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THE 1960 KUUSAMO—SALLA EARTHQUAKE
II. Macroseismic Data

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Abstract

Results of macroseismic studies of the two earthquakes occurred on February 20, 1960, in the border region between Kuusamo and Salla communes in Finland and on February 2, 1960, at Tolvantijärvi in the U.S.S.R., are given.

Introduction

On February 2, 1960, a relatively strong near-by earthquake was registered at the Sodankylä Seismological Station, at a distance of only 1.7°. The earthquake was widely felt in the communes of Kuusamo, Salla and Kemijärvi over an area of about 18,000 sq. km. A macroseismic investigation was started, but soon after, on February 20, another earthquake was felt in the same district, at a distance of about 1° from Sodankylä. The macroseismic investigations of these two tremors were combined, and over 300 questionnaires were mailed to places where the macroseismic influence was assumed to have been felt, to Kuusamo, Salla, Posio, Kemijärvi, Pelkosenniemi and Savukoski communes.

These communes all lie within the region of Finland in which, according to the investigations of RENQVIST [1, 2], the seismicity is highest. The oldest macroseismic notes concerning earthquakes in this area date

Table 1. Tolvantijärvi Earthquake

2. 2. 1960, 12—32—30 GMT

Epicentre 66.92°N, 31.02°E (PENTTILÄ, [5])

Lat.	Long.	Observ.[1] place	Ground[2]	Intensity	Direction	Remarks
64.°7	30.°0			0		
64.8	28.8			0		
64.9	29.0			0		
65.5	29.5			0		
	29.5			0		
65.7	29.3			0		
	29.6	b	1	III		
65.8	28.8	b	1	IV	E	
	29.9			0		
	30.0			0		
65.9	28.1			0		
	28.5	b	2	IV		
	29.3	a	2	IV		
	29.8	b	2	III		
66.0	27.5	b	2	IV	SW	
	27.9	b	1	IV		
	28.3	b	2	IV		
	29.1	c 1	2	III		
	29.1	b 1	2	III		
	29.2	b	2	IV	NNE	
	29.5	b	1	III		
	29.5	a	2	III	NE	
	29.9	b	2	IV		
66.1	28.1			0		
	28.3			0		Road construction
	28.6	b	2	III		
	28.7	b 1	2	IV		
	28.9	a	2	IV		
	29.1	b	2	IV	S→N	
	29.5			0		
	29.5			0		
	29.5	b	2	IV	SW→NE	
	29.5	b, c	2	IV	SW→NE	
66.2	27.5			0		
	28.9	c	2	IV		
	28.9	a, b	2	IV	E	
	29.4	b	2	IV		
66.3	27.2			0		
	28.0	b	2	IV		
	28.8	b	2	IV	N or NW	
	29.2			0		

Table 1 (continued)

Lat.	Long.	Observ.[1] place	Ground[2]	Intensity	Direction	Remarks
66.4	28.1	b	2 ?	IV		
	28.4			0		
	28.4	b	1	IV		
	28.4	b	2	IV	N	
	28.4	b	2	IV	N→E	
	28.4	b	1	IV		
	28.4	b	2	IV	W→E	
	28.4	b	2	IV	N	
	29.1			0		
	29.3	b	2	III		
	29.5	b, b 1	1	IV		
66.5	27.2			0		
	27.3			0		Channel construction
	28.3	b	2	IV		
	29.0	b, b 1	2	IV		
66.6	26.8			0		
	27.9	a, b	2	IV		
	28.5	b	2	IV		3 obs. of IV togeth.
	28.5	b	2	IV		Nearly V
	28.6	b	2	IV	E	
66.°7	27.°4	c 1,2	2	III		
	27.4	c 2	2	IV		
	27.4	c 3	2	IV		
	27.5	b	2	IV		Several obs. of IV
	27.6	b	—	IV		
	28.9	b	2	IV	E→W	
	29.0	b	2	IV		
	29.0	b	2	IV		
	29.2	a, b, b 1	2	V	N ?	
66.8	27.4	a, b	2	III		
	27.4	b	2	III	W	
	28.0	b	2	IV	N	
	28.0	b	2	IV		
	28.1	b	2	IV	N	
	28.1	b	1	IV		
	28.1	b	2	IV		
	28.1	a	2	IV	NW	
	28.2			0		
	28.2	b	2	IV		
	28.4	b	2	IV		
	28.6	c 2	2	IV		
66.9	27.4	b	2	V		
	27.4	b	2	V		

