PRELIMINARY DATA ON THE EVENTS RECORDED BY NOTSSI IN JULY – DECEMBER 2003

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Abstract. A map of epicentres of 858 earthquakes that occurred in the Balkan Peninsula sector outlined by latitude $\varphi = 37^0$- 47^0N and longitude $\lambda = 19^0$-30^0E is presented. Expert generalized analysis of the seismicity over the territory of Bulgaria and its adjacent lands (with more than 490 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 2003. 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.

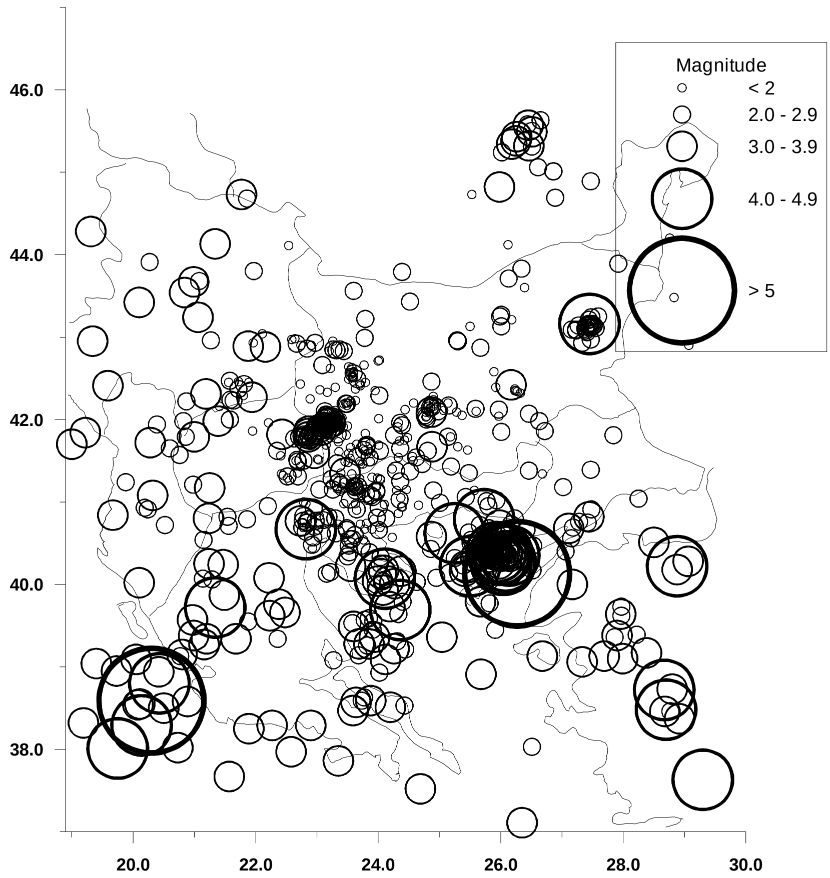

Fig.1. Map of epicenters in Central Balkans during July – December 2003.

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 more than 1200 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 858 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 337, in M=2-2.9 - 354, in M=3-3.9 - 143, in M=4-4.9 – 23 and in M=5-5.9 – 2 earthquakes.

As a whole, the seismic situation in the study part of the Balkans during the second half-year of 2003 is characterized by very high activity (858 events against 798 for the first half-year of 2003, and around 500 - 600 for most of the previous half-years). It can be noted that the observed tendency of increase in the activity compared with the former half-year is partly due to the earthquake activation in the Saros Bay, NE Aegean Sea. This happened in July and the mainshock was with M=5.3 according to the Euro-Mediterranean Seismological Centre in Strasbourg. The mainshock was felt in the Kurdzhali district with intensity V MSK. Actually, it was the strongest earthquake for the whole investigated period. On the territory of Romania, only Vrancea region is active during the second half of 2003 (Fig.1). There the activity is expressed by weak earthquakes not felt at all. The activity on the territory of continental Turkey is not high as usual. It develops at about 100 km inside and parallel to the Aegean coast. The contact area of Northern Greece is characterized by the well known high frequency of low magnitude seismic events. Strongest events are localized to the NNW of Thessaloniki and in the Khalkidhiki region. That one of them of a magnitude 4.2 that occurred on 29th October at about 60 km from the political Greece-Bulgarian border, in the area between Kilkis and Lagadina, was felt with intensity III MSK in the southwestern lands of Bulgaria – in the town of Petrich. Many earthquakes with a magnitude lower than 4 take place within the border region between Albania, Kosovo and Macedonia. The same is along Morava River on the territory of Serbia. No one of these events was important for Bulgaria.

It should be mentioned that events with M<3.0 which occur outside Bulgaria are difficult to be localized by the national seismological system and, 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 ($\varphi = 41^0$ - 44.5^0N, $\lambda = 22^0$ - 29^0E). The earthquakes are differentiated by magnitude intervals The seismic stations are also noted in the same figure by triangles. The parameters of relatively stronger earthquakes are presented in Table 1.

