EXPERIMENTS IN THE DECORATIVE USE OF VITREOUS ENGOBES

DISSERTATION
Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By
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Because of the nature of this dissertation, which is concerned with both aesthetic and technical problems, it is necessary to present the body of work in two parts—the written text and the pottery examples.

The formal research material and general discussions are set forth in the written section, and this material is to be considered an accompanying text to clarify and to supplement the results obtained from the development of the exhibition pieces.

The exhibition of pottery, which constitutes the major part of the dissertation, is comprised of selected examples chosen from numerous experimental pieces evolved while exploring the decorative possibilities of the vitreous engobe. The exhibition pieces represent the various decorative techniques found suited to the nature of vitrified engobes along with the aesthetic realizations made from adapting pottery forms to a particular decorating material.
CATALOGUE OF PIECES PRESENTED IN THE EXHIBITION

1. FLOWER POT WITH WHITE AND BROWN ENGOBE

Stoneware. Height 63/4 in.; diameter 62 in.

The flowerpot was made from a coarse stoneware clay, firing to a dark brown color. A white engobe and a dull brown engobe were poured alternately around the pot to create vertical stripes following the contour of the form. The flowerpot is illustrated in Figure 2, page 70.

2. BOTTLE WITH YELLOW ENGOBE

Stoneware. Height 73 in.; diameter 4 in.

The bottle was made from stoneware clay containing some sawdust, vermiculite and granular ilmenite. Small pits and speckles appeared on the surface of the clay which fired to a warm beige color. A thin application of yellow engobe was poured over the exterior; the interior was glazed with a dark brown slip-glaze. The bottle is illustrated in Figure 3, page 71.

3. BOTTLE WITH BLUE ENGOBE

Stoneware. Height 13 in.; diameter 72 in.

The bottle was formed from stoneware clay having slight additions of granular ilmenite, which produced brown and yellow-brown spots in the fired glaze. A brown engobe was poured over the surface of the pot, and a mat glaze was applied on top of the engobe. The resulting color was blue-green in areas where the engobe was thin and blue-brown where the engobe was thick. The bottle is illustrated in Figure 4, page 72.

4. COVERED JAR WITH BROWN AND BLUE ENGOBE

Stoneware. Height 113 in.; diameter 53 in.

The covered jar was made from stoneware which burned a dark orange-brown color. Two engobes were poured over the exterior of the jar in panels. A tan semi-mat glaze was applied over the exterior and interior of the pot. The two wider panels of blue engobe produced a grey-green color, and the two narrower panels of brown engobe resulted in a dark brown color. The foot was left unglazed. The covered jar is illustrated in Figure 5, page 73.
5. BOTTLE WITH SPECKLED ENGObE

Stoneware. Height 8 3/4 in.; diameter 4 1/4 in.

The bottle was made from stoneware clay, firing a dark brown color. The sides of the form were pinched while the pot was still damp. A speckled brown engobe was poured in overlapping areas around the pot, and a white mat glaze was applied over the engobe. The granular ilmenite and the iron present in the engobe composition produced a speckled surface of orange and brown spots. The bottle is illustrated in Figure 6, page 74.

6. BOTTLE WITH GREY ENGObE

Stoneware. Height 7 3/4 in.; diameter 4 3/4 in.

The bulbous bottle form was made from stoneware clay which burned a dark brown. A ground coating of grey engobe was sprayed over the form before it was dipped in a contrasting black-brown glaze. Since the bottle was only partially immersed in the glaze, circular areas following the contour of the pot resulted. The texture of the engobed area is rough while that of the glazed surface is contrastingly smooth and waxy. The bottle is illustrated in Figure 7, page 78.

7. BOTTLE WITH BLUE ENGObE

Stoneware. Height 13 in.; diameter 6 1/8 in.

The bottle was made from coarse stoneware clay having additions of sawdust and vermiculite. Vertical impressions were made in the wet clay, and a blue engobe was poured over the form. A white mat glaze covered the engobe and resulted in a violet-blue color where the glaze was thin, and a white or grey-blue color appeared where the glaze was thick. The bottle is illustrated in Figure 8, page 82.

8. FLOWER POT WITH BLACK ENGObE

Stoneware. Height 6 3/4 in.; diameter 10 1/2 in.

The flowerpot was made from stoneware clay, burning a dark brown. A light speckled engobe was poured over the exterior of the pot with spiraling brush strokes of black engobe being applied on top. A white semi-transparent glaze was applied over the exterior decoration, and a blackish-green glaze was applied to the interior. The bottom portion of the pot was left unglazed, revealing the warm-brown color of the reduced clay body. The flowerpot is illustrated in Figure 10, page 88.
9. **LAMP BASE WITH WHITE AND BROWN ENGOBE**

Stoneware. Height 15\(\frac{1}{2}\) in.; diameter 6 in.

The lamp base was made from stoneware clay, having granular ilmenite added to the clay body. A white engobe was poured over the form, and a repeat pattern of vertical strokes was applied with dark brown engobe over the white ground. The white engobe shows specks resulting from the granular ilmenite, and the brown engobe varies in color from dark brown to orange. The sgraffito technique was used to accentuate the shape of the decorative motif. The lamp base is illustrated in Figure 11, page 89.

10. **FLOWERPOT WITH BLACK AND WHITE ENGOBE**

Stoneware. Height 6 7/8 in.; diameter 8\(\frac{3}{4}\) in.

The unglazed stoneware surface of the flowerpot served as a background for the slip-trailed decoration of black engobe. The clay, which had additions of sawdust, vermiculite and granular ilmenite, burned a warm orange-brown. Dots of white engobe were used to accent the diamond-shaped areas formed by the black engobe. The flowerpot is illustrated in Figure 12, page 94.

11. **COVERED JAR WITH BROWN ENGOBE**

Stoneware. Height 10 3/4 in.; diameter 4 3/4 in.

The covered jar was made from a stoneware clay which fired a light beige color. Slip trailing was the decorative technique used. Vertical lines of brown engobe were trailed around the outside of the form, and dots of the same engobe were placed in a vertical grouping between the trailed lines. The inside, lip-rim and knob were glazed with a dark brown mat glaze, and the decorated exterior and the lid were glazed with a thin coating of white semi-transparent mat. The covered jar is illustrated in Figure 14, page 96.

12. **BOTTLE WITH GREY AND WHITE ENGOBE**

Stoneware. Height 11 in.; diameter 7 in.

The bottle form was made from a coarse red stoneware clay which fired a dark brown color. A black engobe was poured over the exterior surface of the pot, and a white engobe was applied over this coating in small tear-drop shapes. The semi-transparent glaze which was poured over the exterior caused the black engobe to turn a soft green. The inside was glazed with a black-brown glaze. The bottle is illustrated in Figure 15, page 97.
13. BOTTLE WITH WHITE AND BROWN ENGOBE

Stoneware. Height 10 1/2 in.; diameter 6 in.

The bottle was made from a stoneware clay which fired to a dark brown. Additions of vermiculite, sawdust and granular ilmenite produced a rough pitted texture on the surface of the form. Two engobes were used as decorative coatings. A panel of white engobe was poured over a wax-resist pattern, and a greenish-brown engobe was applied over the remaining portion of the bottle with the overlapping areas turning a yellow-green. The bottle is illustrated in Figure 16, page 103.

14. FLOWERPOt WITH SPECKLED ENGOBE

Stoneware. Height 5 3/8 in.; diameter 12 in.

The flowerpot, formed from a stoneware clay body to which vermiculite, sawdust and granular ilmenite were added, fired a dark purplish-brown. The pot is unglazed, and the exterior is covered by a wax-resist pattern of white speckled engobe. The flowerpot is illustrated in Figure 17, page 104.

15. VASE WITH WHITE ENGOBE

Stoneware. Height 14 1/8 in.; diameter 4 in.

The vase was made from a dark-burning stoneware clay. Decorative panels of white engobe were formed by the wax-resist technique. Granular ilmenite added to the white engobe produced dark brown specks which burned through the covering semi-transparent glaze. The vase is illustrated in Figure 18, page 105.

16. BOTTLE WITH DARK RED ENGOBE

Stoneware. Height 6 in.; diameter 5 in.

The almost-spherical bottle was made from a red stoneware clay, having additions of vermiculite, sawdust and granular ilmenite. In areas where the clay body was exposed, a dark metallic brown color resulted. A spiraling pattern of wax-resist was applied to the surface of the bottle, which was then covered with a copper-bearing engobe and a semi-transparent glaze. The engobed and glazed areas turned a dark red color with pits of orange-brown. The bottle is illustrated in Figure 19, page 106.

17. BOTTLE WITH GREEN ENGOBE

Stoneware. Height 18 1/2 in.; diameter 7 in.
The bottle was formed from red stoneware clay which fired dark brown. Horizontal stripes of dull green engobe were revealed where the wax-resist pattern was applied. Alternating with the green stripes are black ones which were formed by pouring a black-brown glaze over the entire surface after the wax-resist had been applied. The interior of the pot was glazed with a white mat glaze. The bottle is illustrated in Figure 20, page 107.

18. BOTTLE WITH BLUE AND WHITE ENGobe

Stoneware. Height 9 1/2 in.; diameter 4 3/4 in.

The bottle was made from a stoneware clay body which fired a dark metallic brown. Two panels of white engobe were poured over the exterior of the form, and two alternating panels of grey-blue engobe covered the remaining portion of the pot. On the blue panels two spirals were sgraffitoed, revealing the dark brown clay underneath. The interior of the pot was covered with a black glaze. The bottle is illustrated in Figure 21, page 113.

19. BOWL WITH WHITE ENGobe

Stoneware. Height 3 7/8 in.; diameter 13 in.

The bowl was made from a dark-burning stoneware clay which contained some granular ilmenite. A white engobe was poured over the outside of the bowl, firing white in the areas where it was thickest and turning a soft beige color in those areas where it was applied thinner. A series of lines was scratched through the white engobe in horizontal bands. The inside of the bowl was glazed with a black-brown glaze which fired to an olive green color in areas. The bowl is illustrated in Figure 22, page 114.

20. VASE WITH BLUE ENGobe

Stoneware. Height 14 1/2 in.; diameter 4 1/2 in.

The vase was formed from a red stoneware clay which turned a beige color. A blue engobe was poured over the exterior surface, and diagonal lines were sgraffitoed through the engobe. The covering glaze, which was a translucent mat, turned the engobe a blue-violet, the sgraffitoed lines becoming white under the glaze. The vase is illustrated in Figure 23, page 115.

21. FLOWER Pot WITH BROWN ENGobe

Stoneware. Height 9 3/8 in.; diameter 11 1/2 in.

The flowerpot was made from a cream-colored stoneware clay, having additions of vermiculite, sawdust and granular ilmenite. Where
the clay body was exposed, it burned a beige color. A dull-brown engobe was poured over the outside of the pot, and vertical lines were sgraffitoed through the engobe. The flowerpot is illustrated in Figure 24, page 118.

22. COVERED JAR WITH BROWN ENGOBE

Stoneware. Height 10 3/4 in.; diameter 6 in.

The covered jar was made from cream-colored stoneware which fired a light beige color. Vertical strips of textured pattern were achieved by the use of the mishima technique. A dark brown engobe was brushed into the impressions. The lip-rim, knob and interior of the pot were glazed with a black-brown mat glaze. A light salt glaze covered the exterior of the jar. The covered jar is illustrated in Figure 25, page 121.

23. VASE WITH BROWN ENGOBE

Stoneware. Height 15 in.; diameter 4 1/2 in.

A red stoneware clay was used in forming this vase, and the resulting color of the clay body was yellow-brown. A pattern of deeply impressed vertical lines and shallow notches was applied to the exterior of the form, a brown engobe filling the impressions. Except for the wide rim, the exterior of the pot was covered with a dull brown engobe; the interior and rim were glazed with a black-brown mat glaze. The vase is illustrated in Figure 26, page 122.
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INTRODUCTION

One of the most familiar decorative materials known to the potter is the slip or engobe,\(^1\) which is recognized as having extensive application to both studio and industrial pottery. Although engobes have been used frequently by contemporary potters for decorative reasons and technical purposes, they have never been well defined or differentiated in terms of their composition or physical appearance.

Since the action of the engobe as a decorative material may vary considerably depending upon the composition, and consequently the extent to which the engobe approaches vitrification, it is necessary to make a distinction between the vitreous engobe and the non-vitreous engobe. The essential purpose of the written text is to consider the differences that exist between these two types of engobes and to develop a workable vitreous engobe which can be used in exploring the decorative possibilities of the vitreous engobe.

It is difficult, at times, to differentiate between vitrified engobes, non-vitrified engobes, and glazes. The lines of demarcation between these decorative coatings are not precise, and the empirical formulae alone fail to provide sufficiently definite evidence.

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\(^1\)The terms "engobe" and "slip" are frequently used interchangeably; they may, however, be considered to be almost synonymous. "Engobe" implies that the material envelops the entire piece of pottery and acts as a veneer to hide an undesirable surface or color; while "slip" suggests that the material is used in relatively smaller areas as a decorative medium.
It is from the state of these materials after having received a given heat treatment, one at which the materials may be considered to be mature, that one group distinguishes itself from another by its physical characteristics.

Vitreous engobes when mature appear very much like immature glaze surfaces, having a dry and somewhat coarse texture, depending upon the fineness of the particles and the extent of vitrification. Although there is an incipient melting of the fusible materials, they do not enter into a glass as completely as might be expected of a typical glaze.

Non-vitreous engobes or slips are generally composed of natural clays, sometimes with an addition of a small amount of fluxing material. This type of engobe seldom forms a hard surface, and without a covering glaze even may be chalky.

Although the rather rough surface of the vitreous engobe may be objectionable for some functional wares, it has an aesthetic appeal when applied to pottery which is appropriate to the coarse nature of this material.

Decorative slips or engobes have had an extensive historical background, and since prehistoric times have been employed by potters to provide decoration and to improve the color quality and surface appearance of their clays. It is difficult, if not impossible, to identify the vitrified and the non-vitrified engobes with any certainty, but it may be assumed that following the development of vitrified ware the vitreous engobe was also in use. Many decorative techniques used historically are explored in this dissertation and a
short chapter on the historical uses of engobes appears at the beginning of the text.

It has not been the purpose of this investigation to justify the use of vitreous engobes by means of the decorative techniques explored in my pottery; however, it can be noted that the techniques related to the vitreous engobe are in keeping with the present trends in ceramics and that they furnish many opportunities for subtle color and textural effects. Architecture, with its greater simplification of form, has provided many opportunities for the use of decorative ceramics. The extension of interiors to fuse with outdoor areas has promoted a need for garden pottery and sculpture. And the physical characteristics and durability of the vitreous engobes make them desirable decorative materials for this garden pottery.

