WILD

Searching for Finnish high-fire clay

Mira Niittymäki 2023

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Master of Arts thesis abstract

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Abstract

Artists and designers across the world are showing interest in local natural materials. Locality has become a big trend and a selling point in an ever-changing world where material flows are guided not only by international market forces but also by wars and pandemics. Regional raw materials that have been taken for granted are now seen as vivid options for industrially produced highly processed and homogenized substances. For me, the starting point for studying Finnish materials was the anxiety about not knowing the ecological and ethical origins of the ingredients that I used in my making. I decided to search for an answer to the questions: "Would it be possible to make a hand-building clay body from Finnish natural clays that could be high-fired in a reduction atmosphere? And how would this be made?"

My goal was to get acquainted with these "wild" clays and their different characters and properties. I was aiming to find a combination of different raw materials that can be fired above 1200°C in a wood fired kiln but also has enough plasticity as a clay body that it can be sculpted by using hand-building techniques. My intention is also to find a clay body that fits to my purposes and is relatively easy to work with but is as minimally processed as possible. The thesis has three distinct components: the empirical material research, the written part, and the artistic production of a set of hand-built ceramic sculptures.

In this thesis, I am also questioning: "What kind of effects does the collection and processing of the used material have on the artwork and the artistic process?" I am particularly inspecting what is the meaning and value of the clay material that I have collected myself. The answers are discovered through reflecting on my own practice and a literature review. Through this study, I gather information on how materials are interpreted, valued, and appreciated differently based on their origins. My main audiences for this thesis are Finnish ceramicists and designers, but the part of this study that refers to locality and appreciation of any material in use can appeal to an even wider audience.

Keywords kaolin, natural clay, sculpture, material literacy, material appreciation

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Tiivistelmä

Taiteilijat ja muotoilijat ympäri maailman ovat osoittaneet kiinnostusta paikallisia luonnonmateriaaleja kohtaan. Paikallisuudesta on tullut suuri trendi ja myyntivaltti jatkuvasti muuttuvassa maailmassa, jossa materiaalivirtoja ohjaavat paitsi kansainväliset markkinavoimat myös sodat ja pandemiat. Itsestään selvinä pidetyt lähiraaka-aineet nähdään nyt elävinä vaihtoehtoina teollisesti tuotetuille pitkälle jalostetuille ja homogenisoiduille aineille. Minulle suomalaisten materiaalien tutkimisen lähtökohtana oli huoli siitä, etten tunne käyttämieni ainesosien ekologista ja eettistä alkuperää. Opinnäytetyössäni etsin vastauksia kysymyksiin: "Voisiko suomalaisista luonnonsavista tehdä korkeapolttoista käsinrakennussavea, joka voidaan pelkistyspolttaa? Ja kuinka tämä tehdään?"

Tarkoituksena oli tutustua näihin "villeihin" saviin ja niiden erilaisiin luonteisiin ja ominaisuuksiin. Tavoitteena oli löytää erilaisten raaka-aineiden yhdistelmä, joka voidaan polttaa yli 1200°C:ssa puupolttouunissa, mutta jolla on myös tarpeeksi plastiset ominaisuudet, jotta se voidaan muotoilla käsinrakentamalla. Tavoitteenani oli myös löytää käyttötarkoituksiini sopiva savi, jota on suhteellisen helppo työstää, mutta joka on mahdollisimman vähän prosessoitu. Opinnäytetyössä on kolme erillistä osaa: empiirinen materiaalitutkimus, kirjallinen osa ja käsinrakennettujen keraamisten veistosten taiteellinen tuotanto.

Tässä opinnäytetyössä kysyn myös: "Millaisia vaikutuksia käytetyn materiaalin keräämisellä ja käsittelyllä on taideteokseen ja taiteelliseen prosessiin?" Tarkastelen erityisesti itse keräämäni savimateriaalin merkitystä ja arvoa. Vastaukset löytyvät oman työskentelyni ja kirjallisuuskatsauksen kautta. Tämän tutkimuksen avulla kerään tietoa siitä, miten materiaaleja tulkitaan, arvostetaan ja arvotetaan eri tavalla niiden alkuperän mukaan. Tämän opinnäytetyön kohdeyleisö on suomalaiset keraamikot ja muotoilijat, mutta se osa tutkimuksesta, joka käsittelee materiaalien paikallisuutta ja arvostusta, voi vedota vielä laajempaan yleisöön.

Avainsanat kaoliini, luonnonsavi, kuvanveisto, materiaalinlukutaito, materiaalin arvostus

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1 Introduction

1.1 Terminology

Aging
Aging the clay body means storing it in its plastic condition before using the clay. Aging improves the plasticity of clay bodies and it's due to physical and chemical changes such as moisture equalization and changes in its acidity. (Colbeck, 1988, p. 30)

Eutectic
An alloy that has a lower melting point than any of its ingredients is called a eutectic alloy. Materials used in ceramics behave in eutectic relations to each other. (Hortling, 1994, p. 82)

Kaolin
Kaolin is a general name for clays materials that consists mainly of kaolinite. Kaolinite is a aluminum silicate and its melting point is 1750-1770°C. Kaolin is the main ingredient of porcelain clays and its plasticity is fairly low. (Jylhä-Vuorio, 2003, p. 43)

Low-fire / High-fire clay
Low-fire clays can be fired to 900-1150°C and high-fire clays to 1100-1450°C. (Palmu et al. 2021)

Natural clay / Wild clay
In a sense all clay is natural. It is all soil after all. Often the terms natural and wild are associated with clays that are not commercially available and are sourced by the ceramic partitioners themselves (Levy et al., 2022, p.7). In this research I refer to the clays as wild or natural when they are in their unprocessed state as they were in their origins.

Natural glaze
Natural glaze is a mixture of natural ingredients that form glasslike surfaces when fired on a clay body. Since naturalness is an ambiguous term, I have narrowed these ingredients to the ones I can easily source from the surrounding nature, such as wood ash.

Plasticity
The malleability of clay is called plasticity. The exact definition or measuring of plasticity is difficult but it can be considered as the formability of clay without cracks appearing to it. The created shape must also remain in the body even after the external force is removed from it. (Jylhä-Vuorio, 2003, p.33-34)

Pyrometric cones and rings
In ceramics the effective firing temperature and time can be accurately measured with pyrometric instruments. These can be cones that melt and bend or rings that shrink according to the temperature and thermal work. Since these cones and rings do not only measure the highest temperature reached in the firing but also the effects of the firing time. (Colbeck, 1988, p. 47)

Reduction/oxidation firing
Reduction atmosphere can be achieved in kilns that are fired with flammable fuel that need oxygen to burn such as wood or gas. If the amount of oxygen is insufficient for a clean combustion carbon monoxide CO is formed in addition to carbon dioxide CO_2. CO is prone to bind another oxygen atom to itself if it can find it from certain metal oxides. This kind of firing where oxygen atoms are reduced from metal oxides is called reduction firing. In kilns where the amount of oxygen is sufficient of surplus, such as electric kilns, the firing atmosphere is neutral or oxidizing. (Jylhä-Vuorio, 2003, p. 175-177)

Sintening
Sintering means the vitrification of the clay body into ceramics where solid particles are connecting to each other without losing their shape. The sintered object shrinks from its original size, and it becomes denser and harder. (Jylhä-Vuorio, 2003, p. 188)

Thermal work
The sintering of ceramic material in firing is not only determined by temperature but also by time and the speed of the temperature rise. Also, the thickness of the object influences how fast the heat can travel and equalize in the mass. (Jylhä-Vuorio, 2003, p. 188) This can be for example compared to baking a cake. 45 minutes in 200°C can get you the same results as 1 hour in 175°C (if not considering the moisture etc.) so the thermal work in both situations is then the same towards the same mass of the cake.

1.2 Background

During my studies, I have started to question multiple aspects of the production of ceramic materials. My journey with clay and ceramics began over two decades ago in a weekly children's workshop called 'Savipaja', led by a local ceramicist. Since then, I have learned to work with a diverse range of materials and ingredients. Throughout my undergraduate studies in ceramics and glass art, I was taught to mix the materials myself instead of taking the clay ready-made from a package. At the time I became more and more aware of the origins of the materials I use, or rather more conscious of how little I knew about the topic. I had come to identify the most suitable mineral available for a certain kind of clay but at the same time, it made me anxious and uneasy not knowing where and what kind of conditions these materials came from. Consequently, I felt it was important that I solely utilize domestic materials and extract the clay for this study myself or at least knew exactly its place of origin.

