1 Pottery and Its History

Pottery was the first synthetic material humans created—artificial stone—and it combines the four basic elements identified by the Greeks: earth, water, fire, and air. As one of many materials within the large sphere of technology known as ceramics, pottery has transformed a broad range of human endeavors, from prehistoric cuisine to the twentieth-century aerospace industry.

Besides prehistoric vessels and fragments, common ceramics include terra cottas, earthenwares, and stonewares such as craft items and flowerpots, and also china and porcelain tableware. Less obviously, perhaps, ceramics also encompass bricks, roof and floor tiles, sewer pipe, glass, and vitreous plumbing fixtures, as well as cements and plasters, abrasives, refractories, enameled metals, electrical insulation and conduction parts, space-shuttle tiles, spark plugs, and dentures (see Norton 1970, 408–74), and recently ceramic materials have been invented that can bond to living human tissue, opening up new medical applications (Hench and Etheridge 1982, 126–48). The connection between ancient pottery fragments, outer space, and modern medicine may seem tenuous, but it is present in the realm of ceramics.

1.1 Pottery and Ceramics: Definitions and Products

The term "ceramic" derives from the Greek *keramos,* variously translated as "burned stuff" or "earthenware"; it describes a fired product rather than a clay raw material (Oldfather 1920; see also Washburn, Ries, and Day 1920). Although in popular usage ceramics denotes materials made of clay, modern science applies the term far more broadly to chemical compounds combining metallic elements (which give up electrons) with nonmetallic elements (which add or share electrons). Thus one definition calls ceramics "the art and science of making and using solid articles which have as their essential component, and are composed in large part of, inorganic nonmetallic materials"

(Kingery, Bowen, and Uhlmann 1976, 3). Although some ceramics are compositionally complex, they may also exist as simple oxides of aluminum (Al_2O_3), magnesium (MgO), or barium ($BaTiO_3$).

The word ceramics has two sets of overlapping meanings, one set common to materials science and another employed in art and archaeology, which complicates its precise definition and usage. In materials science ceramics is a broad generic term, referring either to the entire range of compounds of metals and nonmetals or, sometimes slightly more restrictively, to materials manufactured from silicates (usually clays) and hardened by applying heat. The term also encompasses the research and applied fields developed around these products, that is, ceramic science, ceramic engineering, and ceramic industries. Pottery is one of several specific industries within the overall ceramic field (table 1.1) and includes low- and high-fired tableware, utensils, and tiles; the other ceramic industries manufacture structural, electrical, refractory, or glass products (Grimshaw 1971, 35).

In art and archaeology the term ceramics usually excludes construction or industrial products (cements, bricks, abrasives, etc.) and conforms more closely to dictionary definitions, which emphasize the plastic arts and clay working. Within these fields, ceramics refers to cooking and serving utensils and objets d'art manufactured of clay. Even here the term is sometimes employed more specifically to distinguish ceramics—high-fired, usually glazed, and vitrified—from pottery, which consists of low-fired, unvitrified objects and/or cooking and storage vessels. In Oriental studies an even finer distinction may be made, whereby ceramics denotes glazed and vitrified material intermediate technologically between low-fired pottery and high-fired translucent porcelain.

In terms of these several criteria of function, firing, and composition, prehistoric archaeologists and anthropologists investigating traditional crafts commonly treat only a subset of the diverse field of ceramics, that is, low-fired, unglazed, relatively coarse pottery vessels or art objects. (It is clear, however, that in the historical period as well as in much of Asia, high-fired glazed and vitrified ceramics provide a major component of the data base.) The fine distinction between ceramics and pottery is difficult to uphold in many situations, for example, in time periods or regions where domestic vessels were of vitrified clay. Nevertheless, given both the extremely broad technical meaning and the narrow art-historical meaning of the term ceramics, the bulk of low-fired, unvitrified material treated by anthropologists and prehistoric archaeologists is more properly referred to as pottery.

Table 1.1 Principal Ceramic Industries

Industry	Product
Structural ceramics	Bricks, tiles, drainpipes, concrete, flowerpots
Pottery	Artware, tableware
	Terra-cotta
	Earthenware, glazed and unglazed
	Stoneware
	China
	Porcelain
Refractories	Fireclay bricks, crucibles, insulation
Electrical	Spark plugs
Abrasives	Abrasives
Glass	Glasses, glaze

Source: After Grimshaw 1971, 35.

Prehistoric, historical, and modern pottery and ceramics are grouped into a number of categories called wares or bodies (table 1.2) on the basis of their composition, firing, and surface treatment (see Norton 1970, 1–7). The broadest division is into unvitrified versus vitrified wares, a distinction based on whether the composition and firing are such that the clay melts and fuses into a glassy (i.e., vitreous or vitrified) substance. Low-fired, porous, unvitrified pottery includes terra-cottas and earthenwares, while high-fired, vitrified ceramics include stonewares and porcelains.

Terra-cottas are relatively coarse, porous wares fired at low temperatures, usually 900°C or less. The earliest fired pottery in all areas of the world falls into this category. Terra-cotta vessels, sculptures, and tiles are generally not covered with a glaze, but they may exhibit several surface treatments that enhance their function. Roughening surfaces by beating with a carved or a cord- or fabric-wrapped paddle can increase the ability of vessels to absorb heat and prevent them from slipping out of the hands when wet. Alternatively, surfaces may be covered with slip or engobe, a liquid solution of fine clays and water that, in addition to cosmetic effects of coloring and smoothing, lowers the vessel's porosity and retards seepage of liquid contents. Terra-cottas are often subsumed within the broader category of earthenwares.

Earthenwares also include porous, unvitrified clay bodies, but they are fired at a wide range of temperatures from 800/900°C or so up to 1100/1200°C. In the lower part of the range they are roughly equivalent to terra-cottas. Earthenwares may be glazed or unglazed; although the body itself is not vitrified, the firing temperature may be high enough to allow a glaze to form properly. These wares are made from "earthenware clays," usually relatively coarse, plastic red-firing primary clays. This category of ceramic material includes a wide range of products, ranging from coarse earthenwares (sometimes called "heavy clay products") such as bricks and tiles to fine earthenwares such as tin-enameled majolicas, made with more refined white-burning

Table 1.2 Ceramic Bodies and Their Characteristics

Body Type	Porosity	Firing Range	Typical Applications	Comment
Terra-cotta	High: 30% or more	Well below 1000°C	Flowerpots, roof tiles, bricks, artware; most prehistoric pottery	Unglazed, coarse, and porous; often red-firing
Earthenware	Usually 10%–25%	Wide: 900–1200°C	Coarse: drainpipes, filters, tiles, bricks Fine: wall and floor tiles, majolicas	Glazed or unglazed; body nonvitrified
Stoneware	0.5%–2.0%	Ca. 1200–1350°C	Glazed drainpipes, roof tiles, tableware, artware	Glazed or unglazed; vitrified body
China	Low: usually less than 1%	1100–1200°C	Tableware	White, vitrified
Porcelain	Less than 1%; often nearly 0%	1300–1450°C	Fine tableware; artware; dental, electrical, and chemical equipment	Hard body; fine, white, translucent; "rings" when tapped

clay bodies. Earthenwares have served an enormous variety of household and construction purposes throughout the world for many millennia.

Stonewares are fired at temperatures of roughly 1200 to 1350°C, high enough to achieve at least partial fusion or vitrification of the clay body, depending on its composition. The body is medium coarse and opaque rather than translucent and often is gray or light brown. It is usually composed of "stoneware clays," which are typically sedimentary deposits such as ball clays (see Rhodes 1973, 22), highly plastic and low in iron. Stonewares may be unglazed or may have a lead glaze or, more frequently in modern times, a salt glaze. A distinctive fine, hard, porcelainlike European stoneware is Wedgwood jasper ware, containing high quantities of barium sulfate, which began to be made in England in the mid-eighteenth century.

