Seismic displays in Lithuania

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The territory of Lithuania is not very seismically active, being situated in a stable, intraplate tectonic setting. However, historical data show that earthquakes of destructive character occurred here in the past. During the last several years, stations of the Scandinavian seismologic system fixed a number of weak seismic events in the territory of Lithuania. Historical data on powerful earthquakes in the Baltic region show that all of them were induced by seismic waves originating from remote seismically active regions such as Italy or Romania. The most powerful earthquakes in Europe, with intensities 8–10, arise in the Carpathian area. Many of these earthquakes were perceptible in Lithuania.

Keywords: seismotectonic, seismogenic zones, seismotectonic potential, magnitude, earthquake

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The regions of manifestation of seismic processes are not distributed evenly on the Earth. The tectonic earthquakes most often happen in recently formed mountainous regions (the Alps, the Carpathians, the Caucasus and other) and in places where the Earth's crust is split by tectonic faults and fractures. There are stable regions of the Earth's crust, where earthquakes almost do not occur, or they are perceptible seldom and weakly as the remote echoes of powerful earthquake focuses located in active seismic zones.

The territory of Lithuania is not very seismic, but the historical data show that in the past earthquakes of destructive character occurred here. During the last several years, stations of the Scandinavian seismologic system fixed a number of weak seismic events in the territory of Lithuania. They are related with tectonic faults. Studies of the last decade show that the whole Earth's crust is affected by a horizontal tectonic stress, thus the manifestation of tectonic deformations is coded in advance in all regions. The most part (about 90%) of deformations is related with tectonic faults, the abundant system of which is distinguished in the territory of Lithuania. Seismologic studies in other countries show that only 2% of seismic deformation energy discharges by earthquakes are less than intensity 5 (the intensities in the MSK-64 scale). Thus, manifestations of strong, though rare, earthquakes in the territory of Lithuania are a natural and unavoidable phenomenon. These facts indicate that the Earth's crust in our territory is in "seismic" condition. Seismic events may be displayed in two cases: 1) when the accumulation of tectonic strain along the fault reaches a certain limit exceeding the stability of the fault and provokes its movement and an earthquake; 2) a strain accumulation is not sufficient to evoke fault movement, but a seismic wave coming from outside may give an impulse sufficient to increase fault activity (Šliaupa, Ilginytė, 2000). Historical data on powerful earthquakes in the Baltic region show that all of them have been caused by seismic waves spreading from remote seismically active regions such as Italy, Romania.

Perhaps the strongest earthquake in Lithuania occurred near Vilnius on January 8, 1909. A crack, 1 km long, opened. At that time, in the entire Baltic region earthquakes reaching the intensity of 5–7 (according to MSK-64 scale) occurred. They are supposed to be related to the earthquake in Messina (Italy), M = 7.5 (Richter scale) which occurred on December 28, 1908 (Fig. 1) (Ilginytė, 1999).

The earthquakes arising in the Carpathians are most powerful in Europe. The intensity of those

Fig. 1. Earthquakes trigerred in the Baltic states region by Messina earthquake (Italy), M = 7.5, 28 December 1908
1 pav. Žemės drebėjimai Baltijos valstybių regione, kuriuos sukėlė Mesinos žemės drebėjimas (Italija; H=7,5), įvykęs 1908 m. gruodžio 28 d.

most powerful reaches 8–10 points, and seismic waves caused by them spread on a large area. Considering the area of seismic wave spread and the seismic effect, it may be supposed that the earthquakes of intensity 3–5 with focuses in Romania in 1091, 1170, 1195, 1230, 1445, 1517, 1790, had been per-

ceptible in Lithuania. Strong earthquakes with deep focuses in the Vranch district (Romania) that occurred on 26 October 1802, 26 September 1829, 23 November 1829, 23 January 1838, 27 April 1865, 31 August 1894, 2 September 1894, 6 October 1908, 29 March 1934, 10 November 1940, 4 March 1977 are well known. These earthquakes were of diverse intensity and had to be perceptible in Lithuania.

