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Lake-System Response to Late Quaternary Environmental Dynamics on the northeastern Tibetan Plateau

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Palaeoclimatic reconstructions in central China often rely on proxy information, obtained from single palaeoenvironmental archives at a distinct study site, such as lake sediments. Although they provide a high temporal resolution of information, their context within the acting depositional and geomorphological processes in a distinct landscape unit often is difficult to ascertain. The nature of lake systems strongly depends on catchment processes in addition to direct responses to climate forcing. In the scope of palaeoclimatic studies on the northern Tibetan Plateau and its foreland, we investigate the complex interaction of landscape evolution in response to monsoon dynamics. Our approach follows a source-to-sink approach along sediment cascades, to infer palaeoclimatic responses and to decipher internal non-climatic dynamics of the landscape system. Lake sediments represent the final and mostly complete sedimentary products, while adjacent landforms and offshore deposits provide insights into the spatial dimension of palaeoenvironmental change.

The approach of concerted geomorphological and limnogeological research was successfully demonstrated at Lake Donggi Cona on the NE Tibetan Plateau at 4,090 m elevation. The 30 km long, 8 km wide, and 90 m deep lake occupies a pull-apart basin. Sub-bottom profiling revealed the presence of tectonic structures as well as subaquatic terraces and ancient fan systems from former low lake stands, draped by younger lake sediments. A prominent moraine arc in the vicinity of the lake can be attributed to a glacial advance during an early stage of the last glacial cycle. Several terrace levels and fossil lake sediments of early to mid-Holocene age around the lake shore document former stages of higher lake level of about 10 m above present level. In addition to alluvial processes, dunes and loess-like sediments in the catchment of the lake give evidence of differing stages in the intensity of aeolian sediment mobilisation or fixation.

Lake development is documented by multi-proxy data in a series of sediment cores across the lake basin. The oldest recovered sediments, younger than 18 ka BP, comprise siliciclastic laminates and lateglacial saline shallow-lake sediments, overlying basal sands. The deposition of fine-grained marls and enhanced biological production characterized the deep lacustrine environment of the Holocene. A switch from a closed lake basin with brackish conditions towards an open oligotrophic fresh-water basin after 6.8 ka BP is indicated by ostracod assemblages and changes in carbonate chemistry. This change in hydrology likely was triggered by tectonic pulses along the Kunlun Fault, an area with severe earthquake activity. Pollen records exhibit climate signals and indicate moist conditions in the early Holocene. During the same time, loess sediments have been preserved from a period from 10.5 to 7.5 ka BP, related to the strengthening of the insolation-driven Asian summer monsoons. This time was characterized by wetter and warmer climate and supported the trapping of dust. A dry and cooler climate resulted in the reactivation of dune sands from 3 ka to present, possibly in combination with stronger human influence.