Earthquake Microzonation Mapping in Lörrach and Weil am Rhein, Southern Upper Rhine Graben

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Introduction

The study area around the cities Lörrach and Weil am Rhein in Baden-Württemberg is situated next to the Swiss and French border in the southern part of the Upper Rhine Graben [*Figure 2*]. The densely populated area at the bend of the Rhine River exhibits a prominent earthquake risk.

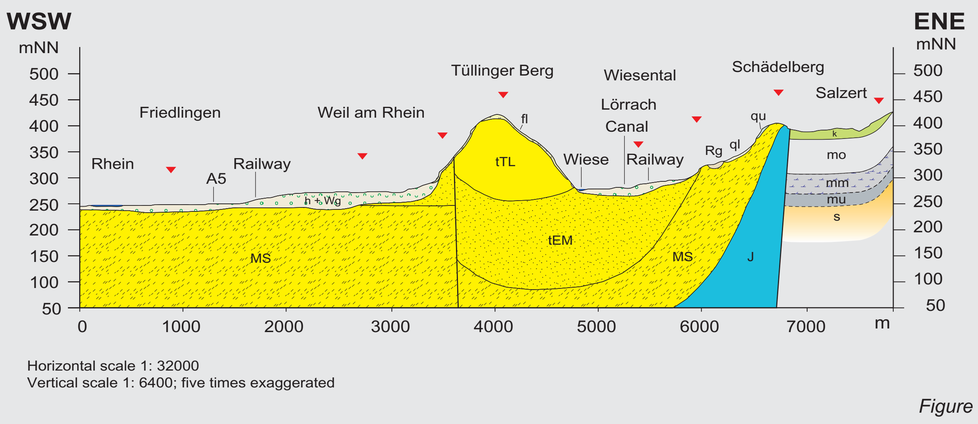
In the event of a major earthquake, ground motion and the related seismic hazard strongly depend on local geology and tectonic features. Therefore, the aim of this project is the compilation of a hazard microzonation map, which describes the amplification effects on seismic waves in the investigation area.

As a cross-border-project of France, Switzerland and Germany the microzonation maps for the conurbation of Basel, Mulhouse, Lörrach and Weil am Rhein will finally be joined together.

Geology

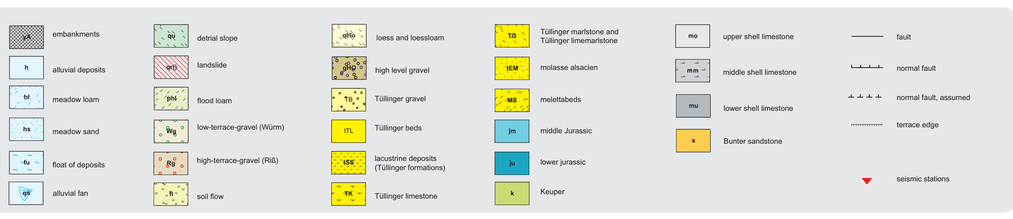
The geological situation in the area of interest is shown in the map [*Figure 2*] and in the geological section [*Figure 1*]. These two figures give an insight into the complicated tectonic structure extending from the Dinkelberg across the Eastern Master Fault to the Tüllinger Berg and the Rhine River.

At the current point the ongoing work is to provide a geological model that will serve as a basis for understanding the geophysical model. *Figure 3* shows the western part of the study area extending from the Rhine River to the foot of the Tüllinger Berg. The layer of loose rock has been removed, the remaining surface corresponds to the rock surface (top Fels). For visualisation of this layer the isopaches had to be constructed. The channel that can be seen in the SW of *Figure 3* represents an old riverbed, most probably of the Rhine River. In the northern part the erosional work of the Kander River also left a small furrow.