The pinnacle of the potter's art, at least in terms of technical accomplishments, was reached with the Chinese production of porcelain, a thin, white, translucent vitrified ceramic that is customarily fired at temperatures of 1280–1400°C or higher. Porcelains are made of a white-firing, highly refractory kaolin clay (sometimes called "china clay"), relatively free of impurities, mixed with quartz and with ground, partially decomposed feldspathic rock that acts as a flux. When fired to high temperatures the feldspar melts, giving the product its characteristic translucency, hardness, and melodious ring when tapped. High-fired (but nontranslucent) porcelains in China are well known from the T'ang dynasty in the ninth and tenth centuries A.D. (Hobson 1976, 148), although "protoporcelains" or "porcellanous" stonewares are sometimes claimed to have been manufactured a millennium earlier in the Han dynasty (Laufer 1917; Li Jiazhi 1985, 159).

When Chinese porcelains of the Song, Ming, and later dynasties reached Europe, potters there tried a variety of experiments to achieve the same hardness and translucency, including adding ground glass to the clay, but they met with little success. The translucency of porcelain could be achieved but not the hardness, and the European product up through the eighteenth century was a "soft porcelain" or *pâte tendre* (Kingery and Smith 1985). Porcelains today are composed of 40% to 50% kaolin (sometimes with the addition of a more plastic ball clay), 25% to 30% feldspar, and 20% to 25% quartz or flint (Norton 1970, 336; Rhodes 1973, 53–54). "Bone china" is a late eighteenth-century English innovation in which calcined ox bones provide the desired translucency. Bone china, consisting of 40% to 50% bone ash, today is made almost exclusively in England (Norton 1970, 346–60).

1.2 History of Pottery and Ceramics

It is impossible to trace precisely the beginnings of human exploitation of the world's resources of earthy and clay substances. Although early stone tools from Africa are more than a million years old, the oldest objects of clay that archaeologists have found date only in the tens of thousands of years. Humans may have experimented with soft, plastic earthy materials considerably before this, perhaps hundreds of thousands of years ago, in uses as ephemeral as painting their bodies with colored clays. But the essential features in the history of use of this resource is the application of heat to transform the soft clay

into something hard and durable. A relatively recent achievement by the yardstick of prehistory, it is this transformation that allowed broken bits of pottery to survive millennia and come into archaeologists' hands for study.

Any discussion of the history of pottery and ceramics must begin with the recognition of clay itself as a useful raw material (see table 1.3). Clay is certainly one of the most abundant, cheap, and adaptable resources available for human exploitation. Earliest archaeological evidence for its use ties it to the diverse artistic expressions of the Upper Paleolithic period of central and western Europe. Many Paleolithic caves have designs traced into wet clay on walls and floors, in addition to the more familiar animal paintings. At the Tuc

Table 1.3 Chronological Sequence of Developments in Pottery and Ceramic Technology

Development	Europe	Near East	Far East	Western Hemisphere
Fired clay figurines	Dolní Věstonice, Czechoslovakia, 30,000 B.C.			
Pottery		Anatolia, 8500–8000 B.C.	Japan, 10,000 B.C.	Various, 3000–2500 B.C.
Kiln	[England, late 1st millennium B.C.]	Iran, 7th millennium B.C.	China, 4800–4200 B.C.	Mexico, A.D. 500
Wheel		3500 B.C.	China, 2600–1700 B.C.	[16th century A.D.]
Brick—adobe		Zagros, 7500–6300 B.C.		Coastal Peru, 1900 B.C. Mexico, 900–800 B.C.
Brick—fired		Sumer, 1500 B.C.		Mexico, A.D. 600–900
Stoneware	Germany, 14th century		China, 1400–1200 B.C.	
Glazes				
Hard		16th century B.C.	China, 1028–927 B.C.	
Lead		100 B.C.	China, 206 B.C.–A.D. 221	
Celadon			China, 4th century	
Fritted			China, 8th century	
Tin	Southern Italy, 13th century England, 17th century	Assyria, 900 B.C.		
Salt	Germany, 16th century			
Porcelain	Germany 1709 France 1768		China, 9–10th century Japan, 1616	
Bone china	England, late 18th century			
Gypsum plaster mold	Italy, 1500			
Jiggering	1700			
Slip casting	1740			
Pyrometric cones	1886			

d'Audoubert cave in France two modeled bison were found, formed of unfired clay. Among the famous "Venuses"—female figurines with exaggerated sexual characteristics—are specimens formed of fired and unfired clay from Dolní Věstonice in Czechoslovakia; dating to about 30,000 B.C. (Zimmerman and Huxtable 1971), some of the figurines were made of clay mixed with crushed mammoth bone.

These examples suggest that by the late Paleolithic period three significant principles of clay use were already known. One is that moist clay is plastic: it can be shaped and formed and will retain that form when dried. Another principle is that fire hardens clay. A third is that adding various substances to clay can improve its properties and usefulness.

The use of clay to make pottery containers does not seem to have originated in any single time and place in human history; rather, the idea seems to have been independently invented in an unknown number of centers. Several scenarios have been proposed to explain the origins of pottery; all are intuitively appealing and may have some basis in fact. Unfortunately, though, simple answers to "Why?" questions in archaeology are not easy to come by, and the whys and hows of pottery origins are no exception. Multiple causes are more probable explanations for almost all prehistoric cultural developments; thus the beginnings of pottery may be a consequence of numerous lines of experimentation and accumulation of practical experience.

One unusual suggestion is that pottery vessels may have developed out of "soil crusts," the surfaces of fine clay deposits that, during sun drying, shrank and warped into shallow bowllike forms (Goffer 1980, 108).

A more typical reconstruction of pottery origins calls attention to the fact that in many parts of the world the earliest pottery known archaeologically occurs in forms or with decorations that resemble earlier containers made of other materials. These pottery skeuomorphs often mimic containers of birchbark (Speck 1931), metal (Trachsler 1965), gourds (Joesink-Mandeville 1973), wood (Mellaart 1965, 220), or soapstone (Griffin 1965, 105–6), or leather bags or baskets. The similarities have led to suggestions that pottery utensils may have developed out of the use of clay to line, mend, or reinforce containers such as baskets (see, e.g., Wormington and Neal 1951, 9). This was once a popular explanation for the origins of Southwestern United States pottery, but the theory was based on the basketlike "corrugated" ceramic wares from this area, which actually occur relatively late in the technological sequence rather than early (Morris 1917; Gifford and Smith 1978).

Alternatively, clay could have been used alone, perhaps to form containers that were only dried and hardened in the sun; these would have served well for holding dry goods such as grains, seeds, nuts, or herbs. In prepottery Neolithic settlements at both Jarmo and Jericho in the Near East, clay-lined storage pits, "baked in place" basins set into house floors, fire pits, and ovens have been found (see Amiran 1965, 242). It is not difficult to imagine that once people recognized the durability and impermeability of the hardened clay that lined these pits they would have experimented with firing clay to create portable containers.

For archaeologists, the problem in all these reconstructions is that unfired clay objects are ephemeral and leave only rare traces in the archaeological

record. They are easily broken, crushed, or dissolved by liquid and quickly return to their original state. Thus the early use of clay for making or modifying containers is still poorly documented.

The use of unfired clay for artistic or utilitarian objects is not restricted to the earliest stages of cultural development, however. Unfired clay vessels were found in tombs in Nubia from A.D. 300–550 (Williams, Williams, and McMillan 1985, 46); in the Near East unfired clay objects come from excavations into structures dating to the early Sumerian civilization, and a variety of unfired "mud" dishes and other utensils are made by Bedouins in the same area today (Ochsenschlager 1974); and some Eskimo pottery from A.D. 1000 to 1600 was unfired (Stimmell and Stromberg 1986, 247). Unfired, sun-dried clay objects are made and used today in Papua New Guinea (May and Tuckson 1982, 7). Nonetheless, in most cases it is only when clay items were subjected to fire—intentionally or accidentally, through burning of dried clay parching trays or setting a clay-lined basket too close to the fire—that they survived and allow us to piece together a technological history of pottery.

