# PRELIMINARY DATA ON THE EVENTS RECORDED BY NOTSSI IN JULY – DECEMBER 2005

*E. Botev, R. Glavcheva, B. Babachkova, S. Velichkova, I. Tzoncheva, K. Donkova, S. Dimitrova*

Geophysical Institute, BAS, Akad. G. Bonchev street, bl.3, Sofia, Bulgaria,
e-mail: ebotev@geophys.bas.bg

**Abstract.** A map of epicentres of 793 earthquakes that occurred in the Balkan Peninsula sector outlined by latitude $\varphi = 37^0 - 47^0$N and longitude $\lambda = 19^0 - 30^0$E is presented. Expert generalized analysis of the seismicity over the territory of Bulgaria and its adjacent lands (with more than 426 localized events) is proposed.

**Key words:** Balkan Peninsula, Bulgaria, seismicity

The present scientific communication contains generalized information on the results of collection, processing and preliminary analysis of the initial data about the seismic events recorded by the National Operative Telemetric System for Seismological Information (NOTSSI) in the second half-year of 2005. The expanded information about the realized seismicity is suggested as a natural generalization and supplementation of the monthly publications of the preliminary seismological bulletin of NOTSSI. The analysis and evaluation of the space, time and energy distribution of the seismicity, periodically been made, open up possibilities for searching for time correlations with the parameters of different geophysical fields aiming to find out eventual precursor anomalies.

The recording and space localization of the seismic events in NOTSSI is realized by means of standard type seismographs S-13 "Teledyne Geotech" in 21 stations spread over the territory of Bulgaria (Christoskov et al., 1987). The routine processing and acquisition of the initial data is organized in a real time duty regime. The operations are fulfilled by the authors of this communication. In such a way the main goal of NOTSSI, namely the seismicity monitoring in order to help the authorities' and social reaction in case of earthquakes felt on the territory of the country, is realized. The computing procedure for determining the parameters of the seismic events is an adaptation of the widespread product HYPO'71 (Solakov and Dobrev, 1987). The energy parameters of the events are presented mainly by the magnitude M calculated according to the record's duration by the formula

(Christoskov and Samardjieva, 1983)

$$M = 1.92 + 2.72\log\tau - 0.026\Delta$$

The high sensitivity of the seismographs allows recording and processing of a great number of long distance earthquakes. As a result of the achieved experience in the authors interpretation work, different magnitude's lower threshold for successful determination of local, regional and long distance earthquakes is established: M=1.5 for the territory of Bulgaria, M=3.0 for the central part of the Balkans, M=5.0 for long distance events. The precision of the epicenter's determination is different; except on the distance it depends also on the specific position of the epicenter in relation to the recording network.

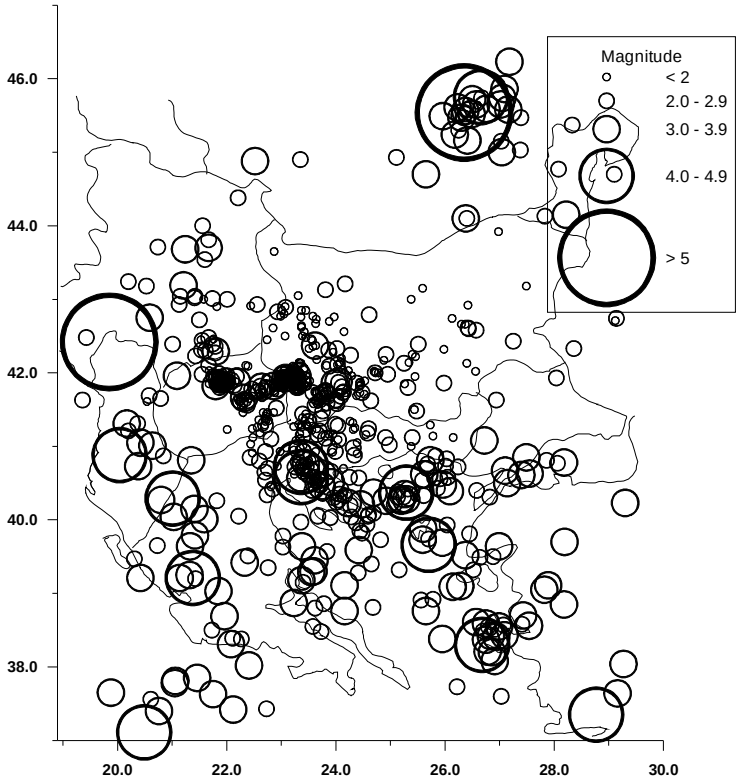


**Fig. 1.** Map of epicenters in Central Balkans during July – December 2005.

The parameters of seismic events occurring at a distance more than 100-150 km outside the territory of Bulgaria should be accepted only informatively and cannot be used for responsible seismotectonic investigation.

