# GlazeMaster™ | User's Guide

by John Hesselberth, *Frog Pond Pottery*

A Glaze and Clay Database
and Calculation Program
for Windows and
Macintosh computers
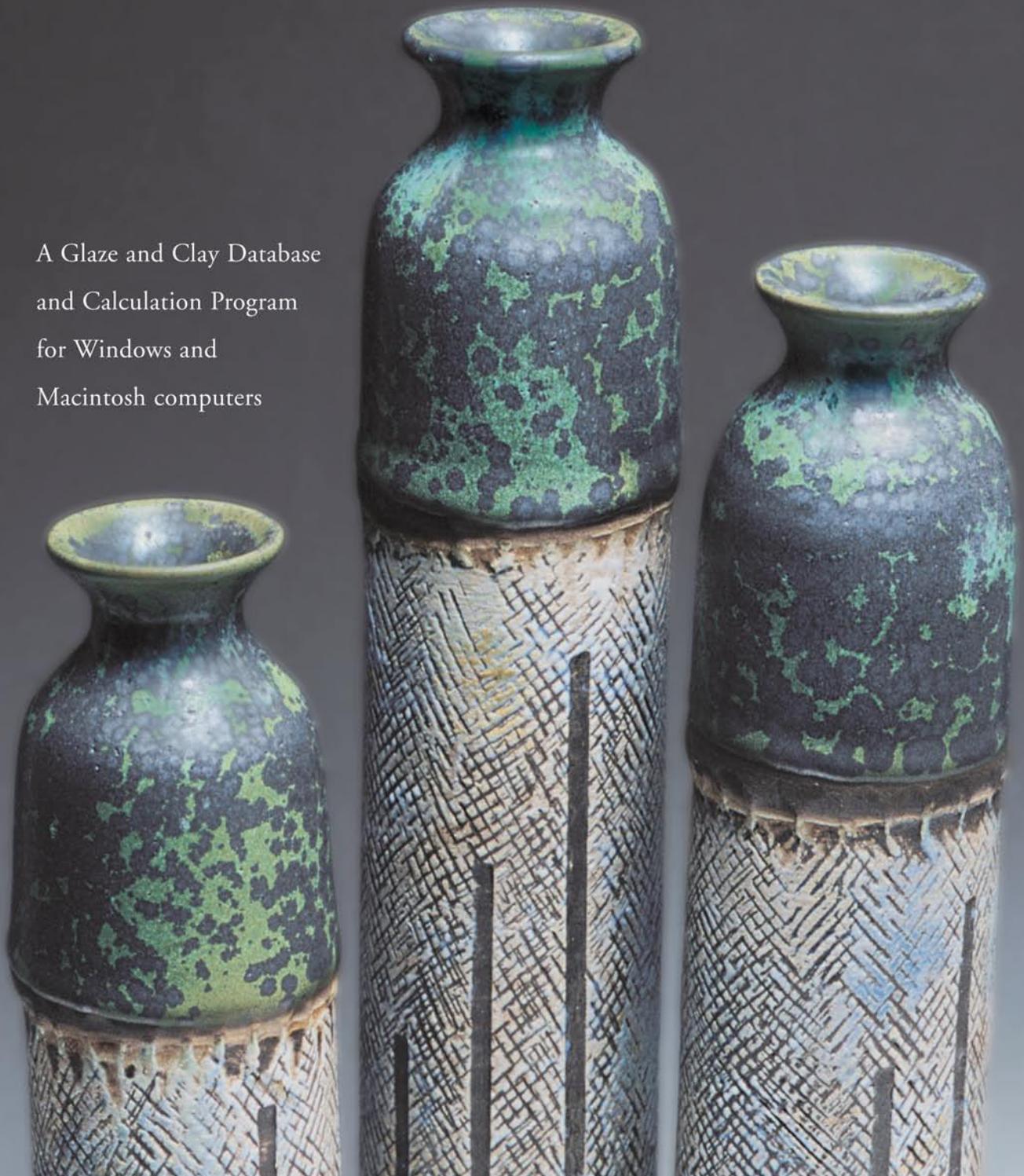
GlazeMaster™
User's Guide

3nd edition

A Glaze and Clay Database and Calculation Program

for Windows and Macintosh computers

Cover Design by Joyce Hesselberth, Spur Design, Baltimore, MD

Cover Pots by John Hesselberth. Assembled from handbuilt and thrown stoneware, textured, multiple slips and glazes, 2 1/2 inches in diameter by 13-17 inches tall.

System Requirements

GlazeMaster runs on both Macintosh and Windows computers. Following are the specific requirements for each.

Windows

Windows 98 or later up to and including Windows 7

30 MB free space on a hard disk

at least 512 MB of RAM

a CD drive or internet download capability

Macintosh

OS X (up to and including Lion – 10.7.x)

30 MB of free space on a hard disk

at least 512 MB of RAM

a CD drive or internet download capability

Highly Recommended for Both Computer Types

A monitor having a screen resolution of at least 1024 x 768. Higher resolution is even better–particularly for Windows machines which use more space at the top of the screen.

Internet Access for updates.

Contents

Note: Contents Entries Are Hyperlinked. Click on Them.

1

GETTING STARTED

Introduction

GlazeMaster™ is a glaze and clay database and calculation software program. It is designed to help you easily keep track of and organize your recipes while, at the same time, providing you with the information you need to assess whether your glazes or clays are likely to give the performance you want. GlazeMaster is useful for all firing temperatures; it can also help you design better glazes or clays. In writing GlazeMaster, my intent was to first make it a useful database so even beginners will want to use it to store their glaze and clay recipes. If you use the program for nothing other than that, fine. However, you will be missing the power of glaze calculation in helping you do things like 1) develop new glazes or improve existing glazes, 2) replace a no-longer-available material with a minimum of fuss, and 3) quickly assess whether a glaze you got from someone else is likely to meet your standards for durability or fit your clay. All this and more is yours for the asking if you will spend the time necessary to understand what the calculations are telling you. But more on that in Chapter 2 and scattered throughout the rest of this User's Guide. Right now let's get the program registered, installed, and up and running.

Registration

Please take a moment to register the software unless you bought it directly from Frog Pond Pottery. If you bought it direct you are already registered. Registering is the only way we will have to notify you of upgrades or usage hints or replacing a lost installation code if the need arises. We will not use the information for any other purpose and our emails to you will normally not be more than 3 or 4 a year. Our primary communication will be by email so please give us an email address that is likely to be permanent. The registration form is a pdf file that is on the GlazeMaster CD. You can also email or fax the information to us if you prefer. Thanks in advance for doing this.

Installing GlazeMaster

Windows Machines

These instructions are for Windows 7 Home Premium. You may have to adjust slightly for other versions of Windows.

Insert the GlazeMaster CD-ROM in your machine. Double click on the CD-ROM icon–you may have to go to 'Computer' via the Start Menu to find it– and then on the Windows folder. Within that folder you will find a Glaze-Master X.Y folder where X.Y is the version number, e.g. 3.0. Simply copy that folder onto your hard drive–GlazeMaster cannot be run from the CD– and put it wherever it is convenient except the Program Files folder. I highly recommend that you **put it in your Documents folder** or any other place that will be backed up regularly. For Windows most programs are in the Program Files folder, but the GlazeMaster folder should not be put there. Recent versions of Windows–at least on some machine types–have an aversion to modifiable files being in that folder–and the GlazeMaster folder contains several modifiable files which are used to record your recipes. If you do put it in the Program Files folder you may well receive an error message saying that something you are trying to do cannot be done because the file is not modifiable. Whatever you do, DO NOT remove any files from that GlazeMaster X.Y folder. They are all needed and they must be in that folder. If you want a GlazeMaster shortcut on your desktop, find the GlazeMaster application file (which may or may not be followed by .exe depending on how your computer is set up). Right click on that file and select Create Shortcut. Then drag the shortcut to your desktop.

Of course, GlazeMaster is started by double clicking on its application file or on the shortcut you just created. If you want GlazeMaster to show up in your Task Bar or in the Start Menu, you can do that by right clicking on the application file and selecting 'Pin to Task Bar' or 'Pin to Start Menu'. Note that when you do this it may be listed as 'FileMaker Runtime Program' rather that GlazeMaster, but you can change its name back to GlazeMaster by selecting it and typing in the correct name.

Also in the GlazeMaster X.Y folder there is a GM3.ico file which can be used to change the icon on your shortcuts. To do this right click on the shortcut and select Properties at the bottom of the list. Then click on the Shortcut tab and select 'Change Icon..'. You will then have to Browse and locate the icon file, select it, click Apply and then OK. The GlazeMaster icon should show up immediately on a desktop shortcut but only after restarting in the Start Menu. For some reason I don't understand it doesn't seem to ever show up on the Task Bar–the generic icon remains. Your mileage may vary.

To uninstall GlazeMaster simply drag the GlazeMaster X.Y folder to your recycle bin or right-click on the folder and select delete. GlazeMaster does

Windows does some curious things that can be confusing to people not thoroughly familiar with this operating system. For example, it will sometimes place a temporary file named '._GlazeMaster.exe' in the GlazeMaster X.Y folder. The '._' at the beginning of the file name indicates a temporary file. Never double click on these; look for the real thing.

not bury files elsewhere on your computer which makes it very easy to install or uninstall. You may also have to delete any shortcuts you have installed and unpin GlazeMaster from your start menu and/or task bar.

When you launch the program the first time you will be asked whether you want to enter the Installation Code now or later. If you have already purchased the program, click 'Now'. Read the GlazeMaster license as you scroll to the bottom of the next screen. You must agree to the license or the program will automatically shut down. Then enter your name and Installation Code. The Installation Code can be found on the card that is inside the CD jewel box. Please keep this code in a safe place as you will need it to reinstall the software or for upgrades. If you bought your software directly from Frog Pond Pottery or if you register the software with us, we will also keep it on file. With proper identification we will resend it to you.

After successful entry of the Installation Code and clicking Continue, you will be taken to the start-up screen for a few seconds and then to the Main Menu. You will not need to agree to the license or reenter the Installation Code when starting GlazeMaster in the future.

Macintosh Machines

Insert the GlazeMaster CD-ROM in your machine. Double click on the CD-ROM icon and then on the Macintosh folder. Within that folder you will find a 'Read Me First' pdf file. Detailed installation instructions are contained in the 'Read Me First' file. Please do read it first.

To install, simply drag the GlazeMaster X.Y folder (where X.Y is the version number, e.g. 3.0) to any convenient place on your Mac. I strongly recommend you **put it in your Documents folder** as that is the place it is most likely to get backed up regularly. The data files are in that folder so you definitely want to back it up regularly. Unlike in Windows, you can put it in your Applications folder if you wish; however very few people back that up on a regular basis. It must be copied to your hard disk–GlazeMaster cannot be run from the CD. Whatever you do, DO NOT remove any files from that folder. They are all necessary and all must be in that folder

To uninstall it, simply drag the GlazeMaster X.Y folder to the trash. GlazeMaster does not bury files elsewhere on your computer which makes it very easy to install or uninstall.

Now open the GlazeMaster X.Y folder and find the GlazeMaster application file. Always launch the program by double clicking on this file or its alias and not one of the others in the folder. You may make an alias of the GlazeMaster program for your desktop or drag it to the dock.

Double click on the GlazeMaster icon or its alias (single click if you put it in the dock) to start the program. When you launch GlazeMaster for the first time you will be asked whether you want to enter the Installation Code

now or later. If you have already purchased the program, click 'Now'. Read the GlazeMaster license as you scroll to the bottom of the next screen. You must agree to the license or the program will automatically shut down. Then enter your name and Installation Code. The Installation Code can be found on the card that is inside the CD jewel box. Please keep this code in a safe place as you will need it to reinstall the program or for upgrades. If you bought your program directly from Frog Pond Pottery or if you register with us, we will also keep it on file. With proper identification we will resend it to you. You will now be shown the start-up screen for a couple seconds and then will be taken to the Main Menu. You will not need to agree to the license or reenter the Installation Code when launching the program in the future.

From here on, GlazeMaster is virtually identical for both Windows and Macs; however, we will point out minor differences from time to time.

Upgrading and Transfering Files from an Earlier Version

Two different procedures are required to transfer files from an old version to a new one depending on the 2 version numbers. First I will describe transfering files from version 2.3r3 or lower to version 3.0 or higher and then what is required if your old files are already on version 3.0 or higher.

Transfering from Version 2.3r or lower to Version 3.0 or higher

Version 3.0 of GlazeMaster is a runtime program based on FileMaker 11 whereas versions 2.3r3 and below were based on FileMaker 6. There is a significant change in file format between these versions of FileMaker such that data cannot be readily exchanged between the two versions. What the following paragraphs will describe is a way to move your recipes, recipe sets and materials from one version to the other; however you will have to manually re-enter Limit Sets, Preference Sets, and Expansion Coefficients if you made any changes to those in your earlier version of GlazeMaster.

The procedure is relatively simple, but must be done carefully. The simplest description is that you must export the Recipes.USR and Materials.USR files from your old program and import them into the new. You must be able to still run your old program to complete this procedure so, if you are a Mac user, make sure you can still run Snow Leopard or an earlier version of OSX. Versions of GlazeMaster 2.3r3 and lower will not run on Mac OS 10.7 (Lion).

First start your current version of GlazeMaster (2.3r3 or earlier).

Exporting Recipes

Select "Import/Export/Delete/Change Recipes and Materials" on the Main Menu (See Figure 1-1)..

Then Select "Export All Recipes". This will bring up a dialogue box where you specify the name, type, and location of the exported file (Figure 1-2).
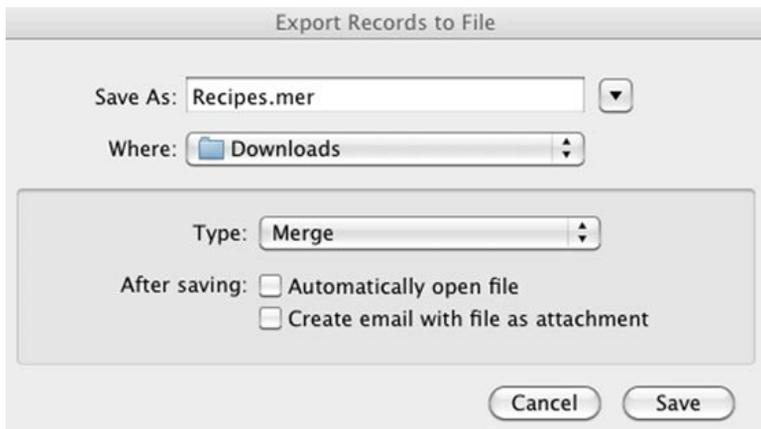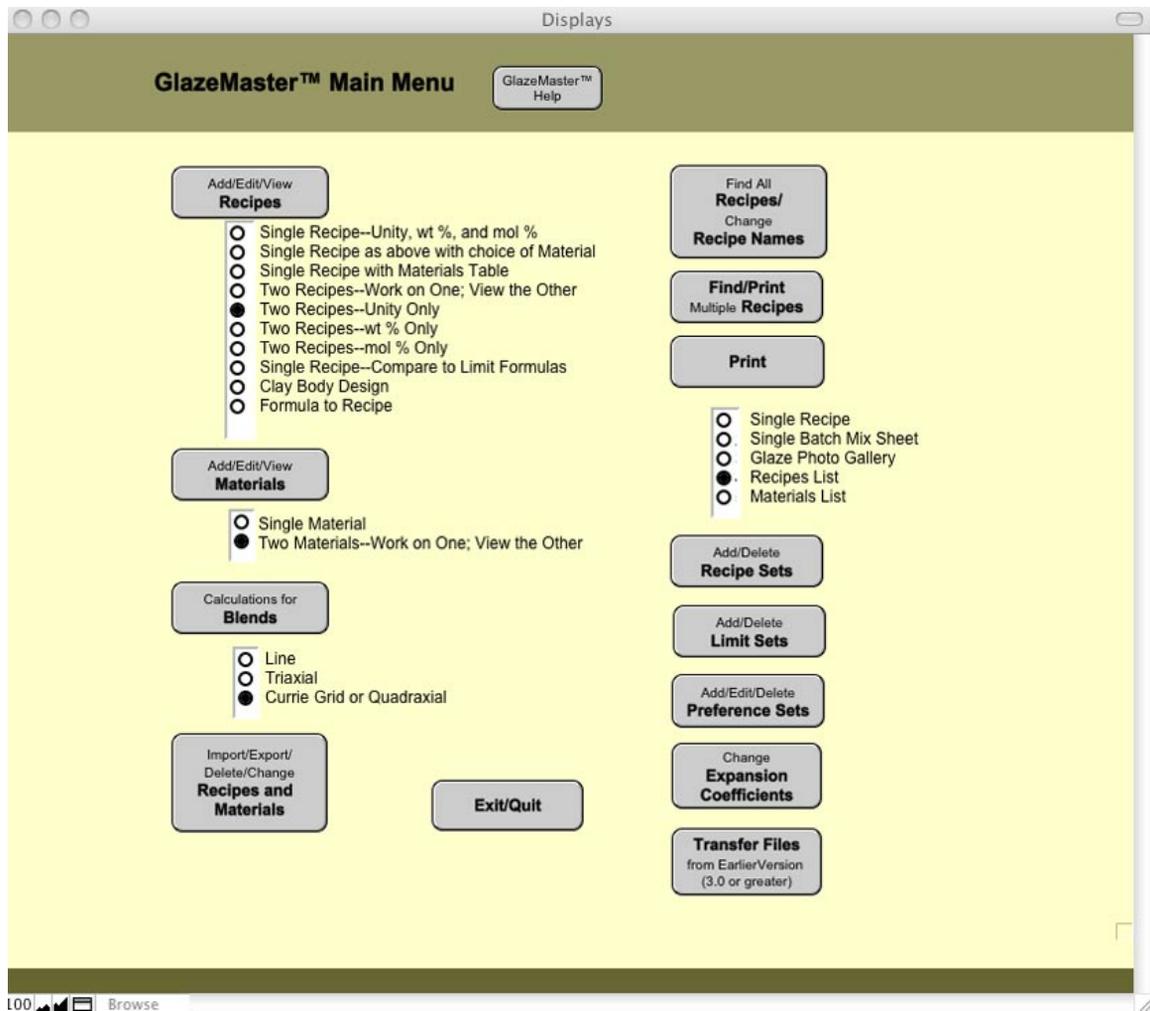
First change the file type by selecting 'Merge' from the pull-down menu. It is critical to select 'Merge' because it is the only file type that will import correctly into the new version. Then change 'Untitled' to a file name you will remember–Recipes.mer would work. Last select a location you will re-

member–right in your original GlazeMaster folder is OK–it really makes no difference as long as you will be able to find it a bit later in the process. Make sure 'Automatically open file' and 'Create email with file as attachment' are NOT checked. That dialogue box will look about like Figue 1-2 (I chose my Downloads folder as a convenient place to store the file):
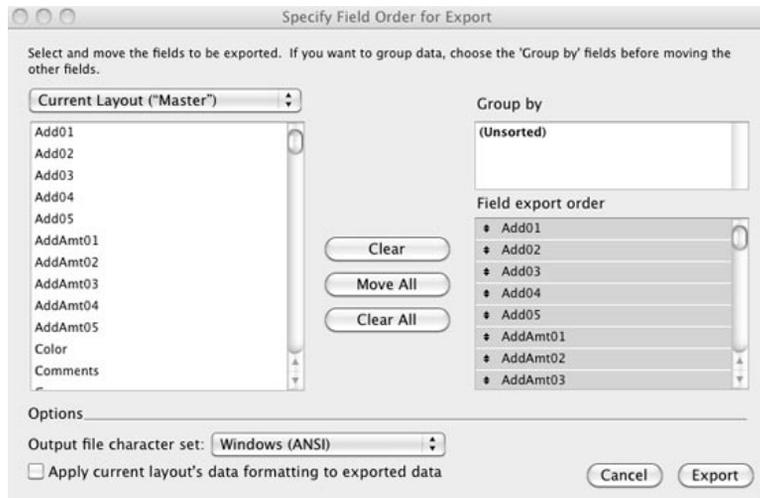
Now click "Save".

