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Cover: Artist's depiction of a mastodon kill site and the volunteers of the Wakulla excavations.

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The Wakulla Springs Lodge Site (8Wa329): 2008 Excavations and New OSL Dating Evidence

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Introduction

The Wakulla Springs Lodge site (8WA329), located in north Florida's panhandle (Figure 1), has been known for many years as one of the state's early sites. Recent reassessment of research conducted by the Florida Bureau of Archaeological Research in the mid-1990s suggests that this site was occupied well before the Clovis people who were initially thought to have been the first Americans. This report summarizes the results of field investigations carried out in 2008 at the Wakulla Springs Lodge site as well as the ensuing research.

In 1994, excavations at the Wakulla Springs Lodge site (Jones and Tesar 2000; Tesar and Jones 2004) generated an *in situ* projectile point identical to pre-Clovis points recovered elsewhere in the region (Dunbar 2006a, 2008). This find suggested that the site was occupied prior to the Paleoindian Clovis interval (ca. 11,200 to 10,800 BP). The Wakulla Springs Lodge site shares a physical similarity with other early sites in Florida, such as the Page-Ladson (8JE591) and Sloth Hole (8JE121) sites (Figure 1); that is, it is adjacent to a deep karst feature (one of the nation's largest first magnitude springs). If that was a common feature of pre-Clovis sites in Florida, then Wakulla may also possess a pre-Clovis component. In order to test this hypothesis, the 2008 project involved excavations adjacent to the location of the 1994 discovery with the goal of identifying additional Paleoindian artifacts and generating material to date radiometrically the earliest strata in the site.

Previous Archaeological Investigations at Wakulla Springs

In 1994, when Calvin Jones (Tesar and Jones 2004) excavated a long trench in the right-of-way for a new sewer line at the Wakulla Springs Lodge site, he found four Paleoindian artifacts adjacent to our 2008 test units within trench segment TS10. The Paleoindian artifacts recovered from TS10 occurred at depths of 105 to 115 cm below surface. They included a large Simpson-like preform, a Page-Ladson point, a flake preform, and a unifacial scraper. Twenty to twenty-five meters west of that location the Paleoindian levels in trench segment TS11 were found more deeply buried at 135 to 165 cm below surface. Bolen artifacts in the TS10 area were recovered from levels 6 and 7, which ranged from 75 to 105 cm below surface with one Bolen point fragment being recovered near the base of level 7.

In August 2007, a park ranger discovered the buried remains of a mastodon in the Wakulla River below the headspring (Dunbar et al. 2007; Porter 2012, this volume). The well-preserved bones vividly demonstrate the difference in preservation between upland and submerged sites in Florida. The mastodon lies beneath 2 m of water about 130 m north of the land excavation.

In December 2007, members of the Bureau of Archaeological Research (BAR), Florida Geological Survey, and the Geology Department and Coastal & Marine Laboratory at Florida State University gathered to vibra-core near the mastodon site on its northern, eastern, and western sides. The results of that effort confirmed that the Wakulla River just below the springhead has channel-fill sediment sequences over a meter in thickness in which the mastodon remains are buried.

Previous Archaeological Investigations of Paleoindian Age in the Region

The Page-Ladson site is located in the Aucilla River in Jefferson County, about 30 km east-southeast from Wakulla Springs Lodge (Figure 1). The deposits there are characterized by levels of still-water deposited peat, fluvial channel-fill calcareous silt, colluvium, smectite, and a few hiatuses formed by episodes of channel bottom subaerial exposure with little to no deposition and reduction by oxidation of exposed organic-rich levels. The stratigraphic column is over 7 m thick, but the total thickness of the sinkhole fill deposit remains unknown. The upper 7 m plus section of the column is very well dated and ranges from ca. 22,300 cal B.P. to ca. 10,700 cal B.P. (Pleistocene late glacial maximum into the early Holocene). The earliest Paleoindian evidence is in the colluvial level of the site, which also yielded butcher-marked mastodon bones as well as non-diagnostic stone artifacts. This level dated to ca. 14,425 cal B.P. (average of seven statistically related ^{14}C dates from Unit 3, the pre-Clovis level at Page-Ladson) (Dunbar 2006a, 2006b; Webb and Dunbar 2006). Though not recovered from in-place contexts, several (n=5) non-Clovis, Paleoindian lanceolate points were identified that eventually became known as Page-Ladson points (Dunbar and Hemmings 2004). These points were made on bifacially reduced flakes and were not fluted, though many displayed overshot flakes or were manufactured on thin flakes. Specimens made on thin flakes have remnants of the original preform flake surface left

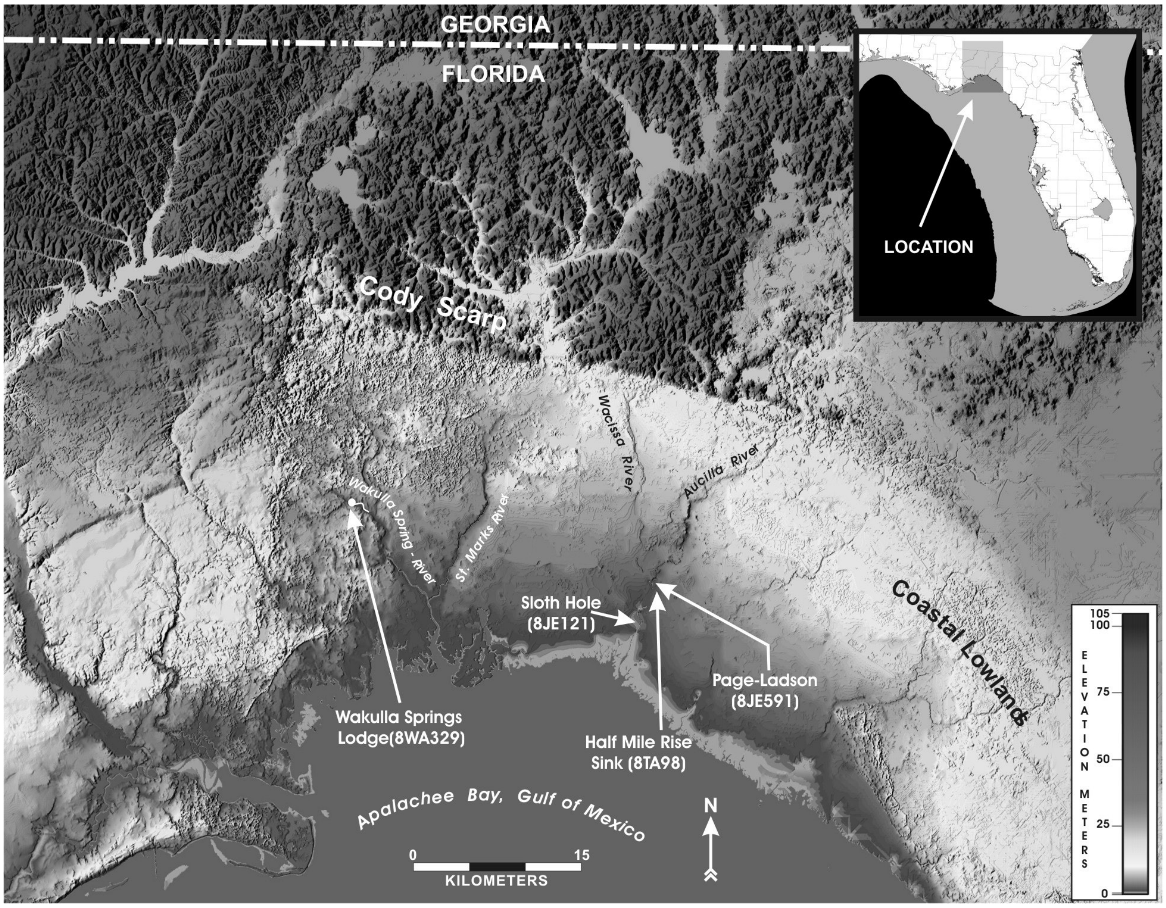

Figure 1: Digital elevation map of the Big Bend area of Florida depicting the location of the Wakulla Springs Lodge site and other early, Paleoindian sites in the Coastal Lowlands of North Florida.

intact in the basal area. These flat basal surfaces form flute-like features.

The Sloth Hole site is located on the southern reaches of the Aucilla River, below Page-Ladson, about 27 km east-southeast of Wakulla Springs Lodge (Figure 1). The deposits there are characterized by levels of silt and shelly silt. Artifacts from an upper Paleoindian level included a Clovis ivory point or shaft that yielded an age of ca. 12,900 cal B.P. along with other artifacts. The lower Paleoindian level, which was 60 cm below the Clovis level, yielded artifacts and mastodon remains with botanical specimens dating to ca. 14,300 cal B.P. (Hemmings 1999).

The Half Mile Rise Sink site (8TA98) is yet another site in the Aucilla River's Half Mile Rise section with Page-Ladson points. Though the site has not been radiometrically dated, it is but one of several with this distinctive artifact type (Dunbar 2008).

Local and Regional Geological Context

The depositional history of the sediment at the Wakulla Springs Lodge site, because of its importance to the interpretation of optically stimulated luminescence (OSL) ages, is the main focus of our interest in the regional geological context. A detailed view of the regional geological context is essential to interpret the granulometry discussed below and aids in some cases the interpretation of technical details of the OSL dating (equivalent dose distributions). The geomorphic setting of Wakulla Springs is the Woodville Karst Plain (WKP) (Means 2012, this volume: the remainder of this section is drawn largely from this reference). The karst nature of the WKP is reflected in the number and diversity of karst features in the area that includes sinkholes, swallets, springs, and caves (both air and water filled). These fluvial systems may have been active to different extents and at different times, but eolian deposits are also present. Approximately 9 km northwest of Wakulla Spring is a geomorphic region known as the Munson Sandhills, which represent a relict dune set and demonstrate that these features exist in the area. In addition, recent LIDAR data used to construct a digital elevation model (DEM) (Means, Figure 4, 2012, this volume) show a number of other features of interest in the geomorphology of the area. Depicted on the DEM is a linear area of higher elevation adjacent to Wakulla Spring that extends to the south and southwest. This topographic high continues farther southwest and possibly represents a relict barrier island or other coastal near-shore landform (beach ridge or bay mouth sand bar). These areas of higher topography are oriented somewhat parallel to the modern coastline, suggesting that they were created by near-shore marine processes. If this is the case, the sediment at the Wakulla Springs Lodge site could have been transported to the near-shore marine environment by a paleo-river system. This would have had to occur during the Sangamon Interglacial Stage, or earlier, as that was the last time sea levels reached this elevation.

