Mineral, Chemical Composition and Firing temperature degree determination of two Pottery vessels – Return to Pre-dynastic period - Helwan cemetery- Egypt

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Research Summary

This research deals with the study of the mineral and chemical composition, and determining the Firing temperature degree of two pottery vessels that return to pre-dynastic period - Helwan cemetery- Egypt. Helwan region was one of the areas that witnessed early civilizational activity from the ancient Stone Age until the end of the ancient era, and Helwan is one of the modern Stone Age civilizations. Between present Helwan and the end of Wadi Hawf or its estuary.

Helwan Cemetery was very attractive in the history of ancient Egypt in Wadi Hof near Helwan, and at the beginning of the dynastic period, Helwan Cemetery was at the suburb of the city (Memphis), which is located on the other side of the Nile River. This conclusion is that is the reason behind the huge number of tombs that Zaki Saad found in Izbat Alwalda northwest of Helwan. The importance of Helwan is that it was an important civilizational station for human activity, that extended in the North African region and the eastern Mediterranean, and this may be supported by what Dibono noticed of the remains of stoves, animal bones and ostrich eggshells, along with some shells, so the Australian mission carried out excavations to complete the work of Zaki Saad in Helwan for a period of 20 Years.

The types of clay and terracotta fabric used in the pottery industry in the Helwan cemetery were two types: the types of clay silty fabric divided into;
soft silty clay which is symbolized by (Asft: c), coarse clay and is symbolized by (Asft: b), and silty clay symbolized by (Asft: a), while the type of Marl is divided into coarse and medium Marl.
Two pottery vessels were selected, examined and analyzed by different means, including: **Visual Investigation - Digital Optical Light Microscope USB - Polarizing Light Microscope - X-ray Diffraction XRD**. The artifact can also return back to the historical period in which it was made through mineral, chemical and thermal analysis to complete the objectives of the study. It goes back to the Archaic Era - the era of the First Dynasty and it was confirmed by the results of the Australian mission excavations.

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Visual inspection:

It is considered one of the most non-destructive tests due to its ease of application and low cost. It can be used with magnifying lenses and appropriate lighting to identify the details and the two vessels from the first and second antiquity family, which are in the form of an amphora, and it is clear that they were used to preserve wine or grains.

The first pottery vessel, Record No. 860 -23: The photographic documentation of the first pottery vessel was carried out of all its details. Then a visual examination with the naked eye and magnifying lenses. It was found that it was made of indigo and sedimentary silt. In addition, it was completely burned, which is evident from the color of the vessel, from the outside it is reddish brown and the inside as well is Reddish brown. Moreover, it is well polished, it is not in good condition, and that appears through the manifestations of damage as it has dirt, and an appearance of damage is prevailing on the surface of the pot from all sides.

That salt is produced from the burial soil, and it appears on the entire surface of the vessel from the edge to the base and is firmly attached to the surface of the vessel from all sides, as crystalline salts cover a large part of the body to the base on all sides.

The vessel and the disintegration grains appears in parts of the vessel in the form of pits. In addition, writing the mission record number on the base of the vessel in black color. Moreover, this distorts the surface and that is one of the methods of registration of the Australian mission, also writing the number of the vessel on the surface of the vessel, and that was one of the methods of recording Zaki Saad's excavations while deforming the surface of the vase. There are falling scales that appear at the base of the pot and on part of the edge.

The second pottery vessel, record number 860 -68: It is a single whole piece, previously extracted from the excavations of the Australian mission. Photographs of the second pottery documented all its details. Then visual examination with the naked eye and magnifying lenses, it was found that it was made of Nile and sedimentary silt, and its color is Reddish brown, which is completely burnt, and it is evidenced by the color of the bowl. On the outside, it is a reddish brown and inside is a reddish brown, which is well polished. It has signs that it is believed to be from the manufacturer or the region. Apparently its condition is not good, that is evident through the manifestations of damage as it has dust and dirt. In addition, it is a predominant appearance of damage from the burial soil on the surface of the pottery. In addition, the crystalline salts bloom that cover a large part of the body to the base on all sides of the bowl.

