CHAPTER FIFTEEN
Reconstructing Mississippian Diet in the American Bottom with Stable Isotope Ratios of Pot Sherd Residues
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In this chapter we report on experiments to evaluate the effects of soil organic matter contamination on carbonized residues in buried prehistoric pottery, using a method conventionally applied to purification of prehistoric bone collagen and plants for isotopic analysis (Ambrose 1990; DeNiro and Hastorf 1985). Experiments show that stable carbon and nitrogen isotope ratios of carbonized residues on ceramic vessel interiors reflect the isotopic composition of the foods cooked in them. Carbonized residues from the interior surfaces of 88 ceramic vessels found at five contemporaneous early Mississippian American Bottom sites were analyzed to determine the percentage of maize (*Zea mays*) cooked in them. Four of the five assemblages studied contained carbonized residues with high carbon isotope ratios, reflecting varied and sometimes high percentages of maize in cooked meals. Nitrogen isotope ratios of eight sherds from Cahokia showed that meat was cooked in at least one vessel. Absorbed soil organic matter and carbonates may contaminate carbonized residues in buried sherds, and in this case could lead to underestimates of the amount of maize. Therefore, chemical pretreatment methods conventionally used to decontaminate buried charcoal and bone for radiocarbon and stable isotope analysis were applied to a subset of 17 samples and compared to their untreated residues. Results show that pretreatment did not, in most cases, significantly alter stable isotope ratios of carbonized pottery residues. We conclude that carbonized potsherd residue isotopic analysis provides a simple and powerful tool for reconstructing dietary practices in such settings, and that simple chemical pretreatments should be used, where possible, for greater accuracy and precision of isotopic analysis.

Stable carbon and nitrogen isotopic analysis can provide quantitative data on proportions of foods with different isotopic composition and can thus be used to assess proportions of marine versus terrestrial, C_3 versus C_4 based food webs, as well as trophic levels. The basic principle underlying this approach to dietary reconstruction is that 'you are what you eat', in other words, the isotopic composition of an organism's diet controls that of its tissues (Ambrose 1993). This principle applies to any reservoir of organic matter, including soil carbon isotopes (Ambrose and Sikes 1991), and can be extended to reconstructing human diet indirectly through the isotopic composition of the food residues preserved in ceramic vessels (Hastorf and DeNiro 1985; Reber and Evershed 2004a; 2004b; Reber et al. 2004). Analysis of such residues can provide information about the isotopic composition of meals and vessel function as well as human diet. One could thus use pottery residue isotopic analysis to ask of humans: 'were they what they cooked?' (Beehr and Ambrose, in press).

Four basic preconditions must be fulfilled for diet reconstruction with stable isotopic analysis of archaeological ceramic residues: there are systematic differences in the isotopic composition of foods prepared by cooking; their isotopic composition is not significantly altered by cooking; their isotopic composition is not significantly altered during burial and contamination by soil carbon and nitrogen can be removed. Many food webs exhibit systematic differences in isotopic composition between major food classes (Van der Merwe 1982; 2005; DeNiro 1987), and heating experiments have shown that cooking temperatures do not significantly affect isotope ratios (DeNiro et al. 1985; Hastorf and DeNiro 1985; Marino and DeNiro 1987; Whitney 1992). DeNiro and Hastorf (1985) documented the effects of soil contaminants and methods of removal of contaminants from carbonized archaeological plants. These methods have been used to treat carbonized ceramic residues for accelerator mass spectrometry (AMS) radiocarbon dating (Lovis 1990). However, the effects of decontamination on carbonized residues in archaeological ceramics have not previously been investigated.

