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Windows into the past: On-shore high-stand sediments from lake Donggi Cona, NE Tibetan Plateau

E. Dietze (1), B. Wünnemann (2,1), K. Hartmann (1), B. Diekmann (3), S. Opitz (3), M. Paprotzki (1), M. Runge (1), S. Yang (4), and G. Lockot (1)

(1) Free University Berlin, Geographical Sciences, Geosciences, Berlin, Germany (elisabeth.dietze@fu-berlin.de), (2) School of Geography and Oceanography, Nanjing University, China, (3) Alfred Wegener Institute for Polar and Marine Research, Research Unit Potsdam, Germany, (4) State Key Laboratory of Frozen Soils Engineering, Cold and Arid Regions Environmental and Engineering Research Institute (CAREERI), Lanzhou, China

Lake sediments integrate a variety of environmental processes of different trigger mechanisms that affect a lake catchment (i.e. climate, tectonics, man). Detrital fractions of lake sediments provide information on sediment transport processes, while element and mineral composition represent provenance, authigenic and post-depositional alteration of lake sediment. However, little is known to what extent both proxy groups contain local (e.g. tectonic) or regional (i.e. climatic) signals, especially in large, heterogeneous catchments. To assess past climatic changes multi-proxy records should be unmixed (e.g. by eigenspace analysis). By including the geomorphological context high-stand lake sediments intercalating with terrestrial sediments in on-shore terraces provide a powerful record of past environmental processes in specific time windows.

We present a study from Tibetan lake Donggi Cona, Qinghai province, China. It is influenced by monsoonal air masses of different origin and character, highly variable in space and time. The currently open freshwater lake (230 km^2) belongs to a pull-apart basin at the Kunlun fault. Its catchment (3200 km^2) is very heterogeneous in its geological and geomorphological configuration. Four generations of on-shore terraces at 17 m, 10.1 m, 6.1 m and 3.5m above the present lake level (i.e. at 4090 m a.s.l.) can be found ubiquitously around the lake. They contain sub-catchment specific facies of lacustrine and terrestrial (dominantly fluvial) sediments. Grain size distributions, element and mineral composition have been analysed with a laser diffraction particle size analyser, ICP-OES and XRD, respectively. Transport processes are quantified from end-member modelling using grain size data. Geochemical processes are unmixed by factor analysis of element and mineral data. Radiocarbon dating of 25 Radix shells and bulk lake sediment samples at 8 sediment profiles of different elevation around the lake provide the time frame.

Comparison with sediment cores from the lake bottom allows a detailed reconstruction of the small-scale hydrological signals, which are reflecting Late Quaternary monsoon dynamics as well as local geomorphological processes. The first two lake high stand phases between 11.8 ka BP and 7.4 ka BP and around 6 to 5 ka BP are interpreted as climate-related and were characterized by a positive water budget with phases of high-energy fluvial dynamics and varying aeolian input. Two further terrace generations formed during Late Holocene and since the 1970s. These are of local character and represent a short-term blockage and an artificial lowering of the lake outlet, respectively. We estimate the total lake volume varied between < 50% (LGM) and > 177 % (Early Holocene) compared to 2001. Altogether, our statistical methods applied on high-stand sediments in on-shore terraces enable a detailed, quantitative palaeoenvironmental reconstruction for certain time windows. Unmixing of sediments and the consideration of sub-catchment specific geomorphological dynamics allow a differentiation between local and regional, climatic and non-climatic processes.