Old and New Cornwall Stone

Jeff Zamek researches the qualities and the results of a replacement for Cornwall Stone

A material commonly used by potters, Cornwall Stone was first commercially produced for the pottery industry in 1807 in the region of St. Stephen, St. Austell, Cornwall, England. It has many names: English Stone, English Cornwall Stone, Cornish Stone, DF Stone, China Stone and Carolina Stone. In a way, the variety of names and chemical analyses is appropriate since there have been several variations in its chemical composition depending on how it was processed and/or the site at which it was mined. Over the years production has ranged from a high of 70,000 tons before the first World War to 28,000 tons on average per year from 1999 to 2003, which were mined for domestic and foreign use by potters and industry.[1]

Cornwall Stone contains feldspar, quartz, kaolinite, mica and trace amounts of calcium fluoride. It is a partially decomposed granite feldspathoid having a greater diversity of alkaloids causing it to go into a gradual melt with less surface tension than true feldspars.[2] When Cornwall Stone is used in a glaze, this characteristic can result in the elimination of crawling (the fired glaze surface rolls back on itself resulting in exposed clay). This is due in part to the diverse composition of granite in various stages of decomposition and alteration from which it was formed.[3] Cornwall Stone contains an equal molecular equivalence of calcium, potassium and sodium along with alumina and silica, making it a unique feldspar-like material. It is, however, more refractory and goes into a melt at a higher temperature than either sodium or potassium feldspars due to its higher silica content. Additionally, at cone 6 (2232ºF) it is more refractory and melts less than other feldspars at this temperature range due to its higher silica content. The high silica content of Cornwall Stone when used in a clay body or glaze can also be a factor in reducing or eliminating crazing (a network of fine lines in the fired glaze surface).

Cornwall Stone is not one mineral but a complex group of minerals that at different times in its processing history have produced varied chemical analyses depending on the deposit being excavated and processed, resulting in no distinct chemical formula. In this respect it is similar to another common flux material used in glaze and clay body formulas, nepheline syenite; both are combinations of minerals. Cornwall Stone has properties similar to feldspars in that it can be used as a flux above cone 6 in clay body and glaze formulas. It differs from true feldspars, however, because it is partly kaolinised and responds well to flocculation and deflocculation adjustments in the glaze batch, resulting in increased wet glaze handling properties.[4]

Processing History

The processing history has played a major part in the chemical composition of Cornwall Stone, which in turn altered the results it produced in glazes over its production run. From 1960 to 1973 fluorite and mica were removed from Cornwall Stone, resulting in a designation of 'DF' Stone, which was defluorinated. The processed Cornwall Stone also contains quartz and feldspar. The 'DF' Stone had reduced fluorine, potash, calcia, iron, alumina and increased silica. This was an improvement as calcium fluoride in a glaze has the potential to exit as a gas, causing blisters in the fired glaze surface.

In 1973 the 'DF' refining of Cornwall Stone came to an end due to increased production costs. After that the material that was not defluorinated was distinguished by a vegetable dye that burns off in the kiln without a trace; the colour is not due to fluorspar in the material. The raw

colour of Cornwall Stone can change, perhaps indicating different batches from the mine.[5] After the 'DF' was discontinued, Purple Stone was produced which contained soda and potash feldspar, quartz, mica and fluorite. A second type known as Hard White, with some of the soda feldspar being replaced by kaolinite, was also available. Hard White contains less fluorine compared to Purple Stone. A blend of both Purple and White Stone was also sold. Since the chemical composition of Cornwall Stone has changed, the potter should be aware of which variation they will be using. Once known, it is best to obtain its chemical analysis sheet before using the material in a glaze formula.[6]

All variations of the material, however, have low iron content. Cornwall Stone is commonly used in cone 6 (2232ºF) to cone 9 (2300ºF) glazes as a flux, helping to bring other materials into a melt. It can also be used in slips as it has excellent adhesion properties to bind it to the underlying clay body. The raw colour can be white, purple, or green; however, Cornwall Stone melts to a white opaque glass between 2102ºF and 2372ºF.[7] Because Cornwall Stone is imported from England, it can cost more than domestically (US) available feldspars. The cost, however, of any raw material used in the production of pottery is marginal compared to the time and labour required to make the pots.

