COMMENTARY

Long-distance wood procurement and the Chaco florescence

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First documented during a military reconnaissance in 1849, Chaco Canyon and the Ancestral Pueblo society that flourished therein [850–1140 Common Era (CE)] have been the focus of archaeological investigation for more than a century. Beginning in the early ninth century CE, the inhabitants of farming communities lining a 14-km stretch of the lower canyon in present-day northwest New Mexico erected massive free-standing masonry pueblos, or "great houses." Great houses are monumental in scale and are among the most iconic and remarkable feats associated with Chacoan societal development. The construction of one multistory great house, Pueblo Bonito, with at least 650 masonry rooms, required the Chacoan people to quarry 50,000 tons of sandstone and harvest and transport more than 50,000 pine (*Pinus* sp.), fir (*Abies* sp.), and spruce (*Picea* sp.) trees from distant (60–80 km) montane forests (Fig. 1). Guiterman et al.'s (1) analysis of a spatially broad sample of construction timbers from 7 of 11 great houses in Chaco Canyon documents the chronology and spatial extent of wood harvesting strategies and reveals a significant and previously unknown wood source.

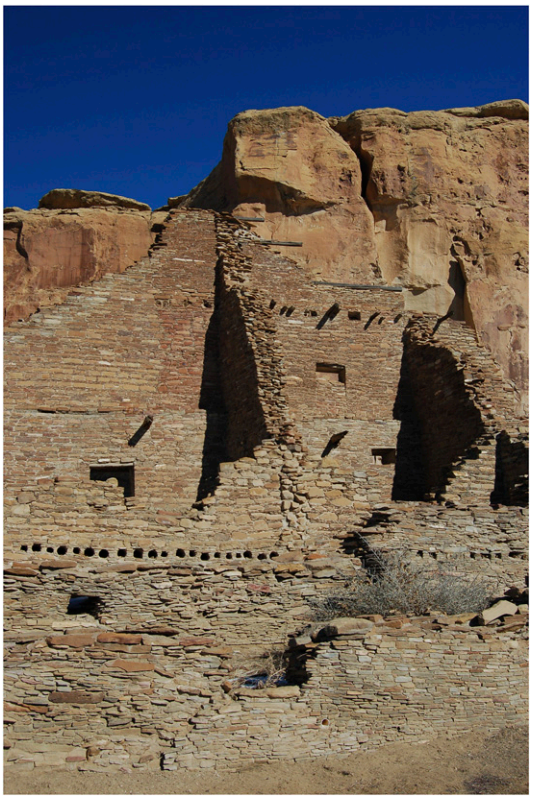

Fig. 1. North wall masonry and construction timbers of Pueblo Bonito great house.

Chacoan Wood Sources

Bordered by forested monoclines and uplifts, the central San Juan Basin of northwest New Mexico is arid, grass-covered, predominantly treeless, and punctuated by buttes, mesas, and canyons. Extending from east to west across the central basin, the entire 32-km length of Chaco Canyon (1,850–1,950 m elevation) is bounded on the north and south by high mesas that are sparsely populated with stands of pinyon (*Pinus* sp.) and juniper (*Juniperus* sp.). Larger tree species such as ponderosa pine (*Pinus ponderosa*) and Douglas fir (*Pseudotsuga menziesii*) are rare in Chaco Canyon and limited to higher-elevation portions of the San Juan Basin distant from the canyon.

Although early great house construction relied on locally available wood species, it is estimated that by the mid-12th century CE, the Chacoan people had harvested more than 240,000 ponderosa pine, Douglas fir, spruce, and possibly aspen (*Populus tremuloides*) trees for the construction of their great houses. In addition to the staggering demand for construction timbers well in excess of postulated local timber resources, tree-ring data indicate selective harvesting of specific size classes of trees, a behavior that would have been possible only in heavily forested areas. Taken together, this evidence has prompted many scholars to theorize that Chacoan builders obtained wood from the uplands of the San Juan Basin, most likely the San Mateo and Chuska Mountain regions to the south and west, respectively (2–4).

Subsequent stable isotope analysis initially supported this interpretation (5). In particular, strontium isotope ($^{87}Sr/^{86}Sr$) ratios measured for Chacoan great house architectural timbers were compared with strontium assays of modern tree samples from the Chuska, San Mateo, and San Pedro Mountains. Analysis of the strontium data suggested that the Chuska and San Mateo ranges were primary foci of tree harvesting, whereas the San Pedro/Nacimiento region east of Chaco was not a significant source. Moreover, the results of this previous research revealed that, at times, wood was simultaneously procured from disparate regions.

