PRELIMINARY DATA ON THE EVENTS RECORDED BY NOTSSI IN JANUARY – JUNE 2005

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Abstract. A map of the epicentres of 684 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. A generalized analysis of the seismicity over the territory of Bulgaria and its adjacent lands (with 445 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 first 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.

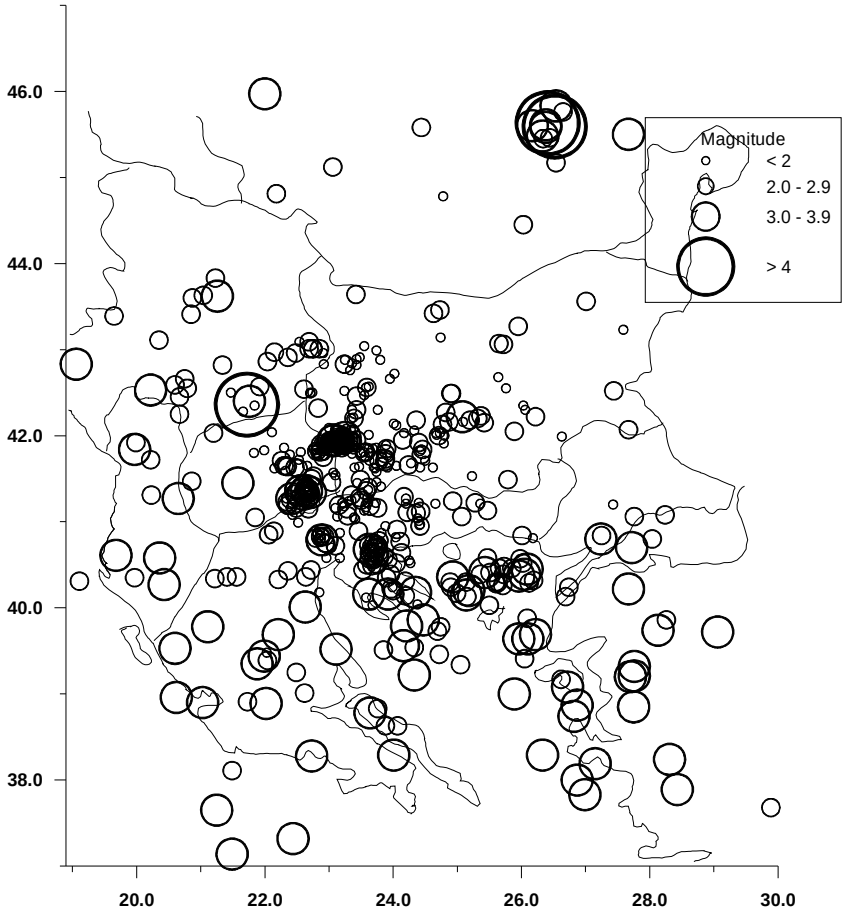

Fig.1. Map of epicenters in Central Balkans during January - June 2005.

The parameters of 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 more than 1000 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 684 of all registered earthquakes are in the Balkan Peninsula region outlined by a 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 344, in M=2-2.9 - 257, in M=3-3.9 - 80, in M=4-4.9 – 3 earthquakes.

As a whole, the seismic situation in the study part of the Balkans during the first half-year of 2005 is characterized by relatively high activity - 684 events against around 500- 600 for most of the previous half-years The strongest earthquakes during the study period come from sources outside Bulgarian territory (Fig.1). The strongest one is originated in the Vrancea region on 14 May 2005. According to the EMSC (Euro-Mediterranean Seismological Centre) determinations, magnitude values in the interval 5.1-6.2 belong to this event. It caused perception of III EMS intensity in the town of Silistra. The second stair in accordance with the released energy again occupies an earthquake from the deep Vrancea source with a magnitude assessed between 4.7 and 5.3 (EMSC); that event raised impact to the Silistra town with intensity of II-III degrees. Among the strongest earthquakes there is one more manifestation – a magnitude M=4.0 occurred in Kossovo; fortunately, it was not felt in Bulgaria.

As usually, the activity over the territory of continental Turkey is not high. Northern Greece is characterized by the well known high frequency of seismic events. The earthquake repetition in Valandovo seismic zone, Macedonia, is remarkable during the considered period.

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.

Fig.2 illustrates the seismicity just in the territory of Bulgaria and nearby lands (φ = 41^0 - 44.5^0N, λ = 22^0 - 29^0E). The epicenters of the earthquakes are differentiated by magnitude intervals. The seismic stations are also noted in the same figure by triangles. The parameters of the relatively stronger earthquakes are presented in Table 1.

