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Assessment of quality and consistency of S-wave arrivals in local earthquake data

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Structural models of the lithosphere based on P-wave velocities only lead to large ambiguities in terms of composition and physical parameters (e.g. fluid content, temperature). Additional information about S-wave velocities can put important constraints on composition and the physical state of the lithosphere and improve the accuracy of the earthquake location. Because waveforms of S-waves of local earthquakes are often contaminated by P-wave coda and S-P phase conversions, correct identification and timing of S-wave arrivals are difficult and sometimes ambiguous. Existing data quality assessment methods like Wadati inversion, which assumes a constant v_P/v_S ratio, are hampered by the fact that both location and residuals strongly depend on the velocity model.

To check the consistency of the picked S-wave arrivals obtained from the routine analysis of local earthquake data at the Swiss Seismological Service (SED) between 1999 and 2004, we relocate selected local earthquakes in Switzerland using P- and S-arrivals independently, with minimum 1D and 3D velocity models. Assuming a comparable resolution of the 3D P- and S-wave velocity models, we expect only slight deviations in location and residuals in case of consistently picked S-wave arrivals. In contrast, inconsistently picked S-arrivals would lead to prominent differences in both parameters. To relocate local earthquakes in Switzerland, we first derive a 3D model for P-wave velocities for the region by local earthquake tomography, using P-wave arrivals only. In a second step, we determine the best possible S-wave velocity models (minimum 1D and 3D) by inverting S-wave travel times. Relocated hypocenters and residuals are compared subsequently with the results of the P-wave study. In addition, we compare the resulting v_P/v_S ratios with the ratios derived from simultaneous Wadati inversions

and discuss the resulting consequences for S-wave identification and picking accuracy in the context of S-wave tomography.