REPORTS

EVALUATING THE OLD WOOD PROBLEM IN A TEMPERATE CLIMATE: A FORT ANCIENT CASE STUDY

Robert A. Cook and Aaron R. Comstock

Schiffer (1986) first identified the old wood problem for wood charcoal-based dates from archaeological contexts in the American Southwest. The potential for dates to be skewed toward excessively old calendar ages in this region has recently generated reticence in part of the archaeological community towards including wood charcoal dates in general. Some scholars have even begun to cleanse the radiocarbon databases of regions throughout North America, partly with this presumed limitation in mind. However, the issues that contribute to the old wood problem have not been closely examined outside the arid climate of the American Southwest, resulting in some studies excluding hundreds of radiocarbon dates. The present study fills that void by examining the radiocarbon record from four well-dated Fort Ancient sites in southwestern Ohio and southeastern Indiana. Specifically, we test whether or not there are significant differences between wood charcoal and non-wood charcoal assays. Our findings suggest that wood charcoal dates should not be excluded. We explore reasons for this difference in the Eastern Woodlands and propose an ideal dating regime.

Schiffer (1986) fue el primer investigador que notó el problema de madera vieja de las fechas de radiocarbono en los contextos arqueológicos del suroeste de Estados Unidos. Recientemente, la posibilidad de que existe un sesgo en las fechas en esta región ha generado reticencia por parte de la comunidad arqueológica de confiar en las fechas de radiocarbono con base en madera de cualquier tipo. Por esta razón, entre otras, algunos investigadores, que trabajan en varias regiones, comenzaron a depurar las bases de datos de radiocarbono a lo largo de América del Norte. Sin embargo, fuera de la zona árida del suroeste de Estados Unidos, los factores que contribuyen a fechas problemáticas por la madera vieja no han recibido mucha atención; y así algunos estudios han excluido cienes de fechas de radiocarbono potencialmente sin base. La presente investigación llena ese vacío a través de un estudio del registro de radiocarbono de cuatro sitios bien fechados de la "cultura" de Fort Ancient, ubicados en el suroeste de Ohio y el sureste de Indiana. Específicamente probamos si existen diferencias estadísticas entre los ensayos de carbón hechos con madera contra los de otros materiales orgánicos. Los resultados sugieren que las fechas basadas en madera no deben ser excluidas; por ende, exploramos las razones que sostienen esta diferencia en los bosques del este y proponemos la estrategia ideal para obtener fechas confiables.

A key distinction for archaeology is its ability to examine cultural change over time. In order to do so, it is necessary to be able to accurately track the chronological aspect of change. The advent of radiocarbon dating began a revolution in how the past was conceptualized, allowing us to relate archaeological events to calendar dates and to understand the scale of time between events and cultural groups (Trigger 2006). While at first many scholars placed confidence in the science of radiometric dating because of its ability to rapidly reshape culture historic chronologies (e.g., Willey and Sabloff 1980:155–157), we now understand that there are inherent issues to radiometric dating, including the chronological resolution of dated materials, inter-laboratory methodological differences, contamination, and calibration (e.g., Bronk Ramsey 2008). These issues, along with sometimes frustratingly wide error ranges, have resulted in a recent trend of critically reassessing radiocarbon databases (e.g., Blockley et al. 2008; Blockley and Pinhasi 2011; Collett and Robertshaw 1983; Knapp 2009; Nolan 2012; Pettitt et al. 2003; Shott 1992; Taché and Hart 2013; Telford et al. 2004; Wilmhurst et al. 2011). These studies, many of

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which utilize aspects of Schiffer's (1986, 1987) "strong-case" approach, can result in the exclusion of numerous extant radiocarbon dates. In many cases, the exclusion of dates is related to the medium that was dated; specifically, wood charcoal assays are commonly viewed with extra scrutiny. While we agree that a critical approach involving contextual evidence is necessary when interpreting radiocarbon dates, unless a laboratory suggests a sample was contaminated during analysis or the sample's context was clearly disturbed, radiocarbon dates are valuable data which have the potential to provide useful insight and thus should not be hastily excluded.

The present study tests a major assumption of some of these strong-case approaches by statistically comparing radiocarbon dates from several Fort Ancient villages in southeast Indiana and southwest Ohio. We focus on the "old wood problem" (*sensu* Schiffer 1986, 1987), concluding that it is not as problematic at sites along the Middle Ohio River as has been recently presumed (e.g., Nolan 2012). Such results are promising considering that the dominant form of prehistoric architecture in this region relied on wooden post construction and that the majority of samples analyzed by previous scholars have been wood charcoal. We suggest that a dating regime that incorporates a wide range of media offers the best chance of developing a robust and representative understanding of site-level occupational histories and regional patterns.

The Old Wood Problem

In the early decades of radiometric dating, many archaeologists viewed this method as a definitive way to understand time, and it quickly was used to establish cultural chronologies in calendar years (e.g., Trigger 2006; Willey and Sabloff 1980). In response to this initial uncritical optimism, scholars have developed a more judicious stance toward radiometric dating (e.g., Schiffer 1986, 1987). Although we largely rely on radiometric dating in order to understand time, each aspect of the process involved is now viewed critically. This is where we are now in the field: the considerable radiocarbon database is largely looked upon with uncertainty, in need of "hygiene" (e.g., Nolan 2012; Pettitt et al. 2003; Taché and Hart 2013). Schiffer's (1986, 1987) "strong case" approach to the radiocarbon record of the American Southwest has been applied in other regions without consideration of whether or not all aspects of it are appropriate. The strong case approach generally requires that strict criteria are met regarding the selection of materials for sampling based on their archaeological context, including accounting for the "old wood" problem (*sensu* Schiffer 1986, 1987).

Schiffer (1986) first described the "old wood" problem in relation to Hohokam chronology, in which specific attention was paid to those formation processes which resulted in the archaeological deposit sampled for dating, as well as the material of those specimens which were dated. He warns that because of our inability to know the context from which wood was collected by prehistoric peoples, the nature of wood charcoal in archaeological carbon samples is problematic. This uncertainty, Schiffer (1986:19) suggests, may skew the relationship between radiocarbon dates and prehistoric events "toward an excessive antiquity." Schiffer's study was conducted in the arid American Southwest, where preservation of organic material is comparatively exceptional. In some situations, wood may remain intact for centuries, later to be used and eventually become part of the archaeological record. In this region, the logic of Schiffer's argument is sound; old wood, if used by prehistoric people and dated by an archaeologist, would skew our understanding of archaeological events, rendering those of interest to appear to have happened much earlier than was indeed the case.

