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Qatar University Life Science Symposium 2016: Biodiversity, Sustainability and Climate Change, with Perspectives from Qatar

Mediation of carbonate minerals formation by aerobic bacterial strains isolated from Dohat Faishakh Sabkha in Qatar

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ABSTRACT

Carbon dioxide (CO_2) is increasingly released to the environment as a result of the extensive use of various industrial facilities. According to the Intergovernmental Panel on Climate Change Report (2015), cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond". Different technologies can be applied for capturing and storing CO2 such as sequestration and carbonate mineral storage. Biominerals are of great importance due to their huge impact on the global biogeochemical cycle. Carbonates such as limestone and dolomite are important carbon reservoirs. Calcium carbonate formation and its burial in marine sediments account for approximately 80% of total carbon removal from the Earth's surface by abiotic and biotic precipitation. The biotic precipitation of calcium carbonates, is performed by various organisms, including bacteria, and has been widely reported and discussed in the literature, while, the formation of high-magnesium calcites is extremely challenging, due to the high level of hydration of Mg^{2+} ions, which promote the formation of Mg-free aragonite, rather than calcite. The dynamic evaporitic systems characteristic of sabkhas are crucial for the precipitation of minerals, and a role for microorganisms in sabkhas in the process of mineralization has been proposed. In this study the Dohat Faishakh Sabkha in Qatar was investigated for evidenc of the role of aerobic bacteria in mediating the formation of high magnesium carbonates and dolomite, two minerals that commonly occur in the sabkha sediments. 29 strains of aerobic microbes isolated from the sabkha and identified by 16S rDNA sequencing as belonging to the genera *Bacillus*, *Salinivibrio*, *Staphylococcus* and, primarily, *Virgibacillus*. All strains examined caused the pH of the artificial growth medium to increase from 7 to 8.5; however, not all were capable of mediating mineral formation. Only *Salinivibrio* and *Virgibacillus* spp. isolates mediated the formation of detectable solid phases within the agar plates. Light microscopy, scanning electron microscopy energy dispersive X-ray (SEM/EDX), and X-ray diffraction (XRD) analyses indicate that the solid phase produced in the presence of these bacterial strains is $MgCa(CO_3)_2$ with a $MgCO_3$ mol% varying from 0% to 40%. The results of these laboratory experiments suggested that, in the Dohat Faishakh Sabkha, aerobic bacteria may contribute in the formation o very high Mg calcite, a mineral that is considered the precursor of ordered dolomite.

http://dx.doi.org/10.5339/qproc.2016.qulss.41

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Cite this article as: Al Disi ZA, Jaoua S, Bontognali TRR, Attia ESM, Al-Kuwari HAS, Zouari N. Mediation of carbonate minerals formation by aerobic bacterial strains isolated from Dohat Faishakh Sabkha in Qatar. QScience Proceedings: Vol. 2016, QULSS 2016: Biodiversity, Sustainability and Climate Change, with Perspectives from Qatar, 41. http://dx.doi.org/10.5339/qproc.2016.qulss.41