Finnish natural clay is commonly perceived as low-fire terracotta earthenware although it is possible to produce also high-fired ceramics from exclusively domestic ingredients. The earthenware receives its distinctive red color from high concentrations of iron compounds, and some of these substances, along with alkaline and heavy metal oxides, act as fluxes (Jylhä-Vuorio, 2003, p. 28). Generally, this type of clay starts to melt already in temperatures exceeding 1080°C (ibid.). Melting starts rapidly after the sintering point and the clay deforms into a lava-like puddle (ibid.) Kaolin, a basic constituent in porcelain and stoneware clays, contains kaolinite which is an aluminum hydroxide silicate. Kaolinite is an optimal ingredient for high-fire clays, but it can be found only in a few deposits around the country such as Puolanka, Virtasalmi, Kuusamo, and Sodankylä among others (Hytönen, 1999, p.159). Despite the research conducted on domestic kaolin for various applications since the 1920s, no commercially viable utilization has emerged (Venäläinen, 1984; Kaoliini, 2009).

My objective in this research was to develop a domestic high-fired clay body due to the nature of my previous works. High-fired ceramic materials are more durable and less porous than low-fired ones, which makes them more suitable for outdoor sculptures, tiles, and tableware which have been the starting points or cornerstones of my earlier productions. During my bachelor thesis, I familiarized myself with the ceramic wood firing process. The procedure was captivating, and ever since I have been compelled to continue with this firing technique. Wood kilns can be fired to low temperatures as well but in temperatures higher than 1225°C the ash from the wood starts to melt while fusing together with silica from the clay body (Hortlling, n.d., p. 23). This forms unpredictable and uniquely glazed surfaces iconic to wood firing. Additionally, I was curious about other types of natural glazes made from domestic ingredients which similarly demand high-fire temperatures to melt.

For this project, I selected hand-building as my sculpting method since it was familiar to me and would serve as a trial for the clay body. Hand-building as a technique demands a certain level of plasticity from the material in use. The low-fire earthenware is commonly a very plastic material, but the addition of kaolin reduces the plasticity (Jylhä-Vuorio, 2003, p. 42-43). If a large amount of kaolin is included the clay body can become hard to handle. I have previously made significantly larger pieces by hand building than by any other clay working methods. Judging by my earlier experience, the grander size of the object demands a higher level of plasticity and integrity from the clay body, so I resulted to hand-build a larger-scale sculpture from the researched material. I also felt that hand-building would be a way to truly connect with the material I had created together with nature and time.

Circular economy and working together with the environment were once evident for craft people but modern-day raw materials for ceramics require environmentally questionable harvesting and preliminary processing methods. Minerals might be sourced from far away and they undergo complex grinding and purification procedures to meet our contemporary standards (Hortling, 1994). These refined and homogeneous materials became widely available with industrialization (Levy et al, 2022). Moreover, the liberalization of trade and new technology has removed barriers and accelerated globalization to the extent that we can only guess the production locations and conditions of the commodities and materials we use. Globalization has influenced almost everything, and design is no exception. Unfortunately, design has been shaped to suit the needs of the economy and consumerism which is seen as a harmful development to the environment (Niemelä, 2010). On one hand, globalization increases political openness and accountability but on the other hand, it also increases social and regional inequality worldwide (Ibid.).

Given that ceramic materials are non-renewable, and their production leaves an environmental footprint, it is essential to consider their sustainability and associated environmental impacts. Industrial mineral mining can have significant effects on air quality, water quality and quantity, land, ecology, and economics. Mining sites can deplete the local water resources, while mineral processing and transportation may contribute to water and air pollution. Erosion of land can accelerate, leading to the destruction of vital ecosystems, among other consequences. Furthermore, lead emissions from mining pose a global concern, as lead lacks any known biological function and exhibits a broad range of toxic effects on organisms (Jain et al, 2016). However, although the mining industry is ecologically problematic, economically it can simultaneously have both positive and negative influences (ibid.).

In light of these considerations, sustainability must be prioritized when selecting materials. Doctor of Arts Mirja Niemelä has argued that environmental aspects can be influenced by the designer’s or artist’s choices (2010). Industrially produced foreign materials often contain fewer impurities, such as iron, than their Finnish equivalents. Iron affects the color and hue of ceramics ranging from yellow, purple, and red to brown, green, and black (Jylhä-Vuorio, 2003, p. 159.) The metal can be removed from minerals through grinding, silting, and magnetic screening. Currently, however, ceramic artists and designers often look for naturalness and subtle nuances as a result instead of the whitest porcelain. In practice, this might mean an addition of the same minerals or metals that were originally removed from the material through complex purification processes. (Hortling, 1994, p. 11 & 90.) In other words, the processed and purified materials have become so affordable, reliable, and easy to use that consumers, in this case, ceramic practitioners, rarely hesitate before purchasing these foreign materials and coloring them with ingredients that were considered impurities at the beginning of the production line.

The idea of utilizing domestic natural clays is at the same time fresh and ancient. Prior to the era of globalization and modern transportation, people relied on locally available materials. Consequently, as an alternative to highly processed materials, natural clays have recently raised their reputation as a trendy and environmentally conscious choice. These clays are minimally processed, and their production is simple; but chemically, the materials are very complex and heterogeneous. They can be “wild”, unpredictable, and challenging to work with. Yet, something about the clays and their origins fascinates people working with ceramics even when economical and stable commercial options are available. This renewed interest has sparked the emergence of new publications and events on the subject. For instance, the Kainuu kaolin festival was organized in 2022 to celebrate untreated kaolin deposits in Puolanka, Finland and this event has raised a lot of excitement among Finnish ceramicists (Guthwert et al, 2022). Furthermore, Finnish Taattisten tila organizes residencies around the local earthenware (Taattisten tila) and in the United States, a book called Wild Clay by Matt Levy, Takuro Shibata, and Hitomi Shibata was published in 2022.

1.3 Objectives

The objective of this thesis is to investigate natural clays found in Finland and their materiality and significance in the context of art and design. Specifically, the aims of this research are as follows:

Firstly, to identify and evaluate the physical and chemical properties of certain natural clays found in Finland. The focus will be on their suitability for creating versatile and functional high-fire clay bodies that can be used for artistic purposes. My goal is to gain tacit knowledge about the used materials on the way to my lifelong goal of developing a deep understanding of how different clay materials and processes interact with each other. Hopefully, I will also be able to translate some of this silent information into written form.

Secondly, to explore the significance and value of material origins and production in creative work.

Thirdly, to engage in critical reflection on the role of clay as a material in contemporary art and design practices and to identify opportunities for further research and development in this area. This will include investigating the environmental impacts of clay production processes.

Finally, my wish is to create a body of work that showcases the potential of Finnish clays as a creative material. The aim is to articulate the aesthetic, conceptual, and practical considerations that went into the production of this work, and to demonstrate the versatility and adaptability of domestic clays.

By achieving these objectives, this thesis aims to contribute to the understanding and appreciation of natural clays found in Finland and to provide insights into their potential as material for artistic applications.

1.3 Research Questions & Methodology

In this thesis, I seek to find answers to the following questions through research, crafting, and reflecting:

Is it feasible to create a hand-building clay body from Finnish natural clays that can withstand high-firing in a reduction atmosphere? If so, how can this be achieved?

What kind of effects does the collection and processing of the used material have on the artwork and the artistic process?

The main methodology used in this thesis is practice-led research but during this study, I am also constantly reviewing literature that connects with and sheds light on this work. To gain more background information on the studied topics I examine writings relating to geology, material appreciation, material literacy, and mineral sciences. The subjects studied are broad but the practical work for this thesis will offer guidelines within which to probe. The applied nature of this work makes the research also more concrete and approachable.

This thesis work has three distinct components: material research, artistic production, and written part. In the material research, I perform empirical tests on different clay materials and their combinations. The empirical nature of this research plays a crucial role since the studied materials behave in eutectic relations to each other. This makes the physical testing a vital part of the examination. The results of each test are analyzed to make decisions about the direction and next steps of the study. The research is qualitative although measures have been taken to make the experiments repeatable and some results can be generalized to a very specific material. Of course, the range of possible results is wide and dispersed due to the fact that the studied materials are natural, heterogeneous, and untreated.

In the material study, I concentrate on the aspects of plasticity, color, and firing temperature of natural clays that I have collected from Finland. By concentrating on these features, I am searching for answers to the first set of questions. The plasticity is tested by using

Rieke-method which is a technique that can be performed without any highly specified equipment (Jylhä-Vuorio, 2003, p.220). This approach represents the plasticity of a material as a number that is based on the range of water content when the clay is in its plastic condition. The Rieke method is applied to different materials with different particle sizes and aged samples. Color and firing temperature are assessed through a series of firings to different atmospheres and temperatures. The thermal work of the firings is considered, and the exact temperature equivalent of the firings is measured by using pyrometric cones and rings. Viscosity, shrinkage, and absorption tests are performed to determine characteristics of melting rate, porosity, and level of sintering.

After the material research, I lay the ground for the artistic production by reflecting on my own ethics through the values of the material and clay-making process. In this section, I am observing material appreciation through material theory and human-material interaction. I also highlight the transparency of material harvesting and production and try my best to compare the origins of commercial and natural materials.

