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Raman spectromicroscopy as a tool to uncover the biomolecular controls of microbial biomineralization

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Biominerals are a fascinating testimony of life's capacity to shape the inorganic world. Through the formation of minerals, bacteria participate in fluxes of most elements present at the surface of the Earth, having profound impacts on biogeochemical cycles. Biominerals often present properties (e.g., size, morphology, chemical composition, crystal structure) that differ from those of their chemically precipitated counterparts, and from one biomineralizing organism to another. These specific properties, composing the "mineral phenotype", strongly influence the stability, reactivity, and bioavailability of biominerals in the environment, and hence determine their biogeochemical roles and ecological functions [1]. Raman spectromicroscopy can be used to investigate the microbe-mineral interface and elucidate the biological mechanisms that control the properties of microbial biominerals. This method presents several important advantages over other micron-scale techniques for the study of microbial biomineralization systems: it is rapid and non-destructive, requires very little sample preparation, and, most importantly, it can be performed directly *in-vivo* on solid or liquid cultures or wet environmental samples. Here, we will show applications of Raman spectromicroscopy that uncover the critical role of sulfur bacteria and their extracellular organics in controlling the composition and crystal structure of sulfur minerals present in natural environments [2,3]. The development of high-throughput screening Raman now allows for the rapid mineralogical characterization of large numbers of samples at a time. Combined with next-generation sequencing and other omics techniques, this method will in the future be employed to uncover new genes and biomolecules encoding biomineral properties, enabling a deeper understanding of the genetic basis of the mineral phenotype.

References

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