ACTA MONTANA IRSM AS CR (1996)
Series A, No.9 (100), 131–138

A CONTRIBUTION TO DISCUSSION ON LOWER LIMITATION OF ENERGY–FREQUENCY DISTRIBUTION

PAVEL KALENDA

CoalExp Ostrava, Kosmonautů 2, 700 30 Ostrava–3, Czech Republic

INTRODUCTION

On the energy–frequency (E–F) distribution compiled from date acquired by seismological observations in all coal fields there is an evident lower energy limitation which leads to the interpretation as a possible influence of structural arrangement of a rock mass and its lower geometric dimension which results in significant changes of material properties being observed on the rock samples [Rudajev 1995; Lasocki 1993]. On the other hand, this lower energy limitation may be interpreted as a principal influence of monitoring basis abilities which does not reliably allow to register and localize weaker events.

Based on comparison of seismologic (SL) and seismoacoustic (SA) monitoring of the same area this contribution solves the problem whether the observed limitation of E–F distribution resulting from SL data is either due to low sensitivity of the monitoring SL network, or it is given by structural impacts of the rock.

DESCRIPTION OF MONITORING NETWORKS

The SL monitoring network of the OKR encompasses monitored coalfaces No.140 804 and 140805 at Darkov Colliery from all sides (see Fig. 1). The mean distance between SL stations in neighbourhood of coalfaces is approx. 1000 – 1800 m. Previously published locating ability of the SL network [Kalenda 1992] resulted in the neighbourhood of respective coalfaces around 100 J and below that limit there, theoretically, should not have been registered (at least at three stations) and correctly localized all events.

The SA monitoring was installed in the coalfaces as early as completing road drivages in December 1993 and since January 1994 there were monitored all the seismic activities in the neighbourhood to the respective coalfaces (see Fig. 2). The SA monitoring with adjusted parameters should have monitored all the seismic activities within the range approx. 100 m from both coalfaces from energies approx. 5 J at events coming from the coalface and from energies approx. 20 – 30 J at events coming from the hanging wall. Due to fact that the energy calculation is based on energy contents of channel waves spreading through the coal seam, the energy calculation at hanging wall events based od P and S volume waves is not correct and resulting energies are underestimated as much as 10 times. Due to fact that

