

# Evidence of cacao use in the Prehispanic American Southwest

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**Chemical analyses of organic residues in fragments of ceramic vessels from Pueblo Bonito in Chaco Canyon, New Mexico, reveal theobromine, a biomarker for cacao. With an estimated 800 rooms, Pueblo Bonito is the largest archaeological site in Chaco Canyon and was the center of a large number of interconnected towns and villages spread over northwestern New Mexico. The cacao residues come from pieces of vessels that are likely cylinder jars, special containers occurring almost solely at Pueblo Bonito and deposited in caches at the site. This first known use of cacao drinks north of the Mexican border indicates exchange with cacao cultivators in Mesoamerica in a time frame of about A.D. 1000–1125. The association of cylinder jars and cacao beverages suggests that the Chacoan ritual involving the drinking of cacao was tied to Mesoamerican rituals incorporating cylindrical vases and cacao. The importance of Pueblo Bonito within the Chacoan world likely lies in part with the integration of Mesoamerican ritual, including critical culinary ingredients.**

archaeology | Chaco Canyon | ritual | chemistry | organic residues

Organic residue analysis of ceramics from Pueblo Bonito, the largest site in Chaco Culture National Historical Park, reveals the presence of theobromine, a marker for *Theobroma cacao* or chocolate. Here, we analyze dry residue samples using HPLC coupled to MS, and show that cacao was consumed in the American Southwest circa A.D. 1000–1125. The ceramics used for this study are fragments of pitchers or cylindrical jars. This is the first demonstrated use of cacao north of the Mexican border and provides evidence for a specific ritual activity in Chaco Canyon.

Chaco Canyon lies in northwestern New Mexico. Although occupied for millennia, the florescence of Chaco culture began about A.D. 900 with the construction of multiple large masonry villages within the canyon. Villages with similar architecture and material culture occur in a large area outside the canyon, and archaeologists argue that extensive exchange and ritual cohesion characterized this regional system of pueblos. Pueblo Bonito is the largest site in Chaco Canyon (1). With an estimated 800 rooms in the multistoried masonry pueblo, tree-ring dates reveal construction between about A.D. 860 and 1128 (2). Archaeologists excavated Pueblo Bonito in two major projects. The Hyde Exploring Expedition (1896–1899) and the National Geographic Society Expedition (1920–1927) investigated most of the rooms in the site and portions of the two trash mounds just south of the pueblo (3, 4). Hundreds of thousands of artifacts from these excavations are housed primarily at the American Museum of Natural History and the Smithsonian Institution.

Among the many unusual objects from Pueblo Bonito are ceramic cylinder jars, vessels typically 2.4 times as tall as they are wide (Fig. 1). Most are painted with black designs on a white background, but red jars and white jars occur as well. Fewer than 200 cylinder jars are known from the American Southwest and 166 of these come from Pueblo Bonito. Excavation revealed 111 cylinder jars in a single large cache in one room at the site (5). While archaeologists generally agree that the vessels had a ritual



**Fig. 1.** Twelve cylinder jars from Pueblo Bonito housed in the Smithsonian Institution Department of Anthropology. Vessel in left center is 21.5 cm in height (Marianne Tyndall, photographer). [Reproduced with permission from Crown and Wills (8) (Copyright 2003, Society for American Archaeology).]

use, they disagree about the nature of this ritual and the specific use of the vessels in ritual (6–8). Various arguments for their specific use in ritual have included holding exotic items such as turquoise (6) or, with a skin cover, serving as drums (9). Ceramic pitchers come from the same contexts as the cylinder jars but are more common both at Pueblo Bonito and throughout the Chacoan region. The pitchers differ from the cylinder jars in having a large vertical handle and a bulbous base. Fragments from cylinder jars and pitchers are difficult to distinguish. Although pitchers occur more frequently than cylinder jars, their recovery in identical locations, including the large cache in Pueblo Bonito, suggests that they may have had similar or related functions.

Recent University of New Mexico re-excavation of trenches originally dug in the trash middens directly south of Pueblo Bonito in the 1920s recovered hundreds of thousands of fragmentary artifacts. For this analysis, we selected sherds from these contexts representing 5 different vessels that were either cylinder jars or pitchers. Three were characterized as probable cylinder jars, one as a definite pitcher, and one as an indefinite cylinder jar/pitcher. The selected sherds date between A.D. 1000 and 1125 based on decorative styles.

