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NATURE EMULATING GLAZES IN CERAMICS: THE HISTORY OF CRATER GLAZES, DEVELOPING AND COLORING

SERAMİKTE DOĞAYA ÖYKÜNEN SIRLAR: KRATER SIRLARIN TARİHİ, GELİŞTİRİLMESİ VE RENKLENDİRİLMESİ

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Abstract

Glazes applied to the surfaces of ceramic bodies sometimes provide functional benefits and sometimes make aesthetic contributions. The factor that creates this diversity is the production purpose of ceramics. While the glazes used in the production of industrial ceramics provide functional contributions, the artistic glazes used in art ceramics are basically the result of visual effects that are accepted as errors in glaze technology, making ceramic forms aesthetically richer and more interesting with the color and texture diversity they create. In this sense, artists who have mastered the technology of ceramics can produce glazes with their own recipes and use them as a personal language in their works of art. This possibility of creating an identity that the material gives to the artist has paved the way for the production of endless variations of glazes with organic and inorganic additives over time. Crater glazes, named after the term "crater" that emerges as a result of natural formations on the earth due to the similarity of its textural appearance, can be produced by adding silicon carbide (SiC), an inorganic substance, to the glaze. Silicon carbide, which creates a blistering effect, which is accepted as a defect in the glaze, shows that a defect can also make an aesthetic contribution with the crater image that appears when it is prescribed in appropriate proportions. In this article, the historical background of crater glazes is investigated, glossy and matte crater glazes are discussed and experimental applications are carried out with coloring alternatives. As a result of the experiments, it was revealed that the textural glaze surfaces obtained created positive effects by providing formal richness in art ceramics.

Keywords: Ceramics, Glaze, Crater, Lava, Silicon Carbide.

Öz

Seramik bünyelerin yüzeylerine uygulanan sırlar kimi zaman fonksiyonel fayda sağlarken kimi zaman da estetik katkı sağlamaktadır. Bu çeşitliliği yaratan temel unsur seramiğin üretim amacıdır. Endüstriyel seramik üretiminde kullanılan sırlar fonksiyonel katkılar sağlarken, sanat seramiklerinde kullanılan artistik sırlar ise sır teknolojisinde hata olarak kabul edilen görsel etkilerin sonucunda ortaya çıkarak, yaratmış olduğu renk ve doku çeşitliliği ile seramik formları estetik olarak daha zengin ve daha ilgi çekici hale getirmektedir. Bu anlamda seramiğin teknolojisine hâkim sanatçılar kendi reçeteleriyle sırlar üreterek bunu sanat eserlerinde kişisel bir dil olarak kullanabilmektedir. Malzemenin sanatçıya tanıdığı bu kimlik yaratma olanağı zaman içerisinde organik ve inorganik katkı maddeleriyle sonsuz varyasyonda sır üretiminin yolunu açmıştır. İsmini dokusal görüntüsünün benzerliği sebebiyle yeryüzündeki doğal oluşumların sonucunda ortaya çıkan "krater" teriminden alan krater sırlar, inorganik bir madde olan silisyum karbür (SiC) katkısının sıra eklenmesi ile üretilebilmektedir. Sırda bir hata olarak kabul edilen kabarma etkisi yaratan silisyum karbür, uygun oranlarda reçetelendiğinde ortaya çıkan krater görüntüsüyle bir kusurun aynı zamanda estetik katkı da sağlayabileceğini göstermektedir. Bu makalede krater sırların tarihsel süreçteki gelişimleri araştırılmış, parlak ve mat krater sırlar ele alınarak renklendirme alternatifleriyle deneysel uygulamalar gerçekleştirilmiştir. Deneylerin sonucunda elde edilen dokusal sır yüzeylerinin sanat seramiklerinde biçimsel zenginlik sağlayarak olumlu etkiler yarattığı ortaya koyulmuştur.

Anahtar Kelimeler: Seramik, Sır, Krater, Lav, Silisyum Karbür.

