A secret forest under the salt crust – high-altitude Andean salt flats as an analogue to photosynthetic microhabitats on ancient Earth

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Early phototrophic microorganisms likely found refuge in protective microenvironments to endure extreme UV radiation. Thick, dry, and dome-shaped gypsum-halite crusts in Laguna Verde (Salar de Antofalla, Argentina) form under extreme conditions of salinity (220.5 ‰) and solar radiation. Yet, they are abundantly inhabited by cyanobacteria and therefore could be analogous to environments where photosynthesis evolved.

We used microsensors to track the depth and dynamics of photosynthetic activity over a diel cycle. Despite the harsh conditions, we measured very high rates of oxygenic photosynthesis, in the range of activity in microbial mats from less saline and UV-affected systems. Intriguingly, photosynthesis was limited to depths greater than 3 cm and even extended down to 6.5 cm. Parts of the crust served as an O_2 reservoir due to negligible respiration rates and remain oxic for several hours in the dark.

We hypothesise that through condensation microhabitats in salt crusts stay cooled and hydrated. Therefore, analogous crusts protecting from the high radiation, but permitting sufficient access to light to enable photosynthesis, could have created an arena of life for early cyanobacteria.