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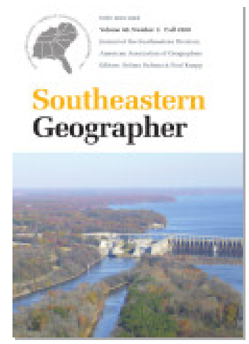

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The Potential of Organic Sediments in Florida Spring Runs as Records of Environmental Change

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HIGHLIGHTS:

- Many Florida spring runs contain thick sequences of organic-rich sediments
- These sediments contain an archive of paleoenvironmental information spanning thousands of years
- Some Florida springs began to flow before mid-Holocene stabilization of sea level

Abstract: The origin of modern spring flow in Florida is generally presumed to correspond with sea-level stabilization at or near present levels during the Middle Holocene. Low sea level and associated karstic aquifer drawdown have been assumed to have prevented artesian flow in current Florida spring systems throughout the Terminal Pleistocene. However, little paleoenvironmental work has been undertaken to test these assumptions. Substantial ecological changes within many of Florida's spring runs over the past two decades have raised interest in the use of sediment core analyses to characterize the nature, extent, timing, and potential triggers of these changes. We evaluated the extent and age of organic material accumulation in a broad sample of fifteen spring runs in central Florida. Radiocarbon dating of sediment cores indicated that many of these runs have accumulated organic material for thousands of years; five of the fifteen spring runs contain organic material that pre-dates Holocene sea-level stabilization. Therefore, either saturation or inundation of Florida's artesian spring runs was much more geographically and temporally variable than has been previously assumed. It is likely that paleoenvironmental reconstructions of those runs with lengthy sediment records will produce new knowledge about paleoclimate, paleobiology, and more recent ecological change.

KEY WORDS: Quaternary, Radiocarbon, Sediment core, Paleoenvironment, Karst

INTRODUCTION

Dramatic temperature decreases during the last glacial period reduced global sea levels, increasing the geographic extent of continents. These lower sea levels may have led to steeper coastal water table gradients, resulting in lower inland water tables and increased groundwater flow on emerged continental shelves in near-coast locations (Faure et al. 2002). It is traditionally believed that these posited lower inland water tables would have reduced the number and extent of surface water bodies, such as lakes and wetlands (Watts and Hansen 1994). These dry surface conditions would logically lead to a lack of anaerobic deposits that could preserve a record of environmental change before the Holocene in such systems. However, here we demonstrate that some of Florida's karst spring runs contain a well-preserved record of latest Pleistocene and Holocene sedimentation.

The effect of sea-level change on the history of water tables and surface water presence is particularly pertinent to Florida, whose exposed land mass has varied substantially over geologic history (Hine et al. 2017). The Floridan Aquifer is a regional aquifer that occurs within permeable Cenozoic carbonates underlying much of the southeastern US coastal plain, including all of peninsular Florida. Dissolution of the carbonates from precipitation has favored development of karst features at or near the surface, including one of the world's highest concentrations of artesian springs in areas where the potentiometric surface of the groundwater exceeds ground level (Scott et al. 2004). It is well known that the potentiometric surface of the Floridan Aquifer can vary according to several factors, including sea-level change, precipitation variation, and groundwater withdrawal, all of which would result in a change in the hydraulic gradient. It is generally believed that propensity of groundwater to flow out through artesian springs would be reduced in karstic near-coastal areas, such as the Florida peninsula, during low sea-level stands (Hine et al. 2017). Accordingly, few previous studies have evaluated organic deposits within karst river systems or considered their potential for extensive paleorecords before Holocene sea-level stabilization. Instead, most paleoenvironmental work within the Florida peninsula has focused on a few sinkhole lakes of sufficient depth to have maintained contact with lowered water tables during the most recent Pleistocene glacial maximum (e.g., Grimm et al. 1993, Watts and Hansen 1994, Quillen et al. 2013, Perrotti 2018).