In the next dialogue box, click on 'Move All' so that all the fields in all of the records in the Recipes.USR file are exported. The dialogue box will look approximately like Figure 1-3.

Now click 'Export' and go throw a few pots. Exporting a large number of recipes is a time consuming task. My file of 706 recipes took just about an hour. So don't despair if your computer seems to be counting its fingers and toes for a loooooong time. It is really working very hard.

Exporting Materials

Now we will do the same thing for the Materials.USR file in your old copy of GlazeMaster.

Select "Import/Export/Delete/Change Recipes and Materials" on the Main Menu.

Then click on "Export Materials"

Change the file type to 'Merge' on the pull down menu, name the file, and select a place to store the file–the same place as you stored the Recipes,mer file would be best.

Click "Save" and then click on "Move All" in the next dialogue box.

Finally click on "Export". You only get a short break this time as exporting the materials file does not take nearly so long.

Importing Recipes

Importing recipes from your .mer file is quick and easy with two little complications. With version 3.0 running, click on "Import/Export/Delete/ Change Recipes and Materials". Then click on "Import Recipes" You will first be asked whether or not you want to delete the existing recipes leaving only the ones you import. This is a good idea if the program is brand new and you have not already been adding to your recipe database. The recipes that came with the program are probably already in your .mer file that you just exported from your old version and having duplicate copies of recipes can confuse your poor computer. So I normally recommend clicking
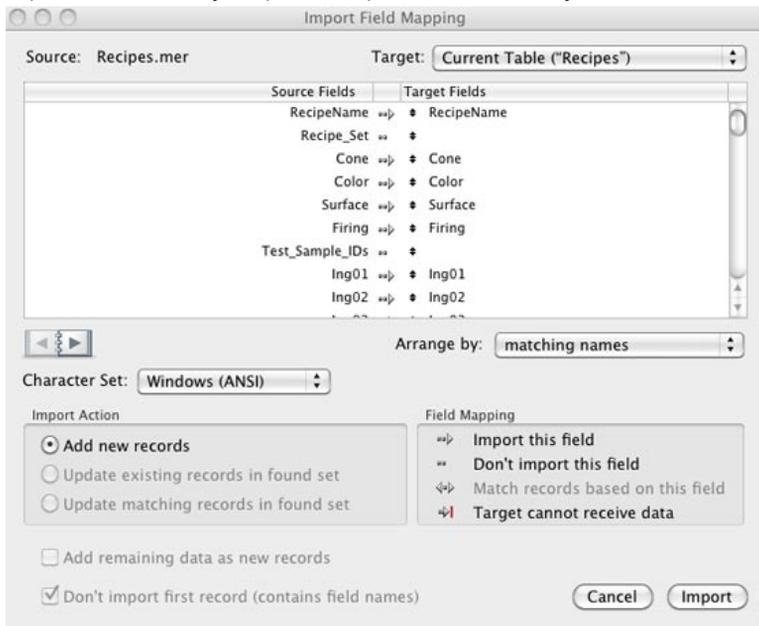
Figure 1-4. Import Field Mapping.

'Yes' unless you have already added a bunch of recipes to version 3.0 or just like mucking up your data file for the perverse pleasure it gives you. If you click 'Yes' you will be asked to confirm that your really want to delete all of those recipes.

Next you will be taken to a file finding dialogue box where you will locate that .mer file you just exported from your old version. When it is highlighted, click 'Open'. Now comes the part where you have to be careful. Take a close look at Figure 1-4:

At the top you will see the names of the file you are importing and where GlazeMaster intends to put the data. Next you will see a box (with a scroll

bar) with all the field names for both the Source and Target fields. They need to be matched up. Below that box you will see that "matching names" has already been selected and if you scroll through the box of field names you will see that all but two are matched (plus some left-overs that are at the bottom). The two that have no match, but should, are 'Recipe_Set' and 'Test_Sample_IDs'. This happened because a .mer file doesn't like spaces in a field name so it put an '_' where there was a space in those two field names. FileMaker/GlazeMaster, on the other hand, thinks spaces are just fine.

Now scroll almost to the bottom of that box and in the 'Target Fields' column you will see 'Recipe Set' and a little above 'Test Sample IDs'. Now this is important: Move 'Recipe Set' up first. You do this by clicking and holding on the little tiny two-headed arrow immediately to the left of the first letter 'R' of Recipe set. If you slide that arrow up 'Recipe Set' will fol-

Figure 1-5. Import Field Mapping after adjusting for proper alignment of field names..
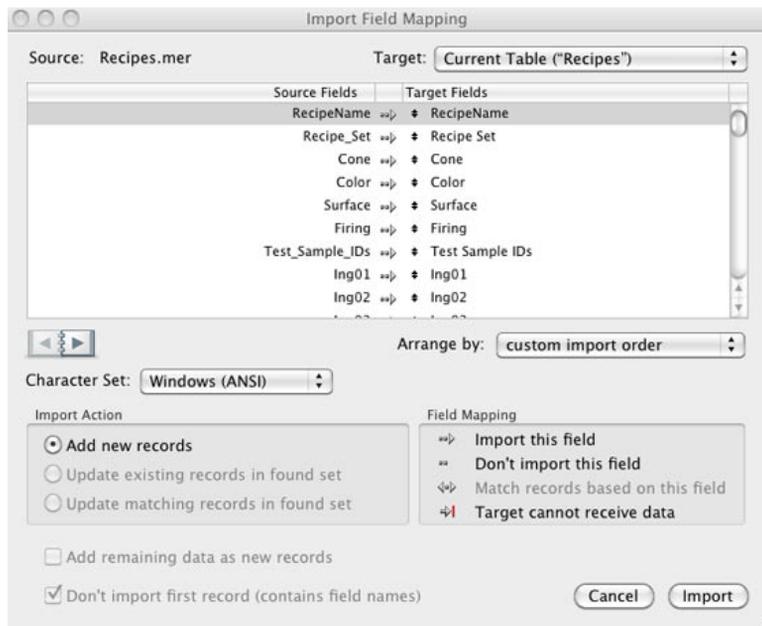
low along. When you get to the top of the box you will have to find just the right spot to get the scrolling to continue on up. But you need to take that 'Recipe Set' target field all the way up until it is alongside 'Recipe_Set'. When you get it in place, be sure to click the little symbol between the two fields so it shows as an arrow. If you don't make this change your Recipe Sets will not be imported. Then do the same thing with 'Test Sample IDs'. Now please double check after you get these two fields moved into place and make absolutely sure that the little 'Import this field' arrow alongside these fields is selected. Just click on it to change it if necessary. The dialogue box should now look like Figure 1-5.

Now notice that 'matching names' has been changed to 'custom import order'. That's OK. As you scroll through the field names you will also notice that some of the field names in the Target Fields column are greyed-out. That is OK too. Those fields are calculated within GlazeMaster so they will not be imported. You will also notice there are some fields that are unmatched at the bottom. That's OK too. That happens because of a difference in the number of fields I used in different versions.

Depending on which version you have exported from, the specifics above may be a little different, but the principles are the same: Match the names as best you can and don't worry if a few don't have matches.

When you are satisfied with the matches, click 'Import' and 'Import' again in the next dialogue box. In a few seconds the import will be complete. GlazeMaster will then go through a routine that re-establishes the master list of recipe set names by looking at each of your recipes. It usually only takes a few seconds--you probably won't even notice the delay. Your recipes and recipe sets have now been imported, but don't peek at them yet, because your materials haven't been imported. Do that now.

Importing Materials

The process for importing materials is exactly the same, but simpler. Start by clicking on 'Import Materials' and decide whether to delete the existing materials. There is almost certainly duplication here, but there is another consideration. I have included significantly more materials in version 3.0 than in earlier versions. So you may want to add the materials and then go through the pain of weeding out the exact duplicates (those with exactly the same name). Or, if you have never added any or changed their names, you may not want to import at all. It is your choice.

The simpler part is that all the field names should line up between the two files so there should be no need to find and move any like there was for recipes.

Matching Up Limit Sets, Preferences, and Expansion Coefficients.

I could find no way to export and import these variables so, if you have changed from the original ones that came with the program, you will have to make those changes manually.

To add Limit Sets or Preference Sets you will have to copy them down using your old copy of GlazeMaster and re-enter them on the new. I found that very few potters used these features so it will not be a big job for most. Even fewer people have changed expansion coefficients, but if you did those changes must also be re-entered manually.

Done. Now go enjoy using the latest version of GlazeMaster!

Transfering Your Files from Version 3.0 or Later

If you have used version 3.0 or later and want to transfer your work to a new version, this task should be done before you start entering work in the new version. This transfer process is more automated than the one described above; however, it completely replaces the information (recipes, materials, recipe set names, preference sets and more) in the new version with those in your earlier version. Before starting this process, make sure you know where the folder containing your earlier files is located on your hard drive. It will normally be in a folder named GlazeMaster X.Y (where X.Y is the version number) in your Program Files (Windows) or Applications (Mac) folder unless you have placed it elsewhere. If you can't find it do a file search for it. Also, make a backup copy of that folder. The files in it will not normally be changed; however, computers or their owner sometimes do unpredictable things. Better safe than sorry.

Start the process by clicking on 'Transfer Files from Earlier Version' on the Main Menu. From there the on-screen instructions are fairly comprehensive. You will have to locate and open seven data files that are in the earlier GlazeMaster folder. Except for locating those files using a dialogue box typical for your type of computer, the rest of the process is automated and only takes a couple minutes to complete–perhaps a little more if your recipes or materials files are huge.

If you want to add recipes or materials from another GlazeMaster file after you have started using this version of the program, use the import procedure described above and again in Chapter 6 rather than the Upgrade/Transfer procedure described above. Importing can add recipes or materials without deleting what is already there, but it will not transfer such things as Limit Sets, Expansion Coefficients, and Preference Sets.

Backups

Before we go farther, a few words about backing up your files are appropriate. I have found over the years that very few potters have backed up their GlazeMaster files–or maybe it is just those who contact me with a sad story and wonder if I have any magical way to help them recover their work. All of the data are stored within the GlazeMaster X.Y folder. The easiest way to back up your files is to back up the whole folder. While there are ways to backup that use less disk space, please do it by backing up the whole folder. It makes file recovery much simpler if and when it becomes necessary. **I strongly recommend you backup regularly**. I cannot help you recover damaged files if you don't have a recent backup. And that is why I now recommend you locate your GlazeMaster folder in your Documents file which is, in my experience, the one people are most likely to back up regularly.

Main Menu

The Main Menu is the hub of GlazeMaster. The program always goes here on start-up. It is also the place from which you switch from one activity to another although, as we will describe later, there are two ways to bypass the Main Menu for most changes in task. The Main Menu is shown in Figure 1-1. The top bar is fully explained in Chapter 3 so we will skip that for now. The large buttons in the central part of the Main Menu take you to various parts of the program to do what you want to do. Simply click on the one you want. While most of these buttons (tasks) are described in detail in later chapters, there are a few features which we will describe briefly here.

Options within 'Add/Edit/View Recipes'

One of the major advantages of GlazeMaster over other programs is the ability to display information in a wide variety of ways. Initially this may seem confusing; however, once you have perused the various options and chosen the one(s) you like best we think you will find this to be a desirable feature. This feature is most evident in the 'Add/Edit/View Recipes' Main Menu choice. As you can see there are several 'radio buttons' underneath that choice. Only one can be selected at a time and the Main Menu is the only place you can change the selection.

While the last option, 'Formula to Recipe' has significantly different functionality the others are really just different ways of presenting information to you while you enter and work on glaze or clay recipes. Let's work through each one and describe the differences as well as why you might elect to use that particular layout or screen (we will use the terms 'layout' and 'screen' interchangeably throughout this User's Guide).

Single Recipe–Unity, Wt %, and Mol %.

This layout has room for only a single recipe at a time, but it also shows three ways to look at the composition of a glaze. The Seger unity formula is the most commonly used by studio potters and the next chapter, Demystifying Unity, is devoted to a discussion of what unity is all about. However, some potters prefer to look at weight percents (wt %) of the various oxides in a glaze while others prefer to look at mole percents (mol %). Weight percents describe the relative weight of each oxide in a fired glaze or clay body while mole percents define the relative molecular concentration of each oxide in a fired glaze or clay body. The three calculations (unity, wt %, and mol %) really all contain the same information in different format. Here, all that information is displayed on one screen plus more. This screen also contains the calculated coefficient of thermal expansion (COE), the silica to alumina (Si/Al) ratio, and the Loss on Ignition (LOI) of the glaze. However the really unique feature on this layout is the ability to add a photo of your glaze (or your children, grandchildren, or pet if you prefer). Details of how to do this are in Chapter 3.

Single Recipe as above with choice of Material.

Some potters prefer to have ready access to material compositions as they are designing or modifying a glaze or clay recipe. This layout displays the composition of any material in your file on the right side of the screen. All of the information from the above screen is still in place–the only thing missing is the place for a photo of your glaze.

Single Recipe with Materials Table.

Another way to have material compostional information displayed while you work on a recipe is shown on this screen. Here, the entire materials file is presented in the form of a scrollable table. The advantage to using this screen is that you can see, for example, the composition of several frits or feldspars or kaolins at the same time. This would help you select the exact one you want more efficiently.

Two Recipes–Work on One; View the Other.

This is perhaps the busiest or most cluttered screen in the entire program. For some, it may contain too much information and you may prefer one of the following 3 layouts to this one. However, one of the most frequently asked-for features in a glaze calculation program is the ability to be able to compare two recipes side-by-side. This layout gives you that option with full information on both recipes.

Two Recipes–Unity Only, Two Recipes–wt % Only, Two Recipes–mol % Only.

These three layouts give you two recipes displayed side-by-side with the choice of having only unity, only weight %, or only mole % numbers displayed. The screen is simplified compared to the one described above and if you prefer to focus on only one of these ways of describing the composition of a glaze one of these layouts may better meet your needs.

Single Recipe–Compare to Limit Formulas.

Some potters like to have limit formulas readily available as they are designing a recipe. This layout gives you that information. You will learn in a later chapter that you can enter any limit formula you wish, whether from the literature or one of your own. A good selection is already included in GlazeMaster.

Clay Body Design.

While clay bodies or glazes can be designed or modified on any of the above screens, this layout has some information that may be more useful specifically when working on clay bodies. First it has room for 15 ingredients rather than 12 on the other layouts, and the 'Additives' section is not shown. More importantly, the calculated numbers that are displayed are

somewhat different. The mole % column has been replaced with Alumina Unity. This means, that instead of arbitrarily setting the sum of the fluxes to one, the alumina has been set to one. This can be a useful way to look at the composition when the alumina level is very high compared to the flux level as it is in a clay body. There is also provision to toggle between the alumina unity column and one that places iron in flux unity. Iron becomes a flux when a clay body is fired in a reduction atmosphere so being able to see how it relates to the other fluxes can be useful. More detail on using this specific layout is contained in Chapter 3.

Formula to Recipe.

This is a procedure where you design a recipe to match a proscribed Seger unity formula. This technique is somewhat involved; however, after you work through it a few times it becomes very easy and can be regarded as a game. Formula to Recipe is fully described and exemplified in Chapter 3.

Options within 'Add/Edit/View Materials'

Here there are only two options–display one material at a time or display two materials at a time. Do you want to be able to compare two materials to examine, for example, the difference between Custer Feldspar and G-200 Feldspar? Or would you rather have a simpler screen and only see one material at a time? It is your choice.

Options within 'Calculations for Blends'

Among the major new capabilities added with the commercialization of version 2.0 of GlazeMaster are sets of calculations and graphic displays that will help you design blend experiments in a more effective way. You have the option of working with line, triaxial, or quadraxial (whether they be standard Currie grids or 5 x 7 grids of your own design) blends. By displaying composition information and color coding each of the compositions in your blend, GlazeMaster allows you to predict which of those compositions are most likely to meet your needs for durability and glaze/clay body fit. This may lead you to modify your experiment before you actually go to the work of running it and, hopefully, make your results more meaningful to your needs. This exciting feature will be described more fully in Chapter 5.

Other Main Menu Selections

These are more self-descriptive or less often used support features of GlazeMaster. Description of them will be deferred until Chapters 6 and 7.

Bypassing the Main Menu

Depending on what you are doing and how you like to work, you may find returning to the Main Menu repeatedly to be a bit tedious. There are two ways to bypass it for most of your work. About the only time you need to go through the Main Menu is when you want to change one of the 'radio

buttons' described in the preceding paragraphs. Here are the two ways:

The 'Go To' Menu

At the very top of the screen, outside the GlazeMaster display, is a menu bar. There are very few items on this menu bar; however, one that is active is the 'Go To' menu. If you pull it down and pause on 'Go To' you will see that the choices that the arrow points to are exactly the same as many of the choices in the central part of the Main Menu. The only difference is that you don't have the option of changing the selections designated by the "radio buttons". But if you don't need to change one of those selections you can go directly from one part of the program to another without going through the main menu.

Keyboard Commands

When you pull down the 'Go To' menu you will also notice that to the right of each choice is a command which can be entered from the keyboard. For Windows machines the command is a number preceded by 'Ctrl'. Simply press the control key and the number key at the same time and you will again bypass the Main Menu. For Macintosh machines you use the 'Apple' or 'Command' key plus the appropriate number key.

2

DEMYSTIFYING UNITY

Anyone writing a glaze calculation/database computer program is faced with several challenges. Of course there is the programming itself and assuring that the program not only gives correct numbers, but is also user friendly. That is a challenge for any computer programmer. In the case of GlazeMaster, though, perhaps the biggest challenge is convincing potters that the program can not only serve as a convenient way to store their glaze and clay body recipes, but also can help them make better and more attractive glazes in a much more effective way.

For several years I analyzed glaze recipes that were published in Clay Times magazine and commented on their probable properties and suitability for use on functional and/or decorative work. As I interacted with people who read those comments, I noticed that there was a real desire on the part of potters to better understand why their glazes do what they do. But, at the same time, we visually oriented people are sometimes intimidated by the numbers or our lack of understanding of chemistry. In this chapter I want to convince you that, while an understanding of chemistry can be helpful, it is not at all necessary to make better glazes and make use of such calculated numbers as are contained in the Seger unity formula. What I will try to do is help everyone understand how much they can tell about a glaze simply by taking a quick look at the Seger unity formula. It is an outstanding tool for helping one understand the basic properties of a glaze. And, of course, the advantage of storing your glaze recipes in a program like GlazeMaster is that the numbers you need are automatically put in front of you. You can use them or not, but it is my hope that they will gradually seep through the pores of your skin and sneak their way into your brain so that, before long, you are looking at them like they are old friends. In my own work, I have gotten to the point where I cannot look at a glaze recipe without wanting to know what the unity formula is for that glaze. I can tell so much about a glaze just with a quick glance at the unity numbers and a few other numbers that we will discuss below.

Before we proceed, though, I would like to add a quick few words about the genesis of the Seger unity formula. In the late 1800s, Hermann Augustus Seger derived a way to think about the materials in glazes. Seger was one of the greatest ceramists of the day and made many contributions to our craft including the invention of pyrometric cones—no they weren't invented by Orton, rather Orton was one of Seger's students. In my view,

Seger has to be called the father of glaze chemistry.

