Investigation of Temporal Variation in Sediment Deposition within the Tropical Wouri Estuary Cameroon using Fourier Transform Infrared Spectroscopy

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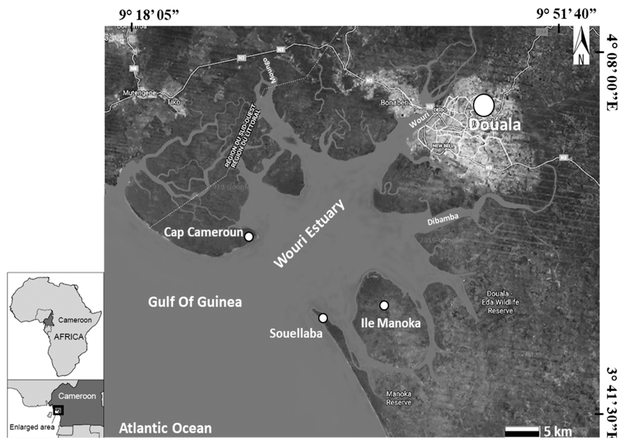
Abstract

In this study, Fourier Transform Infrared Spectroscopy (FTIR) was employed to qualitatively analyze organic and mineral components of the sediment core collected from the Wouri Estuary. The FTIR spectra revealed distinct transmittance corresponding to different organic and mineral phases, allowing for the characterization of sediment composition. The FTIR spectra showed changes and variation progressively from the bottom to the top. These sediments are proxies for time this can be inferred to say deposition in the Wouri Estuary has always changed.

Introduction

Sediment cores from tidal flats are archives for historical changes (Lintern et al, 2016), they provide glimpses into past environmental conditions, pollution trends, and depositional processes. Fourier Transform Infrared Spectroscopy (FTIR) is a valuable tool in sediment core analysis, offering insights into various components present in sediments. Different components have different transmittance values as such if there are variations in materials, we expect to see a variation in their transmittance. This method does not require many samples and is characterized by quick and easy sample preparation and a short analysis time. The purpose of this study is to investigate the sediment composition as a function of the depth in a sediment core sample obtained from a tropical woury estuary.



Map of Wouri Estuary

Materials and Equipments

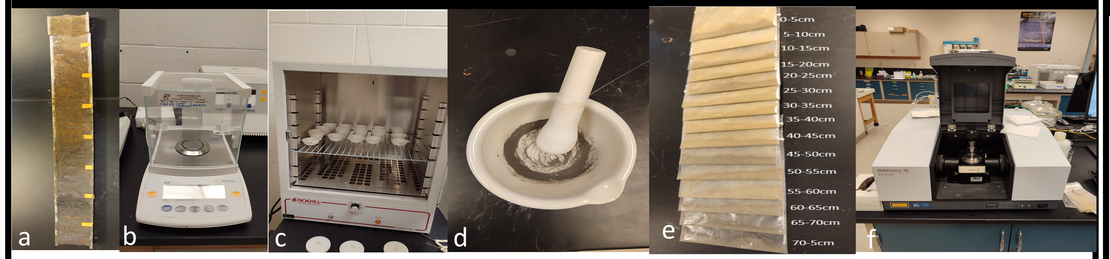


Figure 1:left to right: **a)** Sediment core **b)** Weighing balance **c)** Oven for sediment drying **d)** Mortar and Pestle while pulverizing dried sediment 1-15 **e)** Pulverized dried sediment from samples 1 to 15 **f)** FTIR instrument used (Shimadzu IRAffinity-1s)

Methods

- A 75cm long sediment core was collected from the tidal flat within the Wouri Estuary, Doula Cameroon using a 2-inch diameter aluminum tube and subdivided into equal halves.
- Samples were obtained at every 5cm interval in the sediment core leading to a total of 15 samples.
- 1g of each of the sub-sampled sediment cores was weighed into a crucible and oven-dried at 40°C for 14 hours.
- The dried sediment samples were pulverized into a very fine powder using a clean, dry mortar and pestle and packed in a sediment bag.
- 1mg of the pulverized samples was conducted using a Shimadzu IRAffinity-1s FTIR spectrometer within the mid-infrared region spanning from 4000 to 400 cm^{-1} utilizing an instrument resolution of 4 cm^{-1} over 40 scans.

