Chapter 3
The Origins of Pottery on the Colorado Plateau[1]

In the days of Gordon Childe (1951), the emergence of pottery seemed sudden and easily understood. Sedentary agriculturalists made pottery, and it signaled the beginning of the Neolithic revolution worldwide. Although this is still generally true, more recent research and better dating techniques have made this once simple equation between pottery and sedentary agriculturalists much more complicated (Pavlů 1997; Rice 1999). We now know that mobile hunter-gatherers made pottery (e.g., Aikens 1995; Bollong et al. 1993; Reid 1984; Sassaman 1993; Tuohy and Dansie 1990), and some cultivators, like those of the Lapita Culture (Green 1979), actually abandoned pottery technology. In areas such as the American Southeast, pottery manufacture preceded agriculture for up to 2,000 years, and in the American Southwest or the Near East agriculture was present long before the first pottery.

In this chapter, we first examine the origin of pottery generally, and then look more closely at one particular case – the emergence of pottery on the Colorado Plateau of the Southwestern USA. The analytical focus of this study is a sample of whole and partially reconstructed vessels from sites dating between AD 200 and AD 600. Using a performance-based analysis, the functions of the early vessels are inferred through an analysis of morphological characteristics and use-alteration traces. The collections of whole brown ware vessels from three sites in northeastern Arizona are dominated by globular neckless jars. From a performance perspective, it is argued that these vessels would have performed very well as storing, cooking, or processing vessels. Preliminary use-alteration analysis suggests that some of the vessels were not used over a fire, whereas others were used in two types of cooking. Moreover, many of the vessels were used for alcohol fermentation that caused extreme interior surface attrition.

Origins

The oldest ceramic objects in the world thus far are the Dolní Véstonice figurines that date to about 26,000 years ago (Vandiver et al. 1989), preceding the appearance of pottery *vessels* by over 15,000 years (see Pavlů 1997; Rice 1987:6–16, 1996a,

[1] This chapter is cowritten by Eric Blinman

1999 for a general reviews of pottery origins). What concerns us here is not the initial invention of ceramic technology, but rather the innovation of ceramic containers. Most archaeologists would now agree that long before the widespread adoption of pottery, hunter-gatherers had knowledge of the basic principles of ceramics: objects can be shaped from moist clay and then be made permanent by placing the object in a fire (Brown 1989:207; Rice 1987:7). The issue is when, where, and why pottery containers make their appearance, and it is clear that there is no single answer (see Arnold 1999b; Barnett and Hoopes 1995; Vitelli 1999).

Although there may not be one reason for the adoption of pottery containers, Arnold (1985) identifies a number of generalizations about pottery and people based on both ethnographic and archaeological observations. The two of most interest here are the relationship between pottery making and sedentism, and the correlation between pottery and more intensive forms of food processing.

Nonsedentary and semisedentary peoples can and do make pottery, but Arnold (1985:113–118) found a strong correlation between pottery making and sedentism. There are several reasons why this would occur. Pottery is less portable and more prone to breakage than other containers such as baskets and skins. Although this may seem to be a logical reason for the lack of pottery among mobile peoples, in practice it may have been only a minor impediment (see also Arnold 1999b). Some hunter-gatherers do carry their pottery vessels with them (e.g., Holmberg 1969; McGee 1971; Sapir 1923), and sedentary people often transport their pottery over long distances (Arnold 1985:111). A more important reason behind the correlation between pottery and sedentism is that pottery making is a technology that takes some investment (Arnold 1985). Although clay is somewhat like McDonald's hamburgers, in that you can always find some nearby, the nearest available clay may not be appropriate for particular pottery-making techniques. For example, locally available alluvial clays may be inappropriate for vessel manufacture because of excessive shrinkage. Among contemporary potters you find that once a good clay source is found it may be exploited for generations because of its known and acceptable working properties (Reina and Hill 1978). People with a mobile settlement and subsistence system may find it difficult to establish and maintain a pottery technology if they do not at least have access to the same pottery resources on a yearly basis. As Brown (1989:116) notes, at least seasonal sedentism may be required for pottery manufacture.

The final reason why sedentism is important to pottery making is because of scheduling conflicts (Arnold 1985:99–108; Crown and Wills 1995). Potters must be near a good clay source during a season of the year when potting is possible and when they have time, free from other tasks, to make pots. In many parts of the world, pottery can only be made during one season of the year because of climatic restrictions (e.g., too wet or too cold), and so scheduling conflicts can indeed be an impediment.

The second generalization made by Arnold (1985:128–144) relates to pottery vessels as tools for food processing. Pottery sherds are the most ubiquitous artifact found at Neolithic or Formative villages worldwide because ceramic vessels had become an essential tool for the processing of staple cultigens, allowing high temperature processing for long periods of time. Boiling or near-boiling temperatures are essential for making many foods palatable and digestible. Cereal grain starches must be completely gelatinized for maximum digestibility, which requires sustained temperatures over 93°C (Reid 1990:10; Stahl 1989:181). Boiling, steaming, or simmering can also destroy potentially harmful bacteria and eliminate or reduce toxins in cultigens (Arnold 1985:129–134; see also Stahl 1989:182). Moreover, cooking in pots can increase the nutritive value of meat (by extracting fat from bones) and some leafy vegetables (Reid 1990).

