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An approach for evaluating the significance of potential fault sources on seismic hazard: A case study using the August 2011 Virginia aftershock-delineated fault source

Lisa S. Schleicher
U.S. Nuclear Regulatory Commission, 11555 Rockville Pike, Rockville, MD 20852, USA

On August 23, 2011, the magnitude 5.7 Mineral, Virginia, earthquake rocked the Washington, DC, area and triggered additional studies of seismic hazard in the central and eastern United States (CEUS). A multi-institution deployment of seismometers in the epicentral region yielded a well-recorded (>395 events) aftershock sequence for the Mineral earthquake, which delineated a fault with an orientation of N36°E, 50°SE that spans ~10 km along strike and ~8 km along dip, centered at a depth of 7 km. This aftershock-delineated fault plane, now termed the Quail fault, is interpreted to define the rupture plane of the Mineral earthquake's mainshock. In Probabilistic Seismic Hazard Analyses (PSHA) for this region of the CEUS, seismic hazard is dominated by background seismicity zones. However, the discovery of new faults from aftershock sequences or field information has the potential to affect the PSHA. Although aftershock sequences provide useful constraints on potential fault geometry, any hazard calculation will be sensitive to assumptions on magnitude and recurrence rate. I evaluated the potential hazard significance of the Quail fault by considering it as a discrete fault source in PSHA calculations for central Virginia. I first calculated the baseline seismic hazard for a grid spanning 50 km from the epicenter using the seismicity catalog and source zones from the Central and Eastern United States Seismic Source Characterization study (CEUS-SSC; NUREG-2115) and ground motion models from the Electric Power Research Institute (2013). Next, I included the seismic hazard from the Quail fault to the baseline hazard by assuming the Quail fault is a moderate magnitude fault source having (1) a truncated Gaussian distribution for the magnitude, (2) a range of hypothetical recurrence rates and (3) the geometry of the aftershock-delineated fault plane from the Mineral earthquake sequence to define the fault plane geometry. I will present results of calculations that focus on differences between the baseline seismic hazard and the hazard with the addition of the Quail fault source, for 1 and 10 Hz and the 10^{-3}, 10^{-4}, and 10^{-5} annual exceedance frequencies. Although geologic and seismic evidence of recurring seismicity would need to be established before including any aftershock-delineated rupture plane as a discrete seismic source, this sensitivity study provides an approach for quantifying and visualizing the potential hazard significance of an aftershock-delineated rupture plane on an existing PSHA in central Virginia. DISCLAIMER: Any opinions, findings, and conclusions expressed in this abstract are those of the author and do not necessarily reflect the views of the United States Nuclear Regulatory Commission or licensees.