Carbon accumulation in the Lafourche delta lobe: towards understanding the potential of sediment diversions as carbon sinks

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Abstract

A study of two late Holocene sediment cores taken near an abandoned distributary of the Lafourche lobe in the Mississippi Delta aimed to quantify organic carbon (OC) accumulation rates and to establish their relationship with different types of deltaic deposits. Counterintuitively, we found that in several cases deposits with relatively low organic content are more efficient at burying carbon than peat. This has implications for coastal restoration by sediment diversions, showing the considerable potential of these landforms to bury carbon.

I. Introduction

The Mississippi River deltaic margin plays a large role as a carbon sink in the global carbon cycle. Carbon sequestration is the process where carbon dioxide is removed from the atmosphere and held in carbon sinks, sequestering more carbon from the atmosphere than they release. The carbon stored in coastal ecosystems (e.g., salt marshes, mangroves, and seagrasses) is called blue carbon (Nellemann et al., 2009). Blue carbon reservoirs are not well quantified, however, and a quantification of the organic carbon (OC) burial rates in this region may help assess how the carbon sink can be enhanced, through sediment diversion for example (Shields et al., 2017).

This project builds on a previously funded UROP project that constrained OC burial rates using a 40 m core taken near the location of the future Mid-Barataria Sediment Diversion (MBSD) in Myrtle Grove, LA. The work reported on herein aimed to constrain OC burial rates in a crevasse splay and associated deposits from the Lafourche lobe to determine the potential of the MBSD as a carbon sink.

The Lafourche lobe of the Mississippi River Delta, which was active between 600 and 1,600 years ago (Chamberlain et al., 2018) has been well-studied. The main objective here was to determine differences in carbon burial rates for crevasse splay, floodplain, and mouth bar deposits on geologic timescales. We tested the hypothesis that crevasse splay, flood-basin, and mouth bar deposits bury OC at different rates.

II. Methods

i. Core Collection

We revisited two previously drilled core sites (Chamberlain et al., 2020) near a Native American mound along an abandoned distributary (Bayou Grand Caillou) of the Lafourche system at Ellesly, Louisiana. The sites were cored by hand and samples of known volume (5 cm^3) were collected in the field and returned to the laboratory for further processing.

ii. Total Organic Carbon Measurements

The samples were then dried in an oven at a temperature of 50°C for 24 hours, which is hot enough to remove any moisture from the sediment but not hot enough to burn the organic matter present in the sample. Once dried, a mortar and pestle were used to grind the sediment and break it down into its individual grains to ensure that there was no clumping in the sample for the following steps of preparation. A slurry of the sediment and water was then made, and the sediment was run through a 63-micron sieve to prevent anything larger than a very fine sand from making its way into the slurry. The slurry was then drained through another filter with the help of a vacuum pump. The sample was then dried again for 24 hours at 50°C. Once the sediment was completely dried, the sample was weighed and then treated with a 0.1M solution of hydrochloric acid to dissolve any inorganic carbon from the sample. The samples were then rinsed thoroughly with multiple rounds of DI water to neutralize the sediment. The sediment was then dried again at 50°C and a small mass (~10-15 milligrams) of the dried sample was then placed in a tin capsule and weighed. The prepared samples were then analyzed for their carbon concentration (% carbon) at Tulane University's Coordinated Instrumentation Facility using a Fisons EA112 Elemental Analyzer. Each run consisted of duplicate samples, as well as standards and certified reference material to ensure accuracy and precision of the results.

III. Results

The Ellesly cross section is shown in Figs. 1 and 2. Since the age of the deposits was established previously by OSL dating (Chamberlain et al., 2020) we were able to determine accumulation rates in the two sampled cores. Combined with the OC measurements, this allowed us to calculate OC accumulation rates. The results show the highest rates in the mouth bar deposits, even though their OC content is very low. Clearly the accumulation rate which is very high in these sandy units has a strong impact on the result. We also note that the crevasse-splay deposits which are the best analog for the MBSD exhibit values that are not much lower than the flood-basin deposits, although this is less the case in Fig. 2 than in Fig. 1.

