AN OUTLINE OF THE DEVELOPMENT OF THE SEISMOGRAPH STATION NETWORK AND OF THE STUDY OF THE SEISMICITY OF THE BALTIC SHIELD

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During the past the study of the seismicity of the Baltic Shield has been based mainly on macroseismic observations because the seismograph stations in the different countries in the area were too few and insensitive (RENQVIST 1930, BÅTH 1953, PANASENKO 1957, MIYAMURA 1952). The situation in the northernmost part of Fennoscandia and in Kola, has been still worse, because, owing to the very sparse population of these areas, even satisfactory macroseismic data are precluded. However, the oldest historical notes, although very few and from different sources, indicate that seismic activy has been by no means at its lowest there.

Already in the early part of the century, when instrumental seismology was making great advances, the lack of instrumental records of earthquakes in the northern Baltic Shield was noticed. The seismograph stations at Copenhagen, Pulkovo and Uppsala were the only ones in the whole area and all were in the south. There were none in the north.

An active attempt to make good the lack of seismograph stations in northern Fennoscandia was made by Prof. B. B. GOLITSYN of Pulkovo, one of the leading seismologists of the time. He offered to donate a complete set of instruments to the Magnetic Observatory at Sodankylä, which was established in 1913. It is greatly to be regretted that the observatory authorities did not see their way to accepting this munificent offer immediately because of local housing difficulties. Then followed the First World War.

It took ten years more before the first seismograph station in Finland was established in Helsinki (1923), and almost fifty years before the setting up of a station in the northernmost part of Finland, at Kevo (1961).

The next important attempt to develop a seismograph station network for the whole Baltic Shield was made at 1933. Again, the work was delayed for a long time and needed actually to be planned anew.

The State Institutes of Geophysics in Finland, i.e. the Institute of Geodesy,

the Finnish Meteorological Office, the Institute of Marine Research and the Hydrological Office, organized a symposium to discuss common problems and long-term projects in geophysics, also taking into consideration the whole area of the Baltic Shield. Prof. H. RENQVIST, Director of the Hydrological Office and also Chief of the Seismograph Station of the University of Helsinki, took the chair. A couple of invited guests participated in the meetings, too. Prof. MUSHKATOFF of Leningrad should be especially mentioned because he was one of those who made an important move to develop the study of the seismicity of the Baltic Shield.

The results of the whole symposium are compiled in a concise report (RENQVIST & FABRITIUS 1935). Here it will suffice briefly to mention the seismological points of the report. First the report emphasized the importance of co-operation in seismology between the neighbouring countries and the necessity for establishing a homogeneous and dense station network over the whole area. The organization of research projects was also discussed. The report mentioned the following seismograph stations in operation, at that time, in the area: Copenhagen in Denmark, Helsinki in Finland, Bergen in Norway, Lund, Uppsala and Abisko in Sweden, and Pulkovo in the USSR. The report recommended the establishment of the following new seismograph stations:

— *Finland*: Stations in Petsamo, Sodankylä, Kuusamo and Jyväskylä.

— *Norway*: One station south of Bodö and a second one in northernmost Finnmark.

— *Sweden*: One station in Värmland, one in Jämtland, and one on the Coast of North Kvarken or of the Gulf of Bothnia.

— *USSR*: Four stations (without indicating their location).

But it was not until some twenty years later that the programme outlined by the symposium began to take effect. The International Geophysical Year 1957—1958 was approaching and its research projects now gave a welcome new impetus to the development of the seismograph station network on the Baltic Shield, too. Thus, regarding the Baltic Shield there were two new stations established already for the IGY in the north in 1956: at Apatity, Kola, in the USSR (PANASENKO 1957) and Sodankylä in Finland. Kiruna, in Sweden had already been established in 1951 when Abisko abandoned (BÅTH 1952).

One of the great projects of the IGY was to study the seismicity of the Arctic. The report on this subject (HODGSON 1960) points out — again — that there have been too few sensitive seismograph stations within the Arctic Circle and this is one of the main reasons why the seismicity of the Arctic is so poorly known. Therefore the development of the station network continued in northern Fennoscandia even after the IGY. Two more

seismograph stations were planned and also established, Tromsø in Norway and Kevo in Finland. In all, the stations in the northernmost part of the whole Baltic Shield are thus Tromsø, Kiruna, Kevo, Sodankylä and Apatity. Skalstugan and Umeå in Sweden, and Oulu, Kajaani and Joensuu in Finland link up with this network well to the south of the Arctic Circle.

