

New Synthetic Biology Tools to Track Microbial Processes in Soils and Sediments

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Synthetic biology tools can be used to program microbes to report on their environment, informing researchers when changes in gene expression have been triggered (*e.g.* in response to shifts in O₂ or H₂O), or when microbes have participated in a specific step of an elemental cycle. Microbial biosensors can be programmed to detect a wide range of biogeochemical processes, including aspects of C cycling (biofilm production, methanogenesis, and synthesis of extracellular enzymes), N cycling (expression of enzymes within the N cycle) and reporting on cryptic aspects of S and Fe cycling.

These uses of synthetic biology have the potential to significantly improve our understanding of microbes' roles in elemental and water cycling by allowing reporting on the environment from the perspective of a microbe, matching the measurement scale exactly to the scale that a microbe experiences. However, synthetic microbes have not yet seen wide use in soil and sediment laboratory experiments in part due to the nascent maturity of synthetic biological tools. In this talk I will describe the suite of synthetic biology tools available to the Earth and environmental science community, provide examples of applications of these tools, and outline remaining engineering challenges for their general use.