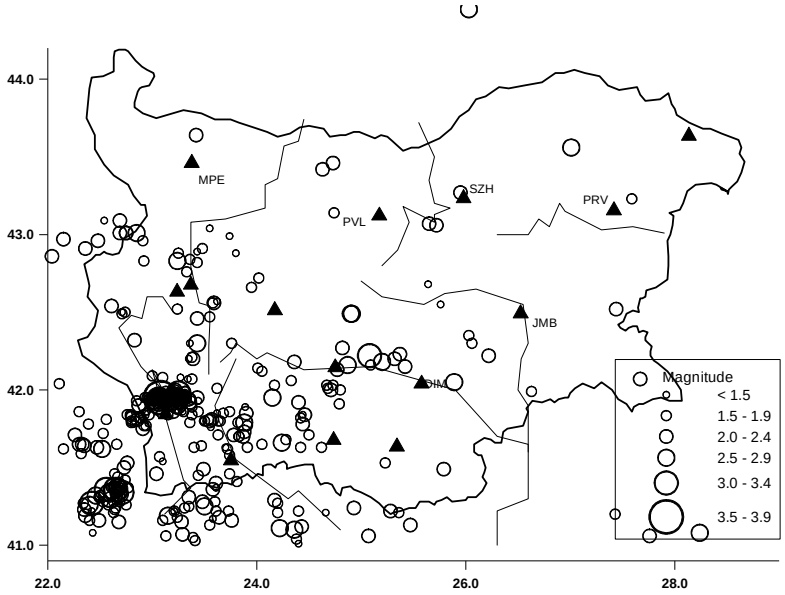

Fig.2. Map of epicentres in Bulgaria and adjacent lands during January - June 2005.

These 6 months can be distinguished by a big number of quite weak earthquakes. Four hundred forty five events have been registered, against 403 and 430 for the half-year periods of 2004. However, the earthquakes with a magnitude equal to or bigger than 3.0 are in low amount, only 9 events, compared with the average number of about 10-15 belonging to most of all previous half-years. At that, five of these earthquakes have their origin in the neighboring Valandovo zone. The maximum realized magnitude M=3.6 is also lower than the maximum magnitude in the course of previous half-years; its usual value used to be about 4.0.

The largest concentration of epicenters is marked in the southwestern part of the territory presented in Fig.2. As in the previous six months, the Kroupnik seismic source is one of the most active ones; besides, it was proved for the entire territory of SW Bulgaria that these lands were the most active after precluding the severe activation known for the first 30 years of the 20th century (Grigorova & Glavtcheva, 1976; Grigorova, Christoskov et al., 1980). 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). Since the beginning of January until June about 100 events with M<3.0 and 3 with M>3.0 occurred there. The strongest of them is the magnitude M=3.6 earthquake which occurred on 14 February and was felt with maximum intensity IV EMS in the region of Blagoevgrad. This is the strongest event for the whole Bulgarian territory for the six-month period of investigation.

It is important to be informed about the seismic situation relying to the Bulgarian capital. The Sofia seismic zone is characterized by about 10 small seismic events (as usually up to M=2.5). The Plovdiv region, known by catastrophic earthquakes in the past, is not so active too. One event of a magnitude M=3.3 was felt on 12 February causing an impact of intensity III EMS to Shishmanovci village.

Table 1. List of the earthquakes with M ≥ 2.5 in Bulgaria and adjacent lands during January - June 2005

