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Pottery: From The Source

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by

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ABSTRACT

This project is aimed towards the production of a suitable bowl set and glaze for tableware usage using locally extracted and processed clay. My interest in this topic stems from the goal of improving my pottery-making skills and knowledge through immersion in clay sourcing, processing, and producing quality tableware. This project gave me hands-on insight and admiration for pottery sourcing and production. Five local clay bodies were sourced, and two were processed to create bowl forms and glazes. Results were documented on which clay body was ideal for durable and easy maintenance tableware. A red clay body was sourced from Red Bluff in Marion County Foxworth, MS, and a brown clay body from Lake Thoreau in Hattiesburg, MS. During the processing step each clay body was sifted through different mesh sizes to separate any debris. Afterward, the clay was placed on a plaster slab for drying. Once dried, each clay was wedged with ball clay for more plasticity, which made the clay malleable. For the glaze test, brown clay was used instead of red due to less debris concentration. Brown clay was mixed with increments of dry ingredients from a copper red glaze called Pete’s Red created by Pete Pinnell. The glaze was chosen for its glossy texture, suitable for an easy clean. After producing bowls on the pottery wheel with each clay body and bisque firing, the red clay was determined to be better suited for bowl functionality and brown for glaze functionality This paper will discuss the pros and cons of ceramic tableware compared to other tableware materials, the methods used for pottery production, and my analysis.

Keywords:

Ball clay, Bisque, Bisque fire, Bone dry, Bubbling, Ceramic, Centering, Crawling, Cracking, Electrons, Extracting, Flux, Functional, Glaze, Glaze Fire, Grog, High fire, Insulator, Kiln, Leather hard, Mesh, Oxides, Particles, Pete's red, Plastic, Potassium Feldspar, Plaster, Pottery, Pottery wheel, Processing, Primary clay, Pulling, Refractory, Secondary clay, Sodium feldspar, Steel, Tableware, Thermal energy, Trimming Wedging.

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INTRODUCTION

Literature Review

Readings that helped expand my knowledge of clay, glazes, and bowl forms include *Clay and Glazes for the Potter* by Daniel Rhodes, *The Complete Potter's Companion* by Tony Birks, *The Complete Guide to High-Fire Glazes* by John Britt, and *500 Bowls* by Lark Ceramics. Rhodes's book discusses Glaze materials, mining and clay preparation, and the physical nature of different types of clay along with other topics. A section of Rhodes's book discusses the variations in clay plasticity and their best usage. *The Complete Potter's Companion* by Tony Birks gave detailed instructions with images demonstrating each step on how to work on the wheel. This book benefited my ability to center clay and to make a cylinder as these were skills that needed improvement. *The Complete Guild to High-Fire Glazes* by John Britt informed me about the variety of oxides with their melting ranges and the characteristics they create for a glaze. The book also discusses how to conduct melt tests and mix glazes. Lastly, *500 Bowls* by Lark Ceramics inspired bowl forms.

CHAPTER I: BECOMING ONE WITH THE DIRT

I took a ceramics class at USM in the Fall of 2022 and became fascinated with the medium immediately. My curiosity led me to research the materials that we were using in class, and this propelled me on an expedition to discover historically how clay processing has developed through research, commerce, and technology. As a ceramics student in 2024, access to industrially processed clay in the modern classroom is a luxury inaccessible to pre-industrialization. This luxury drove my curiosity and interest in sourcing and producing clay; I wanted to understand how raw clay was processed. Along with this, I wanted the challenge of creating a set of bowls as bowls are the most used tableware, easier to make compared to other tableware, and have more design options compared to other tableware. Finding tableware that is durable, sanitary, and easy to clean/store can be challenging. A typical tableware is subject to the use of a microwave, dishwasher, knife, and oven. Ceramic tableware is an excellent choice among the tableware selection. This paper will discuss the qualities of ceramic ware as compared to other tableware materials such as steel, plastic, and wood. This paper will also present in detail the methods and processes that were executed to produce a quality functional ceramic bowl set and glaze and an analysis of which extracted clay was better suited for pottery and glaze production.

