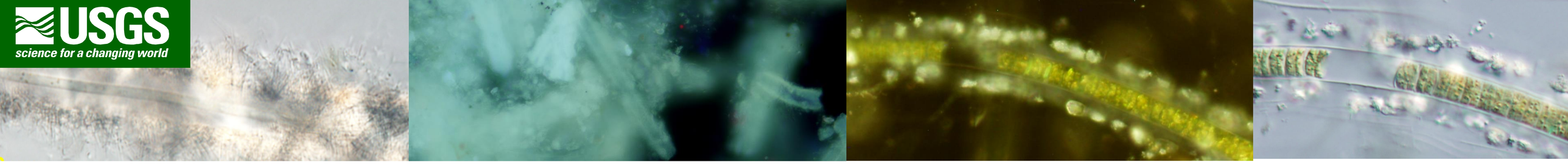

Cyanobacterial mediated mineralization of a rare form of calcium carbonate in the Everglades: vaterite

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Abstract

Calcium carbonate mineralization is a well-known process of ecological and geological importance that can be mediated by cyanobacteria in freshwater and marine habitats. The milieu outside the cyanobacteria cell wall, commonly called mucilage and consisting mainly of extracellular polymeric substances, is the site of nucleation for mineralization. Cyanobacterial mediated mineralization of calcium carbonate occurs in settings with proper environmental conditions of high alkalinities, pH, bicarbonate ion concentrations, and dissolved calcium. In the oligotrophic regions of the Everglades, such as the marl prairies, sediments characteristically have abundant amounts of calcium carbonate that likely originate from cyanobacteria-dominated benthic microbial communities. Several species of cyanobacteria thrive in these habitats; however, only a few of these species are directly involved in calcium carbonate mineralization.

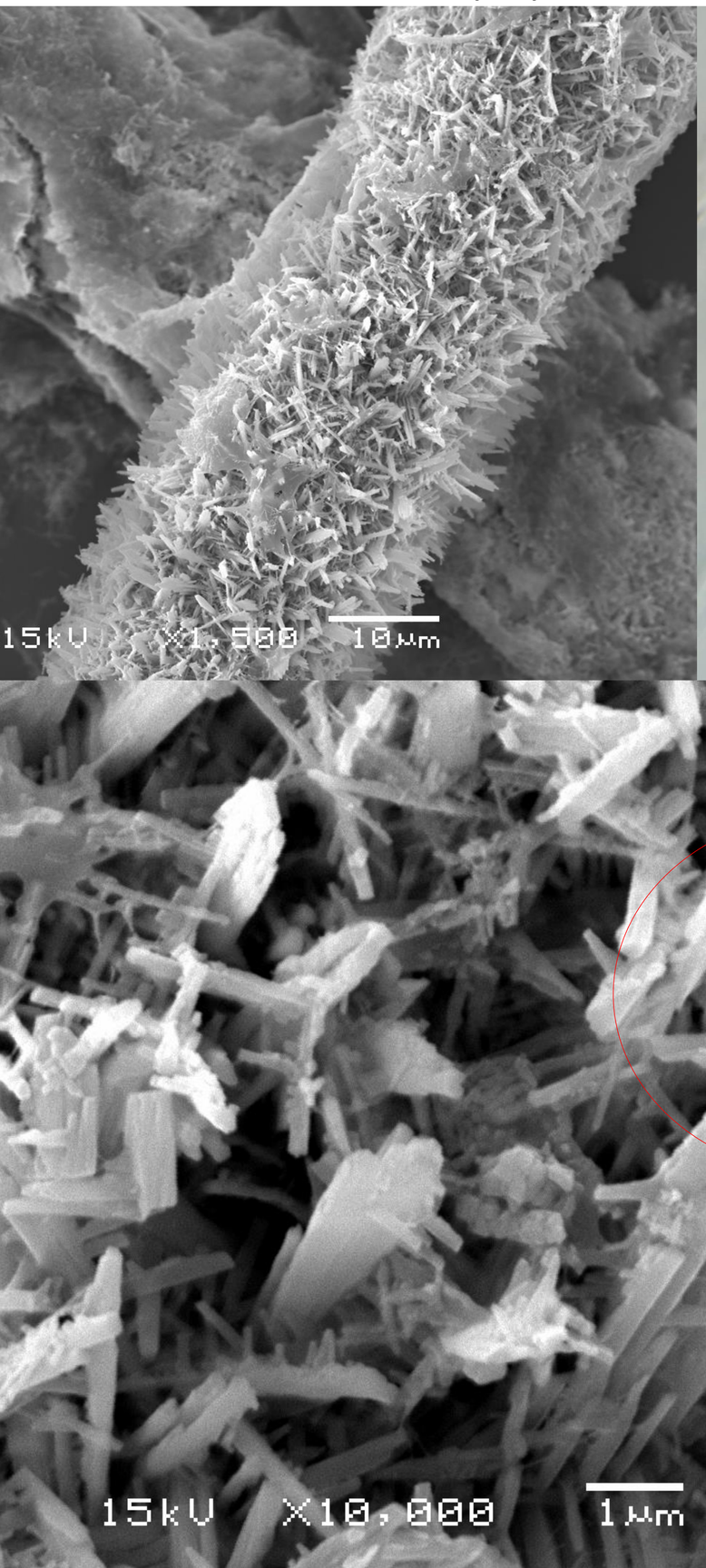
Cyanobacteria from the central part of the Everglades were examined using compound light and epifluorescent microscopy to identify species that mediate calcium carbonate mineralization. Cyanobacteria genera such as *Johannesbaptista pellucida,* previously reported to not mediate the mineralization of calcium carbonate were identified with calcitic encrustations. As previously described, the two cyanobacterial species responsible for the majority of the biologically mediated calcium carbonate mineralization in the Everglades are *Scytonema hofmannii* and *Schizothrix calcicola*. Microscopic examination of these filaments indicated that these two species formed distinct types of calcium carbonate.

