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Sedimentary DNA can influence evolution: Establishing mineral facilitated horizontal gene transfer as a route to increased bacterial fitness

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Horizontal gene transfer is the one of the most important drivers of bacterial evolution[1]. Transformation by extracellular DNA is not considered to be an effective mode of gene acquisition, because of the assumption that extracellular DNA degrades within days and is largely present in the environment in a highly fragmented state[2]. However, DNA in the environment can be efficiently preserved when it is retained on the surfaces of mineral surfaces. In fact, it has been established that approximately 0.5 gigatons of fragmented DNA is stored in the top 10 cm of the sediments on the sea floor[3]. It has been established that bacteria can take up large kilobase DNA molecules adsorbed to mineral surfaces via horizontal gene transformation. However, sedimentary DNA is highly fragmented and is rarely present as large kilobase molecules.

Here, we show that the naturally competent soil bacterium, *Acinetobacter baylyi* can incorporate 60 bp DNA fragments adsorbed to a wide range of common sedimentary minerals such as iron oxides, clays, carbonates, and silicates. We observed that negatively charged minerals such as quartz and mica were the most efficient donors of DNA whereas positively charged hematite was the poorest donor. Our results demonstrate that the transformation frequency depends on the mineral types and scale inversely with mineral surface charge and the ability of the mineral to immobilize DNA in a liquid environment. We propose that minerals are reservoirs of fragmented DNA, and their surface properties can influence the mobility of DNA across time and space, thereby placing interfacial geochemical processes in a central role in gene innovation in bacteria.

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[3] Overballe-Petersen, S. & Willerslev, E. *Bioessays* **36**, 1005-1010 (2014).