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Woodland-period mound building as historical tradition: Dating the mounds and monuments at Crystal River (8CI1)

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ABSTRACT

Changes in monumental architecture are fundamental to the theory and practice of archaeology in eastern North America, yet we have rarely examined these changes at spatial and temporal scales commensurate with the lived experience of the people of the past. The problem is exemplified by the transition from conical burial mounds to truncated pyramids, or platform mounds. We report a combined total of 24 radiocarbon dates (10 reported here for first time) and four OSL dates from mounds at the Crystal River site (8CI1) in west-central Florida, among the most diverse Woodland-period mound complexes in the US Southeast. We then review the results of Bayesian modeling of mound construction episodes indicated by geophysical survey, small-diameter coring, and reviews of previous excavation. Finally, we synthesis the modeled start dates for mound construction episodes into a five-phase Bayesian model that allows us to approach mound building at Crystal River as a form of historical tradition characterized by both stasis and rapid change in architectural form.

1. Introduction

Changes in monumental architecture are fundamental to the theory and practice of archaeology in eastern North America (Anderson, 2012: 85–86), yet we have rarely examined these changes at spatial and temporal scales commensurate with the lived experience of the people of the past. The problem is exemplified by the transition from conical burial mounds to truncated pyramids, or platform mounds. Cultural historians saw these forms as markers of broad-scale temporal patterns, specifically the Burial Mound and Temple Mound stages, respectively (Ford and Willey, 1941; Griffin, 1946, 1952). Processualists considered them indicative of evolutionary stages of organizational complexity, from the simple, relatively egalitarian societies of the Woodland period (ca. 1000 BCE to 1050 CE) to the ranked societies of the Mississippian (ca. 1050 CE to 1540), respectively (Peebles and Kus, 1977; Steponaitis, 1978, 1986: 392). Neither was concerned with variation from historical sequences or evolutionary trajectories, or the manner in which the transition played out over shorter time frames in specific localities. Nevertheless, over the years a number of exceptions to the general pattern were documented, in the form of anomalously early platform mound construction at sites such as Anneewakee Creek (Dickens, 1975); McKeithen (Milanich et al. 1997); Swift Creek (Kelly and Smith, 1975); Mandeville (Kellar et al., 1962a, 1962b; Smith, 1975); Garden Creek (Keel, 1976); Toltec (Rolingson, 2012); and Pinson (Broster and Schneider, 1976; Fischer and McNutt, 1962; Mainfort, 1986, 1988a, 1988b; Mainfort and McNutt, 2013; Mainfort et al., 1982) (Fig. 1).

By the 1990s, a broader theoretical landscape had emerged, favoring historical understanding of specific settings over chronological and typological generalization. This expansion of archaeological thought coincided with the growing recognition that the progression from burial- to platform-mound architecture was not as tidy as previously assumed. Knight (1990, 2001) presented evidence for Woodland-period platform mound building at the Walling site and, drawing from a roster of 55 mounds on 30 sites, went on to describe this as a "generalized phenomenon," albeit with great variability in time and form. Jefferies (1994), in a slightly later synthesis that included documentation of another example at the Cold Springs site, reached similar conclusions. Lindauer and Blitz (1997) contrasted early (primarily Woodland) and late (primarily Mississippian) platform mounds in the Southeast. Several additional descriptions of pre-Mississippian platform mounds have followed (Boudreaux, 2011; Kimball et al., 2010; Pluckhahn, 1996; Rafferty, 1990; Seinfeld and Bigman, 2013; Sherwood et al., 2013).

Yet a true historical perspective on the diversity of mound architecture during the Woodland period has remained elusive, owing to limitations of both the archaeological record and our approach to it. Regarding the former, relatively few extant Woodland-period sites encapsulate the full diversity of mound forms. The problem is exacerbated by the modern-era destruction of several prominent mound centers; perhaps most unfortunate is the loss of the 13 mounds at the Troyville site, including one of considerable size and formal complexity (Neuman, 1984: 170–171; Walker, 1936). Of the major Woodland-period mound complexes that remain, many are poorly dated or lack absolute dates entirely. Many of these—such as the Kolomoki (Sears, 1956) and Marksville (Toth, 1974) sites—were principally excavated before the development of radiocarbon dating, or at least before the retrieval of samples for radiocarbon dating became standard practice. Compounding the problem, newer field investigations of the largest and most architecturally-diverse Woodland-period mound complexes are relatively infrequent, owing partly to deference to Native American

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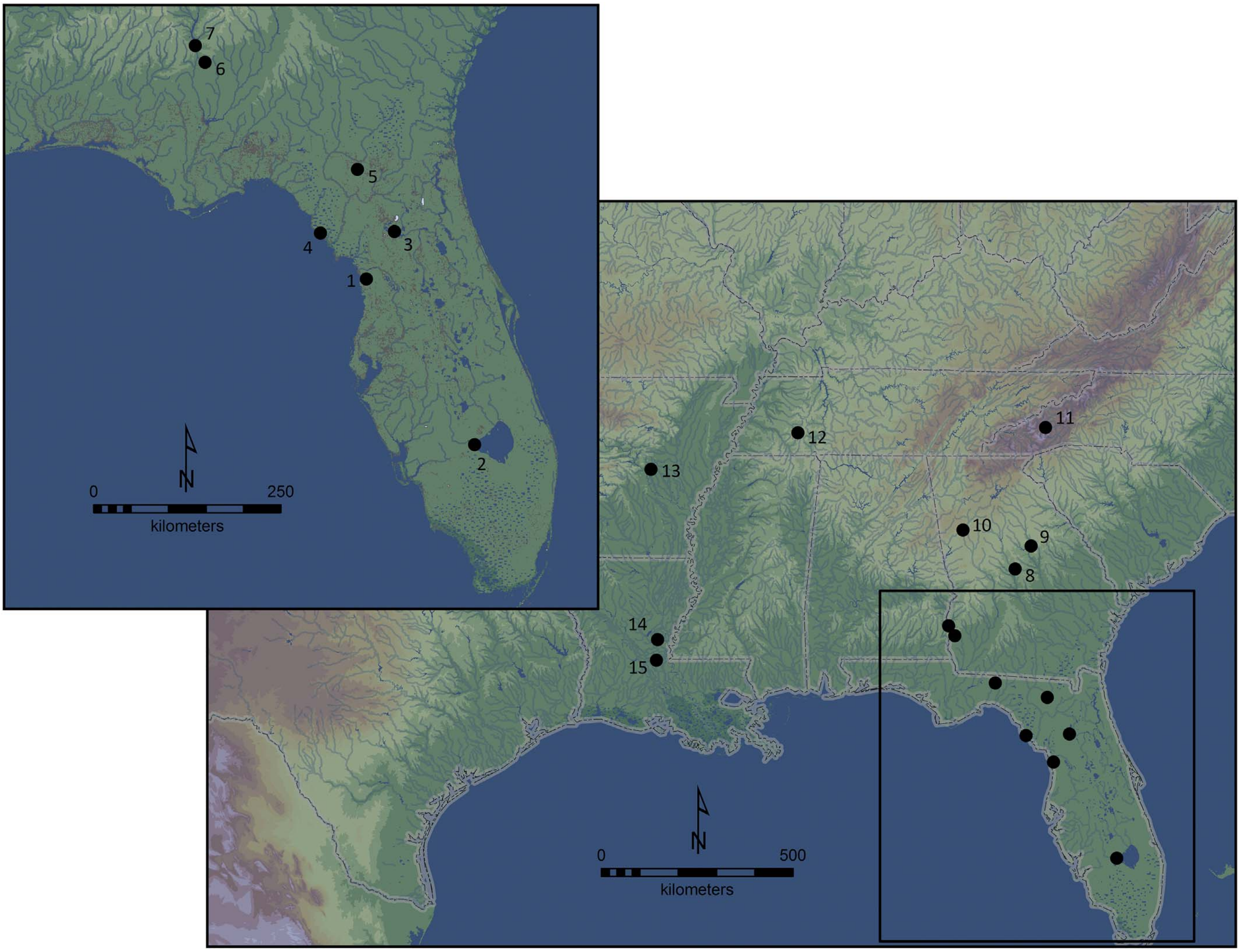

Fig. 1. Location of Crystal River and other sites mentioned in the text.

preferences. Archaeologists have also been slow to implement minimally-invasive methods or alternative dating techniques, such as the optically-stimulated luminescence dating (OSL) that contributed to new understanding of Archaic-period mound building (Feathers, 1997; Saunders et al., 1997).

While many of these limitations remain, recent advances in Bayesian modeling present archaeologists with unprecedented opportunities to understand changes in monumental architecture at scales approaching the lived experience of the people of the past. Drawing from Bayes' Theorem, data relevant to a specific problem (standardized likelihoods), such as radiocarbon assays associated with a mound we wish to position chronologically, are considered in the context of our knowledge (prior beliefs), such as the stratigraphic or phase-based ordering of the dated contexts, to arrive at a new understanding of the problem (posterior beliefs) (Bayliss et al., 2011: 19). OxCal 4.2 (©Christopher Bronk Ramsey 2013; Bronk Ramsey, 2009) allows users to develop Bayesian models that, depending on the quality of the prior beliefs and standardized likelihoods (see Bayliss et al., 2007), can help us understand monument construction at generational or decadal scales with relatively high certainty (e.g., Chirikure et al., 2013; Culleton et al., 2012; Schilling, 2013).

We present new evidence for the dating of mounds at the Crystal River site (8CI1), a Woodland-period mound complex on Florida's central Gulf Coast (Fig. 2). Crystal River is among the most diverse Woodland-period mound complexes in the US Southeast, with two burial mounds (Mound G and Mounds C–F—the latter a complex consisting of several parts), one large platform mound (Mound A), and two or three smaller platform mounds (Mounds H, J, and K). Ten years ago, the site was virtually undated. As a result of new field excavations, as well as new analyses of previous collections, it is now among the most thoroughly dated Woodland-period mound and village complexes in eastern North America.

As described elsewhere (Pluckhhan, Thompson, et al., 2015), recent investigations included the retrieval of 36 radiocarbon dates from midden contexts; Bayesian modeling of these and the handful of previous dates identified four phases of village growth and decline. Briefly, habitation began in Midden Phase 1, modeled to between *69 and 265 cal CE* (95%), probably between *125 and 242 cal CE* (68%) (Pluckhahn, Thompson, et al., 2015) (in keeping with the convention (Bayliss et al., 2011: 21) we use italics to differentiate modeled date ranges from simple calibrated dates). Isotopic studies of oysters from these contexts suggest the initial settlement was likely seasonal, occurring in cooler months and perhaps in association with ceremonies (Thompson et al., 2015). The village grew rapidly in permanence and size during the second midden phase, modeled to the interval between *238 and 499 cal CE* (95%), probably between *221 and 544 cal CE* (68%) (Pluckhahn, Thompson, et al., 2015). Settlement declined at Crystal River in Midden Phase 3, modeled between *478 and 810 cal CE* (95%), probably between *521 and 747 cal CE* (68%). In the fourth and final midden phase, modeled between *723 and 1060 cal CE* (95%), probably between *779 and 982 cal CE* (95%), the occupation at Crystal River declined even further, perhaps reflecting only a continuing caretaker

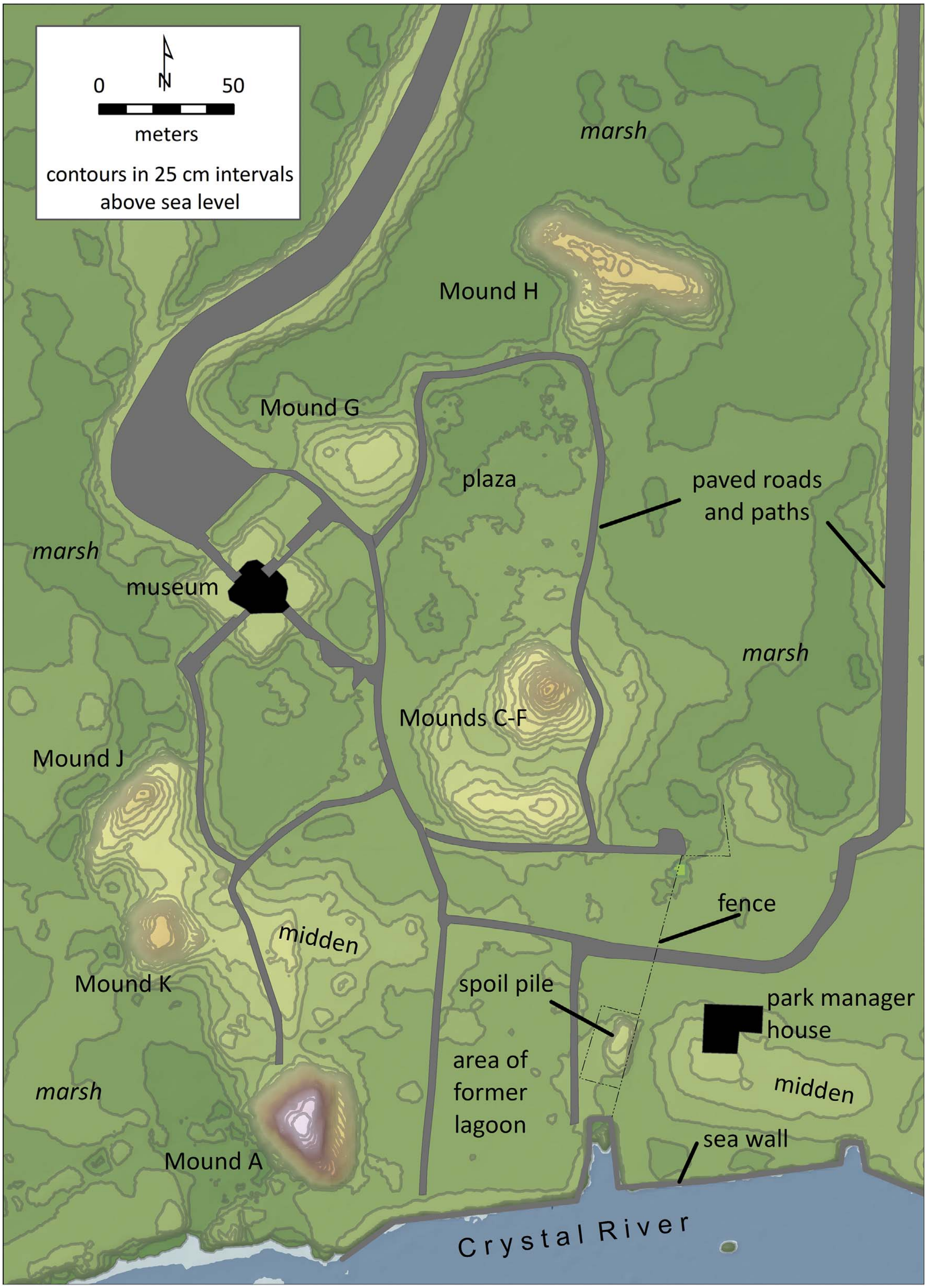

Fig. 2. The Crystal River site.

presence.

