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Unraveling the landscape evolution of the Atacama Desert coast of Northern Chile through numerical models: the Pan de Azúcar National Park study case (~26°S).

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The Atacama rocky coast in Northern Chile is a tectonically active region that displays a particular morphological assemblage along its extension. There is a major morphostructural element named the Great Coastal Cliff (GCC) that runs parallel to the coastline for almost 1000 km in hyper-arid conditions. This cliff reaches heights between 800 and 2000 m a.s.l. and its continuity is only interrupted by a few, great fluvial valleys that drain from the High Andes and by several, small creeks of the Coastal Cordillera. At the mouth of these creeks and valleys, it is possible to recognize sequences of staircased marine terraces formed and preserved by the interplay between the tectonic uplift, sea-level changes, and marine erosion action. The Pan de Azúcar National Park (~26°) is a segment of the Atacama rocky coast which exhibit a morphological segmentation along strike into three domains that shows how the GCC is limited by areas characterized by marine terraces: one domain with a high, steep scarp (>500 m) that sits on top a single shore platform, and two domains with a further inland, degraded cliff (heights <300 m) and a sequence of dated marine terraces (<400 kyr). A numerical model was used to study the morphological evolution of this segment. Results unravel that a particular tectonic history should have taken place to develop all domains. This history begins with a slow subsidence event (0.04 mm/yr) between 1 Myr and 400 kyr ago, followed to the present by several uplift events with different rates (0.25-0.35 mm/yr). These last allow the terrace emersion. Particularly, a faster uplift event after 100 kyr should have taken place to preserve the lowest terrace recorded in the study area at 7-20 m. With this tectonic history, models suggest marine erosion rates of at least > 1.5 m^2/yr (1.5 m^3 for one meter of coast length) to develop the morphology of the GCC without stair-cased terraces. Instead, much lower erosion rates of 0.25-0.5 m^2/yr or less are necessary to reproduce a shorter cliff with different terraces, i.e. low erosion rates to preserve terraces. This erosion variability is likely due to alongshore gradients in erosion efficiency by sediments-fed beaches that act as natural barriers against incoming waves, dissipating their energy. These sediments are provided by creeks with large catchment areas that discharge into the Pacific Ocean.