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PRELIMINARY DATA ON THE EVENTS RECORDED BY NOTSSI IN JANUARY - JUNE 2003

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Abstract. A map of the epicenters of 783 earthquakes that occurred in the Balkan Peninsula sector outlined by latitude φ =37°- 47°N and longitude λ =19°-30°E is compiled. A generalized analysis of the seismicity over the territory of Bulgaria and its adjacent lands (with 450 localized events) is made.

Key words: Balkan Peninsula, Bulgaria, seismicityIntroduction

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 2002. 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 20 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 distant 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 epicentre's determination is different; except on the distance it depends also on the specific position of the epicentre in relation to the recording network.

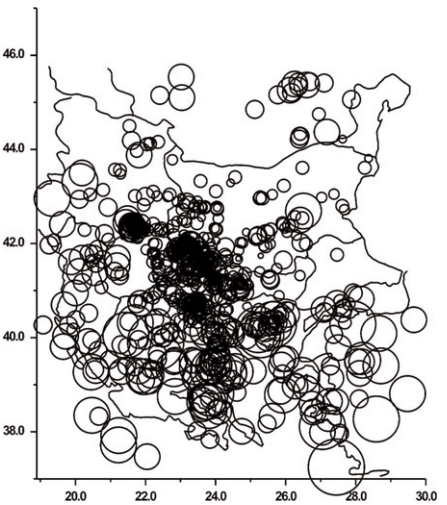

Fig.1. Map of epicenters in Central Balkans during January - June 2003.
The size of the circles of epicenters is proportional of the magnitude of earthquakes

The natural and necessary condition for the preparation of the final seismological catalogue is to accomplish the primary data by means of information from the international seismological centers. 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 investigations.

For the six-month period of observations presented in this communication, the primary data about more than 1600 local, regional, distant earthquakes and industrial explosions on the territory of the country are recorded, classified and processed (as work bulletin) in NOTSSI. After the comprehensive analysis of the records and application of the above mentioned calculation procedures it is established that 783 of all registered earthquakes are in the Balkan Peninsula region outlined by geographic latitude 37° - 47° N and longitude 19° - 30° E. The epicenters of the earthquakes separated in different magnitude levels are plotted on Fig.1. The size of the circles corresponds to each half unit

of the earthquake magnitude. The number of events in the magnitude interval M=1-1.9 is 499, in M=2-2.9 - 256, in M=3-3.9 - 117, in M=4-4.9 - 11 earthquakes.

As a whole, the seismic situation in this part of the Balkans during the first half-year of 2003 is characterized by high activity (798 events against around 500 - 600 for most of the previous half-years). It can be noted that the observed tendency of increase in the activity is on account of the increased number of earthquakes in Northwestern Turkey, actually in the Marmara Sea region.

A relatively small number of events can be noticed on the territory of Romania during the investigated period (Fig.1). Of course this is connected with the registration network possibility of successful localization of the smallest events outside the netwotk perimeter. The activity on the territory of continental Turkey is not high as usual. Northern Greece is characterized by the well known high frequency of seismic events. An earthquake that occurred on 14th January in the northern part of Northern Greece was felt with intensity III MSK in the southern parts of Bulgarian Rhodopes. The strongest earthquake for the whole period (magnitude M=4.2) occurred on 10 of June in the NE Aegean Sea; it was slightly felt (intensity II-III MSK) in the town of Kurdjali. It must be reminded 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 (φ = 41° - 44.5°N, = 22° - 29°E). The epicenters of the earthquakes are separated in different magnitude level. The size of the circles corresponds to each half unit of the earthquake magnitude. The parameters of the relatively stronger earthquakes are presented in Table 1. The places and code names of the seismic stations are noted in Fig. 2. A relatively high activity of the weak earthquakes is

