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REMARKS ON THE MAGNITUDE DETERMINATION FOR NURMIJÄRVI, KAJAANI AND KEVO SEISMOGRAPH STATIONS BASED ON THE RAYLEIGH WAVES

by

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Abstract

The magnitudes of more than 200 earthquakes recorded at Nurmijärvi, Kajaani and Kevo seismological stations between 1970 and 1982 were calculated. Two different methods were used for computing Rayleigh surface wave magnitudes: the IASPEI formula and the Homogeneous Magnitude System (HMS). The magnitudes obtained were respectively compared with magnitudes given by seismological centres in Moscow and Denver (NEIS) and with magnitudes calculated by the Polish stations Cracow and Warsaw. All earthquakes were divided among six regions according to their geographical distribution. Differences of magnitude values were found for the whole earthquake data set as well as for some of the regions.

1. *Introduction*

Earthquake magnitudes determined from recordings at various stations usually differ from each other. The differences for the same earthquake may be caused by asymmetry of seismic radiation from the focus, the effects of seismic wave transmission through the hypocenter – station path, and the geological structure in the region of the station itself. In order to compare the earthquake magnitude

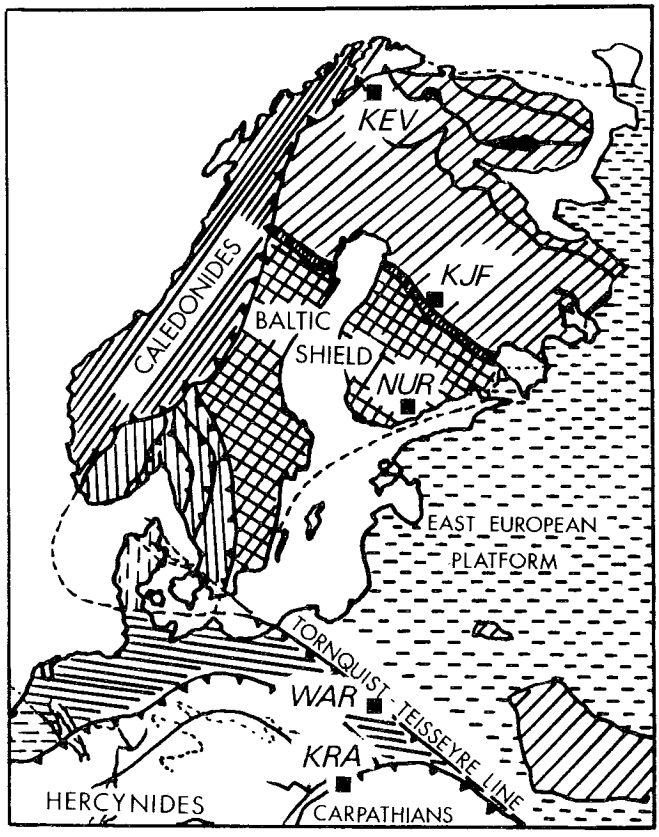

Fig. 1. Map indicating the locations of seismic stations used in this study. (Tectonic map of Europe adapted from Berthelsen, 1983).

determined from the recording of a single station with the magnitudes determined at other stations, it is necessary to introduce empirical corrections calculated according to statistical methods.

In this paper we compared the magnitudes of five seismological stations, Cracow (KRA) and Warsaw (WAR) in Poland and Nurmijärvi (NUR), Kajaani (KJF) and Kevo (KEV) in Finland, all located in central and northern Europe in regions of different geological structures. The Cracow station is situated at the edge of the young Carpathian geosyncline, the Warsaw station in the marginal zone of the East European Platform, the Nurmijärvi station on the Svecokarelian area, the Kajaani and Kevo stations on the Presvecokarelidic basement complex (Fig. 1).

The determination of earthquake magnitude from surface waves is usually made using the calibrating function given by VANEK *et al.* (1962) and recommended by IASPEI. This function, called in literature the Prague, the Moscow – Prague or the IASPEI formula, has been used to calculate the mean magnitudes by seismological center in Denver (USA; NEIS), Newbury (Great Britain; ISC) and Moscow (USSR). At the same time, selected Eurasian stations have been developing a system of corrections and calibrating functions called the Homogeneous Magnitude System; HMS (CHRISTOSKOV *et al.*, 1977, 1983).

The object of this paper is to compare the surface wave magnitudes determined from the Rayleigh wave registrations of the Polish stations KRA and WAR with those of the Finnish stations NUR, KJF and KEV using the calibrating function described in the IASPEI formula, and to determine the corrections for magnitudes of the Nurmijärvi, Kajaani and Kevo stations relative to the magnitude determinations made by seismological centers in Moscow and Denver (NEIS).

