Geophysical Research Abstracts, Vol. 7, 09536, 2005
SRef-ID: 1607-7962/gra/EGU05-A-09536

Active tectonics and continental topography development in the Pannonian basin

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This paper presents an overview on the active tectonic processes and related continental topography development in the Pannonian basin system. The Quaternary through recent 3D deformation pattern and related landscape evolution have been analysed. The obtained data and structural models indicate a strong spatial as well as temporal variation of horizontal and vertical motions during the latest stages of basin evolution. Accordingly, the related structural styles of basin inversion vary both in time and space, resulting in a complex pattern of ongoing tectonic activity. As a result of "Adria-push", i.e. the main driving force of active tectonic processes in the Alpine-Pannonian region, significant compressional stresses are concentrated in the underlying lithosphere of the actively inverting Pannonian basin. This is well demonstrated by the results of neotectonic structural studies, seismological analysis and contemporaneous stress data, and has led to large-scale lithospheric buckling manifested in significant differential vertical motions and active faulting associated with the recorded seismicity. The spatial distribution of subsiding and uplifting areas inside the Pannonian basin shows a very characteristic pattern. Several flat-lying, low-altitude areas (e.g., Great Hungarian Plain, Danube basin, Sava and Drava troughs) have been continuously subsiding since the onset of basin formation in the early Miocene and were completely filled with a 500-2500 m thick Pliocene-Quaternary alluvial-lacustrine sequence. In contrast, the periphery of the basin system and some internal mountain ranges, such as the Transdanubian Range (TR), have been uplifted and significantly eroded since late Miocene-Pliocene times. Quantifying uplift and erosion rates by means of low

temperature geochronology, in relation with the estimated rates of active tectonic processes, has been crucial to the understanding of the 3D topography development in the area. The focus has been put on determining the amplitude and rates of uplift and denudation processes to explore the interaction mechanisms between tectonics, erosion and climate. A key factor is the quantification of feedback between deep crustal/lithospheric processes and the observed Pliocene-Quaternary to recent surface deformation patterns. The ages of several ancient landforms have been determined by means of cosmogenic noble gas isotopes, providing the cosmic-ray-exposure history of the area, which includes mainly the axial zones of the uplifting TR in the central part of the Pannonian basin. Data were collected at selected geomorphic profiles for systematic exposure-age determination of terrace horizons along river Danube. In addition, upper Miocene sandstone series showing traces of wind erosion (ventifacts) were also probed for exposure-age dating. Further to the southwest, results of structural analysis along the Mid-Hungarian shear zone provided additional constraint for the style and rates of the vertical and the horizontal component of deformation in Transdanubia. Data suggest that structural inversion and related deformation progressively propagated into the basin interior. The temporal and spatial evolution of fault kinematics indicate a relatively early (latest Miocene) onset of basin inversion closest to the front of “Adria-push”, the main engine driving inversion in the Pannonian basin. Uplift and fault reactivation has gradually become more and more delayed (Pliocene through Quaternary) towards the east-northeast, i.e. at greater distance from the collision zone between Adria and the Dinarides. This temporal migration of inversion in the Pannonian basin is a remarkable feature and provides valuable constraints for the analysis of basin inversion mechanisms. It also underlines the great importance of a multidisciplinary approach when analysing active tectonic tectonic and related landforming processes.