Within the artistic production, I test the materials by hand-building ceramic sculptures from them. These sculptures draw inspiration from the naturality and the original surroundings of the materials in use. Hand-building allows me to experiment with the created clay bodies and dwell with the material, facilitating a deeper understanding and perception. Based on my experience a clay body can act very differently in a small test piece compared to a large sculpture this observation is reinforced by Niemelä in her dissertation (2010, p. 191). To complement the wild origins of the raw material and involve me as an active participant in the firing process, I also employ primitive firing techniques. During the creative process, I am keeping a learning diary where I record my encounters with the materials. These recordings embody both practical observations and philosophical introspection.

The entire research is documented and captured in the written part where I reflect on the hands-on elements and learning diary through the literature review on related topics. In this thesis process as a whole, the emphasis is on the practical work considering the laborious nature of the empirical and applied components. This written section is meant to be concisely structured and compact but informative.

2 Material Research

2.1 Raw materials

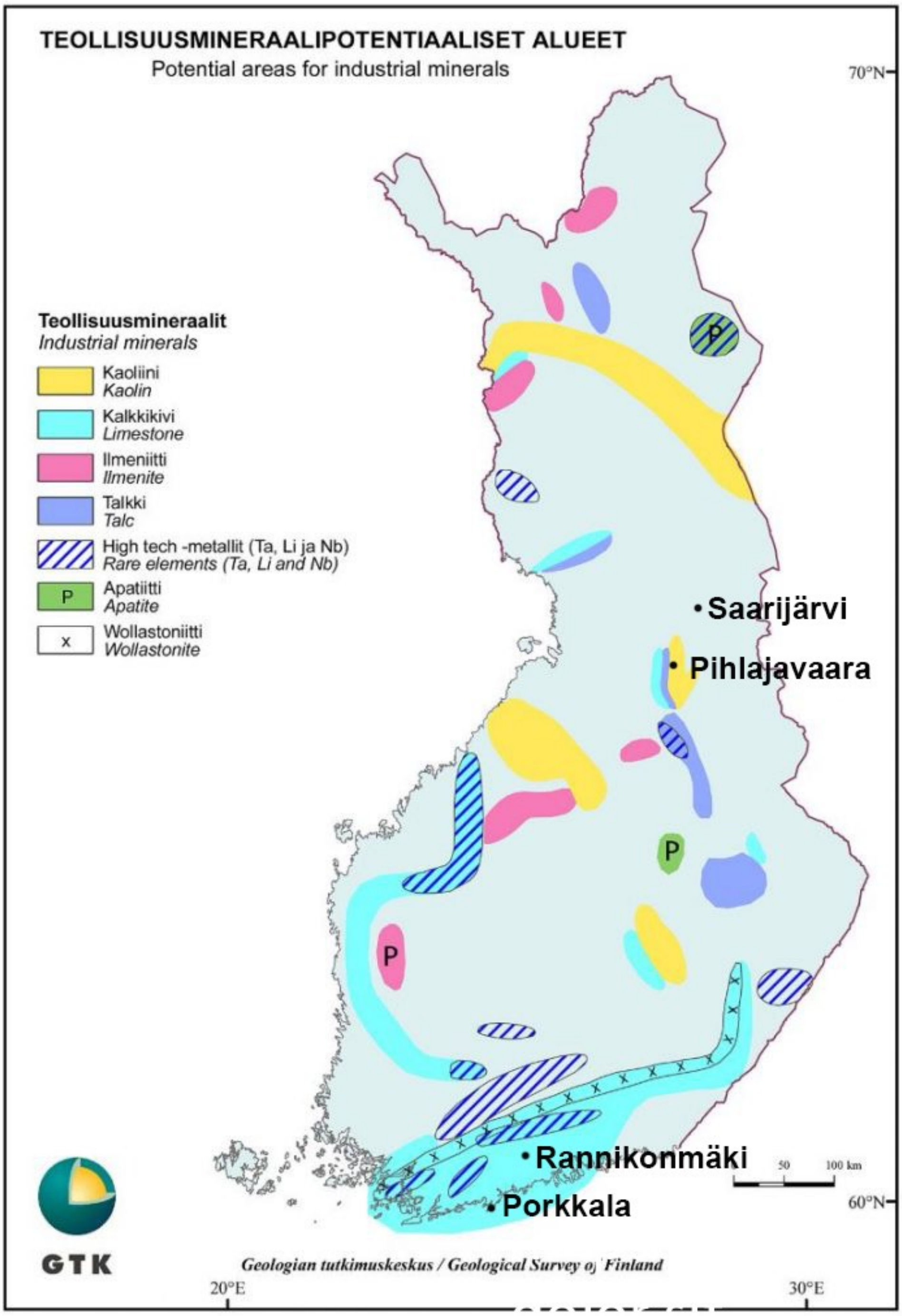


Image 1. Map of Finland with mineral deposits and clay collection sites.

Pihlajavaara kaolin, Puolanka
These clays are a part of the kaolinite deposit in Puolanka. This kaolin was the first to be found in Finland in the 1920s and Pihlajavaara deposit is the best-known of the several found there (Venäläinen, 1984). Since then, the clay has been researched by different organizations, and in the 1940s Arabia porcelain factory used the Puolanka kaolin in their production due to material shortage after the war with the Soviet Union (Hortling, 1994, p. 117-118). In 2010 Morenia Oy applied soil permit to utilize Pihlajavaara kaolin (Morenia, 2010) but it has not been suitable as a raw material for modern industry. Recently, in 2021 ceramic artist Kartariina Guthwert got interested in the clay and in 2022 she organized an exhibition and a festival around the mineral (Guthwert et al, 2022). Pihlajavaara clay comes in many different colors with different properties and in this research, I refer to them as Pihlajavaara white, pink, yellow, brown, red, purple, and black.

Saarijärvi clay, Metsäkylä, Taivalkoski
The clay is excavated from next to a meteor lake called Saarijärvi and it contains kaolinite thanks to which it withstands significantly higher temperatures than other Finnish red clays (Hyyppä & Pekkala, 1987). People from Metsäkylä village have traded the clay for salt, flower, and other goods at least since the 19th century due to its special properties and in the 1920s it was used by a brick factory that was built next to Saarijärvi. Since the 1930s there have been different projects around the research and productization of this clay which have received e.g., EU, state, and municipality funding. (Lassila, 2005) The clay has been mechanically excavated in 2003-2004 and it is now sold in small quantities by Metsäkylän käsityöpaja craft workshop. Currently, a Natura 2000 zone is located in the immediate vicinity of the clay extraction site which may affect future collection permits. (Hirvonen et al, 2010)

Rannikonmäki earthenware, Tuusula
From all the different clay bodies I have the most sentimental relationship to this earthenware. It does not have any special properties out of the ordinary, but it is most likely the first clay I touched. It is clay from my late grandmother's field. There she lost the tiny diamonds from her wedding ring while picking up potatoes. And there I picked up my first potatoes with her and my mother.

Porkkala earhenware, Kirkkonummi
This clay is collected from the field next to the house where I currently live. The place has become very meaningful to me. It is situated next to the Baltic Sea. The field has been farmland at least since 1725 and the earliest mentions of the village called Lillkantskog, which is situated there, are from the year 1540 (Perttola, 2012).

2.2 Plasticity

In their raw and untreated state, the various variations of Pihlajavaara kaolin exhibited extremely low plasticity, making them nearly impossible to shape by hand. Particularly, lighter colors such as white, pink, and brown posed significant challenges in handling. The other raw materials from Rannikonmäki, Porkkala, and Saarijärvi displayed high plasticity, but all of these low-fire, high-iron content clays demanded an addition of kaolin to make them withstand higher temperatures and reduction atmosphere. In reduction firing, such as gas or wood firing, Fe2O3 reduces to FeO which is a strong flux (Jylhä-Vuorio, 2003, p. 157).

Plasticity can be increased by additives, reducing particle size, and aging the clay. However, measuring and precisely determining plasticity is challenging and lacks unambiguous methods. One approach to defining plasticity in clay materials without expensive equipment is the Rieke method Jylhä-Vuorio, 2003, p. 33 & 218-221). In this approach, clay is rolled first in hands and then on a plaster surface and weighed at every stage to determine the range in water content where the clay is possible to handle (ibid.).

The research began by defining the plasticity of the raw materials in different particle sizes, by using the Rieke-method. The testing was initiated by drying the materials and then soaking them in water to form a sludge that could then be drained through screens with different meshes. After this, the sludge had to be dried to the right consistency for the plasticity tests. Although time-consuming, I knew from experience that wet screening would eventually promote efficiency and safety. Additionally, a kaolin study conducted by Venäläinen for the Geological Survey of Finland supported my decision (1984, p. 6). The used screens were 20 mesh and 120 mesh in size the hole size being 0,842 mm and 0,125 mm. A small container of each wet ≤120 mesh batch was left at room temperature to age for six months. The Pihlajavaara black, Saarijärvi, and the earthenware yielded significantly more particles that were 20 mesh and smaller in dry weight while the Pihlajavaara white, yellow the least.