For the six-month period of observations presented in this communication, the primary data about 1300 local, regional, distant earthquakes and industrial explosions on the territory of Bulgaria are recorded, classified and processed (as a work bulletin) in NOTSSI. After comprehensive analysis of the records and application of the above

mentioned calculation procedures it is established that 793 of all registered earthquakes are in the Balkan Peninsula region outlined by geographic latitude $37^0$ - $47^0$ N and longitude $19^0$ - $30^0$ E. The epicenters of the earthquakes differentiated by magnitude levels are plotted on Fig.1. The number of the events in the magnitude interval M=1-1.9 is 358, in M=2-2.9 - 299, in M=3-3.9 - 123, in M=4-4.9 – 11 and for M>5.0 - 2 earthquakes.

As a whole, the seismic situation in the study part of the Balkans during the second half-year of 2005 is characterized by relatively high activity (793 events against around 500- 700 for most of the previous half-years). It can be noted that the observed tendency of relative increase in the activity compared with the former half-year is partly due to the earthquake activation in Northern Greece, East Aegean region, Vrancea and FYROM.

The strongest event outside Bulgaria during the study period occurred on $10^{th}$ July 2005 in Albania. Its magnitude was in the interval 4.9 - 5.5 according to the Euro-Mediterranean Seismological Centre. This earthquake was not felt in Bulgaria. The Vrancea activity is expressed by many earthquakes (Fig.1). One of them ($13^{th}$ December) with a magnitude 5.1 according to the NOTSSI determination, 5.0 according to the Euro-Mediterranean Centre, 5.8 by Romanian evaluation, was felt in Bulgaria; the maximum excitation was assessed as IV-V EMS in the town of Silistra.

Two earthquakes with magnitude around M4.0 that occurred to the South of Bulgaria were felt in the vicinity of the town of Kurdzhali: an impact of intensity II-III EMS was caused by activation in the West Marmara Region on $4^{th}$ November, and intensity of III EMS was documented in consequence of an earthquake in the North Aegean Sea on $11^{th}$ November.

The seismic activity on the territory of continental Turkey is quite sluggish. The area of Northern Greece is characterized by the well known frequent shocks of low magnitude; the strongest events are localized in the Khalkidiki region - they did not concern Bulgaria. Rather frequent earthquake occurrence is to be noted along two rivers the Low Vardar and the Low Strouma. High density of seismic events suggests prolongation of the Kroupnik structure, SW Bulgaria, on the territory of FYROM.

As a whole, events with M<3.0 which occur outside Bulgaria are difficult to be localized by the national seismological system; consequently, not all of them have been marked on the scheme in Fig.1.

Figure 2 illustrates the seismicity just in the territory of Bulgaria and nearby lands ($\varphi = 41^0$ - $44.5^0$N, $\lambda = 22^0$ - $29^0$E). The earthquakes on the plot are arranged in magnitude intervals. Triangles in the same figure mark places of the seismic stations. The parameters of relatively stronger earthquakes are presented in Table 1.

Over the territory of Bulgaria a relatively high degree of activation expressed by weak earthquakes has been observed during these 6 months - 426 events. The productivity of this period does not differ considerably from the latest previous half-years (400-450 events). The earthquakes with magnitude equal or more than 3.0 are in normal amount – 10 events; the average number in most of the previous half-years is 10-15. In the same time there are no events with magnitude M > 3.5. The maximum realized magnitude M=3.4 is lower than in the previous half-years; its usual value used to be about 4.0.