Table 1 (continued)

Lat.	Long.	Observ.[1] place	Ground[2]	Intensity	Direction	Remarks
	28.0	b	2	IV		
	28.4			0		
	28.9	a, b	2	IV	SE	
	28.9	b 1	2	IV	ESE	
	28.9	b	2	III		
	29.1	a, b	2	V	E→W	
67.0	27.3	b	1	IV		Not elsewhere in the village
	27.3			0		
	28.0	b	2	IV		
	28.9	b	2	IV		
	29.0	b, b 1	2	V		
67.1	27.2			0		
	27.4			0		
	28.8	b	2	IV		
	28.8	b 1	2	IV		
	28.9	b	—	IV		
67.2	27.8			0		
	28.6	b	2	V		Several observations
67.3	28.1	c 1	2	V	ENE	Generally V
	28.1	b	2	V	NNE	
67.4	29.3	b	2	V	SE→NW	
67.5	27.5			0		
	28.3	b	2	IV	N ?	
	28.3	b		IV		
67.8	27.6	a	2	III	SW or S	
68.3	28.5			0		
68.4	28.4			0		

[1]) Observation point:
a) outdoors
b) indoors, wooden house (ground floor)
b1) » » » (first floor, etc.)
c) » stone building
c1) » » » (first floor, etc.)

[2]) Soil
1 = bed rock
2 = loose soil

Table 2. Kuusamo-Salla Earthquake

20. 2. 1960, 00—52—50 GMT

Epicentre 66.59°N, 28.76°E (PENTTILÄ, [5])

Lat.	Long.	Observ.[1]) place	Ground[2])	Intensity	Direction	Remarks
65.6	29.5			0		
	29.5			0		
65.7	29.3			0		
65.8	28.5	b	2	IV	N	
	30.0			0		
65.9	28.1	b	2	IV		
	28.4	b	1	IV		
	28.5	b	2	IV	NW→SE	
	28.8			0		
	29.2			0		
	29.2			0		
	29.8	b	1	III	E→W	
66.0	27.5	b	2	IV		
	28.9	b	2	III	E→W	
	28.9	b	2	IV	E→W	
	29.1	b	2	III		
	29.1	b	2	IV	SE→NW	
	29.2	b	2	IV		
	29.5			0		
	29.6			0		
	29.9	b	2	IV		Generally observed
66.1	28.1	b	2	IV		
	28.6	b	2	IV		
	28.6	b	2	IV		Generally observed
	28.6	b	2	IV		
	28.7	b 1	2	IV		
	28.9	b	2	IV	N→E	
	29.0	b	2	IV	S	
	29.3	b	2	IV	SE→NW	
	29.3	b	2	IV	S→N	
	29.4	b	1,2	IV	NW	
	29.5	b, c 1	2	IV (V)		
	29.5	b	2	III		
	29.7			0		
	29.7	b	2	IV		
	29.8	b	2	IV		
66.2	28.7	b, b 1	2	IV	NW→SE	
	28.9	c	2	IV		
	28.9	b	2	IV		
	29.2	b	2	IV		V ?
	29.2	b	2	IV	SE→NW	
	29.4	b	2	III		

Table 2 (continued)

