Ceramics:
from the earth to the fire

Learning Goals:

- Know where clay comes from
- Understand what clay is

- Know what ceramic means
- Understand how the ceramic process works

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What does ceramic mean?

Ceramics are things made from materials which are permanently changed when heated.

Examples of ceramics:

- Clay
- Stoneware
- Porcelain
- Glazes

Clay as seen in nature

Clay = Alumina + silica + water.

What exactly is clay?

Clay minerals are hydrous aluminum phyllocilicates, sometimes with varable amounts of iron, magnesium, alcali metals, alkaline earths, and other cations (an ion with fewer electrons than protons, giving it a **positive charge.**)

Collecting clay for ceramics? Oxford Clay (Jurassic) exposed near Weymouth, England.

Where does clay come from?

Clay is a general term including many combinations of one or more clay minerals with traces of metal oxides and organic matter.

Clay minerals are typically formed over long periods of time by the gradual chemical weathering of rocks, made up of silica, carbonic acid, and other dilluted solvents.

The Gay Head cliffs in Martha's vineyard consist almost entirely of clay.

Deforestation in Atlantic Forest Rio de Janeiro - Brazil. This hill was deforestated in order to use its clay in civil construction (brick making) in Barra da Tijuca.

Oldest known ceramics

The oldest utilitarian ceramic objects discovered to date were made approximately 11,000 years ago (9,000 B.C.E.)

Ancient Bowl (7th–6th millennium B.C., Halaf period : Syria, Tell Halaf*)(…painted diamond pattern similar to Hemaka Disk on the inner rim)*

Ceramics as a building material

The earliest bricks were *dried brick*, *meaning they were formed from clay-bearing earth or mud and dried (usually in the sun) until they were strong enough for use. The oldest discovered bricks, originally made from shaped mud and dating before 7500 BC, were found in the Middle East.*

Ceramic, or fired brick was used as early as 4500 BC (6500 years ago) in early Indus Valley cities (in the Middle East).

An old brick wall in English bond laid with alternating courses of *headers and stretchers*

Popular Ceramic Materials

Ceramic pottery and sculpture is generally made from one of two classes of ceramic materials:

Earthenware – The oldest, used for millenium, the kind we will use in class

Stoneware – believed to have been invented in China 900 or so years ago. It requires much hotter firing temperatures than earthenware, is usually only fired once, and is stronger than earthenware (e.g. more scratch-resistant, can been used as an electrical insulator)

Pictured: A Chinese Song Dynasty(960-1279 AD) cizhou-type stoneware vase with sgrafitto decoration and carved white slip under a transparent colorless glaze; made in the 11th century, most likely in Dengfeng County of Henan province.

Greenware

Greenware - *a pot that has been formed from clay and has not yet been fired. It can still be wet, or it can be completely dry.*

Greenware: Leather Hard

Leather Hard: Stage of the clay between plastic and bone dry. Clay is still damp enough to join it to other pieces using slip. For example, this is the stage handles are applied to mugs.

The leather hard stage is the last opportunity to modify your sculpture before it is fired and hardened.

Most carving and trimming is done when the clay is leather hard, which is part of the greenware phase.

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Greenware: Before Firing

Greenware must be **bone dry** (completely air dried) before it can be fired.

Check for any cracks in the bottom and on handles and attachments. Determine how bad they are.

- If they are small, you can paint some slip mixed with vinegar into the crack to seal it.

- Unfortunately, if they are already large at this point, they are only going to get worse.

As clay is dried and fired it continues to shrink, which will worsen any cracks.

If the crack is too large to save, it is often best to abandon the pot while it can still be recycled into usable clay.

Slaking

Greenware can be recycled into usable clay. This is called slaking. Wet the clay/combine it with water in order to re-use it. **Pug Mill** - A machine for mixing clay and recycling clay.

Firing

Firing ceramics is the process of controlling the heat rise in the kiln to produce the desired results.

This accomplishes two things for the ceramics.

1. First, it heats the pottery just to the point of maturity, bringing out it's highest quality and function.

2. Second, it allows the potter to manipulate the fuels to create special glaze and surface effects.

Firing: Vocabulary

Maturing Point The temperature (during the bisque fire) at which clay becomes hard and durable

Reduction - Firing with reduced oxygen in the kiln.

