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A QUESTION OF MASTERY. DEFECTS AND LAYERS

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Master in Ceramics Glass Art and Science

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Abstract

This work began with a topic that was interesting and exciting to me: the technology of multiple firing in ceramics and defective glazes. Almost immediately, I thought I knew how to build a testing and scientific research process. My goal was to collect an extensive library of effects and techniques that would meet my expectations, and using this palette, as a painter move directly to the very process of creating art objects.

For the study, I chose one defect of my interest - the appearance of craters in the glaze driven by Silicon Carbide (SiC) and the dependence of the characters of the craters on the amount of SiC. The project was undertaken to evaluate how crater glazes work with other glazes such as copper red and crystalline glazes in layers, which will provide a variety of glazing textures.

In the process of working with defects in glazes, there was an encounter with control, a desire to conform to the outlined plan, followed by the attempt to free myself and follow a more organic process. "Two" fundamental questions emerged on which to base the study of my art practice:

1. What are the layers of process that make up my artistic practice? Who are the participants in this process: the inner values, intuition, the material with which I interact, fire, chance...something else?
2. What role do 'chance and control' play in my art practice?

Trying to find answers to these questions brought me closer to personal understanding about my artistic practice:

- Dealing with uncertainty
- Failure and disappointment
- Empathy for the material
- Trust of fire
- Acting, not just planning

Keywords: Defects, Layers, Chance, Control, Glazes, Surface

Resumo

Este trabalho começou com um tópico que era interessante e entusiasmante para mim: a tecnologia de múltiplas cozeduras em cerâmica e vidrados com "defeitos". Quase imediatamente, consegui imaginar um protocolo para testar estes processos de forma científica. O meu objetivo foi recolher uma extensa biblioteca de efeitos e técnicas que fossem ao encontro das minhas expectativas, usando esta paleta diretamente no processo de criação de obras de arte.

Para o estudo, escolhi um dos defeitos que me interessavam – o aparecimento de crateras (ou pústulas) no vidrado por efeito do carboneto de silício (SiC) e a relação entre as características das crateras e quantidade de SiC. O estudo incluiu ainda a avaliação da interação entre os vidrados de crateras (*crater glaze*) e outros – tais como o vidrado vermelho de cobre e os vidrados cristalinos – quando aplicados em camadas, originando uma variedade de texturas e cores.

No processo de trabalhar com os defeitos em vidrados, deparei-me com a questão do controlo, com o desejo de corresponder a um plano delineado, a que se seguiu a tentativa de me libertar e seguir um processo mais orgânico. Surgiram "duas" questões fundamentais nas quais basear o estudo da minha prática artística:

1. Quais são as camadas do processo que constituem a minha prática artística? Quem são os participantes neste processo: os valores intrínsecos, a intuição, o material com que interajo, o fogo, o acaso... algo diferente?

2. Que papel desempenham o "acaso e o controlo" na minha prática artística?

Tentar responder as estas questões aproximou-me de uma compreensão pessoal acerca da minha arte:

- Lidar com a incerteza
- Fracasso e desilusão
- Empatia pelo material
- Confiar no fogo
- Agir, não planear apenas.

Palavras-chave: Defeitos; Camadas; Acaso; Controlo; Vidrados; Superfície

Table of Contents

List of Figures

Figures without source are taken by myself

List of Tables

1. Introduction

Art education often teaches the pursuit of perfection, a process that will help create 'great art. Art institutions are usually full of rules and visions of what 'art should be'. My first art education was excellent: persistence, a broad view of art and visual culture, tolerance for frustration, and a fear of making mistakes. Unfortunately, I still can't sit down to paint, although I think I 'know how to' with I can’t allow myself to make a mistake. Ceramics and glazes have become the only bastion of freedom through which errors and chance have opened the way to creativity, where there is no longer fear to make mistakes, and I LEARN

The artistic process sometimes looks like a complex layering of different solutions and unknown variables. One solution clinging to another, and the result is impossible if one does not go through the entire process of creating something.

Paul Klee compared the artistic process to a perpetual movement, a development that does not stop, including when the object, the image seems finished, it continues to live in a state of genesis, but only figuratively: «The point, becoming motion and line, takes time... the moving point, creating the line, creates form. The form is not a result. It is genesis. Art exists according to the same laws as the universe... Motion is a given in the universe... In the same way, a work of art is primarily a genesis, and it is never experienced as a product... A work of art has arisen from motion, is itself a fixed motion, and is perceived by the movement of the eye muscles... Motion is at the basis of all becoming.»[1]

Of course, a lot begins with curiosity as a basic artistic instinct, but then what does it grow into? How does or does not the transition to a desire for ordering take place? Why, when faced with the unknown and chaos, is there a tendency to over control in order to feel ‘safe’ within the research process? And most interestingly, what are the necessary conditions for the emergence of freedom and empathy for the material which opens up a new level of artistic process and cognition? As an artist working on my thesis for about a year, I have been searching for answers to seemingly simple, yet incredibly complex questions about art practice: What role do control and chance play in my personal art practice?

[1] Zahn, Leopold. *Paul Klee Leben ; Werk ; Geist*. Kiepenheuer, 1920.

The second part of my thesis research is the experience with defect glazes. I focus on studying the defect called 'pinholing', which is the base of crater glaze and its interaction with other glazes. The main question about crater glaze is:

- The role of SiC in crater glaze
- Creating surface using crater glaze in layerings with other glazes

2. Layers in abstract painting and ceramics

2.1. The matter of layers in Gerhard Richter's and Jackson Pollock's works

Glazing in one firing is one perfect movement, a gesture. The multi-firing method combined with different materials is in its quality, like a dance with chaos. I see a whole choreography in it, the development of material movement and thought.

The power of the multi-firing technique was revealed to me by chance, when I knew nothing yet about the chemistry of glaze, the technology of working with ceramics. One of my pieces came out "unsuccessful" from the firing. The color was muddy and was not the color I was looking for. I felt sorry to throw it away, and I decided to put another layer of glaze on top and see what came out. To my surprise, when I took it out of the kiln, I saw the first notes of “painting”, and from that moment on, I was no longer satisfied with just one firing. [Figure 1]

Figure 1–The first experiments with multi firings and layers of glazes. Personal Archive 2017.

This process sparked my strong interest in the poetry of color and texture, an anthropological witness to the artistic process and the life cycle of the object, its flesh.

For me, there existed a similarity between my process and the results I got and the paintings of Gerhard Richter. In his painting «November.1989» [Figure 2] which was painted over an existing painting, we can see and feel the material gravity, references to the past states of the painting:

«The formal principle, which is aneffect not only of the massive amount of paint layers applied to the canvas and size of the paintings, but also an effect of the dark materiality of the painting. The 'heaviness' applied is not a problem of vision and touch; instead, what we find here is the contrast and tension between color as something ”transparent” ideal, and nonmaterial, and its quality of weight. Since volume and weight are properties of bodies, we can see that the 'flesh' of these paintings that can be identified as melancholy is not simply an effect of layers, which open up reference to the past in painting and through its materiality, but, is also an effect of 'weighing'on someone, almost as if these paintings are weighing on the vision that tries to get into them.»[2]

Figure 2 – Gerhard Richter's paintings, «November.1989»

[2] Lotz. *The Art of Gerhard Richter: Hermeneutics, Images, Meaning*. Bloomsbury Academic, 2017, p.174.

In a sense, as we can see in Richter's paintings, layers represent the object's life path, the footprints of stages passed, mistakes, failures, past lives. The past and the present blend in the layers, and the linearity of time disappears. Layers act as a geological testimony of experience and evolutionary processes the artist passes through with the material. Pollock's painting is an example of such a testimony. [Figure 3,4]

«The painting is a complex and intricate composite of brushstrokes, splatters, smears, and dabs. A multitude of colors weaves across the canvas, and it is difficult to establish the exact order of application, as the same colors were used from start to finish. Many of them appearing in both the early and late stages of painting. The combination of quickly applied but controlled brushed paint and more 'accidental' thrown paint results in wonderful graphic and painterly effects. Colors of varying intensity and texture and paint of different consistencies were applied across the great canvas with an energy that is evident in the effects that have been achieved.»[3]

Figure 3 – Jackson Pollock, Mural, 1943. Gift of Peggy Guggenheim, 1959. University of Iowa Museum of Art. Reproduced with permission from The University of Iowa.

[3] Y.Szafran, L.Rivers, A.Phenix, T.Learner, E.G.Landau, S. Martin, Yvonne. *Jackson Pollock's Mural: The Transitional Moment*. J. Paul Getty Museum, 2014, pp. 35-37.

Figure 4 – Cross-section from the passage of dark-black paint of Mural, 1943.

In Richter's and Pollock's abstractions, I see one feature which for me is crucial.
A high physiological emotionality of colorful layers is born out of a body in presence, a moment and an act of movement. The layers become an anthropological testimony to the presence of the artist, his acting. This way of painting makes it possible to see traces of the physical birth of the creative act, which was born in the body and spirit of the artist.

«Paint is applied with brushes, but more often it is smeared, dabbed, rubbed, blotted, streaked, and dripped ... The emphatic paint textures created may be sensuous or plain, coarse or smooth, even or inconsistent.»