Lat.	Long.	Observ.[1]) place	Ground[2])	Intensity	Direction	Remarks
66.3	27.2			0		
	27.8	b	1,2	IV		
	27.9			III		
	28.0			0		
	28.1	b		IV	N	
	28.2	b	2	IV	SE	
	28.3	b	2	IV		
	28.8	b	2	IV	N→S	
	28.8	b	1	V	NE	Generally observed
	28.8	b	2	V	NW	
	28.9	b	2	IV	NE→N	
	29.2	b	2	IV		
	29.2	b, b 1	2	IV		
	29.3	b	2	V	E	
	29.3	b 1	2	V	S	
66.°4	28.°1	b 1	2	V		Generally observed
	28.2	b	2	IV	S→N	
	28.4	b	2	IV	NE	
	28.5	b	1	IV	N	
	28.5	b	2	IV	N	
	28.5	b	1	IV	W→E	
	28.5	a, b	2	IV	NE→SE	
	28.5	b	2	IV	E→W	
	28.5	b	2	IV	N, E	
	28.5	b, b 1	1	IV		
	28.5	b	2	IV		
	28.5	b	2	IV	E	
	28.5	b	1	IV		
	28.5	b	2	IV		
	29.0	b	2	IV	W	
	29.2	b	2	IV	SW	
	29.5	b	1	IV	W	
66.5	28.1	b, b 1	2	V	E ?	
	28.3	b	2	V	SW	Generally observed
	28.6	b 1	2	V		
	29.0	b	1	V	E	
	29.0	b 1	2	IV		
	29.0	b		V		Generally observed
66.6	27.8	b		IV		
	27.9	b	2	IV (V)	SE→NW	
	28.5	b	2	IV	NW	In a stationary motor car
	28.6	b		V		

Table 2 (continued)

Lat.	Long. place	Observ.[1])	Ground[2])	Intensity	Direction	Remarks
	28.9	b	2	IV	E	
66.7	26.9			0		
	27.5	b		IV		Generally observed
	28.9	b		IV		Generally observed
	29.2	b	2	V	N	70 % observed
	29.2	c 1	2	IV	S→N	
66.8	27.5			0		
	28.0			0		
	28.1			0		
	28.1			0		
	28.2	b	2	IV		Generally observed
	28.2			0		
	28.9	b	2	IV		Several observations
	29.1	b	2	III		
	29.1	b	2	III		
66.9	26.9			0		
	28.0	b	2	III		Several observations
	28.4			0		
	28.9			0		
	29.0	a, b	2	IV	E→W	
67.0	27.7			0		
	28.0	c, c 1		IV	→W	
	28.9	b		IV		
	29.0	b	2	IV		
67.1	28.7	b		III, 0		Some persons observed
	28.7	b		III		Some persons observed
67.3	29.3	b		IV	S→N	

[1]) [2]) Legends for footnotes as in Table 1.

from the beginning of the 16th century; the strongest known shock occurred in 1626 and damaged the church at Paltamo; about 25 — 30 earthquakes are felt in the area in a century.

The Analyses

The questionnaires returned, over 30 % were analyzed. The results are compiled in Tables 1 and 2. In the tables the co-ordinates of the observation points are given to a tenth of a degree. The type of ground

