Maciej Pawlikowski*, Jacek Strzelczyk**

Mineralogical investigation of selected phenomenon present in Kom C. Tell el-Farcha archaeological site. The Nile Delta - Egypt.

*/ *Cathedral of Mineralogy, Petrography and Geochemistry AGH, Krakow, Poland*

/* *Cathedral of Geoinformatics and Applied Computer Science, AGH, Krakow, Poland*

Abstract

Investigation of selected samples collected coming from Kom C at Tel el Farcha site were performed using various mineralogical methods. Examination were conducted in order to identify substances as well as to explain their origin. Samples represent material filling up old fireplaces, mineralized charcoal and organic mat, dark substances coating alabaster vessels and other.

Determination of the mentioned substances and samples help to understand the life in the past better.

Key words: mineralogy, archeology, Nile Delta.

Introduction

Investigation of Tel el Farkha archaeological site was started by Italian scientists and continued later by combined Polish-Egyptian mission. Three big trenches localized in west (trench W), central (trench C) and east (trench E) part of the come were explored (Cialowicz 2004, Chłodnicki 2004, Pawlikowski 2004, Pawlikowski, Wasilewski - in press). Exploration showed the presence of great architectonic objects, such as tombs as well as small, very interesting, special findings of unknown origin. These findings are the object of presented investigation.

Material and methods

Samples were collected at trench C, Kom C (Fig. 1) and material for investigation is represented by following samples:

Sample 1 - mostly charcoal

Sample 2 - yellowish but not burnt clay

Sample 3 - fragment of altered bone

Sample 4 - light, fine material filling up the fireplaces (Photo 1)

Sample 5 - burnt and mineralized organic grains of plants

Sample 6 - thermally altered clay – slag probably

Sample 7 - mixed brown, burnt powder composed of mineral and organic compounds (Photo 2)

Sample 8 – yellowish, very fine material filling up the fireplace (Photo 3)

Sample 9 – secondary mineralized organic mat

Sample 10 – black organic substance coating external wall of alabaster vessel (Photo 4, vessel from kom C)

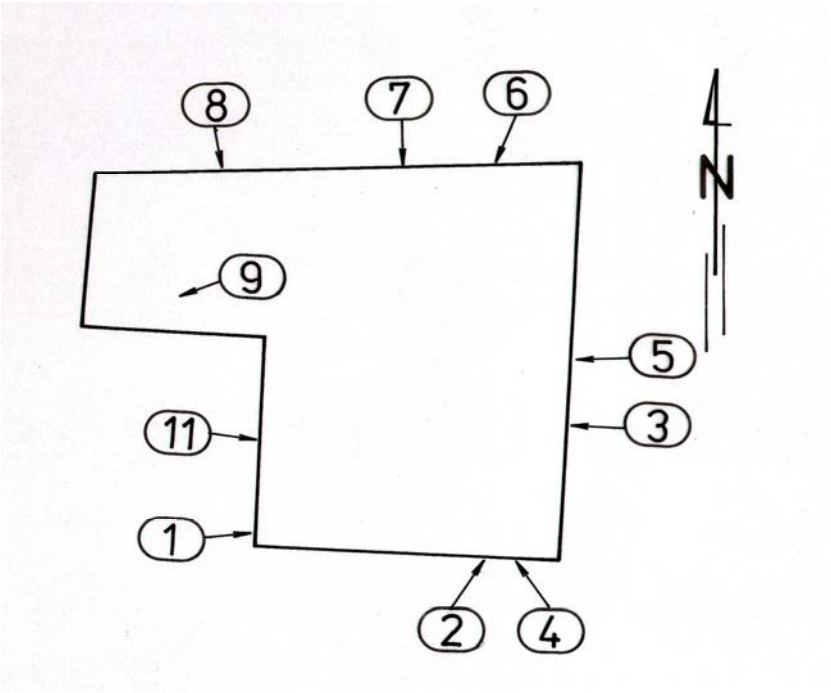


Fig. 1 Scheme of Kom C. Location of tested samples nos 1-11.

Photo 1 Fireplace filled up with light substance (arrow). Sample no 4

Photo 2 Profile with brownish substance (arrow). Sample no 4.
"powder" (arrow). Sample no 7

Photo 3 Fireplaces filled up with light substance (arrow). Sample no 8.

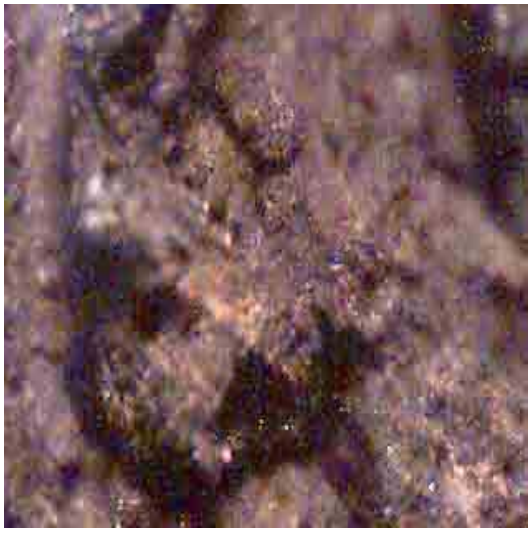
Photo 4 Black organic substance coating vessel made of alabaster. Sample no 10.