INTRODUCTION

The attitude of emulating nature, which exists in all branches of art, can also be achieved in art ceramics with textural surface effects created by glaze diversity as well as form. Glaze, which is one of the most important means of expression of artists using ceramic materials, appears as a plastic element in art ceramics by including the concepts of color and surface texture (Kaplan, 2023, p. 15). While the development of glazes that emulate nature requires a strong command of ceramic technology, it also reveals that some visual effects known as defects can actually turn into an aesthetic value in art ceramics. Crater glazes serve precisely this function, creating interesting and aesthetic effects on ceramics with their swelling, flowing and perforated glaze formations, just like crater images in nature. When the literature on crater glazes was searched in the field of ceramics, very few publications were found. For this reason, it is thought that research on this subject will contribute to the field.

Crater glazes, also known as volcanic glazes, appear as the crater image formed on the surface as a result of the silicon carbide (SiC) additive creating air pressure under the glaze layer. When the glaze softens and starts to melt, the gas outflows that occur create pressure under the glaze layer and create cavities in the form of a crater image. Accordingly, when glazes containing silicon carbide reach the melting point, the silicon (Si) element in the glaze bonds with oxygen (O_2) in the furnace atmosphere to form the SiO_2 compound. This reaction is followed by carbon (C) taking the oxygen in the atmosphere and forming the compound carbon dioxide (CO_2). The pressure created by the gases released as a result of these reactions causes foaming and bubbles to form on the glaze surface (Bloomfield, 2020, p. 125).

In the first part of the research, an introduction to the subject was made and in the second main title of the research, the history of crater glazes and examples of artists were examined. In the third main title of the study, the formation of crater glazes was revealed through experimental studies. The coloring experiments of the successful results obtained were also applied in this section and their visual effects were evaluated. In the fourth main title, the colored glazes obtained within the scope of the research were supported with personal applications.

HISTORY OF CRATER GLAZES AND ARTIST EXAMPLES

The mass production methods that emerged with the industrial revolution have led to the simplification of decorative ceramic objects in order to reduce production costs. The monotonous lines of fabricated ceramic objects, especially in Europe, led people to search for something different. In this process, the interest in handicrafts in relation to the Arts&Craft movement in England with its revival thanks to Bernard Leach, ceramics in Europe has been recognized to as a studio art or as part of the fine arts.

Founded in 1903 in Austria, the Wiener Werkstätte (Vienna Workshop), modelled on the British Arts & Crafts movement, aimed to strengthen the relationship between craft and art and to revalue handicrafts as a collective community of artists. The Wiener Werkstätte, together with the Bauhaus School, which had a strong influence in the neighboring region, caused the aesthetic understanding in the region to change. The colorful and decorative influence of the Wiener Werkstätte and the elegant simplicity of the Bauhaus were reflected in the production practices of German and Austrian ceramicists. The ceramic works produced in this period reflect the unadorned forms of modernism as well as an awareness of the importance of craftsmanship. Although this production approach continued until the 1950s, different searches emerged in the following period (Roberts, p. 5). In this period, when production techniques that create randomly variable effects by giving ceramics "uniqueness" came to the fore, the effect of swelling in the glaze, which is considered a defect in ceramic technology, but which makes monotonous mass production ceramics more interesting created a new trend called *"fette- lava"* in West Germany. Recognized as the origin of crater glazes, fette-lava is a German term for glazes that flow and swell. *"Fette-lava"* has been translated into English as *"fat-lava"* and has reached today. *"Fat-lava"* is originally meant as *"thick lava"* because the glaze swells to a level that creates depth on the body.

According to the British writer Mark Hill, the fette-lava movement was "*a product of the*

Wirtschafterswunder, *Germany's economic miracle after the Second World War*" (Hill, 2006, p. 8). As Hill emphasizes, the economic recovery in the post-war period created an optimistic atmosphere for the German public, while at the same time creating a financial freedom that encouraged the public to pursue aesthetics and to buy fat-lava's brightly colored and decorative ceramics in large quantities.

On the other hand, when we look at the origins of fat-lava ceramics, we see that their foundations were laid about ten years before the Wirtschafterswunder. In 1938 Lucie Rie, a studio potter of Austrian descent who fled the repressive regime, produced decorative objects and artifacts in London, while Gertrud and Otto Natzler, also of Austrian descent, produced decorative objects and artefacts by skillfully using crater glazes in Los Angeles. Lucie Rie's artifacts with crater glazes are particularly noteworthy for their color transitions and her ability to overlap layers of glaze in blue and pink tones and produce them with precision (Figure 1). Rie produced crater glazes mostly later in her artistic career, in the 1960s and early 70s. As Hill emphasizes, the added value of fette-lava as a glaze technique in the German industry is striking, but it is also clear that a similar effect was seen in art ceramics.