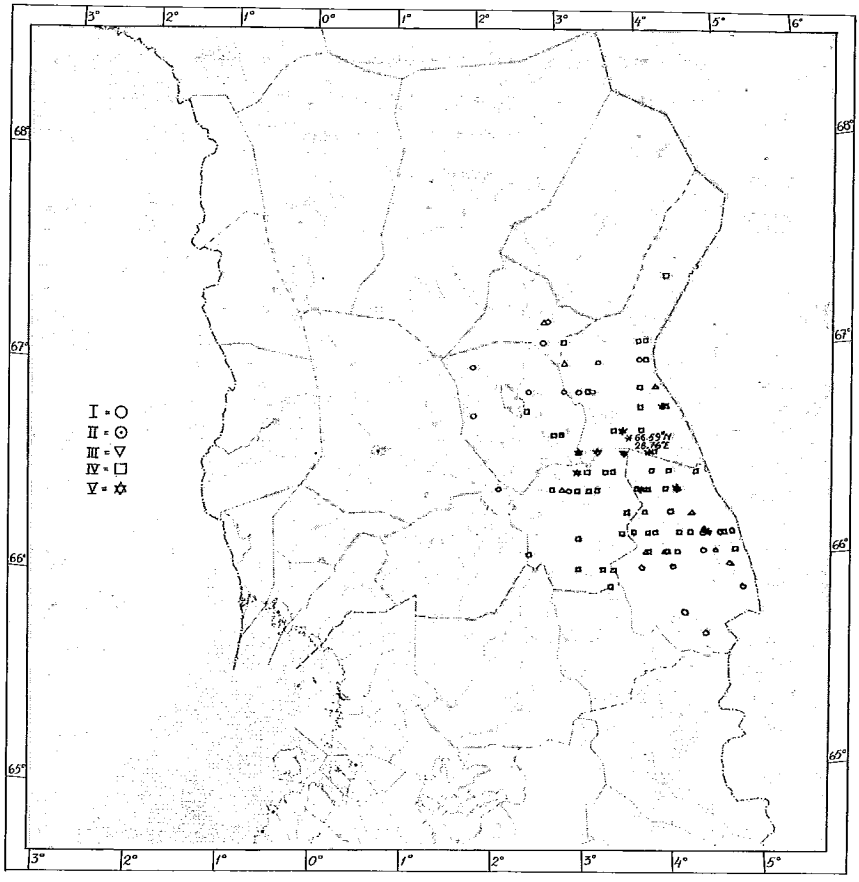

Fig. 1.

is given either as bed rock or loose soil. It is also stated whether the observations were made outdoors or in a building. Under remarks is given the direction of sound phenomena or shaking, if mentioned. The intensity of the earthquakes is estimated according to the modified Mercalli-Cancani scale (Wood and Neumann, [3]).

Discussion

The investigation indicates that the macroseismic data greatly depend on the observer. Positive and negative results have been reported from the same or near-by localities, especially on the boundaries of the earth-

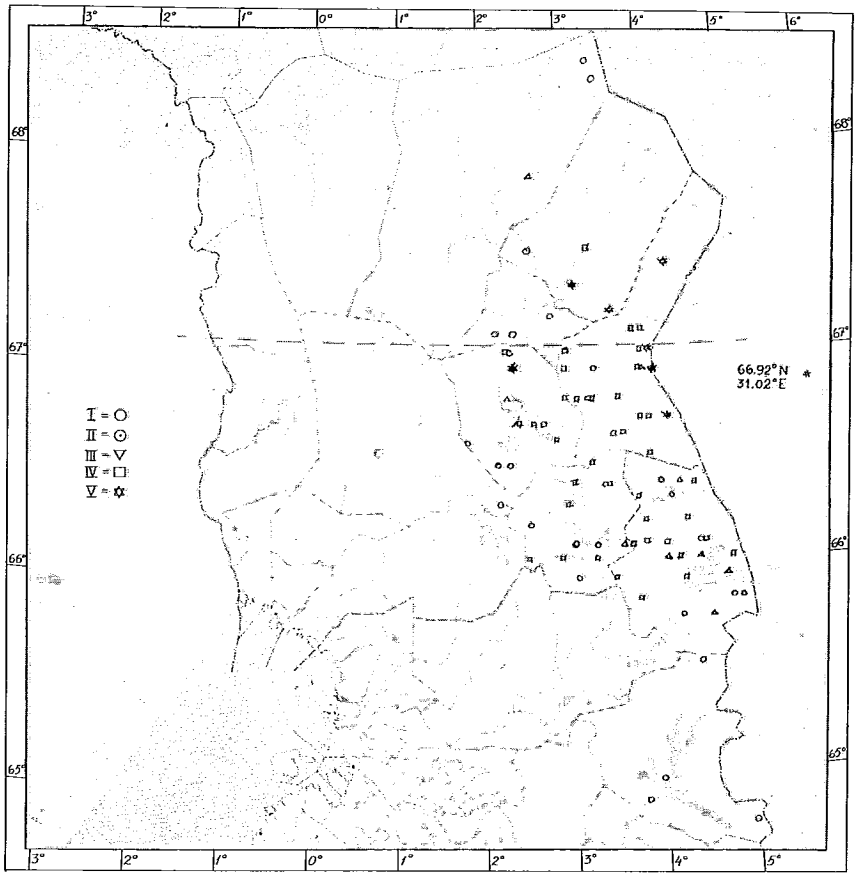

Fig. 2.

quake area. The intensity indicated may differ noticeably, even in the vicinity of the epicentre. In the case of the 20. 2. 60 earthquake, its occurrence at night may have influenced the results. The lowest intensities (I and II) are seldom felt.

