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Analysis and Characterization of the Soteria Mosaic in the Antakya Museum with Archeometric Techniques

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ABSTRACT

Mosaic, like all other branches of art, is one of the most important aesthetic ties that human beings establish with the world. When we look at the mosaic, we can see the changing traces of the past and relive the time that has been forgotten for a long time. Mosaic is an eternal art that has endured natural conditions such as wind and rain and has survived to the present day with slight damages.

This study was carried out in three stages. First, the stone tessera of the Soteria mosaic were color analyzed using the portable Color Detector X-Rite CAPSURE precision color measuring instrument. The tesserae were then analyzed using the Energy Dispersive Portable X-Ray Fluorescence Spectrometer device, which is a non-destructive method for quantitative analysis of its elements. In the next stage, petrographic analysis was performed in laboratory environment to determine the rock type and minerals of 10 stone tessera belonging to the Soteria mosaic.

As a result, the examination of the qualities and contents of the materials used in the mosaics; By establishing a connection between the past, present and future, it will be able to make important contributions in revealing the reasons why the mosaics have survived to the present day.

1. INTRODUCTION

For the first time in human history, the concept of art began to emerge with the figures of the mother goddess shaped by hand from the earth and the murals made in the caves, and has come down to the present day as a serious activity put forward by humanity for centuries. Understanding of art; It has shown different characteristics due to the different lifestyles of human communities and their being in different geographies, which has led to an artistically rich accumulation [1]

Mosaic is the technique of lining up small pieces of different types (wood, metal, glass, etc.) side by side and flattening them by embeding them in mortar. Unlike many arts, mosaic is not a high-cost art, but even an art in which waste materials are re-evaluated [2]. As Vasari said, "Mosaic is an eternal art. The things that best resist the blows of wind and water are those made with color" [3]. Mosaic art has become a form of expression of the traces and forgotten time experienced in the past [4].

Hatay is the place where civilizations, ideas and art come together between East and West. Since it has a very important place in terms of mosaics, you can see some of the most distinguished mosaics of the world in Hatay Museum.

In this study, the Soteria mosaic, one of the most important mosaic works in the Hatay Archaeological Museum, was discussed (Figure 1). Soteria Mosaic is one of the most important mosaic works exhibited in Hatay Archaeological Museum. This mosaic belonging to the Roman period is dated to the 5th century a.d. It was found as the flooring of a bathroom in Narlıca village of Antakya. In the very center of the Soteria Mosaic, which is in an octagonal form, there is a bust of a woman and inscriptions around it. At the beginning of the mosaic, a wreath of leaves is depicted as a full-bodied woman carrying a necklace in Byzantine style on her chest. The perimeter of the mosaic is decorated with geometric patterns [5].

According to the bibliography research, we can summarize the studies on the structural analysis and characterization of mosaics as follows. In the study titled "Analysıs of Materials Used in Mosaic Machig", first of all, the definition of mosaic was made, its development in the historical process was included and then the use of the mosaic in the structure and the performance characteristics expected from the material were discussed [6]. In the study titled "Characterization of the Mosaic Mortars of the Ancient City of Perge", information was given about the characterization, qualities and construction technologies of mortars and plasters with important functions such as stone, brick, wood and iron in historical buildings [7]. In the study titled "Painting Analysis of the Mosaics of Antioch and Zeugma", based on the mosaics in Zeugma, they concluded that the importance given to mosaic construction in this city about 1800 years ago was probably the workshops and a mosaic school in the city. In their studies, they stated that mythological stories gained weight as subjects in Zeugma mosaics[8]. (Şahin, 2010). They analyzed the metal, mortar and mosaic samples unearthed in the Maltepe Rescue Excavation with the Energy Dispersed Portable X-Ray Fluorescence Spectrometer (P-EDXRF)[9].

