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Mg-rich carbonates mediated by a bacterium isolated from an extreme alkaline lake in Central Spain

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Microbial mats known to contain up to 45% of hydromagnesite and other Mg-rich carbonates (nesquehonite, dolomite) are present in Las Eras, a highly alkaline and brackish to saline playa-lake situated about 150 km north of Madrid, Central Spain. This water body contains a high concentration of chloride with dominant carbonate over sulphates ions, which results in pH values ranging from 9.2 to more than 11. Unlike, other soda lakes, Las Eras is characterized by significant amounts of Mg that, in addition to Na-carbonates, favor the formation of Mg-carbonates (Cabestrero and Sanz-Montero, 2016). Here we report the bacterial precipitation of Mg-rich carbonates (hydromagnesite, dypingite and dolomite, among others) mediated by an isolated bacterium from the playa lake microbial-mat. Scanning electron microscopy (SEM) images shows that the carbonate precipitates are closely associated to bacterial cells and extra-cellular polysaccharides (EPS). Analysis of the 16S rRNA sequence of this isolated bacterium revealed a 99.8% identity (i.e. same species) with Desemzia incerta (Y17300).

This EPS-forming bacterium was cultivated in a saline and organic rich solid medium at 30º C, in order to simulate the extreme conditions in this playa lake system and the precipitation in its microbial mat. This bacterium belongs to the Firmicutes order Lactobacillales (Stackebrandt et al. 1999) and has also been isolated in other extreme environments as cold desert soils, gold mines biofilms (Yavad et al., 2014; Drewniak et al., 2008).

The role that microorganisms have in the biological process and their influence over the mineralogy of the precipitates is still not understood. Thus, certain microbial species have been found to be associated with biomineral precipitation in many different environments such as saline habitats, biofilms, and soils (e.g., Sánchez-Román et al., 2009a,b; Bontognali et al., 2012). Relationships between microbial species and biomineral characteristics have been suggested, although the biological precipitation mechanisms as well as the impact of this process in the microbial ecology of the precipitating microorganisms are still unknown. In this work, we expanded the current knowledge on culturable diversity of carbonatogenic bacteria by providing evidence for the precipitation of Mg-rich carbonates by Firmicutes. Moreover, bacterial Mg-rich carbonate precipitation could be of importance in bioremediation of CO_2 and Mg in extreme saline and alkaline environments.

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