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Assessing soil formation under coastal hyperaridity since the Mid-Pleistocene using a chronosequence dated by in situ cosmogenic ^{10}Be at Paposo, Atacama Desert (N Chile)

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Soil formation under hyperaridity is governed by the limited availability of water, biotic activity, and unfavourable soil properties, which results in a group of taxa subsumed under Aridisols according to the USDA soil taxonomy. In the Atacama Desert, previous investigations have focussed on the hyperarid core of the desert, describing and identifying soils with salic, gypsic, or nitric characteristics. Contrarily, and although also classified as hyperarid, the coastal sector of the Atacama Desert receives much larger amounts of moisture, mainly due to the orographic blocking of advective fog by the Coastal Cordillera between ~500 and ~1,200 m above sea level. Adapted to this conditions by being able to comb out precipitation equivalents of several hundreds of mm/a, Loma vegetation populates the western Coastal Cordillera and coastal plain. Despite the large climatic contrast to the core of the desert, neither the soil properties, the pedogenic processes nor the timescales on which the coastal soils evolved have as yet been studied. We therefore assessed the physical and chemical parameters of a soil catena at an alluvial fan system at Paposo, composed of four morphostratigraphic units over minimal spatial and thus climatic variation. From each alluvial fan surface generation, we sampled four upper soil profiles. On the one hand, examining the soil physicochemical parameters across the chronosequence allows to deduce the pedogenic processes that are active under coastal hyperaridity. On the other hand, we established an absolute morphochronology based on exposure dating of the depositional surfaces using in situ cosmogenic ^{10}Be, which enables us to indirectly assess rates of soil formation.

The results show mostly monotonic relationships of physicochemical soil properties with increasing time since abandonment of the first fan surface in the Mid-Pleistocene. Contrary to the expectation, a trend towards desalinization seems to prevail. Moreover, complete decalcification of the oldest soils is closely related to a drop of pH values from slightly alkaline to neutral and slightly acid conditions. Spectrophotometric analysis of the soil colour as well as the geochemistry of pedogenic iron oxides indicates that rubification is a major pedogenic process active under

coastal hyperaridity. The combined effects of soil-forming and weathering processes on the soil texture are reflected by a continuous fining towards older soils. Strong indication for in situ formation of clay-sized particles and colloids is provided by the difference of the grain size distributions calculated between two optical laser diffraction models. However, different proxies derived from bulk geochemistry do not support a relevant role of hydrolytic feldspar weathering. In contrast, a significant cumulative effect of biotic activity becomes apparent in the organic carbon content as well as the concentrations of colloidal plant nutrients, both featuring a high temporal and spatial variability.