Discovery and development of clays in the area of Marysville, California
by Eduard Allen Mikkelsen

A THESIS Submitted to the Graduate Faculty In partial fulfillment of the requirements for the degree of Master of Applied Art at Montana State College
Montana State University

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The area surrounding Marysville, California, was explored for sources of clay lending themselves to development as clay bodies. A total of twenty-two clays were found in a radius of sixty miles of Marysville. These clays were subjected to simple tests to determine their usefulness. On the basis of these tests, two clays were selected and developed for classroom use, one a low fire clay, the other a high fire clay. Permission was obtained from the landowners to use the clay in the Yuba College Art Department,

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Approved:

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Dean, Graduate Division

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VITA

Eduard Alden Mikkelsen was born on June 14, 1933, in Augustana Hospital, Chicago, Illinois, the son of the art director of Montgomery Ward. Alden's father, who is currently a designer and builder of homes, was born in Denmark, his mother, in Chicago.

Alden's early education was obtained in New York, and Glen Ellyn, Illinois. At the age of eight he moved with his family to Lewistown, Montana. His secondary schooling completed in Lewistown, he enrolled in the school of agriculture at Colorado A and M in Fort Collins, Colorado. Schooling was interrupted at the end of the first year by his enlistment in the United States Army. After spending two years in the Army, during which time he was stationed in Korea and Japan, he continued his undergraduate study at Colorado State University, and, in 1957, graduated with a degree in Humanities.

After serious deliberation, Alden returned to school at Montana State College to further his learning in the field of education and to study for a Master's degree in art.

He has taught art and English at Marysville Union High School, Marysville, California, and is currently teaching art at Yuba Junior College in Marysville, where he lives with his wife and two children.

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TABLE OF CONTENTS

ABSTRACT

The area surrounding Marysville, California, was explored for sources of clay lending themselves to development as clay bodies. A total of twenty-two clays were found in a radius of sixty miles of Marysville. These clays were subjected to simple tests to determine their usefulness. On the basis of these tests, two clays were selected and developed for classroom use, one a low fire clay, the other a high fire clay. Permission was obtained from the landowners to use the clay in the Yuba College Art Department.

INTRODUCTION

The purpose of this thesis is not merely to fulfill degree requirements but to try to give myself and my students the opportunity to become more completely involved in the making of a pot.

As a potter and teacher of ceramics I was faced with the problem of setting up a ceramics laboratory. One of the decisions was what clay to use. There were two possibilities; one, select a commercial clay that would be suitable; the other, discover and use a local clay. The factors involved in arriving at this decision were cost, ease of handling, preparation time, contribution to the development of the creative process and involvement of the student. As far as the cost was concerned, not much money could be saved by using a local clay. It would be much easier and much cleaner to purchase commercial clay in plastic bags. The usually important odds seemed to be in favor of selecting the commercial clay. However, if this were done we would eliminate the involvement of the individual in digging and mixing his own clay, and the opportunity to feel and see the character and potential of his clay, from the beginning to the end product. For these reasons, which contribute to the development of the individual's creative potential, it was decided to use local clays. The potter who has developed his finished product from the earth to the final firing will undoubtedly derive far greater satisfaction from his creation and may incidentally produce a superior end result.

STATEMENT OF THE PROBLEM

The problem in this thesis was to discover and develop native clays surrounding the Marysville, California area. The clay deposit had to be easily accessible, within short driving distance of Marysville, and large enough to warrant its useage in a classroom situation. Since very few clays can be used for wheel thrown and hand constructed objects as they are found, it was assumed that some commercial additive would have to be used. However, if the additives necessary to make the clay useable exceeded 30 per cent of the body, the clay would be abandoned for reasons of economy.

PROCEDURE

Because I was interested in the discovery of clay, I contacted, as a source of information, Gladding McBean Clay Company in Lincoln, California, about 20 miles from Marysville.

Mr. Ed Goin of Gladding McBean took me through their plant where I had the opportunity to observe commercial clay preparation. Mr. Goin knew of no undeveloped clay bed in the area not leased by his company. However, he gave me three samples of clay they had found and not yet used, and referred me to the Division of Mines in San Francisco for further assistance.