Taking into account that the Cracow station is a »reference station» in the HMS, and the fact that the corrections for the LV waves in this system have been recently determined for Warsaw (GUTERCH *et al.*, 1982), we made an attempt to determine the corrections for the Nurmijärvi, Kajaani and Kevo stations in the HMS by calculating relative station corrections between NUR – KRA, NUR – WAR KJF – KRA, KJF – WAR, KEV – KRA and KEV – WAR. All the »reference stations» in the HMS are equipped with the Kirnos long-period seismographs. The Nurmijärvi, Kajaani and Kevo stations have had long-period seismographs of the Press-Ewing type since 1962, 1970 and 1962 respectively. However, taking into account the good agreement of magnitude determinations at Obninsk station, which uses both the Kirnos and the Press-Ewing long-period seismographs (GORBUNOVA *et al.*, 1974), we made an attempt to determine the corrections for the Nurmijärvi, Kajaani and Kevo stations in the HMS, although the instrumentation is not the same type as in the Polish stations.

2. *Method of analysis*

Recordings of vertical long-period seismographs were used to determine surface wave magnitudes. Dynamic characteristics of vertical components of the Kirnos instruments at Cracow and Warsaw and of the Press-Ewing instruments at Nurmijärvi, Kajaani and Kevo are given in Fig. 2.

Earthquakes with magnitudes higher than 5.0 were selected. The values of the maximum amplitudes of surface waves in the period range between 12 and 28 seconds were determined for every station.

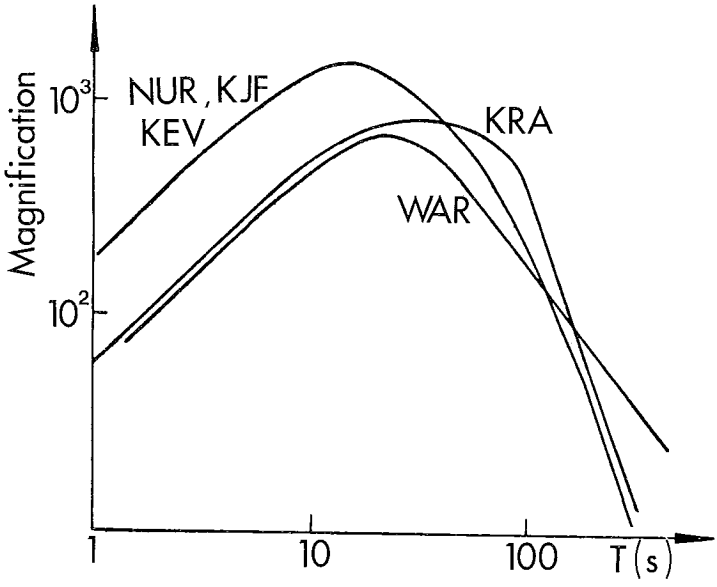

Fig. 2. Frequency response curves of the Kirnos vertical seismographs SKD at Cracow and Warsaw and the Press-Ewing seismographs at Nurmijärvi, Kajaani and Kevo.

Magnitudes of earthquakes were calculated using the IASPEI calibrating function as well as the calibrating function determined in the HMS (CHRISTOSKOV *et al.*, 1983).

The division of data was made according to the regions adopted in the HMS:

I – Alaska, Aleutian Islands (1, 42)
II – Japan, Kurile Islands (19, 20)
III – Formosa, Philippine Islands (21, 22)
IV – Asia: Shechuan, Southern Tibet (26), Kansu to Sinkiang (27), Mongolia (28), Iran to Urals (29), Eastern Siberia (41), Baluchistan (47), Hindukush and Pamir (48)
V – Mediterranean (30, 31, 32)
VI – Remaining regions

The region numbers in parenthesis are given after GUTENBERG and RICHTER (1954, p. 12).

The relative regional station corrections were established according to the criterion given by VANEK *et al.* (1980):

$$|S_r^{km} - S^{km}| > 0.1$$

$$\delta < 0.05, \quad n > 25 \quad \text{for} \quad S^{km}$$

$$\delta < 0.08, \quad n > 10 \quad \text{for} \quad S_r^{km}$$

where S^{km} is the relative station correction, S_r^{km} is the relative regional station correction, δ is the standard error of the mean value.

3. *Surface wave magnitudes calculated using the calibrating function given in the IASPEI formula*

About 250 earthquakes were selected with epicentral distances $\Delta > 5^\circ$, well recorded in the five seismic stations during the period 1970–1982. The data were analysed taking into account all earthquakes and subsequently the earthquakes for a given region.