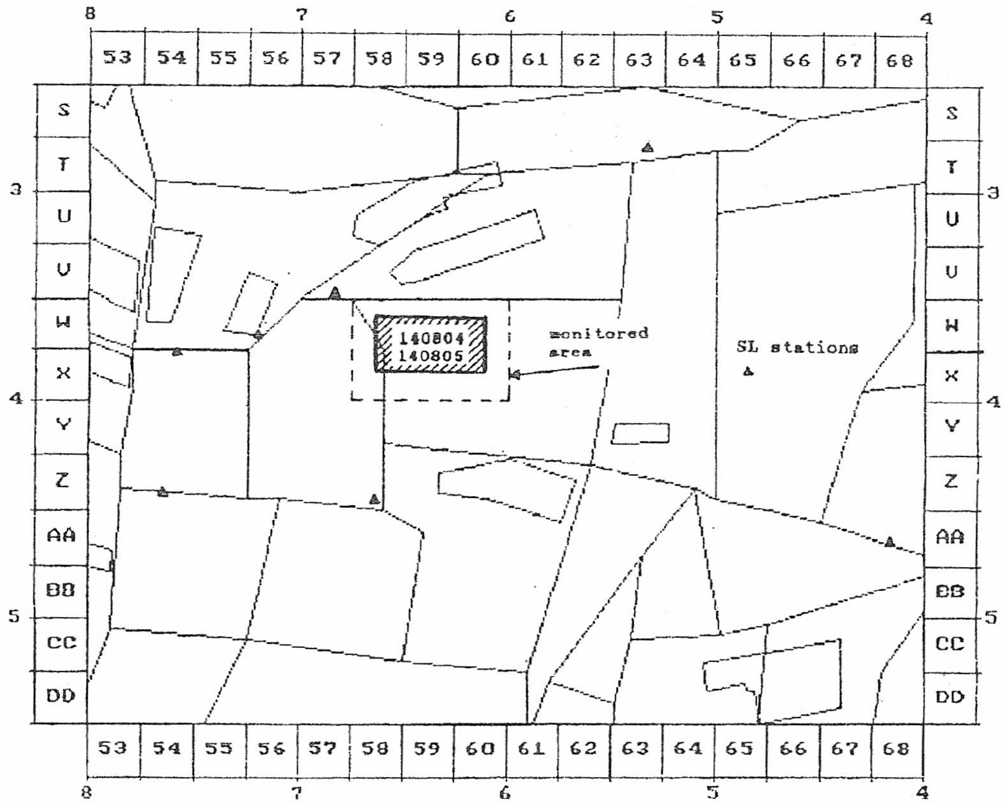

FIG. 1. Map of surrounding of coalfaces No.140804+5 with dislocation of SL network stations

number of hanging wall events is negligible in comparison with that of events arisen in a coal seam or in an adjacent hanging wall (compare Figs. 3 and 4), this error will be significantly demonstrated at E–F distribution as far as at higher energy classes from 100 J, as these events usually have already transferred their greater part of energy by volume waves even in case when there took place a sinking of an adjacent hanging wall into a coal seam.

Energy attenuation by the distance at SA monitoring is calibrated by means of blastings and linked absolutely to energies determined by SL monitoring network based on a 100 J level. Nevertheless, SA and SL energies may differ at levels of 1–50 J (if SL network would register such a SL event) and namely, by a method of energy calculation using different wave types.

COMPARING THE RESULTS FROM SA AND SL MONITORINGS

Monitored period was divided into three sectors:

- Period A from Jan. 1, 1994 to Aug. 1, 1994 when there were predominantly some preparatory works starting at near proximity to the coalfaces and the first coalface No.140804 started to operate (Jun 1, 1994) and a relatively low seismic activity was linked to a wider neighbourhood with relatively equal distribution.

