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Mineralogy and salt contents in soils of the Atacama Desert and their impact on physical-chemical characteristics

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Two transects were selected in the hyperarid zone of the Atacama Desert (AD), with a marked regional slope to east, to characterize the geological setting of desert soils and evaluating its impact on the gas oxidizing microbiota. The southern transect, Yungay (YUN), extends 200 km from 1,242 masl, to the semi-arid slopes of the High Andes at 3,533 masl. In turn, the northern transect Baquedano (BAQ), begins at 895 masl, and continues 250 km to 4,166 masl. Sensors were installed 20 cm depth to monitor relative humidity (RH) and temperature. Samples were taken in pits at 5, 20 and 40 cm depths in August 2023, to analyze the gravimetric water content (GWC), chemical, mineralogical, granulometric and lithological composition.

Most of the sites are located in alluvial deposits from Miocene-Pliocene to Pleistocene-Holocene. In turn, the highest points of BAQ are Quaternary pyroclastic deposits (Fig. 1). The GWC ranges between 0.10 and 6.93 YUN and between 0.45 and 3 m3/m3 in BAQ. An ordination analysis (Fig. 2) indicates that the sample distribution is not dependent on the transect, but rather on factors such as the altitude, lithology and mineralogy of each site and their respective depths. The highest gypsum content stands out at YUN1005 and biotite, hematite and illite in YUN3533 present in a dacitic tuff of crystalline ash at 20 cm depth. In contrast, in BAQ the highest concentration of anhydrite at depth at BAQ1370 stands out, and a higher concentration of anorthite in a crystalline lapilli dacitic tuff at 20 cm depth in BAQ4166. Sulfate and nitrate contents are higher in the sites located to the west in both transects.

The colluvial and fluvial deposits of the AD suggest that their origin is associated with periods with rainfall that exceeded the soil saturation threshold, generating the mineralogical variability and a focused westward concentration of pedogenic salts by transport.

The impact of lithology and mineralogy on the physicochemistry of the soil suggested by the statistical analysis allows us to assume a potential causality of these variables in the distribution of the microbiota in desert soils.

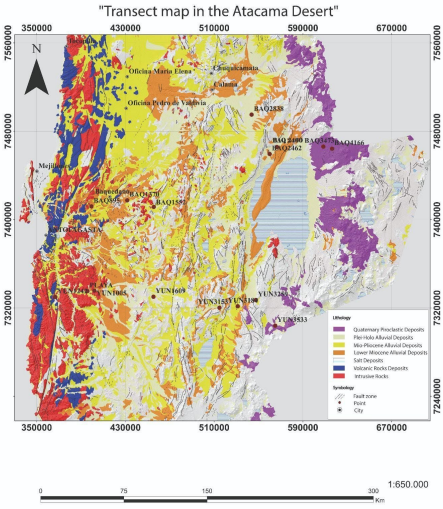

Figure 1; Map of transects in the Atacama Desert. It includes the 28 sites studied identified by the Baquedano (BAQ) and Yungay (Yun) transects, along with their corresponding altitude in masl. Additionally, it displays the lithological classification represented in colors.

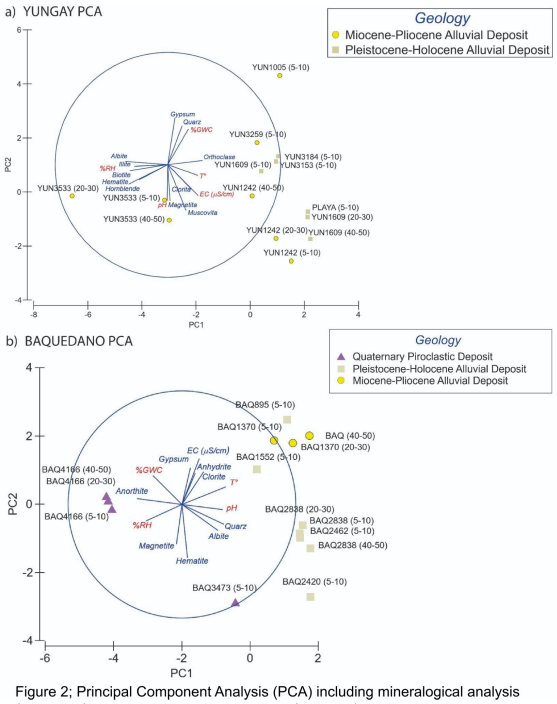

Figure 2; Principal Component Analysis (PCA) including mineralogical analysis (blue color) and environmental parameters (red color). Additionally, it encompasses the identification of 28 sites studied according to (a) the Yungay (YUN) and (b) Baquedano (BAQ) transects, along with their respective altitude in masl. The symbols of the samples represent the lithological composition.