

RECENT BIOMARKER TRANSITION IN A HIGH ALTITUDE HYDROTHERMAL SYSTEM (EL TATIO, CHILE).

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Introduction: Siliceous sinter deposits are hot spring related rocks formed by a dynamic process of evaporation and cooling of thermal waters. Hot spring waters are characterized by the high concentration of many elements (chloride, sulphate, etc.) and can be supersaturated regard to an array of minerals.

Hot spring and their silica deposits are extreme environments that have received attention by many different research areas. Despite their importance in geothermal and ore exploration due to their link to high temperature (>175 °C) hydrothermal reservoirs at depth [1]. They have value information about the development and preservation of life in extreme environments that can contribute to understand early Earth environments and thus to search for possible fossil life on Mars [2]. Associated prokaryotes and eukaryotes (e.g., thermophilic bacteria, cyanobacteria, diatoms, plants) become mineralized in different sinter structures, in which they reflect the paleoenvironmental conditions in temperature, pH and hydrodynamics, from the vent of the geyser/hot spring to the distal aprons [3, 4] The aim of this work was to study the organic molecules biosignatures, the early taphonomic process and the environmental controls which drive this process in an environmental transition between a water base (NB), steam based (OB) and a dry sinter system (OM) in a high altitude hydrothermal system.

Methods: minerals were analyzed using X-Ray diffraction, ions and cations by ion chromatography and lipids biomarkers using gas chromatography-mass spectrometry.

Results: The XRD analysis indicated that the sinter (geyserite) samples are mineralogically composed of amorphous silica. Ion chromatography analysis, of geyser sinters (NB, OB and OM) samples shows different composition in inorganic ions (i.e. chlorides and nitrates) were observed to be well differentiated in the three defined sinter systems. Total n-alkanes were found at similar concentrations in the samples, with higher concentrations in the OB sample (0.08 µg g⁻¹), respect to the NB sample (0.05 µg g⁻¹) and OM sample (0.05 µg g⁻¹) The distribution of n-alkanes shows differences between NB/OB and OM samples, the fist have a clear maximum at C₁₅, C₁₇ and C₁₈ with the n-alkanes chains ranged from C₁₀ to C₃₃, meanwhile OM

had a higher chain congener distribution with a maxima at C₂₄, C₂₅ and C₂₇. Branched alkanes (mono, di, tri and tetra-methyl) were found in all the samples, with similar concentrations (0.11 and 0.14 µg g⁻¹, in the NB and OB samples, respectively), but lower concentrations were found in the OM sample (0.04 µg g⁻¹). Among this monomethyl-alkanes were the most abundant (i.e. m- m-C₁₃, m-C₁₅, m-C₁₇ and m-C₁₈) in the samples with higher concentration in the OB sample.

The n-carboxylic acids were measured in a range (2.71 to 2.35 µg g⁻¹), with higher values in the OM sample, and lower values in the OB sample. The n-carboxylic acids chains lengths ranging from C₆ to C₃₀. The congener distribution have a different trends in NB and OM with a clear dominance in the C₁₆ and C₁₈, meanwhile the maxima shift towards higher chains lengths to C₂₄ and C₂₆ in OB sample. Additionally, branched (iso, anteiso, other middle chain methyl), unsaturated, dicarboxylic and cyclopropane fatty acids were found in the samples (Figure 1).

Iso and anteiso fatty acids (C₁₅ to C₁₉) were found with C₁₅ and C₁₇ chain lengths, the most abundant ones (with NB>OB>OM decreased concentrations), branched fatty acids (methyl) were also found in the samples, following the same trend than iso/anteiso fatty acids. Unsaturated (MUFA and PUFA) , with C₁₆, C₁₈ and C₁₉ chain lengths were found (with NB>OB>OM decreased concentrations), short chain dicarboxylic acids (C₆ to C₁₀) were also found in the three samples, with higher concentration in NB sample and lower in OM. Cyclopropane acids were only found in the OM sample (Cyc17:0 and Cyc19:0) (Figure 1).

n-Alkanols (C₁₀-C₂₉) were found at similar concentrations within samples, in a range of 1.8 µg g⁻¹ to 1.12 µg g⁻¹, with higher values in the OM sample, a general dominance of C₁₆, C₁₈ were found in studied samples, C₁₄, C₁₂ and C₂₂ were also abundant.

The n-alkenes were represented by octadecene (C_{18:5}) with a range of 0.001 to 0.05 µg g⁻¹, higher values were found for the OB sample. Pristane (Pr, C₁₉) and phytane (Ph, C₂₀), were found in NB and OB samples, with a range 0.12 -0.05 µg g⁻¹ with higher concentrations in the OB sample and no detection in OM sample. Squalane (C₃₀) and Crocetane (C₁₆) were only

found in the OM sample, with 0.003 and 0.001 $\mu\text{g g}^{-1}$ respectively.

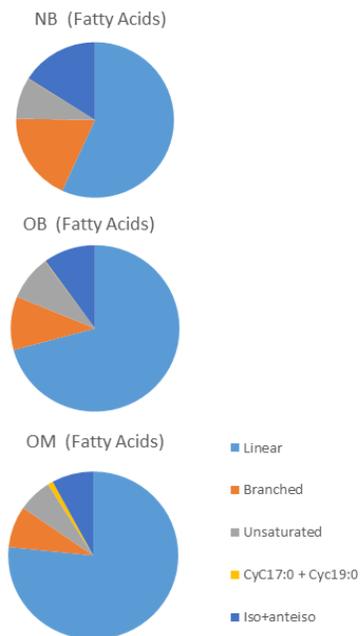


Figure 1. Fatty acid composition of the analyzed samples

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