact for its color.

Research show, that for mastaba's construction bricks from different raw materials. A various mineral content, suggested of fast mastaba's building, perhaps in two or more workshops. Fast building of the mastaba may also suggested of it erection after a death of a person, who would be buried in it.

Research display of their usefulness not only in architectonic details' elicitation, but also in evaluate of undertaking activities during building – in this case a mastaba.

Coals' research results

In the first stage coal's samples research were observed using a binocular magnifier. In not-burning material small, fibrous vegetable shreds was observed (photo 22).

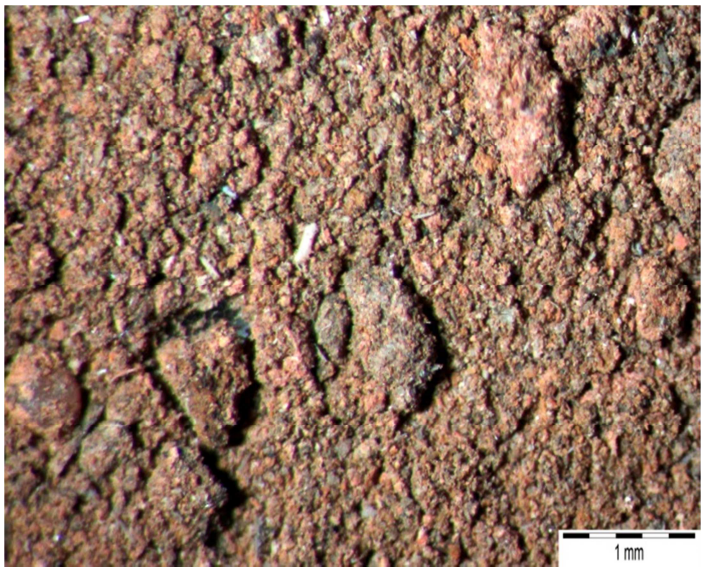


Photo 22. *Tiny fragments of a straw in not-burnt-out sample, came from 'center' B.*

During further observations, it was stated that, small coals descended from ‘centers’ are sets of small coal’s grains (photo 23), which without greater effort are disintegrating for coal’s dust in hands. A diameter of grains is not more than few millimeters.

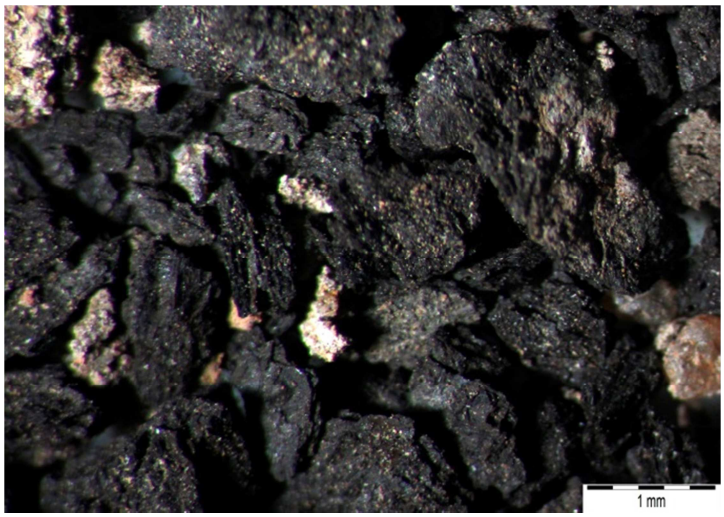


Photo 23. *Sets of coal, consisted of tiny grains.*

In the next stage of research, after making microscope slides from samples, an observation at visual microscope in polarized light was starting. It allows to identify not-burning plant’s fragments. It transpired that, there was a straw descended from crops in the neighborhood of a site (photos 24-25).

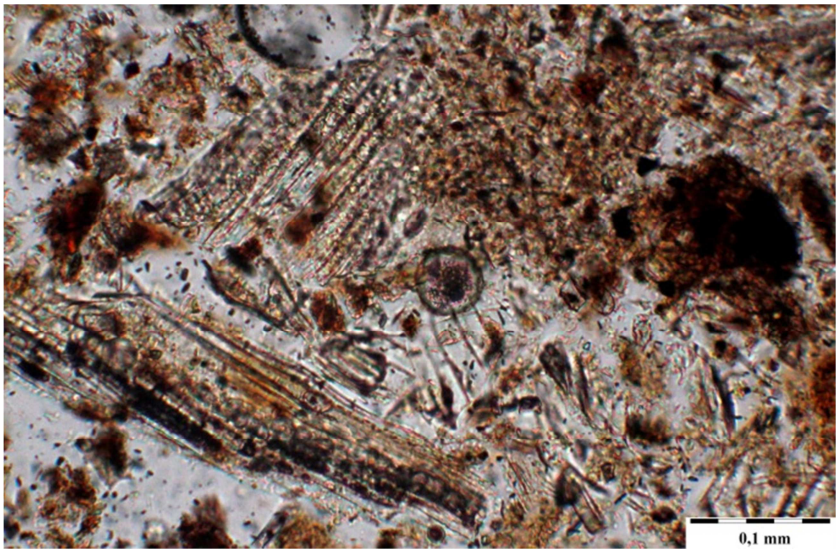


Photo 24. *Not-burning fragments of a straw (a barley). Light microscope. Nicol prisms are partly crossing.*

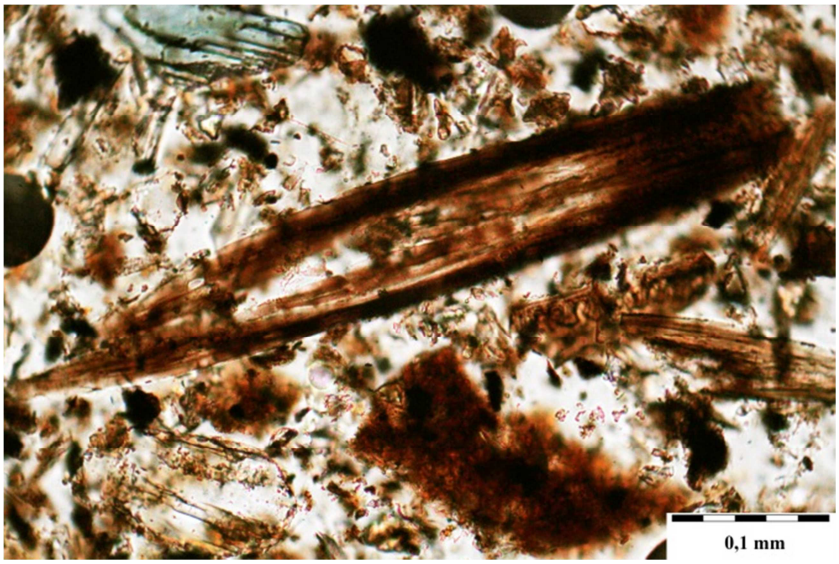


Photo 25. *Not-burning fragment of grain's skin. Light microscope. Nicol prisms are partly crossing.*

Performing research show that, an organic material after burning, is a set of a soot, which build sets in different sizes, in the shape of a ball or porous sets, consist of coal's micro-grains. Microphotographs is presenting below (photos 26-27).