Probably the biggest contribution Seger made to glaze chemistry was to propose a way to think about the composition of a fired glaze that was independent of the materials used to mix the glaze. He offered us a standard way to calculate and present the relative number of molecules of the various oxides in a fired glaze, e.g. silica, alumina, potassium oxide (potash), sodium oxide (soda), calcium oxide (calcia), etc. Now let's stop right here before the pure technologists tell me molecules of these materials don't exist in a glass—they don't. But for the purposes of our discussion that doesn't make a bit of practical difference and talking about molecules makes it a whole lot easier to visualize and explain to potters who often don't have a theoretical background in ceramic science.

Simply stated, the Seger unity formula is a representation of the relative number of molecules of each oxide present in a fired glaze. For example it might tell me that I have 12 molecules of silica for every molecule of alumina. Or that I have 3 times as many molecules of silica as I have of fluxes. Seger chose to calculate these numbers so the total of the fluxes always equals 1.0—hence the name "unity formula". That's it! If you understand this paragraph you understand most of what you need to know to begin using the Seger unity formula to help you in your day-to-day glaze development and problem-solving. You don't ever have to calculate the numbers yourself. That's why you just bought GlazeMaster–it does all the math for you. You just enter the recipe and the program calculates the numbers! Now let's take a look at what those various ratios of molecules can tell us. I will focus in this part of the chapter on the numbers generated by GlazeMaster in the "unity" column plus the numbers of Si/Al ratio, the coefficient of thermal expansion (COE), and the loss on ignition (LOI). At the end of the chapter I will also discuss briefly the weight per cent (wt %) and mole per cent (mol %) numbers which are also generated. They all give the same kind of information in different formats.

Silica First

The first number I look at for any glaze is the silica level. Silica provides the backbone of a glaze. It is the primary glass-former. Without silica we do not have a glass; with too little silica we do not have a durable glaze, i.e. a glaze that doesn't come apart in use. While we give the supporting data in our book Mastering Cone 6 Glazes, Ron Roy and I have demonstrated that you need a minimum silica level of 2.5 or above to have a durable glaze. Silica levels of 3.0-4.0 are ideal. A silica level above 4.0 will still give a good glaze, but it will be more difficult to melt and you will have to pay special attention to either the temperature at which you fire or the fluxes plus boron that you use in the glaze. Although most of our data were generated at Cone 6 we believe these numbers are equally valid all the way from earthenware

temperatures up to high fire porcelain. After all, durability is important at temperatures where the glaze is used and it is the composition of the glaze there that is key–regardless of the temperature to which it was fired.

So what happens when silica level is substantially below 2.5? Figure 2-1 shows a glaze called Toshika Green. It is a very attractive matte mottled green glaze. However put a nice juicy slice of lemon on this glaze for as little as 2 hours (Figure 2-2) and you get a substantial loss of color (Figure 2-3). This glaze is ruined!

What has happened is that the citric acid in the lemon slice has dissolved part of the glaze and drawn some of the copper colorant right out of the glaze. Most foods are acidic to some degree, and this can easily happen over time with foods other than those that are very acidic. Have you ever bought a coffee mug, used it regularly for a year or so, and then noticed that the glaze on the inside has faded? I, unfortunately, have. I now keep them to show other potters the importance of glaze stability in functional pottery. Dishwasher detergents can cause similar problems with some glazes.

Let's examine why this happened to Toshika Green and, at the same time, start to become familiar with the information presented the way it looks in GlazeMaster. Figure 2-4 shows part of the screen that is displayed when you 'Add/Edit/View Recipes'. It is the one that is the first choice under that Main Menu selection–it shows a single recipe with unity, wt % and mol % numbers. For the time being, we'll focus on the column labeled 'Unity'; we'll refer back to some of the other columns of numbers later. Notice that the silica level is less than 1.7. This glaze simply does not have enough silica in it to be stable. It also contains copper as a colorant which, it turns out, is one of the most difficult materials to

Figure 2-1. Toshika Green is a beautiful matte green glaze; however, as you see in Figures 2-2 and 2-3 it should only be used for decorative work. It is not sufficiently durable for functional pottery.

Figure 2-2 (left). A juicy slice of lemon was placed on the sample for 2 hours at room temperature.

Figure 2-3. After rinsing and thoroughly drying the sample this was the result. A significant part of the color has been permanently leached out of the glaze.

keep in a glaze. While this is a beautiful glaze and may be satisfactory for some kinds of decorative work, it is not a glaze you would want to use on functional pottery.

Alumina Is Important Too

Alumina helps keep your glaze from running off your pot during firing, but it is also important to durability. Reports in the literature vary, but it is usually associated with resistance to alkaline materials like dishwasher detergents. In Mastering Cone 6 Glazes, we also demonstrate that it is important to acid durability. I like to see a level of 0.25-0.45. A higher level won't hurt durability, but it will make the glaze difficult to melt. A very low level of alumina (<0.1) tells you the glaze is intended to be a macro-crystalline glaze. A high level of fluidity is needed in order to grow large crystals and, of course, keeping the glaze on the pot is one of the biggest challenges to practitioners of this aspect of our craft.

Figure 2-4. A screen shot from GlazeMaster showing the glaze Toshika Green.

Silica to Alumina Ratio

The level of gloss a glaze will have is largely defined by the ratio of silica to alumina. Ratios above about 8 define the domain of glossy glazes. Ratios of 5 or less is the domain of matte glazes. In between–well, it depends. They might be matte, semimatte, or glossy depending on other aspects of the glaze. All of this assumes, however, that the glaze is well melted during firing. You can make matte glazes at higher silica to alumina ratios by incompletely melting them during firing. This is not a desirable thing to do; however, a lot of glazes being used by potters today–particularly those firing at earthenware or mid-fire temperatures–are, in fact, unmelted mattes. Those glazes might have been fully satisfactory matte glazes if they had been fired to the proper temperature and cooled slowly or they might have been glossy–the silica to alumina ratio can help you understand which. For example if you have a matte glaze which has a silica/alumina ratio of 8 or above you almost know it was not fully melted during firing. While such a glaze might be satisfactory to use on some decorative work, it would probably be a disaster on functional work.

The Balance of Fluxes + Boron

Fluxes and boron are what help a glaze to melt. Glazes intended for firing at earthenware temperatures must have a larger percentage of the more active fluxes like sodium, potassium, and lithium and/or more boron or zinc. Usually they have both. Cone 6 glazes almost always contain moderate levels of either boron or zinc plus a "normal" mix of the more common fluxes like sodium, potassium, lithium, magnesium, calcium, strontium and barium. Cone 10 glazes rarely use boron or zinc. Just knowing this information can help you identify the probable maturity temperature of a glaze.

However, examining the balance of fluxes can tell you much more about a glaze. For example, good matte glazes can be made with higher than normal levels of magnesium, calcium, strontium, or barium–the so-called alkaline earth elements. Unfortunately "normal" is different for each of these fluxes. For calcium a level of 0.8-0.9 is required to get into the matte range, but for magnesium only about 0.4 is required. You can also often cure crazing or dunting problems by adjusting the balance of flux + boron, sometimes without otherwise affecting the aesthetics of the glaze. Increasing the level of magnesium or boron while reducing sodium and potassium can often solve a crazing problem. There are other ways to address crazing–the preceding statement only addresses the fluxes and flux-like materials. It sometimes doesn't take much of an adjustment. Going in the opposite direction can reduce the propensity for dunting or shivering.

Coefficient of Thermal Expansion and Loss on Ignition

There are two other numbers calculated by GlazeMaster which deserve some mention at this point. While not directly related to the Seger unity formula, they rely on some of the same numbers and can be very useful.

The coefficient of thermal expansion (COE) can help you understand whether or not a glossy glaze will craze on your pot or cause dunting or shivering. I inserted the word glossy in the sentence above because this calculated number is only valid for glazes that are free or relatively free of crystals. Once crystals start to form (which are what make matte glazes matte) the calculation is just not sophisticated enough to be accurate. It still, however, can often indicate the direction of change that would occur if you modify the composition of the glaze. COEs can be quite confusing because everyone seems to present them a little bit differently. In addition, there are more than one set of measured numbers for the primary oxides we use in making pottery glazes. While this can be quite confusing, it doesn't have to be because we are primarily interested in trends and relative numbers. We really don't care what the absolute numbers are. Again, there are several pages on this subject in Mastering Cone 6 Glazes if you are interested in learning more. For the purpose of learning to use the numbers to help you solve problems, my strong recommendation is to pick one set, get used to it and don't worry about the units and whether or not you are getting a highly accurate result. The two most commonly used sets of numbers for the individual oxides are given in the Appendix of this User's Guide along with instructions on entering them in GlazeMaster (if you want to change from what is already entered) so you will have calculated COE numbers you are familiar with.

Loss on Ignition (LOI) is quite simply the amount of material that goes up the stack when a glaze is fired. It can readily be calculated while we are calculating Seger unity formulas because it is a part of the analysis of each of the ingredients. Why is it useful? It tells you the amount of gas that is going to be generated as the glaze is heated and melted. Some potters like to minimize the amount of off-gassing during firing because they believe it can result in glaze defects like pinholes or blisters–not always, but enough of the time that they prefer to minimize it. Minimizing LOI is one of the reasons that many potters use wollastonite rather than whiting as their source of calcium in a glaze. As an experiment, when you are working with a high calcium glaze replace the whiting with wollastonite (reducing silica enough to compensate) and notice the huge reduction in LOI. A quick glance at the LOI can tell you how careful you might have to be during firing to give the liberated gas time to get out of the glaze before the glaze is allowed to solidify.

Weight and Mole Percentages

Weight percents and mole percents (often abbreviated wt % and mol %) are simply different ways of presenting the oxide composition of a glaze. Weight %, of course, show how much of each oxide in grams or pounds there are in 100 grams or pounds of the fired glaze. Weight % is the common way of reporting the composition of the materials we use so you will see these numbers frequently if you look at materials analysis sheets. The information is similar to that presented by the Seger unity formula, and which you prefer probably depends on what your first teachers of the subject used.

Mole percents simply adjust the wt % numbers by the molecular weight of each oxide so you see numbers that represent the relative number of molecules of each. This is exactly the same information as presented by the Seger unity formula–only the format is different. Again, whether you prefer these numbers to Seger unity numbers probably depends on how you were first exposed to this subject.

The Calculations

Avoiding doing the calculations yourself is part of the reason you bought GlazeMaster. However, for those curious about exactly what we are calculating there are several places in the literature where you can find this explained and exemplified. My favorite, of course, is in Appendix B of Mastering Cone 6 Glazes–a book which really is an excellent companion to this program and which contains a lot of information applicable to any cone. Another excellent explanation can be found in Pioneer Pottery by Michael Cardew.

Summary

There is a lot of information contained within the Seger unity formula. I hope you will agree with me that extracting that information in a way that can help you better understand your glazes is not very complicated. It just takes some practice. I highly recommend that you look at the unity formula for every glaze you use or test. After you have done that for a few months you'll be surprised how much you know about the glaze even before you weigh out the first ingredient.

3

ADD/EDIT/VIEW RECIPES

Working with Recipe Screens–Common Elements

Working with recipes–either glaze or clay body–is the heart of Glaze-Master. This selection on the Main Menu has several options because we all like to work in different ways. We will go through each of those options pointing out the advantages and possible uses of each in more detail than we did in Chapter 1. There are some features, though, that are common to all options so we will cover those first.

Look at the top bar on Figure 3-1 below. This will be the same, except for the title, on each of the several options under 'Add/Edit/View Recipes' on the Main Menu. On the left is the button which takes you back to the Main Menu. Next to it is a button which allows you to Exit (Windows) or Quit (Macintosh) the GlazeMaster program. To the right of the title is

Figure 3-1. This is the Add/ Edit/View Recipes screen showing a single recipe with room for a photo of the glaze.

the GlazeMaster Help button. This brings up an abbreviated on-line help system, but for complex questions always consult this User's Guide. The fields on the right of the top bar show the current selections for Preference Set and Material Set. We'll cover each of these features in the following paragraphs.

Preference Sets

The current Preference Set is the first item displayed in the upper right-hand corner of the top screen shown in Figure 3-1. Different Preference Sets allow you to have different settings for the way you increment individual ingredient amounts up and down using the '+' and '-' buttons that you can see in the Figure. For example, if you are fine tuning a recipe you might want each click of a button to change the number by only 0.1 units. On the other hand, if you are just roughing in a recipe you might want each click of the button to change the numbers by 1 or even 2 units. For clay body design you might want to work in 25 pound or 10 kilogram increments. The point is that you can customize these settings to fit the way you like to work.

Another setting you can change with a Preference Set is the way you like to see the Materials list displayed when you are adding ingredients to a recipe. There is a long form (like was used in GlazeMaster 1.0) and there is also a short form. If you use the long form you simply click on the ingredient field you want to fill in, move the mouse up or down the list until you find the material you want, and click again. If you use the short form, after clicking in the ingredient field, you have 'type ahead' capability, i.e. you start to type the name of the material you want and GlazeMaster will show only those that match the first few letters you have typed. You then find the exact material you want by using the up/down arrow keys or the scroll bar on the side of the materials list and click again when you find the specific material you want. You can also accomplish entering materials with the Return (Mac) or Enter (Windows) keys or by tabbing from field to field. Experiment a bit to figure out which keys do what and find the way you are most comfortable choosing the ingredients for your recipe. Setting up Preference sets to suit your style will be covered in Chapter 7.

If you want to change to another Preference Set click on that field and select it from the pop-up menu.Then click on "Change Sets". There is no separate dialogue box as there was in earlier version.

Material Sets

The other item in this upper right-hand corner is the current Material Set. Included in the Materials file within GlazeMaster are over 200 different materials. In addition there are web site references in the Appendix where you can get the compositions of many more materials. In actual practice, however, most of us don't stock and use more than 30 or 40 different materials. Therefore we have included the option to designate each material

as 'In Stock', 'Available' (meaning you could buy it if you wanted to), 'Not Available', and 'Not Specified'. This designation is easily changed for each material and we will cover that in the next chapter. The usefulness of this feature becomes obvious when you are entering a recipe. When you click on a field in the Ingredients column a pop-up menu appears showing all the materials (potential ingredients) in the current Material Set. That way if you only want to work with materials you currently have in stock you only have to look at, say, 30-40 materials on that pop-up menu. Or you might choose to look at the materials you have in stock plus those you can readily buy to give you a broader choice. Of course, you also have the option of displaying all of the materials in the file–you may want to do this when you are examining a historical recipe that uses less common or no-longer-available materials.

We should point out that this Material Set feature requires that you customize it. As you buy the program all materials are designated as Not Specified and 'All' is the selected Material Set. A suggested early task would be to go through your personal glaze material inventory and mark the materials you have as In Stock. We'll cover that more specifically in Chapter 4.

Single Recipe–Unity, wt %, mol %

The main part of the window in Figure 3-1 shows the information that is available or that you enter in the first selection under 'Add/Edit/View Recipes'. At the top and working from left to right you can see that there are fields for the recipe name, some of the characteristics of the glaze or clay body, and its firing temperature. You can also add test tile number(s) for that glaze if you wish and, assign the current recipe to a Recipe Set (think of Recipe Sets as file folders for organizing your recipes and see more information about them in the side bar a couple pages from here and in Chapter 7). Of course, there are places to enter the ingredients, the amount of each and the additives or colorants. While you can leave the additives section blank if you wish and list colorants and glaze names in the Comments section at the bottom, we find most potters like to be able to locate their recipe by name. Said another way, they would rather look up 'Field Mouse Brown' than have to remember that Field Mouse Brown is based on High Calcium Semimatte Base 1 from Mastering Cone 6 Glazes. So most potters, we believe, will have one entry for the glaze Field Mouse Brown complete with colorant levels and another for the base glaze with a note in the comments section that it is used for several glazes.

The actual entering of ingredients or additives is a simple matter. Click on the field where you want to enter something. Use the combination of the mouse, entering the first few letters of the material you want, the up/down

arrow keys, the scroll bar, the Tab key, or the Return/Enter key as described above, to locate and enter the specific material you want. To enter or adjust amounts either type the number in the appropriate field or use the '+' and '-' buttons described below.

Immediately to the right of the Ingredient Amounts are a series of buttons which you will probably use regularly. The small '+' and '-' buttons allow you to incrementally change the ingredient amounts up or down quickly without entering a new number on the keyboard. The amount of the increment can be set or changed on the 'Add/Edit/Delete Preference Sets' Menu which you can reach from the Main Menu, and as discussed above, you can define several Preference Sets so you can quickly switch from one to another right on any recipe layout. Of course, if you prefer you may enter any number from the keyboard in the Ingredient Amount field. Choose whichever way you find most convenient or use a combination of the two.

The 'Recalc/Enter' button does just that–it causes the numbers on the right to be recalculated based on any adjustments (new or different ingredients or different amounts) you have made on the left. **Very Important! After making changes, you need to click this button before you go to a different part of the program or your latest entries will not be saved.** The only exception to this is when you are using the '+/-' buttons and have them set for 'Immediate' recalculation as described in the next paragraph.

The larger button ('+/- Button Recalc Freq') immediately below the 'Recalc/Enter' button allows you to use the '+/-' buttons in a way that best meets your needs. If you click on the 'Immediate' radio button, GlazeMaster will recalculate the recipe and the unity information each time you click one of the '+' or '-' buttons. This is most desirable if you are fine tuning a recipe and/or have a fast computer. If you click the 'Delay' radio button you can click any or all of the '+' or '-' buttons as many times as you wish to change the amounts of your ingredients as much as you want and the program will not recalculate. So, for example, if your preferences are set to change the amount by 1 unit with each click and you want to reduce the silica by 5 units and increase the clay by 5 units, you can do that with 5 clicks on the appropriate button for each. Then click 'Recalc/Enter' and the recipe will be recalculated and saved in your file. This way of operating is usually best when you want to use the '+' and '-' buttons to make large changes and/or you have an older, slower computer. Try them both and see which way is best for you–it is easy to change back and forth at any time. This feature was part of the Preferences in GlazeMaster 1.0; it has now been moved to a button on the screen to make it more accessible.

The 'Clean Up Recipe' button is used if you are actively working with a recipe and have decided you don't need some of the ingredients you were

It is important to note that all the materials used in a recipe must be included in the materials file whether they be primary ingredients (feldspars, frits, clays, silica, etc.) or such things as colorants, opacifiers, and processing aids. If you enter the material in the Ingredients section its composition (if known) will be included in unity calculations. If you enter it in the Additives section its composition will be ignored in the unity calculations.

Caution: When you enter changes from the keyboard or have the '+/- Recalc Freq' set to 'Delay', the changes you make will not be recorded and saved until you click 'Recalc/Enter'. Also, the calculated numbers will not be updated until you click 'Recalc/Enter'. If you fail to do this before moving to another part of the program your changes will be lost.

trying. Clicking it will remove any ingredient or additive names that have zero (or are blank) for the ingredient or additive amount. It will also close up the empty space by moving other ingredients or additives up as needed. This requires lots of 'finger and toe counting' by the computer so it takes a few seconds.

The 'Reset Total' button will reset the total amount of the ingredients to any number you want. Additives are automatically scaled the same way. We are all creatures of habit and glaze recipes are traditionally set to total 100 with the colorants, opacifiers and processing aids added as extras. However, if you want to set the total to equal your batch size or any other number that meets your needs, you can do that. If you decide to stick with the convention of setting the total equal to 100, batch size and amounts can easily be set and displayed on the Batch Printout Sheet described later. Note that rounding error may occasionally cause the reset total to be very slightly different than what you specified, e.g. 99.8 or 100.2 if you specified 100.

Near the top of the screen to the right of the Recipe Name are two small buttons titled 'Change' and 'Add'. Change means change to a different recipe that is already on file. Add means add a new recipe.

When you click on 'Change' the dialogue box shown in Figure 3-2 comes up. Click in the field under 'Select the Recipe to Change to' and a pop-up menu of the recipes in the current Recipe Set will appear. If you don't see the recipe you want you can probably find it by looking in a different Recipe Set. Change the Recipe Set in the lower part of the dialogue box. Click 'Continue' when you are done and the selected recipe will replace the one you have been viewing.

