

Seismic risk in Romania

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ROMANIA

- This is the list of significant earthquakes in Romania. During 1800 – 1900 there have been registered only the major earthquakes, for 1900 – 1990, only earthquakes measuring above 7 and from 1990 until present - all earthquakes measuring > 6 on Richter scale. The time is GMT. Source: NIEP (INFP).

- Date, time: 26.10.1802; 10:55
- Magnitude Mw: 7.9
- Depth: 150 km
- Date, time: 5.03.1812; 12:30
- Magnitude Mw: 6.5
- Depth: 130 km
- Date, time: 26.11.1829; 01:40
- Magnitude Mw: 7.3
- Depth: 150 km

- Date, time: 23.01.1838; 18:45
- Magnitude Mw: 7.5
- Depth: 150 km
- Date, time: 6.10.1908; 21:40
- Magnitude Mw: 7.1
- Depth: 125 km
- Date, time: 10.11.1940; 01:39:07
- Magnitude Mw: 7.7
- Depth: 150 km
- Date, time: 4.03.1977; 19:21:54
- Magnitude Mw: 7.4
- Depth: 94 km

- Date, time: 30.08.1986; 21:28:37 GMT/
31.08.1986, 00:28:37 local time
- Magnitude Mw: 7.1
- Depth: 131.4 km
- Date, time: 30.05.1990; 10:40:06
- Magnitude Mw: 6.9
- Depth: 90.9 km
- Date, time: 31.05.1990; 00:17:48
- Magnitude Mw: 6.4
- Depth: 86.9 km
- Date, time: 27.10.2004; 20:34:36
- Magnitude Mw: 6
- Depth: 98.6 km

- Year 1940 recorded a higher seismic activity in Vrancea, due not only to earthquake on 10 November and its aftershocks, but in fact, along this year several earthquakes have occurred. Earthquakes occurred in Vrancea from the very beginning of year 1940; these earthquakes, according to catalogues, had magnitudes of 4.5-5 and occurred at depths greater than 130-160 km.

- On 24 June 1940 an earthquake of a 5.5 magnitude occurred at 115 km depth and was weakly felt in Wallachia and Moldavia. A quiet period lasted to the beginning of October, but on 3 October 1940, an earthquake measuring 4.7 – 5.0 occurred at 150 km depth.
- In the evening of 21 October 1940 several earthquakes occurred in Vrancea, the most important of them occurred in the midnight, at 100 km depth ($M = 4.5$). On 22 October 1940, at 8:37am a stronger earthquake measuring $M_w = 6.5$ and maximum intensity of VII to VII $\frac{1}{2}$ on Mercalli scale, occurred in Vrancea, at 122-125 km depth; this earthquake was strongly felt especially in Wallachia and Moldavia (with intensities which on an extended area were of VII on Mercalli scale). It seems that the rupture was at 125-140 km depth.

- There were noticed only low damages, wall breaks, broken windows but without human loss. This earthquake had no immediate aftershocks (of at least 4.0).
- Several earthquakes of more than 4.0 occurred at 140-150 km depth, at the beginning of November. Another earthquake measuring 5.5 occurred in Vrancea, at 145 km depth, on 8 November 1940, at 14:00 pm, with less than 2 days before the catastrophic earthquake; this earthquake was felt even in Bucharest. One day later, in the afternoon of 9 November 1940, weak local earthquakes were recorded in the area of Panciu town, movements which were almost not noticed by people (II-III on Mercalli scale).

- The great earthquake measuring $M_w = 7.6$ and maximum intensity $I_0 = IX \frac{1}{2}$ occurred at 140-150 km depth, on 10 November 1940, at 3:39 am (local time). The most severe consequences were noticed in south and centre of Moldavia, but also in the north-east of Wallachia. 90% of the town of Panciu was destroyed, although most of the buildings were made up of wood. Towns like Focsani, Galati, Marasesti, Tecuci and Iasi were greatly damaged. The main damage of Bucharest was that of Carlton block, although other buildings were significantly damaged.

- The earthquake on 10 November 1940 had many aftershocks, from the very first moments, among which, 6 measured more than 5.0. The strongest aftershock was recorded in the morning of 11 November 1940, at 8:34, having a 5.5 magnitude, maximum intensity of VI, focal depth: 150 km; this aftershock seemed to be weakly felt in Bucharest. The series of aftershocks continued towards the beginning of December 1940, and after that it gradually stopped. Further studies concluded that the great earthquake of November 1940 had broken the lower segment, the deepest one, of the lithospheric block, somewhere between 135 and 160 km depth.

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Earthquakes in Dobrogea and the Black Sea

Lately, public considerations have been drawn upon many earthquakes having their epicentres located in the south-eastern region of the country, in Dobrogea and even within the continental platform of the Black Sea. Consequently, the region of Dobrogea is rather a seismic one.

- Seismic character of Dobrogea is based on a series of crustal faults, more or less active, faults which cross Dobrogea from east to west, having extensions both in the continental area of the Black Sea and towards west, in Wallachia and even in front of the Oriental Carpathians curvature. Four significant faults have played a major role in the tectonic evolution of Dobrogea area. Obviously, tectonic movements of these faults must be linked with the dynamics of tectonic block, in some works named “The micro-plate of the Black Sea”. This micro-plate is likely to have a slow displacement move from south-east towards north-west, being pushed by the Anatolian plate, Arabian-Iranian one and that of the Caspian Sea.