Date	Time	Coordinates	H,km	M
20050104	06:56:27	42.16 24.87	11	2.8
20050105	15:24:09	41.26 22.40	12	2.9
20050105	16:24:40	41.32 22.46	2	2.6
20050117	05:38:24	41.95 23.25	13	2.6
20050212	17:33:32	42.22 25.08	11	3.3
20050214	00:35:36	41.94 23.06	18	3.1
20050214	00:38:40	41.95 23.08	5	2.7
20050214	00:44:02	41.95 23.08	17	3.6
20050214	00:48:28	41.93 23.02	15	2.5
20050214	00:55:08	41.94 23.11	12	2.7
20050214	02:55:07	41.95 23.06	18	2.6
20050215	04:01:35	41.08 28.24	2	2.7
20050224	11:10:22	41.90 23.24	2	2.5
20050307	06:27:01	41.19 23.15	5	2.8
20050316	21:07:14	41.98 23.25	8	3.1
20050317	15:18:09	41.95 23.26	8	2.7
20050319	02:21:40	41.36 22.65	9	3.1
20050319	03:27:11	41.27 22.42	9	3.0
20050319	23:26:42	41.33 22.69	10	2.5
20050321	01:45:11	41.35 22.62	2	2.6
20050321	03:17:34	41.32 22.60	3	3.0
20050325	23:34:03	44.45 26.03	20	2.5
20050330	06:08:46	41.11 24.22	4	2.7
20050330	09:29:08	41.79 23.88	2	2.5
20050401	05:34:36	41.37 22.67	2	2.7
20050401	14:02:56	43.56 27.01	5	2.9
20050406	03:38:24	41.25 23.50	15	2.6
20050410	11:33:53	41.10 24.36	12	2.7
20050413	17:13:44	41.62 22.52	9	2.5
20050413	18:52:23	41.36 22.56	1	3.1
20050414	08:19:36	41.38 22.67	4	2.5
20050415	09:08:57	42.83 23.24	11	2.5
20050415	13:23:44	42.30 23.43	5	2.5
20050424	07:47:53	42.18 25.20	13	2.6
20050424	09:26:56	41.34 22.71	5	3.2
20050430	23:03:40	41.66 24.24	10	2.6
20050522	23:07:21	41.95 23.21	7	2.5
20050523	20:11:35	43.01 22.85	10	2.7
20050601	02:09:59	41.95 23.21	8	2.6
20050602	20:19:32	42.49 24.90	10	2.5
20050602	20:38:01	42.49 24.91	15	2.5
20050605	07:07:47	42.05 25.89	8	2.5
20050629	10:19:01	41.95 24.15	20	2.8

The region of Western Rhodoppi being not active during the previous half-year period, demonstrates its capability of generating weak shocks. On 29 June a seismic event with M=2.9 was felt in the Velingrad seismic zone with intensity III EMS. A clear chain of epicentres stretches along the Vucha River.

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 characterize predominantly the seismicity parameters of the southwestern part of the territory under investigation.

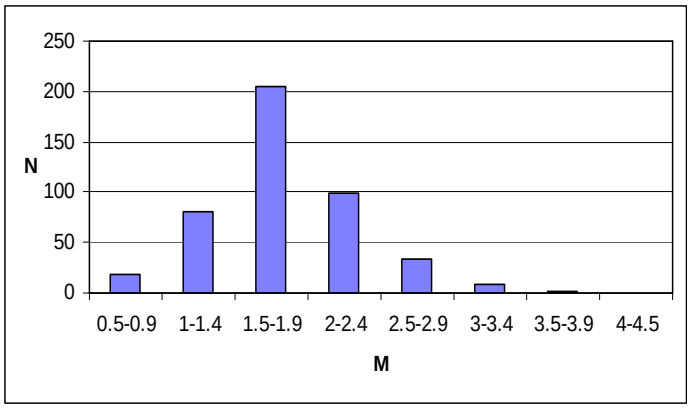

Fig. 3. Magnitude - frequency distribution of the earthquakes

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 > 3.5 the number of events is 1, for M > 3.0 it is 8, for M=2.5-2.9 - 34, for M=2.0-2.4 - 99 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.

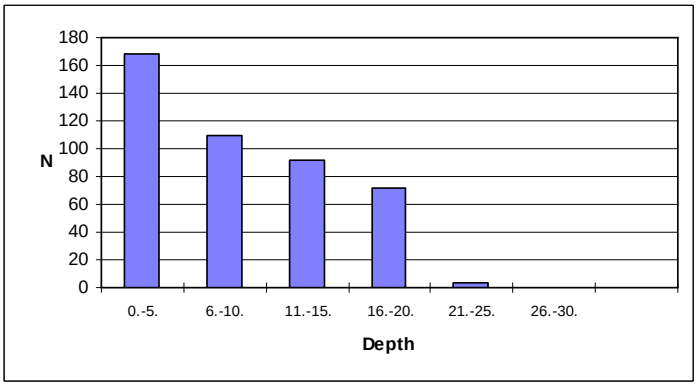

Fig. 4. Depth - frequency distribution of the earthquakes

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.