In the Eastern Woodlands, Schiffer's strong case approach has been used in several cases; we will focus on two examples in the closest vicinity to our samples. Shott (1992) focused on the Late Woodland period Childers site, eventually excluding 75 percent (15/20) of the analyzed dates. While he understandably questions dates identified as laboratory errors and from disturbed contexts, he further excludes data based on less defensible criteria. One criterion of note is that different labs have different techniques that may affect the comparability of samples, so he disregards half of the remaining assays as a result of different laboratory conditions, preferring dates analyzed at Southern Methodist University

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(SMU) while omitting those from Beta Analytic. Importantly, a critical factor that led to the exclusion of these dates was the material analyzed; among other reasons, samples analyzed at Beta Analytic were considered less reliable because they were wood charcoal. While much of Shott's (1992) discussion regarding contextual reasons to omit dates is well conceived, dismissal on the basis of laboratory (and material) excludes a large number of dates that is difficult to accept without specific testing.

Following methods developed by others who have turned a critical eye toward the radiocarbon database in other areas of the world (e.g., Hunt and Lipo 2006; Pettitt et al. 2003), Nolan (2012) presents a method for cleansing the radiocarbon record of the Late Prehistoric period of the Middle Ohio Valley. Each sample is weighted based on material type, whether or not it was dated using accelerator mass spectrometry (AMS) methods, and if the sample was dated before or after 1970 (see Nolan 2012:195–196 for an extended discussion of this method). Unless it can be determined that they were derived from small or young trees, the maximum score wood charcoal dates can achieve is a "3", which is the arbitrary cutoff for rejection, rendering these samples unacceptable in this scheme (samples determined to be derived from small wood samples from the outer ring of trees merit a 3.5, rendering them acceptable; however, this information is not typically available). This process results in the exclusion of approximately 80 percent of the radiocarbon dates for the study sites (Nolan 2012:196). Ultimately, Nolan's approach winnows the radiocarbon database into a small suite of dates. One of the main consequences of the cleansing is a lack of dates for the Early Fort Ancient Period (ca. A.D. 1000–1200 [Nolan 2012:199]), which our study does not support. However, it is important to note that this was a summary finding and not predictive (Nolan 2012: 199).

If such approaches are followed without detailed consideration of the samples in question, then the vast majority of the radiocarbon dates in the Eastern Woodlands could potentially be disregarded. If this general rate were applied to the approximately 1,850 dates in the Maslowski et al. (1995) radiocarbon database of the Kentucky, Ohio, and West Virginia tri-state area, 1,480 dates would be discarded, resulting in a vast gap in our understanding of many sites, as well as the prehistory of this region as a whole. We are in a position where we need more not fewer dates; such claims need to be thoroughly vetted before proceeding. While criteria based on disturbance and laboratory errors are necessary when assessing radiocarbon records, rejecting wood charcoal samples in the Eastern Woodlands based on a problem associated with a radically different environment is premature. Full consideration has not been given to regional variation in wood decomposition rates and the effect this has on the age of wood. We do so below after presenting a controlled comparison between dates from wood charcoal and other materials. We agree with Nolan (2012: 196, 201) that wood dates cannot be taken at face value without critical consideration. We also appreciate the spirit of his study in opening up a discussion of these issues (Nolan 2012: 186), and do so here by unpacking the old wood issue.

Comparing Radiocarbon Dates

In order to evaluate whether wood charcoal is as problematic a medium as proclaimed we need to statistically compare dates. However, radiocarbon dates are notoriously difficult to examine statistically due to the fact that they are not continuous data, but instead represent unique probability distributions dispersed around a mean value (Ward and Wilson 1978). Because of the attached error estimate, dates cannot simply be averaged. Specific methods for statistically pooling and comparing radiocarbon dates have been developed (e.g., Long and Rippeteau 1974; Shott 1992; Spaulding 1958; Ward and Wilson 1978). The present study utilizes methods devised by Ward and Wilson (1978) to pool and compare radiocarbon dates.

Ward and Wilson (1978:20–24) present two scenarios in which comparisons between radiocarbon dates may be made. Case I scenarios represent situations in which one dates parts of the same object; the mean is considered to be the same for all samples. Case II scenarios represent situations in which "one does not *know* whether all determinations are estimating the same date" (Ward and Wilson 1978: 21), meaning we must assume that the radiocarbon samples in question

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represent a random sample of prehistoric events. By necessity, the present study represents a series of Case II scenarios, as our samples represent multiple materials and events from four sites. The following methods were formulated with this limitation in mind.

To assess whether or not a set of dates is statically equivalent, it is necessary to calculate the Pooled Mean (A_p),[1] which takes into account sample variance, calibration error, and other environmental sources of error. Additionally, the test statistic (T')[2] must be calculated, which is tested against a chi-square distribution with n-1 degrees of freedom. This is used to test the null hypothesis that the dates in question are not significantly different. If the sample of dates cannot be statistically differentiated, the pooled variance ($V[A_p]$)[3] is calculated, allowing dates to be combined into a pooled mean (A_p)with an accompanying variance (Ward and Wilson 1978:20–21). This method allows for intra-site comparison of groups of dates in order to understand differences in context, material, and laboratory, factors that may influence subsequent interpretations of site and regional dynamics.

In the present study, each site was evaluated in turn. Dates derived from different media were averaged and statistically compared using the above methods in order to determine whether or not wood charcoal dates from villages with relatively brief occupations present as older than non-wood dates. Once a group of materials at a site was determined to be statistically homogenous, assays were averaged into a pooled mean and variance. These media averages were then compared using the T' statistic discussed above. Outliers were identified through cumulative pairwise tests of contemporaneity starting with the oldest date and adding the next in the series one at a time; outliers were excluded from statistical tests. All dates were calibrated in OxCal v4.2.2 (Bronk Ramsey 2012) using IntCal 09 (Reimer et al. 2009) after statistical tests were conducted. Statistical calculations and comparisons were conducted in Calib Rev 6.1.0 (Stuiver and Reimer 2011), which incorporates the methods of Ward and Wilson (1978), discussed above.

Case Study

We test the relationship between assays from wood charcoal compared to non-wood materials from four Fort Ancient villages located in southwest Ohio and southeast Indiana (Figure 1). Following the statistical methods outlined above, dates from each of the sites were assessed, pooled, and compared based on media analyzed. For those sites with a mixture of existing dates and new dates, these were often divided between both laboratory[4] and material (Schomaker and State Line [Table 1]). For those sites from which dates were primarily new and from the same laboratory (Guard and Horseshoe Johnson), we differentiated between wood charcoal and non-wood sources for comparisons. Once dates in a materially derived sub-set from a site were determined to be statistically homogeneous, they were averaged into a pooled date and variance. These means were then statistically compared to determine if marked differences existed between media.