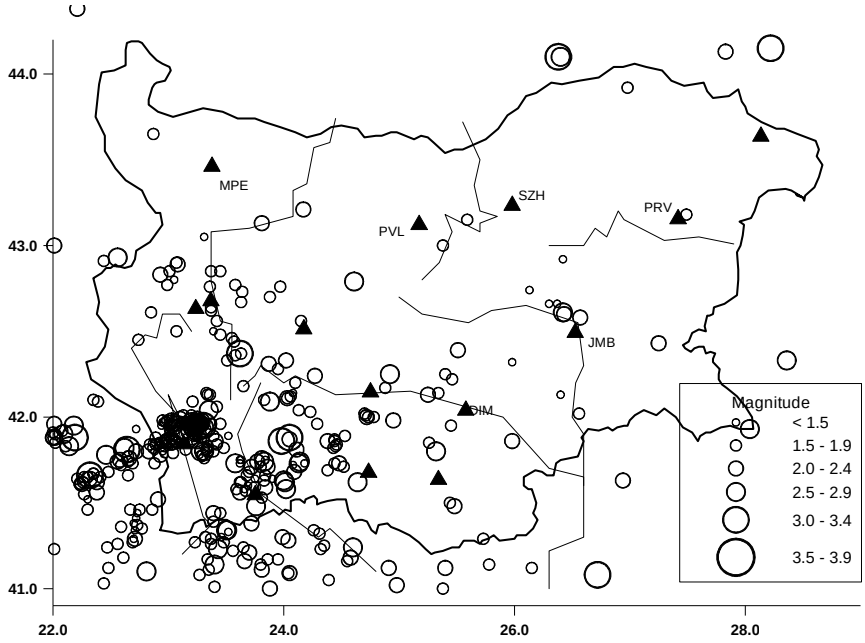


**Fig. 2.** Map of epicentres in Bulgaria and adjacent lands during July – December 2005.

As usually, the largest concentration of epicenters is marked in the southwestern part of the territory presented in Fig.2. As it is shown on the basis of the 20th century seismicity (Grigorova & Glavtcheva, 1976; Grigorova, Christoskov et al., 1980) these lands were the most active ones already at that time. The Kroupnik seismic source is also known with the strongest crustal earthquakes in Europe (M=7.8, 7.1) for the last 160 years (Christoskov and Grigorova, 1968). It is worth noting that in July-December 2005 more than 100 events of M<3.0 and only 3 of M≥3.0 occurred in this region. The strongest earthquake is with magnitude M=3.3; it was not felt on the Bulgarian territory. However the 23th July event with magnitude M<3.0 was felt in the region of Blagoevgrad with maximum intensity of II-III EMS.

The Rila-Rhodoppi seismic region of Bulgaria (Grigorova, Christoskov et al., 1980) gives the biggest contribution to the seismicity during July-December 2005. Besides the Kroupnik source, the western flank of the Rhodoppi massif in the region of Kovachevitsa shows high seismogenic activity. Several earthquakes of a magnitude around 3 are noticed around the southern slopes of Rhodoppi Mountain as well. The strongest event in Bulgaria for the whole study period occurred on 19th October in the Velingrad seismic zone. Its magnitude was M=3.4 and the impact to the Velingrad vicinity was with intensity II-III EMS.

The Sofia seismic zone is characterized by about 20 small seismic events. Consequently, the seismic activity in the Sofia zone is lower than during the previous half-years. It has been manifested presumably along the Iskar river valley.

The North-Eastern Region (Grigorova, Christoskov et al., 1980) is too quiet in the

study period. Only single shocks insinuate that the Gorna Oryakhovitsa and the Shabla zones exist.

As a whole the seismic activity of Bulgarian territory during the second half of 2005 is relatively low and without any occurrence of long seismic sequences like these ones in some previous years – the Yambol one (2001), Krumovo (2002), Provadia (2003).