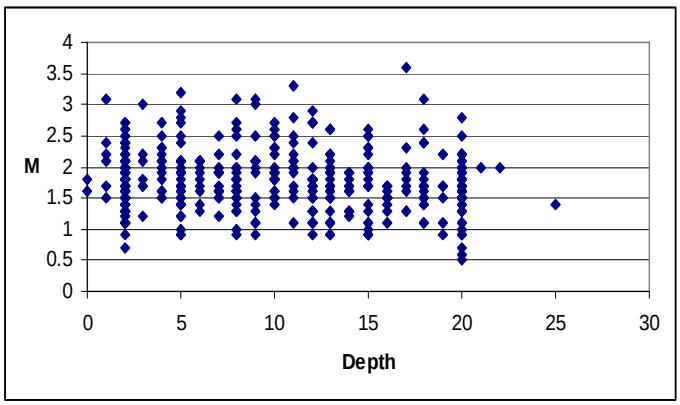

Fig. 5. Magnitude - depth dependence

The picture of the depth distribution in Fig.4 shows that almost all events occur down to 20 km depth. It is possible the established predominating depth (from 0 to 5 km) for most events to be also due to the presence of unidentified industrial explosions. The magnitude distribution of the events in depth (Fig.5) does not permit any categorical differentiation of depth "floors" with the increase of magnitude. It seems that most of the strongest earthquakes during this period have their origins at depths down to 12 km.

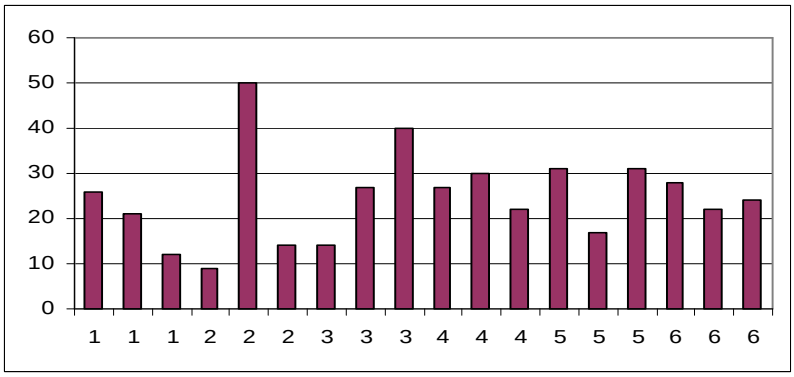

Fig. 6. Time distribution of the earthquakes in decades during January - June 2005.

Figure 6 illustrates the distribution of seismicity in time according to the number of events per decades. The biggest earthquake's amount is displayed in the second half of the period – started from the last decade of March. The maximum number of earthquakes is realized in the second decade of February - 50 events. The time distribution per month shows certain stability (from 73 to 81 earthquakes per month) with one exception – in January only 59 events have occurred.

Figure 7 shows the energy release in time through the earthquake magnitude time distribution. It suggests that in the second decade quarter of February, as the period when the strongest events occurred, is comparable with the maximum in relation to the frequency

release (Fig.6). In other words the maximum energy during these 6 months has been released in the period of the maximum number of earthquakes.

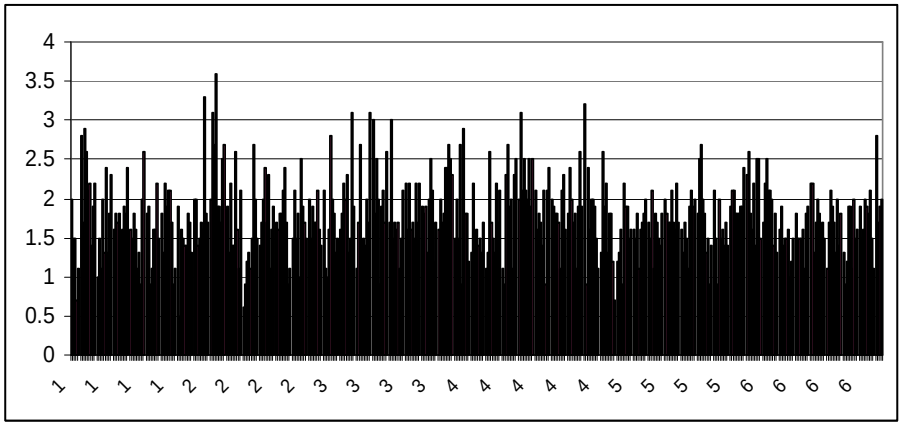

Fig. 7. Magnitude-time distribution of the earthquakes during January - June 2005

Additionally, about 200 distant earthquakes have been recorded in the period under study, as well as more than 100 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 януари - юни 2005

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С. Димитрова

Резюме. Предлаганото научно съобщение съдържа обобщена информация на резултатите от събирането, обработката и предварителния анализ на първичните данни за сеизмичните събития регистрирани от Националната Оперативна Телеметрична Система за Сеизмологична Информация (НОТССИ) за първото полугодие на 2004 г. Представена е карта на епицентрите на общо 684 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 (445 сеизмични събития в район с координати $\lambda = 22^0$ - 29^0E и $\varphi = 41^0$ - 44.5^0N). Сеизмогенните прояви се обсъждат по зони, сравнени със съседни периоди време.