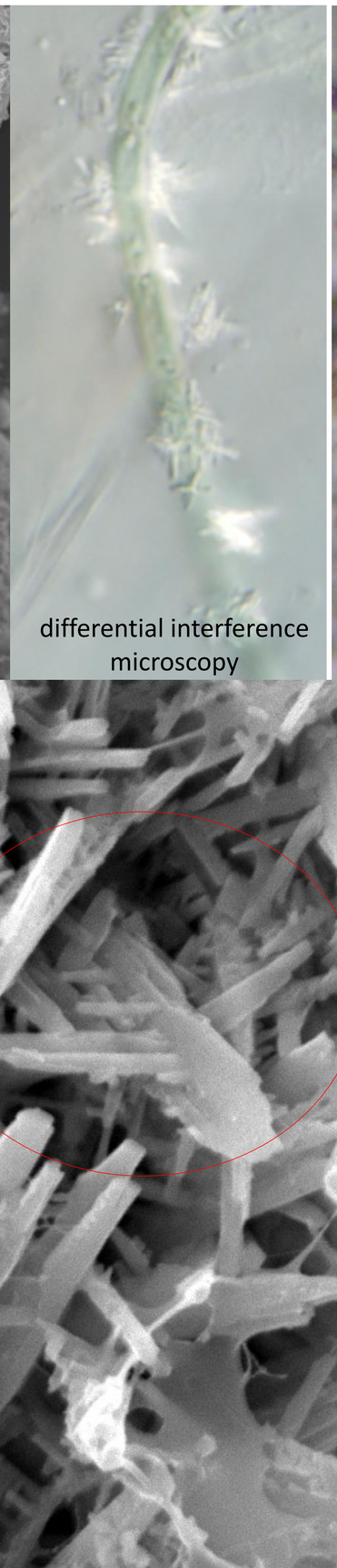
Scytonema filaments were up to 20 µm in diameter, and calcium carbonate was deposited outside the sheath as orthorhombic blocks. The active sites of filament growth lacked crystals; older portions of the filament generally were surrounded completely by calcium carbonate crystals. *Schizothrix* filaments ranged up to 2 µm in diameter and the crystals appeared needle-like.

To determine the elemental composition of these two distinct forms of calcium carbonate, energy-dispersive X-ray spectroscopy was performed on the crystals associated with the two dominant species of cyanobacteria. The *Scytonema*-associated crystals had a $CaCO_3$ composition consistent with aragonite. In contrast, the crystals of *Schizothrix* were found to be Ca_2CO_2, consistent with vaterite, a rare form of calcium carbonate from biological systems. No evidence of phosphorus was found in either type of crystal. Both cyanobacteria species are important to calcium carbonate mineralization in the Everglades, but the mineralization of vaterite by *Schizothrix* reveals unreported complexity of calcitic soils that may lead to a better understanding of carbon storage in the Everglades.

	Scytonema		Shizothrix	
	Wt%	At%	Wt%	At%
Ca	31.1	14.1	63.5	39.5
C	19.4	29.4	9.12	18.9
O	49.5	56.4	26.1	40.7
	aragonite (CaC_2O_4, CaC_2O_5, CaC_2O_2)		vaterite (Ca_2CO_2)	

calcium carbonate precipitation on *Shizothrix*





calcium carbonate precipitation on *Scytonema*