**Table 1.** List of earthquakes with M ≥ 2.5 in Bulgaria and adjacent lands during July – December 2005

| Date | Time | Coordinates | H,km | M |
|---|---|---|---|---|
| 20050706 | 23:26:22 | 41.08 26.72 | 20 | 3.0 |
| 20050708 | 16:45:24 | 41.78 22.46 | 2 | 2.5 |
| 20050712 | 12:43:33 | 41.34 23.50 | 15 | 2.9 |
| 20050712 | 13:00:01 | 41.34 23.51 | 16 | 2.6 |
| 20050720 | 19:06:18 | 41.73 23.58 | 8 | 2.9 |
| 20050722 | 13:55:54 | 41.94 23.31 | 13 | 2.8 |
| 20050723 | 16:10:47 | 41.82 22.62 | 8 | 2.7 |
| 20050725 | 19:41:48 | 41.88 22.19 | 10 | 3.3 |
| 20050730 | 03:51:01 | 41.83 22.14 | 20 | 2.9 |
| 20050804 | 07:50:26 | 41.93 23.08 | 8 | 3.3 |
| 20050807 | 04:35:54 | 41.94 23.21 | 10 | 2.5 |
| 20050812 | 15:19:03 | 42.79 24.61 | 18 | 2.5 |
| 20050814 | 17:23:02 | 41.14 23.40 | 20 | 2.6 |
| 20050818 | 17:42:32 | 41.62 24.01 | 14 | 2.8 |
| 20050829 | 03:14:19 | 42.09 23.88 | 10 | 2.5 |
| 20050903 | 03:15:57 | 41.48 23.76 | 18 | 2.5 |
| 20050903 | 19:08:06 | 41.97 23.20 | 12 | 2.5 |
| 20050908 | 03:01:50 | 41.95 23.30 | 2 | 3.0 |
| 20050908 | 22:41:13 | 41.10 22.81 | 4 | 2.5 |
| 20050910 | 09:58:59 | 42.04 23.35 | 10 | 2.6 |
| 20050914 | 14:44:45 | 42.33 28.36 | 15 | 2.9 |
| 20050916 | 02:42:44 | 41.95 22.18 | 10 | 2.7 |
| 20051001 | 11:35:10 | 41.90 22.09 | 2 | 2.5 |
| 20051001 | 20:56:48 | 41.58 24.02 | 19 | 2.5 |
| 20051002 | 22:01:45 | 42.25 24.92 | 11 | 2.5 |
| 20051006 | 19:14:14 | 41.92 23.12 | 5 | 2.6 |
| 20051015 | 01:28:33 | 41.24 24.60 | 7 | 2.7 |
| 20051016 | 07:01:12 | 41.81 22.64 | 9 | 3.3 |
| 20051016 | 11:14:15 | 44.10 26.40 | 20 | 2.7 |
| 20051018 | 02:50:12 | 41.74 23.83 | 6 | 2.7 |
| 20051019 | 08:54:36 | 41.88 24.05 | 11 | 3.4 |
| 20051030 | 01:45:10 | 41.97 23.28 | 11 | 2.7 |
| 20051030 | 23:12:45 | 41.63 24.00 | 2 | 2.6 |
| 20051031 | 16:54:47 | 44.10 26.38 | 20 | 3.0 |
| 20051101 | 06:20:48 | 42.61 26.42 | 12 | 2.6 |
| 20051105 | 10:07:55 | 41.80 25.32 | 9 | 2.6 |

| Date | Time | Coordinates | H,km | M |
|---|---|---|---|---|
| 20051107 | 16:42:29 | 41.80 23.31 | 10 | 2.8 |
| 20051109 | 00:20:43 | 41.80 23.28 | 16 | 2.6 |
| 20051114 | 03:43:08 | 44.15 28.22 | 20 | 3.4 |
| 20051116 | 16:43:07 | 41.87 23.25 | 2 | 2.5 |
| 20051121 | 01:35:43 | 41.74 24.14 | 13 | 2.7 |
| 20051122 | 08:58:22 | 41.93 28.04 | 10 | 2.7 |
| 20051125 | 12:43:08 | 41.66 22.32 | 20 | 3.4 |
| 20051126 | 22:13:27 | 41.73 24.13 | 2 | 2.5 |
| 20051129 | 11:43:53 | 41.62 24.64 | 20 | 2.5 |
| 20051203 | 20:31:42 | 42.37 23.62 | 20 | 3.0 |
| 20051210 | 10:09:14 | 41.96 23.24 | 8 | 2.7 |
| 20051211 | 03:02:18 | 41.23 23.43 | 9 | 2.5 |
| 20051220 | 17:38:36 | 42.93 22.56 | 13 | 2.7 |

