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Stress transfer modelling of the strong earthquake sequence at intermediate depths in the Vrancea area, Romania

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Since 1940 a sequence of 5 strong earthquakes with moment magnitudes M_w between 5.8 and 7.7 took place in the Vrancea area, which is situated in the Southeast Carpathians. The most striking feature is the alternating depth of successing earthquakes. These earthquakes are concentrated in a small seismogenic volume of 30 x 70 km at depths between 80 and 150 km. This seimogenic volume is located within a high-velocity body (HVB) determinated by seimic tomography. The observation of the recurrent alternating depth for the hypocenters encouraged us to investigate the static stress transfer between subsequent earthquakes and the possibility of earthquake triggering using the static Coulomb Failure Stress change (ΔCFS) approach. The geometry of the 3D finite element model incorporates the topographies of the surface and the Moho as well as the shape of the HVB and uses linear elastic rheologies. The rupture planes of the 5 earthquakes are implemented as frictional contact surfaces. At the bottom and upper boundary of the model only displacements parallel to the model boundaries are allowed. To simulate the co-seismic displacement of the rupture planes the hanging wall and footwall were displaced by half the average displacement. We calculated the ΔCFS due to each event on the following one, i.e. single event. We also calculated the contribution of all the preceding ruptures on a subsequent one, i.e. cumulative event. Our results show that 4 out of 5 strong earthquakes occurred in areas with ΔCFS in the range of 10^{-2} to 10^{-1} MPa, where the hypocenters were located. These high positive values of ΔCFS on the hypocentral planes indicate that static stress transfer is likely to occur in these areas. One event occurred in an area with ΔCFS=10^{-3} and -10^{-3} MPa generated by the second earthquake of 1990. We conclude that earthquake triggering due static stress transfer is possible. Future steps consist in introducing viscoelastic rheologies, which are capable of describing transient transfer processes.