Based upon the existence of relict drainage features that clearly show past, overland flow toward Wakulla Spring (Means, Figure 4, 2012, this volume) it is plausible that sometime during the past glacial stage a paleo-creek/river system flowed to Wakulla Spring, which, at the time, may have functioned as a swallet. Numerous swallets occur in the area immediately to the west and north of Wakulla Spring. A number of swallets in the Wakulla Spring basin have been shown, via dye tracing studies to be connected to the cave systems that deliver water to Wakulla Spring. If Wakulla Spring was once a swallet it would have been the termination point for a stream where sediment laden water would have periodically flooded into and perhaps overwhelmed the basin such that sediment could have been deposited several meters above the current level of the Wakulla River. This would account for the current elevation of the sediment and for fluvial signature of the sediment samples analyzed by Means (2012, this volume). This water could have also reworked any sand deposits that might have been deposited previously at Wakulla Spring during the Sangamon Interglacial (ca. 75,000 to 125,000 B.P.). From the present authors' perspective, this leaves open two possibilities: 1) Sangamon sands were reworked exclusively by fluvial processes even at times as late as 10,000 years ago, and 2) Sangamon sands were reworked by fluvial and eolian processes.

It is also likely that eolian processes played a role in the deposition or reworking of the sediment at the Wakulla Springs Lodge site. Some of the topography in the vicinity is reminiscent of crescent-shaped dune features. Although the granulometric analysis (discussed below) from Wakulla Spring suggests that the sediment is fluvial in origin it is plausible that paleo-river systems delivered sediment to a former nearshore environment (during a previous sea-level high stand) and after the marine regression these sediments were isolated and available for transport via eolian processes. Ivester et al. (2001) discuss the formation of relict dune sets along river systems in the southeastern United States.

Although the results from Means (2012, this volume) suggest that the sediment at the Wakulla Springs Lodge site was deposited by fluvial processes, he states "it is likely that the origin of the sediment samples is related to fluvial transport to a nearshore, marine environment, which then was acted upon by other transport mechanisms which might include eolian." He also hypothesizes that a paleo-river system, possibly nearby disappearing streams, like Lost Creek or Jump Creek, could have transported sediment from siliciclastic-rich areas to the north and west.

Previously recognized eolian dune features sourced from fluvial contexts have been recognized in the southeastern United States. Transported by eolian processes, dunes in and adjacent to river basins in the Southeast were formed by sediments of fluvial origin (Ivester et al. 2001; Ivester and Leigh 2003; Leigh 2008). Otvos and Price (2001:152) found granulometric results from Louisiana dunes that exhibited multi-modal, very poor to poor sorting of grain-size distribution, while Ivester and Leigh (2003) found in riverine dunes of the Georgia coastal plain "moderately to moderately well sorted (0.52µ phi < r < 0.87 phi), similar to values for the fluvial sands.

Figure 2 depicts the DEM for the area very close to the Wakulla Springs Lodge site. What appear to be crescent-shaped features may in fact be eolian dune features that occur at higher elevations than the surrounding terrain. If this is the case, it may be yet another set of eolian features for which there is regional evidence in the Southern Coastal Plain dating from about 50,000 to 11,000 years ago (Ivester et al. 2001). We further note that Pleistocene Coastal Plain dunes typically have crescent shapes. Such dune fields have been identified in the Suwannee River area east of the site, along the Flint River basin north of the site, and from the Apalachicola River west to the Mississippi River.

Optical Luminescence Dating

Optical luminescence dating utilizes the effects of light exposure on radiation-sensitive defects in the lattice of the quartz or feldspar mineral. Time dependence arises from a two-stage process in the history of a quartz grain. The first stage involves the fact that during deposition of quartz, sunlight erases previous radiation effects and sets the quartz grain into a zero-age state. The second stage encompasses the burial of the quartz to prevent further light exposure, during which natural uranium, thorium, and potassium in the surrounding minerals, as well as cosmic radiation from the sky, introduce energy into the quartz. A small proportion of this energy is trapped inside the quartz grains. This gives rise to a time-dependent accumulation of radiation effects that can be measured in the laboratory.

The total dose of radiation experienced in the burial interval (which is delivered at a steady rate) is measured in the laboratory by using light to release the stored information during which the quartz is reset to a zero age state, as happened at the time the quartz was exposed to light in nature. Effectively, the quartz acts as a radiation-sensitive photographic film, which must remain in the dark to record an image that can be converted to time (as opposed to photographic film, which must be exposed to light to record the image).

The time interval of dark storage (burial time) is obtained by establishing the total dose since the last light exposure (called the equivalent dose in laboratory language), and calculating how much dose was acquired in each year of dark burial. The latter quantity is known as the total dose rate and is the amount of dose each year delivered by the uranium, thorium, and potassium in the environment and the amount delivered downward from the sky due to cosmic rays. The burial time is given simply by the ratio of the dose acquired during dark storage (equivalent dose) to the total dose rate (dose per year). Equivalent dose divided by dose per year gives the number of years since burial.

In order for OSL to give an accurate burial age in the archaeological context, the buried grains must remain in their

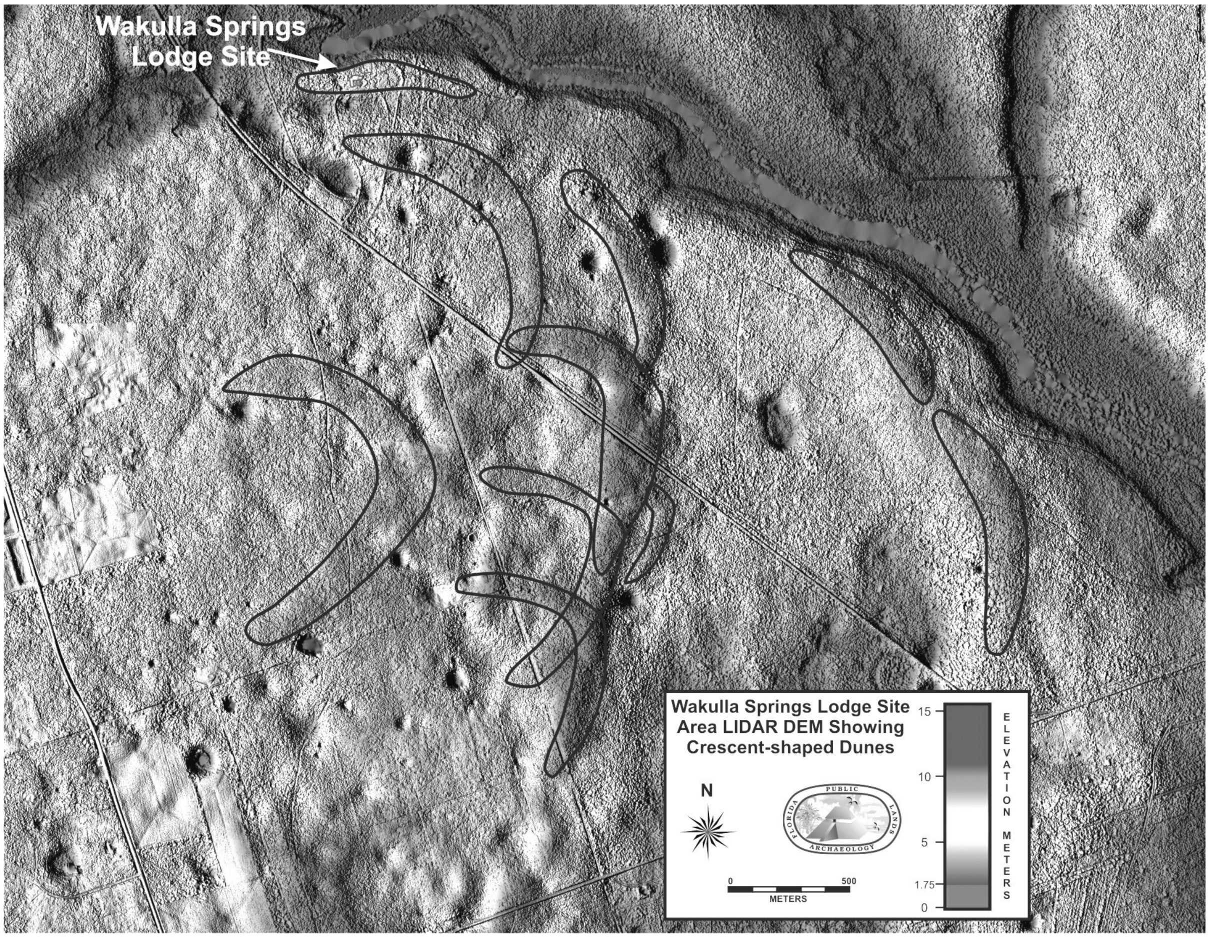

Figure 2: Processed LIDAR elevation model of the Wakulla Springs area showing multiple crescent-shaped features that are reminiscent of crescent-shaped dune features.

burial location relative to artifacts that are buried with them. If the grains that are buried move downward relative to the artifacts, then grains that were buried at shallower levels may be found with the artifacts, and the grain-age will be too young. Conversely, if grains that were buried move upward relative to their original burial location, they may arrive into locations with artifacts that were buried at a more recent time in the past. In the latter case, the grain-age will be older than the age of artifact burial.

