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Radiocarbon and Luminescence Dating at Flamingo Bay (38AK469): Implications for Site Formation Processes and Artifact Burial at a Carolina Bay

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Over the last three years, the Savannah River Archaeological Research Program (SRARP) has engaged in a long-term, volunteer-based geoarchaeological study of Carolina bays in the Central Savannah River Area (CSRA) (Moore and Brooks 2010). This work builds on previous Carolina bay research by the SRARP stretching back more than 15 years (e.g., Brooks et al. 1996, 2010). Carolina bays are oriented upland ponds on the Atlantic Coastal Plain from Northeast Florida to New Jersey, with their greatest numbers occurring in the Carolinas and Georgia (Walker and Coleman 1987). The focus here is on understanding site formation processes, particularly as they relate to archaeological site burial and preservation within bay sand rims.

A major long-term goal of this research is directed at understanding the functional role of Carolina bays within Paleoindian and Archaic settlement systems. To that end, data collected on the Savannah River Site (SRS) from Flamingo Bay (38AK469) and elsewhere in the CSRA are providing important linkages between climate, burial processes, and human adaptation since the late Pleistocene (Fig. 1). The most intensive investigations have been conducted at Flamingo Bay (Fig. 2), with more limited archaeological testing and specialized geoarchaeological analyses conducted at Carolina bay sites in Allendale and Barnwell counties (Moore et al. 2009, 2010). A detailed monograph on all three Carolina bays is forthcoming and will be published later this year as an occasional paper of the SRARP. The remainder of this paper will discuss the results of radiocarbon and optically stimulated luminescence (OSL) dating at site 38AK469 at Flamingo Bay. These dates were partly funded through generous grants provided by the SCIAA Archaeological Research Trust (ART) in 2009 and 2011.

Radiocarbon Dating

Thirteen (n=13) radiocarbon dates were obtained from samples of carbonized nutshell from Flamingo Bay (Table 1 and Fig. 3). Eight of the 13 radiocarbon dates obtained in 2011 were funded by a grant through ART. Radiocarbon samples were selected from various units along north-south and east-west transects across our excavation block and included samples from a large feature or buried pit context, “general level” samples of carbonized nutshell from 2.5-centimeter excavation levels (Prov. 62, NE Quad), and general level samples from arbitrary 10 centimeter excavation levels (Prov. 55, 57, 58, 60, and 61). Two samples were collected from two different levels (Level E and G) from a large pit feature in Prov. 63. Together, these 13 radiocarbon dates serve as a check of single-grain luminescence age estimates (discussed below) and provide higher resolution temporal data on archaeological occupations and features. Below, the results of the radiocarbon dating are discussed along with implications for site formation and stratigraphic integrity.

The results of radiocarbon dating for Flamingo Bay produced an impressive number (n = 8) of middle Holocene, Middle Archaic dates between ca. 7,889 +/- 44 and 7,018 +/- 66 cal BP, as well as early...
Holocene, Early Archaic dates (n = 5) that range between ca. 9,098 +/- 63 and 10,986 +/- 121 cal BP. All radiocarbon dates were acquired from carbonized nutshell from across the entire excavation block and, in most cases, produced dates consistent with the known archaeostratigraphy of the site. Several deeper Middle Archaic dates appear to represent the injection of younger carbon into older sediments from pit features. Pit features are indicated by the distribution of carbonized hickory nut and vertical cobble refits through multiple levels. A large pit feature in Prov. 63 produced very similar 14C dates (7,456 +/- 30 and 7,275 +/- 39 cal BP) for nutshell fragments between two samples separated by a 10-centimeter level.

While most 14C dates are in good chronostratigraphic order, the oldest date (10,986 +/- 121 cal BP) appears out of place in the sequence of five dates from Prov. 62NE (Fig. 4A). With the exception of this date, a uniform and linear relationship between age and depth is suggested from the general level samples collected from this provenience. Together, these dates generally support archaeostratigraphic data from the site indicating a relatively intact archaeological sequence. For Flamingo Bay, three age clusters are evident, with gaps in between, suggestive of limited occupation or site abandonment at various times between ca. 7,000 and 11,000 cal BP (Fig. 4B).

