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PRELIMINARY DATA ON THE EVENTS RECORDED BY NOTSSI IN JULY - DECEMBER 2002

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 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.

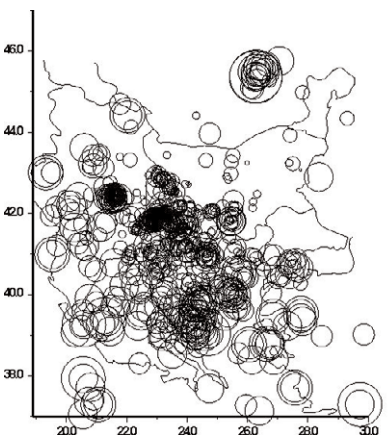

Fig.1. Map of epicentres in Central Balkans during July - December 2002.
The size of the circles of epicenters is proportional of the magnitude of earthquakes.

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 299, in M=2-2.9 - 364, in M=3-3.9 - 112, in M=4-4.9 - 8 earthquakes.

As a whole the seismic situation in this part of the Balkans during the second half-year of 2002 is characterized by the highest activity in the last years (783 events against about 500 - 600 averaged for the same half-years in the last decade). It can be noted that this fact is due to the big number of earthquakes over the territory of Bulgaria.

The seismicity distribution in Fig. 1 shows a relatively big number of seismic events on the neighboring territories of Romania and Serbia. But the strongest earthquakes from those areas, the 30 November Vrancea event (M 5) and the 2 August shock in the Serbia-Romania border region (M 4.2) are not felt on the territory of Bulgaria. The neighboring northern part of Greece is characterized by very high frequency of seismic events; one of the earthquakes there that one on 31 July with M4.3, was felt in the very SW sector of Bulgaria (the Petrich area) with intensity 4 degree MSK or some more. The usual high activity of the coast line of Greece and Turkey is established again. A high activity, as usual for the last years, is observed in this period on the territory of NW Turkey, on the east and south of the Marmara Sea. It must be reminded that the 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. Finally, the strongest earthquakes in adjacent territories, those ones with magnitude M>4.5, occurred in and around the Vrancea region (Fig.1).

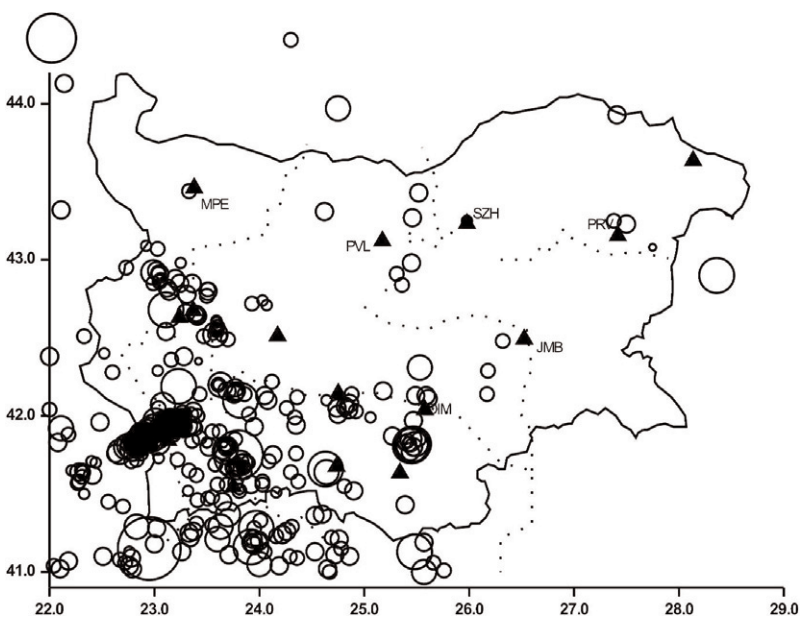

Fig.2. Map of epicentres in Bulgaria and adjacent lands during July - December 2002
The size of the circles of epicenters is proportional of the magnitude of earthquakes.

Fig.2 illustrates the seismicity in the territory of Bulgaria only and nearby lands

(λ= 22° - 29° E and φ= 41° - 44.5° N). 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 observed - 450 events against about 300 - 350 for the previous ten half-years. The earthquakes with a magnitude bigger than M=3.0 are 15 (against 10 or less for the previous half-years). The maximal realized magnitude is M=4.3 in the case of an earthquake in the Bulgaria-Greece border region.

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 the most active one. 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 July until December more than 80 events with M<3.0 and only 2 with M>3.0 have occurred here. There is no information about whatever felt effects accompanying even the strongest of them.