As has happened with many other raw materials, the mine producing Cornwall Stone has closed. Its demise represents an ongoing ceramics 'fact of life' that at some point a favourite material will become unavailable. The reasons for the loss of any given raw material are almost always economic, as many are still geologically available. The market demand by larger industries, however, has shifted. In many instances a raw material will go out of production because the volume users drop demand and potters, as marginal customers, are left to seek another material. What can potters do to correct this disadvantage? The direct answer is 'nothing', as the larger players determine the demand and continuance of any material. Potters can educate themselves about the raw materials in their clay body and glaze formulas and then have the tools to make an appropriate substitution 'when' and not 'if' a material has gone the way of Albany Slip, Barnard/Black Bird, Oxford feldspar, PBX fireclay, Ocmulgee, A-3 feldspar, Kingman feldspar, Avery kaolin, NYTAL HR 100 talc. The complete list of materials that are no longer available to potters would fill many books.

Hammill & Gillespie, a supplier of speciality clays and minerals, has found a substitute named H&G Cornwall Stone which can be used as a replacement in most glaze formulas. It is always best to test any new material, however, before committing to large scale production.

Chemical Analysis of Original and New Cornwall Stone
Typical % Analysis

Original Cornwall Stone[8]		New Cornwall Stone	
SiO2	72.90%	SiO2	77.39%
Ti02	0.02%	Ti02	0.05%
Al203	14.93%	Al203	14.06%
Fe203	0.13%	Fe203	0.20%
Ca0	2.06%	Ca0	0.42%
Mg0	0.09%	Mg0	0.05%
Na20	4.00%	Na20	3.56%
K20	3.81%	K20	3.34%
		P205	0.22%
		Ba0	0.05%
		Pb0	0.02%
Loss on ignition	1.06	Loss on ignition	1.05

Comparison of 100 Percent Samples of New and Original Cornwall Stone
Cone 9 (2300°F)

1. New Cornwall Stone *Original Cornwall Stone*

When matching the new Cornwall Stone to the old Cornwall Stone the goal was to use glaze formulas that used high percentages of Cornwall Stone in order maximize the matching qualities of the substitute material.

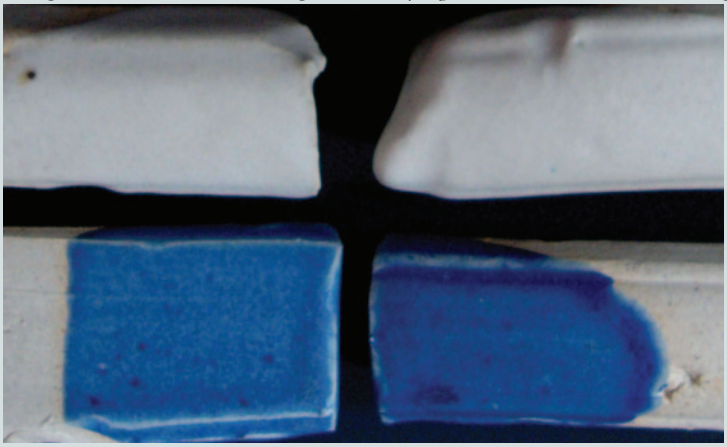
A popular cone 9 glaze was chosen for comparative testing as a base glaze (no metallic colouring) and a variation with cobalt carbonate. The glazes were fired in an oxidation electric kiln.

Base Glaze with Original Cornwall Stone	
Cornwall stone	46
Whiting	34
E.P.K.	20
Blue Glaze Variation	
Cobalt carbonate	1/8%

Base Glaze with New Cornwall Stone	
Cornwall stone	46
Whiting	34
E.P.K.	20
Blue Glaze Variation	
Cobalt carbonate	1/8%

Original and New Cornwall Stone in Glaze Formulas
Cone 9 (2300 0F.) oxidation firing

Top left: ***Original Cornwall Stone base glaze.*** *Top right:* ***New Cornwall Stone base glaze.***

