Cryogenic Raman Signatures of Hydromagnesite-rich Samples from Lake Salda: Understanding the Modern Geochemistry and Life Potential of Mars

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The search for water, organics and potential signs of life on Mars has been a major topic in planetary sciences and astrobiology. Mars 2020 of NASA and the upcoming ExoMars of ESA are two robotic missions that will specifically assess the life potential of Mars by investigating past aqueous environments of the planet and searching for biological signatures, using the latest generation of exploration rovers. The Mars 2020 Perseverance rover of NASA is currently investigating the Jezero crater, an open-basin paleolake featuring a well-preserved delta with clays and carbonates (Grant et al. 2018). The orbital detection of a carbonate-bearing unit ("marginal carbonates") comprising hydrated Mg-carbonates in the inside margin of the crater is particularly noteworthy. A hypothesis suggests that these deposits include authigenic carbonates, precipitated in the near-shore environments of the lake (Horgan et al. 2020). On Earth, lacustrine (authigenic) carbonate deposits often form in connection with microorganisms. Some carbonate minerals (e.g., Mg- and Ca-carbonates) are found to be able to preserve biological signatures by trapping them inside layered deposits (*e.g.*, stromatolites). Some of the oldest fossils on Earth, which show the signatures of microorganisms preserved on sedimentary rocks confirm the preservation ability of carbonates (Allwood et al. 2007).

Lake Salda, Turkey, is a relevant Mars analogue site for the marginal carbonates identified in the paleolake of Jezero crater. In Lake Salda, the evaporation of alkaline Mg-rich lake waters induces the precipitation of carbonate minerals by forming mostly hydrated Mg-carbonate called hydromagnesite ($Mg_5(CO_3)_4(OH)_2 \bullet 4H_2O$). In particular, hydromagnesite-rich stromatolites actively grow along the shorelines of the lake (Braithwaite & Zedef 1996). Understanding the interplay between environmental, chemical, and biological processes that are involved in these rock formations is an important focus of study (Balci et al. 2020). To support ongoing and upcoming Mars missions, the carbonate samples from Salda Lake also need to be comprehensively examined by the spectroscopic instruments included in the rovers, such as Raman spectrometers at Mars-relevant temperatures.

In this study, we characterise various hydromagnesite-rich samples from the Lake Salda, such as gravels and lake sediments using various analytical techniques, including Raman spectroscopy. The identification and assignment of the mineral phases, as well as organic components enable us to resolve the geochemical conditions of the Salda lacustrine settings. Furthermore, we report on a spectral database of hydromagnesite powders, aqueous solutions of hydromagnesite and hydromagnesite-rich sediments under Mars-simulated conditions of temperature using cryogenic Raman spectroscopy. The phase transformations of water/ice and hydrated carbonates, as well as the entrapment of potential organics in these matrices are under investigation. The collection and interpretation of these spectra from the Mars analogue samples of Lake Salda can contribute to our understanding of the Mg carbonate deposits in Jezero crater and to identify any life signature if it has ever existed on Mars.

References

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