Also of importance is the use of variable aliquot size (i.e., the number of grains tested) as a tool to identify the possibility of incomplete zeroing at burial or post-depositional mixing of grains from higher or lower levels relative to a dated sample. The spectrum of doses (or ages) obtained in an individual sample is plotted for each aliquot size, and these plots are compared among aliquot sizes. An interpretation of the true burial age of a level can then be obtained by use of statistical methods combined with information from the geological context. An increase in the proportion of older ages or doses as the aliquot size is reduced indicates the presence of a significant component of older age grains is present, whereas if the increasing proportion of younger ages is found, the presence of a significant component of younger age grains is present. In each case the cause may be related to bioturbation of grains after burial (see Thulman 2012, this issue). Alternatively, incomplete zeroing at burial may be the cause when an increasing proportion of older ages is found with decreasing mask size.

Archaeological Methodology

Preparations for the April to May 2008 field season included establishing control points. They were recorded in the UTM Zone 16 metric grid by using nearby existing datum points for elevation (NAD88) and conducting a survey-grade GPS satellite session (with the assistance of the Bureau of Beaches and Coastal Systems of the Florida Department of Environmental Protection) to establish horizontal control (NAD83). From the control points, a survey utilizing an electronic total station was used to establish the site grid in the excavation area and to gather topographic data for the area of the Wakulla Lodge overlooking the springs. The collected data were then electronically mapped (Figure 3) using AutoDesk Civil 3D engineering software (Dunbar et al. 2008). It should be mentioned that we were unable to calibrate our depth measurements to the vertical datum that Calvin Jones used, because his benchmark was altered and moved by the subsequent sewer line installation.

Though an initial ground penetrating radar (GPR) survey was conducted before the fieldwork, its results never became available. After the fieldwork, a second GPR survey was carried out by staff from the Florida Geological Survey with assistance from the Public Lands Archaeology program of BAR. Closely spaced passes of the GPR unit allowed creation of a three-dimensional GPR tomography, one that identified the lodge's pipeline networks and the top of limestone bedrock below the overlying sediments (Smith 2012, this volume).

Sampling during the field project included artifacts, bulk sediments, OSL sediments, and sediment monoliths. Sediment was sifted through 1/4-inch (6.4 mm) screens for the first 90 cm then through window screen (1.4 mm) in the lower levels. Samples of oxidized wood, most likely the decomposing remains of tree roots, were also recovered and sampled; however, nothing suggesting charcoal from a fire pit was identified, and none of these samples are deemed worthy of ^{14}C dating. Paleoindian and Early Archaic Bolen people did not thermally alter rock for tool making, but some Early Archaic peoples did purposefully heat treat chert. Thus, a comparison of thermally altered versus unaltered artifacts was undertaken to investigate whether artifact migration through the sediment might have taken place and to estimate the Middle/Early Archaic boundary. However,this study yielded equivocal results, because determinations of the presence of thermal alternation were ambiguous and difficult to confidently identify without a reference collection and better protocols. A study to determine thermally altered versus non-thermally altered rock is worth doing, however the use of a digital microscope, such as a Keyence VHX with optics capable of 1000X magnification or higher is needed to determine if the patinated chert specimens display the characteristic change caused by thermal alteration where the individual crystals become smother and no longer resist fracture along crystal boundaries as a result (Purdy 1974:51-52, Figures 11-12).

Dating Methodology

An important field objective and justification for including both geoarchaeological and geological consultants on the project was to insure, to the extent possible, the sediment column proposed for OSL sampling represented apparently undisturbed areas of the stratigraphic column (but see Thulman [2012, this volume] for a discussion of bioturbation at the site). Both OSL sampling loci were determined to represent unified, undisturbed locations based only on visual inspection and excavation records of zones removed to expose profiles. Jack Rink and Kevin Burdette conducted the OSL sampling, taking four samples from Unit B and three samples from Unit C. After each sample was taken the gamma dose rates from each sample location were calculated using a gamma spectrometer employed *in situ*, and neutron activation analysis was also

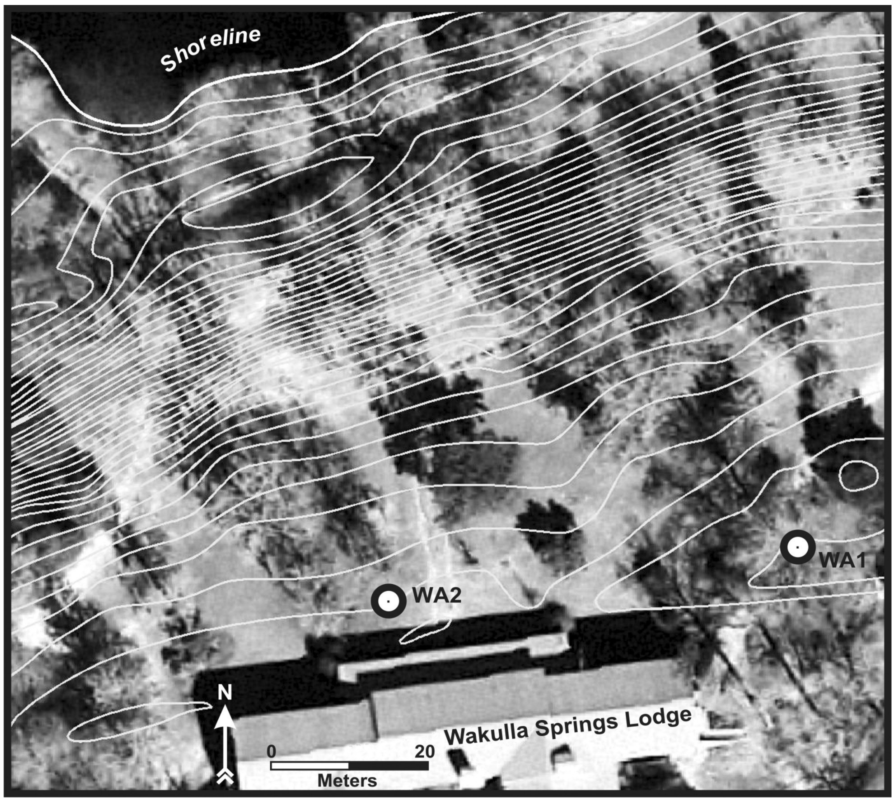

Figure 3. Digital, one-foot pixel, 2010 aerial photograph of the Wakulla Springs Lodge site depicting 10 cm topographic contour intervals as well as the locations of the survey control points, WA1 and WA2. The topographic high point is 5.8 m above sea level on the contour line passing through WA1 and the topographic low is about 1.9 m above sea level at the shoreline.

used to check the *in situ* results. Gamma spectrometric gamma dose rates were used as they better represent the full volume of sediment irradiating a given sample. Initial studies utilized large several thousand-grain aliquots (8 mm diameter), and initial ages were calculated using the central age model. Those results were presented at the 2009 Society for American Archaeology annual meeting (Rink et al. 2009). However, we continued the age evaluation by reducing the aliquot size on all samples to approximately 20-50 grains (1 mm diameter aliquot size) and used the minimum age model (Galbraith et al. 1999) to establish the burial age.

Sampling locations for the OSL samples were taken in Units B and C (Figures 4 and 5) at the elevations that the Paleoindian blade and endscraper, respectively. Samples were also taken above and below these elevations in order to develop a chronology within the Paleoindian levels.

All optically-dated samples were processed at the School of Geography and Earth Sciences at McMaster University under UV-filtered subdued orange light. Pure quartz grains were obtained using standard OSL preparation methods that include HCl and H_2O_2 digestions to remove carbonates and organics, respectively, sieving to obtain desired grain size, heavy liquid separation using lithium polytungstate to remove heavy minerals and feldspars, HF digestion to remove the outer alpha affected layer, a second H_2O_2 digestion to remove any remaining feldspars and any fluorides that may have formed during the HF digestion, and finally resieving to remove any grains that no longer fall in the desired size range (90-150 microns).

Calculated gamma and beta dose rates were based on neutron activation analysis (NAA) of ^{232}Th and ^{40}K and delayed neutron counting (DNC) analysis of ^{238}U (conducted at the McMaster University Nuclear Reactor). Untreated subsamples of the original samples were used to determine the elemental concentrations of radioactive ^{238}U, ^{232}Th, and ^{40}K (Table 1). NAA/DNC-based dose rates were calculated assuming radioactive equilibrium in the ^{238}U and ^{232}Th decay chains.

Luminescence measurements were conducted on a RISØ OSL/TL-DA-15 reader using blue light LED stimulation (470 nm) and a 7 mm-thick Hoya U-340 filter (270–400 nm). A calibrated ^{90}Sr beta source was used to perform laboratory irradiations. The single aliquot regeneration (SAR) protocol (Murray and Wintle 2000) was conducted on a minimum of 24 aliquots to determine a final equivalent dose (D_E). Quartz grains, between 90-150 microns, were mounted with silicon spray on aluminum discs using a 3mm and a 1mm mask and were illuminated for 100 seconds at 125^o C. The background (the last 4 s) of the OSL decay curve was subtracted from the "fast" component (first 0.4 s) to determine the samples luminescence signal. Only aliquots whose recycling ratios were within 10 percent were accepted for equivalent dose D_E determinations. Linear plus exponential fits were made to the dose response data to determine individual D_E values.