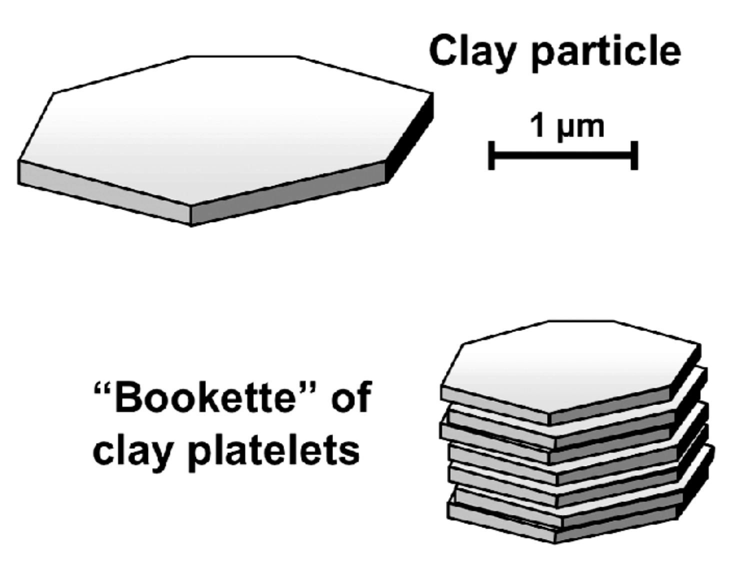
Why Ceramic Tableware?

Sourcing and processing clay to produce bowls also revealed some of the advantages and disadvantages of ceramic tableware. Ceramics are one of the most durable man-made materials. It is almost completely impervious to most chemical and elemental stresses.

Ceramics is harder than steel, plastic, and wood. It does not rot or mold like wood, it can withstand heat exposure without leaching chemicals or holding stains and flavors, unlike plastic, and it does not rust or degrade like steel. Ceramics require little to no maintenance. Due to their tightly bound electrons, ceramics are great heat insulators that help maintain food warmth. Judy Brewer from the University of Illinois Urbana-Champaign states, "Ceramics generally have strong bonds and light atoms. Thus, they can have high-frequency vibrations of the atoms with small disturbances in the crystal lattice. The result is that they typically have both high heat capacities and high melting temperatures. As temperature increases, the vibrational amplitude of the bonds increases." Brewer also states "Valence electrons in ceramic materials are usually not in the conduction band, thus most ceramics are considered insulators. However, conductivity can be increased by doping the material with impurities. Thermal energy will also promote electrons into the conduction band, so that in ceramics, conductivity increases (and resistivity decreases) as temperature increases." [1] According to the University of Calgary's Energy Education, "The conduction band is the band of electron orbitals that electrons can jump up into from the valence band when excited. When the electrons are in these orbitals, they have enough energy to move freely in the material." [2] In simple terms, ceramic ware is a good insulator when cool, but increases in conductivity when it is hot. Ceramics tableware as compared to steel, plastic, and wood stands out as the better tableware overall. However, it does have its disadvantages. Ceramic ware's durability and other characteristics are determined by its ionic and covalent bonds,

[1] Brewer, *MAST Modules* (Department of Materials Science and Engineering University of Illinois) Electrical Properties.
[2] *Energy Education* (University of Calgary), Conduction Band.

which can also create some undesirable characteristics, such as brittleness. Rhodes states that "Clay was formerly thought to be more or less colloidal in its physical make-up, but later studies seem to indicate that the extremely small size of the grains of clay account for most of its physical properties." Rhodes also states "Examination under the electron microscope has revealed that these clay particles are plate-shaped, elongated in two dimensions, and thin in the other dimension." [3]



[4]

Figure 1. Clay Particle (Martin A. Hubbe. Acidic and Alkaline Sizings for Printing, Writing, and Drawing Papers, 2005)

Finding quality ceramic tableware that suits specific demands and styles might be a challenge and once found can be expensive. Buying from a small pottery business is an

[3] Rhodes, *Clay and Glazes, 9.*

[4] Martin A. Hubbe, *Acidic and Alkaline Sizings for Printing, Writing, and Drawing Papers,* The Book and Paper Group Annual (2004) 139, figure 1.

alternative, but well-crafted pottery can be expensive. Though this tableware is durable and strong, it can scratch easily, so caution should be taken with sharp objects.