The appearance of pottery vessels in the archaeological record was at one time interpreted within evolutionary theories as marking the development of human societies out of "Upper Savagery" into "Lower Barbarism" (Morgan 1877), but in more recent thinking pottery is seen as part of the so-called Neolithic technocomplex. This is an assemblage of tools and containers for food preparation and storage, together with the associated technology of their manufacture and use, that correlates in a very general way with worldwide changes in human lifeways at the end of the Paleolithic period or soon thereafter. These changes are dramatic, involving the adoption of food production rather than collecting, and settlement in villages rather than temporary encampments. Although there is no necessary causal relationship between agricultural life and pottery making, it is true that even today pottery is primarily made in sedentary as opposed to nomadic societies (table 1.4). When scrutinized on a smaller scale, however, the Neolithic changes appear as the culmination of a long series of connected adjustments and alterations in social and ecological relationships. The changes took place over several millennia and occurred in different ways at different times in different areas.

Pottery, rather than being a spectacular new achievement at this time, is better considered as a transformed exploitation of an already familiar raw material. The appearance and widespread adoption of fired pottery reflects both continuing and new needs for tools and resources—principally storing and

Table 1.4 Relation between Pottery Making and Sedentism among Fifty-nine Ethnographic Societies

	Settlement Type			
	Nonsedentary	Partially Sedentary	Fully Sedentary	Total
Pottery-making societies	2	12	32	46
Non-pottery-making societies	6	4	3	13
Total	8	16	35	59

Source: Arnold 1985, table 5.3. From the Human Relations Area Files Probability Sample Files.

preparing newly important foods such as domesticated grains—and new ways of meeting these needs. In fact one theory of the origins of pottery relates it to the need to detoxify plant foods by heating (Arnold 1985, 129–35). All of this is not to minimize its significance from the viewpoint of the history of technology, however, The technological achievements that underlie pottery making established the foundations for many other ancient and modern technologies such as metallurgy, brick architecture, and engineering.

1.2.1 Pottery and Ceramics in the Old World

1.2.1.1 The Near East

In the Near East, although Paleolithic use of clay has not been documented archaeologically, after about 10,000 B.C. clays were used for a variety of purposes including architecture, pottery, and small modeled clay objects. Their order of appearance varies from region to region within the area.

Architectural use of clay is widespread very early (by 7500 B.C.) in all areas of the Near East and calls attention to the integration of clay exploitation with sedentary agricultural settlements. Clay was used by itself or mixed with chaff or straw from the fields as poured or "puddled" adobe for constructing walls of permanent houses, as plaster or mortar over rock or pole walls, and for floors and roofs. Indeed, wheat and barley kernels are often found embedded in the clay of these buildings (Amiran 1965, fig. 1). Adobe bricks began to be used as early as 7500–6300 B.C. in the Zagros area (Schmandt-Besserat 1974). Planoconvex bricks, formed in a mold and dried in the sun, continued to serve in the construction of residences, temples, and burial chambers for millennia; fired bricks were probably regularly in use by 1500 B.C.

Pottery containers appear perhaps as early as 8500–8000 B.C. at Beldibi (Bostanci 1959, 146–47, cited in Schmandt-Besserat 1977a, 133) and Çatal Hüyük (Mellaart 1964, 1965) in southern Turkey, whereas in Syria pottery did not occur until about 6000–5500 B.C. (Schmandt-Besserat 1977b, 40). In the Zagros area, figurines and geometric cones, spheres, and disks were made of clay as early as 8500–7500 B.C., and in the succeeding millennium pottery containers—which may or may not have been fired—began to be made (Schmandt-Besserat 1974). The earliest vessels in the Near East were hand built by coiled or segmental building (Mellaart 1965, 220) and then scraped, paddled, or rubbed to produce an even finish; they were fired without kilns in open bonfires, using wood or dung cakes for fuel. These and later vessels come in a range of shapes, including bowls, cups, and trays, and later are decorated with paint and incised lines. Their decoration depicts a variety of plant and animal forms (fig. 1.1), human activities, and costuming; and the context of recovery—burials, household activity areas, refuse deposits—provides many clues to their diverse functions.

Despite the common use of fired clay, objects formed of unfired clay continued to be important. At Çayönü, in Anatolia, in the period about 6500 to 6000 B.C., before the manufacture and use of fired pottery, various unfired clay objects have been found, including models of houses, a bowl formed by lining a basket with clay, animal and human figurines, and a clay-lined bin (Redman 1978b, 160).

Figure 1.1 Painted Samarran-ware bowl from the site of Hassuna, a sixth-millennium B.C. village in Iraq. After Redman 1978b, fig. 6-9.

At a number of sites in the Near East, unfired or low-fired clay tokens, inscribed with various notations, may constitute early records of economic transactions that can be linked to the later development of writing (Schmandt-Besserat 1978; cf. Lieberman 1980). The variety of sizes and shapes of the objects (cones, disks, etc.) may correspond to kinds and quantities of goods. These shapes are echoed in the earliest examples of writing, which appear in cuneiform on clay tablets by the late fourth millennium. When fired, as at Ebla (Tell Mardikh), whether intentionally or accidentally, these clay tablets formed a permanent "library" of knowledge and activities of the time (Matthiae 1977).

Female figurines, "mother goddesses," were widely produced in early agricultural towns and villages in the Near East and may have connections with fertility or household religious practices. Numerous other items of clay were also manufactured, including toys, models of houses, and tools. Among the tools are "administrative artifacts" such as stamp and cylinder seals used for recording and identification in economic transactions, loom weights and spindle whorls used in weaving and spinning, and clay sickles, with inset stone blades, for harvesting grain.

By 1500 B.C. three major characteristics of ceramic manufacture—ancient and modern, craft and industrial—had developed in the Near East. These include the use of kilns (open topped) for firing, the potter's wheel, and glazes. These developments had far-reaching significance in pyrotechnology and in the organization of craft production beyond simply providing household cooking pots and drinking cups.

Kilns, or firing chambers, are significant innovations because the enclosed space concentrates available heat, permitting higher temperatures, better control of the firing process, and more efficient use of fuel. The earliest kilns were probably open topped—either pit kilns or built aboveground—and fulfilled these functions only minimally. Later changes in kiln design, involving enclosed chambers to provide maximum firing control, permitted successful manufacture of high-fired vitrified ceramics. Such high-temperature firing control also contributed to the beginnings of bronze metallurgy (smelting of metal ores) and glassmaking. Several kilns are known from the fifth millen-

nium B.C. in the Near East, and one near Susa in Iran is dated to the seventh millennium B.C. (Majidzadeh 1975–77, 217).

The potter's wheel allowed rapid mass production of standardized forms and development of a ceramic industry serving a large market. The true potter's wheel, on which vessels are "thrown," combines the principle of the pivot, also used in wheeled vehicles, with the principles of rotary and centrifugal motion. It was probably preceded by a "slow wheel," "hand wheel," or tournette on which vessels could be turned during shaping but where the actual rotary force was not a fundamental part of vessel forming as it is in the true wheel. One line of evidence—not entirely reliable—for the use of potter's wheels is the characteristic "rilling" or spiraling ridges on vessel surfaces formed by pressure of the potter's hands during throwing. Archaeological discovery of actual potter's wheels is of course the best evidence of this technique, but those made of wood may not have survived. Wheels or pairs of socketed hand wheels of stone or clay seem to have been common in the Near East after about 3500 B.C. (Amiran and Shenhav 1984; Lobert 1984).