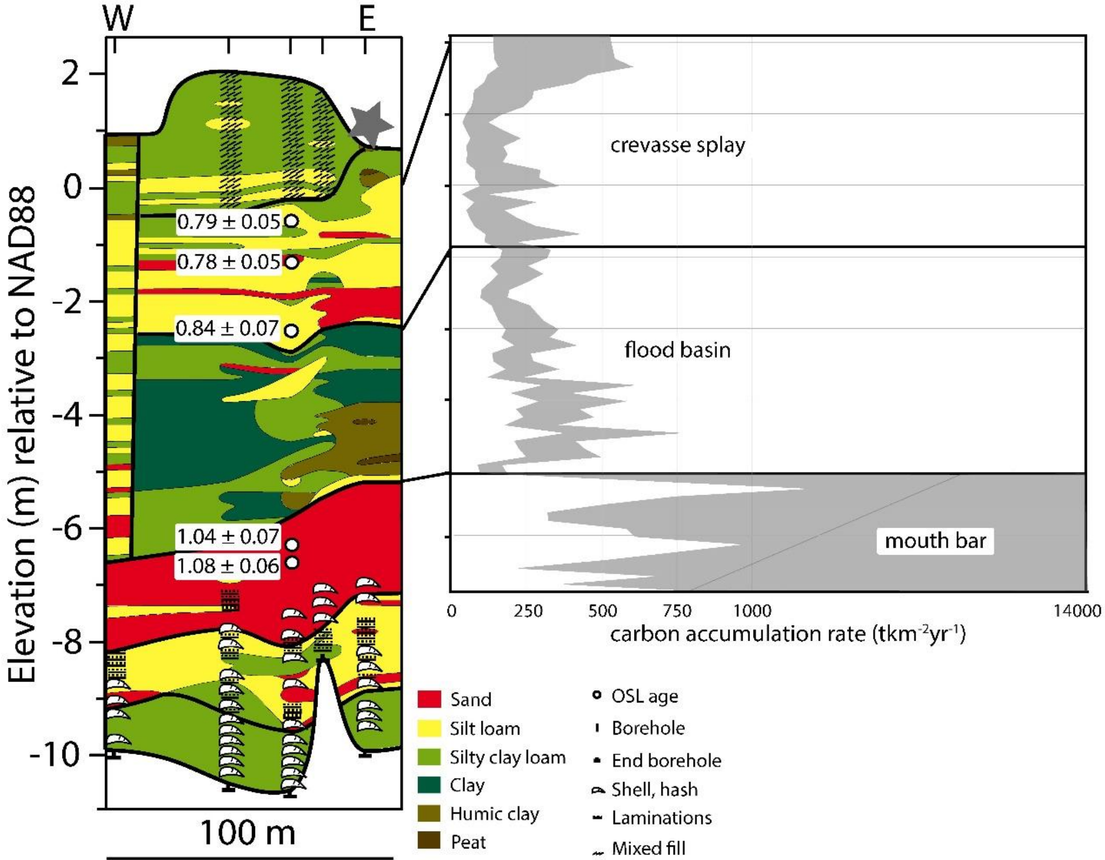

Figure 1: Cross section over and adjacent to a prehistoric mound at Ellesly, Louisiana (after Chamberlain et al., 2020) with a plot of carbon accumulation rates measured from the core taken at the site marked by the star.