Clicking on 'Add' brings up a slightly different dialogue box as shown in Figure 3-3. You must enter the name of the new recipe. One of the features of GlazeMaster is that every Recipe Name must be unique. So if you have several versions of, say, a shino glaze, you might name them Shino–Malcolm Davis, Shino–mine, and so on. Doing this will keep them grouped together in alphbetical listings while providing each with a unique name. When you click OK on this dialogue box the computer will run a quick check for duplicates. If it finds one you will be asked to try again. Then, the dialogue box will disappear and the added Recipe Name will appear in the Recipe Name field. All the other fields will be blank except the Recipe Set name will be set to the default value of 'Unassigned' as described in the side bar

Figure 3-2. Change to a Different Recipe.

The Recipe Sets feature is one of the advantages of GlazeMaster over other programs. It allows you to easily organize your recipes any way you wish. In Chapter 7 we will show you how to add or delete Recipe Set names. For now, start to think about how you would like to organize your recipes. For example you may wish to organize them by Clay or Glaze and firing temperature, e.g. Glazes–Cones 4-6 or Clay–Porcelain. Or you may prefer to organize them by original sources, e.g. Ceramics Monthly, Clay Times, Developed by Me, etc. A person who consults for others would probably want to organize them by client. The real point is that you can decide how you want to organize your recipes and assign any names to those groups or sets that you want. Note that the Recipe Set name 'Unassigned' cannot be changed or deleted. When you add a new recipe it will automatically be put in the 'Unassigned' category. You may change it at any time. If you have 'lost' a recipe, look for it in the Unassigned Recipe Set. You may have forgotten to assign it to the set that you intended.

The three columns in Figure 3-1 titled Unity, weight %, and mole % are where the computer enters the results of its calculations based on the recipe you have entered and, of course, based on the compositions of the

materials in the glaze. Here again, there is a matter of choice and personal preference. On this screen all three sets of calculated numbers are shown. Please remember that all three sets of numbers contain the same information in a different format. Which you prefer to use is probably related to how you were trained. My personal preference is to use unity; however, I know other people who prefer to look at weight % or mole %. On some of the Add/Edit/View options we'll look at later you have your choice of only seeing one of these sets of numbers.

The farthest right object on the screen shown in Figure 3-1 is a place to insert a photograph of your glaze. To insert a photograph you first must click in the field (about 3 inches x 3 inches in size) that is directly above the Words 'Glaze Photo'. Then click on the button 'Insert Photo'. You will be taken to a dialogue box typical for your type of computer and specific to your operating system. They all are similar, but not identical. In this dialogue box you have to locate the file that contains the photograph of your glaze. You can choose to either have the file incorporated into your recipe file (this takes the most file/disk space but assures the photo is always there) or just incorporate a reference to it (this option takes least space on your hard disk–it may be best if you do not move the file at a later date). That selection is made by clicking or not clicking on the box that says 'Store only a reference to the file'.

There are three other buttons toward the bottom middle of the screen in Figure 3-1 that require brief explanation. First is 'Change Exp Coeffs'. There are three sets of Coefficients of Expansion built into GlazeMaster. You can toggle between these to find the one you are most used to using. Any of those sets can be changed and this will be explained in Chapter 7. Second is a button that says 'Show Photo Gallery'. GlazeMaster actually allows you to store up to 4 photos of each glaze. Click on this button and you will be taken to a layout where all 4 are shown. You add others in the same manner as described above and you can also print that page to use as part of your portfolio or sales kit. Third is 'Copy Recipe to Clipboard'. Clicking this button will do just that. You can then paste the recipe and unity information into an email, another text document, or wherever. The best way to understand what these three buttons do is to try them out. You won't do any harm by giving all 3 of them a test drive.

That completes the description of the first option under Add/Edit/View Recipes. In discussing the other options we will skip over the elements described here which are also present in the others.

Working on One Recipe while Viewing Materials

The second option for working on a recipe allows you to simultaneously view material compositions on the right hand side of the screen. This is illustrated in Figure 3-4. The advantage of this layout is that you can quickly switch from material to material to help you select the ingredient closest to the composition you want. For example, who can remember the exact difference in composition between, say, Nepheline Syenite and Kona F-4 Feldspar? They are both used where you want higher levels of sodium in the glaze, but what else do they contain? Using this screen will help you compare them easily. Note that to switch from one material to another, all you have to do is put the cursor on the material name and find the material you want on the pop-up menu that appears. That new material will quickly replace the one that is on the screen.

Other than having a material displayed instead of having space for a photo of the glaze, this layout is virtually identical to the single recipe layout described previously.

For optimum use of memory when adding photos to your file, set the size to 3 inches x 3 inches and the resolution to 72 dpi. If QuickTime is installed on your machine (it is on all Macs and many Windows machines) almost any graphic file format can be used including jpg, tiff, gif, psd, pct, and others.

Figure 3-4. Another option for working on recipes is to display the recipe and your choice of materials.

Working on One Recipe while Viewing the Materials Table

Figure 3-5 shows yet another variant of making materials compositions available while you are working on a recipe. Here you can scroll through the entire materials table which can be a good way to select just the right frit or feldspar or clay to use while you work on a recipe. In Figure 3-5 we have scrolled the materials table so the compositions of all of the feldspars are shown.

Working on One Recipe while Viewing Another

GlazeMaster has a lot of flexibility in how you view the information important to you. One of the most desired features in glaze calculation programs is to be able to have two recipes on the screen at once. We offer four variants of this feature. In each case the recipe on the left side of the screen is the "active" recipe, i.e. the one you work on. The recipe on the right side of the screen is for reference only–it cannot be modified.

The first variant of the two-recipe layouts has the most information in one spot, but it is also the most crowded and potentially the most confusing. It has the same information as is shown in Figure 3-1, but for both recipes.

Instead of illustrating the first variant, let's work with one that has a little less information but is one of my favorites. It is shown in Figure 3-6. Rather than have unity, weight % and mole % numbers all shown on the

Figure 3-5. A layout showing a scrollable materials table. Use this when you want to see several materials compositions at once.

							Current					
Main Menu	Exit Quit	**Add, Edit, View Recipes**		GlazeMaster™ Help		Preference Set	Clay--25--short		Select a different set using the pop-up menus. Then click button below.			
						Material Set	All		Change Sets			

Recipe 1 Charcoal Satin Matte   [Change] [Add]

Cone 6   Surface Semi-Matte or Satin   Color charcoal

Firing Oxidation   Recipe Set Mid-Fire

Test Sample IDs ____   Date 12/26/2002

Material Composition Table (Wt. %s)

Material	Li₂O	Na₂O	K₂O	MgO	CaO	SrO	BaO	ZnO	PbO	Al₂O₃	B₂O₃	Fe₂O₃	SiO₂	TiO₂	P₂O₅
Epsom Salts				16.36											
Feldspar--Buckingham		3.00	11.60	0.10	0.20					18.00			66.90		
Feldspar--C6		6.90	5.20		0.70					18.50		0.07	68.42		
Feldspar--Custer		3.02	10.08		0.30					17.13		0.15	69.02		
Feldspar--Custer 10/08		1.52	13.20		0.75					18.20		0.09	65.90		
Feldspar--G-200		3.01	10.67		0.81					18.41		0.08	66.86		
Feldspar--G200 HP		1.52	13.20		0.75					18.20		0.09	65.90		
Feldspar--K-200		3.00	10.98		0.23					18.07		0.05	67.49		
Feldspar--Kingman		2.80	12.00		0.10					18.70		0.10	66.00		
Feldspar--Kona F4		6.90	4.80		1.70					19.59		0.04	66.77		
Feldspar--Moose Creek		1.45	12.04	0.03	0.23					17.94		0.04	66.46	0.01	
Feldspar--NC 4		6.89	3.76	0.01	1.60					18.74		0.07	68.81		
Feldspar--Norfloat Soda		7.46	2.84		1.68					18.80		0.08	68.40		
Feldspar--Oxford		3.22	7.92		0.38					17.04		0.09	69.40		
Feldspar--Potash		3.02	10.08		0.30					17.13		0.15	69.02		
FHC		0.55	0.68	0.50	0.50					20.65	1.61	66.75	0.53		
Fire Clay--A. P. Green		0.50	0.50	0.35	0.35					31.00	2.00	52.00	2.00		
Fire Clay--Hawthorne		0.20	1.30	0.70	0.30					35.10	1.40	51.10	1.90		
Fireclay--Greenstripe		1.30								27.70	2.00	57.20			
Flint										3.00			94.00		

Ingredients   Amt.

Ingredients	Amt.	
Frit--Ferro 3124	31.0	
Wollastonite	23.2	
Kaolin--EPK	31.7	
Silica	14.1	

Unity

	Unity
Li₂O	
Na₂O	0.110
K₂O	0.012
MgO	0.032
CaO	0.846
SrO	
BaO	
ZnO	
PbO	
Subtotal Alkalis	0.122
Total Fluxes	1.000
Al₂O₃	0.505
B₂O₃	0.204
Fe₂O₃	0.007
SiO₂	3.225
TiO₂	0.004
P₂O₅	0.001

[Recalc/ Enter]

+/- Button Recalc Freq
⦿ Immediate
○ Delay

[Clean Up Recipe]

Add	Total	100.0
Mason Stain 6600		10.0
Rutile		6.0

[Reset Total]

Si:Al   6.38

Exp Coeff   65.20

L.O.I.   5.12

[Change Exp Coeffs]

Recipe Cost, $ / lb ____

Comments

This glaze is one published by Ron Roy and me in a Ceramics Montly article in September of 2000. It was derived from one of Tony Hansen's base glazes and is a predecessor to the 2 high calcium semimatte glazes we have in our book, Mastering Cone 6 Glazes. It has been thoroughly tested and is very stable. Note that it has plenty of alumina and silica. It has a Si/Al ratio that puts it in the matte range; however, it needs to be cooled slowly to achieve a good matte surfaces. It is suitable for functional, decorative, or sculptural work.

[Show Photo Gallery]

[Copy Recipe to Clipboard]

same screen, only unity is displayed. Further the arrangement has been modified slightly so that the unity figures for both recipes are close to each other on either side of the vertical line that separates the two recipes. This was done to facilitate easy comparison of unity formulas.

There is one added feature on all of the two-recipe layouts that is important and useful. On the right side toward the top of the screen is a button titled 'Copy This Recipe to Left'. This is used when you want to make modifications to an existing recipe but want to leave the original undisturbed. Put the recipe you want to modify on the right side of the screen by clicking on the 'Change' button and finding the recipe you want as described above. When that recipe has been displayed on the right, click on 'Copy This Recipe to Left'. A pop-up dialogue box will ask you to give the copy of the recipe a new name. I suggest you give it a name that will help you remember why you modified it, e.g. 'Floating Blue–lower expansion'. Click OK and the copy of the recipe will now be placed on the left side of the screen. The original recipe stays on the right where you can use it for reference while you work on the left.

There is a second reason why you will use the 'Copy This Recipe to Left' feature. Suppose you have a base glaze with several color variants. If you want each entered as a separate recipe, enter the base glaze and bring it

Figure 3-6. There are several options for displaying two recipes at a time. This one shows only unity formulas.

up on the right side of the screen. Then copy the recipe once for each color variant giving each the name you know it by. Enter the specific colorants in each. You may also want to add different comments for each.

The other two variants of the two-recipe screens are similar except, instead of displaying the Seger unity formula, one displays only weight % numbers and the other only mole % numbers. As was mentioned earlier, which display of data you prefer is probably dependent on how you learned glaze chemistry in the first place. If you are just now learning I highly recommend you use the unity display because that is the common language of studio potters. Ceramic scientists and engineers in industry are more likely to prefer one of the other two displays.

Working on a Recipe while Displaying Limit Formulas

Yet another option for displaying and working on recipes is to have the recipe you are developing or modifying on the left side of the screen and your choice of Limit Formulas on the right side of the screen. Limit formulas are sets of numbers developed by a number of workers in the field over many, many years. They purport to set limits–both upper and lower–for the various oxides in a glaze. A careful examination of the scientific literature has shown that most, if not all, of these limit formulas were derived by examining glazes that worked, i.e. glazes that gave "good glass". In other words, they are based mostly on visual observation of the glazes and not on any rigorous testing of glaze properties. Ron Roy and I have now developed a more technically sound way of specifying how to make durable glazes and that is explained briefly in the chapter titled Demystifying Unity (Chapter 2) and in more detail in our book Mastering Cone 6 Glazes. Nonetheless, limit formulas can be useful guides to let you know whether you are inside or outside the range of compositions that others have found to work well. The caveat is that excellent glazes can be made outside of "limits" and poor glazes can be made within limits. However your odds of making a good glaze are higher if you choose to stay within limits. It is certainly an excellent place to stay when you are just learning your way around glaze formulation.

Since limit formulas were derived primarily by visual observation they vary a bit from worker to worker. We have built several sets of limit formulas into GlazeMaster and you are also able to add others you think may better meet your needs. I haven't shown the Limit Formula screen in this User's Guide, but take a moment to bring it up on your computer and check it out.

Clay Body Design

Calculation software can also be helpful in clay body design. For example, if you want to replace an ingredient that is no longer available or adjust a

Caution. It is tempting to put the same recipe on both sides of the screen and then work on the left side thinking the right side will remained unchanged. Not so! When you change a recipe you change all copies of that recipe no matter where displayed. Instead, use the 'Copy This Recipe to Left' feature and give the one you want to work on a new name. The original will not change.

recipe where the composition of one or more of the materials has shifted, matching unity formulas between old and new is a good place to start. There are, of course, other factors which must be managed in clay body design, such as plasticity level and color, where calculation software cannot help.

The Clay Body Design layout is quite similar to the other two-recipe layouts with some important distinctions. First it should be said that you can also use this layout for glaze recipe development. There is no fundamental difference between it and the glaze layouts. Your ability to add new recipes, choose materials and amounts, and store the relevant data is identical. It is just that the information displayed is a little different and more relevant to working with clay bodies. A recipe developed in one place can be displayed and worked on in another. The clay body layout has room for 15 ingredients, but the area for additives is missing. Adding space for a few more ingredients can be useful it you are blending two complex bodies (or glazes) and have more than the 12 ingredients allowed for on the other layouts.

In addition the clay body layout shows a set of numbers called 'Alumina Unity' in place of mole % (See Figure 3-7). Alumina Unity is just a different way of displaying the same information that is in a normal Seger (or flux) unity formula. Here alumina is set to equal one. This type of display of the

Figure 3-7. This Clay Body Design layout can also be used for glazes; however, it displays some information such as Alumina Unity and Iron in Flux Unity more useful when working on clay bodies.

information is useful when the relative amount of fluxes is quite low compared to the alumina and silica as it is in a clay body.

The other unique calculation on this screen is one that shows iron (as FeO) in flux unity (Figure 3-8). You can toggle between Alumina Unity and Iron in Flux Unity by clicking the button toward the bottom of the screen. Iron becomes active as a flux in reduction firing and, hence, showing it as a flux can show you how big an effect it might have on the total flux system. In calculating this set of numbers for Iron in Flux Unity, we have assumed that the iron is partially reduced and has an average composition of FeO. This turns out not

Flux Unity	Weight %	Iron in Flux Unity	
0.012	0.03	0.011	Li_2O
0.341	1.60	0.318	Na_2O
0.298	2.12	0.278	K_2O
0.219	0.67	0.205	MgO
0.129	0.55	0.121	CaO
			SrO
			BaO
			ZnO
			PbO
		0.067	FeO
0.651	3.75	0.608	Subtotal Alkalis
1.000	4.96	1.000	Total Fluxes
3.683	28.37	3.435	Al_2O_3
			B_2O_3
0.036	0.43		Fe_2O_3
14.588	66.21	13.608	SiO_2
0.003	0.02	0.003	TiO_2
			P_2O_5

Figure 3-8. Here we have zoomed in on a portion of the Clay Body Design screen to fucus on the area showing Alumina Unity and the button that allows you toggle to Iron in Flux Unity.

to be a critical assumption–the numbers shift relatively little if other iron compositions are assumed.

Formula to Recipe

I put Formula to Recipe in last position under 'Add/Edit/View Recipes' for good reason. It is the most complicated display to explain and use; however, it can be extremely useful. The object in Formula to Recipe is to construct a usable glaze recipe from a unity formula. Suppose, for example, you had a historical recipe for which some or all of the materials are no longer available. If you know the composition of those out-of-production materials–and we can usually find them–we can enter the recipe in GlazeMaster and calculate the Seger unity formula. Then we can try to match that unity formula using currently available materials. In theory we can come very close to duplicating a glaze by that technique. In practice it works most of the time, but sometimes it does not. The primary reason for this is that many of our materials contain trace amounts of unanalyzed "contaminants" which affected the appearance of the original glaze or will affect the appearance of the glaze we formulate to match.

Note that if you enter, say, 14 ingredients on the clay body screen and then shift to one of the glaze recipe displays, only 12 of those ingredients are shown. Not to worry. They are still there and are still included in the calculations. They will reappear on layouts where there is room for them including the Print Recipe and Print Batch Mix Sheet layouts discussed later.

All this said, there are many times when you would like to try to match the unity formula of a particular glaze using different materials or derive a glaze recipe having a specific unity formula to try to achieve a special effect. This is also a very effective technique for attempting to replace one or two key materials that are no longer available, e.g. replacing Gerstley Borate, with an alternative material. It can also be used to adjust a recipe when you purchase a new batch of a material that has a slightly different composition. That is what Formula to Recipe is all about.

Formula to Recipe consists of four steps and I recommend you follow them rigorously the first few times you attempt using this technique. After that you will probably figure out some shortcuts.

Before I describe these four steps, let's take a quick look at what the screen looks like when we first go to it. That is shown in Figure 3-9. On the left side of the screen is the recipe that happened to be on the left side of whatever previous display we were viewing. However the three columns of numbers to the right of the buttons don't look familiar at all. First, they have funny looking names like Actual Molar Equivalents, Goal Molar Equivalents and Goal Unity. Second, they really don't belong to the recipe on the left. The numbers, themselves, are left over from the last time we used this screen. Not to worry. We will soon fix all that. On the right side of the screen is a

Figure 3-9. This is typical of the first thing you see when your switch to the Formula to Recipe screen.

display of a material. You will find this useful as we build up the recipe and you want to find just the right material to add. You can quickly bring up any material for reference just by clicking on the Material Name and selecting the material you want on the pop-up menu. Now, on to using the Formula to Recipe screen. It might be a good idea to start the program and work along with me as I describe the example.

Step One

The first step is to enter the goal unity formula you want to match. You can do this one of two ways. If you want to match the unity formula of an existing recipe you bring that recipe up on the left side of the screen using the 'Change' button as described earlier. When the appropriate recipe is displayed you click on the button 'Copy Unity to Goal'. The computer will then ask you to name a new recipe and fill in the Goal Unity column for you. It will also fill in the middle column titled Goal Molar Equivalents. You see, we are not going to match the unity formula directly. In this case it is easier to work in molar equivalents which is just another way of displaying the same information.

Alternatively, if you want to match a specific Unity Formula, rather than matching one in an existing recipe, enter those number in the Goal Unity column. Then click the 'Add' button and enter a new recipe name.

For the purpose of this example, let's match the unity formula of Xavier's Warm Jade Green using different ingredients. We will name it 'Xavier's-New Ingredients'. After clicking 'Copy Unity to Goal' and entering the new name, the left side of the screen will now be as shown in Figure 3-10. Notice that all the ingredient and amount fields are empty. The only columns on the left side

Figure 3-10. After adding a new recipe name for the recipe you will develop the only entries, other than the name, are in the Goal Unity and Goal Molar Equivalents columns.

of the screen with any information in them are those titled 'Goal Molar Equivalents' and 'Goal Unity"

Step Two

Now the real work begins. We have our goal unity formula in place and the goal molar equivalents calculated. The essence of the second step in this process is to add ingredients to the recipe and set their amounts so we match the actual to the goal molar equivalents. There are both efficient and inefficient ways to do this. The way I will describe in the paragraphs below is the one I have found to be most efficient. After you get some experience with the technique you may find a way you like better. If so, go for it.