Horizontal scale 1: 32000
Vertical scale 1: 6400; five times exaggerated

Figure 1



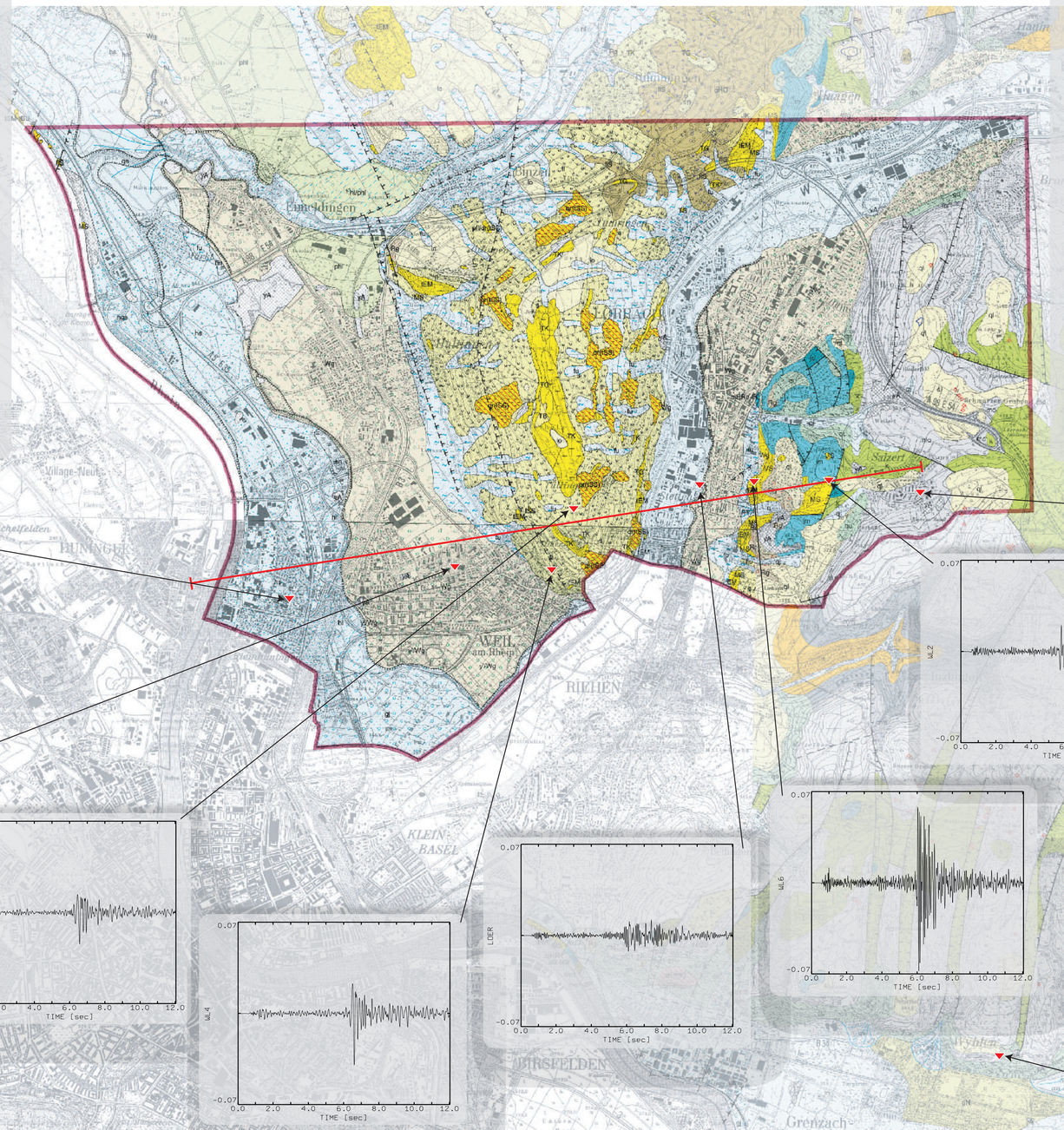


Figure 2

Earthquake recordings

To record actual earthquake signals eight seismic stations were set up in a profile from the Dinkelberg across the Tüllinger Berg to the River Rhine.

The geological map and the section [*Figure 1+2*] show the positions and the geology beneath the seismic stations. A first indication of actual ground motion amplifications in the target area could be derived from the recordings of the 2004 May 28 earthquake near Brugg (CH, ML=4.4, distance range from 36 km to 45 km). Mainly across the Eastern Master Fault, the horizontal seismograms show strong variability of the peak ground acceleration of neighbouring stations by a factor of up to 3 [*Figure 4*, all seismograms use the same scale!]

Geophysical approach

Besides active-source shear-wave seismics (here carried out by the GGA*, Hannover) the measurement of ambient noise spectra has become an important tool for the compilation of microzonation maps. In general, peak frequencies of the horizontal over vertical spectral ratio (H/V) are identified with the fundamental resonance of the sedimentary package and hence are inverted for shear-wave velocity depth models. H/V measurements were performed at all of the seismometer sites shown above and a striking correlation was found between H/V-amplitudes in the 0.7 Hz to 5 Hz range and the horizontal peak ground acceleration of the 2004 May 28 earthquake [*Figure 5*].