Thulman (2009) suggested that during times of lower water level (from both low precipitation and sea level), surface water resources in Florida's karst geology would have been tied to locations where the Floridan Aquifer system communicated with the surface readily, including parts of the St. Johns, Suwannee, Santa Fe, Aucilla, and Chipola river systems. Although it is likely that surface water resources would have been scarcer under these conditions, there has been speculation that some current-day springs might have functioned as "water-holes," supporting Pleistocene fauna and Paleoindians, particularly in coastal areas like Florida (Neil 1964). Paleoindian-age artifacts have been found concentrated near aquatic resources in Florida, largely related to spring systems, suggesting that human activity was abundant around these "oases" (Dunbar and Waller 1983, Faught 2019), and that wet sites did exist along spring runs. The co-occurrence of early artifacts and megafauna has made Florida a primary location for the study of the initial peopling of the Americas. However, little well-dated research has focused on sediment records from Florida spring-fed systems and most of this research was conducted in the Aucilla River system, where a record of deposition spanning over 10,000 years has been described (Webb 2006). Indeed, Dunbar (2012, p. 99) stated that karst river channel-fill deposits have high potential for providing multi-proxy data, but that except for sites in the Aucilla River, these records are "virtually untapped."

There is potential for locating sites along Florida's spring runs that have preserved a paleoecological history since the distribution of Paleoindian artifacts along spring systems suggests that wet spring runs existed during the Terminal Pleistocene (Dunbar and Waller 1983, Faught 2019). This is true regardless of whether the springs were actually flowing. However, a first step requires identification of specific locations where this type of record was likely to be preserved for detailed core work. Many paleoecological sites are found in saturated or inundated environments, which promote anaerobic conditions that preserve organic matter, thus providing a foundation for analysis of paleoenvironmental proxies and of organic material that can be radiocarbon dated (Jacobson and Bradshaw 1981). Therefore, the best candidate sites for this type of analysis in Florida's spring runs will contain thick, organic-rich sediments that record many years of deposition.

The primary objective of this study was to establish the age and thickness of organic sediment accumulation in a sample of fifteen spring runs in the Florida peninsula and to evaluate the potential of spring run sediments as paleoenvironmental proxies. We measured organic accumulation within each of these spring runs and obtained twenty-three radiocarbon dates on both bulk organic sediments and on plant macrofossils, making this study unique in the number of spring runs sampled and dated in a uniform manner. We show that at least some of Florida's spring runs contain thick sequences of organic-rich sediments that were deposited over thousands of years. We also show that the potential for preservation of a paleoenvironmental record in spring runs is high, and that several of the spring runs contain deposits pre-dating the Pleistocene/Holocene transition. Additional study of sediment records in Florida springs could help address questions related to paleoclimatic changes, historical ecological shifts in aquatic systems, variability in the initial timing of spring flow, and perhaps mechanisms controlling initial artesian flow.

METHODS

We visited fifteen different springs over the course of 2018 and 2019 and probed each spring run up to 300 m downstream from its headspring (Figure 1). Detailed descriptive information for these springs and many other Florida springs is available in Scott et al. (2004). Depending upon the morphology and emergent vegetation at the spring, we established one or two 30 to 50 m transects along each spring run. On each transect, we took thirty samples at even intervals using an Eijkelkamp 2 cm diameter, half-spoon gouge auger probe with extension rods. From these transects, we identified the deepest organic deposits along each spring run and we selected three locations for further coring, with preference given to separate locations with the deepest organic accumulation. Once we identified the three locations with the deepest organic accumulation with probe samples, we removed three core samples using an Eijkelkamp 4 to 6 cm diameter half-spoon auger or piston corer depending on sediment characteristics. We collected these cores to maximum penetration depth of our coring equipment given sediment