Carbonized organic matter readily absorbs dissolved soil organic matter such as humic acid and fulvic acid. Removal of these soil organic contaminants is necessary because the stable isotopic composition of soil organics can vary substantially in the tropics, and warmer temperate regions, where both ^{13}C-depleted C_3 and ^{13}C-enriched C_4 plants grow, and because the radiocarbon age of soil organic matter integrates that of plant communities that post-date the buried artifacts (Ambrose and Sikes 1991). Soil and shell carbonates generally have substantially higher $^{13}C/^{12}C$ ratios than soil organic matter (Cerling 1984; Fritz and Poplawski 1974), and failure to remove them will usually inflate estimates of the amount of C_4 carbon in a residue. Soil carbonates generally do not form in recent soils in our study region, so the residues were not treated with acids to remove carbonates. However, many sherds analyzed in our study have shell temper, and carbonate bedrock underlies the entire region and could be a component of the clay matrix, so carbonate contamination remains a possible source of error.

Maize was one of the most important components of later prehistoric agricultural diets in eastern North America. Because maize is the only major dietary staple that uses the C_4 pathway for photosynthesis, and thus the only staple with a high $^{13}C/^{12}C$ ratio, its consumption can be easily measured with stable carbon isotope analysis of food residues or consumer tissues. During Late Woodland and Mississippian times, reliance on maize agriculture may have increased along with social complexity (Fritz 1992; Kidder 1992; Lopinot 1992, 1994, 1997). Quantitative evidence for maize consumption can thus provide important evidence for testing hypotheses about developments in prehistoric economy and society. Most isotopic research in the American Bottom region of the Mississippi Valley in Illinois and Missouri has used human bones. Research at Mound 72 in Cahokia, suggests a link between maize consumption, protein nutrition, health and social status (Ambrose et al. 2003). Skeletal isotopic analysis is ideal for estimating long-term average diets of individuals. However, skeletal analysis is destructive and labor-intensive, skeletons are often poorly preserved or absent and access to human skeletal material is increasingly restricted.

Carbonized residues on potsherd interiors can also be used to reconstruct human diet. They preserve the carbon and nitrogen isotopic composition of foods even after they have been cooked to temperatures high enough to become carbonized (Hastorf and DeNiro 1985; Whitney 1992). Depending on the frequencies of burning and cleaning, and the stickiness of the foods, vessel residues may provide a 'single-meal' snapshot, or they may integrate the isotopic composition of a series of cooking episodes. Pottery is ubiquitous in Mississippian and Late Woodland sites in the American Bottom. Compared to skeletal isotopic analysis, sherd residue analysis is simple, fast, non-destructive and inexpensive. Because potsherds are often found in residential contexts, isotopic analysis may provide useful evidence for household culinary practices and vessel functions.

In this chapter we will summarize the results of carbonized sherd residue isotopic analysis from five sites in the American Bottom region, including one probable ceremonial locality on the valley floor at Cahokia Mounds, and four sites of the Richland Complex in the surrounding uplands (Beehr and Ambrose, in press). We will focus on a subset of these samples treated to remove potential soil organic contaminants. These results will be compared with results from the untreated sherd residues to determine the effects of this pretreatment procedure on stable carbon and nitrogen isotope ratios of sherd residues. The generally small shifts in isotopic composition inspire confidence in the accuracy of the analyses of the untreated sherd residues.

Cahokia and its Neighbors

Cahokia was a farming village along the Mississippi river that arose to prominence around 1050 CE, in a process so rapid it has been called the 'Big Bang in the Bottom' (Pauketat 1997, 31). The rise, dominance, decline and eventual abandonment of Cahokia have been divided into four stages: the Lohmann, Stirling, Moorehead and Sand Prairie phases, of which only the first two are relevant to this study. Cahokia's fluorescence during the Lohmann and Stirling phases was accompanied by widespread changes in pottery, architecture, spatial organization, complexity, social organization and ritual, and may indicate that Cahokia assumed dominance over this region at this time (Pauketat and Emerson 1997; Emerson 1997a; 1997b; Kelly 1990, 136).

At the beginning of the Lohmann phase (1050-1100 CE), construction on a monumental scale began at Cahokia, including the massive Monks Mound, which was the largest earthen structure in North America. Monks Mound was probably built in annual construction episodes that may have been accompanied by feasting events (Pauketat 2000). Some of the sherds in this study are from the sub-Mound 51 feasting pit, a contemporaneous feature filled with feasting debris that may have served as a borrow pit for the construction of Monks Mound (Pauketat et al. 2002).