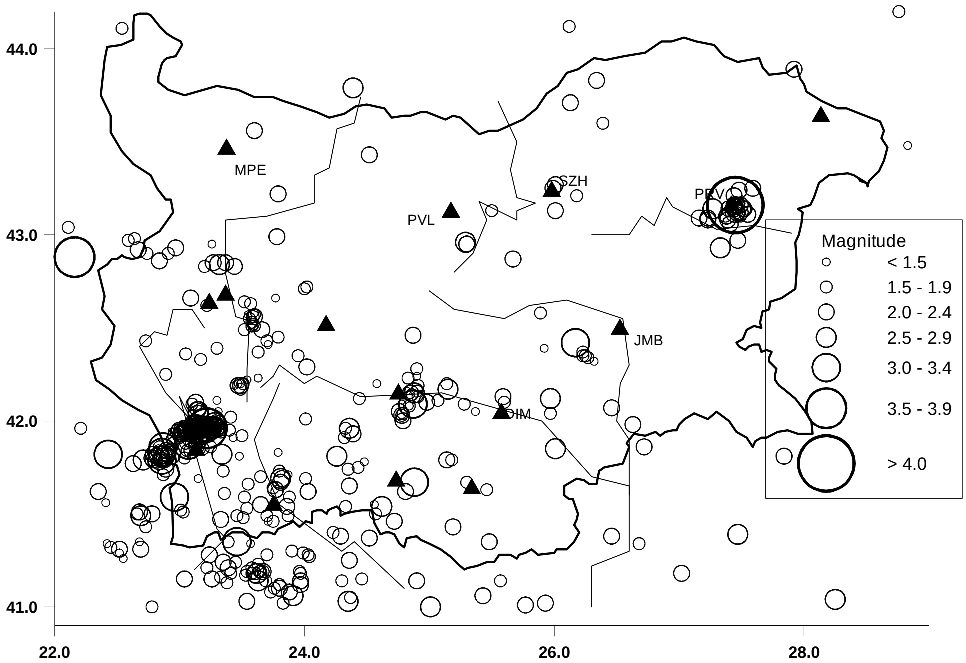

Fig.2. Map of epicentres in Bulgaria and adjacent lands during July – December 2003.

On the territory of Bulgaria a relatively high degree of activity of weak earthquakes is observed during these 6 months - 494 events against 430 for the first half-year of 2003 and 300 - 350 roughly for most of the previous half-years. The earthquakes with a magnitude higher than 3.0 are again in common amount - 14 events compared with the averaged number of about 10-15 for most of the all previous half-years. The maximal realized magnitude in Bulgaria is M=4.4 – much stronger in comparison with the maximal magnitude for the previous half-year (M=3.7).

As usually, the largest concentration of epicenters is marked in the southwestern part of the territory presented in Fig.2. And therein the Kroupnik seismic source, known with the strongest crustal earthquakes in Europe (M=7.8, 7.1) for the last 160 years (Christoskov and Grigorova, 1968), is one of the most active ones. By the way, a quantitative prevalence of the seismic activity in SW Bulgaria was marked for the first time in (Grigorova, Glavcheva, 1976). The activity of the northeastern part of Bulgarian territory should be outlined in this period. There namely, on 17 of December the Provadia zone became the origin of the strongest event in Bulgaria for the investigated period (magnitude M4.4). A field survey team was compiled from seismologists and earthquake engineers to examine the epicentral area. It established intensity VI MSK in several settlements and maximum 7 MSK in the village of Manastir. The conclusion was that the reason of the worst damages should have been the very poor quality of buildings (Dimova et al., 2004).

Interesting information is that starting in July until December about 80 events with M<3.0 and 5 with M>3.0 occurred in South Rila Mnt. The strongest of the earthquakes is with a magnitude M=3.7 and it was felt on 9 November with maximum intensity up to V MSK in the region of Blagoevgrad. Earthquakes with magnitude around 3 can be seen as follows: not far from Chepelare in central Rhodoppi Mnt. (on 7 July, M=3.1), close to Yambol in Tundzha zone (on 16 August, M=3.1), and in vicinity of Plovdiv city, the Maritsa zone (on 15 November, M=3.2). Finally, the Sofia seismic zone is characterized by about 20 small seismic events (up to M=2.5).