One of the greatest advantages of vitreous engobes is that they can provide a wide variety of color and texture with the use of only one glaze. Since the coloring oxides can be introduced into the engobe, they serve also to color the superimposed glaze, and they afford a variety of color effects on a single piece. It is true that the colors resulting from vitreous engobes are more muted than those in a glaze, but this may be considered an advantage when a more neutral effect is desired.

The same engobe may be used with or without a glaze to provide two completely different effects; the former being variegated in color, and the latter being dull and matt in texture. It is also possible to obtain a variety of effects by varying parts of the glaze formula and the thickness of application. An adjustment of certain
raw materials in the glaze may produce completely different color effects. Vitreous engobes provide excellent opportunities for exploring both visual and tactile effects since they adapt themselves to uneven surfaces and provide a vehicle for carrying such coarse materials as granular manganese and ilmenite; a fact that increases their value as a means for decorating ceramic forms.

A number of different formulae were considered in this investigation. In order, however, to concentrate more thoroughly on one particular aspect of the vitreous engobe, its decorative possibilities, this research was limited mainly to one formula which exhibits the desired characteristics at stoneware temperatures of cones 8, 9, and 10. All of the pottery under discussion was fired within this range and was made from clay bodies which matured at these temperatures.

A more challenging limitation was imposed here by the use of reducing conditions in the firing process. Since the average potter is more familiar with the results obtainable in oxidizing atmospheres, it seemed that a greater contribution to ceramic knowledge could be made by working under the more unusual conditions of reduction. It was also apparent that under reducing conditions more neutral colors resulted.

The clay compositions and the forms developed from them were purposely conceived for further treatment with engobes. In order to emphasize the beauty of the engobes, the ware was kept simple and direct in the process of forming, with expanses of unbroken surface left to provide an opportunity for exploring bold decorative techniques. A number of experiments was made on the clay body to obtain textural
effects which would be in agreement with the nature of the engobes.

All of the examples selected for this investigation were formed on the potter's wheel. In some cases the wares were altered from their original shapes as conceived on the wheel to provide a greater variety of forms; the emphasis, however, was on obtaining forms and surfaces that were compatible with the vitreous engobe and that illustrated clearly its most salient features. Experiments to alter the surface appearance were an important part of the research, and foreign materials were frequently introduced into the clay body to provide more opportunities for textural effects. It may be assumed that the introduction of these non-plastic, non-ceramic materials such as vermiculite and sawdust are detrimental to the plastic throwing properties of the clay; consequently it was a challenge to use particles sufficiently large to provide texture, without destroying the plasticity necessary for throwing. The clay body which finally resulted from the experiments was used in conjunction with the vitreous engobes to enhance their individual qualities and to provide an even greater variety of surface enrichment.

Prior to the consideration of the decorative techniques and forms to be evolved, it was necessary to consider the technical problems and tests essential to the development of suitable vitreous engobes. It was decided that the decorative materials and the research involved should be limited in order to give greater emphasis to the aesthetic considerations as regards the uses of the vitreous engobes. The materials, consequently, were limited to one engobe composition, a
number of ceramic colorants and a few glazes which were to be superimposed over the engobes.

The vitreous engobe composition was one which had been altered several times to fit various clay bodies, and it was selected for its favorable reaction to colorants and its property of adhering to either greenware or biscuitware.

After the engobe to be used was chosen it was necessary to consider the color additions and combinations of colorants that would produce the most aesthetic results. Based upon previous results obtained from the additions of metal oxides, a series of tests was made adding oxides to the vitreous engobe, and from the results of these tests approximately eight engobes were selected.

Following the color experiments eight known glazes were tested for their appearance when applied over the colored engobes. Only one of these glazes, #12, proved satisfactory with all of the engobes; others were favorable to only one or two compositions.

Experiments with form were restricted somewhat by the demands of the vitreous engobe and the decorative techniques; it was found, however, that a greater realization of these forms could be achieved when they were limited to a particular shape for a period of time than when numerous divergent forms were being considered simultaneously.

\[2\] The compositions of the engobes and the glazes referred to in the text by number are to be found in the appendix.
It was not possible in this type of research to predetermine the exact approach to the investigation in terms of the number of experiments to be conducted or the engobe and the glaze compositions to be adhered to because each succeeding step required some deviation or suggested new potentials that had not previously been realized.
PART I

THE NATURE OF THE VITREOUS ENGOBE

AND ITS BACKGROUND
CHAPTER I

A HISTORICAL INTRODUCTION

It is not difficult to search into the ways in which slips have been employed in the history of ceramics either as decorative materials or as coatings to cover and enhance the appearance of poor clays, but determining the extent to which these engobes were vitreous is a far more difficult problem. Many natural clays and pigments that might fuse or melt at relatively high temperatures could appear as vitreous engobes, and investigations in several museum collections failed to provide any conclusive evidence that the vitreous engobe, as described in this paper, was ever in use prior to the twentieth century.

The differences between a clay slip which does not vitrify and a vitreous engobe are discussed at some length in Chapter II, and in cases where the vitreous engobe is used alone and without a glaze coating, its detection is not too difficult. Most potters who have advanced technically to the point of producing vitrified wares have also developed glazes to a high degree, and these glazes with their fluxing action tend to obscure the identifying characteristics of the vitreous engobe.

The identification of vitreous engobes cannot be determined by a chemical analysis and inspection of the molecular formula but must be concluded from the appearance of the surface of the wares. Generally these examples, which appear to exhibit decorations having characteristics of the vitreous engobe burning through the surface of the superimposed glaze, are decorated with iron compounds. As already
noted, iron is a very active flux, and when combined naturally with
the clay substance it may act as a flux producing what appears to be
a vitreous engobe at stoneware temperatures.

Traditionally engobes or slips have been used most extensively as
a veneer or coating to hide an unattractive clay body or to provide a
dark body with a light-colored surface. Some early evidences of this
engobage can be found among examples of Greek pottery where light-
colored clays were brought from particular areas such as Melos, and
these clays were used as coatings to cover red burning clays. It is
suggested that white lead may have been added to the lighter clays,
and as a result of this addition of fluxing material a low-fire
vitreous engobe may actually have been achieved. It is doubtful,
however, that such an engobe could have had any properties comparable
to a vitreous engobe fired at stoneware temperatures.

The early Egyptian potters also employed the light-burning engobe
to correct the disadvantages in color resulting from the use of dark
iron-bearing clays. Wares from the 12th Dynasty indicate that these
light engobes were applied as very fine intermediate layers between
glaze and clay body. One might speculate that this specialized use

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and Sons, 1924, p. 69.

4Samuel Birch, *History of Ancient Pottery*. London: John Murray,
1853, p. 176.

5Cullen W. Parmelee, *Ceramic Glazes*. Chicago: Industrial
of the engobe provided a more desirable background for the translucent or transparent glazes used by the Egyptians, improving the color and giving greater brilliancy to the appearance of the glaze.

The earliest vitrified wares of any great quantity can be found in the Far East, and where engobes have been employed it is possible that they were sufficiently fluxed by colorants to be considered vitreous. It is doubtful, however, that the natural clays were combined with fluxing agents and colorants to produce a variety of vitreous engobes. It is more probable that those materials used under the glaze for decorative purposes were left unrefined and in the natural state in which they were found.

The Chinese, being the first to discover stoneware and porcelain, had an abundance of white-burning clays that were used in the manufacture of these vitrified wares; the engobe, consequently, had little value as a factor in improving the color quality of the clay body. There may, however, have been other uses for the engobes, and evidences suggest that the Chinese potters of the 10th Century Sung Dynasty utilized the vitreous engobe to achieve a particular decorative effect. "The engobe was vitrified while the body was still too incompletely fired to be perfectly impermeable." Crackling of the glaze on the surface was brought about by the vitrification of the engobe it covered.

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6 It should be noted that where vitrified ware has been made, light-burning clays have generally been available, thus eliminating the need to obscure a dark body with a lighter one.

The non-vitreous engobes or clay slips in a natural form undoubtedly claim a much more ancient usage than the vitreous engobes because of their low-firing properties and easy accessibility. As decorating media, these slips have been employed since prehistoric times, and their use probably resulted from the discovery that clays from different localities or strata were of different colors, suggesting that these clays might be used in combination for decorating purposes. The preparations used by primitive man for decoration were generally ferruginous clays and powdered rocks, some being slips, and others being pigments (pigments are predominantly metal oxides).

The earliest slip decorations were applied with a brush and examples of this technique are frequently found among early Kansu wares of China, Greek and Roman pottery, and 9th and 10th Century Islamic wares. These early painted wares were generally unglazed except for the Near Eastern examples which were covered by a thin transparent glaze.

The sgraffito technique, a method of scratching through the clay slip, originated in the Far East and may be found on examples from the T'ang Dynasty. From China the sgraffito wares reached the Near East,

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8 Samuel Birch, op. cit., p. 130.


10 Terra Sigillata was a special preparation of clay slip frequently used to decorate Roman and Greek wares.
and the technique was adopted by the Islamic potters. This decorative method is probably most prevalent among examples of Italian Renaissance pottery where it is found combined with the majolica technique.

Slip trailing or the barbotine technique is a very spontaneous decorating method of applying the liquid slip in a trailed pattern over the surface of the pot. The technique is typical of the decorating method used on Pennsylvania Dutch peasant wares. It is suggested by Parmelee that the barbotine technique originated in Gaul or Germany, but examples can be found among Sassanian wares of the 7th Century.

The most complex decorative technique involving slips is the mishima technique. Mishima wares are almost exclusively confined to examples of Korean pottery. The technique suggests that of engraving and is accomplished by applying slip into an impressed pattern and scraping away the surface. Most of the slips used were lighter in color than the background; this resulted in a strong contrast between decoration and ground. Although these Korean wares were vitrified, there is no evidence that the slips were vitrified enough to fuse through the covering glaze.

All of the decorative techniques discussed were used in examples illustrated in Chapter VI, and a more complete discussion of their nature and appearance will be found in that section.


CHAPTER II

HOW THE VITREOUS ENGobe RELATES TO CLAYS AND GLAZES

Since vitreous engobes exhibit properties similar to both clays and glazes, it is essential to study their compositions in order to understand their distinguishing features. Practically all of the minerals present in ceramic raw materials can be classified as either clay minerals or non-clay minerals. It might be assumed that ceramic bodies are strictly composed of these clay minerals and that glazes are primarily comprised of non-clay minerals; it becomes apparent, however, in studying the molecular formulae of compounded glazes and clays that there is no clear line of demarcation between these presumably divergent materials, clays and glazes.

Most clays, except for pure forms such as the hydroxides of alumina,\(^{13}\) contain an appreciable amount of non-clay minerals such as those of iron and calcium. Glazes, especially those maturing at stoneware temperatures, contain considerable amounts of clay which is the source, in part, of the alumina and the silica essential to the glaze composition. It may be concluded, then, that stoneware clays and glazes are not greatly divergent in the kinds of oxides present; and that, although the amounts of these oxides may vary considerably, there is a tendency for the two to approach a common formula. They

\[^{13}\text{These hydroxides of alumina are not considered by some experts to be clay minerals, but they are comparable in structure to clay minerals. See F. H. Norton, Elements of Ceramics, Cambridge: Addison-Wesley Press, Inc., 1952, p. 13.}\]
differ chiefly in the amount of glassy phase developed during the firing.

Vitreous engobes are closer in composition to ceramic bodies than to glazes; yet they exhibit the characteristics of both in the firing. In order to make a comparison between vitreous engobes and non-vitreous engobes it is essential to consider their respective maturing temperatures or at least the temperatures at which each exhibits the characteristics that distinguish it as being different from the others. Otherwise they may exhibit overlapping qualities and make the adequate placing of them into any one category impossible. A typical example would be Albany Slip,\textsuperscript{14} which at certain temperatures below cone 6 would appear similar to a vitreous engobe, sintering but not fusing into a glass; this same material fuses into a dark brown glaze at a point above cone 6. It would seem appropriate, then, to call Albany Slip a slip glaze, or glaze, at high temperature ranges and a vitreous engobe at the intermediate range. It is understandable then that a clay "body that might be excellent at low temperatures might make an excellent glaze at porcelain temperatures."\textsuperscript{15}

The vitreous engobe used throughout these experiments has an unusually wide maturing range and is but slightly changed in appearance at any point between cone 4 and cone 10. With heat treatment above

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\textsuperscript{14} Experiments conducted in various parts of a reducing kiln indicated that Albany Slip fuses quietly into a glaze between cones 7 and 8; this is further substantiated by F. H. Norton, \textit{Ibid.}, p. 25.

cone 10 the engobe may blister, and indications are that it would fuse into a glaze, possibly at cone 12 or above. Although the fluidity of the glaze which might be applied over the engobe may contribute markedly to the appearance of the engobe, there is reason to believe that the engobe itself becomes more active in association with a glaze. This characteristic was particularly noticeable under glazes maturing above cone 7; below this range the engobe remained in place and did not burn through the surface of the glaze.

Comparing two formulae, one of a glaze and one of an engobe, which are expressed in molecular equivalents, would illustrate the similarity between the two in that they both contain materials or oxides from the three categories: basic oxides, amphoteric oxides, and acidic oxides. For example, the vitreous engobe used in this research falls between the clay body and the glaze as indicated:

<table>
<thead>
<tr>
<th>Glaze #12</th>
<th>Engobe #9^16</th>
<th>Clay Body #7^16</th>
</tr>
</thead>
<tbody>
<tr>
<td>KNaO 0.30</td>
<td>KNaO 0.40</td>
<td>CaO 0.194</td>
</tr>
<tr>
<td>CaO 0.50</td>
<td>Al2O3 1.90</td>
<td>MgO 0.173</td>
</tr>
<tr>
<td>Al2O3 0.50</td>
<td>SiO2 9.31</td>
<td>Al2O3 6.850</td>
</tr>
<tr>
<td>SiO2 2.50</td>
<td></td>
<td>SiO2 28.700</td>
</tr>
<tr>
<td>BaO 0.20</td>
<td>B2O3 0.31</td>
<td>Na2O 0.133</td>
</tr>
</tbody>
</table>

^16 The compositions of the engobe and the clay body have been expressed here in the form usually reserved for glazes, in order to make an easier comparison with the glaze.
In studying these formulae it becomes apparent that a major chemical difference between a clay and a glaze is that there is a greater amount of alumina and silica in the former. Also, one can observe that the vitreous engobe lies somewhere between the two in alumina and silica content.

