Seismotectonic regions in Germany and adjacent areas - Concept and results -

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1. Concept and goals

Our new concept explicitly takes into account the two aspects of a seismotectonic region, which were not considered in detail in the previous studies: (1) a transparent implementation of the required criteria of uniform geological structure and development (Fig. 1), and (2) the role of the geological history. The new regionalization will consider geological boundaries that continue to mid-crustal depth. The geological history will be tracked by the evolution of major fault systems (without the Alpine region) over six time slices: (1) Permian, (2) Triassic, (3) Jurassic to Early Cretaceous (Fig. 2), (4) Late Cretaceous, (5) Cenozoic (> 25 Ma) and (6) Recent (< 25 Ma).

For each time slice we have delimited areas according to deformation intensity and coded them by use of different transparencies T of deformed areas in the maps (Fig. 2 and Fig. 3): (a) without deformation (T = 100 %), (b) with unknown deformation (T = 90 %), (c) with moderate deformation (T = 85 %) and (d) with high deformation (T > 70 %). When different time slices are superimposed, areas with repeated strong deformation appear darkest, areas without deformation remain white.

In a further step that is still in progress, for each time slice, a subset of active faults will be identified based on geological evidence for fault activity at that time (Fig. 2).

4. Superposition of all time slices and seismicity

Fig. 4: Superposition of all time slices and seismicity for the period 1000-2006 from SHARE European earthquake catalog (SHAREver3.3). Earthquake activity and regions with strong or repeated past deformation do not always coincide. E.g. London-Brabant Massif (LBM) with no deformation is characterized by high earthquake activity. Tornquist-Teisseyre-Zone (TTZ) with high deformation show only rare single earthquake events (faults and cities as in Fig. 1).

5. Results: The new seismotectonic regions

Fig. 5: Superposition of all time slices and seismicity for the period 1000-2006 from SHARE European earthquake catalog (SHAREver3.3). Earthquake activity and regions with strong or repeated past deformation do not always coincide. E.g. London-Brabant Massif (LBM) with no deformation is characterized by high earthquake activity. Tornquist-Teisseyre-Zone (TTZ) with high deformation show only rare single earthquake events (faults and cities as in Fig. 1).

3. Example Time slice 3 Jurassic to Early Cretaceous

Fig. 2: Time slice Jurassic to Early Cretaceous. The different deformation intensities are shown in different grey tones. The more detailed (cf. Fig. 1) extensional/transitional fault systems that are active in this period are shown in black, moderately active faults are grey, faults with no or unknown activity are white.

6. Conclusions and Outlook

(1) Areas with strong accumulated deformation during all time slices are: the central part of Germany, the Lower Rhine Embayment, the Glückstadt Graben, the Horn Graben, the Eger Graben and the Tornquist-Teisseyre-Zone.

(2) Areas with low deformation are the Bohemian Massif, the Rhenish Massif, Ardennes and the Molasse Basin.

(3) London-Brabant Massif and East European Craton are almost undeformed.

(4) In the Cenozoic rift system strong geological deformation coincides with historical earthquakes (Lower Rhine Graben, Upper Rhine Graben, Eger Graben, Fig. 3).

(5) North of the Cenozoic riffs, relatively sparse seismicity traces areas of strong Mesozoic deformation (Mesozoic Inversion Belt, Tornquist-Teisseyre-Zone).

(6) Some areas of high earthquake activity are located in regions of no or low past deformation (London-Brabant Massif, Altstadt shear zone).

(7) The final regionalization will combine the regionalization based on geological history (Fig. 4) as shown here with another one based on seismicity. Both can be modified independently and assigned different weights.

References


Carte géologique de la France 1:1.000.000 (1968), Bureau de recherches géologique et miniéres, France. Institut géographique militaire (Belgium), different tectonic maps of the Dutch Ministry of Economic Affairs, The Hague.


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Seismotectonic regions are a basic input in seismic hazard assessment. We are developing a new regionalization based on the definition in the Safety Standard of the Nuclear Safety Standards Commission of Germany KTA 2201.1 (2011-11): “A seismotectonic unit is a region for which uniformity is assumed regarding seismic activity, geological structure and development and, in particular, regarding neotectonic conditions. A seismotectonic unit may also be an earthquake source region.”