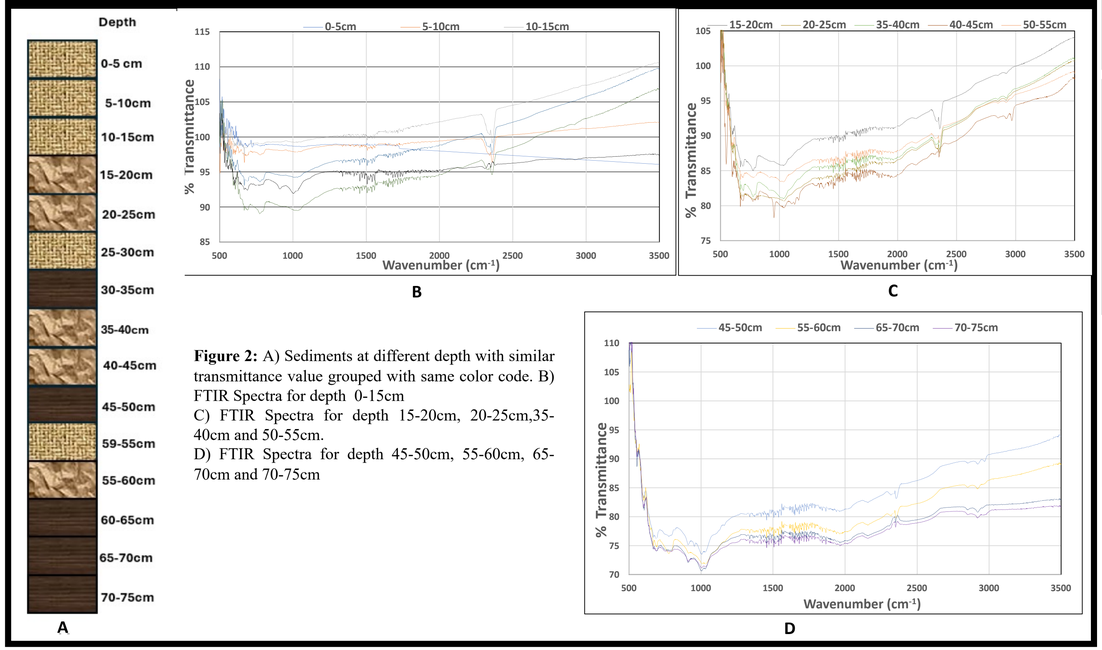


Figure 2: A) Sediments at different depth with similar transmittance value grouped with same color code. B) FTIR Spectra for depth 0-15cm
C) FTIR Spectra for depth 15-20cm, 20-25cm,35-40cm and 50-55cm.
D) FTIR Spectra for depth 45-50cm, 55-60cm, 65-70cm and 70-75cm

Discussion

- Based on IR transmittance values at 1000cm^{-1}wavelength, there were three (3) different categories (B, C, D) in Figure 2.
- The general trend in the sediment core is that sediment composition and properties change with depth.
- The sediments at depths of 60cm to 75cm showed similar transmittance values across all wavelengths which suggests that these samples have similar material. The sediments at this depth are muddy and very dark in color, this suggests a high presence of organic matter thereby corroborating the FTIR results.
- The sediment at depth 0cm to 15cm depth shows high transmittance. This suggests another grouping of samples with similar organic matter content. Sediments in this region were observed to be light brown in color suggesting a low presence of organic matter.
- Sediments at depths 15 cm to 45cm were observed to have moderate transmittance value suggesting that they may be moderately enriched with organic matter. However, at depth 25-35cm a change in transmittance. occurred which signify a likely change in organic matter content A similar pattern was observed at depths 50-60cm. Looking at this trend it shows that organic deposition was varying with depth.

Conclusion

The FTIR results depict a compositional change with an increase in depth which is a time proxy showing that this sediment composition were changing in time. Which has been interpreted to be mainly influenced by the amount of organic matter in the sediment.

References

Lintern, A., Leahy, P. J., Zawadzki, A., Gadd, P., Heijnis, H., Jacobsen, G., Connor, S., Deletic, A., & McCarthy, D. T. (2016). Sediment cores as archives of historical changes in floodplain lake hydrology. *The Science of the total environment*, *544*, 1008–1019. https://doi.org/10.1016/j.scitotenv.2015.11.153

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