We used HPLC coupled to MS to analyze each of the samples. There were no visible residues on the sherds, so we extracted absorbed residues from the paste of the sherds. The procedure involved burring the surface from each 10 g sherd

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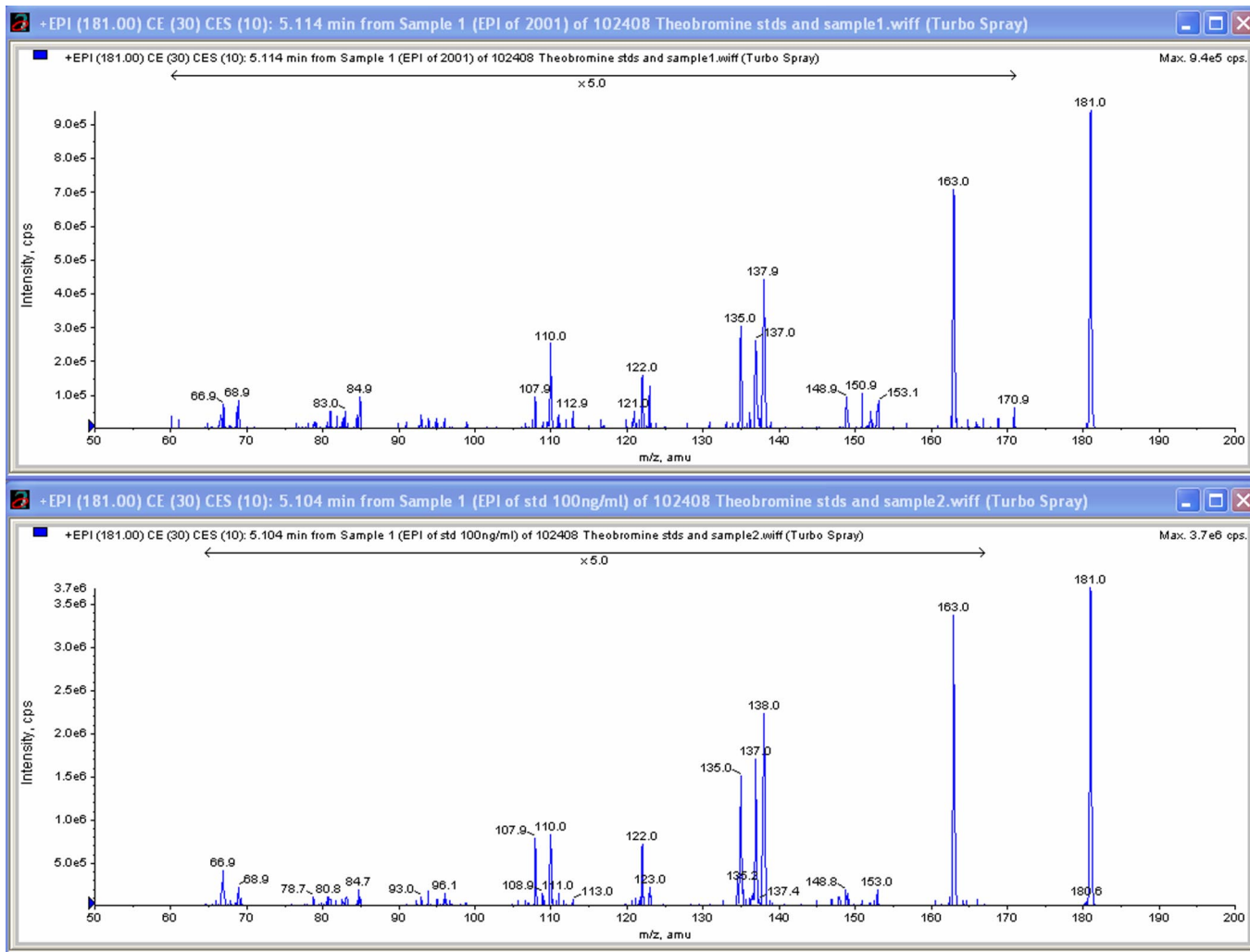


Fig. 2. Mass Spectrum of Sample 2001 (top) and Theobromine Standard (bottom).

