Stockholm March 1, 1971

SECOND NORDIC SEMINAR ON DETECTION SEISMOLOGY

HAGFORS MARCH 1 - 4, 1971

Program

Monday	1 March	15.00 - 18.00	Opening and Invited Lectures by: Dr Ulf Ericsson, Superintendent of Research, The Research Institute of the Swedish National Defence, on: "Event Identification by Seismic Networks", and by: Dr Jan Prawitz, Special Assistent for Disarmament, Ministry of Defence, on: "Swedish Contributions to Test Ban Control".
Tuesday	2 March	09.00 - 12.00	Session on Event Detection Chairman U Ericsson
		13.30 - 15.30	Session on Event Identification Chairman I Noponen
		16.00 - 18.00	Session on General Geophysics and Instrumentation Chairman H Korhonen
Wednesday	3 March	09.00 - 12.00	Session on Event Location and Local Travel Times Chairman H Bungum
		13.30 - 14.30	Session on Long Period Signals Chairman J Hjelme
		15.00 - 17.00	Plenary Session, Chairman O Dahlman
		19.00	Dinner sponsored by the Research Institute of the Swedish National Defence. After Dinner Speech by: Mr L Eckerberg, Head of Division, Foreign Office.
Tuesday	4 March	09.00 - 13.00	Visit to the Hagfors Observatory
Friday	5 March	09.00 - 15.00	Special Meeting on Future Activities in Refraction Seismology in the Nordic Countries

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Papers to be presented

Session on Event Detection

1.	L Götherström	Detection of Hydroacoustic Signals
2.	K A Berteussen H Bungum	Real Time Signal Detection on a Single Time Trace
3.	O Dahlman	Phase Velocity Filtering Detector
4.	H Bungum	Prefiltering in Seismic Surveillance
5.	E Hjortenberg	Comparison of the Recording Capabilities of Some Arctic Stations
6.	H Korhonen	Noise Spectrum at the Oulu Seismograph Station

Session on Event Identification

1.	J Hjelme	Geometric Relations in Identification Diagrams
2.	D Rieber-Mohn	Short Period Discriminant Criteria
3.	H Israelson	Seismic Identification Criteria on Hagfors Data

Session on General Geophysics and Instrumentation

1.	T Risbo	Proposal for Seismic Detection of Gravitational Radiation from Pulsars in the 1 - 30 Hz Band
2.	L Liska	Ray Tracing of Atmospheric Waves
3.	L Liska	On the Generation and Detection of Artificial Atmospheric Waves
4.	O Dahlman	Magnetic Records from Presumed Nuclear Explosions at Novaya Zemlya
5.	T Risbo	Operating Principles and Preliminary Results from a Thomas 6-dimensional Seismometer Installed at the Hagfors Seismic Observatory

Session on Event Location and Local Travel Times

1.	I Noponen+ M-L Mäki	Location Accuracy of Helsinki Tripartite Array
2.	H Israelson	Location Capability of the Hagfors Observatory for Teleseismic Events
3.	G Hörnström	Location Accuracy of the Nordic Station Network
4.	M T Porkka H Korhonen+ M K Saviaro	Study of P-Wave Velocity below Moho
5.	R Slunga	Location Capability of the Hagfors Observatory for Local Events
6.	I Noponen	Location of Near Events by the Finnish Station Network

Session on Long Period Signals

1.	E Rygg	On the Spectral Character of Surface Waves from the Sino-Soviet Region
2.	L Bruland	On the Application of Experimentally Generated Chirp Signals

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+ = speaker

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Abstracts

Detection of hydro-acoustic signals

L Götherström

The paper is tutorial and presents some of the theoretical and experimental work on detection of noise-like signals against a background of sea-noise that has been done at the Research Institute of the Swedish National Defence during the last 10 years.

Real time signal detection on a single time trace

K A Berteussen and H Bungum

The NORSAR Detection Processor includes the following real time test: A Short Term Agerage (STA) of a few rectified samples is compared to a Long Term Average (LTA) estimating the preceding noise, and a detection is declared whenever the ratio exceeds a given threshold Q out of Q' successive times. This study has been undertaken in order to determine the different parameters in the process, i. e., first of all the time constant in the LTA-analysis, the window length in the STA-analysis, and the parameters Q and Q'.

Phase velocity filtering detection

O Dahlman

The propagation velocities of most of the coherent seismic noise are considerably lower than the apparent velocities of signals from seismic events at teleseismic distances.
An automatic event detector has been developed at the Hagfors Observatory which filters out teleseismic signals using a velocity filtering technique. The detector has been in continous operation for more than a year. On the average 10 to 15 seismic events a day have been detected with a presumed false alarm rate of 1 to 3 alarms a day.

