Ongoing orogeny? Comparing Miocene and recent dynamics of the Eastern Alps for seismic risk assessment

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Miocene as well as active tectonics in the Eastern Alps and the surrounding areas are triggered by the plate convergence between Europe and the Adriatic plate. A comparison of reconstructed Miocene convergence rates with GPS data (H. Sünkel, Technical University of Graz) serving as a snap-shot on recent plate motion indicates continuous convergence with a velocity similar to the Miocene average. We report on a first approach of a geologic study which is carried out to discriminate faults in the Alpine thrust belt which could account for this shortening and to assess the seismic potential of such faults. The Austrian Alps show moderate seismicity and maximum intensities of historical quakes of I_0=9. Until now, seismic hazard assessment relied on the probabilistic analysis of historical earthquake catalogues, which, however, are extremely short compared to any geological process and which may be incomplete.

The fault pattern in the Eastern Alps is dominated by Miocene thrusts and strike-slip faults which formed in a N–S to NW-SE-compressive paleostress field. The paleostress directions are comparable to recent NNW- to NW-directed compression indicated by focal solutions and in-situ stress measurements. The comparison of the Miocene fault pattern in the Eastern Alps with the location of earthquake hypocenters and with the orientations of nodal planes of focal solutions indicates a good agreement of Miocene and recent kinematics. Neotectonic slip may dominantly occur on (N)NE- and NNW-striking strike-slip fault zones which are favourably oriented with respect to the compression direction. Frequency analyses of faults lengths show that most faults have lengths between 10 and 30 km. Large fault zones like the Inntal-, Salzach-Ennstal-, Mur-Mürz-, Vienna Basin-, Lavanttal and Periadriatic faults display variable segmentation with about 100 km maximum lengths of individual segments. Faults in the northern parts of the Eastern Alps root in the Alpine floor thrust and do not penetrate to the basement, thus only dissecting the uppermost 10 km of the crust. Information about the depth range of faults in the Central Eastern Alps comes from rheological modeling of the Alpine lithosphere which indicates that, due to the thermal structure of the lithosphere, brittle fracturing is restricted to the uppermost 10–15 km of the crust. This matches the observed distribution of hypocenter depths. This reasoning allows to estimate maximum strike-slip fault surfaces which are in the order of 500 to 1000 km, and which could be used to constrain the magnitude of the hypothetical largest possible earthquake.