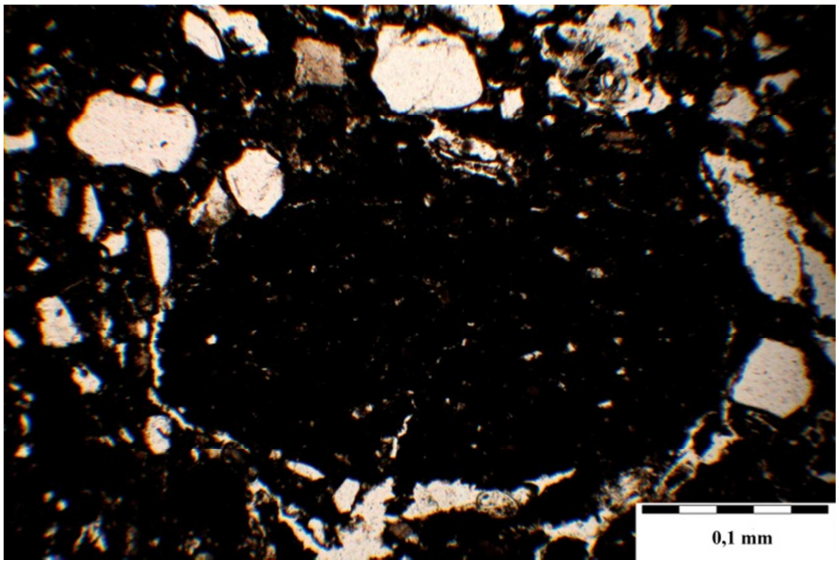
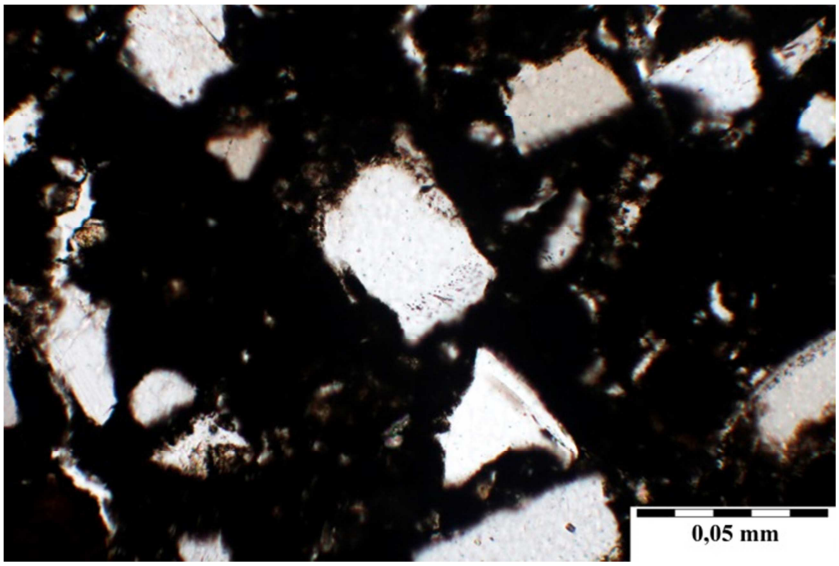


Photo 26. *A set of soot in a circle shape. It is encompassing of soot, in which composition consist an addiction of quartz.*



Fot. 27. *Mikrofotografia sadzy zawierającej ziarna kwarcu. Mikroskop optyczny, nikole częściowo skrzyżowane*

The next stage of research were observations of samples at scanning microscope with an adapter to chemical's composition analyze (EDS). They validate that in coal's sets from 'centers', there are many grains of quartz, loamy minerals and others components. Results of an analyze are presenting below (photos 28-31).

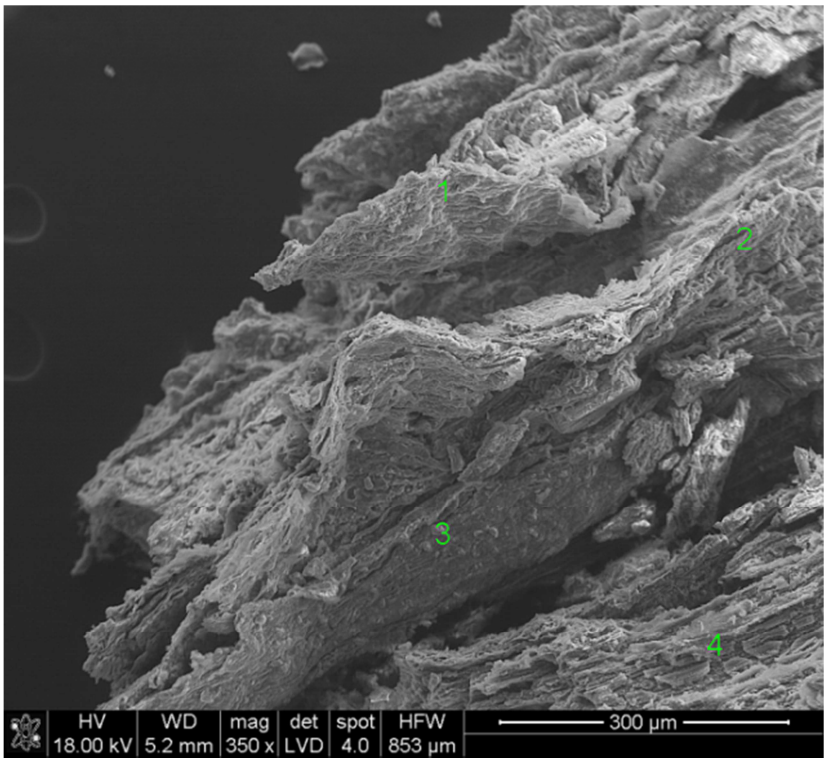


Photo 28. *A picture of charred plant tissue (SEM), which was subjected of an EDS analyze.*

