MERIT BADGE SERIES

POTTERY

Scouting America

SCOUTING AMERICA
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POTTERY

"Enhancing our youths' competitive edge through merit badges"

Scouting America

Requirements

Always check scouting.org for the latest requirements.

1. Explain to your counselor the precautions that must be followed for the safe use and operation of a potter's tools, equipment, and other materials.
2. Do the following:
   (a) Explain the properties and ingredients of a good clay body for the following:
      (1) Making sculpture using the hand-building method
      (2) Throwing on the wheel
   (b) Tell how three different kinds of potter's wheels work.
3. Make two drawings of pottery forms, each on an 8½-by-11-inch sheet of paper. One must be a historical pottery style. The other must be of your own design.

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4. Explain the meaning of the following pottery terms: bat, wedging, throwing, leather hard, bone dry, greenware, bisque, terra-cotta, grog, slip, score, earthenware, stoneware, porcelain, pyrometric cone, and glaze.

5. Do the following. Each piece is to be painted, glazed, or otherwise decorated by you:

   (a) Make a slab pot, a coil pot, and a pinch pot.

   (b) Make a human or animal figurine or decorative sculpture.

   (c) Throw a functional form on a potter's wheel.

   (d) Help an experienced adult to load and fire a kiln OR describe in detail how to load and fire a kiln.

6. Explain the scope of the ceramic industry in the United States. Tell some things made other than craft pottery.

7. With your parent or guardian's permission and your counselor's approval, do ONE of the following:

   (a) Visit the kiln yard at a local college or other craft school. Learn how the different kinds of kilns work, including low fire electric, gas or propane high fire, wood or salt/soda, and raku.

   (b) Visit a museum, art exhibit, art gallery, artists' co-op, or artist's studio that features pottery. After your visit, share with your counselor what you have learned.

   (c) Using resources from the library, magazines, the internet (with your parent or guardian's permission), and other outlets, learn about the historical and cultural importance of pottery. Share what you discover with your counselor.

8. Find out about career opportunities in pottery. Pick one and find out the education, training, and experience required for this profession. Discuss this with your counselor, and explain why this profession might interest you.

Contents

Introduction

Consider this *Pottery* merit badge pamphlet an introduction to pottery making, a potter's tool in its own right to help you understand the process and learn some of the language. The greater part of your new knowledge will come with experience—the skill and understanding you will gain from actually creating pottery. You will be involved in hands-on production of a work of art, from start to finish.

The resources listed in the back of this pamphlet are good materials to help you learn. The local library is a good place to look for information. Many libraries have magazines about pottery making and ceramics with illustrated articles about techniques and design, tips for professionals and beginners, and advertisements from manufacturers and dealers of clay and supplies.

Before you discover the fun of sinking your hands into a lump of clay, here is a little background about and history of pottery.

Pottery has a language of its own. All the words you see in **boldface** appear in a glossary at the back of this pamphlet.

What Is Pottery?

Pottery can be defined simply as any item that is formed from clay then hardened by heat, and a bit more specifically as the baked-clay wares of the entire ceramic industry. As an art form, pottery is one of the oldest and most widespread in the world. In fact, archaeologists have uncovered pottery objects that have been on Earth almost as long as the human race, which places them among the oldest human-made artifacts ever found.

As you explore the world of pottery, you will discover that pottery making is as much science as it is art. The process is fun and challenging, and the end product can be as useful as it is beautiful. With your first pieces of pottery, be prepared to gain a greater sense of self-confidence and accomplishment.

There are three broad categories of pottery: **earthenware, stoneware,** and **porcelain.** Within each category are many different styles of pottery, each one unique, according to the type of clay used, the kind of **glaze** or decoration applied, and the **kiln** temperature at which it is **fired.** We have only enough space in this pamphlet to cover some of the most famous and most popular styles of pottery, and expand on the three main categories.

The Ceramic Industry

The term *ceramic* refers to any human-made solid produced from nonmetallic mineral substances—such as clay—by **firing** in a kiln. The ceramic industry provides much more than just dinnerware and decorative articles. Many manufacturing industries use or produce clay products including brick, sewer pipe, floor and wall tile, electrical porcelain, glass, abrasives, engine components, superconductors, rocket nose cones, and cements used in the construction of concrete roads, bridges, buildings, and dams.

The word *ceramic* has been traced back to an early Greek term, *keramos,* which means "pottery" or "potter's clay." *Keramos* is related to an ancient root word that means "to burn." The Greeks used the term to mean "burned stuff" or "burned earth" when referring to articles they produced through the action of fire upon materials they dug from the earth.

Ceramics and Our Environment. Ceramics play an important role in our environment by helping to decrease pollution. The catalytic converters in cars and trucks, which are made of ceramics, help change harmful exhaust fumes into ordinary carbon dioxide and water. Ceramic engine components are lightweight and heat- and wear-resistant, which results in significant fuel savings, more efficient combustion, and, ultimately, cleaner air.

Absorbent ceramics also are used in oil-spill cleanup equipment to help restore our environment after such a disaster.

Ceramics are even used to make musical instruments—ocarinas, whistles, flutes, and whistling jars.

Ceramics in Medicine. Ceramics are increasingly being used in medicine and dentistry. Special ceramic materials can be used for repairing and replacing human hips, knees, teeth, and even heart valves. Ceramic materials that are used in the human body, from replacement parts to coatings on metal replacements, can stimulate bone growth, promote tissue formation, and help protect the immune system. Modern ceramic materials are also used in ultrasound and X-ray computed tomography (CT) systems.

Ceramics played a significant role in NASA's space shuttle program. Each shuttle had a protective shield made up of about 34,000 lightweight, reusable ceramic tiles that protected the astronauts and the shuttle's aluminum frame from the extreme temperatures generated as they passed through Earth's atmosphere.

The History of Pottery

No one knows for sure *how* the process of making pottery was invented, but for many years archaeologists throughout the world have been uncovering pieces of pottery from as far back as prehistoric times. Since the clay base of pottery does not react to chemicals and does not corrode like metal, cloth, or wood, these artifacts often are preserved nearly unchanged, while other items of the same age are at least partially destroyed. For this reason, pottery is used extensively by archaeologists to determine how ancient peoples lived their daily lives.

The First Ceramics

Archaeologists in the Czech Republic have uncovered human-made ceramics that they believe date to at least 24,000 B.C. These artifacts are in the form of slabs, balls, and animal- and human-shaped figures, and are made of animal fat, bone, bone ash, and a claylike material. It is not clear what these articles were used for, but they might have been used for ritualistic or religious purposes.

Scientists date this Chinese vessel to the Western Han dynasty in the second century B.C.

The earliest clay vessels were sun-dried, not fired. They probably were used to store only grain and other dry foods, because filling them with water would have caused the clay to absorb the liquid and soften. Not long after these first crude clay vessels were made, people learned how to use fire to make them stronger, harder, and more watertight.

Many scientists believe the discovery that fire could change clay into a useful, beautiful, and more durable vessel occurred independently among different cultures throughout the prehistoric world. This eventually led to the development of structural clay products, including brick and tile.

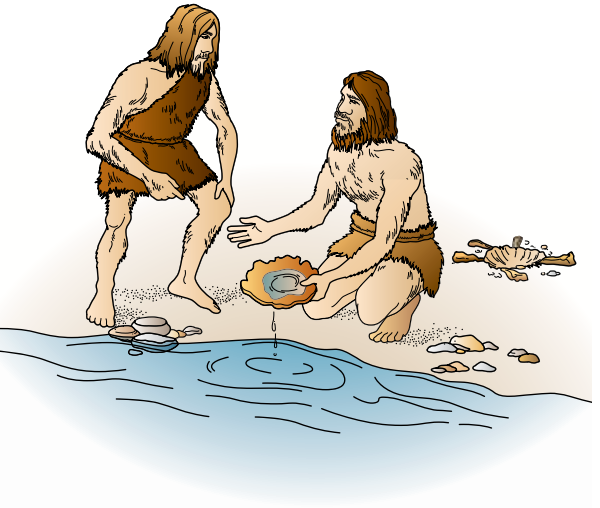
Many scientists believe that the oldest known functional pottery came from Neolithic cultures in Japan and Turkey. They believe dirt-brown pot fragments, or shards, unearthed from a cave in Kyushu, Japan, date to around 10,500 B.C. and were made by a fishing, hunting, and shellfish-gathering culture. This pottery is called Jomon, which means "cord markings," because much of it was decorated with cord patterns. Pot shards found in other Japanese sites are believed to be even older—by about 500 years. Pieces of crude, soft earthenware excavated from a Neolithic settlement on the Anatolian Plateau of Turkey are thought to be 9,000 years old.

Neolithic means "new stone" and refers to the last period of the Stone Age, when people began to farm the land and raise livestock, and to make pottery.

Scientists date this example of Jomon pottery to be circa 5,000 to 4,000 B.C.

How Was Pottery Discovered?

There are several theories about the long-ago discovery that fire could change clay into a material that would not dissolve in water. At least two of them involve the hunter-gatherers who lived at the beginning of the Neolithic stage of cultural evolution. During this time, cultures around the world gradually were changing from a nomadic lifestyle to a more settled one. The people were learning to raise crops and keep livestock. This new lifestyle not only created a necessity for food storage, but it also gave the people more time to pursue handicrafts such as weaving and pottery.



People in ancient times discovered that the intense heat from their fire pits caused the clay in the ground to harden.

You might wonder how these people came up with the idea of making pottery. One theory holds that these Neolithic families would often camp alongside rivers and build their fires in pits that they had dug into the clay banks. When the fires burned down, the people noticed that their pits had turned into hard, sunken "bowls" that could hold water.

Another theory involves Jomon pottery. To begin with, it is thought that Neolithic people had learned from their Stone Age ancestors to line their baskets with clay and then leave them to dry in the sun so that they would hold water—at least until the clay dissolved. Because some of the Jomon pottery has a basketlike texture, some scholars believe that it might have originated when baskets lined with clay either fell into a fire or were intentionally used for cooking. The natural fibers of the basket would have burned away, leaving behind a crude and more watertight pot.

The Development of Glaze

The earliest pots were decorated with liquid clay **slip,** a mixture of clay and water that had a practical use of holding pieces of pots together. Another form of pottery decorating, **glaze,** was discovered around 2700 B.C. in Egypt. At the time, Egyptians found that the sand they used in making their pottery created a colored glaze when overheated in a kiln. By 1500 B.C., potters learned that by sprinkling their pots with powdered lead, they could produce a glaze that covered the piece.

Around A.D. 1500, German potters found that salt made an effective glaze. This was a major contribution to the evolution of pottery and would later play an important role in English and American ceramic industries.

The First Porcelain

Porcelain was developed and first produced in China between A.D. 618 and 906 to withstand the extreme temperatures of Chinese kilns. The ware was exported to Korea, Japan, and the Middle East, where it became immensely popular.

The Chinese potters continued to refine their ware and by the 13th century had learned how to use cobalt from the Middle East to make beautiful blue-and-white ware. When supplies from Persia were cut off by the emperor's ban on overseas travel, the potters began using copper in their glazes and enamels, which gave them a range of shades from blue to green. Eventually the Chinese potters added colors such as red, yellow, turquoise, deep violet, and purple to their pottery.

The highly prized Chinese porcelain had influenced Middle Eastern potters, and their product in turn greatly influenced European potters. Middle Eastern and European potters tried to imitate the blue-and-white porcelain, which had been widely imported into Europe. They developed a tin-based glaze that was bright white on buff or red **clay bodies.**

Ming porcelain from the early 15th century

Japanese potters succeeded in producing true porcelain in the 16th century, having been influenced by Chinese as well as Korean ware. However, it was not until the 18th century that true porcelain was produced in Europe—first in Germany, then in England.

Hard-paste, or true, porcelain was developed in China and gradually was exported to many parts of the world. Made primarily of petuntse (china stone) and kaolin (white china clay), the semitranslucent ware fired bright white and quickly became the envy of the Western world.

During the 16th century, Italian potters tried to imitate the semitranslucent Chinese porcelain and eventually developed soft-paste, or artificial, porcelain from a mixture of white clay and **frit**. This ware required a lower, or "softer," firing than that required for hard-paste porcelain, which resulted in a softer, warmer body.

Pottery in North America

The first potters in North America were Pueblo Indians, who made plain, undecorated pots. It is thought that the earliest pots were baskets that had been smeared with clay and then dried in the sun.

By about A.D. 1000, Mimbres potters used slips to decorate their pottery with black-on-white designs of insects, animals, birds, or geometric shapes. Over the next few hundred years, they introduced black decorations on a red slip. After the 12th century, they started replacing these older styles with polychrome ware decorated with stylized birds, feathers, animals, and human figures along with the geometric patterns.

The Mimbres were a prehistoric North American people who lived in the mountains along the Mimbres River, in an area now known as southwestern New Mexico. They are famous for their beautiful black-on-white pottery.