Although there are similarities between non-vitreous engobes, vitreous engobes and glazes, the differences are more apparent under fired conditions than might be expected from studying merely the molecular formulae. Parmelee points out one of the major differences in his definition of an engobe:

An engobe or slip is a natural clay or mixture of clays, fluxes and non-plastics which is applied on a ceramic body to form a homogeneous, thin coating, smoothly covering all surface defects, coarse particles and harmful minerals. An essential difference between a glaze and an engobe, or underslip, is the greater amount of glassy phase in the former. If a glaze is applied on the engobe, the latter may be called an underslip.\textsuperscript{17}

The fact that there is more "glassy phase" in the glaze than in the engobe seems to be the main distinction; yet this is a rather nebulous point, especially when considering vitreous engobes or "vitrified slips," as Parmelee calls them.

From working with the vitreous engobe and observing the tests and the results of the fired wares, a number of general conclusions regarding the relationship between non-vitreous engobes, glazes and vitreous engobes is possible.

If a clay slip, such as one having the composition of body #7, a

stoneware glaze (maturing at cone 9), and the vitreous engobe #9 were all fired in the same kiln to cone 9, the differences in surface appearance would be most apparent. The clay slip would be dull and rough in texture and would not melt to an even surface. The vitreous engobe would not present an absolutely smooth surface, but it would fuse into a more even and uniform surface providing a slight sheen or luster. The glaze, provided that it was mature at this temperature, would melt into a uniform glassy surface that would not appear broken by particles of material which did not go into solution.\textsuperscript{18}

If the glaze applied over a non-vitreous engobe were semi-opaque or transparent, the engobe would not contain sufficient fluxing materials to fuse into the surface of the glaze and would, consequently, lie as a thin film beneath the glaze surface. However, if the glaze were applied over a vitreous engobe, the engobe would obtain additional fluxing materials from it, and as a result of the presence of partially fused particles which would fuse through the glaze in parts, an attractive variegated surface with a slight suggestion of a pleasant tactile texture would be achieved. Any particles of iron and cobalt or other coloring agents which would readily go into the glaze solution are aided by the partial fluxing action of the bases in the vitreous engobe and enter into the glaze to produce an irregularly colored glaze surface. This partial combination of materials from

\textsuperscript{18}In the case of a true matt, a dull surface would appear on the cooling of the glaze as a result of crystallization; the irregularities of surface, however, would differ from those appearing when certain particles do not go into solution.
the vitreous engobe and the glaze also increases the appearance of depth in the glaze.

The action of the vitreous engobe greatly affects the oxides of the low-melting metals used as colorants. Where they might seem to color a non-vitreous clay engobe, their action as colorants is reduced greatly by the lack of auxiliary fluxes; only when a glaze is superimposed over these slips do the metals provide strong color. When the same low-fusing colorants are added to a vitreous engobe, they become far more active; and although they do not actually go into solution as in a glaze, they provide soft neutral colors and a more evenly fused surface.\(^{19}\) The more refractory coloring oxides such as those of chromium, nickel, and vanadium have a great effect on the fusibility of the vitreous engobes and tend to produce a more refractory, less fusible covering. The differences of appearance in vitreous and non-vitreous engobes are less noticeable when the lower-melting metals are used as colorants. It requires a superimposed glaze to bring about the color from the vitreous engobe where the colorant is highly refractory.

Another important advantage exhibited by the vitreous engobe over a non-vitreous engobe is its ability to attach itself more closely to the surface of the pot because of its fluxing action.\(^{20}\) Although Mr. Leach in his *A Potter's Book* does not mention the use of

\(^{19}\)When the engobe formula #9 is ground prior to the addition of the colorant, this fluxing action is increased.

vitreous engobes as such, he discusses the preparation and the extensive use of clay slips which have additional fluxing material added to them. The main purpose of this fluxing material is to cause a greater bond between the slip (probably a vitreous engobe in this case) and the clay body. Where the underlying body reaches vitrification at the same time as the engobe, the bond between these vitrified slips or engobes and the pot becomes much greater.

The firing procedures and conditions in the kiln also have an appreciable effect upon the appearances of the non-vitreous engobes, glazes and vitreous engobes and many of the important differences are emphasized by the type of firing. These differences are discussed in Chapter IV.

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PART II

EXPERIMENTAL DATA
CHAPTER III
THE RAW MATERIALS AND THEIR PREPARATION

In considering the selection of materials, the clay composition is of primary importance; it must be selected or prepared in accordance with the methods of forming and the nature of the decorating media. Since throwing on the wheel was the forming method selected for this particular research, it was necessary to have a stoneware body that would combine the plasticity and the strength needed to meet the demands of wheel-thrown forms. A clay body which is made up wholly or largely of natural stoneware clays is more desirable than a compound or synthetic paste because the long weathering and combining by natural forces it has undergone provide a much more intimate union of materials and a much more workable substance than man has been able to produce. Generally, however, a natural clay requires some alternation to permit it to mature under a particular heat treatment; yet it must also maintain the desired plasticity without being so fine-grained that the interstices between the particles absorb water rapidly and the mass breaks down.

Table 1 on the following page lists the compositions of the various clay bodies tested. The body selected for most of the experiments in this research was body #7. It is a light creamy orange body which fires to a dark brown in reduction and has excellent throwing properties when aged for about two weeks.

Another clay, an alteration of #7, was developed to change the
**TABLE 1**

**CLAY BODY TESTS**

<table>
<thead>
<tr>
<th>Raw Materials</th>
<th>#1</th>
<th>#2</th>
<th>#3</th>
<th>#4</th>
<th>#5</th>
<th>#6</th>
<th>#7</th>
<th>#8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watt Stoneware Clay</td>
<td>40</td>
<td>40</td>
<td>45</td>
<td>40</td>
<td>50</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Dalton Clay</td>
<td>25</td>
<td>20</td>
<td>15</td>
<td>25</td>
<td>25</td>
<td>10</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Tennessee Ball Clay #7</td>
<td>35</td>
<td>30</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>30</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>Keystone Regular Feldspar</td>
<td></td>
<td>10</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bentonite</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potter's Flint</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jordan Stoneware Clay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barnard Clay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grog (35 Mesh)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The grog and bentonite were not calculated into the percentage batch.
tactile and visual qualities and to add a speckled quality to the glazes which would be used over the engobes. These effects were achieved by a number of experiments in which sawdust and ground corn-cobs were used as additions, the organic substances burning out during the firing and leaving an interesting broken surface.

It was discovered as a result of these experiments that coarse particles of foreign substances decreased the plasticity to a great extent; consequently it was necessary to decrease the particle size by screening the material through a 20 mesh screen. Also it was noted that if the volume of sawdust added exceeded one-third the total mixture, it was impossible to throw the resulting body without its breaking and crumbling. Best results were obtained with the addition of equal parts of sawdust and vermiculite, 0.6% granular manganese dioxide, 1% granular ilmenite, and 2% ferric oxide. Both the granular ilmenite and manganese dioxide produced pleasant speckling in the clay body along with the voids left by the burned-out sawdust and vermiculite. A warm orange speck remained where the sawdust had been, and a purple cavity was left in place of the vermiculite.

Two other bodies were used in forming approximately twenty-five pots. Since these were commercially-prepared bodies sold by the Italian Terra Cotta Company in Los Angeles, and the Westwood Ceramics Supply Co. of Westwood, it was impossible to obtain the recipes.

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22 The Italian Terra Cotta Clay Company of Los Angeles supplies a clay called "terra cotta red"; the Westwood Ceramics Supply Company of Westwood, California supplies a clay called "WC-33-10."
The red body, sold by the Italian Terra Cotta Company, was a very smooth mixture that was extremely plastic but that did not hold up well during the throwing. This clay body was colored by a natural red clay mined at Alberhill, California, and it was noticed that the refractory nature and highly plastic qualities of the Alberhill were similar to those of the Dalton Ball Clay. The Westwood body was a buff-burning stoneware mixture which had excellent plasticity and structural strength but did not fire to a pleasant color. A combination of the two clays was found most satisfactory, providing excellent throwing properties and a pleasant warm-brown color in reduction.

Following the selection of the clay body, the clays and fluxes were chosen for testing the engobe composition. The four important properties to be considered in this selection of raw materials are suggested by Parmelee as (1) whiteness, (2) good covering power, (3) suspension, and (4) adhesive power.23

The adverse effect that a dark engobe would have on color additions makes the maintaining of a relatively white base engobe desirable. Thus it is necessary to have an abundance of ball clay in the engobe in order to permit the engobe to shrink at the same rate as the walls of the pot. In these particular experiments the vitreous engobes were applied almost exclusively to bone-dry ware, which necessitated a lower degree of shrinkage than would be required of engobes applied to leather-hard wares. For this reason a plastic

kaolin, which had a lower shrinkage than ball clay, was selected.

Parmelee has listed the following compositions as suitable for application on the wares as indicated: 24

<table>
<thead>
<tr>
<th>CLAY CONTENT</th>
<th>BISCUIT</th>
<th>LEATHER HARD</th>
<th>BONE DRY</th>
</tr>
</thead>
<tbody>
<tr>
<td>china clay</td>
<td>15-20%</td>
<td>25-65%</td>
<td>15-25%</td>
</tr>
<tr>
<td>ball clay</td>
<td>10%</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>

The engobe in the bone-dry stage or in the biscuit stage offers its greatest suitability for application because in these stages there is greater consistency of application and easier handling of the ware. When applied on biscuit there is greater danger of its rubbing off prior to firing. Another reason for applying engobes to biscuit or dry ware is that the light burning clays in the engobe composition tend to shrink less than the darker clays, of which the body of the pot may be formed. 25 The use of the body clay as a base for the engobe provides the advantage of securing better adhesion in the unfired state and a better fit during the drying and firing shrinkages. 26

The fluxes constitute an essential group or class of ingredients in the vitreous engobe. Although these fluxes may be present to a small degree in a non-vitreous slip, they are not sufficient to cause

24 Ibid., p. 76.
25 Bernard Leach, op. cit., pp. 53-54.
26 Cullen W. Parmelee, "Engobes, Slips and Underslips," Ceramic Industries, XLVII (February 1946), p. 76.
vitrification. "All engobes are sintered or vitrified to a greater or less degree."27 The flux not only serves partially to fuse the particles of clay substance in the formulae but also aids in making a more elastic coating of the engobe which must adjust to the much thicker body underneath.

The most common fluxes for a complex compounded engobe are: feldspar, cornwall stone, and whiting. Fluxes more limited in use are magnesium carbonate, barium carbonate, bone ash, zinc oxide, mica and lead oxides.28 In the particular engobe formula used in these experiments, it was desirable to have a high alkaline content to aid in producing certain color effects, such as copper reds.

Nepheline syenite is a rather consistent mineral in composition which is high in soda and alumina. Parmelee suggests that sodium carbonate helps to make a bond between the engobe and the clay.29 The nepheline syenite furnishes the main fluxing ingredients in the engobe. An additional flux of whiting proved to be most effective in controlling the fluidity of the engobe. Whiting is an unusually powerful flux, and in a later experiment when an equal amount of whiting replaced the borax, the engobe became far more active under the more viscous glazes. Parmelee notes that calcium carbonate (whiting) is

27Ibid., p. 78.
28Ibid.
29Ibid., p. 80.
a powerful accessory flux in the presence of feldspathic materials.\textsuperscript{30} An additional flux of raw borax was added to the engobe composition to help lower the maturing temperature and to increase the alkalinity. This borax served another function later in the breakdown of the particle size. Borax serves the additional purpose of producing a hard surface when the engobe dries, permitting easier handling.\textsuperscript{31} It may be noted that engobes which are used as undercoatings for a glaze may be fluxed also by adding about 10\% of the glaze to the engobe composition (this would of course present a variable with each glaze used).\textsuperscript{32} Although the borax is helpful in producing a more alkaline solution, it has the great disadvantage of being soluble in water.

Sufficient flux is necessary to help the engobe to adhere to the pot, but an excess of flux can destroy the whiteness of the engobe; especially when applied over a heavy-iron-bearing clay. The fluxes act with the iron in the body and grey the engobe.\textsuperscript{33}

A most important ingredient in the engobe is the flint which aids in fitting the engobe to the body and also aids in forming the glassy or semi-vitreous surface. Flint is a non-plastic material which reduces the shrinkage of the engobe. Flint also helps in

\textsuperscript{30}Ibid., p. 78.
\textsuperscript{32}A. B. Searle, op. cit., p. 17.
\textsuperscript{33}Cullen W. Parmelee, "Engobes, Slips and Underslips," Ceramic Industries, XLVII (February 1946), p. 80.
retaining the whiteness of the engobe; large quantities, however, may reduce crazing.\textsuperscript{34}

Although the engobe as first prepared did not craze or peel on body \#7 when used as an underslip, it did appear to chip away from the edges or ridges caused by a sharp change in the contour of the pot. Also the engobe did not always adhere properly to the dry pot and would flake away in spots. In order to bring the engobe closer to the clay body in composition, half of the ball clay was replaced by Watt stoneware clay, this being the same stoneware clay as that used in the body formula. This alteration appeared to help the engobe and eliminate the peeling or flaking that occurred.\textsuperscript{35}

It might be suggested in light of this experiment that the clay body used in the ware should comprise about \(20\%\) of the engobe formula. Of course, if the clays involved in the body formula are all high in iron content, some substitution of clays would be necessary to maintain whiteness. It is not expected, however, that highly-ferruginous clays would withstand the stoneware temperatures at which these vitreous engobes mature.

Another undesirable feature of the engobe \#9 was its failure to vitrify sufficiently when used without a covering glaze. When a glaze was applied over the engobe, sufficient flux was provided by the glaze to fuse the engobe. An increase of \(5\%\) in the whiting at the

\textsuperscript{34}Cullen Parmelee, \textit{Ibid.}, p. 80.

\textsuperscript{35}The original engobe formula, \#9, and the new formula, \#9A, are listed in the appendix.
expense of the flint helped to fuse the engobe into a more uniform surface. Still the engobe retained a rather rough surface and tended to blister at temperatures above cone 9. It was assumed that the blistering was caused by the coarseness of the particles and possibly the raw borax which was not sufficiently ground with the other constituents, since it is known that a concentration of borax may cause boiling.