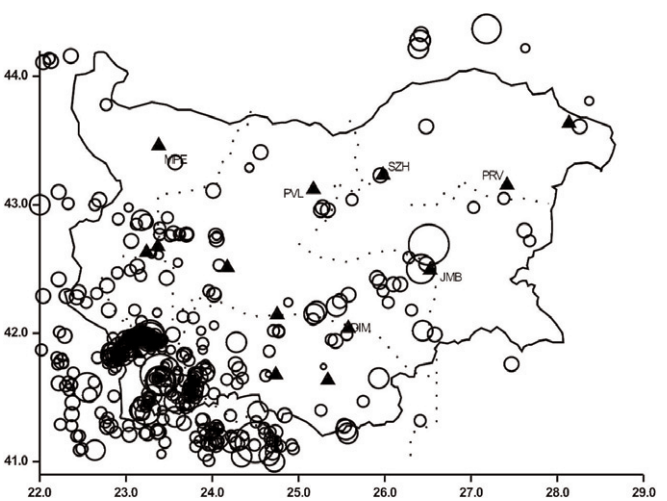

Fig.2. Map of epicentres in Bulgaria and adjacent lands during July - December 2002
The size of the circles of epicenters is proportional of the magnitude of earthquakes.

observed during these 6 months - 430 events against averaged about 300 - 350 for the most of the previous half-years. The earthquakes with a magnitude higher than M=3.0 are again in normal amount - 12 events compared with the averaged number of about 10-15 for most of the all previous half-years. The maximal realized magnitude is M=3.7.

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. This source is known with the strongest crustal earthquakes in Europe (M=7.8, 7.1) for the last 150 years (Christoskov and Grigorova, 1968). Since the beginning of January until June about 60 events with M<3.0 and only 3 with M>3.0 have occurred here. The strongest of them is with magnitude M=3.3 and it was felt on 20 January with maximum intensity up to V MSK in the region of Blagoevgrad (to the east of the city). In the region of the Kroupnik seismic source as well but on the territory of R.Macedonia, about 10 microearthquakes (with M<3.0) occurred. The Sofia seismic zone is characterized by about 10 small seismic events (as usually up to M=3.0). The activity of the northern part of the Pirin Mountain should be outlined in this period. There namely, the Pirin heart was hit on 9 of June by the strongest event for the whole Bulgarian territory (magnitude M3.7); the intensity reached as high as 5 MSK in the settlements at the mountain slopes. It is worth reminding here that a seismogenic activation in the Pirin's interior has been noticed on occasion of the magnitude 5, 1972, earthquake series (Grigorova & Glavcheva, 1975).

Table 1. List of the earthquakes with M > 2.5 in Bulgaria and adjacent lands during July - June 2003

Date	Time	Coordinates	H	M
20030101	01: 2:45	41.35 23.57	4	2.8
20030102	06:14:14	41.65 25.93	2	2.8
20030104	05:41:33	41.17 24.31	8	2.5
20030110	08: 3: 8	41.15 24.50	7	3.6
20030111	08:26: 0	42.21 25.44	14	2.9
20030114	07: 8:30	41.18 24.07	9	2.5
20030117	18:54:47	41.99 23.28	5	3.1
20030120	18: 8:28	41.97 23.28	2	3.3
20030121	22: 7:46	42.15 25.18	13	2.8
20030123	22: 7:46	42.17 25.21	13	2.9
20030128	14:17: 8	42.88 23.18	10	2.5
20030201	07:53:37	41.05 24.66	6	2.6
20030203	19:19:15	41.52 23.30	10	2.5
20030205	00:53: 9	41.63 23.41	2	3.0
20030207	13: 4:26	41.00 24.72	9	2.7
20030213	07:33:16	41.15 24.22	6	2.6
20030217	08:22:23	44.28 26.41	2	2.5
20030221	23:24:17	41.81 22.85	20	2.5
20030226	00:25: 1	41.40 23.16	8	2.5
20030228	18: 2:33	41.40 23.23	20	3.0