A thermal transfer test and a dose recovery test were performed to determine the final D_E preheat temperature (Madsen et al. 2005). For both tests, twelve aliquots from each sample were optically bleached by blue light illumination for 40 seconds, followed by a 10,000 second pause and another 40-second illumination. For the dose recovery test, the aliquots were given a known dose. Both tests continued with the standard SAR protocol except the preheat temperatures varied (160, 200, 240, 280^o C), with 3 aliquots from each sample receiving a different preheat temperature. For each sample the dose recovery test was used to determine which preheat

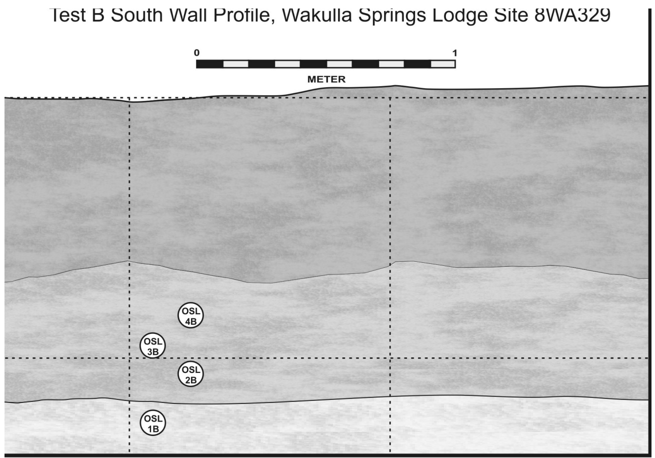

Figure 4: Unit B south wall profile taken after the test unit had been expanded a half meter east and south. The OSL sample locations shown here represent the relative positions of the sample location before this test unit was expanded. The sediment profile shown here was drawn based on post-processed sediment sample desiccation to detect boundaries in sediment color, and no interpretation of the cause of the coloration changes is available. The blade tool was recovered at OSL sample location 3B. Scale bar is for vertical and horizontal dimensions.

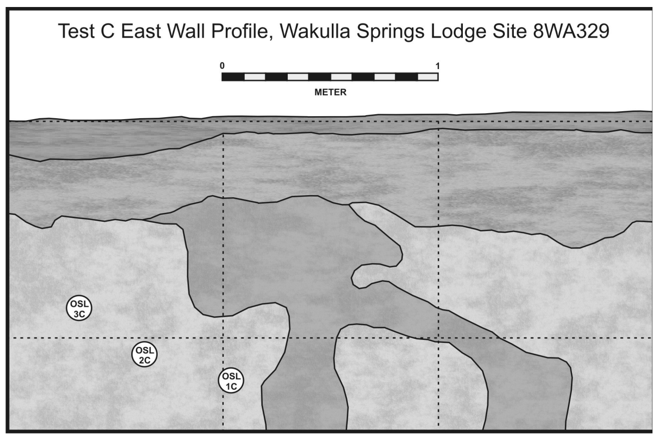

Figure 5: Unit C east wall profile depiction the locations of OSL sampling. The endscraper was recovered at OSL sample location 2C. The sediment profile shown here was drawn based on post-processed sediment sample desiccation to detect boundaries in sediment color, and no interpretation of the cause of the coloration changes is available. Scale bar is for vertical and horizontal dimensions.

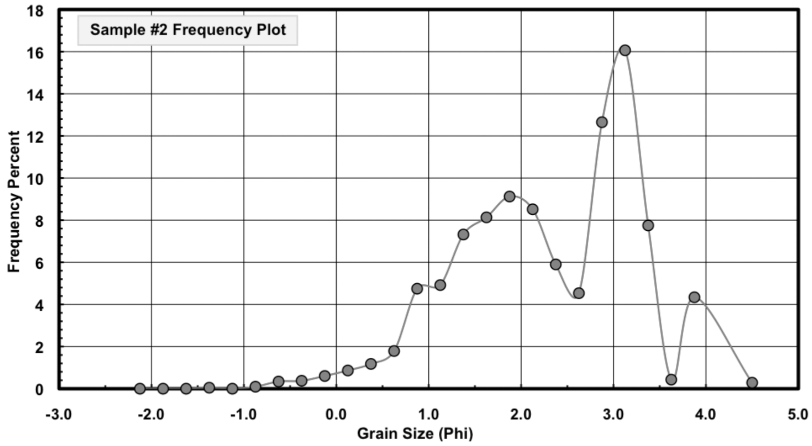

Figure 6. Granulometry of Sample 2 (Means 2012, this volume). This sample was recovered in close proximity and elevation to our OSL B2 sample.

temperature produced a D_E closest to the given dose. Once this preheat temperature was determined, the thermal transfer test was analyzed to insure there was no induced charge transfer at that given temperature.

A feldspar contamination check was also performed on each sample to insure purity of the quartz grain separates. An initial D_E was estimated by comparing the natural OSL signal (preheat T = 200^{o}C) of 3 aliquots to the regenerated OSL given by a single dose. A second identical regeneration dose was applied to the same aliquots and the IRSL signal was measured. If a ratio of IRSL to regenerated OSL signal was less than 1 percent for all aliquots, it is assumed there is no significant feldspar contamination. Finally, moisture contents were measured in the lab from the recovered sediment and used for the dose rate calculations.

Geological Methodology

The Florida Geological Survey collected five sand samples from the top to the bottom of the sediment column in Unit B to determine sand-size granulometry (see Means 2012, this volume).

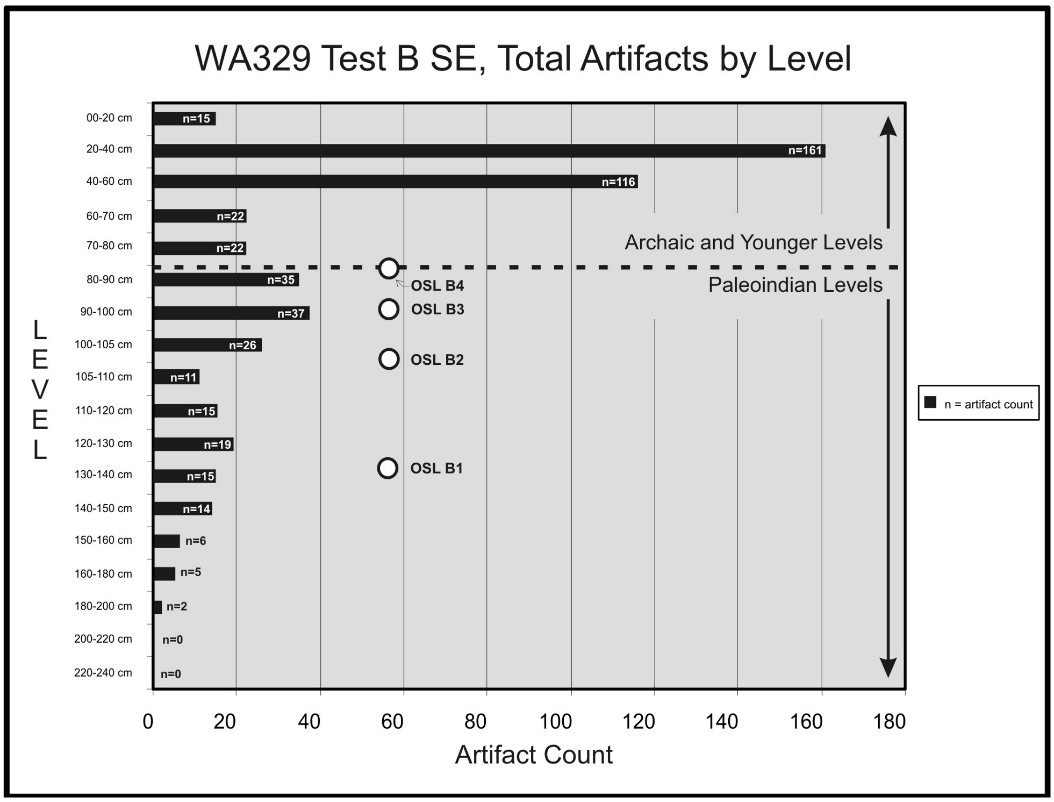

Figure 7. Total artifact counts by 10 cm level in Unit B.

Geological and Archaeological Results

Sedimentological Analysis

We report here on the sedimentological analysis of sediments from the site (Means 2012, this volume). This analysis is essential to best interpret equivalent dose determinations in OSL dating. It can help classify some equivalent dose signatures as the type resulting from incomplete zeroing during fluvial deposition. All samples studied showed a similar bimodal distribution of grain size and were negatively skewed. Figure 6 (sample 2 of Means 2012, this volume) is representative of all five granulometric samples, whose average mean grain size had a standard deviation of 0.9493, indicating that they were moderately sorted. This sample had a mean grain size of 2.2755 phi, grain size standard deviation of 0.9546, skewness of -0.4352 and a kurtosis of 2.6735. Negative skewness can represent winnowing effects commonly seen in beach and nearshore marine environments. The bi-modal distribution suggests that two different current transport regimes acted upon the sediment. A plot of skewness versus standard deviation of the grain size data was constructed (Means 2012, Figure 3, this volume) in an attempt to determine whether the sediment transport and depositional mechanism was wave action (beach) or fluvial processes. The five samples fell within the river sand (fluvial) portion of the graph, suggesting that the sediment, at some point in time, was acted upon by fluvial processes.

Our OSL analysis was performed on the 90-150 micrometer grain size fraction (phi 3.47 to 2.74). This corresponds to the large peak in Figure 6 near 3.0 phi. This is a sand-size capable of accumulating in wind-blown dunes and fluvial sediments. Granulometry, though not conclusive, can be a good indicator of how sediment accumulates. Notwithstanding this, we believe that the granulometrics do not categorically identify the sediment as being of purely fluvial origin. In our opinion, though fluvial signatures are present here, there is a high likelihood that eolian processes participated in the deposition of the sediment. Fluvial deposition at Wakulla is admitted as a possibility (Means 2012, this volume). This is because proxy and geologic evidence indicates that inland water tables in Florida were lower, sometimes considerably lower than present (Grimm et al. 1993; Grimm et al. 2006; Dunbar 2006b; Willard et al. 2007) during marine isotope stages 2 and 3, from about 59,000 cal B.P. to 12,000 cal B.P. (Wright 1999). In sum, we wish to leave open the possibility that the sediments we date here were deposited initially by fluvial deposition and later reworked by eolian processes. No sedimentary features consistent with fluvial deposition were found in the sections, though the appearance of the sediment in profile was entirely consistent with eolian deposition.