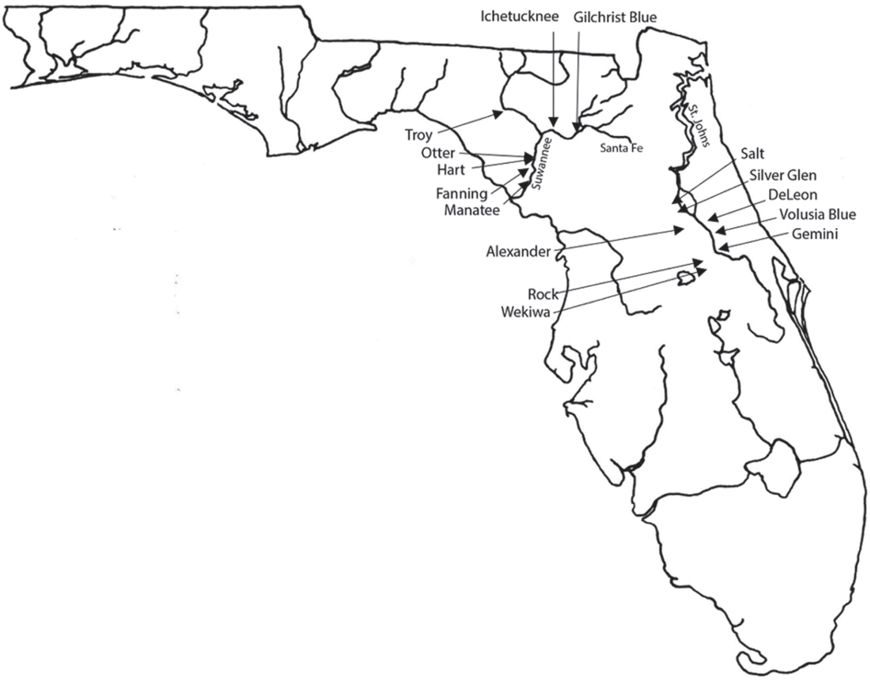

Figure 1. Map of Florida showing the location of the fifteen spring runs sampled in this study.

characteristics (refusal) and then collected sub-samples of 8 cm length from the core top, mid section, and core bottom for further analysis.

Approximately 10 cm^3 portions of each sub-sample were air dried at 65°C to a constant weight in a gravity convection oven and were then powdered and split for further analysis. Half of the split fraction was further processed for loss on ignition (LOI) of organic matter through combustion at 550°C for two hours using a muffle furnace. LOI was calculated based on the percent mass loss after combustion. Measurement of carbonate content through combustion at higher temperatures (e.g., 1000°C; see Dean 1974) was not attempted. The other half of the split fraction was sent to the University of Tennessee's Department of Earth and Planetary Sciences Stable Isotope Laboratory for analysis of bulk organic carbon (C), nitrogen (N) and stable carbon isotope composition ($\delta^{13}C$) using a Costech Elemental Analyzer (Costech Analytical Technologies Inc., Valencia, CA, USA) coupled to a Thermo-Finnigan Delta+ XL Mass Spectrometer (Thermo Finnigan LLC, San Jose, CA, USA). Samples were acidified using 1.2 N HCl prior to analysis in order to remove carbonates. Isotope ratios are reported in delta notation (‰) relative to the Vienna Pee Dee Belemnite (VPDB) standard.

One core from each site was selected for radiocarbon dating based on a combination of maximum core depth and high LOI. Basal samples from these cores were dried as described previously and sent to International Chemical Analysis (Miami, FL, USA) for Accelerator Mass Spectrometry (AMS) radiocarbon dating of bulk organics. Radiocarbon analysis was performed following standard procedures for organic sediments and calibrations were calculated using CALIB Rev. 7.1.0 and the IntCal13 calibration database (Reimer et al. 2013). These standard procedures included examination of the samples and manual removal of contaminants like rootlets during the physical pretreatment. Additionally, samples underwent Acid–Alkali–Acid pretreatment, which included acid (HCl) treatment to remove acid soluble compounds and secondary carbonates, as well as a base (NaOH) treatment to remove humic acids, and a final acid treatment (HCl) to eliminate atmospheric CO_2. For dated bulk organic sediments, $\delta^{13}C$ values are also presented (Table 1) for the other portion of the sediment fraction that was sent to the

Table 1. Radiocarbon data for the fifteen spring run sites. Core B at Hart Spring and Core B at Otter Spring were each collected subsequent to the analyses of Core A from each site. Core B from Wekiwa Spring represents a separate coring location from Core A. Core B represented archived material, which had been stored frozen; it was dated after it was discovered that the material from Core A was older than expected (the Core B dates confirm the antiquity of the site). ICA-19O/0205 was the initial date obtained from Gilchrist Blue Spring. ICA-19O/0549 was from an archived sample of the same sediment sample, but plant fragments were dated instead of bulk organics. ICA-19O/0546 represents the archived, middle section of the same core. In the dated material column, "Org." represents bulk organic sediment. No $\delta^{13}C$ values were obtained for plant macrofossils.

