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Links between cyanobacterial activity and redox cycling of sulfur, iron and arsenic in a high-altitude Andean microbial mat system.

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Arsenic, sulfide and iron are nowadays uncommon and perceived as toxic, however their cycling likely played a key role in regulating the type and extent of primary production in the Precambrian. During this time microorganisms that grew stratified communities (microbial mats) took advantage of specialized microenvironments, where potentially toxic metabolites and reduced substrates could rapidly be recycled due to the close spatial and temporal interaction of processes and microbial functional groups. Among these groups, cyanobacteria are unique as they evolved the capability to perform oxygenic photosynthesis. In order to investigate the link between cyanobacterial oxygenic and sulfide-driven anoxygenic photosynthesis, and redox cycling of iron and arsenic, we studied modern stratified, lithifying microbial mats in Pozo Bravo, an arsenic-rich, hypersaline lake in Salar de Antofalla, a volcanic influenced environment in the Argentinian Andes (3300 masl). *In-situ* microsensor measurements over a diel light cycle showed that a deep (4 mm) cyanobacterial community ceased oxygenic photosynthesis before midday, and switched to anoxygenic photosynthesis. In the late afternoon, this layer resumed oxygenic photosynthesis, albeit at a diminished capacity, simultaneously with anoxygenic photosynthesis. Redox dynamics of iron and arsenic strictly followed diel light availability and were thus uncoupled from the local oxygen dynamics, suggesting an involvement of anoxygenic phototrophs. Our results suggest that the light-driven changes in arsenic speciation regulated transitions in the mode of cyanobacterial photosynthesis. The diel pattern of net oxygen production was therefore not predictable from illumination dynamics but was governed by complex regulatory effects of sulfide and arsenic.