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Role of co-adsorbed proteins in mineral-mediated DNA preservation

TARU VERMA[1] AND KARINA KRARUP SVENNIGGAARD SAND[2]

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

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Taru Verma[1] and Karina K. Sand[1]

[1]Section for GeoGenetics, Globe Institute, University of Copenhagen, Øster Voldgade 5-7, 1350 Copenhagen, Denmark

Soil and sediments are a rich source of DNA containing upto 1 µg DNA per gram of material. While free DNA can degrade rapidly owing to the action of nucleases, spontaneous hydrolysis and UV radiations, it is surprising to know that DNA bound to minerals present in sediments is protected from degradation and can persist in the environment for geologically relevant timescales. Along with DNA, the soil is also rich in other organic matter comprising proteins, lipids and polysaccharides. These biomolecules can also bind to minerals and be stabilized by them, which is speculated to influence the binding of DNA, its retention and preservation in the environment. To date, it remains unclear whether the binding of other biomolecules such as proteins to the mineral surface influences DNA preservation and confers protection against degradation. With more fundamental and quantitative knowledge of the mechanisms, processes and associations that drive DNA adsorption, stabilization and preservation, we can advance our understanding of DNA as a reservoir of past information and help advance the resolution of DNA studies by providing a conceptual model for DNA preservation in soils and sediments.

In this study, we examined how proteins influence DNA interactions with mineral surfaces. Adsorption experiments were conducted with bovine serum albumin (protein), salmon sperm DNA and hematite (mineral) to assess changes in binding capacity, while high-resolution Atomic Force Microscopic imaging captured the dynamics of these interactions under different conditions. DNA and proteins can interact with each other and/or bind directly to the mineral surface, potentially competing for surface sites. To investigate these processes, we combined adsorption studies with nanoscale AFM imaging to analyze spatial distribution and dynamic behavior. Fluorescent staining further distinguished DNA and protein localization, providing insight into their binding tendencies on the mineral surface.