Compared with other cooking containers, pottery vessels permit direct heating with less constant attention. Although indirect heating of water with hot rocks (as in basket boiling) is an effective way to reach boiling or near-boiling temperatures, it requires continuous attention to avoid boilover and to maintain those temperatures for long periods of time. When ceramic containers are used, once the relationship between the heat source and the pot is established (nestled in coals, supported over the fire, etc.), constant temperatures can be maintained by occasionally tending to the fuel. Ceramic vessels also provide sturdy processing containers for preparation techniques such as fermentation or alkaline soaking that may break down other types of containers. Clearly, ceramic containers provide many advantages as cooking and processing tools, permitting the exploitation of many new foods and the more effective processing of others (see also Crown and Wills 1995:245–246).

Cross-cultural generalizations can provide insights into the relationship between pottery and people and shed light on ceramic vessel origins, but these data cannot be applied simply to explain pottery origins. To search for the clues to specific pottery origins we must turn to the archaeological record.

Rice (1999) and Barnett and Hoopes (1995) provide a good worldwide summary of some of the earliest pottery technologies, and it is clear that there is not just one explanation for pottery origins. The striking aspect of early ceramics is the lack of correlation between pottery making and agriculture. Although pottery becomes the processing workhorse for agriculturalists, as described earlier, the earliest people to use pottery as a tool were hunter-gatherers. In many parts of the world, it was hunter-gatherers who first employed ceramic containers to process food. Indeed, the earliest known pottery vessels in the world are small cooking pots that come from Fukui Cave on Japan's southernmost island (Aikens 1995). Incipient Jomon pottery, as it is called, appears on sites with evidence of intensive marine harvesting during the Pleistocene–Holocene transition beginning about 12,400 b.p. (uncalibrated).

In North America, there are many examples of hunter-gatherer pottery, mostly in the southeastern and northwestern USA, but extending into Canada and Alaska as well. There is evidence that these pots were also used as processing tools (Reid 1990; Sassaman 1993, 1995). The majority of these vessels are low-fired open-bowl or jar forms often tempered with organic matter. Although these Late Archaic vessels often have soot on the exterior suggesting that they were used over a fire (Beck et al. 2002; Sassaman 1993), both Reid (1990) and Sassaman (1993, 1995) make the argument that these vessels may have been used to process food by indirect moist cooking (i.e., stone boiling) as well. The highly porous thick walls and open mouth make poor heat conductors but excellent insulators, which is a performance characteristic that would be well suited to simmering foods by indirect heating. They argue that simmering temperatures, easily maintained by indirect heating, were employed by these hunter-gatherers to stew meat and obtain oils from seeds and nuts or the marrowfat from bones (Reid 1990:10; Sassaman 1995).

But processing of food cannot explain every case of early pottery. In some regions of both the Old and New Worlds, the earliest ceramic vessels were not tools for food processing but rather were important artifacts of ritual activity. The early pottery of Colombia is highly decorated, and Oyuela-Caycedo (1995) argues that these vessels were not used for cooking. Clark and Gosser (1995:116) also suggest that early Mesoamerican pottery may not have been used for food preparation. In the Old World, Vitelli (1989, 1995, 1999) also finds that early vessels of the Greek Neolithic were not used for cooking, and she suggests that these early assemblages played a symbolic or shamanistic role.

To summarize, early pottery around the world appears in three separate contexts: (1) sedentary cultivators that use the vessels to process and make digestible cereal grains, (2) seasonally sedentary hunter-gatherers who use vessels with either direct or indirect heating to extract additional nutrients from animal products or to more effectively process seeds and nuts, and (3) early cultivators or hunter-gatherers who produce and use the vessels in ritual activity. The first two contexts involve food processing and are much more widely documented than the evidence for the ritual use of pottery. The latter context will be better understood after more information is gathered on vessel use.

Theoretical Models

Several scholars have attempted to explore the origins of pottery from a theoretical perspective. We will review the models proposed by Brown (1989) and Hayden (1995) as they may be the most relevant to the origins of pottery on the Colorado Plateau (see Rice 1999 for a thorough review of these and other models).

Brown (1989) revived interest in the origins of pottery by exploring an economic approach. His model considers that (1) pottery containers were adopted long after there was knowledge of ceramic technology, (2) pottery was introduced when people had other well-developed container options, and (3) pottery is not the only container for heating water and processing food (Brown 1989:208). Under these conditions, pottery was used when there was a "rising demand for watertight, fire-resistant containers…coupled with constraints in meeting this demand" (Brown 1989:113). In this model, groups would have to be at least seasonally sedentary to permit pottery to be a realistic container option. Pottery is adopted when other types of containers such as baskets or skins fail to meet the increasing demand brought about by new types of food processing, new forms of storage, or the emergence of food presentation as a form of social expression (Brown 1989:113). Thus pottery was not used because of some foreseen potential but rather because it was a container that could be made cheaply and quickly by semisedentary groups.