Mimbres pottery

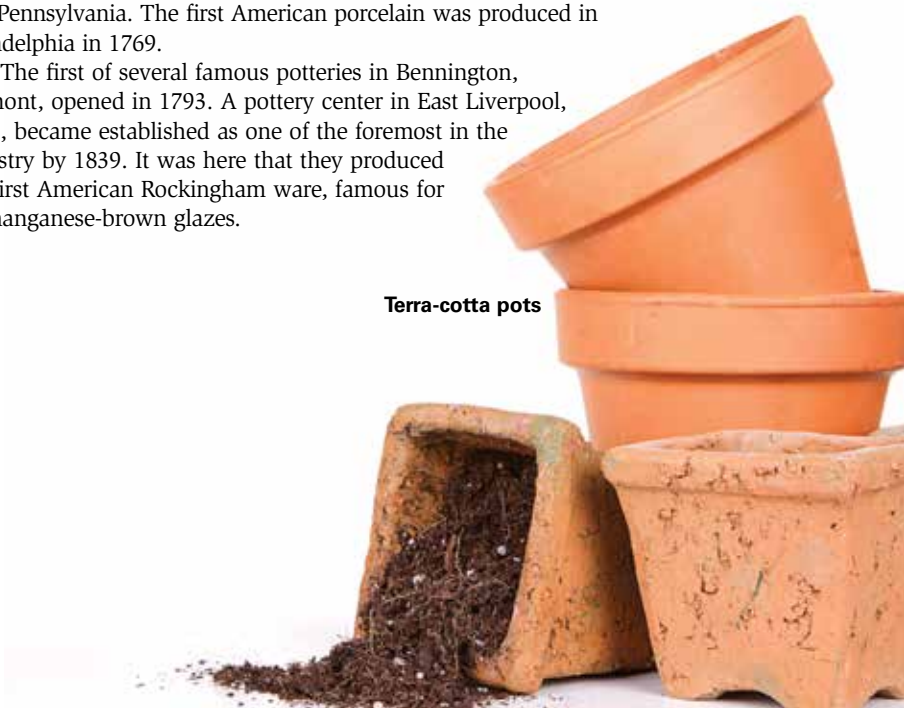
When European settlers first came to North America, they brought only woodenware and some pewter mugs and utensils. They did not have china as we know it today. In fact, household pottery was not in common use among the colonists until the late 17th century when a reddish slip-decorated earthenware was imported from England.

As English, Dutch, and German immigrants came to the New World, they brought their rich heritage of pottery making with them. Soon the colonists were buying earthenwares from local farmers who also worked as part-time potters. Only the well-off had luxurious, decorative ceramics imported from England, Germany, and China.

Although there were potters in the colonies, they were so busy making bricks and tiles to meet the urgent need for building materials, they didn't have time to make pottery.

The first American potteries were established in Virginia, Pennsylvania, and New York. The first whiteware was produced in 1684. A stoneware factory opened in New York in 1730, and in North Carolina, Jugtown pottery was first produced around 1750. Soon after, **terra-cotta** works began operating in Massachusetts and Pennsylvania. The first American porcelain was produced in Philadelphia in 1769.

The first of several famous potteries in Bennington, Vermont, opened in 1793. A pottery center in East Liverpool, Ohio, became established as one of the foremost in the industry by 1839. It was here that they produced the first American Rockingham ware, famous for its manganese-brown glazes.



Terra-cotta pots

Modern Pottery

In the 1900s, art pottery became very popular, and the influence of Oriental and European potters revitalized the studio pottery life beginning in about 1950. The 20th-century development of mass-production techniques and the use of synthetic materials did not diminish the demand for fine, handcrafted pottery. Major artists of the century, including Pablo Picasso and Henri-Émile-Benoît Matisse, produced exquisite ceramic works.

Historical Pottery Styles

Throughout the history of pottery, different cultures have developed individual styles, and from those styles, others have evolved.

Chinese. The Chinese were the world leaders in the production of beautifully glazed and decorated porcelain and stoneware. Some very early styles of imperial ware (porcelain made for and sponsored by the emperor's court) included a buff stoneware covered with a dense greenish-blue glaze, a stoneware washed with brown slip and glazed in colors that varied from pale green to lavender blue, and a dark stoneware with a grayish-white glaze. Most of these styles also had a well-marked **crackle** as a design element.

A style of imperial ware made during the Ming dynasty was the fine white porcelain painted in blue underglaze that made "china" a household word. Another very famous and prized Chinese pottery is celadon ware, which has a gray or grayish-white body with a transparent sea-green glaze and usually a well-marked crackle. Celadon ware was very important in China's trade with the Middle East because of the superstition that a celadon dish would crack, break, or change color if a poisoned food were served on it.

Chinese export porcelain includes most of the porcelain shipped from China from the 17th through the 19th centuries. It was specifically designed to appeal to the Western world; most of the styles were based on European pottery or metalwork designs or on a combination of Western and Oriental motifs. Blue-and-white decoration was the most common, but Chinese potters also were influenced by the Japanese Imari ware, imitating their blue, red, and gold patterns, among others.

Ming porcelain

This Imari dish is estimated to have been made in the early 1700s.

Greek. The pottery of early Greece was notable for its graceful use of human and animal figures. Commonly, the design was painted in shiny black pigment on the reddish clay body. The design was sometimes left unpainted on the red body and the black pigment was applied to the surface outside the design.

Imari ware is still made today.

Japanese. Japanese pottery was influenced by Chinese and Korean pottery. One style that became popular in the West is called Imari, a generic term for Japanese porcelain made in the Arita kilns on the island of Kyushu and shipped from the port of Imari. Imari ware is believed to date from 1616, when porcelain clays were discovered in Arita by Korean craftsmen.

Most early Imari work was blue-and-white only, but with the gaining popularity of Chinese porcelain, the Japanese potters began to add gold and color enamels to porcelain decorated in underglaze blue. One common style was produced in red with touches of gold in imitation of some Chinese Ming porcelain. By the mid-17th century, native Japanese designs were introduced, and during that century Imari ware became so popular in Europe that even the Chinese, the English, and the Dutch imitated it.

In 1592, during the Japanese invasion of Korea, many Korean potters were taken back to Japan and put to work making porcelain for the traditional tea ceremony. These potters later helped to establish the Japanese porcelain industry.

Raku is a traditional Japanese pottery that was developed in the 16th century to replace the Chinese bowls that were being used in the tea ceremony. Traditional raku is still made today by the 15th-generation ancestors of the man who originated the technique. Potters throughout the world admire raku ware for its rugged shapes and soft lead glazes.

Raku ware is molded entirely by hand, which makes each piece a unique creation. The shape of traditional raku tea bowls was very simple: a wide, straight-sided yet irregular form set on a narrow base. Raku glaze colors included dark brown, light orange-red, straw, green, and cream. The special firing technique used for raku ware produces unique characteristics throughout the glaze, and sometimes in the pottery itself. This technique sets it apart from any other type of pottery.

Black raku tea bowl, 16th century

Majolica. Majolica pottery is **bisque-fired** earthenware that is coated with an opaque white tin-based glaze then decorated with colorfully painted designs on the white surface before firing. Majolica was first made in the Middle East to emulate Chinese porcelain. Later, the technique spread to Spain (where it later came to be known as Talavera ware), then to Italy from the island of Majorca, Spain, where it got its name.

The tin-glazing technique used in majolica eventually spread to France, where it was called faience, and to the Netherlands, where it was called delft.

Majolica

Delft. The potters of Delft, Holland, decorated their pottery in imitation of Chinese porcelain and some Imari ware, usually in blue and white. They used the majolica technique of applying a white opaque tin-based glaze to earthenware, then painting and firing the piece. But there was a difference between the two in that cobalt was used as the main colorant in delftware.

From Holland, the art of tin-glazing earthenware was introduced to England. Generally, the Dutch and the English potters copied the Chinese motifs, but occasionally the Dutch delftware was decorated with landscapes and seascapes of windmills, dikes, and ships.

Della Robbia Ware. Luca della Robbia was a great Florentine sculptor in the 1400s. His beautiful glazed terra-cotta sculptures are most famous for the interesting effects he achieved from layering glazes.

Sculpture of Madonna by Luca della Robbia

Staffordshire ware

English. Staffordshire ware is a famous English stoneware that began production in the late 17th century in and around Staffordshire, England. The local abundance of coal and clay gradually turned a small community of farmer-potters into a substantial industry by 1740, and the area later became the center of England's pottery industry. The first products were lead-glazed earthenware and unglazed or **salt-glazed** stoneware. Porcelain was first made in Staffordshire around 1750.

John Astbury was a pioneer of English pottery technology and was one of the earliest great Staffordshire potters. It is said that he pretended to be an idiot so that he could learn the secrets of the craft from potters who had emigrated from Holland in 1688.

English potter Josiah Wedgwood started his manufactory in Staffordshire in the mid-18th century. By 1765, he was famous for his version of creamware, a lead-glazed earthenware that soon replaced tin-glazed ware in popularity. In 1775, he introduced jasperware, a fine-grained, unglazed stoneware adorned with white figures or Greek classical scenes in relief on soft or dark blue, sage green, lilac, black, or yellow backgrounds.

Jasperware was so named because it resembled the natural stone jasper in its hardness. Jasperware was the result of a long series of experiments in trying to discover the techniques of producing porcelain.

Jasperware

Before 1800, Josiah Spode II, also of Staffordshire, introduced bone china after successfully adding bone ash (ground bone) to porcelain clay, which strengthened the porcelain and gave it an ivory white look. Bone china is still one of the more popular types of porcelain. Some say it is the most successful English porcelain ever made.

English potters in the 17th century dug their clay from the roads so they could conserve land for cultivation. Eventually the roads became so dangerous that a law was passed to forbid the potters from continuing the practice. Many believe it was the potters' unpopular practice that gave us the term "pothole."

Sèvres. In the mid-1700s, King Louis XV sponsored a famous pottery in Sèvres, France, to produce extravagant dinner services, urns, centerpieces, and serving ware. Made of the highest quality soft-paste porcelain, Sèvres ware prospered and became widely known for its superb glazes and richly colored backgrounds in royal blue, turquoise, yellow, green, and rose. It was decorated with floral patterns and birds, often in white panels outlined in gold, and lavishly trimmed in gold on the edges, handles, and bases.

American Indian. This pottery often was **coil-built** and smooth, decorated with colored slips, and **burnished** before being pit fired. Common designs were geometric patterns or forms inspired by animals. Most American Indian pottery has continued in this style.

American Indian pottery

Pottery on Parade

To get a better feel for the long history of pottery making and the great beauty of the wares produced, visit a museum, art gallery, artist's studio, or other place where pottery is made or displayed. Many museums have large collections of ceramic works. Some exhibit modern ceramics; others specialize in early ceramics or the pottery-making traditions of different cultures.

Whether you see contemporary works of art or pottery shards from ancient civilizations, a museum visit is worthwhile. Search for "museums" on the internet (with your parent or guardian's permission) or ask your counselor for advice.

You may be able to locate an artisan or a pottery studio or co-op in your community by searching for "pottery" or "art galleries" on the internet (with your parent or guardian's permission). A gallery exhibits and sells artists' creations. Look for a gallery that offers ceramics and pottery. Some represent only ceramic artists, while other galleries offer many kinds of art, from paintings and sculptures to jewelry and glass. Your counselor can help you arrange a visit.

Your community may have an art fair or festival; check with your local or regional arts council or foundation. Such organizations often publish calendars of events. You may be able to find a local arts council by searching for "arts organizations" on the internet (with permission).

No matter where you live, a festival or similar event is likely to be within reach. To widen your search, try these:

- At the public library, ask for information on arts festivals or organizations. The reference desk librarian may help you find calendars of events.
- Be alert to radio, television, and newspaper announcements about festivals, events, museum exhibits, and classes.
- Use the internet (with permission) to locate nearby festivals. In a search engine, type in the city or state and the phrase "art festivals" or "art fairs."

If you cannot visit a museum or gallery or see handmade ceramics at a festival or studio, learn from other sources about the historical and cultural importance of pottery. The resources section at the end of this pamphlet lists books, magazines, and websites that are good sources of information.

All About Clay

Clay is found almost everywhere, maybe even in your own backyard. It can be white, beige, buff, gray, green, red, brown, or, in rare cases, black. When moist, it is soft and malleable, which means it can be molded or modeled. Some potters get clay by digging it out of the ground, or they buy it from brickyards, potteries, ceramic factories, trade and craft schools, hobby shops, or other retailers of clay and ceramic supplies.

Clay can be created from inexpensive dry clay powder. The powder can cost a few cents per pound for common clay to around a dollar a pound for imported English porcelain.

Many suppliers advertise in pottery-related magazines; their ads explain how to contact them for a catalog.

Properties of Clay

Pure clay is made of chemically combined silica, alumina, and water. In its natural state, it is rarely pure and usually contains impurities such as sand, limestone, pebbles, iron oxide, and traces of other elements it has accumulated over the long period of time it has taken to become clay. These impurities—in any combination—provide the clay with a unique set of properties that make different types of clay useful for different purposes.