For investigation of collected samples following methods were used:

1. polarizing light microscopy (PLM),
2. scanning electron microscopy (SEM),
3. chemical semiquantitative analyses (EDS)
4. infrared spectroscopy (IR)
5. X-ray diffraction

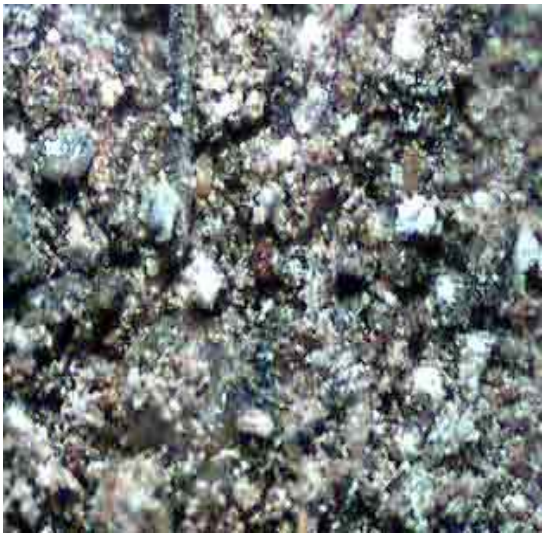
Macroscopic description of samples

Observation made using digital microscope showed, that the sample no 1 is out of structure. Under the microscope, one can see irregular organic structure (Photo. 5A).



A

B



C

D

E

F

G

Photo 5 Microscopic pictures of the tested samples.

A- Sample no 1. Structure of burnt organic substance. Digital microscope, magnification 50 x,

B- Sample no 3. Microscopic picture of altered bone. Digital microscope, magnification 5 x,

C- Sample no 4. Grains and fragments of substance filling up fireplace. Digital microscope, magnification 50 x,

D- Sample no 5. Burnt grain. Digital microscope, magnification 5 x,

E- Sample no 6. probably slag. Digital microscope, magnification 50 x,

F- Sample no 8. The material present in fireplace. Digital microscope, magnification 50 x,

G- Sample no 10. Microscopic picture of granular surface of black organic substance coating some vessels made of alabaster. Digital microscope, magnification 60 x.

Sample no 2 is too fine to enable the detailed observation using digital microscope and magnification up to 60 times. Sample 3 showed parallel structure and complicated texture under the microscope (Photo 5B). Observation of sample 4 showed the presence of fine components impossible to identify usings mall magnification (Photo 5C). Microscopic pictures of sample 5 document the presence of burnt grains now present as small grains of charcoal (Photo 5D).

Sample no 6 showed complicated granular and slightly porous structure under the microscope (Photo 5E). Sample no 7 is too fine for detailed observation using digital microscope and magnification up to 60 times. Material filling up the next fireplace represented by sample no 8 is seen, under the microscope, as the mixture of fine grains of minerals and probably bones (Photo 5F). Microscopic observation of mineralized mat (sample no 9) showed, that tested fragments of mat are too small to be examined properly. Microscopic pictures of sample no 10 document granular character of black organic substance coating vessels made of alabaster (Photo 5G). Sample no 11 i.e. mineralized bone, was not tested using digital microscope, because of small magnifications of apparatus.

Results of investigation

Sample no 1

Observation of structures, performed using SEM, showed irregular, organic structures of burnt organic matter. In some places, one can see, relics of ground organic grains (probably binds). Microscopic pictures under polarized light confirmed the presence of traces of silica crystallizing in pores of organic matter. Observed phenomenon (Photo 6) and specially, organic structures represented by burnt and destroyed during grinding grains, suggest, that the tested sample most probably represent small fragment of burnt bread.

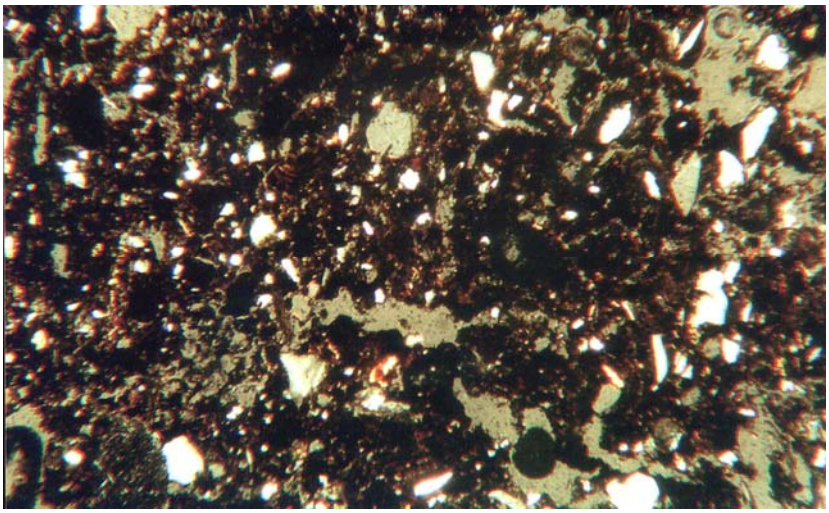


Photo 6 Burnt bread containing admixture of small grains of quartz. Polarizing light microscope, Polaroids in part X, magnification 80 x.