Table 1. List of the earthquakes with M > 2.5 in Bulgaria and adjacent lands during July - December 2002

Date	Time	Coordinates	H	M
20020705	02:15:52	41.29 23.63	10	2.8
20020705	02:15:53	41.37 23.70	20	2.7
20020721	10:53:33	42.20 23.63	2	2.7
20020723	03:27:13	42.90 28.36	20	3.0
20020731	04: 5:51	41.15 22.95	11	4.3
20020802	09:37:22	44.42 22.02	8	3.9
20020802	21:44:27	41.13 25.48	13	3.1
20020803	21:47:24	41.00 25.57	9	2.9
20020803	22:37:26	41.85 22.90	11	2.5
20020810	09:25:30	41.29 22.83	7	2.7
20020903	19:49:28	42.68 23.11	12	3.3
20020904	20:39:11	41.75 23.80	8	3.5
20020906	03:25:49	41.70 23.82	11	2.9
20020910	15:36: 5	41.83 23.03	2	2.5
20020910	17:50: 5	41.88 22.88	4	2.5
20020918	09: 9:17	42.19 23.23	8	3.3
20020921	12:55:37	41.92 22.11	18	2.5
20020927	08:51:48	41.79 22.79	2	2.5
20020927	08:55:58	41.83 22.86	13	2.6
20020927	09:33:37	41.85 22.98	20	2.5
20020927	10: 9:36	41.81 22.83	2	2.5
20021002	17:58:41	43.97 24.75	5	2.7
20021024	23: 4:33	42.07 23.08	18	2.7
20021025	14:25:12	41.85 22.85	11	2.6
20021025	14:35:37	41.87 22.88	14	2.7
20021025	21:43:41	41.84 22.87	6	2.5

20021026	16:21:15	41.80 22.73	7	2.9
20021026	16:45:11	41.90 23.01	2	3.2
20021031	05:20:42	41.94 23.29	2	2.6
20021031	22:50:17	42.10 23.82	2	3.2
20021101	09:53:48	42.31 25.53	14	2.9
20021102	04:51:39	41.66 24.63	12	3.0
20021102	05:37:37	41.64 24.64	17	2.7
20021107	17:34:43	42.52 23.58	13	2.8
20021109	08:59:44	41.97 23.01	7	2.7
20021109	15:35:45	41.21 23.60	10	2.5
20021111	23: 1:43	41.82 25.49	13	2.8
20021113	06:12:60	41.16 23.92	14	3.3
20021113	06:13: 1	41.28 23.97	20	3.0
20021113	19:35:20	41.77 23.67	9	2.7
20021117	03:15:12	41.82 25.47	14	3.1
20021118	05:21:24	41.81 22.76	2	2.8
20021118	05:26:42	41.77 22.67	2	2.5
20021118	10:53:37	41.81 25.46	12	3.0
20021118	10:54:37	41.81 25.44	14	3.1
20021119	14:54: 8	41.85 25.43	5	2.6
20021120	22: 1: 6	41.94 23.12	7	2.7
20021121	05:11:57	41.91 22.95	6	2.8
20021121	06: 7:24	41.88 22.90	2	2.5
20021123	23:45: 7	41.86 22.96	10	2.7
20021201	17:56:28	41.79 23.68	20	2.7
20021203	07:57:35	42.92 22.99	8	2.5
20021216	02:52:48	41.05 24.00	8	2.5

To the south of the considered seismogenic zone, high activity can be noted in the space between the rivers of Struma and Mesta, most of all in the neighboring territory of Greece.

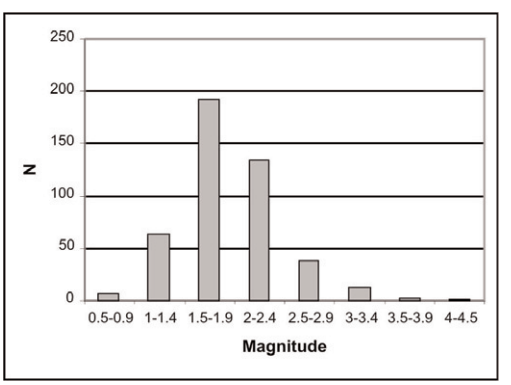

Fig.3. Magnitude - frequency distribution of the earthquakes

The Sofia seismic zone is characterized by about 20 small seismic events (microearthquakes with magnitude M<3.0), but the M=3.3 event on the 3 of September was felt with intensity of 4 to 5 degree MSK in a few villages to the west of Sofia city. The Plovdiv region was relatively active - about 30 small earthquakes were realized there, but without felt local events. In the Provadia seismic zone only 8 microearthquakes are localized by means of the Provadia local seismic network without being felt.

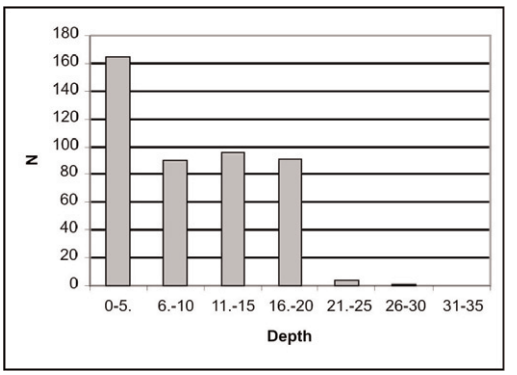

Fig.4. Depth - frequency distribution of the earthquakes

A detailed analysis of seismicity in the individual seismic zones is hard to be fulfilled because of the insufficient amount of events and the narrow magnitude range of 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 illustrates the magnitude-frequency distribution: the number of localized events increases with the magnitude decrease:

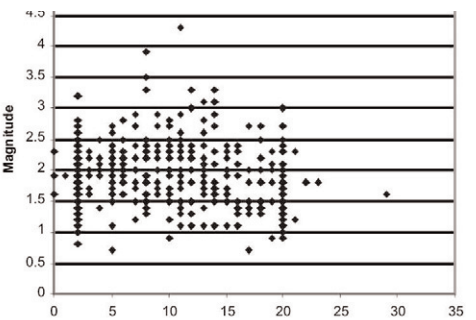

Fig.5. Magnitude - depth dependence

for M > 3.5 it is 3, for M=3.0-3.4 - 9, for M=2.5-2.9 - 33 , for M=2.0-2.4 - 101 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. In this way 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 country territory.

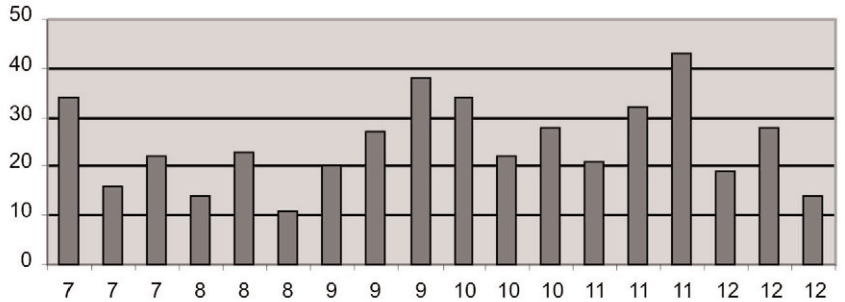

Fig.6. Time distribution of the earthquakes during July - December 2002

The picture of the depth distribution in Fig.4 shows that the majority of the earthquakes occur down to 20 km depth. The smooth increasing of the events with the decreasing of the depth to the 0-5 km level proves the successful distinguishing of the industrial explosions from earthquakes. The distribution of the events' magnitude in depth (Fig.5) permits some differentiation of depth "floors" with the increase of magnitude - a tendency of concentration of stronger events can be traced out in the depth interval 8 - 13 km approximately.

Fig.6 illustrates the distribution of seismicity in time according to the number of events per decade. Figure 7 displays the energy release in time through the earthquake magnitude time distribution. The mean seismic energy released in the late October - November is a bit higher in comparison with the other months. This is due to the occurrence of several M 3 earthquakes in three seismogenic regions, the Kroupnik, along the mid-Mesta fault and near Haskovo in the East Rhodopean massif (Table 1).

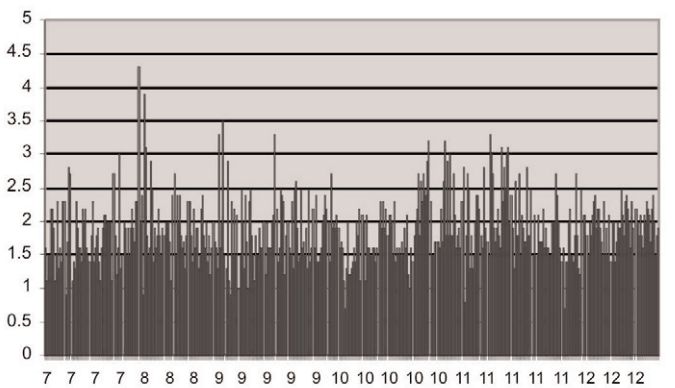

Fig.7. Magnitude-time distribution of the earthquakes during July- December 2002

Additionally, about 280 distant earthquakes have been recorded in the period under study, as well as more than 160 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.

References

Christoskov L. and E.Grigorova, 1968. Energetic and space characteristics of the destructive earthquakes in Bulgaria since 1900. *Izv.BAS*, vol XII, (in Bulgarian).

Christoskov L. and E.Samardjieva, 1983. Investigation on the duration of the seismic signals like an energetic characteristic of the earthquakes. *BGJ*, vol.IX, N1, (in Bulgarian).

Christoskov L. et al., 1987. Real time and background data processing in the Bulgarian seismological network. *Proc. Xx gen. Assembly* 1986, Kiel, Zurich.

Deneva D. et al., 1988. On the discrimination between industrial explosions and weak earthquakes using records of local seismic networks. *Proc. of Conference in Liblice*, 1988, Praha.

Solakov D. and Tch.Dobrev, 1987. Program for determination of main parameters of the earthquakes. *BGJ*, vol.XIII, N4, (in Bulgarian).

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Предварителни данни за сеизмичните събития регистрирани от НОТССИ през юли - декември 2002

Е.Ботев, Р.Главчева, Б.Бабачкова, С.Величкова, И.Цончева, К.Донкова, 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 второто полугодие на 2002 г. Представена е карта на епицентрите на общо 783 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 (450 сеизмични събития в район с координати φ =41°- 44.5°N и λ= 22°-29°E).