A most interesting feature of this development over the whole Baltic Shield area is the fact that although new men were now in charge of seismology in the different countries and the afore-mentioned report had been completely forgotten, the basis of the whole endeavour to develop the seismograph station network followed exactly the same lines.

Table 1
List of the present seismograph stations of the Baltic Shield.[1]

Country	Station	Abbr.	Co-ordinates		
			N	E	h
Denmark	Copenhagen	COP	55° 41′	12° 26′	13
Finland	Helsinki	HEL	60° 10′ 32″	24° 57′ 25″	20
	Joensuu	Joe[2]	62° 36′	29° 42′	90
	Kajaani	KJN	64° 12′	27° 42′	160
	Kevo	KEV	69° 45′ 21″	27° 00′ 45″	97
	Nurmijärvi	NUR	60° 30′ 32″	24° 39′ 05″	102
	Oulu	OUL	65° 05′ 07″	25° 53′ 47″	60
	Sodankylä	SOD	67° 22 ′16″	26° 37′ 44″	181
Norway	Bergen	BER	60° 23′ 18″	5° 18′ 18″	20
	Kongsberg	KON	59° 39′	9° 35′	300
	Tromsø	TRO	69° 37′ 57″	18° 55′ 41″	
Sweden	Göteborg	GOT	57° 41.9′	11°58.7′	66
	Karlskrona	KLS	56° 09.9′	15° 35.5′	11
	Kiruna	KIR	67° 50.4′	20° 25′	390
	Skalstugan	SKA	63° 34.8′	12° 16.8	580
	Umeå	UME	63° 48.9′	20° 14.2′	16
	Uppsala	UPP	59° 51′ 29″	17° 37′ 37″	14
USSR	Apatity	APA	67° 33′	33° 00′ 20″	
	Pulkovo	PUL	59° 46′ 22″	30° 19′ 25″	65
	Vyborg[3]	Vyb[2]	60° 43′[4]	28°48′[4]	

[1] Main source for the list: *Seismograph station abbreviations, August 1963* (by USCGS).
[2] Unofficial abbreviation (not in the list by USCGS).
[3] Operation begins according to *BCIS, Bulletin Mensuel*, at 1962.
[4] Given in the *List of Seismograph Stations, 1958* (by IGY 1957—1958).

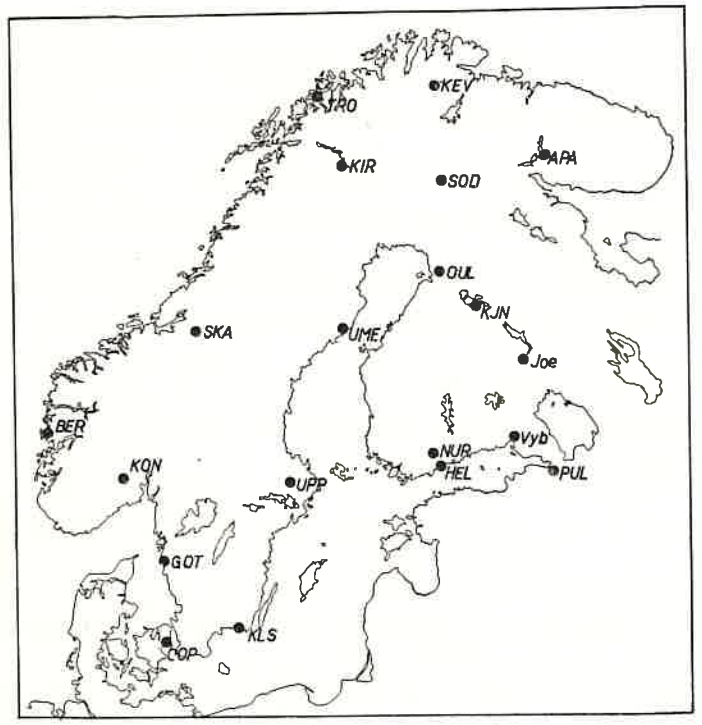

Fig. 1
Map of the present seismograph station network of the Baltic Shield.

A complete list of the present seismograph station network of the Baltic Shield is given in Table 1 and the location of the different stations in Fig. 1.