Furthermore, raw materials were milled in a ball mill for 8 hours to study the smaller particle size in relation to plasticity. Prior to this, some firing tests were made that allowed iteration. Pihlajavaara pink and brown kaolin were excluded from the milling process. The Saarijärvi, Rannikonmäki, and Porkkala clays were not milled either, given their already satisfactory plasticity properties. The milling and Rieke-testing were slow and tedious processes, so it became important to rule out some materials as I familiarized myself with their properties.

The ball mill grinds the clay into a fine powder which increases the plasticity but simultaneously decreases the melting temperature (Jylhä-Vuorio, 2003, p. 206). In this process, the chemical ratios of substances remain the same that in the raw materials since nothing is excluded by screening. Here the hypothesis was that the majority of the material that would be removed in the screening process is silica which has very low plasticity (Jylhä-Vuorio, 2003, p.52), so the smaller particle size accomplished would not necessarily increase the plasticity of the clay. The Rieke-test was repeated five times for each sample and the average plasticity number was counted.

	20 Mesh	20 Mesh	Milled	Aged (120 Mesh)	Sensory (120 Mesh)
White	1	7	8	7	4
Pink	4	4		7	4
Yellow	3	7	7	9	4
Brown	1	6		11	6
Red	4	6	9	11	6
Purple	3	8	9	12	6
Black	8	11	9	12	8
Saarijärvi	10	10		13	12
Porkkala	9	16		16	15
Rannikonmäki	16	15		16	16
Super standard			13		

Table 1. Rieke-test results. Commercial Super Standard Porcelain as comparison.

The Rieke method turned out to be quite unclear and prone to errors. For example, when working with the same plaster table too long it became too moist, and the experiments had to be repeated later due to clearly inaccurate results. Even after repeating the test in more controlled conditions, and changing the plaster table more frequently, some results were still contrary to my sensory experience. Saarijärvi clay at ≤120 mesh, for instance, felt significantly more plastic than Pihlajavaara black but the Rieke's plasticity number gives opposite results. In the ≤20 mesh samples of Porkkala earthenware the plasticity score is much lower than how experienced it. Finnish earthenware tends to feel quite sticky to touch even in its malleable state. This in turn can lower the plasticity number since the first weight is measured when the clay no longer sticks to the hands of the experimenter. The method can therefore be considered indicative when comparing similar materials but even in this case, the test would have to be repeated more to achieve greater accuracy. That is why I decided to test mindfully every ≤120 mesh material in my hands and give each of them also a plasticity value based on my sensorial perception. After all the application of the chosen materials was to be formed by hand so it felt justified and sensible. In ceramic practice, plasticity affects the experience of how difficult handling the clay is. If in my experience the clay feels plastic enough that is what matters the most so from this on, I decided to evaluate the plasticity of the clay bodies solely through tactual experience.

The tests showed that aging and reducing particle size by screening had a significant effect on the plasticity of the materials. All in all, the ≤120 mesh samples improved in plasticity compared to the ≤20 mesh sample. The most promising materials in terms of plasticity were Pihlajavaara purple and black, Saarijärvi clay and, the earthenware.

2.3 Color & Firing Temperature

In this material research color was not only an aesthetical aspect. The small color samples were additionally used to estimate how well the clay body would endure the desired reduction atmosphere. I started by firing the materials to different temperatures in both oxidation and reduction atmospheres. More firings were conducted in electrical oxidation firing than reduction because of the availability. Reduction tests were made in a gas kiln. The first reduction test ruled out the Pihlajavaara pink and brown since they were well-sintered and shiny whitch indicated that the clay had already started to melt. In the ≤20 mesh samples the colors were varied and the surfaces vivid, but these had to be ruled out from the study due to their low plasticity.

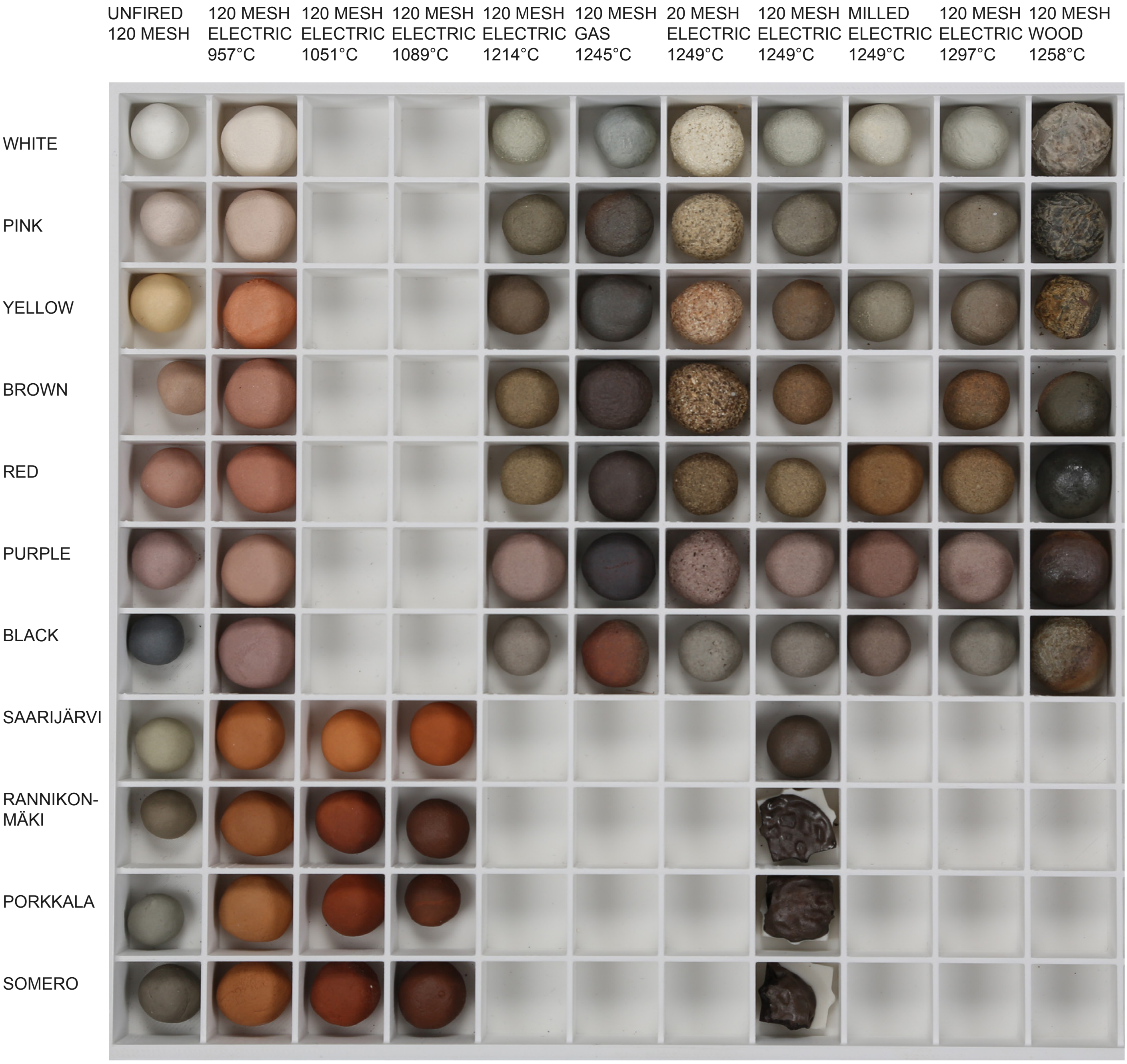


Image 2. Raw material tests in different firings

I proceeded with the study of the milled samples by comparing them with the ≤120 mesh by performing viscosity tests on them. Each sample contained 50% of clay and 50% of frit 2960 and was fired in an electric kiln at a 45° angle to 1280°C with a 1-hour soaking time. The samples show clearly how several of the milled samples melted more and had lower viscosity most likely due to their smaller particle size. The milled samples were also more transparent, and glass-like after melting which indicated towards higher content of glass-forming silica. Since most of the milled samples melted significantly more and due to the fact that milling is energy-consuming, I decided not to continue with this manufacturing method. The ≤120 mesh Pihlajavaara yellow kaolin melted the most, which allowed me to exclude it from the study at this point.

Picture 3. Viscosity tests. 1st commercial Super Standard porcelain and KaoPearl. After that Pihlajavaara white, black, yellow, red, and purple. Left side is ≤120 mesh and right side milled.

Next, the ≤120 mesh Pihlajavaara white, red, purple, and black were tested by pressing them as tiles with a plaster mold. These were fired in electric and gas kilns, and the dry to high-fired shrinkage percentage was measured from the samples (see image 4). The temperature and thermal work were substantially higher in the electric firing. Yet all the other samples except the Pihlajavaara black shrunk more in the reduction firing. Absorption tests were performed on all the samples to observe their apparent porosity. These tests were executed by drying the samples at 110°C for one hour. After that, the samples were immediately weighed and then boiled in water for one hour. Excess water was wiped off from the samples with a paper towel and they were weighed again. The mass of water absorbed by each sample was then expressed relative to the original weight.