Hayden (1993, 1995) looks at prehistory and does not see people trying to solve the practical problems of life, but rather he sees individuals involved in economically based competition. As in Brown's model, prerequisites for the emergence of pottery are technological advances and more sedentary settlement and subsistence systems. Hayden (1993) argues that as people become more sedentary and sharing of food is no longer required for survival, there is a worldwide tendency for increased economic competition along with more pronounced inequality. In this context, pottery first appears as a prestige food container made by individuals in direct competition with their neighbors.

The primary difference between the Brown and Hayden models is the role of practical versus prestige technologies. Although they both are economic models, Brown suggests that the demand for pottery containers was to fulfill practical needs, whereas Hayden promotes the idea that demand for pottery was generated by economic competition. The implications are that Brown's model predicts that the earliest pottery in a region would have been processing vessels, whereas Hayden's model predicts that the first pottery would have been food-serving containers. As noted earlier, both situations can and do occur worldwide. Some researchers have found that the earliest pottery in a particular region was used to cook or process food (e.g., Gebauer 1995) and others have shown that the first ceramic containers, often highly ornate, were not used in food processing but, presumably, as a prestige technology (e.g., Clark and Gosser 1995:2.14–2.16; Oyuela-Caycedo 1995).

These models are not mutually exclusive. Although Brown (1989) focuses principally on practical demands as an impetus for pottery and Hayden (1995) suggests that social or economic competition was the important factor, they each leave room in their models for the opposite to occur. Brown (1989:113) notes that one of the new container demands could be the "presentation of food as an emergent social expression." Similarly, Hayden (1995:261) suggests that in the process of producing pottery as a prestige good, its practical benefits are quickly realized and put into use. Moreover, in some peripheral areas, "derivative practical pottery" used for cooking or storage may have been the first ceramic vessels (Hayden 1995). Clearly, there is a great deal of overlap between the two models, with the main difference being the weight placed on prestige versus practical ceramic containers. It is possible that each can be used to explain the emergence of pottery in various parts of the world, but testing the models requires a level of analysis that is rarely attained. What is often lacking is a clear idea of how the earliest pottery was used (Longacre 1995; Rice 1999). The example that follows attempts to remedy this deficiency with an analysis of the earliest pottery on the Colorado Plateau.

Emergence of Ancestral Pueblo Pottery

Ancestral Pueblo pottery is known worldwide for the elaborate forms, made without the help of the wheel, and its intricately painted designs. If you consider prehistoric North American pottery traditions from the perspective of art, Ancestral Pueblo pottery is at the top. And from the perspective of the Southwestern archaeologist, no single artifact class has played a more important role. From defining culture groups and marking the passage of time, to inferring population size and social organization, pottery from the Colorado Plateau is usually at center stage. But despite the attention paid to this artifact type and the important role it plays in archaeological inference, very little attention has been given to the origins of this pottery (for exceptions see Crown and Wills 1995; LeBlanc 1982).

This scant attention is not for lack of collections since much of the early ceramic material we will describe was excavated decades ago. But we can identify several reasons for this lack of interest. First, it is only recently that we have better data on important issues related to pottery origins, such as the appearance of cultigens and beginning of more sedentary settlement (Crown and Wills 1995:241). Without understanding these important covariables, pottery emergence is not easily explained. Second, the earliest pottery on the Colorado Plateau is brown, and every introductory student in Southwestern archaeology knows that Ancestral Pueblo pottery is gray, and Mogollon pottery, located just southeast in the mountain transition, is brown. Prior to more accurate dating of the brown ware sites, it was often assumed that the brown pottery was imported from the Mogollon region or represented Mogollon immigrants. Third, dates for the early brown ware pottery are consistently prior to AD 600, thus placing it in the Basketmaker II period. Generations of Southwestern archaeologists were taught that there was no pottery during the Basketmaker II period. Although in the Southeastern U.S. archaeologists have come to accept that there is Archaic pottery, the time-honored Pecos Classification has indeed served as an impediment to studying the earliest Southwestern ceramics.

In the Southwest, as well as in most parts of the world, there is evidence that people were well aware of ceramic technology long before the manufacture of pottery containers (Crown and Wills 1995:244). Unfired clay figurines that date between 5600 and 5000 BC have been found in southeastern Utah (Coulam and Schroedl 1996), and ceramic figurines have been located in a southern Arizona pithouse village that dates to about 800 BC (Huckell 1990). It is safe to assume that Archaic people throughout the Southwest had knowledge of ceramic technology. Domesticated cultigens also preceded the appearance of pottery vessels, which is analogous to the Near East and the prepottery Neolithic. Corn was introduced into a mobile hunter-gatherer subsistence system by at least 1000 BC (Tagg 1996), followed by an apparent transition to a more logistic settlement system with semisedentary occupation of pit structures in rock shelters and camps (Crown and Wills 1995; Matson 1991; Wills 1988). More than a millennium later, pottery appears to have been used on a regional scale over the course of one or two centuries, accompanied or closely followed by the architectural and material correlates of the Hohokam, Mogollon, and Ancestral Pueblo (Crown and Wills 1995; LeBlanc 1982).

