Organic carbon burial and its association with reactive iron in mangrove-salt marsh ecotones

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1) Introduction

- Blue carbon ecosystems (e.g., mangroves, salt marshes, and sea grasses) are importance carbon stocks in coastal ocean[1].
- Mangroves and salt marshes have unequal efficiency in regulating organic carbon (OC) accumulation[2]
    - OC burial efficiency depends on regional conditions such as maturity of the communities
    - Mangroves typically bury higher amount of recalcitrant OC relative to salt marshes (Fig. 1).
    - Black mangroves (*A. germinans*) generally develop larger oxidizing rhizosphere[3] (Fig. 1), which potentially
        1) promote oxidative decomposition of OC
        2) stimulate the formation of reactive iron-OC association (FeR-OC) that facilitates OC preservation.
- Because of global warming, mangrove habitats are expanding poleward, replacing the former salt marsh communities.
    - This global changes raised a question how these vegetation shifts modified coastal wetland carbon storage and FeR-OC formation.

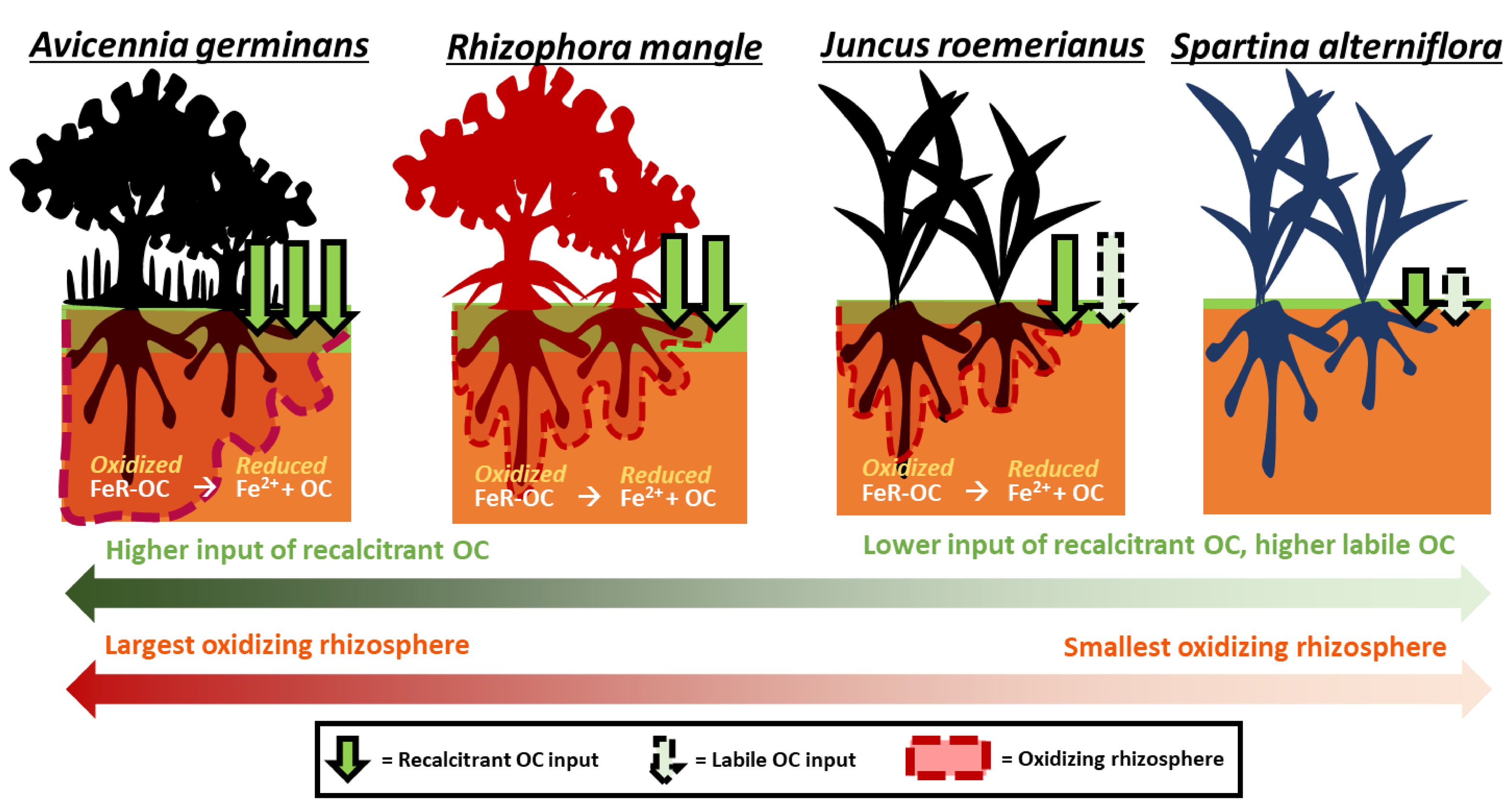


Figure 1. Roles of mangroves and salt marshes in coastal OC cycle

2) Study areas and methods

1) Sediment cores were collected, using PVC push cores, from salt marsh sites recently invaded by *R. mangle* and *A. germinans* at Pilot's Cove (Fig. 2)

2) Determining %TOC, C/N and $\delta^{13}C$ using IR-MS, lignin-derived phenols using GC-MS (CuO oxidation method[5]), and FeR-OC (citrate dithionite bicarbonate reduction[6])

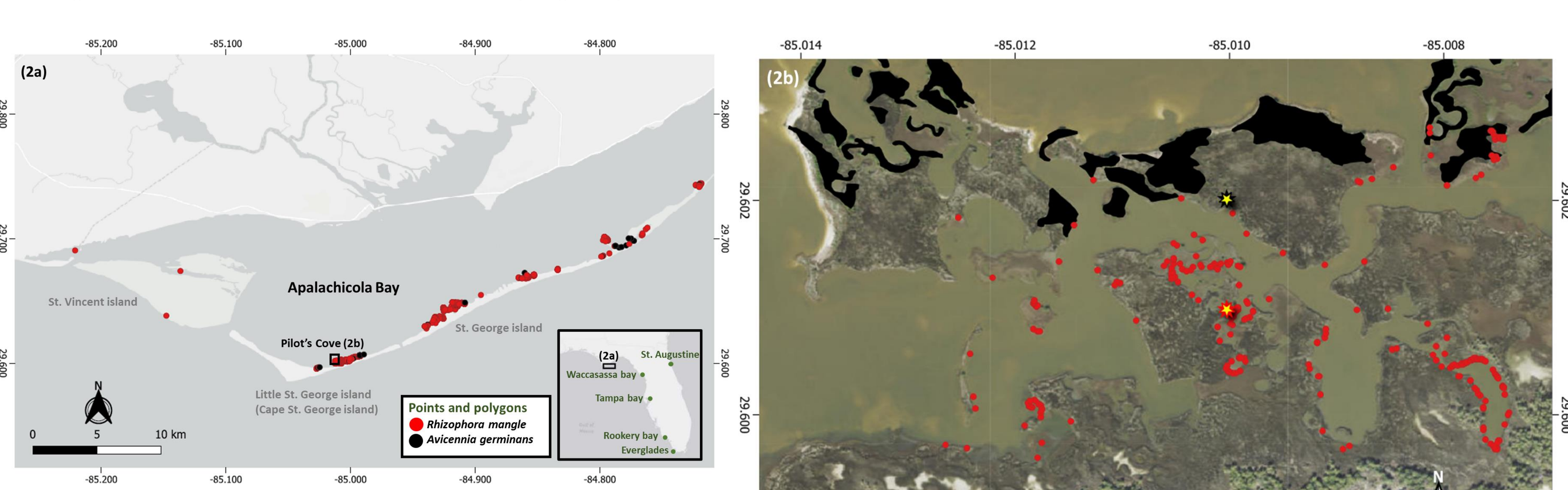


Figure 2. Sampling location, mangrove distribution in Apalachicola bay, and locations of cited Florida OC studies (modified from[4])

3) Hypotheses and objectives

Working Hypothesis:

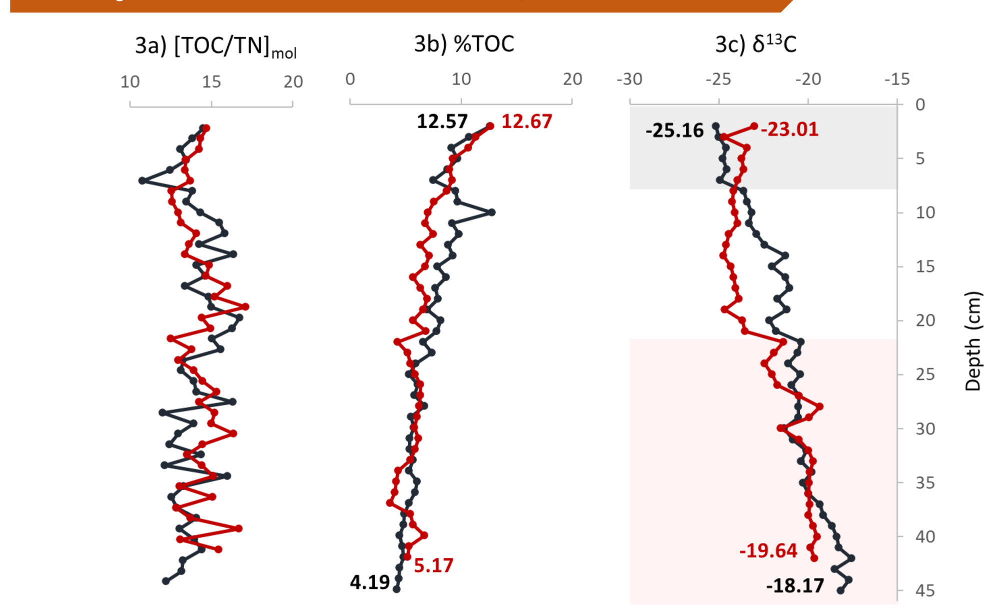
Sedimentary OC burial and stocks will increase after replacement of salt marshes by mangroves, because of 1) higher input of recalcitrant woody OC from mangroves, and 2) higher fraction of stabilized FeR-OC.

Objectives:

1) Determine downcore TOC/TN, $\delta^{13}C$, and concentration of lignin biomarker to identify sources of OC and their decay patterns.
2) Evaluate sedimentary OC burial/stocks, %FeR-OC, and their short- and long-term changes where salt marshes were replaced by mangrove habitats.