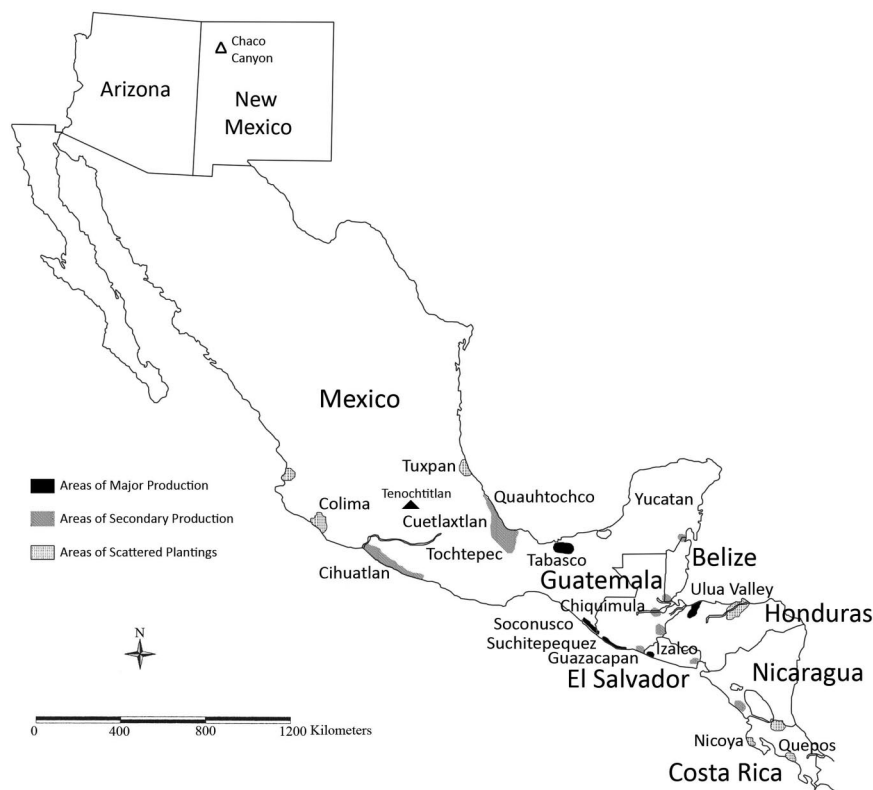
and crushing the sample in a degreased agate mortar. We used about 500 mg of the powder and added 3 ml of distilled water at 80 °C to solubilize the materials. Before analysis, we passed each sample through membrane filters to eliminate particulate matter.

Cacao has a unique chemical composition of more than 500 different compounds, including members of the methylxanthine class (primarily theobromine, with a lower concentration of caffeine). Theobromine is used as a marker of cacao in organic residues studies of ceramics from Mesoamerica because *T. cacao* is the only Mesoamerican plant that contains theobromine as the primary methylxanthine. HPLC coupled to MS has previously revealed cacao residues in ceramics vessels from sites in Belize, Guatemala, and Honduras (10–14).

The MS was operated in positive-ion mode with MS/MS in Enhanced Product Ionization (EPI) mode to monitor for the major peak at  $m/z = 181$  (theobromine) and other fragments using authentic theobromine as a standard. The results of the HPLC MS confirmed the existence of theobromine in 3 of the 5 samples analyzed. These 3 samples were those characterized as probable cylinder jars. The sherds from the pitcher and indefinite cylinder jar/pitcher did not show the peaks characteristic of theobromine. Peaks from the extract of the residue from Sample 2001 were evident in the mass spectrum of the sample (Fig. 2), which confirms the existence of theobromine.

There are 4 important implications of this research that we explore more fully below. First, it documents the presence of cacao north of the Mexican border, far outside the area of cultivation. Second, it shows the likely function of the ceramic cylinder jars found at Pueblo Bonito. Third, it reveals a specific ritual performed at Pueblo Bonito with possible ties to Mesoamerican ritual. Finally, it enhances our understanding of Pueblo Bonito as the center of the Chacoan ritual world.