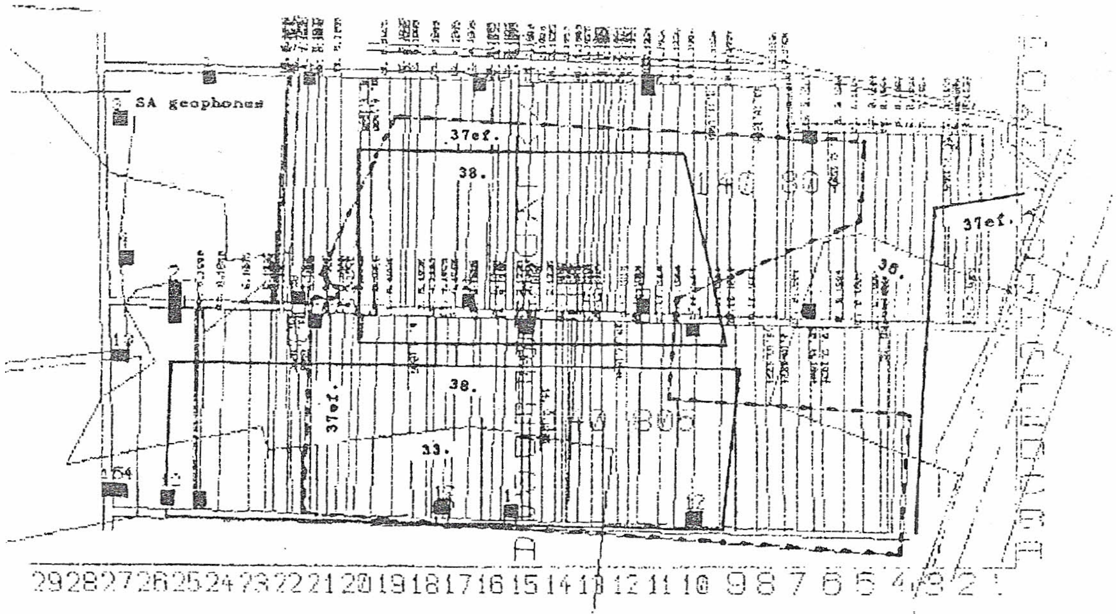

FIG. 2. Dislocation of SA and weak–steps of coalfaces No.140804+5

- Period B from Aug. 1, 1994 to Dec. 1, 1994 when both coalfaces reached their fully developed activities which were displayed below the first overlying small pillars with events having energies up to $3 \cdot 10^4$ J, but was no special continuous monitoring in progress, except ordinary evaluation of the SA activity carried out by employees from Darkov Colliery.
- Period C from Dec. 1, 1994 to Sep. 1, 1995 when extraction was in progress at continuous except evaluation of SA events. For check purpose this period was divided into two stages from Dec. 1, 1994 to May 1, 1995 when similarly, as in the period B, there was extraction in progress, taking place below the small overlying pillars.

Since the accuracy of energy determination in both systems is approximately of the third order, the energies wave classified into three classes of one order. The table below collects results of energy–frequency distributions.

Fig. 5 represents commonly plotted E–F distributions of SA and SL events for the period from 1/94 to 7/94. It is evident that the distribution of SA events for this period represents energy interval from approx. 20 J to 100 J, continuity of distribution of SL events registered in near proximity to the coalfaces ($X = 3500$–4000, $Y = 6000$–6750) even under such conditions when seismic activity is not linked only to the extraction process in the coalface, but it is equally distributed all over the monitored region.

Fig. 6 represents E–F distributions of SA and SL events plotted from 8/94 to 11/94. The SA distribution again forms the continuity of SL distribution, although its frequencies in energy classes ranging from 10 to 100 J are almost double the quantity against theoretical calculations derived as a continuity of SL distribution. In this case the miscalculations can be caused by transferring the partial quantity