Two sites were examined that had dates from different laboratories and that also had coincident differences in the materials dated. Dates from the Schomaker village are divided between those analyzed at Beta Analytic (n = 5), which were wood charcoal, and those dates analyzed at the University of Arizona AMS laboratory (n = 5), which were carbonized annuals (Table 1). The annual dates from the University of Arizona laboratory are not statistically different and have a mean pooled age of 651 ± 17 radiocarbon years before present (B.P.). The Beta Analytic samples were not statistically different with a mean pooled age of 571 ± 26 B.P. A comparison of these ages suggests that there is a significant difference between laboratory and/or material dated (t = 6.547; X^2 = 3.84; p < .05) (Figure 2). However, as opposed to the common expectation that wood charcoal dates should pre-date other materials, wood charcoal dates from Schomaker analyzed at Beta Analytic were significantly more recent than the carbonized annual dates from the University of Arizona laboratory, suggesting that whatever difference exists between these assays (see discussion), it is not attributable to the old wood problem.

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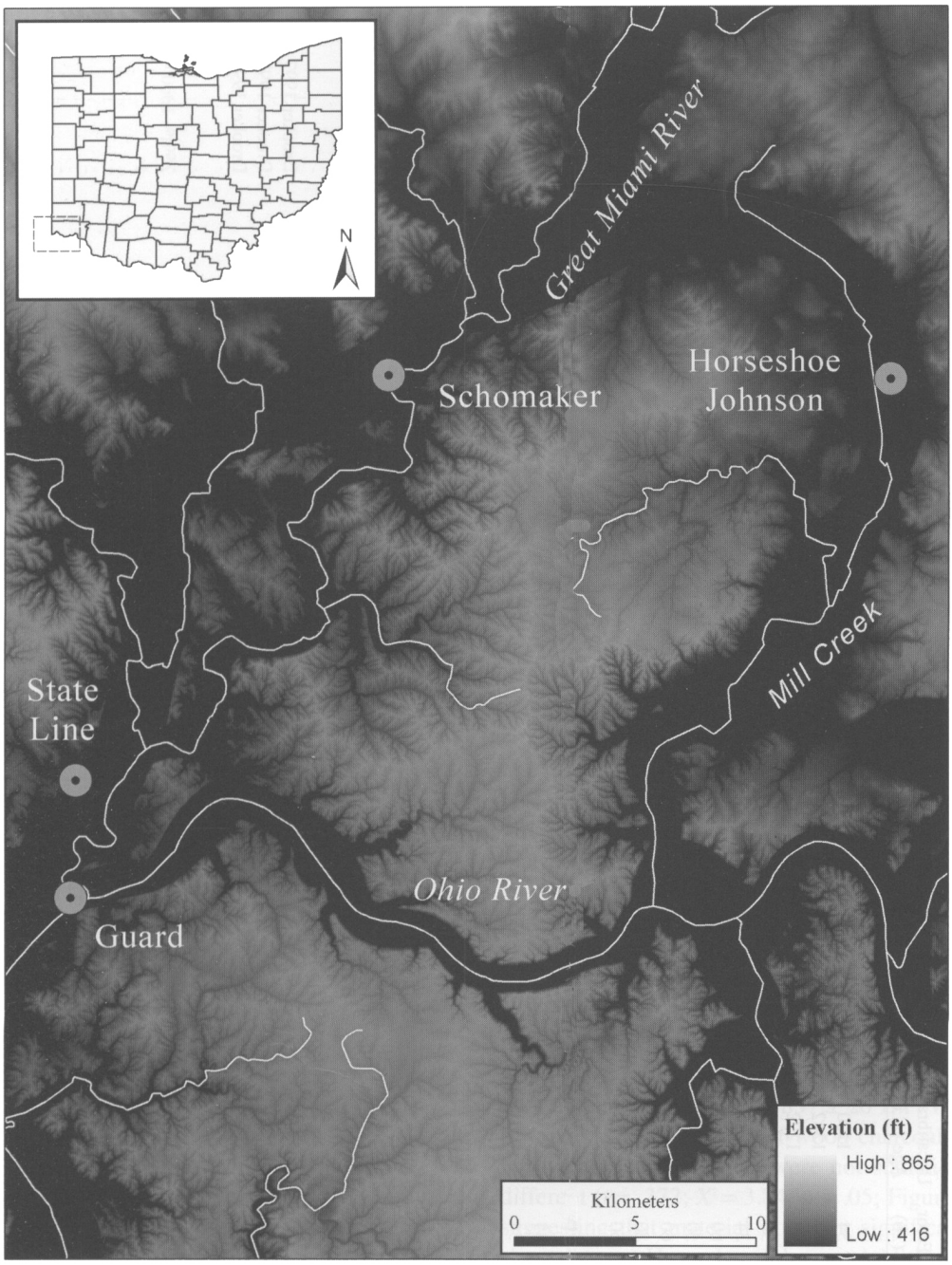


Figure 1. Location of study sites.

Radiocarbon dates from the State Line site can also be differentiated on the basis of laboratory as well as material. Wood charcoal dates were analyzed at the University of Georgia (UGA) (n = 3), while bone and annuals were dated at the University of Arizona laboratory (n = 10). The UGA wood dates were not statistically different, with a mean pooled age of 731 ± 34 B.P. Non-wood charcoal dates from the Arizona laboratory were also not statistically different, with a mean pooled age of 847 ± 13 B.P. A statistical comparison of the non-wood dates from the

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Table 1. Radiocarbon Dates used in the Present Study