On November 10, 1940 an unusually strong underground seismic impact shook the Earth in the Carpathians. It was perceptible in the entire East Europe (Fig. 2). Judging by the available data, in southeastern Lithuania this earthquake was of intensity 4–5 (MSK-64 scale). On March 4, 1977, the echoe of the earthquake that occurred in Romania (its intensity in the epicentre reached 8 points according to MSK-64 scale) (Fig. 3, A) reached the territory of Lithuania (Ilginytė, 1998). Its intensity in our republic reached about 4 points. The waves of the earthquake formed a local resonance epicentre dissected by a submeridianal tectonic fault (near the town of Kėdainiai) (Suveizdis et al., 1994). This earthquake was manifested in the large area from Belarus to Estonia. Another earthquake that occurred on August 30, 1986 in the Precarpathian region reached the territory of Lithuania and showed an intensity of 3–4 points. The earthquake that occurred on May 30, 1990 demonstrated the same effects. The above-mentioned cases are fixed by the data of population inquest (Fig. 3, B, C).

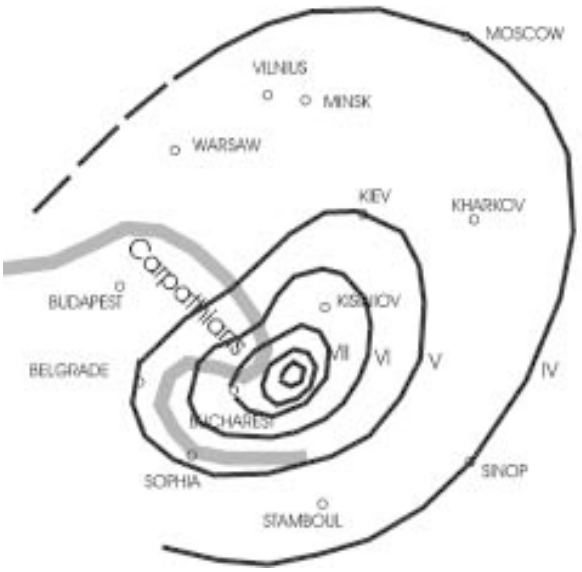
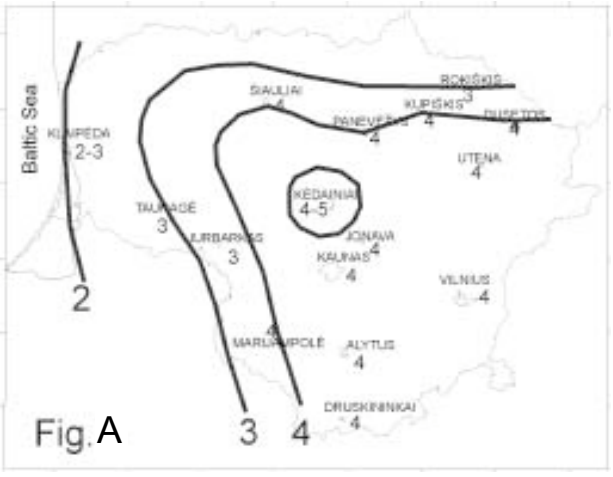
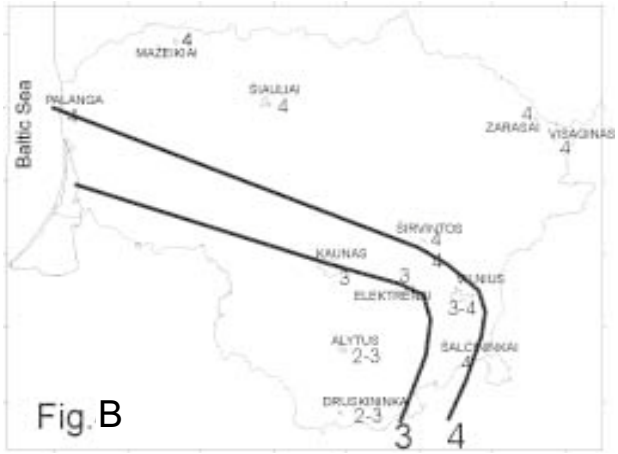


Fig. 2. Intensity scheme of the Carpathian earthquake 10 November 1940 (after V. Gudelis, 1977)
2 pav. Žemės drebėjimo, įvykusio Karpatuose 1940 m. lapkričio 10 d., intensyvumo schema (pagal V. Gudelis, 1977)