2.2. Moving layers in contemporary ceramics

By firing my ceramic objects repeatedly, each time covering them with a new layer of glaze, conditions are created for the development of color and texture transformations:

- The entry of one texture into another
- Destruction, permeation, joining one surface to another.
- The absorption and reflection of color
- The manifestation of the lower layer through the five subsequent layers

The downside of this technology is that you are almost always a confused beginner, you don't know what the result will be, how the glazes will combine in the firing, what the final color will be, what texture will emerge. Layer by layer the process begins to balance between chaos and order. And the artist can act as a kind of medium between his desire, intention and material. It is a dynamic process,holding a lot of emotion, and a sense of the presence of constant movement. This can also be seen in the works of the artist Morten Løbner Espersen (Danish, born 1965).

On this work of Espersen, call «Horror Vacui» [Figure 5] bubbling and frothy appendages writhe and twist on a vase profile that's hidden within. Resembling a mass of spilled intestines and oozing flesh, the surface initially evokes revulsion - but after further observation, the true beauty and astonishing depth of glaze becomes apparent. The fine balance between control and unruliness achieved by Espersen is held in a perfect state of equilibrium, resulting in a work that is wildly expressive and compelling.

Taking inspiration from the refined colour palette of East Asian glazes, Espersen applies layer upon layer of «contrasting» glazes. He fires the work multiple times - up to seven in some instances - Espersen says, «My goal is to create rich, complex surfaces… I never have a precise image of the final glaze in mind, but every time I empty the kiln I hope to be surprised and something I've never seen before.»[4]

[4] Taylor, Louisa. *Ceramics Masterclass: Creative Techniques of 100 Great Artists*. Thames&Hudson, 2020, p.65

Figure 5 – Morten Løbner Espersen «Horror Vacui #2», 2019, Stoneware and glazes. 62x50 cm

In a sense, a multi firing technology opens a Pandora's box which can contains both errors and breakthroughs. «Aneta Regel throws the rule book out of the window and employs a refreshing approach to working with clay. She simply enjoys materiality and allows material 'to do what it wants to do'. With this in mind, challenge yourself to think differently about your own methods.»[5]

A brief work description of a British ceramist Aneta Regal, who usually doesn't even know how many times she has fired the object [Figure 6] and how many layers of material have been used.[6]

'During the extensive making process, she does not dictate the overall form, but instead allows the piece to emerge and flourish until she feels 'It works'. This can involve multiple firings at high and low temperature.' [5]

[5] Taylor, Louisa. *Ceramics Masterclass: Creative Techniques of 100 Great Artists*. Thames&Hudson, 2020, p. 66.
[6] Layton Thompson. “Ceramic Review: Masterclass with Aneta Regel.” 2017, https://www.youtube.com/watch?v=Vpkmk3t6XLA.

Figure 6 – Aneta Regal «Open Metamorphosis 2» 2012, stoneware, slips, rocks,33x25x22cm

As with Morten Løbner Espersen, the surfaces, color, and plasticity of Regel's objects seem to reflect the whole internal art process: determination, freedom, dialogue, and empathy with the material.

This wonderfully vivid sculpture speaks with energy and life. It'' a visual feast sumptuous surfaces and textures, where rich, craggy and dry surfaces are juxtaposed with elements of bright, oozy glaze. She says: «I create objects that exist neither in this natural or in the manufactured world but which, once brought into being, can reflect and transmit information and feelings about nature and my own existence». [7]

Relationships largely determine the multilayer technique in ceramics between different textural layers. The creation of volume comes from the physical and chemical interaction between the layers. The relationship between matte and glossy layers, cracked and voluminous glazes, constitutes visual poetry's vocabulary.

[7] Taylor, Louisa. *Ceramics Masterclass: Creative Techniques of 100 Great Artists*. Thames&Hudson, 2020, p.105.

Figure 7 – Brain Rochefort,Paint Can 2019, ceramic, glaze, 11x11x11.

Brain Rochefort (American, born 1985) creates heavily decorated, experimental sculptures that explore the realms of glaze and surface. 'Overflowing with thick, oozing glazes and textured, crackling effects, this piece from the Paint Can series, projects energy and visual delight. Spills of luscious, gloopy material flow and pour from the rims and sides of the vessel. Beneath the dense overlay of heavy globular decoration, a chequered gingham pattern forms the background on which everything else is built. The piece [Figure 7] gives the illusion that it is in contrast, flux and movement, yet it remains preserved in a fixed state.

He channels his experiences and emotions into his artwork by 'amplifying colours and textures to the point where they become totally alien. «He achieved the molten glazed surface by carefully applying layer upon layer of glaze and firing the piece between each stage.»[8]

[8] Taylor, Louisa. *Ceramics Masterclass: Creative Techniques of 100 Great Artists*. Thames&Hudson, 2020, p. 173.

3. Defect glazes

In traditional ceramics, there has always been an unspoken dictate to achieve perfection with glazes. Classical defects such as crawling, pitting and pinholing, blistering and glazes dripping were well known and always avoided by potters.[9] This, of course, has more to do with the primary purpose of traditional ceramics – functionality. I assume that the abstract art of the 20 century has permitted chaos to manifest in material, and the value of defects, errors, and accidents has grown.

Using different textured glazes with multi-firing technology inevitably creates new defects, new textures. The unpredictable behavior and interplay of glaze layers creates the ideal conditions for these accidents. As soon as I started working more with layers, a natural need arose to understand precisely how defects form and whether or not this chemical process can be controlled?

In 2020 as part of my master course, I did research into defect glazes [Annex, page 58]. I was study three types of common defects: pitting and pinholing, crawling, and glaze dripping. During this study, Glaze tests were carried out to understand how the defects are formed and how they change with firing temperatures, and application methods. Additionally, I was trying to understand which defect I would like to study as a part of my thesis, and at that time I stopped my experimentation with crater glaze, which can be more volatile, sensitive and create more accidental effects [Figure 8].

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[9] Hopper, Robin. *The Ceramic Spectrum: A Simplified Approach to Glaze and Color Development*. The American Ceramic Society, 2018.

Figure 8 – The first experiments defect glazes. Personal Archive 2020

4. Crater glaze

«I love to control what cannot be completely controlled, what nature creates – the accidental and, at times, the impossible.»
— Otto Natzler[10]

4.1. History of Crater glaze

Crater glaze was first made in Europe in the mid -20th century and emigrant studio potter Lucie Rie in London, and by Gertrud and Otto Natzler in Los Angeles.

Lucie Rie was an Austrian-born British ceramics artist. Rie experimented with glazes, pushing the boundaries with her fantastically detailed and painterly designs, many of which have the same gestural expression of a painting by Pollock or de Kooning. Lucie Rie didn't leave notes about her discovery of crater glaze. Her work with crater glaze reflects her incredible ability to work delicately with tones: transitional colors by superimposing layers of multi-colored crater glaze.

Figure 9 – Lucie Rie (1902-1995; Austria/UK), ‘Flared Rim Bottle,’ circa 1986, stoneware; soft pink and gray crater glaze, 9 1/2 inches high.

[10] Quoted in Otto Natzler, “Immortal Clay: The Exploration of a Medium,” Form and Fire: Natzler Ceramics 1939–1972 (Washington, D.C.: The Renwick Gallery of the National Collection of Fine Arts, Smithsonian Institution Press, 1973), p. 19.

Another creator of crater glaze was Otto Natzler (1908 – 2007). He was an Austrian–born ceramicist. With his wife Gertrud Natzler, they produced what many consider to be among the most important ceramics of the 20 century. In his meticulous records – notes for some 25,000 pieces – Otto described the details for more than 2,000 glazes developed over the years through careful research and observation. Otto was self-taught in glaze chemistry and first consulting his chemistry textbook from high school, he began to learn the properties of materials he could use to mix his own recipes. Admittedly, disaster after disaster ensued before he finally achieved a consistent, smooth glaze. Ironically, during this process Otto found himself more fascinated by his failures. [8]

Figure10 – Gertrud Natzler, Otto Natzler, Bowl (no. L637), 1961,
"Crater" glazed ceramic.

"Instead of working toward a smooth surface, I tried to increase the blisters, make the pockmarks, the holes and craters more
pronounced, get away from those bright shiny colors,"
— Otto Natzler[11]

Thus were born some of the Natzlers' trademark glazes, with names that suggest geothermal forces like "Pompeian," "Lava" and "Crater." As he learned to control – or at least to predict the likely outcome of his process, Otto also learned the value of accident: of letting the force of fire become one of his materials rather than simply the fuel for a kiln.

[11] Prudence, Robert. The Ceramics of Gertrud and Otto Natzler. The Museum of Contemporary Craft, 2008.