Here, we take a similar tactic to the dating of mounds, using Bayesian statistics to model construction episodes indicated by geophysical survey, small-diameter coring, and reviews of previous excavation. Our mound modeling is based on a combined total of 24 radiocarbon dates (10 reported here for first time) and four OSL dates (previously reported by Hodson (2012) and Pluckhahn, Hodson et al. (2015)). Finally, we synthesis the modeled start dates for mound construction episodes into a five-phase Bayesian model. We approach mound building at Crystal River as a form of historical tradition, defined by Pauketat (2001a:2) as “practice brought from the past to the present.” In contrast with earlier views of tradition that assumed stability and conservatism, the historical approach recognizes that traditions are subject to constant negotiation by individuals and larger social collectives and may be both constraining and enabling of social change (Pauketat, 2001a: 4–6, 2001b: 80). It follows that traditions may be either enduring or subject to rapid transformation, in contrast with the slow change inherent to previous views of architectural tradition through the lenses of culture history and social evolution.

2. Previous investigations of the mounds at Crystal River

Brinton (1859: 178–9, 1867: 357) provided the first written account of Crystal River, based on a visit in 1856–7. Moore (1903, 1907, 1918) later provided a more detailed account, mapping many of the Crystal River's major features and assigning to these the letter designations that are still used today. In addition, Moore conducted three seasons of fieldwork in the Main Burial Complex (Mounds C–F), as discussed in more detail below.

Gordon Willey visited Crystal River in 1949, providing additional descriptions of several of the mounds and conducting surface collections of Mounds C and F (Milanich, 2007:22; Weisman, 1995:28; Willey, 1949a, 1949b). A short time later, Hale Smith excavated a 2-×-2 ft (0.6-×-0.6 m) test in Mound H, several tests in Mounds C and E, and a surface collection of Mound A (Smith, 1951; Weisman, 1995:14, 28–29).

In 1951, Ripley Bullen initiated the first of several seasons of field work at Crystal River (Bullen, 1951, 1953, 1965, 1966; Weisman, 1995:28–29). Topographic mapping led to the identification of two previously unidentified Mounds J and K (Weisman, 1995:37). Small tests were excavated in these, as well as Mounds H and K. Bullen completed a larger excavation in Mound G, recovering approximately 35 burials. Finally, Bullen identified and excavated portion of the Main Burial Complex that had not been previously disturbed by Moore, recovering additional burials. Bullen's work at Crystal River, like Moore's before him, is fundamental to the interpretation of the site, but unfortunately even less thoroughly documented.

Contemporary investigations of the mounds at Crystal River have been limited. Among the most substantial was the documentation of damage caused to several of the mounds by trees felled by a tornado (Weisman, 1993).

3. New investigations of the mounds at Crystal River

In 2008, we began a pilot project at Crystal River that included mapping, geophysical survey, and small-scale coring (Pluckhahn et al., 2009). In 2010 with assistance from the National Science Foundation, we began more comprehensive archaeological investigations with the goal of understanding the dynamic between competition and cooperation in the development of early villages, using Crystal River as a case study. The construction history of mound architecture is obviously key to this question. To address the issue, we relied on a combination of minimally-invasive, new field investigations and the analysis of the collections generated by previous excavations. The latter method was the principal means for understanding the construction history of the two burial mound complexes. Artifacts and human remains resulting from Bullen's excavations are curated at the Florida Museum of Natural History (FLMNH) in Gainesville; Katzmarzyk (1998) had previously inventoried and analyzed the human remains; Kemp (2015) analyzed the ceramics. Artifacts from Moore's excavations are curated at the National Museum of the American Indian, Washington, DC.

Geophysical survey of the platform mounds, including resistance and ground penetrating radar (GPR), provided a window on major construction episodes (Pluckhahn et al., 2009; Thompson and Pluckhahn, 2010). We used a Geoscan RM RM-15 Advanced Resistance Meter with a parallel twin-probe array and 50-cm probe separation to conduct the resistance survey, collecting data at 50-cm intervals along survey transects spaced 1 m apart in 10-×-10-m and 20-×-20-m grids. To process the resistance data, we used ArcheoSurveyor (now known as TerraSurveyor) and applied the procedure prescribed by Gater and Gaffney (2003:104), which included de-spiking the readings and using a high-pass filter. For the GPR survey, we used the Geophysical Survey Systems, Inc. (GSSI) SIR-3000 with a 400 MHz antenna. For most of the mounds, we collected GPR data on several transects extending from mound summit to base. The GPR data were process using GPR Viewer, developed by Jeff Lucius and Lawrence Conyers (see Conyers, 2012:14). For our larger surveys involving multiple transects over the mounds we used GPR-SLICE to create planview amplitude slice maps.

Minimally invasive excavation of platform mounds took the form of small-diameter coring conducted using a GeoProbe Model 6620DT, a hydraulic coring device that hammers a metal tube containing a plastic sleeve 4.5 cm in diameter and 116 cm long. The sections are retrieved one at a time, progressing deeper with each section. Cores in the mounds varied from three (Mounds H and K) to five (Mound J) to nine (Mound A) sections deep, depending on the height of the mound and the nature of the underlying sediments. We retrieved two adjacent cores from each platform mound, one for stratigraphic data and the other for OSL dating. For the stratigraphic cores, we split the clear plastic tubes in half lengthwise. One half was used to document the soils (Norman, 2014), with samples taken for pollen and other specialized studies (Jackson, 2016); the other half was screened for artifacts using 0.32 cm (0.125 in.) mesh (Blankenship, 2013). The OSL core sections were collected with black plastic tubes to prevent exposure to light. Geologist Jack Rink and his students Alex Hodson and Robert Hendricks processed these samples at McMaster University (Hodson, 2012; Pluckhahn, Hodson et al. 2015).

Table 1 summarizes radiocarbon dates from mound contexts at Crystal River. Table 2 summarizes OSL dates from mound contexts; for additional information on the calculation of these dates, see Hodson (2012) and Pluckhahn, Hodson et al. (2015). Previous efforts to radiocarbon date oyster shell from Crystal River produced results so erratic that no reliable correction was possible, perhaps owing to the introduction of older carbon from the limestone substrate (Cherkinsky et al., 2014; Pluckhahn, Thompson, et al., 2015). This is unfortunate in that shell is the dominant constituent of much of the sediments, especially in the mounds. Fortunately, the dating of soil-charcoal proved effective; a series of dates on minute quantities of soil-carbon samples from different depths in the midden revealed excellent stratigraphic ordering (Pluckhahn, Thompson, et al., 2015). We thus took the same approach to dating soil-charcoal recovered from mound cores. Soil-charcoal samples were process by the University of Georgia Center for Applied Isotope Studies.

As noted elsewhere (Pluckhahn, Thompson, et al., 2015: 27), we recognize that soil-carbon should be considered suspect for dating archaeological contexts due to possible biases introduced by the old wood effect, the mixing of charcoal of different ages, and the downward transport of humic acids (Nolan, 2012; Pettitt et al., 2003). However, we attribute the positive results here to the fact that we dated very small samples of sediment (typically no more than 2 g) from mound layers that are generally very compact and separated from one another by dense shell deposits, factors which together may impede the vertical displacement of materials through the profile by ants and other organisms (see Pluckhahn, Hodson et al. 2015; Tschinkel et al., 2012). We have not attempted to compensate for an old wood effect in our modeling of soil-charcoal, owing to the inherent uncertainties (the fragments are too small identification) and for consistency with our modeling of the village midden (see Pluckhahn, Thompson, et al., 2015).

Previous efforts at radiocarbon dating bone from Crystal River have produced mixed results. Dates on terrestrial mammals such as deer show generally good correspondence with soil-charcoal dates from the same stratigraphic contexts (Cherkinsky et al., 2014; Pluckhahn, Thompson, et al., 2015). On the other hand, dates on human remains have produced anomalous results, perhaps owing to a heavy reliance on marine foods or the introduction of contaminants (Katzmarzyk,

Table 1
Summary of radiocarbon dates from mound contexts at Crystal River.

Sample	Provenience	Material	13C, 0/00	14C BP	±	pMC	±	95% calibrated range[a]	Reference
UGA-14112	8CI1, Mound A, Core 13, Section 3, Stratum 11	Soil-carbon	− 23.6	1560	20	82.3	0.23	431 to 541 cal CE	Pluckhahn, Hodson et al. (2015): Table 1
UGA-13469	8CI1, Mound A, Core 13, Section 5, Stratum 22	Soil-carbon	− 24.3	1410	25	83.92	0.26	601 to 662 cal CE	Pluckhahn, Hodson et al. (2015): Table 1
UGA-13467	8CI1, Mound A, Core 13, Section 9, Stratum 42	Soil-carbon	− 27	1640	25	81.5	0.26	340 to 532 cal CE	Pluckhahn, Hodson et al. (2015): Table 1
I-1365	8CI1, Mound A, charcoal found 19 ft (5.8 m) below the top of the mound	Unidentified charcoal		1310	100			551 to 968 cal CE	Bullen (1966): 865
BETA-254521	Main Burial Complex Mound C, area A, south wall 36″–42″	Human bone collagen	− 16.5	2490	40			789 to 477 BCE (93.8%), 462 to 458 BCE (0.4%), 445 to 431 BCE (1.2%)	Pluckhahn et al. (2010): Table 1
OxA-32691	Main Burial Complex Mound C, Area A, Burial 19	Human bone collagen (rib fragments)	− 12.94	2801	26			1020 to 894 BCE (94.4%), 866 to 855 BCE (1.0%)	This report
BETA-259306	Main Burial Complex Mounds E and F, Bullen's Test 16	Bulk organics from Deptford Check Stamped sherd	− 17.9	1980	40			88 to 77 BCE (1.0%), 56 BCE to 92 CE (91.0%), 98 to 124 CE (3.3%)	Pluckhahn et al. (2010): Table 1
BETA-259307	Main Burial Complex Mounds E and F, Bullen's Test 15 ext (F?), under Burials 1–10	Bulk organics from plain sand tempered sherd	− 20.2	2120	40			352 to 297 BCE (10.6%), 229 to 221 BCE (0.8%), 212 to 43 BCE (84.1%)	Pluckhahn et al. (2010): Table 1
OxA-32709	Main Burial Complex, Mound F, Burial 3	Human bone collagen (rib fragments)	− 13.75	2025	28			110 BCE to 55 CE (95.4%)	This report
BETA-98043	8CI1, Mound G, Bullen's Burial 1 (adult female)	Human bone collagen	− 20	2520	60			802 to 476 BCE (93.2%), 463 to 455 BCE (0.8%), 445 to 431 BCE (1.4%)	Katzmarzyk (1998): Tables 3-8, 3-9
OxA-32688	8CI1, Mound G, Bullen's Burial 1 (adult female)	Human bone collagen (rib fragments)	− 13.7	1909	25			24 to 139 CE (94.9%), 198 to 205 CE (0.5%)	This report
BETA-97072	8CI1, Mound G, Bullen's Burial 20 (possibly older adult female)	Human bone collagen	− 18.3	1990	40			94 BCE to 86 CE (94.5%), 108 to 118 CE (0.9%)	Katzmarzyk (1998): Tables 3-8, 3-9
OxA-32689	8CI1, Mound G, Bullen's Burial 20 (possibly older adult female)	Human bone collagen (rib fragments)	− 13.04	1813	25			128 to 255 CE (92.3%), 301 to 317 CE (3.1%)	This report
BETA-98044	8CI1, Mound G, Bullen's Burial 35 (young adult female)	Human bone collagen	− 17.4	1620	40			345 to 541 CE (95.4%)	Katzmarzyk (1998): Tables 3-8, 3-9
OxA-32690	8CI1, Mound G, Bullen's Burial 30 (adult female with infant/fetus)	Human bone collagen (rib fragments)	− 14.36	1720	25			251 to 389 CE (95.4%)	This report
UGA-13465	8CI1, Mound H, Core 22, Section 1, Stratum 3	Soil-carbon	− 24.6	180	25	97.74	0.29	Modern	Pluckhahn, Hodson et al. (2015): Table 1
BETA-254520	8CI1, Mound H, Bullen's Test 1, 1–2 ft	Deer bone collagen	− 21.3	1550	40			418 to 594 cal CE	Pluckhahn et al. (2010): Table 1
UGA-13466	8CI1, Mound H, Core 22, Section 2, Stratum 11	Soil-carbon	− 24.2	1560	25	82.35	0.26	424 to 555 cal CE	Pluckhahn, Hodson et al. (2015): Table 1
UGA-14111	8CI1, Mound H, Core 22, Section 3, Stratum 22	Soil-carbon	− 24.1	1730	20	80.58	0.22	250 to 381 cal CE	Pluckhahn, Hodson et al. (2015): Table 1
UGA-13470	8CI1, Mound J, Core 32, Section 3, Stratum 7	Soil-carbon	− 22.4	1440	25	82.63	0.27	575 to 652 CE (95.4%)	This report
UGA-14114	8CI1, Mound J, Core 32, Section 4, Stratum 14	Soil-carbon	− 15.6	2000	20	77.94	0.22	45 BCE to 54 CE (95.5%)	This report
UGA-13471	8CI1, Mound J, Core 32, Section 5, Stratum 17	Soil-carbon	− 26	1890	25	79.03	0.25	59 to 214 CE (95.4%)	This report
UGA-13468	8CI1, Mound K, Core 21, Section 3, Stratum 3	Soil-carbon	− 23.9	1550	25	82.48	0.27	426 to 566 cal CE	This report
UGA-13464	8CI1, Mound K, Core 21, Section 3, Stratum 6	Soil-carbon	− 23.7	1730	25	80.58	0.25	247 to 383 cal CE	This report

[a] Radiocarbon ages calibrated using OxCal 4.20 and the IntCal13 curve (Reimer et al., 2013).