According to our bibliography research, it was not found that the structure of Soteria mosaic was evaluated qualitatively and quantitatively using archaeometric techniques. In the light of this information, the Soteria mosaic, one of the most important mosaic works in the Hatay Archaeological Museum, was discussed in this study. In order to characterize the structure of the Soteria mosaic qualitatively and quantitatively, 21 stone tessera samples were examined. First of all, color analysis was performed with the portable Color Detector X-Rite CAPSURE precision color measuring device. After the color analysis, chemical analysis was performed on the tessera belonging to Soteria mosaic with the P-EDXRF method, which is a non-destructive method. Thanks to the properties in the P-EDXRF device, it is used in the characterization studies of the elemental composition of archaeological and artistic materials [10]. The P-EDXRF device has significant advantages over other analytical techniques with its easy to use, fast results and analysis feature without destroying the material, especially with the possibility of on-site analysis. In addition, petrographic analysis was performed to determine the color, rock type, minerals, hardness and texture of 10 stone tessera belonging to the Soteria mosaic taken from the museum in the laboratory environment.

Figure 1. The places where the Soteria mosaic exhibited in the Hatay museum is analyzed.

2. MATERIAL and METHOD

A total of 20 stones belonging to the Soteria mosaic were examined with permission from the Hatay museum for tessera analysis. Places marked in blue (1-10) are taken for laboratory environment. Places marked in red (11-20) were analyzed on-site at the Hatay Museum (Figure 1). The tesserae selected for the laboratory environment were deformed from the edges of the mosaic in a way not to damage the pattern of the mosaic, and broken tessera were preferred. In order for the selected samples to give healthy results, they are soaked in pure water and softened, and the dust and dirt on them are cleaned with the help of soft-tipped brushes and scalpels.

For the archaeometric analysis of stone tessera, the following operations were carried out, respectively.

1. Analysis was performed with the P-EDXRF device, which is a non-destructive method to determine which compounds or elements (CaO, MgO, SiO2, Fe2O3, Al2O3, etc.) are present in the chemical structure of the tesserae (Figure2). Samples 1-20 were analyzed with the geochem mode of the P-EDXRF instrument, while sample 21 was analyzed with soil mode (Figure 3-4).

Figure 2. The process of analyzing samples with the P-EDXRF instrument.

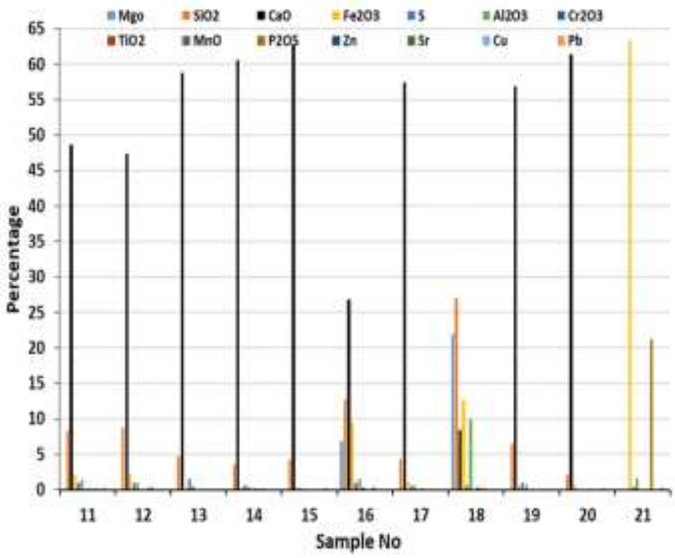

Figure 3. Distribution of P-EDXRF Analysis Results of MgO, SiO2, CaO, Fe2O3, Al2O3, Cr2O3, As, TiO2, MnO, P2O5, S, Zn, Sr, Cu and Pb in Taş Tessera(1-10).