If this correlation can be further established H/V-amplitude measurements will be a tool for the direct determination of relative site amplifications in case of an earthquake.

*GGA: Institut für Geowissenschaftliche Gemeinschaftsaufgaben, Hannover.

Figure 4

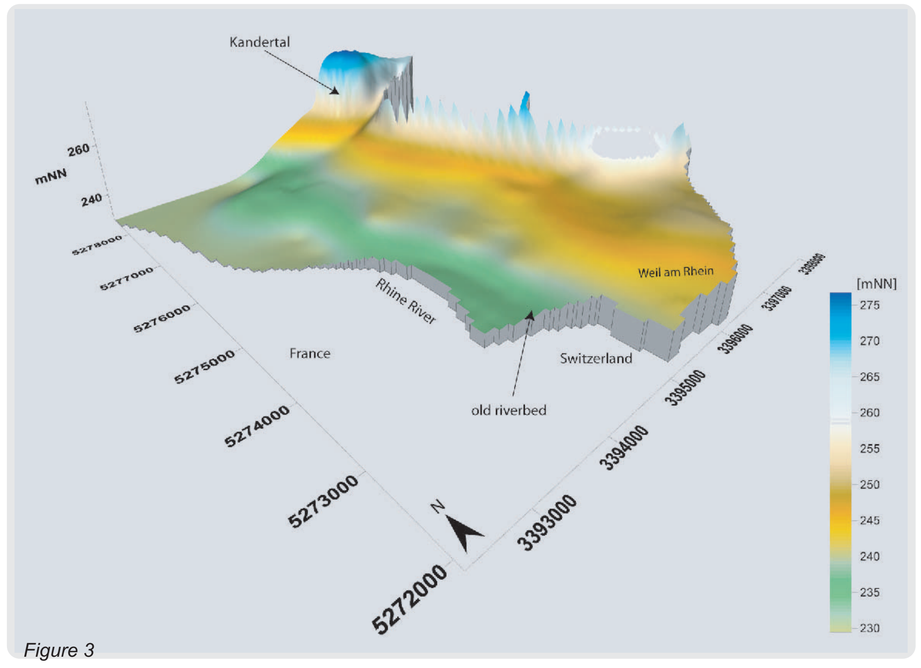


Figure 3

Outlook

Geological data is found as point information or line information (tectonic features) at best. The same holds for geophysical data with point measurements (ambient noise, earthquake signals) or line measurements (shear-wave seismics).

The main task of the described project is to complete the currently available data with more and more robust information towards detailed two- and three-dimensional models of the study area. With these models a hazard microzonation map can then be compiled.

Acknowledgements

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Contact

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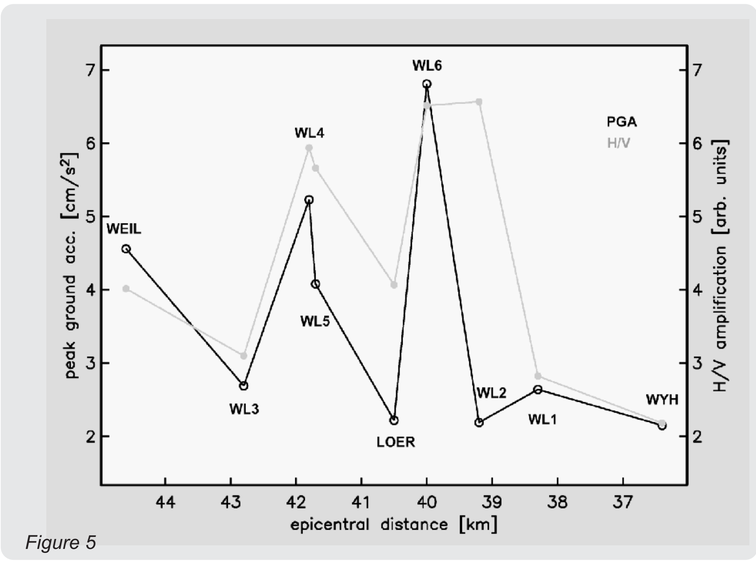

Figure 5

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