Ceramic tableware has more advantages compared to other tableware materials such as wood, plastic, and steel. Unlike ceramic tableware, wooden materials retain stains, odors, and flavors, which can be a hassle to sanitize. Wooden materials are also prone to split. Plastic materials also retain stains and smell. Plastic materials cannot withstand the degree of heat compared to ceramic ware and may leach chemicals into food. Though stainless steel combats corrosion, it can eventually rust over time with poor maintenance. Hajian et al. state, "It is well known that the corrosion resistance of stainless steels can be significantly affected by cold working, alloy composition, inclusions, heat treatment, sensitization, and precipitates. Specifically, there are studies reporting the detrimental influence of cold working on the pitting corrosion resistance of AISI 304, 316L, and 301 type austenitic stainless steels."[5] Lu et al. state, "Additionally, the initial surface conditions can also affect the cavitation erosion resistance. It was reported that a rough surface with a high initial surface roughness could negatively affect the cavitation erosion resistance, resulting in extra material removal. However, the cavitation erosion resistance of the arc-sprayed Fe-based amorphous/nanocrystalline coatings decreased with the increasing initial surface roughness. Therefore, this makes stainless steel a competitor for ceramic due to its gained strength through surface roughness caused by corrosion.

[5] Hajian et al., "Improvement in cavitation erosion resistance of AISI 316L stainless steel by friction stir processing" *Applied surface science* 308 (2014): 184–192.

Extracting

Figure 2. Red Bluff

Daniel Rhodes discusses how to locate and identify raw clay in *Clay and Glazes for the Potter*. Rhodes states, “The likely place to look is usually some spot where the earth has been cut through, revealing some of the underlying strata. Along creeks and rivers, or where highway and railroad grading has cut down into the earth, one can find the layers of the clay that so frequently underlie the topsoil.” [6] To identify clay, a sample of the collected raw material can be tested by adding water to it to observe its plasticity, which is similar to gum texture. Once the raw material is identified as clay, it must be determined what purpose it can serve in ceramics. Rhode states, “Many clays, if not most, are not suitable for any practical purpose. For example, a clay which is too highly contaminated with soluble alkali is not worth digging.” [7] It is also worth noting that clay with too much debris can hinder its use. Rhodes states that “Secondary clays or transported clays are more common than primary

[6] Daniel Rhodes, *Clay and Glazes for the Potter* (Philadelphia, Clinton Book Co. 1973), 64.
[7] Rhodes, *Clay and Glazes, 65.*

clays."[8] and "The great amount of majority of secondary clays contain brown, or red color, and the maturing clay may be found in small, localized pockets, the sedimentation of one stream, or it may occur in vast deposits of millions of tons covering several square miles."[9] This was the case when searching for clay as an abundant amount of red and brown clay, secondary clay, was found compared to primary clay like kaolin. The brown clay was extracted from a small, dried creek, and the red clay was extracted from a large geologic feature. Primary clays are the purest form of clay and through erosion, they become mixed with other materials creating secondary clay.