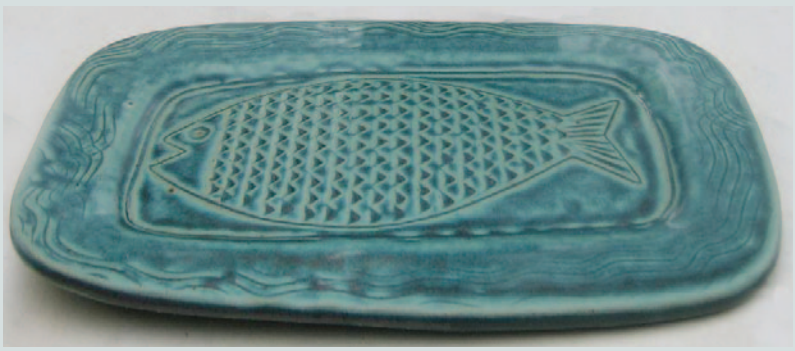


2. Above left: ***Blue Glaze Variation (Original).*** *Above right:* ***Blue Glaze Variation (New).***

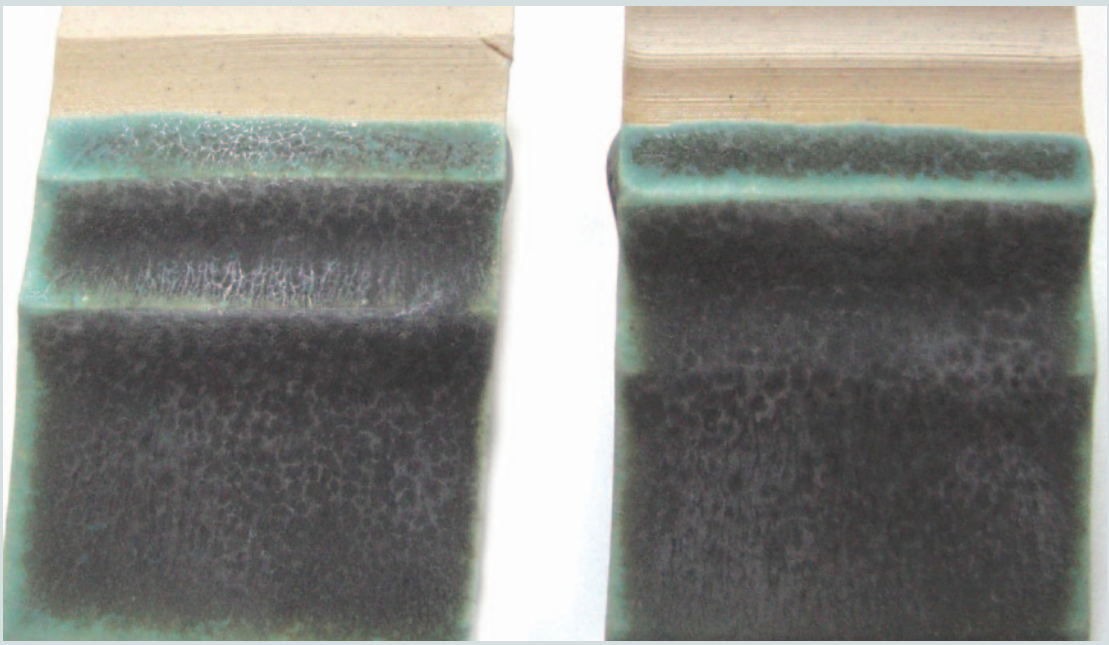
This popular satin matt light green glaze formula was fired to cone 9 in a reduction kiln atmosphere.

Glaze with Original Cornwall Stone	
Cornwall Stone	46
Whiting	34
E.P.K.	20
Copper carbonate	4%
Tin oxide	4%

Glaze with New Cornwall Stone	
Cornwall Stone	46
Whiting	34
E.P.K.	20
Copper carbonate	4%
Tin oxide	4%



Left: 3. ***Satin matt green glaze using original Cornwall Stone.***
Right: 4. ***Satin matt green glaze using new Cornwall Stone.***
Pottery and photos by Jim Fineman.



5. Left tile: ***Satin matt glaze using original Cornwall Stone.***
Right tile: ***Satin matt glaze using new Cornwall Stone.***

A cone 6 oxidation electric kiln fired satin matt glaze was used for comparing original and new Cornwall Stone in the following glazes. (Glaze tile illustration #5 on previous page.)