Table 1. List of earthquakes with M > 2.5 in Bulgaria and adjacent lands during July – December 2003

Date	Time	Coordinates		H	M
2003 7 3	15:49: 8	42.96	25.29	10	2.6
2003 7 3	20:51:16	41.96	23.28	12	2.9
2003 7 7	7:15:20	41.67	24.88	10	3.1
2003 7 8	2:48:35	41.82	22.93	12	2.8
2003 7 8	12: 0: 8	42.84	23.32	10	2.5
2003 714	0:31:51	41.96	23.11	10	2.6
2003 715	20:13:57	41.96	23.11	9	2.8
2003 715	20:13:56	41.95	23.06	8	2.8
2003 717	7:26:34	41.04	28.25	2	2.5
2003 721	1:10:20	41.98	23.12	20	2.5
2003 725	6:26:17	41.79	22.71	9	2.5
2003 727	22:44:15	42.88	22.16	8	3.6
2003 731	1: 0: 7	41.79	22.86	7	3.2
2003 731	1: 0: 8	41.87	23.07	20	3.0
2003 731	1:12:26	41.83	22.86	2	3.1
2003 8 4	2:54:46	41.80	22.87	2	2.5
2003 8 9	6: 1:47	41.96	24.36	20	2.7
2003 815	6:34:19	41.86	22.87	2	3.2
2003 816	4:54:26	42.42	26.17	12	3.1
2003 817	9:44: 2	41.69	23.81	13	2.5
2003 817	16:50:16	41.06	23.91	15	2.5
2003 821	23:44:26	41.59	22.96	8	3.0
2003 822	4:10:14	41.82	22.43	8	3.0
2003 822	10:31: 2	43.79	24.39	14	2.5
2003 825	3:59: 0	41.49	22.69	3	2.5
2003 830	17:23:56	41.85	26.01	18	2.5
2003 831	13:42:29	43.12	27.45	2	2.5
2003 920	16: 9:40	42.05	23.15	6	2.5
2003 920	16: 9:40	42.03	23.15	14	2.8
2003 924	13:26:19	41.03	24.35	2	2.6
200310 1	17:49:28	42.17	25.15	13	2.7
200310 6	22: 8:30	42.15	24.88	17	2.9
20031015	14:31:18	41.39	27.47	10	2.5
20031028	3:51:23	42.12	25.97	20	2.8

20031030	9: 5:37	41.35	23.46	20	3.0
200311 5	9: 2:35	41.82	23.34	9	2.7
200311 9	17:51:11	41.96	23.22	7	3.7
20031115	14:11: 8	42.09	24.87	13	3.2
20031116	2:53:46	41.81	24.26	2	2.5
200312 8	5: 4:12	41.94	23.23	2	2.5
200312 9	5: 4:12	41.93	23.16	8	2.5
200312 9	18:59:25	41.94	23.17	20	2.7
200312 9	18:59:25	41.94	23.20	10	2.8
200312 9	18:59:25	41.94	23.17	20	2.7
20031210	10:22:52	41.95	23.18	6	3.1
20031210	10:34: 9	41.96	23.25	7	2.5
20031211	3:55:58	41.00	25.01	2	2.5
20031212	1:27:18	41.99	23.28	0	2.6
20031212	9:49:47	41.18	23.62	18	2.5
20031214	9: 6:29	41.14	23.63	0	2.5
20031217	23:15:13	43.16	27.45	9	4.4
20031218	2:19:26	43.14	27.27	16	2.5
20031219	9:50:46	42.93	27.33	10	2.5
20031228	7:23:47	41.54	24.62	5	2.6

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.

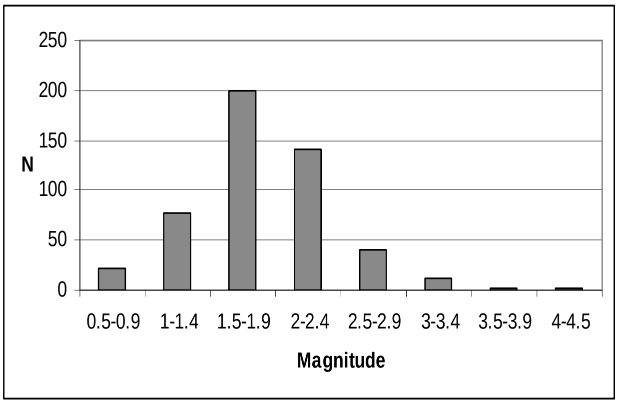

Fig.3. Magnitude - frequency distribution of the earthquakes

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 > 4 the number of events is 1, for M > 3.5 it is 2, for M=3.0-3.4 - 11, for M=2.5-2.9 - 40, for M=2.0-2.4 - 141 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.