Pure clay, with few or no impurities, lacks some of the properties that a potter needs. One of these properties is plasticity, which refers to how well the clay holds a shape when bent or molded. Clay that cracks when bent around an object is called nonplastic or short.

One of the world's few natural sources of pure clay is in Cornwall, England, where there are vast deposits of kaolin, or china clay. The mining industry in that area creates huge heaps of mined clay that cause the local streams to run milky white in rainy weather.

The fired piece at *left* shows the effects of shrinkage when compared with an identical piece, *right,* that has not yet been fired.

Shrinkage is another property of clay. The process begins naturally as water evaporates from air-drying clay. During firing, further shrinkage occurs when the clay particles undergo chemical changes that cause them to fuse into a solid material.

The hardness, or strength, of a particular clay is another important property. It refers to how well the clay stays together when it is **leather hard, bone dry,** and in the fired state.

Color and texture are two more properties of clay. When planning pottery projects, you will want to know what color a particular type of clay will be when fired and whether it is coarse and rough or fine-grained and smooth.

Kinds of Clay

Choosing the type of clay for the project is the first step in making pottery. Choose from several types: kaolin, ball clay, stoneware clay, fireclay, and earthenware clay.

A kaolin mineral mine in Bulgaria.

Kaolin. Kaolin, or china clay, is a very pure form of clay, weathered from granite rock by water, dissolved carbon dioxide, and organic acids. It fires white in color and **vitrifies,** or becomes glasslike, at very high temperatures. Kaolin is an essential ingredient in high-fire whiteware and porcelain clay bodies.

Ball Clay. Ball clay, also weathered from granite rock, is a plastic, fine-grained cream- or white-firing clay. It is deposited by wind or water erosion in swampy areas where the organic acids and gases have broken it down into fine particles. Ball clay provides plasticity and dry strength in clay bodies. It generally can be fired to high temperatures, but it is rather sticky and shrinks more than other kinds of clay. Ball clay is not useful alone and is used only in combination with other clays.

The term "ball clay" has been traced to historic mining methods in England. The clay was scooped and rolled into balls of 30 to 50 pounds each and measuring about 10 inches in diameter, then wrapped in burlap for shipping.

Stoneware Clay. Stoneware clay is usable right from the ground as a **clay body.** Other clays and chemicals often are added to stoneware clay to introduce various properties such as color and texture and to affect **maturation** temperature. This clay will **vitrify** when fired at middle- to high-range temperatures. Some stoneware clays are smooth like ball clays; others are coarse like fireclay. Iron and other impurities color stoneware clay, which can be white, beige, buff, red, brown, gray, or, in rare cases, black. It usually has an attractive fired color.

Fireclay is widely used in making brick.

Fireclay. Fireclay has a coarse texture, but some fireclays are smoother than others. Fireclay can withstand high firing temperatures without disintegrating or deforming. Fireclay also is used in clay bodies to lend strength and decrease shrinkage. Coarse fireclays often are used for the gritty texture they add to clay bodies.

Earthenware Clay. Earthenware clay is found in every part of the United States and is often used in its natural form. Earthenware clays are usually full of iron impurities, which give it color but also cause it to melt at a low temperature. If left unglazed, earthenware is **porous** after firing and is useful for making flowerpots, tile, and brick.

Clay Bodies

Nature is not always kind enough to combine the right kinds of clay in just the right proportions for a specific ceramic purpose. An experienced potter mixes several different kinds of clay and other substances in specific proportions according to a formula, or recipe, to get a certain result. This mixture is called a clay body.

If you desire whiteness in your finished piece, use kaolin clay; for plasticity, add ball clay; for dry strength, fireclay; and for red color, earthenware clay. Chemicals also can be added to a clay body to make just about any color.

The terms "clay" and "clay body" do not have the same meaning. Clay is a naturally occurring material, but a clay body has been mixed from several clays and other ingredients. The difference is similar to the difference between flour and a cake mix. For your project, you can use a premixed clay body or mix your own to suit your needs, with guidance from your counselor or an experienced potter.

The Qualities of a Clay Body

When mixing a clay body, you need the right clay for the job. To do this, you must know which qualities the clay body must have for a particular project. For instance, any clay body must be plastic—it must hold together and bend and mold easily. In a clay body, the clay provides the plasticity. Also, the clay must be appropriate for the kiln. Some kilns will not produce the high temperatures required for some clays to **mature.** It also is wise to choose a clay that is easily available.

Next, a material must be added to help the clay melt into a solid material when fired. This is the **flux.** Flux is like the glue that holds the clay particles together when fired.

The final kind of material in any clay body is the **filler.** Fillers lend fired strength, determine **porosity,** and affect shrinkage. Very porous clay bodies usually contain sand or **grog,** which creates more space between their clay particles than between those of dense clay bodies that have no sand or grog. Porous clay bodies can be used to make bigger, thicker pots that will not crack, warp, or burst when dry or fired.

Kinds of Clay Pottery and Their Clay Bodies

Each of the three major types of clay pottery—earthenware, stoneware, and porcelain—are made by creating a unique mix, or recipe, for their clay bodies. The ingredients in the recipes are what give each type of pottery its distinguishing qualities.

Earthenware

Earthenware, the oldest and simplest form of pottery, usually is full of impurities that, aside from giving it color in ranges of buff to red and gray to black, cause it to mature at low temperatures. As a result, the clay does not completely solidify into a watertight state. For this reason, depending on the intended use, glaze can be applied inside and out.

Terra-cotta is a type of earthenware pottery. Common orange clay flowerpots are made from terra-cotta clay. Because of its attractive color, terra-cotta is often left unglazed. Throughout history, beautiful glazed and heavily decorated pots also have been made from terra-cotta. One example would be majolica, which is first bisque-fired, then covered with an opaque white tin glaze that is allowed to dry, and then overpainted with colored **oxides** before being fired a second time.

Here is one recipe for a white-colored earthenware clay body:

30 percent plastic kaolin
+ 30 percent ball clay (the clays)
+ 40 percent talc (the flux)

And here is a terra-cotta earthenware recipe:

15 percent ball clay
+ 15 percent stoneware clay
+ 40 percent earthenware clay (the clays)
+ 10 percent nepheline syenite
+ 10 percent talc
+ 10 percent borax frit (the fluxes)

Unglazed terra-cotta

Stoneware

Stoneware fires to higher temperatures, which leaves the surface very hard and **nonporous.** It is usually opaque, but when thinly potted can be somewhat translucent. Stoneware is more plastic than porcelain, which makes it much easier to use in **throwing** on the wheel or in **hand-building.** Some natural clays are stoneware, but often several clays are combined to make a stoneware clay body. Grog or sand can be added for wet strength.

Here is a good recipe for stoneware:

18 percent ball clay
+ 55 percent stoneware clay
+ 12 percent fireclay (the clays)
+ 10 percent potassium feldspar (the flux)
+ 5 percent silica (the filler)

Unglazed stoneware

Porcelain

Porcelain is known for its beautiful, smooth, white surface when fired. Some kinds of porcelain objects are known as whiteware, including some restaurant and hotel china, fine china, and plumbing fixtures such as toilets and sinks. China is a kind of porcelain that has special properties. It is usually fired to a high maturing temperature before being glazed at a lower temperature.

A good mix for whiteware follows:

55 percent plastic kaolin (the clay)
+ 25 percent potassium feldspar (the flux)
+ 20 percent silica (the filler)

The name "china" was coined by the British, who tried to imitate the porcelain made by Chinese potters. This piece is unglazed.

Equipment and Tools

While your hands and fingers can be used to make almost any kind of pottery, most potters also employ basic tools to create their works.

The Potter's Wheel

It is not known exactly when the potter's wheel was invented, but the earliest evidence of the device is shown in ancient Egyptian paintings. It is known that the potter's wheel was widely used in Egypt and Mesopotamia before 3000 B.C.

Early potter's wheels were just circular slabs of stone or wood that pivoted on a wooden axle so that the wheel head revolved freely in a horizontal plane. The wheel was hand-turned either by an assistant or by the potter moving a stick that fit into a notch on the wheel's surface. These wheels rotated very slowly and even wobbled a bit.

The wheel remained unknown in North America until the arrival of Europeans, although it is thought that the native peoples of this country might have used a turntable occasionally.

The power provided by electric wheels is helpful when making objects that require more than 15 pounds of clay.

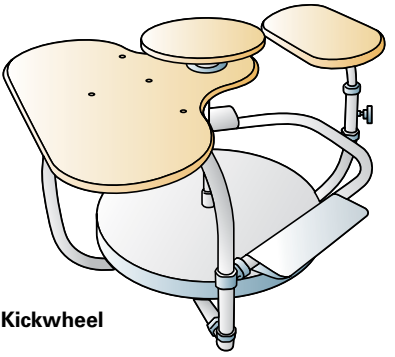
In contrast, modern potter's wheels are precise machines that turn quickly and smoothly. Although there are many variations of each kind of wheel, three types are now most common: the kickwheel, the treadle wheel, and the electric wheel.

The first potter's wheel was turned by hand, which made for slow, difficult work. Next came the kickwheel, which was turned by foot. By the 18th century, the wheel was no longer powered by the potter's foot but by small boys who worked as apprentices to learn the pottery-making trade.

Kickwheel

The modern kickwheel usually has a heavy, round flywheel near the ground, with a shaft that connects it to the wheel head. The wheel head and shaft are usually made of metal, and the flywheel, either concrete or metal. Ball-bearing attachments fasten the shaft to a frame, which in most cases includes a seat.

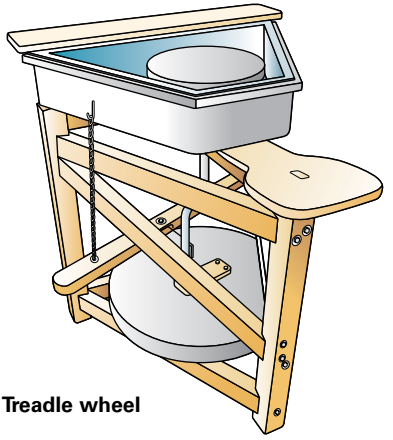
To use a kickwheel, sit in the seat and turn the flywheel with your right foot, which turns the wheel in a counterclockwise direction. The faster the flywheel is turned, the faster the wheel head turns. This fast foot motion is the "kicking."



Kickwheel

Treadle Wheel

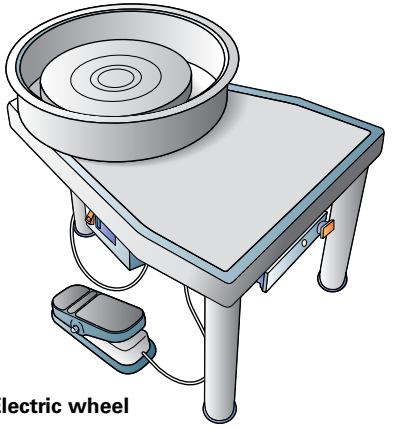
A treadle wheel is similar to a kickwheel. It also has a flywheel (usually lighter weight), a shaft, and a wheel head. A treadle bar—a straight bar attached to a central point on the frame and to a cog on the flywheel—is pushed with the foot. It must be pedaled constantly, usually with the left foot, to keep the wheel rotating. The rhythm of the pedaling controls the rhythm of the throwing. Some treadle wheels have seats, while others are used while standing.



Treadle wheel

Electric Wheel

The electric wheel is popular with potters and is the type most commonly used at colleges and craft schools. Electric wheels can be small and portable, and they usually have a foot pedal that allows the potter to control the speed. Most electric wheels do not have an attached seat.



Electric wheel

Tools

Potters use a variety of tools in their work. Perfectly wonderful pots can be made using only the most important tools—hands and fingers—but potters also enjoy using tools for various jobs. Pottery tools can be sophisticated or simple. For example, to **score** a clay surface, a serrated rib, a needle tool, a wire brush, a cork with sewing needles sticking out of it, or a kitchen fork could be used.

Ribs are tools used for shaping or for adding surface texture to clay articles. They can be made of wood, flexible steel, rubber, or plastic. Some creative potters cut ribs out of expired credit cards or from the sides of empty plastic detergent bottles.

Commercial tools

Carving and modeling tools come in an amazing array, and most are made of wood, metal, or plastic. Discarded (and sterilized) steel dental tools are excellent for detailing, as are wood-carving tools. Restaurant suppliers and hardware and kitchenware stores are great sources for tools that can be used in pottery making. Cookie cutters, molds, paddles, cheese slicers, sandpaper, utility knives, rasps, chamois cloth, wallpaper rollers, drill bits, soft paintbrushes, and sponges are just a few worth mentioning.

An experienced potter probably has collected a variety of tools, but beginners will do well with a basic tool set from a clay supplier. These sets commonly contain a sponge, a metal rib, a rubber rib, a metal loop tool, a wooden stick, a metal needle tool, a **fettling** knife, and a **cutoff wire.** Pottery tools should be kept handy and safe in a sturdy container.

