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Field and laboratory experiments to constrain biologically impacted precipitation of minerals in evaporitic environments, Salar de Llamará, Chile

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Salar de Llamará is an endorheic basin located in Pampa del Tamarugal, Central Depression, of Norte Grande de Chile (Fig. 1A), subjected to intense evaporation. In this basin, groundwater upwelling produces depressions (*Puquíos*) filled with brines on which a varied paragenesis of minerals precipitate within microbial mats [1, 2, 3]. It is known that microorganisms can influence mineral precipitation, but the degree of biological participation in the mineralization process in evaporative settings is an open debate in this basin and other locations worldwide [4]. Here, we evaluate the role of microorganisms in evaporite mineral precipitation by designing two experiments which reproduce the precipitates observed in the *Puquíos*. First, a set of glass slides were placed in the field (Fig. 1B). These slides were collected periodically and studied by X-Ray Diffraction and Scanning Electron Microscopy. Second, a set of microbial mats were collected, purified, and incubated in microcosms simulating original hydrochemical conditions, day-night light cycles, and *in situ* substrates (Fig. 1C). These mats were maintained in the absence of evaporation for over a year, and sub-sampled to study their microbes and mineralogy. Results from both experiments were compared, and a similar paragenesis of minerals was found to occur coincident with the mineral paragenesis observed at the microbial mats *in situ*. Gypsum, carbonate species, sodium sulfates, halides, opal, native sulfur, arsenic sulfides, magnesium silicates, and manganese oxides were characterized (Fig. 2). This study can be seen as the first attempt and proof of concept to differentiate biotic and abiotic participation in evaporitic sedimentary environments. We are not aware of other studies in which mineral precipitation has been monitored in laboratory microcosms and compared with field experiments.

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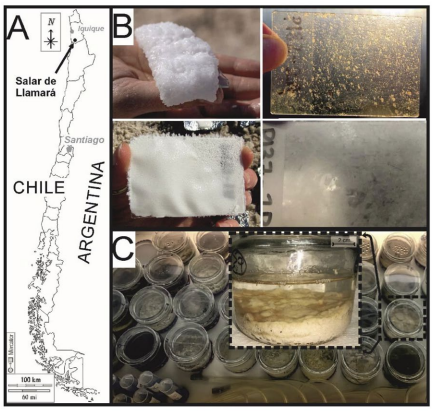

Figure 1: (A) Location of the sampling site. (B) Mineral precipitating over glass slides in the field experiment. (C) View of laboratory experiment with incubations. Note microbial gels.

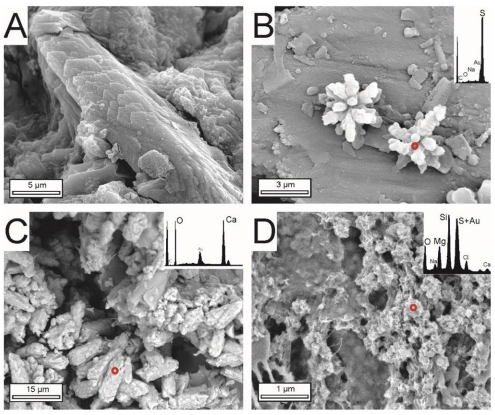

Figure 2: FE-SEM microphotographs of minerals precipitated within microbial mats. (A) Gypsum crystal. (B) Sulphur flowers over a gypsum crystal coated by exopolymeric substances (EPS). (C) Calcite crystals embedded within EPS. (D) Aggregates of Mg silicates embedded within EPS. EDX analyses are displayed as an insert in the upper right side of B, C and D; EDX point in red circles.