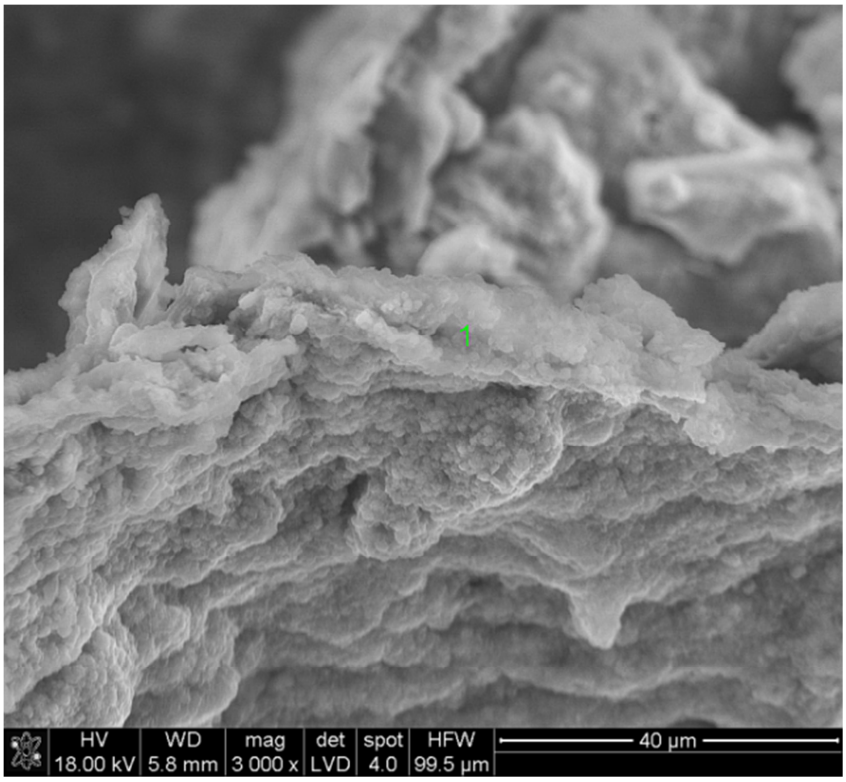


Photo 29. *A picture of charred plant's tissue structure with a soot, in the form of micro-balls. SEM.*

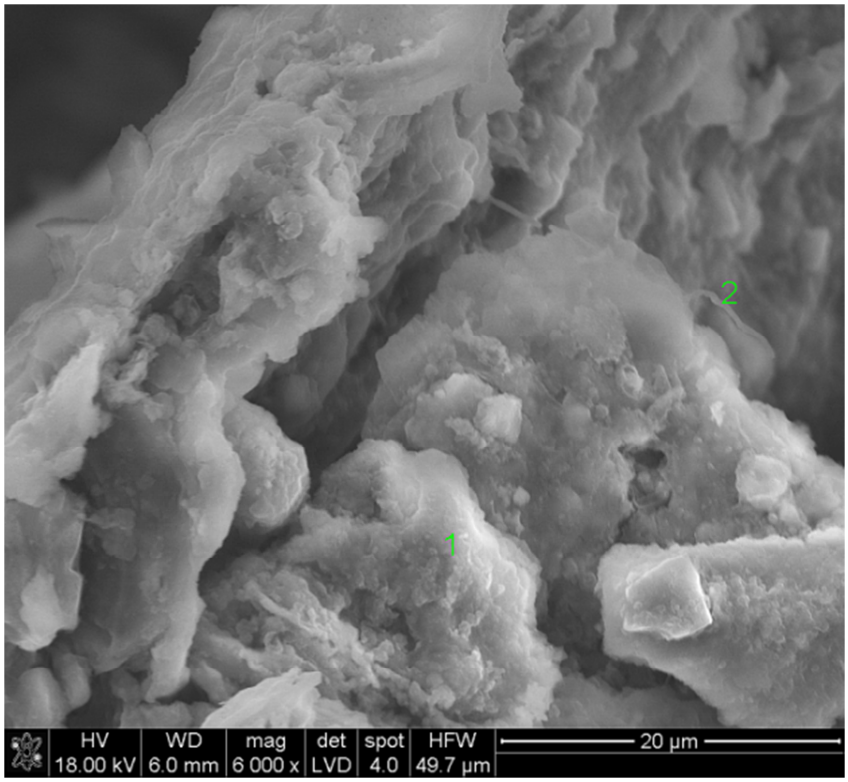


Photo 30. *A picture of charred plant tissue (SEM), which has absorbing cations. Places of making an EDS analyze were marked. 'Center' A.*