20030301	00:13:49	44.22 26.39	8	2.8
20030303	03: 7: 6	41.55 23.77	9	2.8
20030308	03:15:30	41.58 23.78	2	2.9
20030315	00: 6:46	41.22 25.57	2	2.8
20030315	06:39:13	44.37 27.18	12	3.0
20030317	11:34:47	44.28 26.41	2	2.6
20030327	13: 2:29	41.39 24.53	20	2.5
20030328	08:13:12	41.47 23.56	2	2.5
20030401	22:59:47	42.02 26.44	5	2.8
20030403	00:52:17	41.94 23.00	6	2.5
20030413	12: 3:37	41.04 24.34	3	2.7
20030424	01: 0:27	41.85 22.83	10	2.7
20030426	02: 5:50	41.25 25.55	2	2.7
20030429	03:52:29	41.58 22.55	2	3.2
20030429	03:56:31	41.48 23.73	14	2.5
20030501	08:51:23	41.97 23.18	11	2.7
20030504	16:41:12	41.98 23.16	13	2.8
20030509	12:22:17	41.70 23.91	14	2.6
20030513	21: 3: 5	41.86 22.95	15	3.3
20030515	15:53:10	41.09 22.64	5	2.6
20030518	01:49: 7	42.69 26.51	11	3.6
20030601	19: 8: 1	41.66 23.83	2	2.5
20030602	01:36:14	41.97 23.23	2	2.8
20030609	06:59:28	43.00 22.00	8	2.6
20030609	09:14:43	41.68 23.40	13	3.7
20030609	09:18:20	41.63 23.39	19	3.0
20030620	09:11:26	42.50 26.42	15	3.0
20030620	11:59:21	41.93 24.28	6	2.7

On 18 May a seismic activation started with M=3.6 in the Yambol seismic zone, Upper Thracian Lowland. The local people were not significantly disturbed because of the slight impact they felt, intensity a bit lower than V MSK.

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.

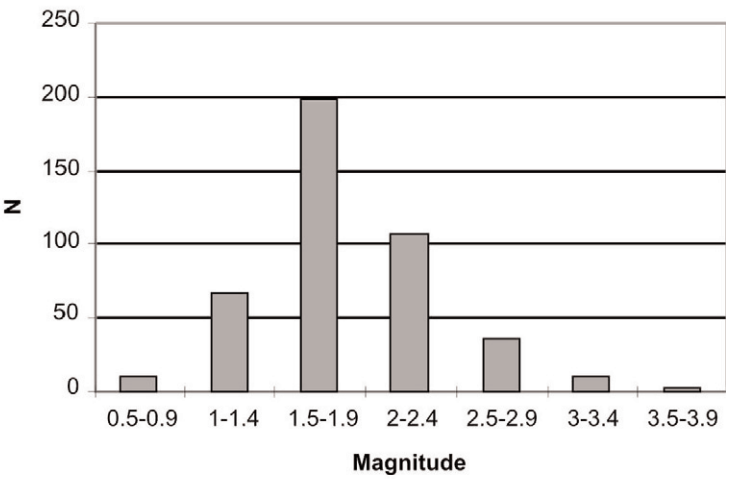

Fig.3. Magnitude - frequency distribution of the earthquakes

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 0, for M > 3.5 it is 3, for M=3.0-3.4 - 9, for M=2.5-2.9 - 36, for M=2.0-2.4 - 108 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.

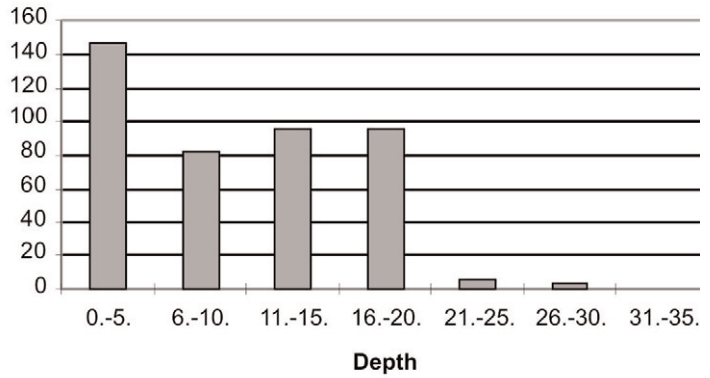

Fig.4. Depth - frequency distribution of the earthquakes

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.