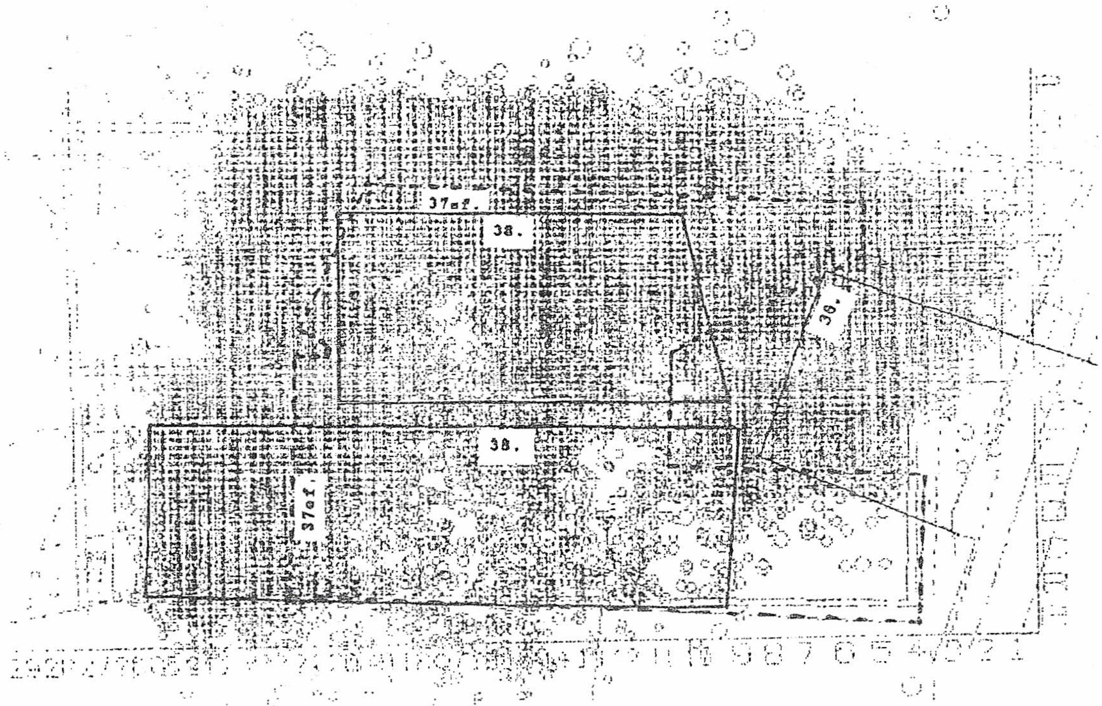

FIG. 3. Location of SA events from coalseam No.40

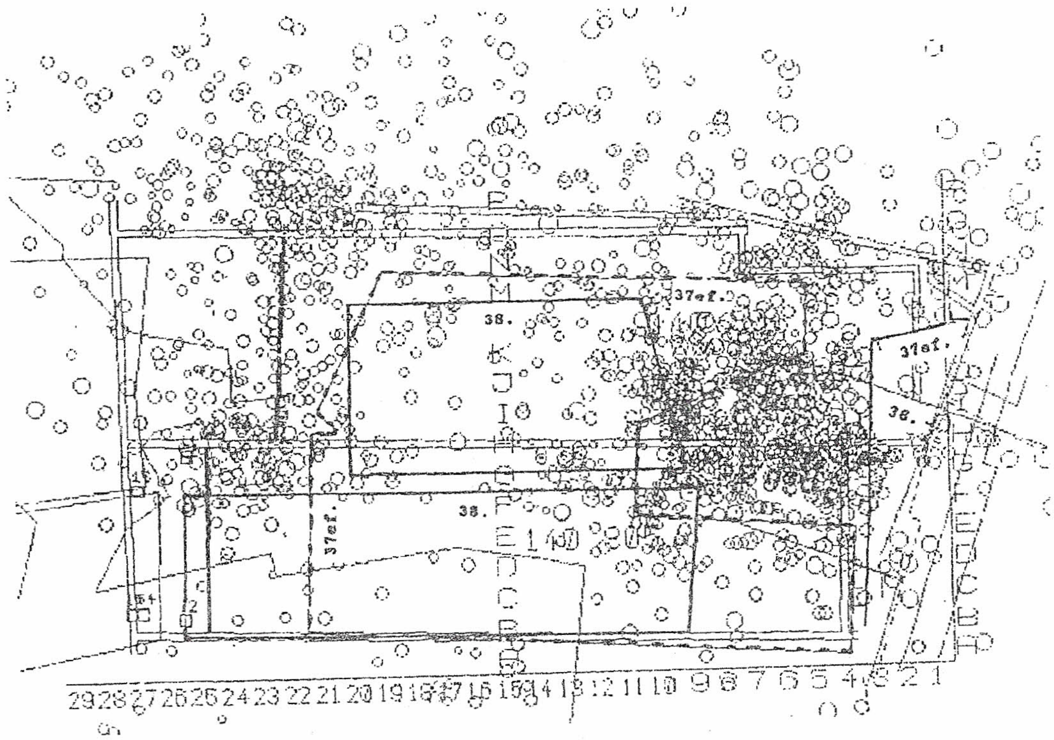

FIG. 4. Location of SA events from roof over coalseam No.40

TABLE 1. SA events

period	1J	2J	5J	10J	20J	50J	100J	200J	500J	1000J	2000J
1–7/94	3	6	59	497	916	473	178	3	3	2	2
8 /94	2	22	135	493	633	539	160	26	3		
9 /94	2	62	320	842	862	473	129	16	4		
10/94	12	204	783	921	719	204	96	9	0	1	
11/94	8	57	298	423	423	252	55	11			
12/94	2	39	397	453	252	136	48	13			
1 /95	1	91	380	303	188	95	40	13	3		
2 /95	36	559	1041	609	313	159	59	9			
3 /95	23	186	376	305	188	101	43	6	1		
4 /95	1	8	198	383	291	134	38	10			
5 /95	4	203	956	967	548	208	115	15	2		
6 /95	4	58	831	1477	838	318	148	14	1		
7 /95	5	131	891	914	504	241	78	6	1		
8 /95	9	219	1126	1176	619	253	47	4			
Summary	112	1845	7791	9763	7294	3586	1234	155	18	3	2

