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Characterizing Organic Matter Accumulation in Freshwater Coastal Plain Wetlands

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Summary

The goal of this project is to assess the rates and characteristics of organic matter that has accumulated in freshwater wetlands across parts of the Atlantic Coastal Plain. Through the examination of multiple sites, I plan to compare and contrast rates of organic carbon accumulation, sources of organic matter, and the paleoenvironmental influences on characteristics of their accumulation. Two wetland areas in eastern Virginia have been targeted as originally planned: the Grafton Ponds Complex and Great Dismal Swamp, and progress has been made to recover samples from these sites and begin a detailed evaluation. This year, I was also able to acquire samples from the Cypress Swamp Formation, a sequence in southern Delaware on the Delmarva Peninsula, that represents a period of late Pleistocene accumulation and which will provide an even broader range of settings to compare. During the first project year, substantial progress has been made to acquire sediment cores and samples from these sites and begin analysis of organic matter properties and rates of accumulation. From each site, cores have been collected, basic sedimentary analysis has been performed, and bulk organic matter properties determined. Select samples for biomarker analysis have recently been processed, but only to assess concentrations and will be the focus of research efforts in year 2. The results collected to date have all been generated by undergraduate research students that have participated in various stages of this project over the past year. A summary of progress on the evaluation of each site is provided below, as well as a plan for research to be conducted in year 2.

Cypress Swamp Formation: This site is a late Pleistocene sedimentary sequence that has been mapped throughout parts of the Delmarva Peninsula. The Cypress Swamp Formation is of interest because recent geologic mapping has shown it has a substantial geographic extent (Ramsey and Tomlinson, 2014), but little detailed stratigraphic analysis has been performed to assess the timing of the earliest period of deposition where significant wetland sediments have been mapped and likely formed in existing depression on the landscape in paleochannels. Through a collaboration with the Delaware Geological Survey, my students and I were able to help recover two ~9-m long cores through the deposit.

Two of my students worked together to develop stratigraphic, organic matter content, and grain size profiles for both sites (Fig. 1). Radiocarbon dating was also successful and shows a significant period of increased organic matter accumulation from c. 40,000-25,000 years BP, with organic matter percentages from 8-12%. I have plans to continue working on these two cores during year 2, to perform more detailed bulk organic matter content analyses as well as the analysis of molecular biomarkers as proposed.

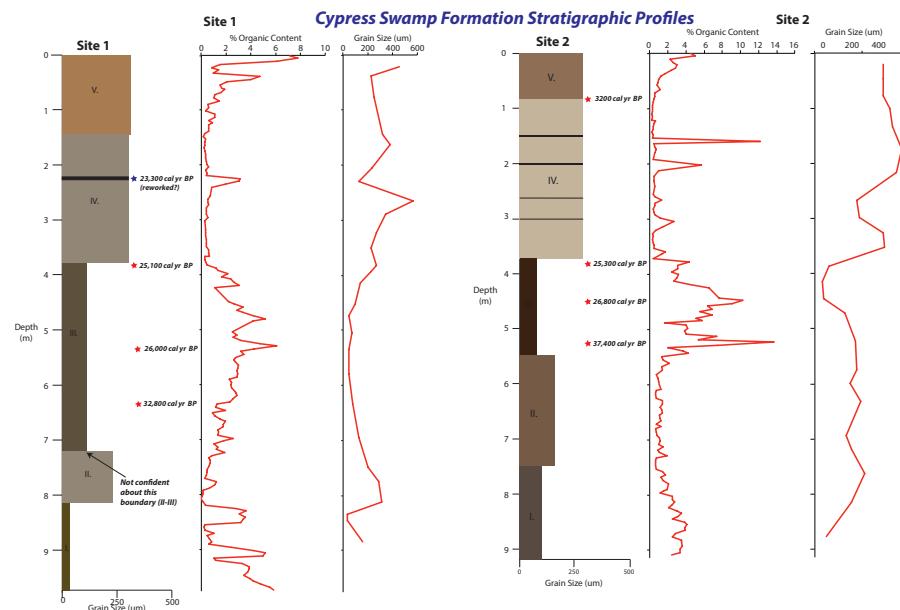


Fig. 1. Select data from cores recovered from the Cypress Swamp Formation on the Delaware Coastal Plain. Significant organic matter accumulation has been identified at both sites in Unit III from c. 40-25 ka.