4.2. Chemistry of crater glaze

Crater glaze is usually made by adding silicon carbide to a matt glaze. If silicon carbide (SiC) is added to a viscous matt glaze, craters form when carbon dioxide is given off during firing. The silicon takes up available oxygen to make SiO_2, while the carbon combines with oxygen to make the CO_2 which creates the bubbles on glaze surfaces.[12] The base glaze is viscous during firing so that the gas bubbles erupt and form craters without healing over. The Stull map [Figure 11] shows that the two types of crater glaze are semi-glossy and semi-matt, but both lie on or near the 1:5 alumina:silica line; the further to the right along the line, the higher the firing temperature.[13]

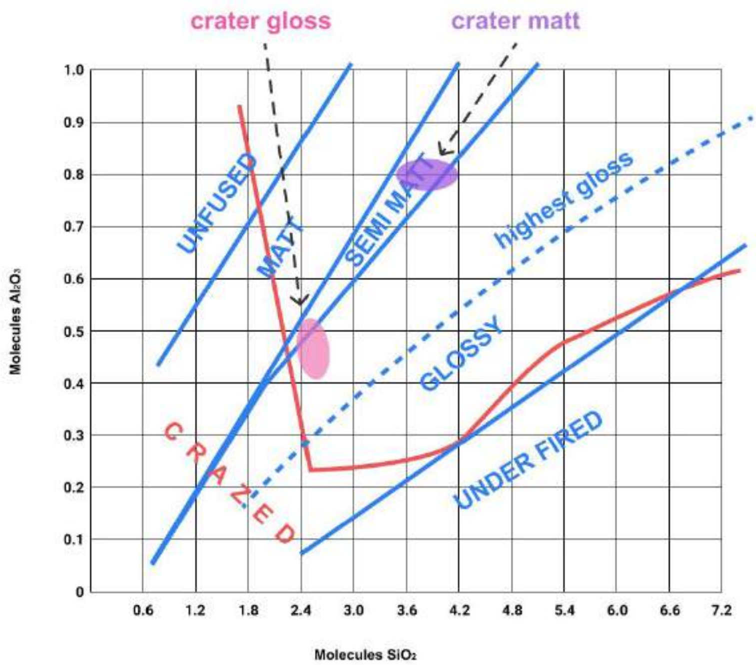

Figure 11– The Stull map. Semi-glossy and semi-matt crater glaze[13]

[12] Hansen, Tony. “Silicon Carbide.” *Digital Fire*, https://digitalfire.com/4sight/material/silicon_carbide_1250.html.
[13] Bloomfield, Linda. *Special Effect Glazes*, Bloomsbury Visual Arts, London, 2020, p. 126.

Influencing factors on the occurrence of craters:

4.2.1. Amount of SiC

Even a small amount (0.2-2%) of silicon carbide in a glaze is sufficient to bring about local reduction[12].

During an experimental study called «Art and Science: The Role of Silicon Carbide in Developing High Temperature Crater Ceramic Glaze Recipes», made by Badar Mohammed Almamari,[14] he researched how a small amount of SiC ranging between 1%-2% can affect different glazes, and which kind of craters SiC can create depending on glaze.

4.2.2. Different grades of SiC

In the published article «Crags and Crevices» by Mike Bailey[15], author studied how different grades of SiC affect crater gaze. Experimenting with a 4% addition of various grades of silicon carbide ranging from coarse 20's through to a very fine 1200's grade, these were added to a simple crater slip (potash feldspar 60% plus Hyplas 71 ball clay 40%) and applied beneath the transparent glaze. The base glazes containing the finer silicon carbide, especially the 400's, 600's and 1200's grades, were the most reactive and produced the typical large pin-holed and cratered surfaces, whereas the coarser 20's- 80's remained as inert and unfused dark grey speckles.

4.2.3. Temperature

SiC works at a wide range of temperatures because it doesn't break down and generate carbon dioxide until it comes in contact with the molten glaze.[16] But still silicon carbide needs heat and time to react with the oxides in the glaze to break down. It's better to fire at 1250 °C - 1280 °C. At lower firing temperatures, a soak at the top temperature for 20-40 minutes will help liberate more gas.

4.2.4. Thickness of applied glaze

Titanium dioxide reacts readily with the silicon carbide and produces large craters if the glaze is applied very thickly.[17]

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[14] Almamari, Badar Mohammed. "Art and Science: The Role of Silicon Carbide in Developing High Temperature Crater Ceramic Glaze Recipes." *International Journal of Humanities and Social Science*, vol. 6, no. 4, 2019.
[15] Bailey, Mike. "Crags and Crevices." *Ceramic Review*, no. 239, Sept. 2009, pp. 65–67.
[16] Almamari, Badar Mohammed. "Ceramic Designers Contemporary Visions: The Contributions of Art". Art and Design Review, 5, 2017, pp. 141-151.
[17] Bloomfield, Linda. *Special Effect Glazes*, Bloomsbury Visual Arts, London, 2020, p. 125.

4.2.5. Rutile

In my first research about defect glazes (annex), where I studied the role of rutile in crater gaze, I concluded: of particular importance is the grinding of rutile. A fine grind of rutile forms better craters on the glaze's surface at high temperature than a coarse grind of rutile. The finely ground Rutile makes the glaze more matte, with a pronounced yellow color. Also, the size of the craters depends on the number of layers applied.

4.2.6. Other

The silicon carbide tends to settle quickly in the glaze bucket, so the glaze needs to be stirred frequently[18]

[18] Bloomfield, Linda. *Special Effect Glazes*, Bloomsbury Visual Arts, London, 2020, p. 125.

4.3. The role of SiC in the formation of craters

The experimental study of crater glaze was divided into two main parts:

1. The investigation of the role of SiC in crater formation
2. Interaction of crater Glaze with crystalline and copper glazes in the layers (see Chapter 5).

4.3.1. Methodology

The main goal of the experiment is to understand which role SiC plays in Crater glaze, in the formation of craters. The main parameter studied is the different amounts of SiC from 0% to 5% in matt glaze, fired at 1250°C.

Figure 12 – Glaze preparation. Personal Archive 2021.

The ceramic tiles used for the experiments in this research were made of white stoneware clay with chamotte 0.5 mm and biscuit fired at a low temperature (980 °C) to guarantee the glaze sample's absorption. The shape of the ceramic tiles was made to facilitate firing in a vertical position. The vertical position for samples was chosen to see if glaze can change position, i.e. be movable depending on the number and size of craters.
The experiments were all conducted in the Ceramics Lab of the Fine-Arts University of Lisbon according to the following recipe and procedure :

Recipe of Crater glaze[19]

Nepheline syenite…60
Strontium carbonate …20
Lithium carbonate…1
Ball clay…10
Silica…9

+Titanium dioxide…5%
+SiC … 0%-5% (220-1200 mesh)

Table 1– Variations with changes % of SIC. Firing Temperature is 1250°C

Table 1	STV1	STV2	STV3	STV4	STV5	STV6	STV7	STV8
SiC	0%	0,25%	0,5%	1%	2%	3%	4%	5%

[19] Bloomfield, Linda. *Special Effect Glazes*, Bloomsbury Visual Arts, London, 2020, p. 126.

4.3.2. Results and discussion: crater glazes

Based on the results obtained [Figure 13, Table 2], the following conclusions can be reached about the effect of the amount of SiC on the texture of the glaze:

- Size of pinholes. Only a small amount of SiC (0.5%) is enough to create craters, because it directly affects the amount of CO_2 produced. As can be seen at increasing amount SiC corresponding changes in of crater size, larger bubbles are formed at a percentage greater than 2% of SiC.
- The higher percentage of SiC creates excess carbon dioxide gas, causing the glaze to froth, the glaze surface increases, and the walls of the formed craters become thinner. The surface of the glaze becomes thin, easily crumbled.
- Also with increasing SiC (from 1.5% and higher) the color of the glaze changes noticeably, it becomes darker, less even in color, from gray to white.
- A high percentage of SiC(3%-5%) foams the glaze surface, and the explosive bubbles slide down vertically.

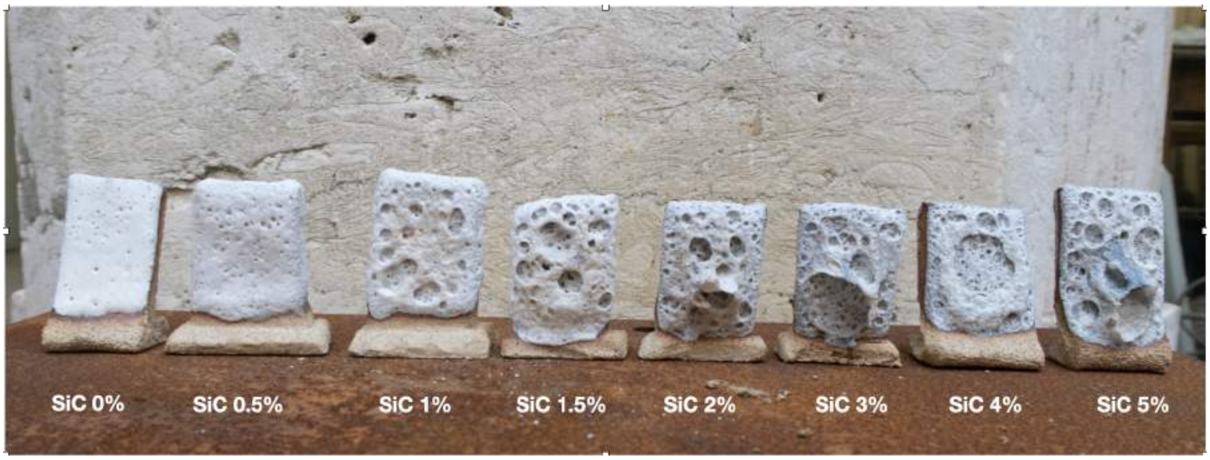

Figure 13 – Crater glaze tests with changes % of SIC. 1250°C

Table 2– Rubric to Assess the Final Results based on changes % of SIC in crater glaze

Table 1	**SiC%**	Craters amount			Size of craters			Surface fragility		
		small	medium	big	S	M	L	normal	medium	high
STV1	0%							*		
STV2	0.5%	*			*			*		
STV3	1%		*		*			*		
STV4	1.5%		*			*			*	
STV5	2%		*		*	*				*
STV6	3%			*	*	*	*			*
STV7	4%			*	*	*	*			*
STV8	5%			*	*	*	*			*

5. Making crater glaze more defective

5.1. Introduction

This project was undertaken to evaluate feasibility of combining crater glazes with other glazes in layers, which will augment ‘the pallette’ for sculptural ceramic artworks by providing a variety of glazing textures and colors.