The age-range for Morrow Mountain based on an analysis of radiocarbon dates for the Southeast suggests ages between ca. 8,100 and 6,000 cal BP (Fig. 5) (Moore 2009). A tighter cluster of dates within this group occurs at ca. 7,700-7,000 cal BP and may represent the peak of the Morrow Mountain horizon in the greater Southeast. The large number of Middle Archaic dates representing the estimated age-range for Morrow Mountain at Flamingo Bay is somewhat of a surprise given the lack of diagnostics recovered from that time period. From this block excavation, a single quartz Morrow Mountain hafted biface was recovered at 36 centimeters below datum (cmbd) in Level D and is likely positioned very near the occupation surface for Middle Archaic inhabitants at the site. The vertical position of this Morrow Mountain Point also corresponds to the likely surface of origin for several leached pits, including the large pit feature in Prov. 63. The number of Middle Archaic dates is also interesting given the observed low frequency of recognized Middle Archaic diagnostic tools in the Coastal Plain and the hypothesized abandonment or demographic shift during the mid-Holocene (Anderson 1996). Despite the lack of Middle Archaic diagnostics, our data indicate extensive evidence for large-scale processing of hickory nut during this time-period—an activity consistent with a fall habitation at Flamingo Bay.

Two 14C dates returned calibrated ages consistent with the terminal Early Archaic (9,098 +/- 63 and 8,993 +/- 42 cal BP). These dates are well placed stratigraphically. While the older sample (from the southernmost portion of the block) is somewhat younger than anticipated, given a similar depth for Early Archaic Corner-Notched occupations at the northern end of the excavation block, sedimentological and archaeostratigraphic
data suggest rim sediments are slightly thicker to the south where this sample was collected. This inference is supported by the recovery of the basal portion of a quartz Taylor Point in Level 8 (70-80 cmbd) in Prov. 63 (not point-plotted). Finally, the three oldest dates for Flamingo Bay (10,986 +/- 121 cal BP, 10,600 +/- 63 cal BP, and 9,593 +/- 55 cal BP) are consistent with early Kirk or Palmer Corner-Notched (i.e., Kirk CN) or more likely Taylor Side-Notched (i.e., two oldest dates), while the later date may represent a later manifestation of Kirk Corner-Notched.

The traditionally accepted age-range for the "Kirk Corner Notched cluster" (i.e., Palmer and Kirk CN) is between ca. 9,500 and 8,800 radiocarbon years BP, or ca. 10,800 to 9,800 in calibrated calendar years BP (Anderson et al. 1996). The 9,593 +/- 55 cal BP date at Flamingo Bay was recovered stratigraphically lower than the recognized Kirk/Palmer occupation from the northern end of the Flamingo Bay excavation block and may represent intrusive carbon from later groups. Alternatively, this radiocarbon date, in conjunction with the two later Early Archaic dates and the relative absence of bifurcate and Kirk Stemmed horizons in the CSRA, may indicate a continuation of the "Kirk CN horizon" for several more centuries in the Middle Savannah River valley than generally recognized elsewhere. A similar, “late” Early Archaic radiocarbon date was obtained recently from carbonized nutshell at the Topper Site in Allendale County, South Carolina in association with Kirk CN (Derek Anderson, personal communication). All of these dates are discussed in context with luminescence age estimates below.

### Luminescence (OSL) Dating

This research incorporates a relatively new dating technique known as luminescence or optically stimulated luminescence (OSL) dating (Murray and Roberts 1997). Generally speaking, OSL

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Table 1. Radiocarbon and calibrated dates from Flamingo Bay (38AK469).

<table>
<thead>
<tr>
<th>Prov.</th>
<th>Level/Depth (cmbd)</th>
<th>Context</th>
<th>Radiocarbon Age</th>
<th>1 cal BP (2 Sigma)</th>
<th>2 cal BP (1 Sigma)</th>
<th>Beta Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>G</td>
<td>General Level</td>
<td>8660 +/- 50 BP</td>
<td>9710 to 9540 cal BP</td>
<td>9593 +/- 55</td>
<td>283750</td>
</tr>
<tr>
<td>57</td>
<td>E</td>
<td>General Level</td>
<td>6620 +/- 40 BP</td>
<td>7580 to 7440 cal BP</td>
<td>7506 +/- 38</td>
<td>283751</td>
</tr>
<tr>
<td>58</td>
<td>D</td>
<td>General Level</td>
<td>7050 +/- 40 BP</td>
<td>7960 to 7800 cal BP</td>
<td>7889 +/- 44</td>
<td>283752</td>
</tr>
<tr>
<td>60</td>
<td>D</td>
<td>General Level</td>
<td>6620 +/- 40 BP</td>
<td>7580 to 7440 cal BP</td>
<td>7506 +/- 38</td>
<td>288772</td>
</tr>
</tbody>
</table>