3.1. Relative station corrections

Relative station corrections between the following pair of stations were determined: KRA–NUR, WAR–NUR, KRA–KJF, WAR–KJF, KRA–KEV, WAR–KEV, NUR–KJF, NUR–KEV and KJF–KEV. The results are presented in Table 1, which also contains standard errors. The values of relative magnitude station corrections for all earthquakes are as follows:

$$\Delta M^{\mathrm{KRA,NUR}} = 0.04 \pm 0.019$$

$$\Delta M^{\mathrm{WAR,NUR}} = 0.06 \pm 0.014$$

$$\Delta M^{\mathrm{KRA,KJF}} = 0.00 \pm 0.021$$

$$\Delta M^{\mathrm{WAR,KJF}} = -0.01 \pm 0.019$$

$$\Delta M^{\mathrm{KRA,KEV}} = 0.18 \pm 0.022$$

$$\Delta M^{\mathrm{WAR,KEV}} = 0.20 \pm 0.020$$

$$\Delta M^{\mathrm{NUR,KJF}} = -0.05 \pm 0.016$$

$$\Delta M^{\mathrm{NUR,KEV}} = 0.14 \pm 0.018$$

$$\Delta M^{\mathrm{KJF,KEV}} = 0.20 \pm 0.022$$

The additional relative station corrections can be barely determined for region III for $M^{\mathrm{KRA,NUR}}$, $M^{\mathrm{WAR,NUR}}$ and $M^{\mathrm{KRA,KJF}}$ and for region VI for $M^{\mathrm{KRA,KJF}}$ as

Table 1. Differences of magnitude values (ΔM) between Polish stations (KRA and WAR) and Finnish stations (NUR, KJF and KEV) calculated from surface waves using the IASPEI formula, n = number of events, μ = standard error of a single observation, δ = standard error of the mean value.

Region	n	$\Delta M^{KRA,NUR}$	μ	δ	n	$\Delta M^{WAR,NUR}$	μ	δ
All	202	0.04	0.27	0.019	200	0.06	0.20	0.014
I	15	0.11	0.18	0.046	16	0.13	0.14	0.034
II	49	0.11	0.25	0.036	49	0.10	0.17	0.025
III	33	-0.11	0.19	0.034	33	-0.05	0.14	0.024
IV	31	-0.06	0.26	0.048	29	0.01	0.22	0.040
V	10	0.04	0.22	0.071	10	0.01	0.26	0.081
VI	64	0.09	0.29	0.037	63	0.08	0.23	0.030
	n	$\Delta M^{KRA,KJF}$	μ	δ	n	$\Delta M^{WAR,KJF}$	μ	δ
All	178	0.00	0.28	0.021	178	-0.01	0.25	0.019
I	16	0.03	0.21	0.053	16	0.04	0.19	0.048
II	44	0.06	0.26	0.040	45	0.01	0.25	0.038
III	31	-0.15	0.25	0.045	31	-0.11	0.20	0.036
IV	27	-0.10	0.30	0.058	26	-0.10	0.27	0.054
V	19	-0.16	0.34	0.113	9	-0.12	0.33	0.109
VI	51	0.13	0.25	0.035	51	0.08	0.24	0.003
	n	$\Delta M^{KRA,KEV}$	μ	δ	n	$\Delta M^{WAR,KEV}$	μ	δ
All	154	0.18	0.27	0.022	152	0.20	0.25	0.020
I	14	0.16	0.15	0.039	14	0.19	0.15	0.039
II	37	0.27	0.28	0.046	37	0.25	0.16	0.027
III	26	0.16	0.25	0.048	26	0.20	0.20	0.039
IV	23	0.10	0.29	0.061	23	0.15	0.38	0.080
V	6	-0.01	0.46	0.189	5	0.13	0.30	0.139
VI	48	0.20	0.26	0.037	47	0.22	0.26	0.038
	n	$\Delta M^{NUR,KEV}$	μ	δ	n	$\Delta M^{KJF,KEV}$	μ	δ
All	143	0.14	0.21	0.018	144	0.20	0.26	0.022
I	13	0.07	0.13	0.037	14	0.14	0.13	0.035
II	37	0.15	0.17	0.027	37	0.25	0.22	0.035
III	24	0.22	0.21	0.042	24	0.28	0.25	0.051
IV	21	0.20	0.27	0.058	21	0.24	0.33	0.071
V	5	0.02	0.19	0.087	6	0.09	0.21	0.085
VI	43	0.10	0.22	0.034	42	0.13	0.29	0.045
	n	$\Delta M^{NUR,KJF}$	μ	δ				
All	164	-0.05	0.20	0.016				
I	15	-0.08	0.17	0.043				
II	43	-0.11	0.18	0.028				
III	28	-0.07	0.17	0.033				
IV	23	0.02	0.23	0.048				
V	7	-0.09	0.16	0.061				
VI	48	0.01	0.22	0.031				