At first it was believed that this blistering might be caused by too heavy an application of engobe, and several tests were made on pots to determine whether or not a thinner coating might be more suitable. The thinner coatings of engobe appeared less vitreous and were affected greatly by the strong action of the iron in the clay body of the pot; this tendency of the iron to color the engobe was increased by the reduction firing. The results of these tests suggested that the tendency to blister and peel was lessened by firing the tests to cone 8 rather than to cone 10, that is, as long as no glazes were applied over the engobe. Of course it must be remembered at this point that there was considerable variation in the firings in spite of careful charting and attempts to reproduce the more successful firings. This is one of the major disadvantages of reduction firing. It will be discussed under the section dealing with firing procedures.

The color variations possible in vitreous engobes, although subtle, are infinite in variety, and a surprisingly wide range of color variations is available. This fact is unusual in that only a few of the metal oxides are stable enough to withstand the high
temperatures necessary to vitrify stoneware. The most common of these oxides are those of iron, cobalt, and copper, all of which were available in various forms to the ancient Chinese potters. Additional metals of more recent use are chromium, nickel and vanadium.

Compounds of iron are most suitable for reduction because they react readily with the engobe composition to color and flux it. The various forms of iron used were: red iron oxide (Fe₂O₃), rutile (TiO₂·Fe₂O₃) and iron chromate (FeCr₂O₄). Each of these iron compounds produces a slightly different color, and those having less iron become more refractory.

Cobalt was used in the form of cobalt carbonate (CoCO₃). It will be noticed that the same percentages of cobalt do not produce appreciable differences in the various engobes; they do cause, however, a change in the engobe when under glazes of differing compositions.

Copper was also used in the carbonate form (CuCO₃) and was only effective when used under a glaze; otherwise it produced a pale green, differing only slightly from the engobe base itself.

Chromium was introduced as chromium oxide (Cr₂O₃), nickel as nickel oxide (NiO) and vanadium as an oxide (V₂O₅).

The first series of tests for color, using glazes over the engobes, was not satisfactory. This may have been due to the firing or the

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36 The metal oxides used by the Chinese were of a much less pure composition. Bernard Leach states that the natural source of cobalt was only 10% to 30% pure. Bernard Leach, *A Potter's Book*, 1951, p. 129.

Ingredients in the engobe, such as not having sufficient fluxing material or the proper clays in the composition. The second series of engobes was ground, and these will be discussed at the end of the chapter.

Table 2, which follows, shows the results of a series of four engobes tested under eight different glazes to determine the type of glaze best suited for use over vitreous engobes and the effects of various glazes on color.

A much wider variety of colors and contrasts was apparent in the test with glaze #12, and this glaze was used as the standard glaze with engobe 9A. It did not tend to craze or shiver, and it produced a semi-matt surface which allowed the engobe to burn through.

Further experiments were made with glaze #12 and additional engobes with new oxides in an attempt to develop a wider range of color and textural effects. 

Table 3 indicates the results of the new engobes prepared and tested in two series, one without glaze, and the other with glaze #12.

As could have been predicted, the compounds of copper, iron, and cobalt produced the most satisfactory results. Vanadium oxide produced black in reduction rather than yellow, which would have been expected in oxidation.

Only the copper and the cobalt engobes tended to flow or bleed into the glaze and then only to a limited extent. This factor would be helpful in certain types of decoration where the colors should remain stationary and controlled.
Some of the colorants which showed very little effect under the glaze did tend to color the bare engobes slightly. The yellow ocher (9-Y5) gave a dark yellow color, the manganese (9-O1) greyed the engobe and the granular rutile (9-X2) produced brown specks in the engobe. When an engobe is covered by a glaze, the increased amount of fluxing material and glass-forming material appears either to intensify some metallic oxides such as copper and cobalt or to neutralize and adulterate the effect as with manganese or ocher. It is as if the glaze exerted a bleaching action on the engobe.

Many different methods of preparing and applying the engobes were tried, but one finally proved more satisfactory than the others. It was found that pouring the engobe on the surface gave the best coverage and that milling the engobe without the colorant helped the fusion.

2000 gram batches of the engobes were weighed-out and placed in ball mills one-third full of balls. Enough water was added to the mixture to make a thin paste (about 3/4 water or 1500 cc).

The engobe paste was milled about two hours before the borax became fine enough to pass through a 60-mesh screen. Another 500 cc. of water was necessary to give the engobe a good pouring consistency. Following this addition of water, the mixture was ground for a few minutes before its screening through a 60-mesh screen. The engobe batch was run through the screen at least twice before measuring it into batches for the color additions.

Since it was most satisfactory to prepare the engobe in large batches because of the necessary grinding, and since all of the engobe
### TABLE 2
RESULTS OF ENGobe 9A*
UNDER DIFFERENT GLAZES

<table>
<thead>
<tr>
<th>Glazes</th>
<th>F10-H3</th>
<th>A1-N2</th>
<th>B6-H6-N10</th>
<th>B5-T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>#16</td>
<td>dark grey</td>
<td>dark blue</td>
<td>red-brown</td>
<td>grey-blue</td>
</tr>
<tr>
<td>viscous</td>
<td>dull blue</td>
<td>green</td>
<td>metallic with</td>
<td>with specks</td>
</tr>
<tr>
<td>semi-matt</td>
<td>mottled</td>
<td>brown spot</td>
<td>dark specks</td>
<td>of yellow</td>
</tr>
<tr>
<td>#7-B2</td>
<td>dark speck</td>
<td>dull grey</td>
<td>dark brown</td>
<td>yellow</td>
</tr>
<tr>
<td>dull</td>
<td>through dull</td>
<td>blue-green</td>
<td>specks on</td>
<td>brown</td>
</tr>
<tr>
<td>green</td>
<td>green</td>
<td></td>
<td>grey-green</td>
<td>specks</td>
</tr>
<tr>
<td>#6</td>
<td>yellow-</td>
<td>bright co-</td>
<td>light blue-</td>
<td>yellow</td>
</tr>
<tr>
<td>clear</td>
<td>orange</td>
<td>blue</td>
<td>green specks</td>
<td>brown</td>
</tr>
<tr>
<td>crackle</td>
<td>speckled</td>
<td></td>
<td>of yellow</td>
<td>specks</td>
</tr>
<tr>
<td>#5b</td>
<td>grey-blue</td>
<td>purple-</td>
<td>metallic brown</td>
<td>white-</td>
</tr>
<tr>
<td>dull immature</td>
<td>orange</td>
<td>blue</td>
<td>to moss</td>
<td>grey</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>dark</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>specks</td>
</tr>
<tr>
<td>#1</td>
<td>speckled</td>
<td>pale grey</td>
<td>dark yellow</td>
<td>speckled</td>
</tr>
<tr>
<td>matt</td>
<td>dark brown</td>
<td>blue</td>
<td>brown with</td>
<td>dark</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>specks</td>
<td></td>
</tr>
<tr>
<td>#24b-30R</td>
<td>yellow-brown</td>
<td>dull grey</td>
<td>dark yellow</td>
<td>yellow</td>
</tr>
<tr>
<td>shiny fluid</td>
<td>blue</td>
<td>brown</td>
<td></td>
<td>brown</td>
</tr>
<tr>
<td>#14a</td>
<td>grey-</td>
<td>pale blue</td>
<td>yellow with</td>
<td>white with</td>
</tr>
<tr>
<td>soft</td>
<td>blue</td>
<td>speckled</td>
<td>specks of</td>
<td>brown and</td>
</tr>
<tr>
<td>matt</td>
<td>speckled</td>
<td></td>
<td>dark brown</td>
<td>yellow</td>
</tr>
<tr>
<td>#12</td>
<td>yellow</td>
<td>blue-</td>
<td>pale green</td>
<td>dark grey</td>
</tr>
<tr>
<td>waxy</td>
<td>cream</td>
<td>purple</td>
<td>with grey</td>
<td>speckles</td>
</tr>
<tr>
<td>semi-transp</td>
<td>with</td>
<td>speckled</td>
<td>specks</td>
<td>crazed</td>
</tr>
<tr>
<td>no glaze</td>
<td>pale</td>
<td>dark blue</td>
<td>dark warm</td>
<td>heavily</td>
</tr>
<tr>
<td></td>
<td>yellow-orange</td>
<td>black</td>
<td>brown</td>
<td>speckled</td>
</tr>
</tbody>
</table>

*This engobe composition was milled for about four hours.*
<table>
<thead>
<tr>
<th>Engobes</th>
<th>Glaze #12</th>
<th>No Glaze</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-D6-H2</td>
<td>dull purple brown</td>
<td>black with scum-like crystals</td>
</tr>
<tr>
<td>9-E2-Q1</td>
<td>dull pinkish red, opaque</td>
<td>light cream edges peeled</td>
</tr>
<tr>
<td>9-E2-F2</td>
<td>dull pinkish red, opaque</td>
<td>light cream edges peeled</td>
</tr>
<tr>
<td>9-A2-R1</td>
<td>speckled purple-blue</td>
<td>dark shiny surface</td>
</tr>
<tr>
<td>9-C5-H2</td>
<td>light brown-grey</td>
<td>dull purple brown with specks</td>
</tr>
<tr>
<td>9-B4</td>
<td>light yellow-green</td>
<td>dark brown shiny surface</td>
</tr>
<tr>
<td>9-Y1</td>
<td>pale grey-green</td>
<td>light grey-green</td>
</tr>
<tr>
<td>9-K2-H2</td>
<td>dull blue-green</td>
<td>light grey-green</td>
</tr>
<tr>
<td>9-Y5</td>
<td>burned out</td>
<td>light brown, edges peeled</td>
</tr>
<tr>
<td>9-01</td>
<td>burned out</td>
<td>white, edges peeled</td>
</tr>
<tr>
<td>9-X2</td>
<td>burned out</td>
<td>white, edges peeled</td>
</tr>
<tr>
<td>9-M2</td>
<td>yellow-green to dull yellow</td>
<td>purple-brown, edges peeled</td>
</tr>
</tbody>
</table>
mixtures proved to contain about 50% water, it was advantageous to weigh out 500 gram batches and add colorants to them on the assumption that 50% of the engobe mixture was water (250 grams of engobe). In this way four thoroughly ground engobes could be prepared from one batch of the base engobe.

If the colorant or metal oxides were fine enough, it was only necessary to add them directly to the liquid engobe and screen the mixture twice through a 60-mesh screen. When the colorants were added to the engobe prior to grinding, it was found that a rather uniform, uninteresting surface resulted. If the colorant was rather coarse, a small amount of the liquid engobe was ground with the colorant before adding it to the entire mixture, which was then screened twice.

In practically every case where a large area was to be covered by the engobe, it proved most satisfactory to pour the engobe over the surface of the pot. Painting the engobe made an uneven surface which was disagreeable; especially if it was not covered by a glaze. Spraying the engobe was not only time-consuming and wasteful of material, but it left a pebbly surface that was more difficult to smooth over in the firing.

After grinding the engobe it was discovered that the alkalies present in the borax and those apparently released from the nepheline syenite acted as electrolytes to over-deflocculate the batch. After standing for a period of twenty-four hours the mixture jelled and would not return to its pouring consistency. It was necessary to add acetic acid to the mixture until it returned to its proper fluidity.
This electrolytic action in the engobe not only affected the pouring consistency of the engobe mixture but also promoted a smoother coverage. Many of the Greek pots exhibit decorations painted with a very finely divided material, and Arthur Lane has suggested that the development of a colloidal suspension may have accounted for this fine surface. 38

The thickness of application of the engobe is very important as it affects not only adhesion, but also the color of the engobe. When the engobe is used without a covering glaze, it is greatly affected by the color of the underlying clay body. Very thin coatings of engobe can scarcely be distinguished from the body color and do not afford much in the way of a decorative coating or contrast. Areas where the engobe is very heavy or where the materials gather from pouring, such as around the lip of the pot, may show blistering or flaking of the engobe. It is good practice to catch the engobe with the finger as it runs over the rim, which prevents an excess from gathering.

Where exceptionally heavy applications of engobe are necessary, such as in the barbotine technique, it is safest either to grind a small amount of borax into the engobe or to add some glaze to it to provide a stronger bond between the engobe and the body.

Since the engobes vary in refractoriness according to the coloring oxides added, it should be noted which of the oxides have the least fluxing action before adding an auxiliary flux.

38 Arthur Lane, Greek Pottery. London: Faber and Faber, 1948, p. 5.
In examples where the engobe was used under a glaze, it was necessary to apply the engobe more heavily to counteract the opacifying action of the glaze and insure a strong color. In some cases where the engobe remained thick around the edge of the pot, both the glaze and the engobe flaked away. It was noted that the more heavily fluxed engobes could be applied thinner and still produce successful color results. Experience in application is the only sure method of noting the proper thickness for application.
CHAPTER IV

FIRING PROCEDURES

The firing procedures were an extremely important part of this investigation as most of the effects obtained were dependent upon a reduction firing which is quite different from the more usual oxidation firing. The results from an oxidized kiln are fairly consistent while those from a reduced kiln tend to be highly variable and difficult to control. It is safe to say that each firing produced a slightly different result, but over a period of time, by observing the results of each firing and noting the action of the kiln, a satisfactory schedule was evolved. Although the resultant schedule produced quite consistent results, it was always necessary to check the kiln periodically to determine the rate of firing and the amount of reduction taking place. Over long periods of time—such as twelve hours—the reduction effect seemed to be cumulative; and the minor variation in firing caused not only a change in the appearance of the surface and the color, but a major change in the results of the engobe or glaze. Another important factor affecting the extent to which reduction took place was the sealing of the kiln with clay. This prevented the escape of oxygen-hungry gases and insured a more complete reducing atmosphere.

One of the most important reasons for reduction was the effect that this type of firing had on the color of the clay body. The rich dark brown of a reduced-iron body can scarcely be duplicated under normal oxidizing conditions. This dark body provided a warm
contrasting background for the engobes. As for the engobes themselves, they too were darkened and dulled to blend more subtly with the body color.

This reduction of the body is only satisfactory at temperatures where the ware is vitrified because it is necessary to reduce the iron to a lower valence, which results in a grey body. If the ware is not vitrified, carbon merely impregnates the ware and turns it black without changing the form of the iron. At the end of the reduction firing, a period of oxidation is required to reoxidize some of the iron and to leave a warm brown surface. The interior of the body remains a cold grey.

