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From depth to surface: how deep-earth processes and active tectonics shape the landscape in Pamir and Hindu Kush

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The Pamir and Hindu Kush are located at the western tip of the India-Asia collision zone. Approximately a third of the northward motion of India's western syntax is mostly accommodated by continental-scale underthrusting of the Indian plate beneath Asia. On its way northwards the arcuate, convex Pamir mountain range acts as a rigid indenter penetrating the weaker Eurasian plate, while lateral extrusion occurs to the west in the Tajik Depression.

Intense present-day shallow seismicity indicates active deformation along the northern and north-western semi-arid margin of the Pamir, where over the last century several M>6 and three M>7 crustal earthquakes, including a recent M6.4 event in 2016, were recorded. Earthquakes are distributed in the proximity of three main fault systems: the Pamir thrust system to the north, and the Darvaz fault and Vakhsh thrust system to the north-west. The pronounced topographic expression of these lithospheric faults is associated to a deeply incised landscape, which was profoundly shaped by past widespread glaciations. The transient evolution of the landscape following deglaciation is observed in the dynamic river network, characterised by intense fluvial incision and changes in the fluvial connectivity of the drainage system.

At depth, recent seismic tomography studies suggest delamination, stretching and tearing of the Asian slab beneath SW Pamir, and slab break-off underneath Hindu Kush. Slab break-off episodes are known to result in stress surges in the overlying lithosphere, potentially causing deformation and uplift.

In this complex system characterised by an important interplay between tectonics, climate and surface processes, we use qualitative and quantitative analyses of the topography and of the drainage systems evolution, inclusive of numerical tools, in order to define what is –and has been- the role played by the main lithospheric active faults of this area. In addition, we aim at identifying how landscape and surface dynamics respond, temporally and spatially, to processes, such as slab tearing/break-off, occurring at depth.

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