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The Hei River Basin in northwestern China - tectonics, sedimentary processes and pathways

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The Hei River Basin (catchment area of c. 130,000 km^2) is situated at the transition between the northern margin of the Tibetan Plateau and the southern slopes of Gobi-Tien-Shan. As part of the northwestern Chinese deserts, the Ejina Basin (Gaxun Nur Basin) constitutes the endorheic erosion base of the drainage system. The basin – hosting the second largest continental alluvial fans in the world, is tectonically strongly shaped by the Gobi belt of left-lateral transpression.

The tectonic setting in combination with competing climatic driving forces (Westerlies and summer/winter monsoon currents) has supported the formation of a valuable long-time sediment archive comprises at least the last 250,000 yrs. of deposition. It is composed by the interplay of eolian, fluvial and lacustrine sedimentation cycles and today is dominated by widespread (gravel) gobi surfaces, insular dune fields and shallow evaporitic playa areas. Thus, it provides excellent conditions to investigate tectonic evolution and Quaternary environmental changes. Recently, geomorphological, geophysical, neotectonic and mineralogical studies have enhanced the understanding of the environmental history and the modern depositional environment. Moreover, the role of the Hei River Basin as an important source area of silt particles which were later deposited on the Chinese Loess Plateau is evaluated. Therefore, a 230 m long drill core, sediment sections and ca. 700 surface samples throughout the whole catchment and basin were analyzed.

Instrumental and historical seismicity are very low, but the proximity to active fault zones and dating irregularities in earlier publications indicate evidence for deformation in the study area. Despite flat topography, indications of active tectonics such as fault-related large-scale lineations can be observed. Seismically deformed unconsolidated lacustrine deposits (seismites), presumably of Holocene age, are evident and must be related to the nearby faults.

The upper catchment is represented by the Qilian Shan mountain range and its immediate foreland. Here, a tripartite altitudinal distribution of terrestrial sediment archives is evident, which is representative of catchment-wide sedimentological processes. Insights into their formation mechanisms, therefore, add valuable perspective regarding the reconstruction of sedimentological and paleoenvironmental conditions in the depositional area of the Hei River Basin.

For the characterization of provenance and dispersal of Quaternary sediments in relation to the modern depositional environment, over 200 surface samples from the whole catchment were analyzed using XRD and XRF measurements on the clay fractions, heavy minerals and bulk sediments. The clay mineral results in-particular show that it is possible to discriminate between the chlorite rich metamorphic sediments originating from greenschist bearing rocks in the Qilian Shan Mountain Range in the south, and the more intrusive rocks from the Bei Shan Mountain Range west of the Hei River Basin. Additionally, these two main sources reflect different transportation processes; the Qilian Shan sediments are mainly transported by the rivers Heihe and Beida He, and the deposition of the Bei Shan sediments is mainly driven by wind or local runoff.

Grain size results of primary loess deposits indicate different eolian transport pathways, i.e. far-travelled dust input (medium silty) vs. local deflation from active fluvial channels (fine sandy). Along the altitudinal transect, the varying geomorphological settings exert a significant influence on the grain size composition showing an increased contribution of far-travelled dust at higher altitudes.