The Tectonic Evolution of Fault Systems with Strong Lateral Variations in Tectonic Style: The Trans-Indus Ranges (Northern Pakistan)

POSTER

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The main focus of this ongoing study is the structural evolution of fault systems with lateral variations in tectonic style between compression and transpression. Such fault systems have been recognized in many mountain belts. However, due to the complex pattern of deformation their formation is still poorly understood, and the tectonic interpretation of regions affected by this kind of deformation is difficult.

The Trans-Indus Ranges are part of the young and still active frontal thrust system of the NW-Himalayan foreland fold-and-thrust belt which is characterized by the occurrence of several pronounced structural re-entrants and promontories. Studies of such structurally complex fault systems in actively deforming regions are important because they can provide information that is usually not available in older mountain belts but necessary to understand the mechanics of their formation. A particularly attractive aspect of the ongoing project is the young age of deformation in the study area (< 1 Ma ?), which allows a very precise quantitative assessment of the rates of deformation. Furthermore, thermal and tectonic overprinting which has occurred in many older mountain belts is absent, and exposure is excellent in most of the region.

Preliminary results of a first field season in the Trans-Indus region (11/91 to 1/92) indicate that the emergence of the Trans-Indus Ranges was controlled by a system of frontal ramps that form the centers of re-entrants and promontories, and lateral or oblique ramps that form their edges. The construction of balanced cross-sections shows that the total shortening along the frontal ramp segment represented by the western Khisor Range is on the order of at least 10 km. This suggests that the deformation along the lateral and oblique ramps is characterized by a strike-slip component of similar magnitude. Pronounced bends of structures in the Khisor Range near the transition zones to adjacent regions of transpressive deformation suggest that vertical axis rotations occur in these areas. Structures show an apparent clockwise rotation near the western end of the Khisor Range, which is truncated by a right-lateral strike-slip fault, and an apparent counterclockwise rotation near its eastern end, which seems to be truncated by a left-lateral strike-slip fault. The sense of the apparent rotations is therefore compatible with the assumed relative motions along the lateral terminations of the Khisor Range. Alternatively, the observed bends could simply reflect a complex ramping geometry, in which case vertical axis rotations would not have occurred at all. Present fieldwork (12/92 to 3/93) therefore includes sampling for a paleomagnetic investigation to test these hypotheses.

With the exception of the results of our previous investigations in the Trans-Indus Ranges, quantitative data on the deformation in that region are not yet available. The main goal of our study therefore is a qualitative analysis of the structural style of deformation, and a quantitative assessment of the total deformation.

The area presently represented by the Trans-Indus Ranges was part of the Himalayan foreland basin and received synorogenic deposits during Late Neogene folding and thrusting further north, and was subsequently deformed as part of the hangingwall of the younger frontal thrust system in the south. The onset of deformation in the Trans-Indus region should be reflected by decreasing sedimentation rates of the more distal facies with a source area further north, and subsequent nondeposition and erosion, or deposition of proximal deposits that have the Trans-Indus Ranges as source area. Ongoing research therefore integrates sedimentological and chronostratigraphic studies of the synorogenic deposits with structural investigations in this area.

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The structural portion of this work includes detailed field mapping to provide constraints on the style of deformation. This mapping also is the basis for the construction of balanced cross-sections that are needed to quantify the total amount of shortening along the Trans-Indus Ranges. The chronostratigraphic studies will include paleomagnetic age determinations of young synorogenic molasse deposits, and fission track dating of volcanic ashes within that sequence. These studies will provide information on the age ranges and deposition rates of syntectonic sediments. Together with sedimentological mapping of syndeformational unconformities, facies changes and paleocurrent analyses these results will constrain the temporal and spatial character of deformation in the NW-Himalayan foreland.