Table 2
Summary of OSL dates from mound contexts at Crystal River.

Sample	Provenience	Material	OSL age[a]	Model
CR22L11	Mound H, Core 22OSL, Level 11, ca. 140 cmbs	Quartz	8214 ± 393	Minimum age model
CR22L21B	Mound H, Core 22OSL, Level 21B, ca. 340 cmbs	Quartz	2145 ± 393	Minimum age model
CR22L25	Mound H, Core 22OSL, Level 25, ca. 370 cmbs	Quartz	12,573 ± 1485	Central age model
CR13L16	Mound A, Core 13OSL, Level 16, ca. 446–458 cmbs	Quartz	3441 ± 396	Central age model
CR13L26	Mound A, Core 13OSL, Level 26, ca. 651–664 cmbs	Quartz	3706 ± 400	Minimum age model
CR13L37	Mound A, Core 13OSL, Level 37, ca. 894–909 cmbs	Quartz	2260 ± 160	Minimum age model
CR13L40	Mound A, Core 13OSL, Level 40, ca. 977–458 cmbs	Quartz	3663 ± 354	Central age model

[a] OSL ages are reported here relative to the 2012 datum when they determined.

1998:32–36; Milanich, 1999:23), or the same issues of older carbon noted above for shell. To minimize the possibility of recent contaminants, we submitted samples of human bone to the Oxford Radiocarbon Accelerator Unit, which uses an ultrafiltration process (Brock et al., 2007; Bronk Ramsey et al., 2004). Beta Analytic Inc. processed previous samples.

To model the dating of mound construction episodes, we utilized the Bayesian modeling capabilities of OxCal 4.2 (©Christopher Bronk Ramsey 2013; Bronk Ramsey, 1995, 2009). In this case, the stratigraphic positions of dated samples relative to each other and construction episodes constitute our prior beliefs, and the radiocarbon and OSL dates are the observed likelihoods. OSL dates were entered into OxCal as calendar dates (C_Dates), with attendant error ranges. OxCal uses a Markov Chain Monte-Carlo (MCMC) model to build up a representative sample of possible solutions (Bronk Ramsey, 2009). The extent to which it is able to do so is measured by Convergence (C), with good convergence indicated by a value above 95. The solution is also evaluated using an agreement index to determine if the data are consistent with the model. OxCal calculates agreement indices for individual dates (A), the model (A_{model}), and the overall agreement between the agreement indices ($A_{overall}$). The critical value (A′c) is 60.0; anything above this is considered significant agreement (Bayliss et al., 2011:34–35).

Table 3 summarizes the models of mound construction, as well as the corresponding agreement indices. For all of the mounds except for Mound K and the burial mounds, we have dates on pre-mound layers that provide constraints on the initiation of the first stages of mound construction. Given the narrow window provided by the cores we excavated in the platform mounds, it is often difficult to differentiate layers of mound fill from the surfaces of mound stages that may have been used or at least exposed for some time before being covered; as a result, where we have multiple dates from the same broad construction episode or surface, we model these as phases. None of the mounds at Crystal River appear to have been expanded in subsequent periods; thus the latest mound stages are relatively unconstrained in the models and the modeled start-, and particularly end-dates for their construction are imprecise. As we describe below, given the coarse documentation of earlier work in the burial mounds it is difficult to parse the sequence of dated contexts; where we have multiple dates from these mounds, we thus model these as phases of construction and use.

After modeling the construction of individual mounds, we also modeled the start dates for major mound construction episodes collectively to better understand the tempo of mound construction. We used sequential phase modeling and between two and five phases. Fig. 3 shows the iteration of models, from our initial two-phase Model 2.1, which simply divided the burial and platform mounds, to Model 5.2, a five-phase model that resulted in the highest agreement indices (A_{model} = 87.0, $A_{overall}$ = 84.0). Table 4 documents the parameters of model, as well as the corresponding agreement indices. Another run of the same model using contiguous, rather than sequential phases produced lower agreement indices (A_{model} = 83.0, $A_{overall}$ = 79.6).

4. Results

4.1. Mound A

Mound A, sometimes referred to as "Spanish Mound" (Weisman, 1995:45), has only been minimally investigated. Brinton (1867:356–7) quotes an account describing Mound A as "a truncated cone" and "on all sides nearly perpendicular…about 40 ft [12.8 m] in height, the top surface nearly level, about 30 ft [9.1 m] in diameter." Moore (1903:379) estimated the height of the mound at 8.7 m, with a summit 32.6 by 15.2 m, and with basal dimensions of 55.5 by 30.5 m. Willey (1949b:41) noted the general accuracy of Moore's description and described the summit as "exceedingly level although not well squared." As described by Bullen (1953), Moore (1903:379), and Willey (1949b:41–42), a well-defined ramp extended down the east side of Mound A. Willey (1949b:42) noted that the ramp approach was still "perfectly preserved." Moore (1903:379) described the ramp as 24.4 m long and from 4.3 to 6.4 m wide.

Unfortunately, the southeastern two-thirds of the Mound A (including the ramp) were removed for construction fill in the 1960s (Weisman, 1995:45). Pluckhahn and Thompson (2009:15) indicate that the surviving portion of the mound has a maximum height of 8.2 m relative to the ground surface to the east. The better-preserved, northwestern end of the mound is about 12 m wide at summit and 28 m wide at base. Consistency with Moore's estimates suggests this portion of the mound retains its original shape and dimensions.

We excavated cores from the summit of Mound A to the sterile sand and clay layers below. For purposes of modeling the construction history of Mound A, we simplify the stratigraphy into three broad episodes (Fig. 4). The mound sediments are preceded by the premound midden, represented by the mix of dark soils and moderately dense shell in Layers 36–42. An AMS date of soil-charcoal from the lowermost level has a range of 340 to 532 cal CE (95% probability) (UGA-13467). One OSL date on sand grains from Level 37 above this produced a slightly older, but nevertheless broadly equivalent age of 2198 ± 160 years ago (CR13 L37) (Pluckhahn, Hodson et al. 2015). Another OSL date on sediment from Level 40 produced a much older age estimate at 3601 ± 354 years ago (OSL CR13 L40), probably as a result of mild disturbance of this geologic layer below the mound.

We interpret denser shell deposits in Layers 31–35 as the first episode of mound construction. We have no dates on this layer, but Bayesian modeling suggests that construction began between *357 and 532 cal CE* (95% probability), probably between *398 and 480 cal CE* (68%). Our model indicates an interval of no more than *96 years* (95%), probably less than *46 years* (68%), between the completion of the first stage and the initiation of the second. This second stage of mound construction, comprised of alternating dense shell and dark loamy sands with less shell in Layers 10–30, is represented by two radiocarbon dates on soil-charcoal with ranges of 429 to 549 cal CE (UGA-14112) on Stratum 11 and 601 to 662 cal CE (UGA-13469) on Stratum 22 (both at 95% probability). We also include one date retrieved by Bullen (1966:865) on charcoal found 5.8 m (19 ft) below the top of the mound, calibrated to 551 to 968 cal CE (I-1365) (95%). The chronology of these

Table 3
Modeled mound construction dates and episodes, with agreement indices.

Mound	Model structure		Posterior density estimates		A
			68.20%	95.40%	
Mound K	Boundary: end stage 2		446 to 566 cal CE	423 to 721 cal CE	
Amodel = 99.2	Stage 2 Date	R_Date UGA-13468	436 to 555 cal CE	427 to 569 cal CE	99.8
Aoverall = 99.1	Boundary: start stage 2		427 to 541 cal CE	394 to 569 cal CE	99.3
	Boundary: end stage 1		390 to 510 cal CE	331 to 552 cal CE	
	Boundary: start stage 1		335 to 476 cal CE	280 to 535 cal CE	
	Pre-mound Date	R_Date UGA-13464	252 to 341 cal CE	244 to 380 cal CE	102.1
Mound J	Boundary: end stage 2		593 to 688 cal CE	558 to 1013 cal CE	
Amodel = 100.2	Stage 2 date	R_Date UGA-13470	603 to 644 cal CE	575 to 653 cal CE	
Aoverall = 100.2	Boundary: start stage 2		561 to 640 cal CE	426 to 653 cal CE	
	Boundary: end stage 1		452 to 634 cal CE	255 to 646 cal CE	
	Boundary: start stage 1		324 to 628 cal CE	133 to 634 cal CE	
	Pre-mound date	R_Date UGA-13471	77 to 130 cal CE	59 to 211 cal CE	100.6
Mound H	Boundary: end stage 2		451 to 555 cal CE	426 to 622 cal CE	
Amodel = 115.5	Phase: stage 2	R_Date BETA-254520	435 to 545 cal CE	426 to 562 cal CE	109.2
Aoverall = 110.4		R_Date UGA-13466	436 to 543 cal CE	427 to 554 cal CE	100.6
	Boundary: start stage 2		425 to 534 cal CE	403 to 552 cal CE	
	Boundary: end stage 1		389 to 495 cal CE	338 to 542 cal CE	
	Boundary: start stage 1		240 to 475 cal CE	284 to 526 cal CE	
	Pre-mound dates	R_Date UGA-14111	254 to 340 cal CE	246 to 380 cal CE	102.0
		C_Date OSL CR22L21B	456 cal BCE to 203 cal CE	854 cal BCE to 312 cal CE	108.7
Mound G	Boundary: end mound		372 to 618 cal CE	263 to 1026 cal CE	
Amodel = 94.1	Phase: mound use	R_Date OXA-32690	257 to 380 cal CE	251 to 388 cal CE	99.7
Aoverall = 93.7		R_Date BETA-98044	344 to 509 cal CE	263 to 535 cal CE	92.4
		R_Date OXA-32689	144 to 240 cal CE	129 to 317 cal CE	100.0
		R_Date OXA-32688	75 to 127 cal CE	30 to 217 cal CE	95.3
	Boundary: start mound		80 cal BCE to 125 cal CE	483 cal BCE to 222 cal CE	
Mounds E and F	Boundary: end mound		41 cal BCE to 145 cal CE	94 cal BCE to 632 cal CE	
Amodel = 93.0	Phase: mound use	R_Date OXA-32709	54 cal BCE to 12 cal CE	106 cal BCE to 50 cal CE	95.2
Aoverall = 93.4		R_Date BETA-259307	148 to 44 cal BCE	206 cal BCE to 3 cal CE	90.3
		R_Date OXA-259306	46 cal BCE to 39 cal CE	92 cal BCE to 80 cal CE	103.3
	Boundary: start mounds		256 to 42 cal BCE	723 cal BCE to 4 cal CE	
Mound C	Boundary: end mound		766 cal BCE to 471 cal CE	772 cal BCE to 478 cal CE	
Amodel = 99.6	Phase: mound use	R_Date OXA-32691	981 to 911 cal BCE	1013 to 851 cal BCE	98.3
Aoverall = 99.6		R_Date BETA-254521	776 to 605 cal BCE	795 to 494 cal BCE	101.2
	Boundary: start mound		2043 to 913 cal BCE	2049 to 899 cal BCE	
Mound A	Boundary: end stage 3		629 to 1166 cal CE	625 to 2548 cal CE	
Amodel = 78.3	Boundary: start stage 3		617 to 940 cal CE	578 to 1756 cal CE	
Aoverall = 75.6	Boundary: end stage 2		612 to 739 cal CE	573 to 920 cal CE	
	Phase: stage 2	R_Date I-1365	570 to 685 cal CE	531 to 777 cal CE	84.9
		R_Date UGA-14112	514 to 561 cal CE	471 to 594 cal CE	70.2
		R_Date UGA-13469	614 to 651 cal CE	586 to 662 cal CE	89.5
	Boundary: start stage 2		481 to 548 cal CE	434 to 578 cal CE	
	Boundary: end stage 1		437 to 521 cal CE	394 to 557 cal CE	
	Boundary: start stage 1		398 to 481 cal CE	357 to 532 cal CE	
	Pre-mound dates	R_Date UGA-13467	384 to 423 cal CE	336 to 431 cal CE	100.4
		C_Date OSL CR13L37	412 to 90 cal BCE	568 cal BCE to 72 cal BCE	100.0

three dates does not correspond with their stratigraphic position. This coupled with the incomplete zeroing of an OSL sample from Stratum 16, with an obviously overestimated age of 3601 ± 354 years ago (OSL CR13 L16) (Pluckhahn, Hodson et al. 2015), suggests that this construction episode included basket-loaded fill—perhaps redeposited midden. The modeled start for the second mound stage is between *434 and 579 cal CE* (95%), probably between *481 and 548 cal CE* (68%). Finally, there is an upper stage represented by the dense shell in Layers 1–9. Recovery in core sections from this stage was poor owing to the density of shell; as a result, we have no dates from this stage. Given the lack of constraints, the model produces only a general estimate for the start of this stage between *575 and 1756 cal CE* (95% probability), probably between *617 and 940 cal CE* (68%).

This simplified model of the construction of Mound A is relatively consistent with the GPR profile from a transect run from summit to the northern toe (Fig. 5). At the base of the profile is a highly reflective layer corresponding with the dense shell of the first mound stage. A less reflective layer, consistent with the alternating shell and loamy sand in our second stage, superimposes this. Finally, the GPR reveals a more reflective capping layer that is consistent with the dense shell we associate with the last construction episode.

Artifact assemblages from Mound A provide little additional clarity owing to the small sample size; Kemp (2015) documented 41 sherds collected from the surface of Mound A by Bullen (1951) and Smith (1951). The dominant temper (limestone) is in contrast with that (sand) of contemporaneous midden assemblages, again suggesting the possibility that Mound A was constructed at least partially of redeposited midden.

