Seismotectonics of the Eastern Alps: New insights from earthquake studies within 4D-MB

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DOI: http://dx.doi.org/10.17169/refubium-41070

The recent installation of the dense SWATH-D network in the Eastern Alps, integrated into the broader AlpArray, provides the basis for new detailed and consistent studies of small to moderate seismicity. In the SPP project *'From Top to Bottom – Seismicity, motion patterns and stress distribution in the Alpine crust'* and the follow-up project *'Constraints on quaternary processes in the Eastern Alps from a new detailed image of seismicity'*, we have focused on event detection, precise location, analysis of seismicity clustering and detailed source parameter studies, involving methodological advancements and subsequent application to the seismological SWATH-D and AlpArray data.

Here, we summarize the main results of our completed and ongoing work:

1. We have developed a new, python-based tool for automated station quality control of dense seismic networks and arrays and applied it successfully to the permanent and temporary AlpArray networks as well as to the denser SWATH-D network (AutoStatsQ, [Petersen et al., 2019]). The toolbox uses a combination of observed and synthetic teleseismic event data to identify and quantify errors in amplitude gain and sensor orientation and to correct the stations accordingly.
2. Based on methodological tests adapted for the complex tectonic setting in the Alps, we have performed centroid moment tensor inversion of seismicity with MW ≥ 3.0 recorded by the AlpArray network and compared the solutions to historical earthquakes, recent seismicity, published focal mechanisms, and GNSS deformation data ([Petersen et al., 2021]). We additionally applied epicenter clustering to resolve in detail the heterogeneity of tectonic movement. Thrust faulting is dominant in the Friuli area of the eastern Southern Alps, related to the N–S convergence of the Eurasian and Adriatic plate and counterclockwise rotation of Adria relative to Europe. Strikeslip faulting with similarly oriented P- axes is observed along the northern margin of the Central Alps and in the northern Dinarides, consistent with right-lateral strike-slip faults and high shear strain rates. The NW Alps exhibit deviant behavior, with NW–SE-striking normal faulting events and NE–SW-oriented T- axes. Faulting styles in the SW Alps are more heterogeneous, with a majority of earthquakes related to an extensional stress regime.
3. We have designed a workflow which combines a priori information from local catalog and waveformbased event detection, subsequent GPU-based event search by template matching, P & S arrival time pick refinement and location in a regional 3-D velocity model. Application to the SWATH-D data provided for the first time a consistently processed seismicity catalog for the Eastern and Southern Alps, which has a magnitude of completeness of −1.0 ML, involves event classification and includes > 6, 000 earthquakes [Hofman et al., 2023a]. The newly revealed clusters better illuminate the fault structures at depth, and we detected and located additional, mostly weak events, a part of them pointing to small, but active upper crustal deformation in the Dolomite indenter, along the Pustertal-Gailtal Fault and in the Tauern window.
4. In our ongoing work, we characterize the earthquake distribution in more detail, using novel approaches from Graph theory, waveform similarity-based clustering and stacked- waveform moment tensor Inversion [Hofman et al., 2023b], [Petersen et al., 2020], [Petersen et al., 2023].

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