I Alaska
II Japan
III Philippines
IV Asia
V Mediterranean
VI Other regions

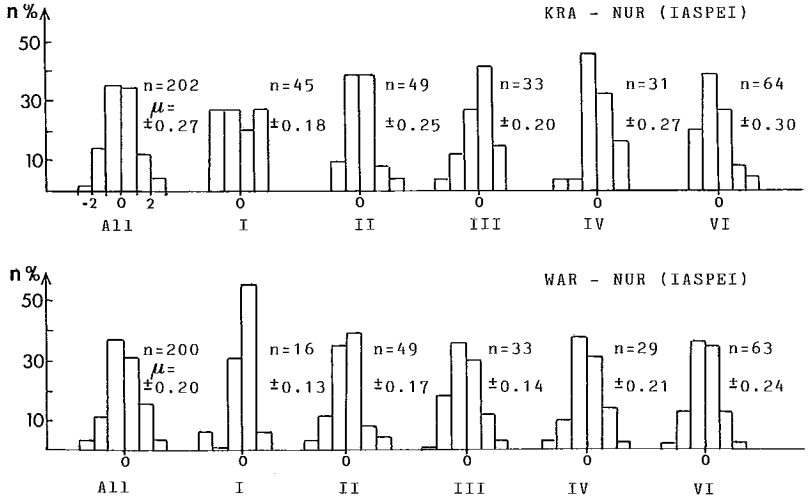

Fig. 3. Histograms of the frequency distribution of the deviations δS_i for Cracow – Nurmijärvi and for Warsaw – Nurmijärvi using the IASPEI calibrating function for magnitude determination; the number of observations n and the standard error μ of a single observation are also given. The value μ is taken as a basic interval of the distribution: for all earthquakes and only for regions I – Alaska, II – Japan, III – Philippines, IV – Asia and VI – other regions.

the values of these regional station corrections are close to the limiting values assumed in the method used (Table 1). Histograms of deviations for KRA–NUR and for WAR–NUR are presented in figure 3.

3.2. Surface wave magnitudes for Nurmijärvi, Kajaani and Kevo compared to NEIS and Moscow determinations

Nurmijärvi, Kajaani and Kevo magnitudes for the IASPEI calibrating function and surface were magnitudes given by NEIS and Moscow were examined. The results are presented in Table 2.

Mean corrected values of NUR, KJF and KEV magnitudes according to NEIS and Moscow magnitudes are as follows:

$$M_{LV}^{NUR} = M_s^{NEIS} + 0.29 \pm 0.023$$

$$M_{LV}^{NUR} = M_{LV}^{Moscow} + 0.15 \pm 0.016$$

$$M_{LV}^{KJF} = M_s^{NEIS} + 0.30 \pm 0.025$$

$$M_{LV}^{KJF} = M_{LV}^{Moscow} + 0.17 \pm 0.019$$

$$M_{LV}^{KEV} = M_{s}^{NEIS} + 0.16 \pm 0.023$$

$$M_{LV}^{KEV} = M_{LV}^{Moscow} + 0.01 \pm 0.019$$

The magnitude differences between Finnish stations and NEIS for region II are about 0.12–0.20 units higher than the mean value for all earthquakes. However, the mean value of magnitude differences between Finnish stations and Moscow for region II does not differ from those for all earthquakes. Similar results were obtained for Cracow and Warsaw by GUTERCH *et al.*, 1982. This results from the predominantly continental paths of surface waves travelling from the Kuril-Kamchatka region to the European and Asian stations, while the magnitudes for this region given by NEIS are computed for stations distributed mainly in areas where the travel paths of surface waves are predominantly oceanic (GORBUNOVA *et al.*, 1976). For the Alaska – Aleutian region (I) the values of NUR, KJF and KEV magnitudes are lower than the magnitudes determined for all earthquakes both by NEIS and Moscow. It may be caused by higher attenuation of Rayleigh waves along the predominantly oceanic paths from epicenters to Finnish seismic stations.

There is also an additional correction for region III, in particular between the magnitude of the Finnish stations and the Moscow magnitude.

The magnitude differences presented in Table 2 may be assumed to be magnitude corrections because the magnitude differences do not depend on the magnitude values.