Spring	Core	Sample Depth (cm)	Conventional radiocarbon age (yr BP)	$\delta^{13}C$ (‰)	Calibrated 2σ range (cal yr BP)	Dated material - Laboratory # (ICA-)
Rock	A	30–38	Modern	−26.1	NA	Org.-18P/0618
Troy	A	50–58	Modern	−28.5	NA	Org.-18P/0621
Volusia Blue	A	80–88	250 ± 30	−27.2	0–428	Org.-18P/0619
Alexander	A	42–50	1,530 ± 30	−27.0	1,352–1,522	Org.-18P/0205
Silver Glen	A	102–110	1,600 ± 30	−27.4	1,412–1,550	Org.-18P/0203
Gemini	A	36–44	2,250 ± 30	−27.7	2,156–2,343	Org.-18P/0616
Fanning	A	84–92	2,330 ± 30	−31.0	2,212–2,432	Org.-18P/0623
Hart	A	144–152	3,360 ± 30	−29.4	3,495–3,691	Org.-18P/0617
	B	70	710 ± 40	NA	562–726	Twigs and leaves-18P/0544
	B	137–138.5	800 ± 40	NA	673–784	Leaves-18P/0545
Otter	A	90–98	4,120 ± 30	−29.1	4,528–4,815	Org.-18P/0615
	B	80	3,290 ± 40	NA	3,407–3,613	Twigs-18P/0547
	B	157–159	3,940 ± 40	NA	4,248–4,516	Twigs and leaves-18P/0543
Manatee	A	166–174	4,130 ± 30	−21.7	4,532–4,820	Org.-18P/0620
DeLeon	A	94–102	5,820 ± 30	−20.8	6,536–6,727	Org.-18P/0623
Salt	A	146–154	7,990 ± 30	−28.3	8,725–8,998	Org.-18P/0204
Ichetucknee	A	76–84	11,240 ± 40	−31.7	13,040–13,185	Org.-18P/0207
Gilchrist Blue	A	67–75	11,590 ± 60	NA	13,298–13,550	Twigs-18P/0546
		134–142	13,070 ± 40	NA	15,369–15,904	Plant fragments-18P/0549
			13,500 ± 40	−24.3	16,068–16,455	Org.-18P/0206
Wekiwa	A	232–240	15,370 ± 40	−29.2	18,534–18,760	Org.-18P/0202
	B	146–154	10,020 ± 50	NA	11,292–11,757	Twigs and leaves-18P/0542
	B	277–285	12,730 ± 60	NA	14,908–15,362	Seeds and twigs-18P/0548

University of Tennessee for stable isotope analysis (see above). Upon receipt of the first set of dates, we chose to resample two of our archived samples, those for Wekiwa and Gilchrist Blue springs, based on the initial Late Pleistocene radiocarbon ages determined for the initial samples. For these samples, care was taken to select individual plant macrofossils (e.g., small woody twigs and leaf fragments) before sending the samples for AMS radiocarbon age determination.

Macrofossils were selected that likely had a terrestrial origin, and which would likely not survive significant transport, with the intent of avoiding any potential freshwater reservoir effect where old carbon derived from carbonate weathering in the aquifer becomes incorporated into aquatic plants that at least partly fix older, dissolved carbon directly from the water column (Philippsen 2013). These samples were analyzed by International Chemical Analysis as described above. In addition, Hart and Otter springs were revisited in 2019 based on ease of access and landowner permission and an additional core was collected from each site. Two AMS radiocarbon age determinations were obtained for each core using the methods described above on plant macrofossils isolated in our lab.

RESULTS AND DISCUSSION

Calibrated 2σ median basal radiocarbon ages ranged from > 18,500 cal yr BP (calibrated years before present; present = 1950 by convention) to modern for the fifteen spring systems sampled (Table 1), and only three of the spring runs sampled returned an age under 1,000 cal yr BP. For three of the spring runs (Wekiwa, Gilchrist Blue, and Ichetucknee), the basal ages pre-dated the Pleistocene/Holocene transition. Surface water is thought to have been available along some portions of the Santa Fe during the latest Pleistocene (Thulman 2009), with associated Paleoindian artifacts supporting this assertion (Faught 2019). However, no clear Paleoindian site is known from the Wekiva River (the Wekiva River is just downstream from Wekiwa Spring and its spring run), although bones of extinct megafauna have been found (Wiseman 1993). Thus, it was surprising to find Late Pleistocene ages for the Wekiwa deposits. The second set of radiocarbon age determinations, which were performed on plant macrofossils from both Wekiwa and Gilchrist Blue springs, were comparable to the first set (Table 1). The second dated core from Wekiwa (Core B) was younger (still Late Pleistocene), but that core was taken 42 m further along the transect than the first, so it is not surprising that the age determinations were slightly different, given that the two cores were removed from different locations. The age for the second Gilchrist Blue sample (Core B) was almost identical to the first; this result was expected given that it was collected from the same subsample, which had been archived (the only difference was that plant macrofossils were dated instead of bulk organics).