Site	Lab Code	Age	Error (2σ)	Uncalibrated Age (A.D.)	Material	Context	Reference
Schomaker							
	AA98026	850	34	1100	Corn Kernel	N994 W106, Str. 86-1, Layer B, F.S. 515 A62861	-
	AA98025	708	34	1242	Unid. Nutshell	N998 W106, Fea. 1986-3, N1/2, L.8, A62859	-
	AA98028	657	35	1292	Unid. Nutshell	F.S. 530 Str. 1986-1 Layer C, A62860	-
	AA98027	634	34	1316	Corn Kernel	N930 W77.5, Fea. 6, E1/2, flot (w1/2 of maize dep.), acc. 1991.43, A62862, F.S. 36	-
	AA98024	605	34	1345	Unid. Nutshell	N990 W100, Fea. 1986-1, L.6, light fraction, A62858	-
	BETA17996	720	60	1230	Unid. Wood	Fea. 1986-7 (trash-filled storage pit)	Cowan et al. 1990
	BETA31966	710	50	1240	Unid. Wood	Fea. 1986-22 (trash-filled storage pit)	Cowan et al. 1990
	BETA14226	540	60	1410	Unid. Wood	Fea. 1985-5 (trash-filled storage pit)	Drooker 1997
	BETA17994	470	80	1480	Unid. Wood	Str. 1986-1 (structural timbers on house floor, Zone C)	Drooker 1997
	BETA31965	390	50	1560	Unid. Wood	Str. 1986-1 (structural timbers on house floor, Zone C)	Drooker 1997
State Line							
	AA98036	896	43	1054	Deer Bone	acc. 1991.44, mound, A62868	-
	AA98040	889	34	1061	Corn Cob (8 Row)	acc. 1991.44, F.S. 4, div. 2 OR 4, subdiv C, vert. 4–8 ft from datum, small ash deposit, A62871	-
	AA98037	875	43	1075	Deer Bone	acc. 1991.44, div. 2, subdiv. C, L.4, 3L5, A62869	-
	AA98038	874	43	1076	Deer Bone	acc. 1991.44, e. wall, div. 2, subdiv. C, IR:4, A62870	-
	AA98041	853	35	1097	Corn Cob (12 Row)	acc. 1991.44, F.S. 4, Div. 2 OR 4, subdiv. C, vert. 4–8 ft from datum, small ash deposit, A62871	-
	AA98039	831	43	1119	Deer Bone	acc. 1991.44, 9R4 div. 2, subdiv. 3, L.4–8, A62867	-
	AA98042	824	43	1126	Human Bone	503-4 mound	-
	AA98043	823	43	1127	Human Bone	503-6 mound	-
	AA100279	745	47	1205	Human Bone	503-4 (mound – different individual)	-
	AA100280	814	60	1136	Human Bone	503-6 (mound – different individual)	-
	UGA2153	785	60	1165	Unid. Wood		Drooker 1997
	UGA2154	715	55	1235	Unid. Wood		Drooker 1997
	UGA2152	695	60	1255	Unid. Wood		Drooker 1997
Horseshoe Johnson							
	AA98046	867	43	1083	Deer Bone	Fea. 26, F.S. 99, A62873	-
	AA98044	856	43	1094	Deer Bone	Fea. 21, F.S. 35, A62878	-
	AA98045	824	43	1126	Deer Bone	Fea. 30, F.S. 69, A62872	-
	AA98050	812	36	1138	Corn Kernel	Structure 1, N4 W3, F.S. 42/CS. 32, A62877	-
	AA98047	887	35	1063	Hickory Wood	Fea. 29, S1/2, A62874	-
	AA98048	795	35	1155	Ash Wood	Fea. 27, CS. 9, A62876	-
	AA98049	792	36	1158	Hickory or Ash Wood	Structure 1, CS. 78, A62875	-
	BETA17993	780	50	1170	Unid. Wood	House 2 basin fill	Drooker 1997

Guard						
	AA99942	936	45	1014	Unid. Wood	OSU Fea. 30, L. 1), Trench 2, deep square hearth	-
	AA99946	928	39	1022	Unid. Wood	OSU N1126 E1047, L. 5, post in wall fall, N1/2 of unit	-
	AA99949	918	39	1032	Unid. Wood	OSU Fea. 2, L. 2, N1040 E1014, hearth	-
	AA99948	887	39	1063	Unid. Wood	OSU Fea. 50, w1/2, postmold under west edge of Trench 1, structure floor	-
	AA99947	873	39	1077	Hickory Wood	OSU N988 E1025, central log on structure floor, Trench 3	-
	BETA17992	860	60	1090	Unid. Wood	Postmold in Main House Pattern	Sedler 1990
	AA99943	654	30	1296	Unid. Wood	OSU Fea. 6, L. 5, N1040 E1009-1010	-
	AA99945	948	42	1002	Corn Kernel	OSU Fea. 12, L. 4	-
	AA99941	875	44	1075	Human Bone	Burial 20 (with Ramey knife)	-
	AA98070	841	38	1109	Corn Kernel	acc. 1991.80, F.S. 524-525, A30724/13	-
	AA98072	807	38	1143	Unid. Plant Bulb	acc. 1991.80, pit, F.S. 222, A30609/16	-
	AA102763	805	35	1145	Human Bone	Burial 8	-
	AA102764	872	35	1078	Human Bone	Burial 10	-
	AA99944	807	35	1143	Unid. Nutshell	OSU Fea. 3, L. 2, N1040 E1058	-
	AA98071	760	38	1190	Unid. Nutshell	acc. 1991.80, F.S. 544, N487 E488, unit 17, pit, level 2, A 62851	-

Arizona lab and wood charcoal dates from Beta Analytic reveals that these samples are different ($t = 10.445$; $X^2 = 3.84$; $p < .05$) (Figure 3). Again, wood charcoal dates are more recent than non-wood dates.

In the preceding cases, it was impossible to control for laboratory and the material that was dated. However, the analysis consistently showed that assays derived from wood charcoal dates were more recent than those derived from non-wood materials, a finding that defies assumptions regarding old wood. The laboratory at which samples from the remaining two sites (Guard, Horseshoe Johnson) were analyzed was more consistent, allowing for assessment of differences in material while controlling for laboratory. An effort was also made here to date multiple materials from multiple contexts at each site in order to assess the utility of selecting multiple types of media when developing a representative dating strategy. These two examples represent what we see as more ideal scenarios where materials were wood charcoal when architectural features were sampled (primary contexts), and short-lived when trash deposits were sampled (secondary contexts) and the laboratory remains consistent.

Dates from Horseshoe Johnson were determined from non-wood (bone and carbonized maize [$n = 4$]) and wood charcoal ($n = 3$), all of which were analyzed at the University of Arizona laboratory. An additional wood charcoal date analyzed at Beta Analytic was added to the sample. The sample of wood charcoal dates was not statistically different, with a mean pooled age of 820 ± 19 B.P. The sample of non-wood dates was also determined to be statistically homogenous, with a mean pooled age of 837 ± 20 B.P. When compared, these samples of wood charcoal and non-wood charcoal dates were not statistically different ($t = .372$; $X^2 = 3.84$; $p > .05$; Figure 4), suggesting that material does not significantly skew dates at Horseshoe Johnson. Additionally, it should be noted that two samples, a wood charcoal specimen (AA980490) and a carbonized maize kernel (AA98050), produced similar dates and were both recovered from the same structure (Structure 1) (Table 1).

At Guard, a different pattern exists among the sample of dates, all but one of which were analyzed at the University of Arizona laboratory.

