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Evidence for activity of the Inn Valley fault zone (Tyrol, Austria) from earthquake and GPS data

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The lower Inn valley shear zone is a Tertiary strike-slip fault which obliquely cuts the Northern Calcareous Alps. Seismicity along the Lower Inn valley (Tyrol, Austria) has been known for a long time. The strongest earthquakes with intensities up to I0= 8 occurred in medieval times. Instrumentally determined earthquake hypocenters are scattered horizontally in a several km wide zone and vertically across the crust down to a depth of 12km. Broad scattering probably results from a combination of a) inaccurately determined hypocenters and b) the fact that present-day deformation does not occur along a single fault. When moving along the Inn valley from SW to NE, the base of the hypocenter distribution rises along a line inclined 9° to SW. This WSW-downplunge trend corresponds to depths of the top of the European crust, proved by wells. According to our interpretation of the TRANSALP seismic section deep hypocenter clusters are located in a ramp fold of the European crust.

Recent in-situ stress measurements from a reconnaissance tunnel in the northern flank of the Inn valley and from deep boreholes south of the Inn valley revealed that the maximum principal stress direction is oriented subhorizontally in NW-SE to NNW-SSE direction. Data are in line with the regional stress field (World Stress Map). We conclude that deep structures in the European crust control neotectonic activity in the alpine nappe stack:

-The offset of the strong reflection pattern of the autochthonous Mesozoic below the Inn valley is interpreted as inverted half graben structures.

-Earthquakes extending into the European plate indicate active reverse or oblique faulting caused by ongoing N-S shortening between the Adriatic and European plates. Present-day deformation north of the Tauern Window is concentrated along the Alpine

basal thrust and extends also into the European plate.

-Above the ramp fold structure of the European crust the deformation is transferred to the surface through the Alpine nappe stack by the broad seismotectonic zone of the Lower Inn valley. Focal mechanisms indicate strike-slip and thrust mechanisms with approximately N-S shortening direction.

The misfit between the major stress axis from borehole measurements (˜NW-SE to NNW-SSE) and the major stress axis orientation calculated from focal mechanisms and moment tensor solutions (˜N-S to NNE-SSW) might be explained by stress de-coupling between different depth levels of the orogen.