Mr. R. R. Kelley of the Division of Mines informed me of a survey being made of the mineral resources of Placer County. At the writing of this thesis the report had not yet been completed. However, a report of California clay was included in Mr. Kelley's letter. The following is taken from the report:

> "California yields annually more than 2 million tons of common clay which is mined from Recent floodplain and alluvial deposits and from Mesozoic shale. Common clay production is centered in the Los Angeles and San Francisco metropolitan areas.
>
> "The yearly production in California of fire clays amounts to about 5,000,000 tons. These clays are of residual and sedimentary origin, and of Eocene and Paleocene ages. They are mined along the western foothills of the Sierra Nevada and around the northern part of the Santa Ana Mountains south of Los Angeles. Sedimentary fire clays also occur in a narrow belt in eastern Alameda County near San Francisco. Fire clay of hydrothermal origin occurs at Hart in eastern San Bernardino County, near Casa Diablo Hot Springs in southern Mono County and in Jawbone Canyon in Kern County. Small amounts of ball clay are mined from the central Sierra Nevada foothill belt. From 10,000 to 15,000 tons of bentonitic clay is produced annually in California and is obtained principally from the Mojave Desert-Owens Valley region and from San Benito County south

of San Francisco."[1]

The reference in the above report to clay beds in the Sierra Nevada Mountains gave me a start in my clay explorations. A trip to Challenge, in the Sierras, resulted in the discovery of nine clay beds in road cuts. Later in October another exploratory trip was made in the Sierra Nevadas, east of Oroville, up the Feather River Canyon. Only two samples were taken here, both of which were very crumbly and hard.

From the science department of Yuba College I obtained a book on the ceramic industry of California. This book described another clay source:

> "Deposits of high-grade clay have been reported from numerous localities in Butte County, especially within a radius of 12 miles from Oroville, the county seat, but only one of these has been developed. Common brick clays are plentiful at many places in the valley region east of the Sacramento River, and northwest of the Feather River, and in some of the Neocene River channels at higher elevations.
>
> "Beginning at a point two miles north of Oroville, and extending northward for nearly eight miles to Pentz and Cherokee, the Ione formation has been traced."[2]

The following further explains the Ione formation:

> "During the Paleocene and Eocene epochs, California's climate was warm and moist and much of the present land surface was inundated by

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[1]George B. Cleveland. Bulletin 176--"Mineral Commodities of California." California Division of Mines, San Francisco, California, p. 131.

[2]Waldemar Fenn Dietrich. "The Clay Resources and the Ceramic Industry of California." California State Printing Office, Sacramento, California, p. 64.

shallow seas. These conditions favored deep chemical weathering and the deposition of sedimentary clays in the lagoons that bordered the inland seas. During this time the principal deposits of high-grade ceramic clays in California were formed. The clay-bearing Ione formation is exposed along the eastern margin of the Great Valley of California, and the Tesla formation is correspondingly exposed on the western margin. These two sedimentary units are similar and may be separate occurences of the same formation. The most productive of their contained sedimentary clay deposits are at Ione in Amador County, Lincoln in Placer County, and at Tesla in Alameda County...

"...The Ione formation consists mostly of sand and clay-sand mixtures, with local beds of clay, shale, siliceous gravel, conglomerate and lignite. The formation was deposited in a lagoon environment and therefore shows a wide range in thickness and lithology within a given basin and from one basin to another. The clay-rich bodies occur as beds and lenses and commonly consists of clay-sand mixtures with a sand content that ranges from a few per cent to 60 per cent. Other beds within the Ione formation are composed essentially of sand and a small proportion of anauxite (Allen, 1929). Although most of the clay is of sedimentary origin, and was derived from the crystalline rocks of the Sierra Nevada, minor residual deposits are developed on Jurassic metamorphic rocks adjacent to the Ione deposits."[3]

It was after reading the preceeding that I went back to Oroville to find the Ione formation. I located the formation 5.6 miles north of Oroville on the John McAndrews ranch. Mr. McAndrews gave me permission to take a sample of the exposed clay.