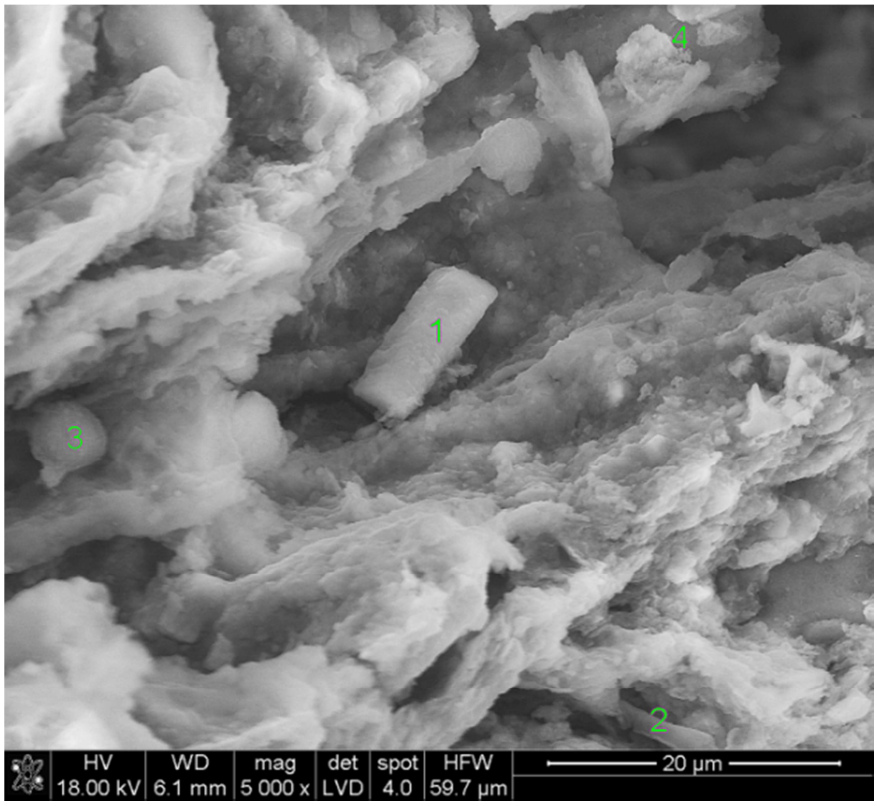
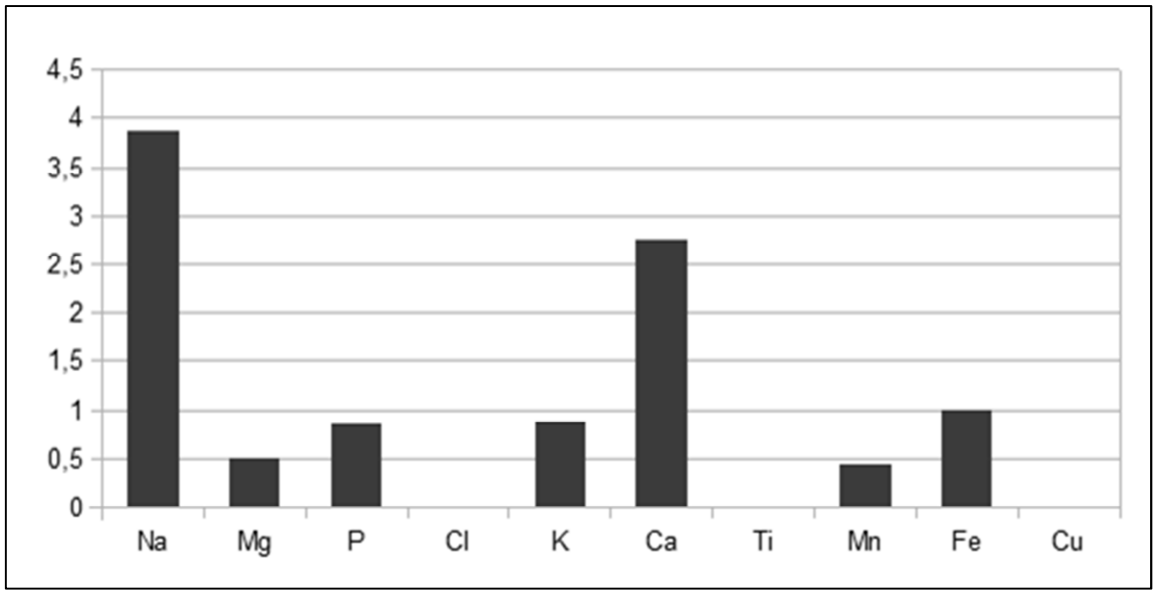


Photo 31. *A picture of charred plant tissue (SEM), which has absorbing cations. Places of making an EDS analyze were marked. 'Center' B.*

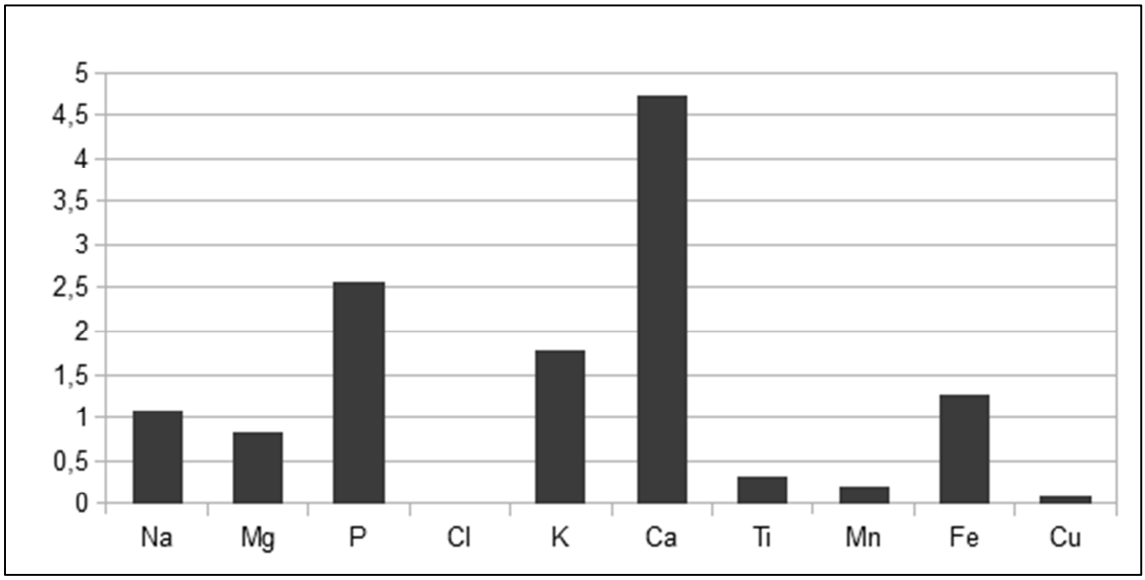
A presence of mineral forms next to a coal impedes studying of it. Nevertheless, a EDS analyze of set coals' forms from 'centers' A, B and C was performed. Results are presenting below (table 17, drawings 46-48).

element	**content in the sample from *'centers' A***	**content in the sample from *'centers' B***	**content in the sample from *'centers'* C**
Na	3,88	1,09	0,78
Mg	0,5	0,83	0,76
P	0,86	2,57	2,35
Cl	0	0	0,55
K	0,87	1,79	2,61
Ca	2,75	4,72	9,47
Ti	0	0,32	0,82
Mn	0,45	0,21	0
Fe	1	1,28	4,01
Cu	0	0,08	0,1