We sampled at limited areas along the spring runs and the possibility remains that some of the spring runs that we sampled contain older material elsewhere. For example, our basal age of 1,477 cal yr BP at Silver Glen Spring (Table 1) is much younger than that associated with an archaeological investigation elsewhere in the spring run, where an age of ca 8,500 cal yr BP was measured (O'Donoughue 2017). Five of the spring runs (Wekiwa, Gilchrist Blue, Ichetucknee, Salt, and DeLeon springs) returned radiocarbon ages pre-dating the mid-Holocene stabilization of sea level, which occurred around 6,000 cal yr BP in Florida (Donoghue 2011). Water tables may have begun to approach modern levels a few thousand years before stabilization of sea level, given that many lakes in Florida began to rehydrate by ~9,500 cal yr BP (Watts 1980). Our data suggest a complicated water table history driving the hydrology of Florida's springs.

Age determinations should be viewed with caution. Some of the radiocarbon age determinations we obtained must be viewed in the context of a potential freshwater reservoir effect, whereby inorganic carbon derived from carbonate aquifer weathering is incorporated into the organic sediment sources during their lifecycle. This incorporation of weathered inorganic carbon can lead to older than expected age determinations, up to ~2000 years, due to the radioisotope-depleted original Carbon-14 source (see Philippsen 2013). Thus, the radiocarbon ages determined on organic sediments, denoted as "Org." in Table 1, should be viewed as maximum ages for the sediment horizons dated. For re-dated and newer cores, care was taken to date small plant fragments such as twigs and leaves, derived from a terrestrial source and unlikely to have survived significant remobilization and transport. Those age determinations are not susceptible to freshwater reservoir effects and are much more likely to represent the actual age of deposition.

Almost half of the sites sampled (7 of 15) contained a > 80 cm thickness of sediment with > 10 percent average LOI in core top, middle, and bottom sections, and basal radiocarbon ages > 1,000 cal yr BP (Figure 2). This result suggests that many of Florida's spring runs contain an untapped archive of paleoenvironmental information that can be used to elucidate spring dynamics and ecological changes over thousands of years. In our samples, these organic sediments were often stratified with other types of channel-fill deposits including shell-rich layers, suggesting that substantial ecological changes occurred over time. Little work has been undertaken to expound the paleoenvironmental record that is likely preserved in the spring runs of Florida. The limited, though valuable, work that has been undertaken has focused on relatively few systems including the already mentioned work along the Aucilla River (Webb 2006), which occurred over many years and was quite extensive along that river. More recent work along Silver Spring run has revealed considerable sediment thickness with high levels of organic carbon as well as stratified, organic-rich sediments that extend through much of the Holocene, underlain by Paleoindian artifacts and bones of extinct megafauna (Smith 2019). Many other remains of extinct megafauna and Paleoindian-age artifacts have been found in channel-fill sediments within Florida's karst rivers, some of which are from stratified sites (Dunbar 2016 provided a thorough review). Unfortunately, the vast majority of these finds lack radiometric ages associated with detailed paleoenvironmental reconstruction.