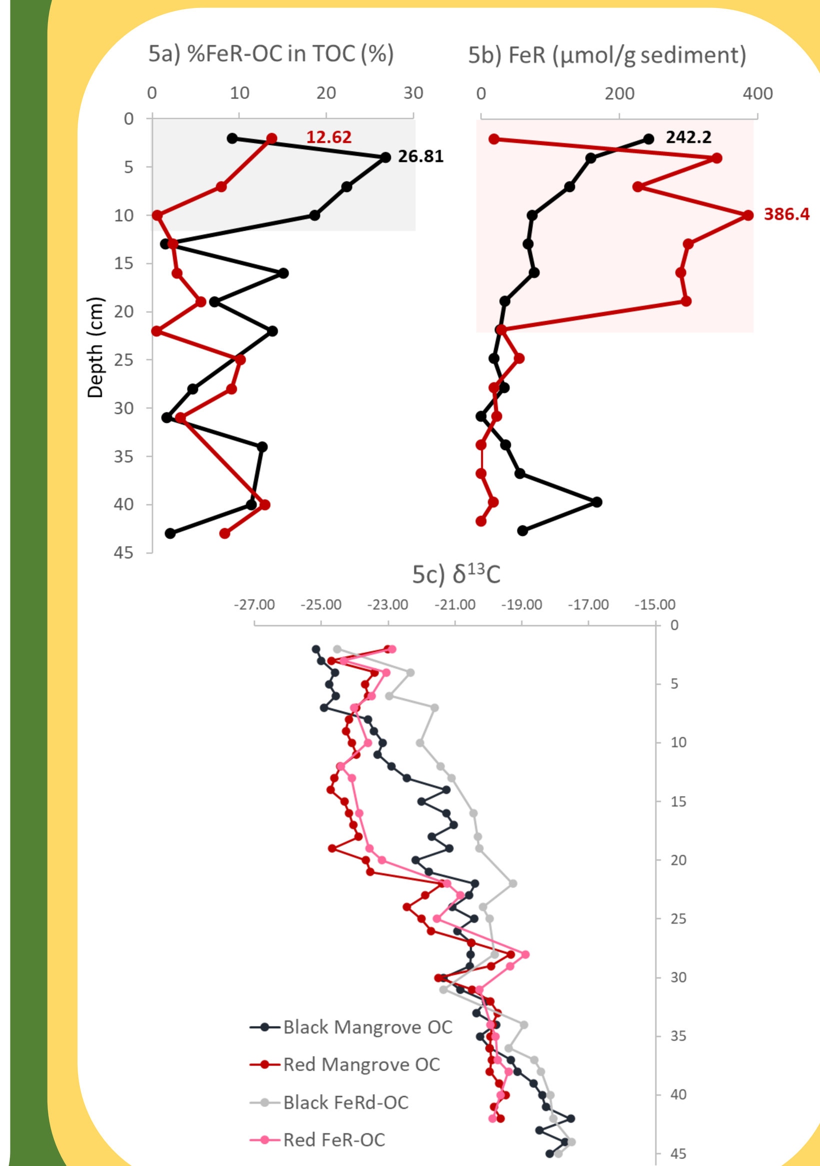
4) Result

4.1) Bulk %TOC, TOC/TN, $\delta^{13}C$



- %TOC decreased with depth = gradual decomposition with depth, or input of recalcitrant OC at surface (Fig. 3b)
    - Our %OC is comparable with Rookery Bay mangroves[7], Tampa Bay mangroves[8], Waccasassa bay salt marshes[9], and St. Augustine transitional sites[9]. However, our %OC is higher than St. Augustine mangrove and salt marsh sites, but lower than Waccasassa bay & Everglade[12] mangroves.
- More depleted $\delta^{13}C$ in shallower part of both cores = replacement of previous C_4 Spartina sp. salt marshes by recent C_3 mangrove communities (Fig. 3c).