Grafton Pond Complex:

This site is a 375-acre area

in York County, VA where wetlands have formed during the late Quaternary as a result of dissolution of underlying carbonate-bearing coastal plain sedimentary units. These wetlands are in the form of depression basins that are 1-3 m deep with aerial extents of 100-400 m². My students and I collected several 4 to 5-m long vibra-cores from two of these wetland areas for analysis. The preliminary analysis shows that we recovered the Quaternary wetland

sediments and penetrated into the underlying upper coastal plain sedimentary units. Interesting variations in physical sediment properties, carbon content, and C/N values define several different sedimentary units (Fig. 2). There has been difficulty in establishing a chronology for the onset of late Quaternary sedimentation related to the formation of these two particular depression wetlands because of low organic carbon content and difficulty with radiocarbon analysis. Further work will continue to evaluate the timing of formation and organic matter accumulation, but these preliminary data show that organic matter accumulation at this site is substantially lower than the other two sites.

Great Dismal Swamp:

This site is located in southeastern Virginia and is a wetland that has blanketed a significant portion of the region, ~112,000-acres, since at least the late Pleistocene. Work on samples from the Great Dismal Swamp site have only recently begun. I have samples collected from a core through one of the thickest sections of the deposit and preliminary radiocarbon dating shows that the cores span the last c. 12,000 years. I have plans for two students to begin working on this core during the spring and summer of 2019.

In the next project year, I plan to focus most of my effort on further evaluation of the Cypress Swamp Formation sequences, which preliminary data show to be the most promising of the sites. I also plan to begin the evaluation of the Great Dismal Swamp site. Evaluation of organic matter accumulation in the Grafton Ponds Complex has proven to be difficult and this may be a function of the nature of its formation, which in itself is an interesting result. However, other depression wetland complexes in Virginia have been identified and I will evaluate at least one of them in the next year to determine their overall usefulness for this study.

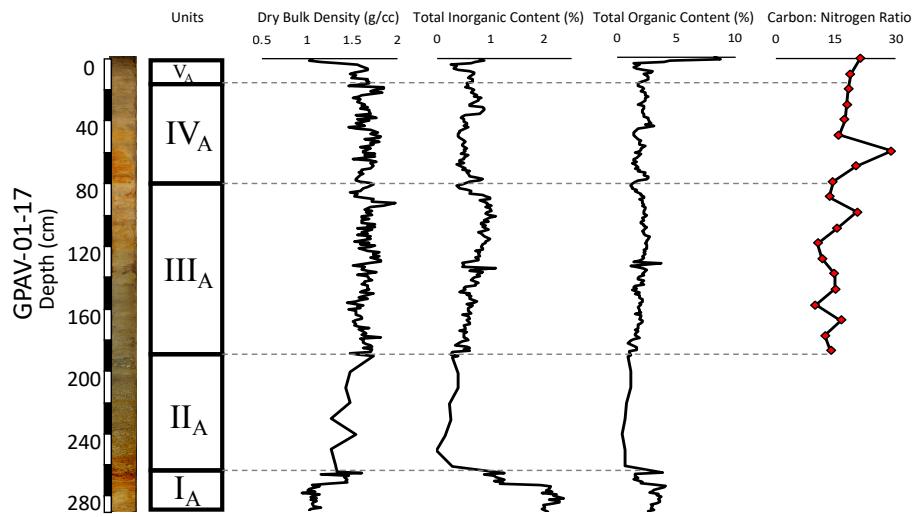


Fig. 2. Select data from a core recovered from the Grafton Ponds Complex showing several stratigraphic units defined by visual changes, physical sediment parameters and organic matter properties. The lowest units represent early Quaternary coastal plain units, and we suspect there is a transition to late Quaternary deposits in Unit IV_A.

Research Impact

The project has helped me initiate a new area of research in the mid-Atlantic region that I would have otherwise not been able to support, and to study fundamental processes regarding various influences on organic matter accumulation in coastal plain environments. As a new assistant professor, this has also allowed me to gain insights into important local research questions, interact with the local scientific community, expand my research program in an undergraduate-only department, and support several students in conducting geoscience research. In the past year, the grant has supported 3 undergraduate student summer research stipends and 1 undergraduate student that volunteered to work as a research student. It also supported several other student to participate in field activities to collect sediment core samples. The project has resulted in one undergraduate senior thesis, the results of which were presented at the Southeastern Regional Geological Society of America Conference in 2018 (Van Hook and Balascio, 2018), and two other senior thesis projects that are currently in progress. The student that was supported through this project last years is now enrolled in a graduate program in geology at Colorado State University.

Publications

Van Hook, J.J., Balascio, N.L. (2018) Late Quaternary evolution of the Grafton Ponds Natural Area Preserve, Yorktown, Virginia. Geological Society of America - Southeastern Section Meeting 2018, Knoxville, TN.