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Mineralogical and technological investigation of pottery and raw materials for ceramic production. Tel el Farcha, Nile Delta. Egypt.

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Research method

The examination was aimed at mineralogical and petrographic as well as technological description of the archaeological pottery from Tell el Farcha.

A thin-section of pottery was subjected to examination under the polarizing light microscope of Nicon 120. A slice of the thin-section was taken from the standard place i.e. from the wall of the vessel belly.

The research comprised mineral and grain size analyses of the fabric. In each case, about 1000 grains were counted for determination of mineral composition and 1000 grains for determination of grain-size composition. The counting as well as generally methods of analyzes were standard. Results of investigations were presented in percentage and collected using POTTERY, a computer program for collecting and analysis of mineralogical and technological data. POTTERY computer program was used for determination the similarity of the tested pottery. All 35 features of each fragment collected on the tables were compared with the same features of the rest of analyzed samples. Obtained data from the comparison were given as the percents of similarity, where 100% means identical. All similarities greater than 50% were printed as a separate chapter: Computer analyses of similarity of tested samples.

Moreover, identical investigation were performed for local raw materials burnt under the laboratory conditions, at temperatures of 600, 700, 800, 900° C. Obtained "laboratory" pottery was compared with archaeological pottery using computer program "POTTERY". This comparison was used for determination of local sources of clay used at the time, when the site functioned .

Mineralogical and technological characteristic of archaeological pottery

Pottery from Tel El Farcha archaeological shows variations of mineral and grain size composition, while technology of production is more or less similar.

Investigation raw materials from delta silts confirmed, that local (Tel el Farcha) silts are composed mostly of smectite and show good technological parameters. This phenomenon is confirmed by local pottery workshops producing pottery vessels all the time. But, local silts are to "fat" and because of the fact, it was necessary to add a tempering material represented by quartz grains (for example - sands of gezira).

Experiments performed in laboratory confirmed, that the greatest part of locally produced pottery was burnt at temperatures 700-800°C. Moreover, experiments showed, that firing of local silts at temperature above 850 °C, leads to damage of vessels and changes of pottery masses into the slag.

Investigation showed also, that no locally produced pottery is represented by most of vessels made at Nile Valley

General conclusions

Results of mineralogical-petrographic investigation as well as of computer comparative tests document the presence of two main groups of pottery. First, big group (A) is of Egyptian production. The second one, smaller group (B), is represented by vessels made of ceramic masses of unknown origin.

A. First group - Egyptian pottery

This group should be divided into following sub groups.

1. pottery made of delta clays (silts)

2. pottery made of silts from Nile Valley

3. pottery done of raw materials from East Desert or Central-South Sinay (??)

4. Pottery done in other regions

Pottery made of delta clays (silts)

Generally, delta silts (clays) are very fine and composed mainly of montmorillonite. They contain admixture of kaolinite and illite as well as small grains of quartz. They are too fat for production of good pottery so, technologically speaking, they are tempered with various tempering materials mainly with grains of quartz. The amount of the tempering material was differentiated. Generally, no more than 20% of ceramic mass was added. Temperatures of firing were not very high (up to 750°C). Pottery was fired at various conditions i.e. oxide and not oxide.

We did not analyze local clays and raw materials, but this pottery is supposed as being of local origin, but we will obtain the confirmed information after their complete mineralogical and technological investigation.

There are variations in the amount of mentioned grains of limestones, and quartz as well as some oscillations in grain size composition (granulation). Variation of mineral and grain size composition of ceramic masses documents not perfectly stable recipe used for preparation of ceramic masses as well as, most probably, utilization of various local sources of raw materials. These phenomenon suggest, moreover, that pottery representing this group have been produced in various workshops.

2. Pottery made of silts from Nile Valley

Samples representing this pottery were produced in various places of the Nile Valley and imported to the site.

