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Fluvio-aeolian paleogeographic evolution of the Namib Desert throughout Cenozoic climate and geodynamic changes

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Desert landscapes are highly-sensitive environments to climate changes. This high sensitivity is mostly due to their scarce water resources, together with a direct exposure of bare rocks and soils to meteorological phenomena. As a result, in these arid environments, even minor shifts in hydroclimatic conditions can significantly modify hydrography, vegetation cover, and sediment transport by rivers and winds, with major consequences for ecosystems and the people living in and beyond these drylands (~1/3 of the landmass and world population). Clarifying the relationships between desert landscapes and climate variations is therefore essential for anticipating their future evolution. In this context, studying the geological history of desert landscapes is necessary to understand how these systems respond to different climatic disturbances. In this work, we focus on the fluvio-aeolian morphosedimentary dynamics of the Namib Desert in Namibia, throughout Cenozoic climate changes. By reconstructing the paleogeographical evolution of the Namib region since the late Oligocene, we explore how the combined action of fluvial and aeolian processes has driven the spatio-temporal transformations of the regional landscape under varying climatic regimes. We compiled all the geological and geochronological constraints available on the Namib paleolandscapes in the literature, and complemented them with new remote sensing and field observations, as well as additional dating. Based on a critical synthesis of these data, we produced four paleogeographical maps illustrating three main phases of periodic expansion and contraction of the aeolian routing-system and associated landforms. We propose a late Oligocene-early Miocene landscape reconstruction preceding the earliest evidence of aeolian system development, when fluvial networks drained freely toward the adjacent Atlantic Ocean. Then, we document two major Mio-Pliocene changes: the early extension of the Namib Sand Sea and surrounding dune fields associated with an aggradation of the fluvio-aeolian systems, followed by the contraction of the sand see associate with river incisions. Finally, we also map the present-day landscape to constrain a second major phase of aeolian extension contemporaneous with river incision during the Quaternary. Together, our four paleogeographic reconstructions provide an opportunity to discuss the origins of these landscape changes in terms of climatic and/or geodynamic forcings.

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