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However, scholars have recently called into question the reliability of strontium data as a means of discriminating source areas (6). Guiterman et al.'s (1) use of tree-ring-based sourcing is thus all the more important, providing independent confirmation of previous interpretations based on strontium signatures and demonstrating the feasibility of this alternative technique for future research in the North American Southwest.

Sourcing based on variation in regional patterns of tree growth has long been used by researchers in Western Europe and has been gaining acceptance among archaeologists in North America. In principle, the method compares correlation coefficients and *t* values to determine the strongest statistical match between tree-ring patterns for beams from settlements and tree-ring width chronologies for surrounding regions. Tree-ring growth patterns of individual trees can be used to accurately determine the specific mountain range from which they were harvested. This method of sourcing is an attractive option given the low expense and relative ease of application for regions with well-developed tree-ring chronologies like the North American Southwest (7). However, the approach exhibits some limitations. Specifically, growth patterns among trees within a particular region are not always strongly correlated, due to differences in ecology, topography, and genetic variation; researchers thus caution that the technique is best used in conjunction with other sourcing techniques such as stable isotope analysis (8).

Guiterman et al.'s (1) analysis yields several key findings. Previous studies of $^{87}Sr/^{86}Sr$ ratios found that as much as 55% of ponderosa timbers could have been obtained from either the Chuska, La Plata, or San Juan Mountains (9). The use of tree-ring width-based sourcing significantly refined these calculations, revealing that the Chuskas accounted for 50% of Chacoan architectural wood. The results also indicate that a previously hypothesized but unconfirmed wood source, the Zuni Mountains southwest of Chaco Canyon, accounted for 20% of the ponderosas used to build Chaco great houses. Taken together, the analysis indicated that the vast majority (>70%) of architectural timbers were probably procured 75 km from Chaco. In addition, Guiterman et al. determined that wood procurement before 1020 CE was largely restricted to the Zuni Mountains, but, by 1060 CE, the Chuska Mountains emerged as the primary source. Overall, the results not only bring needed resolution to questions surrounding the geographic extent of wood procurement but also provide a definitive chronology of shifting tree harvest strategies.

Implications for Chaco

The scale of Chaco's influence through time is measured, in part, by evidence of regional connectivity, exchange, and emulation. More than 400 km of formal road networks—many 8–10 m wide in places—connect some outlying great houses to Chaco. Shared ceramic styles, raw materials such as chipped stone and wood, and extraordinarily high concentrations of raw and finished turquoise, marine shell, and copper, as well as scarlet macaws (*Ara macao*) and cacao (*Theobroma cacao*), indicate that Chacoan exchange networks spanned the San Juan Basin and beyond, likely extending 1,000–2,500 km into present-day Central America. For many scholars, the ability to orchestrate labor and the maintenance of these long-distance networks was a means by which political elites consolidated and signaled their power (10, 11).

The timing and extent of these procurement networks is therefore central to models of Chacoan societal change. Before 1040 CE, ceramics and chipped stone concentrations indicate a tendency for greater levels of interaction between Chaco and the southern San Juan Basin (12, 13). After 1040 CE, the increasing frequency of Narbona Pass Chert from the Chuska Mountains and Chuskan ceramics, a pattern consistent with Guiterman et al.'s (1) wood sourcing results, points to growing social and economic ties between people of the Chuska and Chaco regions (12, 14).

The early 11th century CE witnessed other significant changes in Chacoan society. Following a 60-y hiatus, building efforts suddenly resumed, with new construction at great houses, including Pueblo Alto and Chetro Ketl, and possibly Hungo Pavi, and remodeling efforts at the Pueblo Bonito, Peñasco Blanco, and Una Vida great houses (15, 16). Chacoans built a number of large ceremonial structures, or "great kivas," suggesting an increased focus on community-level ritual (15). Finally, this time period also marks the widespread adoption of Gallup and Chaco Black-on-white style ceramics with their distinctive hachure designs that potentially signify the propagation of a Chacoan ideology throughout the San Juan Basin (17). Coupled with other sources of data, Guiterman et al.'s (1) findings reinforce the importance of better understanding Chaco's ties to the Chuskan region during the Classic Bonito phase, a period defined by Chaco's growing regional influence and increasing construction labor demands.

The application of new theoretical approaches, technologies, and methods during the last decade has yielded a number of significant discoveries, ushering in an exciting period of research on Chaco Canyon (10, 18–20). This innovative analysis of sourcing the wood Chacoans harvested to build their great houses constitutes another important contribution to research on Chaco Canyon. The results buttress previous conclusions based on stable isotope analysis and demonstrate the viability of an alternative wood sourcing technique. The method has great potential for advancing researchers' understanding of procurement strategies in the North American Southwest and elsewhere in pre-Columbian North America.

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