Periodic Upward Migration Model for Intermediate-depth Earthquakes in Vrancea, Romania

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Intermediate-depth earthquakes with a depth range of 60-160 km have frequently occurred in the Vrancea region of Romania and caused severe damages in Romania as well as the surrounding countries. In order to understand the regularity of earthquake occurrences and to predict future earthquakes, we analyzed M7.0 or greater earthquakes during the years 1500-2000 using ROMPLUS - a Romanian earthquake catalogue. We propose a periodic upward migration (PUM) model according to which (1) the front of an active zone migrates upward starting from the deepest part during Tz years and (2) this migration repeats every Tp years. We assumed that the active period lasts for T1 years at each depth. One of the optimal solutions is as follows: Tz = 75 years, Tp = 100 years and T1 = 19.5 years. We tested the model by using the Akaike information criterion (AIC) and investigated whether the model is better or not as compared to a uniform Poisson model with regard to time and space (depth). We applied the AIC procedure in the model selection. The difference in the AICs between the two models is 4.22 in the case of M7.3 or greater earthquakes; therefore, we can conclude that the PUM model is significantly better than the Poisson model. By considering the fact that the focal depths of historical earthquakes (as determined by their intensity distributions) contain greater errors for smaller earthquakes and that the earthquakes reoccur at the same place, we propose the following regularity for the intermediate-depth earthquakes occurring in Vrancea. (1) The first M7 earthquake occurs at a deeper segment of the seismic region (depth: 140-160 km) at the beginning of each century. (2) The second M7 earthquake occurs at an intermediate segment of the seismic region (depth: 110-140 km) in the middle of each century. (3) The third M7 earthquake occurs at a shallower segment of the seismic region (depth: 80-110 km) at the end of each century. This activity repeats every century. On the basis of this regularity, we can predict the following three M7 earthquakes that would occur in the 21st century:

No., Year, Lat(N), Lon(E), Z(km), M
1, 2007.2+-6.1, 45.7, 26.7, 145+-11, 7.34+-0.36
2, 2041.1+-4.1, 45.8, 26.9, 132+-16, 7.43+-0.27
3, 2082.5+-9.2, 45.9, 26.9, 104+-05, 7.38+-0.18

Furthermore, by referring to the source processes involved in recent larger earthquakes, the source processes of future earthquakes can be predicted as follows. (1) A pure thrust exists with a strike of NE-SW and a dip of 60-80 degrees towards the NW and the steep-dip nodal plane dips towards the NW with an angle of 60-80 degrees. (2) The rupture is unilateral and propagates from the NE towards the SW. The length of the fault is 30-50 km.