Potters use objects as tools in unusual ways. For instance, small, very smooth river stones are useful for **burnishing** and **compressing** clay surfaces, as are spoons. Use seashells or pinecones to make interesting textures on pottery.

Handmade and improvised tools can be found just about anywhere.

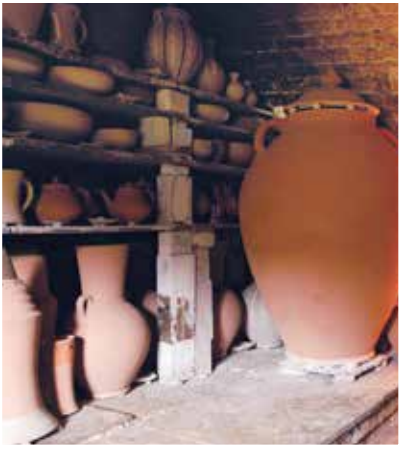
Kilns

A **kiln** is a structure that generates and holds heat. The first kilns were just open trenches covered with firewood and a dome of broken pots to hold in the heat. Although today's kilns are more sophisticated, the principle is the same. Heat is introduced into the space where the clay articles have been placed. The temperature is raised and the amount of oxygen around the ware is controlled according to the needs of the clay and the glaze.

Electric Kiln

Electric kilns are popular and easy to use. Electricity generates heat from wire elements attached to the brick walls of the kiln. Because electricity generates the heat, the oxygen level in the kiln remains the same as in the atmosphere outside the kiln. This kind of atmosphere is referred to as neutral.

Electric kilns are commercially built of a soft brick that enables them to heat up and cool down quicker than fuel-burning kilns. It generally takes 10 to 20 hours for an electric kiln to reach low-fire temperatures and another 12 to 15 hours to cool.



Mark Hewitt's 900-cubic-foot kiln was modeled after a 14th century kiln from northern Thailand.

Fuel-Burning Kiln

Kilns also can be heated by burning oil, wood, natural gas, propane, or coal as fuel. Natural gas and propane are the most common fuels for these types of kilns. Fuel-burning kilns have in common several construction features:

- Entry ports for the fuel
- Controlled air intakes
- Interior baffles to deflect and spread the flame from its source
- Exit flues
- Dampers to control air flow
- Chimneys to draw air through the kiln

This loaded wood-burning kiln is ready to fire.

A typical fuel-burning kiln will take 12 to 24 hours to reach high-fire temperatures and another 24 hours to cool.

Wood is sometimes used as the primary fuel in a kiln. Wood gives a particular quality to pottery. As the wood burns, it creates ash that is so light it flows through the kiln and lands on the pottery, creating a special glaze. Also, the variable flame produced by the burning wood creates **flashing marks** on the pottery.

Wood-burning kilns need more open space around them than other fuel-burning kilns because the fire must be stoked regularly. Such kilns can be fired continuously for days. They also need larger fireboxes and chimneys and produce more smoke and fumes than other kilns.

Kiln Furniture

Kiln furniture is the shelves, posts, or bricks used to support clayware in the kiln. The items are made of ceramic **refractory** materials, which means that they are heat-resistant and will not melt. Kiln furniture is available in many shapes and sizes. Potters also use kiln accessories like steel-pointed stilts to raise pieces that have glazed bottoms.

Kiln shelves can be expensive, so it is wise to take care of them properly. Before use, make sure the shelves are dry and there are no cracks, and apply kiln wash to shelves for protection against glaze drips. Kiln wash is a thick solution of 2 parts kaolin and 1 part silica or alumina mixed in a bucket of water. Apply kiln wash with a brush or roller, to the tops of the shelves only, and allow it to dry completely before using the shelves in the kiln. Once the kiln shelves are protected, any glaze drips can be easily scraped away.

Pottery Projects

As with any project, you should know the general safety rules and the basics of the craft before you begin.

Handling Clay Safely

Clay dust can be a serious health hazard. A deadly lung disease called silicosis can be contracted from breathing in fine clay particles. It is very important to protect yourself whenever you are working with clay. Follow these guidelines at all times.

1. When using dry, bagged clay, wear a protective mask.
2. Do not sweep a dusty studio. Always wet-mop to prevent clay dust from flying into the air.
3. Do not use sandpaper or other abrasive materials to refine a pot unless you are wearing a protective mask.
4. Work outside when possible.
5. Do not eat or drink in an area where clay dust might be in the air or might be contaminated with chemicals.

Take care when using knives, needles, carving tools, scissors, and other sharp or pointed tools to cut and shape clay.

In rare cases, a skin rash called dermatitis can develop on the hands and arms from handling wet clay. This form of dermatitis is an allergic reaction to the clay. If you notice any redness, itching, tenderness, rash, swelling, or even a feeling of warmth in the exposed area, wash the affected skin thoroughly with lots of water, and avoid any further contact with the suspected irritant until you have seen a health-care provider. Do not try to treat the condition yourself; some remedies can actually make the condition worse, especially if overused. It is wisest to let a medical professional treat you.

You should learn and follow all pottery safety guidelines. People of all ages all around the world have found that working with clay is fun and rewarding—be sure to keep your pottery-making experience a safe one.

Getting Started

Before starting each project, think about the desired look and size of the finished piece. Sketch the design in actual size, and remember to allow for shrinkage. Be sure to design the piece so your fingers can reach inside.

Some potters like to use **templates** to help check their work as they build. Templates are easy to make. When you are satisfied with the shape and size of the piece, make a final drawing of it on cardboard, then cut the template from it.

Templates can be especially useful for geometric forms that fit together at precise angles, such as squares or parallelograms. If you decide to use templates, don't be afraid to change the design during the building process. In other words, don't limit your creativity just because you have made a sketch or a template of your design.

Another step to be done before you begin the project is to prepare the clay by thoroughly **wedging** and **kneading** it so that the moisture is evenly distributed and there are no air bubbles, lumps, or hard spots. The clay must have a consistent texture for it to be suitable for working.

Wedging Clay. Wedging is the first phase in preparing clay for pottery making.

Step 1—Use the cutoff wire to slice the block of clay into several uniform slices.

Step 2—Lay the slices down, turning every other slice sideways. Then, pick up the first slice and slam it down on top of the slice next to it. Slam the next slice on top of those two and continue until all of the slices have been slammed onto the stack.

Step 3—Reform the clay into a block (with the slices still alternately vertical and horizontal). Turn the block on its side so that the slices are perpendicular to the work surface, then repeat the slicing, turning, and slamming together until the clay is well-mixed.

Kneading Clay. One kind of kneading, known as "ox's head," "ram's head," or "dog's head" kneading, is accomplished this way.

Step 1—Take a lump of clay the size of a grapefruit from its container and form it into an oval ball.

Step 2—Grasp the oval ball with both hands, one on each end. Press the heels of your hands downward and toward each other at the same time, pushing the clay into itself.

Step 3—Rotate the top edges of the clay forward with your fingertips and again press the heels of your hands downward and toward each other, pushing the clay into itself.

To get the proper consistency, you should repeat steps 2 and 3 about 40 times.

Slab Pottery

Clay slabs are simply sheets of clay; they can be of any size or thickness. The slabs are pieced together to make forms.

When working with slabs, pay attention to the amount of moisture in the clay. Low-moisture, stiff slabs will be difficult to curve without breaking, but they are good to use for making box-shaped forms. High-moisture, soft slabs will curve easily but might not stand up without complete support.

Forming a Clay Slab

There are three basic ways to form a slab.

Rolling by Hand. Begin by preparing the working surface. Spread out a piece of heavy fabric, such as canvas, to prevent the slab from sticking and to make it easier to move the slab to another working space. Flatten a ball of clay in the center of the fabric.

Using a rolling pin or other long wooden cylinder, roll along the surface of the ball to further flatten and smooth it into a slab. Some potters place guides at the sides of the slab to support the rolling pin and force the clay into a uniform thickness. These guides are made from wooden or metal strips that are at least ¼ inch thick.

Roll the slab on one side, then cover it with another piece of heavy fabric, flip it over, and roll it again. This action compresses both sides of the slab and strengthens it.

Throwing. This is just what it sounds like. Start by forming the lump of clay into a fat, bunlike shape. Grasp the clay in both hands, extend your arms out in front of you, then quickly throw the clay down on the table at an angle toward your body. This will cause the clay to spread in one direction and thin into a slab.

Rotate the clay 180 degrees and repeat the process to prevent the clay from becoming too thin in one direction. Repeat the slamming and turning until the slab reaches the desired thickness, commonly about ¼ inch.

Generally, slabs must be made while the clay is soft and then allowed to dry out a little before use.

Using a Mechanical Slab Roller. These rolling machines have a series of gears or cables and rollers that squeeze the clay into a uniform slab. They are expensive and difficult to repair, but they make uniform slabs quickly and easily.

To use a mechanical slab roller, prepare the clay by wedging it and flattening it into a thick pancake shape. Spread a piece of heavy fabric on the bed of the slab roller and place the clay pancake on top. Place a similar piece of fabric on top of the pancake, making sure that the fabric does not overlap the slab roller bed. The fabric will keep the clay from sticking to the bed or the roller.

Turn the handle of the slab roller to finish rolling the slab.

Building With Slabs

Slabs should be shaped when they are fairly soft. Building with them should be done when the slabs have had time to set and are fairly firm.

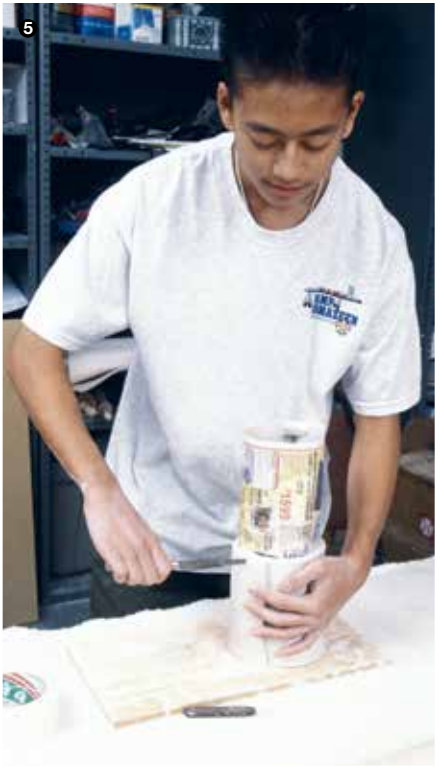
Building a Cylindrical Pot. Slabs can be used to make a cylindrical pot.

Step 1—Think about the shape and size you want your pot to be. Draw a picture of your idea, but don't let that limit your creativity.

Step 2—Use a cylindrical form like a coffee can, soft drink can, or cardboard tube as a support for the pot. Measure the circumference with a tape measure or piece of string.

Step 3—Make a slab several inches longer than the circumference of the form. The width of the slab will be approximately the height of your finished pot. Trim rough edges off all four sides of the slab and reserve this excess for the bottom of the pot. Make sure the edge that will be at the bottom of your pot is trimmed straight with a ruler.

Step 4—While the slab is resting and firming up a little, cover the support form with newspaper, neatly folded and taped with masking tape. The tape should be applied to the newspaper only, not to the support form itself. This newspaper layer will keep the clay from sticking to the form.



Step 5—Wrap the slab around the form. At the overlap, cut through both layers of clay at a 45-degree angle so that you have two mitered edges that will fit perfectly together. Reserve the excess length of clay for the bottom. Slip and score the mitered edges, and press them together to form a smooth seam. Tap the form on the table to make sure the slab is resting at the bottom of the form. The pot can rest like this for a few minutes.

Step 6—If none of the reserved pieces is large enough to use for the bottom, knead them together and roll out a new slab. Set the cylindrical form on the bottom slab and gently trace the outline of the bottom with a needle tool. Remove the cylindrical form; trim the excess clay from the traced outline of the bottom piece. Slip and score the bottom piece and the bottom edge of the pot. Attach the cylinder to the bottom and *carefully* remove the form, leaving just the newspaper layer for support. At this point, the newspaper will be sticking to the clay and the form should pull out easily.

Step 7—Remove the newspaper when the pot is leather hard. Refine the pot if necessary, and carve, **stamp,** or decorate if desired.

In the "slip and score" method for joining pieces of clay, the two surfaces are scratched up and slip is added to create a strong, welded bond. Scoring or texturing the surface makes the clay grip; the added slip acts like glue.

Building a Four-Walled Slab Pot. Using a template will help ensure a uniform shape.

Step 1—Draw a template for each wall and for the bottom of the pot. For a square pot, the walls and bottom will be the same size. For a rectangular pot, two opposite walls will be the same size, and the other two walls will be another size. The bottom can be any size. Cut out the templates.

Step 2—Form five slabs, cutting one for each template. Let the slabs rest until they are firm enough that they do not bend when picked up.

