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ACTIVE TECTONICS, DOMAINAL DEVELOPMENT OF TOPOGRAPHY AND DRAINAGE PATTERNS IN THE CENTRAL EASTERN ALPS: A GEOMORPHOLOGIC INDICES STUDY

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The geomorphologic evolution of drainage basins and river systems of the Eastern Alps as well as the Cenozoic formation of peneplain surfaces reflect the Neogene extrusion and uplift processes (e.g. FRISCH et al. 2000). We have defined two principal research areas for this study because these areas reflect two different tectonic domains affected by these tectonic processes: the Tauern window area with strong Neogene exhumation and Pliocene and Quaternary surface denudation and the Gurktal/Murau Mountain area with Neogene to Quaternary block uplift following an early Neogene peneplanation. We used quantitative geomorphic indices which have been developed in areas of active tectonics (e.g. KELLER & PINTER, 1996) to describe the present landscape in the two test areas and to test methods in an area with glacial overprint on morphology.

The Tauern window is characterized by almost orogen-parallel strike-slip faults with eastwards trend due to the continental plate collision. N-trending joints are common in the interior, low-angle normal faults are located along the western and eastern margins of the window and display a SSW-NNE trend (NEUBAUER et al., 1999 and references). In the Gurktal/Murau Mountains, the valleys follow WSW- and dominantly NW-trending faults not considered in present tectonic models.

The Gurktal/Murau Mountains show a lower overall elevation, extended remnants of former peneplains and short and steep valley systems with various directions. Low rates of uplift and small differences in relief caused less intense erosion and denudation and therefore, the preservation of elevated Neogene peneplains. The entire region was uplifted and tilted eastwards after Middle/Late Miocene. Incision of recent valleys is a result of the block uplift (EDER & NEUBAUER, 2000). We can observe flat peneplain surfaces at high altitude (at 2.000 meters a.s.l.). Two different sorts of valleys with different features can be observed. (1) Valleys placed at the upper part of the mean stream are very short (2 to 7 km) with higher river gradients. Some of these rivers present longitudinal sections with peneplain surfaces that are separated by steep slopes that sometimes include gorges/incised valleys range between 50 and 300 meters in elevation. These features may indicate apparent discontinuous uplift, glacier activity and that these valleys were affected by the uplift and tilting process during standstill periods of the uplift process. (2) Other valleys are located at lower altitudes further east and show very flat final portions and no peneplain surfaces. These features may indicate that the valleys are affected by lower rate of uplift than further to the east. The peneplains studied along these valleys were observed at the upper part of the Gurk between 1.000 and 1.800 meters.

In the Tauern window area the valleys are controlled by the fault patterns therefore the general drainage basin structure in Tauern window follows parallel and perpendicular valleys. All valley systems present deep and long valleys (10-20 km long) with north trending direction. The highest points range between 2.100 and 2.800 meters high and the confluence to the Salzach base level river is placed between 750 and 900 meters ele-

vation. The deep, flat ground and wide valley floor portions with U-shape reflect the Quaternary glacier activity. Incision of the recent valleys can be observed as steep portions with gorges, which also reflect the Pliocene to Recent uplift. A common feature can be found in several valleys: Sometimes the peneplain surfaces can be correlated at the same height level, for example, between 1.500 and 1.700 meters high, a peneplain surface can be observed along the Krimml Ache, Obersulzbach, Kapruner Acher and Stubache.

Within the Tauern window, the peneplains can be observed in all the valleys studied from 800 metres to nearly 2.500 meters altitude. The peneplains are separated by steeper portions including gorges and deeply incised valleys whose thickness range from 50 to 800 meters. Even four levels of peneplains were found in some of these rivers and sometimes the peneplain surfaces placed in different valleys can be correlated at the same elevation level.

Holocene river terraces present in this region were deposited after the last glaciation both in the Tauern and Gurktal areas. Two or even three sedimentary levels can be observed along the different valleys studied. The river terraces deposited before the last glacier span were eroded by the glacier-cap. Therefore these sedimentary levels would reflect the same processes as the terraces in Gurktal and they can be correlated. The river terraces in the Tauern window area are thicker than the terraces in Gurktal. The reason may be a higher rate of subsidence and posterior uplift due to the glacier-isostasy which produced thicker terraces in the Tauern window than in Gurktal. Due to the glacier sheet, which in the Tauern window may have reached even 2000 meters thickness, the subsidence and uplift rates were higher than further east in the Gurktal area where the sheet reached only about 500 meters.

Morphometry in geomorphology is defined as a quantitative measurement of landscape shape. Drainage basin asymmetry (*AF*) is 100(Ar/At) where *At* is the total area of the drainage basin, *Ar* is the area of the basin to the right (facing downstream) of the trunk stream. The drainage basin asymmetry *AF* was studied for two areas along the eastern and western margins of the Tauern window. *AF* in the *Lieser* drainage basin is 62.3 %, that of the *Ziller* drainage basin 64.9 %. In this region the uplift and the tilting process occurred westwards therefore the same effects are supposed to be found on drainage basins but in the opposite direction.

Vf is the Valley-floor width-to-height ratio. When calculating *Vf* these parameters are measured at a set distance from the mountain front for every valley studied. This index differentiates: (1) Broad-floored canyons, with relatively high values of *Vf and (2)* V-shaped valleys, with relatively low values of *Vf.* High *Vf* values are associated with low uplift rates, so these streams cut broad valleys floors, low values of *Vf* reflect deep valleys with streams that are actively incising, commonly associated with uplift. Different measurements of *Vf* have been performed for the Krimml stream, Tauern window area. We have obtained both high values as well as low values where high values corresponding with low uplift rates and broad-floored canyons were found not only next to the confluence but also at the distance of 10 kilometers from the confluence where a peneplain is situated. The low values of Vf, which indicate V-shaped valleys and uplift were measured not only at the upper part of the stream but also at the distance of 4.75 Km. These values corresponding with the steep sections of Krimml.

The principal reason is that some peneplain surfaces are placed along the Krimml stream at different height levels. These peneplain surfaces were formed before the uplift process. They are very flat ground and wide areas with very high width of the valley floor. This sort of valley formed by the Quaternary glacier activity that modeled the valleys in this region as *U-shaped* valleys resulted. Contemporaneously they have been affected by uplift during Pleistocene and Holocene. At the present these peneplains can be observed in different areas like Gurktal or Tauern at different elevations, although we have not observed any at the lowest part of Gurk. All *Vf* values have been measured 3 km from the con-

fluence of the streams. In general *Vf* values are low which indicate an uplift process. Within the Gurktal area the highest values are in secondary streams at the lowest part of the Gurk river. The lowest values correspond to a higher uplift rate measured in secondary streams at the upper Gurk valley. We can see that the streams at the upper part of the Gurk are very narrow in contrast to the streams in the lower Gurk, which are very wide.

References

EDER, N. & NEUBAUER, F. (1999): On the edge of the extruding wedge: Neogene kinematics and geomorphology along the southern Niedere Tauern, Eastern Alps. – Ecl. Geol. Helv., 93, 8 1 –92.

FRISCH, W., SZEKELY, B., KUHLEMANN, J. & DUNKL, I. (2000): Geomorphological evolution of the Eastern Alps in response to Miocene tectonics. – Z. Geomorph. N.F., 44, 103–138.

KELLER, E.A. & PINTER, N. (1996): Active Tectonics. Earthquakes, Uplift, and Landscape. – 338 p., Prentice Hall, Upper Saddle River/NJ.

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