Kevo is the most recent addition to the Finnish seismograph station network. It occupies the gap in the station network of the northern Baltic Shield. Kevo is not only the northernmost seismograph station of the Baltic Shield but it is also the northernmost in the whole continent of Europe. Besides, Kevo is one of the world standard seismograph stations, and thus has an important international significance, too.

The station was established, paying attention to the report of the Finnish Geophysical Symposium of the year 1933, in the northernmost part of Finland. Fortunately, the Subarctic Research Station of the University of Turku is located at Kevo, which is in Utsjoki, the northernmost commune of Finland, and the seismograph station could be established within the precincts of the Research Station.

The Kevo station began operation in very temporary quarters on September 15, 1961. At the beginning there was only one vertical seismograph. The following summer more space was acquired in the basement and improve-

ments were planned at the station. It was at the same time proposed that the station, being the northernmost seismograph station on the European continent, should be one of the world standard stations. Therefore, the new seismograph vault was constructed and the recording room improved for the purpose. The standard instruments were installed in August, 1962.

However, even the present installation is wholly temporary. The housing is not yet satisfactory and the hard climate has so far caused many difficulties, especially regarding the long-period instruments. There is at present a project under discussion for Kevo aimed at rendering the standard of the station as high as possible. A new seismograph vault is now under construction and it will be in a tunnel in the granitic bedrock. It is expected that the whole new station will be in operation from the beginning of the year 1965.

The constants of the instrumentation at Kevo up to now are given in the following Table 2 (TEIKARI 1963).

Table 2
Constants of the instrumentation at Kevo.

Beginning from	Seismometer	Period sec. Seism.	Galv.	Magn.	Damp. ratio	Recording type	Drum speed
15. 9. 61	Nurmia Z	0.4		100.000	2:1	Smoked. pap.	60
23. 8. 62	Sprengnether Z	30	100	1.500	17:1	Photo pap.	30
	Sprengnether N	30	100	1.500	17:1	Photo pap.	30
	Sprengnether E	30	100	1.500	17:1	Photo pap.	30
	Benioff Z	1.0	0.75	25.000	17:1	Photo pap.	60
	Benioff N	1.0	0.75	25.000	17:1	Photo pap.	60
	Benioff E	1.0	0.75	25.000	17:1	Photo pap.	60

The seismograph station network of the Baltic Shield is at present quite satisfactory. There are still, of course, a few blank areas on the map. According to the report of the year 1933 the following few shortages should be mentioned:

1) In Finland, the Kuusamo area and Jyväskylä are still without any seismograph stations. Kuusamo is the most seismically active area in Finland according to RENQVIST (1930). The University of Oulu, however, is planning to establish a station there in the immediate future.

2) The instrumentation at the different stations is not yet homogeneous enough. This is especially true regarding the station network of Finland. The standard apparatuses for two stations are, however, ready for installation, and a couple more are on order, but the corresponding housings are not yet ready.

After a few improvements the present seismograph station network of the Baltic Shield should be quite prepared for long-term research projects. As to the joint and co-ordinate programme of the research work itself, there is still much to be done. It is necessary to organize working groups to study the seismicity according to the microseismic records, the velocities according to the great explosions, the tectonics, the recent crustal movements, etc.

Since the year 1933, two noteworthy resolutions have been published which strongly urge the importance of the study of the seismicity of the Baltic Shield. In connection with these resolutions we must not omit to mention the name of Prof. E. F. SAVARENSKY, the successor of Prof. B. B. GOLITSYN. The resolutions are:

1) "The Working Group on Seismology recommends that the IGY Committees of Finland, Sweden and the USSR jointly discuss the possibility of intensifying the work on study of minor shocks in Fennoscandia, particularly in its eastern part." (*The general report of the fifth meeting of CSAGI,* Moscow, July 29—August 9, 1958. *Annals of the IGY,* Vol. X, 1960, page 237, point 11).

2) "The ESC resolves to found a working group to study the seismicity of the Baltic Shield. This group is to consist of national representations from Finland, Norway, Sweden and the USSR, together with the president of the Sub-Commission on the seismicity of Europe. It is further resolved that this group report to the next meeting of the ESC." (*The report of the seventh meeting of the ESC,* Jena, September 24—30, 1962. *Resolution Circulaire,* 1962, page 8, point 6).

