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Peer Review

Review of: "Microbial Mediation in Gypsum Dissolution and Its Role in Evaporitic System Transformation in Northern Chilean Salt Flats"

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This manuscript addresses an important topic in geomicrobiology, investigating microbial influences on gypsum dissolution and secondary mineral formation in extreme evaporitic environments. The study employs controlled laboratory incubations using brines and microbial mats from three Andean salt flats, coupled with microscopy and geochemical analyses. The results highlight the role of microbial processes, particularly extracellular polymeric substances (EPS), in modulating dissolution dynamics and promoting mineral diversity.

Strengths:

- The study addresses a relevant research question with the potential to advance understanding of microbial mediation in evaporitic systems.

- Laboratory experiments under both biotic and abiotic conditions provide a solid framework for distinguishing microbial effects.
- The discussion situates the findings within the geomicrobiological literature and highlights site-specific differences among the salt flats.
- Conclusions summarise key findings and reasonably discuss broader implications, including astrobiological relevance.

Major concerns and suggestions:

- - Regarding the structure and clarity, the Introduction could be improved by providing more conceptual context and clearly defining the study objectives. Background information appears uneven

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and occasionally overlaps with interpretation; restructuring may help improve clarity.

- - In the methodology, the assessment of filamentous cyanobacteria could be clarified. Cell counts alone may be insufficient; the authors could consider including measurements of length or other morphometric parameters. Cyanobacterial identification relies mainly on Bergey's Manual. The authors might consider incorporating the keys of Komárek & Anagnostidis, which cover both unicellular (Chroococcales) and filamentous cyanobacteria (Oscillatoriales) for morphology-based identification. However, when studying more complex processes and interactions between microorganisms and minerals, it would be beneficial to consider knowledge from a polyphasic approach that integrates morphology, pigmentation, ultrastructure, and molecular data, as recommended by Komárek et al. (2014). The term "culture evolution" could be reconsidered, as it seems to describe the temporal development of microbial mats rather than evolutionary processes. Alternative phrasing, such as "culture development over time" or "temporal growth of cultures", may improve clarity.

In the data presentation, the Figures and tables could be improved for clarity and reproducibility. For example, the curves in Figure 4 are difficult to read, and Table 2 could be replaced with heatmaps or numerical values to facilitate easier comparison across samples. Species naming appears inconsistent, alternating between common and Latin names. The authors could consider consistently using Latin nomenclature, with common names provided in parentheses at first mention. Supplementary tables summarising sample parameters (origin, EPS presence, pH, cell density, dominant taxa, and morphological features) help improve readability and facilitate comparisons.

Results and interpretation. Some qualitative observations are presented in a way that suggests quantitative or mechanistic conclusions. Inferences regarding dissolution rates, porosity, and endolithic boring are mainly based on surface SEM images, and the authors might consider tempering their statements about biotic versus abiotic contributions. Proposed microbial metabolic mechanisms remain speculative and could be presented more cautiously.

Regarding internal consistency, issues such as saturation-state interpretations, table references, and distinctions between biotic and abiotic could benefit from careful revision, as they can occasionally reduce clarity. Some conclusions generalise beyond the supporting evidence.

Recommendations for improvement: Please consider reorganizing the Introduction to define objectives and provide a balanced, clear conceptual background. Consider strengthening the methodology by specifying culture-monitoring approaches, microscopy parameters, and cyanobacterial identification

using a polyphasic approach with the keys of Komárek et al. Consider replacing “culture evolution” with more precise terminology and improving Table 2 for cross-sample comparison. Consider standardizing species nomenclature and improving the readability of some of the figures; supplementary material summarising key microbial mat characteristics could be added. Consider aligning interpretations more closely with the qualitative dataset, clearly distinguishing observations from broader implications. Consider revising English for clarity and style.

In summary, the manuscript presents promising data and addresses a topic of considerable scientific merit. With careful attention to structure, clarity, methodology (especially microbial identification), terminology, data presentation, and interpretation, the manuscript could be substantially strengthened. A **major revision** is recommended before publication.

Declarations

Potential competing interests: No potential competing interests to declare.