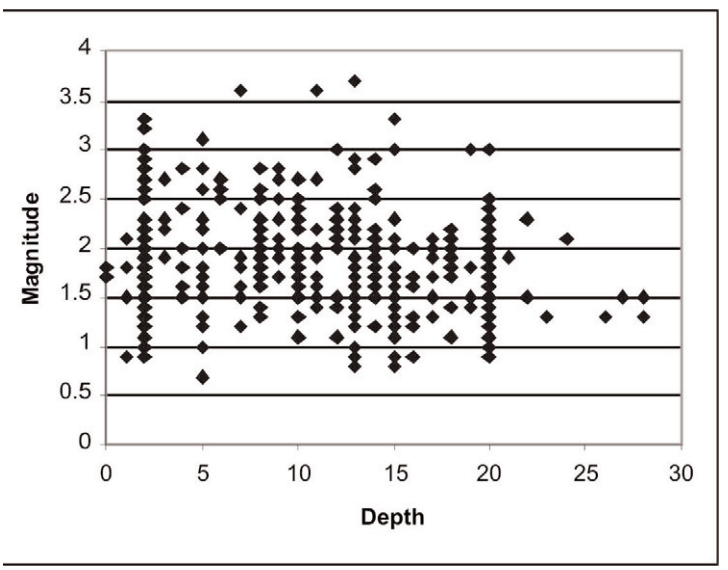

Fig.5. Magnitude - depth dependence

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 - 13 km

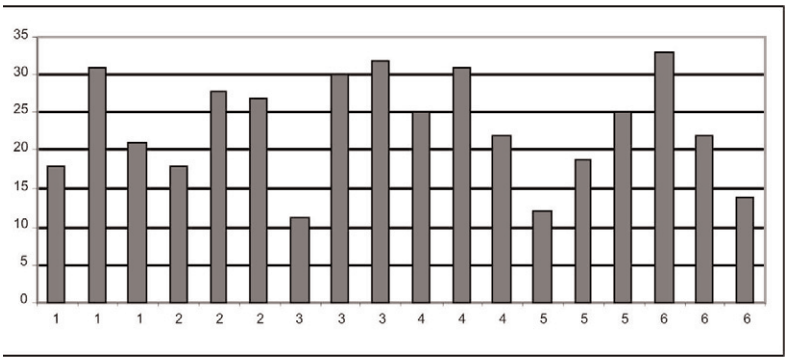

Fig.6. Time distribution of the earthquakes during January - June 2003.

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 March-April, the mid-point of the investigated period; however this increase is not remarkably different on the background of the remained number variations. The lowest earthquake quantity is in May, 56 events only. Figure 7 shows the energy release in time through the earthquake magnitude time distribution. It suggests that June the month when the strongest event occurred is comparable with January in relation to the energy release.

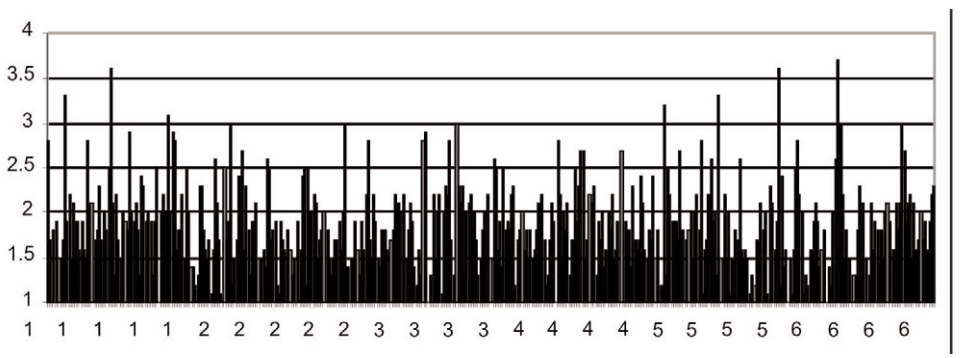

Fig.7. Magnitude-time distribution of the earthquakes during January - June 2003

Additionally, about 190 distant earthquakes have been recorded in the period under study, as well as more than 80 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 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 първото полугодие на 2003 г. Представена е карта на епицентрите на общо 798 земетресения в частта от Балканския полуостров, ограничена от географска ширина 37° - 47° N и дължина 19° - 30° E. По-подробно се анализира сеизмичността за територията на България и прилежащите й земи (431 сеизмични събития в район с координати λ= 22° - 29°E и φ=41° - 44.5°N).