On the calibration of the first 3D transform fault system model of the South Iceland Seismic Zone and Reykjanes Peninsula Oblique Rift

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Abstract

Geohazards, volcanic and seismic activity, are pronounced in Iceland due to its location on the Mid-Atlantic Ridge. The strongest earthquakes in Iceland occur primarily in two transform zones, the Tjornes fracture zone in the North, and the South Iceland seismic zone (SISZ) and Reykjanes Peninsula oblique rift (RPOR) in the South. The left-lateral transcurrent motion across the SISZ-RPOR is accommodated by "bookshelf faulting" on an array of NS near-vertical dextral strike-slip faults oriented near perpendicular to the vector of plate motions. In this study, we have developed new 3D physics-based bookshelf fault system models for the SISZ-RPOR. The models have been calibrated to the steady-state relative velocity of plate extension in southwest Iceland and are constrained by the geometry of the fault system and its spatially variable seismogenic potential. We model this spatial variability by through distinct subzones of faulting and allow for both deterministic and random fault locations across the SISZ-RPOR. The fault system models are fully specified in terms of fault locations, fault dimensions, expected maximum magnitudes, long-term slip rates, and moment rates on individual faults. The long-term cumulative rate of seismic moment predicted by the new fault system models are fully consistent with those calculated from the various long-term earthquake catalogues for the region. The slip-rate along the zone is shown to vary systematically and increasing towards the west. This allows us to designate average slip-rates for each subzone and calibrate zone-specific magnitude-frequency relationships (i.e., Gutenberg-Richter). In other words, we present seismic area source zones of different maximum magnitudes and distinct a and b-values that are equivalent to the activity of the 3D physics-based fault system model of this study. The cumulative seismicity rate of the area source zones is in complete agreement with the earthquake catalogues, including the new ICEL-NMAR. The findings presented here form the basis for physics-based probabilistic seismic hazard assessment of the bookshelf fault system in Soutwest Iceland.

Keywords: bookshelf fault system; slip rate; finite-fault model; physics-based probabilistic seismic hazard assessment; RPOR; SISZ

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