Glazes are vitreous (glassy) coatings melted on the surfaces of vessels to make them watertight. Their manufacture is dependent both on knowledge of how to prepare a substance that will melt to form a glass and on the ability to sustain a high enough temperature in firing so this melting can take place. Glazed faience beads were made in Egypt during the Predynastic period, about 4000–3100 B.C. (see Vandiver 1982), and there is some evidence that alkaline glazed pottery manufacture may have begun about the sixteenth century B.C. in the Near East (Hedges and Moorey 1975).

One of the major kinds of glazes on earthenwares, ancient and modern, is the lead glaze. Lead acts as a flux in glaze composition; that is, it lowers the melting or fusion point of the glaze mixture, allowing it to form a glass at lower temperatures. Lead glazes are generally clear and often green though yellows and reds are also common; copper was a typical colorant. They apparently developed in China during the Han dynasty, 206 B.C. to A.D. 200 (Shangraw 1978, 44), and in the Near East about 100 B.C.

A second kind of earthenware glaze is the tin glaze, a thick white coating made opaque by adding stannic (tin) oxide to a lead glaze. These opaque glazes mask defects in finish or color of the vessel body and provide a clean background for painted decoration, often executed in blue or in polychrome colors. Tin glazes (or enamels) were first used in decorating brick panels by the Assyrians after 900 B.C., then the knowledge of their manufacture was lost until it was rediscovered by Islamic potters in the ninth century A.D. Never popular in China, tin-glazed pottery and tiles were produced in the Islamic Near East and North Africa; knowledge of their manufacture traveled with the Moors to Spain and Italy and later to the New World in the sixteenth century.

1.2.1.2 The Far East

It is in the Far East—primarily China, Korea, and Japan—that the earliest innovations in virtually all stages of the potter's art can be found. Because of these outstanding technical and aesthetic advancements throughout the history of the craft, little attention has been paid to the earliest "primitive" stages, and as a result many questions remain concerning the beginnings of clay use in this area.

The oldest pottery known in Japan is a very well made type called Jōmon, or "cord pattern," because of its distinctive cord-marked or string-impressed decoration (fig. 1.2). The dates of Jōmon pottery are highly controversial, because radiocarbon measurements suggest some pieces may be over twelve thousand years old (Ikawa-Smith 1980, 138). A thermoluminescent dating program on some Jōmon material, while not yielding evidence of such antiquity, generally supported the radiocarbon ages of the various periods and gave mid-sixth millennium B.C. dates for the earliest Jōmon period pottery (Ichikawa, Nagatomo, and Hagahara 1978). Jōmon pottery is hand built and consists primarily of beakers or deep jars with small bases, which often seem unstable and poorly suited for practical use. Although the entire range of early through late Jōmon pottery is characterized by impressed and modeled (rather than painted) decoration, the most elaborate of these products were produced in the Middle Jōmon period (second millennium B.C.), with heavy appliquéd fillets and buttons, castellated rims, and deeply incised grooves (see Kidder 1968; Rathbun 1979).

In China little is known of the very earliest stages of the potter's art, though the late prehistoric and historical periods are very well studied. The earliest pottery in the area comes from coastal southeast China and adjacent regions and consists of a variety of cord- and shell-marked and incised types (Chang 1977, 85–90). Dating is somewhat uncertain; although dates in the fifth millennium range seem most acceptable, a new radiocarbon determination from the interior of Jiangxi Province gives a date of 6875 ± 240 B.C. (Chang 1977, 511). Nine thermoluminescence dates on pottery from Zenpiyan, in Guangxi

Figure 1.2 A late Jōmon jar from Japan, showing characteristic cord marking; height 47 cm. Courtesy Royal Ontario Museum, Toronto, Canada.

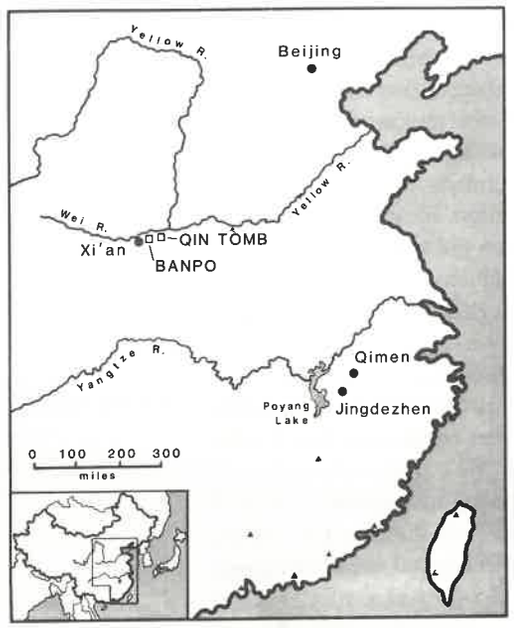

Figure 1.3 Map of east-central China, showing locations of interest in ceramic history. Small triangles show locations of sites with early cord-marked pottery.

Figure 1.4 A late Yangshao funerary urn of Banshan type, from northwest China. After Blandino 1984, 15.

Province, range from 6990 to 10,340 B.P. (Wang and Zhou 1983, tables 1 and 3).

The best-known early Chinese pottery (see Shangraw 1978) comes from the Yangshao culture in the Yellow River valley (fig. 1.3), between 4800 and 4200 B.C. Potters at Banpo and other Yangshao villages produced beautiful hand-formed jars and dishes painted with red-and-black geometric decoration (fig. 1.4), so skillfully made that they could not represent the beginnings of the craft. Furthermore, these wares were fired in small, subterranean horizontal and vertical updraft kilns (fig. 1.5) on the outskirts of the villages (Shangraw 1977); these Neolithic kilns could achieve firing temperatures of 950°C (Li Jiazhi 1985, 143). The date of production of these wares is comparable to the fifth-millennium dates of the early kilns in the Near East. Incised marks on some of the Banpo vessels have been interpreted as maker's marks associated with particular family lines (Chang 1983, 84–86) and may show

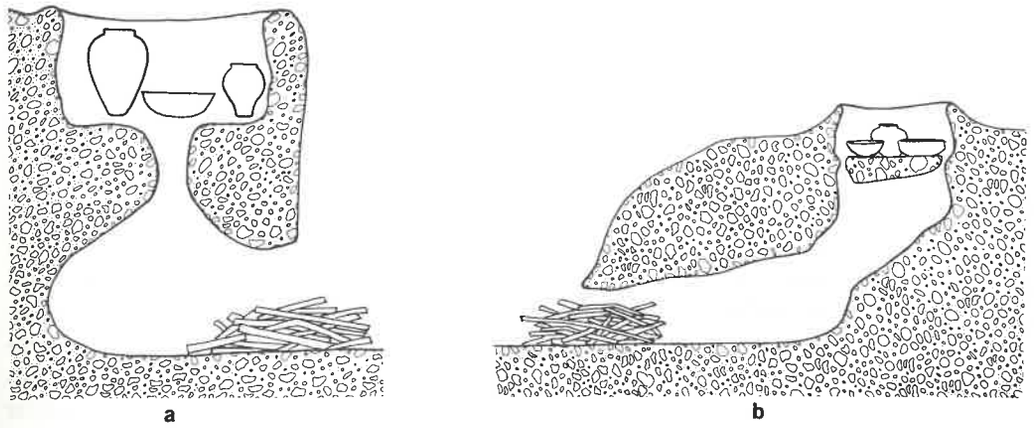

Figure 1.5 Reconstruction of early bank kilns found at Banpo, China: *a*, vertical kiln; *b*, horizontal kiln. After Shangraw 1977, 389.

some relation to later characters, particularly numerals, in Chinese writing (Cheung 1983).

There is little evidence for the beginning of use of the potter's wheel in China. It has recently been suggested that a low, thick-walled dishlike vessel commonly found at Yangshao sites between 4800 and 3600 B.C. may actually have been used as a slow or low-speed wheel (Zhou Zhen-xi 1985). The fast or true wheel was apparently used during the Zhou (Chou) period, roughly the first millennium B.C. (Hobson 1976, 2).