It is not easy to maintain an even atmosphere in the kiln, reducing each piece equally, and this is especially true in an up-draught-type kiln where the atmosphere must be forced down from the top of the kiln to reach the pieces on the lower shelves. Frequently a dividing line may be observed in a kiln where the reduction took place only at a certain level; also in particular pieces a fracture of the piece reveals that the reduction penetrates only certain parts or sides of the ware, producing a half-reduced and half-oxidized piece.

The basic problems of reduction are: (1) ability to rise in temperature from red to white heat while reducing, (2) ability to distribute heat evenly during reduction, (3) and ability to distribute

39Daniel Rhodes, op. cit., p. 172.
It is not difficult, when firing a kiln, to change from an oxidizing atmosphere to a reducing one, since it can be accomplished by limiting the primary and secondary air, and by increasing the fuel input to provide unburned carbon which is thirsting for oxygen. The real problem is to avoid losing temperature when oxidation is stopped. During reduction the fuel is only partially burned within the chamber or fire box, and there is a steady decrease in the temperature of the kiln. Too rapid a drop in temperature may affect the glazes seriously, and if an important quartz change is taking place, the strain on the body at this point is severe; it is necessary, consequently, to regain the temperature lost through reduction. This can be done only by re-oxidizing the kiln. This system requires a constant alternation between oxidation and reduction, gaining a few degrees in temperature each time until the kiln reaches maturity. It is obviously slow and uncertain. This method of reduction also causes great stress on the body of the ware as it contracts and expands. Even the outside atmosphere and weather may affect greatly the firing time and the conditions in the kiln.

40 Harold Driscoll, "Studio Stoneware Kilns," Ceramic Age, (September 1950), p. 44.

41 One of the major quartz changes takes place above 870°C when cristobalite transforms to tridymite. This irreversible inversion is accompanied by considerable volume change. See F. H. Norton, op. cit., p. 132.

42 Bernard Leach, op. cit., p. 194.
Frequently reduction firings require long, tedious periods of attendance at night, sometimes an exhausting assignment for a single individual. The method necessitates that two or three persons collaborate in a firing, and yet it is seldom satisfactory to divide responsibility in firing a reduction kiln.

After consecutive firings of the alternating reduction-oxidation type, a new schedule was attempted. Rather than reducing the kiln heavily during the early part of the firing, mainly from 800° C through 1000° C and following this by an oxidizing period up to the temperature at which the glaze began to sinter, it was found more convenient in time and equally satisfactory to follow the early heavy reduction by a period of very light, almost neutral reduction. During this early neutral period, the pressure built up within the kiln, causing increased reduction; yet a maximum efficiency was obtained from the fuel, and the temperature rose consistently, at almost the same rate as it would if it had been oxidizing.

During the period when the glazes began to fuse, a slightly heavier reduction was necessary to insure the proper effects. A short oxidation period was necessary, at the end of the firing after the desired temperature had been reached, to clear the kiln and burn off any excess carbon that might have settled on the ware and to reoxidize the surface of the exposed body to a warm brown. Generally the body remained grey under the glaze or engobe, but in areas where it was thin, some reoxidizing of the body could be observed where a warm brown color appeared through the glaze. The color of the body
cannot be changed once it has been sealed over by the molten glaze.\textsuperscript{43}

The most difficult part of the firing was determining the proper amount of reduction to be maintained throughout the long period of firing following the early reduction period. It has been mentioned that this should be a neutral atmosphere, but this was not easy to determine and was even more difficult to maintain. The color of the flame, which was controlled by the amount of unburned carbon present and the amount of back pressure present in the kiln were the most obvious gauges that the potter could observe. An instrument for measuring the carbon dioxide present in the kiln would be the most accurate indicator of the atmosphere, but this expensive apparatus is not available to the average studio potter.

It was found that the most satisfactory results were obtained by building up pressure within the kiln by closing the dampers completely or by waiting until the flames shot out the ports; then slowly opening the dampers until the orange flame was just licking out the top spyhole. A thin trickle of smoke was present, indicating a slight reduction.

If a kiln has more than one damper, it is necessary to adjust the openings so that the flames from them are nearly equal; this will insure a more even firing within the kiln.

In order to reduce the lowest part of the kiln, it was found necessary to raise the muffle wall four to six inches and place bricks opposite the openings to prevent the flames from hitting the ware

\textsuperscript{43}\textit{Bernard Leach, \textit{op. cit.}, p. 203.}
directly. With this adjustment the kiln appeared to fire more uniformly, reaching nearly equal temperatures on the top and bottom; also the reduction was more uniformly distributed throughout the kiln.

Plate I, on the following page, indicates the appearance of the kiln as adjusted.

Table 4 shows a typical firing schedule for continuous reduction. The results of this type of firing were quite satisfactory, producing a dark orange-brown body which enhanced the beauty of the vitreous engobes used over it. Actually the body alone was pleasant, with sufficient variation and texture supplied by the granular manganese, ilmenite, sawdust, and vermiculite.

Many of the major differences between non-vitreous engobes, glazes and the resulting vitreous engobes were emphasized by the behavior of the materials under reducing conditions.

One series of tests using sixteen colored engobes was conducted. These engobes were applied in radial sections around the edge of a flat plate. In circular bands, five different glazes were applied over the engobes. One of these sets of tests was fired to cone 9 in an oxidizing or neutral atmosphere, another was fired to the same cone in a reducing gas kiln. In observing these tests it was noticeable that the same cone apparently did not indicate the same heat treatment in the two different firings.

Although the effects of reduction may cause the standard pyrometric

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The oxidizing kiln was an electric kiln with silicon carbide heating elements; the reducing kiln was a gas kiln.
Figure 1

INTERIOR OF UP-DRAUGHT GAS KILN
MUFFLE PLATES
BRICK FOR SUPPORT AND PROTECTION OF WARE FROM DIRECT FLAME
FLAME
GAS BURNER
### TABLE 4

**TYPICAL CONTINUOUS REDUCTION SCHEDULE**

<table>
<thead>
<tr>
<th>Time</th>
<th>Temp.</th>
<th>Air</th>
<th>Gas</th>
<th>Damper</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:30 AM</td>
<td>0 0</td>
<td>0</td>
<td>2</td>
<td>0 2 1/2</td>
<td>open All cracks and doors sealed with micaceous mud and muffle wall</td>
</tr>
<tr>
<td>1:10 PM</td>
<td>2 0</td>
<td>3</td>
<td>0</td>
<td>4 1/2</td>
<td>All oroks and doors sealed with micaceous mud and muffle wall raised 5&quot;</td>
</tr>
<tr>
<td>7:30 PM</td>
<td>0 0</td>
<td>0</td>
<td>0</td>
<td>5 1/2</td>
<td>Slight glow Top and bottom glowing</td>
</tr>
<tr>
<td>10:00 PM</td>
<td>1/2 0</td>
<td>0</td>
<td>5 1/2</td>
<td>close to 1&quot; <em>Reduce with wood 1 hr.</em></td>
<td></td>
</tr>
<tr>
<td>11:00 PM</td>
<td>0 1/2</td>
<td>0</td>
<td>5 1/2</td>
<td>open to 2&quot; Open damper until only slight back pressure forces flame out top spy hole.</td>
<td></td>
</tr>
<tr>
<td>8:15 AM</td>
<td>C/7 1/2 C/8</td>
<td>1</td>
<td>0</td>
<td>Full 5 1/2</td>
<td>close to 3/4&quot; Cone 8 almost down on bottom-reduce heavily for 15 min.</td>
</tr>
<tr>
<td>8:30 AM</td>
<td>1 1/2 0</td>
<td>0</td>
<td>&quot;</td>
<td>5 1/2</td>
<td>open to 2&quot; C/9 bending on bottom</td>
</tr>
<tr>
<td>12:00 AM</td>
<td>C/9 C/9</td>
<td>1</td>
<td>0</td>
<td>&quot; 5 1/2</td>
<td>&quot; C/9 bending more on top</td>
</tr>
<tr>
<td>4:00 PM</td>
<td>2 0</td>
<td>&quot;</td>
<td>5 1/2</td>
<td>open to 2 3/4 C/10 down on bottom open damper more on top and air on top to increase heat</td>
<td></td>
</tr>
<tr>
<td>4:45 PM</td>
<td>C/10 C/10</td>
<td>0</td>
<td>0</td>
<td>&quot; 5 1/2</td>
<td>close to 3/4&quot; Cone 10 down on top and bottom. Reduce kiln 15 min.</td>
</tr>
<tr>
<td>5:00 PM</td>
<td>3 3</td>
<td>&quot;</td>
<td>5 1/2</td>
<td>open</td>
<td>Oxidize 15 min. to clear kiln and shut off kiln and close air and damper</td>
</tr>
</tbody>
</table>

*Wood chips were introduced through the bottom spyhole during this period to increase reduction.*
comes to act in different ways, there still appears to be a noticeable
difference between glazes fired in the oxidizing atmosphere of an
electric kiln and those fired in the oxidizing atmosphere of a gas
kiln. The results of these tests may be observed in Table 5 on the
following page.

Under the more usual oxidizing conditions the engobes were, for
the most part, much lighter in color; this was particularly true of
those containing an appreciable amount of iron. It was also noted
that those engobes containing oxides with even small amounts of iron
present, such as provided by rutile, were brighter in appearance
under reducing conditions. In clay bodies where small amounts of
granular manganese or granular magnetite were added, spots resulting
from the fusing of these metals were much more apparent in the tests
conducted under reduction.

As would be expected, the oxides of iron and copper were changed
in color by the reducing atmosphere; the color, however, did not
appear until a glaze was applied over the vitreous engobe. The
darkening of the clay body by reduction did have a slight effect on
the vitreous engobe colors, but generally they remained unchanged by
this factor.

It may be noted that those engobes containing cobalt showed very
little difference in the two firings. Engobes with nickel were a grey
or brownish green rather than dull green produced in oxidation. Since
some of the glazes contained metallic oxides themselves, these
colorants reacted with those in the engobes to produce a very subtle
<table>
<thead>
<tr>
<th>Engobe #9</th>
<th>Glaze #1</th>
<th>Glaze #4-B5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>O</td>
<td>R</td>
</tr>
<tr>
<td>P6</td>
<td>light</td>
<td>dark</td>
</tr>
<tr>
<td></td>
<td>grey</td>
<td>grey</td>
</tr>
<tr>
<td>R10-A3</td>
<td>grey</td>
<td>dull</td>
</tr>
<tr>
<td></td>
<td>blue</td>
<td>blue</td>
</tr>
<tr>
<td>T25</td>
<td>grey</td>
<td>dark</td>
</tr>
<tr>
<td></td>
<td>grey</td>
<td>brown</td>
</tr>
<tr>
<td>A5-R6</td>
<td>grey</td>
<td>grey</td>
</tr>
<tr>
<td></td>
<td>blue</td>
<td>blue</td>
</tr>
<tr>
<td>A2-I8</td>
<td>grey</td>
<td>dark</td>
</tr>
<tr>
<td></td>
<td>grey-green</td>
<td>brown</td>
</tr>
<tr>
<td>B5-02</td>
<td>grey</td>
<td>mottled</td>
</tr>
<tr>
<td></td>
<td>brown</td>
<td>brown</td>
</tr>
<tr>
<td>A1-B3</td>
<td>dark</td>
<td>dark</td>
</tr>
<tr>
<td></td>
<td>grey</td>
<td>blue-grey</td>
</tr>
<tr>
<td>B7-02-A2</td>
<td>dark</td>
<td>dark</td>
</tr>
<tr>
<td></td>
<td>grey</td>
<td>blue-grey</td>
</tr>
<tr>
<td>C8</td>
<td>pale</td>
<td>grey</td>
</tr>
<tr>
<td></td>
<td>green</td>
<td></td>
</tr>
<tr>
<td>C10-F5</td>
<td>grey</td>
<td>grey</td>
</tr>
<tr>
<td></td>
<td>green</td>
<td>green</td>
</tr>
<tr>
<td>E3-Q1</td>
<td>pale</td>
<td>pinkish</td>
</tr>
<tr>
<td></td>
<td>green</td>
<td>white</td>
</tr>
<tr>
<td>F10-H3</td>
<td>pale</td>
<td>speckle</td>
</tr>
<tr>
<td></td>
<td>grey</td>
<td>grey-blue</td>
</tr>
<tr>
<td>F3-X3</td>
<td>grey</td>
<td>grey-blue</td>
</tr>
<tr>
<td></td>
<td>blue</td>
<td>grey-blue</td>
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<tr>
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The recipes for the glazes and code used in this chart will be found in the appendix. The results are continued on the following page.
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</table>

Table 5 (cont.)
range of colors. Usually the colorant that was present in the glaze predominated but was either lightened or darkened depending upon the engobe beneath. Generally the combination of the glaze and engobe colorants produced a color similar to that derived from blending hues in pigments. In the reduction firing, however, the combined colorants produced a much more somber tone. They seemed to combine less completely but gave greater nuances of color.

Variations in the firing did have some effect on the body, glaze and engobes; it was noted, however, that the engobes were more consistent in color and texture than the glazes. Also there was more variation in color when the engobes were covered by a glaze than when they were left plain.

Those examples, as determined by the appearance of the fracture, which had an excess of reduction were much darker, and the engobes containing iron turned a metallic color with a tendency to blister or wrinkle slightly. The white engobe which contained no color was much darker, taking on the color of the underlying body even though under normal reduction it appeared opaque.

In these over-reduced examples the engobes with rutile appeared changed and were a grey-brown rather than the rich orange resulting from the normal reduction firing. Any areas which did not happen to receive sufficient reduction appeared similar to the examples in Table 1, which were oxidized.

The final appearance of the body, glaze and engobe depended a great deal on the clearing or oxidation period at the end of the
firing. If this was insufficient, the appearance was similar to that of being over-reduced. If the oxidizing was in excess, the surface was re-oxidized too much and lost its reduced appearance. The size of the kiln and the amount of reduction during the firing were the factors which determined the amount of clearing necessary; fifteen to twenty minutes, however, was usually adequate. Draw-tests were used sometimes to determine the color of the glaze, but these tests darkened if allowed to remain in the kiln after it had been turned off and did not indicate the true color of the body.

Some tests were made of the engobes in a salt kiln to determine their appearance under a salt glaze. It was found that body #7 was unsuitable for this type of firing because it would crack during cooling, possibly indicating that it was contracting more than the glaze. Some adjustments were made as follows:

<table>
<thead>
<tr>
<th></th>
<th>#7</th>
<th>#8</th>
<th>#9</th>
<th>#11</th>
<th>#12</th>
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<tr>
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<td>40</td>
<td>41.5</td>
<td>45</td>
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<tr>
<td>Dalton ball clay</td>
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<td>5</td>
<td>3.5</td>
<td></td>
<td></td>
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</tbody>
</table>

Body #12 was the only clay body which did not crack during cooling. In these tests the kiln was allowed to cool two days without the damper being opened. It was possible that over-reduction might have caused the body to become brittle enough to break; the cracking in most cases, however, occurred several hours after the pieces were removed from the kiln. On occasion an excess of iron in the body has
been known to cause this brittleness.

