Formal forecast of the Gutenberg–Richter law parameters based on geodynamic and seismotectonic data

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The study covered the territory of the Calaveras Fault (California) section where Morgan Hill earthquake (M=6.2) took place in 1984, and for which detailed regional seismic data are available. As follows from geodetic observations, the north-west section of this section is confined, while the south-east part features creep. To find out the factors governing seismic regime parameters in different areas, the observed recurrence curves based on the seismic data were compared with the forecasted curve boundaries calculated using a model of the investigated territory, with consideration of model scale and type, deformation conditions, and fracture pattern. The study was performed using a modular hierarchical model that incorporated preparation and earthquake focus areas. The model scale depended on maximum size of the L1 structure responsible for seismic conditions in the investigated territory. Predicted boundaries were assessed using models of two scales (L11 = 100 km and L12 = 50 km), and two types of deformation (2D and 1D models of multi-axial and uniaxial deformation, respectively) and fracture (brittle fracture and brittle-to-ductile fracture). The minimum deformation rate of Gmin = $1.8\text{x}10^{-9}$ per year was adopted in the 2D model with multi-axial deformation, while the 1D model with uniaxial deformation assumed maximum deformation rate of Gmax = $4.1\text{x}10^{-7}$ per year. The comparison of the observed and predicted data suggests that model type and fracture pattern govern recurrence curve slope, while the model type and scale, ductile limit and rate of deformation account for seismic activity. It is shown that integral assessment of slope and seismic activity in the Gutenberg–Richter law depends on relationship of number of focuses formed under multi-axial and uniaxial deformation, brittle and brittle-to-ductile fracture. It is recommended to monitor deformation rate variations and changes in ductile boundary of potential earthquake focus areas when conducting engineering surveys, in order to evaluate potential changes in seismic regime parameters and occurrence of typical earthquakes whose magnitude and frequency can be much greater than those obtained with a single-parameter Gutenberg–Richter model.