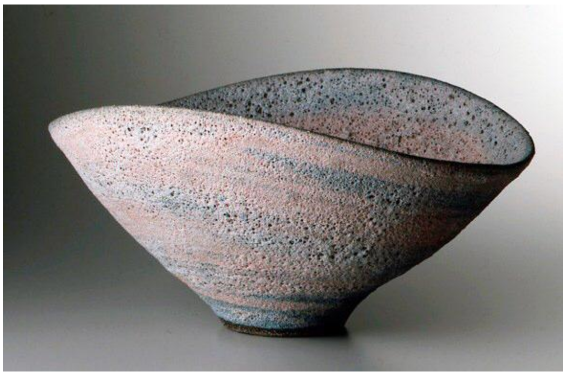


Figure 1. Lucie Rie, Pink and Grey Crater Glazed Stoneware Bowl, Middlesbrough Institute Of Modern Art, 1989.

Gertrud and Otto Natzler, who used crater glazes as a distinctive language in their production practices, were self-taught, although they had no academic training in ceramics. Gertrud's immense skill in shaping with the potter's wheel and the elegant eggshell-thin forms she produced were complemented by the innovative crater glazes developed by Otto Natzler (Figure 2) (Oller, 2022, p. 9). The forms they produced in sizes that can be held between two palms are mostly functional. Especially forms such as bowls, vases, bottles and goblets reflect the absolute mastery of material and technique and the perfect harmony between the glaze and the form (Natzler, 1973, p. 11).

Figure 2. Gertrud ve Otto Natzler, Green Crater Glazed Ceramic, Los Angeles, 1955.

Otto Natzler explains the emergence of crater glazes as follows; *"Instead of trying to obtain a smooth surface, I tried to make the pits, holes and craters more prominent and to get away from those bright colors by increasing the bubbles*" (Roberts, p. 5). With these words, Natzler introduced geological terms such as *"lava"* and *"crater"* into the ceramic literature. Otto and Gertrud Natzler not only contributed greatly to the shaping of the emerging ceramic identity of California, located on the west coast of the United States, but also influenced the young artist James Lovera, another pioneer of crater glazes (Natzler, 1973, p. 107). On the other hand, around the same time, Lucie Rie, with her eventual business partner Hans Coper in London, contributed to the movement of ceramics from the countryside to the city center. In this sense, Rie and Otto-Gertrud Natzler, the pioneers of crater glazes, also made social contributions to the cities they migrated to.

When contemporary art ceramics are analyzed, it is seen that many artists from different geographies prefer glazes that create a crater effect. Akiko Hirai is perhaps the most well-known contemporary ceramic artist using crater glazes. Any ceramicist who searches for recipes to apply crater glazes to their own work will inevitably come across Akiko Hirai's publicly shared recipe, *"Akiko's Crater Glazes*". With her sharing attitude, Hirai influenced many artists and made crater glazes widespread. Although born in Japan, Hirai studied ceramics formally at the University of Westminster and Central St Martins in England, earning a bachelor's degree in the field. Hirai later established his workshop in London, where he still lives and works (Whiting, 2023).

Figure 3. Akiko Hirai, Poppy Vase. **Figure 4.** Akiko Hirai, Round Poppy Vase.

Michael Hamlin, another artist who uses crater glazes in his works, reveals the suitability of crater glazes for coloring by preferring vivid colors. The artist's well-known forms are crater glazed vases in various sizes, shaped by the slab method. Hamlin uses multiple firings to create movement and motion in his ceramics. Thus, he obtains multi-layered ceramics with a flowing effect. Figure 5 shows a group of his works produced with this method.

Figure 5. Michael Hamlin, Crater Glazed Vases.

