Colored Glaze Tiles during the Ottoman Empire (beginning of the 15th to the mid-16th century)

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Problematic & Corpus

The first centuries of Islamic civilization were characterized by major technological developments which resulted from intensive technical experimentation and aesthetic research: one of these is the colored glaze decor, where a non-vitreous line surrounds different areas of colored glazes serving to keep these glazes separated during the firing. This ornamentation has spread in Central Asia from the end of the 14th century to the Ottoman Empire during the 15th and the 16th century, and finally in Iran and India during the Safavid reign. This kind of decor is still little known from the technologic point of view and the literature stays muddled about it.

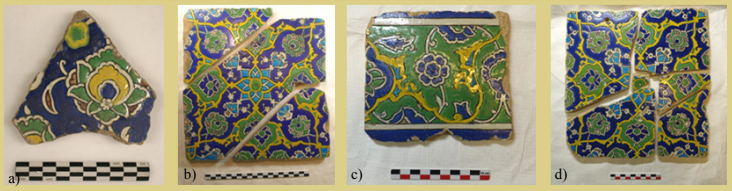
The object of this poster is to characterize the craftsmen's recipes for making these tiles during two periods of the Ottoman period: the beginning of the 15th century and the first half of the 16th century. The corpus of this study is currently made of tiles coming from the reserve of the Islamic Art Department of the Louvre Museum and of the museum of Sèvres – Cité de la Céramique. These shards have been subjected to physicochemical analysis in order to have a better understanding of their operating process (the stratigraphy of the decor the nature of the paste, the glazes, the black line…) and their evolution according to different geographical areas. A part of this sampling has been examined with MEB-EDS , PIXE and PIGE analysis and with Raman spectrometry.

15th (8 samples)

Examples of studied samples: a) MNC 18618 (Museum of Sèvres – Cité de la Céramique); b) MAO 2069 and c) UCAD 956a (Islamic Art Department, Louvre Museum)

At the beginning of the 15th century, craftsmen produced colored glaze tiles for monuments in Bursa (Green Complex, 1412-1421/ Muradiye, c. 1420), Edirne (Sah Melek Pasa Mosque, 1429/ Muradiye, 1435-1436), Kütahya (Yakub II Mausoleum, 1428-1429), Karaman (Ibrahim Bey Imaret, 1432) & Konya (Mevalana Mausoleum, c. 1430?)

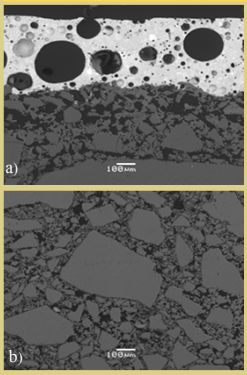
16th (11 samples)



Examples of studied samples : a) OA 3919/1006, b) OA 3919/989, c) OA 3919/1008, d) OA 3919/987 (Islamic Art Department, Louvre Museum)

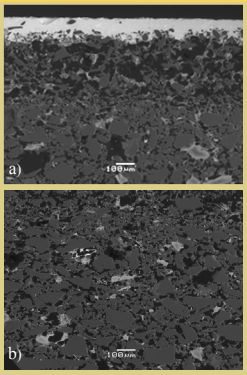
During the first half of the 16th century, craftsmen produced colored glaze tiles for monuments in Istanbul (Yavuz Sultan Selim complex, 1522/Topkapı Palace, 1527-1528/Haseki Hürrem Sultan Madrasa, c. 1540/ Sehzade Complex, 1543-1548/Kara Ahmet Pasa Mosque, 1554) & Bozüyük (Kasim Pasa Mosque, 1525-1528)

Section stratigraphy



Two types of colored glaze decor can be seen in the beginning of the 15th century. One of them is the legacy of the **Timurid tradition** (type 1) when the other one seems to be an **Ottoman innovation** (type 2 – Fig. a). The second technique is present only on the tiles of Bursa and Konya.
Tiles are made of different layers:

	Type 1	Type 2
4	Colored glazes *Thickness: 400-600 µm*	
3	Gold leaves, red and/or black line *Thickness: 20-30 µm*	
2	White lead-alkaline glaze opacified by the addition of tin oxide (SnO_2 ~ 6-7%)	Clay-rich slip with many quartz inclusions (SiO_2 ~ 88%) *Thickness: 200-250 µm*
1	Red clay body with quartz inclusions (Fig. b) *Granulometry: up to 1.5 mm*	

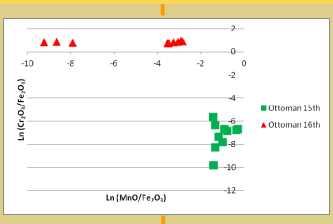


The majority of this colored glaze decor was produced during the reign of Suleiman the Magnificent (1520-1566) (Type 3 – Fig. a). They are the **precursors of the well-known "Iznik" underglaze productions**.
Tiles are made of different layers:

	Type 3
4	Colored and uncolored glazes *Thickness: 100-200 µm*
3	Black line *Thickness: ~ 10 µm*
2	Silica-rich slip (quartz inclusions) with lead frit *Thickness: 300-350 µm*
1	White clay with quartz inclusions and soda-lead frit « stonepaste » (Fig. b) *Granulometry* <200 µm

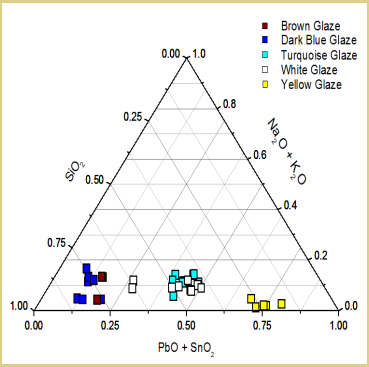
Black Line

➢ The **black line** is composed of Fe/Mn-rich compound where iron is predominant and aluminum content are important (4-8%). The Raman analysis shows us that these inclusions are from **Braunite** (Mn_7SiO_{12}) and **Hematite** (Fe_2O_3).
For the "type 2" productions, the absence of interdiffusion between the colored glazes and their rounded appearance is a proof of its compartmenting role during the firing.



➢ The **black line** is made of chromium-rich phases. The Raman analysis confirms us the use of **Chromite** ($FeCr_2O_4$) and/or **Magnesiochromite** ($MgCr_2O_4$) minerals from the spinel group.

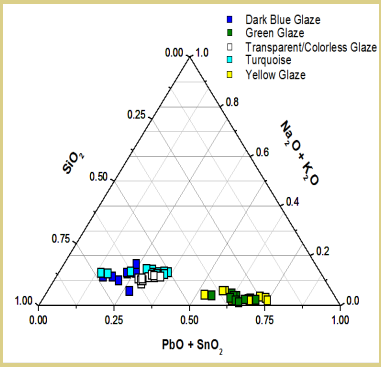
Glazes



➢ For type 1 and type 2, we observe:
1) **Transparent lead-alkaline glazes** (Brown and dark blue)
2) **Lead-alkaline glazes opacified with tin oxide** (White, turquoise and yellow)
The thickness of these layers are generally about 400-600 µm.

➢ A distinction has to be made between the white glaze used as a preparation layer (type 1) and the white glaze used for decor (type 2). Quantities of lead and tin are lower for the first one, therefore the melting point is higher and the tile can suffer a second firing for the glazes of the decor.

➢ The main colouring agent are the following: **cobalt with traces of nickel arsenic element** for dark blue, **copper** for turquoise, **(Type II) lead-tin** yellow, **manganese** for brown.



➢ For type 3, we observe:
1) **Lead-alkaline glazes** (Dark blue, turquoise, transparent glaze). Small amounts of tin are detected (SnO_2 ~2%) but rare particles of cassiterite are visible. The **tin remains in solution**.
2) **Lead glazes** (Yellow and green)
The thickness of these layers are generally about 100-200 µm.

➢ The main colouring agent are as follow: **cobalt with traces of As and Bi,** forming Co_2SiO_4 precipitate, for dark blue, **copper** for turquoise, **(Type II) lead-tin** yellow, green is obtained by mixing **copper and lead-tin .**
Craftsmen didn't use white glaze for decor but cover the white areas of the silica-rich slip with a **transparent and colorless glaze.**

➢ The glazes of the type 3 distinguish themselves with a higher lead concentration and a significant decrease of impurities. PIGE analysis show the presence of bore and lithium. M. S.Tite[1] formulates the hypothesis of the use of **evaporitic rocks** from West Anatolia as alkali flux.

➢ In 1411 after a decree ordered by Ullugh Beg, some craftsmen deported in Samarkand by Timur came back in Anatolia, as the famous 'Ali ibn Ilyâs 'Ali. They probably introduced some Timurid technique in the Ottoman workshops, as the colored glaze decor. After a gap of production of 50 years, tiles with colored glazes decor once again decorated the buildings of Suleiman the Magnificent. This resumption seems to be connected with the victory of the battle of Chaldiran in 1514 and the deportation by Selim I of hundreds of craftsmen to the Ottoman court in Istanbul.

➢ The observations and physico-chemical analysis enlight us on the different techniques used for the production of colored glaze tiles in Anatolia during the 15th and 16th century. Each period is characterized by technological special features, among them the most significants are:

1) For the beginning of the 15th c., the use of red paste with coarse quartz inclusions for the body, Fe/Mn-rich compounds for the black line and cobalt ion colouring agent with traces of nickel arsenic element for dark blue glaze. Moreover, we observe two types of preparation layer: white glaze as a Timurid heritage or clay-rich slip as an Ottoman specificity.

2) For the first half of the 16th c., the use of stonepaste for the body, chromium-rich phases for the black line and cobalt ion colouring agent with traces of arsenic and bismuth for dark blue glazes

[1] M.S. TITE & Al, « New Data on the Soda Flux Used in the Production of Iznik Glazes and Byzantine Glasses", *Archaeometry* (2015)