Mineral Facilitated Horizontal Gene Transfer: A New Principle for Evolution of Life?

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Polymers adsorbed to minerals are more resistant to degradation and have higher longevity in the environment compared to free polymers. Considering the properties of DNA-mineral associations and the possilibity to transfer the genes horizontaly, we propose that the DNA stabilizeded by minerals could have played a significant role in the evolution of life.

Free DNA (not part of a dead biomass) are in general degraded in a matter of weeks in aqueous solutions, however the DNA longevity is dramatically increased when adsorbed to minerals. Free DNA is found in the majority of Earth's surface ecosystems and up to 95% of it is estimated to be associated with minerals. On a global scale, there is currently ~0.4 Gt of free DNA in the uppermost 10 cm of marine sediments. DNA adsorbed to minerals can get transferred to organisms and incorporated in their genome through the process of horizontal gene transfer (HGT). We think that that once geologic processes start acting on such a vast “mineral archive of genes”, minerals function as protective shuttles propagating DNA across environments and enabling transfer of the adsorbed genetic material to distant species in different ecologic niches.

We hypothesize that minerals hold an unrecognized potential for propagating adaptive traits across environments and timescales to distant organisms and that this process has significantly impacted the evolution of life. The hypothesis will be illustrated in the context of the evolution of early microbial life and the oxygenation of the Earth’s atmosphere and we offer an explanation for observed outbursts of evolutionary events known as the “oxygen whiffs”.