4.2. *The Main Burial Complex (Mounds C, E, and F)*

As described by Moore (1903:379–382), the Main Burial Complex is comprised of four parts (Fig. 6). Mound C is the circular embankment, described by Moore (1903:379) as 1.8 m high and 22.9 m wide. Within this is an area he denoted as “D” and described as “territory on the general level,” meaning the same elevation as the original ground surface. Moore (1903:379) described Mound E as “an artificial elevation of sand, irregularly sloping,” often shortened to simply “the elevation” (1903:382), “the slope” (Moore, 1907:407) or “the rise” (1918:571). Later observers referred to this feature as a “platform,”

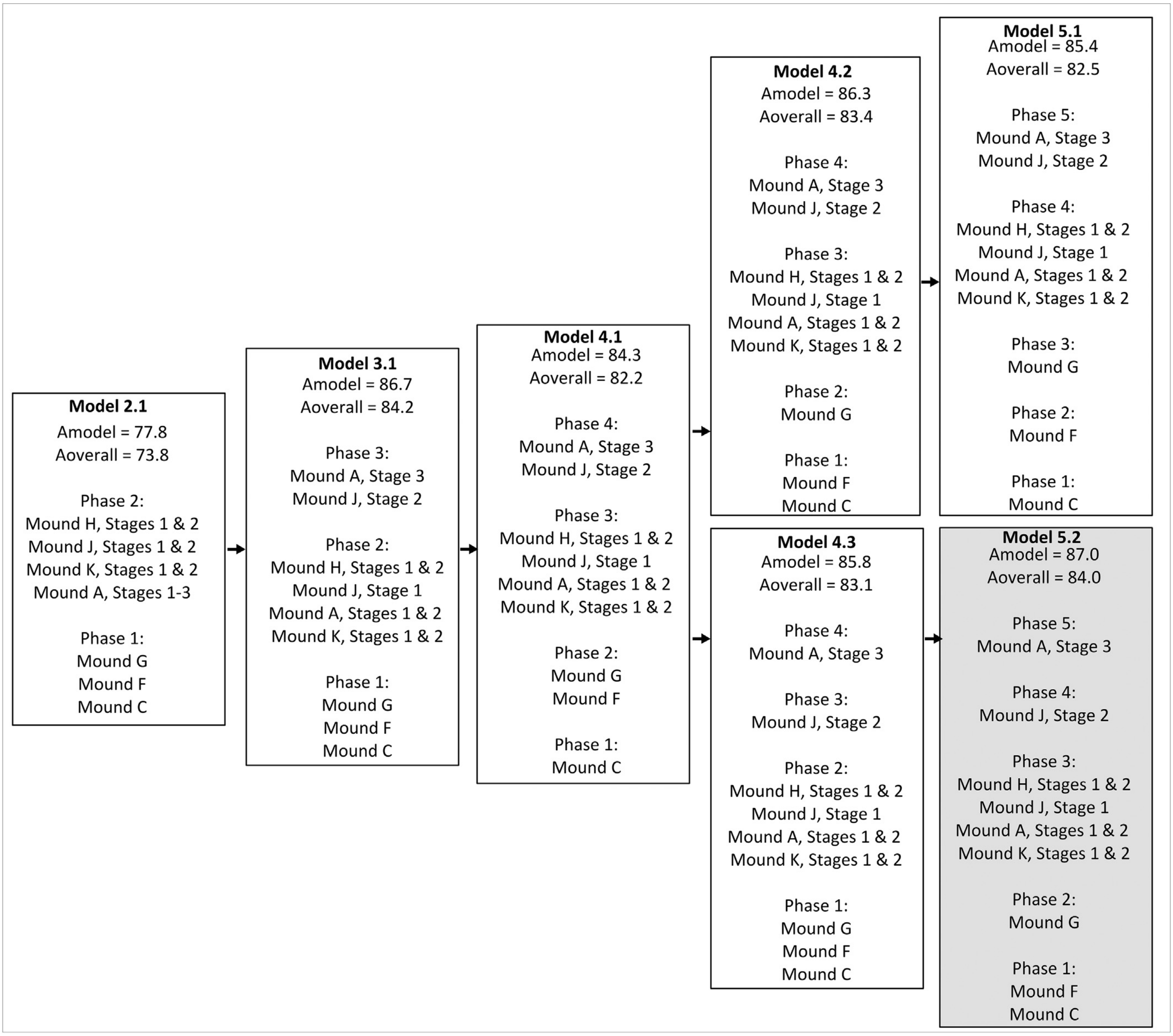

Fig. 3. Schematic of iterative models of mound construction phases, with agreement indices.

"annex," or "apron" (Bullen, 1953:12; Willey, 1949b:42). Although Moore did not provide a height for Mound E, Bullen (1953) estimated this at about 1.1 m, based on Moore's profile of the complex. At the center of the complex was the dome-shaped Mound F, measuring about 3.3 m high and 21.3 m across at its base (Moore, 1903:379). The complex was more or less "demolished" by Moore (1903:379); it was later rebuilt to these dimensions under Bullen's directive (Weisman, 1995:18).

Moore's extensive excavations of the Main Burial Complex revealed differences in grave goods and burial treatment suggestive of temporal divisions among its principal architectural components (see also Bullen, 1953, Weisman, 1995:52–58, Willey, 1949a:316–317). Extended burials and Hopewellian artifacts were most common in the lowermost burials of the Mound F, and less common in the surrounding platform and circular embankment (Moore, 1907:425). This suggested to Moore that the platform was a later addition. Bullen (1953) mainly concurred with these observations, but suggested a slight refinement: the lowermost layer of the central burial mound (F) was followed by the addition of the platform (E), and then by the addition of the upper layer of Mound F and Mound C. His later excavations of several areas that had not been previously disturbed by Moore reinforced his notion that there was a temporal division between the two burial layers in Mound F (Bullen, letter to George C. Dyer, November 11, 1960, on file at the FLMNH; Weisman, 1995:55–56). However, Bullen's recovery of diverse ceramics from Mound C suggested both an earlier start and a longer period of use for the circular embankment than he had previously supposed (Bullen, 1965; Weisman, 1995:56–58).

Recent radiocarbon dating, although limited, provides some clarification of the sequence. Based on early dates retrieved on two sets of human remains, the circular embankment appears to have been initiated first, although poor provenience control and the issues of dating human bone we described above complicate the results. Pluckhahn et al. (2009, 2010) dated human bone associated with an unnumbered burial recovered by Bullen from a depth of 36–42 in. (91–107 cm) in the embankment; recalibration produces a range of 789 to 431 cal BCE (95%) (BETA-254521). A newly obtained date on Burial 19 from Bullen's Area I has an even older range of 1020 to 855 cal BCE (95%) (OxA-32,691). These dates are several centuries older than the earliest dates from midden layers (Pluckhahn, Thompson, et al., 2015). Bullen's recovery of several vessels with early forms (e.g., podal supported) in

Table 4
Modeled mound construction phases, with agreement indices.

Model structure	Posterior density estimates	
	68.20%	95.40%
Boundary: end mound phase 5	671 to 1406 cal CE	589 to 2498 cal CE
Start Mound A, stage 3	644 to 1226 cal CE	565 to 2129 cal CE
Boundary: start mound phase 5	604 to 1056 cal CE	452 to 1820 cal CE
Interval: mound phase 4/5	0 to 306 years	0 to 986 years
Boundary: end mound phase 4	563 to 718 cal CE	508 to 1046 cal CE
Start Mound J, Stage 2	575 to 631 cal CE	535 to 647 cal CE
Boundary: start mound phase 4	532 to 607 cal CE	486 to 631 cal CE
Interval: mound phase 3/4	0 to 66 years	0 to 122 years
Boundary: end mound phase 3	476 to 550 cal CE	443 to 573 cal CE
Start Mound A, stage 2	462 to 533 cal CE	432 to 550 cal CE
Start Mound H, stage 2	440 to 536 cal CE	428 to 544 cal CE
Start Mound K, stage 2	438 to 538 cal CE	426 to 548 cal CE
Start Mound J, stage 1	436 to 523 cal CE	400 to 556 cal CE
Start Mound H, stage 1	422 to 504 cal CE	397 to 540 cal CE
Start Mound K, stage 1	419 to 496 cal CE	392 to 542 cal CE
Start Mound A, stage 1	416 to 491 cal CE	399 to 535 cal CE
Boundary: start mound phase 3	390 to 480 cal CE	345 to 534 cal CE
Interval: mound phase 2/3	107 to 414 years	0 to 562 years
Boundary: end mound phase 2	25 to 317 cal CE	146 cal BCE to 464 cal CE
Start Mound G	34 cal BCE to 122 cal CE	275 cal BCE to 203 cal CE
Boundary: start mound phase 2	258 cal BCE to 102 cal CE	743 cal BCE to 150 cal CE
Interval: mound phase 1/2	0 to 458 years	0 to 938 years
Boundary: end mound phase 1	1018 cal BCE to 4 cal CE	1096 cal BCE to 50 cal CE
Start Mound F	1108 to 57 cal BCE	1238 to 40 cal BCE
Start Mound C	1080 to 915 cal BCE	1305 to 850 cal BCE
Boundary: start mound phase 1	1263 to 942 cal BCE	1718 to 876 cal BCE

association with burials in the lower levels of the embankment (Bullen, 1965; Weisman, 1995:56–58) lends support for both the earlier radiocarbon dates and the relative dating of the initiation of Mound C before that of the village (Kemp, 2015:41).

Owing to the paucity of dates and their lack of stratigraphic associations, our model for Mound C is general; we suggest that construction began between *2049 and 899 cal BCE* (95%), probably between *2043 and 913 cal BCE* (68%). Our model suggests that construction ended between *772 cal BCE and 478 cal CE* (95%), probably between *766 cal BCE and 471 cal CE* (68%), but this likely underestimates the period of use. As we noted above, both Bullen and Moore remarked on the diversity of ceramics, and the former (Bullen, 1965) specifically noted that later (Weeden Island) pottery types were prevalent in the upper levels of the embankment. Kemp's (2015:53–57) reanalysis likewise supports a long history of use for Mound C, given the diversity in form and decoration.

Mound F was probably initiated next in the sequence. Bullen's excavation of a small portion of Mound F that had not been previously disturbed by Moore, as summarized in a letter he wrote to then-landowner George Dyer (Ripley Bullen to George C. Dyer, November 11, 1960, letter on file at the FLMNH), indicated that there were two layers of burials in the mound. Assuming superposition, as well as the sequential numbering of burials and photographic negatives, Bullen's Burials 16–18 should be from the deepest and oldest part of the mound, and his Burials 1–15 from the layer above. With this in mind, we attempted to date one burial from each of these layers. Unfortunately, the presumably older sample failed due to a high Carbon to Nitrogen ratio. But we retrieved a date on Bullen's Burial 3 that has a calibrated range 110 cal BCE to 55 cal CE (95%) (OxA-32,709). Two other dates were retrieved on bulk carbon from the core of ceramics recovered by Bullen from Mound F; a plain sherd found below Bullen's Burials 1–10 produced a calibrated range of 37 cal BCE to 61 cal CE (95%) (BETA-259306), while a Deptford Check Stamped sherd with only a general provenience has a range of 200 to 61 cal BCE (95%) (BETA-259307). These latter two probably overestimate the age of the ceramics and their interment in the mound at least slightly, since the carbonized wood fragments extracted from ceramics predates the pots and the pots predate their interment in the mound.

Considering these three dates as a single phase of construction, our model suggests Mound F was initiated between *723 cal BCE and 4 cal CE* (95%), probably between *256 and 42 cal BCE* (68%). Successful dating of the lowermost burials would presumably extend this range back a century or two earlier. In general, this time frame is consistent with the prevalence of Hopewell artifacts of copper and exotic stone. The modeled range is also consistent with the ceramic assemblage from Mound F, which also includes early (podal support) vessel forms (Moore, 1903:387–393) that are not represented in village middens (Kemp, 2015:41–42; Thompson, 2016; see also Pluckhahn et al., 2017).

The Mound E platform is currently undated. Following Moore's description of burial treatments and grave goods, we can assume it was added after at least the lower levels of Mound F. Contra Bullen, we suggest it was also added after the upper levels of Mound F. Our reasoning is that Weeden Island pottery, including the sort of effigy vessels common to pottery caches on the east side of burial mounds elsewhere in the region (e.g., Milanich et al., 1997; Moore, 1901, 1902, 1903, 1918), seems to have been much more prevalent in Mound E than in Mound F (Moore, 1907:411–415). Milanich et al. (1997) retrieved three dates on a cache of Weeden Island pottery in Mound C at the McKeithen site: two on the same pine post have recalibrated ranges of 475 to 654 cal CE (UM-1436) and 434 to 636 cal CE (UM-1565), and a third date on an in situ pine post has a range of 543 to 655 cal CE (UM-1434) (all at 95% probability). A similar time frame might be expected for Mound E at Crystal River.

4.3. Mound G

Mound G, often referred to as the “Stone Mound” (Weisman, 1995: 59), was described by Moore (1903:379) as a “low and irregular” shell ridge about 30.5 by 45.7 m in extent. Willey (1949b:43) was unable to find the mound due to the heavy vegetation covering the area at the time of his visit. Bullen began excavations in Mound G around 1960, when a bulldozer cut a swath through the mound (Katzmarzyk, 1998: 16; Weisman, 1995: 37–38). He reportedly excavated a 5-×-5-ft (1.5-×-1.5-m) unit east of the cut to secure a profile and pottery sample (Katzmarzyk, 1998:16). Bullen subsequently excavated two additional trenches, one to a depth of 2 ft (0.6 m) and the other to 5 ft (1.5 m) (the latter reaching sterile subsoil). Bullen alternately referred to these as measuring 10 × 20 ft (1.5 × 3.1 m) (letter of Bullen to George C. Dyer, November 11, 1960, on file at the FMNH; Weisman, 1995:37–38) and 15 × 15 ft (4.6 × 4.6 m) (Bullen, 1965). Unfortunately, while burials were separated by square, there is no surviving documentation that allows these to be located either in an absolute sense or relative to one another. Generally, the burials seem to have been clustered in a 10-×-10-ft (1.5-×-1.5-m) area, which may have prompted Bullen's speculation of a mass burial episode (Katzmarzyk, 1998:20).

