Geophysical Research Abstracts
Vol. 21, EGU2019-9085, 2019
EGU General Assembly 2019

Lipid biomarkers in high-altitude geysers with resemblance to Hesperian surfaces on Mars (El Tatio, Chile).

Laura Sánchez-García (1), Miguel Ángel Fernández-Martínez (1), Miriam García-Villadangos (1), Yolanda Blanco (1), Sherry L. Cady (2), Nancy Hinman (3), Mark E. Bowden (2), Stephen B. Pointing (4), Kevin Lee (5), Kimberly Warren-Rhodes (6,7), Donnabella Lacap-Bugler (5), Nathalie A. Cabrol (6,7), Victor Parro (1), and Daniel Carrizo (1)

(1) Centro de Astrobiologia (CIF: ESQ2818002D), Torrejón de Ardoz, Spain (lsanchez@cab.inta-csic.es), (2) Environmental Molecular Sciences Laboratory, Pacific Northwest National Laboratory, Richland, WA, United States, (3) Department of Geosciences, University of Montana, Missoula, MT, United States, (4) Yale-NUS College, National University of Singapore, Singapore, Singapore, (5) School of Science, Auckland Q11 University of Technology, Auckland, New Zealand, (6) SETI Institute, Mountain View, CA, United States, (7) NASA Ames Research Center, Moffett Field, CA, United States

Geothermal springs support microbial communities at elevated temperatures in an ecosystem with high preservation potential that makes them interesting analogs for early evolution of the biogeosphere. The El Tatio geysers field in the Atacama Desert is one of the highest hydrothermal systems (4,320 masl) in the world and has astrobiological interest due to its extreme aridity, high solar radiation, salinity and oxidant conditions during the last 10–15 millions of years, and presence of volcanic and hydrothermal activity, which resembles the ancient Mars. This is the first multidisciplinary molecular study of the biogeochemical evidence preserved in the sinter formations at El Tatio, which reveals more about the habitability, adaptability, and preservation of biosignatures in this type of Mars analogue environment.

We sampled three morphologically similar geyser mounds characterized by differences in water activity (i.e. episodic liquid water, steam, and inactive geyser lacking hydrothermal activity). Multiple approaches were employed to determine (past and present) biological signatures and dominant metabolism. Lipid biomarkers indicated relative abundance of thermophiles (dicarboxylic acids) and sulfate reducing bacteria (branched carboxylic acids) in the sinter collected from the liquid water mound; photosynthetic microorganisms such as cyanobacteria (alkanes and isoprenoids) in the steam sinter mound; and archaea (squalane and crocetane) as well as purple sulfur bacteria (cyclopropyl acids) in the dry sinter from the inactive geyser. The three sinter structures preserved biosignatures representative of primary (thermophilic) and secondary (including endoliths and environmental contaminants) microbial communities. Sequencing of environmental 16S rRNA genes and immuno-assays generally corroborated the lipid-based microbial identification. The multiplex immunoassays and the compound-specific isotopic analysis of carboxylic acids, alkanols, and alkanes indicated that the principal microbial pathway for carbon fixation in the three sinter mounds was through the Calvin cycle, with a relative larger contribution of the reductive acetyl-CoA pathway in the dry system. Other inferred metabolic traits varied from the liquid mound (iron and sulfur chemistry), to the steam mound (nitrogen cycle), to the dry mound (perchlorate reduction).

The combined results revealed different stages of colonization that reflect differences in the lifetime of the mounds, where primary communities dominated the biosignatures preserved in sinters from the still active geysers (liquid and steam mounds), in contrast to the surviving metabolisms and microbial communities at the end of lifetime of the inactive geothermal mound. Our results demonstrated the effectiveness of integrating microbiological and biogeochemical approaches to document and understand the microbial community structure and function in high-altitude geothermal environments with resemblance to Hesperian surfaces on Mars. Gathering data about the capability of different analytical techniques to decipher information from preserved fossil biosignatures is of vital importance for future astrobiological missions.