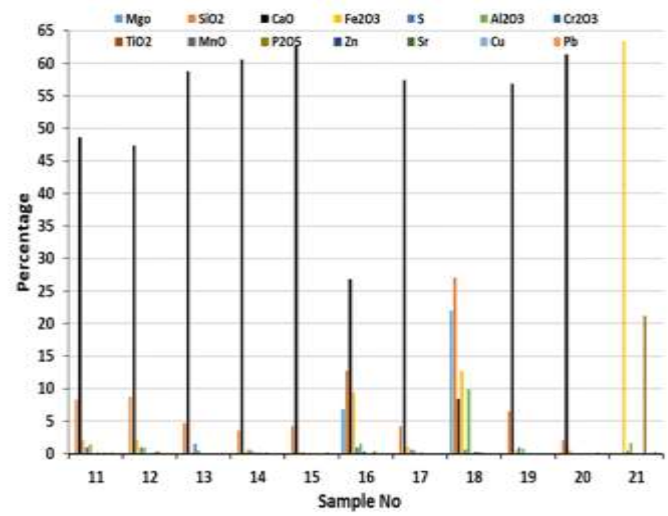

Figure 4. Distribution of P-EDXRF analysis results of MgO, SiO2, CaO, Fe2O3, Al2O3, Cr2O3, As, TiO2, MnO, P2O5, S, Zn, Sr, Cu and Pb in Taş Tessera (11-21).

2. Color analysis was performed for 10 samples (Example-11-20) examined on-site in Hatay museum to determine the code of the color of the tessera in the munsell catalog, using the portable Color Detector X-Rite CAPSURE precision color measuring device (Figure 5). According to the color code obtained as a result of the analysis, equivalent color was determined from Munsell Color Catalog (Table 1)[11].

Figure 5. X- Color analysis with Rite CAPSURE device

3. Petrographic Analysis was performed to determine the Rock Type, Hardness, Texture, Rock and Minerals of 10 stone tessera (Example 1-10) taken for laboratory environment. The Stone Tessera was photographed with the Leica DFC280 digital camera (Figure 5) and evaluated with the Leica Qwin digital imaging program (Table 2). Petrographic descriptions of thin sections are given in detail in table 3.

Table 1. Color analysis results according to the Munsell catalogue of stone tessera.

Sample No	Y(Yellow), G(Green), R(Red)	Colour	Munsell Cat. Equivalent Color
11	5 YR 4/4	Brown	
12	5 GY 4/1	Green	
13	2.5 H 8/2	White	
14	10 YR 6/4	Yellow	
15	10 YR 4/1	Brown	
16	5 YR 2.5/1	Black	
17	2.5 H 7/2	White	
18	N4.25	Dark Grey	
19	5 YR 4/2	Red	
20	10 R 5/1	Brown	

Table 2. The results of color analysis of stone tessera.

S. No	L	a	b	Colour	Eq. Color
1	11,0197	1,2029	-0,3462	black	
2	19,2067	1,3607	-0,9680	black	
3	16,3326	2,8304	2,5137	black	
4	15,8228	0,4961	3,1370	black	
5	49,1020	2,9112	18,8351	Cream	
6	45,5402	0,0859	22,8356	Yellow	
7	52,5901	3,3480	9,7531	white	
8	46,6333	5,1693	10,6312	white	
9	40.2910	4,2228	11,7770	white	
10	18,8053	6,5806	8,3087	Brown	
L: 0/100; White/Black, **A**: 0/-60; Green and 0/+60; Red, **b**: 0/-60; Blue and 0/+60; Yellow					

Table 3. Petrographic properties of Hatay Soteria Mosaic tessera specimens.

No	Rock Type	Tissue	Mohs	Rocks and Minerals
1-4	Serpentinite	Sieve	5-5.5	Its structure, which contains mainly antigolite, includes a small proportion of chrysotil, chromite, hematite and magnetite.
5	Breschic Limestone	Breschic	2.5 - 3	Its structure, which mainly contains calcite, includes limestone, limonite, hematite, fossil and fossil shells.
6-7	Crystallized Limestone	Crystallized	2.5 - 3	In its structure, which mainly contains calcite, aragonites are seen in places.
8	Biosparitic Limestone	Sparitic	2.5 - 3	Its structure, which mainly contains calcite, includes fossils (nummulites and alveolina species) and fossil shells.
9	Biomicritical Limestone	Micritical	2.5 - 3	Its structure, which mainly contains calcite, includes aragonite and fossil and fossil shells.
10	Listvenit	Crystallized	4.5– 5	In the cavities in the structure where a high degree of carbonation is seen, quartz, hematite, limonite, calcite and clay accumulation and silicization in structural fractures / cracks are included.