Step 3—Attach the walls to each other using one of the following methods:

- Slip and score the edges of two walls, then press them onto a third wall that also has been slipped and scored. The two outside walls are perpendicular to the third wall between them, which is lying flat. Add the fourth wall to the top, then stand the structure and add the bottom.
- Cut the edges of the slabs at 45-degree angles and make mitered corners. Slip and score the edges, then press them firmly together. The structure should be able to stand unsupported.

Step 4—Roll a thin rope of soft clay and press it with your fingers into the joint where two walls come together inside the pot. Repeat for the remaining inside joints.

Step 5—Refine the joints, carve or **clean** the rim, and trim the base to be flush with the outside walls, if desired. Decorate the piece when it is leather hard.

Pinch Pottery

Pinch building was probably the first method used to make a pot from clay. It is almost instinctive when holding a ball of soft clay in your hands to push your thumb into it and then turn it around while pinching the sides, making a hollowed-out shape. Although the method is simple, the result does not have to look primitive or rough.

To begin pinch-building, thoroughly wedge and knead the clay. Then make a test pinch. Your finger and thumb should have no clay sticking to them. If any clay sticks, continue the wedging and kneading process.

Continue pinching the clay, turning the clay in one hand and pinching with the other. The warmth of your hands will dry out the pot. This natural drying of the clay as it is worked can help the walls hold their shape as the pot becomes larger, but it also can cause the rim to become crumbly. It is best not to add water to the walls while they are being pinched out; they can become slimy and tear easily if they get too wet.

Making a Pinch Pot. Use the pinch-building technique to create a ceramic pot.

Step 1—Draw a picture of how you want the pot to look and what size you would like to make it. If you have more design ideas during the building process, don't let the picture stop you from using them.

Step 2—Hold a ball of prepared clay in one hand. Gently push the thumb of your other hand, using the entire pad of the thumb, into the center of the ball. Slowly rotate the clay and continue pushing the pad of your thumb into the center while rounding out the base of your pot. Work slowly and patiently, using small body movements.

Step 3—With the base established, use a circling series of pinches to raise the walls. Gently pinch the clay between your finger and thumb while turning the pot, making a ring of depressions, each slightly overlapping the ring before. It is important to keep the pressure between your finger and thumb even, and the distance between each squeeze equal.

Step 4—If the pot is to curve inward, gently ease the top inward between each row of pinching. Also, more pressure can be applied from the outside while pinching. If an outward curve is the goal, pinching with more pressure on the inside will cause the pot to expand outward.

Step 5—Variations in the rim—such as bending, curling, or splitting—are part of the pinching process. Sometimes this effect can emphasize the look of the pot, and sometimes a more refined rim is preferred. To refine the rim, cut off the ragged edges with a sharp knife, a needle, or sharp scissors. Then, using a tiny bit of water on your fingers, smooth out the newly cut edge.

Cross-sectional view

Coil Pottery

Coil building is an ancient method of forming pottery. It is still the preferred method for many American Indian potters. Modern potters use this method because coiling allows greater freedom in constructing very large forms and forms that have unusual profiles.

To form coils, first place a small lump of thoroughly wedged and kneaded clay on the table. Place your hands next to each other, with your palms facing down, gently touching the lump of clay. Roll the lump forward and backward in a smooth, even motion.

Rolling coils is not as easy as you might think. If the clay is not soft or bendable, the resulting coil might have a rough, cracked surface and will not be suitable for construction. The coils must be round; making short, choppy movements with your hands will result in a flat-sided coil. The coils must be of an even thickness; coils that are irregular tend to break easily.

Try to relax your hand muscles, and roll the clay at least 10 to 12 inches forward and backward. Some potters roll coils vertically between their palms instead of on a table.

Building With Coils

Coil-built pieces are always built on a slab- or pinch-formed base, which serves as a strong foundation. If the base of a pot were made only of coils, it would very likely crack open and not be structurally sound. When the base is firm but not leather hard, you can begin adding coils, working in a spiral. Each coil layer must be firmly attached to the layer below it by slipping and scoring. As you work, the bottom layers will start to firm while the top layers are still soft.

Wet coils that are under the pressure of additional layers sometimes sag and fall or collapse, so you might need to pause after adding several layers to allow the wall to become firmer. As you build, weld the coil layers together with your fingers or a tool. This will help prevent cracks from developing in the walls of your pot during firing.

Coil-Building a Cylindrical Pot. Practice the coil-building technique by creating a pot.

Step 1—It is always helpful to design a pot before you begin building it. Draw a picture to help you plan the height and width. Cut a template of the profile if you wish, and use it to check your progress as you work.

Step 2—Ensure that the clay is properly prepared.

Step 3—Form a flat base in the shape of your cylinder. Allow this base to become firm.

Step 4—Slip and score the top edge of the base. Place a coil on this edge, working in a spiral and applying slip to the top edge of each layer.

Step 5—After adding several coils, weld the walls together inside and out. Allow the pot to become firm and strong; this could take several hours. Keep the top layer soft by covering it with plastic. This will allow you to add more coils later.

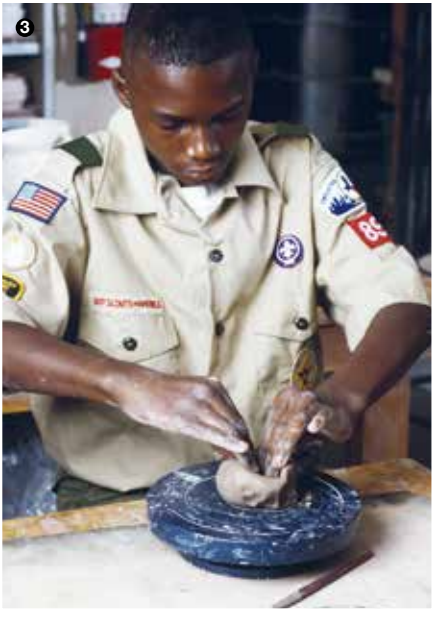
Step 6—When the pot has reached the desired height, smooth the surface if desired. Add a final thick coil to the rim for strength.

Coil-Building a Spherical Pot. The same basic technique can be applied to coil-building a spherical pot.

Step 1—Design your pot. Draw a picture to help you visualize the curve. Cut a template of the profile to help check your progress.

Step 2—Ensure that the clay is properly prepared.

Step 3—Form a rounded base by pinching a shallow bowl with the bottom and sides of uniform thickness. For example, the very bottom of your base might be ½ inch thick and the side would be ½ inch thick and slightly taller than the bottom piece. Some potters put this pinch-bowl base into a wooden or bisque-fired clay dish for support, but the walls of the pinched base must be a little higher than the support dish so that a coil can be added when the base becomes firm.



Step 4—Slip and score the rim of the pinched base and apply a coil to the top outer edge. Continue to apply slip to the rim of the exposed coil, but apply the coil to the top outside edge of it. This will make your pot expand outward in a ball shape.

Step 5—Pause periodically to weld the coils together, inside and out, and then let the walls become firm, leaving the very top edge covered with plastic.

Step 6—Halfway through building, begin to curve inward rather than outward. Now apply each coil to the inside edge of the top coil instead of the outside edge. Continue to build the walls, welding and allowing them to firm, until the pot is complete.

Step 7—Smooth the surface with a rib if necessary.

Ceramic Sculpture

Most ceramic sculptors use common methods for forming sculptures, but the best clay for sculpting might be different from that used for other clay articles. Grog added to a clay body makes the clay more porous and easier to form into irregular shapes.

While you are preparing the clay, think about what kind of sculpture you want to make. Size is one consideration: A small-scale sculpture is generally one that will fit on a table; anything bigger than that is considered large-scale and will require very special treatment to survive the creating, drying, and firing processes.

Making an Animal Sculpture. Follow these instructions to create a ceramic animal sculpture.

Step 1—Draw a rough picture of the animal to help you plan the body parts.

Step 2—Roll out a ball of clay for the body and a smaller one for the head. Score and slip both surfaces to weld the head to the body. Use your fingers to shape the body and head.

Step 3—Roll out coils or cut slab pieces for legs, ears, paws, etc. Attach these parts to the body—from largest to smallest—scoring and slipping the surfaces that will touch; weld them together.

Step 4—Add details, such as eyes, hair, fur, whiskers, etc., using a toothpick, needle tool, paper clip, or other sharp tool.

Step 5—When the piece is complete in the rough, you can smooth it, then add details and decoration. Do not worry about tool marks and fingernail marks that show at this time.

Step 6—Any piece more than ½ inch thick must be hollow so that it will not explode when heated in the kiln. To hollow out a completed sculpture, first wait until the clay is firm enough to stand without support. Carefully cut the sculpture in half. Use a loop tool to hollow out the walls to less than ½ inch thick. Score and slip the walls, and weld the sculpture back together. Use soft clay to repair any seam that shows.

Step 7—Carefully wrap the sculpture in a plastic bag and let it rest for 24 hours, then dry completely and fire.

Thrown Pottery

Making pots on a potter's wheel is known as **throwing.** Throwing pottery on the wheel takes a lot of practice. A skilled potter working at the wheel makes the process look easy, but first-timers nearly always are surprised at how awkward and difficult it can be. Most beginners do not produce an acceptable pot the first few tries. Don't get discouraged; with persistence, you will develop the skill.

The process of throwing a pot can be divided into six steps:

1. Prepare the clay.
2. **Center** the clay into a cylindrical shape.
3. Open the clay.
4. Pull up the walls into a hollow cylinder.
5. Shape the form.
6. Finish the form.

To accomplish these steps, you will need the following:

- An area for wedging and kneading the clay
- A bowl of water near the wheel to keep your hands and the clay wet while throwing
- Tools—sponge, needle tool, wooden knife, cutoff wire, and shaping rib made of wood, metal, plastic, or rubber

Centering the Clay. Because the wheel travels in a circle, pushing the clay into **center** is simply a mechanical process. For a beginner, soft clay is much easier to center than stiff clay. Save stiff clay for slab projects.

Step 1—Place a prepared ball of clay as close to the center of the wheel head as possible. Give it a little slap to push it down solidly onto the wheel. Dip your hands in the water bowl and turn the wheel to a high speed.

Step 2—Gradually press your hands onto the clay parallel with the wheel head. Then, using your whole body, brace your arms firmly against your hips or legs and stiffen your hands and fingers. Surround the clay on the top and sides with your hands and press toward the center of the wheel with your body weight leaning into it. If your body is braced and stiff, the clay has nowhere to go but into the center. Usually, your left hand controls the side of the clay and your right hand controls the top. Rewet your hands often to keep the clay gliding easily.

Step 3—When the clay feels centered, gradually lighten your pressure on the clay and gently, slowly remove your hands. Any quick moves—either putting your hands onto the clay or taking them off suddenly—will move the clay off center.

Opening the Clay. There are many ways to open a hole in the center of a clay ball. The following is one effective way.

Step 1—With the wheel still spinning at a high speed, wet your left hand and brace the clay around the side. Then place the thumb of your right hand onto your left hand for further bracing.

Step 2—Using a strong finger from your right hand, slowly push that finger into the middle of the clay ball.

Step 3—When your finger gets near the bottom of the clay ball, stiffen your finger and slowly pull your right arm back toward your body. This should open up a hole in the clay.

Step 4—When the hole is large enough, slow down the wheel and, using the pad rather than the tip of your finger, compress the bottom you have just made.

Pulling Up the Walls. Pulling up the walls of a pot is somewhat similar to pinching a wall. The difference is that one hand works on the inside of the pot and the other hand works on the outside, rather than just one hand pinching with the thumb and fingers.

Step 1—Thoroughly wet your hands. Place your fingers at the bottom of the pot, one hand inside and one outside. Your hands will be right next to each other with the wall in between, and your fingertips will do the work. Keep your elbows braced against your hips, your arms stiff, and your hands well-lubricated with water. Press or pinch your hands slightly together, and very slowly, keeping that pinched distance the same, raise your arms to bring your fingers up the wall of the pot.

Step 2—The wall will rise as your fingers distribute the clay upward. As you get to the top, gently release the pressure so that the walls will stay a uniform thickness.

Step 3—As the wheel is going around, support the wall with the thumb and fingers of your outside hand and press down gently on the top rim with the index finger of your other hand. This is called “setting the rim.”

Step 4—Repeat this procedure three or four times, or until the pot reaches the desired height and the walls are of the desired thickness.

Shaping the Form. You may notice that pressure from your fingers makes the clay move. If your hands are lined up together, but you press harder with your inside finger than with your outside finger, the wall of the pot will swell outward. Similarly, if you press harder with your outside finger than with your inside finger, the pot will curve inward.

Once the wall of the pot has been moved outward, it is difficult to get it to go back in. However, a narrow pot can easily be made more spherical. Practice using your inside and outside fingers to make gradually curving walls.

Use a sponge to drip water on the walls of the pot to keep them slippery. But be careful; too much water can cause the walls of the pot to collapse. Use just enough to keep the walls well-lubricated.