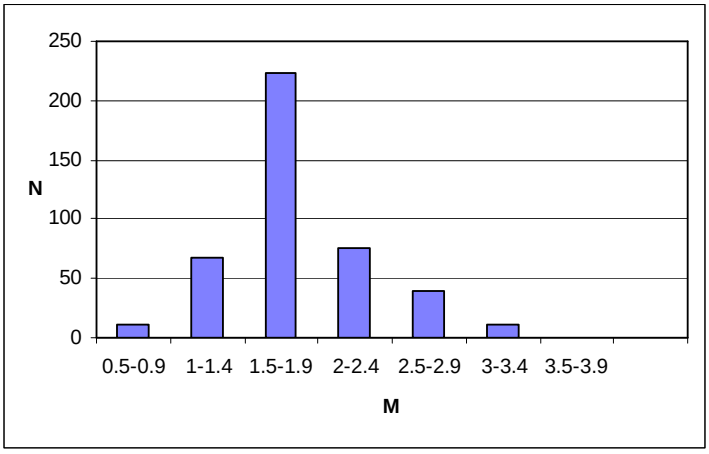


**Fig. 3.** Magnitude - frequency distribution of the earthquakes

A detailed analysis of seismicity in the individual seismic zones is hard to be fulfilled because of the insufficient quantity of events and the narrow magnitude range of the earthquakes. The joint statistics of all the events in Fig.2 characterizes predominantly the seismicity parameters of the southwestern part of the territory under investigation.

The magnitude-frequency distribution for the entire data set is presented in Fig.3. The number of localized events increases with the magnitude decreasing: for M ≥ 3.0 it is 10 events, for M=2.5-2.9 - 39, for M=2.0-2.4 - 75 and so on. The abrupt diminishing of the number of earthquakes in the first two intervals (M<1.5) in Fig.3 determines also the registration power of the seismic stations network.

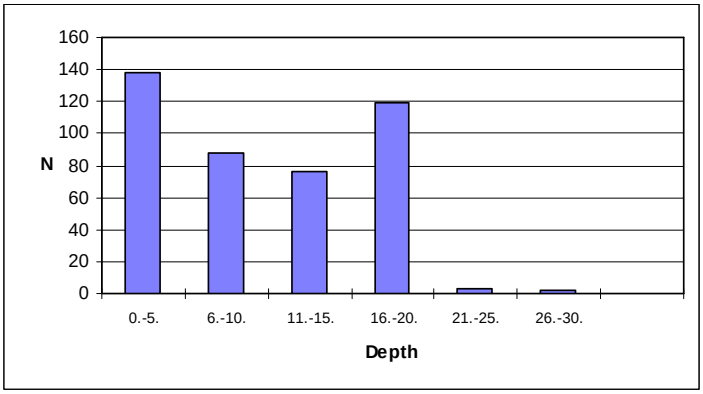


**Fig. 4.** Depth - frequency distribution of the earthquakes

Taking the latter into account, it can be supposed that the magnitude sample for levels with M > 1.5 is comparatively closer to the reality for the bigger part of the Bulgarian territory.

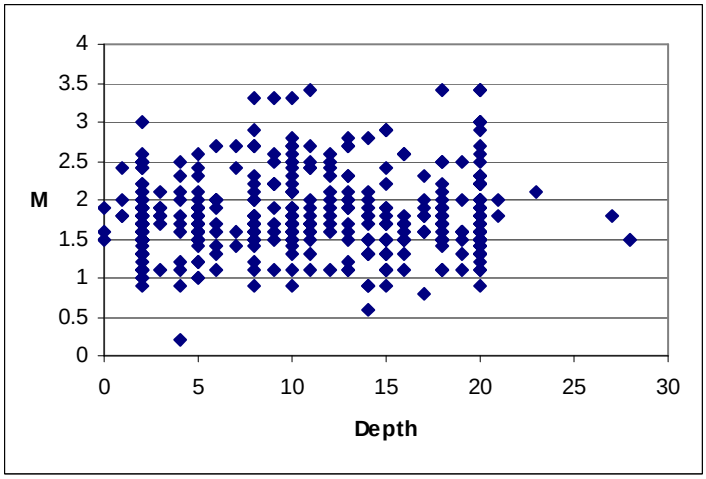


**Fig. 5.** Magnitude - depth dependence

The picture of the depth distribution in Fig.4 shows that the majority of events occur down to 20 km depth. It is possible the established predominating depth (from 0 to 5 km) to be also due to the presence of unidentified industrial explosions. In the same time the number of events in the interval 16-20 km is comparable with this one. The magnitude distribution of seismic events in depth (Fig.5) is rather homogeneous in the cases of very slight shocks. The relatively stronger events (M ≥2.7) originate at depths 8-15 and around 20 km.