Based on discussions with my thesis advisor about the goal of finding abundant varieties of clay, I decided to travel to two locations: Red Bluff in Foxworth, Mississippi, and Lake Thoreau in Hattiesburg, Mississippi. Primary clays such as kaolin (white clay) are the purest and rarest form of clay. These clays are usually found deep underground or in mountains. Secondary clays, such as red and brown, are more common than primary clay and can be found near lakes, rivers, creeks, and other areas. Secondary clays form through erosion, which contaminates the clay with organic materials. They are high in iron, which gives them their color. Red clay is plentiful at Red Bluff, hence the name, but there are also purple and white clays, white being kaolin. Two buckets of red clay were extracted, but no

[8] Rhodes, *Clay and Glazes, 12.*
[9] Rhodes, *Clay and Glazes, 12.*

purple and white due to there being little to none.

Figure 3. Brown clay from Lake Thoreau

At Lake Thoreau, four buckets of the lightest clay found were collected, the clay is light brown. The next step is to process the raw clay and compare which clay is better suited for bowl and glaze creation.

Processing

Figure 4. Sifting Process: Red Clay

Once the clay has been extracted, it needs to be mixed with water so it can be screened free of debris such as rocks, roots, and other non-clay materials. Rhodes states, “For small batches, clay may be mixed by hand with a paddle or stick.” [10] Rhodes also states that “If the clay must be screened to remove granular impurities, this can be done after the fluid slip is thoroughly mixed and smooth.” [11] After this step, water must be removed from the clay. Rhodes states “Plaster is very absorbent and draws the water rapidly from the slip.” [12] The red clay body from Red Bluff had a large amount of grog or debris, organic material such as roots, twigs, rocks, and trash, which made this process difficult. To remove the debris, clay chunks were sifted through a large mesh. Water was added to the remains to absorb for about 10 minutes, then mixed until it became a slurry texture. Then, the slurry was sifted through a 20, 30, 60, and 100 mesh, with multiple passes if required, to refine the clay. However, the red clay was still groggy due to its fine mineral grains. The properties of the red clay make it classified as non-plastic, so instead of needing to be blended with less plastic clay to be useful, it needed to be blended with more plastic clay, which is ball clay.

[10] Rhodes, *Clay and Glazes, 68.*
[11] Rhodes, *Clay and Glazes, 68.*
[12] Rhodes, *Clay and Glazes, 68.*

Figure 5. Sifting Process: Brown Clay

The brown clay was easier to process than the red clay because it is naturally smoother and more plastic. The brown clay only required to be sifted through a large mesh once which is depicted in (Fig. 5) and did not require 30, 60, or 100 mesh since it was sourced from a location free of debris contaminants. Therefore, it only needed to be broken down through the largest mesh for the hydration process. Next, the excess water from the clay was removed by drying the clay on a plaster slab so it could reach a plastic state. Another word for plasticity is malleability, which is a state in which an object can be easily molded. Potters often refer to clay that is non-plastic as short. Short clay is prone to cracking.

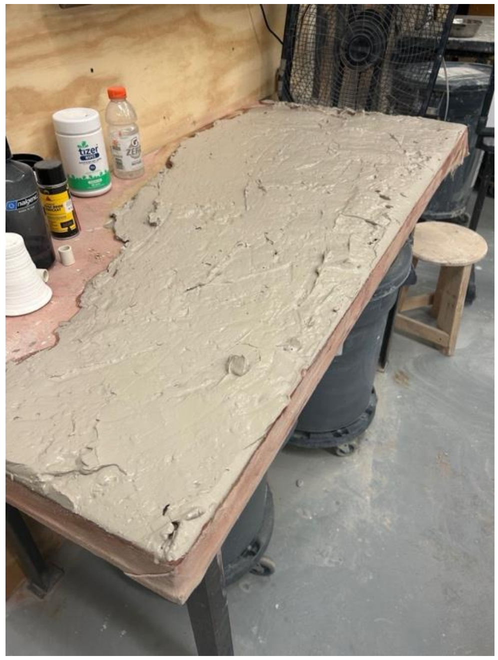


Figure 6. Plaster Slab: Ball Clay

To remedy this issue of cracking, we have multiple options. One option is to apply water to the clay and allow it to hydrate the clay fully to increase plasticity. Since the harvested raw red clay has already been through option #1, it is inherently short. To remedy this, ball clay was wedged into the clay, which is depicted in the pottery production section, to increase plasticity, which makes the clay moldable. According to Rhodes, ball clays "are higher in iron content, more fusible, much more plastic, and fine in particle size. Ball clays and kaolin are complementary in character and are often combined in clay bodies to adjust the mixture toward practical, workable clay." [13] Rhodes also states, "Other clays are too plastic and sticky to be used by themselves and must be blended with less plastic clays to be