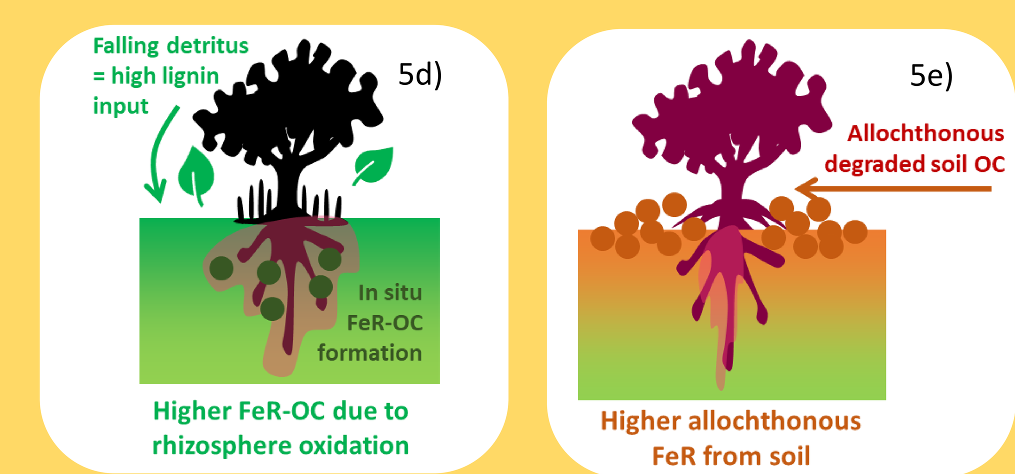
4.3) FeR-OC



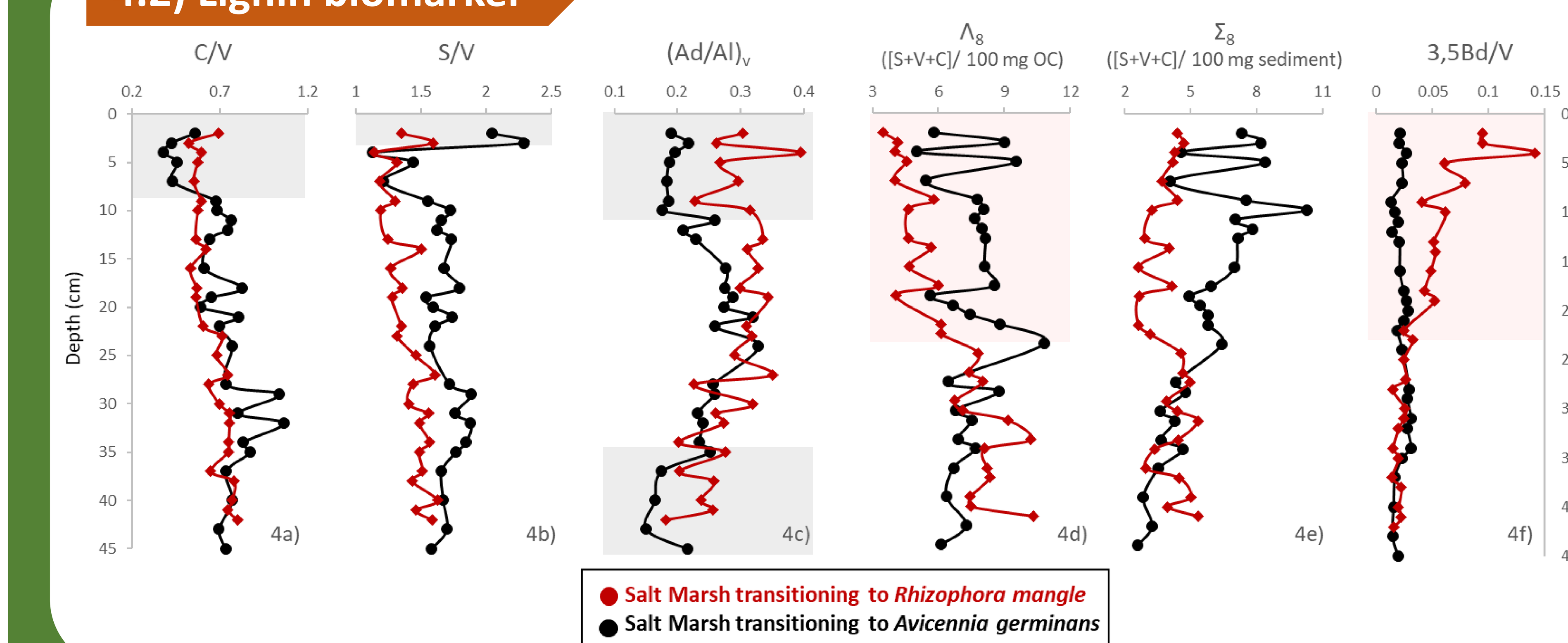
***A. germinans* shallow sediment**
- Higher %FeR-OC (Fig. 5a) but lower FeR (Fig. 5b)
- In situ formation of FeR-OC probably by interaction between newly deposited plant detritus and O_2 from its extensive oxidizing rhizosphere[3] (Fig. 5d)

***R. mangle* shallow sediment**
- Lower %FeR-OC (Fig. 5a) but higher FeR (Fig. 5b)
- Allochthonous input of soil particles that contained FeR but didn't contain FeR-OC (Fig. 5e)

$\delta^{13}C$-FeR-OC (Fig. 5c)
- Preferential retention of $\delta^{13}C$-depleted OC by FeR = selective preservation of terrestrial OC by FeR



4.2) Lignin biomarker



***A. germinans* sediments**
- Decrease in C/V (Fig. 4a) and increase in S/V ratio of lignin-derived phenols ratio in shallower sediments (Fig. 4b) = higher contribution of woody mangroves relative to non-woody angiosperm (salt marshes)[9].
- High [Ad/Al]v at 13-34 cm = intense oxidative decomposition
- Σ_8 is higher in the upper part of the core. This reflects greater input of vascular plant materials into sediments (Fig.4e)

***R. mangle* sediments**
- Σ_8 didn't change with depth while Λ_8 decreased in shallower part of the core (0-23 cm) (Fig. 4d) = less relative contribution of vascular plants as it was diluted by intensive input of allochthonous degraded soil organic carbon evidenced in higher [Ad/Al]v and greater 3,5-dihydroxybenzoic acid (3,5Bd) (Fig. 4f)

5) Preliminary conclusions

1) $\delta^{13}C$ and lignin biomarker indices show higher contributions of mangrove OC in shallower sediments of invaded marsh sites.
2) *R. mangle* habitat might receive OC and FeR from allochthonous sources.
3) *A. germinans* establishment potentially increases OC stock in shallow sediments due to input of recalcitrant OC and development of oxidizing rhizosphere that promotes FeR-OC formation.

References

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