My next important clay find developed out of a conversation with Mr. Jack Windsor of Chico State College. He suggested I try to locate some clays in the Salt Creek area. I found a good source of clay on Salt Creek that works well for an earthenware clay body. Permission was obtained to use the clay for the classroom from the landowner, Mr. Richard Charter.

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[3]Cleveland, op. cit., p. 135.

My remaining clay samples were supplied by Mr. Hayes of the Division of Highways in Marysville. The Division of Highways took core samples of proposed roadways and numerous clay deposits were found.

When I had found 22 clay sources, I subjected the clays to simple tests to determine their usefulness as a clay body. Since I wanted to find a clay that could be used in as close to its natural state as possible, I selected only a few basic ingredients to add to the clay to develop it. Ball clay was added for plasticity, if small coils of clay broke when bent, indicating excessive shortness. A test, with clay bars 14 centimeters long, 4 centimeters wide, and 1 centimeter thick, on which a 10 centimeter mark was made, indicated the amount of dry and fired shrinkage. If the clay shrank over 15 per cent this was considered too high and grog was added in an attempt to lower the shrinkage. When the piece was fired to the desired temperature a simple test was made to determine its maturity by touching it with the tongue. If the tongue stuck it meant the clay was not mature and feldspar was added to lower its maturing point. If, after firing, a white scum appeared on the surface of the clay, barium carbonate was added to render the soluble sulfides insoluble. If the total of these ingredients made up over 30 per cent of the clay body, it was decided that the clay was unsatisfactory for our use.

Once a clay was satisfactorily developed, samples of thrown, coiled and pinched pieces were made to determine the worth of the clay body. From these tests, two good clay bodies were developed. The results of these tests will be found in the following tables.

Table I: Clays without additives

Map No.	Clay	Location	Plasticity	Color and Shrinkage			Foreign Matter
				Dry	Cone 05	Cone 8	
1	Spring Valley	Spring Valley Road	Little short	Brown 9%	Brick red	Melted and separated	Rocks and weeds
2	Dobbins Turn Off	Browns-valley	Very short	Dark ochre and iron 2%	Brick red 5%	Melted to a glaze	Much sand
3	Challenge 3	Past Dobbins Turn Off	Very short	Light pink 8 1/2%	Red orange 10%	Light pink 12%	None
4	Lone Tree	Dobbins	Short	Ochre rust 6%	Brick red light 12%	Brick red light 14%	Little plant matter
5	New Ochre	Dobbins	Very short	Ochre black olive 2%	Brick red 6%	Melted to a glaze	Much sand
6	New Road Pink	Dobbins	Too short	Pink and white 5%	Grey 5%	Grey 7%	None
7	Dobbins 9	Stanfield Hill	Short	Ochre Iron black 2%	Brick red 5%	Melted to a glaze	Much sand
8	Challenge 9	9 miles to Challenge	Short	Pink red 9%	Brick red 12%	Was not fired to cone 8	None
9	Wood Orange	6 miles to Challenge	Short	Light orange 5%	Brick red light 10%	Brick red light 13%	None
10	Brownsville 1	1st spot north of Brownsville	Short	Light tan orange 4%	Brick red light 8%	Lighter red 10%	None
11	Sawmill Pink	By Challenge sawmill	Short	Pink orange 5%	Red orange 9%	Pink orange 13%	None

Table I (Continued)

Map No.	Clay	Location	Plasticity	Color and Shrinkage			Foreign Matter
				Dry	Cone 05	Cone 8	
12	Oroville 1	East of Oroville	Very short	Light green black 2%	Brick red 4%	Melted to satin brown glaze	Sand
13	Oroville 2	By Cooley Drive	Very short	Light olive tan 2%	4%	Melted to satin brown glaze	Sand
14*	Oroville Buff	North of Oroville	Good	Buff 3 1/2%	Pink buff 7%	Buff 10%	Sand
15	Meridian Blue	West of Meridian	Excellent	Light blue 5%	Brick red 11%	Melts and separates	None
16	Salt Creek II	Salt Creek	Good	Tan 9%	Brick red 16%	Melts to a red brown glaze	None
17*	Salt Creek I	Salt Creek	Little short	Light green 4%	Brick red 9%	Melts to a dark brown glaze	None
18	Yolo Brown	Woodland	Good	Light brown 5%	Brick red 12%	Melts to a red brown glaze	Small plant matter
19	Wheatland	Wheatland	Good	Dirty brown	Supplied by Gladding McBean and was not fired.		None
20	Gladding McBean Ball	Lincoln	Very plastic	White	Supplied by Gladding McBean and was not fired.		None
21	Livermore	Livermore	Good	Light brown	Supplied by Gladding McBean and was not fired.		Small plant matter
22	US 40 Buff	Highway 40	Very short	Buff 4%	Buff 7%	Chocolate 9%	None

