NEOTECTONIC INFORMATION FROM DRAINAGE BASIN GEOMETRY IN THE TAJIK DEPRESSION

Alexandra Käßner, Richard Gloaguen

TU Bergakdemie Freiberg, Department of Geology
Bernhard-von-Cotta-Straße 2, 09596 Freiberg

1. INTRODUCTION

Tectonic geomorphology examines the relations between the processes that build topography and those that tear topography down. The main part of erosion is concentrated along rivers. Thus examination of rivers and watersheds is a strong tool in geomorphology and may be the key to understand the interactions between tectonics and erosion. Neotectonic movements have the capability to change the position of watersheds and the relationship between watershed and stream. By and by the geometry of the watershed will tend to reach an equilibrium state that is manifested in defined hillslopes and a centered stream course. Deviations from the equilibrium state are a strong indication for neotectonics.

2. AREA OF INTEREST

India collided with the southern margin of Asia 50Myr ago [1]. During this collision, the Cretaceous and Paleogene deposits in the Tajik basin were deformed into a thin skinned fold and thrust belt. The folded sediments are up to 10km in thickness. The basic decollement is a layer of Jurassic Evaporites. The fold and thrust belt is made up of a series of anticlinal ranges, striking nearly N, which swing into parallelism to the Gissar belt toward north. Both the fold-and-thrust-belt and the Gissar range (southern part of Thien Shan), which is likely a left-lateral strike-slip fault [1] are the focus of this study. The depression is situated at the northwestern margin of the Pamirs.

3. METHODOLOGY

Both the form of a watershed basin and the relation between a stream and its basin can be analysed by remote sensing techniques to gather information about neotectonic folding and faulting.

The analysis is performed on SRTM DEM with a resolution of 90m.

3.1. Basin Asymmetry

In a steady state landscape with uniform lithology streams will flow along the centerline of the watershed basin [2], [3]. Valley sides and therefore hillslope angles are controlled by threshold processes such as landslides. Thus a watershed basin with uniform hillslope angles and same slope length on both sides will evolve, if the system is not disturbed by changing rock types or tectonic influences.

The basin centerline suggested by Cox [2] can be defined using the medial axis transform (MAT, also called skeleton), which is a popular approach to abstract the structure of shapes [4].

As a tool for neotectonic investigations basin asymmetry may indicate recently tilted fault blocks or actively growing folds.

3.2. Basin Elongation

Basin elongation is quantified by comparing basin major and minor axes [5]. The length of these axes can be computed from the minimum area enclosing rectangle. For strongly irregular polygons this rectangle is approximated by first calculating a bounding box with minimum and maximum x- and y-coordinates. The area of the first bounding box can be compared to the

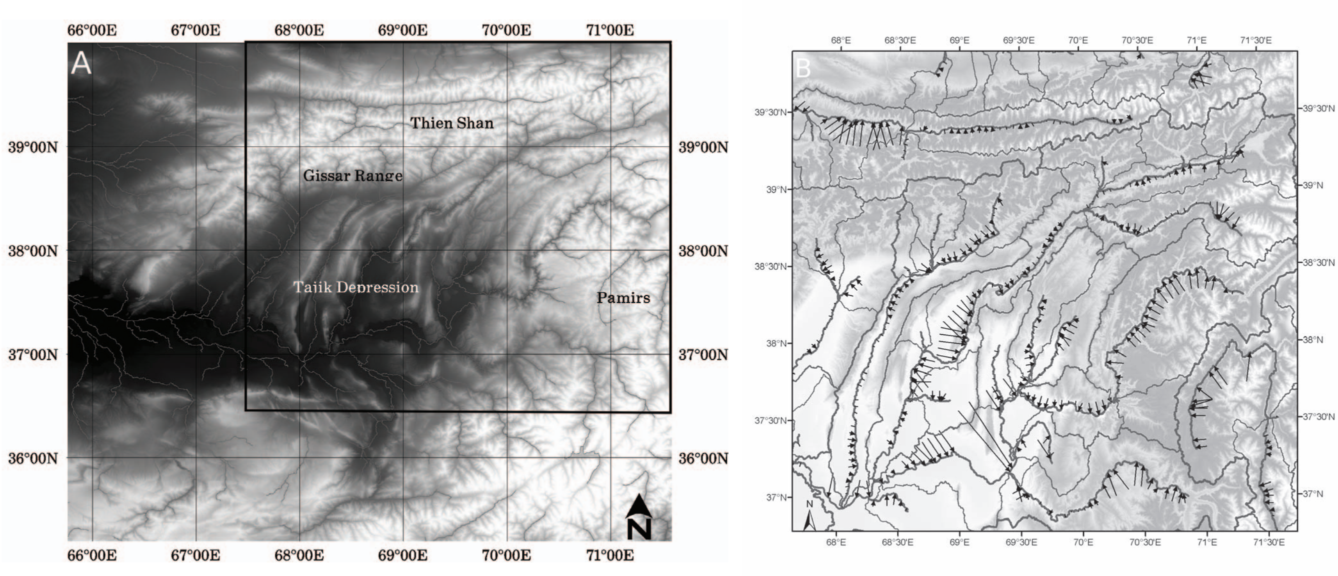

Fig. 1. A:SRTM DEM of the Tajik Basin and surrounding mountain ranges. The black box shows the location of map B. B: Assymetry vectors for streams of Strahler order 5 and 6. The direction of movement in the Pamirs and the Thien Shan can be observed as well as the fold growth in the depression.

area of a bounding box of the same irregular polygon slightly rotated. If the area becomes smaller, the operation is rerun until a minimum area is reached. The relation of length and width are used to calculate the basin elongation.

4. RESULTS

The result of the method of basin asymmetry is a vector field describing the deviation of streams from the basin midline. Watershed basin size is selected according to the Strahler stream order. That means the basin outlet is situated at the point of conjunction of two smaller streams to form a larger one.

Using these techniques, it is possible to understand recent evolution of a fold and thrust belt such as the Tajik depression. Growth of single faults and piracy caused by folds or faults can be analysed (see figure 1 B).

5. REFERENCES

[1] O. Burgeois, D. Cobbold, D. Rouby, Thomas J.C., and V. Shein, “Least squares restoration of Tertiary thrust sheets in map view, Tajik depression, central Asia,” *J. Geophys. Res*, vol. 102, no. 12, pp. 7553–27574, 1997.

[2] R. T. Cox, “Analysis of drainage basin symmetry as a rapid technique to identify areas of possible Quarternary tilt-block tectonics: An example from the Mississippi Embayment,” *Geological Society of America Bulletin*, vol. 106, pp. 571–581, 1994.

[3] J. Garotte, R. T. Cox, C. Swann, and M. Ellis, “Tectonic geomorphology of the southeastern Mississippi Embayment in northern Mississippi, USA,” *GSA Bulletin*, vol. 118, no. 9,10, pp. 1160–1170, 2006.

[4] S. Rana and M. Batty, “Visualising the structure of architectural open spaces based on shape analysis,” *International Journal of Architectural Computing*, vol. 2, no. 1, pp. 123–132, 2004.

[5] N.W. Harkins, D.J. Anastasio, and F.J. Pazzaglia, “Tectonic Geomorphology of the Red Rock fault, insights into segmentation and landscape evolutionof a developing range front normal fault,” *Journal of Structural Geology*, vol. 27, pp. 1925–1939, 2005.