One of the most spectacular finds of archaeological pottery is the army of 7,500 life-size soldiers and horses found in 1974 near Xian, China. Guarding the tomb of Emperor Qin Shi Huang, the first unifier of China in 221 B.C., the terra-cotta army was formed in separate pieces but without molds. Solid or hollow legs support hollow torsos made of coils of clay; heads, arms, and legs were shaped separately, then attached to the bodies with strips of clay; individualized facial features and costume details were sculpted or appliquéd to finish the pieces before firing, then after firing the pieces were painted with red, green, black, and other colors (Hearn 1979, 46–48; Museum of Qin Shi Huang 1981, 11–14).

Chinese ceramic history is marked by numerous technical achievements of lasting impact, particularly in the field of high-fired bodies and in glazes (Li Jiazhi 1985; Zhang Fukang 1985). By the Middle Shang period, between the fifteenth and thirteenth centuries B.C., stonewares were being produced in kilns capable of reaching 1200°C (Li Jiazhi 1985, 144). At about the same time, glazes were produced using a combination of CaO (lime) and wood ash as fluxes (Zhang Fukang 1985, 164, 170), so vessels may have been given a "natural kiln glost" from wood ash during the firing. True hard (feldspathic) glazes began to be used a few centuries later in the Early Western Zhou period (Shangraw 1977, 383; 1978, 43–46).

One of the most beautiful of Chinese wares is celadon, identified by its distinctive sea green, apple green, or olive green glaze. The delicate color, described as "the blue-green color of distant hills," is so similar to jade that the

ware was sometimes called "false jade." The origin of the term celadon is uncertain: one theory is that it was named after Saladin, a twelfth-century Islamic potentate, while another calls up the gray-green costume of Celadon, the shepherd hero in a seventeenth-century French pastoral comedy (Wykes-Joyce 1958, 54). Although celadon glaze manufacture has been dated as early as the fourth century A.D. (Mikami 1979, 12), the most famous of the celadons were those produced in the Longquan (Lung Ch'uan) District of the Southern Song dynasty (A.D. 1127–79) and later (Hobson 1976, 16; Li Hu Hou 1985; Vandiver and Kingery 1984). Celadons were widely popular throughout Asia, which can be attributed not only to their beauty but also to their supposed magical or curative powers. It was believed in India and Persia, for example, that a celadon bowl would crack or change color if its contents were poisoned, and a famous Song celadon censer, shaped like a bird, was said to make birds burst into song and to cry out to its owner if danger was near (Spinks 1965, 98–99). Medications were also thought to be more powerful if prepared in a celadon vessel or if such a vessel or its glaze was ground and mixed into the potion (Spinks 1965, 99–100).

The most enduring legacy of Chinese potters is porcelain, originally called *porcellana* (shell) by Marco Polo becaue of its delicate translucency. The origins of porcelain are uncertain. Historical texts are not conclusive: there is no single Chinese word for porcelain as distinct from other kinds of pottery, although the beginning of a new written character, *tz'u* (or *ts'e*) during the Han dynasty (206 B.C. to A.D. 220) has sometimes been interpreted as signaling the creation of a distinctive new ceramic product (see Hobson 1976, 140–42). Compositionally, some of the hard-fired stoneware ceramics manufactured in this period or earlier (Shang-Zhou) have been called "porcellanous" stoneware (Laufer 1917) or protoporcelain (Li Jiazhi 1985, 135), but they lack the characteristic white color and translucency of true porcelain. Excavations of tombs in the region of Anyang and Xian in northern China yielded white porcelains, revealing that its manufacture dates as early as the Northern and Sui dynasties (late sixth century A.D.), though no kiln sites of this early date have been found (Li Guozhen and Zhang Xiqiu 1986, 217). Until recently, it was the recovery of Chinese porcelains from outside China that provided the basis for inferring a somewhat later date of production, that of the T'ang dynasty, A.D. 618–906 (Hobson 1976, 148). A set of thirty polychrome porcelain headrests was excavated at an ancient Nara period (A.D. 649–794) temple in Japan (Mikami 1979, 110), and porcelains were also found in the ninth-century Moslem center of Samarra, on the Euphrates River in modern Iraq, which flourished from A.D. 836 to 883 (Wykes-Joyce 1958, 51). White, hard, translucent, and resonant, porcelain reached its finest development in the Song dynasty (A.D. 960–1279) and thereafter and was compared by lyrical Chinese poets to jade, snow, and lotus leaves.

Chinese porcelains are most closely identified with the "imperial kilns" at Jingdezhen (formerly Ching-tê-chên, or Ch'ang-nan). This city (see Tichane 1983) rose from humble origins as an old market town (*chên*) on the east bank of the Chang River in northern Jiangxi (Kiangsi) Province, to become "the metropolis of the ceramic world, whose venerable and glorious traditions outshine Meissen and Sèvres and all the little lights of Europe, and leave them

eclipsed and obscure" (Hobson 1976, 152). Although skilled potters were to be found in the area centuries earlier, the meteoric rise of Jingdezhen as one of the world's great potting centers began when Emperor Ching Te (A.D. 1004–7) of the Song dynasty decreed that its kilns should produce wares for the imperial capital (Hobson 1976, 45, 156). Most of the later Chinese export porcelains (see Gordon 1977; Weiss 1971, 44–46) were manufactured at Jingdezhen for shipment to Europe and the New World.

Chinese pottery and porcelains exerted incalculable influence on the ceramic industries of other nations for more than a millennium. The earliest evidence for long-distance export of Chinese products is in the time of the T'ang dynasty, when porcelains came to be popular among the Asian aristocracy (Mikami 1979, 35). Celadons reached Korea by the eleventh century (Mikami 1979, 13), and porcelains arrived there in the fourteenth century. The arrival of Korean potters in Japan, allegedly by force during the "Ceramic Wars" (1592–98) involving trade with Europeans, led to the beginnings of porcelain manufacture there, and the discovery of kaolin clay stimulated the founding of the famous kilns at Arita in 1616 (see Weiss 1971, 48–49). Archaeomagnetic dating has been used to confirm some of the legends surrounding the beginning of porcelain at the time (Fleming 1976, 173).

Contacts with the Near East flourished especially during and after the Mongol Yuan dynasty (A.D. 1280–1367), when there was considerable interchange between the Chinese and Islamic ceramic arts. One significant import from the Near East during this period was pure cobalt pigment—called "Mohammedan blue" or "sacrificial blue" (Zhang Fukang 1985, 173)—for underglaze decoration; the local cobalt in China was contaminated with small amounts of manganese and did not fire well (Wykes-Joyce 1958, 57). The result of this trade was the foundation of the Chinese blue-on-white decorative tradition that has continued to the present (see Weiss 1971, 26–29).

1.2.1.3 EUROPE AND THE MEDITERRANEAN

Europe was not an independent center of pottery development; the appearance and development of the craft were tied to the broader range of technology associated with agriculture and sedentary life pioneered in the Near East.

Two kinds of pottery in Europe and the classical world, Greek figured pottery and Roman Arretine ware, represent outstanding technical achievements. Both these wares, judged by their firing and other characteristics, probably should be classed as high-fired terra-cottas or low-fired earthenwares. Neither is glazed, though their fine glossy slips have sometimes been erroneously referred to as glazes.

Greek black- and red-figure pottery (Noble 1966; Richter 1976) was manufactured during the sixth through fourth centuries B.C. in Athens. The distinctive painted decoration (fig. 1.6) was applied by potters or by a separate group of vase painters who sometimes signed their work, and the painted scenes depict a variety of activities of Greek life, both ceremonial and prosaic (Beazley 1945; Thompson 1984; Von Bothmer 1985). The occurrence together of both red and black iron paints and slips on these vessels entranced and perplexed scholars for generations, but experiments to reproduce them did not succeed until the early twentieth century (Schumann 1942; Stross and Asaro 1984,

Figure 1.6 A Greek red-figure vase, showing painters at work. Courtesy of Joseph V. Noble.

