A geochemical perspective on eDNA taphonomy: implications for ecological inference

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Introduction

Retrieval of modern and ancient environmental DNA (eDNA) from sediments has revolutionized our ability to reconstruct past and monitor present ecosystems. Little emphasis has been placed, however, on the fundamentals of the DNA-sediment association. Currently, our understanding of interfacial reactions and the controls geochemical processes and DNA-mineral association can have on eDNA taphonomy remains extremely limited. If we are to accurately infer community dynamics across time and space from eDNA, we need to understand how depositional processes and the stability of DNA-sediment associations in different environments influence our interpretation of retrieved eDNA.

Approach and scope

In this talk, I'll give an overview of our work on DNA-mineral interactions at the nano to bulk level. We show how mineral surface characteristics help drive DNA adsorption and stabilization and how we conceptually can use this data to address eDNA taphonomy.

Specifically, we:

- Apply interfacial geochemistry to address DNA preservation in sediments. We use atomic force microscopy and monitored the mobility of adsorbed DNA to a range of mineral surfaces and investigate how the mobility and forces of the interactions changes as a function of solution composition (ions, pH). Molecular dynamic simulations provide insight into the chemistry of the bonds involved in the binding and highlight that a strong DNA-mineral bond can lead to fragmentation.
- Combine mineralogic composition with experimental adsorption data and outline a way to increase the DNA extraction yield as well as scope and resolution of ecological interpretations from eDNA,
- Use distribution coefficients to address the fate of DNA in aqueous environments and showcase how it is influenced by the mineralogy of sediment particles and by the particle loading in the water column.

We outline how mineralogic and geochemical principles can be integrated with eDNA taphonomy analysis to improve the reconstruction of modern and past ecosystems. Furthermore, we evaluate the challenges associated with inferring ecological information when using eDNA from sediments of different provenance subjected to various sedimentary processes.