On the Colorado Plateau of Arizona, New Mexico, Utah, and Colorado, there is now widespread, though scattered, evidence that the first pottery was made sometime before AD 300 (see Wilson and Blinman 1993, 1994, 1995; Wilson et al. 1996).

The pottery occurs in contexts that are similar in all respects to aceramic settlements of the same time. This pottery, known regionally as Los Pinos Brown, Sambrito Utility, Lupton Brown, Adamana Brown, Obelisk Utility, and Obelisk Gray, is a plain polished brown ware (Spurr and Hays-Gilpin 1996; Wilson 1989). In most of the cases, the pottery appears to be locally made (although this must be confirmed with subsequent testing), and in all cases it precedes the typical gray and white wares. A similar stage of incipient pottery manufacture was identified by Haury (1985) to the south in the Mogollon area and in the deserts of the Hohokam homeland (Heidke et al. 1997). Although there is a good deal of regional variability, this early brown ware represents a pan-Ancestral Pueblo ceramic tradition made with self-tempered alluvial or soil clays that tend to be rich in iron. All of the vessels were made using the coil and scrape technique with the possible exception of Adamana Brown, some of which may have been finished using a paddle and anvil (Mera 1934). All of the early brown wares have polished exteriors and surface color ranging from dark gray to brown (for detailed descriptions see Spurr and Hays-Gilpin 1996; Wilson and Blinman 1993; Wilson et al. 1996).

Early Ceramic Sites

Early brown ware sites are currently known from three areas of the Colorado Plateau: (1) the eastern portion of the northern San Juan, which includes the Upper San Juan, Animas, La Plata, and Mancos river drainages, (2) the Prayer Rock District on the Navajo Reservation in northeastern Arizona, and (3) along the southern portion of the Colorado Plateau from the Petrified Forest to the Zuni Reservation. Other sites with this early pottery include the Little Jug site (Thompson and Thompson 1974) near the Grand Canyon, the Hay Hollow site (Martin and Rinaldo 1960), a site east of Gallup, New Mexico (Blinman and Wilson 1994), and a number of sites in Chaco Canyon (for a review of early pottery sites see Breternitz 1982; Fowler 1991; LeBlanc 1982; Morris 1927; Schroeder 1982; Wilson et al. 1996).

An early ceramic period occupation was identified in the northern San Juan area of northwestern New Mexico as part of the Navajo Reservoir archaeology project (Dittert et al. 1961; Eddy 1966). Eddy referred to the earliest pottery as Los Pinos Brown. Although the Los Pinos sites with pottery are not well dated (Eddy 1966:444–445), the pottery clearly pre-dates the later gray wares and represents the earliest attempt at pottery manufacture in this region. Sambrito Brown, which follows Los Pinos Brown in time and is indistinguishable from this type (Wilson and Blinman 1993), provides a larger ceramic sample and comes from slightly better dated contexts (i.e., AD 400–700).

Sites in the Petrified National Forest may represent the best collection of pre-AD 300 brown ware pottery on the plateau. Excavations at the Flattop site (Wendorf 1953) and Sivu'ovi (Burton 1991) yielded a plain brown pottery type classified as Adamana Brown (Mera 1934). Recent dates from the two sites (Burton 1991:97–101) suggest that Adamana Brown may be the oldest dated pottery on the plateau.

The caves of the Prayer Rock District of the Navajo Indian Reservation provide evidence of early pottery making in the Southwest (Hays 1992; Morris 1980). The caves yielded both a classic Basketmaker III pottery assemblage and an earlier assemblage dominated by a pottery type that is called Obelisk Gray. Obelisk Gray is a polished brown ware that is similar to the brown wares described earlier (Wilson and Blinman 1994).

This chapter demonstrates that pottery manufacture was taking place on the Colorado Plateau after AD 200. There is also strong circumstantial evidence that the pottery is locally made, not "Mogollon," and thus not imported from south of the Colorado Plateau (Burton 1991:108; Eddy 1966:384; Fowler 1991; Wendorf 1953; Wilson and Blinman 1993:16). Because similar pottery types are not made in the Mogollon region, we must be careful to distinguish ceramics of the Mogollon tradition from brown ware technology, per se (see Fowler 1991). Many alluvial clays and some geologic clays will fire to brown colors, so the similarities between Mogollon brown wares and those of the Colorado Plateau may represent a similar technology in the first attempts at pottery manufacture (see also Wilson 1989; Wilson and Blinman 1993, 1994).

The Study

The project involved both an analysis of whole vessels and a preliminary clay resource survey from the Petrified Forest area of Arizona to the vicinity of Crownpoint, New Mexico. The objective of the study was to both understand why people started making pots at this place and time, and why the technology changed so rapidly to the typical gray wares.