Sample no 2

X-ray examination showed (Fig. 2), that tested clay is composed of (???) and is not of local origin because local silts differ in mineral composition, i.e. contain mostly smectite and mixed smectite-illite clay minerals, mixed with very fine quartz and traces of feldspars as well as organic matter. Described yellowish clay is known from region of Helwan as accompany for the local limestones. Up to now, it is used for coating of pottery with yellowish colour.

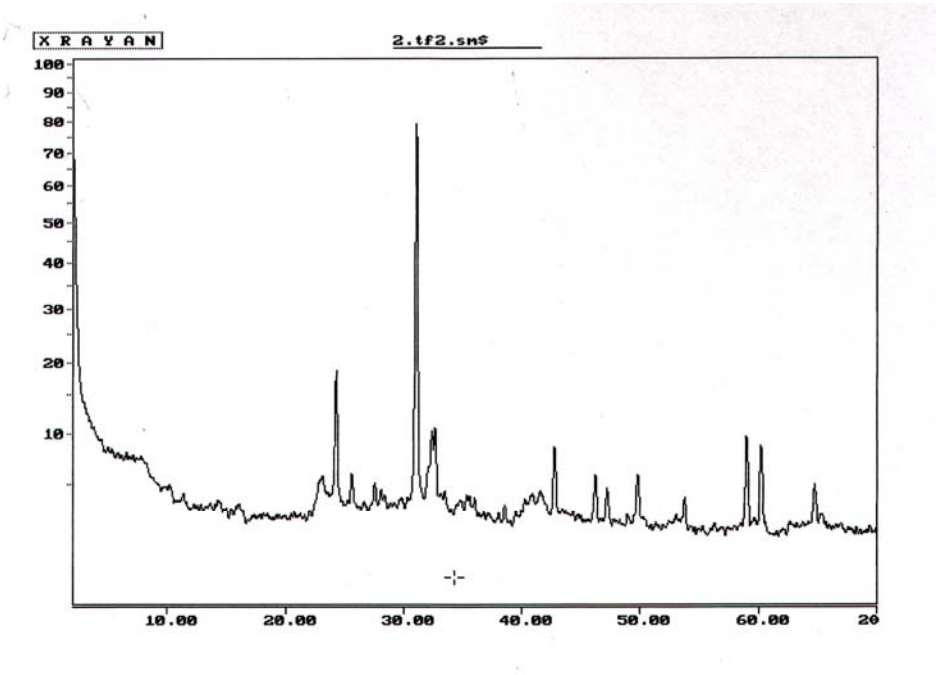


Fig. 2 X-ray pattern of yellowish clay containing clay minerals, quartz and traces of feldspars.

Sample no 3

Observation of the sample using polarizing light microscope showed, that the bone is altered and mixed hydroxy-apatite-collagen cortical structure is changed. The process of alternation is seen under the microscope as changes of polarized light confirming formation of secondary carbonates after primary phosphates (Photo 7). Holes of sponge bone are empty or partly filled up with secondary opaque minerals represented by iron minerals. Moreover, in some places one can see secondary mineralization by black epigenetic manganese oxides.

Sample no 4

Identification of the sample using polarizing light microscope documents, that it is composed of various components. There are small fragments of destroyed pottery, burnt clay, traces of burnt organic matter, pieces of bones, detritus quartz, clay minerals, fragments of silts present (Photo 8). Such

composition of sample and powdered structure document material filling up the fireplace is of rubbish character.

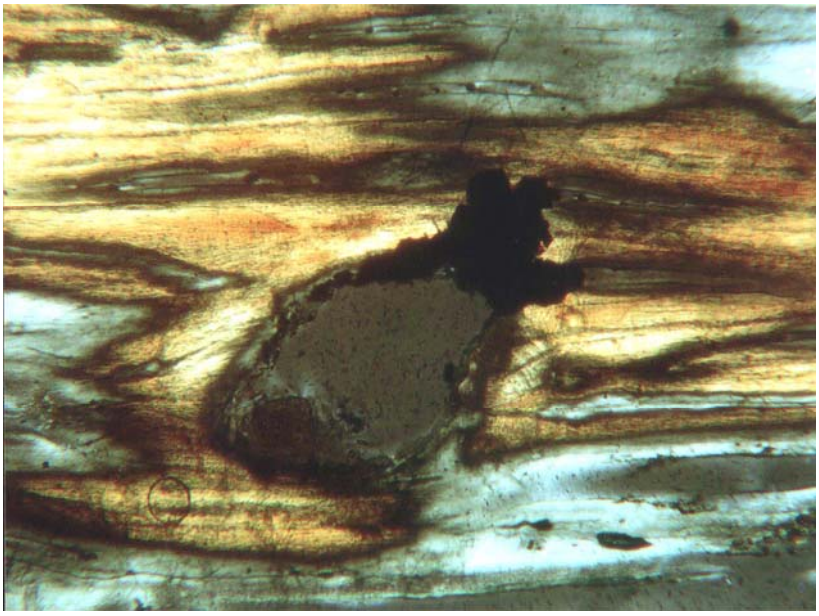


Photo 7. Alternation of cortical bone into secondary carbonates as visible changes in polarized light (gray to yellowish colour). Central hole is partly filled up with secondary (black) sulphides. Polarizing light microscope, Polaroids X, magnification about 80 x.