If you have boron in the recipe it is the first thing you want to match. In the original recipe boron was supplied by Ferro Frit 3124. For purposes of this example, let's say I am out of 3124 and would like to substitute 3134. I enter 3134 as the first ingredient and increase its amount until the boron numbers in the actual and goal molar equivalents column match (or nearly match–sometimes you just can't get it exact). In Figure 3-11, we see that 3.7 units of Ferro Frit 3134 (after clicking on the 'Recalc/Enter' button) gives the desired boron match. Don't think of this as 3.7%. It is not. We will convert to a more standard recipe format later–for right now it is just 3.7 units of Frit 3134. Also notice, though, that some of the other oxide rows in the 'actual' column now have numbers in them. This is because Frit 3134 has more in it than boron.

After matching boron it is usually best to match the alkalis: lithium, sodium and potassium. Since we have no lithium to match we will work on sodium and potassium. The original recipe used Custer Feldspar so we'll try that. Note in Figure 3-12 that 28.7 units of Custer comes

	Main Menu	Exit Quit		Formula to Recipe			GlazeMas Help

Recipe 1	Xavier's-New Ingredients			Change	Add	
Cone		Surface		Color		
Firing		Recipe Set	Unassigned			
Test Sample IDs			Date	8/6/2011		

Ingredients	Amt.				Actual Molar Eq.	Goal Molar Eq.	Goal Unity
Frit--Ferro 3134	3.7	+ -	Recalc/Enter				
		+ -		Li₂O			
		+ -	+/- Button Recalc Freq	Na₂O	0.61	2.04	0.087
		+ -		K₂O		3.05	0.130
		+ -	⦿ Immediate	MgO		4.74	0.202
		+ -	○ Delay	CaO	1.33	13.62	0.581
		+ -		SrO			
		+ -	Copy Unity to Goal	BaO			
		+ -		ZnO			
		+ -		PbO			
		+ -		Subtotal Alkalis	0.61	5.09	0.217
		+ -		Total Fluxes	1.94	23.44	1.000
		+ -		Al₂O₃		7.88	0.336
		+ -		B₂O₃	1.23	1.24	0.053
	Total	3.7		Fe₂O₃		0.07	0.003
Comments				SiO₂	2.86	67.35	2.873
				TiO₂		0.02	0.001
				P₂O₅			
				Si:Al	?		
				Exp Coeff	93.04	Change Exp Coeffs	
				L.O.I.	0.00		

Figure 3-11. If boron is needed it is usually best to match it first.

very close. The sodium is 0.03 units low and the potassium is 0.02 units high. That is as close as you can get in these kinds of matches.

After the alkalis are matched, match the alkaline earth oxides followed by alumina and silica. The original recipe sourced calcium and magnesium from whiting and talc respectively. I prefer to source calcium from wollastonite so I'll use it along with talc to match the alkaline earths. The results of that match are shown in Figure 3-13. There are several things to notice. First I had to go back and forth a bit on talc and wollastonite because

Figure 3-12 (screen)

Main Menu	Exit Quit	**Formula to Recipe**		GlazeMas Help

Recipe 1 Xavier's-New Ingredients   [Change] [Add]

Cone ____ Surface _____ Color _____
Firing ____ Recipe Set Unassigned
Test Sample IDs _____ Date 8/6/2011

Ingredients	Amt.			Actual Molar Eq.	Goal Molar Eq.	Goal Unity
Frit--Ferro 3134	3.7	+ -	Recalc/ Enter			
Feldspar--Custer	28.7	+ -		Li₂O		
		+ -	+/- Button Recalc Freq ⊙ Immediate ○ Delay	Na₂O 2.01	2.04	0.087
		+ -		K₂O 3.07	3.05	0.130
		+ -		MgO	4.74	0.202
		+ -		CaO 1.48	13.62	0.581
		+ -		SrO		
		+ -	Copy Unity to Goal	BaO		
		+ -		ZnO		
		+ -		PbO		
		+ -		Subtotal Alkalis 5.08	5.09	0.217
		+ -		Total Fluxes 6.56	23.44	1.000
		+ -		Al₂O₃ 4.82	7.88	0.336
		+ -		B₂O₃ 1.23	1.24	0.053
Total	32.4			Fe₂O₃ 0.03	0.07	0.003

Comments

		SiO₂ 35.85	67.35	2.873
		TiO₂	0.02	0.001
		P₂O₅		
		Si:Al 7.43		
		Exp Coeff 82.27	[Change Exp Coeffs]	
		L.O.I. 0.27		

Figure 3-12. Matching alkalis (lithium, sodium and potassium) is done next.

Figure 3-13 (screen)

Main Menu	Exit Quit	**Formula to Recipe**		GlazeMas Help

Recipe 1 Xavier's-New Ingredients   [Change] [Add]

Cone ____ Surface _____ Color _____
Firing ____ Recipe Set Unassigned
Test Sample IDs _____ Date 8/6/2011

Ingredients	Amt.			Actual Molar Eq.	Goal Molar Eq.	Goal Unity
Frit--Ferro 3134	3.7	+ -	Recalc/ Enter			
Feldspar--Custer	28.7	+ -		Li₂O		
Wollastonite	15.0	+ -		Na₂O 2.11	2.04	0.087
Talc	5.7	+ -	+/- Button Recalc Freq ⊙ Immediate ○ Delay	K₂O 3.07	3.05	0.130
		+ -		MgO 4.80	4.74	0.202
		+ -		CaO 13.60	13.62	0.581
		+ -		SrO		
		+ -	Copy Unity to Goal	BaO		
		+ -		ZnO		
		+ -		PbO		
		+ -		Subtotal Alkalis 5.18	5.09	0.217
		+ -		Total Fluxes 23.57	23.44	1.000
		+ -		Al₂O₃ 5.11	7.88	0.336
		+ -		B₂O₃ 1.23	1.24	0.053
Total	53.1			Fe₂O₃ 0.07	0.07	0.003

Comments

		SiO₂ 54.05	67.35	2.873
		TiO₂	0.02	0.001
		P₂O₅		
		Si:Al 10.58		
		Exp Coeff 79.13	[Change Exp Coeffs]	
		L.O.I. 1.32		

Figure 3-13. Matching alkaline earths is next. Here we chose talc and wollastonite.

talc contains some calcium and wollastonite contains a little bit of magnesium. To make it all a little more complex, both talc and wollastonite contain sodium. Therefore I will have to decrease the amount of Custer Feldspar a little bit once I got the calcium and magnesium to match. But I will wait to do
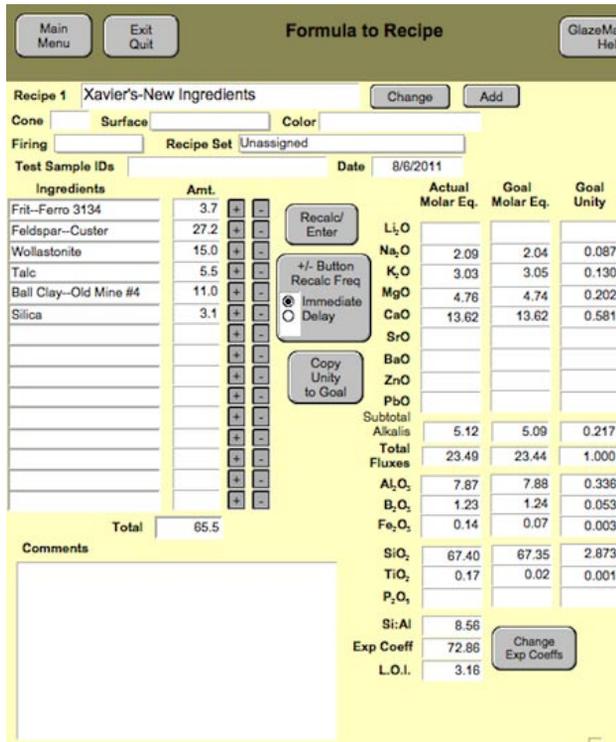
Figure 3-14. Alumina and silica are matched last using your choice of clay and silica.

that until I balance alumina and silica so I can see the total picture. This kind of back and forth juggling sounds complicated, but you will get the hang of it pretty quickly and it will become a game. Again the matches are not perfect, but they are close enough.

We are nearly done now. Let's match alumina and silica. The original recipe used EPK, but let's use a ball clay, OM-4, instead. For silica we'll use–what else–silica! Figure 3-14 shows the last part of this second step. Note that, compared to where I was in Figure 3-13, I had to adjust the feldspar and talc a little bit. But overall, it is a very close match.

Step Three

Of course, the recipe still looks funny. It doesn't add to 100 and we would really like to see that the unity formula was a close match to the original. So the fourth step involves going to another screen. After making sure we have clicked 'Recalc/Enter' after the last change we made, we go back to the Main Menu and pick another selection under 'Add/Edit/View Recipes'. The selection I like to make for this next step is 'Two Recipes–Unity only'. That way we can have our new recipe on the left side of the screen where it will appear automatically and bring up the original recipe on the right side of the screen. As soon as we bring up the screen we can examine the two unity formulas and see that they match very closely. But the numbers on the left side only total 65.5. So we will click the 'Reset Total' button and

enter the new total we want–in this case 100. After the total equals 100, we can put the colorants back into the recipe and enter things like the Cone, Surface, and Color appropriately in the upper part of the screen. And don't forget to assign the new recipe to a Recipe Set if you want one other than 'Unassigned'.

And there we have it. A new version of Xavier's Warm Jade Green with the ingredients we want. The final result compared to the original is shown in Figure 3-15. As you can see the Seger unity formula numbers are very close for both recipes. This is about as close as you can realistically come and certainly close enough that the recipes should give virtually the same glaze. Anybody want to mix them both up and see how close we came? I haven't done this myself; however, one of the potters who bought an earlier version of GlazeMaster did and she reports it is 'dead-on' and somewhat less troublesome (Xavier's can be a bit frustrating at times–it can pinhole or do other untoward things to cause a potter grief).

Figure 3-15. The unity formulas of the orignal and the one with new ingredients are virtually identical.

Summary

The section of the program, titled 'Add/Edit/View Recipes' is where most of the action is. It is important that you understand how to use it well. Start by just playing around. Enter some made-up recipes. Change

the materials in them and see how the numbers change. Don't worry about making mistakes. Everything in the program can be changed or deleted. So I encourage you to explore the ins and outs of what is here. Then we will be ready to move on to Add/Edit/View Materials.

4

ADD/EDIT/VIEW MATERIALS

Having an accurate and thorough materials file is a critical part of being able to make effective use of GlazeMaster. Explaining how to use this part of the program is the simple part. Sometimes the most difficult part is getting good material analyses for the particular materials you have. Many of the materials we use are mined and about the only purification they get is to dry them, crush them, and screen out the rocks and roots. Natural materials vary in composition from place to place in the mine and, of course, from mine to mine. Nonetheless with some persistence we can get material analyses that are sufficiently accurate for our purposes. Where?

Analyses that are up-to-date as of the publication of this program are included for many materials that are common in North America. I also have a section of the masteringglazes.com web site devoted to downloadable files that are easy to import into GlazeMaster. Go to:

http://masteringglazes.com/Pages/GM1frame.html

and click on Materials Compositions in the left-side Menu. In addition there are other web sites listed in the Appendix which have extensive materials lists. However the best source is to get a current analysis from your supplier every time you buy materials. Most pottery supply dealers do not make a habit of maintaining a file of materials analyses like they do Material Safety Data Sheets; however, they can and usually will get them for you in short order. That is what fax machines are made for. In addition, if enough of us keep asking for analyses regularly they will become more readily available. If your supplier won't get them for you it is time to look for a new supplier. It is also an excellent reason to buy as many of your materials as you can by the full 50 or 100 pound bag. The less often you have to switch to a new lot of materials and get a new analysis for it, the less often you will have to test to be sure the compositions haven't moved on you.

Most material analyses are presented in a similar form. They list the weight percent of each of the oxides present in the material and the Loss on Ignition (LOI). LOI represents the amount of combined water (water of hydration) that might be present plus the carbonaceous compounds, sulfates, and other materials that burn off during firing. Weight percent of the oxides and LOI is the way you enter material analysis data into GlazeMaster.

Occasionally you will see an analysis in another format. For example cobalt carbonate is usually shown as percent cobalt instead of the equiva-

lent percent of cobalt oxide. This is rare and we have not made provision for it in this program. If you run into that situation ask for help in making the conversion if you do not know how to do so yourself.

It is also worth mentioning the difference between theoretical analyses and actual analyses. Many books only show theoretical analyses of key materials like feldspars and clays. These are usually text books and they do it to make the examples they show easier to illustrate. I suppose these theoretical analyses are better than having nothing, but it is a really bad idea to use them. There are lots of impurities in real materials and they make a difference in our glazes. You can usually spot these theoretical analyses because they are often presented in unity or mole percent formats instead of weight percents. This is because theoretical analyses are usually discussed in terms of 2 molecules of A and 3 molecules of B and, therefore, it is 40 mol % A and 60 mol % B. Always try very hard to get an actual analysis.

Using Material Sets

Before we launch into a discussion of how to use the materials part of the GlazeMaster program there is one feature which needs to be explained, i.e . Material Sets. Materials are added to a recipe via pop-up menus. This is done for two reasons. First, it is a labor saving way of not having to retype the same material names in recipe after recipe. But equally important is to assure that the names are always spelled the same so the program can recognize them when it comes time to find their composition. The result of using these pop-up menus is that they can become very long. By the time you have entered a few materials of your own, the materials file will be quite large and files as long as 200 or 300 entries would not be uncommon. But in actual fact most of us only maintain an inventory of 30-40 materials–maybe 50 or so including colorants. We prefer to do most of our recipe formulation using only those materials. We still need access to a bigger materials list, though, because we will occasionally want to analyze or convert a recipe containing no-longer-available materials or one from a different part of the world where the available materials are different from ours.

From this dilemma comes the concept of Material Sets. You can designate each material in the materials part of the database as being 'In Stock', 'Available' (meaning you can buy it if you want to badly enough), 'Not Available', or 'Not Specified'. All materials, when they are initially entered in GlazeMaster are designated as 'Not Specified'. I recommend that one of your early tasks with GlazeMaster would be to inventory your own materials, or those in the studio where you work, and designate those that you have as 'In Stock'. Again, though, it is totally up to you whether or not you use this feature. If you don't want to use it simply leave the Materials Set on 'All'.

Having designated your materials as noted above you can then display them in the pop-up menus in the sets of 'In Stock', 'In Stock + Available', 'Not Available', and 'All'. 'All' will, of course, display all the materials in the file no matter how big it is.

It is important to note that just because a material is not being displayed in the current Material Set does not mean it cannot be used in recipes or will not be included in the calculations. Once you enter a material in the 'Ingredients' part of a recipe it is always included in the calculations if its composition is in the materials file. So if you want to enter Albany Slip–a material which is no longer available-in a recipe, you change to either the 'Not Available' or the 'All' Material Set. Then enter Albany Slip and switch back to the Materials Set you prefer for most of your work. If you elect to use this feature I would predict you will spend 90% or more of your time using either the 'In Stock' or 'In Stock + Available' Material Sets.

Material	Ball Clay--Old Mine #4			Add
Availability	Not Specified			
Oxide	Analysis (Wt. %)	Unity	Mole %	
Li2O				To change an analysis enter new numbers in the "Analysis" column
Na2O	0.30	0.158	0.39	
K2O	1.00	0.346	0.85	
MgO	0.40	0.323	0.80	
CaO	0.30	0.174	0.43	
SrO				
BaO				
MnO				
ZnO				
PbO				
Subtotal Alkalis	1.30	0.503	1.24	
Total Fluxes	2.00	1.000	2.47	
Al2O3	27.90	8.907	21.98	
B2O3				
Fe2O3	1.10	0.224	0.55	
SiO2	55.20	29.912	73.80	
TiO2	1.20	0.489	1.21	
P2O5				
L.O.I.	12.60			
Total	100.00		100.00	
"Molecular Weight"			70.18	
Expansion Coefficient	51.51			
Comments				
Mine/Manufacturer				
Lot				
Cost, $ / lb				

Figure 4-1. One of the two screens where you can add or edit materials. You can view them on this and several other screens. Note that while Material Cost is displayed in $/lb. the units may be changed to those you use. See the text for details.

Add/Edit/View a Single Material

Choosing this selection on the Main Menu takes you to the screen, part of which is shown in Figure 4-1 (The top bar of the screen is identical to the ones in 'Add/Edit/View Recipes' and will not be described again here). Materials are added to the file in exactly the same way recipes are added to the recipe file. You click on the 'Add' button and a dialogue box pops up where you enter the name of the new material. Material Names must also be unique and you will be asked to enter another one if you choose one that is already taken. Notice in the materials I have entered for you, I have entered the name so all the materials in a family, e.g. feldspars or ball clays or frits, will show up together in an alphabetized listing. So, for example, you see the names as :

Ball Clay–OM #4	instead of	OM #4 Ball Clay
Feldspar–Custer	instead of	Custer Feldspar
Frit–Ferro 3124	instead of	Frit 3124
Frit–Fusion F12	instead of	Fusion F12 Frit

It will make materials easier to find if you continue to use this naming convention.

After entering the name of the new material and clicking OK, the screen will clear and only two things will be entered in the fields–the name of the new material and Not Specified in the Material Availability box. First, note that you can change to another material at any time in a little different way than you change to a different recipe. Just click on the name of the current material and a pop-up menu will be displayed showing the names of all of the materials in the current Materials Set (the one shown on the right side of the top bar on the screen).

However, switching to a different material is not what we want to do right now. Rather, we want to enter whatever information we have about the material we just added. First, if you are using the Materials Set feature click on 'Not Specified' and change the Material Availability to what you want. Then enter the composition of the added material in the left-hand column. Don't worry if the numbers don't add to 100. Some materials contain impurities which are not analyzed for or are not included in the oxides list incorporated into GlazeMaster. For most materials, though, the weight percentages (including LOI) will total well into the nineties and many will total to 100. Just leave the field blank when the analysis indicates there is none of a particular oxide present. You can enter a zero if you want, but the program will just set it back to a blank field.

Note that there are also places to enter comments about the material

For some materials that you want in your materials database, you will not have an analysis. For those you intend to use only in the Additives section of recipes, it makes no difference at all. Just leave the wt % column blank. For those materials you intend to list as Ingredients in recipes, be aware that they will not be included in the unity calculations if there is no analysis for them. While the unity and mol % numbers will still look normal, the wt % numbers will not add to 100.

While there is no limit on the length of material names, it is best to keep them to 22 or fewer characters so they will display properly on the various screens in GlazeMaster.

as well as noting the mine or manufacturer and the lot number. If, however, you have more than one lot of a particular material on hand you may want to incorporate some of that information into the material name. That way you can see it when you select ingredients from the pop-up menu. For example you might have Feldspar–Custer, Lot 3045 and Feldspar–Custer, Lot 9056.

If later you find you made an error in entering a material composition or if you get an updated analysis, you can correct/change the composition at any time. When you do this the recipes will automatically calculate new unity, wt % and mol % numbers using the new analysis. Those numbers are never stored but, rather, are calculated each time they are displayed. An important example of how this may effect your work is as follows:

> Suppose you have been making a glaze successfully for some time with a specific lot of material. When you buy a new lot you notice that the analysis is significantly different. If you just change the analysis of that material you will lose the unity calculation as well as the percentage calculations of your successful glaze. Instead, add a new material and give it a slightly different name, e.g. Material Name–2/11. Then you can use this material in a modification of your recipe that gives a unity formula the same as the original. This is what has been done in the listings of Gerstley Borate that were included with the program. Gerstley Borate is a material that changes significantly over time and you usually have significant differences in the glaze using one lot versus the other.