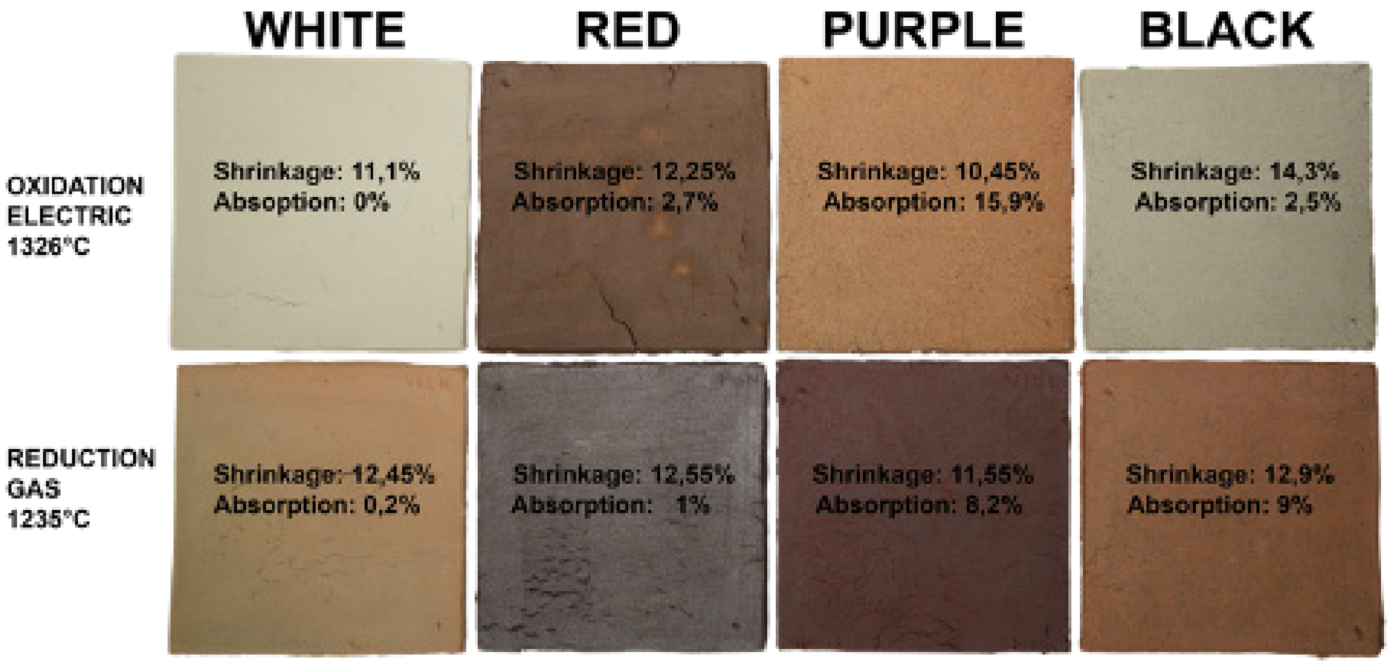


Image 4. Tile tests.

Since I was looking for a versatile clay body that would not fire excessively dark in a reduction atmosphere, I finally ruled out all the colored kaolin and decided to proceed with the research with Pihlajavaara black and white. As these materials were not plastic enough on their own, I chose to mix the Saarijärvi clay with them. Considering that all these materials were transported from further away they had become very precious to me. I knew that if I ran out of these clays, I would not be able to fetch more anytime soon. I felt that it would make sense to develop a different clay body for electric firing since this would allow me to use the local earthenware for added plasticity.

Image 5. Triangle test 1 for Pihlajavaara white, black and Saarijärvi clay. Fired in 1326°C oxidation.

Image 6. Triangle test 2 for Pihlajavaara white, black and Saarijärvi clay. Gasfired in reduction 1235°C.

For the oxidating electric firing, I proceeded as before but replaced the Saarijärvi clay with the Rannikonmäki earthenware since it felt the most plastic to me (see image 7). The tests with 20% of the earthenware seemed successful but I started to doubt if I needed the Pihlajavaara white at all in this clay body. In its raw form, the white kaolin had the smallest number of particles by weight that passed the 120 mesh screen. As a result, it is very time-consuming to obtain this material. In addition, the white kaolin had very low plasticity, so I began to experiment by replacing it with the Pihlajavaara purple which was more plastic and had a beautiful color in electric firing (see image 8). The results were very promising, and I will most likely continue with them in the future. Furthermore, a few natural glaze tests were conducted but at this point of the study I had to limit my next material tests to the ones linked to the desired reduction of high-fire clay body.

Image 7. Triangle test with Pihlajavaara white and black and Rannikonmäki earthenware, fired to 1250°C in electric kiln.

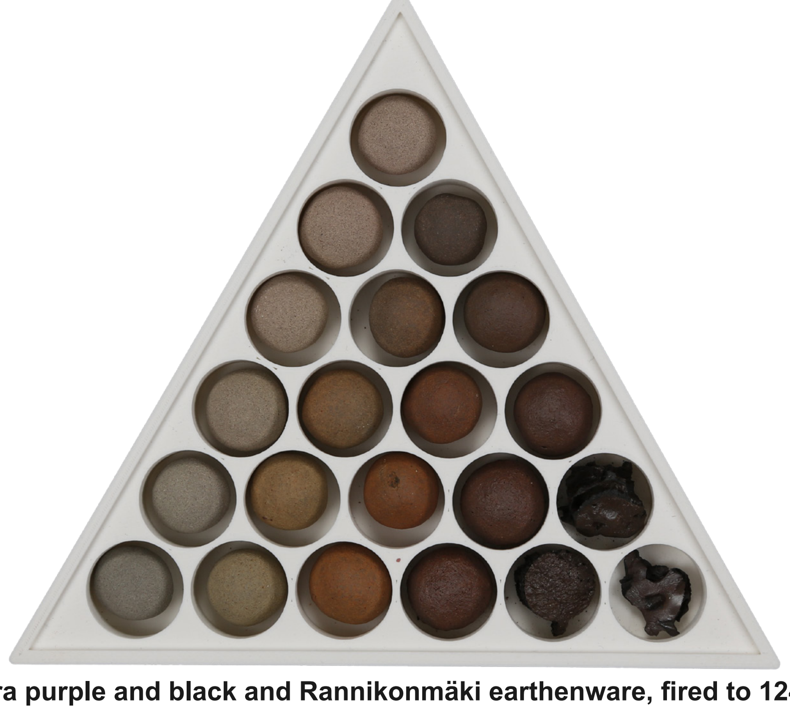


Image 8. Pihljajavaara purple and black and Rannikonmäki earthenware, fired to 1248°C in electric kiln.

I decided to continue the samples 5, 8, and 12 from the triangle test 2 (see image 6) since they seemed to be the most promising. They were not melted or so shiny that they would have gone close to their melting point. The color of these samples was still fairly light even in reduction atmosphere. The lightest colored samples were 1, 2, and 4 but I did not want to continue with these since I was afraid that their plasticity would have been insufficient for hand-building. The research was carried on by making 500 g batches of these with 33% water added and testing the materials by hand-building small vessels. They were not the easiest clay bodies that I had worked with but not impossible either. The plasticity of sample 5 felt a bit lower than that samples 8 and 12 which was expected based on the previous Rieke-tests.
Next, I threw three tea bowls from the sample materials to test how the clay bodies would behave and if they would start to bend and warp in a thin-walled vessel (see image 9). The feel of these three clays resembled porcelain but not exactly. The bowls were glazed from the inside with a natural glaze containing 50% of milled Pihlajavaava white clay and 50% of beech ash to 1314°C in an electric kiln. Sample 12 warped a bit, but it was the thinnest of the three. All of the bowls endured the temperature rather well but the fumes from the natural glaze started to melt the outer surface of the vessels. The reason why I glazed the bowls was aesthetic and functional, but I also wanted to get some information on how the clay body would react to the ash glaze deposited on it in wood firing.

Image 9. Tea bowls

2.4 The Clay Body

The task of choosing a recipe for the clay body used in my sculpture turned out to be very demanding. I only had enough dry and screened material to make one sculpture for the quickly approaching wood firing so this decision was the one that I would have to carry out the rest of the material research. The data I had collected, and my intuition led me to choose the recipe of the sample number 8 from the triangle test 2. After making my decision I consulted my advisor Jari Vesterinen who has a significant amount of knowledge and experience about both natural clays and wood firing. He encouraged me to change 10% of the Pihlajavaara black to white one to reduce the iron content of the clay body and the final recipe ended up having 20% of Saarijärvi clay, 50% of Pihlajavaara white, and 30% of Pihlajavaara black.