Initial laboratory analysis focused on collections of whole vessels curated at the Arizona State Museum and Western Archeological and Conservation Center in Tucson, and the Museum of Northern Arizona in Flagstaff. Several vessels from the Laboratory of Anthropology in Santa Fe, New Mexico, were also inspected. These vessels were analyzed and the formal characteristics were recorded to draw inferences about their *intended* function. We also recorded the use-alteration patterns of interior carbon and exterior soot deposits, as well as attrition in an effort to determine *actual* vessel function.

The whole and partially reconstructed vessels come from three sites: Flattop, Sivu'ovi, and the Prayer Rock Caves. Sivu'ovi is located in the Petrified National Park, about 20 miles east of Holbrook, Arizona. The site is a large Basketmaker period pithouse village that was partially excavated by the National Park Service archaeologists to salvage material that was eroding off the small mesa (Burton 1991). The pottery consists of 4 restorable vessels and 1,072 sherds that were recovered from the surface and from 2 pit structures. The vast majority of the ceramics are an early brown ware referred to as Adamana Brown. Similar to all the other early brown wares, it is lightly polished and tempered with fine sand that may be naturally occurring within the clay source or may be augmented by the potter (Rye 1976).

The distinguishing feature of Adamana is the presence of mica inclusions in the temper (Shepard 1953).

Within sight of Sivu'ovi is Flattop, another site dominated by Adamana Brown pottery. Wendorf (1953) excavated 8 pit structures at Flattop and recovered 30 whole or restorable vessels and 2,522 sherds, with all but 84 classified as Adamana Brown. Wendorf did not obtain absolute dates, but ceramic cross-dating suggested that the site pre-dated to AD 500 and was contemporaneous with the earliest Mogollon ceramics (Wendorf 1950:49, 1953:51–53). For example, Adamana Brown was the most common intrusive in the Hilltop phase (tree ring dated to AD 200–400) at the Bluff site (Haury 1985). Burton (1991) obtained radiocarbon dates from two Flattop houses and three houses from Sivu'ovi that confirmed Wendorf's suspicion that Adamana Brown pottery dates very early. Multiple samples were obtained from outer rings of construction timbers, and calibrated dates were averaged for each structure. Burton (1991:101) reports the dates as follows (one-sigma range): Flattop House D, AD 130–318; Flattop House H, AD 35–215; Sivu'ovi Structure 1, 86 BC to AD 131; Sivu'ovi Structure 2, AD 82–252; and Sivu'ovi Structure 3, 406–311 BC.

The caves in the Prayer Rock District of the Navajo Nation were excavated by Earl Morris in the 1930s, and Elizabeth Ann Morris (1980) prepared the report of the excavations and artifacts. Our analysis focuses on the Prayer Rock Caves material because it is one of the largest collections of early Basket-maker pottery. Although the majority of whole vessels come from the slightly later gray ware period, there are also a significant number of brown ware whole vessels and sherds referred to as Obelisk Gray (Morris 1980). This is a bit of a misnomer because this type is quite comparable with early brown wares found elsewhere in the Southwest (Wilson and Blinman 1993; Wilson et al. 1996).

Whole Vessel Design and Performance

There are a total of 211 whole or partially reconstructible vessels from the Prayer Rock Caves, and 74 of those are Obelisk Gray. The remarkable aspect of the Obelisk Gray collection is that half of the vessels are globular neckless jars (Table 3.1), which in Southwestern vernacular are referred to as "seed jars" (this shape is almost identical to the Mesoamerican *tecomates*). Three out of the four whole vessels from Sivu'ovi were also seed jars, and the most common restorable vessels from Flattop were the globular jars without a neck. The early brown ware seed jars

Table 3.1 Obelisk gray vessel forms from the Prayer Rock Caves curated at the Arizona State Museum

Seed jars	37	50%
Necked jars	33	44.6%
Pitchers	2	2.7%
Total	74	100%

are generally spherical in shape, although some are more elongated. They are relatively thin walled and have a restricted orifice. The exteriors, however, are what make these seed jars and all the early brown wares unique. The exterior surfaces are typically quite irregular but they all show evidence of polishing. Sometimes the polish is only visible on the high points of the surface, whereas in other cases more time and effort has been put into smoothing and polishing, resulting in relatively lustrous surfaces.

Based on these technical properties alone, one can begin to make general inferences about intended vessel function and performance. The globular shape of these vessels is a very strong structural design that would impart strength in both the manufacturing and use stages. Shapes approaching spherical have the most green-strength and would be more likely to survive drying without cracking. This would be especially important if alluvial clays of differing shrinkage characteristics were being used within the brown ware tradition, allowing the potter to achieve successful results with either low- or high-shrinkage clay. The same spherical properties also would give the vessel a good deal of strength in use. Curved surfaces have greater structural integrity and thus can better withstand the strains imposed by both thermal shock and physical impact. Moreover, spherical shapes are better able to distribute the weight of their contents, reducing the risk of breakage from internal loading.