Archaeology

We excavated approximately 46 m^3 of sediment from seven test units covering a horizontal area of approximately 35.5 m^2. About one third of the total volume excavated consisted of disturbed sediment resulting from lodge construction or from subsequent maintenance such as the replacement sewer line that Calvin Jones' crew excavated in 1994 to mitigate the impact on the archaeological resource (Jones and Tesar 2000).

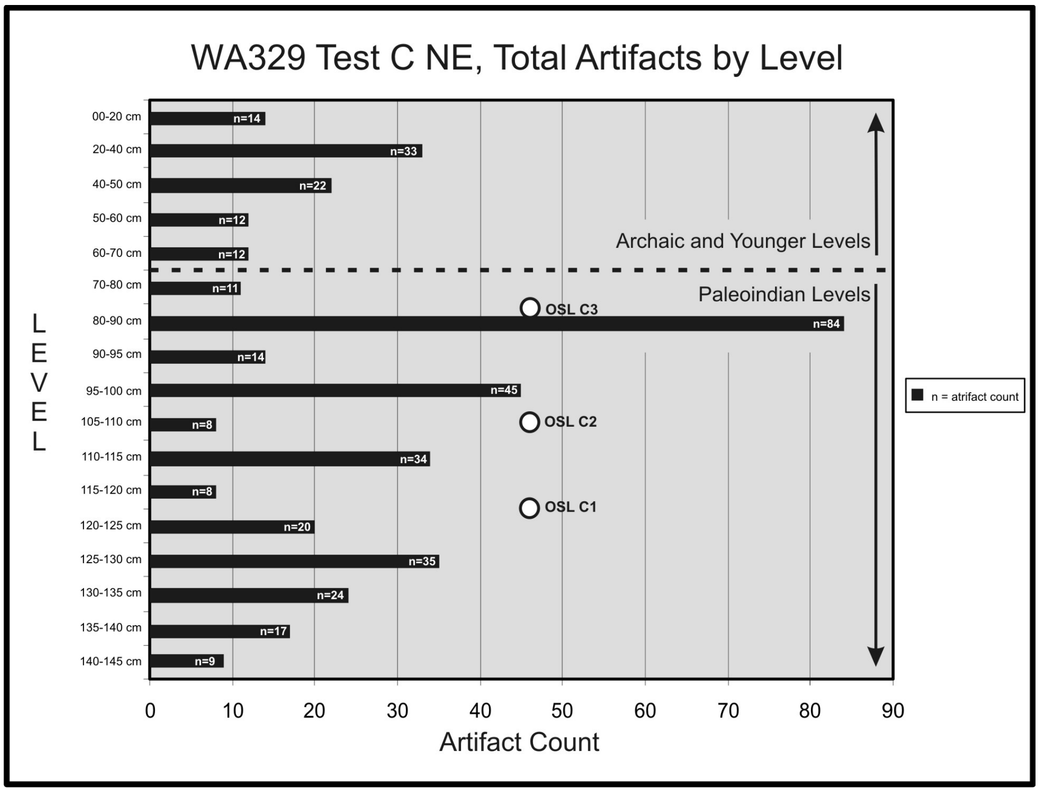

Figure 8. Total artifact counts by 10 cm level in Unit C

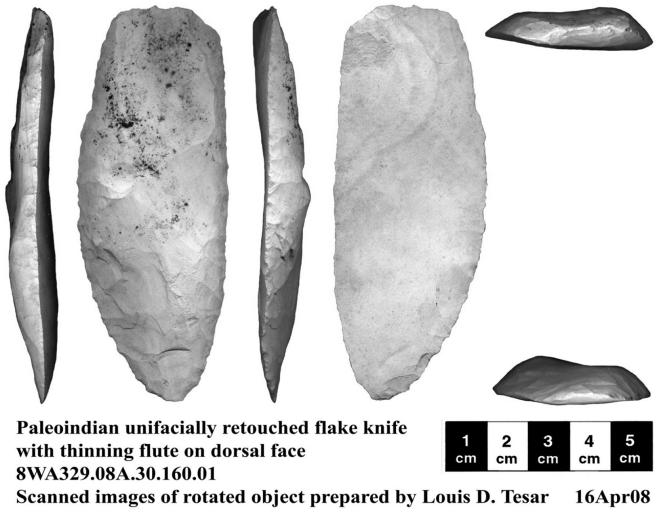

Figure 9. Paleo blade recovered from Unit B.

The most substantial ground disturbance was in Unit A and the western half of Unit D where pipeline ditches were more than 1 to 1.5 m deep. Shallower cast-iron storm water drains were encountered in Units B and E with ditches extending about 70 cm deep. A number of abandoned sprinkler and water lines were encountered in Units B, F, and 1. These shallow pipes were buried about 20 to 40 cm deep. Ground disturbance of the upper levels of the site was also detected and varied in depth from about 15 to 40 cm. This more generalized disturbance appeared related to landscaping of the park in 1937 when the Wakulla Lodge was built. To date, few historic records or photographs have been found that provide details about lodge construction as it relates to ground disturbance and the types of excavation machinery used. A bulldozer is suspected to have been used for landscaping and tree removal.

Depending on location, artifacts from approximately 75 to 100 cm below surface represent the Paleoindian component(s) of the site. In Unit B, an Early Archaic Bolen point was recovered about 20 cm below a Clovis-like blade knife, but it clearly had been displaced. The Bolen component of the Wakulla Springs Lodge site had been previously dated to about 10,500 cal B.P., and was unequivocally found above the Paleoindian levels (Tesar and Jones 2004:155-156). The Bolen point from Unit B in 2008 came from a deeper level than the Bolen-age artifacts Calvin Jones's crew identified, also indicating that it was displaced.

We encountered numerous dark-stained areas classified as non-cultural features, most of which were the remains of organic-rich, sediment-filled tracks of stumps, roots, or animal burrows. One particularly large feature appeared to represent the work of a bulldozer that had successfully uprooted a tree and then backfilled the excavation hole in Unit A. These types of features predictably yielded younger artifacts from deeper levels of the site than they should. The Bolen point in Unit B is judged to represent the same type of displaced object, fallen from its original level of deposition to a much deeper one through some type of opening, albeit temporary, in the ground. The Bolen point's angle of repose was not flat; rather it was on edge with its distal end facing downward. It is why we believe the Bolen point represents an artifact displaced by bioturbation (Thulman 2012, this volume). Calvin Jones also found a downward displaced Bolen point in his TS10 test area in a dark-stained feature.

Our investigation adjacent to Jones' TS10 area identified Paleoindian stone tools at 97 cm and 105 cm below surface in Unit B (Figure 4) and Unit C (Figure 5), respectively, as well as other artifacts to depths of 140 cm below surface. Differences in coloration of the sediment are shown here, and in this context have not been attributed to stratigraphic levels. The source of the color variation is not ascribed to any

Figure 10. Endscraper recovered from Unit C.

particular process because studies of this were not undertaken. The shallowest of the Paleoindian artifacts, a formalized blade tool, has no counterpart in the Early Archaic Bolen assemblage, but appears to be very much like a Clovis blade or Clovis-like blade tool, a tool type found elsewhere in Clovis sites in North America (Bradley et al. 2010). Other than this and one other Clovis-like blade tool recovered from controlled excavations, there is no other evidence for a Clovis component occurring at Wakulla Springs.

The debitage distributions from Unit B (Figure 7) show that the most intensive occupation occurred within the top approximately 90 cm of sediments found here (referred to here as the upper strata). These strata also had higher percentages of heat-treated lithics, a typical signature of lithics from the Middle Archaic and more recent periods. The distributions below about 90 cm show a dramatic drop in the total number of artifacts in one unit (B), which is to be expected if we presume smaller populations in the Early Archaic and Paleoindian periods and thus less material culture in those levels. The distributions in Unit C (Figure 8) do not show the clear trend of decreasing debitage with depth. In fact, three 5-cm intervals in the lower portion of the site (95-100 cm, 110-115 cm, and 125-130 cm) show more debitage than the 20-40 cm interval. We acknowledge that effects of pedoturbation could lead to some of the characteristics in the distributions of debitage presented here. Suspected heated lithics, all heavily patinated, were also present in the lower levels but at lower percentages.

The lower levels of the site yielded three notable artifacts and a number of tools of lesser importance such as biface fragments and flake tools. The more noteworthy artifacts include the blade from Unit B and an endscraper from Unit C. Perhaps the most unusual stone artifact is an item of adornment. It is a stone seed bead recovered from Unit D, 1.35 m below surface (Glowacki 2012, this volume).

The blade knife from Unit B is similar to or is of Clovis manufacture (Bradley et al. 2010: Figure 9) made from a large prepared blade struck from a blade core. Though we are uncertain what tool assemblage it belongs to, its recovery from the Wakulla Springs Lodge site in the area where Calvin Jones recovered Simpson and Page-Ladson artifacts suggests that it either belongs with that assemblage or another site component yet to be identified, most likely Clovis. The tool appears to have been a hafted knife on its proximal end, backed on one lateral side and sharpened on the other. High-resolution magnification shows the cutting edge was smoothed during usage, which suggests use as a knife on soft tissue.

The endscraper manufactured on a flake from Unit C (Figure 10) could comfortably fit into any Paleoindian toolkit from Florida (Daniel and Wisenbaker 1987). It is manufactured from a medium-sized flake. High-resolution magnification of the worked edge in two places displays a smoothness caused during usage and indicative of activities such as hide working.