Mapping by Pluckhahn and Thompson (2009:17) puts the contemporary mound at roughly 51 m east-west and 34 m north-south at its base, with a height of approximately 1.5 m relative to the plaza to the east. However, the mound may once have been taller, as Bullen (1965) cryptically suggested in a draft manuscript without citing any substantiating evidence; Katzmarzyk (1998:15), apparently drawing

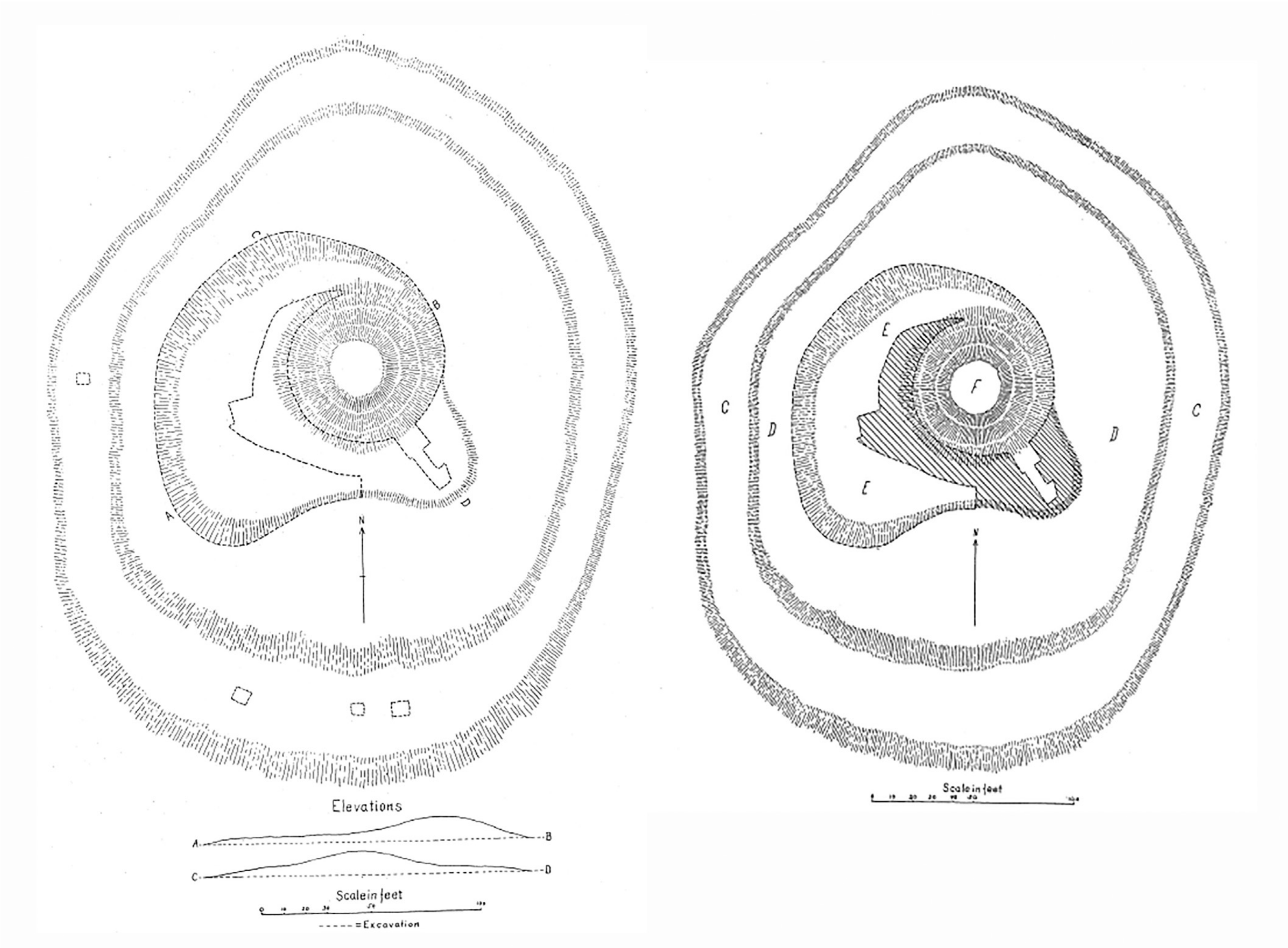

Fig. 4. Moore's (1903:Fig. 17, 1907:406) maps of the Main Burial Complex (Mounds C, E, and F).

from Bullen, suggests the surface of the mound may have been graded for road construction.

GPR survey provides insight on the construction and excavation of Mound G; Fig. 7 shows amplitude slices at approximately 29 and 54 cm below the surface. Both slices clearly exhibit a linear swath with low reflective values, consistent with the north-south path of the bulldozer cut as it was mapped by Bullen in a 1960 sketch (see Weisman, 1995:Fig. 7). The uppermost slice shows a square area of similarly low reflective values to the east (right) of this that may represent Bullen's 5-×-5-ft (1.5-×-1.5-m) square; higher amplitude reflections in this area on the lower slice may indicate that Bullen did not excavated below the mound. To the west (left) of the linear swath is a square area of lower reflection that almost certainly represents Bullen's main excavation, although this appears larger than previous accounts suggest. Regarding the apparently unexcavated portions of the mound, scattered high amplitude reflections in the uppermost slice suggest the presence of dispersed, but relatively undisturbed burials. In the lowermost slice, concentrated higher amplitude reflections are consistent with either a much denser concentration of burials (as suggested by Bullen and apparent in his photographs on file at the FLMNH) or a prepared surface or fill (e.g., the use of shell as a base or cover for burials, which also finds possible support in the shell apparent in some of Bullen's photographs).

Radiocarbon dating of Mound G has produced somewhat contradictory results, owing largely to the issues with dating human bone we described above. Katzmarzyk (1998): Tables 3-8, 3-9) obtained an early date on Bullen's Burial 1, an adult female that was presumably located toward the outer margin of his trench into the mound, given that he appears to have worked toward the center. The calibrated range for this date is 802 and 431 cal BCE at 95% (BETA-98043), which would make this burial equivalent to those cited above from Mound C. However, this date is contradicted by a more recent one obtained for the same individual, with a range from 24 to 205 cal CE (95%) (OxA-32688). A similar, albeit less extreme discrepancy is noted in two dates on Bullen's Burial 20. Katzmarzyk (1998): Tables 3-8, 3-9) obtained a date for this individual that has a range of 94 cal BCE to 118 cal CE (95%) (BETA-106092). A more recent date on the same human remains produced a range several centuries more recent: 128 to 317 cal CE (95%) (OxA-32,689). The later dates obtained on Burials 1 and 20 are in greater agreement with two other dates from Mound G. The first, which we retrieved from Bullen's Burial 30, has a range of 251 to 389 cal CE (OxA-32,690) (95%). The other, obtained by Katzmarzyk (1998): Tables 3-8, 3-9) on Burial 35, has a range of 345 to 541 cal CE (BETA-98044) (95%).

Omitting the presumably errant dates on Burials 1 and 20 obtained by Katzmarzyk, our modeling suggests that Mound G was initiated between *483 cal BCE and 222 cal CE* (95%), probably between *80 cal BCE and 125 cal CE* (68%), and finished between *263 and 1026 cal CE* (95%), probably between *372 and 618 cal CE* (68%). Surprisingly, given this range, Mound G produced none of the Hopewellian artifacts common to the Main Burial Complex, and few burial goods in general (Katzmarzyk, 1998:30–31; Weisman, 1995:59). Pottery from the mound is consistent with the one sigma date ranges, given the scarcity of later (Weeden Island) types (Kemp, 2015:49;

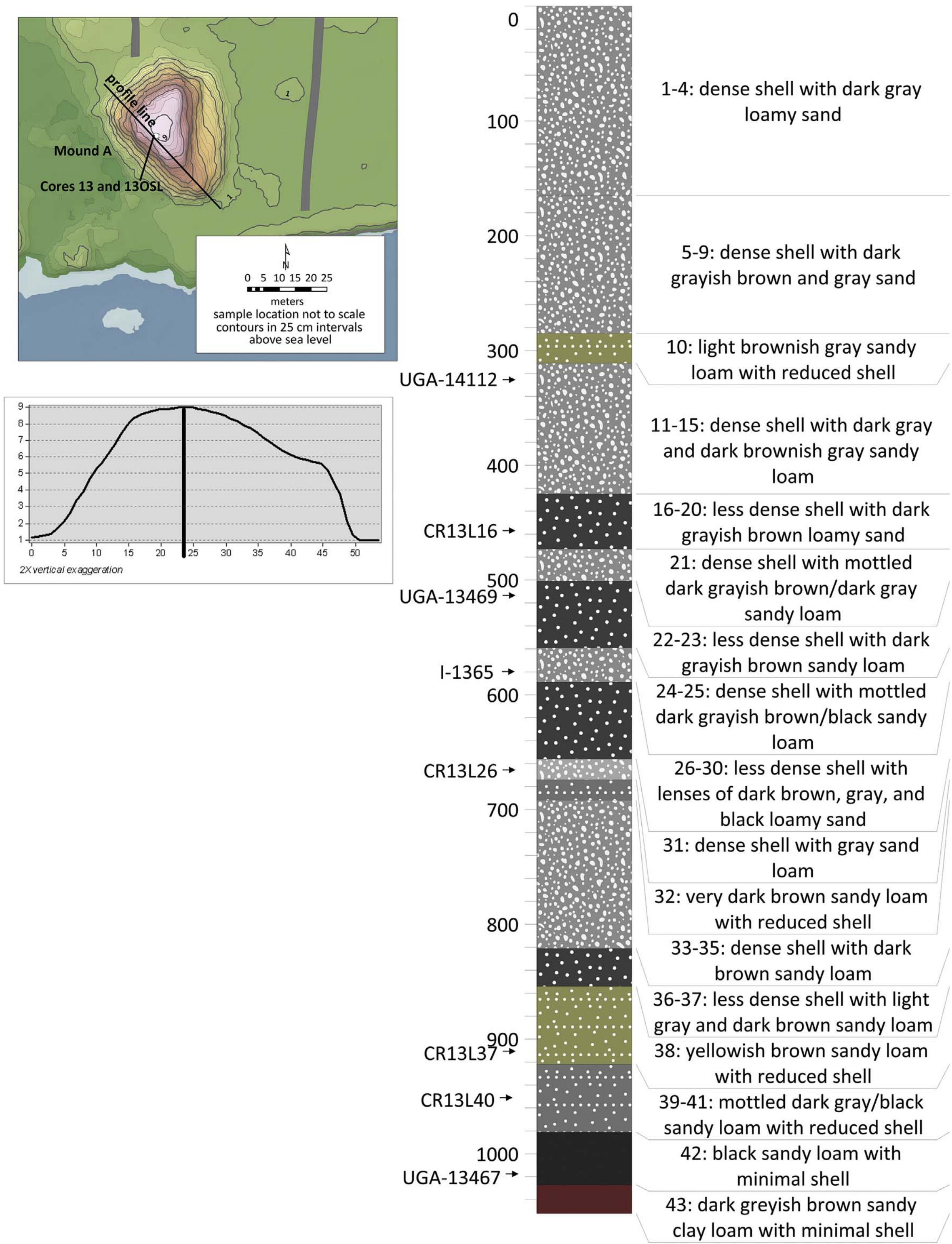

Fig. 5. Map, profile, and generalized lithology (with locations of dated samples) of Mound A.

Pluckhahn et al., 2017).

4.4. Mound H

Moore (1903:379) described Mound H as a ridge of shell "12 ft [3.7 m] in maximum height, with a graded way," the latter indicating a clearly defined ramp. Willey (1949b:42) was unable to find the mound, describing the area inland from Mound A as "an extremely dense, mucky swamp." Smith (1951) was more successful, having excavated a small test on the summit. Bullen later excavated two tests on the summit and one on the ramp of Mound H (Weisman, 1995:60). The mound measures about 73 m by 25 m at its base (not including the ramp) (Pluckhahn and Thompson, 2009:17–18). It has a well-defined, rectangular summit approximately 55 m long and 8 m wide, rising about 3.7 m above the plaza area to the southwest. The 6-m wide ramp extends about 31 m southwest from the summit to the plaza. There is a discontinuity in elevation on the northernmost portion of the rear slope of the mound suggestive of a second, smaller ramp or apron.

We excavated cores from a point just northeast of the center of the summit of Mound H (Fig. 8). Well below the mound, we encountered a

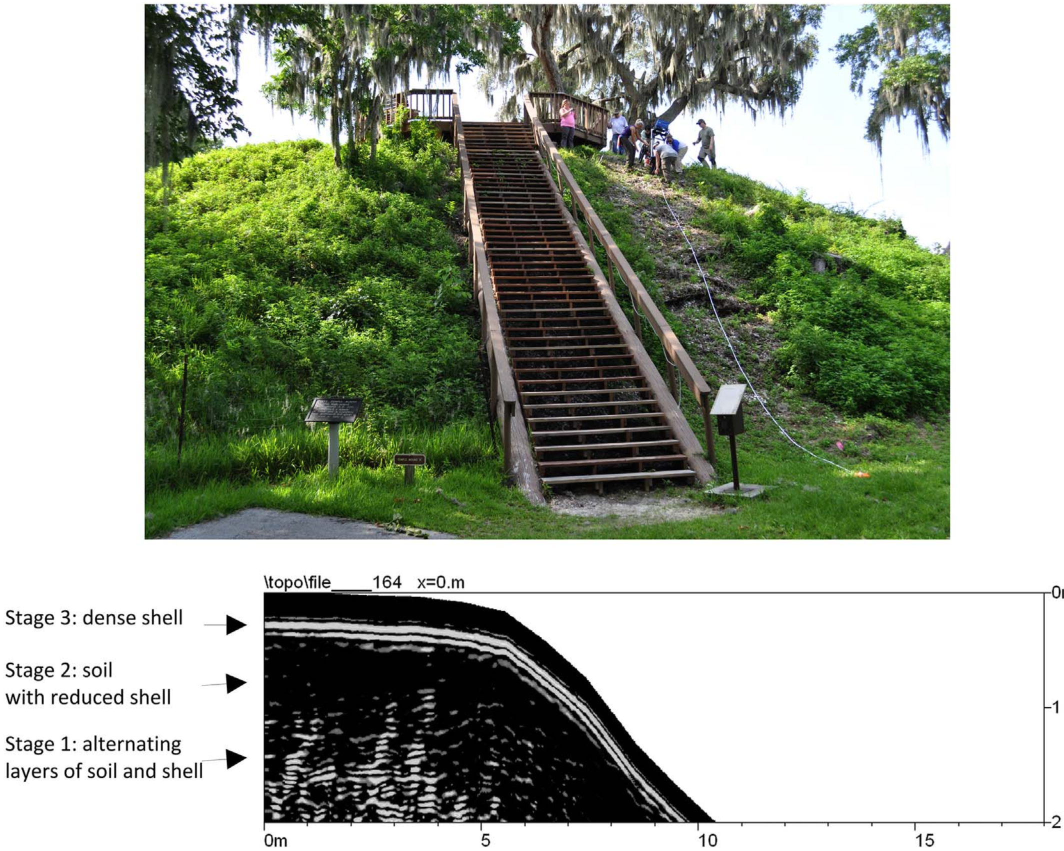

Fig. 6. GPR survey transect on Mound A (top) and resulting GPR profile (bottom).

layer of white sand (Stratum 25) that was OSL dated to 12,511 ± 1485 years ago (OSL CR22 L25), consistent with deposition during the late Pleistocene to early Holocene (Hodson, 2012; Pluckhahn, Hodson et al. 2015). Above this, but also below the presumed mound layers, we observed a dark soil horizon (Strata 22–24) that we interpret as a pre-mound humus; soil-charcoal from Stratum 22 was dated to 250 to 382 cal CE (95% probability) (UGA-14111). An OSL date of the same strata yielded a roughly equivalent age of 2083 ± 393 years ago, albeit with a large uncertainty (OSL CR22 L21B) (Pluckhahn, Hodson et al. 2015). Above these premound surfaces were several layers of generally dark, mottled soils with relatively high shell content (Strata 16–21). We interpret these as possible fill associated with a low platform, a feature common to other mounds in the region (e.g., Knight, 1990:36; Wright, 2014b). These layers, collectively referred to herein as Stage 1, are currently undated owing to the absence of sufficient quantities of soil charcoal.