The restricted orifice diameter imparts a number of techno-functional qualities. In the seed jar shapes, the strength of the pot increases as the orifice diameter decreases. The small openings are easily covered or plugged to protect the vessel's contents. Moreover, even if the vessel were left uncovered, the restricted opening would limit loss of heat during cooking or spillage during transport or storage. But the restricted orifice also limits access to the vessel's contents. Although all of the analyzed seed jars had openings large enough to permit the entry of a hand or ladle, these openings were small enough to inhibit both access and visibility. Even with lamps for analysis it is difficult to inspect the interior of the vessels, and with a hand or implement in the opening it would have been impossible for the vessel users to see the pot's contents. Moreover, this type of opening is not well suited to pouring liquids, which would not only be difficult to control but would also slop onto the sides of the vessel.

Polishing or burnishing is usually associated with decorated wares in the Ancestral Pueblo Southwest, but it is a technical property that can also greatly influence performance. One of the most important performance characteristics of polishing is its effect on water permeability (Schiffer 1988a). In low-fired earthenwares, water permeability is a constant concern. Without any surface treatment to impede permeability, most vessels will weep badly and greatly reduce heating effectiveness. In fact, water will not boil in some low-fired pottery without a surface treatment to at least slowdown water permeability (Skibo 1992:165–168). But polishing is not often a property found in low-fired cooking pots because escaping water turns to steam and will spall the surface (Schiffer 1990; Schiffer et al. 1994b). This may be the reason for the "poor" polishing job on the early brown ware vessels. They are polished just enough to inhibit the flow of water, but the surface is open enough to permit the escape of steam.

The technical properties of these seed jars, when combined, create vessels that would perform well in both cooking and storage (see also Arnold 1999b). The two most important performance characteristics of cooking with water are thermal shock resistance and heating effectiveness. The spherical shape, thin wall, low firing temperature, and large amounts of temper create a vessel with excellent thermal shock resistance. The thin walls and high percentage of temper also provide excellent heating effectiveness. The polished exterior would also inhibit the flow of water, which is an important property related to heating effectiveness, possibly without closing the exterior surface enough to cause steam spalling. Thus, from a design perspective, the seed jar forms would perform well as cooking pots. The only property of these vessels that is not well suited to cooking is the restricted access. The narrow openings would give the vessels greater strength but also make it more difficult to access the vessel's contents.

As a storage or processing vessel, the seed jar forms also would perform adequately. The spherical shape is a design well suited to storage because of its strength both in terms of holding heavy contents and in being carried while full. Moreover, its low center of gravity, despite its spherical shape, makes it quite stable while resting on its base. The restricted vessel entry is also easily plugged to protect the pot's contents, but it would not be the best design for a storage pot that needs to be accessed regularly or one that requires that its liquid contents be poured out.

From a purely design perspective, the early brown ware seed jars could have adequately performed cooking, storage, transport, or food processing. These designs are multifunctional, and if a person wanted a pot to perform many different functions, the early brown ware seed jars would be ideal. The globular neckless jars with the paste characteristics and surface finish of the early brown wares are the ceramic equivalents of Swiss army knives – one tool that can perform a variety of functions (see also Schiffer Chap. 7).

Whole Vessel Use-Alteration Traces

The majority of analyzable seed jars are Obelisk Gray examples from the Prayer Rock Caves collection. Unfortunately, most of the vessels inspected came from burned houses, which greatly hindered our ability to infer use from carbon deposition. A total of 26 of the 37 seed jars inspected had evidence that postuse burning significantly affected both interior and exterior carbon patterns. Only seven of the vessels survived the burning without evidence that their carbon patterns had been altered. House fires of the type at Prayer Rock Caves can either add or remove carbonized deposits. Fortunately, carbon patterns from the house burning could be easily discriminated from those created during cooking over an open fire. Of the seven pots unaffected by the house fires, two had evidence of cooking and five had no evidence that they were placed over a fire. Both cooking pots had exterior sooting patterns characteristic of being placed over the fire on rocks or on some form of support. The interior of one of the vessels (ASM 14313) had a carbon pattern typical of vessels that heat food in the absence of water (Fig. 3.1). This can occur by roasting seeds or some other food, or by boiling something until all or most of the water has been removed. Cooking a thick gruel would also create this pattern, as would reheating previously cooked food. The other vessel (ASM 14400) has an interior carbon pattern more typical of cooking food in the presence of water (Fig. 3.2). The base has no evidence of carbon while the middle interior has a ring of carbon. When you boil with water, organic particles spatter from the water surface, adhere to the vessel wall, and carbonize. This vessel has a wide ring, as if this pot was used with various water levels or in cases where the water level had boiled down during use.