[13] Rhodes, *Clay and Glazes, 20.*

useful. Many clays, however, are usable just as they come from the earth and may be modeled or thrown on the potter's wheel without any adjustments in composition." [14]

The brown clay was plastic enough to be molded and worked on the potter's wheel without any clay additives but was still molded with ball clay for portion control. After having the necessary processing steps finished, the next step is to test and create a functional glaze suitable for tableware.

Glaze Testing

Glaze is a ceramic material often mixed with water into liquid form for ease of application onto pottery forms. When the glaze is fired, it solidifies into a glass coating. John Britt states in *The Complete Guide to High-Fire Glazes,* that "Glazes are composed of materials called oxides, which are categorized as either glass formers, primary silica; stabilizers, containing alumina; and fluxes, which assist in melting. These can be combined in a variety of proportions, to which colorants and opacifiers are added, and these combinations create the infinite variety of glazes we use in pottery." [15] A suitable glaze for ceramic tableware based on utilitarian functionality is durable, chemically stable, easy to clean, and stable when fired in a kiln without defects. The processed red and brown clay bodies were also used for glazes. I wanted the glaze to have a glossy finish rather than a matte. The glossy finish was preferred for its shine and smooth coating that allows for easy cleaning and is less prone to scratches compared to a matte finish. Fluxes are oxides that help glazes melt and solidify into glass at a lower melting range. Higher melting ranges are

[14] Rhodes, *Clay and Glazes, 11.*
[15] John Britt, *The Complete Guild to High-Fire Glazes* (An Imprint of Sterling Publishing Co., 2004), 13.

referred to as refractory. Rhodes states that feldspar "is used in almost all glazes, and in high-fired glazes, it is often the principal material and provides the principal flux." [16] For this project, potassium and feldspar were two fluxes chosen to test the melting point of both clay bodies during the initial glaze test. Britt states "Potassium oxide is a strong alkaline flux which is similar to sodium oxide but is slightly less strong and it begins its fluxing action earlier than does sodium oxide. It's a predictable, stable flux that produces bright glossy glazes." [17] This is the reason potassium and sodium were the choices of oxides for the flux testing portion of the project, as a glossy coating that does not run a lot when fired was desired. Britt also states "The thickness of the glaze coat is very important. Too thin, and the clay body shows through; too thick, and it runs and sticks to the shelf." [18] This statement gave me an explanation for an error that was made while creating a glaze for this project by adding too much water as the consistency was too thin. I began by testing both fluxes reacted with both clays. This test was to see how much each flux melted the clay. incrementally.

[16] Rhodes, *Clay and Glazes, 106.*

[17] John Britt, *The Complete Guild to High-Fire Glazes* (An Imprint of Sterling Publishing Co., 2004), 18.
[18] Britt, *High-Fire Glazes* 29.

Figure 7. Glaze Flux Test: Brown Clay

Figure 8. Glaze Flux Test: Red Clay

Twenty-four clay slabs with five individual sections were created for testing with two strong fluxes, sodium and potassium feldspar. Twelve slabs were designated for red clay with salt, red clay with custard feldspar, and twelve for brown clay with salt and brown clay with custard feldspar. 200 grams of each clay had about 10 grams of either salt or custard feldspar added to four sections of each slab, with the first section having none added and fired in the kiln. Neither slab melted or reacted ideally for functional purposes, with the red clay having the worst reaction due to its bloating and cracking.

