8 EUTECTICS AND GLAZE DEVELOPMENT WITH TWO MATERIALS

EUTECTIC MATERIAL COMBINATIONS

Glaze development, at any temperature, is totally bound up with a rather obscure and seemingly illogical scientific phenomenon called *eutectics*.

A eutectic is the lowest common melting point of two or more materials, which individually have melting points sometimes considerably higher than that of their mixture. For example, silica melts at 1710°C and lead oxide melts at 880°C. Logically, you would expect a mixture of equal parts silica and lead to melt at the halfway point of 1295°C. In fact, they melt at about 800°C, which is a lower temperature than the melting points of both materials but by no means the lowest eutectic point at which a combination of silica and lead will melt. This point would be reached at approximately 510°C, with a mixture of 90% lead and 10% silica. Other materials behave in similar fashion in conjunction with silica, causing it to melt at a variety of temperatures. These materials are mainly known as the fluxes and are discussed at length in Chapter 11. It is an over-simplification to say that the flux attacks and melts the silica, because in reality they react with each other. And it is not only the fluxes that create eutectics with silica; clay materials, or amphoterics, also react in this way because they also contain fluxing materials in their makeup.

As a glaze is heated, the simplest eutectic combinations will melt first. Once fluid, they will soak into the surrounding material and find other oxides or combinations with which to produce more complex eutectics. This process continues until the whole mass is molten. If it is stopped before the end point, it will be found that some parts have completely melted, producing a glass, but within this glass are specks of unmelted material. The overall effect may be a desirable opaque glaze, but the maturity point where all the eutectic combinations have occurred would be a transparent and possibly colored glass.

The process of chemical change is basic to the development of glaze and in the majority of glazes various eutectics are developed during the firing cycle. The theory of eutectics is very complex; for the ceramist it is not essential to understand every detail, but you should be aware that eutectic combinations cause the melting of materials at various percentages and temperatures. You must accept that this is the underlying control mechanism for the temperature at which a glaze matures.

Perhaps the best place to witness the development of some eutectic reactions is in the simple line blend method of glaze development using two materials. The selection of materials is important and should include a flux and either a glass-former or an amphoteric that contains a glass-former (according to the FAG principle, see Chapter 6, page 69). This selection will allow eutectics to be formed at a workable temperature. In most cases, but certainly not all, a mixture of two materials will develop in fusion as they move toward the middle of the line blend, as is shown in the following section. The point of most fusion will be the eutectic.

TWO-MATERIAL TESTING BY THE LINE BLEND METHOD

The line blend is the simplest method for mixing a complete variation of two materials. It is done by increasing the amount of one material while decreasing the amount of the other. It is usually done by increasing or decreasing at 10% intervals; the sum of the two materials should always add up to 100, as in the following table:

Test #	1	2	3	4	5	6	7	8	9	10	11
Material A (%)	100	90	80	70	60	50	40	30	20	10	0
Material B (%)	0	10	20	30	40	50	60	70	80	90	100
Total	100	100	100	100	100	100	100	100	100	100	100

There will be times when the most interesting mixtures could benefit from a smaller interval variation, usually after testing at 10% intervals.

This will be found in the area between 80/20 and 20/80, and can be done simply as follows:

Test #	1	2	3	4	5	6	7	8	9	10	11	12	13
Material A (%)	80	75	70	65	60	55	50	45	40	35	30	25	20
Material B (%)	20	25	30	35	40	45	50	55	60	65	70	75	80
Total	100	100	100	100	100	100	100	100	100	100	100	100	100

In fact, after the initial understanding of how materials fuse together is achieved, from 100 to zero and zero to 100, you will notice that the section between the 80/20 and the 20/80 variation is probably the area where most usable fusions and glazes develop. Many very beautiful glazes, in all temperature ranges, are simply a matter of combining two materials.

The following list of suggested dual materials for line blend testing will give some idea of where to start in the process. It is divided into low-fire, from cone 04 to 1, mid-fire, from cone 3 to 6 and high-fire, from cone 8 to 11. Where frits are used they should be thought of as one material.

Low-Fire Line Blends, Cone 04 to 1

1. Calcium borate and any clay
2. Calcium borate and any feldspar
3. Any frit and any clay
4. Any frit and any feldspar
5. Lead and clay (any form of lead - use with care - not for functional use)
6. Lead and feldspar (any form of lead - use with care - not for functional use)
7. Any frit and any flux (see materials list, Chapter 6)
8. Any frit and flint
9. Borax and any clay
10. Borax and any feldspar
11. Boric acid and clay
12. Boric acid and feldspar
13. Any frit and any other frit
14. Calcium borate and any frit

In most cases, a mixture of materials that has only just started to fuse at the low-fire temperature will enter a more complete fusion at a slightly higher temperature, and so many of those mixes suggested above could also be used for the mid-fire area.