It is important to enter an analysis for every material that you intend to use as in Ingredient in GlazeMaster. It is not important if you intend to use the material and enter it as an Additive. Remember, all materials entered in the Ingredients section of a recipe will be used in the compositional calculations if a composition is available. If one is not available you will end up with incomplete Seger unity formulae, wt %s, and/or mol %s. This could give you very misleading information if the materials are present at a significant percentage. Even though I was critical of theoretical analyses above, I would enter one before I would leave the analysis section blank. If you do this, however, it would be wise to note that it is theoretical in the comments section or give it a name like Feldspar–Potash, Theoretical. Then when you get a real analysis for your particular potash feldspar you can enter it and replace the theoretical one in your recipes.

In addition to entering compositional information you also have the opportunity to enter cost information for each material. If you do so, the cost of each glaze will be calculated for you and will be displayed on the Recipe screens. Before you start, however, you need to decide what monetary and weight units you wish to use. From the Main Menu, choose Add/Edit/De-

lete Preference Sets. At the bottom of that screen chose the currency you want to use ($, ¥, £, or) and whether you buy your materials by the pound or the kilogram. Then enter the cost of each material in your inventory or of those for which you know the cost. Note that, if the cost of any of the materials in a particular glaze is missing, the calculations for that glaze will be inaccurate and lower than it really is.

Add/Edit/View a Material while Viewing Another

While you certainly can use this screen for adding materials or editing their composition, its primary purpose is to allow you to compare two materials. If you do add or edit, as in the recipes layouts, you make all of your changes on the left-hand side of the screen.

But suppose you want to see what the difference is between Ferro Frits 3124 and 3134. Bring one up on one side of the screen and the other on the other side. Questions like what is the difference between a typical ball clay like OM-4 and a typical kaolin like EPK or what is the difference between two different feldspars are ones you will encounter more and more as you get further into glaze design.

5

CALCULATIONS FOR BLENDS
Introduction to Blending Experiments

Exploring glazes using blends of various kinds can be an extremely useful technique for potters. We have probably all done simple blends before we are very far into mixing our own glazes. For example, mixing test batches having 1, 2, and 3% of our favorite colorant is an illustration of a simple line blend. Blend techniques are usually talked about in three categories: line blends, triaxial blends, and quadraxial blends. We will discuss each of these in more detail in the paragraphs below. While it is feasible to design even more complex blends it is rarely, if ever, done because of the difficulty of visualizing and interpreting the results.

From the standpoint of technique, I highly recommend you use volumetric blends. This technique is described in detail in Ian Currie's book Revealing Glazes: Using the Grid Method; however I'll give a simple volumetric line blend example here. Suppose I have two glazes X and Y and want to explore the space between them. I'll mix 500 grams of each–1000 grams total for the two batches. I'll dilute each of the 500 gram batches to the same volume using a graduated cylinder. For purposes of illustration and to keep the numbers simple, lets say each of the two batches is 750 ml for a total of 1500 ml. To do a 5-part line blend you would simply construct an experiment as illustrated in the Table 5-1 below.

Sample	A	B	C	D	E
Parts of Glaze X	4	3	2	1	0
Parts of Glaze Y	0	1	2	3	4
ml of Glaze X	300	225	150	75	0
ml of Glaze Y	0	75	150	225	300

Table 5-1. An illustration of the volumetric line blending technique

I use a calibrated syringe to measure the appropriate amount of each glaze into 5 separate containers, A - E, and I end up with 300 ml of each of my 5 line blend samples. This is enough to coat a couple of test tiles–one stoneware and one porcelain–plus glaze a small cup. You may want to cut these numbers in half if you only want to glaze test tiles. If you are working

on something as small as a five x seven grid test tile you might want to mix as little as 100 grams of each corner glaze.

So how can GlazeMaster help you in making your blending experiments more effective? It is very difficult by looking at recipes to tell if the intermediate points in the blend you design are likely to be in the compositional range you want or not. Here let's focus on the needs of the functional potter; however, the logic can easily be extended to the needs of potters doing decorative or sculptural work. If you remember, back in Chapter 2 of this User's Guide we said that durability of glazes is determined by four factors. The first two of those factors were having appropriate levels of silica and alumina. Using glaze calculation techniques we can easily ask the computer to calculate silica and alumina levels for every composition within the blend we will be testing. Another factor of importance to the functional potter is clay/glaze fit. This will be discussed in more detail in Chapter 8 and a full chapter is devoted to the subject in Mastering Cone 6 Glazes; however, for now we need to recognize that the coefficient of thermal expansion of the glaze needs to approximately match that of the clay body. Again, these expansion numbers can easily be calculated for every composition in the blend. Well, they can easily be calculated by a computer–calculating them by hand for triaxial and quadraxial blends would be a nightmare. Focusing on just these numbers–silica, alumina, and expansion–can tell us a lot about a glaze.

So the essence of what GlazeMaster does for blend experimentation is twofold. First, it calculates and graphically displays simultaneously the silica, alumina, and expansion numbers for every composition in the blend. As an added benefit it color-codes red or green every compositional point based on limits you set for them. Secondly, GlazeMaster makes the full unity formula, weight %, and mole % calculations readily available for any individual composition in your blend.

Using Calculations for Blends

The first step in having GlazeMaster help you with blend experiments is to enter the recipes that will be used for the end or corner points of your blend. It might be useful to designate a new Recipe Set, e.g. Recipes for Blend Experiments, to keep these recipes in one place. This would be especially useful if you are using Currie's techniques where the corner points seldom, if ever, are useful glazes in their own right. The way you enter recipes has, of course, already been described in Chapter 3. Once the recipes are entered you are ready to explore and we'll discuss each kind of blend in more detail below.

Line Blends

As illustrated in Table 5-1, line blends are quite easy to do and are a good place to start for a potter who hasn't done blend experiments before. We have chosen to focus GlazeMaster assistance on a simple five-point line blend–two end points and three intermediate points. If you want to do a six or seven point line blend see the side-bar for more information. Figure 5-1 shows the primary line blend screen as you will see it the first time you bring it up from the Main Menu. Let's take a moment to explain what is here. First, note the five boxes. In these boxes will be displayed the silica, alumina, and expansion numbers as described above. On the left is a button you use to select/change the recipes you want to use for your end points. Remember, you must have already entered those recipes using the procedure already covered in Chapter 3. Clicking this button brings up a dialogue box very much like the one you used to change recipes in the 'Add/Edit/View Reci-pes' section of GlazeMaster; however, here there will be the opportunity to select two recipes. In the sections for triaxial and quadraxial blends you will be asked to select three and four recipes respectively.

After you select your two recipes and click 'Continue', GlazeMaster will calculate away and, in a few moments show you a screen that looks like the one in Figure 5-2. For Figure 5-2 we have just used two recipes that were already in our recipe file to illustrate what the software does–we are not recommending these as providing any particular insight into the world of glazes, but we will use them to illustrate the software's capability.

Would you prefer to have a six or seven segment line blend instead of the five segment one illustrated below? If so just use of the sides of the triaxial (six) or quadraxial (seven) grids shown on subsequent pages.

Figure 5-1. The screen you see the first time you use the line blend layout.

Next, let's look at the three blocks of text in the lower half of the screen. On the left are some words about how to interpret the red and green areas on the screen. We won't repeat those words here.

Second, in the middle is a place where you can enter the number of any compositional point (the number in the lower-left-hand corner of each square), click the button 'Show Details', and promptly be taken to a screen (Figure 5-3) that shows the full unity, weight %, and mole % calculations for that square. Also on Figure 5-3 is a button labeled 'Convert to a Recipe' that will take you to the Formula to Recipe section of GlazeMaster and enter the unity formula of the currently displayed square as the Goal Unity Formula in Formula to Recipe. You can then begin to build up the specific recipe you want to use from your blend experiment. This screen is similar for all three types of blends.

Back to Figure 5-2, on the right side is an area where you can customize the limits you want to use for silica, alumina, and expansion numbers. Simply click in each field and change the number to anything you wish. When you change these numbers for one kind of blend you change it for all of them. The numbers that are entered when you first use the program are those I have found to be about right for cone 6 glazes working with Standard Ceramics 306 clay. They won't be far off for many of the cone 6 and

cone 10 clay bodies that are commercially available. However you should modify these numbers as appropriate based on your own experience, what you are trying to do, and the needs of your clay body. Also, if you work with earthenware you might want to enter different numbers based on your own experience.

Triaxial Blends

Triaxial blends are seldom used, although they can be very helpful at times. Perhaps having the power inherent in GlazeMaster available to help with the analysis will make them more popular. Although you can use them to explore the space between three glazes, they are perhaps best used to look at the effects of adding specific materials or oxides to a glaze you want to modify. For example, you might want to try to improve (make more durable) Toshika Green. You know from looking at its unity formula that it is very low in silica and probably not fully melted. So you might want to try to improve it by adding silica and additional flux. But how much of each? For purposes of illustration I have added two recipes to the recipe file in GlazeMaster. It's not fair to call them glazes because neither would yield a good glaze. One is 100% silica and the other is an 80/20 mixture of Custer feldspar and whiting. So I am adding silica and/or "flux" as we progress

Figure 5-3. Complete unity, weight %, and mole % data can easily be displayed for any single composition in the blend

Line Blend Square [2]

Calculate Another Square

To see the detailed calculationf for another line blend square, click on the Line Blend Square field above and select the desired box/square. Then click on the button below..

	Unity	Weight %	Mole %
Li_2O	0.187	2.08	4.36
Na_2O	0.133	3.08	3.11
K_2O	0.125	4.39	2.92
MgO	0.107	1.60	2.49
CaO	0.448	9.36	10.47
SrO			
BaO			
ZnO			
PbO			
Subtotal Alkalis	0.445	9.54	10.40
Total Fluxes	1.000	20.50	23.36
Al_2O_3	0.359	13.62	8.38
B_2O_3	0.064	1.66	1.49
Fe_2O_3	0.003	0.18	0.07
SiO_2	2.848	63.69	66.53
TiO_2	0.001	0.04	0.03
P_2O_5	0.005	0.29	0.13
Si:Al	7.93		
Exp Coeff	73.79		
L.O.I.	55.86		

Return to Line Blend Screen

Calculate Another Square

Convert This Unity Formula to a Recipe

If you click on the button below, the unity formula currently displayed will be automatically copied to the "Formula to Recipe" screen and you will be asked to name the new recipe. Then you can proceed to develop the recipe using the procedures described in the User's Guide.

Convert to a Recipe

down the triangle. In Figure 5-4 you can see the results of the calculations. I pass into a green area part way down the triangle and then back into a red area near the silica corner.

Note that I have also opened up the limits on expansion so none of the squares are colored red because of it. As noted earlier, expansion numbers are really only useful for glossy glazes and I am seeking to duplicate Toshika Green's matte surface with this experiment. In actually running this experiment it would also be helpful to put the same amount of colorant (1.7% copper carbonate) and processing aid (1.7% bentonite) in each of the bottom two corners so those remain constant across the entire triaxial blend. Another thing to note is that two of the numbers are missing in the silica corner. This is because they are so high that they won't display properly in the limited size field available on a monitor screen. Since we have no interest in making a glaze of this composition anyway it doesn't really matter.

The rest of the information on the triaxial blend layout is virtually identical to that on the line blend layout. Its position has just been changed to fit the available space on the screen.

Figure 5-4. Triaxial blends can be a very useful tool, particularly for exploring changes in composition of an existing glaze.

Triaxial blends can also be used to explore compositions that are similar to glazes in that they contain three types of materials, e.g. a flux, silica, and alumina. For example you can explore a $CaO/SiO_2/Al_2O_3$ system. Just enter recipes for each of the pure ingredients in the recipe file, place those
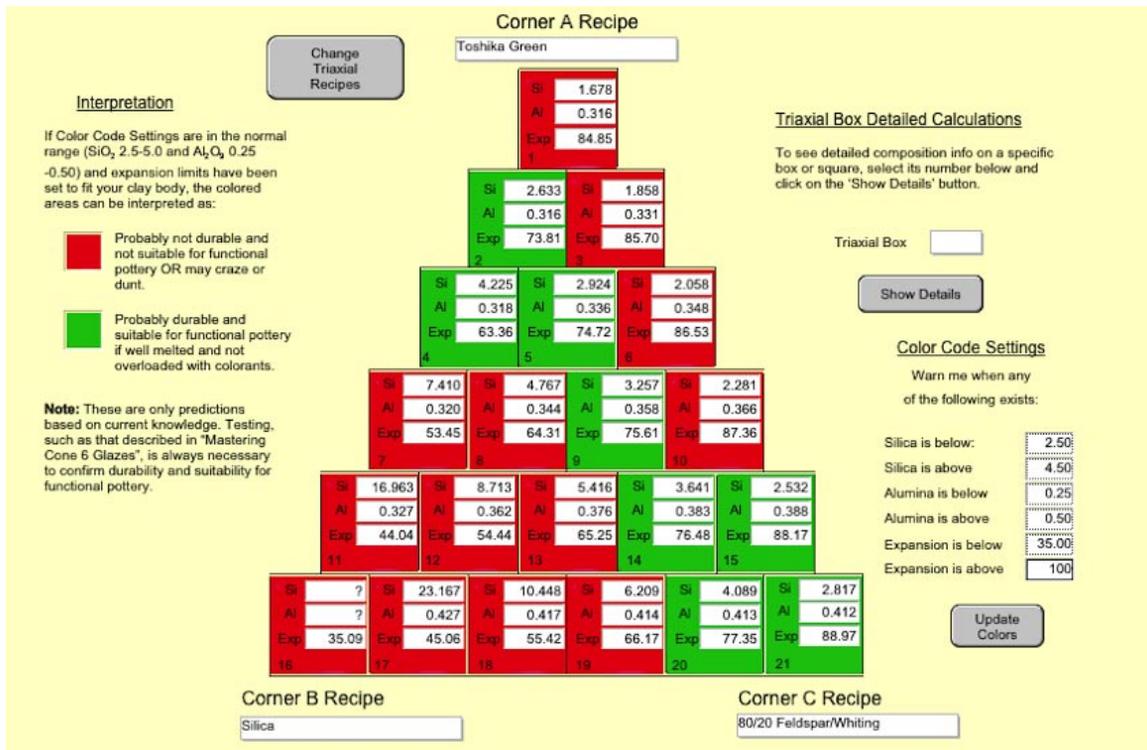
recipes in the corners of the triaxial blend layout, and you can quickly see the range of compositions you will be generating and which of those might make the best glazes. You may well get a surprise when you actually run the experiment because of the existence of eutectics that melt at lower temperatures than one might predict. Ian Currie gives a good discussion of this in his first book, Stoneware Glazes: A Systematic Approach. See Chapter 13.

A third use for triaxial blends might be to explore different flux combinations. For example, try placing Charcoal Satin Matte, a very high calcium glaze, on top of the triaxial grid. Then, after adding recipes for them, put spodumene in another corner and Ferro Frit 3278 in the third corner. This would allow you to see what happens as you replace calcium with lithium and sodium/potassium. If you enter these 'recipes' into the triaxial blend grid you will quickly see that only a handful of these compositions are likely to be good functional glazes. This might cause you to use a modification of Charcoal Satin Matte, to lower the silica and alumina levels in that corner of the triangle, before you actually spend the time to run the experiment.

Currie Grids or Quadraxial Blends

Ian Currie, in his second book Revealing Glazes: Using the Grid Method, has popularized a specialized form of quadraxial blends more specifically known as a biaxial blend or a Currie Standard Grid. Since many people use this system to explore glaze compositions I have elected to use a 5 x 7 grid like Currie uses for whatever quadraxial blends (Currie standard, a modified Currie standard, or one of your own design) you might choose to work on. Currie makes a good case against using four random recipes as the corner recipes, and I agree with his reasoning. However, as we will see later in this section I think there is room for a modification to his approach which will be more effective for the functional potter and maybe for others as well.

Again, we start by entering the recipes we want to use into GlazeMaster using previously described techniques. In the case of a Currie Standard Grid, once the C corner recipe is stated, the others are specified and readily calculated. For details see Revealing Glazes.

Note: Ian Currie passed away on May 5, 2011. His books may still available in limited quantities as of this writing. An online copy of his first book can be found at http://stonewareglazes.currie.to

In Figure 5-5, I have entered the 4 recipes that make up his 0.7 Standard Limestone set. Currie uses this example throughout Revealing Glazes. When I first calculated this set of glazes within GlazeMaster I got quite a surprise. As you can see, using normal ranges for silica, alumina, and expansion numbers, only 2 of the 35 compositions are in the green area. Even if I widen the expansion limits so they do not have an effect, only 7 of the 35 compositions are green. This troubles me. It may mean that

Would you like to do triaxial blends but don't have a nice triangular grid test tile comparable to those used for Currie grids? Just use 22 of the 35 squares in one of your Currie grid tiles. You can still almost arrange them in a triangular pattern (admittedly a right triangle instead of an isoceles triangle) by using six of the squares in the first column, five in the second, and so on. Just one sample will have to be put outside the triangle.

this is not a very high payoff technique for a functional potter who wants durable glazes that fit the clay body well. This is why I would suggest that functional potters consider modifying their Currie grids staying within the principles that he lays out for separating variables, namely vary alumina on the vertical axis by adding clay and silica on the horizontal axis by adding silica to the C corner recipe. The modifications I would make would be to explore smaller ranges of silica and alumina. Doing that will cut down on the total range of compositions explored, but it potentially gives more useful intermediate compositions to help select the very best.

In Figure 5-6, I give an example of cutting down on the range of silica and alumina explored while holding true to the basic principles Currie specifies. Specifically I set the silica level in corner C at 20% while holding the ratio of feldspar to whiting at 70/30. I reduced the silica level in the D corner to 40%, and I held the addition of kaolin to the A corner to be 20%. Notice that 14 squares are now green. For a functional potter this gives a much more interesting area to explore with still enough room around the edges to see what happens when you get out of normal ranges.

I suspect you can do an even better job of designing experiments to give you more of what you want, but this example should illustrate the potential

Firgure 5-5. A Currie standard grid might have relatively few squares having compositions of interest to a functional potter.

Corner A Recipe

Cone 10 Limestone Set--A

[Change Grid Recipes]

Interpretation

If Color Code Settings are in the normal range (SiO$_2$ 2.5-5.0 and Al$_2$O$_3$ 0.25 -0.50), the colored areas can be interpreted as:

🟥 Probably not durable and not suitable for functional pottery OR may craze or dunt.

🟩 Probably durable and suitable for functional pottery if well melted and not overloaded with colorants.

Note: These are only predictions based on current knowledge. Testing, such as that described in "Mastering Cone 6 Glazes", is always necessary to confirm durability and suitability for functional pottery.