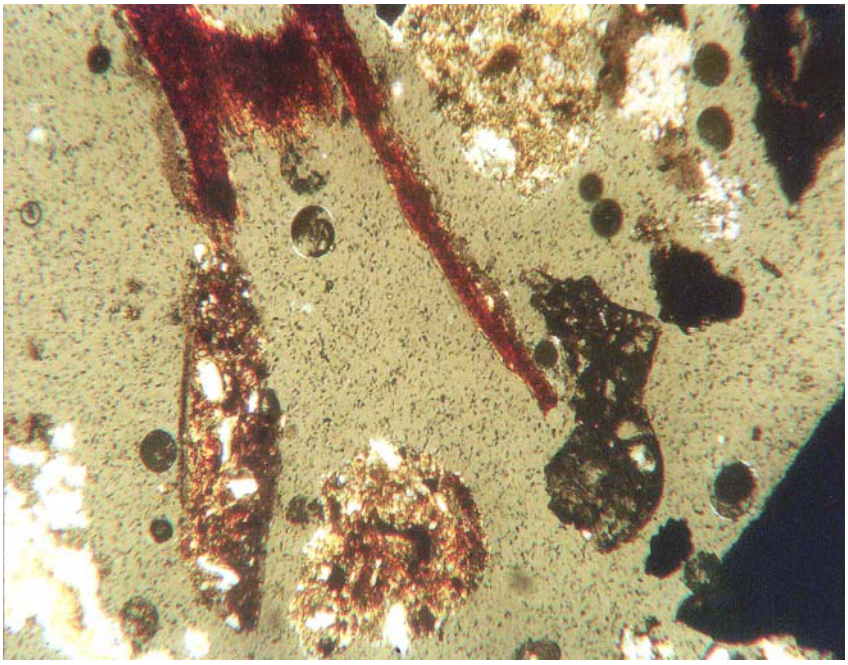
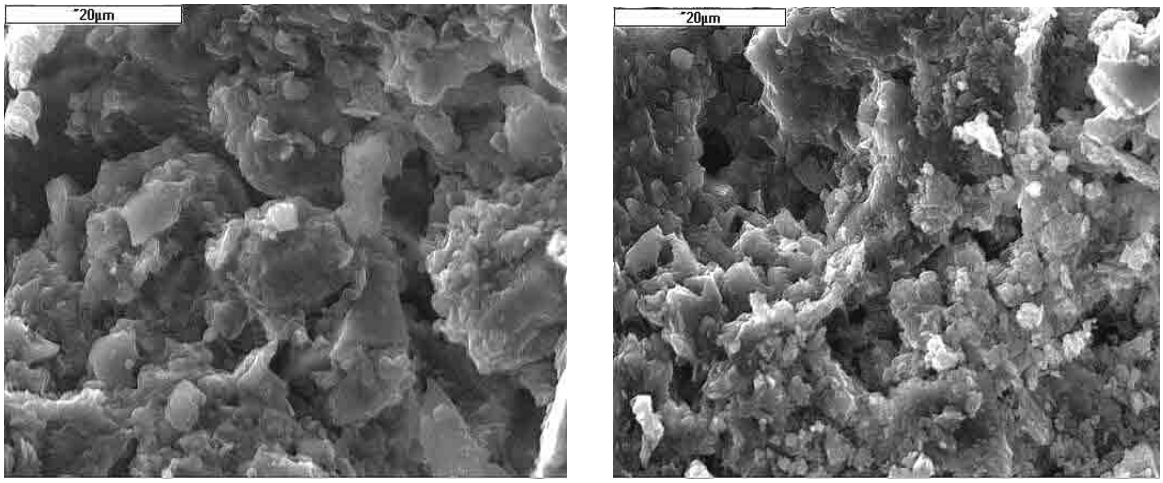


Photo 8 Material representing sample no 4 composed of burnt clay (brownish), burnt organic matter, (black), pieces of bones (light) , grains of quartz etc. Polarizing light microscope, Polaroids X, magnification about 80 x.