Note: Level depths are 10 cm intervals (e.g., level E equals 40-50 cmbd) except where given as 2.5 cm intervals (Prov. 62, NE Quad)

1. INTCAL04 (2 Sigma) calibration

2. Fairbanks0107 calibration curve (1 Sigma)
provides a measure of the amount of time sediments have been buried or the time since they were last exposed to sunlight. During depositional events, exposure to light releases any acquired luminescence signal. After burial, sand grains begin to accumulate natural background ionizing radiation (i.e., equivalent dose) within electron traps or defects in the crystalline structure of the sand grain. Equivalent dose is measured in the lab by artificially stimulating the acquired luminescence signal and modeling the measured equivalent dose as a function of time of burial (Feathers 2003). The goal of luminescence geochronology is to establish the timing of burial events (Aitken 1985).

Luminescence dating is perhaps the most critical for establishing a landform geochronology. With respect to Flamingo Bay (38AK469), single grain OSL dates (n = 5) collected during the 2009 field season returned minimum age model estimates consistent with the observed archaeostratigraphy at the site (Fig. 6). These age estimates range from 5.0 kiloannum (ka) at 35 centimeters below surface (cmbs) (40 cmbd) to 15.5 ka at 80 cmbs (85 cmbd) (below archaeological deposits). Age estimates of 9.2 ka and 11.5 ka between 50 cmbs (55 cmbd) and 65 cmbs (70 cmbd) bracket Early Archaic occupations at Flamingo Bay. Finally, a 13.1 ka OSL date at 100 cmbs (105 cmbd) statistically overlaps with the 15.5 ka data higher in the profile and may indicate a thicker package of potentially Younger Dyras aged sediments within the upper meter of the sand rim at Flamingo Bay.

Use of the minimum age model in OSL dating should not be confused with the use of ‘minimum age’ estimates derived from very old 14C dating. In the latter case, the minimum age implies the potential for much greater antiquity, while the former (OSL minimum age model) is a method for extracting the true age of the desired or studied burial event in question. The ‘minimum age model’ age estimate is derived from a subset population of sand grains from positively skewed or multimodal equivalent dose distributions in cases where partial-bleaching or bioturbation of ‘older’ grains into younger sediments is suspected or inferred from analysis of luminescence and other proxy data (Galbraith et al. 1999). In the latter case, the archaeostratigraphy and corroborating 14C dates become paramount to the application of various age models and the development of an OSL geochronology (Feathers et al. 2006; Moore and Daniel 2011).

Radiocarbon dates for Flamingo Bay support the use of the minimum age model for luminescence dating since 14C dates indicate an entirely Holocene origin for the upper ~70 centimeters at Flamingo Bay. In addition, only minimum age model estimates are consistent with the observed archaeostratigraphy at the site. Recently recovered Clovis artifacts (Fig. 7) were found between 50 and 58 cmbd. The apparent vertical overlap of Clovis artifacts with Early Archaic artifacts is due to slightly more shallow deposits along the eastern sloping portion of the excavation block leading into the bay basin. In this case, historic erosion and plowing likely contributed to a lowering of the preexisting landform along this part of the sand rim.

Discussion

The development of a radiocarbon and luminescence chronology for 38AK469 is a crucial first step towards understanding site formation and post-depositional (i.e., taphonomic) processes affecting the distribution of artifacts at the site. In fact, this step is essential for making appropriate inferences about the meaning of archaeological data for understanding human behavior.

The saying that, “Lucky is the archaeologist with only one radiocarbon date” is probably true if that date meets your preconceived notion of what constitutes a “good” radiocarbon date, or if resources limit the number of radiocarbon dates to a very small number of samples. Clearly, as demonstrated here, more radiocarbon dates are not only desirable, but with increasing sample size, actually can tell us something about the natural and anthropogenic site formation processes that affect artifact distributions and subsequent behavioral inferences about those assemblages. Multiple dates...
are all the more appropriate when dating carbon from general level (i.e., non-feature) contexts, where stratified deposits indicate a preserved matrix of sediments, artifacts, botanicals, calcined bone, and carbon (i.e., wood charcoal and charred nutshell) that are recognizable and represent various and distinct cultural, biological, and sedimentological inputs through time.

Luminescence dating, on the other hand, compliments radiocarbon dating by providing a check on radiocarbon dates and by establishing a timeline or geochronology for burial or sedimentation events. Thus, radiocarbon dating of cultural carbon (i.e., carbonized nutshell) provides a timeline of archaeological occupation, while OSL dating provides a geochronology of landform development and presumably postdates non-intrusive carbon contained within the stratified sediment matrix. Luminescence dates also provide additional information about site formation processes and site integrity not provided by radiocarbon dating (Feathers 2003).