An attempt was also made to calculate magnitude corrections according to M_s values given by the International Seismological Center in Newbury, but the number of observations for the selected list of earthquakes was strongly limited since the ISC had only been publishing M_s since 1978. Thus it was only possible to obtain corrections for all earthquakes as follows:

$$M_{LV}^{NUR} = M_{s}^{ISC} + 0.10 \pm 0.021$$

$$M_{LV}^{KJF} = M_{s}^{ISC} + 0.06 \pm 0.029$$

$$M_{LV}^{KEV} = M_{s}^{ISC} + 0.05 \pm 0.028$$

Table 2. Differences of magnitude values calculated using the IASPEI formula for stations NUR, KJF and KEV and surface wave magnitudes M_S given by NEIS and Moscow.

Region	n	$M^{NUR}-M^{NEIS}$	μ	δ	n	$M^{NUR}-M^{Moscow}$	μ	δ
All	185	0.29	0.32	0.023	194	0.15	0.23	0.016
I	15	0.13	0.18	0.046	16	-0.04	0.18	0.046
II	43	0.46	0.30	0.045	45	0.12	0.18	0.026
III	28	0.39	0.28	0.053	32	0.29	0.12	0.022
IV	28	0.34	0.33	0.063	29	0.15	0.27	0.050
V	8	0.04	0.25	0.089	10	-0.04	0.11	0.035
VI	63	0.17	0.30	0.037	62	0.17	0.26	0.033
	n	$M^{KJF}-M^{NEIS}$	μ	δ	n	$M^{KJF}-M^{Moscow}$	μ	δ
All	165	0.30	0.33	0.025	171	0.17	0.25	0.019
I	15	0.22	0.22	0.057	16	0.04	0.23	0.058
II	40	0.50	0.30	0.048	41	0.17	0.24	0.038
III	27	0.39	0.29	0.056	30	0.35	0.19	0.035
IV	25	0.31	0.32	0.063	24	0.14	0.28	0.058
V	7	0.23	0.32	0.120	9	0.09	0.28	0.092
VI	51	0.11	0.29	0.041	51	0.13	0.24	0.034
	n	$M^{KEV}-M^{NEIS}$	μ	δ	n	$M^{KEV}-M^{Moscow}$	μ	δ
All	140	0.16	0.27	0.023	145	0.01	0.22	0.019
I	13	0.08	0.19	0.053	14	-0.10	0.20	0.054
II	32	0.28	0.24	0.042	33	-0.03	0.21	0.036
III	23	0.15	0.22	0.047	25	0.09	0.15	0.029
IV	21	0.17	0.34	0.075	21	-0.10	0.20	0.043
V	4	0.26	0.22	0.109	6	-0.01	0.25	0.102
VI	47	0.10	0.29	0.042	46	0.07	0.25	0.037

4. *Earthquake magnitudes determined on the basis of stations NUR, KJF and KEV according to the HMS for LV waves*

As the amplitude – distance curve for LV waves in the HMS was determined only for distances $5^\circ < \Delta < 100^\circ$, we eliminated earthquakes outside of this interval. So the number of earthquakes is small for region VI (as epicentral distances $\Delta > 100^\circ$).

4.1. Relative station corrections in the HMS

Relative station corrections for magnitudes in the HMS were determined between Polish stations and Finnish stations and additionally between Nurmijärvi, Kajaani and Kevo for the list of earthquakes in the period 1970–1982. Cracow is the reference station in the HMS (CHRISTOSKOV *et al.*, 1982). The Warsaw station was also included in the HMS by determining its station corrections (GUTERCH *et al.*, 1982). The results are presented in Table 3. Histograms

Table 3. Relative station corrections for LV waves according to the Homogeneous Magnitude System (HMS).

Region	n	$s^{KRA,NUR}$	μ	δ	n	$s^{WAR\ NUR}$	μ	δ
All	151	0.03	0.28	0.023	145	0.03	0.19	0.016
I	16	0.04	0.18	0.040	16	0.07	0.15	0.037
II	49	0.10	0.24	0.034	49	0.06	0.19	0.028
III	27	-0.07	0.23	0.044	27	-0.03	0.17	0.033
IV	31	-0.13	0.26	0.047	28	-0.03	0.21	0.040
V								
VI	26	0.17	0.35	0.069	23	0.08	0.21	0.044
All-I	135	0.03	0.29	0.025	129	0.03	0.20	0.018
All-II	102	-0.01	0.29	0.029	96	0.02	0.19	0.020
All-III	124	0.05	0.28	0.026	118	0.05	0.20	0.018
All-IV	120	0.07	0.27	0.025	117	0.05	0.19	0.017
All-V	149	0.03	0.28	0.023	143	0.03	0.19	0.016
All-VI	125	0.00	0.25	0.023	122	0.02	0.19	0.017