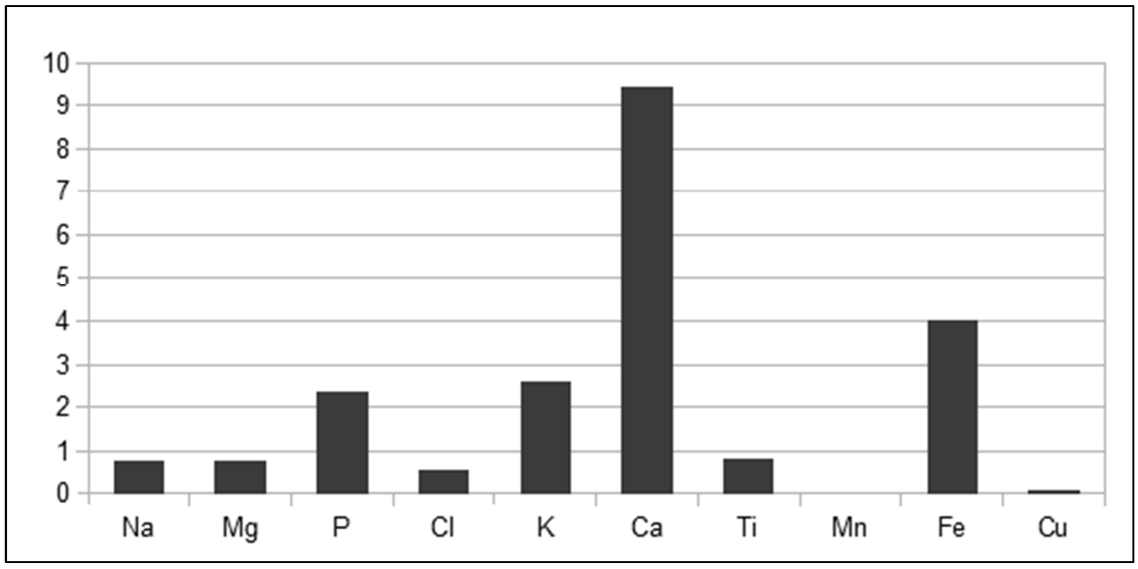
Table 17. *Chemical composition (EDS) of coals from 'centers' A, B and C. Values are dish up in weight percent (weight %).*



Drawing 46. *A composition of chemical elements in small coals from 'center' A [weight %].*

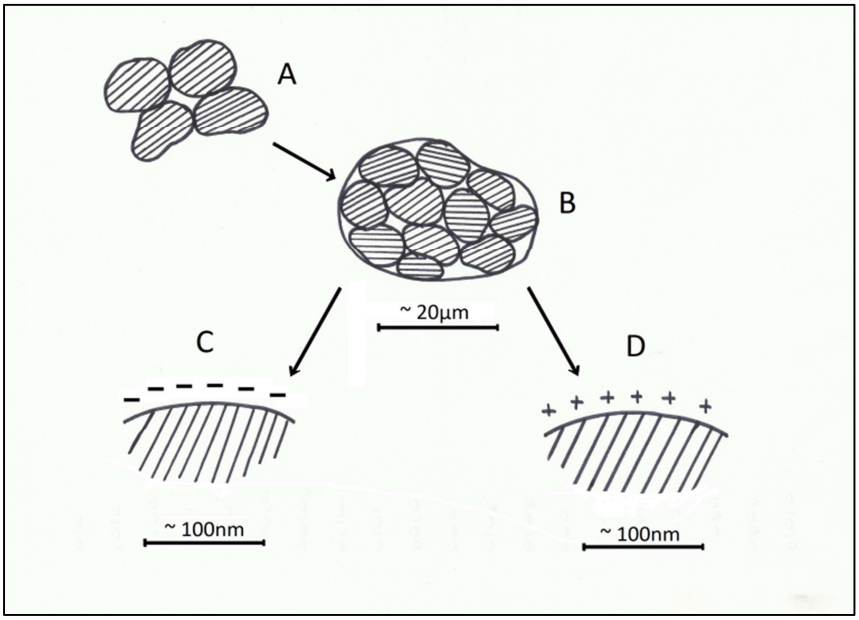


Drawing 47. *A composition of chemical elements in small coals from 'center' B [weight %].*



Drawing 48. *A composition of chemical elements in small coals from 'center' C [weight %].*

Studying coal performs above contents of succeeding chemical elements: Na, Ca, K, P, Mn, Ti and Cu. In them, individual crystalline phases, which can be a source of this chemical elements weren't state. It follows that, a coal from before about 5000 years, has a sorbent attributes, related to its reduction during a fire. It brought an inception of minus charges at the surface of micro-grains. This process' schema is presenting below (drawing 49).

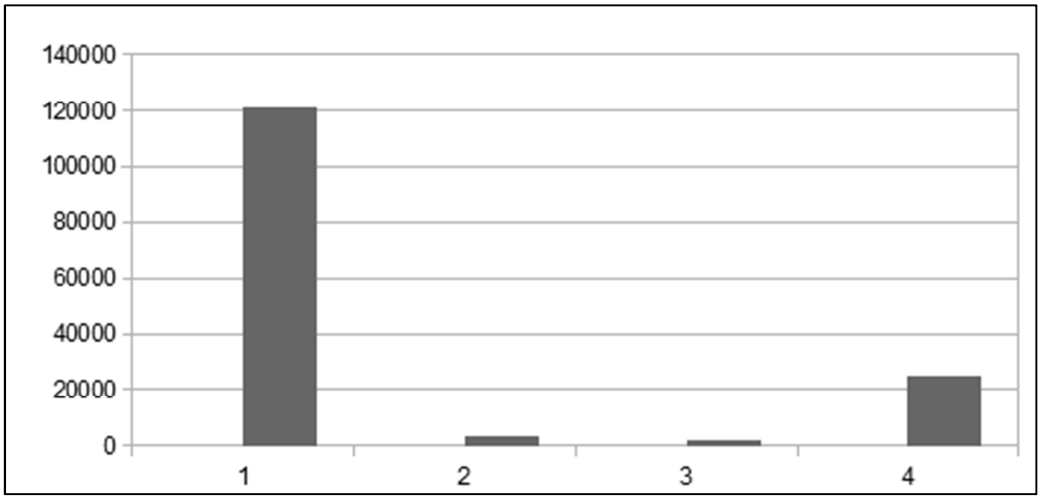


Drawing 49. *A scheme of soot's studying structure. A-sets of soot observed in polarized microscope. B-sets of soot in scanning microscope. C-hypothetical positive charge on a coal's surface.*

