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Late Pleistocene lake-level fluctuations and relief inversion at Paleolake Tsodilo, Kalahari, NW Botswana

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Permanent water bodies are rather exceptional in the Kalahari under today′s arid climate. However, there are drainage basins, indicating large lakes existed at least since the Middle Pleistocene during more favorable periods. One example is the paleolake Tsodilo, embedded within a linear dune system at the Tsodilo Hills, 40 km west of the Okavango panhandle in northern Botswana.

The aim of the study is to reconstruct the up to 70 km^2 large paleolake for the period of around 44-19 ka as a dynamic ecosystem, including variations in climate, weather conditions and environment. We investigate geomorphological processes which are the base for a paleohydrological interpretation of the proxy time series, especially regarding the local feedbacks within the sediment cascade. The morphostratigraphy will help to separate climatic from non-climatic processes affecting the hydrology of the ecosystem.

In order to derive a morphostratigraphical model, we focused on a multi-methodological approach for surface and subsurface topography analyses. Basin-wide, a filtering procedure with discrete wavelet transformations (DWT) was applied at different spatial levels to a high-resolution Digital Elevation Model (TanDEM-X 12 m) to detect possibly hidden patterns. However, the accuracy of the DEM is strongly influenced by the spatial variation in density and height of the savannah type vegetation as well as changing soil properties in the catchment. In order to filter random, vegetation and soil-related signal parts, different DWT were applied and inverse DWT then provided a significantly noise-reduced DEM. For model evaluation, ground control D-GPS measurements were used.
This method enabled us to extract hidden paleo-drainage channels, paleo-shorelines and -fans. The former shorelines indicate at least three different lake phases.

Furthermore, parts of the drainage features appear as positive forms, leading to the hypothesis of relief inversion. We successfully tested the hypothesis by the combined application of seismic refraction and ground penetration radar and got deeper insights into the sediment structure and thus the geomorphological evolution.

Additionally, four pits were sampled to reconstruct the sedimentation history of the lake. First results show at least two time frames of extensive and stable lake existence during MIS 3 (44-40 ka cal. BP) and the LGM (21-19 ka cal. BP). Gastropod shell-bearing sediments indicate freshwater to oligohaline conditions.

From a geomorphological point of view, our analyses suggest the existences of at least three paleolake phases with unique related drainage systems. However, the morphostratigraphy suggests inferior fluctuations with identifiable sub-phases.