Region	n	$s^{KRA,KJF}$	μ	δ	n	$s^{WAR,KJF}$	μ	δ
All	138	-0.05	0.30	0.025	135	-0.05	0.25	0.022
I	16	-0.06	0.26	0.066	16	-0.05	0.22	0.055
II	45	-0.01	0.28	0.042	45	-0.07	0.26	0.038
III	25	-0.17	0.28	0.057	25	-0.15	0.25	0.050
IV	27	-0.15	0.26	0.050	25	-0.02	0.24	0.048
VI	22	0.16	0.30	0.065	21	0.05	0.23	0.051
All-I	122	-0.05	0.30	0.027	119	-0.05	0.25	0.023
All-II	93	-0.06	0.31	0.032	90	-0.04	0.25	0.026
All-III	113	-0.02	0.29	0.028	110	-0.03	0.25	0.023
All-IV	111	-0.02	0.30	0.029	110	-0.06	0.25	0.024
All-V	135	-0.05	0.30	0.026	132	-0.05	0.25	0.022
All-VI	116	-0.09	0.28	0.026	114	-0.07	0.25	0.023

Region	n	$s^{KRA,KEV}$	μ	δ	n	$s^{WAR,KEV}$	μ	δ
All	115	0.16	0.26	0.025	113	0.16	0.22	0.020
I	14	0.11	0.13	0.034	14	0.13	0.13	0.035
II	37	0.23	0.24	0.040	37	0.17	0.15	0.025
III	21	0.16	0.27	0.059	21	0.20	0.20	0.044
IV	24	0.05	0.26	0.053	23	0.16	0.34	0.071
V	3	0.07	0.56	0.321	3	0.07	0.30	0.175
VI	16	0.17	0.32	0.079	15	0.12	0.19	0.048
All-I	101	0.16	0.28	0.028	99	0.17	0.22	0.023
All-II	78	0.12	0.27	0.030	76	0.15	0.24	0.028
All-III	94	0.15	0.26	0.027	92	0.15	0.22	0.023
All-IV	91	0.18	0.26	0.027	90	0.16	0.17	0.018
All-V	112	0.16	0.26	0.024	110	0.16	0.21	0.020
All-VI	99	0.15	0.26	0.026	98	0.17	0.22	0.022

Region	n	$s^{NUR,KEV}$	μ	δ	n	$s^{KJF,KEV}$	μ	δ
All	113	0.12	0.22	0.021	117	0.21	0.26	0.024
I	13	0.07	0.14	0.039	14	0.17	0.20	0.053
II	37	0.11	0.20	0.033	37	0.26	0.23	0.037
III	21	0.21	0.21	0.046	20	0.31	0.28	0.063
IV	22	0.19	0.26	0.055	21	0.20	0.30	0.065
V	5	0.02	0.19	0.084	6	0.08	0.22	0.089
VI	15	-0.02	0.23	0.058	19	0.10	0.28	0.065
All-I	100	0.12	0.23	0.023	103	0.22	0.27	0.027
All-II	76	0.12	0.23	0.026	80	0.19	0.27	0.031
All-III	92	0.10	0.22	0.023	97	0.19	0.26	0.026
All-IV	91	0.10	0.21	0.022	96	0.21	0.26	0.026
All-V	108	0.12	0.22	0.021	111	0.22	0.26	0.025
All-VI	98	0.14	0.21	0.021	98	0.23	0.25	0.026

Region	n	$s^{NUR,KJF}$	μ	δ
All	131	-0.10	0.19	0.017
I	15	-0.12	0.25	0.064
II	43	-0.16	0.18	0.028
III	24	-0.11	0.18	0.037
IV	22	0.00	0.17	0.037
VI	20	-0.04	0.19	0.042
All-I	116	-0.09	0.19	0.017
All-II	88	-0.07	0.19	0.021
All-III	107	-0.09	0.20	0.019
All-IV	109	-0.11	0.19	0.018
All-V	124	-0.10	0.20	0.018
All-VI	111	-0.11	0.19	0.018