Alternating layers of yellow and white sands (Strata 8–15) capped the presumed initial platform over a meter thick. Two dates were obtained on this layer. Radiocarbon dating of charcoal found in a thin lens found mixed with the sand at a depth of 153–174 cm produced a range of 427 to 558 cal CE (UGA-13466). OSL dating of sand grains at a depth of 140 cmbs produced an anomalously old age of 8152 ± 1185 years ago (corr) (CR22 L11) (Hodson, 2012; Pluckhahn, Hodson et al. 2015). The incongruity of this sample is likely caused by the incomplete zeroing or admixing of older sediment grains.

The uppermost mound stage in Mound H is represented by several layers (Strata 2–5) comprised primarily of oyster shell. A radiocarbon date of 180 ± 25 RCYBP (UGA-13465) on soil charcoal found in Stratum 3 is obviously associated with recent organics, and thus of no use in dating the mound. However, Pluckhahn et al. (2010) obtained a radiocarbon date on a worked deer bone that Bullen recovered from the upper 31–61 cm of this shell cap. With a range of 422 to 596 cal CE (BETA-254520) (95%), this date is virtually indistinguishable from the radiocarbon date on charcoal from the sands below. We interpret this as evidence that Mound H was constructed in a short amount of time, possibly in a single episode and almost certainly in no more than two or three. The sand layers must have been capped by shell within a relatively short amount of time, given that they would have easily washed away if left uncovered for too long in the rainy climate of central Florida. As a result, we combine the sand layers and shell cap as Stage 2.

GPR profiles from Mound H are consistent with the soil layers observed in cores (Fig. 9) (see also Thompson and Pluckhahn, 2010). At the surface is a uniformly highly reflective layer that corresponds with the uppermost dense shell deposit of Stage 2, and below this is a less reflective layer that we equate with the sandy fill of the same stage. At the bottom of the profile is a more uneven, but generally reflective zone that matches the mottled, moderately shell-dense primary mound. Resistance data are largely complementary, with a highly resistant layer near the surface and, below this in profile on the northern edge of the mound, alternating layers of relatively high and low resistance (see Fig. 9). The uniformity of this layering across the front face of the mound and ramp suggest that the mound retained the same basic plan as it was constructed upward.

Bayesian modeling of the three radiocarbon dates from within and below Mound H, plus the two acceptable OSL dates, suggests that construction of the lower stage began between *284 and 526 cal CE* (95% probability), probably between *340 and 475 cal CE* (68%). Our modeling suggests that the construction of the upper stage of this mound began between *403 and 552 cal CE* (95%), probably between *425 and 534 cal CE* (68%). This places the mound construction coeval with Phase 2 of the midden. The pottery assemblage from Mound H, although limited in size, corresponds closely with that of contemporaneous midden contexts (Kemp, 2015:50).

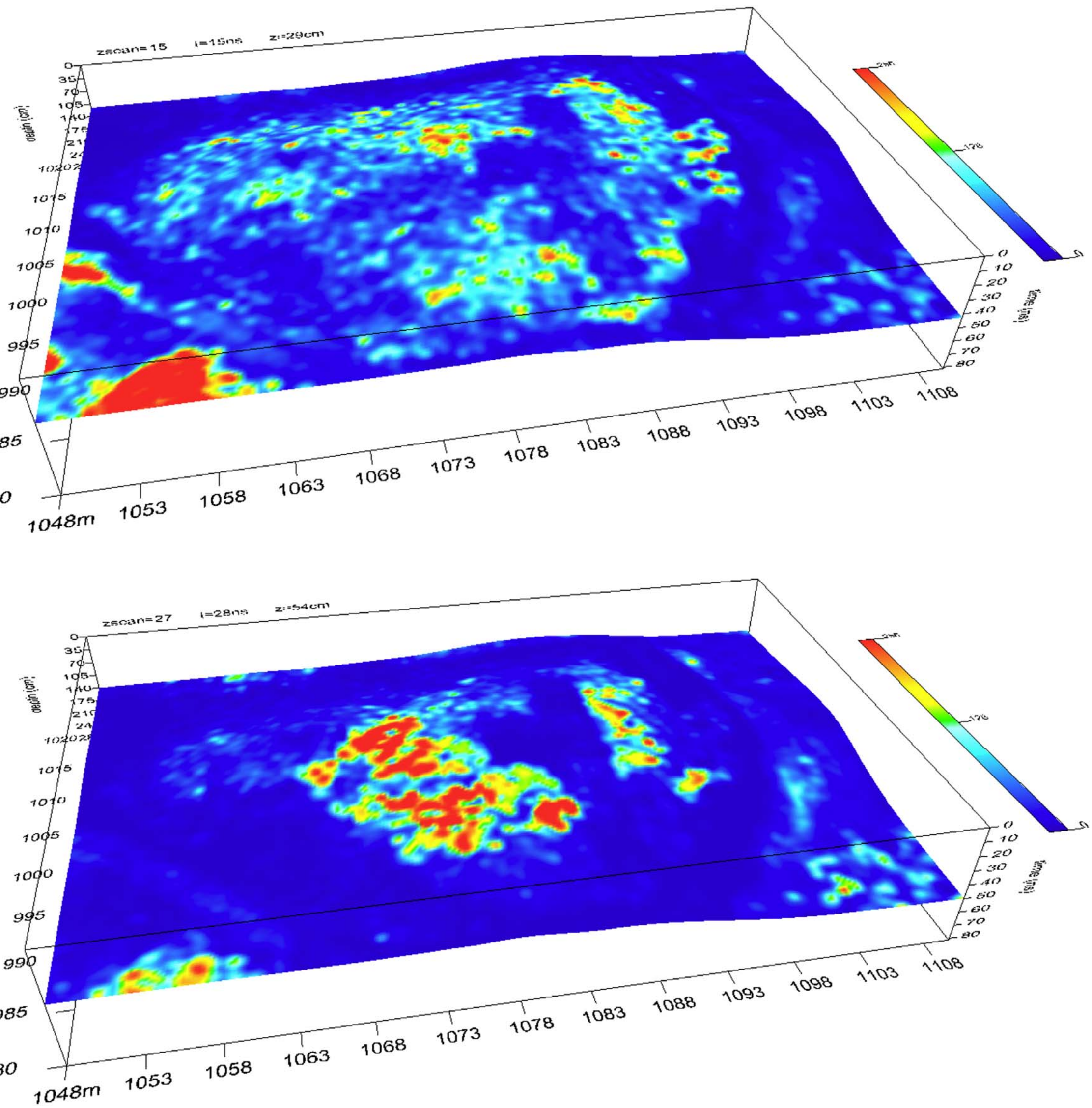

Fig. 7. GPR amplitude slices from 29 cm (top) and 54 cm (bottom) below the surface of Mound G.

4.5. Mound J

Mounds J and K are the only mounds at Crystal River that were never mentioned by Moore (1903); he appears to have missed the mounds owing to heavy vegetation that once covered this portion of the site (Weisman, 1995:60–62). Bullen (1951, 1953) and Smith (1951) also failed to mention these mounds in their initial published reports of Crystal River, despite the fact that both archaeologists excavated units nearby. Bullen discovered the mounds around 1960, as indicated by a sketch map he completed that year (Weisman, 1995:Fig. 7).

Mound J measures approximately 27 m northeast-southwest by 12 m northwest-southeast at its base, although its lowermost contour is somewhat indistinct and the mound could be said to extend farther on the northeast-southwest line (Pluckhahn and Thompson, 2009:18). The summit is likewise poorly defined, but measures roughly 12 by 4 m. We excavated cores from a point near the apex of the summit, which has a height of 1.7 m relative to the ground surface to the south.

The interpretation of Mound J is vexing owing not only to its irregular shape, but also the complicated stratigraphy exhibited in our core (Fig. 10). One date from what we interpret as pre-mound midden (Stratum 17) has a range of 59 to 214 cal CE (UGA-13471). This pre-mound midden layer appears to have been capped by alternating shell- and soil-dense layers (Strata 8–16) that we take as an early mound stage. However, radiocarbon sample from one of the layers with denser soil (Stratum 14) has an earlier calibrated range than the pre-mound layer below, at 45 cal BCE to 54 cal CE (95%) (UGA-14114), suggesting the possibility that even earlier midden was repurposed as mound fill. Above the uppermost shell-dense layers (Stratum 8) in this early mound stage is a layer of darker clay loam (Stratum 7), possibly representing an A horizon associated with the use of this platform. A sample of soil-charcoal from Stratum 7 has a range of 575 to 652 cal CE (95%) (UGA-13470).

Considering only the two stratigraphically ordered dates from the pre-mound and Stratum 7, our modeling broadly suggests that the first stage of Mound construction in Mound J began between *133 and 634 cal CE* (95% probability), probably between *324 and 628 cal CE* (68%). The shell-dense layers at the top of the mound were added between *426 and 653 cal CE* (95% probability), probably between *561 and 640 cal CE* (68%).

4.6. Mound K

Mound K is a flat-topped mound nearly square at its base, measuring about 21 m north-south and 19 m east-west (Pluckhahn and Thompson, 2009:18). The summit is more rectangular, extending about 12 m north-south and 7 m east-west. The mound measures about 2.1 m high

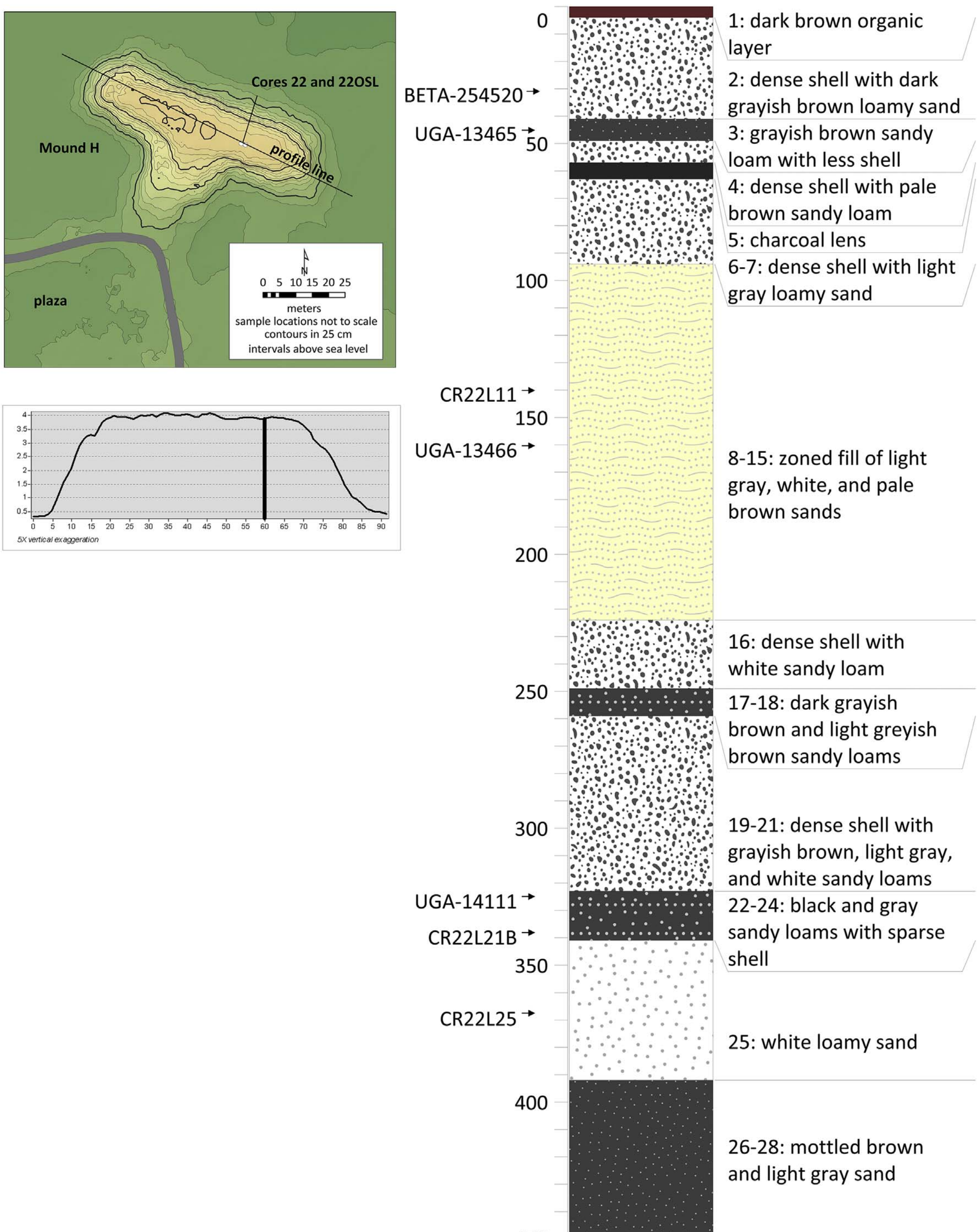

Fig. 8. Map, profile, and generalized lithology (with locations of dated samples) of Mound H.

relative to the ground surface to the north. Bullen (1966) sketched the mound with a ramp extending northeast, but this is difficult to justify based on current topography; Weisman (1995:62) suggested that Bullen may have added the ramp to bolster the case that this mound was a substructure for buildings associated with chiefs or priests.