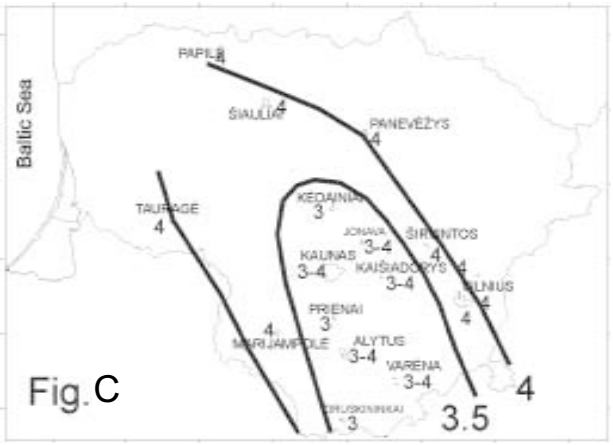


Fig. 3. Macroseismic data (MSK-64 scale) on Carpathian earthquakes: A – 04 march 1977, B – 30 august 1986, C – 30 may 1990
3 pav. Karpatų žemės drebėjimų makroseisminiai duomenys (MSK-64 skalė): A – 1977 m. kovo 4 d., B – 1986 m. rugpjūčio 30 d., C – 1990 m. gegužės 30 d.

Fig. 4. Seismic events trigerred in the Baltic states–Belarus–NW Russia region by Turkey earthquake M = 74 August 17 1999
4 pav. Seisminiai įvykiai Baltijos šalių–Baltarusijos–ŠV Rusijos regione, sukelti žemės drebėjimo, įvykusio 1999 m. rugpjūčio 17 d. Turkijoje (M = 7,4)

Table. **17 August 1999 Turkey earthquake**
(influence on Baltic states–Belarus–NW Russia region)
Time = 00 03 00 (GMT); M = 7.4
(The bulletins contain : UNCHECKED, FULLY AUTOMATIC locations from the NORSAR Generalised Beamforming (GBF) system)
Lentelė. **Turkijos žemės drebėjimas, 1999 m. rugpjūčio 17 d.**
(poveikis Baltijos šalių–Baltarusijos–ŠV Rusijos regionui)
Laikas = 00 03 00 (Grinvičio); M = 7,4

N	Time (GMT)	Latitude	Longitude	Magnitude
1	00 05 04	55.53	28.02	3.56
2	00 07 54	56.27	24.73	3.96
3	00 09 58	57.04	22.81	3.83
4	00 14 29	55.34	19.96	2.58
5	00 16 33	50.26	34.80	
6	00 18 26	54.44	29.73	
7	00 47 53	56.43	21.36	1.95
8	01 11 15	55.83	23.66	2.35
9	01 34 51	52.05	31.90	3.14
10	01 49 11	52.99	29.17	
11	02 45 18	53.07	33.93	2.72
12	02 54 03	54.63	32.83	2.89
13	03 11 21	55.49	31.07	2.37
14	03 16 56	54.00	33.67	2.93
15	04 36 01	52.53	31.94	2.27
16	06 30 58	56.48	31.41	2.86
17	07 23 22	51.56	27.20	
18	07 25 41	55.95	33.27	
19	07 46 58	61.03	38.21	1.81
20	07 56 11	59.30	27.45	0.69
21	08 40 20	55.33	30.21	2.33
22	08 44 34	60.30	29.10	1.04
23	09 04 31	51.95	26.88	
24	09 58 32	59.74	24.88	1.85
25	10 28 11	59.34	27.27	1.06
26	10 48 42	50.13	25.82	

The waves of the earthquake that took place in Izmit, Turkey on August 17, 1999, according to NORSAR data, reached the Baltic states and surrounding regions (Fig. 4, Table). The magnitudes of resonance seismic events were from 1 to 4.

Thus, it is evident that the main seismic danger to our territory is related with the influence of external factors – strong earthquakes in seismically active regions. Seismic waves of strong earthquakes that occur in the Carpathians, in the district of Oslo Graben and in the Finland-Kola peninsula, reach the territory of Lithuania (Fig. 5).