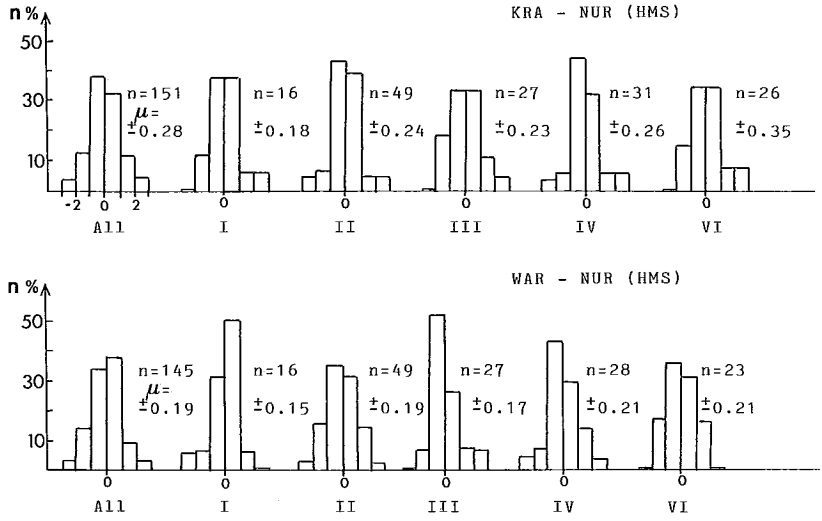

Fig. 4. Histograms of the frequency distribution of the deviations δS_i for Cracow – Nurmijärvi and Warsaw – Nurmijärvi using the HMS calibrating function for magnitude determination; the number of observations n and the standard error μ of a single observation are also given. The value μ is taken as a basic interval of the distribution: for all earthquakes and only for regions I – Alaska, II – Japan, III – Philippines, IV – Asia and VI – other regions.

of deviations are shown in Fig. 4 and in Fig. 5.

There are relative regional station corrections between Cracow and Nurmijärvi for region IV and for region VI, but the last one was obtained with a standard error $\delta = 0.07$, close to the limiting error value assumed as $\delta = 0.08$. Relative regional station corrections were found as follows: between Cracow and Kajaani for regions III and IV and between Kajaani and Warsaw for region III. There are no regional station corrections between Nurmijärvi, Kajaani and Kevo. An analysis of relative station corrections obtained for all earthquakes confirms the results presented above.

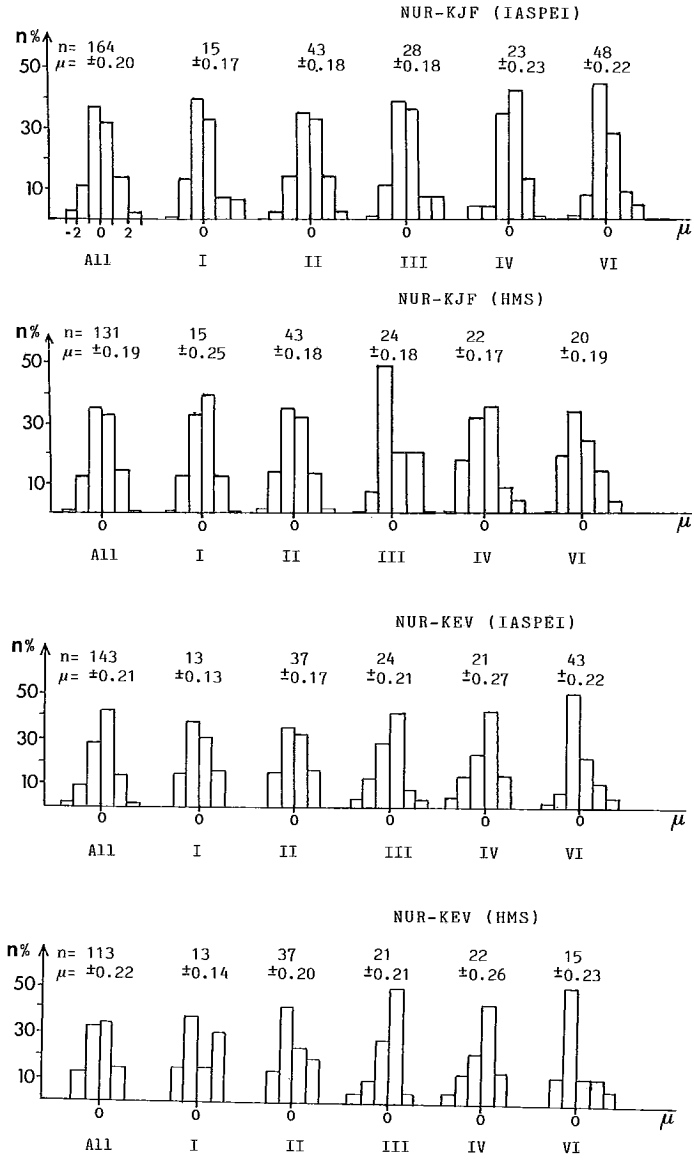

Fig. 5. Histograms of the frequency distribution of the deviations δS_i for Nurmijärvi – Kajaani and Nurmijärvi – Kevo using the IASPEI and the HMS calibrating functions for magnitude determination.