31803 events

TABLE 2. SL events

period	1J	2J	5J	10J	20J	50J	100J	200J	500J	1000J	2000J
1–7 /94	5	34	63	62	186	204	121	131	71	28	17
8–11/94	0	4	17	50	293	322	230	153	98	51	36
12–4/95	0	20	47	98	187	171	92	75	42	23	10
5–8 /95	4	42	172	230	225	129	99	69	37	31	5
Summary	9	100	299	440	891	826	542	428	248	133	68

3984 events

of events with higher energies into lower energy classes (namely at events from the hanging wall) and/or by overestimating the energies of lower energy classes (namely at events from the coal seam).

Fig. 7 represents E–F distribution of events from 12/94 to 4/95 which are better linked to than shown in previous Fig. 6. Nevertheless, there is evidently overestimated number of events in SL distributions classes ranging from 10 J to 100 J against the distribution of SA events in near proximity. Fig. 8 represents E–F dis-

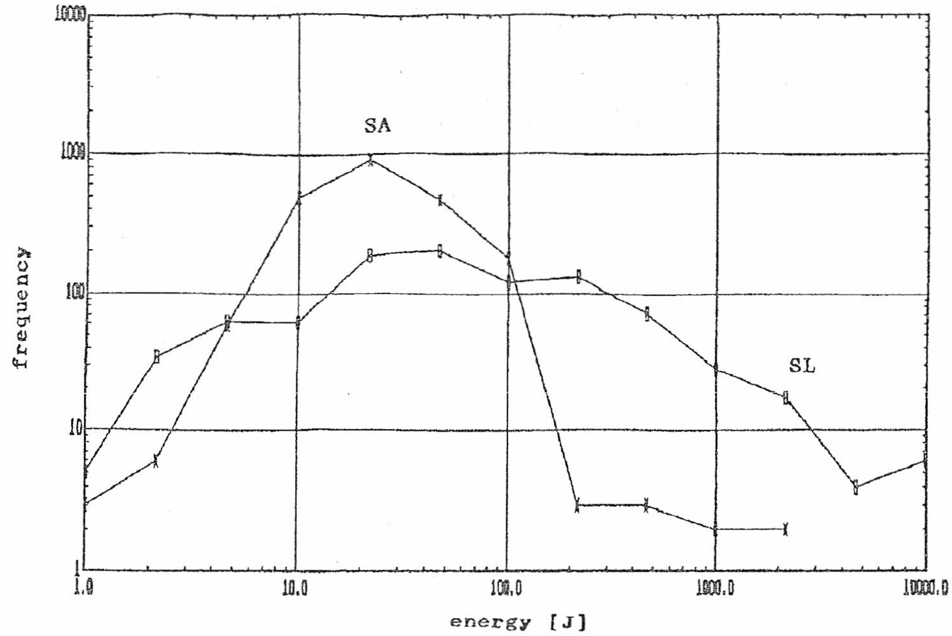

FIG. 5. Energy–frequency distribution of SA and SL events Darkov Mine, Coalfaces No.140804+5, 1/94–7/94