We excavated two cores from the northern end of the summit of Mound K (Fig. 11). Relative to Mound J, the stratigraphy here was more straightforward. Charcoal from a dark soil layer (Stratum 6) below what we believe to have been the first mound stage was dated to 245 to 385 cal CE (95% probability) (UGA-13464). The mound itself appears to have been constructed mainly of shell and may have been constructed in a single episode. However, we noted a layer of dense shell (Stratum 5) topped by darker soils with lower shell content (Strata 3 and 4) in the lower levels of the mound that may represent an initial low platform, similar to that observed in Mound H. A sample of charcoal from Stratum 3 has a calibrated range of 430 to 566 cal CE (95% probability) (UGA-13468).

The highly reflective shell layer dominates GPR profiles from Mound K (Fig. 12). The signal appears to have not reached sufficient depth to have detected the possible low platform at the mound base. A less reflective layer between the highly reflective surface and the thick shell layer is not well-represented in the core sediments.

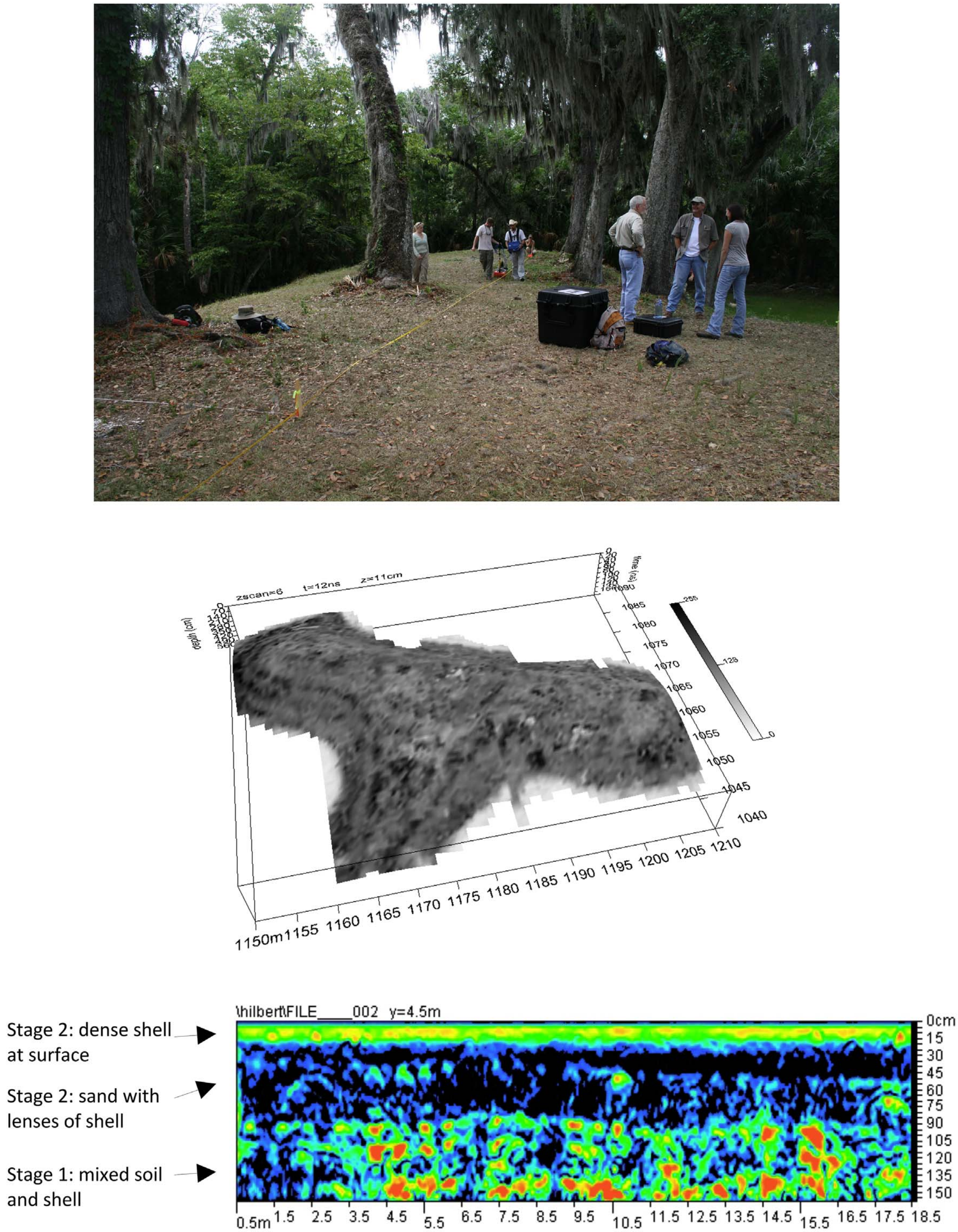

Fig. 9. GPR survey on summit of Mound H (top); three-dimensional perspective of resistance survey data (middle); representative GPR profile from transect on and parallel with the northwestern half of the summit.

Bayesian modeling of the two dates from Mound K suggests that construction of the lower mound stage began between *280 and 535 cal CE* (95% probability), probably between *335 and 476 cal CE* (68%). Our modeling suggests that construction of the upper stage began between *394 and 569 cal CE* (95% probability), probably between *427 and 541 cal CE* (68%). Bullen excavated one unit in Mound K; the ceramic assemblage is small, but again shows consistency with contemporaneous midden collections with regard to dominant temper (limestone) and surface treatments (plain) (Kemp, 2015:51; Pluckhahn et al., 2017).

5. Mound building at Crystal River as historical tradition

Fig. 13 is a graphical representation of the posterior density estimates for the five modeled mound phases. Fig. 14 illustrates changes in monumental architecture by phase.

Mound Phase 1 began between *1718 and 876 cal BCE* (95%), probably between *1263 and 942 cal BCE* (68%), with the initiation of Mounds C and F. Small geometric enclosures like Mound C are common to Adena and Hopewell traditions in the Midwest (e.g., Byers, 2004; Burks, 2014; Clay, 1987), and occur more occasionally at related sites

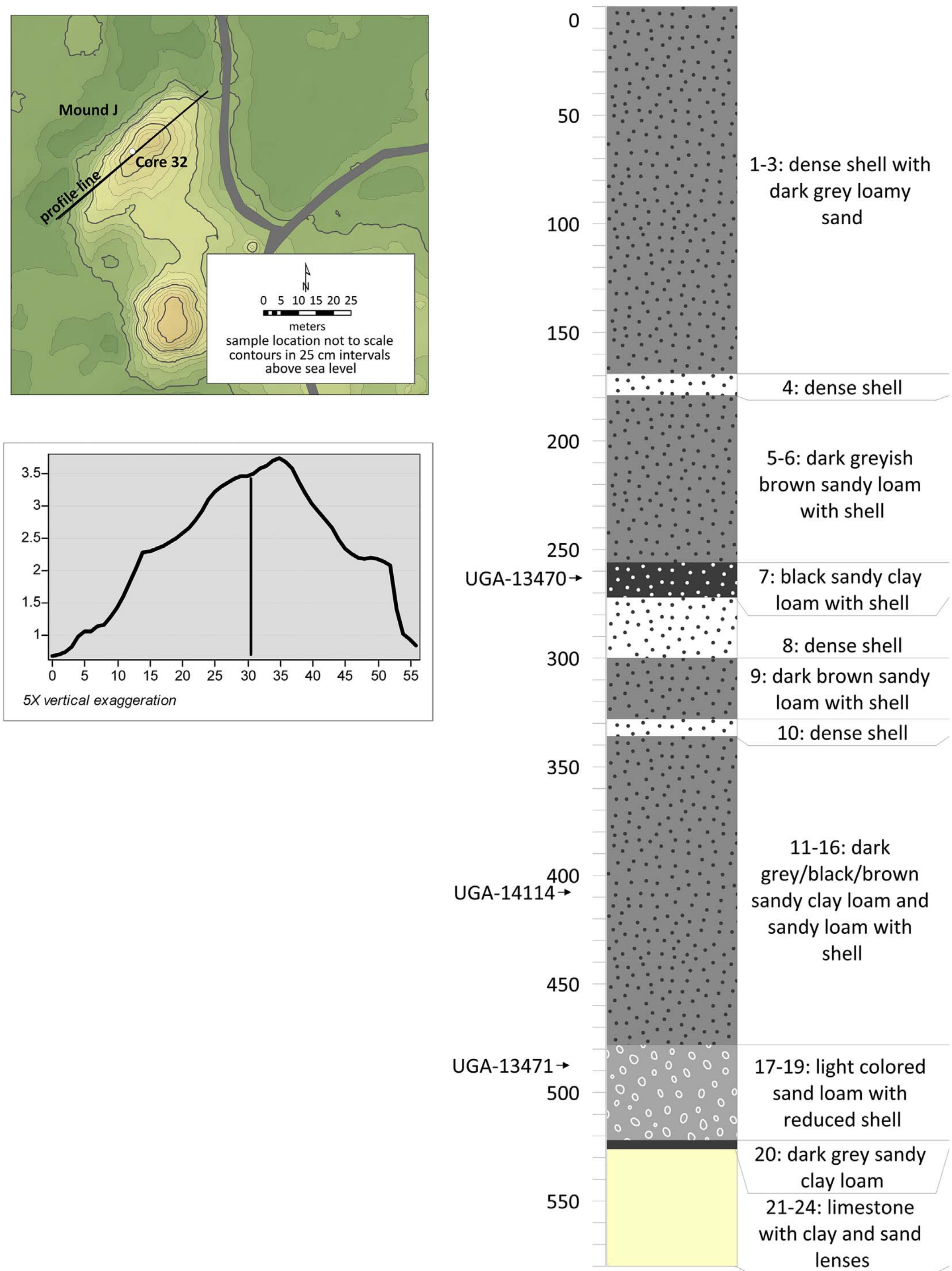

Fig. 10. Map, profile, and generalized lithology (with locations of dated samples) of Mound J.

in the lower Southeast (e.g., Mainfort, 2013; Toth, 1974; Wright, 2014a, 2014b, 2016). However, the early dates for the initiation of Mound C at Crystal River also invite comparison with the Late Archaic-period (ca. 3000 to 1000 BCE) tradition of circular shell rings, common mainly to the Atlantic coast of the Southeast (Russo, 1991, 1994; Russo and Heide, 2001; Trinkley, 1980, 1985; Thompson, 2007, 2010; Thompson and Andrus, 2011). Unlike these earlier shell rings, the circular embankment at Crystal River was comprised mainly of sand and was heavily laden with human burials (Moore, 1903:379). Still, in another possible continuity with tradition, Mound C was positioned on a low spot not unlike the swampy areas that native peoples of the Florida peninsula had used as burial places for thousands of years (Doran, 2002).

We noted above evidence for the long use of Mound C. It was probably still in use when the first burials were interred in the center of the enclosure, in the lower levels of Mound F. In general form, Mound F is similar to the dome-shaped burial mounds that were ubiquitous in eastern North America during the Middle Woodland period, especially along the coasts of the Southeast. In relation to Mound C, it also resembles the Midwestern Adena and Hopwell traditions of placing mounds within ditches and embankments (Henry et al., 2014; Webb and Snow, 1945). However, the combination of a central burial mound within an encircling embankment (sans ditch) may be an architectural tradition unique to peninsular Florida. A close analogue is the River

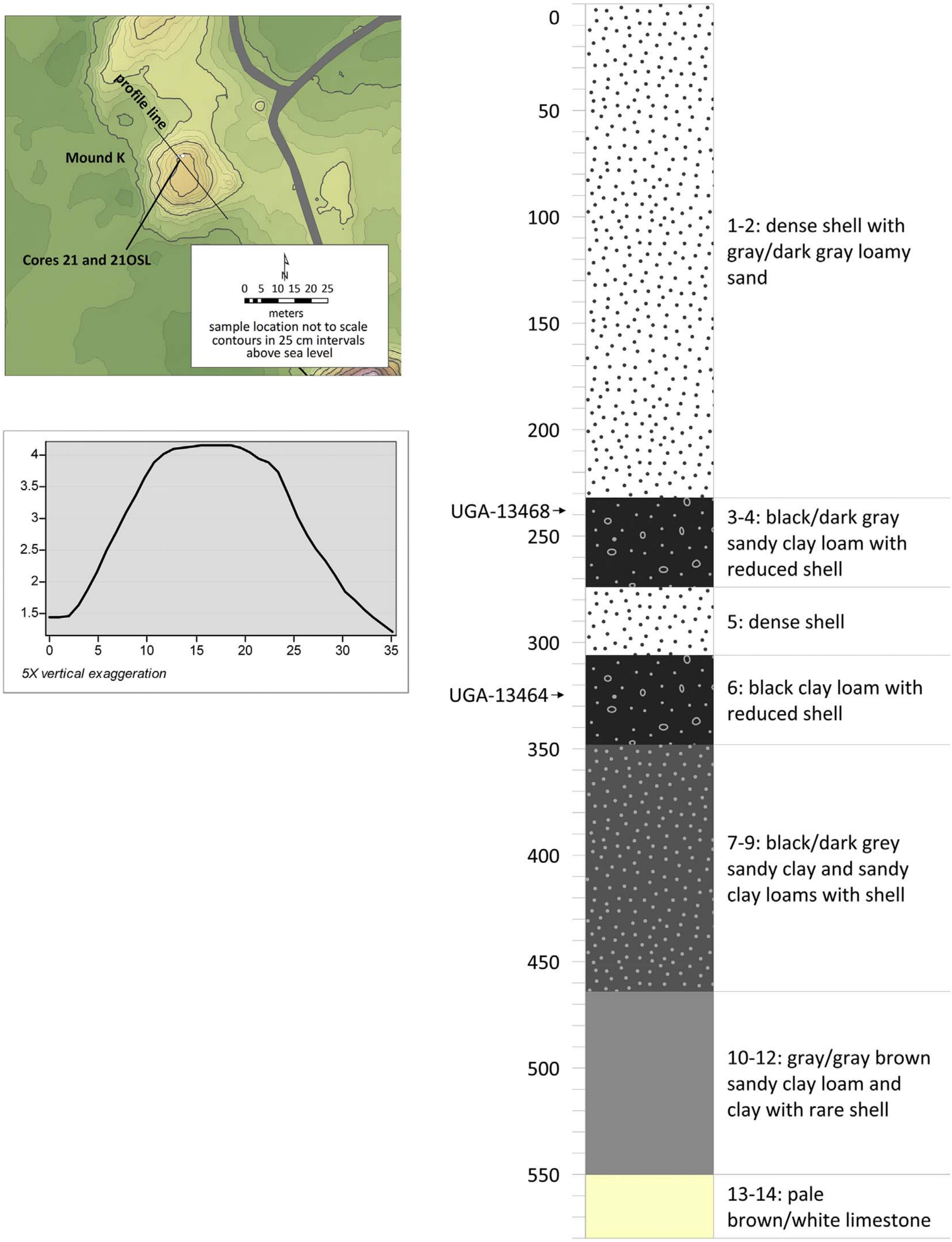

Fig. 11. Map, profile, and generalized lithology (with locations of dated samples) of Mound K.