The following engobes were tested on body #12 with these results:

<table>
<thead>
<tr>
<th>Engobe</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>9A-B6-H6-N10</td>
<td>red metallic brown with broken surface</td>
</tr>
<tr>
<td>9A</td>
<td>creamy white and mottled</td>
</tr>
<tr>
<td>9A-A1-B2</td>
<td>soft blue</td>
</tr>
<tr>
<td>9-F10-H3</td>
<td>warm orange with specks</td>
</tr>
<tr>
<td>9-A3-R6-H3</td>
<td>black-brown with metallic spots</td>
</tr>
<tr>
<td>9-A1</td>
<td>pale blue</td>
</tr>
</tbody>
</table>

The engobe colors were successful on the salt-glazed wares showing the variegation and the mottling typical of a salted surface. The colors were more intense and the contrast greater with less iron in the body because the salt glaze seemed to activate the iron and draw it into the glaze more than was to be found in the ordinary feldspathic stoneware glazes. The tendency was for the glaze to turn a warm metallic brown, almost aventurine in appearance.
PART III

VITREOUS ENGOBES USED IN DECORATION

IN RELATION TO POTTERY FORMS
Since the plastic form of pottery and its decoration are so highly interrelated, a general discussion of ceramic form is essential to the introduction of the decorative techniques which follow. Decoration cannot be considered as a separate aspect of the pot but must always be viewed as a part of a larger whole—namely the total form of the pot.

If the pottery form is to be considered the initial statement of the potter, decoration becomes that phase which permits further clarification of this statement and allows the craftsman to further his original intentions. Frequently the character of a pot may be asserted in more forceful terms by the careful placement of decorative elements and an otherwise expressionless form be made more articulate. Directional movement which is established by the articulation of the form may be increased by the decoration and made more emphatic.

Decoration may also serve to assist the observer's eye as it follows the contour of the pot and in so doing permit a longer time for contemplating the salient features of the pottery form. As in other art media, these pauses or arrestments are essential to the development of an art expression as they allow a period of relaxed tension and provide an opportunity for reflection and anticipation.

"Surface enrichment" is a common term employed to encompass the various decorative techniques, but it erroneously suggests that the
decoration is applied to the surface of the pot, which is too frequently the case. If decoration is to become an integral part of the form, it must be conceived simultaneously with the form—perhaps not with all its ramifications but to the degree that the form has suggested the essential characteristics of the decoration during its forming process.

The craftsman must determine the decorative needs of each pottery form and must ascertain the proper placement of the decoration so that it completes the statement intended. Bernard Leach has expressed the basic problem of decoration with his statement, "Subordinate to form but intimately connected with it is the problem of decoration, and the question arises whether the increased orchestration adds to the total effect or not."45

Pottery form is determined principally by the nature of the material from which it is made. No craft is without this limitation imposed by its medium and it is essential that the dictates of the material be respected if the form is to be expressive of that material.

Clay is the material of the potter and its most prominent characteristic is its plasticity, the quality of being easily molded and providing a means of rapid expression for the craftsman. The very plastic nature of clay suggests the possibilities of forming, and it is the retention of this plasticity—that is most important to the designer-craftsman; it is his way of remaining in touch with

inherent characteristics of his material even though it becomes physically changed through the drying and firing processes.

Individual clay bodies have their own subtle characteristics which demand varying treatments and necessitate forms appropriate to their divergent properties. Earthenware, stoneware and porcelain clays exhibit varying degrees of plasticity and refinement, requiring different forms appropriate to each.

Pottery forms are greatly influenced by the methods of forming and are to some degree limited by these processes. The potter's wheel, for example, provides an ideal instrument for forming hollow vessels with great rapidity and clarity of purpose, but although the advantages to this constructional method are many, the limitations are also apparent. The fact that the clay must be quite soft for the throwing process detracts from its structural strength; also the momentum of the revolving wheel tends to throw the soft clay outward, making it necessary to retain certain shapes that will counteract this centrifugal force. The potter's wheel is essentially a means of forming round symmetrical vessels, and the extent to which these forms can be altered is limited since the pot always tends to retain the ingrained characteristics of its initial shape.

Clay forms manipulated on the wheel must be derived from shapes based on cylindrical or spherical volumes. These basic forms are structurally sound and are most resistant to the centrifugal force of the wheel and the weakened structure of the softening clay. They also are forms which are simple enough to permit the necessary thinning
and distribution of the clay along the walls of the vessel. It is only after the forming of these basic shapes that more inventive and individual characteristics can be readily incorporated into the form.

Another factor resulting from the throwing process is the series of concentric ridges that form along the walls of the pot as the potter manipulates the clay with his hands or tools. These ridges must be considered as a necessary part of the form and cannot be ignored in the consideration of decoration.

Although materials and process may be essential to the character of a pottery form, function is more frequently the motivating force which determines the appropriate clay and forming methods. Traditionally, pottery forms have served as containers for storing and serving food; it is natural, therefore, that most of the fundamental shapes known to potters are based on these needs. Bottle forms are an outgrowth of the need for a form from which liquids could be easily poured, yet one that would not permit evaporation. Low, open bowls were accessible forms for the preparation of food and beverages. These forms so familiar to the potter are an outgrowth of his need, and he has adapted his materials to provide him with objects of necessity.

Pottery form goes beyond the basic needs of utilitarian objects, and it becomes apparent that within the range of these limitations placed by material, process, and function there is an unlimited selection of forms that will provide the essential qualities of a well-crafted object.
It is naive to assume that functional considerations alone will determine a well designed pot, for this assumption precludes any inventiveness on the part of the craftsman who merely becomes a producer of functional wares. Although some of the basic considerations for various functional forms have been established, the possibilities for solving the requirements of these forms have not yet been exhausted nor will they be in all probability. The aesthetic qualities of pottery forms are of utmost importance whether the forms be functional or decorative.

A study of the history of pottery reveals that many racial groups have exhibited a form-preference which goes beyond the basic needs and is expressive of an unconscious inheritance. The liberties which the potter takes with particular functional forms that have historic precedence are his most creative outlets, and it is this essential need to express individuality that is most indicative of the creative craftsman. Traditional forms are reiterated over and over again from one historical period to another, but each period reinterprets these forms in such a way that they are reflective of its own taste or preference. The individual potter, being aware of the trends and styles taking place in other media cannot help but incorporate these awarenesses into his own work.

In selecting forms the contemporary artist-potter is placed in a unique position as he is no longer called upon by society to supply

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the functional objects so essential to everyday life. He also finds himself in a peculiar relation to the history of pottery forms. "In a broad way the difference between the old potters and the new is between unconsciousness within a single culture and individual consciousness of all cultures."^47

This individual awareness of the vast historical heritage can be of great value to the present-day craftsman, but it can also work to his detriment if he comes under the influence of particular historical forms or is eclectic to the exclusion of his own imagination and experimentation.

There is a tendency among a group of present-day potters to place a great premium upon "experimentation" to the neglect of craftsmanship and functional considerations. This trend may be an outgrowth of the frustration that potters have felt in trying to determine a place for their wares in a society that finds a less expensive and more "refined" source of utilitarian pots in the industrial world. It is also possible that the non-objective direction of painting and sculpture has at last impressed itself on the more conservative and traditional crafts.

Whatever the reasons lying behind this revolutionary movement in pottery form, it has undoubtedly caused the more progressive artist-potters to question the direction of their craft in terms of historical precedent. A recent meeting of the Conference of American Craftsmen

^47 Bernard Leach, op. cit., p. 20.
indicated that many of the leading craftsmen and art educators felt
that there has been too much intellectualizing and self-conscious
effort to affect a direction that is in vogue. Mr. Cullers stated,
"Subjected to conflicting demands upon them, people no longer know
with certainty from within themselves what is important and what is
not. They tend to attach themselves to whatever value system is
most aggressively asserted..."48 The fact that craftsmen are meeting
in local and national groups is in itself unprecedented, and it may
be concluded that "the potter is no longer a peasant or journeyman as
in the past, nor can he be any longer described as an industrial
worker: he is by force of circumstances an artist-craftsman..."49

Much of what may be termed objects of poor craftsmanship,
violating the dictates of the material and completely void of function,
has served to stimulate craftsmen out of a lethargy and awaken them
to new possibilities in clay, helping them to see the need for
expressing forms that will be a reflection of their own culture. One
craftsman has suggested that contemporary society has freed the
craftsman from utility, making a living at his craft and from the
dictates of tradition.50 This freedom that the craftsman enjoys today
is of great value only if he can also be aware of the disciplines of
his own medium.

48"Second Annual Conference of American Craftsmen," Craft
It may be concluded from the observation of contemporary trends in pottery that the potter has been awakened to a new social position and a new freedom from the traditional demands on his craft, and as a result the emphasis has been placed upon freedom to express new and fanciful forms that may not relate to function. The value of this development lies in the possibilities for stimulating new form ideas and greater freedom for the craftsman, but the danger of denying this ancient craft its traditional motivation and intent, function, is most apparent.
CHAPTER VI

DECORATIVE TECHNIQUES EXPLORED AND THEIR EXAMPLES

Much of the research on vitreous engobes and the technical problems involved, along with the aesthetic considerations that have preceded, are culminated in the examples of the decorative techniques.

It is difficult to say that function did not play a part in the evolution of these examples, and it would perhaps be more exact to say that function acted as an inspirational guide rather than as a controlling factor.

The nature of the vitreous engobe and the clay body was of the greatest importance in determining the resultant forms. The coarse quality of the stoneware, the dull matt surface of the engobe and its subtle color qualities suggested forms which were bold rather than delicate, forms that were simple and direct, lacking somewhat in the sophistication of more refined surfaces.

The potter's wheel was selected as the means for forming, with the consideration that this forming process provides a rapid method of examining volumetric forms and exploring the plastic possibilities of the clay. Every effort was made to retain the natural surface quality of the clay and to respect the forms which were suitable to the wheel, and yet take advantage of the experimental possibilities suggested.

The fact that the pots were to be decorated with vitreous engobes was predetermined, and it was necessary to keep in mind the suitability
of the decoration techniques to the particular forms. Forms which were complex in contour were generally considered as inadequate volumes for realizing the potentials of the engobes since the interaction between form and decoration would be more difficult to obtain.

Those decorative techniques that have traditionally made use of engobes or slips were considered as offering the most possibilities for vitreous engobes; the examples, consequently, make use of these known techniques, arriving at a somewhat different effect as a result of the vitrifying nature of the engobes.
Pouring is perhaps the most suitable way of applying the vitreous engobe to the surface of a pot; this method permits the engobe to penetrate the surface, providing a smoother surface and a more uniform thickness of application. Before the use of the spray-gun, pouring and dipping were the most usual techniques of glaze and engobe application.

A decorative technique using the pouring method might be termed "contour pouring" because the engobe is poured in panels over the surface of the pot. This is a simple, spontaneous process, requiring little imagination to evolve decorative patterns which adhere to a form and emphasize its contours. Generally some change of contour is necessary, however, to produce an interesting decoration. In applying this technique, the pot is usually inverted and the engobe is poured down the side, allowing it to follow the form of the pot. Where the engobe drips and gathers at the rim, it is advisable to run a finger around it immediately to catch the excess.

The flowerpot (Figure 2), a waisted cylinder, is dependent largely on its subtle proportions and decorative technique for interest. The form is a very substantial one appropriate to its function and permits a wide area for decoration. Two engobes were used in this decoration (9-H2 and 9-C5-E2). As used here, they overlap one another producing many tones in between the two engobe colors. It is difficult to tell which of the engobes was applied first, and a transparent appearance results from the one vitreous
engobe burning through the other. Where the clay shows through, it produces another tone of brownish orange, speckled with manganese and ilmenite. This speckled quality in the engobe and the body acts as a unifying agent and brings the two into harmony.

In pouring the engobes down the contour of the pot, care was taken to provide interesting variations in the widths of the areas covered in a rather quick spontaneous approach. The engobes lend themselves to this method of decoration readily because they are of a fairly viscous creamy consistency that adheres well to the raw pot.

The underside of this pot shows that it was not exposed to a reducing atmosphere, and as a result light orange specks appear, rather than a cold grey-green. The orange speckling is a result of the sawdust in the clay body.

The surface of the bottle form (Figure 3) gives a clear illustration of the rough-textured surface which results when the vitreous engobe (9-F8) is fully exposed without a covering glaze. The sawdust and vermiculite used in the clay body leave a pitted porous-looking exterior which is accented by the melted granules of ilmenite.

Only a simple undecorated form such as this small bottle can adequately convey the interesting variegations and subtle nuances of color that the materials alone can provide.

The bottle is a clear statement of the wheel process and of the plastic quality of the clay which permits a maximum expansion and
contraction of the form. From the nearly-straight walls of the base, the pot curves gradually out and tapers rapidly to a small neck which accentuates the swelling quality. The top rim, which curves over to terminate the form, is glazed, like the interior of the pot, with Albany slip glaze. The surface of the slip glaze, being much smoother, provides contrast for the rough exterior.

This example (Figure 4) illustrates the type of pattern which results from pouring the engobe over a full bulbous form. Such a natural process gives an almost accidental appearance. It is true that a carefully calculated pattern can only be obtained with difficulty, but experience in this type of application on various forms suggests which are appropriate.

The slightly twisting lozenge shape of the decoration repeats the general form itself and again adheres well to the surface. The engobe used is 9-A2-B6-W10, and under the glaze 24A appears grey-blue with specks of brown. Here it can be seen that the glaze has dragged the engobe slightly and that they have mingled to produce a mottled surface.

The covered jar (Figure 5) presents a more complex form than most of the pots illustrated since it includes a lid, a knob and a prominent foot in addition to the undulating curve of the body. Although each part can be readily identified, there is a consistent treatment that unifies the three major aspects of the form. The base curves outward in a direction which relates it to the rim of the body, the "S" curve of the body is subtly repeated in the lid and again the flaring base and rim are reflected in the shape of the knob.
The four decorative panels were obtained by pouring the engobe from the base over the belly of the pot, the darker brown areas being 9-A2-B6-N10 and the lighter areas being 9-F10-H3.