- The block of the Black Sea has a more complex dynamics, which represents the origin of occurrence of deep earthquakes from Vrancea area.
- Having in view the seismic character of Dobrogea and the Black Sea, it has to be mentioned that most Pontic and Dobrogea earthquakes are of crustal type, having a small depth ($h=5-60$ km); there have been noticed occasionally, deep earthquakes in the Black Sea, but of low magnitude. Seismologic records had led to localization of many epicentres in Dobrogea, both in the northern area, and in the middle of Dobrogea and southern region, the most important have been generated in two different epicentral areas: the region of Northern Dobrogea and the off-shore region from the south of Dobrogea, in the south of Mangalia, towards the eastern region of Shabla Cape (Bulgaria).

- In the Northern Dobrogea, the tectonic system generating seismic movements is that mainly linked with Sfantu Gheorghe fault, which follows the route of the branch having the same name, of the Danube Delta. The fault extends to west of Tulcea, towards Braila-Galați, and to north-west, but even to the east, to the Black Sea, towards the Snake Island. Sfantu Gheorghe fault is a rather active one and several low earthquakes record here, along this fraction, every year. Earthquakes from the north Dobrogea region occur in the earth's crust, depths with many foci being of 7-10 km, 14 km, 18-22 km. Maximum magnitude of local earthquakes in Northern Dobrogea does not exceed 5.4 – 5.5 on Richter scale, but due to low focus depths, these earthquakes are felt strongly enough in the epicentral region (at Tulcea and the surroundings).

- The last important seismic movements generated by the Northern Dobrogea tectonic system took place on 11 September 1980, 13 November 1981, 3 October 2004 and 7 May 2008.
- *Earthquake on 11 September 1980* occurred in the area of Galati-Braila, at about **25 km** depth, its magnitude was of **4.6** on Richter scale and it was felt in the epicentral region with an intensity of about V-VI on Mercalli scale.
- *Earthquake on 13 November 1981* occurred in the area of Tulcea-Mahmudia-Bestepe, at **11 km** depth, measuring **5.2** on Richter scale and it was felt in Tulcea with an intensity of **VI-VII** on Mercalli scale.

- *Earthquake on 3 October 2004* occurred again, in the area of Tulcea-Mahmudia, at about **22 km** depth, its magnitude was of **5.4** on Richter scale and the intensity in the epicentral region was of **VI-VII** on Mercalli scale; the earthquake was felt in east of Moldavia, Wallachia and Bessarabia, including Kishinev.
- *Earthquake on 7 May 2008* occurred in the North-West of the Black Sea, near the Snake Island, at **10 km** depth and had a magnitude of **5.0 – 5.2** on Richter scale; the earthquake was felt in the South of Ukraine, in Bessarabia at Kishinev, but also in the East of Moldavia and in Dobrogea, in Tulcea, Constanta, as well as in other localities from the eastern region of Romania; this earthquake's intensity on the Romanian territory was lower than that of the earthquake in 2004.

Beside these earthquakes, others but of lower magnitude (below 4.5 on Richter scale) have occurred in the area of Northern Dobrogea.

Central Dobrogea is characterized by a lower seismic activity, defined by earthquakes which seldom occur, and low magnitudes, which do not exceed 4-4.5 on Richter scale; these earthquakes are of crustal type, with hypocentral depths of 50-60 km. A significant seismic activity has been noticed in the neighbourhood of Harsova locality, but without posing special risks.

The off-shore region of Southern Dobrogea, especially the epicentral area located in the south of Mangalia, including the Bulgarian off-shore of the Black Sea, has been emphasized, along the years, by earthquakes which in certain cases have been violent, reaching magnitudes of 7-7.5 on Richter scale. These are also crustal earthquakes, of low depth (5-30 km), with severe effects on the epicentral area. Sometimes, in case of earthquakes with underwater focus (as those located in the East of Shabla Cape), Tsunami waves were generated, like in 1901.

The Pontic earthquake on 31 March 1901, with a magnitude of 7.2 on Richter scale, was apparently generated, in the East of Shabla Cape, at about 15 km depth below the sea bottom. The earthquake had destructive consequences on the off-shore area located in the south of Mangalia, several villages being destroyed (maximum intensity: IX-X on Mercalli scale); the strongest aftershocks measured 5.5-6.0 on Richter scale and were felt in the south of Romania, including Bucharest. After 1905, the Pontic seismic activity began to decrease, although low earthquakes were recorded next years.

Research studies carried out by experts have shown that Pontic earthquakes with destructive behaviour, comparable to that in 1901, repeat at mean periods of 300-500 years. Besides the earthquake in 1901, there are also known very strong Pontic earthquakes in 1444 (likely, with its epicentre in Varna), around year 800, in 543, etc.

Local geotechnical structure is complex enough, but many seismologists consider that the origin of Pontic earthquake is represented by an extension of IntraMoesic major fault from the Walachian Plain, but even a series of local faults from the off-shore area of Southern Dobrogea. The geodynamics of this region is a very complex one, the movement of the Black Sea micro-plate represents the origin of local seismic activities in Dobrogea. Along the centuries or even millennia, there have been recorded movements of subsidence, rising and descending movements of the crust, as well as extremely violent earthquakes, but within longer periods, of hundreds of years.

During the 20th century, local moderate earthquakes were generated in 1920 and 1956; the earthquake on 30 June 1956, measuring 5.5 on Richter scale, occurred in the region of Shabla, in the south of Mangalia, at 25 km depth and was felt in the north-east of Bulgaria, in Dobrogea and in the south-east of Wallachia, but it did not generate material damages.