4.2. Absolute station correction in the HMS

The values of absolute station corrections in the HMS were computed taking into account the values of the basic station corrections for Warsaw and Cracow after GUTERCH *et al.*, 1982:

$$S^{KRA} = -0.02 \qquad S^{KRA}_{IV} = 0.16$$

$$S^{WAR} = -0.03$$

The values of absolute station corrections in the HMS for Nurmijärvi, Kajaani and Kevo were computed from the relations:

$$S^{NUR} = S^{WAR} + S^{WAR,NUR} = 0.00 \quad (1)$$

$$S^{NUR} = S^{KRA} + S^{KRA,NUR} = 0.01 \quad (2)$$

$$S^{KJF} = S^{KRA} + S^{KRA,KJF} = -0.07 \quad (3)$$

$$S^{KJF} = S^{WAR} + S^{WAR,KJF} = -0.08 \quad (4)$$

$$S^{KEV} = S^{KRA} + S^{KRA,KEV} = 0.14 \quad (5)$$

$$S^{KEV} = S^{WAR} + S^{WAR,KEV} = 0.13 \quad (6)$$

The values of relative station corrections were taken from Table III. The values of station corrections for all earthquakes obtained from relations 1 and 2 for Nurmijärvi, 3 and 4 for Kajaani and 5 and 6 for Kevo are in very good agreement. They were obtained for different earthquakes from each pair of stations. The final values of absolute station corrections in the HMS were calculated taking the number of observations at each pair of stations as the weight of corrections.

$$S^{NUR}_{LV} = 0.00 \qquad S^{KJF}_{LV} = -0.07 \qquad S^{KEV}_{LV} = 0.13$$

The values of absolute regional station corrections can be found for regions where relative station corrections fulfil the criterion mentioned in paragraph 2.

$$S^{NUR}_{IV} = S^{KRA}_{IV} + S^{KRA,NUR}_{IV} = 0.03 \quad (7)$$

$$S^{KJF}_{III} = S^{KRA}_{III} + S^{KRA,KJF}_{III} = -0.19 \quad (8)$$

$$S^{KJF}_{III} = S^{WAR}_{III} + S^{WAR,KJF}_{III} = -0.18 \quad (9)$$

$$S^{KJF}_{IV} = S^{KRA}_{IV} + S^{KRA,KJF}_{IV} = 0.01 \quad (10)$$

$$S^{KJF}_{VI} = S^{KRA}_{VI} + S^{KRA,KJF}_{VI} = 0.14 \quad (11)$$

Thus it can be assumed the absolute regional station correction for region III:

$$S_{\mathrm{III}}^{\mathrm{KJF}} = -0.18$$

and for region VI:

$$S_{\mathrm{VI}}^{\mathrm{KJF}} = 0.14$$

There is no regional absolute station correction for region IV (see relations 1,2,7 for Nurmijärvi, 3,4,10 for Kajaani and 5,6,11 for Kevo).

5. *Results and conclusions*

There have been found corrections to magnitudes at the Finnish seismograph stations Nurmijärvi, Kajaani and Kevo calculated using the IASPEI calibrating function. Compared with both the NEIS and Moscow determinations, for region I (Alaska – Aleutians), the corrections to magnitudes at the Finnish stations were about 0.1 units lower than those for all earthquakes. For region II (Kurile – Kamchatka) the magnitude corrections were about 0.2 units higher than those for all earthquakes compared with NEIS determinations, but there are not such differences in magnitudes between the Finnish stations and the seismological centre in Moscow for region II.

Station corrections were determined for the Finnish seismic stations Nurmijärvi, Kajaani and Kevo in the Homogeneous Magnitude System (HMS) for LV-waves. The values of station corrections are:

$$S_{\mathrm{LV}}^{\mathrm{NUR}} = 0.00 \qquad S_{\mathrm{LV}}^{\mathrm{KJF}} = -0.07 \qquad S_{\mathrm{LV}}^{\mathrm{KEV}} = 0.13$$

No regional station corrections were found for Nurmijärvi and Kevo in the HMS. There are two regional station corrections for Kajaani, for regions III and VI. We suppose that particularly the station correction for region III at Kajaani might be caused by differences in attenuation of seismic waves along the epicenter – station path, mostly in the vicinity of the station. A detailed analysis of azimuthal distribution of magnitude station corrections recorded at Kajaani station should be made, especially in the azimuthal range from 50 to 110 degrees, which comprises earthquakes from regions III, IV and VI.

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