The maps (Figs. 1 and 2) in which the coordinates of the observation points have been plotted indicate that the earthquake area was elongated and irregular in shape, at least on the Finnish side of the boundary line. In both cases, however, a part of the area lies on the U.S.S.R. side, from which no macroseismic information is to be had. In the 2. 2. 60 earthquake the longer axis is about 280 km in a NNW-SSE direction and the shorter possibly about 170 km in a WSW-ENE direction; in

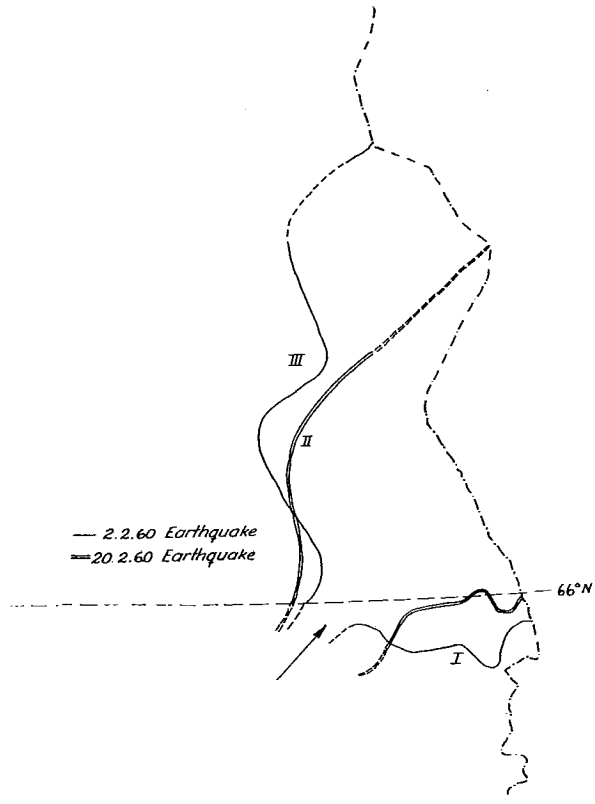

Fig. 3.

the 20. 2. 60 earthquake the longer axis is about 200 km in a NE-SW direction and the shorter 150 km in a SE-NW direction. From the maps we see that in the north the shock was felt at greater distances from the assumed epicentre than in the south and west (Fig. 3, I and II—III). In the south-west at 66° E there seems to be a kind of channel (see the arrow in Fig. 3), along which the influence of the earthquake diminishes more slowly than on either side. This may depend on the geology of the area.

The macroseismic distribution areas in Finland are about 18 000 and 14 000 sq. km, respectively. In both cases the highest known intensity is V, but it is possible that the 2. 2. 60 event was of intensity VI in the vicinity of its epicentre. At all events, the macroseismic influence has been felt over a much greater area than in the later (20. 2. 60) case.

In the case of the first earthquake the location of the epicentre cannot be determined exactly from the data available. The strongest intensities felt indicate, however, that it should lie near the 67° line, on the U.S.S.R. side of the boundary line. This result is consistent with the result 66.92°N, 31.02°E obtained by PENTTILÄ [5]. In the case of the 20.2. earthquake, we get the epicentre 66.4°N, 28.6°E, or some 15 km south-west of the epicentre that PENTTILÄ gives in his investigation.

As to the results, we may point out that sufficient data to estimate the influence of the soil could not be obtained because the areas all round are so sparsely populated. Moreover, not all those answering the questionnaires have mentioned the type of ground. As mentioned before, it seems that the nature of the ground did exert some influence, for the intensities diminish more quickly in some directions than in others.

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