The territory of Lithuania is commonly regarded as free of any seismic hazard. However, historical

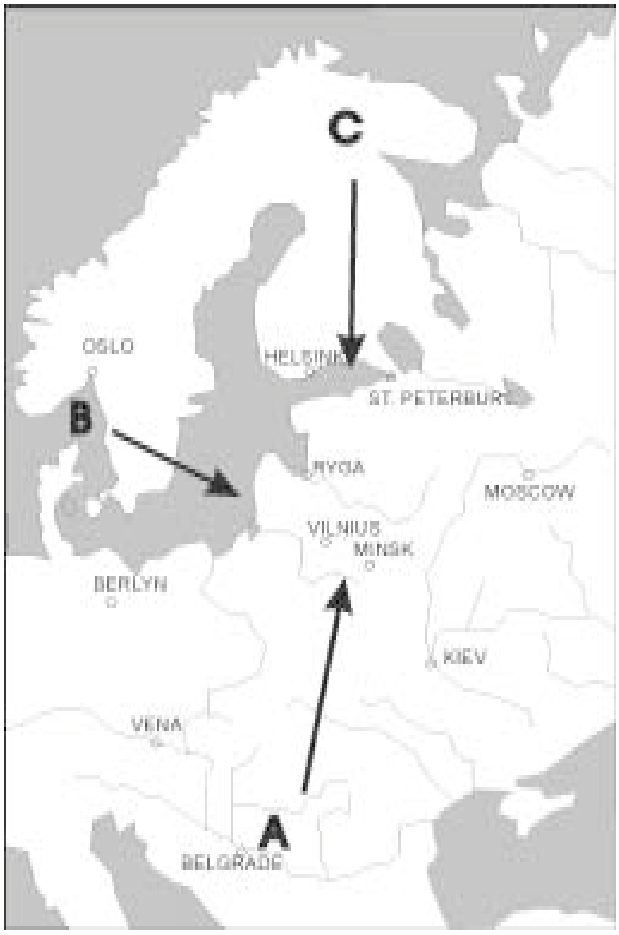


Fig. 5. *A, B, C* – Carpathians, Oslo region and Kola-N. Finland earthquake center
5 pav. *A, B, C* – Karpatų, Oslo regiono ir Kolos-Š. Suomijos žemės drebėjimų centrai

data indicate that about 40 strong earthquakes of up to 7 points (MSK-64 scale) have occurred in the South Baltic region since the 17th century. Moreover, hundreds of small-scale seismic events from this territory were registered in the Scandinavian seismological network during the past two decades. The strong earthquake of 1976 in Osmussaare Island (Estonia) impelled to start seismological studies in the Baltic states, which, however, became more intensive only in the last 5 years.

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SEISMINIAI REIŠKINIAI LIETUVOJE

S a n t r a u k a

Seisminių įvykių sritys nėra vienodai pasiskirsčiusios Žemės plutoje. Lietuvos teritorija nepasižymi dideliu seismingumu, tačiau istoriniai duomenys rodo, kad praeityje būta ir gana stiprių Žemės drebėjimų. Skandinavijos seismologinio tinklo stotys per pastaruosius keliolika metų užfiksavo gana nemažai seisminių įvykių mūsų teritorijoje.

Pagrindinis seisminis pavojus Lietuvos teritorijai yra siejamas su stipriais Žemės drebėjimais, kurie įvyksta seismiškai aktyviose srityse. Stiprių Žemės drebėjimų seisminės bangos sukelia mūsų krašte rezonansinius Žemės drebėjimus, kurių intensyvumas siekia apie 4 balus (pagal MSK-64 skalę). Labai akivaizdus pavyzdys yra 1999 m. įvykęs žemės drebėjimas Turkijoje: seisminių bangų sukeltų rezonansinių seisminių įvykių magnitudė mūsų regione siekė 3,5 (pagal Richterio skalę).

Вита Ильгините

СЕЙСМИЧЕСКИЕ ПРОЯВЛЕНИЯ В ЛИТВЕ

Р е з ю м е

Проявления сейсмических событий на Земном шаре неодинаковы. На территории Литвы сейсмическая активность невысока, но из исторических данных известно, что и на этой территории были зафиксированы довольно сильные землетрясения. Станции Скандинавской сейсмической сети за последние десятилетия зафиксировали немало сейсмических проявлений в нашем регионе.

Основная опасность сейсмических проявлений на территории Литвы связана с сильными землетрясениями, происходящими в сейсмически активных регионах. Сейсмические волны этих землетрясений вызывают на нашей территории резонансные землетрясения, интенсивность которых достигает 4 баллов (шкала МСК-64).

Очевидное доказательство этого – землетрясение, которое произошло в 1999 г. в Турции. Вызванные им резонансные сейсмические явления достигли магнитуды 3,5 (шкала Рихтера).