Given our increased understanding of site formation and chronology, several preliminary observations are warranted with respect to behavioral or archaeological implications for bay rims in our study area. First, the presence of numerous Middle Archaic, mid-Holocene radiocarbon dates at Flamingo Bay was somewhat of a surprise, given the paucity of diagnostic Middle Archaic bifaces in most of the South Carolina Coastal Plain (Anderson et al. 1996). These dates may reflect a more substantial mid-Holocene presence at Flamingo Bay (a time when the bay basin was likely shutting down as an open water system) than generally recognized. Alternatively, the fact that all of our 14C dates come from carbonized nutshell may have biased our sample towards the Middle Archaic since there is widespread evidence for increasing use and processing of nuts in the Southeast at this time (Anderson 1996).

Second, the presence of several Middle Archaic pit features at Flamingo Bay indicates more substantial resource utilization of diverse bay rim and bay basin environments in the Coastal Plain uplands. In many cases, these pits are only just barely recognizable by the presence of tiny flecks of carbonized nutshell and wood charcoal visible through multiple levels within individual or multiple excavation quads. The presence of Middle Archaic radiocarbon dates in levels normally associated with Early Archaic or Paleoindian occupations, along with a few cases of significant vertical displacement of artifact refits, testifies to the anthropogenic disturbance by Middle Archaic inhabitants. Out of 13 identified artifact refit groups, the average vertical displacement was ~five centimeters. Greater vertical separation for several refit groups appears to correlate with natural or anthropogenic disturbances (e.g., Middle Archaic pits). These pits may indicate long-term habitation of bay rim sites or more seasonally intensive exploitation of variably xeric to hydric bay rim slopes for collection and processing of nuts from masting trees.

Thus, it appears that archaeological data (i.e., tight vertical controls on archaeostratigraphy, diagnostic points, and artifact refits) and chronometric dating of sediments and carbonized nutshell may be useful for understanding not only where we have generally intact (relatively undisturbed) deposits, but also where sediments have been disturbed through later biological or anthropogenic activities. Overall, the radiocarbon and luminescence dates from Flamingo Bay are consistent with the archaeology.

Third, dating of carbonized nutshell has revealed that processing of hickory nuts has been an ongoing activity at Flamingo Bay for more than 10 millennia. Fragmented and carbonized nutshell found in association with gizzard stones and calcined animal bone (including bird) in pit features suggests smoking and preservation of meat was a significant activity at the site. The presence of
broken and carbonized nutshell shows that hickory and other masting trees were well established along the mesic slopes of bay sand rims by the early Holocene and were attractive to early hunter-gatherers in the region. In fact, carbonized nutshell fragments and grape seeds have also been recovered from within the area of the site that appears to contain a relatively pure Clovis activity area, consisting of numerous unifacial tools, gravers, and broken Clovis points. Nutshell fragments will be dated in the near future to determine if these botanicals relate to the Clovis occupation of the site. Confirmation of a Clovis age, ca. 13,150 to 12,850 cal BP (Waters and Stafford 2007), for these samples has significant implications for the ecological setting within the CSRA during the climate amelioration of the Bolling-Allerød interstadial and just before the onset of the cooler Younger Dryas climate event.

Together, radiocarbon dates and luminescence age estimates preclude bioturbation as the primary mechanism of artifact burial. Instead, these data suggest that Carolina bay sand rims, while shallow and stratigraphically complex, contain valuable paleoenvironmental and archaeological data if analyzed using appropriate methods and scales of analysis. These methods include a combination of numerous and close-interval radiocarbon and OSL dating to place archaeological deposits into appropriate environmental and cultural context. Further elaboration of these and other analyses is forthcoming in subsequent publications on Carolina bay geoarchaeology.

Work will continue at Flamingo Bay in 2012 to further investigate the Clovis occupation at the site, and to gather more data on the Archaic, Woodland, and Mississippian components. Lastly, this work would not be possible without the dedication of our Carolina bay research volunteers and contributions of the board members and trustees of the SCIAA Archaeological Research Trust (ART) that provided grants used in this research.

For more information on the Carolina Bay Volunteer Research Program please contact Dr. Christopher R. Moore, cmoore@srarp.org, office: 803-725-5227 or Dr. Mark J. Brooks, Mjbrooks@mailbox.sc.edu, office: 803-725-5221.

References


