

Vrancea intermediate-depth earthquakes in Romania -seismicity and mechanisms-

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Isolated intermediate-depth earthquakes occur at the SE corner of the Carpathian arc in central Romania. The depth ranges from 60 to 200 km and epicenters concentrate 40 km x 90 km area in Vrancea. Since there is no plate boundary at present, they say there was a paleo-subduction zone. The seismicity is very high and over the last five hundred years, five earthquakes of magnitude 7 and greater occurred in every hundred-year period. Eight earthquakes of magnitude 7.5 and greater occurred in the last five hundred years and caused severe damage in Bucharest, of which epicentral distance is about 150km, and other cities in Romania. An Mw 7.5 earthquake caused 1,581 deaths in 1977.

We relocated the crustal and intermediate-depth earthquakes in Vrancea by using a modified joint hypocenter determination method (MJHD) proposed by HURUKAWA. The method was applied to locate 507 earthquakes occurred between January 1996 and November 2003 (moment magnitudes in the range 2.3 to 5.7), using P-wave arrival times at 27 seismic stations operated by the National Institute for Earth Physics from Bucharest. Events were selected based on the following criteria: (1) The minimum number of stations that observed each event is 6. (2) The minimum number of events observed at each station is 20. (3) Exclude bad readings for which travel-time residuals were greater than 1 s.

The relocated hypocenters of intermediate-depth earthquakes concentrate along a nearly vertical plane striking on a NE-SW direction. The earthquakes located deeper than 120 km depth are generated in a stripe of less than 10 km thickness, steeply dipping toward NW, spread over 80 km length along the plane strike direction (NE-SW). For the depth interval between 60 and 120 km, the stripe thickness is similar, while the length along the plane strike continuously diminishes toward the upper part. The crustal seismicity is much more diffuse and separated from the subcrustal activity by a gap of about 20 km in depth.

Fault-plane solutions of M 4.0 and larger earthquakes are compared with the seismicity regime. Almost all earthquakes are characterized by reverse-type focal mechanism. Although there is a variety of nodal planes' geometry, many events show down-dip extension with T-axes parallel to the seismic plane and nearly vertical.

We relocated past large earthquakes and their aftershocks using P arrival times reported by the ISC. They are 1977 M7.5, 1986 M7.2, 1990 M6.9 and M6.3 earthquakes. In order to locate them relative to locations of smaller earthquakes, we jointly relocated past large earthquakes and present smaller earthquakes using 63 stations including foreign stations. All past large earthquakes were located on the seismic plane of smaller earthquakes.

The dip angle of the nodal plane dipping NW of the 1977 M7.5 earthquake obtained by P-wave first motions is 76 degrees, while that by the Harvard CMT is 62 degrees. The difference will be explained by the following model. (1) The rupture started at the bottom of the fault plane (125 km in depth), which is located inside the seismic plane and propagated upward. (2) The dip angle of the fault plane becomes gentle at the top of the seismic plane (60 km in depth). (3) The largest aftershock (M4.7) occurred at the top of the fault plane (48 km in depth)