On the other hand, South Korean artist Jane Yang-D'Haene creates forms inspired by traditional ceramic forms known as *"dalhangari"* or *"moon jar"*. She makes experimental shaping on the surfaces of her works that refer to Korean cultural heritage. Instead of mirroring the smooth white exterior of the original moon jar vessels, D'Haene uses crater glazes to create changes in texture, movement and tone. The resulting works take on a sculptural quality with both the effect created by the brush strokes during the glazing phase and the relief effect created by the crater glaze (Figure 6). (https://www.janeyangdhaene.com/about, 2024)

Figure 6. Jane Yang-D'Haene, Crater Glazed Moon Jar.

DEVELOPMENT AND COLORING OF CRATER GLAZES

Crater glazes are usually produced by adding silicon carbide to a base glaze. During melting, silicon absorbs the available oxygen to form silicon dioxide (SiO_2), while carbon combines with oxygen to form carbon dioxide (CO_2), which creates bubbles on the glaze surfaces (Hansen, 2024). During firing, when the glaze is in the melting phase, the gas bubbles burst and form craters. At the stull chart in Figure 7, it is emphasized that crater glazes with an ideal appearance are formed in the diagram range where semi-matting takes place. It is shown that both glossy and matte crater glazes are located on or near the aluminum oxide: silicon dioxide line in a ratio of 1 to 5. In the chart, firing temperature and gloss increase as one moves to the right along the SiO_2 line (Bloomfield, 2020, p. 126).

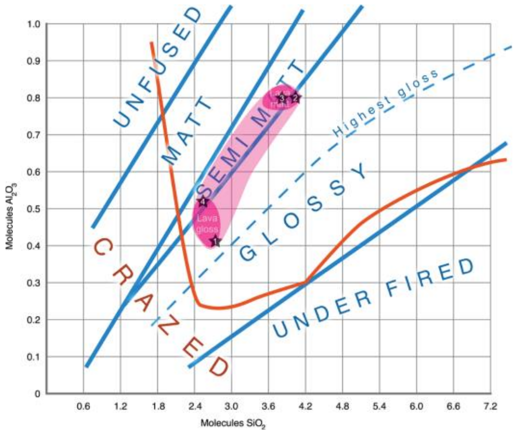


Figure 7. Stull Chart (Alumina-Silica Relationship) (Bloomfield, 2020, p. 127).

Crater glazes can also be applied as a second layer over or under a different matte glaze. Crater effects can also be achieved by applying a matte glaze on a ceramic or slip containing silicon carbide. Although crater-like bubbles can be created with cryolite, lepidolite (both of which release toxic fluorine gas) and vanadium pentoxide (slightly soluble and toxic) additives, the high toxicity and difficult accessibility of these materials have led most ceramicists working with crater glazes to use silicon carbide (Bloomfield, 2020, p. 127).

The experimental part of the study started with the bright 1200°C glaze recipe in Table 1. The most suitable additive ratio was tried to be determined by adding silicon carbide additive at increasing rates to the recipe used as a base. Silicon carbide additive was added to the prepared glaze at the rates of 0.1%-0.4%-0.7%-1%-3%-5%-7% and 10%. The prepared added glazes were applied on the tiles produced for glaze tests to form a thick layer to increase the swelling effect.

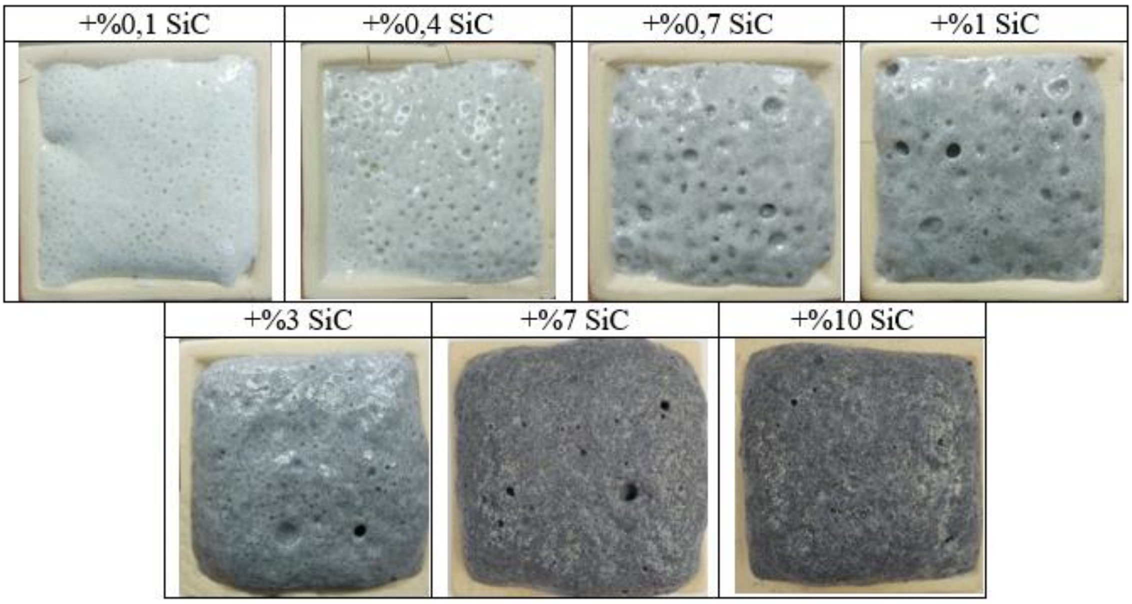
Table 1.

