Microbial mats and the search for their biosignatures in deep time and space

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Cyanobacterial mats provide insights into ancient benthic microbial communities and their biosignatures. Thick mats occupy hypersaline saltern ponds at Guerrero Negro, Baja California, Mexico. Mat biota maintains rapid rates of biogeochemical processes under steep and rapidly changing environmental gradients. Cycling of C, O, and S all increased identically with temperature, indicating the tight coupling of these cycles. An enormous microbial diversity exhibits a highly structured spatial distribution of populations. Combined universal clone libraries from all mat layers indicated Bacteria/Archaea/Eukarya ratios of 57:7:1. More than 10,000 unique bacterial sequences were present. The relative abundance of Archaea increased with depth - below 10 cm, solvent-extractable archaeal lipids were twice as abundant as bacterial lipids. Only 15 species of Eukarya were found among 890 clones analyzed. Degradation of the mats' insoluble macromolecular organic fraction (IMOM) by hydropyrolysis released a complex variety of linear, branched and polycyclic alkane structures, e.g., hopanes, methylhopanes and steranes. Covalent binding of these biosignatures into IMOM aids their long-term geological preservation. Mars rover missions revealed evidence of long-lived fluvial lacustrine systems and organics in associated mudstones. NASA's Mars 2020 rover mission will examine sediments in Jezero crater, including a delta and shoreline carbonate deposits, environments that on Earth have sustained microbial mats.