At Wekiwa, Gilchrist Blue, and Salt springs, the Late Pleistocene/Early Holocene radiocarbon ages and thick, organic-rich accumulation suggest that these spring runs were wet, at least periodically, during that time. The preservation of abundant organic material suggests deposition and burial under anaerobic conditions well before the mid-Holocene stabilization of sea level (Table 1, Figure 2). This result highlights the possibility that some Florida springs may have been active, at least intermittently, during this time. The areas where the Floridan Aquifer emerged from the dry karst landscape of the

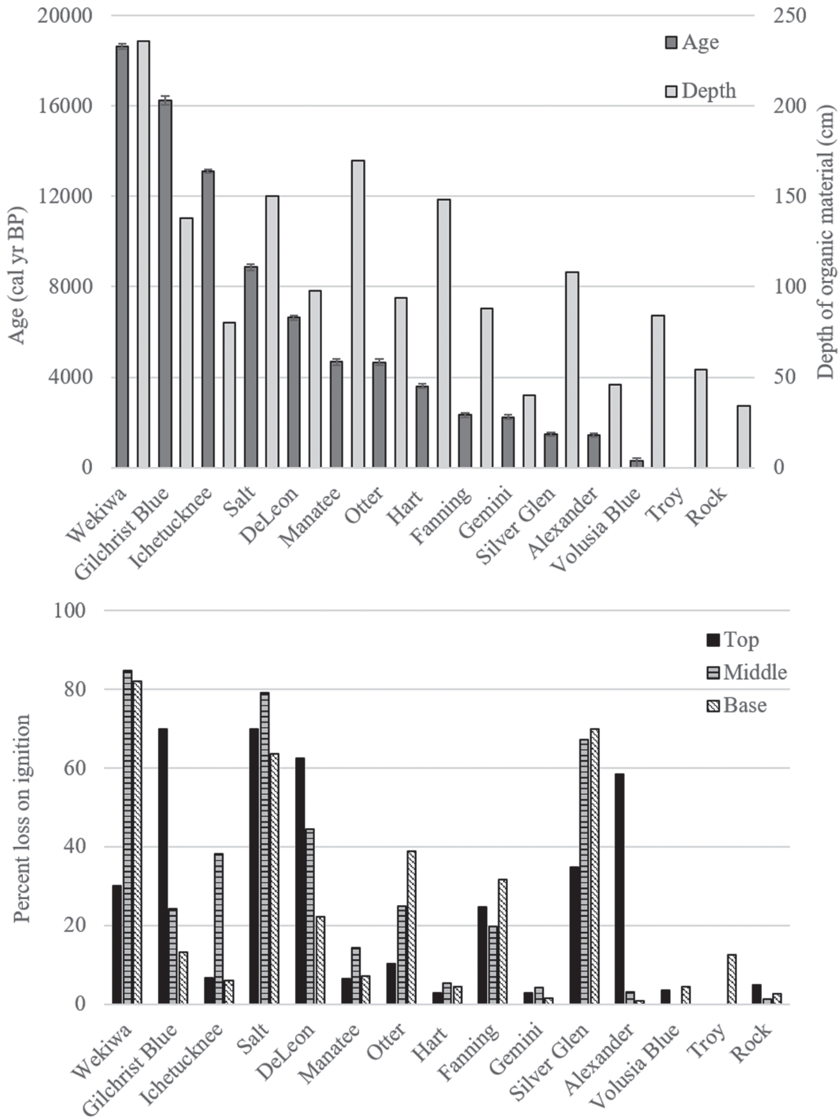

Figure 2. Maximum age and organic matter depth (top) and percent loss on ignition for the deepest core (bottom) for each of the fifteen springs sampled in this study.

Late Pleistocene and Early Holocene may have been represented only as still water oases, where rivers did not flow and contained water only in limited areas (Thulman 2009). Further analysis is required to determine whether pre-Holocene spring flow occurred, or whether organics accumulated in anaerobic, stagnant, wet depressions, which later became spring runs, or perhaps were previously spring runs (which would, in and of itself, indicate pre-Holocene spring flow).

One study suggested that noble-gas recharge temperature data indicate that water tables were not lower during the last glacial period, despite the lower sea levels, but that groundwater flow rates were higher, thus allowing the possibility of flowing springs (Morrissey et al. 2010). A paleoflow record constructed by Aucilla River researchers using the excellent stratigraphic sequence preserved at the Page-Ladson site supports the hypothesis of at least limited Late Pleistocene river flow in Florida (Dunbar 2006). That record spans from 23,500 to 10,000 cal yr BP. The site remained continuously wet over the entire time period, but river flow was indicated only intermittently, from ~18,800 to 18,000 cal yr BP, from ~14,300 to 13,700 cal yr BP (with two brief hiatuses), and then from ~11,400 to the end of the record at ~9,800 cal yr BP. Initial radiocarbon data from Wakulla Spring also support river flow there from ~12,500 to 13,500 cal yr BP, given that three radiocarbon dates are associated with channel-fill deposits that include gastropod species requiring aquatic vegetation (Hemmings and Dunbar 2019). It should be noted that these three radiocarbon ages were obtained on bulk sediments and thus should be considered maximum ages given the potential for a freshwater reservoir effect, as discussed above for our bulk dates.