For this experiment, I chose the glaze STV5 with 2% of SIC. This glaze has two essential characteristics : a considerable variation of craters sizes but able to produce a stable surface. It was important for me to have visible and at the same time, not very fragile craters. I wanted to be able to add additional layers of various glazes on top of the craters in unique ways: e.g. a thicker layer inside the crater and a thinner layer on the topmost layer. In this way, I imagined that the different color appearances of the other glazes should increase, making the whole surface more complex.

I aimed to better understand the possibilities,how the Crater glaze STV5 with 2% of SiC interacts with other glazes, creating   another layer of defects. For this research, the following glazes were chosen:

1. Copper glaze
2. Crystalline blue glazes
3. Crystalline white glazes
4. Crystalline matte satin glazes

The main goal of this experiment is to understand how Crater glaze STV5 reacts with other glazes to form new defects, depending on firing regimes and application methods.

5.1.1. Copper red glaze

The reduction of copper to make red glazes has intrigued potters for many years.The effect produced by the finely dispersed copper metal particles gives reds or pinks. A similar colloidal colouring effect is also obtained from gold in the manufacture of red glass. Glaze used for this test is called Ed’s Red.[20]

At around 500°C the copper carbonate changes to copper oxide, with carbon dioxide being driven off as a gas (Equation 1). Copper carbonate is usually recommended for the

[20] Bailey, Mike. “Copper Reds in the Electric Kiln.” *Ceramic Review*, no. 244, July. 2010, p. 65.

source of the copper as it gives a better dispersal throughout the glaze, whereas copper oxide tends to produce fine dark specks.

Equation 1
$CuCO_3 \rightarrow CuO + CO_2 \uparrow$

Above 1000°C the silicon carbide (SiC) begins to break down with the silicon (Si) taking oxygen atoms from the copper oxide to form silica (SiO_2). The carbon (C) removes the oxygen from the copper oxide by forming carbon monoxide (CO) or carbon dioxide (CO_2) (Equations 2 and 3). The small amount of silica simply becomes part of the glaze matrix, but the carbon gases will need to escape out of the molten glaze. [20]

Equations 2 and 3
$3CuO + SiC \rightarrow 3Cu + SiO_2 + CO \uparrow$
and/or $4CuO + SiC \rightarrow 4Cu + SiO_2 + CO_2 \uparrow$

5.1.2. Crystalline glazes

Ordinarily, when the glaze cools, it remains an amorphous, non-crystalline substance. Under special circumstances, however, the glaze can be made to crystallize partially as it cools, and the various forms of crystalline glazes are the result., In ordinary glazes the presence of alumina (Al_2O_3) prevents the glaze from crystallizing as it cools. Alumina also serves the valuable purpose of increasing viscosity, which prevents the glaze from running excessively. To make crystalline glazes, the amount of alumina in the composition must be drastically reduced, usually to less than 0.1 molecular equivalents, which in a high-fired glaze is one-third of normal. Many crystalline glaze compositions have no alumina at all. The absence of alumina usually makes the glaze very fluid. A high content of zinc oxide in the glaze favors the development of crystals. In crystalline glazes, about 0.3 equivalents of zinc are usual. The presence of some rutile or titania also favors crystalline development.[21]

Because of the presence of large amounts of zinc and rutile, crystalline glazes are typically somewhat opaque, and the absence of alumina makes them fluid and bright in surface. The crystals in the finished glaze may be either small and appear in clusters or groups, or the crystals may be large and spectacular in appearance. [22]

The firing cycle is a critical factor in producing crystals in glazes. The heating phase may be carried out at the usual speed, but cooling must be slowed down at the point where the materials in the glaze tend to crystallize. This is usually at a temperature somewhat below

[21] Rhodes, Daniel. Clay and Glazes for the Potter. Greenberg, New York, 1957,p.189.

the top temperature, but above the point where the glaze solidifies. The point of temperature at which crystallization occurs must be determined experimentally.
Slow cooling through the right range of temperature will, if the glaze composition is right, produce large crystals.[22]

5.2. Methodology

5.2.1. Glaze Recipes

The following table includes the recipes of the glazes used in this study.

Table 3. Glaze recipes

Copper red glaze[22] (Test 1) Soda feldspar…47 Silica…18 Borax frit…15 Whiting…14 China clay…5 + Tin oxide (SnO_2)…1 + Copper oxide…0,3 + SiC…0.3	**Blue crystalline glaze[23] (Test 2)** Soda feldspar…41 Dolomite…22 Whiting…3 Zinc Oxide…5 Silica…11 China clay…18 + Cobalt oxide…0.75
White crystalline glaze (Test 3) Ferro Frit 3110… 52.07 Zinc Oxide… 22.39 Kaolin…22.16 Silica…3.38	**Matt satin crystalline glaze (Test 4)** Soda Feldspar …41 Dolomite…22 Silica…11 China Clay…18 Whiting…3 Zinc Oxide…5 +Cobalt Oxide…0.3 +Nickel Oxide… 0.9

After weighing all materials for each recipe, they were placed in containers to mix and store the glazes (each test included 100 g of dry materials). The researcher then added water (nearly 70 ml of water per 100 g of dry materials) to make a mixture the consistency of liquid

22 Bailey, Mike. “Copper Reds in the Electric Kiln.” *Ceramic Review*, no. 244, July. 2010, p. 67.
23 Bailey, Mike. “Crystalline Glazes.” *Ceramic Review*, no. 242, April. 2010, p. 69.

yogurt. As soon as the test glaze recipes were properly mixed with water, they were ready for application on ceramic tiles.

The ceramic tiles used for the experiments in this research were made of white stoneware clay with chamotte 0.5mm and biscuit fired at a low temperature (980 °C) to guarantee the glaze sample's absorption. The shape of the ceramic tiles was made to be fired in a vertical position.

5.2.2. Firing conditions

Using the Ceramic Glazing Laboratory at the Fine Arts Faculty of the University of Lisbon (FBAUL), this study was conducted according to the following scenario:

Test 1: Crater glaze STV5 + Copper red glaze:

a) First layer is crater glaze STV5, the second is Copper glaze, with one firing at 1250°C
b) First firing STV5 at 1250°C, then a thin layer of Cooper red was applied and fired at 1250°C
c) First firing STV5 at 1250°C. Second firing after application of two layers of copper glaze at 1250°C

Tests 2/3/4: Crater glaze STV5 + Blue/White/Matt satin crystal glazes:

a) First layer is crater glaze STV5, the second is crystal glaze, fired at 1250°C, with natural cooling
b) First firing STV5 at 1250°C, then a layer of crystal glaze, fired at 1250°C, with natural cooling
c) First firing STV5 at 1250°C, then a layer of crystal glaze, fired again at 1250°C, cooling first till 100°C then hold 4 hours, then natural cooling

5.3. Results and discussion

5.3.1. Crater and red copper glaze

Based on the results obtained, the next conclusions can be made about the interaction between crater and copper red glazes:

- Test 1b – copper was reduced, it gives a bright red color, and glossy surface [Figures 15,19].
- Test 1c – part of the copper oxidized and became green, which might be explained by the presence of Cu^{2+} in the glaze matrix [Figure 16].
- On Test 1c, the surface lost the most crater effect [Figures 19,20]. On Test 1b there are some craters left because the layer of copper red glaze was thinner [Figures 17,18]. The existing craters melted under the copper glaze because much CO_2 was released in the first firing. Compared with Test 1a [Figure 14], more small and middle craters appear, through the copper glaze. But in Test 1a, it is clear that it is harder to obtain the red color, the same as in Test 1c.