*Indicates clays selected for use.

Table II: Clays with additives

Map No.	Clay	Additions up to the maximum	Results	Conclusion
1	Spring Valley	20% ball 10% 40 mesh grog	Suitable for throwing	Abandoned: too much foreign matter, supply limited
2	Dobbins Turn Off	None	Too hard to work as a clay body	Forms very good brown glaze at cone 8
3	Challenge 3	30% ball	Much too short to use as a body	May be useful as a refractory
4	Lone Tree	30% ball	Much too short; did not mature at cone 8	May be useful as a refractory
5	New Ochre	None	Too hard to work as clay body	Forms a very good brown glaze at cone 8
6	New Road Pink	None	Much too hard to break up	Abandoned
7	Dobbins 9	30% ball	Much too short	Forms a very good dark brown glaze at cone 8
8	Challenge 9	30% ball	Much too short	May be useful as a refractory
9	Wood Orange	30% ball	Much too short	May be useful as a refractory
10	Brownsville 1	30% ball	Much too short	May be useful as a refractory
11	Sawmill Pink	30% ball	Much too short	May be useful as a refractory

Table II (Continued)

Map No.	Clay	Additions up to the maximum	Results	Conclusion
12	Oroville 1	None	Much too short and hard for a clay body	Useful as a glaze at cone 8
13	Oroville 2	None	Much too short and hard for a clay body	Useful as a glaze at cone 8
14*	Oroville	1% Barium Carb. 10% 40 mesh grog 5% Feldspar 15% Ball clay	Excellent for thrown slab and coil construction	Used as a stoneware clay body
15	Meridian	10% 40 mesh grog	Excellent for thrown slab and coil construction	Could be used when land is excavated for a new bridge
16	Salt Creek II	10% ball 10% 40 mesh grog	Good for thrown slab and coil construction	Shrinkage too high for a clay body
17*	Salt Creek I	1% Barium Carb. 10% 40 mesh grog 18% Ball clay	Excellent for thrown slab and coil construction	Used as a low fire clay
18	Yolo Brown	10% ball	Good for thrown construction	Could be used when land is excavated
19	Wheatland	None	Good plastic clay with potential	Abandoned; clay site owned by Gladding McBean
20	Gladding McBean Ball	None	Very plastic ball clay	Abandoned; clay site owned by Gladding McBean
21	Livermore	None	Good plastic clay with potential	Abandoned; clay site owned by Gladding McBean
22	US 40 Buff	30% ball	Still too short	May be useful as a refractory

*Indicates clays selected for use.