Since the recipe was made with a very small particle size, I chose to add some roughness and fibers which could help with the integrity of the build. I screened the Saarijärvi clay to ≤60 mesh (0,25 mm) because it was the most plastic of the three materials in use and the plasticity tests did not show any significant variation between the different particle sizes. The fiber added was hemp that I had previously collected for a previous study from a field in Janakkala. I peeled the fibers from the stems by hand and separated them with a valley beater used in paper testing.

I also resulted to adjust the pH of the clay body to increase its plasticity. The acidity of the clay has a clear effect on its malleability. The pH can be regulated by adding either sodium carbonate or acetic acid to the clay. (Jylhä-Vuorio, 2003, p. 65) Optimal pH values for acidic clays are between 6,0-8,5 and for alkaline clays 7,3-10,5 hence I had to begin by measuring the pH of the studied clay body (Baker & Truog, 1938, p 21 & 324). Since a pH meter for solid materials was not available, I had to add water to the clay mixture and count the unknown pH of the clay component from this mixture. The pH of the clay body was acidic pH 5,2 therefore I decided to raise it with a moderate addition of sodium carbonate to pH 6,02. The alkaline sodium carbonate was augmented gradually, and each addition was shown to improve plasticity. The final recipe for the desired clay body was as follows:

Pihlajavaara white ≤120 mesh	*50%*
Pihlajavaara black ≤120 mesh	*30%*
Saarijärvi clay ≤60 mesh	*20%*
+ Hemp fibers	*0,33%*
+ Sodium carbonate	*0,15%*
+ Water	*28%*

3 Philosophy

3.1 Appreciation

Material appreciation can be inherited through learning, or adopted according to the latest price tag of the ingredient in use but this research suggests that respect for a material can also be developed through making processes and empirical research. When making artifacts or performing physical experiments on a material the artisan or researcher is in direct interaction with the material and its properties. This interaction can be interpreted as an active agency of the material (E.g., Malafouris, 2013 & Aktaş, 2020). The active nature of the studied materials in this thesis is emphasized on several occasions throughout the experimenting and making processes. The clays that were strange and unfamiliar to me before became characters and dynamic actors in the study.

Even before this work I was quite aware of the material I used. When working with wood I would ponder how old the tree was and what it had experienced. While knitting I contemplated how many sheep it takes to make a sweater. Whilst handling clay I consider how long it has taken for the rock to be finely ground over time or whether was it crushed from an existing bedrock that we can never get back. These thoughts are raised by my endless curiosity but due to the above-mentioned notions, I might not be the best subject for this study since my awareness and appreciation towards materials was already prominent. Despite my previous consideration of the materials, I could already observe this respect growing at the beginning of the material research.

Relating to material appreciation in Finnish ceramic context design professor Mirja Niemelä mentions in her dissertation (2010, p. 74) the influence of Kyllikki Salmenhaara's material philosophy. Salmenhaara was a professor at Institution of industrial arts of Helsinki (Taideteollinen oppilaitos), currently known as Aalto ARTS, between 1963-1981. During these years she developed and highlighted material research and the use of domestic earthenware as an ecological, ethical, and aesthetical statement. (ibid.) Glimpses of this ideology can still be detected at Aalto University, yet I worry about its continuity. The current study plan may not call for mastering a specific material or medium from graduates but desirably this thesis can contribute to the appreciation of ceramic materials.

The absence of material appreciation can be reasoned in a few ways. An archaeologist Ruth van Dyke suggests that our long history with materials may be the reason for taking them for granted (2015, p. 4). On the other hand, this thesis indicates that working with a material and knowing its origins can create a new respect for it. This can be due to the emergence of a deeper understanding of the material in question. Currently, this material awareness is often lacking perhaps due to the superficial and brief contact with them. As mentioned before the vast availability of materials and products appeared after industrialization and accelerated with globalization (Levy et al, 2022 & Niemelä, 2010). Ease of availability, affordability, and unfamiliarity with manufacturing processes may well be the reason for the decline in the acknowledgment of materials.

Natural untreated materials such as "wild" clays are commonly seen as impure compared to commercial clay bodies. These impurities are often considered as one of their weaknesses despite the fact that the researcher and professor of ceramics Airi Hortling has stated that these impure raw materials can have significance in taking creative processes closer to nature encouraging experimentality (1994, p.14). In line with this, Niemelä introduces an approach where determining the beauty of a product includes its impact on nature (2010, p.102). As an addition, I could state that the truly impure materials should be those that have unclean or questionable production and harvesting methods.

Slow and comprehensive making processes and seeing materials as active and dynamic components of design processes can attribute to the appreciation towards them and possible previous processes they went through. Acknowledging the material's active contribution is by no means a way to draw attention away from the maker or the designer but a central step in understanding the work of the author (Cooke, 2022). The creative practice can be seen as a dialogue between the maker and material agents. (E.g., Malafouris, 2013 & Aktaş, 2020). Another archaeologist and the developer of the Theory of Material Engagement Lambros Malafouris even states that ”no distinctions between human and nonhuman entities can be sustained in terms of agency” (2013, p. 221). As dynamic agents, the material and the body and the mind of the crafter are entangled together in the making process (Aktaş, 2020, p. 53). Judging by these regards, it can be understood that the origin of the material also has an active influence on the making process and the outcome.

If materials were seen as static entities this research would be very different. I would be the only actor in this thesis who studied, produced, and assessed and reported the outcomes. But the material can also be seen in a crucially active role if the dynamism and agency of the material are accepted. As an example, if domestic kaolin would not exist this research would be about something else than Finnish high-fire clay. And if the materials would have been different, they may have demanded different working methods. Because of these natural clays and their cooperation empirical approach was needed in this study and at each research stage, the material dictated the next possible steps. This active dialogue with the material also confirmed the need for the building of the sculptures in addition to the small test pieces. Without this last interaction, the conversation and negotiation with the materials would have been insufficient and shallow.

The research conducted for this thesis indicates that material research and creative making can lead to an increase in material appreciation and material literacy. This literacy that is strongly connected with tacit knowledge can be developed especially through empirical hands-on experimentation. In this kind of research, the agency of material, in this case clay, is distinct. When I am forming the clay, it is shaping me simultaneously. I am learning new and my material literacy and my intuition toward similar materials develop.

The demand for material literacy has recently been acknowledged by Yale University professor Edward S. Cooke, Jr. (2022). His concerns about the diminishing of material understanding in an ever more virtual world were shared by designer Raino Ranta already in 2000 (p. 18-24). Ranta emphasizes the value of manual skills and tacit knowing in the design process. He argues that even when the planning and drawing happen solely via computer material literacy is an essential ability that guarantees the manufacturability of the product. Similarly, as Hortling (1994) and Niemelä (2010) Ranta as well raises material knowledge as ground for ethical choices. (ibid.)

3.2 Transparency

As humanity, we have driven ourselves to the point where we are dependent on products whose origins we do not know. In the current time of Anthropocene, we must not ignore the fact that our actions can have multiple consequences we cees to know of. Making responsible choices is not always feasible or straightforward, but as practitioners and humane individuals, we are liable for our decisions. As creative practitioners, we can start by making conscious and informed choices of the materials we use. Of course, when it comes to ceramics for example there are always environmental impacts to consider. Firing consumes energy, materials have to be sourced from nature and the end product is not easily recyclable, so we have to be thoughtful of what we produce in the first place.

The purpose of this thesis is not to pretend to save the world. Instead, it offers alternative ways to act and think. All the materials for this work were sourced from places where they were easy to collect mainly due to previous human interference. The two earthenware were from agricultural fields, the kaolins were from a pit dug for testing and research, and Saarijärvi clay was previously dug and moved from its original site since it was not certain that future collection permissions would be allocated. The main reason and idea behind collecting and sourcing the materials was transparency. I wanted to know what kind of environment these ingredients came from and be open and truthful to others about it. Without this openness, it is impossible to compare the ethics and ecology of materials.

Transparency is not always realized in the marketing and sales of clay. In Finland, several clay bodies are sold as domestic, even if most of their raw materials are foreign (Laasasenaho,

P. Kerasil Oy, personal communication, 31.05.2023). For clay to be called domestic, it seems to be enough that the clay body is mixed in Finland. This creates distorted illusions that completely domestic high-fire clays are commercially widely available. Nonetheless, this is not the case. In this research, only one entirely domestic high-fire clay body was found that could be purchased. This is the Saarijärvi clay sold and treasured by a small village organization in Metsäkylä. However, this clay body cannot be high-fired in reduction since it starts to melt from the surface.

