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Pliocene to recent surface motion and indentor-induced deformation in central Eastern Alps: tectonic vs. climatic controls

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Neogene tectonics of Eastern Alps is governed by indentation of the Adriatic microplate into the Alpine orogenic wedge, and associated eastward lateral extrusion of eastern part of Eastern Alps along sinistral and dextral strike-slip faults. In principle, this tectonic setting is still in operation as earthquakes along the sinistral Inn Valley, Salzach-Enns, and Mur-Muerz faults and dextral Save fault and GPS data indicate. The driving force is the ca. northward motion of the Adriatic microplate, which leads to indentation of the Venetian platform at the northern tip of Alps forming the Friuli orocline. GPS data indicate eastward motion of the extruding block in the Eastern Alps. Further geodetic measurements display pronounced surface uplift (ca. 1.5 mm/a) of the Hohe Tauern area. Pliocene, Quaternary and Recent deformation structures of Central Eastern Alps are studied in an ongoing project. Pleistocene conglomerates are widespread along fault-controlled valleys. Many of conglomerate exposures show thrust respectively normal faults and a set of joints with a preferred orientation with a ca. NNW- to subordinate NW-, resp. rare NE-trend. These are considered to represent extensional joints due to NNW-SSE/NW-SE resp. local NE-SW shortening consistent with focal plane solutions of earthquakes. These observations argue for a similar, post-Riss/Wuerm interglacial age of these structures although present-day seismicity is relatively weak (M=3-4) in the region. Shortening (and waning seismicity?) may have also resulted in surface uplift of several blocks and in northward tilting of the Dachstein paleosurface, a pronounced Neogene peneplanation surface of the Northern Calcareous Alps. These new data significantly extend knowledge of Pliocene/Quaternary to present-day deformation and stress of state in Eastern Alps. A review of existing data shows several distinct areas with different orientations of

stress conditions. In Central Eastern Alps, NNW-trending shortening prevails although structural and geomorphic evidence for N-S extension along the Salzach-Enns fault and E-W extension within the Tauern window exists. Dominant NNW-SSE shortening in central sectors of Eastern Alps systematically changes to NE-SW shortening in northeastern sectors. The tectonic signal of surface uplift is superposed by the signal of post-glacial unloading and is estimated now at ca. 1.5 mm/a, which is obviously related to the distribution of the last, Würm ice shield. However, due to topography and limited thickness of the Alpine ice shield, we calculate a vertical motion in the order of minimum 60 and maximum 180 metres. Five sets of moraines walls in the Alpine foreland suggest a fivefold cycle of ice-loading and unloading during the last ca. one million years. Observations from ice shield and climatic proxies argue for slow ice-shield build-up and rapid ice decay. For Holocene, series of elevated river terraces indicate stepwise surface uplift with increasing surface elevation from external Alps towards the Hohe Tauern with a minimum of 60 meters of terrace elevation in the centre. The present-day rivers incise into bedrocks, sometimes blanketed by moraines, so that the Holocene uplift is ca. 5 mm/a close to the Hohe Tauern, more than in external sectors of Eastern Alps where the Holocene river terraces are at much lower elevation. Cyclic Pleistocene surface uplift is monitored by a number of other geomorphologic effects including: (1) river terraces external to the area covered by the Alpine ice shield, (2) bedrock terraces along valleys in the centre of the Eastern Alps, (3) gorges along rivers, which could have been formed during rapid surface uplift due to rapid post-glacial river incision, and (4) elevated Pleistocene karst caves close to present-day river levels.