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Organic matter in samples from hypersaline Tirez lake (La Mancha, Spain); a projection into Europa and Enceladus analyses.

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Europa and Enceladus, two ocean worlds in our solar system, are targets of high interest for astrobiology in the decades to come. Past space missions (Cassini-Huygens and Galileo) and recent observations with the Hubble Space telescope have revealed the presence of salts (sulfate and/or chloride) in the plumes of Enceladus and in the components of Europa's surface (1-4). Future missions aiming at evaluating the habitability of Europa and Enceladus and detect potential traces of life on these satellites will face many challenges. One of them is the presence of salts in the oceans and therefore in the surface deposits material that would be sampled. These salts could degrade both the mechanical functioning of a chemical analysis instrument, and their analytical performances. The salts may also interfere with the sample preparation techniques (*e.g.*, pyrolysis, derivatization or thermochemolysis).

Figure1: Chromatogram of a derivatized sample (from Lillo Lake) with DMF-DMA after evaporation of the water. I.S.: internal standard.

In this work, we explored natural samples coming from the hypersaline lacustrine system Tirez in Spain, an analogue sample of Europa and Enceladus ocean regarding salinity. The samples studied in this work were collected from seven salty lakes in 2019. They are in liquid state and characterized by a high concentration of Mg, Na, SO₄ and Cl. Spectra obtained from Fourier transform infrared technique were similar to the Galileo spectral data for Europa (5). In addition, micro-organisms from the three domains (bacteria, archaea, eukaryotes) were identified in Tirez lake materials (6). Among the numerous samples collected during the field trip, this work focused on ten of them. These samples were analyzed in order to evaluate the potential impact of the salts on the gas chromatography couple to mass spectrometer (GC-MS) instrument, and associated sample preparation techniques. The results showed that pyrolysis-GC-MS, derivatization-GC-MS and thermochemolysis-GC-MS are complementary analytical tools for the detection of organic molecules (Fig. 1). All the techniques used in this study allowed to detect and identify compounds directly related to the presence of microorganisms in the sample, such as archaea and eukaryotes. Nevertheless, it appeared that thermochemolysis was the best way to extract a large number of molecules by limiting their structural modification and thus facilitating their identification. The strict identification of the biological families remained complicated given the universality of numerous organic compounds amongst the phyla.

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