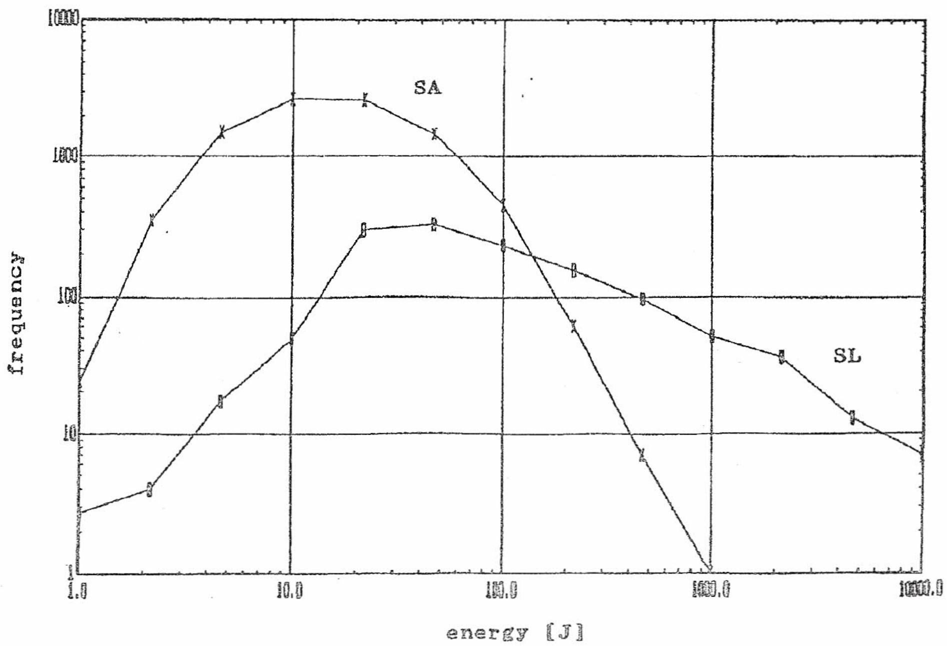

FIG. 6. Energy–frequency distribution of SA and SL events Darkov Mine, Coalfaces No.140804+5, 8/94–11/94

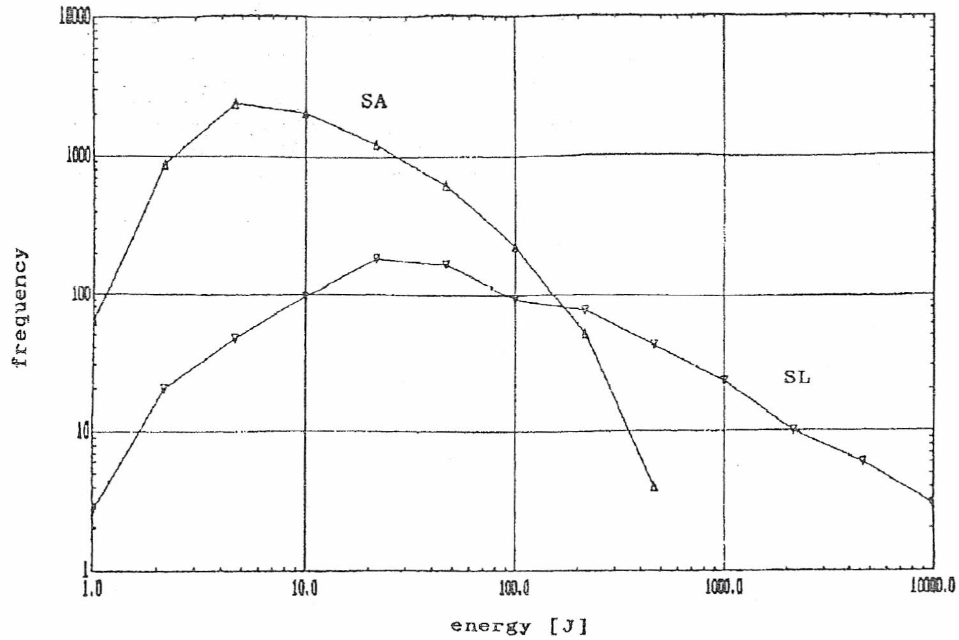

FIG. 7. Energy–frequency distribution of SA and SL events Darkov Mine, Coalfaces No.140804+5, 12/94–/95