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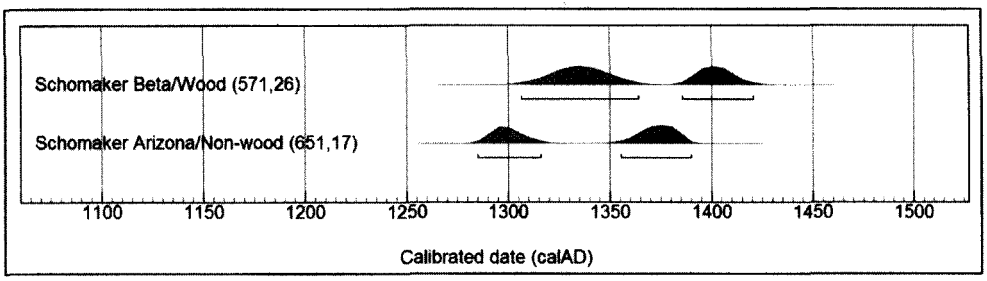


Figure 2. Schomaker pooled mean ages (OxCal v4.2.3 [Bronk Ramsey 2012]; r:5 IntCal13 atmospheric curve [Reimer et al. 2009]).

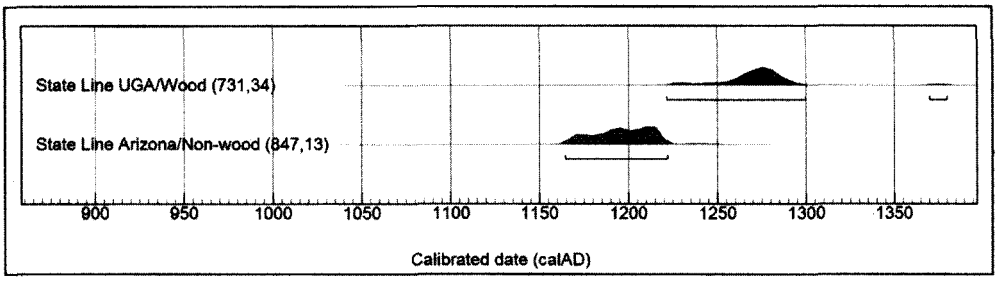


Figure 3. State Line pooled mean ages (OxCal v4.2.3 [Bronk Ramsey 2013]; r:5 IntCal13 atmospheric curve [Reimer et al. 2013]).

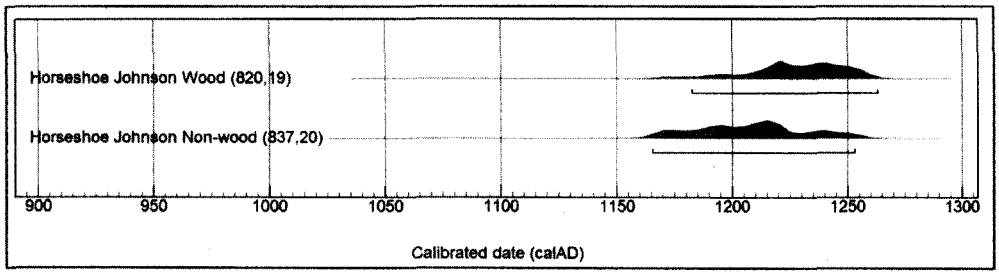


Figure 4. Horseshoe Johnson pooled mean ages (OxCal v4.2.3 [Bronk Ramsey 2013]; r:5 IntCal13 atmospheric curve [Reimer et al. 2013]).

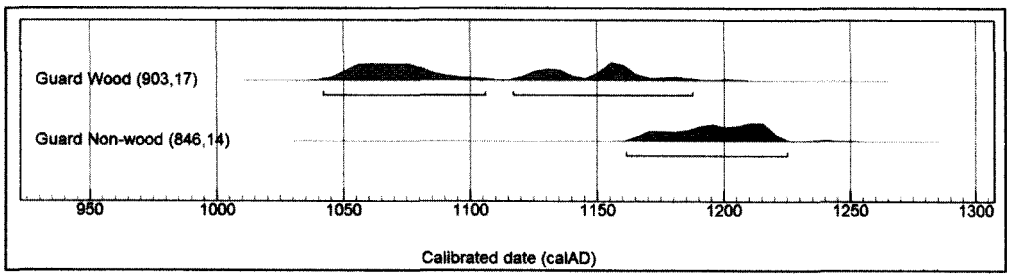


Figure 5. Guard pooled mean ages (OxCal v4.2.3 [Bronk Ramsey 2013]; r:5 IntCal13 atmospheric curve [Reimer et al. 2013]).

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Wood charcoal dates were not statistically different, with a mean pooled age of 903 ± 17 B.P. Non-wood dates were also not statistically different from each other, with a mean pooled age of 846 ± 14 B.P. Dates from wood charcoal and non-wood charcoal samples are statistically different ($t = 6.64$; $X^2 = 3.84$; $p < .05$), with wood being older than the non-wood samples (Figure 5) (this excludes the one clear outlier [AA99943]). Taken at face value, these results suggest that wood charcoal dates at Guard are earlier than non-wood charcoal dates, in line with old wood expectations. However, upon examination of the context of these dates the temporal distinction is consistent with our previous findings. Four of the wood charcoal dates come from features below village structures. The final date comes from a shallow hearth associated with an early structure. We interpret the earlier wood charcoal dates at Guard not as being due to their material, but rather as being due to their association with stratigraphically earlier portions of the village that were sampled.

Discussion

Our case study has made it clear that close consideration of the contexts being dated is of key importance when assessing and selecting wood charcoal for dating purposes. Our study reveals that there is no systematic bias for wood toward earlier and erroneous conclusions as the old wood problem warns. The Guard case illuminates that in order to investigate household and site-level temporal relationships, it was necessary to date wood charcoal from burned architectural elements. Stratigraphic relationships allowed us to predict which wood dates were likely to be earlier than others. The Schomaker case also allows for predictions regarding the dates on architectural elements. An earlier study proposed on the basis of material culture that the house was filled in with earlier trash (Cowan et al. 1990), which is also supported by our dates. The larger issue demonstrated here is that radiocarbon dates are best understood in relation to several other lines of evidence if possible. In this way, radiocarbon dates can be considered to be a relative dating method (e.g., Cook 2007). In all three cases (Guard, Schomaker, SunWatch), a case can be made for site formation histories affecting the radiocarbon data sets, including reuse. Based on statistical comparisons, Horseshoe Johnson is the only site in the sample to be a single use village. This finding is very consistent with the fact that it is a site with very little material culture and feature patterning devoid of stratigraphic relationships (horizontal or vertical) implying occupational depth (Hawkins 1998). State Line was the only site in the sample not amenable to stratigraphic consideration due to the nature of the excavation (amateur and salvage [see Vickery et al. 2000]).