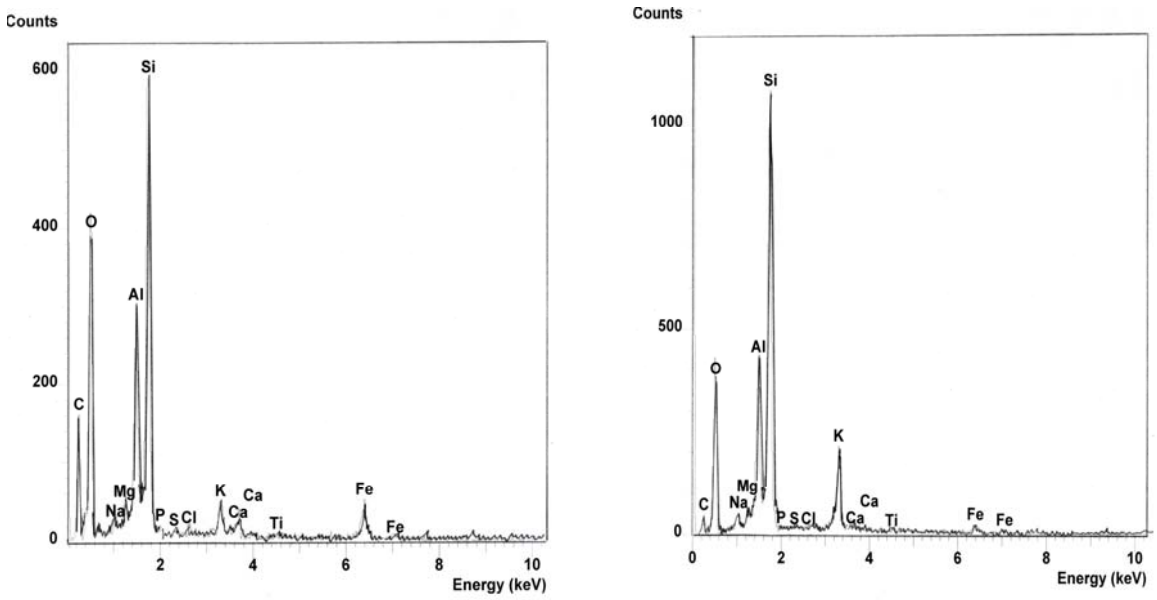
Sample no 5

SEM observation (Photo 9) showed, that internal structure of the tested grains is not ordered. One can see a lot of semi-grains, fissures, cracks and small secondary formed minerals. EDS examination documents they are represented by aluminium silicates and contain admixture of traces of K, Ca and Fe (Fig. 3).



A **B**

Photo 9. Sample no 5. Burnt grains of plant seen as irregular cracked structure (A) and small light grains of secondary aluminium silicates (B). SEM, magnification on scale.



A **B**

Fig. 3 EDS of sample no 5 – burnt grains of plant.
One can see energetic peaks of Al, Si, C, K and Fe documenting presence of secondary mineralization as burnt organic matter.

The presence of mentioned minerals is caused by the interference of minerals from the surrounding environment into grains or can result from

secondary crystallization of the mentioned minerals from underground waters. Answer for these questions needs more examination of burnt, organic material present in the site.

Sample no 6

Observation of material using polarizing light microscope documents, that it is composed of thermally changed clay minerals, i.e. slag formed due to burning of local silts (Photo 10). It is difficult to determine, whether the mentioned fragments of slag result from applying inappropriate production technology of pottery (destroyed by overheating), or are the effect of fire in the village. The form of that slag does not suggest sufficient explanation.

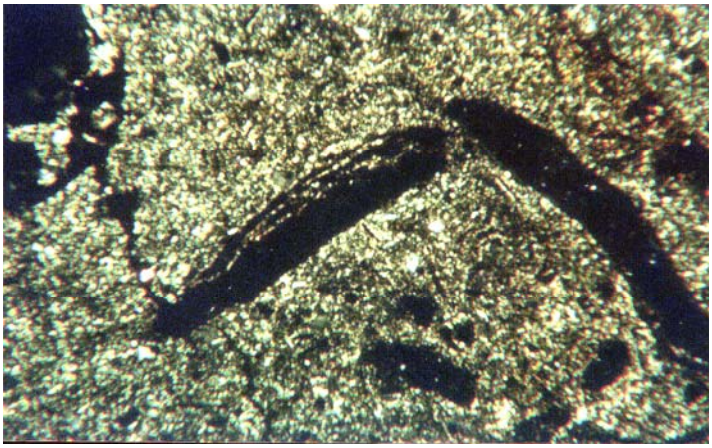


Photo 10 Microscopic picture of tested slag composed of minerals typical for local, thermally changed silt. Polarizing light microscope, Polaroids X, magnification about 80 x.

Sample no 7

Tested “powder“ is composed of many various components and is impossible to identify using polarizing light microscopy as well as SEM. Because of the fact, that the sample was ground in the presence of following components: quartz, feldspars, carbonates and small amount of clay minerals. Moreover, traces of not crystalline substance are seenn as elevation within the background of X-ray pattern.

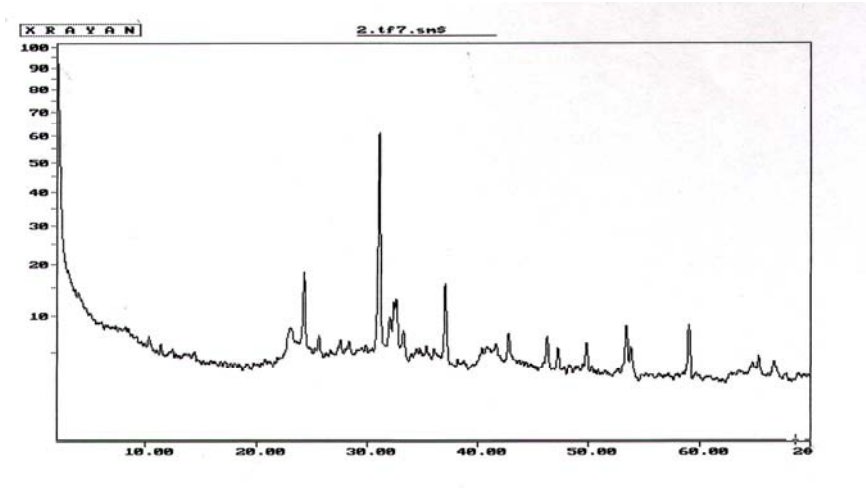
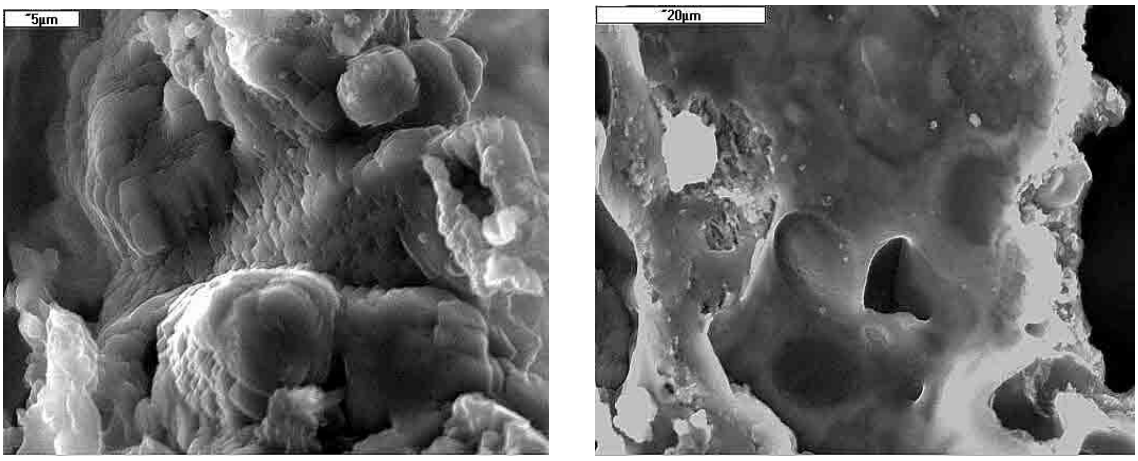