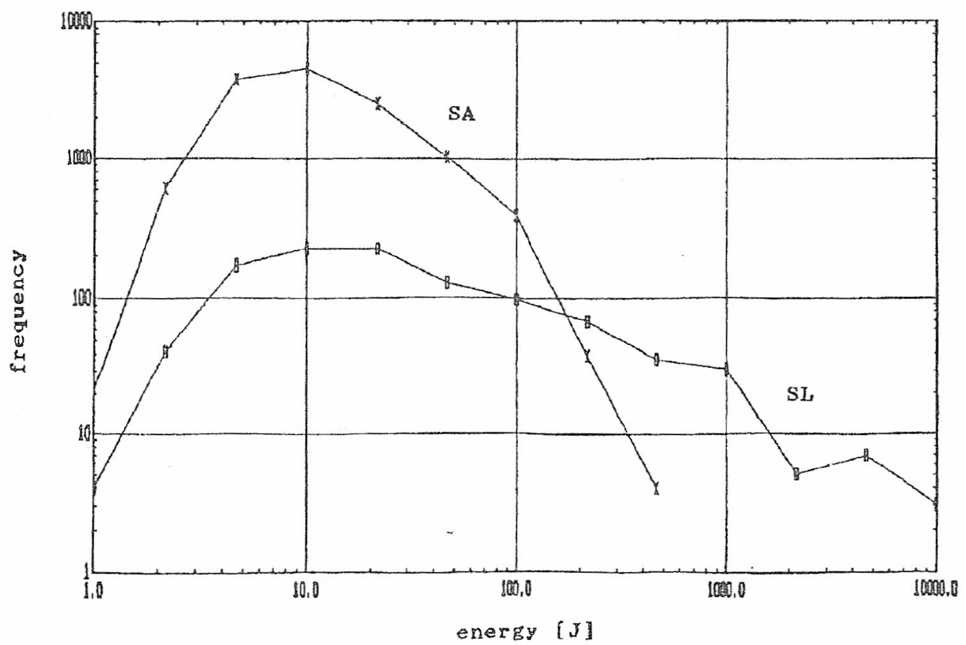

FIG. 8. Energy–frequency distribution of SA and SL events Darkov Mine, Coalfaces No.140804+5, 5/95–8/95

tributions SA and SL events from 5/95 to 8/95 with a similar results as in previous periods.

From all comparisons made on distributions of SA and SL events hence it followed that up to energies approx. 10 J, there is no decrease in quantity of events registered by the SA network in the coalfaces No.140804 and 140805 against theoretical distribution which is an extrapolation of real E–F distribution into lower energy classes, but on the contrary, there takes place an overestimation of quantity of events in these energy classes. This overestimation is probably caused partly by transferring the events from higher energy classes at hanging wall events and partly by moderately overestimated energies at coal events with lower energy levels.

Conclusion

From energy–frequency distribution of events registered by SA and SL monitoring systems in the area of coalfaces No.140804 and 140805 at Darkov Colliery results, that within the frames of error energy determination by means of both systems, the SA E–F distribution in interval from registration and localization ability (approx. 10 – 20 J) to the monitoring limit is given by a dynamic range of the apparatus (approx. 100 J), by continuity of the E–F distribution, determined by SL monitoring network namely in all extraction conditions within the reach of SA monitoring.

The observation limit of SL monitoring is not given within a 100 J area by physical parameters of the rockmass, but by localizing and registrating features of SL network. The limit of energy events, given by physical parameters of rocks, lies lower than 10 J and possibly below 1 J energy. The limitation of SA monitoring below 10 J is now given namely by physical possibilities of registration and processing of events and it is determined artificially.

References

Kalenda P. (1992), *Zhodnocení závislosti vyzařované seismické energie na parametrech horninového prostředí a technologii dobývání*, Kandidátská práce, GFÚ ČSAV, Praha.

Lasocki S. (1993), *Statistical prediction of strong mine tremors*, Acta Geophys. Pol. **XLI**, no. 3, 197–234.

Rudajev V., Lokajíček T., Číž R. (1995), *Energy-frequency distribution of acoustic emission from loaded rock samples*, Acta Montana.