The very plastic looking form (Figure 6) has a dark speckled brown engobe (9-B6-H6-N10) poured over its entire surface, the overlappings creating a contour pattern with a pleasant accent resulting from the finger marks. Greater variegation may be observed in this engobe than in Figure 3, and the fusing of the glaze (16-B.5) and engobe has produced a marbleized effect. The feeling of plasticity is increased by the impressions made in the wet pot. It was found that the sooner these impressions were made in the damp pot the more direct and plastic would be the final result.
EXAMPLES OF THE FOUERING TECHNIQUE
Figure 2

FLOWERPOT WITH WHITE AND BROWN ENGobe
Figure 3

BOTTLE WITH YELLOW ENGOBE
Figure 4

BOTTLE WITH BLUE ENGOBE
Figure 5

COVERED JAR WITH BROWN AND BLUE ENGobe
Figure 6

BOTTLE WITH SPECKLED ENGOBE
DIPPING

The bottle form (Figure 7) illustrates the use of the vitreous engobe as a background material for glaze patterns which are formed as a result of the dipping technique. It would be difficult to identify this technique in any historical examples because it appears to be a contemporary innovation. Of course the dipping method of submerging a pot into a vat of glaze is a usual method of applying glaze over the entire surface, but this method of restricting the glaze to a particular area of the pot is more unusual.

Two almost circular patterns were formed when the sides of the bottle were immersed into a brown glaze (12-Al-B6). The shapes of the patterns formed by this method are somewhat arbitrary; they can, however be predetermined by the form of the pot, the angle held while dipping, and the depth of immersion. As in the pouring technique, the patterns formed follow the contour of the pot, providing a natural means of unifying the shape of the pot with its decoration.

The covering engobe (9-M5-H2) fires to a grey-green in reduction and tends to turn this particular glaze (12-Al-B6) black, forming small metallic specks such as might be observed in the ancient Chinese "oil spot" glazes. As in Figure 3, a pleasant contrast of surfaces is provided between the smooth uniform glaze and the rough texture of the engobe.51

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51 The engobe was sprayed on this particular pot, and it can be noted that the surface is rougher than that which results from pouring.
Although this bottle form is similar to those in Figures 4 and 5, the shorter base and greater swelling of the body create a completely different impression. In forming the pot, a greater emphasis was placed on the full swelling of the pot than on the vertical lift, and this intention was reinforced by the round decorative pattern which accentuates this spherical appearance.
EXAMPLE OF THE DIPPING TECHNIQUE
Figure 7

BOTTLE WITH GREY ENGobe
Patterns impressed into the surface of wet clay are not uncommonly found on historical examples such as the early Sassanian wares or those of Medieval England. The damp plastic clay presents a natural invitation to impress fingers or tools into the surface, resulting in a direct method of decorating or developing the form of the pot. This technique of impressing patterns in the clay is suitable for wheel-thrown forms as the walls are soft and plastic after forming and respond readily to pressure from the finger or tool. Furthermore, the treatment is consistent because the same tools may be used for both forming and decorating.

The vertical direction of the bottle form (Figure 8) is given emphasis by the finger impressions that run from the foot to the base of the neck. These impressions deepen toward the widest diameter of the belly, giving increased emphasis to the swelling of the form. The neck of the pot does not seem to aid the movement established by the foot and the belly, and it could have been improved if it had been narrower just below the rim.

Like the glaze (24A), the vitreous engobe (9-A1-H2) was poured over the form; this process of application helps to accent the impressed areas by gathering in the depressions and running thin over the ridges. Because of the high magnesium content in the glaze, the

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52 Arthur Lane, Early Islamic Pottery, Plate III.
cobalt from the engobe produced a blue-violet which is intensified in areas where the pot received a greater heat treatment. The interior of the pot was glazed with a darker glaze (24A-41-36) for contrast.
EXAMPLE OF AN IMPRESSED DECORATION
Figure 8

BOTTLE WITH BLUE ENCOBE
FREE BRUSH PAINTING

The use of free brush painting of engobes on a raw clay body is an ancient practice, and exquisite examples may be found among the Sung pieces, the Chinese being undisputed masters of the brush. These examples which follow differ slightly in technique in that the vitreous engobe is painted over a ground-coat of another vitreous engobe, producing, in some cases, an effect similar to that obtained by watercolor. Since it is necessary to thin the engobe before using it in free brush work, the brush strokes present a thick-and-thin appearance. This technique requires a rather rapid and controlled brush stroke so that one can take advantage of the variation in thickness of the engobe. It is not a precise method of decorating and does not permit a carefully developed painting. For the greatest contrast a light background of engobe is applied before the brush strokes are superimposed. If the brushwork is applied directly to the body, the contrast is inadequate with such thin layers of engobe since the iron in the body eats into the engobe and darkens it.

The footed bowl (Figure 9) has a broad and shallow surface for decoration. A blue (9A-A2-R1) engobe was poured over the surface; then light strokes of dark brown (12-A1-B6) were applied in a bird motif with very rapid strokes. The coating of blue engobe underneath, being nearly dry, rapidly absorbed the moisture from the darker engobe applied over it, presenting a fused and softened effect similar to that obtained from painting watercolors onto a moistened surface of absorbent paper.
At first this pot gave the appearance of being unstable, but several experiments with thrown feet indicated that the form would have more of a growing quality if the base tapered to a narrow point. The rapid spreading of the foot gives it adequate stability for practical purposes. The rim treatment and the base of the foot help to unite these two parts of the form.

The rather traditional form (Figure 10) also has an engobe (9A-V1-H2) poured over the exterior prior to the brush pattern which was applied very rapidly, taking advantage of the thick-and-thin qualities of the brush strokes. The darker engobe (9A-D6-H2) used for painting is softened by the exterior glaze (#12) which fuses it with the underlying engobe. This interior glaze is a dark blackish-brown mottled one (12-A1-B6), and helps to accent the color of the engobe painting. The dark specks appearing on the outside are caused by the granular material in the clay body and also by the ilmenite in the engobe. In many pots such as this one it will be noted that the bare clay is exposed at the foot or through sgraffito and wax resist; this helps to retain an awareness of the material underneath, especially where a glaze is applied.

This particular example (Figure 11) shows the use of the base engobe (9A-H2) with ilmenite specks breaking through the dull surface. A rapid brush stroke in warm brown (9A-B6-H6-N10) engobe is applied thinly as a wash over the ground; here it can be noted how important the thickness of application can be in providing a rather sensitive medium for painting. The form remains simple with
a rather tight substantial base, swelling out to suggest the power of the interior void pressing on the wet clay walls. A slightly firm tightening of the clay at the lip seems to be a proper conclusion.

Another technique is combined with the free brush painting to give greater force to the pattern; that is the use of sgraffito lines which follow the brush strokes and provide a certain crispness in what might otherwise seem too nebulous in pattern.

In this particular pattern a conscious effort has been exerted to maintain a certain reciprocal feeling between the ground and the figure; this was done by giving equal attention to the background and the patterned areas during the painting.
EXAMPLES OF THE FREE-BRUSH TECHNIQUE
Figure 9

FOOTED-BOWL WITH BLUE ENGobe
Figure 10

FLOWERPOT WITH BLACK ENGobe
Figure 11

LAMP BASE WITH WHITE AND BROWN ENCOBE
SLIP TRAILING OR BARBOTINE TECHNIQUE

The barbotine technique is a rather natural method of applying a raised pattern in liquid slip over the partially dry clay form. Many Sassanian wares are the result of great facility in handling this type of decoration. Frequently the pots were unglazed.

Some experience is required in handling the bulb or applicator as the liquid slip, or vitreous engobe in this case, must be of the proper consistency to flow evenly and not run down a vertical surface. Experiments proved that the consistency of the engobe greatly affected the character of the decoration. A stiff material will be more easily controlled, but it will also appear less fluid and direct, resulting in a more mechanical look.

A good example of the controlled appearance resulting from an application of thick engobe (9A-D6-H2) pattern is to be seen on the flowerpot (Figure 12). The stiff lines of the pattern are not completely out of character with the pot form, which is quite formal, but there is less feeling of a liquid material. The pattern appears to lie on the surface rather than to be integrated into the total form. This is partially due to the nature of the pattern, but also results from the viscosity of the engobing material. The accents of white engobe, although somewhat thick, appear to adhere to the surface better and do not tend to crack or peel; this is the result of a more complete fusion of the engobe.

Another flowerpot (Figure 13) of a different character reveals a pattern of a much more fluid nature. The ground is a dull blackish-
brown engobe (9-D6-H2) which serves as a strong contrast for the white (9A-H2) trailings. The variation in width of line caused by the fluidity of the engobe combined with the feeling of a unit of decoration brought about by the placement of the two lines help to integrate this pattern with the pottery form and the body of the pot. The placing of the decorative elements again suggests a reciprocation between the ground and figure and holds the two in bond. This reciprocation of forms is a common device skillfully employed by the Persian potters, and many early 10th Century lustre pieces are excellent examples of this possibly unconscious awareness of spatial illusion.

The cylindrical form of this covered jar (Figure 14) suggests the albarello or drug-pot that so frequently appears among pottery of the Italian Renaissance. Although this jar has nearly vertical walls, the subtle drawing-in of the form toward the middle of the pot and the strong indented rim clearly indicate the derivation of its form.

The simplicity of the main part of the form provides an ample area for decorating and invites the slip-trailing technique which is most easily accomplished on a surface that is not complex or that does not obstruct the free movement of the applicator. Vertical lines of dark engobe (9-Al-B6-N1O) were trailed from the rim to the base of the pot, and a heavier flow of material from the syringe created wider, darker lines at the top which taper to thinner lines at the base. The dots of the same engobe were also applied with a
syringe, and they diminish in size from the rim to the base. Because of the strength of the decoration at the top of the form and as a result of the dark glaze (12-A1-B6) applied around the rim, the top portion of the pot is greatly emphasized. Further attention to this section of the form is promoted by the glazed knob. If the covering glaze (12-B1-H2) had been of a lighter value, the knob would have been too overpowering; but as a result of the soft grey quality of the glaze, a more subtle relationship between the parts of the pot is created.

A very simple pattern of freely applied white trailings (9A-E2) covers a dark engobe ground (9-D6-H2) in this full-blown form (Figure 15). The elements are close enough together to suggest a texture which envelopes the pot, each unit being somewhat suggestive of the general shape of the pot. A translucent glaze (#12) softens the contrast between the dark and light engobes and helps to unify them. The interior is glazed with a dark iron glaze (12-A2-B6) which furnishes a subtle contrast to the exterior. The same engobe which appeared a dull black (Figure 13) now turns soft green as a result of the reduced iron drawn from the clay body.
EXAMPLES OF THE SLIP-TRAILING TECHNIQUE
Figure 12

FLOWERPOT WITH BLACK AND WHITE ENGObE
Figure 13
FLOWERPOT WITH BLACK AND WHITE ENGobe
Figure 14

COVERED JAR WITH BROWN ENGobe
Figure 15

BOTTLE WITH GREY AND WHITE ENGobe
WAX-RESIST TECHNIQUE

The wax-resist process is not a new one, having been used by Chinese and Japanese potters to obtain reserved areas of unglazed pattern—the waxed areas resisting the glaze and remaining the natural color of the clay body. One of the foremost Japanese potters, Shoji Hamada, uses the wax-resist technique of decorating and thins the wax with paraffin oil which produces a smoother flowing liquid than is possible with wax alone. This method was undoubtedly used by the ancient potters of the Orient.

Present-day potters have at their disposal certain emulsions of paraffin in water. These may be easily applied to clay wares with a brush and, on application, the water is almost immediately absorbed by the clay, leaving a coating of wax on the surface. The use of the emulsions precludes the necessity of melting the wax.

One of the great advantages of wax-resist patterns is that they are essentially a reserve of the ground; consequently the figure or pattern caused by the resist tends to hold itself to the form. While being conscious of the clay’s being literally the ground, the larger area covered by the engobe or covering material becomes the ground for the new pattern.

The bulbous bottle form (Figure 16) illustrates this reciprocation between figure and ground. A dark spiral pattern follows the form of the bottle and reveals the natural clay through a white engobe

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54 Bernard Leach, op. cit., p. 148.
(9-H2) which is poured in a panel over the surface, a second engobe
(9A-C5-H2) covers the other side of the pot. The speckling which
appears both in the body and engobe assists in unifying the two parts.
The pattern remains flat and on the surface of the pot, completely
integrated. The interior glaze (12-A2-B6) provides contrast in value
and texture and is allowed to come over the rim of the pot as a
further integrating factor.

The sturdy open flowerpot form (Figure 17) depends mostly on the
clay for its color and texture, but a subtle wax-resist pattern covers
the exterior of the form. The engobe (9A-T2-H5) could not be expected
to provide a strong contrast with the clay body since it contains some
of the Dalton clay which is used to color the body. The high amount of
granular ilmenite produces a pebbly texture because of its violent
reaction in reduction.

A repeated spiral motif goes around the pot and fits to the
bulbous form. The decoration might have been more successful if there
had been larger areas of engobe remaining. A conflict seems to
develop between the engobed and clay surfaces.

The waisted cylinder provides a great variety of forms, and
although this vase (Figure 18) is derived from the same basic pattern
as the flowerpots (Figures 2, 12, and 13) its elongated body is of
a completely different character. The vertical pull of the pot is
allowed to continue from the base to a short distance below the rim
where it flares out to conclude the direction. Those forms combin­
ing straight and curved elements are difficult as the point at which
these elements meet and resolve is critical to the success of the total form.

Three contrasting values are provided by the glaze (12-A2-B6), the engobe (9A-E2), and the clay body. A further contrast of surfaces is produced by the covering glaze (#12) and the bare clay. Each is varied in amount to provide interest. The two vertical elements caused by the wax-resist hold together as one unit.

In the globular bottle (Figure 19) the strong evanescent quality of the brush stroke has been used to provide a pattern which envelopes the form in curves which repeat the principal form. By allowing the brush to press firmly against the pot at the point of its greatest expansion, then slowly diminishing the pressure at the narrower points, a graduated pattern is created which conforms to the pot form.

The engobe (9A-E2-F2) with its glaze (#12) is used in an attempt to obtain copper red with ilmenite specks bursting through. The inside is glazed with a contrasting dark brown glaze, (12-A2-B6).

