Quaternary paleoenvironmental change preserved in alluvial fans systems in semiarid to arid mountain areas: Examples from western Mongolia, western USA, and the Chilean Andes

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Alluvial fans represent complex landforms with the potential to record past environmental conditions. However, their decryption is difficult as their formation depends on a broad set of influences (catchment properties, climate, accommodation space, base level change). A comparison of alluvial fans in three (semi)arid regions aims to illuminate dominant controls on alluvial fan evolution.

Large scale alluvial fans in the semiarid to arid mountain areas of western Mongolia, southwestern USA, and the northern part of the Chilean Andes are controlled by different sediment supply. Geomorphological processes in these mountain ranges vary along altitudinal and latitudinal gradients and, additionally, due to climatic change during the late Quaternary. Alluvial fans in Mongolia (Gobi Altai and Mongolian Altai) are mainly formed during the Pleistocene. Higher terraces and alluvial fan generations can be dated to the penultimate glacial cycle. Sheet flow dominated as alluvial fan constructing process during the last Glacial. Since the late Glacial, debris flow accumulation and Holocene incision occurred (Lehmkuhl et al. 2018). Quaternary alluvial fans in mountain areas of the southwestern United States develop in three major settings related to the availability and nature of sediment transport. These include alluvial fans that develop in: i) glaciofluvial settings, ii) areas of tectonic uplift, and iii) regions dominated by periglacial processes. There is evidence for Pleistocene periglacial activity throughout the mountain ranges of the American Southwest in different elevations (Löhrer, 2008). Frost weathering in periods of higher moisture produces debris in the catchment areas and, thus, primarily governs the sediment supply of alluvial fans during the Pleistocene. In the semiarid Andes of northern Chile, alluvial fans form in similar glaciofluvial as well as fluvial settings in elevations above ~4000 m asl.

A comparison between these three (semi)arid systems shows that the main fluvial activity occurred during cold and semihumid phases of the Pleistocene resulting in an altitudinal lowering of periglacial processes, thus leading to a higher sediment supply. In addition, in all these regions higher lake levels occurred during the transition from glacial to interglacial periods, e.g. from the Pleistocene to the Holocene. Moister conditions during the transitions control the interplay between lake level variations and the fluvial activity.