Figure 9. Glaze Test: Pete's Red with Brown Clay

A second glaze test only using brown clay was conducted for this reason. Four slabs were tested with a copper red glaze called Pete's Red, created by Pete Pinnell, [19] with increments of brown clay added to each slab. This glaze was chosen for its deep, vibrant red, and glossy texture, ideal for an easy clean. This test also did not produce a functional glaze due to the clay's reaction with the glaze, causing bubbling, so a third test was done.

A container of Pete's Red was made without tin oxide and copper carbon dioxide, which withdrew the glaze's color. 182g of brown clay were added to the dry ingredients of

[19] Britt, *High-Fire Glazes* 91.

Pete's Red, which were multiplied by 5 to make 500g of glaze. This test successfully produced functional glazes but had some crawling, a glaze defect when the glaze does not adhere to the clay body, leaving the form bare in some spots. This defect can be remedied by adding a small amount of flux or gum.

Since the crawling defect took time to correct, the bowls were produced before the glaze, so the final focus could be the glaze. After pottery production, more glaze tests were conducted by adding more flux to the glaze. The final batch of glaze had an additional 300g of flux added to help correct the crawling. Since the brown bowls had excessive cracking after being bisque fired (Fig. 16-17) while the red bowls had none, the brown clay is unsuitable for tableware and was instead used for glaze testing. Though multiple glaze tests were conducted to improve the flux to correct the crawling defect, the final glaze still crawled on the red clay body bowls. Some bowls had minor crawling and were able to be refired with an additional high fire and low fire glaze to cover the defect while others had an excessive amount of crawling. One bowl inside was refired with a high fire glaze the other with a low fire clear glaze. A final glaze test was conducted to determine if the crawling was caused by the harvested clay body or glaze. The test was done on stoneware and porcelain clay from USM's ceramic class, and the glaze still had some minor crawling therefore the glaze is at fault and not the harvested clay body. Next, the executed pottery preparation steps and production of both processed brown and red clay will be discussed.

Pottery Production

Wheel-thrown pottery is one of the oldest art disciplines across cultures and comes with numerous trials and errors. This section will briefly overview the general steps of wheel throwing: wedging, centering, pulling, shaping, and trimming.

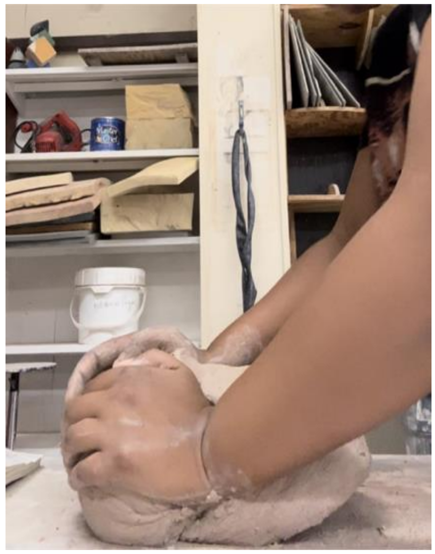


Figure 10. Preparing Clay Process: Wedging

Figure 11. Preparing Clay Process: Weighing clay after wedging

Wedging

Rhodes states, “For modeling, and particularly for throwing, clay must be kneaded or wedged to remove the pockets of air and to disperse lumps and make the clay smooth and homogeneous. The clay is rolled or kneaded by hand on a plank or plaster table or is repeatedly cut and recombined, which has the effect of crushing out all pockets of air. These methods are age-old and have been used by potters everywhere” [20] Once wedging and weighing of clay is done, any leftover clay should be stored properly in a dry sealed container to prevent drying.