Glaze with Original Cornwall Stone	
Nepheline syenite 270 mesh	36
Cornwall Stone	16
Whiting	26
Thomas ball clay	9
E.P.K.	8
Zinc oxide	5
Copper carbonate	3%

Glaze with New Cornwall Stone	
Nepheline syenite 270 mesh	36
Cornwall Stone	16
Whiting	26
Thomas ball clay	9
E.P.K.	8
Zinc oxide	5
Copper carbonate	3%

A cone 6 oxidation electric kiln fired gloss transparent glaze was used for comparing original and new Cornwall Stone below.

6. Left tile: ***Transparent gloss glaze using original Cornwall Stone.***
Right tile: ***Transparent gloss glaze using new Cornwall Stone.***

Note the lower half of the test tiles where the artificially highlighted black craze lines are comparable in quantity and spacing on both glaze tests indicating a similar glaze fit under tension.

Glaze with Original Cornwall Stone	
Cornwall Stone	61
Whiting	8
Gillespie borate	3
Lithium carbonate	5
Dolomite	7
Flint 325 mesh	6

Glaze with New Cornwall Stone	
Cornwall Stone	61
Whiting	8
Gillespie borate	3
Lithium carbonate	5
Dolomite	7
Flint 325 mesh	6

The New Cornwall Stone can be purchased from Hammill & Gillespie, 466 Southern Washington Boulevard, Suite 1, Chatham, NJ 07928, ph 973-822-8000

Potters can educate themselves about the raw materials in their clay body and glaze formulas and then have the tools to make an appropriate substitution 'when' and not 'if' a material has gone the way of Albany Slip, Barnard/Black Bird, Oxford feldspar, PBX fireclay, Ocmulgee, A-3 feldspar, Kingman feldspar, Avery kaolin, NYTAL HR 100 talc. The complete list of materials that are no longer available to potters would fill many books.

Footnotes

1. Source: Obstler, Mimi, *Out of the Earth into the Fire,* The American Ceramic Society (1996) Original Source: Presidential Address of CV Smale 1977, Letters to Mimi Obstler, C.V. Smale, June, July 1989. March 1993. (Jim the original source was listed as a footnote in the *Out of the Earth into the Fire* book as she stated it came from a letter sent to the author).
2. Frank & Janet Hamer, *The Potter's Dictionary* 4th Edition 1977. A&C Black, University of Pennsylvania Press, p 77.
3. Source: http://digitalfire.com/4sight/material/cornwall_stone_240.html
4. Frank & Janet Hamer, *The Potter's Dictionary* 4th Edition 1977. A&C Black, University of Pennsylvania, Press p 78.
5. Source: http://www.potters.org/subject02304.htm/
6. Obstler, Mimi, *Out of the Earth into the Fire,* The American Ceramic Society (1996) p 21.
7. Frank & Janet Hamer, *The Potter's Dictionary* 4th Edition 1977. A&C Black, University of Pennsylvania Press, p 77.
8. Typical Chemical Analysis of Cornwall Stone.

Jeff Zamek walked into a pottery studio 44 years ago and started his career as an amateur potter. After completing a degree in business from Monmouth University, W Long Branch, NJ he earned BFA/MFA degrees in ceramics from Alfred University, College of Ceramics, New York. While there, he developed the soda firing system at the college and went on to teach at Simon's Rock College and Keane College. During this time he earned his living as a professional potter. In 1980 he started Ceramics Consulting Services, a ceramics-consulting firm developing clay body and glaze formulas for ceramics supply companies throughout the US. He works with individual potters, ceramics companies and industry, offering technical advice on clays, glazes, kilns, raw materials, ceramic toxicology and product development. He is a regular contributor to *Ceramics Monthly, Pottery Making Illustrated, Pottery Production Practices, Clay Times, Studio Potter, Ceramics Technical,* and *Craft Horizons*. Zamek's books, *The Potter's Studio Clay & Glaze Handbook, What Every Potter Should Know*, and *Safety in the Ceramics Studio* (featuring the safe handling of ceramic materials) and "The Potters Health & Safety Questionnaire" are available from Jeff Zamek/Ceramics Consulting Services. Zamek is currently working on several ceramics research projects and is making pots as an amateur potter. For technical information call 413.527.7337 or visit www.jeffzamek.com

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