Fig. 4 X-ray pattern of burnt powder mixed with quartz, feldspars, carbonates and burned organic substance

Sample no 8

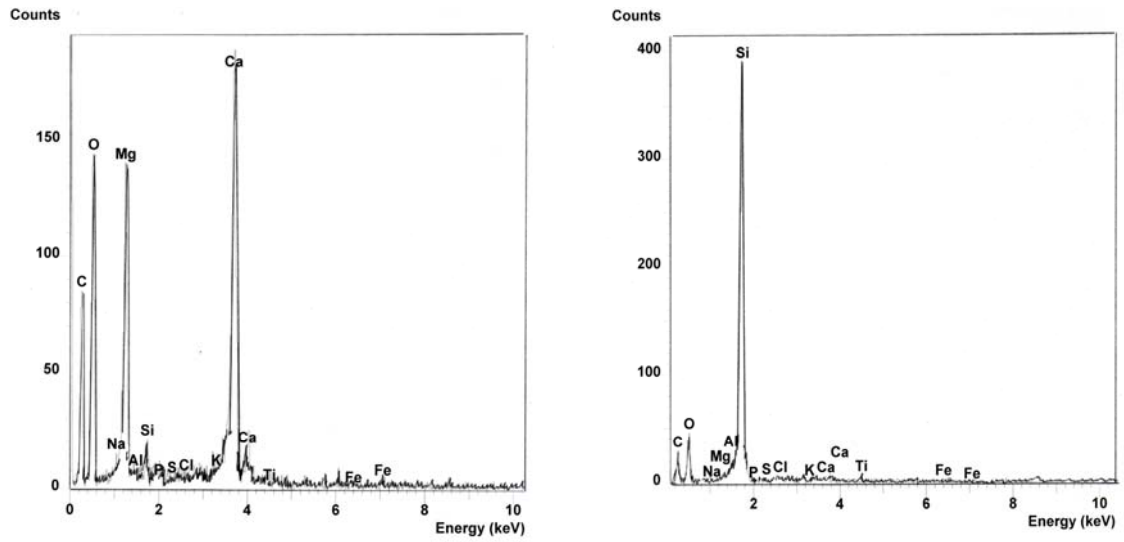
Examination of material filling up fireplace confirm the presence of organic and inorganic components. The organic once are seen under the microscope as unidentified, mostly burnt fragments of flora tissues. Secondary crystallized grains of dolomite of unknown origin are present together with organic matter (Photo 11 A, Fig 5 A).



A **B**

Photo 11 Sample 8 - the material from fireplace. A – secondary crystallized dolomite (See EDS – fig. 5 A). B – fragment of porous Si glass (see EDS fig. 5 B). SEM, magnification on scale.

SEM (Photo 11B) and EDS (Fig. 5B) confirmed the presence of fragments porous light in colour or even white glass. They are probably mixed fragments of organic matter and fine grains of quartz. Mentioned fragments of glass are most probably artificial suggesting, that at Tel el Fakha technology of glass production was known.