Considering the importance of transparency and dialogue with the chosen materials it was evident that the fibers used in the clay body would have to be sourced by me, the practitioner. I had previously conducted research about utilizing the fibers of Finnish oil hemp and had some unprocessed stems available. This material is in a sense a side stream of hemp oil production and would be otherwise left to the field. In retrospect, the nature of the research would have also required replacing the sodium carbonate with a self-harvested material. A substitute ingredient could have been wood ash, or the sodium carbonate could have been extracted from kelp ash (Wisniak, 2003). The previous notion was unfortunately ignored during the material research due to the time frame, yet it was important to gain information about the effect of pH adjustment on plasticity.

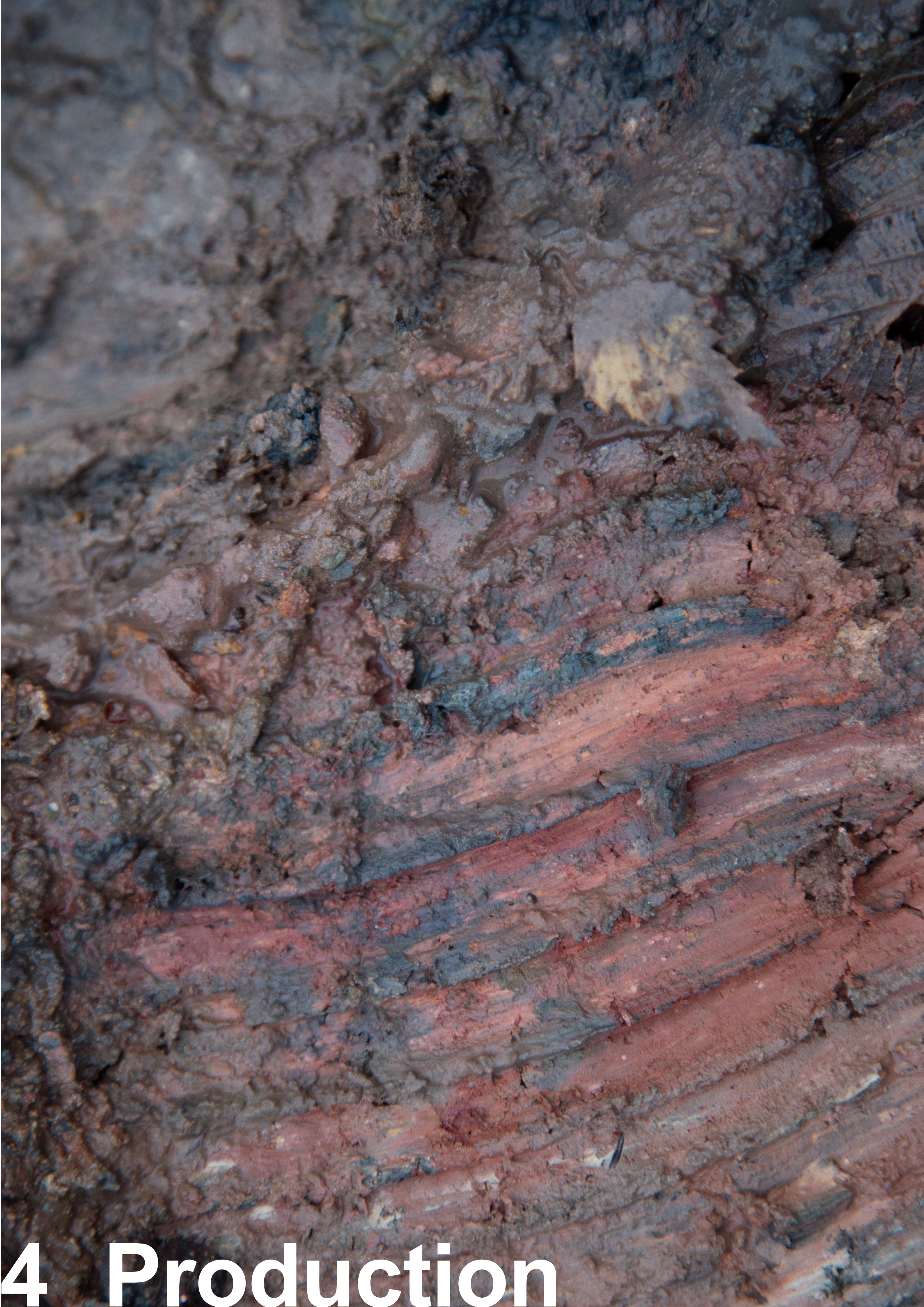
To emphasize the fact that alternative recourses for materials exist the differences between commercial and self-harvested materials can be highlighted. This study compares the Pihlajavaara kaolin, Saarijärvi clay, and commercial kaolin sourced from St. Austell Cornwall UK. It needs to be stated that this kind of comparison can be fairly superficial due to the availability of information needed and different production methods, but it can provide some new insights and perspectives.

	Saarijärvi clay	**Pihlajavaara kaolin**	**St. Austell kaolin**
Composition	Heterogenous. Unprocessed and appears in different particle sizes. Includes high amounts of kaolinite, quartz, muscovite, and microcline. Holds many metal oxides as impurities.	Heterogenous. Unprocessed and appears in different colors and wide dispersion of particle sizes. Includes high amounts of kaolinite, quartz, and muscovite. Holds many metal oxides as impurities.	Homogenous. Processed and highly purified kaolinite in small particle size.
Land impacts	Minor. Research and excavation sites are small-scale, and they are surrounded by forest and swamp. Erosion is prevented by limited size, administered use and surrounding vegetation.	Minor. Pit is less than 100 m in length and surrounded by forest. Erosion is prevented by limited size and use and surrounding vegetation	Significant. Large area of land is exposed and transformed into a mine. The site is over 10 km in length. Erosion is inevitable due to extensive topsoil loss. Waste is piled in multiple spoil tips measuring tons.

Water impacts	Some impacts might occur during excavation due to the immediate vicinity of the lake Saarijärvi. However, excavations are strictly regulated and uncommon. Processing consumes approximately equal amount of water in weight to the raw material. Wastewater is partly vaporized and partly discarded in the sewer network through a settling tank. Some harmful water-soluble substances may enter the drain such as small amounts of lead and zinc.	No considerable impacts during excavation. The distance to nearest water areas is more than 1 km. Processing consumes approximately equal amount of water in weight to the raw material. Wastewater is partly vaporized and partly discarded in the sewer network through a settling tank. Some harmful water-soluble substances may enter the drain such as small amounts of lead and zinc.	Large quantities of water are used during excavation. Kaolin is mined by hydraulic washing with high-pressure hoses. Impurities are separated from kaolin by hydrocyclones. Wastewater is stored in open lagoons. There are several bodies of water within the mining region.
Air impacts	No data available about the impacts on air quality during excavation. Logistics produce pollutants.	No data available about the impacts on air quality during excavation. Logistics produce pollutants.	Measures have been taken to prevent wind dispersal. Yet considering the vastness of the site some airborne particles must be inevitable. Logistics produce pollutants.
Ecologic impacts	Considering the size of the excavation site the impact on ecosystems must be minimal. Yet some negative impacts might occur since the area is recognized for its' biodiversity. The amount of solid waste generated during processing is minimal and processing consumes energy little to non. The harvested material is transported around 750 km to Aalto university where it is used.	Considering the size of the excavation site the impact on ecosystems must be minimal. Solid waste is repurposed as a material for glazes and slips. Processing of the clay does not consume energy, but the solid waste needs to be machine milled. The harvested material is transported around 650 km to Aalto university where it is used.	Mining has significant ecological impacts and ecosystems have been wiped out or dramatically changed due to the tillage. Processing consumes energy in multiple different stages. The harvested material is transported at least 2200 km (beeline) to Aalto university where it is used.
Economic impacts	Currently the clay is used and sold by local ceramicist for whom it creates a partial source of income.	The deposit is not commercially utilized but the festival around it has had some economic impact to local businesses and organizers.	The industry around the kaolin mines has had significant economic role locally, nationally, and internationally throughout its' existence.
Transparency	The material has been academically studied and the area is currently monitored due to the Natura 2000 zone located nearby.	The deposit has been academically studied but there is no data available of current monitoring.	The deposits are highly researched but only a few articles cover any environmental aspects. Nevertheless, monitoring must occur due to the industrial and commercial nature of the site.

Table 2. Comparison of the used materials to a commercial kaolin that is found in several clay bodies used in Aalto university (Ellis & Scott, 2004; Kaarakainen J. research assistant, Radical ceramics project, Aalto university, 20.02.2023; Laasasenaho, P. Kerasil Oy, personal communication, 31.05.2023; Trewhela, 2023; Hirvonen et al., 2010).

Image 10. Satellite images from Saarijärvi, Pihlajavaara and Cornwall in the same scale.



4 Production

4.1 Harvesting

The laborious task of material harvesting was colored by aesthetic experience, physical presence, and spiritual dimension. The materials had to be collected before the ground was frozen which enhanced the impression of working on the conditions of the soil. Timeframe dictated by the clays made me feel closer to nature and I was reminded of the insignificance of my being in a larger whole. These observations are further endorsed by Van Dyke's remark on the psychological aspects of ceramic practice (2015, p. 83). In her publication Practicing Materiality she argues that due to its properties, clay has always influenced the minds of populations working with it (ibid.). Since I had previously witnessed the excitement of a few people attending the Kainuu kaolin festival the 1500 km journey to Puolanka, Metsäkylä, and back was magnified into a pilgrimage-like experience.