Styx site in north-central Florida, where a 100-m-long, horseshoe-shaped earthen embankment surrounded a low sand burial mound (Hemmings, 1978; Milanich, 1994:235–237; Wallis et al., 2014). Bullen recovered Hopewellian artifacts similar to those from Mound F at Crystal River from central burial mound at River Styx (Wallis et al., 2014:170–171). A radiocarbon date on carbonized wood recovered from the burial area at River Styx has a calibrated range only slightly later than our dates on Mound F, at 55 to 428 cal CE (95%) (Wallis et al., 2014:169–170). Similarities in architectural form, artifacts, and radiocarbon dates suggest a historical connection between Crystal River and River Styx. Another historical connection may be posited between Crystal River and the Fort Center site to the south, where a discontinuous earthen enclosure surrounded a large sand burial mound and pond (Sears, 1982:146–148; Thompson and Pluckhahn, 2012). As at Crystal River and River Styx, the burial mound at Fort Center produced Hopewellian artifacts (Steinen, 1982), although the only carbon date falls slightly later in time (Sears, 1982: Table 7.1).

Mound Phase 2 began between *743 cal BCE and 150 cal CE* (95%), probably between *258 cal BCE and 102 cal CE* (68%). This phase is represented only by the start of Mound G. Mounds G and F were almost certainly in use at the same time; the spatial arrangement of these burial facilities, across an apparent plaza, is unique to Crystal River. Mound Phase 2 overlaps partly with the initiation of the village at Crystal River in Midden Phase 1 (Pluckhahn, Thompson, et al., 2015), although as we noted above the site seems to have been only seasonally occupied in this interval (Thompson et al., 2015). Given the spatial

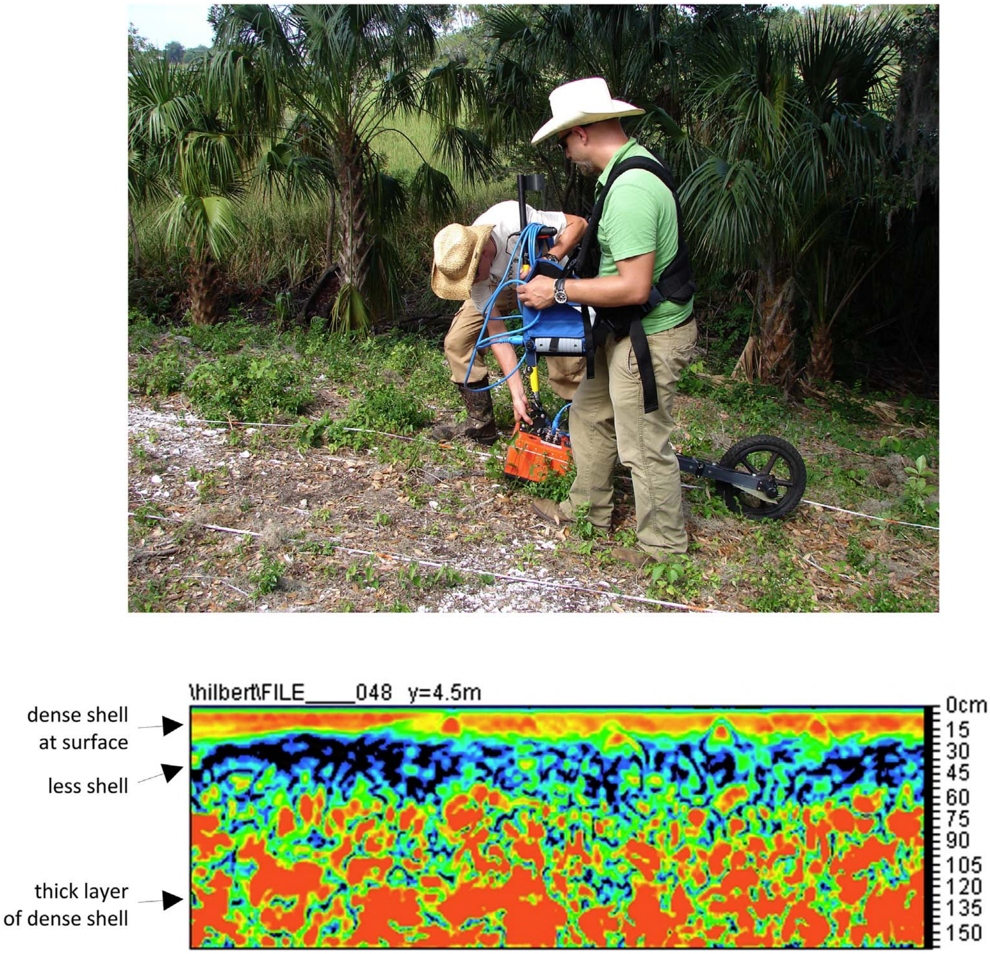

Fig. 12. GPR survey on summit of Mound K (top) and representative GPR profile (bottom).

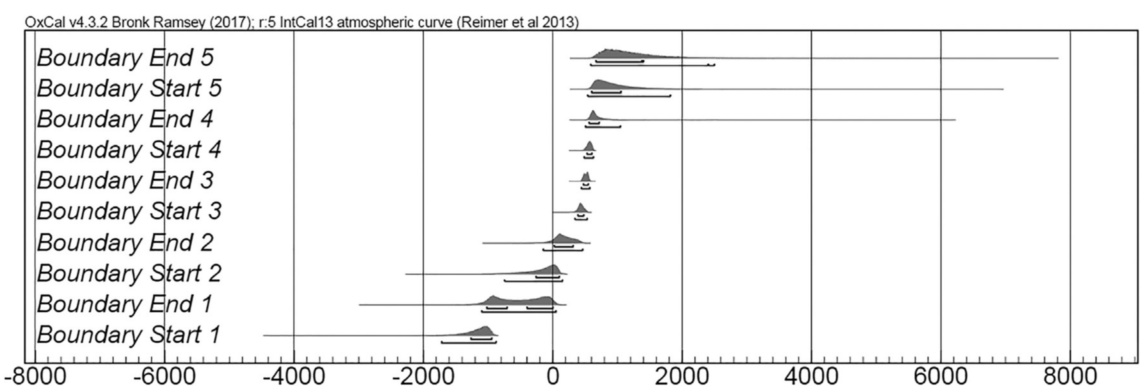

Fig. 13. Graphical representation of the posterior density estimates for the five modeled mound phases.

separation of the two burial complexes, it seems possible that the two burial facilities were intended for different segments of the population, perhaps a founding group and newcomers, or a local population and their more distant kin.

Mound Phase 3 began between *345 and 534 cal CE* (95%), probably between *390 and 480 cal CE* (68%), and ended between *443 and 573 cal CE* (95%), probably between *476 and 550 cal CE* (68%). All four of the platform mounds at Crystal River were initiated in this interval. Radiocarbon evidence suggests that first stage of Mound K may have been earliest, followed by the first stages in Mounds H, A, and J. Initiation of the second stages in Mounds K, H, and A soon followed. Our model suggests that these seven mound construction episodes began in an interval of *less than 179 years* (95%), probably *between 9 and 99 years* (68%).

Crystal River is perhaps one of the only sites in the region with four platform mounds that can be positively dated to the Woodland period. However, it was not the first site to witness the development of this architectural form; at a minimum, the platform mounds at Mandeville (Smith, 1975), Pinson (Mainfort, 2013), and Garden Creek (Wright, 2014a, 2014b) and Mound II at Garden Patch (Wallis et al., 2014) may all date slightly earlier. Historical connections between Crystal River and Garden Patch seem entirely plausible, given that the two sites are separated by only about 50 km. There are suggestions of contact between Crystal River and Mandeville, in the form of rare (negative painted and incised) ceramics (Smith, 1975), and possible evidence for the same sort of contact with Garden Creek (Wright, 2014a:287).

The seemingly sudden appearance of platform mound construction in Mound Phase 3 at Crystal River might be construed as evidence of

Fig. 14. Changes in monumental architecture by phase. For changes in village configuration, see Pluckhahn, Thompson, et al. (2015).

either the diffusion of new ideas or an evolutionary transformation in Middle Woodland societies, but we see it instead as a reinterpretation of existing traditions. First, we suspect that the burial mounds continued to be used even as the construction of these platform mounds began, as indicated by late dates from Mound G and by the strong representation of later (Weeden Island) pottery types in burials in the circular embankment and the platform (Mound E) added to the main burial mound. Next, we note that platforms are present in the construction sequences of several early burial mounds that took conical forms when completed; in many cases, the platforms appear to have been used for mortuary ceremonies for a time before the surfaces were sealed with a dome-shaped capping layer. For example, Moore (1903:382) noted a "ledge of shell" about 0.6 m high and 6.1 m across in the lower levels of Mound F at Crystal River. More commonly to the region, the platforms within burial mounds were made of mounded earth, as exemplified by Mound B at Mandeville (Kellar et al., 1962a, 1962b), Mound D at Kolomoki (Sears, 1956), Mound B at Fort Center (Sears, 1982) and Mound B at Marksville (Toth, 1974). Perhaps not coincidentally, free-standing platform mounds were eventually erected at all of these sites. This new architectural form may thus have been an incremental alteration of the longstanding tradition of platforms capped after use for mortuary ceremonies.

While we recognize continuity of form between free-standing platform mounds and their antecedents, we do not necessarily assume the continuity in the practices associated with the summits of these two types of platforms, beyond perhaps their common use for ritual performances. Bullen (1966) described a shell causeway connecting Mound H to Mound G; this apparent processional suggests that mortuary-related rituals may have been conducted on the summit of the former mound in relation to interments in the latter. The presumed causeway is still present, although the presence of a paved pathway on its surface makes it difficult to investigate and hence the functional connection is largely circumstantial.

Consistent with the common understanding of the flat-topped monuments of the Mississippian period, Bullen suggested that Mounds A, H, K served as foundations for temples or the homes of chiefs or priests (Bullen, 1965). However, we see no clear evidence for the presence of structures on top of Mounds H and K in either the GPR or coring data. This is typical of the platform mounds of the Woodland period; excavations on the summits have typically revealed evidence only of scattered pits and large posts, many of which appear to have been periodically removed and replaced in a manner suggestive of rituals of renewal (Knight, 1990, 2001). Mound H is distinguished from contemporary platform mounds at Crystal River and elsewhere in the region by its clear connection to a plaza, as indicated both by its location and the ramp that leads from its summit. This appears to be the earliest dated platform mound-plaza arrangement north of Mexico. Mound K may anchor the southern end of the plaza, but it is less clearly oriented in this direction. Regardless, any activities on the small summits of these two mounds would have been easily viewed by an audience in the plaza or other flat areas, as suggested by Lindauer and Blitz (1997) for Woodland-period platform mounds generally. We presume the same would have been true for the summit of the first stage of Mound A.

Mound Phase 4 began between *486 and 631 cal CE* (95%), probably between *532 and 607 cal CE* (68%). This relatively brief interval was marked only by the addition of the second stage of Mound J. This mound phase corresponds closely with Midden Phase 3, when people began moving away from Crystal River (Pluckhahn, Thompson, et al., 2015). The decline in mound construction would seem related to whatever larger processes precipitated this movement.

Nevertheless, mound construction did not cease entirely; the third stage of Mound A was added during the fifth and final phase of mound construction at Crystal River, which began between *542 and 1820 cal CE* (95%), probably between *604 and 1056 cal CE* (68%). In its final form Mound A was of imposing size, with an extensive summit, steep slopes, and clearly defined edges. Like Mound H, it once had a clearly defined ramp, but in this case the ramp was oriented northeast across a small lagoon to the midden, rather than to an adjacent plaza; perhaps in this case whatever activities that took place on the summit were intended for audience moored in watercraft in the adjacent river and marsh. However, it is also possible that, in contrast with earlier platform mounds, the activities on the summit of Mound A were not intended for a wider audience, foreshadowing the more socially restricted activities associated with later Mississippian platform mounds (Lindauer and Blitz, 1997).

Our chronology monument construction at Crystal River approaches a generational scale for some intervals of mound building, while other phases are of much longer duration. This difference is no doubt partly methodological; more intensive excavations and additional dating and modeling would no doubt reveal finer grained intervals that more closely approximate the lived experience we called for at the start of this paper. Still, we suspect that in broader outline our chronology accurately characterizes a history marked by intervals of both relative conservatism and profound innovation in monument building traditions. Conservatism is illustrated by the long tradition of mortuary mound building, although even here tradition was not reproduced exactly; the circular embankment that was in use for more than a millennium was eventually elaborated with a burial mound at its center, and still later by the addition of another burial mound across a plaza. Innovation is perhaps most evident in the construction of three or four platform mounds in the one- or two-century span of Mound Phase 3, a generational scale more in keeping with a historical event than evolutionary stage or chronological period. Yet we suspect that even this "new" tradition was not made up whole cloth, but borrowed from the platforms previously used in association with mortuary mounds. Rather than a step-like transition from one static form to the next across stable and enduring stages or periods, the history of monument building at Crystal River reveals that mounds were a "continuously unfolding phenomena" (Pauketat, 2001a:10).

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