Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.30815

Environmental salinity determines DNA-mineral interactions

PABLO ARELLANO[1], IOANNIS KONTOPOULOS[2], CARLOTA CARBAJO MORAL[1] AND KARINA KRARUP SAND[3]

[1]University of Copenhagen
[2]University of Tübingen
[3]Globe Institute, University of Copenhagen

Despite the recent advances within sedimentary environmental DNA, we still have much to learn about the taphonomic processes leading to DNA preservation in sediments. In the environment DNA can be degraded by physical, chemical and biological factors. DNA degradation in an aqueous suspension is well understood, however, the nano level mechanisms of DNA adsorbed on mineral surfaces are still unclear [1]. We know that the DNA adsorption capacity of minerals depends on their mineral surface properties. Mineral surface charge and surface charge densities are the most important properties that drive DNA-mineral interactions and are strongly influenced by aqueous environmental conditions including salinity [2]. Essentially, an adsorbed DNA molecule is expected to change its binding affinity and interaction strength to a surface (mineral) as a function of solution composition. Consequently, solution composition will influence the DNA preservation potential of DNA stored at environmental surfaces, and a shift in e.g. salinity can influence the DNA-mineral bond leading to poorer or enhanced preservation.

In this work, we used Chemical Force Microscopy (CFM) to measure adhesion forces between DNA backbone phosphate groups and the iron(III) oxide-hydroxide mineral goethite. We probed the association strength in two different salinity conditions (10mM NaCl and 10mM $MgCl_2$).

Our results show that DNA is stronger adsorbed to goethite under the higher saline conditions ($MgCl_2$>NaCl>H_20). Our findings comply with principles of interfacial geochemistry and can be explained by Na^+ and Mg^{2+} decreasing the thickness of the electric double layer surrounding the mineral surfaces. Our results highlight that geochemical properties of depositional environments are a crucial step for DNA preservation. Additionally, our data can be used to inform design of targeted eDNA extraction protocols.

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