

The double helix meets the crystal lattice: The power and pitfalls of nucleic acid approaches for biomineralogical investigations

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ABSTRACT

The inability to culture the majority of microorganisms from natural habitats has been well documented. In response to this constraint, the development and application of culture-independent methods for studying microbial communities have been a focus of microbial ecology for the past several years. Molecular approaches, in particular, offer great potential to investigate the role of microorganisms in areas as diverse as biogeochemistry, pollutant remediation, and disease causation. The purpose of this review is to give a brief critique of nucleic acid-based techniques currently used in microbial ecology, to serve as a reference for those wishing to employ such techniques, and to examine the applicability of these techniques toward studying the biogeochemical roles of bacteria, especially as related to metal cycling and biomineralization. Although published reports on the application of molecular techniques to biogeochemical and biomineralogical problems are scarce, this review aims to familiarize biogeochemists and biomineralogists with the strengths and weaknesses of these approaches. Advances have been made in describing the diversity of uncultured microbial communities, detecting/identifying specific cells and functional genes in environmental samples, detecting in situ activities of specific microorganisms, and determining some of the factors controlling gene expression in in vitro studies. However, the current methods provide limited quantitative information about natural processes. Acknowledging these limitations can assist the development of methods to answer basic questions concerning the in situ distribution and activities of microorganisms. Studies relating these in situ measurements of microbial activity and distribution to the physical and chemical microenvironment will ultimately permit a better understanding of the importance of microorganisms in mineral formation and dissolution processes.