In addition to Van Dykes observations artist-researcher Priska Falin has noted that apprehension towards clay connects us with "time and existence" due to the eternal nature of minerals (2022, p.11). The timeless essence of the collected materials was truly accentuated by their organic origins. Even though all the clays had already previously confronted the interference of humans their significance was not diminished, and I was drawn to comprehend their geological history.

4.2 Inspiration

The inspiration for the sculptures was drawn from the clay harvesting sites. These places had been disturbed by people, yet the soil did not entirely yield to the will of humans. The fields were no longer cultivated, the lakeside was protected, and the hill was untamed in the face of commercialization attempts. The spirit of the controversial term 'wild clay' was inevitably present.

Wild is commonly perceived as something living and free. For me wild is something natural. The wilder something is the closer it is connected to nature. Although the wild is often seen as unbounded for me it is something that carefully fills its ecological niche and works by instinct in perfect interaction with nature. I started to retrieve recollections of wild animals that I had come across. The synergy with other beings was a significant idea that I wanted to emphasize with my choice of characters. My attention was drawn to the lynx and the black woodpecker because both of them aid other species by their intuitive behavior and my encounters with them have always been inexplicably spiritually meaningful. While making holes in a tree trunk the large woodpecker provides nesting spots to numerous small birds. The lynx, on the other hand, maintains a healthy prey population and when the game is abundant the cat eats only a small part of its prey thus providing several levels of the ecosystem with food.

The instinctive behavior of the wild can also be seen negatively in modern society. Untamed can be equated with uncivilized, which as a way of thinking is strongly linked to colonialism and domination. Although civilization and the technology it brings are often considered positive developments, they have facilitated the imbalance between humans and nature. Due to these notions, I wanted to depict the animals in their usual and simple everyday actions, eating and bathing. Functions that we as humans have shaped so complicated for ourselves.

4.3 Making

Abiding close contact with the clays gave them a voice and personas. The screening and rolling of the materials seemed endless after two months of tedious tasks. During this first step of processing, I discovered several insects and plants in the clay and was desperate to save them all. While carrying these beings to flowerpots or outside I realized that it was not only the living that had made an impression on me but also the clays themselves. Dwelling with the material had turned my approach virtually animistic and I began to perceive the different clay types as characters with diverse traits. The slow progress enhanced my appreciation of these entities and

allowed me a deeper connection with them.
During the testing and making processes the materials became so important to me that I did not want to waste a bit. I wanted to find purposes and uses for all of them so they would not be collected for no reason. The iteration process resulted in the use of only five clays in the artistic production, but I desired to understand all of them and intend to continue the research in the future outside the scope of this thesis. All of the solid side streams were either returned to their origin or retained for further processing into glazes and slips.

The materials used in the final artworks were Saarijärvi clay, Pihlajavaara white, Pihlajavaara black, and both earthenware. Since the earthenware was not included in the high-fire reduction clay body I decided to sculpt the woodpecker and its meal out of them. This allowed me to create further dialogue and connection with every place the clay was harvested from. Working with the clays made me truly feel closely linked to these sites.

Neither of the clay bodies was the easiest to work with. The earthenware were very plastic and therefore cracked easily while drying. The cracking may have been avoided with the addition of sand or chamotte but in the case of the woodpecker and the insects the surface of the clay body needed to be smooth and burnished. I crafted two similar birds in order to improve the chances of firing one successfully. In the case of the high-fire clay body sand could have also helped by giving more support in the structure. This clay had lower plasticity so it had to be worked quite wet therefore the walls of the sculpture could be built just a little bit at a time. On the other hand, this clay body was fast to dry without developing cracks. The challenges created by the material properties forced me to concentrate on an intensive discourse with the clay bodies throughout the crafting process. Along this dialog added literacy, appreciation, and respect were developed towards the materials.

4.4 Firing

The sculptures were fired by using primitive firing techniques and wood as fuel. These kinds of firings often require experience and a communal effort to succeed. People have to be present and attentive throughout the firing which can last for days. Firing with wood demands appropriate knowledge of the elements yet it still leaves room fi chance. The participatory nature of wood firing allows the crafting process to continue until the artifact is a complete which is usually not the case in passive electric firing.

Sustainably considering wood firing might not be the most efficient way to produce ceramics. Electric kilns are regularly programmed to the fastest possible firing and the excess heat could be utilized whereas wood firings are usually slow, the heat runs away from the chimney and combustion is often intentionally incomplete. However, wood firings occur seldom, the kilns are fired fully loaded and the pieces are generally carefully selected. Judging by my experience in the Aalto University's ceramic workshop the same cannot be said about electric firings. If not constantly supervised the students are eager to fire half-full kilns to quickly see the finished works that often, in the absence of careful finishing end up discarded. Of course, it goes without saying that the situation might be different if the students paid for the firing themselves. Yet I would argue that seeing the amount of fuel disappear in wood firing makes the energy consumption of any ceramic firing appear more concrete.

The earthenware sculptures (see image 12) for this thesis were fired in a small black firing kiln I had laid from discarded bricks in my yard. The name black firing comes from the dark black color of the fired pieces that is caused by the reduction atmosphere and soot. I had three of my friends and colleagues participating in the firing, but this was the first time black firing for all of us. The goal was to reach 1000°C temperature and then provide a heavy reduction by closing all of the air channels with clay. At the beginning I failed to give my inexperienced friend specific enough instructions and the temperature was raised too fast from 280°C to 380° and four objects were heard breaking. The firing took 13 hours and 950° was reached. The kiln was opened the next day. One of the two birds had exploded, and the black color covered the uppermost works more comprehensively than the lower ones.

The Lynx sculpture (see image 11) was fired in a bourrybox kiln at Keracomp oy in Porvoo. The firing was organized as a part of Aalto University's wheel throwing course and there was a dozen of us participating. The loading took the whole afternoon and evening and the actual firing extended over 28 hours. The temperature raised slower than anticipated and the firing could have been continued if anyone had the time and the energy to do so. Some of the glazes at the upper parts of the kiln, where also the lynx sculpture was situated, were slightly underfired. In the middle of the firing chamber, a temperature of 1258°C was measured with a pyrometric ring. The firing was unloaded after a week and the lynx along with other works was found intact.

4.5 Outcomes

The whole making process provided countless amount of information on the materials and methods. The outcomes from my first ever black firing were exciting and enlightening. The woodpecker sculpture was not entirely black which was a beautiful occurrence but at the same time I was eager to develop my skills in this technique and try again. The lynx sculpture handled the firing well although further experiments will have to be made with the same clay body.

Image 11. The Lynx.

Image 12. The woodpecker.

5 Conclusions

The feasibility of creating a hand-building clay body that can withstand high-firing in a reduction atmosphere using Finnish natural clays has been successfully explored within the scope and timeframe of this thesis. Through empirical tests and experimentation, it was determined that a combination of specific clay materials, including the addition of kaolin to low fire, high iron content clays, can result in a clay body capable of withstanding higher temperatures and reduction firing. However, it needs to be stated that the number of tests performed is quite limited, so the research should be continued in order to draw certain conclusions.

The collection and processing of the raw materials have a significant impact on the artistic process and the final artwork. The plasticity, color, and firing temperature of the natural clays were carefully examined and assessed through a series of firings and testing methods. The results demonstrated that different raw materials exhibited varying levels of plasticity and response to firing, highlighting the importance of material selection and preparation in artistic production.

The research methodology employed in this thesis, combining practice-led research with literature review, proved to be effective in gaining valuable insights into the studied topics. The practical work provided concrete evidence and guidelines, while the literature review contributed to a broader understanding of geology, material appreciation, material literacy, and mineral sciences, enhancing the contextual background of the study.The three distinct components of this thesis, namely material research, artistic production, and the written part, complemented and supported each other in a comprehensive exploration of the research questions. The empirical nature of the material research, coupled with the hands-on artistic production and reflective written analysis, allowed for a holistic investigation of the subject matter.

The findings and outcomes of this research contribute to the field of ceramic arts and material studies. By providing insights into the plasticity, color, firing temperature, and other characteristics of natural clays, as well as the ethical considerations related to material sourcing and production, this thesis offers valuable knowledge and guidelines for ceramic artists, researchers, and practitioners.

Overall, this thesis successfully addresses the research questions, offers practical and theoretical insights, and contributes to the existing body of knowledge in the field of ceramics. It provides a foundation for further exploration and opens avenues for future research and artistic experimentation in the realm of natural clay materials and their artistic applications.

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Image 1. adapted from https://www.geologia.fi/2019/12/12/teollisuusmineraalit/

Image 10. from Google Maps.