Mid-Fire Line Blends, Cone 3 to 6

1. Frit and any clay
2. Frit and wood ash (see also Chapter 12, wood ash)
3. Calcium borate and wood ash
4. Calcium borate and any frit
5. Calcium borate and any feldspar
6. Calcium borate and red clay
7. Calcium borate and any other flux
8. Frit and any flux
9. Wood ash and any flux
10. Wood ash and red clay, or Alberta slip clay

Once again, mixtures where incomplete fusion has taken place at a lower temperature will develop into a more fusible mix at the higher range.

High-Fire Line Blends, Cone 8 to 10

1. Wood ash and any clay
2. Wood ash and any feldspar
3. Wood ash and any flux
4. Whiting and any clay
5. Whiting and any feldspar
6. Wollastonite and any feldspar
7. Wollastonite and any clay
8. Cornwall stone and wood ash
9. Any feldspar and any flux

10. Any feldspar and any clay
11. Nepheline syenite and Alberta slip clay, or red clay
12. Cornwall stone and kaolin
13. Porcelain clay body and wollastonite
14. Porcelain body and wood ash

The above lists could have been much longer and more specific as to which frits, which feldspars, and which fluxes to use for best results. However, I feel that this would possibly lead to the imposition of limitations, which could inhibit the learning process.

Within the above suggested high-fire tests may be found a number of simple and beautiful glazes that are quite similar to some of the earliest and best Chinese glazes of the Han, Tang, and Sung dynasties.

8.1. Ann Cummings, Canada, "Artemis Entering the Forest," 1997. Earthenware, terra sigillata and slip glazes. 10cm x 59cm x 33cm.

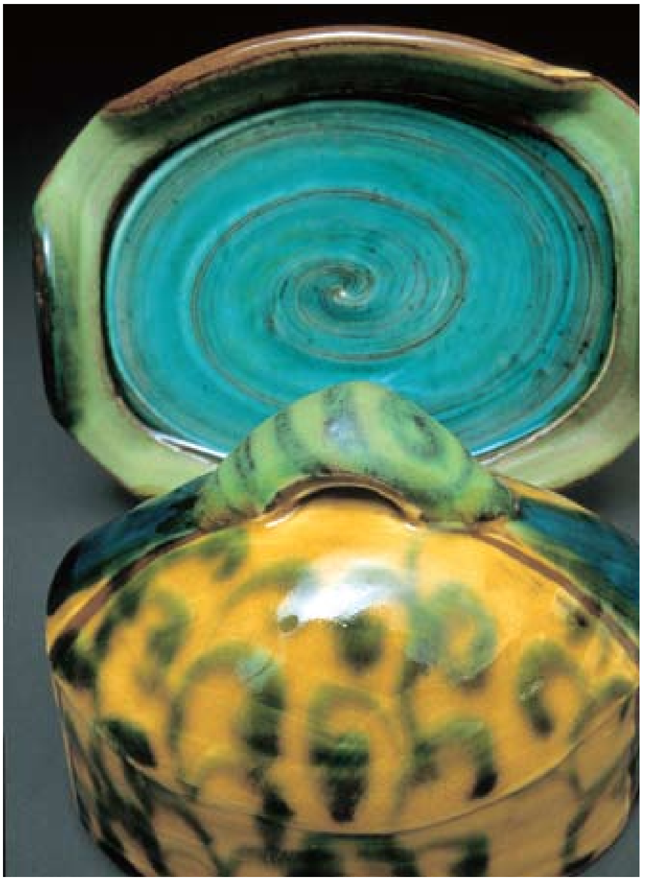
8.2. Angelo di Petta, Canada, "Valle," 2000. Slip cast white earthenware, coated with red terra sigillata, majolica, and washes of stain. Decals from graphite rubbings fired at cone 016, all oxidation firings. 16" x 9" x 5".

8.3. Kathryn Finnerty, Canada, "Flower Holder," 2000. Cone 03, terra cotta, white slip. Photo by Tom Rohr.

8.4. Bud Gillies, Canada, "Women Warriors." Design incised with pin, multicolored glazes, raku fired, manipulation during reduction, bisqued at 04, glaze fired at 06. Photo by Peggy Mercer.

8.5. Friederike Rahn, Canada, "Pitcher," 1998. Earthenware, hand-built, slip and terra sigillata, polychrome glazes. 16cm x 22cm x 10cm.

8.6. Joan Bruneau, Canada, "Butter Dish With Lid." Thrown and constructed earthenware with white slip, cone 04, polychrome glazes and terra sigillata.



8.7. Carol and Richard Selfridge, Canada, "Leda's Dilemma (So Many Swans, So Little Time)." Terra cotta, majolica, 63cm tall.