Data from Salt Spring run related to an archaeological investigation suggests spring flow there beginning around 9,350 cal yr BP (O'Donoughue 2011), in line with our age determination for that spring run (Table 1). In fact, O'Donoughue (2017) used data from Salt and Silver Glen springs in combination with GIS data of potentiometric surface elevations of the Floridan Aquifer in the St. Johns area to suggest that onset of artesian spring flow would be variable, and that it would begin to occur well before Holocene stabilization of sea level. That GIS model suggests the possibility that Wekiwa Spring began to flow quite early given a high potentiometric surface in that area, and our data from Wekiwa Spring run strongly support that assertion. Our data suggest that a complete paleoenvironmental record spanning the past ~20,000 years could be produced by detailed investigation of multiple spring runs in close proximity (e.g., Wekiwa, Salt, DeLeon, and Silver Glen springs, Figure 2), allowing questions of the timing of artesian flow in Florida's aquifers to be resolved over a more widespread geographic area, something that was also recognized by O'Donoughue (2017).

The potential for multiproxy work in spring runs is high. Of course, one difficulty in using spring run sediments as a paleoenvironmental archive is the possibility of erosion of portions of the sediment record during spring flow. However, unconformities exist in many of the environments where paleoenvironmental proxies are employed, and the potential for missing time in a spring sediment record should not be cause for ignoring the portion of the record that does exist. Also, additional paleoenvironmental information can potentially be obtained by constraining the timing of erosional events. Even macroscopic examination of our sediment cores revealed the preservation of obvious environmental changes recorded by the presence and abundance of gastropods (Figure 3). Sediment grain-size analysis also would likely allow for interpretation of past spring run dynamics. These types of analyses have been useful at the Ryan-Harley site in the Wacissa River (Balsillie et al. 2005). Pollen, plant macrofossils, and diatom abundance analyses

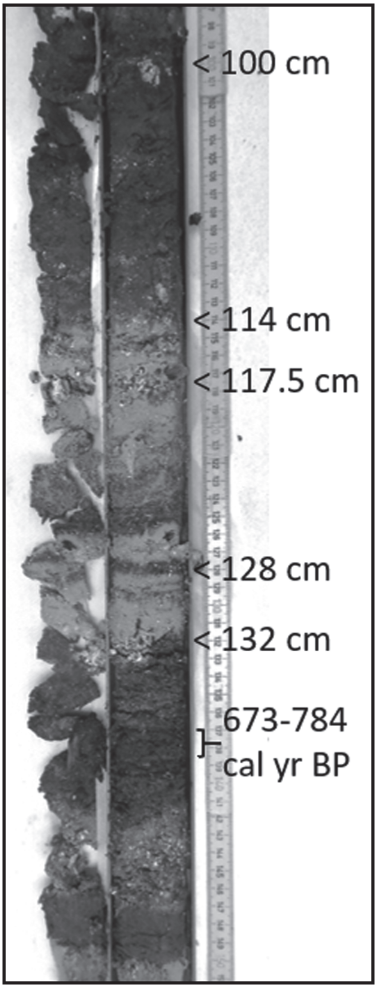

Figure 3. Piston core section recovered from Hart Spring run. The ruler shows depth below the sediment surface, starting at 97 cm below surface and ending at 151 cm. Layers of leaf litter (e.g., at 128 cm) occur in both the organic layers and the mineral-rich section between 114 and 132 cm. Abundant freshwater gastropod shell fragments (e.g., at 117.5 cm) and complete shells (e.g., at 100 cm) also occur in layers.

have been applied in karst settings in Florida (e.g., Webb 2006, Quillen et al. 2013) and should be employed in future analyses of Florida spring runs. Temporal changes in algal abundance have been inferred from organic C to N ratios along with their stable isotope abundances and organic pigments in Florida lakes and karst settings (e.g., Brenner et al. 1999, Waters 2016, Tanner et al. 2018) and these proxies also should be useful in investigating spring run paleoenvironments.