Pottery made of silts from the Nile Valley is characteristic, due to the presence of medium or small, well-rounded grains of quartz, and admixture of disseminated organic matter coloring ceramics mass. Generally, one can say, that silts from region of Aswan are slightly coarser then silts from region of Dahshur.

Silts present in Upper Egypt contain, as almost every clay mineral resource, mainly kaolinite. This mineral (covering in the past, Eocene limestones (red soils - red residuum), was washed out into Nile Valley from Gebel, or have been transported from Sudan. Silts of Delta contain Ca-smectite and small admixture of kaolinite.

Pottery of this group was fired relatively long time, at temperatures up to 750°C. Good preservation of „calcite" components occurring in ceramic masses, that was observed during firing, confirms the proposed temperatures of firing. Good technical parameters of pottery were obtained by long heating rather than by higher temperatures. This opinion was confirmed by careful optical izotropy of clay minerals. Coarser grains of quartz and as well as grains of limestones are mainly natural admixture of ceramic masses.

Atmosphere of firing was generally slightly oxidized. It was confirmed by observed, under the microscope, thin oxide layer occurring directly under the external surface of vessels. Some ceramic masses were poorly prepared. This is confirmed by the presence of small „nodules" of not-well mixed raw clay and documents rather fast preparation of the vessels.

Generally, proper comparison of pottery representing this group with sediments is impossible due to weak mineralogical research on the deposits of the Nile.

3. Pottery done of raw materials from East Desert or Central- South Sinai

This pottery is rare and samples from East Desert - Sinai represent it. The presence of sharp grains of magmatic and metamorphic rocks as well as feldspars (plagioclase and K-feldspars) in ceramic mass is the feature, which allows to select this group. Magmatic rocks are represented by grains of diabases, sometime granites. Both rocks are present at the area of Southern Sinai as well as the Eastern Desert so, exact determination of their origin is at the moment impossible. There are not good mineralogical data in literature concerning clay raw materials of these regions.

4. Pottery done in other regions

Pottery of this group is rare and was divided into three subgroups

Subgroup 4a

This pottery is characterized by admixture of sharp fragments of claystones. They are identical in both samples but the about of this admixture is differentiated. Pottery is of good quality but was burned at relatively low temperatures. Firing was conducted at slightly oxide conditions.

Observed shists are not present in Delta. They are similar do Esna calystone from Upper Egypt.

Subgroup 4b

Pottery representing this subgroup is characteristic due to the presence of relatively pure, heavy clay containing admixture of coarse grains of quartz, fragments of limestones and fragments of calcitic shelles. Pottery was fired at oxide or slightly oxide conditions and relatively low temperatures.

Mineral as well as grain composition of this pottery is not typical for ceramic prepared in Delta or Nile Valley. General microscopic picture suggest that it is similar to some kinds of pottery from North Sinai.

Generally all pottery of this group (4) is not of local production.

B. Second group - pottery of unknown origin

The samples have specific features but connections with sites or outcrops of raw materials are not evident.

It is characterized by fine, homogeneous well burned mass. Together with clay minerals (thermally changed) one can see small grains of quartz as well as admixture of opaque -organic minerals. This type of raw material is characteristic for relatively silent sedimentation at stream-river conditions but is not typical for Delta or Nile Valley. This pottery was imported to the site.

Other types of ceramic of unknown origin

Generall, this ceramic mass shows other technological and mineral character. It contains micro-flakes of muscovite confirming parallel structure of pottery. Additionally, one can see admixture of small amount of pottery fragments.

The origin of this raw material is, at the moment, difficult to determine, but pottery was imported into the site because local raw materials are completely of other mineral composition.

Performed investigation showed, that locally produced pottery is of very good quality. So, import of vessels was not necessary. Imports of pottery vessels was rather an effect of import various products in pottery vessels than import of ceramic. Because of this is important possible determination of relics of organic substances all time present in fragments of imported pottery. This idea is supported by discovery at the site of locally produced pottery type red polished bud made of local silts.