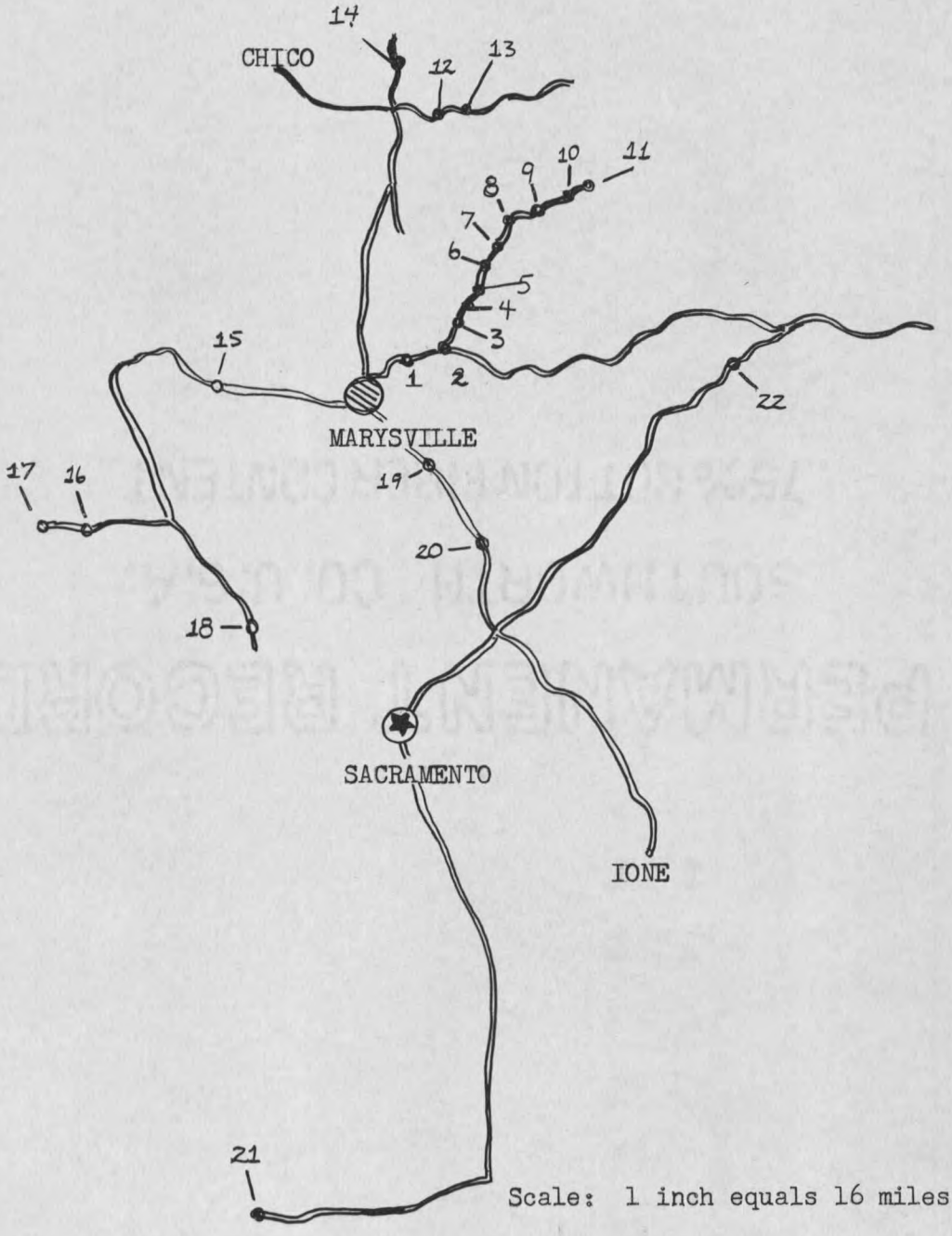

Figure 1. Map showing clay locations.

Figure 2. Location of Salt Creek I

Figure 3. Close-up of Salt Creek I

Figure 4. Location of Oroville Buff

Figure 5. Close-up of Oroville Buff

Figure 6. Pots made of Salt Creek I Clay

Figure 7. Pots made of Oroville Buff Clay

CONCLUSION

The two clays I have selected from the total discovered, have proven very successful. Oroville Buff, the stoneware clay, is found in large outcroppings of the Ione formation. Easily dug and mixed into a clay body, it is quite versatile as charted in tables I and II. As with most clays, it works much better when aged. Salt Creek I, the earthenware clay, is found on a huge exposed hillside near a dry creek bed. It is extremely easy to make into a slip and can be used for the development of almost any idea conceived by the potter. Interestingly this clay at cone 04 is an earthenware body, at cone 2-4 is self glazing, and at cone 8 is a dark brown glaze. A palette of glazes is being developed for both clays and so far all fit well.

Many other good clays were found but not used for reasons listed in tables I and II. Assumedly many good clays lie undiscovered in this area and elsewhere. Herein a challenge remains for others. Any potter who has not yet found and used a native clay has the opportunity to do so and the opportunity to play a greater part in the development of his ceramic creation.

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