Research work on the seismicity of the Baltic Shield is thus beginning to crystallize into a definite programme. It is expected that the working group mentioned in the last resolution will prepare a report containing a concise proposal for the meeting of the ESC in Budapest at 1964. This proposal should mark the end of the past macroseismic period and the beginning of a new one, which, let us hope, will be more co-ordinated and characterized by co-operative study of the seismicity and related phenomena of the Baltic Shield.

REFERENCES

BÅTH, M., 1953: Seismicity of Fennoscandia and related problems. — Gerl. Beitr. z. Geophys. 63, 173—208.

„ 1952: Observations séismographiques de l'Observatoire géophysique de Kiruna de juillet à décembre 1951. — Publ. de l'Inst. de météorologie de l'Université d'Uppsala, 59 p.

HODGSON, J. H. and collab., 1960: Seismicity of the Arctic. — Annals of the IGY, Seismology (manuscript).

MIYAMURA, S., 1962: A Note on Fennoscandian seismicity. — Geophysica 7: 4, 197—207.

PANASENKO, G. D., 1957: Bjulleten seismičeskoi stancii Apatity (Bulletin of the seismological station Apatity — in Russian only), 1, Jul—Dec, 1956. — Publ. of the S. M. Kirov Kola Branch of the Academy of Sciences, USSR, 39 p.

„ 1957: The seismic character of the Kola Peninsula and North Kareliya. — Bulletin of the Academy of Sciences of the USSR, Geophys. Ser. 8, 1957, 1—10. (Published in English by Pergamon Press, New York)

RENQVIST, H., 1930: Finlands jordskalv (with German summary: Erdbeben in Finnland). — Fennia 54: 1, 113 p.

„ & FABRITIUS, Å., 1935: Die geophysikalische Erforschung von Fennoskandia zur Erörterung der Krustenbewegungen. — Geophys. 1, 11—16.

TEIKARI, P., 1963: The present instrumentation of the station network (In Progress Report for 1962 of the Institute of Seismology). — Publ. Inst. of Seismology, U. of Helsinki 62, p. 9.

SIMPLIFIED APPARATUS FOR RECORDING WATERLEVEL FLUCTUATIONS

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To obtain continuous information of waterlevel fluctuations in waters where no permanent observations are made, e.g. in the lakes of Lapland, a simplified recorder was constructed. The main requirements for a field recorder were: Lightness, reliability, cheap construction without electrical parts and easy installation where no permanent sounding well is necessary. The recorder was also planned to operate during the ice-free period, which made possible the use of an all-glass float.

The frame of the recorder is made of impregnated plywood (12 mm). The recording drum C consists of a copper cylinder (diameter 80 mm) provided with a steel axle and ball bearings for soft running. At the other end of the axle is placed a toothwheel D, which is rotated by the mechanism of an 8-day clock E. This allows the recorder to operate for a period of one week during which the drum makes one revolution.

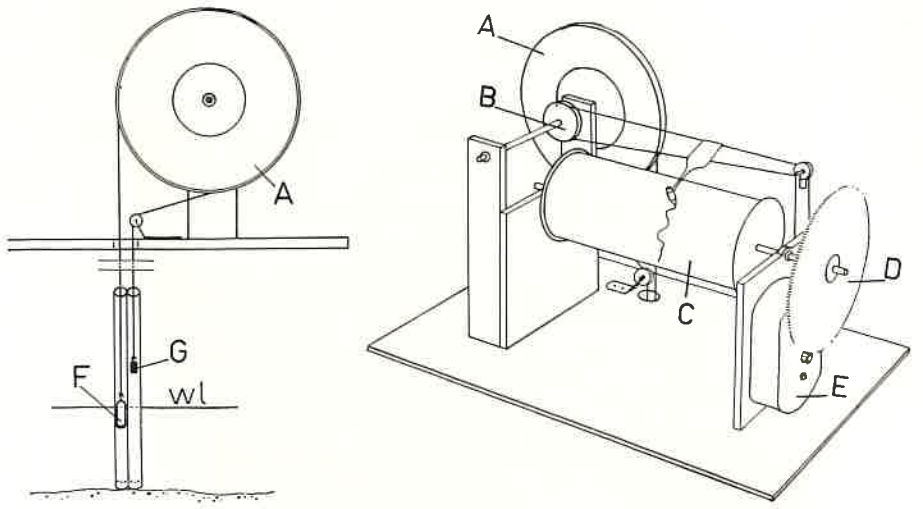

Fig. 1. Apparatus for recording waterlevel fluctuations. Explanation of symbols in text.