Figure 12. Pottery Wheel: Coning

[20] Rhodes, *Clay and Glazes, 71.*

Figure 13. Pottery Wheel: Compressing/Centering

Centering

Centering is the first step in working on the pottery wheel and can be challenging due to improper hand positioning, strength control, wheel speed control, clay stiffness, and clay moisture. This step helps with symmetry and consistency. Beginners should work with 1 lb. of clay or an amount that fits their hand size. Once the clay is secured in the center of the wheel, slowly spin the wheel before placing your damp hands onto the clay and gently removing your hands when stopping the wheel. The potter must focus simultaneously on these steps while maintaining the right amount of moisture on the clay, so it does not become too wet or dry to work with. Begin slowly coning the clay and compressing it back down. This step further wedges the clay for any potential air bubbles.

Figure 14. Pottery Wheel: Opening

Figure 15. Pottery Wheel: Measuring

Once centered, begin making an indentation in the center of the clay, then further deepen and widen the hole by compressing fingers slowly down and out.

Pulling

Pulling the clay upward into a cylinder form is also a challenge, as this step also requires strength, control, and patience. Pull the clay upward into a cylinder by placing one hand on the base outside and the other hand on the inside above the outside hand placement of the form, then slowly spin the wheel and guide the clay up to the desired height. Pulling the clay upward too fast can also interfere with consistency and can tear the clay when too much pressure is applied. If the cylinder bellows too wide, gently collar it upward with both hands then trim the rim with a needle tool if uneven and remove excess water from the inside of the form. To shape the clay into the desired form whether it is curvaceous or graceful the potter must first have set a good foundation to work within the previous steps. Maintaining the form's figure while removing it from the wheel with a wire tool and monitoring its level of dryness for trimming is essential as it is ideal to do so while the form is neither wet nor bone dry but in a state of leather hard for easy trimming of a finished foot.

Trimming

When trimming, the potter must center and secure the piece for even trimming being cautious to not trim away too much clay and ruin the piece, but also trim enough so the piece is not chunky and heavy. The level of thickness on the foot can be determined during this stage by knocking on the form's bottom and listening for a hollow sound. Use a small trimming tool for small, thin forms and a large tool for thick, chunky forms. While spinning the wheel at a rapid speed, gently glide the tool up and down the piece. Finally, leave the form to dry before bisque firing and then high firing.

CHAPTER II: ANALYSIS

Red vs Brown

Both clay bodies served a purpose. The red clay contained a large amount of debris, creating problems for processing, pottery, and glaze production. The brown clay was easy to process and produced pottery and glaze with only the inconvenience of the clay thinning quicker while working on the pottery wheel. The brown clay was easier on the hands compared to the red clay and produced a functional glaze due to its low debris. While it was assumed that the brown clay would also be great for producing pottery, this was not the case compared to the red clay.

Figure 16. Bisqued red bowls

Figure 17. Bisqued brown bowl: Inside

Figure 18. Bisqued brown bowls

After all bowls were bisque fired, the brown bowls had excessive cracking, and the red bowls had none. This is due to the grog/impurity within the red clay, which gave it structural strength. In conclusion, red clay was better suited for pottery production and brown, while it had some defects, for glaze production.

Figure 19. Glazed Bowls

Figure 20. Glazed Bowls: Inside

Conclusion

In conclusion, the red clay extracted from Red Bluff Foxworth, MS, was better suited for pottery production, and the brown clay extracted from Lake Thoreau Hattiesburg, MS, was better suited for glaze production due to its lower level of impurity concentration. This project benefitted my pottery-making skills and knowledge through immersion in clay sourcing, processing, and producing quality tableware. I experienced hands-on insight and admiration for pottery sourcing, which allowed me to discuss the advantages and disadvantages of ceramic tableware compared to other tableware materials such as wood, plastic, and steel. Through my original thesis related to ceramic education, I wanted to explore the history of ceramic education within Southern US states. The goal was to bring more awareness to fine arts education through ceramics, which I believe this project's thesis conveys more successfully by immersing the readers in similar primitive clay processing steps, listing the advantages of ceramic tableware, and listing gained and enhanced skill-making from pottery making. I believe this project shows that ceramics are more than just an art medium but have scientific importance in daily aspects of life, even outside of art, that many fail to realize.

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