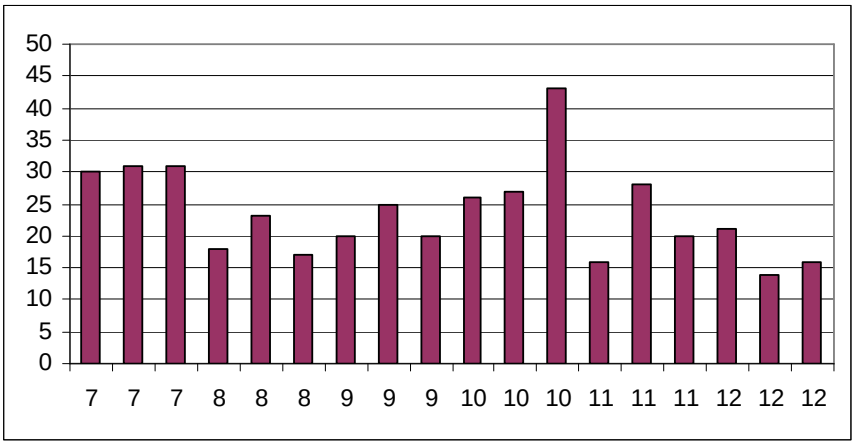


**Fig. 6.** Time distribution of the earthquakes during July – December 2005.

Fig.6 illustrates the distribution of seismicity in time according to the number of events per decade. The biggest earthquake's amount is displayed in July and October. The relative abundance of earthquakes in July (92 events) is due to the neighboring seismogenic zones in FYROM and Northern Greece. The last decade of October shows 43 shocks, the greatest earthquake amount in the considered half-year interval. The lowest number of events is in December, 51 events. Certain stability in the monthly earthquake amount (60 – 65 events) can be noticed in August, September and November.

Figure 7 shows the energy release in time through the earthquake magnitude-time distribution. It suggests that October and July, the months when the biggest number of events occurred, are also with maximum of energy release. Some other strongest events occurred in November. The released energy amount in the second half of September and the beginning of October is lowest for the whole period of investigation.

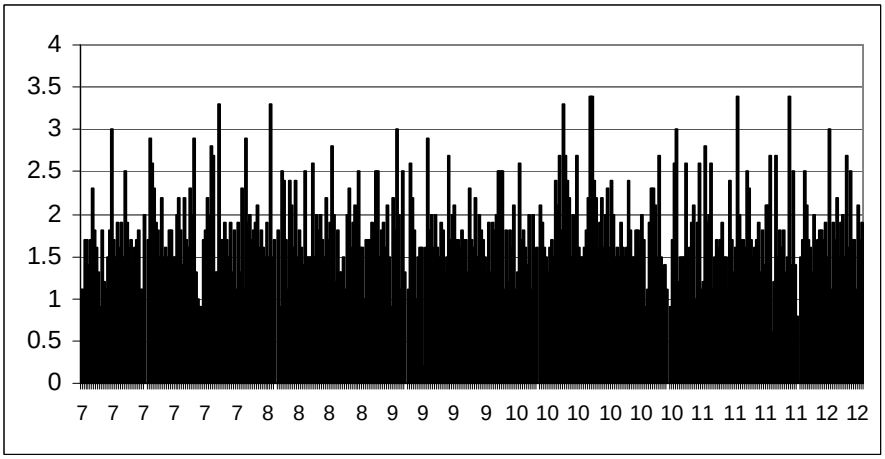


**Fig. 7.** Magnitude-time distribution of the earthquakes during July – December 2005

Additionally, about 300 distant earthquakes have been recorded in the period under study, as well as more than 150 industrial explosions, processed and classified in the preliminary monthly bulletins. In order to identify the artificial seismic sources the methodical approach described by Deneva et al. (1988) and some information about the quarry sites in Bulgaria have been used.

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**Предварителни данни за сеизмичните събития регистрирани от НОТССИ през юли - декември 2005**

Е. Ботев, Р. Главчева, Б. Бабачкова, С. Величкова, И. Цончева, К. Донкова, С. Димитрова

**Резюме.** Предлаганото научно съобщение съдържа обобщена информация за резултатите от събирането, обработката и предварителния анализ на първичните данни за сеизмичните събития, регистрирани от Националната Оперативна Телеметрична Система за Сеизмологична Информация (НОТССИ) за второто полугодие на 2005 г. Представена е карта на епицентрите на общо 793 земетресения в частта от Балканския полуостров, ограничена от географска ширина $37^0$ - $47^0$ N и дължина $19^0$ - $30^0$ E. По-подробно се анализира сеизмичността за територията на България и прилежащите й земи (426 сеизмични събития в район с координати $\lambda = 22^0$ - $29^0$E и $\varphi = 41^0$ - $44.5^0$N). Сеизмогенните прояви се обсъждат по зони, сравнени със съседни периоди време.