Contribution ID: **4** Type: **Poster presentation**

Metabolomic profiling of microbial-mineral interactions

Wednesday 6 September 2023 17:00 (20 minutes)

Chemolithoautotrophic organisms thrive under extreme conditions (e.g., high metal concentrations, high temperatures, and low pH) through redox-altering minerals by oxidizing inorganic molecules (e.g., iron, sulfur, and other reduced inorganic sulfur compounds). As the early planetary phases of Earth and Mars are similar, this metabolomic path makes these microbial organisms good candidates for astrobiological investigation. The molecular residues may differ owing to the different mineralogical compositions of Earth and Mars, which may result in a Mars-specific biopattern [1]. It is feasible to identify the biological substances of interest and validate their biogenicity by metabolomic and lipidomic investigations using different mass spectrometry methods. To trace the metabolomic profile of the extremely thermoacidophilic archaeon *Metallosphaera sedula*, we used a suite of mass spectrometry (MS) techniques, including electrospray ionization (ESI), Liquid Chromatography (LC) - MS, and matrix-assisted laser desorption ionization –Time of Flight (MALDI-ToF). *M. sedula*, a member of the archaeal order Sulfolobales, is extremely resistant to high temperature, low pH, and heavy metals and can be found in hot sulfur springs, volcanic regions, and acid rock drainages. Quinones, in addition to lipids, are chemotaxonomic indicators of archaeal cells, including information about mediating redox processes [2], showing that they could be used as diagnostic biomarkers in the Martian subsurface. In particular, thiophene-bearing quinones with thiophene heads and quinone tails are promising stable compounds for biosignature detection applications. These molecules have attracted the attention of scientists in connection with the discovery of sulfur compounds such as ethanethiol and thiophene in the Martian Gale Crater [3]. The emphasis is on similarities and differences in specific molecular sites (e.g., extra methylations), number of cyclizations, and changes in the integrated S-moieties. Our proposed research may provide a mechanism for successful analytical examination to determine the possible biogenicity of materials acquired and eventually recovered from Mars.

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Session Classification: Poster session