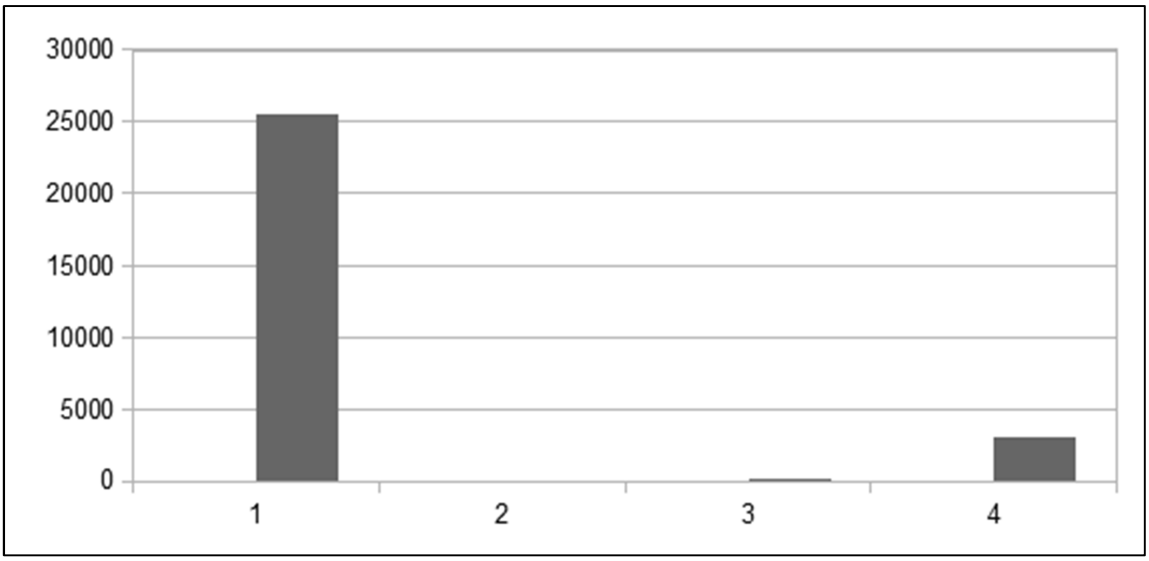
Research showed sorbent attributes of old small coals, performing in burning slit, in the mastaba's neighborhood. A presence of slightly increasing content of copper in coals from B and C 'centers', can suggests a presence of things made from copper in their neighborhood. It will be checking during further excavation research in this part of a site.

Nr	*A number of oxygenic bacteria [g s.m.]*	*A number of non-oxygenic bacteria [g s.m.]*	*A number of fungi [g s.m.]*	*A number of xerophilous fungi[g s.m.]*	*A number of bacteria, which putrid fat [%]*	*A number of bacteria, which putrid a protein [%]*	*A number of bacteria, which putrid a starch [%]*
1	121 000	25 500	1285	10 200	80	50	33
2	3 200	0	500	700	22	33	5
3	2 300	187	270	1200	75	45	15
4	25 000	3100	5700	7000	83	61	25

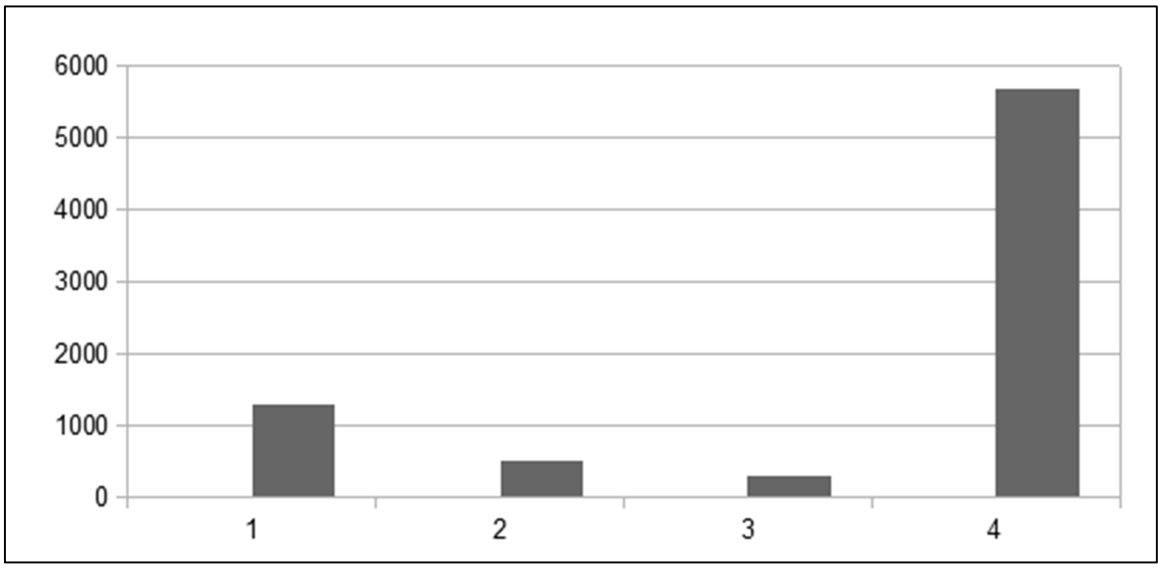
Table 18. *A composition of individual bacteria and fungi in samples charged to research.*