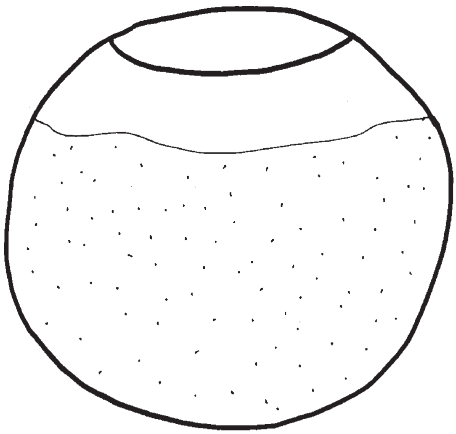

Fig. 3.1 Interior of vessel with a carbon pattern caused by heating food in the absence of water

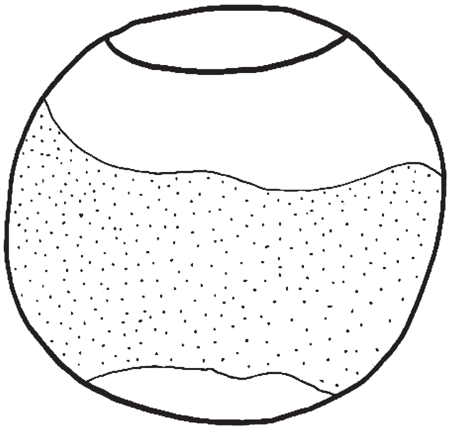

Fig. 3.2 Vessel with an interior carbon pattern characteristic of wet-mode cooking. The wider band of carbon likely resulted from variable water levels

The three seed jars from Sivu'ovi provide the best evidence for cooking. These vessels were found in a covered storage pit and there is no evidence that they were affected by postuse burning. One of the small seed jars (WACC 5918) demonstrates the classic carbon pattern associated with boiling food. The exterior base is slightly oxidized, which is created by having an intense fire under a pot that is raised on rocks or some type of support (Fig. 3.3). The lower third of the exterior wall has a heavy patch of soot, which gradually fades above the midsection toward the rim. The interior of this vessel has the band of carbon that forms in pots used to boil food (Fig. 3.4). A gray carbon patch on the interior base could have been created if most of the moisture had been removed from the vessel in the last stages of cooking.

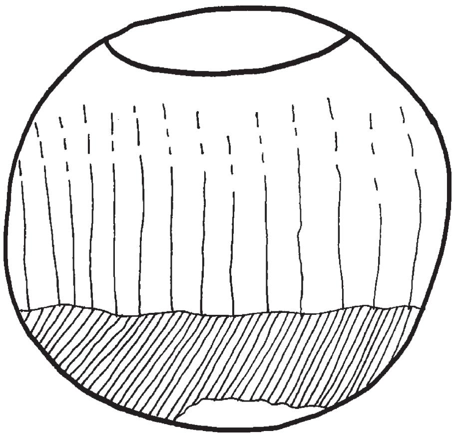

Fig. 3.3 Exterior of a vessel that was used over fire

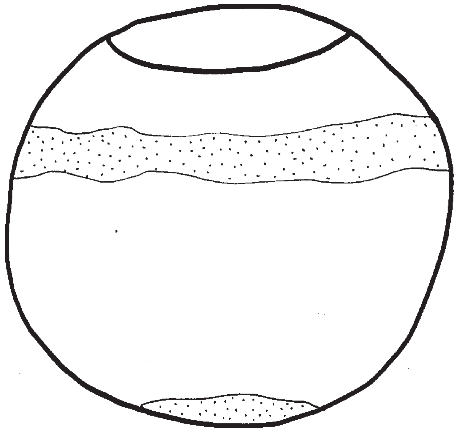

Fig. 3.4 Interior of a vessel used to heat food in the wet mode

The second vessel from Sivu'ovi (WACC 9155) also has clear evidence of use over a fire (Fig. 3.5). This vessel, however, has an interior carbonization pattern that suggests that water was absent during at least some time during most cooking episodes. Water was either removed at the last stage of boiling or food was cooked in the pot in the absence of water.

The largest of the seed jars (WACC 9156) has a similar soot–carbon pattern. The exterior is sooted and the interior has a carbon patch below the midsection, which is caused by heating in the absence of moisture. For food to char it must reach at least 300°C. This can only occur when water is removed from the vessel because temperature in the food below the water line will not exceed 100°C.

This large seed jar also has a heavily abraded interior, which was also observed on nine of the Obelisk seed jars from the Prayer Rock Caves. Only one of these abraded Obelisk Gray pots had evidence of use over a fire, four were not used over a fire, and four were indeterminate. The most likely cause of the abrasion is fermentation. Abrasion by mechanical contact, such as with a scoop or ladle, was ruled out because of the pattern of attrition. In most of the pots with interior abrasion, the entire interior surface was removed, and in other cases the abrasion patch stops abruptly and follows a relatively straight line around the vessel diameter several centimeters below the rim. Such a pattern is more likely caused by the chemical erosion of the interior surface by its liquid contents (Arthur 2003; Hally 1983:19). In low-fired pottery, contents with the opposite pH of the clay can break down the clay structure (Patrick Mc-Govern, personal communication). Thus an acidic ceramic could be broken down by contents with a basic pH, such as the alkaline soaking of maize, and a ceramic with a basic pH can be eroded by acidic solutions. The latter could be caused by the fermentation of some fruits or other highly acidic food. The exact nature of this process, however, is unknown and requires further experimentation.

