Gregory Dick
Associate Professor
University of Michigan

Longer days for more oxygen? What modern cyanobacterial mats tell us about the oxygenation of Earth's atmosphere

Plentiful oxygen (O2) is critical for life as we know it. However, Earth's atmosphere was not always rich in O2 as it is today; for the majority of Earth's history there was not enough O2 to support animal life. Thus, the story of how Earth attained it's O2 is the story of how it became habitable for plants, animals, and humans. In addition to depending on O2, life also played a crucial role in producing the O2. O2-producing photosynthesis is the only known source of O2 sufficient to fill our atmosphere. Despite this importance of biology in Earth's oxygenation, comparatively little work has been done to understand biological controls or constraints on oxygenation. This talk will explore how the biology of cyanobacterial mats, thought to be key producers of O2 in deep geological time, may help to explain why O2 remained so low for so long. Our studies of modern cyanobacterial mats suggest that the intensity and duration of light, coupled with unexpected microbial behaviors, are critical yet heretofore overlooked factors in determining how much O2 is produced. This finding is intriguing in the context of how day length has varied through geological time: Earth's rate of rotation has been increasing to give us 24-hour days now, but daylength was much shorter in the Precambrian. Results of modeling the effect of day length on O2 production in cyanobacterial mats indicate that it could help explain the pattern of Earth's oxygenation. Thus, we suggest that changes in Earth's rotation rate, together with biological behaviors and feedbacks, conspired to give us the O2-rich atmosphere we enjoy today.