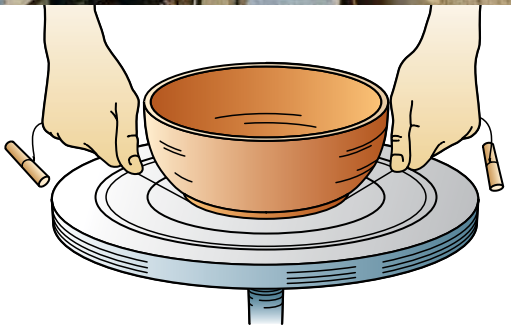
You also can use a rib to shape the walls. Hold the edge of the rib against a uniformly wet wall. As the wheel goes around, support the wall with one hand and press the rib to move the wall in or out.

Finishing the Form. Use a wooden knife to trim extra clay off the outside bottom of the pot. Then use the cutoff wire to free the pot from the wheel head.

Step 1—Holding the wire at both ends, place it firmly down on the edge of the wheel head that is farthest away from your body.

Step 2—Firmly hold the wire down with your fingers and slowly rotate the wheel, pulling the wire toward your body.

Step 3—When the wire has passed completely under the bottom of the pot, wipe your hands dry. Gently pick up the pot with both hands and place it on a board to dry.



Decorating and Glazing

Many techniques can be used to turn a simple piece of pottery into a uniquely decorated work of art. Experiment with each one to discover how the techniques affect the pottery.

Textured Decoration

Pottery can be decorated in many ways. Some decorating techniques originally had practical purposes. When primitive potters formed wet pots, their fingers left indentations in the sides. The potters noticed after firing that these dents made the pots easier to handle. Some potters pressed rope into the sides of pots they were forming, making the pots less slippery when wet. As the potters experimented with other objects and tools in their clay work, they noticed that adding these practical features made the pots more interesting to look at, too.

Use your imagination to design pottery projects that will make distinctive textured or indented decorations on the surface.

Decorating With Slip

Another ancient technique that you might consider is slip painting, which simply is painting colored **slip** onto the surface of an unfired pot. Using several fairly thin coats, you can cover the entire pot, or paint a specific design onto it, or you can paint a base coat and then paint a design of a different color on top of that. Once the pot is painted with slip, use a sharp tool to scratch or carve a design through the slip, down to the surface of the clay. This technique is called **sgraffito.**

Slip also can be trailed onto the clay surface of the pot or onto a slip-painted surface for a raised effect. Put some thick slip into an applicator bottle (basically a rubber bulb with a removable nozzle, available from clay suppliers) or any clean squeeze bottle with a narrow, tapered tip (such as a mustard squeeze bottle). While applying constant pressure and working at a constant speed, squeeze out a line of slip in a unique pattern or design.

If several colors of slip trails are placed close together on a pot, the lines can be combed with a feather or a comb from which several teeth have been removed. A marbled effect can be created on the inside of the piece by pouring several colors of slip into a pot and swirling them around slightly. Keep in mind that pots with very thick layers of slip must dry very slowly to prevent cracks.

Most of the time, slips are used on clay that is still wet, and glaze is used on clay that has been bisque-fired. There are exceptions: Some potters glaze their **greenware** and fire it only once, but they must use specially formulated glazes. Some potters apply slip to their **bisque ware,** but again, this slip must be specially formulated.

Applied Decoration

Another attractive way to decorate a clay article is to attach damp pieces of clay in various shapes. This is called sprigging. Sprigs are made by pressing soft clay into a small, decorative plaster mold. The clay hardens quickly and is easily removed with a needle. Paint the edges with a little water, then press the sprig onto the pot.

A Caution About Lead

Lead is a toxic material. If handled improperly in glazes applied to ceramic ware made for drinking or eating, small amounts can leach into a person's system and over time will accumulate to a dangerous level.

The Food and Drug Administration allows the use of lead glazes because of their durability but closely regulates their use with strict controls and guidelines to ensure consumer safety.

For individual potters, using lead in glazes, particularly low-fired glazes such as for raku pottery, can be dangerous to the potter as well as the user of the pottery. Exercise extreme caution when using lead. Check with your counselor or an experienced potter for guidance on how to safely use lead in glazes.

It is best to play it safe and avoid the use of lead glazes. There are many alternatives available. Using "unleaded" glazes will ensure the safe enjoyment of your piece when it has been fired.

Decorating With Glaze

Glaze is a combination of several substances: alumina, which keeps the glaze from running too much; a flux, which helps the glaze melt into a glass at a safe temperature for the clay; silica to give it shine; and, often, chemicals to add color.

Although much useful and attractive pottery is made without glaze, potters also like to use glaze because it gives functional ware a sanitary, nonporous surface and serves as decoration. To begin experimenting with this type of decoration, first get advice from your counselor or an experienced potter. Decorating with glaze is a fairly complicated technique, but the sense of accomplishment after a successful glaze firing can be well worth the effort.

Glaze is nearly always applied to bisque-fired ware. You can use a paintbrush, but it is more effective to dip the pot into the glaze or pour the glaze onto the pot. The inside is glazed first. Pour the glaze into the pot, roll it around to cover the entire inside, and carefully pour it out. After the inside has dried (usually in less than a minute), you can glaze the outside.

Dipping, *above,* is the most effective way to glaze clayware, but pouring the glaze onto the piece, *right,* also is effective.

Either dip the piece into the glaze, or hold the pot over the glaze bucket while pouring glaze over the outside. Be sure to wipe the glaze from the **foot** of the piece to keep it from sticking to the kiln shelf when the glaze melts during firing.

Many potters use tongs or gloves when applying glaze to prevent it from getting on their skin. Some chemicals in the glaze can irritate or be absorbed by the skin. If you do get any glaze on you, rinse off immediately with plenty of water.

Commercially prepared glazes, especially those manufactured for low-fire clays, are easily applied with a paintbrush. Follow the instructions on the label. Wash your hands immediately and thoroughly after handling glazes.

Firing

Firing the kiln is undoubtedly one of the most exciting and challenging steps in pottery making. The process can be quite technical. There are several things you will need to know before you begin.

General Rules for Firing

The following safety rules must be followed when firing pottery.

Wear full, sturdy shoes that won't easily melt or catch fire. Open footwear, such as sandals, is inadequate protection for your feet.

All work must be bone dry before bisque firing. This will prevent cracking and possibly exploding. Hold the bottom of the clay article against your cheek. If it feels cold, there is still moisture in it and it is not safe to bisque-fire.

Before loading the kiln, vacuum it out completely. Doing so will prevent bits of kiln dust or brick from landing on your work during firing and spoiling it.

Never brush a kiln shelf with your bare hand. Jagged, razor-sharp pieces of glaze can be stuck to the shelf.

Clayware must be stacked in the kiln skillfully. All pieces should stand level. Unglazed ware can be stacked or packed closely, but glazed ware must stand alone so that melted glaze will not stick or drip onto another piece.

To prevent the piece from sticking to kiln shelves when the glaze melts, **make sure the undersides are not glazed.** If the bottom of a piece is glazed, be sure to use steel-pointed stilts where it would touch the shelf.

Always keep the room in which you are firing well-ventilated. Clay and glazes give off vapors that can be poisonous. Do not stay in the room with a kiln that is firing, even if the room is well-ventilated.

Fire the kiln slowly. An average bisque firing should take no less than eight hours.

Once the kiln has risen to 200 degrees, do not open the kiln door. This would be risky for you as well as the pieces. Do not touch the sides of the kiln or the door handle.

Wear protective insulating gloves and safety glasses or welding goggles when checking the cones through the peephole. Doing so will protect your hands and eyes from the intense heat.

Do not try to open the kiln or remove pieces from the kiln when it is still hot. Wait until everything has cooled enough to handle with bare hands.

Assessing the Heatwork

Before you begin firing, you must know the proper firing temperature for clay (and glaze if you are using it). If you don't fire high enough to mature the clay, the surface will be soft and porous; if you fire too high, the piece will melt out of shape. You also will need to know how to measure the temperature in the kiln to determine whether the proper **heatwork** has been reached.

Before the development of modern aids to measure and control kiln temperatures, potters had to read the heat in a kiln by the color of the flame and the opaqueness of the kiln atmosphere. Today there are various instruments and tools to help potters track the progress inside the kiln.

Pyrometer

There is a special process for measuring kiln temperature. No regular thermometer could withstand the extreme heat in a kiln, but many types of firing require the potter to know the actual temperature in the kiln. A pyrometer, a high-temperature thermometer, is used for this. But the pyrometer alone is not always sufficient for indicating shutoff time. It reads the actual temperature but does not indicate the amount of work done by the heat.

Pyrometric Cones

Pyrometric cones are little pyramids made of clay and glaze that melt and bend, each at its own specific temperature, to signal the end of a firing or, in some electric kilns, to trigger a kiln shutoff. Cones respond to time and heat and are reliable for assessing heatwork. For this reason, many potters use cones in addition to the pyrometer.

Cones are available in a wide range of temperatures. Once you know the temperature at which the clay you are using matures, you would use the cone that corresponds to that temperature, as well as the next lowest and the next highest cones.

Pyrometric cones are numbered in a peculiar way. The lowest temperatures start with a zero; for example, cone 018 corresponds to a common temperature for certain low-fire glazes called **lusters.** Also, the cones are numbered in reverse order, with 018 representing a lower temperature than 015, which represents a lower temperature than 012, and so forth through 01. Then the numbering picks up at 1, and continues in regular numerical order, from the coolest to the hottest temperatures.

For instance, if a potter should say, "This clay matures at cone 06," this means that the firing will be finished and the clay will have become dense and reached its optimum strength when an 06 cone melts in the kiln.

Potters typically do not use cones higher than 15. Earthenware and terra-cotta usually fire to maturity at cone 04. A common high-fire porcelain and stoneware temperature is cone 10. Raku is usually low-fire—cone 06—and salt or soda can create a glaze from cone 7 and up. Wood-burning kilns usually reach very hot temperatures, above cone 10.

Temperature is not the potter's sole concern. A potter needs to know how much work has been accomplished by the heat in combination with how much time has elapsed. This is known as the heatwork.

Cone Pack

To make a cone pack, you will need the cone that corresponds to the maturing temperature of the clay, as well as the next highest and the next lowest cones. For instance, if you will be firing to cone 4, you would use cones 3, 4, and 5.

Line up the cones in a pad of clay. Slant them slightly so that as they melt they will bend over in a direction that will allow you to see them. It works well to slant the lowest cone (which will melt first) away from the other two, and slant those two toward the first one.

When the cone closest to the bottom melts, this is a warning signal. When the middle cone melts—the one that corresponds to the maturing temperature of your clay—it is time to shut off the kiln. This must be done quickly before the third cone begins to melt.

For some larger kilns, it is common practice to place several cone packs in different areas throughout the kiln.

Cones are lined up in the cone pack, all slightly slanting in the same direction.

A cone pack looks like this after it has been used in firing.

Packing the Kiln

When you consider the time and fuel spent in a single firing, you will understand why it is important to pack the kiln efficiently. Not only is it more economical, but it also ensures a more even firing and a good atmosphere in the chamber.

Make full use of the kiln's capacity by grouping similar sizes of ware together. Begin with short or flat pieces on the bottom; save the taller pots for the higher levels. Keep in mind that unglazed ware can be packed so that pieces touch each other; glazed pieces must not touch. Leave ample room for air to circulate around their bases. Keep ware at least 1 inch away from the kiln walls.

Support each shelf with three posts. Some electric kiln shelves require four posts, but an arrangement of three posts usually provides the most stable support, depending on the shape of the shelves. Posts should be at least 1 inch taller than the pots.

Before putting any clayware on the first shelf, place the posts that will support the shelf above. Then, when the first shelf is packed, lower the next shelf carefully into the kiln without touching the side walls or jarring the kiln. Carefully position the shelf and lower it onto the posts. It should be stable enough that it doesn't move when lightly touched.

Position the next set of posts directly over the base posts. It is important for the posts to be stacked directly in line with each other vertically. If posts are stacked vertically offset from each other, the shelves will not be as stable.

Clay articles should be fired in the position in which they will be used when finished. For example, a box, jar, or teapot should be fired with its lid in place. However, clock faces should be fired lying flat to prevent warping.

Make sure cone packs are clearly visible through the **peepholes** in the door or sides of the kiln. Do not place them too close to the peephole or it might be hard to tell which cone is which. If placed too far away among other vague outlines, it might be difficult to tell what is a cone and what is not. Cones are most easily seen against a plain, solid background, whether in front of a large pot or with nothing just behind them.

Average Bisque-Firing Schedule (Cone 06)

Once the work is properly loaded and you have ensured that the cones are easily visible through the peepholes, turn the bottom control on the lowest setting and prop the lid or door slightly open with a soft brick or post; this will allow steam to escape. It is extremely important to ensure that no one—a small child or a pet, for instance—will interfere with the kiln in any way during this preheating phase of the firing.

