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H/V mapping of active faults in the urban area of Aachen, Germany

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In the vicinity of the Lower Rhine Graben, Aachen is located in one of Germany's most seismically active regions. The ongoing process of synsedimentary fault block tectonics causes highly variable soft cover layer thicknesses. Due to a lack of drillings which reach the bedrock in this area, for many of the potentially active faults neither location nor offset is known in detail.

We attempted to learn more about the faults' spatial distribution and conducted 194 noise measurements in two areas NW and S of Aachen's densely developed city centre. With the horizontal to vertical (H/V) spectral ratio technique, we derived the resonance frequencies of mainly Late Cretaceous and Quaternary deposits. These overlay the internally folded thrust sheets of Devonian and Carboniferous bedrocks, which have been multiply faulted since Tertiary. We calibrated the frequencies and derived a transfer function using lithology information from boreholes close to our measured profile lines.

Based on an interpolation of the transfer function's results, we mapped the subsoil thicknesses to identify the locations of faults. Even in densely settled areas, we were able to estimate their trace by profiles perpendicular to the fault. Between Mt. Lousberg and Mt. Königshügel (NW of the city centre) the sedimentary cover increases from about 50 m to 108 m. In the extension of the Laurensberg fault S of the city centre, the thickness rises from 28 m to 64 m from E to W. The observed shifts in thickness led to a relocation of the NW-SE trending Laurensberg fault and two of its parallel normal faults, of which one is currently not represented in the geological maps. The Lousberg fault, with a vertical offset of approximately 10 m, seems to be less active and relevant compared to the Laurensberg and Königshügel faults with large vertical offsets up to 17 m. It appears that the offset between Mt. Königshügel and Mt. Lousberg is not only concentrated on the Laurensberg fault but it is also distributed on the Königshügel and Lousberg faults.

Additionally, we developed the relationship between average shear-wave velocities and thicknesses of soft cover layers. Local shear-wave velocity-depth profiles and an evaluation of the amplification potential of the deposits provide the basis for further research on the consolidation of soft layers in Aachen.