This is the first recovery of cacao in a Prehispanic context north of the Mexican border. The presence of cacao in the sherds from Pueblo Bonito indicates exchange in cacao from Mesoamerica. *T. cacao* is a neotropical tree requiring a shaded humid atmosphere, deep alluvial soils, high rainfall, and high average temperatures for survival. Evidence for the distribution of cacao in Mesoamerica for the period around Spanish contact (or about 400 years later than the Chacoan vessels) is reconstructed from tribute lists (15, 16). Relative to the Chaco area, the closest cacao cultivation at contact was in Central Mexico (Fig. 3), including portions of northern Veracruz and Colima (15). Larger cultivation areas occurred farther south in Mexico and Central America. Other Mesoamerican goods, including copper bells; cloisonné; and Scarlet Macaws, a species native to the humid lowlands of Mexico, occur at Pueblo Bonito, so cacao may have come to Pueblo Bonito through exchange or acquisition that included additional exotic items from Mesoamerica.



**Fig. 3.** The distribution of cacao cultivation in Central America and Mexico in A.D. 1502, relative to Chaco Canyon. (Adapted from ref. 12.)

*T. cacao* produces large seed pods. Either the pulp or seeds may be prepared into beverages or foods, but the seeds alone were exchanged long distances (14, 16). Preparation of seeds for long distance exchange required some processing, including fermenting the seeds in the pulp, removing the pulp, and drying the seeds (16). Seeds might have been roasted before transport. In Mesoamerica, cacao seeds were ground and combined with cold water, ground corn, ground chile pepper, and some flavorants to create beverages consumed largely by the elite class and in rituals (15, 16). The stimulant properties of cacao beverages made them highly desirable.

Cacao seeds were highly prized throughout Mesoamerica and were a form of currency among the Aztec. Cacao beverages were consumed in parts of Mesoamerica before 1500 B.C. (14, 17), became an integral part of ritual and rites of passage in much of Mesoamerica and remain important aspects of ritual activity in some areas today (12). During the time represented by the Chacoan pottery analyzed here (ca. A.D. 1000–1125), there were several competing polities in Mesoamerica that may have been involved in cacao exchange, so the exact source (or sources) for the cacao used in Chaco is not known.

This is not only evidence for cacao use north of the Mexican border, but, if these sherds are indeed from cylinder jars, it is evidence for how cylinder jars were used in rituals in Pueblo Bonito. At least on some occasions, the jars held a drink made from cacao seeds brought from a great distance. Creating froth by stirring the drink or by pouring it from one vessel held high above another was important in Mesoamerica. A Late Classic Maya image shows a woman pouring a cacao beverage from one cylinder vase to another (18). Because the organic residues analyzed on the Pueblo Bonito sherds were absorbed residues, they probably derived from a cacao beverage rather than the storage of cacao seeds. It is possible that the cylinder jars were used for frothing the beverage in a manner similar to the Maya. The restricted distribution of the cylinder jars particularly sug-

gests that, as in Mesoamerica, this beverage was consumed by only a small portion or subset of the population, perhaps ritual specialists or the elite.

Recovery of evidence for cacao in the American Southwest provides further evidence for ties between this area and Mesoamerica. The likely association of cacao with cylinder jars at Pueblo Bonito suggests that knowledge concerning the proper preparation, serving, and consumption of cacao beverages accompanied the seeds from Mesoamerica. Chacoan ritual practitioners imported or acquired both the ingredients and the culinary knowledge to incorporate elements of Mesoamerican ritual activity into the Chaco world. The stimulant properties likely heightened the sensory aspects of the ritual, while the exotic nature of the cacao tied the ritual and its practitioners to foreign cultures far to the south. The specialized knowledge and equipment required to prepare and serve the beverage would have set some individuals apart. It is possible that the growth of Chaco Canyon, particularly Pueblo Bonito, was coupled to the ability of some individuals to acquire Mesoamerican objects, cacao, and macaws, and perhaps their esoteric knowledge of Mesoamerican ritual activity. While we have known for more than a century that Mesoamerican items occurred in the Southwestern United States, the recovery of cacao in association with specialized ceramic forms indicates that during the 11th century, some aspects of Mesoamerican ritual, including cacao, were a part of ritual practice at the center of the Chacoan world. Whether Chacoan ritual practitioners appropriated and adapted the use of cacao and cylinder vessels to existing ritual in a way that was uniquely southwestern or adopted a Mesoamerican ritual remains an open question.

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