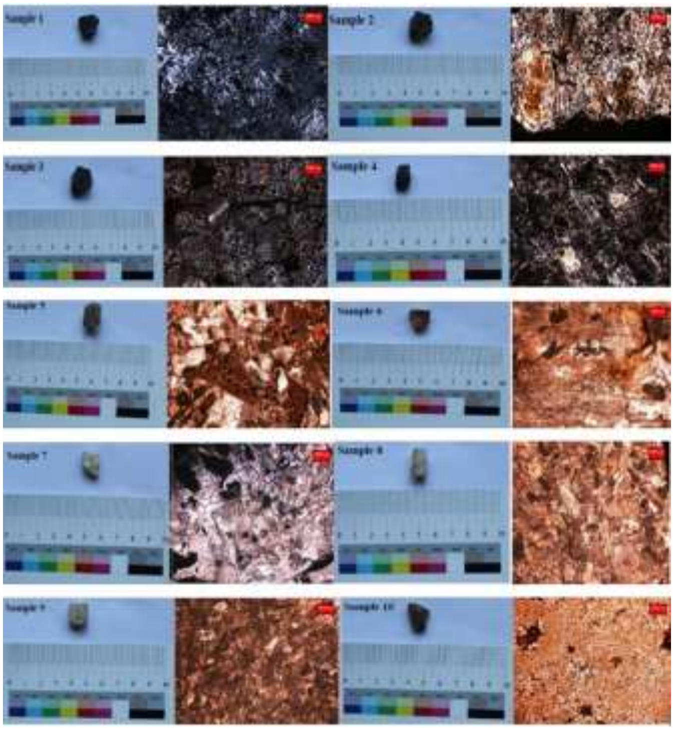

Figure 6. General and thin section images of samples

3. DISCUSSION and CONCLUSION

In the presented study, the qualitative and quantitative analysis of Stone Tessera was performed with Color Detector X-Rite, P-EDXRF and petrographic techniques.

As a result of color analysis of the Stone Tessera (Examples 1-4), it was determined that the samples were black as shown in Table 2. When Figure 3-4 was examined in detail, as a result of the analysis of these tesserae with P-EDXRF, SiO 2, MgO, CaO and Fe2O3 compounds were detected at a higher rate than the other components. Petrographic analysis was performed to support the analyzes and to determine the rock structure in the structure of the mosaics. According to the results of the analysis, it was determined that these stone tesserae (Table 3) belonged to the serpentite rock species (Figure 6). The mineral contents of this rock species, mainly antigoride, include a small percentage of chrysotyll, chromite, hematite and magnetite. Serpentine is dark green, black or red black [12]. In addition to having a wide range of mineral contents, the serpentinite rock type usually has a chemical composition of Mg2(Si2O5).(OH)4 species[13]. According to the results of petrographic analysis, P-EDXRF based on the minerals and chemical composition of the serpentite rock species supported the compound ratios (MgO, SiO2 and CaO) obtained as a result of the analysis. In addition, due to the hematite and chromite it contains, it is estimated that the Fe2O3 compound is seen and the color comes from this compound.

According to the color analysis result of Sample 5 (Table 2), the P-EDXRF chemical analysis of the sample, which was determined to be a cream-colored stone tessera, determined that the ratio of CaO compound was very high compared to other chemical components as shown in Figure 3-4. As a result of the thin section analysis (Figure 6), it was determined that this rock species was Breşik limestone and that limestone, limonite, hematite, fossil and fossil cavals were determined in the structure containing calcite in this rock type. According to the results of petrographic analysis and P-EDXRF analysis, the high incidence of CaO compound is estimated to be due to the calcite mineral contained in Breşik limestone (Table 3).

According to the color analysis results of Sample 6-7 (Table 2), CaO, SiO2 and MgO compounds were found to be higher than other chemical components in the chemical structure of these samples as shown in Figure 3-4 as a result of P-EDXRF chemical analysis of the samples determined to be yellow and white colored stone tessera. According to the results of the thin section analysis (Figure 6), it was determined that the rock type of the 6 and 7 samples were crystallized limestone. In this rock species, it was determined that aragonites were included in its structure, which mainly contains calcite (Table 3). As a result of P-EDXRF analysis, the high incidence of CaO compound is estimated to be due to CaCO3, the chemical composition of Calcite and Aragonite [14].