Considerable coloration differences in the sand were found. Faint coloration differences can more easily be

Figure 11. 1970 Photograph of the Simpson point lying on the upper maxilla of *Mammut americanum* (mastodon) in the lobby of the Wakulla Springs Lodge. Photograph provided by Dan F. Morris.

detected once the samples from each level are desiccated and high-resolution images acquired through a flat bed scanner with samples placed in optically clear sample bags. Changes in sediment coloration might be due to decomposing organics and differential leaching and therefore represent differences in post-depositional development. We also considered that the color differences of each level represent distinct episodes of deposition through time but were unable to reach a firm conclusion on the sources of the color variations. However, we note that the level of the Paleoindian blade knife in Unit B originates in dark-colored sediment compared to the endscraper in Unit C, which was in light-colored sediment. The Paleoindian endscraper may therefore represent a second Paleoindian site component.

The Simpson type as first proposed by Ripley Bullen (1968, 1975) has been applied to Paleoindian recurvate, waisted points in Florida by many researchers (see for example Daniel and Wisenbaker 1987). However, Bullen's Simpson type is represented by a heterogeneous assemblage of similar-shaped points that are often inseparable from the waisted Suwannee type in his type case collection housed at the Florida Museum of Natural History in Gainesville (Dunbar and Hemmings 2004). In this paper, we restrict the Simpson type to a single, unified category of recurvate, waisted points dominated by percussion flaking and having extreme width to thickness ratios.

With the exception of the Clovis-like blade knife from Unit B, the stone tools recovered from the Paleoindian context at the Wakulla Springs Lodge site are not Clovis, yet the site has yielded Page-Ladson and Simpson types. The Simpson from Wakulla (Figure 11), once on display in the Wakulla Lodge, disappeared just before the State completed purchase of the property. A photograph taken by Dan Morse remains as the only documentation of its existence. Neither Page-Ladson nor Simpson types have ever been found in a Clovis context, but both occur in the deepest levels at Wakulla found by Jones (Jones and Tesar 2000). Images of several of the Paleoindian artifacts found at Wakulla and other locales are shown in Figure 12. We therefore propose that the lithics shown in Figure 12 are part of a Simpson toolkit with the possible exception of the Clovis-like blade tool. However, if the blade tool is related to the Page-Ladson/Simpson assemblage, it is the only artifact showing unequivocal correspondence to Clovis

.

Results of the OSL Dating of the Wakulla Springs Lodge Site

Luminescence measurements were made on single aliquots of three different diameters: 8 mm, 3 mm, and 1 mm. Figures 13 and 14 show the results for two samples: B3 and C2. This comparison is often made as a basic check for incomplete zeroing at burial but can also be used to identify

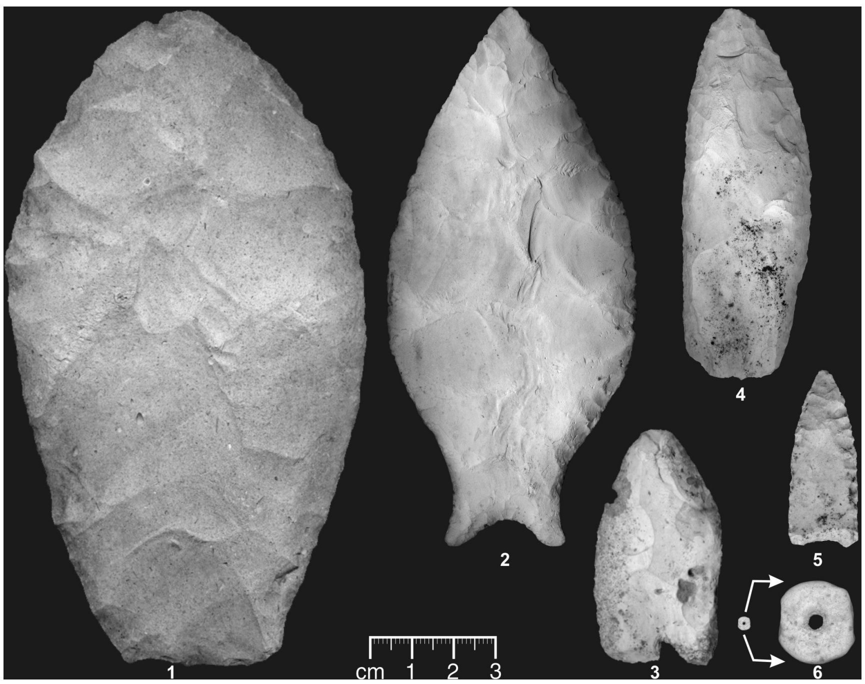

Figure 12. The proposed Simpson tool kit including 1) Simpson preform also used as a core to yield flakes for small tool manufacture, recovered during Calvin Jones dig Wakulla Lodge site; 2) Simpson bifacial knife from the Chason Cache (8CA185)(a similar point was on display at Wakulla Lodge but disappeared prior to state's purchase of the park); 3) flake preform taken from a biface tool core such as depicted in 9.1 recovered during Calvin Jones dig, Wakulla Lodge site; 4) a Clovis-like blade from Unit B Wakulla Lodge site (also shown in Figure 8); 5) a Page-Ladson projectile point recovered during Calvin Jones dig Wakulla Lodge; and 6) a seed bead manufactured from a small quartz pebble recovered from Unit F.

effects of disturbance of grains after burial. Sample B3 (Figure 13) exhibits a shift to larger proportions of aliquots with smaller equivalent dose (D_E) as the aliquot size decreases. While the 8 mm mask (diameter) distribution shows no doses lower than about 6.5 Gray (Gy), we see that the 1 mm mask aliquots show 5 of 7 aliquots with doses lower than 6.5 Gy. We see a similar trend for sample C2 (Figure 14), where all aliquots at 8 mm mask have doses larger than 7 Gy, while a large proportion is less than 7 Gy in the 1 mm mask size. We also observe one aliquot at around 14 Gy, which is a dose that was not observed in either of the other two mask sizes. Since the trend is to lower doses with decreasing mask size, we do not see any evidence for incomplete zeroing at burial, which generally would be evidenced by a strong spreading to higher doses with decreasing mask size.

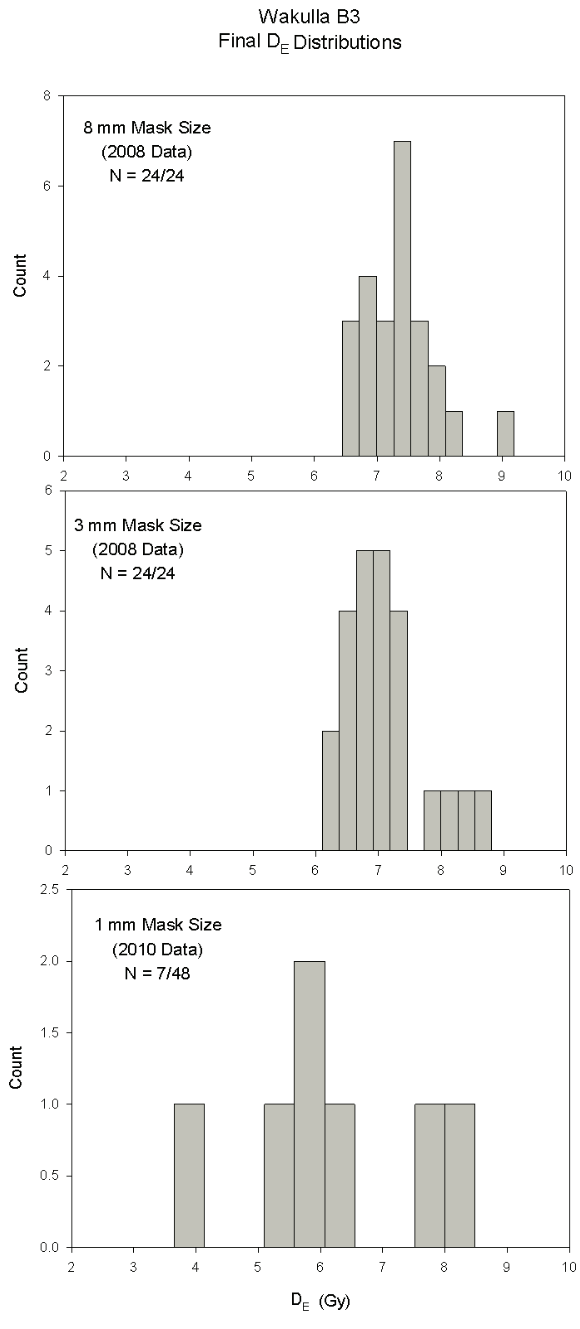

Figure 13. Wakulla B3 Histogram for 8 mm, 3 mm, and 1mm masks.

From these observations we believe that the mean of the equivalent dose distributions are not a good indicator of burial age, and that there appears to be a mixing of older (higher equivalent) dose grains with younger grains. We believe that our observation of increasing proportion of younger grains with decreasing mask size is a result of dilution of the older grain component by increasing contributions to the light sum by the younger grains on the smaller aliquots. From this analysis, we have chosen to calculate the burial age based on a statistical analysis of the 1 mm distribution that seeks to find the minimum possible burial age of the sample, called the minimum age model (Galbraith et al. 1999). The computer programs to calculate the central and minimum age model equivalent doses and other characteristics were provided by S. Huot (University of Quebec at Montreal).

We compare the results of the central age model and the minimum age model in Tables 2 and 3. It is seen that ages based on the minimum age model are considerably younger than that of the central age model throughout the deposit. The OSL ages are basically comparable to calibrated ^{14}C ages (calendar years [cal] BP), except that all ^{14}C ages are calculated based on years before 1950 (B.P.), while the ages reported here are calculated in years before 2010. We see that Unit B has a very old basal age below the archaeology of about 25 to 29,000 years ago, while samples from within the upper dated levels range from about 14,900 $\pm$ 1400 years ago to 10,600 ±1000 years ago. Unit C shows a lower sample within the archaeology dating to 18,000 $\pm$ 4500 years ago to an uppermost sample of 15,100 $\pm$ 1600 years ago. Further support for using the minimum age model is found in the over-dispersion parameter (Table 3), which in nearly every case exceeds a threshold of 20 percent, which is considered to be evidence by most workers of a mixed age population of grains.

