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From source to sink in the sediment cascade of the Hei-River Basin: Implications for late Quaternary landscape dynamics in the Gobi Desert, NW China

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The Hei River Basin with a catchment size of ∼130,000 km^2 is host to one of the largest continental alluvial fans in the world. The basin comprises: (1) its high-elevated river sources in the glacier and the permafrost zone of the Qilian Mountains, (2) the semi-arid foreland of the Hexi Corridor in the middle reaches and (3) the endorheic Ejina Basin (Gaxun Nur Basin) as its recent sink. The river basin is characterized by small subcatchments of hyper-arid mountain ranges of the Gobi-Tienshan and Beishan as well as of smooth and fuzzy water divides of the Hexi-Corridor and the Badain Jaran Sand Sea. Up to 300 m of Quaternary sediments establish the large Ejina Basin, with a size of 28,000 km^2, as an excellent archive for environmental reconstructions located at the recent intersection of westerly and monsoonal air masses. Three sediment cores (up to 230 m long) provide evidence of sedimentation dynamics over the last 250,000 years, and cover at least two terminations since OIS 6. The sediments have to be regarded as a result of the interplay between tectonic activity and climate dynamics, accompanied by a related eolian and hydrological response of the catchment. Thus, it is crucial to understand and reconstruct the sedimentary processes along the huge sediment cascades, and to identify the most important sediment sources.

Here we present a provenance analysis from mineralogical fingerprints of modern sediments that have been deposited along recent pathways from the sources to the Ejina Basin. The methodical approach combines the analysis of clay minerals, bulk mineralogy, and bulk geochemistry. Furthermore, we use heavy mineral data obtained from automated particle-analysis via a computer-controlled scanning electron microscope (CCSEM) and XRD measurements. We analyzed ∼200 surface samples from the whole catchment as reference material, as well as the upper 19 m of cored sediments, to gain insight into temporal changes of depositional processes and provenance. Geostatistical analyses of the compositional data reveal a clear discrimination between sediments from the Qilian Shan in the south and from local basin sediments in the north. Moreover the mineralogical fingerprints allow the differentiation of sources from intrusive rocks that are dominant in the Bei Shan mountain sub-catchment, and from greenschist-bearing metamorphic rocks, that are widespread in the Qilian Mountain catchment. Finally, we draw conclusions about the main transport processes and pathways from assumed source regions to the sink (Ejina Basin).

The provenance analysis of the sediment core reveals strong changes from local (Bei Shan) to long-distant (Qilian Shan) sources. The Late Pleistocene record reveals frequently changing sediment supply between periodic high mountain runoff and local episodic runoff. We assume that these variations are related to basin internal processes (e.g. fan dynamics, tectonics) and changing environmental conditions that are linked with variations in meltwater runoff and precipitation in the upper reaches of the southern catchment. These conclusions are supported by grain size characteristics that indicate phases of predominant alluvial activity and limnic deposition around the Late Glacial to Holocene transition and enhanced pre-Holocene eolian activity.