The kiln can stay in this position for two hours or overnight, if necessary, depending on the thickness of the pots. From this point on, turn up the kiln once every hour as follows:

Hour 1—bottom control on low
Hour 2—middle control on low
Hour 3—top control on low (Close the door or lid before turning the top control on low.)
Hour 4—bottom control on medium
Hour 5—middle control on medium (At this point, if color is visible through the peepholes you can also turn the top control on medium. If the kiln is still dark, wait until hour 6 to turn up the top control.)
Hour 6—top control on medium, or bottom control on high
Hour 7—bottom control on high, or middle and top controls on high
Hour 8—middle and top controls on high if needed

Watch the cones carefully, checking every 30 minutes, until the appropriate cone has melted. Turn off the kiln and let it cool completely.

Firing Schedule for Low-Fire Glaze (Cone 04)

The following is a commonly used schedule for firing low-fire glaze in an electric kiln.

First, preheat by turning the bottom control on low for one hour with the lid or door propped open; this will allow any remaining moisture to escape as steam. Then, turn up the kiln as follows:

Hours 1 and 2—all controls on low
Hours 3 and 4—all controls on medium
Hour 5—all controls on high

The kiln will be ready to shut off within three to five hours after the last controls are turned up. Watch the cones carefully after about two hours.

High-Fire Schedule

Because many high-fire kilns are built by individuals, each kiln follows a unique schedule. Do not attempt to fire any fuel-burning kiln without close supervision from the owner.

Most firings are documented by keeping logbooks. It is possible to follow another potter's log, but commonly the notes about temperature and atmosphere are subjective, and a beginner should never attempt this type of firing unsupervised.

Reduction and Oxidation Firings

Copper oxide can produce a brilliant red in a reduction firing, but it would produce greens in an oxidation firing.

Fuel must have a sufficient amount of oxygen to burn. The dampers in fuel-burning kilns enable the potter to adjust the amount of oxygen inside the kiln. When the kiln contains more than enough oxygen needed to completely burn the amount of fuel being used, the atmosphere inside the kiln is oxidized. However, if the dampers are adjusted so that not enough oxygen is available inside the kiln to burn the fuel, then the air inside the kiln looks smoky and hazy and the atmosphere is reduced.

In a reduction firing, the flame is seeking oxygen inside the kiln, and because there isn't enough, it "steals" oxygen from the clay and glazes. This chemical reaction darkens the clay and changes the look and texture of some glazes. For example, a celadon glaze works only in a reduction firing; it would turn yellowish if fired in an oxidizing atmosphere.

Visit a Kiln Yard

To see firsthand how different kinds of kilns work, visit the kiln yard at a local college or craft school. Many colleges and universities have ceramics programs, often as a part of their art departments or schools of ceramic engineering. Their kiln yards or kiln rooms house various kinds and sizes of kilns. Work with your counselor to locate and arrange a visit to such a school or facility. You should be able to find one nearby.

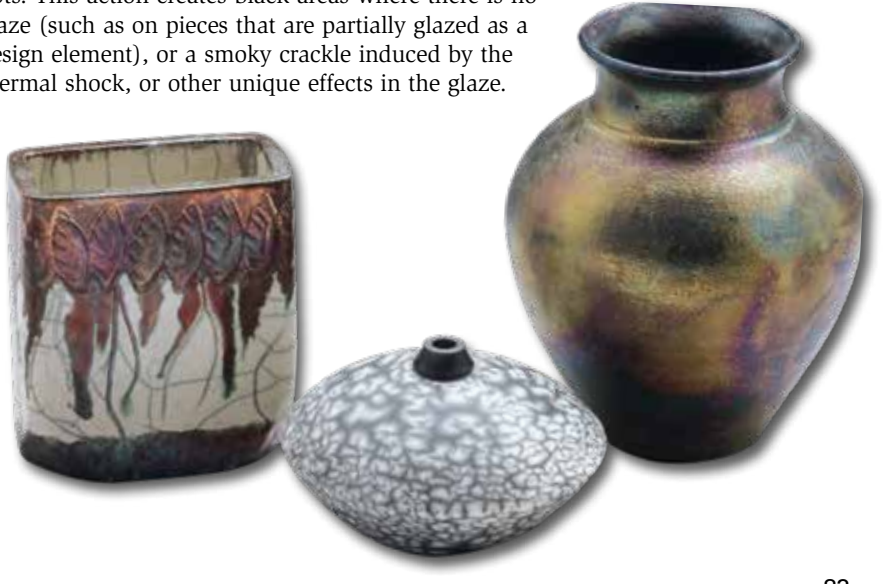
Special Firings

Raku firing and salt or soda firing can be done in any of the fuel-burning kilns, although salt or soda firing should be done in a dedicated kiln because, over time, a thick layer of **salt glaze** will form on the kiln's inner surface. Electric kilns are not very suitable for salt, soda, or raku, because the heating elements in electric kilns are easily damaged when exposed to high levels of sodium or extreme temperature changes.

Raku Firing

Raku firing is a special process invented hundreds of years ago for the traditional Japanese tea ceremony. Raku tea bowls were actually made and used during the tea ceremony. Today, the raku technique is popular with many potters because it enables them to produce unique pottery in a relatively short period of time.

An American version of the raku technique involves first firing glazed pottery at a low temperature in a fuel-burning kiln until the glaze melts, often for only a few hours. Then, when the glaze is molten, the pieces are removed from the kiln with long metal tongs and placed into a fireproof container with sawdust, newspaper, or other combustibles, and covered. The combustible materials catch on fire, but the fire is immediately smothered and the smoke penetrates the surface of the pots. This action creates black areas where there is no glaze (such as on pieces that are partially glazed as a design element), or a smoky crackle induced by the thermal shock, or other unique effects in the glaze.



Also, since the fire is trying to burn, it needs oxygen and takes it from the molten glaze. This reducing activity gives some raku glazes flashes of metallic gold, copper, blue, or green. Raku pottery made with this technique is usually **crazed,** very porous, and not very strong, which makes it suitable only as decorative ware.

Removing pots from the kiln is a hazardous process that requires the potter to wear a special fire suit, protective face shield, and insulating gloves.

If you decide to try the raku technique, you *must* have the supervision of a knowledgeable adult, you *must* wear the protective clothing, and you *must* wear shoes that will not easily melt or catch fire if a pot were to accidentally fall on your foot while being removed from the kiln.

Salt or Soda Firing

In salt firing, the firing proceeds as usual until near the end of the firing, just before the peak temperature has been reached, when sodium is introduced into the kiln. Because the kiln is so hot, the salt immediately volatilizes—the sodium chloride splits into sodium and chlorine gas. The chlorine combines with moisture and forms hydrochloric acid, which eventually escapes from the kiln through the flue; the sodium chemically reacts with the surface of the clay to form a glaze that often has an "orange peel" texture.

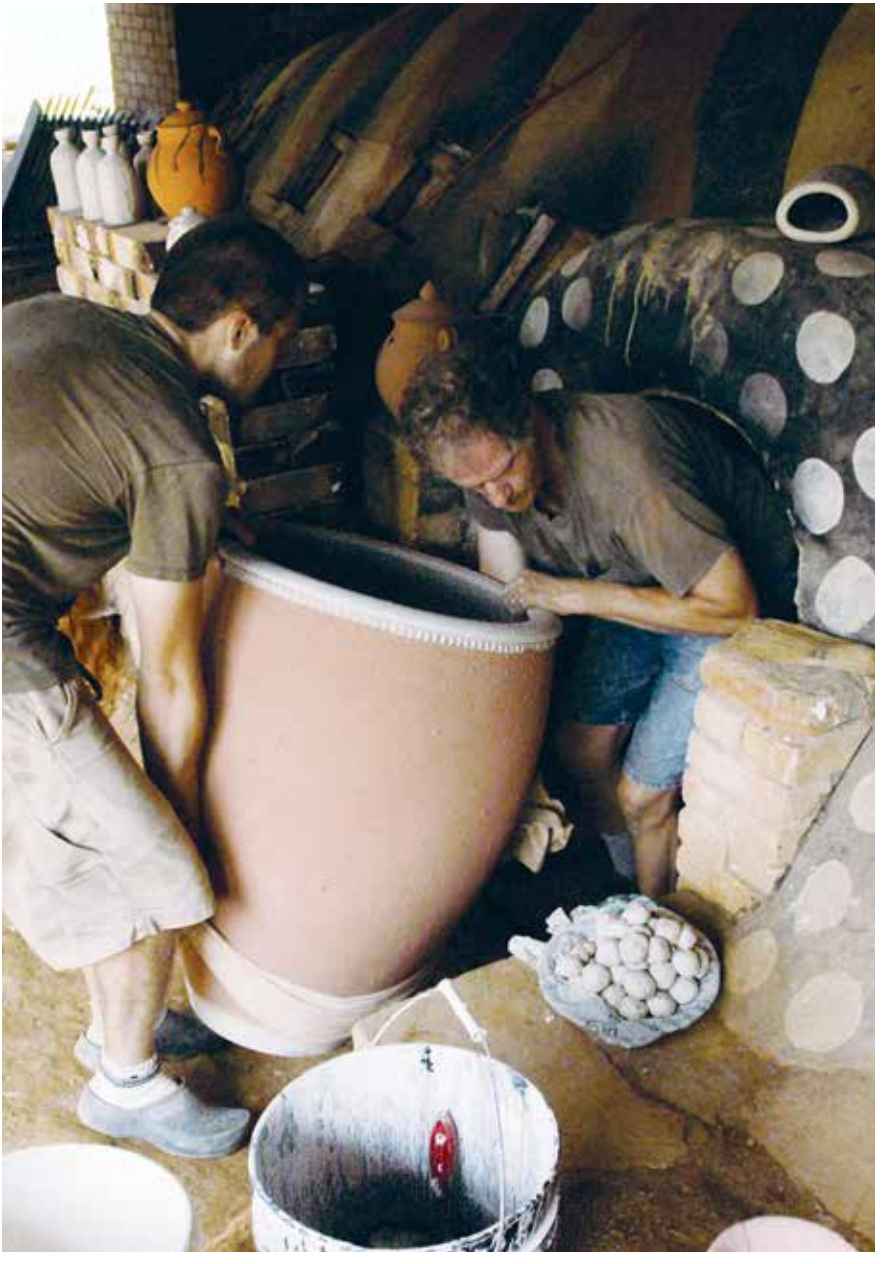
Sodium can be put into the kiln in many ways. You can use regular salt, rock salt, baking soda, washing soda, or any combination of these. Roll it up in sheets of newspaper and throw them in; blow the powder into the kiln with a compressor; or dissolve the sodium in hot water and spray it into the kiln with a garden-type pump sprayer with a metal nozzle.

The fumes produced by salt firing are toxic, and safety procedures must be followed during the firing. Follow the instructions from your counselor or an experienced potter whenever you are participating in a salt firing.

Baking soda (sodium bicarbonate) and washing soda (soda ash or sodium carbonate) do not change from powder to gas as readily as salt does. Put these substances into the kiln in a dissolved form or mixed with lots of salt.

Peep!

Generally you can tell if the kiln is still hot by touching the outside or by opening the peephole. If heat comes out of the peephole, it is probably still too hot to open the kiln. If it feels warm, but you aren't sure if it is really hot, try this test: Stick some paper into the peephole for about 30 seconds. If it comes back charred or has actually caught on fire, then you know the kiln chamber is still at least 451 degrees, the combustion point of paper, and is much too hot to open.

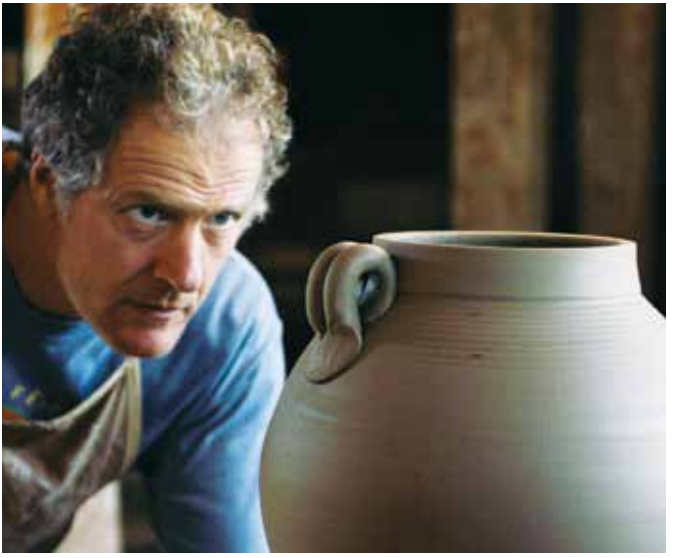


Opportunities in Ceramics

The ceramics industry is one of the largest industries in the United States. Ceramics are useful because of their chemical, electrical, mechanical, thermal, magnetic, and structural properties. The ceramics industry is vital to the successful operation of other industries.