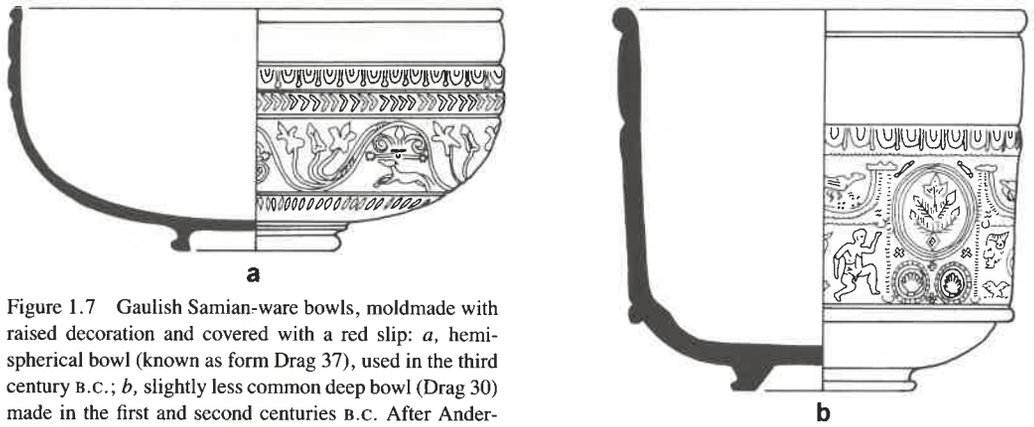

Figure 1.7 Gaulish Samian-ware bowls, moldmade with raised decoration and covered with a red slip: *a*, hemispherical bowl (known as form Drag 37), used in the third century B.C.; *b*, slightly less common deep bowl (Drag 30) made in the first and second centuries B.C. After Anderson 1984, fig. 27.

181–83). It was found that the colors and gloss of the paint derived from a particular clay mineral (illite) and from careful control of kiln atmosphere in firing.

Roman Arretine ware dates from the first century B.C. to the fourth century A.D.; the name comes from ancient Arretium (modern Arezzo), a center of production in northern Italy. These beautiful lustrous red bowls and jars were copied at multiple centers of manufacture (Johns 1977a; Peacock 1982, 114–28) and were widely traded throughout Roman Europe. Wares made in what is now France and Germany, for example, are referred to as samian or Gaulish Samian (from Samos) ware (fig. 1.7) or as *terra sigillata* (meaning "clay impressed with designs"). Like the Greek gloss paints, the distinctive red slips of Arretine and Samian wares are fine illite clays fired in a carefully

controlled atmosphere at temperatures between 980 and 1260°C (Lawrence and West 1982, 212; Bimson 1956; Tite, Bimson, and Freestone 1982). Vessels were formed in wheel-thrown molds and often feature the name or mark of either the vessel maker or the mold maker on their surface (see Hoffman 1983).

During the Renaissance, the technique of tin glazing moved from the Mahgreb (North Africa) to southern Italy by the fourteenth century (Whitehouse 1980) and then to Spain, France, Germany, and the Netherlands, finally reaching England in the seventeenth century. The type of pottery on which this glaze appears is a fine earthenware known variously as majolica or maiolica, faience, or delft after the hypothesized (and often confused) locations of manufacture or distribution throughout Europe (Wykes-Joyce 1958, 74). Maiorca (or Majorca) is an island from which tin-glazed wares were shipped to Italy, so Italians named the pottery after the island, maiolica; Faenza is a city in Italy from which Italian tin-glazed wares were exported to France, so the French called the pottery faience (not to be confused with a much earlier Egyptian silica-rich glazed material also called faience). Delft wares (Fourest 1980) are later products from the town of Delft in the Netherlands, made in imitation of Chinese blue-and-white porcelains.

European potters continued making tin-glazed earthenwares, and by the fourteenth century Germany had taken the lead in producing a well-developed stoneware. Potters also experimented with reproducing the highly desirable "hard" Oriental porcelains (Weiss 1971, 60–83), but they were hindered in that endeavor by a lack of suitably plastic and white-firing kaolins. Although an experimental porcelain had been made by Grand Duke Francesco Maria de' Medici in Italy in the late sixteenth century (Wykes-Joyce 1958, 78–79; Weiss 1971, 69; Kingery and Smith 1985), it was not until the early eighteenth century that a viable product was achieved. Two Germans, "alchemist" Böttger and physicist von Tschirnhausen, found a local source of kaolin clay that permitted them success in creating a hard, white, translucent porcelain body—a success achieved, according to Böttger's notes, at 5:00 P.M. on January 1708, after a twelve-hour firing (Weiss 1971, 60). With that discovery in 1710 a royal porcelain factory was later established at Meissen, near Dresden (Wykes-Joyce 1958, 136–39). The French continued to produce soft porcelains at Vincennes (d'Albis 1985) and Sèvres until kaolin was discovered at Limoges in 1768, at which point true hard porcelain soon began to be manufactured in that country. In the late 1700s in England, Josiah Spode added calcined ox bones to a porcelainlike fine stoneware body formula, producing "bone china," which is white, translucent, and very hard.

1.2.2 Pottery in the New World

In the Western Hemisphere the development of pottery proceeded independent of that in the Old World, and from several apparently unrelated areas of origin. As in the Old World, its beginnings in the New World archaeological record are broadly correlated with the transition to horticulture and sedentary settlement in several regions after the end of the Pleistocene. But because these developments themselves varied considerably in time and mode of occurrence, the association of pottery with them is general, not specific.

Two facts are striking about the development of pottery in the New World as compared with the Old. One is that its earliest appearance is considerably later in the New World, by five thousand years or so. Second, two of the hallmarks of Old World ceramic production, glazes and the potter's wheel, never appeared in the pre-Columbian New World, nor were kilns ever widely used.

Surfaces of aboriginal vessels were covered by clay-rich slips rather than glazes, although vitreous glaze paints were manufactured and used in the Southwestern United States after A.D. 1000 (Shepard 1942a, 1965; DeAtley 1986). A shiny, lead-colored surface appeared on a widespread trade pottery called "Plumbate" in Mesoamerica about A.D. 1000 and is sometimes mistakenly referred to by archaeologists as a glaze. The coating was actually a clay-rich slip, however, its distinctive color and shine resulting from peculiarities in composition and firing (Shepard 1948a), and although it is vitrified in places it is not a true high-fired vitreous glaze. Similarly, potter's wheels were unknown in the New World. Although several devices (e.g., the *kabal* in Yucatán [Thompson 1958] and the *molde* in Oaxaca [Foster 1959] were used by potters to help turn the vessel during forming, the continuous, high-speed rotation of the true wheel was not attained.

Probable pottery kilns have been identified in highland Mexico (Abascal 1975; Payne 1982) as well as a few other areas, and these were primarily used after A.D. 500. In general, however, most New World pottery was fired in open bonfires rather than enclosed chambers. Firing temperatures were most commonly in the range of 700 to 900°C (see Shepard 1976, 84, 87). Stonewares and porcelains were never manufactured in the New World because in the general absence of kilns the consistently high temperatures necessary for vitrification could not be attained, and thus all New World aboriginal pottery falls into the category of terra-cottas or earthenwares. Glazes, wheels, and kilns were introduced to the Americas in the sixteenth century by European explorers and settlers.