Oxidation - Firing with a full supply of oxygen. Electric kilns fire in oxidation. Oxides show bright colors.

Vitrification - The firing of pottery to the point of glossification, the transformation of a substance into a glass

Peephole - A small observation hole in the wall or door of a kiln.

Kiln

A furnace of **refractory** (retains its strength at high temperatures) clay bricks for firing pottery and for fusing glass.

Inside an Electric Kiln

Kiln Furniture:

Refractory posts and shelves used for stacking pottery in the kiln for firing.

Kiln Wash:

Mixture of Kaolin, flint and water.. It is painted on one side of the kiln shelves to separate any glaze drips from the shelf.

Pyrometric Cones

When firing pottery, the most common and reliable method to determine when the pottery has reached the maturation point is with pyrometric cones

Cone pack before firing. The different colors are for different temperature cones. They are also stamped with the cone number.

Cone pack after firing. The lowest temperature cone has melted.

Pyrometric Cones

Here is a list of the cone numbers from lowest temperature to highest:

022, 021, 020 ,019, 018, 017, 016, 015, 014, 013, 012, 011, 010, 09, 08, 07, 06, 05, 04, 03, 02, 01, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.

Notice how the lower temperatures have a "0" in front of them. Higher number = **lower temperature.**

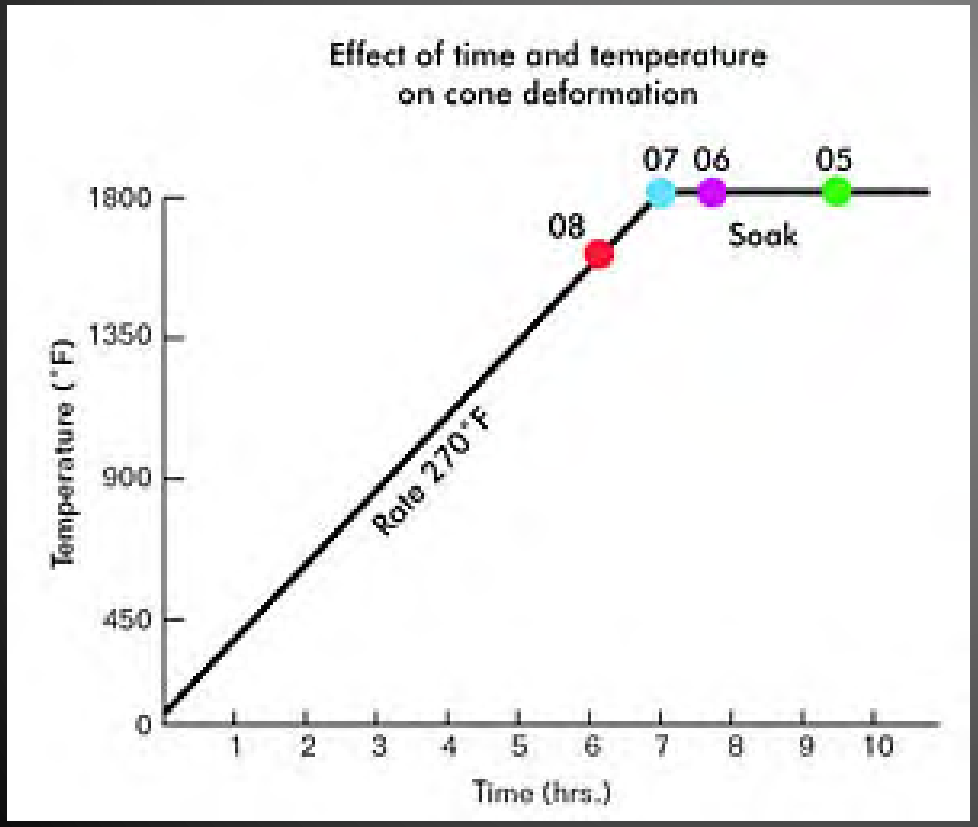
TIP: think of the "0" as having the same value as a "-" sign