Figure 14 – Test 1a

Figure 15 – Test 1b

Figure 16 – Test 1c

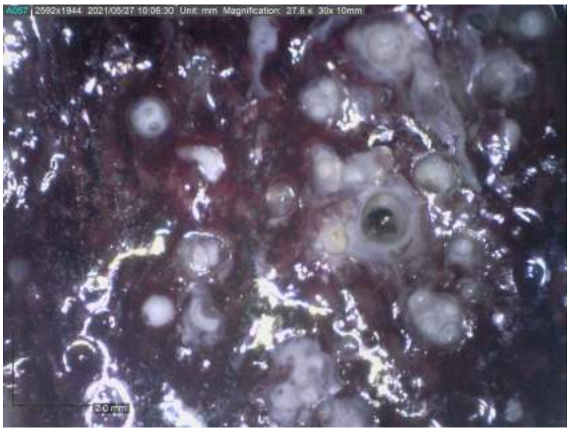

Figure 17 – Test 1b under the microscope, top view

Figure 18 – Test 1b, cross-sectional view

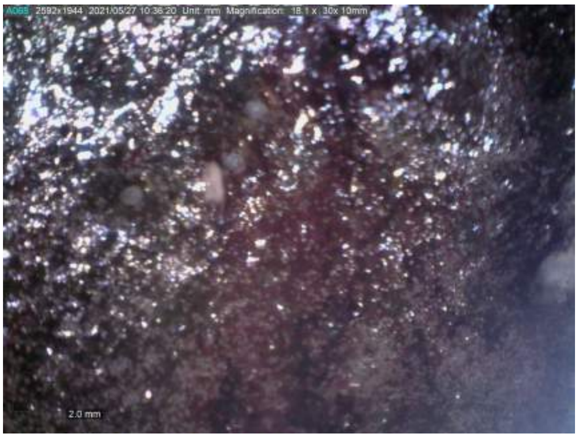

Figure 19 – Test 1c under the microscope, top view

Figure 20 – Test 1c, cross-sectional view

5.3.2. Crater and crystalline glazes

The crystalline glazes in one firing [Tests 2a,3a,4a] allowed more craters to appear, and colors are clear bright [Figures 21,28,35]. Craters on Test 2a with blue crystalline glaze appear more prominently [Figures 21,24,25]. They are larger and open, and the glaze color is brighter if compared with Test 4a [Figure 35].

On Test 3a, there is a significant surface transformation–it is bloated and flows down. The forms of the craters are not characteristic for crater glaze, and the surface looks like soap foam [Figures 28,31,32].

On Test 2b crystalline gaze cover and melted craters, some reduction can be seen in crystalline glaze [Test 2b, Figures 22,26,27]. In comparison with Test 3b, where it is noticeable the bubbles remain under the thick, shiny glaze [Figures 29,33,34].

The entire surface of glazes on tests 2c,3c,4c is more fluid due to the low Al content of the crystalline glaze. Also is almost no pronounced colors, and most of the craters melted and disappeared [Figure 23,30,37].

Figure 21 – Test 2a

Figure 22 – Test 2b

Figure 23 – Test 2c

Figure 24 – Test 2a under the microscope, top view

Figure 25 – Test 2a, cross-sectional view

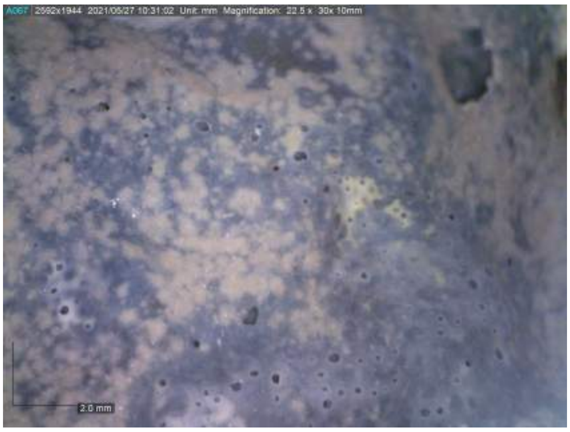

Figure 26 – Test 2b under the microscope, top view

Figure 27 – Test 2b, cross-sectional view

Figure 28 – Test 3a

Figure 29 – Test 3b

Figure 30 – Test 3c

Figure 31 – Test 3a under the microscope, top view

Figure 32 – Test 3a, cross-sectional view

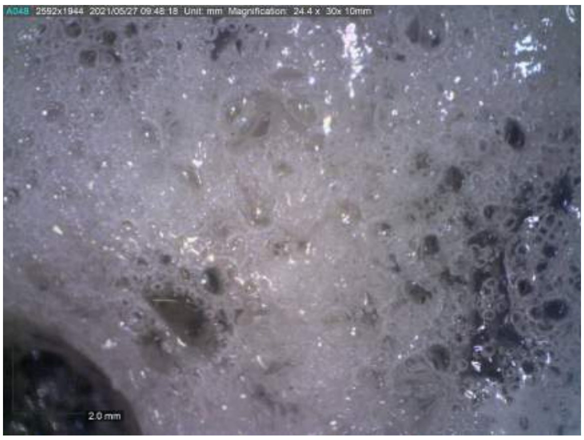

Figure 33 – Test 3b under the microscope, top view

Figure 34 – Test 3b, cross-sectional view

Figure 35 – Test 4a

Figure 36 – Test 4b

Figure 37 – Test 4c

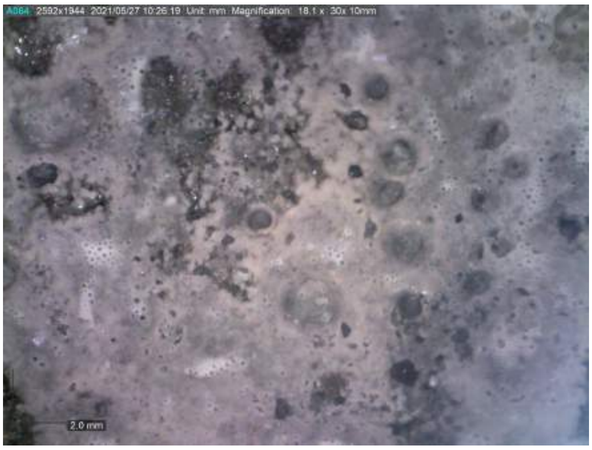

Figure 38 – Test 4b under the microscope, top view

Figure 39 – Test 4b, cross-sectional view

6. The Role of control and chance in art practice

What role should- and do 'control' and ‘chance’ play in art practice? Is depending on chance occurrence a fruitful opportunity for discovery, or simply loss of control and a guarantee for failure? Each step of my current artworks represents an additional layer of glaze and firing, resulting in new sculptural states. In the beginning, after each successive firing, I was dissatisfied as an artist, what resulted was not what I expected or hoped for. Successive firings with new layers of applied glazes then followed each other up, seemingly without end.

«After experimenting with different defects, I have already begun to create a plan to build layers and firings. I want to understand how it behaves when superimposed and what effects can be predicted and repeated.»

From my art diary. December 2020

The technology I have chosen, or rather its singularity, is randomness, and it has a flip side, which is the manifestation of control. It arises imperceptibly in the desire to predict the result, to determine the layers. At the beginning of my work, I worried about which layer is the first and the second; how will they interact? The more carefully I tried to probe and find answers to these questions, the more my control increased, the less room for play and risk.

I believe everything is driven by a different kind of movement and different stages: growth, falling, expansion, contraction. How high is the desire to take control of a strong ego's development of this movement, especially if there is a strong desire for conformity to anything or anyone? What happens when the goal is more important than the journey itself, the evolution.

In my process, at the moment when I caught myself trying to exert control, to predict the result. Each time I took an object from the kiln, I experienced disappointment, because I hoped to see something specific, invented initially, not new. The new is always surprising, often disappointing at first. I was then forced to reconsider what I was doing: i.e. decide to simply destroy the work and start over again, or regain control by working out what would happen after each individual firing. By the 6th and 7th firings, it was clear to me that this process was beyond my control. I simply needed to decide whether to carry on trying to get the material to conform to my initial expectations, or alternatively, to accept a process whereby chaos reigned. I found myself at a point far distant from my initial expectations about the work, but at the same time, somehow closer to some new understanding.

6.1. Dealing with uncertainty

The process of working with material in science and art is often not linear. It's more like a treasure map, presenting many challenges, but also some valuable opportunities. As human beings, we have difficulty dealing with uncertainty, we much prefer to imagine and design linear processes that lead to pre-determined results. And that, I discovered, was the main challenge for me. Could I give up on the notion of a fixed end result, and instead see the process of working with material as a game, rather than to very considerably constrain that process by starting with fixed expectations?

Figure 40 – Layering of glazes and firings in progress

6.2. Failure and disappointment

I could, I have now learned, harness the loss of control of the material as an opportunity to discover some unexpected things, both about the material I use, and about myself as an artist and human being. Relinquishing control of the process unchains the material and processes, resulting in unpredictable new approaches and strategies. Chance, of course, often results in failure and disappointment, But even failure can be harnessed, if taken up as a challenge to one’s creativity in science and art.

6.3. Empathy

I think the initial empathy for an unsuccessful object, for the defect of matter, opened up an entirely new relationship to the material for me as an artist. It helped me see the material not as part of a process in which it is a performer, but as a partner whose relationship must be built through empathy and giving up control to the material.

6.4. Trust to fire

In ceramics, unlike other materials, the firing itself, the processes inside the kiln, plays a unique role. As soon as I initiate another firing and close the door, I hand over the wheel to the kiln and the fire.

It is both an anxiety and a relief at the same time. I cannot physically control the processes inside the kiln. The most incredible thing that can happen to an artist is collaborating with an invisible force called "fire," which is not afraid of chaos. Of course, I can test for a long time, determine how certain glazes will come together on a sculpture. Still, I can never predict how some glaze drops will come together or how the mixing of colors will be distributed over the body of the sculpture. The less control I exert over the glazing process, the greater the chance of randomness in the results.