Corner C Recipe

Cone 10 Limestone Set--C

1	2	3	4	5
Si 3.027, Al 0.870, Exp 77.58	Si 3.764, Al 0.877, Exp 72.61	Si 4.695, Al 0.886, Exp 67.80	Si 5.908, Al 0.898, Exp 63.13	Si 7.553, Al 0.914, Exp 58.61
6 Si 2.738, Al 0.730, Exp 80.61	**7** Si 3.439, Al 0.738, Exp 75.04	**8** Si 4.336, Al 0.748, Exp 69.65	**9** Si 5.523, Al 0.761, Exp 64.44	**10** Si 7.172, Al 0.780, Exp 59.38
11 Si 2.500, Al 0.614, Exp 83.63	**12** Si 3.168, Al 0.621, Exp 77.46	**13** Si 4.031, Al 0.631, Exp 71.50	**14** Si 5.192, Al 0.644, Exp 65.73	**15** Si 6.836, Al 0.662, Exp 60.15
16 Si 2.300, Al 0.517, Exp 86.65	**17** Si 2.938, Al 0.523, Exp 79.88	**18** Si 3.771, Al 0.531, Exp 73.34	**19** Si 4.905, Al 0.542, Exp 67.03	**20** Si 6.537, Al 0.558, Exp 60.92
21 Si 2.131, Al 0.434, Exp 89.66	**22** Si 2.742, Al 0.438, Exp 82.29	**23** Si 3.546, Al 0.444, Exp 75.18	**24** Si 4.653, Al 0.452, Exp 68.31	**25** Si 6.270, Al 0.464, Exp 61.68
26 Si 1.985, Al 0.363, Exp 92.66	**27** Si 2.572, Al 0.365, Exp 84.69	**28** Si 3.350, Al 0.369, Exp 77.01	**29** (green) Si 4.430, Al 0.373, Exp 69.59	**30** Si 6.031, Al 0.380, Exp 62.44
31 Si 1.858, Al 0.301, Exp 95.66	**32** Si 2.423, Al 0.301, Exp 87.08	**33** Si 3.176, Al 0.302, Exp 78.82	**34** (green) Si 4.231, Al 0.303, Exp 70.87	**35** Si 5.814, Al 0.304, Exp 63.20

Corner B Recipe

Cone 10 Limestone Set--B

Grid Box Detailed Calculations

To see detailed composition info on a specific grid box or square, select its number below and click on the 'Show Details' button.

Grid Square [   ]

[Show Details]

Color Code Settings

Warn me when any of the following exists:

Silica is below:	2.50
Silica is above	4.50
Alumina is below	0.25
Alumina is above	0.50
Expansion is below	65.00
Expansion is above	75

[Update Colors]

Corner D Recipe

Cone 10 Limestone Set--D

power of GlazeMaster to help you do this. A few minutes or even a few hours at the computer could save you days of experimental time.

Lastly, I believe there must also be a way to explore the domain of fluxes using Currie's principles; however, I have not tried to work this out. As you know the standard Currie grid explores silica and alumina variation within the framework of a single flux system. What if I wanted to hold silica and alumina (or the ratio between the two) constant and explore, say the calcia/strontia flux system? Can I use a biaxial blend to do this? Or would a triaxial blend make more sense? I leave questions of that type for homework with the knowledge that GlazeMaster can help you explore such questions.

Summary

Blends can be a powerful tool to help you design the glazes you want. Coupling them with calculation software, and particularly a software package like GlazeMaster that lets you predict what might happen, can give you a real advantage. The predictions, of course, will not be 100% accurate. You may get some surprises here and there. But, on balance, the blend experiments you design should be much more effective in giving you the results you want if you use glaze calculation to help in the design.

Figure 5-6. By modifying a standard grid in the way described you can significantly increase the area of interest for functional glazes.

6

IMPORT/EXPORT/DELETE/CHANGE NAMES

Importing Recipes and Materials into GlazeMaster

The fourth menu selection on the Main Menu allows you to perform some of the maintenance items in GlazeMaster. Importing data from GlazeMaster or other programs is among the most complex so let's dive right into it. By way of introduction it should be said that this task is worthwhile undertaking only if you have a lot of recipes entered in another program and don't want to reenter all of them. If you only have two or three recipes I recommend you do the task the old-fashioned way–just manually transfer them. It is a much simpler task to import from another GlazeMaster file.

For imports from another file note that GlazeMaster stores recipes in the file Recipes.USR and materials in the file Materials.USR. After clicking on the Main Menu item 'Import/Export/Delete/Change Recipes and Materials' you will be taken to another menu divided into 3 sections: Import, Export, and Delete/Change. Instruction for exporting are later in this chapter. To import click on 'Import Recipes' and you will be taken to a pop-up dialogue box asking whether you want to delete the existing recipes in your file. This is often the case if you are importing your own recipes from a version of GlazeMaster prior to 3.0. However, if you are importing from another source
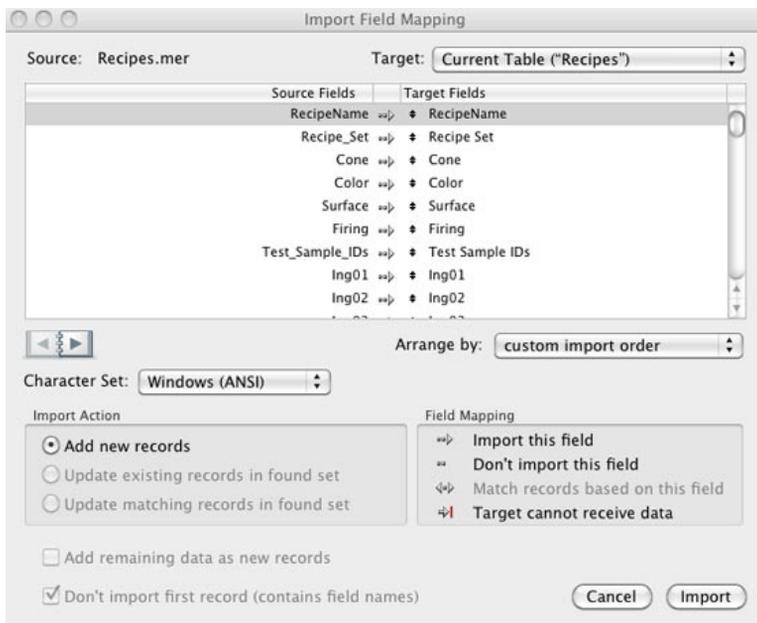
Figure 6-1. The import field mapping screen is where you match fields in the file to be imported with those in GlazeMaster.

you may want to add recipes to those already in your file. If that is the case, click 'No'. If you are importing materials, a similar dialogue box will appear. You will then be asked to locate the file from which you will import. Glaze-Master can import from several file types. You can see the list by using the pop-up menu toward the bottom of the file-finding dialogue box. When you find the correct Recipes.USR or Materials.USR file and click Open, you will see another dialogue box titled 'Import Field Mapping' as shown in Figure 6-1. Note that this figure is identical to Figure 1-5 but is reproduced here to allow making a couple extra points.

The biggest difficulty in importing from a non-GlazeMaster source is aligning GlazeMaster's field names with those of the import file. While it won't solve all of your problems, there is a forward/backward arrow set on the left side near the middle of this dialogue box. This allows you to step through the import file to get a better handle on which field is which. It is particularly helpful if some fields are blank on one record but have data in another.

Here are some additional hints about importing from a non-GlazeMaster file. The only firm rule in importing is that each recipe or material MUST be contained within a single record in the file to be imported. That usually means they will be on separate lines, i.e. each recipe/material will be separated from the next by a carriage return. As noted above, the challenge is to get field names aligned with those used by GlazeMaster. While most of the GlazeMaster field names are easy to guess, a list of the key ones is given in Appendix B.

To repeat part of what was in Chapter 1, if you are importing from a GlazeMaster file be sure to choose 'Matching Names' on the right middle of this dialogue box–then adjust as necessary. Also be sure that the little arrow is set properly (between the 'source' and 'target' fields) for those fields you want to import.

If you are importing from a non-GlazeMaster file do this:

1. You must properly align the data on the left with the field names on the right so the data gets put in the right spot when it is imported. You do this by putting your cursor on a field name and sliding it up or down until it is alongside the correct piece of data. Start at the top and work your way to the bottom. Flipping between recipes using the arrows described above can help you figure this out.

2. Secondly, you need to decide whether or not to import a particular piece of data. There are a couple things to consider in this decision. Some of the data may not have equivalent fields in GlazeMaster. Also the field names that are grayed back on the right are reserved for numbers that are calculated within GlazeMaster. You cannot import

Where the word 'recipe' is used in GlazeMaster, substitute the word 'record' in database talk. Each recipe is stored in a separate record.

While you can guess what most of the field names stand for, a listing of them is given in Appendix B.

Note that if the person whose files you have imported has been adding materials and using a naming convention different from what you have used, you will also have to check for materials name consistency and change them where appropriate.

into those. To change the symbols that indicate whether you import or not, simply click on them. They will change from one to the next and back again.

When you have this dialogue box set up as well as you can, click 'Import'. One last dialogue box will now appear asking if you want to 'Perform auto-enter options while importing'. Make sure this box is checked and click OK. The program now goes into a 'finger and toe counting' routine where it checks for duplicate Recipe (or Material) Names. If it finds any you will see a dialog box that tells you this. Click OK and you will be taken to a screen titled 'Remove Recipe Name Duplicates' as shown in Figure 6-2.

On this screen, focus your attention on the upper left-hand corner. There is a small graphic (or icon) that has 2 arrows. You click on this graphic to scroll through the recipes (or materials) that are now in your copy of Glaze-Master . Note that file has been sorted to show only those sets of 2 that are duplicates. You can also move more quickly between recipes by sliding the little tab on the right side of the icon left or right. There are also three numbers in the upper left of the screen. The '1' indicates you are currently looking at the first recipe. The '34' indicates there are 34 total recipes in the file and the '4' indicates the number of recipes that have been segre-

gated because they contain duplicate Recipe Names (2 pairs of duplicates). Those 4 recipes have been sorted so the ones with duplicate names will be adjacent to each other. All you have to do now is scroll through the recipes by clicking on the arrows (or sliding the little tab mentioned above) and decide to either change one of the duplicate names or to delete one of them. To change a name you just type a new one in the Recipe Name field; then click the 'Record Name Change' button before moving to the next recipe. If you choose to delete a recipe click the 'Delete Recipe' button. You will be asked to confirm that you really want to 'Permanently delete this ENTIRE record'. Click Delete (or Cancel if you made a mistake). When you are done, click the 'Continue' button in the upper right and your importing of recipes (materials) is complete.

Exporting from GlazeMaster

Both recipes and materials can be exported from GlazeMaster. This would enable you to use the data in spreadsheets or another database of your own construction. It would also enable importing to other glaze calculation programs if those programs support importing in standard database formats.

To export you choose 'Import/Export/Delete/Change Recipes and Materials' from the Main Menu. You will then see you have the options of 'Export Recipe Set', 'Export All Recipes', or 'Export Materials'. If you choose to export a Recipe Set you will first be taken to a dialogue box where you choose the set. Otherwise you will see a dialogue box specific to your type of computer and operating system. This is where you specify the name of the file and where you want it stored; however, there is one other important choice you make in this dialogue box. That is the type of file you want to write. The default selection is a 'Tab-Separated Text' file and this is a very common file type which most spreadsheet and database programs can import. However, there are several other choices including an XML file which is a newly agreed on standard for information interchange. You can even export an HTML table which you will then be able to open in your web browser or restructure as you wish in a web site design program.

After you click 'Save' you have one more task to do before the export can be accomplished. You must select which fields you want to export and in what order. This is done on a dialogue box similar to the one in Figure 6-3. All of the available fields in the GlazeMaster Recipes.USR or Materials.USR are displayed on the left-hand side of the screen including the ones that are calculated within the program. This is different from what was described in importing–you can export the current value of a calculated field. So, for example, while you cannot import unity numbers you can export them. You select them for exporting by clicking on them to highlight them. Then click 'Move'. They will appear on the right side of the screen. You can also adjust

When importing, always make sure you have backups of your files before you start. If you make a mistake and end up with a cluttered up recipe or materials file it may be a lot easier to trash it and start over with your backup up copy than it is to try to clean up the mess.
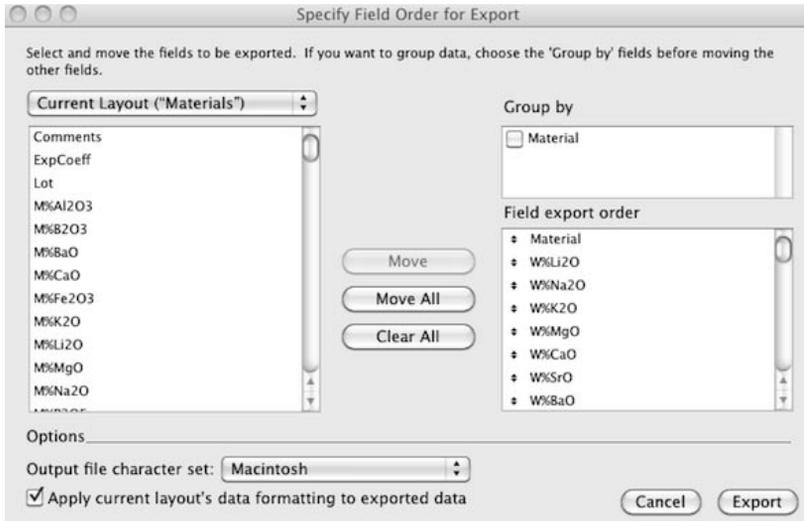
the export order by sliding them up and down by clicking and holding on the double-headed arrow to the left of the field name.

The last choice to make is whether or not you want your output format-ted. For example the numbers displayed in GlazeMaster are all formatted to show a specified number of digits to the right of the decimal place. The actual calculation may have resulted in a number like 0.75483295867 and I have chosen to display only 0.755 on the screen. If you want the first number exported make sure that 'Apply current layout's data formatting to exported data' is NOT checked. If you prefer the looks of the second number and don't care about all those extra digits check the box. Then click 'Export' and the file will be written. If your export includes fields that are calculated within GlazeMaster, exporting a file with a lot of recipes can take a while. All the calculations are done for those calculated fields as the file is being written.

Changing Names and Deleting–Recipes or Materials

Renaming a recipe is very easy. Simply choose 'Find All Recipes, Change Recipe Names' on the main menu and follow the on-screen instructions. You can also change Recipe Sets for any recipe on this same screen.

To delete a recipe, click on 'Import/Export/Delete/Change Recipes and Materials' on the Main Menu. On the right side of the next menu are the buttons that will allow you to delete a recipe or material or to change a material's name. If you click on 'Delete Recipes', a screen similar, but not identical to Figure 6-2 will asspear. The difference is that you can access all of the recipes or materials instead of just those having duplicate names. You can use the small 'arrows' icon in the upper left-hand corner to move

Here's another way to align ingredient names that will be easier if you have a large number of recipes to import from another program. First make a backup copy of your exported file. Then open the exported file in a word processor. Now use the 'Find and Replace' capability of the word processor. So, for example, you might find every occurrence of 'Custer Feldspar' and replace it with 'Feldspar–Custer'. Just make sure you use exactly the same names that are used in GlazeMaster and your recipes will be ready to go when you complete the import. Thanks to Jon Singer for suggesting this improvement.

from recipe to recipe. In order to make them easier to find, the recipes are alphabetized without regard to their recipe set. To delete a recipe, bring that recipe onto the screen and click 'Delete this Recipe'. You will be asked to confirm that you really want to delete it. When you're finished, click 'Done' and you will be returned to the previous menu.

Changing names of or deleting materials is a virtually identical process except that, in addition to deleting materials, you can also use this area of the program to change a material's name. Just click in the field containing the material name and enter a new one. There are, however, two additional things to note. First you can also change the material availability when you are changing names. More important, though, is a caution with respect to changing a material's name. If you already have a number of recipes which contain that material as an ingredient you will also have to update each of those recipes with the new name. If you don't the calculations will be wrong because the program will not be able to find that particular ingredient's composition.

Rather than change a material name, you might find it easier to just add a material having the name you prefer while leaving the old name intact. That way you won't have to sort through your recipes and adjust them to the new name. It doesn't hurt to have the same material listed under two names.

7

OTHER MAIN MENU SELECTIONS

There are several other tasks that can be selected from the Main Menu, from the Mini Main Menu–>Go To on the top menu bar, or by keystroke as described in the chapter, Getting Started. Most are pretty obvious for experienced computer users but, nonetheless, we'll go through those one by one.

Find All Recipes/Change Recipe Names

Can't find a recipe you know is there? Follow this procedure. Click on 'Find All Recipes, Change Recipe Names' on the Main Menu. This will bring up a screen that has all of your recipes listed in alphabetical order without regard to recipe set. When you find the recipe you are looking for, you may want to change its Recipe Set so that you can more easily find it in the future. You can do that right on that screen. You can also change the recipe name by clicking on that button and entering a new one in the dialogue box that appears. Specific instructions are given on the screen.

Find/Print Multiple Recipes

This choice allows you to print an individual recipe sheet for every recipe in GlazeMaster or to 'Find' a subset of your recipes and print those. Using the Find feature you can search by Cone, Surface, Color, Recipe Set, Date, Test Sample ID, or Comments. You can also search for any combination of the above. Specific instructions are given on the layout 'Find Selected Recipes'.

Note that you can make best use of this feature if you make some thoughtful choices as you enter recipes. For example, if you want to be able to locate just recipes that have passed the vinegar test you might put 'passed vinegar test' or just 'PVT' in the comments section. Then you can find recipes that have that notation whenever you want to.

Print

Special layouts or screens have been built into GlazeMaster so you won't have to waste all that yellow ink when you want printed copies of your recipes, batch mix sheets, photo galleries, recipe lists, or materials lists. Before clicking on the 'Print' button, use the radio buttons to select what you want to print. For the first 3 choices (Print Single Recipe, Print Single Batch Mix Sheet, or Print Photo Gellery) you will be taken to a layout spe-

cific to these tasks where additional instructions are given. All you need to do is bring up the recipe you want to print (if it is not already displayed) by clicking on the 'Change' button. You may also change to a different recipe set at the same time if you need to in order to find the recipe you want. You, of course, can set the batch size on the Batch Mix Sheet. When you click the 'Print' button you will be taken to a dialogue box typical for your type of computer and operating system. Don't worry, none of the buttons or instructional information that is on your monitor screen will be printed.

For the last 2 choices (Print Recipe List and Print Materials List) you will be taken directly to a printing dialogue box–there are no additonal choices to be made.

In printing, Macintosh owners using OS X have one additional option that some Windows users may not have. You can automatically write a pdf file rather than printing to a piece of paper. Look for the pop-up menu at the bottom of your printer dialogue box. Windows users see the box at the right for your options.

Windows users can also print to pdf files; however, doing so requires some additional software. I have not tried any of this software and, therefore, am not in a position to recommend any of it. A review of several shareware or freeware programs can be found at: http://www.techsupportalert.com/best-free-pdf-writer.htm

Add/Delete Recipe Sets

Using the Recipe Set Names feature allows you to organize your recipes any way you wish. The only Recipe Set Name which is mandatory and may not be deleted is 'Unassigned'. Whenever you add a new recipe or import recipes from another program its Recipe Set Name is set to 'Unassigned' until you change it. Of course, if you prefer not to use this feature just leave all the recipes in the 'Unassigned' set and they will all be available on the pop-up menus.

However, most of us accumulate a lot of recipes over time and get lost sorting through our recipe file if we don't organize them into some kind of subgroups. While I have provided a starter set of names there is certainly no need to retain them if you prefer to think about your recipes differently. For example you might want to organize them 1) by Active/Inactive, 2) by original source such as Ceramics Monthly, Clay Times, Mastering Cone 6 Glazes, etc., 3) by client if you are a glaze consultant, 4) by surface type, or 5) by functional vs nonfunctional. Of course there are many other ways you might want to think about your glazes and/or clay bodies. The above list is only intended to get you to think about how you want to organize your recipes.

It is best, however, to think about this and decide how or whether to use this feature of the program before you enter a large number of recipes. That way you can assign them to a Recipe Set as you enter them rather than having to go back through them all and assign a set later.

The actual process of establishing new Recipe Set Names or deleting

old ones is quite simple. Click on 'Add/Delete Recipe Set Names' in the Main Menu (you may also select the same item in the Mini Main Menu on the top menu bar or enter 'Ctrl 6' (Windows) or 'Command 6' (Macintosh)). The dialogue box which appears contains explicit instructions for adding or deleting Recipe Set Names. Remember that each Recipe Set Name must be unique.

