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Uplift and River Incision of the western Pamir Plateau - New insights from river-profile analysis and thermochronology

Rasmus Thiede (1), Edward Sobel (1), Paolo Ballato (1), Mustafo Gadoev (2), Ilhomjon Oimahmadov (2), and Manfred Strecker (1)

(1) Potsdam University, Erd- und Umweltwissenschaften, Potsdam-Golm, Germany (thiede@geo.uni-potsdam.de), (2) Acad o Science of Republic of Tajikistan, Inst. o. Geology, Seismology, Dushanbe, Tajikistan

The mechanisms responsible for driving the growth and destruction of orogenic plateaus are subject of ongoing international debate. In addition to thermo-mechanical and structural models, a third class of models emphasizes the pivotal role of surface processes in concert with tectonic processes. The Pamir forms the NW extension of the Tibetan Plateau. Crustal shortening along its western and northern flanks continues until today. In contrast to other Cenozoic plateaus, major climatic gradients in the Pamir are oriented E-W, perpendicular to N-S oriented crustal shortening. The tectonic growth, uplift and incision history of both marginal and interior parts of the Western Pamir are poorly constrained.

To assess the impact of the surface-process system on the geomorphic evolution of the plateau, we performed several standard morphometric analyses. In detail, we analyzed local topographic relief, the overall character of the drainage network, knickpoints, and river concavities. We have also begun measuring apatite He/U-Th data (AHe) to obtain the timing of incision. Combined, the geomorphic observations and the thermochronology data provide proxies for the uplift history of the orogeny, which may ultimately provide data to infer the nature of deep-seated processes that caused uplift and the formation of a plateau in this region. We focus on the western margin of the Pamir , where we observe three zones with different geomorphic characteristics of fluvial network. First, along a 50-km-wide swath across the W-NW flank of the orogen, we find low-relief landscapes with gentle, concave river profiles which are interrupted by major knick points and steep segments in the downstream longitudinal river profile draining towards the deeply incised trunk river, the Panj River. These areas may correspond to pre-uplift relict landscape sectors. Second, beyond this western to northwestern frontal zone lies the Panj River, which has confluences with rivers from five major watersheds which drain the internal parts of the western plateau margin. All of these tributaries are deeply incised (2-3 km) and U-shaped in the vicinity of the mouth, and rise continuously until they reach the plateau realm. In turn, tributary valleys to these valleys are over steepened or convex, with concavities less than <0.3. In many cases, these valleys have the typical morphology of glacial hanging valleys. Three preliminary AHe cooling ages between 5 and 3 Ma provide valuable estimates on the timing of valley incision, indicating that incision started not earlier than latest Miocene. Third, the central and eastern parts of the Pamir are predominantly characterized by wide, sediment filled basins at elevations >3km and gentle stream gradients.

Based on our preliminary observations we suggest that (1) the frontal segment of the western flank of the Pamir has been rapidly uplifted on the order of 2 to 3 km and (2) the internal portion of the western flank of the orogen constitutes an important orographic barrier for westerly moisture sources, which facilitated the Cenozoic glacial overprint of this region. The topographic growth of the western flank is recorded by the deeply incised hydrologic system draining the plateau interior and its margins. Our preliminary AHe data indicate that this process started during the late Miocene.