Having clarified the validity of wood charcoal dates, we considered issues related to why the style of architecture and deterioration rates in the study region generally obfuscates warnings raised regarding the old wood problem. Wood timbers were often used in construction as wall posts and roof beams, but aside from larger marker posts and unusually large structures they are derived from relatively young trees. Regarding wood decomposition, Warrick (1988) shows that in many circumstances, architectural timbers decay within 4–6 years. Based on decomposition rates and experimental reconstruction, Cook (2008:52) posits a span of 5–15 years for use-lives for structures in this region, which is consistent with several ethnographic examples of perishable architecture in other parts of the world (e.g., Cameron 1991). Using ethnographic accounts of Eastern Woodlands and Great Lakes populations, Shott (1992) suggests that Childers, a Late Woodland habitation site, had an occupation span of between 10 and 50 years.

The relationship between wood and architecture raises another important issue regarding the dating of wood charcoal. Most importantly, we emphasize that when possible all new dates obtained from wood charcoal were from structural timbers in wall fall, on house floors, or in postmolds (instead of postholes). As noted above, the architecture of prehistoric structures in this region relied on wooden post construction. In order to accurately date issues of household use-life, reconstruction, and site occupational history, the most relevant material to date is often wood charcoal from structural contexts. Assays from architectural elements give contextual insight into the archaeological events related to construction and renovation.

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A key criticism often raised regarding wood dates is that the age of a tree that is being dated is unknowable (and often hundreds of years). However, this claim needs to be contextualized in specific cases, for there is good reason to cast doubt on it in particular situations and indeed more generally when focusing on architecture in our study region. If one focuses on woods from postmolds, for example, which in our case are most often quite small, they fall well below a 50-year age based on comparisons with modern comparative data from the same species (mostly hickory, oak, ash, locust [e.g., Ginrich 1967]). With this information in mind, we feel strongly that it is best to date wood charcoal from architectural contexts in order to identify household construction events and village growth dynamics. Dating wood from non-structural contexts is more problematic (but see below).

The major reason for this discrepancy is the relatively arid climate of the American Southwest compared to the moister, temperate Eastern Woodlands. In the Southwest, arid conditions can result in wood that is available on the surface for centuries, making it prime firewood and as a result skewing the radiocarbon database (Schiffer 1986). In the temperate forests of the Eastern Woodlands, however, decomposition rates are much higher, and thus the availability of old wood is much lower. In a general model of decomposition rates in eastern United States forests, Pastor and Post (1986) suggest that trees with a diameter at breast height of greater than 10 cm decay at approximately 3 percent per year, a rate which increases as the tree becomes more decayed. This is more conservative than Brown and Schroeder's (1999:978) estimate of 4–10 percent per year or higher. Even considering moderate rates, most wood in the forests of the Eastern Woodlands would be recycled into the ecosystem and thus not available for firewood within roughly 33 years. Additionally, we suspect that as a log decomposes, there is a distinct negative correlation between time and its usefulness as firewood. In other words, the longer wood sits on the forest floor, the wetter and more decayed it becomes, likely limiting the viability of the majority of logs to relatively few years. This range is relatively negligible when compared to radiocarbon error ranges as well as the time wood is available for in arid climates.

A final point regarding the dating of architectural events is that a select few species of tree are comparatively resistant to decay. The only such species we are aware of in the study region is Eastern Red Cedar (*Juniperus virginiana*), which is occasionally incorporated into Fort Ancient architecture. It is important to note that the village center pole and a potential special purpose structure in at least one Fort Ancient community (SunWatch) were found to be constructed with this species (Wagner 1988:82). The uncalibrated radiocarbon age of the center pole is 820 ± 110 B.P. (A.D. 1130), which is on the early side of the occupation (Cook 2007). However, considering the likelihood that such a post would be reused, it is likely that this date is not contemporary with subsequent village occupation because of such cultural practices. Additionally, upon excavation, it was clear that the center pole was reset at least once as the community expanded, suggesting it was an enduring community marker (Cook 2008). We include this exception to clarify the contexts in which old wood may exist in our study region.

Architectural elements are not the only wood items subject to decay. Wood charcoal from non-architectural contexts was often dated in the past, forming a significant part of the existing databases. Are we to use these or set them aside? While wood can be used for many things other than construction, here we focus on practices related to firewood selection. Shott (1992) presents a cogent overview of available resources and notes that there is a distinct paucity of ethnohistoric data on what species and sizes of tree were used for firewood in an everyday context. His review of Asch and Brown's (1990) report suggests distinct patterns regarding prehistoric firewood use east of the Mississippi. Firewood typically consisted of small portions (i.e., twigs and branches) of wood, which were collected opportunistically. This behavior resulted in the collection of all types of wood, not just hardwoods. Asch and Brown (1990) also note that most of the wood charcoal remains recovered archaeologically come from the outer, younger layer of trees. These factors point to wood charcoal not contributing significant error to radiometric dates in the Eastern Woodlands.

Ethnographic accounts of Middle Ohio Valley are limited (Henderson et al. 1986; Shott 1992).

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As such, in order to understand contact-era practices, we must look to other areas of the Eastern Woodlands. Hudson (1976) notes that among the Creek and Natchez, firewood collection was typically done by individuals, and that as settlements remained in one place for long periods, people would have to travel long distances to find wood (Hudson 1976: 264, 292). This practice suggests that most of the firewood collected would have been smaller pieces, instead of heavy decaying logs, a pattern consistent with Asch and Brown's (1990) findings. Based on these limited samples, it seems fair to generalize that typical firewood collection practices in the Eastern Woodlands more often involved the gathering of smaller fragments of wood, as opposed to larger logs, behaviors which largely negate the old wood problem of excessive age in charred remains recovered from secondary contexts.

Toward an Optimal Dating Strategy

This study has demonstrated that wood charcoal should not be the basis for excluding a date, at least for sites we have analyzed in this report. By examining archaeological and radiometric data from four sites in the Middle Ohio Valley, we have demonstrated that there is no evidence that wood charcoal systemically skews dates "toward an excessive antiquity," as Schiffer (1986:19) found to be the case in the arid American Southwest. While our sample cannot be seen as being representative of the entirety of temperate climates, the results here should encourage others to examine their regions before excluding dates on wood charcoal. Recent calls to remove wood charcoal dates from the radiocarbon database, as part of a cleansing process, are simply not supported by our study.