The rather tall bottle form (Figure 20) has the same engobe and glaze combination as Figure 3, the light grey engobe (9-M5-E2) poured over the entire form and the brown glaze (12-A1-B6) applied by pouring over the wax resist pattern. In the areas where the wax-resist was not applied, the glaze covered the engobe and caused a black glazed portion.

The careful placing of the wax-resist bands in graduating sizes, with the widest bands at the greater diameter, accentuates the fullness of form and gives it increased lateral dimension. Wide areas
were left at the base and the top rim of the pot to accent the beginning and the terminating points of the form.

A better solution to the neck and rim may be observed on this bottle than on the one shown in Figure 8. The transition from the swelling body of the form to the narrow tapering neck is more gradual, and the concluding lip-rim relates better to the curve of the form in Figure 20.

The sawdust and vermiculite used in the clay body provide an appealing texture to the engobed surfaces, and the pits which appear in the glaze are not objectionable in that they have fused sufficiently around the edge. The chrome present in this particular engobe (9-M5-E2) induces the surface to appear mottled in pink, grey, and green.
EXAMPLES OF THE WAX-RESIST TECHNIQUE
Figure 16

BOTTLE WITH WHITE AND BROWN ENGobe
Figure 17
FLOWERPOT WITH SPECKLED ENGLOBE
Figure 18

VASE WITH WHITE ENGLOBE
Figure 19

BOTTLE WITH DARK RED ENCOBE
Figure 20

BOTTLE WITH GREEN ENCOBE
SGRAFFITO TECHNIQUE

Sgraffito is an excellent technique for producing a calligraphic linear pattern, and it is a natural type of decoration for the engobe or slip since the pattern is merely scratched through the surface to reveal the clay beneath. The great disadvantage of the sgraffito technique is that it requires a sharp instrument for removing the slip, and there is the tendency to draw in a rather stiff manner rather than to create swiftly curving and flowing lines of varying breadth resulting from the changing angle of the inscribing instrument.

Four panels were formed on the bottle (Figure 21) by first pouring a dark blue engobe (9A-A2-R1-H2) on two opposite sides and then pouring a light engobe (9A-H2) on the remaining two sides. Within two of the panels a very subtle sgraffito spiral was rapidly scratched through the engobe. It is essential that this linear pattern be done freely, and it takes experience to accomplish this on a curved surface.

The neck and body of this pot do not create a continuous curving contour, but they are broken by sections of flattened areas which produce a form of greater variety and interest. The flattened walls of the base repeat the slant of the neck.

Panels of dark engobe (9A-V1) were formed on two sides of the pot by pouring from the neck down the base. The sgraffito pattern is designed to fill the engobed areas and carry down the form to help in uniting the lower and upper portions of the body.
A strong contrast is created between the interior and exterior of the bowl (Figure 22) not only by the difference in value between the glaze and the engobe but by the difference in texture. The engobe naturally presents a rough, textured surface, but this quality is increased by the fine sgraffito lines scratched through the white engobe (9-B2). In contrast to the exterior, the interior of the bowl is glazed with a black-brown matt glaze (12-A1-B6) that overlaps the rim sufficiently to relate the two surfaces. The glaze and engobe both show the evidences of pouring which help to break the uniform surface that would result from other methods of application. Where the white engobe is thinly applied, the iron present in the clay body has turned the engobe to a soft tan, helping to further unite the interior and the exterior.

The bowl is simple, and its success as a pottery form depends largely on the subtle changes of the curve and its initial springing at the base to the gentle outward movement at the lip. The undecorated area remaining at the top of the form stabilizes the rim and offers a conclusion.

The vase (Figure 23) tends to solve a problem of form which results from a broad foot with walls which gradually taper inward. Forms which have their widest diameter at the base are more unusual in pottery, even though they have increased stability, because it is difficult to endow the pot with any feeling of lift. There is a tendency for the form not only to appear heavy at the base but to actually be heavy because of the difficulty of raising the clay from
the acute angle formed between the bottom and the wall.

The exterior of this vase was covered with a blue engobe (9-A2-H1-H2), and diagonal lines were sgraffitoed through the engobe. A semi-opaque covering glaze (24A) was applied to the inside and the outside surfaces. Overlapping areas resulting from the pouring of the two coatings, the glaze and the engobe, introduce a diagonal direction which is further emphasized by the decorative lines. The blue color of the engobe seems more intense than when used on other examples; this is particularly noticeable in comparing this vase to the bottle in Figure 21. The engobe on this bottle has no covering glaze while the same engobe on the vase has a glaze that turns the cobalt in the composition to blue-violet. A strong contrast in value between the interior and the exterior of the pot gives the appearance of greater width to the mouth-rim and lessens the apparent constriction of the form.

This seemingly static form is activated by the diagonal movement of the sgraffito lines and the abrupt turning of the lip.

The unglazed flowerpot (Figure 24) has a brown engobe (9-C5-H2) poured over the exterior surface and sgraffitoed lines grouped in vertical units with undecorated strips between them. Sawdust and vermiculite wedged into the clay body provide a heavily textured surface which is visible on both the engobed and unengobed surfaces. The undecorated areas of the pot appear lighter in value than might
be expected from this clay mixture; a fact that is undoubtedly caused by a lighter reduction firing.

A simple and substantial form was selected for this functional flowerpot; and, although it is not greatly divergent from the traditional prototypes, its terminal parts such as the foot and rim are sufficient to give this pot greater dignity and elegance. A comparison with the flowerpot in Figure 2, which contains many of the same elements, points out the importance of the mouth-rim treatment in determining the character of the pot. While the flowerpot in Figure 2 appears tight and constricted, the one in Figure 25 has an open, expanding quality. The contrast in value between the interior and exterior has helped considerably in establishing the greater feeling of expansion.

55 The clay body used for this pot is a mixture of Italian Terra Cotta and Westwood stoneware clays.
EXAMPLES OF THE SCRAFFITO TECHNIQUE
Figure 2h

BOTTLE WITH BLUE AND WHITE ENCOBE
Figure 22

BOWL WITH WHITE ENGLOBE
Figure 23
VASE WITH BLUE ENCOBE
Figure 24

FLOWERPOT WITH BROWN ENGobe
The mishima technique is essentially reciprocal to the sgraffito technique in that the first technique utilizes the engobe as the pattern, and in the second technique the engobe serves as a background for the pattern. While sgraffito decoration requires a free linear pattern that is calligraphic in nature, the mishima decoration is usually less fluid and consists of more isolated units, suggesting a textured surface. The textural feeling is also increased by the deeper impressions of the mishima pattern, which are essential to the clarity of this type of decoration.

The covered jar (Figure 25) illustrates a free use of the mishima technique which has been given strong textural emphasis by the deep impressions made in the wet clay shortly after the forming on the wheel. A less precise and detailed pattern than is to be found on Korean wares is evident; this partially is due to the softness of the clay while decorating and is partially a result of the scraping of the background which was done less completely and prior to the bone-dry stage of the clay.

A brown engobe (9-C5-H2) was applied to the outside surface of the pot using wax-resist to prevent the engobe material from covering the areas to be left undecorated. The liquid engobe penetrated the impressions previously made and was allowed to remain after the background had been scraped away to reveal the clay body underneath. Originally it was not intended that the pot should have any glaze other than the black-brown (12-Al-86) applied to the indented rim and
knob, but a light salt-glace covered the lid and body as a result of firing the piece in a converted kiln which once had been used for salt glazing. This superficial glaze coating added a slight sheen to the pot and provided a more contrasting surface.

The form of this covered jar is similar to the one in Figure 15, but various subtle differences in the treatment of the parts and the decoration produced quite divergent pots. Both pots have a vertical emphasis which is intensified by the directional movement of the decoration, the contrast and emphasis being greater in Figure 15. Careful observation of the lip-rim and knob reveals that the jar in Figure 25 arrives at a more complete solution, mainly through the treatment of the lip-rim and the knob. A more gradual transition from the body to the lid and the knob can be seen in this pot; also there is a greater springing quality to the rim which does not compete with the knob, as in Figure 25. The slight flare of the foot on this pot relates more completely to the direction of the rim, and a greater unity of the parts is felt.

The vase form (Figure 26) is treated in a decorative manner similar to the mishima technique used on the jar in Figure 25. The brown engobe (9-A1-B6-N10) was poured over the impressed decoration, as previously noted, and the excess material was scraped away from the surface after the pot had dried; a lighter tan engobe (9-C5-H2) was then poured over the entire pot. The brown engobe underneath only slightly penetrated the covering tan engobe, minimizing the strength of the mishima decoration. As in Figure 25 the rim and
interior of this vase were covered with a black-brown matt glaze (12-A1-B6), providing both a contrast of value and a contrast of surface texture with the decorated area of the pot.

The strong vertical direction of this form is broken only by the broad rim which aids in giving a more plastic feeling to the pot. Other experiments with this form indicated that the tapering of the walls from the foot to the lip-rim should be very gradual and should not be as pronounced as in this example where an emphasis on the broad base detracts from the elevating sensation created by the form. A definite foot is essential to give lift to the pot; otherwise the form appears heavy as in Figure 23.

A relationship is established between the base and the rim by directing them in a similar curve which departs strongly from the otherwise straight, severe sides of the form. Proportion becomes an important problem in a form of this nature, and the widths of the base, the neck, and the mouth must be sufficiently varied to provide interest.
EXAMPLES OF THE MISHIMA TECHNIQUE
Figure 25

COVERED JAR WITH BROWN ENGobe
Figure 26

VASE WITH BROWN ENCOHE
The utilitarian forms shown in Figure 27 are in keeping with the traditions of salt glazing. They are simple and unpretentious forms, suitable for this technique where an even glaze coating over the ware is not always easily obtained.

The engobe used on both of these pots is high in iron (9A-B6-H6-N10) which is supplied as red iron oxide ($Fe_2O_3$) and as Barnard clay. On the pitcher, the pattern was applied in a few strokes of wax resist with a heavy coating of engobe poured over the entire pot. The small bowl has a pattern of rapid brush strokes in a bulls-eye motif, with the engobe being rather thin for painting.

Unlike the darker browns usually resulting from this engobe (Figure 6) the salt glaze intensifies the reddish-orange quality of the iron. A number of tests suggested that alternating reduction and oxidation at the end of the firing caused flashing which intensified this metallic effect of iron. The characteristic orange-peel texture adds interest to the engobing.

The interior was coated with a mixture of 50% Albany and 50% Michigan slips which resulted in a soft grey-brown matt.
EXAMPLES OF ENGOBE UNDER SALT GLAZE
Figure 27

PITCHER AND BOWL WITH BROWN ENGObE
SUMMARY

An investigation in the field of ceramic art frequently takes on aspects of a technical research, yet it necessitates aesthetic application in order to be of value to the artist-potter. Since ceramics has a dual nature, it is difficult to maintain a balance between its divergent characteristics, and too frequently technical research in ceramics is not applicable to the work of the potter in his search for aesthetic realizations through the ceramic medium.

Throughout this dissertation dealing with vitreous engobes, there has been an attempt to resolve the differences that exist between the major technical and aesthetic problems, and to offer information on the nature of the engobes in relation to their preparation and application.

It is essential that the experienced potter have a knowledge of his materials, their physical characteristics, and their reaction to heat treatment. Without a minimum of technical background, the greatest formal conceptions would be of little value in their final application because of a lack of skill and knowledge to realize them.

The artist-potter needs to establish more exchange with the ceramic engineer and needs to discipline himself more by recording observations and utilizing experimental data. Similarly, the ceramic technologist could be of greater service to the industry and the studio-potter if he would attempt to understand the creative problems involved in his medium.

The fact that most of the great examples of ancient pottery were
created in ignorance of ceramic chemistry and engineering as they are known today cannot be ignored, but it must also be recognized that many technical improvements in materials and equipment have taken centuries to be developed. The artist-potter in contemporary society cannot afford to ignore the advantages of scientific advancement as generally he is not in possession of the composite of experiences that might be derived from a long lineage of ancestral potters. Crafts are no longer family institutions as in the past, and the craftsman does not have the opportunity of availing himself of family secrets or techniques; he must use more scientific approaches rather than depend completely on empirical methods.

Although a particular decorative technique has been the subject of this dissertation, it is not to be inferred that the vitreous engobe has value apart from the pottery form itself. Unfortunately, the study of glazes, clay bodies and other technical aspects of ceramics frequently becomes an end in itself when actually for the complete potter it is only incidental to his fully realized creations. Such material as is afforded by any research in the crafts, whether it is of a technical or an aesthetic nature, can only be of value when it coincides with the individual artist's inspiration.
APPENDIX

DEFINITION AND IDENTIFICATION OF SYMBOLS

FOUND IN TEXT

In order to facilitate the identification of the engobe mixtures when referring to them in charts or in the text, a group of symbols was adopted. The first of the group of symbols is a number which refers to the engobe or glaze formula used. If a letter follows this number, it indicates a variation on the original formula. The second group of symbols refers to the color addition to the engobe or glaze, the capital letter corresponding to the particular colorant and the number following indicating the percentage of colorant added.

EXAMPLE:

Engobe mixture 9A with an addition of 10% red iron oxide would be written as: 9A-B10

MATERIALS USED AS COLORANTS IN THE EXPERIMENTS

A-coal carbonate  M-chromium oxide
B-red iron oxide  N-Barnard clay
C-nickel oxide  O-manganese dioxide
D-vanadium stain  P-lead chromate
E-copper oxide  Q-tin oxide
F-rutil  R-Albany slip
G-Black #158 (Mason) S-vanadium oxide
H-granular ilmenite  T-Dalton clay
I-iron chromate  U-black #470 (Mason)
J-black iron oxide  V-black #299 (Mason)
K-blue green #1754 (Mason) W-Watt stoneware clay
L-titanium oxide  X-granular rutil

ENGobe AND GLAZE FORMULAE USED IN THE EXPERIMENTS

Engobes and Glazes:

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<th>Engobe #9A</th>
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<td>Glaze #16 (Tan Matt)</td>
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I, Robert Ward Ramsey, was born in Fullerton, California, March 5, 1928. I received my secondary school education in the public schools of Fullerton, California. Following my high school graduation, I attended Fullerton Junior College for two years, after which I continued my studies at The University of Southern California, receiving the Bachelor of Fine Arts Degree in 1949. After serving 18 months in the United States Army, I enrolled in the New York State College of Ceramics, Alfred, New York, from which I received the Master of Fine Arts Degree in Industrial Ceramics Design in 1954. In 1956, I commenced my work at the Ohio State University, where I specialized in Ceramic Art. In 1957 I assisted in Art History while working toward completion of the requirements for the degree, Doctor of Philosophy.