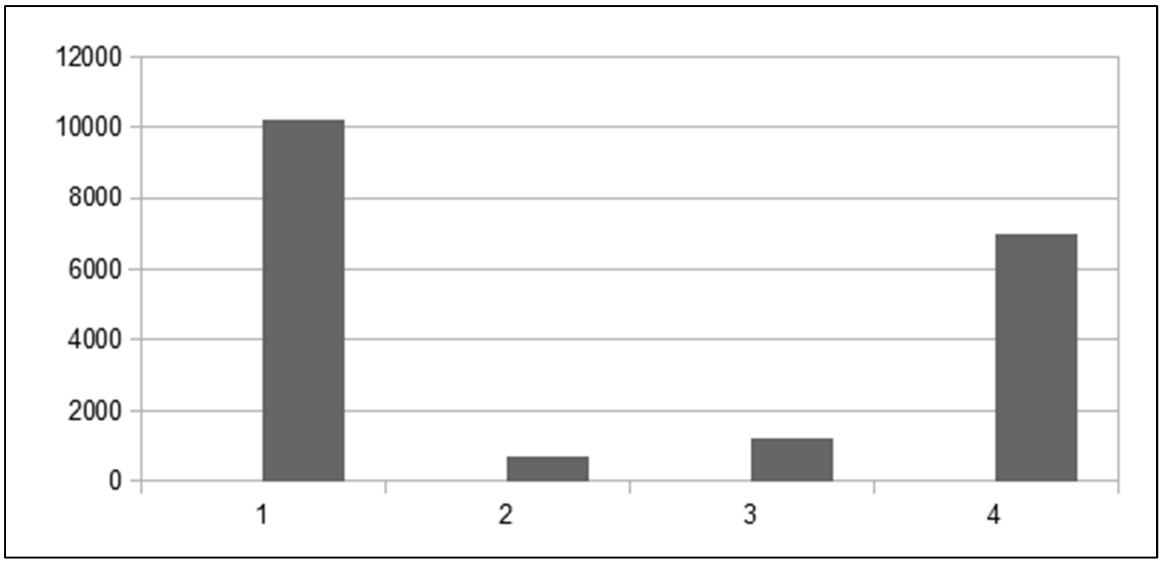
Drawing 50. *A graph presenting a number of oxygenic bacteria [g s.m.], developing in samples 1-4.*



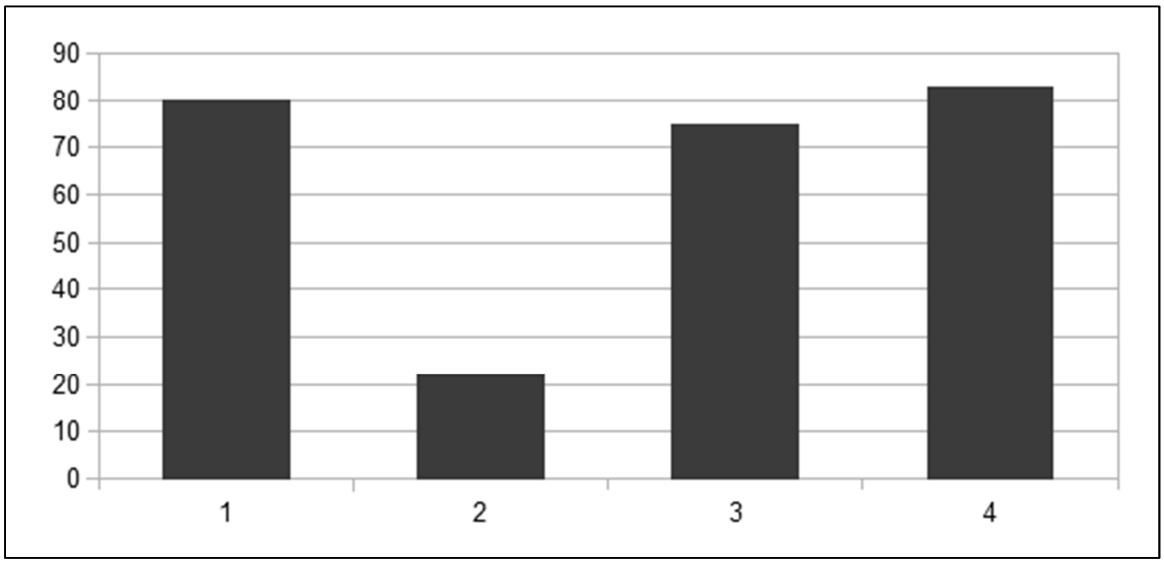
Drawing 51. *A graph presenting a number of non-oxygenic bacteria [g s.m.], developing in samples 1-4.*



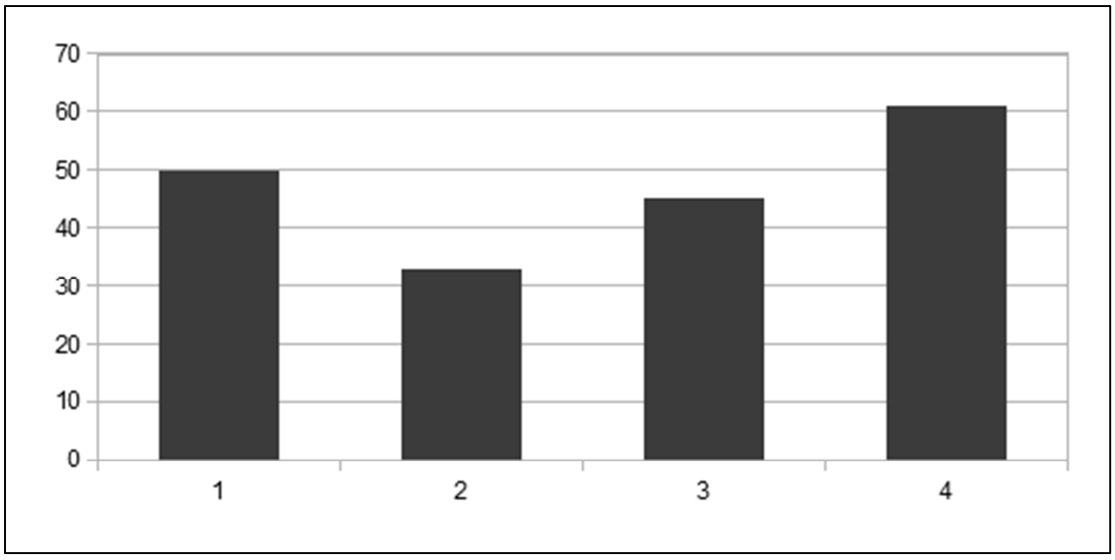
Drawing 52. *A graph presenting a number of fungi [g s.m.], developing in samples 1-4.*