Guard and Horseshoe Johnson demonstrate what we suggest is a move toward a more optimal solution for dating sites in our region. These two examples included wood when architectural features were sampled (primary contexts), and short-lived materials when trash deposits were sampled (secondary contexts) and the laboratory was relatively consistent. Dating results from Horseshoe Johnson support that it was a single, short-lived site, which was hypothesized on the basis of the paucity of material culture and the lack of stratigraphic relationships (Hawkins 1998). Based on lessons learned at Guard and Schomaker, it was key to date wood when making this assessment. Dating results from Guard are in line with expectations derived from stratigraphic relationships. Wood is older there but this is because the events that are being dated are older and wood from structural elements is the only way to examine this.

As Ward and Wilson (1978) warn, most archaeologists are fated to endure Case II situations, where there is no guarantee that dates are representative of the archaeological site from which they were sampled. However, we suggest that by utilizing an approach that negates the laboratory at which dates were analyzed as a potential source of error, and samples multiple media from multiple contexts throughout the site, we should be able to reduce the uncertainty regarding the representativeness of radiocarbon assays.

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References Cited

Asch, David L., and James A. Brown
1990 Stratigraphy and Site Chronology. In *At the Edge of Prehistory: Huber Phase Archaeology in the Chicago Area*, edited by James Brown and Patricia J. O'Brien, pp. 174-185. Center for American Archeology, Kampsville, Illinois.

Blockley, S. P. E., C. Bronk Ramsey, and T. F. G. Higham
2008 The Middle to Upper Paleolithic Transition: Dating, Stratigraphy, and Isochronous Markers. *Journal of Human Evolution* 55:764–771.

Blockley, S. P. E., and R. Pinhasi
2011 A Revised Chronology for the Adoption of Agriculture in the Southern Levant and the Role of Lateglacial Climatic Change. *Quaternary Science Reviews* 30:98–108.

Bronk Ramsey, C.
2008 Radiocarbon Dating: Revolutions in Understanding. *Archaeometry* 50:249–275.
2012 OxCal v4.2.2. https://c14.arch.ox.ac.uk/

Brown, S. L. and P. E. Schroeder
1999 Spatial Patterns of Aboveground Production and Mortality of Woody Biomass for Eastern U.S. Forests. *Ecological Applications* 9:968–980.

Cameron, Catherine M.

https://doi.org/10.7183/0002-7316.79.4.763 Published online by Cambridge University Press

1991 Structure Abandonment in Villages. *Archaeological Method and Theory* 3: 155–191.

Collett, David, and Peter Robertshaw
1983 Problems in the Interpretation of Radiocarbon Dates: The Pastoral Neolithic of East Africa. *The African Archaeological Review* 1:57–74.

Cook, Robert A.
2007 Single Component Sites with Long Sequences of Radiocarbon Dates: The SunWatch Site and Middle Fort Ancient Village Growth. *American Antiquity* 72: 439–460.
2008 *SunWatch: Fort Ancient Development in the Mississippian World*. University of Alabama Press, Tuscaloosa.

Cowan, C. Wesley, Sandra Dunavan, John P. Nass, and Susan Scott
1990 The Schomaker Site, A Middle Period Fort Ancient Town on the Great Miami River, Hamilton County, Ohio. *West Virginia Archaeologist* 42: 11–35.

Drooker, Penelope
1997 The View from Madisonville: Protohistoric Western Fort Ancient Interaction Patterns. Memoirs No.31, Museum of Anthropology, University of Michigan, Ann Arbor.

Ginrich, Samuel F.
1967 Measuring and Evaluating Stocking and Stand Density in Upland Hardwood Forests in the Central States. *Forest Science* 13:38–53.

Hawkins, Rebecca A.
1998 Coming Full Circle: Plowzone Assemblages and the Interpretation of Fort Ancient Settlement Structure. In *Surface Archaeology*, edited by Alan P. Sullivan, pp. 91–109. University of New Mexico Press, Albuquerque.

Henderson, A. Gwynn, Cynthia E. Jobe, and Christopher Turnbow
1986 *Indian Occupation and Use in Northern and Eastern Kentucky During the Contact Period (1540–1795): An Initial Investigation*. University of Kentucky, Lexington.

Hudson, Charles
1976 *Southeastern Indians*. University of Tennessee Press, Knoxville.

Hunt, Terry L., and Carl P. Lipo
2006 Late Colonization of Easter Island. *Science* 311:1603–1606.

International Study Group
1982 An Inter-Laboratory Comparison of Radiocarbon Measurements in Tree Rings. *Nature* 298:619–623.

Knapp, Timothy D.
2009 An Unbounded Future? Ceramic Types, "Cultures," and Scale in Late Prehistoric Research. In *Iroquoian Archaeology & Analytic Scale*, edited by Laurie E. Miroff and Timothy D. Knapp, pp. 101–130. University of Tennessee Press, Knoxville.

Long, Austin, and Bruce Rippeteau
1974 Testing Contemporaneity and Averaging Radiocarbon Dates. *American Antiquity* 39:205–215.

Maslowski, Robert F., Charles M. Niquette, and Derek M. Wingfield
1995 The Kentucky, Ohio and West Virginia Radiocarbon Database. *West Virginia Archeologist* 47:1–2.

Nolan, Kevin C.
2012 Temporal Hygiene: Problems in Cultural Chronology of the Late Prehistoric Period of the Middle Ohio River Valley. *Southeastern Archaeology* 31: 185–206.

Pastor, John, and W. M. Post
1986 Influence of Climate, Soil Moisture, and Succession on Forest Carbon and Nitrogen Cycles. *Biogeochemistry* 2:3–27.

Pettitt, P. B., W. Davies, C. S. Gamble, and M. B. Richards
2003 Palaeolithic Radiocarbon Chronology: Quantifying Our Confidence Beyond Two Half-Lives. *Journal of Archaeological Science* 30:1685–1693.

Reimer, P. J., M. G. L. Baillie, E. Bard, A. Bayliss, J. W. Beck, P. G. Blackwell, C. Bronk Ramsey, C. E. Buck, G. S. Burr, R. L. Edwards, M. Friedrich, P. M. Grootes, T. P. Guilderson, I. Hajadas, T. J. Heaton, A. G. Hogg, K. A. Hughen, K. F. Kaiser, B. Kromer, F. G. McCormac, S. W. Manning, R. W. Reimer, D. A. Richards, J. R. Southon, S. Talamo, C. S. M. Turney, J. van der Plicht, and C. E. Weyhenmeyer
2009 IntCal09 and Marine09 Radiocarbon Age Calibration Curves, 0–50,000 years cal BP. *Radiocarbon* 51:1111–1150.

