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Geodesy and seismicity in the Eastern Alps

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Combination of weekly solutions of the EUREF permanent GPS network (EPN) with similar solutions for national networks of permanent stations enables velocities to be reliably computed for a locally denser network than the EPN, while maintaining proper alignment and scale. Scattered velocities can be further analyzed by suitable algorithms, such as Least Squares Collocation, to yield estimates of the horizontal velocity gradient, and hence the eigenvectors of the strain rate tensor. If such estimates are done at locations with a distribution of neighbor velocities sufficiently dense and homogeneous, the principal directions of strain rate are affected by uncertainties sufficiently small that they provide a geophysically meaningful estimate of the average surface strain rate in the area. If a seismic catalogue is also available, a number of important questions can be addressed, such as a) how does the strain rate released seismically relate to geodetic strain rate? b) what is the maximum earthquake magnitude expected in a seismic province of known Gutenberg –Richter 'a' and 'b' parameters and geodetic strain rate? c) how does failure on a fault at depth relate to strain measured geodetically on the surface?

The area of the Eastern Alps is covered by several Austrian and Italian permanent GPS stations, in additions to those contributing to the EPN, and has an excellent catalogue of historical earthquakes. Based on available strain rate maps, we show that a) the strain rate which, according to the Kostrov formula, has been released in the past 30 years is typically one order of magnitude larger than the strain rate measured geodetically, about 30 nanostrain/year. One needs to sum the seismic moment of individual earthquakes backwards in time for approximately 160 years for the seismically released strain rate to equal the geodetic strain rate; b) with the Gutenberg Richter's a and b parameters computed for events in the past 160 years we show that the equality between geodetic and seismic strain rates constrain the maximum earthquake magnitude to M=6.7; c) using a simple slider block model on an inclined plane, and the Coulomb Failure criterion to describe quantitatively the sliding instability, we estimate the pattern of strain rate which is expected to be measurable on the surface above a locked reverse fault. We show that failure is expected where the horizontal strain rate at the surface has a minimum: for reasonably low values of the coefficient of static friction and dip angles, the normal stress has a small horizontal component at the point of failure, explaining a small strain rate measured at the surface.