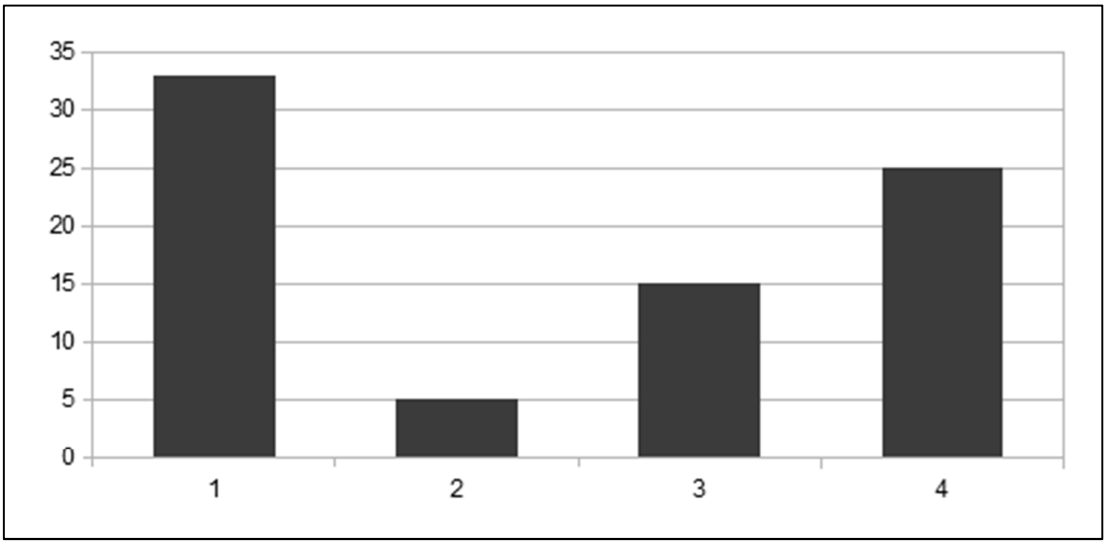
Drawing 53. *A graph presenting a number of xerophilous fungi[g s.m.], developing in samples 1-4.*



Drawing 54. *A graph presenting a number of bacteria, which putrid fat [%], developing in samples 1-4.*



Drawing 55. *A graph presenting a number of bacteria, which putrid a protein [%], developing in samples 1-4.*



Drawing 56. *A graph presenting a number of bacteria, which putrid a starch [%], developing in samples 1-4.*

Microbiological research results

In the laboratory by Department of Environmental Microbiology and Biotechnology at the Nicolaus Copernicus' University in Torun, microbiological research of four samples, descending from a site were made. Sample number 1 was charged from the tomb number 94 (from under a mat), sample number 2 – from an old center in C kom, sample number 3 – from within of ceramics crockery, founded in E kom, and sample number 4 – from within of animal's bone in tomb, in E kom.

A content of developing different kinds of bacteria and fungi was determined. Results are presenting in a table (table 18) and on the graphs (drawings 71-77). Research showed a presence of numerous and dangerous bacteria in all studying samples. This result disposes to conduct excavation with being specially cautious, especially in the case of tombs' exploitation.

A summary and results

All conducted research have an innovative character and bring a great amount of new and essential information, which allow to know a site and human activity thousands of years ago.

Tiny fractions' research

Research results' of micro-relics prove a function's change of analyzing place within a time lapse. One time, fish were rearing (a presence of a great amount of fish' bones indicate about it), another time fire was burning or stone crockery were processing (or breaking). There are additional information, which are hard to obtain, when a classical exploitation of a site is conducting.

Based on research results' of tiny fractions, it can be stated that the main component of almost all samples (aside from one – sample number 18) is a pug. Their content in samples vary from 32,8 to 93,9% of their volume. In the sample number 18, its content amount only 3,6%, and its main component are stone's fragments (65,7%).

The highest amount of pug is located in lower part of a profile and it declines in its upper side. A content of a clay and presence of directionally disposing straw, suggest that it was used to construct small buildings. A presence of burning pug's

fragments, denote that the buildings had to being burn. A huge amount of arid clay's fragments, in almost all layer, indicate about that, at site fires were often.

Ceramics' fragments perform random in a profile. They came from destroyed ceramics crockery and from bread's forms.

A content of charcoal in samples vary from 0 to 21,8% of their volume. It can be detected that, in surroundings, where the sample number 12 was charged, a fireplace was.

In samples 5, 11 and 12 there is a huge amount of bones' fragments. Unfortunately, it was no ascertain, to which species they belonging.

In all samples a low content of flints was observed.

Rocks' fragments are mainly concentrated on the layer number 18. Sharp-edged crumps of quartzite and limestones, indicate that they were processing in surrounding of sample's charging.

In samples 4, 5, 11, 12 and 17 a huge amount of fish bones' were founded. It can be an evidence for that, on five periods in places of samples' charging, fish were baking in fires.

Quartz's grains in all profile comprise from 0,9 to 27,5% of samples' volume. A variable amount in proportion of burning and not-burning grains was also observed.

Mineralogical-petrographic research of dried bricks

Mineralogical-petrographic research of dried bricks, haven't been made for so broad scale in Egypt yet. They ascend a huge amount of new information about the technology and raw materials, which were used for building different objects. A structure of studying walls was also various.

A research of bricks from tombs

Research results' of dried bricks from tombs, are showing, that they have an approximate length and width, as well as thickness more or less. They were made from dried Nile's slit, mixing with another ingredients, mainly with a local sand.

Research of dried bricks from a mastaba

Research of dried bricks from a mastaba, suggest that it was building in a rush and probably it was rebuilt (double walls from a leeward side). Bricks have regular dimensions, but patchy mineral composition, which can denote that they were made in different workshops.

Research of small coals

Research of small coals can be used to recognize of archeological environment's geochemistry. Considering to this, that small coals absorbing metals, they can be useful to a localization of, for example: copper, bronze and other metals, which in geochemistry conditions' of a site undergo a migration.

Fragments of burning small coals, which were charged to research, located on a burial ground. It was stated, that they have sorption attributes. In them, there are trace amounts of cooper chemical element's. It can indicated for nearby presence of cooper relics, which probably will be found in future. Research of coal's sorption may be helpful someday, for the localization of relics, built from concrete chemical elements.

Microbiological bacteria

Microbiological research indicated for an occurrence different types of bacteria (oxygenic, non-oxygenic and this which degrading fat, starch and protein) as well as fungi (also xerophilous) in samples.

Previous research were general and depended on a presence of different bacteria and fungi, so based on them it can't be stated no threats for people working at diggings. So, essential is a site's research, in such a way that people leading exploitation, don't be exposed for serious problems with a health.

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