The only caution I would add is that if you plan to delete names it is best to change the recipe set of individual recipes before you delete the Recipe Set Name. Otherwise you will need to use the procedure described under Find All Recipes/Change Recipe Names on page 69 to regain access to that recipe. Once the Recipe Set Name is deleted, recipes that still carry the deleted Recipe Set Name will no longer appear on any pop-up menu.

Add/Edit/Delete Preference Sets

Preference sets allow you to set two things within GlazeMaster. First you can set the size of the increment when you use the '+' and '-' buttons on the recipe layouts. Second, you can elect to have the lists of materials displayed in one of two ways–a short or a long display.

The initial preference sets that are built into the program are just intended to be examples. Please set up your own to fit your preferred way of working. For example, if you work with clay recipes as well as glaze recipes you may want a set or two that are specific to clays. You might want to adjust the '+' and '-' increments to 50 so you can work in full bags of clay. For glazes you might want a fine and a coarse adjustment of, say, 0.25 and 1.0.

Try both the short and the long version of the materials list and see which you prefer. GlazeMaster 1.0 had only the long version–if you are used to that you may want to keep it. The short version allows you to zero in on the material you want by using their "type-ahead" capability. It is more keyboard oriented. The long version is more mouse oriented.

The actual adding, editing or deleting of preference sets is fully explained on that particular layout and does not need to be duplicated here. Again, try it out. Set up a couple of new preference sets and find out what you like best.

Change Expansion Coefficients

Coefficients of thermal expansion (COE–sometimes abbreviated CTE) for the oxides in our glazes and clays can be very confusing if you let them be. We will try to keep it simple. There are three sets of COEs in the literature which are nearly complete for the materials of primary interest to potters. However they were measured by different workers at different times and

they came out with different numbers. It is not possible to judge which of these sets of numbers is "best" or most accurate and it probably does not make a big difference for our purposes. This is because we are really only interested in relative COEs and in whether a change we make in a recipe causes the COE to go up or down and by approximately how much. In most cases the COEs in these three sets are in the same relative order–not always, but most of the time. Which set do we use then? It makes little difference, but you should pick one and stick with it. If you have been using GlazeChem or HyperGlaze and are comfortable with those numbers, use the set by West and Gerrow. Insight (the original materials database, not the one by Ron Roy) also uses West and Gerrow numbers but offset by a factor of 10 in the way the numbers are presented. Ron Roy's material database for Insight uses a modified English and Turner set of numbers. If you are comfortable with that, use it. While COEs do have units (and I show them in the Appendix) I have elected to leave units off the displays in GlazeMaster.

In order to change to different COEs in GlazeMaster simply click on 'Change Expansion Coefficients' on the Main Menu. You can enter new numbers in any of the fields. It's that simple. For a list of the three sets of COEs and some guidance on choosing where to put the decimal point see Appendix C. Note that you can toggle between any of these 3 sets of coefficients on any recipe screen.

Transfer Files from Earlier Version

This task is covered in Chapter 1, Getting Started, and will not be repeated here.

Exit/Quit

The last point I would make in this chapter is to point out that Glaze-Master is bilingual. 'Exit' if you are using a Windows machine; 'Quit' if you are using a Mac.

There is one other complicating factor with COE sets of numbers. None is complete for the materials of interest to potters. Therefore we must either ignore the effects of some materials or estimate numbers to fill in the blank spaces from other literature sources. We indicate which are estimated numbers and which are directly from the workers' literature in Appendix C.

8

HINTS FOR EFFECTIVE GLAZE DESIGN

A comprehensive discussion of this subject would require an entire book or a significant part of a book. However, I can't end this manual without at least giving an abbreviated discussion of the things you can do to solve specific glaze design problems. We'll look at them in several categories. Please note these suggestions are not meant to be all inclusive–they only represent some of the more common ways to achieve the desired effect. Also, in this brief treatment I will completely ignore color. That is a very complex subject and there already are complete books devoted to it.

Eliminating Crazing (or Shivering/Dunting)

A full chapter in Mastering Cone 6 Glazes is devoted to glaze/body fit, but, in a word, crazing occurs when the glaze is too small for the pot, This means it has contracted more in cooling than the pot did or that its coefficient of thermal expansion (or contraction) is too high. To solve a crazing problem by modifying the glaze, we need to substitute ingredients having a lower COE. Here are some modifications to try:

Substitute magnesium for some of the calcium

Add more silica and alumina keeping the ratio of Si/Al constant

Add more boron while reducing the alkalis sodium and potassium

Add calcium while reducing sodium and potassium

Replace some of the sodium and potassium with lithium

Don't do any of these things in large amount. Make small changes or do line blends to see how big the change has to be to solve the problem. The smaller the change you make, the more likely you are to preserve the current aesthetics of the glaze.

To address dunting or shivering do the opposite of the above.

Raising (or Lowering) the Maturity Temperature of a Glaze

It is very difficult to raise or lower the maturing temperature of a glaze more than a cone or two without affecting aesthetics. However, most of us are determined to try at one time or another. Here are a few suggestions to raise the maturity temperature:

Raise both the silica and the alumina while keeping the ratio con-

stant

Reduce the amount of boron; cone 10 glazes seldom have any. About 0.05-0.07 boron equals 1 cone.

Reduce the amount of zinc oxide; again C10 glazes seldom have much, if any.

Reduce the amounts of sodium and/or potassium and increase the amounts of calcium and magnesium

Here again, to get the opposite effect, reverse the above recommendations. Also keep your changes as small as possible to get the desired effect.

Increasing Durability

To do this you should follow the four rules for glaze design briefly mentioned in the chapter Demystifying Unity.

Make sure the silica level is above 2.5

Make sure the alumina level is above 0.25 and less than 0.4 for Cone 6 (probably less than 0.5 for Cone 10)

Don't overload with colorants, particularly copper.

Make sure the glaze is fully melting during firing.

Making Matte Glazes

There are several ways you can make mattes–durable mattes as opposed to unmelted mattes which are not durable. You have to push the composition to a point where some kind of crystals will precipitate out on cooling. Some things to try, not all of which will result in durable glazes, are:

Raise the calcium level above 0.85

Raise the magnesium level above 0.4

Use a low silica/alumina ratio–about 5.0 or a little lower

Raise barium levels above 0.2 (most potters have stopped using barium for functional glazes)

Use strontium at levels of 0.3 and above.

Reduce boron levels to the minimum needed to get good melting.

Slow down cooling of the kiln to allow time for crystals to form.

Often, trying 2 or 3 things from the above list simultaneously is the best approach.

Making Glossy Glazes

Keep the silica/alumina level above 8. Levels of 10-12 are not unusual and occasionally glossy glazes go higher than that.

Keep the individual flux levels below those shown in the section above on matte glazes. A glaze well-balanced in fluxes is more likely to be glossy.

Glaze Stability in the Bucket

I always try to have 10% or more clay in every glaze. If you can't manage that you may have to resort to materials like 2% bentonite or bentonite coupled with Epsom salts.

Choosing Materials

One of the questions I get most frequently has to do with what materials to choose to increase or decrease particular oxides most rapidly and with the least effect on the overall composition. While the list below is not complete it gives the materials I reach for first.

Lithium
Spodumene or lithium carbonate (try to keep lithium carbonate to less than 2 or 3 %. It has a reputation of resulting in crazing and/or shivering at high levels)

Sodium
Some of the frits are the best sources of sodium, e.g. Ferro Frits 3110, 3134, 3185, 3269, and 3278. Nepheline syenite is an excellent source also. Soda feldspar is actually lower than any of the above in sodium content.

Potassium
Potash feldspars such as Custer or G-200 are the most common and best source.

Magnesium
Talc (my favorite) and dolomite

Calcium
Whiting or wollastonite. Wollastonite, of course, also contains silica.

Strontium
Strontium carbonate

Barium
Barium carbonate–most potters have stopped using barium in glazes for functional pottery.

Zinc

Zinc oxide

Lead

Lead-containing frits–please make sure you are thoroughly versed on the safety issues before using lead in any glaze!

Alumina

Clay. While you can find alumina in some frits it is usually more cost effective to use clay. Clay will also help glaze stability in the bucket.

Boron

I always source boron from a frit. Colemanite and Gerstley Borate are of questionable availability and are notoriously nonuniform. CadyCal is another good source if it is available to you.

Silica

Silica or clay, although some also comes from talc, wollastonite, feldspars and other sources. Always leave silica to last, though, and top-off with the pure material.

Appendix A

SOURCES OF MATERIAL COMPOSITIONS

As pointed out in the body of this User's Guide, the best source for getting the compositions of materials is to ask your supplier to get them for you. However that is not always possible. For example, if you are looking at a recipe out of the literature or one obtained from a friend it may have some ingredients your supplier does not carry or that are no longer obtainable from anyone. When you encounter situations like this, there are at least four resources on the internet where you can find help. Please note, however, that people are constantly redoing web sites and the URLs listed below may change periodically. Please make liberal use of search engines to find the latest information if these do not work.

First is a web site maintained by Frank Gaydos where frit compositions are listed. The URL is:

http://home.comcast.net/~frankgaydos/frits.html

Second, Tony Hansen of Digitalfire Corporation maintains an extensive materials database at

http://digitalfire.com/4sight/material/index.html

This is an extensive database with material listed alphabetically. If you can't find your material of interest here it may not be available.

A third source of materials information is one the Matrix site, maintained by Lawrence Ewing of New Zealand. It also has an extensive listing of materials which are organized alphabetically rather than being searchable. It can be found at

http://www.Matrix2000.co.nz/MaterialsWeb/default.htm

Finally, I have put a number of materials compositions in easily downloadable and importable format at:

http://www.masteringglazes.com/Pages/GM4frame.html

Instructions for downloading and importing into GlazeMaster are availabe on that web page.

The one source to be most careful of is textbooks. Many authors have used theoretical compositions in order to make their examples easier to describe and illustrate. Theoretical compositions may be better than nothing, but not much. Always try to get actual analyses for the materials you plan to use.

Appendix B

FIELD NAMES

Fields have been named within GlazeMaster to be largely intuitive; however, a listing is given in the table below:

Recipes

Field Name	Description
RecipeName	Recipe Name
Recipe Set	Recipe Set Name
Cone	Cone to which the glaze is fired
Color	Glaze color
Surface	Fired glaze surface
Firing	Type of firing
Test Sample IDs	Identification numbers of test tiles
Ing01...Ing15	Ingredients 1-15
IngAmt01...15	Ingredient Amounts 1-15
Add01...Add06	Additives 1-6
AdAmt01...06	Additive amounts 1-6
Comments	Comments entered by user
Date	Date recipe was entered
Glaze Photo	Glaze Photo
Total	Total of ingredient amounts
Total Batch	Batch size of this recipe
WtLOI	Loss on Ignition, weight percent
Wt%Li2O, etc	Weight % of oxides in the fired glaze
Wt%STAlkalis	Weight % of alkalis in the fired glaze
TotWt%Fluxes	Total weight % of fluxes in the fired glaze

Field Name, cont	Description, cont
Oxide01...Oxide15	Oxides used in the calculations
TotalMolarEquiv	Intermediate calculated number
Mol%Li2O, etc	Mole % of oxides in the fired glaze
Mol%STAlkalis	Mole % of alkalis in the fired glaze
TotalMol%Fluxes	Total mole % of fluxes in the fired glaze
UnLi2O, etc.	Seger unity formula numbers for the glaze
Unity	Sum of fluxes in unity terms = 1.000
UnSTAlkalies	Subtotal of alkalies in the glaze–unity terms
Interim	Interim calculated number
ExpCoeff	Calculated expansion coefficient–fired glaze
Si:Al	Silica to alumina ratio in fired glaze
BatchAmtIng01...15	Batch amounts of Ingredients 1-15
Remainder of fields	Used only for internal calculations

Material

Field Name	Description
Material	Material name
Wt%Li2O, etc.	Weight % of various oxides in the material
Wt%L.O.I.	Loss on ignition, weight percent
Wt%STAlkalies	Weight % of alkalis in the material
Wt%Fluxes	Weight % of fluxes in the material
Wt%Total	Sum of the analyzed materials
TotalMolarFractions	Intermediate calculated number
Mol%Li2O, etc.	Mole % of oxides in the material
Mol%STAlkalis	Mole % of alkalis in the material
TotalMFFluxes	Mole % of fluxes in the material
UnLi2O, etc.	Seger unity numbers for the material
MolWtMaterial	Equivalent molecular weight of the mateial
UnSTAlkalis	Subtotal of alkalis in the material–unity terms

Field Name, cont	Description, cont
MFTotal	Intermediate calculated number
Oxide01...Oxide17	Oxides in the material
Unity	Sum of the fluxes in unity terms = 1.000
ExpCoeff	Calculated expansion coefficient of material
Comments	Comments entered by user
Mine/Manufacturer	Mine/Manufacturer
Lot	Manufacturers lot number
Mark	Internally used variable
Global	Internally used variable
MaterialSet	Material Set
MaterialAvail	Material availability

Appendix C

COEFFICIENTS OF THERMAL EXPANSION

As explained in the body of this manual there are three sets of Coefficients of Thermal Expansion in the literature which are relatively complete for materials of interest to potters. These are shown below in Table C-1. All are weight percent linear coefficients. The units are all x 10 $^{-9}$ / °C. So the question is what do we do with all the blank spots and what numbers do we actually enter in GlazeMaster to use in the calculation of glaze COEs? The answer to the first question is that we estimate the critical missing numbers by using other literature sources. Without knowing exactly how the authors of other software programs estimated those missing numbers, we present the numbers they use (or, in the case of HyperGlaze, that we think they use) in Table C-2. Please note that the decimal point of the numbers presented have been adjusted so that, if entered into GlazeMaster as shown in Table C-2, they will give numbers similar to what you are used to

Oxide	West & Gerrow	English & Turner	Winkelmann & Schott
Li_2O			
Na_2O	387	416	333.3
K_2O	331	390	283.3
MgO	26	45	3.3
CaO	148	163	166.7
SrO	159		
BaO	129	140	100
ZnO	94	70	60
PbO	83	106	100
Al_2O_3	63	14	166.7
B_2O_3	31	-65.3	3.3
Fe_2O_3			
SiO_2	35	5	26.7
TiO_2	144		
P_2O_5			
MnO_2			
SnO_2			
ZrO_2	99	23	

Table C-1. Weight % Linear Coefficients of Thermal expansion for oxides of interest to potters as reported in the literature. Units are x 10 $^{-9}$ / °C.

seeing in those programs.

If you examine Table C-2 carefully you will come to realize this is not an exact science. On the other hand, since we are usually only interested in relative numbers, the calculated COEs still can provide very useful information for glossy glazes, in particular. This is well illustrated and proven in Chapter 5 of Mastering Cone 6 Glazes. However, useful directional numbers are often provided for matte glazes also. You should just be a little more circumspect is using them to guide you on the development of or adjustment of matte glazes. Of course, one of the features of GlazeMaster is that these individual oxide COEs can be easily modified if/when better numbers or a more complete set becomes available in the future.

In addition, all of the recipe screens in GlazeMaster provide for easy toggling between these sets of COEs. That allows you to very readily choose the set that makes most sense to you while still letting you exchange information with someone who uses another set.

Oxide	Insight Regular MDT	Insight RR MDT	GlazeChem & HyperGlaze**
Primary Source	West & Gerrow	English & Turner	Winkelmann & Schott
Li_2O	6.8*	745*	68*
Na_2O	38.7	4160	387
K_2O	33.1	3900	283.3
MgO	2.6	450	3.3
CaO	14.8	1630	166.7
SrO	13*	1350*	159
BaO	12.9	1400	129
ZnO	9.4	700	94
PbO	8.3	1060	83
Al_2O_3	6.3	140	63
B_2O_3	3.1	-653	31
Fe_2O_3	12.5*	1040*	125*
SiO_2	3.5	50	35
TiO_2	14.4	1060	144
P_2O_5	0	745*	67*
MnO_2	5*	570*	73*
SnO_2		365*	67*
ZrO_2	9.9	230*	99
Range of Glaze COEs in Program	6.5-9.0 x 10^{-6} / °C	350-650 x 10^{-8} / °C	65-90 x 10^{-7} / °C
* Numbers apparently estimated from other sources			
** HyperGlaze numbers are estimated–they are hidden within the program			

Table C-2. Coefficients of thermal expansion suggested for GlazeMaster. Enter the numbers as shown in the table without worrying about the exponent. This will result in calculated numbers within GlazeMaster similar to those on the bottom line of the table.

In addition, all of the recipe screens in GlazeMaster provide for easy toggling between these sets of COEs. That allows you to very readily choose the set that makes most sense to you while still letting you exchange information with someone who uses another set.

Appendix D

SUPPORT/TROUBLESHOOTING

Support

Check the GlazeMaster section of the web site at:

http://www.masteringglazes.com

for information on updates, bugs, and frequently asked questions.

If you don't find the help you need there, support for GlazeMaster is also available by Email by writing to:

GMsupport@frogpondpottery.com

Email is almost always answered promptly unless I am traveling. If you prefer regular mail or phone the address and number are below; however, either of those will usually result in a delay of several days before I am able to respond.

<u>Mailing address:</u>

GMSupport

Frog Pond Pottery

PO Box 88

Pocopson, PA 19366

USA

<u>Phone:</u>

610-388-1254

Troubleshooting

GlazeMaster has been remarkably free of problems since it was commercialized in early 2003; however, here are some things you might encounter.

Recovering damaged files.
GlazeMaster is a relational database. That means, among other things, it is very frequently updating the hard drive files. If you quit for any reason other than a normal Exit/Quit (e.g. the power goes out, you have to force quit the program, or your machine does it on its own) while those files are being updated, you may get a 'damaged file' message on restart. If it refers you

to a 'Recover File' routine, that routine does not appear in the GlazeMaster File menu; however, it can still be accessed. Exit/Quit GlazeMaster, hold down both the Option and Command keys (Macintosh) or the Ctrl and Shift keys (Windows) while you double click on the GlazeMaster exe or application file. That will bring up a file-finding dialogue box which you use to locate the damaged file. In most cases–but not all–GlazeMaster will be able to repair the file. But please also back up your GlazeMaster folder regularly. It is bad news to lose dozens of glaze recipes when your computer hiccups–don't ask me how I know this. Of course as stated abie , a normal Quit or Exit will not cause this problem.

Finding the GlazeMaster.exe file in Windows

Window has preferences that can be set to either show or hide common extensions like '.exe'. If you can't find GlazeMaster.exe, look for plain GlazeMaster. In addition Windows writes a lot of temporary files that are preceded by '._'; don't be fooled into thinking one of these is the real thing. Those temporary files cannot be used to start the program. Double clicking on one of them will probably generate some kind of error message.

Messages saying this field cannot be modified

This can happen on any type of machine if you try to run from a CD. GlazeMaster must be installed on a hard disk and run from there.

This can also happen on some Windows machines if the GlazeMaster folder is installed in the Program Files folder as explained in Chapter 1. I recommend installing it in your Documents folder.

However, on some Windows machines you can also get a message like this even when the software has been installed properly on your C disk, i.e. not in your Program Files folder. If you do get them, the fix is easy. Find and open the GlazeMaster X.Y folder and look for the '.USR' files. Don't be fooled by temporary files described in the section above. In version 3.0 there are 9 .USR files; there may be more in subsequent versions. Right click on each of those files and select 'Properties'. When the Properties dialogue box opens you will see that 'Read Only' is checked toward the bottom of the box. Uncheck it. Repeat for all the .USR files and your problem will go away.

Additional Problems

Other problems and troubleshooting notes will be posted on our web site as they are discovered. Go to:

http://www.masteringglazes.com/Pages/GM1frame.html

and click on Errata/Troubleshooting.