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OSL dating of fluvial terraces for incision rate estimation and indication of neotectonic activity in Pamir

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ThePamir owes its special attraction for geo-scientists to being among Earth's largest intra-continental orogens and to display some of the highest uplift rates as well as to host among the most powerful river systems on the planet. The evolution of the drainage network as a proxy for the landscape's response to tectonic signals provides a powerful tool to study neotectonics. The relation between tectonic forcing and surface response is indicated by structural anomalies (e.g. river-capture, river-reversal or –deflection) and spatial differences of process rates (e.g. incision rates). We combine OSL dating with remote sensing tectonic geomorphology in order to determine the zones of active deformation in the Quaternary.

The local drainage system of the study region aligns mainly to the east-west-trending belts of shortening, which results from the ongoing northward propagation of the Indian plate. In contrast the major trunk river, the Panj, is unusual in that it deflects northwards and then doubles back to the southwest, cutting the southern and central Pamir doming and several other major Cenozoic deformation zones.

We use fluvial terraces along the deflected north-south orientated part including the doubled back prolongation of the more or less normal orientated Panj. These sediment bodies are used as a geomorphic record to reveal changes in the balance between sediment flux and discharge. Dating these fluvial terraces by OSL provides the burial ages of the sediments indicating periods of sedimentation. The remains of those periods are far from equally distributed and mark the time of local conditions for sedimentation as especially the close neighbourhood of most of the terraces from the two youngest periods demonstrate.

Precise measurements of the heights of the dated terraces with respect to the present river level based on relative kinematic GPS quantify the total vertical incision of the river subsequent to the sedimentation and abandonment. Incision rates from about 2 mm/a to more than 11 mm/a are measured. Young fluvial terraces generally provide high incision rates (7 – 11 mm/a), whereas the oldest terraces give incision rates of about 5 mm/a. This likely reflects the averaging effect over much longer period of time including several distinct periods of fast and maybe event-related incision altered by periods of low geomorphologic activity in the sense of no incision, maybe even sedimentation.

Further evidence for the important role of neotectonic forcing to surface response processes in Pamir is deduced from remote sensing techniques. Prominent knickpoints do not refer to lithological boundaries and therefore, illustrate a rather composite character of the longitudinal river profile pointing at certain localities of neotectonic activity. Very small valley shape ratios were derived from valley cross-sections orthogonal to the longitudinal profile and demonstrate generally deep valleys relative to their valley floor width. The analysed geomorphological indices (incision rates, longitudinal profile, valley shape ratios) speak for enhanced geomorphological activity after sedimentation (especially of the last terrace generation) driven by local base level changes, which result most likely from feedbacks to neotectonic processes.