Glossy Glaze Recipe (%)
1200°C
16 Ulexite 5 Lead Oxide 33 Sodium Feldspar 22 Potassium Feldspar 12 Kaolin 12 Quartz 100

(+) Silicon Carbide Additive							
% 0,1	% 0,4	% 0,7	% 1	% 3	% 5	% 7	% 10

(Silicon carbide (SiC) was added in 100 Mesh-149 Micron grain size.)

Table 2. Silicon Carbide (SiC) Additive Glossy Glaze Tests, 1200°C.



The applied tests were fired at 1200°C and the results were observed. Accordingly, in the first tests of silicon carbide-added glossy glazes, it was observed that there were gradually increasing amounts of swelling and the gaps that provide the crater appearance remained under the glaze layer. In other words, the silicon carbide added into the glossy glaze causes the glaze surface to cover the crater cavities invisibly. When the surface of the blistered glaze layer is engraved, the crater cavities are revealed (Figure 9). When the rate of silicon carbide increases above 1%, the crater voids increase and the blistering becomes evident. It has been observed that glaze tests with silicon carbide additives between 1 and 3% have an ideal appearance, however, very high swelling occurs at rates between 3% and 10%. Silicon carbide added in high rate changes the attribute of the glaze from being a surface coating and creates effects that create deep relief and even transform into a form (Figure 9). In addition, the surface appearance of the fired glaze tests became matte the silicon carbide content increased, while at the same time dark grey tones were obtained at increasing values.

Figure 9. a) Blistering image of 7% SiC added glaze b) Crater image revealed by engraving the top surface of 7% SiC added glaze.

The second stage of the research continued with matte glaze applications. The matte glaze recipe in Table 2 was inspired by the recipe shared by Japanese artist Akiko Hirai as public access. Silicon carbide was added to this high temperature (1200°C) matte glaze at varying rates and the effect of crater at matte glazes was observed.

Table 3.

Matte Glaze Recipe (%)
1200°C
60 Nepheline Syenite 18 Barium Carbonate 10 Kaolin 10 Quartz 2 Titan Dioxide 100

(+) Silicon Carbide Additive				
% 1	% 2	% 3	% 4	%8

(Silicon carbide (SiC) was added in 100 Mesh-149 Micron grain size.)

Table 4. Matte Crater Glaze Tests.

+%1 SiC	+%2 SiC	+%4 SiC	+%8 SiC
			

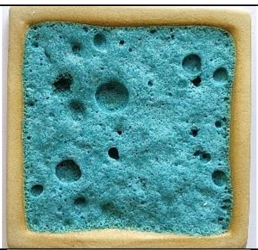
According to the results of the first tests, it was determined that the best crater effect in matte glazes appeared with 2% silicon carbide additive. However, in the case of adding silicon carbide to matte glazes, it was determined that the crater image appeared to form a texture on the entire surface of the glaze layer, contrary to the effect obtained in the glossy glaze. In the coloring experiments carried out in the continuation of the study, the silicon carbide ratio in the glaze content was kept constant at 2% and coloring experiments of matte crater glazes were carried out by adding mason stains and coloring oxides at variable rates.