The minimum age model results are in stratigraphic order in both Units B and C or are statistically indistinguishable with depth within the unit. Overall they exhibit a clear trend toward younger dates with decreasing elevation (Figure 15). We acknowledge that this type of age-depth trend has been interpreted as a result of biomantling, where upwardly mobile sediment progressively buries artifacts and modifies age profiles (Wilder et al. 2007). Indeed, we strongly suspect that biological agents such as ants may be moving sediment grains upward (without zeroing them) to produce older than expected aliquots observed in our distributions (Thulman 2012, this volume). In this case, however, not all grains are moved to the surface as might be suspected in a full biomantling scenario. The use of the minimum age model to isolate the grains that represent the best burial age (youngest grains) may not be able to remove all the effects of upwardly mobile older grains, though it is currently the best method available to do this.

Sample C3 (Table 2) appears to be relatively older than the trend; however, our confidence in the age of this sample is relatively low because of the small number of aliquots that could be used from the analysis at the 1 mm size (4 of 48) (this resulted from the restriction that we used only aliquots that pass a criterion that the palaeodose error is less than 10 percent). If we restrict our analysis to the other samples but also exclude B1, which was below most of the debitage, a line fitted to the data produces a slope that gives an average sediment accumulation rate for this portion of the deposit of 0.046 meters/thousand years, or about 5 cm per thousand years. This represents an average accumulation of about 1 mm per 20 years. The position of two significant artifacts found in the units are also shown on Figure 15 and correspond to sample locations B3 and C2, which date to 13,700 ± 1100 years ago and 15,600 ± 1900 years ago, respectively. At this two sigma error, the levels from which the artifacts were excavated are statistically indistinguishable in age. The Bolen point found in a non-horizontally disturbed context comes from near the level of C1, which happens to also show the largest age uncertainty. There may be a factor of disturbance in this portion of the

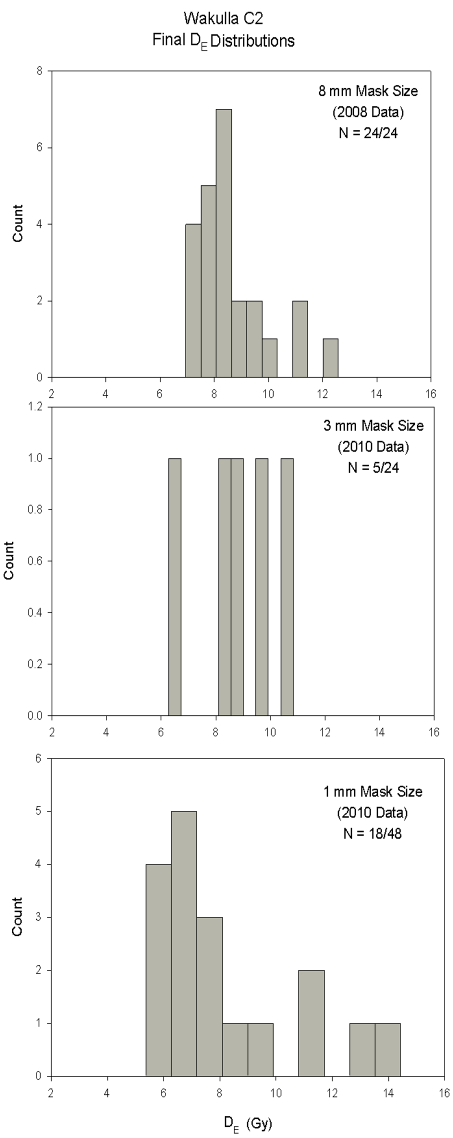

Figure 14. Wakulla C2 Histogram for 8 mm, 3 mm, and 1 mm masks.

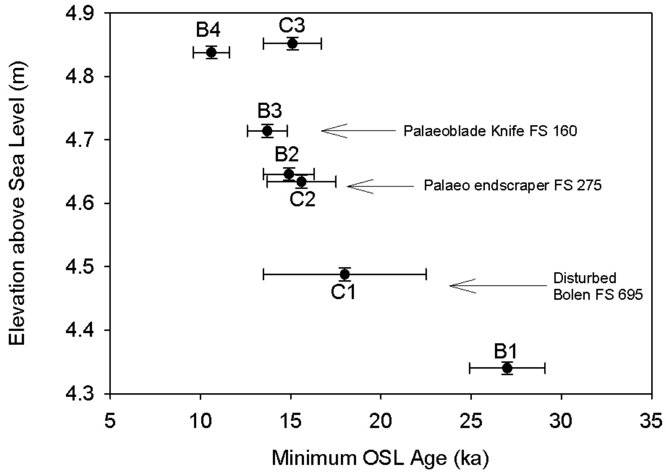

Figure 15. Minimum OSL age Wakulla Springs Lodge Unit B and C combined with artifact depths on chart

deposit that has also increased the uncertainy of the OSL age. Its age uncertainty stems directly from the relatively large spread in the 1 mm aliquot D_E distribution, which may be due to a larger amount of mixing there than in other samples.

The chemical analyses and radiation dose rate data are given in Table 3. We note the extremely low concentrations of U, Th, and K present, which are not surprising in view of the lack of any material other than quartz. This leads to very low gamma and beta dose rates. We see for the most part extremely good agreement between the *in situ* measurements of the gamma dose rate and those calculated by use of U, Th, and K values with moisture correction. The discrepancies probably arise from small variations in the dose rate over the 30 cm radius sphere of influence of the gamma rays. Finally, we can see that the cosmic dose rate is by far the most important of all, in most cases accounting for 50-60 percent of the total dose rate. This is important because it mitigates against uncertainty in the ages that arise from moisture content variations through time, because cosmic rays are not significantly affected by moisture, while beta and gamma dose rates are.

Overall, the minimum age model age ranges (last column of Table 1) constrain the archaeological levels to be as young as 13,500-13,700 years ago in all but two samples, which could be as young as 12,600 and 9600 years ago, respectively. Considering the older end of the uncertainty ranges of the ages, we can state that the minimum model ages constrain the archaeological levels to be as old as 22,500, but as young as 11,600 years ago.

Final Discussion and Conclusions

Our observations that smaller aliquots yielded dose distributions with larger numbers of smaller equivalent doses has also been observed in other sandy, shallowly-buried upland archaeological sites in central Florida at the Avon Park Air Force Range (Wilder et al. 2007). Their studies compared single grain aliquots to 8 mm diameter aliquots. They attributed their observations to upward mixing of older grains into

Table 1. Wakulla Springs Lodge Chemical Analyses and Dose Rate Data.

Sample Name	**U^{238} (ppm)** [a]	**Th^{232} (ppm)** [a]	**K (%)** [a]	**Water Content (%)** [b]	**Cosmic Dose Rate (μGy/a)** [c]	**Beta Dose Rate (μGy/a)** **[e]**	**Total Internal Dose Rate (μGy/a)**	*In-situ* **Gamma Dose Rate (μGy/a)** [d]	**NAA Gamma Dose Rate (μGy/a)** [e]	**Total Dose Rate (μGy/a)**
OSLB-4	0.24	0.72	0.0512	2.69	204.61±20.4	84.5±12.9	10.1±2.3		72.5±11.4	371.7±17.4
OSLB-4								**79.5±4.0**		**378.7±13.7**
OSLB-3	0.42	0.92	0.0563	2.59	200.79±20.1	114.6±12.8	10.1±2.3		102.1±11.4	427.7±17.3
OSLB-3								**78.37±3.9**		**403.9±13.6**
OSLB-2	0.19	0.48	0.0291	2.23	198.27±19.8	56.4±12.8	10.1±2.3		50.4±11.3	315.3±17.3
OSLB-2								**78.25±3.9**		**343.9±13.6**
OSLB-1	0.28	0.76	0.0522	2.69	192.04±19.2	90.3±12.8	10.1±2.3		78.3±11.4	370.9±17.3
OSLB-1								**75.39±3.8**		**367.9±13.6**
OSLC-3	0.22	0.53	0.0292	2.75	205.48±20.5	60.9±12.7	10.1±2.3		55.6±11.2	332.2±17.1
OSLC-3								**80.38±4.0**		**356.9±13.5**
OSLC-2	0.21	0.50	0.0307	3.02	197.71±19.7	60.0±12.7	10.1±2.3		53.5±11.2	321.4±17.1
OSLC-2								**79.28±4.0**		**347.2±13.5**
OSLC-1	0.28	1.02	0.0403	2.50	194.43±19.4	87.5±12.8	10.1±2.3		87.5±11.6	379.7±17.4
OSLC-1								**84.20±4.2**		**376.3±13.7**

Table Footnotes:

Results shown in bold are our best gamma and total dose rate estimates. They utilize the *in-situ* gamma dose rate rather than the NAA-derived gamma dose rate. μGy/a is 1 x 10^{-6} Grays per year.

[a] U, Th, and K values were determined by NAA on sub-samples derived from the OSL samples prior to chemical treatments.
[b] Water content was calculated as a fraction of dry weight determined from laboratory measurements.
[c] Cosmic dose rate value calculated using a linear accumulation model for an accrual of the sediment above the sample and an overburden density of 2 g/cm^3.
[d] These gamma dose rates were calculated based on use of a gamma spectrometer employed *in-situ*.

Table 2. Wakulla Springs Lodge Optically Stimulated Dating Results (1mm Diameter Aliquots).