Figure 41 – At the left, the object is on a protective stand with leaking glazes.
On the right is the final state after four firings.

Figure 42 – Fragments of mixed glazes in cross cat.

6.5. Acting, not just planning

Figure 43 – Layering of glazes and firings in progress. In the center, hand destroying the fragile parts of crater glaze between firings.


Figure 44 – Layering of glazes and firings in progress.

«You can rehearse your role like a theater actor, but this will not help genius emerge when on stage in front of the audience. You can be brilliant ,when you are in the moment , if you act with your body.»[24]

I think Pollock knew, in advance what layer he wanted to apply - but he didn't know in advance how his body, his hand would make the gesture. The artist connected not only with Logos (the ability to control and accurately place a stroke), but also with feeling and sensation, can express which can reveal something alive in the material.

I think that's why I made seven firings and trusted more to the plan than to an inner state, I was further and further away from the "Yes, this is it" moment. As a product of the mind (a primary value in our society), 'plan and concept' is more accessible to trust than an inner state and feelings. My personal experience with the thesis helped me understand this: an idea/concept will always stay silent in an artist's work if it is subordinate only to the mind. Without the body, without attaching the inner state to the material, material will remain merely a material. But if we are able to take risk and allow an inner state to be a part of the creative process act on it, there is the possibility to create something alive in such a static material as ceramics.

[24] Bykov, Dmitry. “Yulia Vysotskaya: «Theater Is My Psychotherapy.».” 2021, https://www.youtube.com/watch?v=bq6Fd1V775o.

7. Conclusion

The experience with crater glazes allows understanding the prominent role of SiC in the creation of 'pinholing' defects. Even a small amount (0.2%) of SiC is enough to create craters. Larger but more fragile craters can be reached with more than 2% of SiC. The color is directly dependent on the increase of SiC. It becomes darker, changing from gray to white.

With copper red and crystalline glazes, crater glaze behaves mainly depending on the number of firings. One firing with crystalline glazes behaves less predictably but with more craters and clear colors. In two firings, crystalline glaze reduces craters. But in comparison with copper glaze, the rich color is possible in two firings, and the surface still manifests craters, but not so evenly.

The question 'What role do control and chance play in my personal art practice?' led me, as an artist, to an understanding of some fundamental points. Control is a tricky tendency which is hard to avoid, but it is essential to learn how to notice that tendency we have and not to allow control to be a primary in all art practice. Control grows from the fear 'not reach to a specific result.' But a specific result is a perfect result, and perfection is not the goal of the art process. I see 'Discovery' as much more important than perfection. It is not easy but as an artist, I need to sharpen my sense of where and how to give up control of a material. I believe that giving up control is one way to allow chance to appear, and it can help achieve more freedom in art practice. Creating space for 'chance' lets me deal with uncertainty, non-linear processes, mistakes, and discoveries.

My Master's thesis, which started as a technical and artistic research, has now also become something of a philosophical journey for me. What I've discovered to date, is that relinquishing a degree of technical control of my material, allows aspects of my personality as an artist/craftsman to emerge and become visible.

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9. Artworks

Figure 44 – Untitled body 23, 2021. Earthenware, ceramic glazes, h21cm x w16cm


Figure 45 – Untitled body 11, 2021. Earthenware, ceramic glazes, h27cm x w21cm

Figure 46 – Untitled body 11, details

Figure 47 – Untitled body 17, 2021. Earthenware, ceramic glazes, h31cm x w17cm

Figure 48 – Untitled body 17, details

Figure 49 – Untitled body 18, 2021. Earthenware, ceramic glazes, h31cm x w17cm

Figure 50 – Untitled body 12, 2021. Earthenware, ceramic glazes, h24cm x w20cm

Figure 51 – Untitled body 12, details


Figure 52 – Mountain skin, 2021. Earthenware, ceramic glazes, h25cm x w12cm

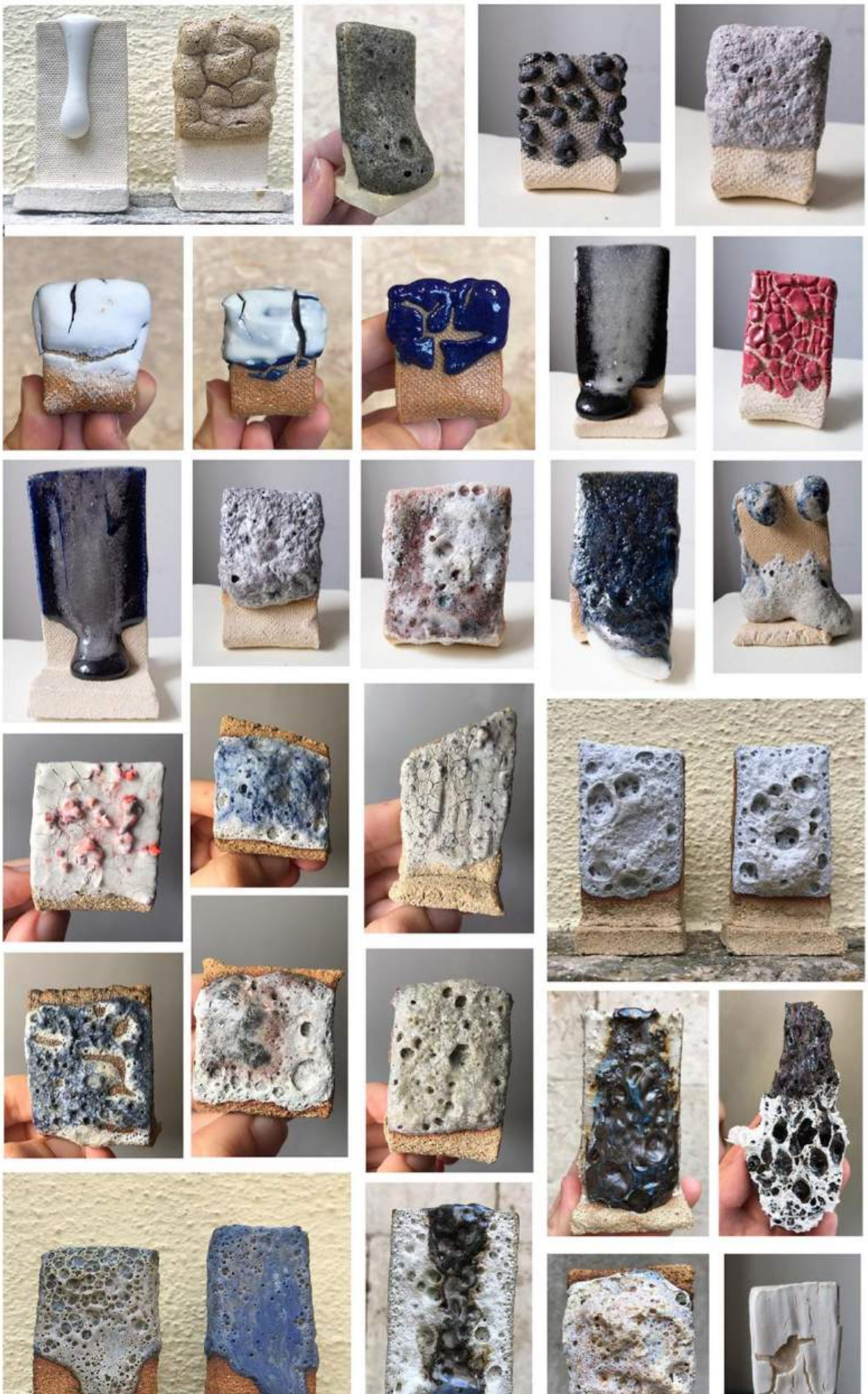


Figure 53 – glazes tests, 2021.

Figure 54 – Fragmented pieces of the mixed glazes, 2021.