For example, kiln furniture and firebrick refractories are a basic component of the steel industry. Abrasive materials made from silica are essential to the machine-tool and automotive industry. Glass products are essential to the automobile industry and to architectural, electronic, medical, and agricultural industries. Uranium oxide fuels are packaged in ceramic rods for use by nuclear power plants. The chips in every computer are ceramic, as are the tiles that covered NASA's space shuttles.

Even the coating on paper used for magazines and books is ceramic.



A college education is very helpful to gain a thorough understanding of the technical aspects of this rapidly expanding industry. Many universities and colleges offer courses in ceramics, the graduates of which are qualified to work as ceramists or ceramic engineers.

The field of ceramics is extremely diverse, offering many possibilities for employment. You might have an interest in the technical fields—chemical, mechanical, or ceramic engineering. Or maybe you prefer the executive side, such as managing ceramic manufacturing operations. You might be more interested in selling and distributing ceramic products, or you might want to specialize in ceramic art.

Be Prepared

High school courses that will help you gain knowledge important in the ceramic industry include chemistry, physics, math, and shopwork. Give special attention to art because it is closely allied with ceramic design and decoration. Also, a knowledge of machinery and drafting would be of great help. Check with your school guidance counselor.

If you are studying ceramics in school, some practical experience under actual working conditions would be of value. Try to locate a pottery studio in your community, then apply for part-time or summer work there. No matter what task you are assigned to do, you will learn something just from working in the environment and absorbing information.

After Graduation

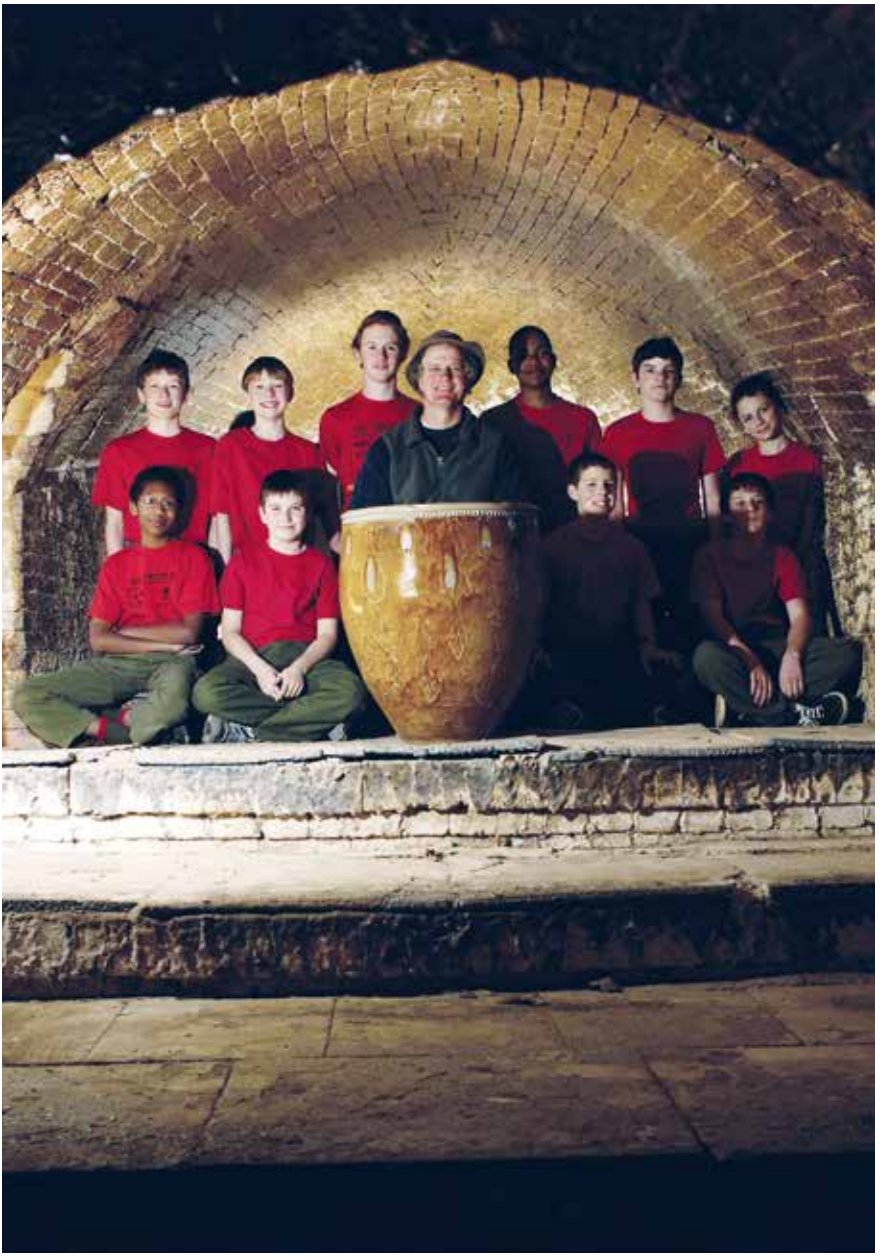
Ceramists and ceramic engineers are concerned with the mining and processing of clay and other nonmetallic minerals and all the products manufactured from these raw materials. Many of them work in research, design, manufacturing, or sales. Some might specialize in such materials as brick, tile, pottery, glass, sanitary ware, enameled metals, abrasives, jet motors, refractories, cements, electronics, and more.

A large percentage of graduates of ceramic coursework are employed in the stone, clay, and glass industries. Other opportunities are in steel, electrical machinery, aircraft, or chemical industries, as well as in education.

Let's not forget the artisan potter, some well-known for their masterful work. Fine examples of pottery are now displayed in world-famous museums; others command high prices at exclusive antiques and art auctions. The most popular designs and styles created by these potters are being reproduced by the world's most respected makers of fine porcelain and stoneware.

Not everyone can create a masterpiece, but that doesn't mean they don't enjoy working with clay and making useful, attractive objects. It never hurts to try, and trying can be a reward in itself. You just might find that you have the creativity and natural ability to become a successful studio or artist potter.

Professional pottery artisans also are often good resources and may be willing to share their expertise.



Potter Mark Hewitt with Scouts inside his massive kiln. It takes six days to load, three and a half days to fire, and seven days to cool. He and his staff fill and fire the kiln three times a year; each firing turns out about 2,000 pieces.

Glossary

Pottery has a language of its own. To know what a potter is talking about, you will need to know the language. Here is a short glossary of some important terms.

bat. A disk or slab of wood, plaster, hardboard, or plastic on which clayware is produced or allowed to dry out. Slightly porous materials make the best bats for pots because they allow the bottoms of the pots to dry. Bats are used on the potter's wheel for large pots that cannot be easily removed after throwing.

bisque or biscuit ware. Unglazed clayware that has been fired once to a low temperature and is still porous.

bisque firing. The first firing, without glaze, to drive off the water chemically combined in the clay, thus making a clay article easier to handle for further work, such as decorating and glazing. (Slips can be used in a bisque firing.)

bone dry. Completely air-dried and not yet fired in a kiln.

burnishing. A finishing technique in which the surface of a clay article is smoothed and polished by rubbing it with a hard object, such as a stone or the back of a spoon.

centering. The process of moving the clay into a symmetrical, spinning axis in the middle of a wheel head so it can be thrown.

clay body. A combination of different types of clay and other substances, mixed according to a formula for a specific ceramic purpose.

clean. To scrape clay with a rib or wipe it with a sponge.

coil-build. To make pottery using pieces of clay rolled like rope.

compressing. The process of pushing the clay down, forcing the clay particles closer together.

crackle. Cracks in a glazed surface, intentionally induced as a decorative element.

crazing. A fine network of hairline cracks in the glaze usually caused by uneven contraction and expansion of the clay article during changes in kiln temperature or during cooling; sometimes intentionally induced as a decorative element.

cutoff wire. A length of wire, usually with a handle at each end, used for cutting clay when wedging or to release the bottom of a clay article from the wheel head.

earthenware. Opaque, porous pottery made from a clay that matures at a low firing temperature; coarser in texture than porcelain.

feldspar. A crystalline mineral used as a fluxing agent in clay bodies and some glaze recipes.

fettling. The removal or correction of blemishes, seams, or other imperfections before bisque firing.

filler. A material added to a clay body to lend strength, determine porosity, and affect shrinkage.

firing. The process of heating clay articles, usually in a kiln, to a specific temperature for a specific time until mature.

flashing mark. An effect on glazed pottery caused by uneven heat during firing.

flux. A melting agent added to a clay body to help the clay particles melt together, or fuse, into a solid material when fired.

foot. The base of a ceramic form.

frit. Ground glass used to make lead salts nontoxic to the skin or certain fluxes insoluble.

glaze. A coating of a glasslike substance that is fired onto a clay surface for decorative purposes or to seal a porous pottery body.

greenware. Formed pottery articles that are not yet bisque-fired.

grog. Unglazed, fired clay that has been ground up and added to a clay body to provide texture, increase porosity, lend strength and stability, or reduce shrinkage.

hand-build. To construct a piece of pottery from parts that might be pinched, coiled, slabbed, press-molded, extruded, or fashioned by hand.

heatwork. The combined measure of time and temperature.

kaolin. China clay.

kiln. A special oven used for firing clay.

kneading. The process of working and pressing plastic clay with the hands to help eliminate air bubbles, hard spots, and lumps; to distribute the moisture evenly; and to give the clay a consistent texture.

leather hard. A stage that clayware reaches during drying, when it is stiff enough to be picked up without distortion, yet soft enough to respond to pressure.

luster. A thin film of a metallic oxide applied to a fired, glazed surface, then fired at a low temperature to produce an iridescent effect.

mature. When ware and glazes have reached their proper heatwork—ware has reached its optimum strength and glaze has fully fused.

nonporous. Having no pores or openings to allow liquid to seep through; watertight.

oxide. One of various metal compounds used as colorants in glazes and clay bodies.

peephole. An opening in the side of a kiln for monitoring the pyrometric cones and the chamber during firing.

pinch-build. To manipulate clay by pushing the thumb into it and pressing with the fingers on the outside while turning the clay, creating a hollowed-out form.

porcelain. A high-fired, vitrified pottery with a white, fine-grained body that is usually translucent.

porosity. The degree to which fired clay can absorb water; also, the degree to which liquid can seep through fired or unfired clay.

porous. Having pores or tiny openings that allow liquid to seep through.

pyrometric cones. Little pyramids made of clay and glaze that are formulated to melt and bend as indicators of the temperature reached in the kiln.

refractory. Capable of being fired at high temperatures without deforming; a heat-resisting ceramic material.

salt glaze. A thin glaze produced by throwing salt into the kiln just before it has reached peak temperature.

score. To scrape a series of crisscross lines—using a needle tool, serrated rib, needle, paper clip, or other tool—onto a clay surface that has been brushed with slip. Two clay surfaces that have been slipped and scored can then be welded together.

sgraffito. Decoration by cutting or scratching away parts of a surface layer to reveal the different colored clay underneath.

slip. A creamy mixture of water and clay that is used to weld pieces of clay together or as a decorative element.

stamping. A decorating technique employing a recessed or raised design pressed into the clay.

stoneware. A strong and usually opaque ceramic ware that is well-vitrified and nonporous when fired to a high temperature.

template. A pattern for shaping the profile of a piece.

terra-cotta. A low-fired earthenware that fires to an orange, red, or brown color.

throwing. The process of shaping clay on the potter's wheel.

vitrify. To become glasslike and nonporous.

wedging. The process of mixing plastic clay by cutting it in half and slamming the halves back together to eliminate air bubbles, hard spots, and lumps; to distribute the moisture evenly; and to give the clay a consistent texture.

Pottery Resources

Scouting Literature

Archaeology, Art, and *Sculpture* merit badge pamphlets

With your parent or guardian's permission, visit Scouting America's official retail site, **scoutshop.org**, for a complete list of merit badge pamphlets and other helpful Scouting materials and supplies.

Books

Andrews, Tim. *Raku.* KP Books, 2005.

Atkin, Jacqui. *Pottery Basics: Everything You Need to Know to Start Making Beautiful Ceramics.* Barron's, 2005.

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Warshaw, Josie. *Handbuilding Pottery: Practical Art Handbook.* Anness Publishing, 2005.

Wensley, Doug. *Pottery: The Essential Manual.* Crowood, 2002.

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Zakin, Richard. *Electric Kiln Ceramics.* KP Books, 2004.

Zamek, Jeff. *Safety in the Ceramics Studio.* KP Books, 2002.

Organizations and Associations

American Art Pottery Association
P.O. Box 834
Westport, MA 02790-0697
aapa.org

The American Ceramic Society
P.O. Box 6136
Westerville, OH 43086-6136
ceramics.org

Ceramics Monthly
Toll-free telephone: 800-342-3594
ceramicsmonthly.org

National Council on Education for the Ceramic Arts (NCECA)
4845 Pearl East Circle, Ste. 101
Boulder, CO 80301
Toll-free telephone: 866-CO-NCECA
nceca.net

The Pottery Studio
thepotterystudio.com

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