Identification of the earliest pottery in the New World is a matter of some disagreement. A very early complex of vessel forms and decorative styles from Valdivia, on the coast of Ecuador, dates to approximately 2500 B.C. (Meggers and Evans 1966). The pottery is similar in some general characteristics (chiefly decoration) to Jōmon pottery from Japan. This has prompted some speculation that a group of Japanese fishermen blown off course and shipwrecked in this area may have managed to persuade or coerce local inhabitants to make what was to be the first New World pottery. But subsequent excavations at the site revealed an earlier pottery style stratigraphically below the Jōmon-like material (Bischoff and Viteri Gamboa 1972), so the Japanese-origins hypotheses is at present given little credence.

The early development of pottery in other areas of the New World at approximately the same time, 2500 to 2000 B.C. or earlier, also supports hypotheses of indigenous development rather than diffusion. These areas of early pottery assemblages include the coast of Colombia (Reichel-Dolmatoff 1961), Pacific coastal Mexico (Brush 1965), and the southeastern United States (Sears and Griffin 1950). Relatively simple forms, often echoing the shapes of gourds or stone bowls, were hand modeled and decorated with incising or, in Mexico, with a red wash or slip. Both the Colombian and the

southeastern United States examples were made of clay mixed with plant fibers, stimulating hypotheses that they may represent interrelated technologies resulting from population movements through the Caribbean islands (Bullen and Stoltman 1972).

From these beginnings, the next four thousand years of New World pottery development reveal great elaboration of forms and decoration, particularly in polychrome painting. Architectural uses of clay varied from area to area. Adobe bricks were commonly used in ceremonial buildings on the Peruvian coast, beginning by the Initial Period (1900–1800 B.C.) at the northern site of Las Haldas, whereas in the Andes highlands stone was more typically used. In Mesoamerica stone was employed far more often than adobe; adobe bricks were used in Late Formative period (ca. 900–800 B.C.) ceremonial architecture at Oaxaca (Flannery 1976, 24), and fired bricks are rare, being particularly associated with a Late Classic (ca. A.D. 600–900) lowland site of Comalcalco, in Tabasco, Mexico.

Lacking the wheel and kiln, New World potters were rarely able to attain the same levels of technical achievement and standardized production as did their stoneware- and porcelain-producing Old World contemporaries. In consequence, the artistic and utilitarian excellence of their products, while entirely the equal of Greek figured or Arretine pottery, is often denigrated as "primitive" or simply ignored by Old World scholars. Yet outstanding examples of the potter's craft are to be found all over the ancient New World.

In South America, from 200 B.C. to A.D. 700, Nazca (Proulx 1968) and Moche (Donnan 1965) potters on the coast of Peru produced stirrup-spouted vessels decorated with modeled and painted houses, animals, plants, and human faces so individualized as to suggest actual portraits (fig. 1.8). These polychrome designs included red, black, brown, yellow, blue, green, pink, and white colors. Other elaborate polychrome vessels, decorated with geometric and stylized natural motifs, were made throughout the Andes up to the coming of the Spaniards.

In Guatemala and Mexico, Maya potters of the Late Classic period civilization, A.D. 600 to 900, produced a variety of bowls and vases with modeled and painted decoration of exceptional technical skill (see Rice 1985). Cylindrical vessels and plates portrayed human and animal figures in a graceful natural style, featuring mythical (fig. 1.9) and ritual scenes such as dances, processions, or royal audiences and often had brief glyphic texts that apparently identified the persons, locations, or events represented (Coe 1973, 1978; Robicsek and Hales 1981; Quirarte 1979). They were painted with subtly toned pigments, often resist applied and underlying a sheer, glossy pale orange slip. After about A.D. 1000, much of the pottery decoration from Mexico through northern South America changed from multicolored designs to combinations of red, black, and white painting. The Aztecs in central Mexico made and used an orange-paste pottery with painted decoration of fine black lines.

Pueblo pottery in the Southwestern United States from A.D. 700 to 1300 (Dittert and Plog 1980) featured geometric and stylized life-form representations, with polychrome or black-and-white painted decoration (fig. 1.10). At the same time, in the southeastern and south-central United States, sophisti-

cated plastic decorative techniques, especially incising and modeling, rather than painting were the outstanding modes of embellishment. Modeled heads of dogs or birds were often added to rims of simple globular vessels, or the vessels themselves might be in human or animal form, the features accented by paint or incising (Rice and Cordell 1986).

The prehistoric pottery vessels made in the New World included the standard repertoire of cooking, serving, and storage vessels—plates, bowls, jars, vases, cups—with local variations on shape and elaboration. In addition, braziers, griddles for toasting tortillas or manioc cakes, and "chile grinders" (bowls with incised interiors for grinding chile peppers) were common. Among the more distinctive of the manufactures are pottery incense burners from Mesoamerica (fig. 1.11), plain vases or bowls with elaborate modeled, ornamented faces and figures of humans and gods (Caso and Bernal 1952). Often two feet or more in height, these censers were painted in bright colors, and openings were placed so that the smoke from the incense would emerge from the figure's nose and mouth. Huge urns were made in South America and used for burials, the deceased being placed inside in a flexed or "fetal" position; elsewhere, smaller vessels were often used to hold cremated remains. Modeled and moldmade figurines of humans and animals and elaborately formed and

Figure 1.8 (left) Moche portrait vessel, Peru. Peabody Museum, Harvard University, photographed by Hillel Burger. Copyright by the President and Fellows of Harvard College, 1985, all rights reserved.

Figure 1.9 (below) Interior of an Early Classic (A.D. 300–600) Maya polychrome bowl from Belize, illustrating a myth in which the sun god, dressed in a deerskin (*right*), appears with a hummingbird and two vultures while waiting to recover his wife, the moon goddess, who has eloped with a vulture. The vessel is painted red, orange, and black. After Hammond 1982, fig. 10.4.

Figure 1.10 Zuñi jar, from New Mexico, painted in black and red on white; height 26 cm. Florida State Museum, catalog number P-1861.

Figure 1.11 A Zapotec effigy urn from Oaxaca, Mexico, depicting the god of rain and lightning. These urns, which usually have a cylindrical vase behind the effigy figure, are approximately 18–24 inches in height and were placed in tombs during the Classic period (ca. A.D. 200–700). After Willey 1966, fig. 3-96.

painted model houses, villages, groups of dancers, and so forth were often found in burials in western Mexico. More utilitarian ceramic manufactures included spindle whorls for spinning cotton fibers, net and line sinkers used in fishing, pipes for smoking, and musical instruments such as whistles, drums, and flutes.

In the early years of the sixteenth century, Europeans arrived in the New World and began exploring and colonizing the land and trading with its native peoples. Their presence is marked by the distribution of European ceramics such as olive jars (Goggin 1970), majolicas (Lister and Lister 1982), stonewares, and porcelains as well as many nonceramic artifacts at missions, forts, trading posts, and settlement locations throughout the Americas. The centuries of European conquest of the native states and chiefdoms had variable effects on the craft of pottery making. Despite the drastic social, demographic, and economic events associated with the conquest—famines, disease, settlement relocation, and depopulation—utilitarian pottery making among the Incas, Mayas, and Aztecs continued virtually unchanged from its pre-European pattern in terms of resources used, form, and decoration. Gradually, however, by introducing the wheel, kilns, and glazes and by stimulating the local manufacture of glazed pottery and tiles for construction and trade, the Spaniards and English transformed and Europeanized the organization and products of the native ceramic craft in the Western Hemisphere.

1.3 Overview of Pottery Studies

Pottery has had a long and varied history of manufacture and use. This range of ceramic products traditionally has been studied from a wide variety of points of view, including artistic, aesthetic, archaeological, historical, classificatory, mechanical, mineralogical, and chemical. Appreciation of the aesthetic qualities of early Chinese porcelains stimulated Islamic potters to try to reproduce them in the ninth century. The antiquarianism of the Renaissance and post-Renaissance centuries fostered interest in collecting Greek and Roman wares and an awareness of early civilizations and their achievements. Finally, mineralogical and chemical experiments by western European potters and scientists trying to imitate Far Eastern porcelains led to improvements in their own manufactures, such as bone china.