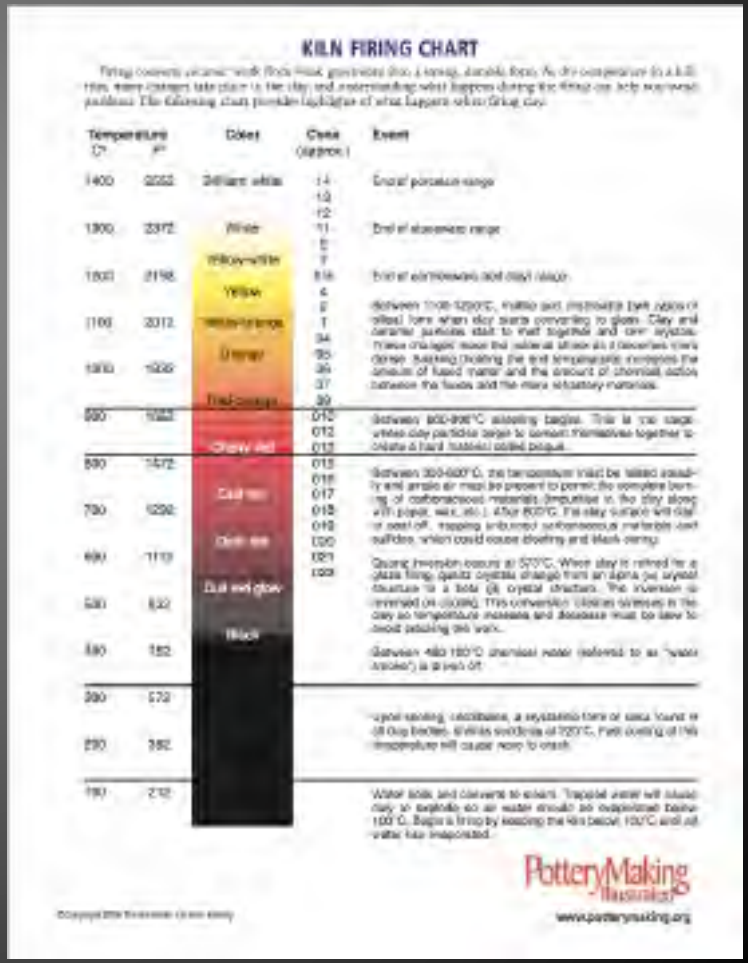
- e.g 05 = -5

On the other hand, the higher temperatures don't have the "0". Higher number **= higher temperature.**

Pyrometric Cones

Cones are placed inside the kiln with the pottery. Because they measure both heat and time exposed to heat, they provide a very accurate measurement of the amount of heat the pots have absorbed.





Bisque Fire

Greenware must be properly dried before it can be bisque fired, which transforms it into a ceramic material that cannot be slaked

Your greenware pot is then fired slowly to bake all of the moisture out of the clay. This first partial firing or bisque cermamics firing hardens the greenware so it can be handled without breaking.

After the pot has been fired once it is called bisque or bisque ceramics

Bisque Fire

To the right are greenware pots being loaded into the kiln to be bisque fired.

If you look closely you can see how they are packed in very tightly, even touching each other and the kiln posts.

You can also see that some have been stacked carefully inside one another. This can only be done with greenware because it has not been glazed yet.

Maturing Point

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Bisque and Glazing

Ceramics which have been fired once are called bisque pottery.

At this stage they are glazed.

Glaze - **A thin coating of glass**. An impervious silicate coating, which is developed in clay ware by the fusion under heat of inorganic materials

Gloss Glaze - A shiny reflective gloss.

Matt Glaze - A dull glaze surface, not very reflective when fired. It needs a slow cooling period or it may turn shiny.

Satin Glaze - A glaze with medium reflectance, between matt and gloss.

Transparent Glaze - Transmits light clearly.

Glaze Firing

Glaze firing - The final firing, with glaze.

Crazing - The cracking of a glaze on a fired pot. It is the result of the glaze shrinking more than the clay body in cooling process.

Crawling - A bare spot (from the shrinking of a glaze) on a finished piece where oil or grease prevents the glaze from adhering to pottery.

Glazed Pottery