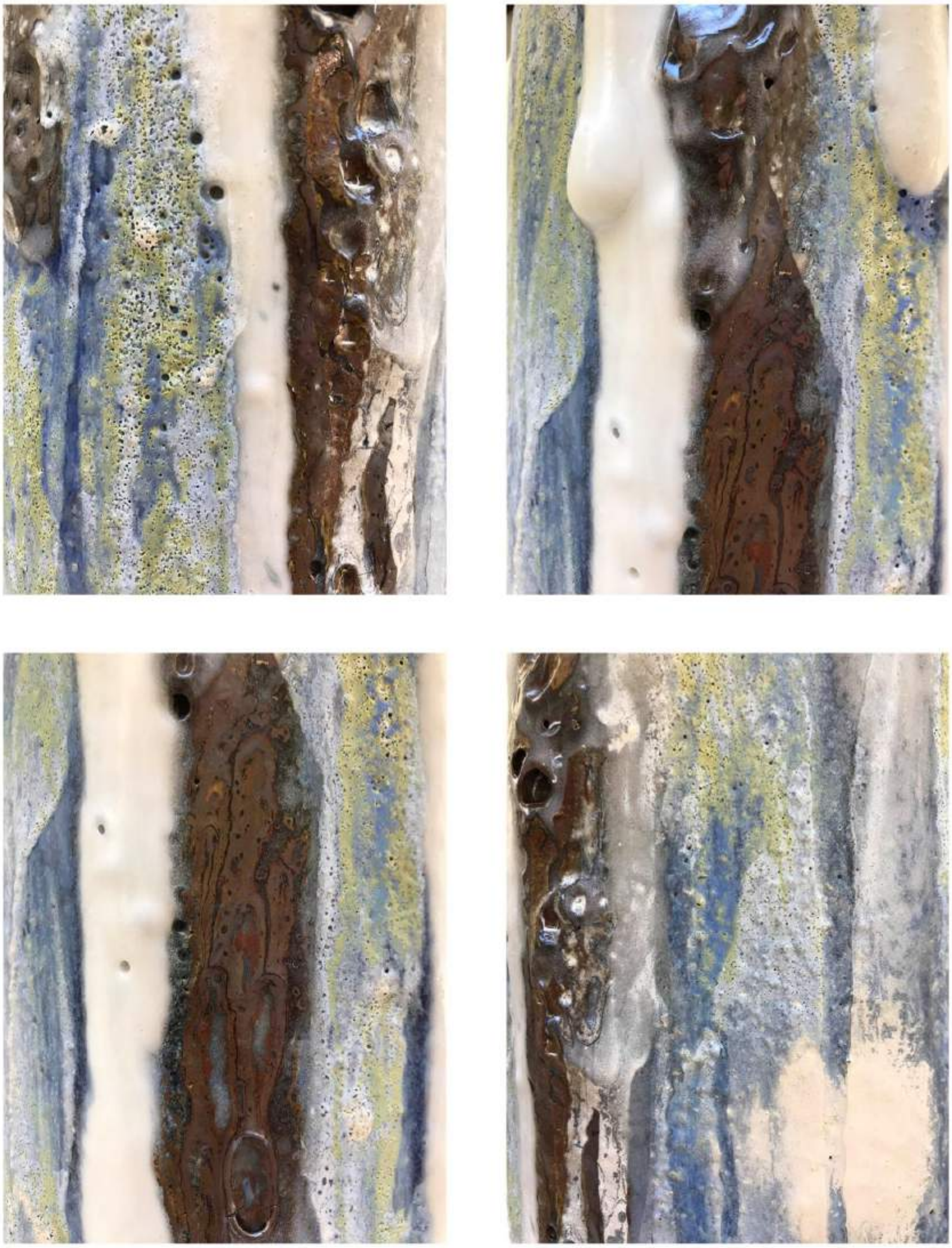


Figure 55 – Surface of the 'Untitled body 11' at the second firing, 2021.

Figure 56 – Sculpture for «Exposição Círculos, Praça da República, em Aveiro, no contexto da Bienal Internacional de Cerâmica 2021.», h1m30cm

Figure 57 – Sculpture for «Exposição Círculos, Praça da República, em Aveiro, no contexto da Bienal Internacional de Cerâmica 2021.», h1m30cm

Figure 58 – Sculpture for «Exposição Círculos, Praça da República, em Aveiro, no contexto da Bienal Internacional de Cerâmica 2021.», fragments.

Exhibition

Figure 59 – exhibition in Gallery of faculty of fine arts of the university of Lisbon, 2022

Figure 60 – exhibition in Gallery of faculty of fine arts of the university of Lisbon, 2022

Figure 61 – exhibition in Gallery of faculty of fine arts of the university of Lisbon, 2022

Figure 62 – exhibition in Gallery of faculty of fine arts of the university of Lisbon, 2022

Figure 63 –Tree, 2021. Earthenware, ceramic glazes, h50cm

Figure 64 –Body, 2021. Earthenware, ceramic glazes, h50cm

Appendix

I. Glazes with special effects

Abstract

Traditional glazes are often smooth, glossy, and well behaved, with no glaze defects such as crawling, dripping, or bubbling. However, some artists use these defects to develop special effects in glazes such as foam or crater, crawl, and gloop to create more complex surfaces. The experimental study aims to test different glaze recipes for obtaining special textures and study the correlation between glaze composition, firing program, and the final result. This research has helped understand how defects glazes can vary in dependency on changes in temperature and recipes.

Introduction

In traditional ceramics, there has always been an unspoken law of achieving perfection with glazes. Classical defects such as crawling, bubbling, dropping were well known and always avoided by potters. This, of course, has more to do with the primary purpose of traditional ceramics - functionality. Modern ceramics of the 21st century has entered the field of sculpture, and defects have become a means of expression rather than a vice. In this research, glazes with the below defects were taken:

Crawling

Crawling appears when the firing glaze separates into islands [1]. This defect can be caused by high glazes shrinking during drying and then cracking. Cracks become the crawl-points during firing. Excessive shrinkage is normally a product of high raw clay in a glaze or with a multi-layer application.

Drips and gloop

If fired low-temperature clay or a thick layer of low-temperature glaze in a high-fire kiln some gloop effect can appear [1]. The extent of running will depend on firing temperature, firing time, application thickness, and clay body. Gloop glaze lives in the area between a glaze and clay, and it represents the movement when material melted and deformed by heat.

Lava/crater

If silicon carbide (SiC) is added to a viscous matt glaze, craters form when carbon dioxide is given off during firing. The silicon takes up available oxygen to make SiO_2, while the carbon combines with oxygen to make the CO_2 that creates the bubbles on glaze surfaces [2]. SiC, which works at a wide range of temperatures because it doesn't break down and generate carbon dioxide until it comes in contact with the molten glaze [3].

Experimental procedure

Glaze tests were carried out to understand how the defects are formed and how they change with firing temperatures, application methods, and slight changes in the three recipes.

The ceramic tiles used for the experiments in this research were made of white stoneware clay with chamotte 0.5mm and biscuit fired at a low temperature (980 °C) to guarantee the glaze sample's absorption. The shape of the ceramic tiles was made to be fired in a vertical position.

Using the university's Ceramic Glazing Laboratory, this study was conducted according to the following scenario:

1. Creation of the Crawl glaze according to the Recipe 1, firing test tiles
2. Creation of the Gloop glaze according to the Recipe 2, firing test tiles
3. Creation of the Lava glaze according to the Recipe 3, firing test tiles
4. Test the Lava glaze according to the Recipe 3.

Recipe 1 – CRAWL – T 1200-1250 °C

Objective: to test the results in glaze crawling by:

- changing % Silica, % Nepheline syenite, and % Feldspar;
- applying two different amounts of glaze: two layers and four layers

	Test 1	Test 2	Test 3
Silica	70	60	60
Nepheline syenite	20	30	
Feldspar			30
Magnesium carbonate	10	10	10
	100	100	100
Each one applied as a thin glaze layer (a) and as a thick glaze layer (b)			
Two layers of glaze	Test 1a	Test 2a	Test 3a
Four layers of glaze	Test 1b	Test 2b	Test 3b

Procedure

After weighing all materials glaze were placed in the three containers to mix and store the glazes (each test included 100 g of dry materials). The researcher then added water (nearly 70 ml of water per 100 g of dry materials) to make a mixture the consistency of liquid yogurt. As soon as the test glaze receipts were properly mixed with water, it was ready for applying on ceramic tiles and firing on temperature 1250 °C.

Test results

Thin layer. Test 1a, 2a, 3a

For all three recipes the glaze in the thin layer did not create the crawl effect. It works more like an engobe creating the white matte effect.


Pic. 1. Test 1a


Pic. 2. Test 2a


Pic.3 Test 3a

Four layers of glaze

Test 1b: The layer of glaze is completely off the surface of the clay, leaving no cracking effect. The glaze cracked, and did not melt. It crumbles.

Test 2b: The glaze gave a crackling effect, the average size of cracks, does not crumble and stay on clay.

Test 3b: The glaze cracked, and did not melt. It crumbles.


Pic. 4. Test 1b


Pic. 5. Test 2b


Pic. 6. Test 3b

Recipe 2 – Gloop GLAZES/1200-1250

Objective: to test the dropping effects by:

- changing firing conditions.

Glaze Recipe		Firing program	
Silica	36.05	Test 1 1250 °C	**Test 2** **1200** °C
Potassium Feldspar	29.45		
Wollastonite	12.56		
Ulexit	11.39		
Kaolin	10.54		
	100		

Procedure

After weighing all materials in the glaze were added water (nearly 40 ml of water per 100 g of dry materials) to make a mixture of the consistency of liquid yogurt. For gloop glaze, water was added less than 40 ml, to be able to make two balls with 20g of weight. As soon as the test glaze receipts were properly mixed with water, it was ready for placing each glaze ball on the top of tiles and firing at temperatures 1250 °C and 1200°C.

Results

Test 1/ 1250 °C

The glaze ball melted completely and formed a thin stream with a drop at the end of the mold. The height of the mold on the surface of the tile is 4 cm high.

Test 2/ 1200 °C

The glaze ball melted completely and formed a thicker, shorter drop on the 2 cm high ceramic tile.

Pic. 7. Before firing

Pic. 8.Test 1

Pic. 9. Test 2

Recipe 3 – LAVA GLAZES – T 1200-1250 °C

Objective: to test the effects on glaze texture and expansion by:

- changing firing conditions;
- using two types of Rutile: in powder and sand state
- varying the amount of glaze layers.