USB digital microscope examination

USB digital microscope examination of the first pottery

The surface texture of the vessel is relatively rough, and the salts accumulate significantly and bloom on the surface of the vessel, and the relatively rough surface of the vessel is clearly covered with salts, there are different shapes of salts and their distribution on the surface of the vessel

USB digital microscope examination of the second pottery

The surface texture of the vessel is relatively rough. Moreover, the salts crystallize and bloom on the surface and their overlap with the dirt resulting from the burial soil on the surface of the body. The difference in salts between crystallization and flowering and their overlap with the surface of the pot, and the difference in the shape of the salts crystallization.

Examination with a polarized microscope

It is one of the most important types of microscopes used in the study of thin slices of rocks and mineral grains. The pottery vessels samples were prepared in thin slices of the body in the laboratory of the Department of Geology - Faculty of Science - Cairo University.

The study and examination were carried out with a polarizing microscope of the first pottery vessel, examining sample A: It shows tissue from grains of large-sized quartz mineral crystals of various shapes, and there are some mica and muscovite grains in the middle of a ground rich in hematite. Sample B: shows the tissue of grains of quartz mineral crystals homogeneous in distribution and sizes with different shapes, and there are some grains of mica in the middle of a ground rich in hematite, feldspar and opaque minerals.

In addition, a polarized microscope examination of the second pottery vessel. Sample A (A): It shows a tissue of grains of quartz mineral inhomogeneous in distribution and size of various shapes, and there are some mica grains (biotite and muscovite) in the middle of a ground rich in hematite, feldspar and opaque minerals. Sample B: An examination of another part of the same sample that shows tissues of granules that are homogeneous in distribution and size, and there are granules of mica and quartz. Muscovite is a medium rich in hematite, feldspar and opaque minerals.

Analysis by X-ray diffraction

The analysis of the selected archaeological pottery samples proved that they consist of the following compounds:

Quartz: SiO_2 appeared in a ratio of 14 to 53% in all the study samples, and it is a basic component. Moreover, the presence of quartz indicates that the firing temperature is less than 850.

Calcite: $CaCO_3$ appeared in a large percentage in the first sample and a few percentages in the other sample. In addition, it is a result of adding calcium carbonate to the clay body, which decomposes at a temperature less than 880.

Diopside: $MgCaSi_2O_6$ appeared in the first and second sample with a high percentage. This indicates that the burning is good, as the diopside appears at a temperature above 800.

Hematite: Fe_2O_3 appeared in all the samples of the study and indicates that the burning was carried out in an oxidizing atmosphere.

Halite: NaCl: appeared in the first sample in a small percentage in the body.

Gehlinite: $Ca_2AL_2SiO_7$ appeared in the second sample in a small percentage and it indicates that the firing temperature is 850.

Wollastonite: $Ca.5SiO_3$ appeared in the third sample with a moderate percentage.

Analysis by thermal differential method

The thermal differential is useful for determining the approximate burning temperature of the pottery. The thermal analysis is useful for determining the temperature of the pottery burning by identifying the loss in the weight of the pottery samples, these changes occur with temperatures that characterize each type of material, and the analysis was performed at the MICROANALYTICAL CENTER - Faculty of Science - Cairo University.

The results of the analysis by the method of thermal differentiation showed that the degree of burning of the first vessel of the pottery body, which was well burned. The color of the clay after firing was close to orange, and in the middle of the thickness of the vessel, there were areas in the form of small black lines that were very good about from 850 C to 900 C.

Moreover, that the second vessel is from the pottery body, which was well fired. The color of the clay after burning is close to orange, and in the middle of the thickness of the body, there are areas in the form of small black lines not extended in each, that was burned at a good temperature of about 850 C.

Through Visual Investigation - Digital Optical Light Microscope USB - Light Microscope Polarizing - X-ray Diffraction XRD - Differential Thermal Analysis - it is possible to identify the most important minerals and chemical components of clay pots. Moreover, it can determine the approximate firing temperature of the selected pottery. Thus, it helps in studying pottery vessels, as we can study treatment and maintenance methods and apply them to pottery vessels without causing harm to them because of knowing the chemical composition of the pots and the temperature of burning, and knowing the best materials for treating clay pots.

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