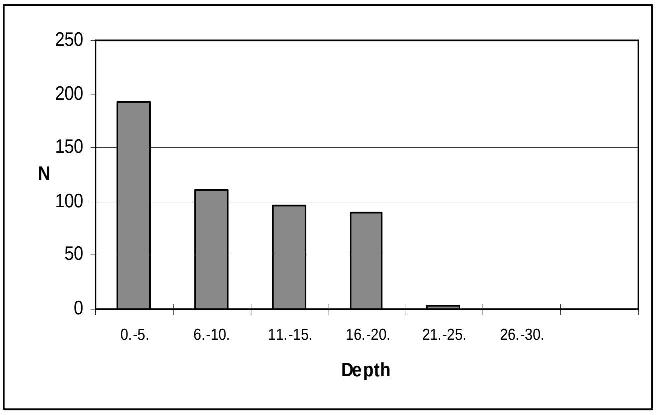

Fig.4. Depth - frequency distribution of the earthquakes

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.

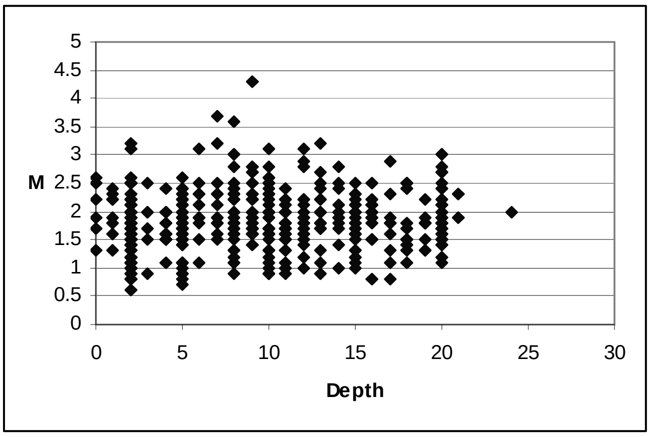

Fig.5. Magnitude - depth dependence

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) 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 - some tendency can be traced out for the formation of a very broad band maximum in the depth interval 7 - 9 km.

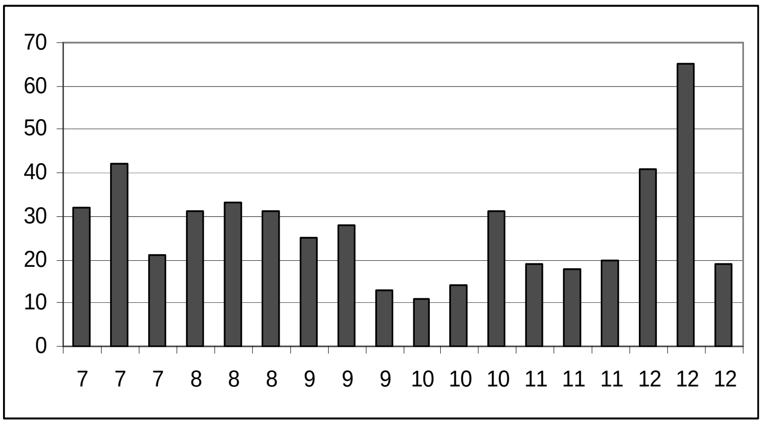

Fig.6. Time distribution of the earthquakes during July – December 2003.

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-August and in the end-point of the investigated period - December; however the increase in December is remarkably different on the background of the remained number variations. The lowest earthquake quantity is in October, 56 events only. Figure 7 shows the energy release in time through the earthquake magnitude time distribution. It suggests that December the month when the strongest event occurred is comparable with July - August in relation to the energy release.

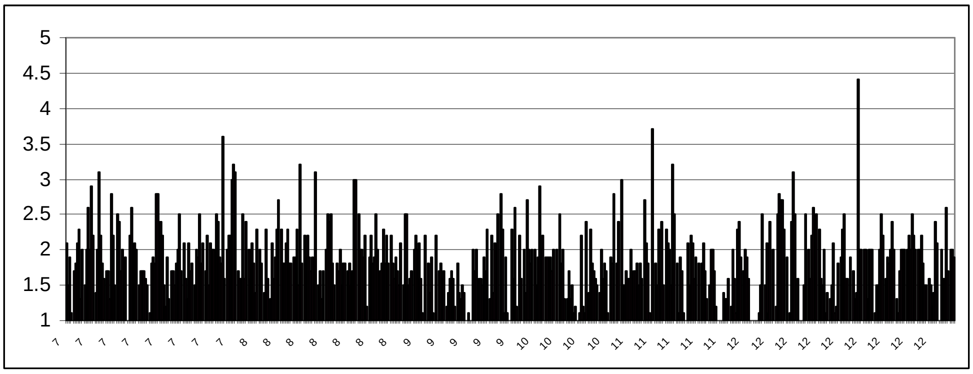

Fig.7. Magnitude-time distribution of the earthquakes during July – December 2003

Additionally, about 210 distant earthquakes have been recorded in the period under study, as well as more than 90 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 2003

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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 второто полугодие на 2003 г. Представена е карта на епицентрите на общо 858 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 (494 сеизмични събития в район с координати $\lambda = 22^0$ - 29^0E и $\varphi = 41^0$ - 44.5^0N).