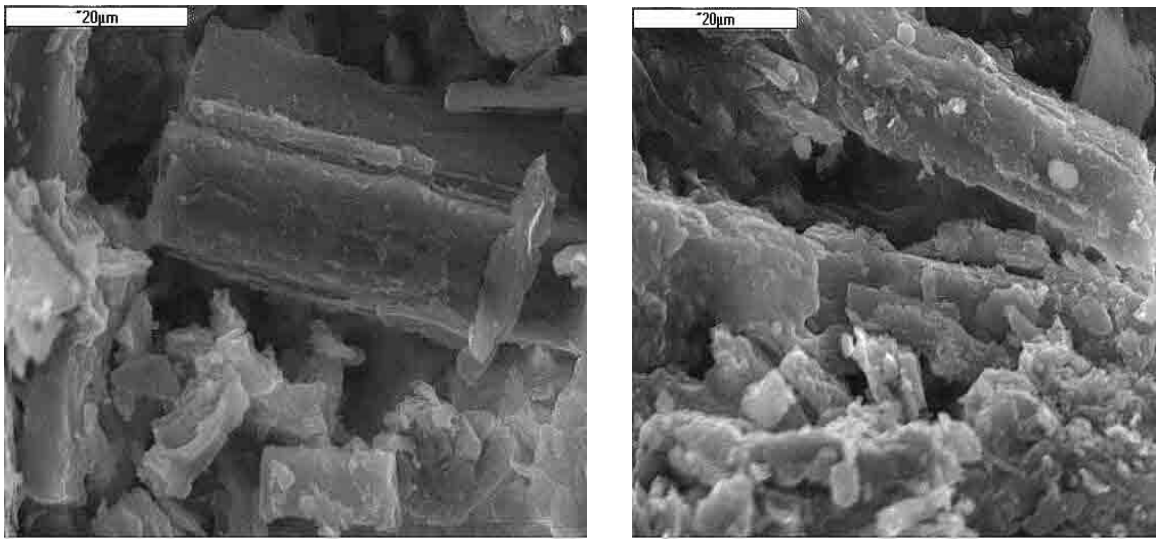


A **B**

Fig. 5 EDS of sample no 8 - burnt material from fireplace.
A – EDS of secondary crystallizing dolomite, B - EDS of Si-glass.

Sample no 9

The considered mat was made of grass and used as the carpet on the floor. Tested relics of the mat, present at Kom C, are strongly destroyed and secondary mineralized with light minerals. SEM examination showed, that only small fragments of grass tissues are present. They are broken, crushed and, in part, damaged due to secondary mineralization of minerals in tissues of grass (Photo 12 A, B).



A **B**

Photo 12. Sample no 9. A, B - fragments of mineralized mat surrounded by secondary minerals. SEM, magnification on scale.

Secondary mineralization of mat is represented by poorly crystallized silica (Fig. 6A), calcium carbonates as well as sodium chlorides (Fig. 6B). This secondary mineralization of the mat tissues is a result of secondary crystallization of silica, chlorides and carbonates from underground moisture migrating capillary up from table of underground waters.

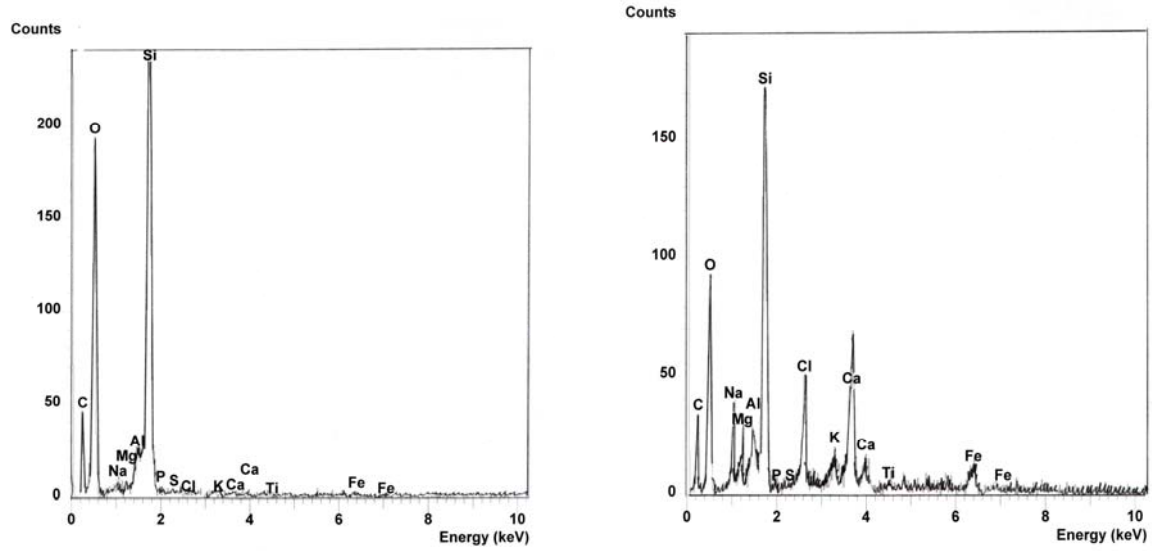
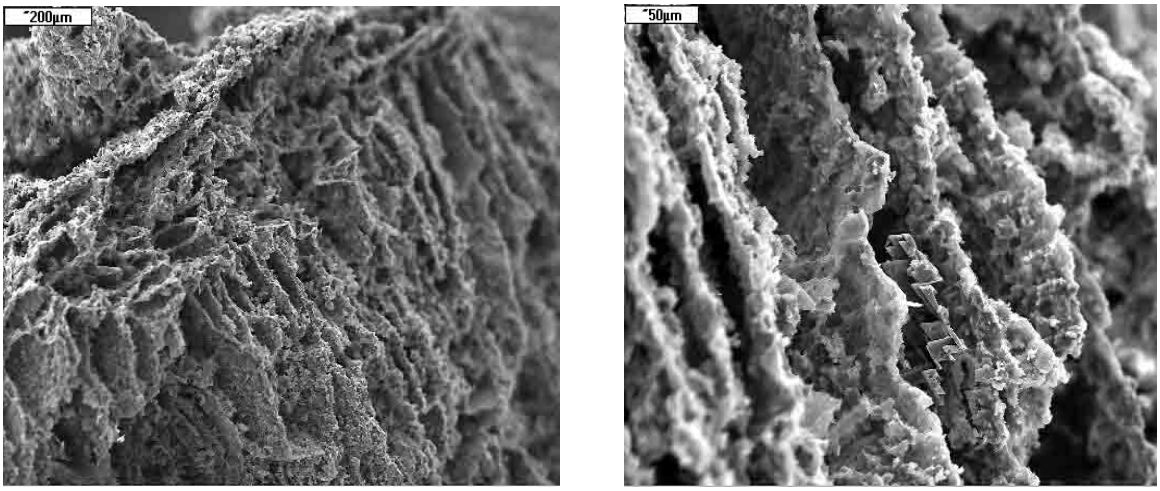