Table 5. Crater Glaze Color Tests with Cobalt Oxide.

%0,5 CoO	%1 CoO	%2 CoO	%3 CoO
			

Since cobalt oxide (CoO), one of the coloring oxides, has a stronger coloring ability than the other oxides tested, four different color shades were tested in the range of 0.5% to 3%. It was observed that the results obtained were positive.

Table 6. Crater Glaze Coloring Tests with Copper Carbonate, Copper Oxide, Chromium Oxide, Manganese Carbonate, Manganese Oxide, Iron Oxide and Red Mason Stain

	%1	%2	%3
$CuCO_3$			
CuO			
Cr_2O_3			
$MnCO_3$			

MnO			
Fe_2O_3			
Red Mason Stain	%5	%10	%20
			

Apart from cobalt oxide, other color-giving oxides such as copper oxide (CuO), copper carbonate ($CuCO_3$), chromium oxide (Cr_2O_3), manganese carbonate ($MnCO_3$), manganese oxide (MnO) and iron oxide (Fe_2O_3) were added to the matte crater glaze at the rates of 1%, 2% and 3%. As a result of the tests, different shades of turquoise, green, brown and cream colors were obtained. Especially with copper oxide, very striking turquoise color tones were obtained.

On the other hand, glaze coloring experiment with red mason stain was also carried out in this study. Three different shades from pink to saturated red were obtained in the tests with 5%, 10% and 20% mason stain addition. This also shows that crater glazes can also be colored with mason stains.

PERSONAL ARTWORKS

The matte crater glaze colored with 2% cobalt oxide (CoO) produced within the scope of the study was applied on the vase form with a brush to form a thick layer. Then, the uncolored matte crater glaze was applied by flowing as the second glaze layer on the form. Crater efects consisting of cobalt blue and cream colors were observed on the surface of the vase fired at 1200°C.

Figure 10. Crater Glazed Cobalt Blue Vase

On the other hand, as a second work, a matte crater glaze colored with 2% copper oxide (CuO) was applied on another vase form with a brush to form two thick layers. When the vase fired at 1200°C was examined, it was observed that the glaze layer on the vase concealed the formal features of the form with the effect of swelling. Although this may be perceived as a negative effect, it should not be forgotten that it can also hide defects such as cracks and deformations that may exist on the biscuit form.

Figure 11. Crater glazed turquoise blue vase.

CONCLUSION

In this article, high grade matte and glossy glaze tests prepared by adding silicon carbide additives at variable rates were fired at 1200°C. It was observed that the silicon carbide added to the glossy glaze created a blistering effect on the glaze surface as a result of firing, but the formation of the crater image remained under the glaze layer. When the top surface of the glaze in these tests is engraved, the crater image appears.

However, matte and semi-matte glazes were found to be more favorable than glossy glazes in terms of creating a crater appearance. The crater texture created by silicon carbide can be clearly seen on the surface appearance of these glazes.

In all glaze tests, it was found that silicon carbide additions between 1% and 10% created an increasing swelling effect, however, silicon carbide additions in the range of 2-3% gave the best visual results. It was observed that silicon carbide added at 5% and higher rates caused excessive swelling in the glaze. This swelling creates effects that transform the glaze from a surface coating into a form. While the excessive swelling of the glaze covers the formal features of the ceramic form, it also hides the faults in the form. In this respect, it is thought that glazes with 5% or more silicon carbide additives can also be preferred in art ceramics. When considered in this context, crater glaze applications directly affect the shaping process of the form. Such applications lead to a semantic transformation of glaze. Although glaze is generally defined as a glassy layer covering and covering the surface, crater glazes evolve to become a tool that plays an active role in the shaping process of the ceramic form.

The increase in the rate of silicon carbide in the glaze also causes the appearance of grey tones even though no coloring agent is added. Especially these glazes with dark grey tones are very difficult to be colored with coloring oxides or mason stains. As a result of this observation, it was determined that the use of maximum 3% silicon carbide in the production of colored crater glazes will not reduce the effect of the colorants to be added.

Highly successful results were obtained with mason stains and coloring oxides used as colorants. It is thought that the textural glaze surfaces obtained as a result of the tests will create positive effects by creating formal richness in art ceramics.

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