Glaze Recipe		Firing program
Potassium feldspar	44.9	Test 1. Rutil in powder 1200 °C
Whiting	21.6	Test 2. Rutil in powder 1250 °C
Silica	11.7	Test 3. Rutil in sand 1200 °C
Kaolin	11.7	Test 4. Rutil in sand 1250 °C
Titanium oxide (Rutiel)	9.9	
Silicon carbide	0.3	
	100	
Each one applied as one glaze layer (a) and as multiple glaze layers (b)		
Two layers of glaze		Tests 1a, 2a, 3a, 4a
Four layers of glaze		Tests 1b, 3b, 4b

Procedure

After weighing all materials glaze were placed in the two containers to mix and store the glazes (each test included 100 g of dry materials). The researcher then added water (nearly 70 ml of water per 100 g of dry materials) to make a mixture the consistency of liquid yogurt. As soon as the test glaze receipts were properly mixed with water, it was ready for applying on ceramic tiles and firing at temperature 1250 °C and 1200 °C.

Test 1a: Rutil in powder; 1200°C; two layers of glaze.
Test 1b: Rutil in powder; 1200°C; four layers of glaze.
Test 2a: Rutil in powder; 1250°C; two layers of glaze.
Test 3a: Rutil in sand; 1200°C; one layer of glaze.
Test 3b: Rutil in san; 1200°C; four layers of glaze.
Test 4a: Rutil in sand; 1250°C; two layers of glaze.
Test 4b: Rutil in sand; 1250°C; four layers of glaze.

Pic. 10. Test 1a

Pic. 11.Test 1b

Pic. 12. Test 2a

Pic. 13. Test 3a

Pic. 14.Test 3b

Pic. 15. Test 4a

Pic. 16. Test 4b

Evaluating Lava glazes

For a deeper analysis only one glaze with the defect was taken-lava glaze Recipe #3.

What we know about lava glaze, and what was discovered during testing
It is common to find much information in the literature [1,2] about the role SiC plays in the formation and size of craters in lava glazes. This study randomly found that rutile (as a source of titanium dioxide) plays no less of a role than SiC. The size of the rutile particles will affect not only the size of the craters but also the appearance of glaze glossiness or matte, different colors of texture.

What we know about rutile
As we know Rutile is the mineral name for natural crystals of titanium dioxide (TiO_2) [3]. However in nature rutile is always contaminated by up to 15% other minerals (especially iron but also elements like tantalum, niobium, chromium, and tin, the analysis provided here is obviously a simplification of the real picture). Rutile produces many crystalline, speckling, streaking, and mottling effects in glazes during cooling in the kiln and has been used in all types of colored glazes to enhance the surface character. Excessive rutile in a glaze can produce surface imperfections (usually if add less than 5 %) [2].

What we got after analyzing the component of Rutile in two variants.
After testing with two different types of Rutile grinding, using the microscope Dino-Lite the next results found:

1. Rutile fine grinding. Test 1 and Test 2.

The finely ground Rutile makes the glaze more matte, with a pronounced yellow color. Also, the size of the craters depends on the number of layers applied.

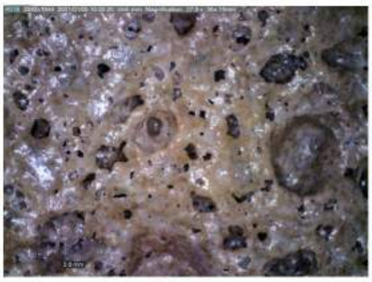
For example, in a thin layer of Test 1a fired at 1200 °C (Picture 17, 18), we see more obvious but irregular craters. The microscope shows air bubbles inside the glaze that have approached the surface but have not come out; this makes the surface more voluminous, with air inside. Also, the bubbles that have only closed the surface make the glaze more fragile to damage. In Test 1b (Picture 19, 20), which were fired at 1200°C, we see that since the glaze layer is thicker, there are significantly more bubbles that have not come to the surface, and we see that the glaze is puffed up.

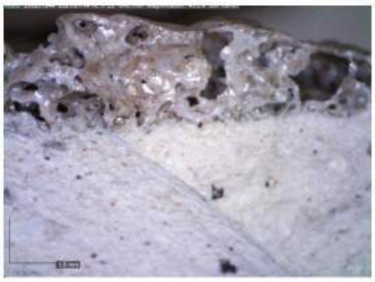
Test 1b in the thick layer shows that the lava effect is almost not yet formed because the oxygen has not yet had time to reach the glaze pores and create craters. Therefore, we observe instead the effect of raised foam, oxygen that has risen but has not come to the surface.

In Test 2 (Picture 21), the opposite situation is if the same glaze fires at a higher temperature (at 1250°C). The craters form a more orderly texture, the oxygen went out, and form craters of small size, but in larger quantities. And even though in the cut (Picture 22) we see a bubble inside the glaze, the high temperature made the glaze stronger and the craters' size (outside and inside) more uniform and orderly.

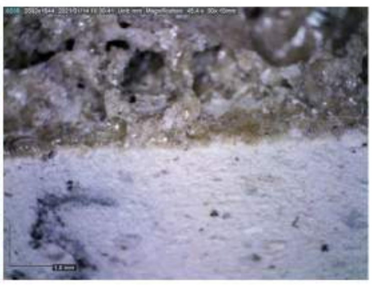
2. Rutile is coarsely ground. Test 3 and 4.

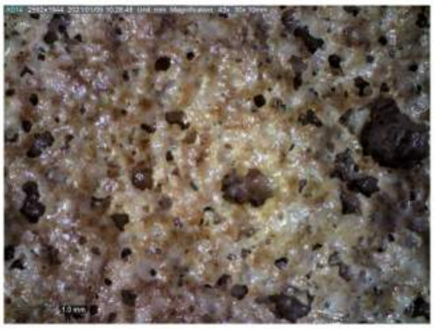
In test 3 (Picture 23) rutile coarse grinding blocks SiC and does not form craters even under a layer of glaze. The glaze looks like an engobe. In the cross-section, we can see that no bubbles were able to form even inside the glaze (Picture 24). Test 4 fired at 1250 °C, the rutile makes the glaze glossy, in a thick layer flowing, with a pronounced gray color. A slight and irregular number of craters can be found only in the thick layer (Picture 25). Also, under the microscope, you can see that the dark particles remain in the form of granules. Under the glaze (Picture 26), a minimal number of craters have just begun to form, but they are closer to the clay than to the surface, making the surface of the glaze more solid.


Pic. 17. Test 1a


Pic. 18. Test 1a in cut

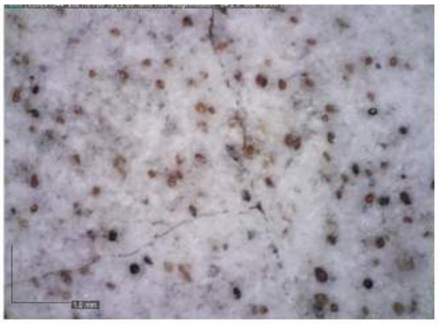

Pic. 19. Test 1b


Pic. 20. Test 1b in cut



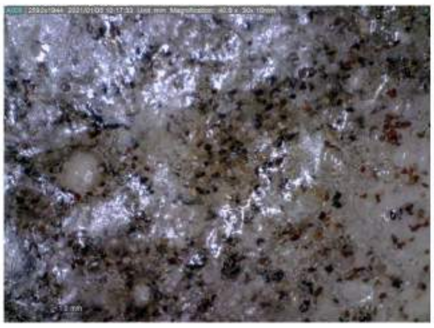
Pic. 21. Test 2

Pic. 22. Test 2 in cut

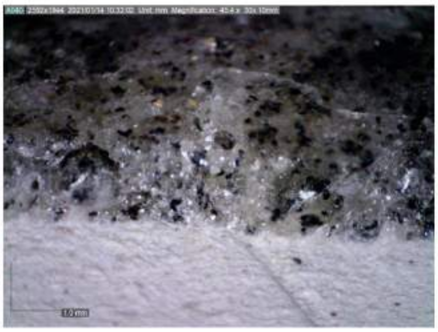


Pic. 23. Test 3

Pic. 24. Test 3 in cut



Pic. 25. Test 4



Pic. 26. Test 4 in cut

Research summary

This study was carried out to highlight the main effects to create special effects in glazes. In this study, lava glazes were chosen as a more profound study to create craters on the surface of the glaze. In the literature [1,2,3] we can often see that SIC directly influences the number and nature of craters. This study showed that the craters' nature is no less strongly influenced by two other points:

1. Temperature. The higher the temperature, the more craters are possible to get on the glaze surface with SIC.
2. Rutile. Of particular importance is the grinding of rutile. A fine grind of rutile forms better craters on the glaze's surface at high temperature than a coarse grind of rutile.

Acknowledgment

During the study, it became clear that there are not research points that are are not covered in the literature [1,2,3] and require further research:

1. Why the fine grinding of Rutile does not allow to form craters even at high temperature.
2. What role in the formation of craters plays iron, which is a part of Rutile.

Literature

[1] Linda Bloomfield (2020). New Ceramics: Special Effect Glaze. Bloomsbury: London.

[2] Hansen, T. (2015). Silicon Carbide. Retrieved June 25, 2019, from https://digitalfire.com/4sight/material/silicon_carbide_1250.html

[3] Daniel Rhodes (2015). Clay and Glazes for the Potter. Martino publishing: New York.