Fig. 6 EDS of sample no 9 - mineralized mat

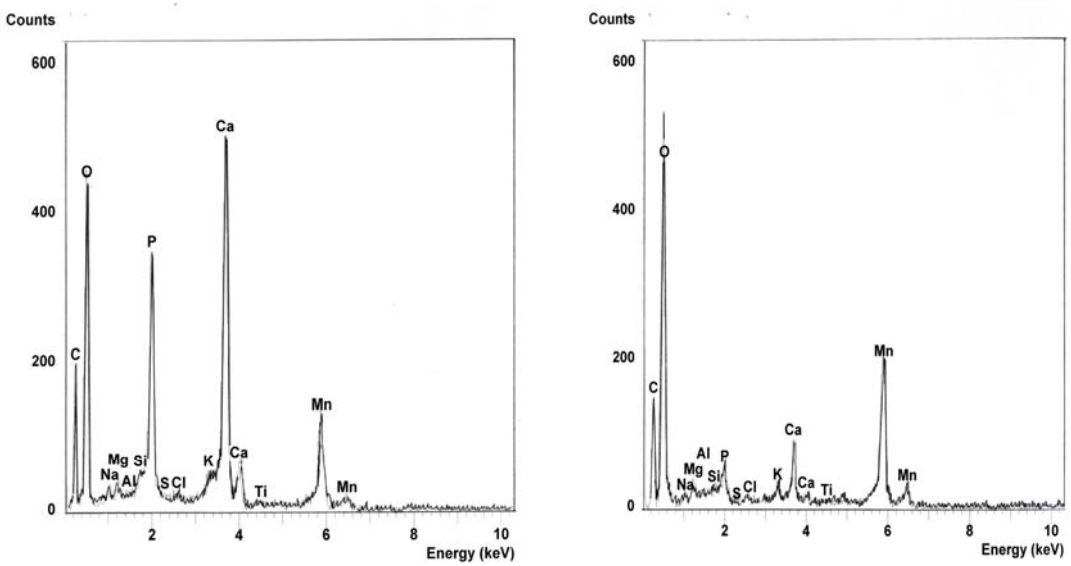
Sample no 10

Examination of mysterious, black organic substance gave new data, but it did not answer the question, what it would be. SEM observations showed a special, parallel structure of black substance, within which, one can see, thin, elongated forms with empty spaces between them (Photo 13 A, B). Chemical analyses EDS showed, that the substance may contain phosphates (Pig. 7A) or admixture of Mn minerals (Fig. 7B)



A **B**

Photo 13 Sample no 10. The structure of black substance coating the surface of alabaster vessels. SEM, magnification on scale



A **B**

Fig. 7 EDS of sample no 10. Black organic substance coating alabaster vessels containing calcium phosphates (A) and Mn-oxides (B).

The performed investigation of black the substance coating walls of vessels discovered in the tombs showed, that it resembles a kind of asphalt. It was used to covering the vessels containing some substances (food, grains, etc). That confirms absence of vessel covers made of pottery.

In situ observation of the vessels (in tombs) suggest, that when they changed position, the cover (organic substance) overflew their wall of alabaster vessel.

Conclusions

Introduction of modern investigation techniques give more detailed information on, how the site functioned. Due to using the mentioned methods discovered:

1- fragments of burnt bread
2- yellowish clay most probably imported into the site from area of Helwan
3- Si-glass

Moreover the following processes were described:

1 - alternation of old wood
2 – mineralization of burnt organic matter (bread and grains of plant) with silica and aluminium silicates
3 – alternation of bones

On the other hand, the identification of the black organic substance coating alabaster as well as other vessels was performed. The assumption is, that

it was used as a cover preserving of substances inside vessels. The origin of this substance, however, still remains unknown.

References

Ciałowicz K., 2004 Tel el-Farkha 2001-2002. Excavation of the western Kom. In: Hendrickx S., Friedman R.F., Ciałowicz K., Chłodnicki M., Egypt and its origin . Proc. Int. Conf. Kraków 2002. p. 371-389.
Ciałowicz K., Chłodniki M., Egypt and its origin. Proc. Int. Conf. Kraków 2002. p. 919-923.

Chłodnicki M., 2004 Tel el-Farkha 2001-2002. Excavation of the central Kom . 1987-2002. In: Hendrickx S., Friedman R.F., Ciałowicz K., Chłodniki M., Egypt and its origin . Proc. Int. Conf. Kraków 2002. p. 357- 371.
Pawlikowski M., 2002 Reasons of the Predynastic-Early Dynastic transition in Egypt. Geological and climatic evidence. In: Hendrickx S., Friedman R.F., Pawlikowski M., Wasilewski M., Geology of site Tel el Farkha. (in press).