According to the color analysis result (Table 2), the sample (example 8), which was determined to be white colored Stone Tessera, was determined at a higher rate than other chemical components as shown in Figure 3-4 as shown in Figure 3-4 as a result of P-EDXRF chemical analysis. According to the results of the thin section analysis (Figure 6), the rock type of the sample is estimated to be Biosparitic limestone (Table 3). In this rock species, the main calcite-containing structure includes fossils (numulites and alyeoline species) and fossil cavities The high incidence of CaO compound as a result of P-EDXRF analysis is estimated to be due to CaCO3, the chemical composition of calcite[15].

According to the results of color analysis in Table 2, the P-EDXRF chemical analysis of sample 9, which was determined to be a white stone tessera, determined the CaO compound at a higher rate than other chemical components as shown in Figure 3-4. According to the results of the thin section analysis (Figure 6) it is estimated that the rock type of the sample is Biomicritical limestone. In this rock species, the structure containing mainly calcite includes aragonite and fossil/fossil cavities in places (Table 3). As a result of P-EDXRF chemical analysis, the high incidence of CaO compound is estimated to be due to CaCO 3 compound, which is the chemical composition of Calcite and Aragonite[15].

According to the color analysis result (Table 2), the P-EDXRF chemical analysis of the sample-10, which was determined to be brown colored Stone Tessera, determined at a higher rate than the other chemical components as shown in Figure 3-4. According to the results of the thin section analysis (Figure 6), it was determined that the rock type of the sample was Listvenit (Table 3). In this rock type, there is a high degree of carbonation in the cavities in its structure with quartz, hematite, limonite, calcite and clay accumulation and silicifications in structural fractures / cracks. Listvenites are defined as carbonated and various proportionally silicized equivalents of serpentined ultramafic rocks in ophiolithic complexes[16]. As a result of petrographic analysis, the chemical composition of CaO and Quartz is SiO 2, and the appearance of CaO, MgO andSiO 2 compounds as a result of P-EDXRF analysis shows that the analysis supports each other.

Color Detector X-Rite CAPSURE device analyzes the remaining samples (Sample 11-20) and their colors are determined and shown in Table 1. As a result of the analyzes, 3 Brown, 2 White, Yellow, Black, Dark Gray, Red and Green colors were determined. According to the results of P-EDXRF chemical analysis (Figure 3-4), it is seen that CaO and SiO2 compounds are higher than other chemical components. It is estimated that the presence of TiO2 (Figure 3-4) compound in very few samples made in the Hatay museum is seen as a trace element because the back of the mosaic is covered with cement mortar. As a result of P-EDXRF chemical analysis performed in Soil mode in the region of cement mortar (Figure 3-4), CaO and TiO 2 compounds are seen at a high rate because the top is covered with lime. The detection of TiO2 as a trace element in the samples examined on site without taking a tessera sample from the mosaic in the Buda Hatay Museum supports this result.

When Figure 3-4 is examined in detail, according to the results of P-EDXRF chemical analysis, CaO, SiO 2, MgO and Fe2O3 chemical compounds with color-determining properties were detected at a high rate. In thin section analysis, the detection of limestones in general supported the P-EDXRF chemical component analysis.

When the geological structure of Hassa district of Hatay is investigated [17]; In the Amanos Mountains, Serpentinite, Limestone, Limestone, Limestone, Sandstone, Quartzite and Pebble are seen intensively. Based on this study, it has strengthened the opinion that the tessera belonging to the Soteria mosaic, which is exhibited in the Hatay Museum and which we have discussed, may have been procured from the Hatay region when evaluated according to the results of the analyzes.

As a result of these archaeometric analyzes and evaluations; the fact that the mosaics have survived to the present day shows how durable materials were used in their construction. In addition, it shows that this study may shed light on the studies to be carried out in this field in the future scientific studies as well as guiding the selection of materials during the restoration and conservation works that can be done.

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BIOGRAPHIES

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