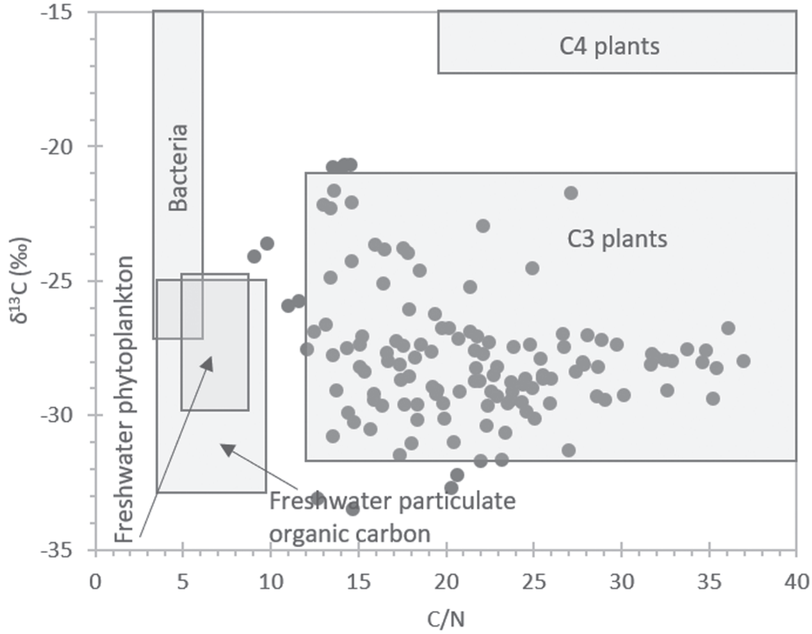

Figure 4. Carbon isotope composition and C/N of organic matter from the three cores collected from each of the fifteen spring runs sampled. Individual data points represent sub-samples collected from each core top, middle, and bottom section (see methods section for sampling strategy). The fields are from Kahn et al. (2015).

Our C/N and $\delta^{13}C$ data collected from core top, middle, and bottom sections from fifteen Florida spring runs reveal substantial variability among springs and suggest contributions from different organic matter sources, but also indicate that much of the organic material that we sampled likely originated from C3 plants (Figure 4). This variability is likely due to environmental changes within the spring runs that could be elucidated with detailed stratigraphic analysis. Terrestrial and aquatic plants, microalgae (attached or floating), and bacteria incorporate differing amounts of C versus N into their organic structures and fractionate C and N isotopes differently; thus, they are useful in paleoenvironmental investigation (Figure 4, Khan et al. 2005). A high-resolution analysis of well-dated cores could be used to infer potential changes at the immediate surface, such as an increase in algal markers, which could be related to recent human activities affecting springs. Analyses that consider multiple environmental proxies are most useful in interpreting ecological change (e.g., Tanner et al. 2015) and should be applied to Florida spring run paleoenvironments to in order to better evaluate current changes. Finally, the potential future effects of climate change on Florida's spring systems are unknown and a detailed, well-dated paleoecological record of past response to Late Pleistocene and Holocene climate changes from multiple spring runs could allow for better prediction of future responses.

CONCLUSIONS

Our work further demonstrates that many of Florida's spring runs have been accumulating organic sediment for thousands of years. Many of the spring runs contained thick, organic-rich sequences stratified with other types of channel-fill deposits. Initial timing of organic sedimentation varied between the spring runs sampled, and spring run sediments have the potential to provide information on spring flow related to variability in water table dynamics and aquifer potentiometric surfaces. These spring run sediments have largely unrealized potential for providing records of paleoenvironmental change from the Late Pleistocene to the present. Care should be taken to date plant macrofossils derived from terrestrial sources, where possible, in order to mitigate potential freshwater reservoir effects. Also, core ages vary depending on where the spring run was sampled, so ideally, exploratory work should occur in multiple locations within spring runs in order to assess variability in sediment depositional history. The application of proxy techniques to elucidate this sediment history will allow for the contextualization of modern changes in spring dynamics, such as the current shift to algal dominance seen in many Florida springs. We encourage the further development of this mostly untapped archive of information.

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