Modern archaeological studies have generally devoted a great deal of attention—in fact, disproportionate attention—to pottery in their reports, and this is true for myriad reasons. First, pottery has a long history and is found in virtually all parts of the world; its presence is rarely controlled by a particular geological or environmental situation or conditions of preservation. Second, as a function of its physical properties, pottery is essentially nonperishable: although a pot may break, the fragments (called sherds) are virtually indestructible. Third, unlike stone projectile points, which are attractive to collectors and easily gathered for display in decorative "point board" arrangements, sherds are not particularly appealing to pothunters (though unfortunately the same cannot be said of intact vessels). Hence the potsherds are less likely to be selectively removed from sites.

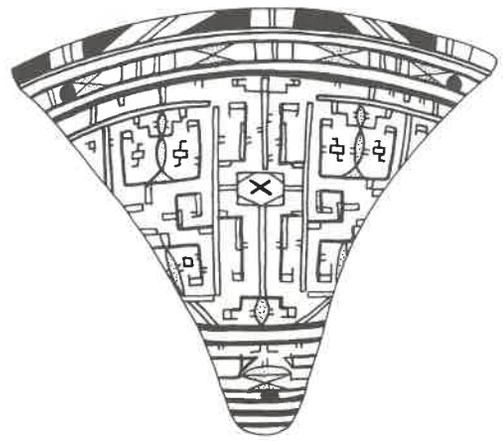

Figure 1.12 A *tanga,* or pottery pubic cover from Brazil, painted in tones of dark brown on tan. After Palmatary 1950, plate 104d.

Fourth, in general pottery is not an exotic or highly valued good, like gold or jade, restricted to the residences and tombs of the upper stratum of society. Although certain kinds of pottery may be confined to elite, ceremonial, or mortuary usage—porcelain headrests, figurines, tea jars, life-size statues—pottery as a general artifact class is not so restricted. Pottery served very ordinary, day-to-day functions in cooking, storage, and hygiene for all members of society. Thus archaeologists and anthropologists have encountered a variety of goods made of fired clay, everything from ordinary bowls and jars to baby bottles in Greece (Noble 1972), footscrapers in Pakistan (Rye and Evans 1976, plate 49b–3), and *tangas* (fig. 1.12) or female pubic coverings in Brazil (Palmatary 1950, 327–328).

A final and perhaps most significant reason pottery has been useful to archaeologists is its manufacturing method. Pottery is formed and *in*formed: pottery making is an additive process in which the successive steps are recorded in the final product. The shape, decoration, composition, and manufacturing methods of pottery thus reveal insights—lowly and lofty, sacred and profane—into human behavior and the history of civilizations. Potters' choices of raw materials, shapes to be constructed, kinds of decoration, and location of ornamentation all stand revealed, as do cooking methods, refuse disposal patterns, and occasional evidence of clumsiness and errors in judgment. The sensitivity, spatial as well as temporal, of pottery to changes in such culturally conditioned decisions has fed archaeologists' traditional dependency on this material for defining prehistoric cultures and their interrelations.

Most modern archaeological studies of pottery are based on three approaches: classification, decorative analyses, and compositional studies. Classificatory studies of pottery form and compare groupings of vessels or sherds representative of a particular culture at a particular time. These groupings are the basis for archaeological dating and go back to the late nineteenth-century work of Sir Flinders Petrie in Egypt. Study of the decorative motifs and styles of pottery, whether expressed in painting or in plastic decoration (incising, molding, appliqué), has always yielded insights into the lifeways of a people as well as their aesthetic perceptions and ideological systems. The third and growing focus of pottery study is technological analysis, which focuses on the paste or composition of a ceramic rather than on the way it is

decorated or shaped and on the properties conferred by that composition.

Archaeologists' and anthropologists' attention has increasingly turned to pottery manufacture and use among Third and Fourth World groups being rapidly acculturated during the twentieth century. In both hemispheres the traditional craft of the potter, often a household livelihood passed down from generation to generation within a family, is suffering at the hands of modernization. Plastic and metal utensils are relentlessly usurping the utilitarian functions of jars and bowls formerly made of clay, because these new materials permit cheaper, more durable products. Although traditional people everywhere are likely to believe that water is more refreshing when cooled in a porous terra-cotta jar or beans are more flavorful when cooked in an earthenware pot, indulging these preferences is more and more difficult as potters abandon their craft to "progress."

Modern ceramic industries, sensitive to the needs of a technologically oriented society, now produce ovenware, flameware, and freezer-to-stovetop cooking utensils, plumbing fixtures, refractory brick for steel furnaces, dentures, and containers for radioactive waste. Meanwhile, the dwindling numbers of traditional potters turn to producing flowerpots, ashtrays, and figurines for a tourist market that too often has little appreciation for the dignity and history of their craft. Fortunately, the value of studing contemporary potters and their products has not gone unrecognized, both as an aid to archaeological interpretation of the distant past and also in helping many peoples recover part of their heritage before it is irretrievably lost.

1.4 References

Abascal 1975
Amiran 1965
Amiran and Shenhav 1984
Anderson 1984
Arnold 1985
Beazley 1945
Bimson 1956
Bischoff and Viteri Gamboa 1972
Blandino 1984
Bostanci 1959
Brush 1965
Bullen and Stoltman 1972
Caso and Bernal 1952
Chang 1977, 1983
Cheung 1983
Coe 1973, 1978
d'Albis 1985
DeAtley 1986
Dittert and Plog 1980
Donnan 1965
Flannery 1976
Fleming 1976
Foster 1959
Fourest 1980
Gifford and Smith 1978
Goffer 1980
Goggin 1970
Gordon 1977
Griffin 1965
Grimshaw 1971
Hammond 1982
Hearn 1979
Hedges and Moorey 1975
Hench and Etheridge 1982
Hobson 1976
Hoffman 1983
Ichikawa, Nagatomo, and Hagahara 1978
Ikawa-Smith 1980
Joesink-Mandeville 1973
Johns 1977a
Kidder 1968
Kingery, Bowen, and Uhlmann 1976
Kingery and Smith 1985
Laufer 1917
Lawrence and West 1982
Li Guozhen and Zhang Xiqiu 1986
Li Hu Hou 1985

Li Jiazhi 1985
Lieberman 1980
Lister and Lister 1982
Lobert 1984
Majidzadeh 1975–77
Matthiae 1977
May and Tuckson 1982
Meggers and Evans 1966
Mellaart 1964, 1965
Mikami 1979
Morgan 1877
Morris 1917
Museum of Qin Shi Huang 1981
Noble 1966, 1972
Norton 1970
Ochsenschlager 1974
Oldfather 1920
Palmatary 1950
Payne 1982
Peacock 1982
Proulx 1968
Quirarte 1979
Rathbun 1979
Redman 1978b
Reichel-Dolmatoff 1961
Rhodes 1973
Rice 1985
Rice and Cordell 1986
Richter 1976
Robicsek and Hales 1981
Rye and Evans 1976
Schmandt-Besserat 1974, 1977a,b, 1978
Schumann 1942
Sears and Griffin 1950
Shangraw 1977, 1978
Shepard 1942a, 1948a, 1965, 1976
Speck 1931
Spinks 1965
Stimmell and Stromberg 1986
Stross and Asaro 1984
Thompson 1984
Thompson 1958
Tichane 1983
Tite, Bimson, and Freestone 1982
Trachsler 1965
Vandiver 1982
Vandiver and Kingery 1984
Von Bothmer 1985
Wang and Zhou 1983
Washburn, Ries, and Day 1920
Weiss 1971
Whitehouse 1980
Willey 1966
Williams, Williams, and McMillan 1985
Wormington and Neal 1951
Wykes-Joyce 1958
Zhang Fukang 1985
Zhou Zhen-xi 1985
Zimmerman and Huxtable 1971