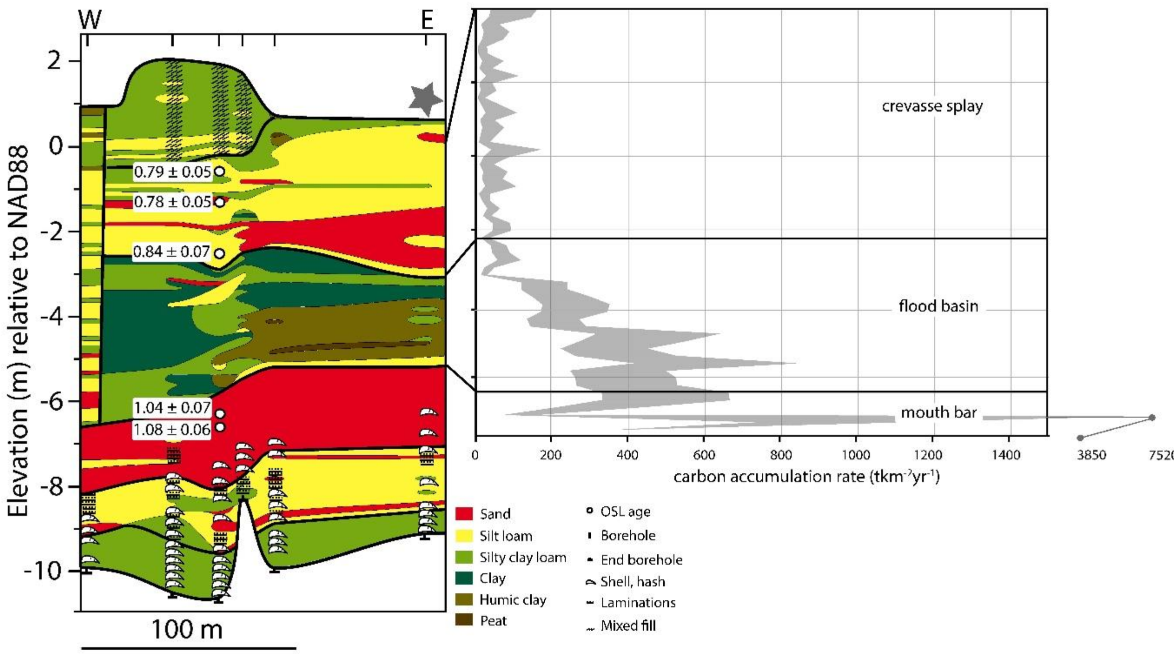

Figure 2: As in Fig. 1, but for a core site slightly farther east.

We examined the relationship between sediment grain size and OC accumulation rate in more detail in Fig. 3. Again, this confirms the counterintuitive finding that relatively sandy deposits with low organic content may be more efficient at burying carbon, even compared to peat. Overall, the results show that OC accumulation rates do not necessarily reflect the organic-matter content of the associated deposits and the potential for burying carbon through sediment diversions is substantial.

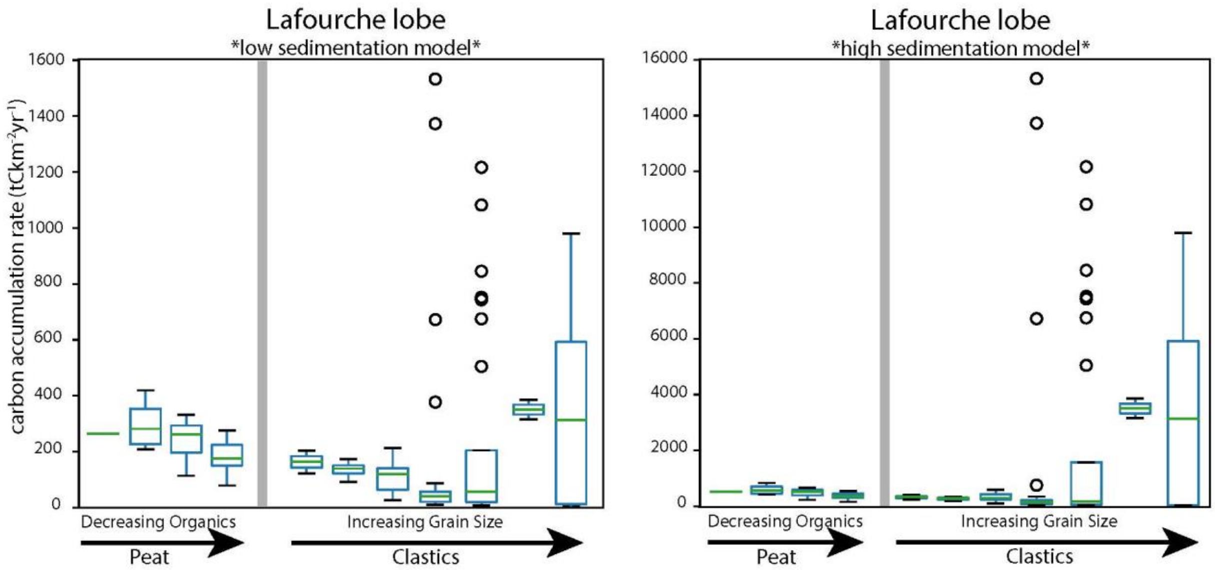

Figure 3: Relationship between organic content of deltaic sediments and carbon accumulation rate.

VI. Works Cited

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