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Author

Choudhary, Kushal, PhD

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Mathematical modeling of modern stromatolites

K. P. Choudhary^{1*}, Xiaoli Dong¹, D. Y. Sumner²

¹Department of Environmental Science and Policy, University of California, Davis, CA, USA

²Department of Earth and Planetary Sciences, University of California, Davis, CA, USA

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Abstract:

A laminated structure formed by photosynthetic microbial biofilms is called stromatolites. Ancient stromatolites, formed by oxygenic photosynthetic microbes, played a significant role in the oxygenation of Earth's atmosphere during the Great Oxidation Event. Modern stromatolites are still forming at the bottom of Antarctic lakes. The morphology of stromatolites depends on the environmental conditions of the medium. The present work is motivated by the microbial pinnacles of Lake Vanda, Antarctica. An attempt at mathematical modeling of stromatolite growth (pinnacle formation) under sunlight and nutrient limitations in flowing water has been carried out using OpenFOAM (a C++ based open source platform with finite volume methods). The formulation builds upon the biofilm growth model proposed by Guibert et al. (SoftwareX 29, 102011, 2025). The model includes biomass growth, biomass diffusion, nutrient transport, light attenuation, and the dynamics of living and dead biomass. Living and dead biomass are responsible for active and inactive growth regions within the biofilm, respectively. Currently, the model is under development and validation. The preliminary results resemble the growth and morphology of *in situ* biofilms. In the present work, the effect of nutrient concentration on the growth rate and morphology of the pinnacles is investigated.

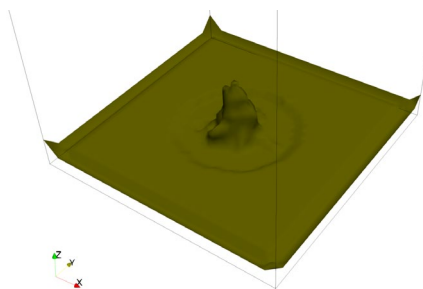


Fig. A sample result of pinnacle formation

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Contact Information for Presenting Author: kpchoudhary@ucdavis.edu