Geophysical Research Abstracts, Vol. 8, 02569, 2006
SRef-ID: 1607-7962/gra/EGU06-A-02569

0.0.1 Topography and recognition of earthquake-prone areas

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A zero approximation in forecasting extreme events is resolving a question of where such events can occur. The question is highly important for knowledgeable seismic hazard assessment. We present the results of long-term studies on recognition of areas prone to large earthquakes that were initiated by the pioneering work by Gelfand et al. (1972). The research methodology combines geological and mathematical approaches. The geological approach employs topographic data for the mapping earthquake-controlling structures or nodes formed around fault intersections) and do not use the knowledge of regional seismicity. The nodes are delineated with the morphostructural zoning method (MZ) based on the concept that the lithosphere is built-up by different-scale blocks separated by mobile boundaries. MZ maps show the regional hierarchical block-structure with the boundary zones and the loci of the nodes. The division of a region into a set of hierarchically ordered blocks is rather evident in the present-day topography expressing clearly recent tectonics. In studied regions, reported large earthquakes nucleate at the mapped nodes. The mathematical approach is based on identification of earthquake-prone areas using the pattern recognition technique to identify potential nodes for large events. These nodes are characterized by an uniform set of topographic, geologic, and geophysical parameters. On the basis of such parameters the pattern recognition algorithm defines the decision rule to discriminate seismogenic and non-seismogenic nodes. The recognition results highlight the crucial role of topographic parameters in the identification of nodes prone to large earthquakes. Maps of seismogenic nodes have been published since the early 1970s for numerous regions worldwide, including California, Caucasus, Himalayas, Mediterranean and some others. Subsequent large seismic events in the studied regions show that 61 out of 73 post-publication earthquakes occurred within predicted nodes; large earthquakes had been not previously recorded in 20 of 61 nodes. The results obtained for regions of high seismicity encourage us to extend the methodology to areas of moderate seismicity such as the Rhine Graben and its surroundings.