Sample	Depth (cm)	Elevation NAVD 88 (m)	D_E (Gy) Central Age Model +/- Standard Error	D_E (Gy) Minimum Age Model +/- Two Sigma	OSL Age (ka) Central Age Model	OSL Age (ka) Minimum Age Model	OSL Age Range (ka) Minimum Age Model
Unit B							
B4	84.9	4.838	5.7 +/- 0.3	4.0 +/- 0.3	15.0 +/- 1.1	10.6 +/- 1.0	9.6 to 11.6
B3	97.3	4.714	6.0 +/- 0.6	5.5 +/- 0.4	14.9 +/- 1.6	13.7 +/- 1.1	12.6 to 14.8
B2	104.1	4.646	8.5 +/- 0.6	5.1 +/- 0.4	24.7 +/- 2.1	14.9 +/- 1.4	13.5 to 16.3
B1	134.7	4.340	14.8 +/- 0.7	9.9 +/- 0.6	40.3 +/- 2.8	27.0 +/- 2.1	24.9 to 29.1
Unit C							
C3	83.5	4.852	7.3 +/- 1.2	5.4 +/- 0.5	20.5 +/- 3.4	15.1 +/- 1.6	13.5 to 16.7
C2	105.3	4.634	7.7 +/- 0.5	5.4 +/- 0.6	22.2 +/- 1.8	15.6 +/- 1.9	13.7 to 17.5
C1	119.9	4.488	11.8 +/- 0.7	6.8 +/- 1.7	31.3 +/- 2.4	18.0 +/- 4.5	13.5 to 22.5

younger units, which we also believe to be the case at Wakulla (Thulman 2012, this volume). For example, at both the Burnt Hammock (8HG887) and Arbuckle Terrace (8PO6091) sites in Avon Park, large aliquot age estimates were consistently a factor of two times larger or older than the single aliquot estimates. This was true for a time range of 300 to 7400 years ago. In addition, in the more deeply-buried levels at the same site, the larger aliquots yielded ages a factor of 3 to 7 times older than single aliquot results over a time range of 6600 to 19,000 years ago. Our results at Wakulla are consistent with upward mixing of grains from older layers, benchmarked primarily on the observation that unless diagnostic artifacts are downwardly mobile, the sediments are much too old (based on the central age model) to host artifacts. The use of the minimum age model to isolate the true burial age may suffer in that it might not be able to remove all the effects of upwardly mobile older grains. As such, the minimum age model may not be as young as the true burial age, but it is the best estimate we can make at present. This is because further analysis of more grains might reveal even a higher proportion of younger grains than found thus far.

In the past several decades, there has been a number of recalculations for the age of the Clovis tool-making tradition, and now it is generally accepted to have begun around 13,000 cal B.P. While there is growing consensus that there was an earlier pre-Clovis occupation in North America, the nature of the assemblage and the dates for that occupation are not yet settled. The Wakulla Springs Lodge excavations go some distance toward providing greater resolution on those questions. The dated Page-Ladson and Sloth Hole sites indicated a pre-Clovis occupation in North Florida and the undated Wakulla Springs Lodge and Half Mile Rise Sink sites became suspected pre-Clovis sites based on the occurrence of Page-Ladson points at both of them. Three of the sites (Page-Ladson, Sloth Hole, and Half Mile Rise Sink) have stone artifacts and *Mammut americanum* (American mastodon) as well as other late Pleistocene faunal remains in associated levels. And three of the sites (Page-Ladson, Sloth Hole, and Wakulla Springs Lodge) have Page-Ladson points.

Before World War II, based on geologic observations before the advent of radiometric dating technology, Clovis (then lumped with Folsom) was originally estimated to be 13,000 years old and younger (Antevs 1936). After the war radiocarbon dating yielded age estimates for Clovis of 11,500 to 11,000 cal B.P. (Haynes 1971) apparently showing the earlier 13,000 cal B.P. age evaluation of Antevs to be too old. However, it soon became apparent that a fundamental assumption of radiocarbon dating, that the amount of ^{14}C has been constant in the earth's atmosphere, was false, a problem that resulted in the development calibration programs (Stuiver and Reimer 1993). With the ability to calibrate radiocarbon age to calendar years, the age of Clovis was reevaluated once more to be 13,500 to 13,000 cal B.P. Yet another problem was recently detected, that of inaccurate age evaluations on Pleistocene and early Holocene animal bone (Stafford et al. 1991) and poor choices of the types of samples selected for dating (Lowe et al. 2001). Because the age of many Clovis sites were based on radiocarbon samples taken from bone and other less desirable samples such as bulk sediments, the age of Clovis sites has been rigorously reevaluated with the oldest Clovis sites, one of which is in Florida, now estimated to be no older than about 13,000 cal B.P. (Waters and Stafford 2007).

There are now three North Florida sites with age evaluations on archaeological components that are 500 to 1,500 calendar years older than Clovis: the Page-Ladson site (ca. 14,400 cal B.P.) (Webb and Dunbar 2006; Dunbar 2006a) and the Sloth Hole site (14,300 cal B.P.) (Hemmings 1999, 2004) in the Aucilla River, determined by calibrated radiocarbon dating, and the results of OSL dating presented here using the most conservative young end of the two sigma error range for the Wakulla Springs Lodge site (ca. 13,500 years ago) age (see Table 2). There may also be a Clovis component at the Wakulla Lodge site that has yet to be positively identified. Though the bulk of the Paleoindian stratigraphy at the site dates no younger than ca. 13,500 years ago, the Clovis-like blade level OSL B3 (Figures 4 and 15) has

Table 3. Wakulla Springs Lodge Optical Luminescence Dating Frequency Distribution Characteristics of 1mm Diameter Aliquots.

Sample	Number of Accepted Aliquots	D_E (Gray) Weighted Mean Central Age Model +/- Standard Error	Overdispersion (%)	D_E (Gray) Minimum Age Model +/- Two Sigma	p-value Minimum Age Model plus or minus 2 sigma	Sigma Minimum Age Model
Unit B						
B4	13/48	5.7 +/- 0.3	19 +/- 4	4.01 +0.2,- .32	0.19 –0.14	0.17
B3	7/48	6.0 +/- 0.6	24 +/- 7	5.53 +0.19, -0.37	0.08 n/a	0.0009
B2	31/48	8.5 +/- 0.6	36 +/- 5	5.1 +0.2, -0.4	0.11 +0.4, -1.2	0.4
B1	30/48	14.8 +/- 0.7	25 +/- 3	9.9 + 0.6, -1.1	0.15 – 1.8	0.3
Unit C						
C3	4/48	7.3 +/- 1.2	33 +/- 12	5.4 +0.3, -0.5	0.5 – 0.9	0.2
C2	18/48	7.7 +/- 0.5	28 +/- 5	5.4 +0.4, -0.6	0.15 – 0.4	0.2
C1	41/48	11.8 +/- 0.7	37 +/- 4	6.8 +1.5, -1.7	0.18 – 1.4	0.4

an OSL age (minimum age model) of 13,700 ± 1100 years ago, which incorporating the uncertainties might be as young as ca. 12,600 years ago, a Clovis culture time, or as old as 14,800 years ago. Therefore, the older levels at Sloth Hole (14,300 cal B.P.) and the younger Clovis levels at Sloth Hole (12,900 cal B.P.) agree with this age range, whereas the Page-Ladson age of 14,400 cal B.P. agrees with the older end of the age range of the Clovis-like blade level.

Three of the sites, Page-Ladson, Sloth Hole, and Wakulla Springs Lodge, have yielded Page-Ladson points. The Page-Ladson point at the Wakulla Springs Lodge site came from the 1994 Calvin Jones excavations at a level similar to that of the endscraper found in Unit C that was determined to have a minimum age of 13,700 years ago. The OSL assay taken below the endscraper has a younger minimum age due to its large 4500 years ago uncertainty. In addition, although not radiometrically dated, the Half Mile Rise Sink site (8TA98) in the Aucilla River also has Page-Ladson type points (recently donated by the late Don Serbousek).

Clovis points are primarily flaked by percussion flaking that includes both fluting and overshot flaking. The lateral edges of Clovis points do have pressure flaking, but pressure flaking does not play a part as a primary means of preform reduction and thinning (Bradley et al. 2010). In fact, Ken Tankersley (1994) has shown that Clovis technology was less effective in its ability to thin certain types of tough, percussion-resistant rock compared to the technological achievements made by subsequent Folsom and Goshen knappers in the western United States who employed pressure flaking as a more effective means of thinning biface hunting weapons. With this in mind, Simpson points, although not overshot flaked or fluted, employ three-fourth shot percussion flaking as a primary means of reduction and thinning to achieve remarkable width to thickness ratios of up to 22:1 (Dunbar and Hemmings 2000). Page-Ladson points, the specimens made on thin flakes, often have a flute-like scar on one side of their base because the flake blank was left unknapped. In other words, the flute-like feature represents an unflaked segment of the original flake preform's surface. Other Page-Ladson points are reduced from thicker biface blanks and are not fluted but often show overshot flakes as a means of thinning (Dunbar 2006a). These traits suggest that the "types", Simpson and Page-Ladson, have a likelihood of not only being pre-Clovis, but also Clovis'ancestor.

From these cumulative findings, although not absolute, it appears the pre-Clovis toolkit differed from Clovis in its biface knife (Simpson) and projectile point (Page-Ladson) assemblage. However, it may show some direct affinity to Clovis if the large, percussion-struck uniface blade tool found in Unit B at Wakulla is related to the Simpson toolkit.

The predominance of percussion flaking as a means of biface reduction is also Clovis-like, yet enough traits differ so that whatever the Simpson/Page-Ladson technology is, it is not Clovis. With three sites in North Florida (Wakulla Springs Lodge, Page-Ladson, and Half Mile Rise Sink) sharing this artifact assemblage as well as three sites (Wakulla Springs Lodge, Page-Ladson, and Sloth Hole) sharing dated artifact levels having a time continuum older than Clovis, our conclusion here is that pre-Clovis in Florida is very nearly confirmed. This is based, however, on the hypothesis that Clovis age is really no older than about 13,000 years ago (Waters and Stafford 2007). Additional sites or reinvestigation of the ones we already know about promise to make this determination.

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