Schiffer, Michael B.
1986 Radiocarbon Dates and the "Old Wood" Problem: The Case of the Hohokam Chronology. *Journal of Archaeological Science* 13:13–30.
1987 *Formation Processes of the Archaeological Record*. University of New Mexico, Albuquerque.

Sedler, Mike
1990 Plan for Archaeological Investigation of the Guard Site, 12D29, Dearborn County. Manuscript on file, Department of Historic Preservation and Archaeology, Indianapolis, Indiana.

Shott, Michael J.
1992 Radiocarbon Dating as a Probabilistic Technique: The Childers Site and Late Woodland Occupation in the Ohio Valley. *American Antiquity* 57:202–230.

Spaulding, Albert C.
1958 The Significant Differences between Radiocarbon Dates. *American Antiquity* 23:309–311.

Stuiver, M., and P. J. Reimer
2011 Calib Radiocarbon Calibration Program, Rev. 6.1.0. http://calib.qub.ac.uk/calib/

Taché, Karine, and John P. Hart
2013 Chronometric Hygiene of Radiocarbon Databases for Early Durable Cooking Vessel Technologies in Northeastern North America. *American Antiquity* 78: 359–372.

Telford, R. J., E. Heegaard, and H. J. B. Birks
2004 The Intercept is a Poor Estimate of a Calibrated Radiocarbon Age. *The Holocene* 14:296–298.

Trigger, Bruce G.
2006 *A History of Archaeological Thought*. 2nd ed. Cambridge University Press, Cambridge.

Vickery, Kent D., Theodore S. Sunderhaus, and Robert A. Genheimer
2000 Preliminary Report on Excavations at the Fort Ancient State Line Site, 33Ha58, in the Central Ohio Valley. In *Cultures Before Contact: The Late Prehistory of Ohio and Surrounding Regions*, edited by Robert A. Genheimer, pp. 272–329. The Ohio Archaeological Council, Columbus.

Wagner, Gail
1988 Paleoethnobotanical Research at the Incinerator Site. In *A History of 17 Years of Excavation and Reconstruction*, Vol. 1, edited by James M. Heilman, Malinda C. Lileas, and Christopher A. Turnbow, pp. 72–111. Dayton Society of Natural History, Dayton, Ohio.

Ward, G. K., and S. R. Wilson
1978 Procedures for Comparing and Combining Radiocarbon Age Determinations: A Critique. *Archaeometry* 20:19–31.

Warrick, Gary A.
1988 Estimating Ontario Iroquoian Village Duration. *Man in the Northeast* 36:21–60.

Wilmhurst, Janet M., Terry L. Hunt, Carl P. Lipo, and Atholl J. Anderson
2011 High-Precision Radiocarbon Dating Shows Recent and Rapid Initial Human Colonization of East Polynesia.

https://doi.org/10.7183/0002-7316.79.4.763 Published online by Cambridge University Press

Proceedings of the National Academy of Science 108:1815–1820.

Willey, Gordon R., and Jeremy A. Sabloff
1980 *A History of American Archaeology*. 2nd ed. Thames and Hudson, London.

Notes

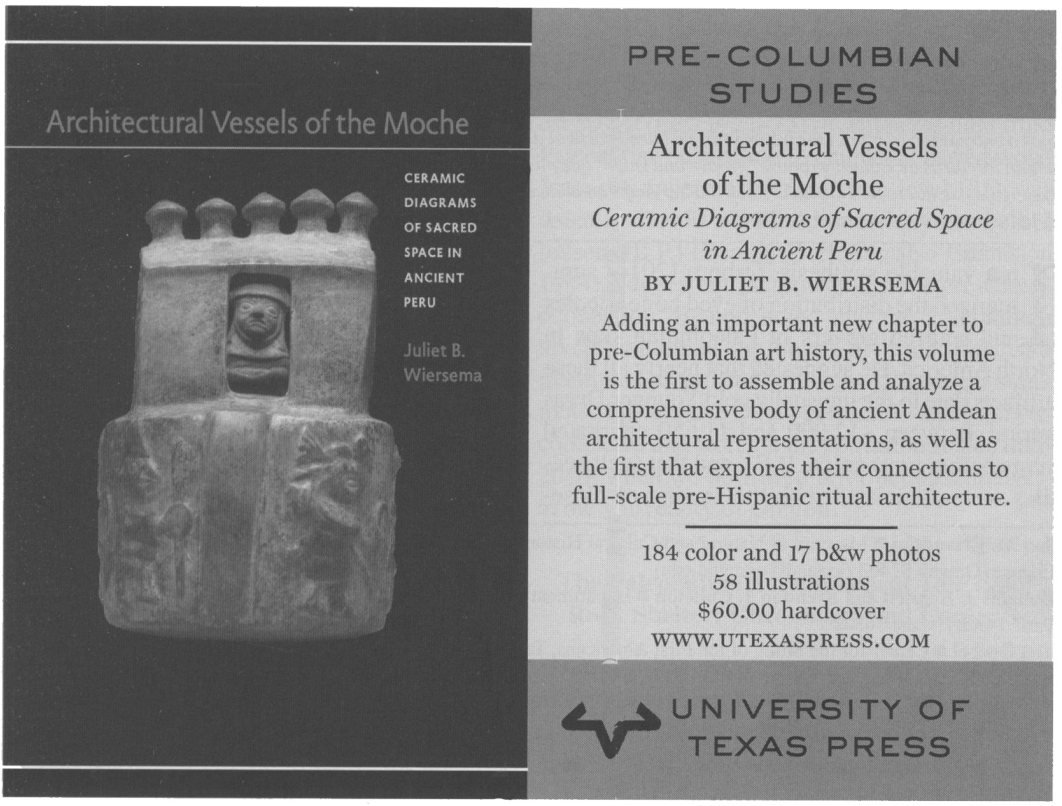
1. $A_p = \left(\sum_1^n A_i / S_i^2\right) / \left(\sum_1^n 1 / S_i^2\right)$

2. $T' = \sum_1^n (A_i - A_p)^2 / S_i^2$

3. $V(A_p) = (\sum_1^n 1 / S_i^2)^{-1}$

4. It has been suggested that the laboratory at which dates were analyzed may contribute to error as a result of different preparation and analysis techniques (e.g., International Study Group 1982). We acknowledge that this may be a confounding factor in the analyses of Schomaker and State Line samples. However, it was not possible to differentiate between laboratory and media, preventing us from testing this issue in our samples. However, the consistent results that wood dates were more recent at these two sites regardless of laboratory lend strength to our interpretation.

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