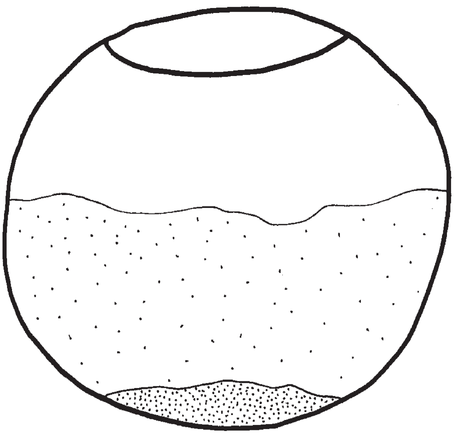

Fig. 3.5 Interior of a vessel used to heat food in the dry mode

Implications

The correlation between seed jar design and function suggests that the vessels could perform well as cooking, storage, or food-processing vessels. The use-alteration analysis demonstrates that the users of this pottery took advantage of their vessel's multifunctionality. There is evidence that some of the vessels were used for cooking (in both the dry and wet modes) and others were not, although the exact function of the noncooking vessels is not known. The heavy interior abrasion on some vessels suggests a chemical erosion most likely caused by fermentation. Organic residue analysis could shed light on what these pots contained. The use-alteration analysis also demonstrated that the vessel users cooked their food in two modes: heating with water and heating without water. The latter can be caused by either cooking dry food (roasting), reheating previously boiled foods, or by boiling something until all or most of the water has been removed. Gruel or stew cooking are cases where enough water could be removed from the contents to cause interior carbon deposits, either as part of the cooking process or by accident.

Southwestern Pottery Origins Revisited

Although the data presented here are just the first step toward understanding the use of early brown ware, we think that they are nonetheless revealing. The earliest pottery on the Colorado Plateau was made by semisedentary pithouse dwellers who began to rely more heavily on maize and other domesticated cultigens (Crown and Wills 1995). They used the multifunctional sturdy seed jars to boil, cook gruel, or reheat a food in the absence of water, for storage, and the fermentation of a liquid that caused the erosion of interior surfaces. Out of the 74 Obelisk Gray vessels from the Prayer Rock Caves only 2 were bowls and 2 were pitchers. One prediction of the Hayden (1995) model is that the earliest pottery would have been dominated by forms used for serving. This expectation is not met at this site because only 6% of the Obelisk Gray vessels were designed for serving. The data presented here agree with the characterization by Crown and Wills (1995) of the context for the adoption of pottery in the Colorado Plateau.

What appears to be happening on the plateau is that the adoption of pottery is a family-by-family decision. The evidence for the brown ware pottery, though widespread, is very scattered. It is likely that between AD 200 and AD 400 there were families that made and used pottery living next to people who did not adopt this technology. The range of early brown ware technological variability also suggests that individuals may have been copying a design (i.e., a seed jar form with sand temper and a roughly polished exterior) but attempting to make it with local resources. Each new potter had to struggle to replicate this design with their own unique local resources.

We do not yet have any direct evidence to infer what was cooked or processed in these pots. Although corn can be processed in new ways with cooking pots, you certainly can effectively prepare corn without ceramic pots, as had been done for centuries. But as Crown and Wills (1995) point out, new variants of maize are also appearing at this time that may have prompted different ways of processing in vessels. Thus, the adoption of pottery could more easily be explained using Brown's model in which people had a greater demand for vessels to store food, soak maize, or store water, but they could not meet the demand with baskets, skins, or some other nonpottery container. Brown's model, however, implies that vessels were not used to solve a particular processing problem. Although we in general agreement with this, we believe that we do not yet have enough evidence for the Southwest to suggest that pots were not used to solve a particular processing need – the boiling of beans.

Beans are the second important cultigen in the great corn, beans, and squash combination that came to dominate the entire Southwest as well as Central and South America. Beans can be soaked and ground into a meal, but by far the most common method to cook beans worldwide is by boiling. The cooking of beans, however, can often take from 2 to 3 h. Long-term simmering of this sort would be tedious with the prepottery cooking technologies. The one great advantage of ceramic pots is their ability to boil foods for long periods with little monitoring. Another advantage of boiling beans instead of some other form of processing is that it reduces the levels of oligosaccharides, the substances that cause flatulence and in some cases extreme abdominal cramping (Stahl 1989:182). Although there is a humorous side to this, it certainly may explain the fact that the most common method of bean preparation is boiling. Intestinal discomfort may in fact play a role in the adoption of pottery on the Colorado Plateau. Certainly, the key to solving this riddle is to further explore how these vessels were used (Longacre 1995:279). Subsequent testing should focus on identifying the organic residues in the early brown ware pottery.