Prefiltering in seismic surveillance

H Bungum

A study has been undertaken in order to determine the prefiltering for the NORSAR Detection Processor which gives the best overall performance, i.e., gives an acceptable average loss for signals with different frequency content. The results indicate that a combination of a 12 dB/octave sloping filter (4 point Lagrange differentiation) and a 0.8 - 2.8 Hz bandpass filter is the best choice.

Comparison of the recording capabilities of some arctic stations

E Hjortenberg

An attempt has been made to estimate the detection thresholds at the following arctic stations:
Alert, Godhavn, Inge Lehmann station, Kevo, Kap Tobin, Nord, Mould Bay and North Pole. Because of the short distance (1 km) between the two latter stations, they have been combined into one.
The data used are the earthquakes of January - June 1967 and latitudes 20°N - 40°N, as reported by USCGS, Earthquake Data Reports and BCIS. The thresholds are based on both cumulative and interval probabilities. Special treatment is given to the two longitude intervals 100°W - 130°W and 120°E - 150°E.

Noise spectrum at the Oulu seismograph station

H Korhonen

Spectral composition of noise at the frequency range from 5 Hz to 0.02 Hz is studied using the ordinary and high magnification recordings at the Oulu seismograph station. The noise spectra were compared with each other and with some signal containing spectra. Some outstanding spectral peaks are discussed. The cumulative noise power spectra of Oulu are compared with corresponding spectra at some other Scandinavian stations.

Short period discriminant criteria

P Rieber-Mohn

Much credit is given to short period wave discriminants as a means for correctly classifying seismic events. The obvious reason is that SP signals are most easily detected in seismic records. We have just started investigating the power of these discriminants, which among others are signal complexity and spectral ratio, using a small population of interim NORSAR events, consisting of both earthquakes and presumed explosions.
So far we have tested the complexity discriminant, where some of the definitions used have been proposed by I T Noponen, Preliminary results indicate that complexity alone cannot be considered a good discriminant, which is in agreement with corresponding LASA results.
Few results are available from spectral ratio tests, which also involve spectrum estimation techniques.

Seismic identification criteria on Hagfors data

H Israelson

In order to test different criteria for discriminating underground nuclear explosions from natural earthquakes an experiment has been performed on short and long period data gathered as yet from US and USSR events at the Hagfors Observatory. In all some 50 events, including 7 presumed Kazakh and 18 announced Nevada explosions, have been analyzed.
For both US and USSR events the m_b-M_s method seems to provide a more efficient discrimination than short period discriminants like spectral ratios and complexity. The data also indicate that the degree of separation between earthquakes and explosions is greatest for USSR events for all discriminants tested.

Proposal for seismic detection of gravitational radiation from pulsars in the 1 - 30 Hz band

T Risbo

F J Dyson has recently discussed the possibility for seismic detection of gravitational waves from pulsars in the 1 Hz band, and R A Wiggins and F Press have carried out a search for seismic signals at specific frequencies belonging to well known pulsars with periods of about one second.
20.5 hours of data from the 525 element LASA array was scanned with negative results. The more recently discovered Vela pulsar (12 Hz) and especially the Crab Pulsar (30 Hz) are, however, more likely candidates as powerful emitters of gravitational radiation and the possibilities to make a detection experiment in that frequency range is discussed.

Ray tracing of atmospheric waves

L Liska

Modified ray tracing technique is applied to atmospheric waves recorded by the microbarographic triangle at Hagfors. It is shown that the proposed methods may be used for location of sources of atmospheric waves. Most of the observed waves in the minute range seems to be associated with weather issues.

On the generation and detection of artificial atmospheric waves

L Liska

Preliminary results of detection of atmospheric waves produced by focusing shocks generated by supersonic aircrafts are presented. Flight trajectories were chosen so that the acoustic gravity waves following the shock fronts were focused on the ground after reflexion from the stratosphere or in the E-layer. Infra-acoustic waves were detected on the ground using an infra-acoustic interferometer correlator. At the E-layer the waves were detected using a modified vertical sounding technique. Results obtained during 10 flights have shown that the ray tracing technique may be successfully used for predicting the propagation of atmospheric waves following shock fronts.

Magnetic records from presumed underground nuclear explosions at Novaya Zemlya

O Dahlman

Disturbances on magnetic micropulsation records at Kiruna and Tromsö have been observed from 5 presumed underground nuclear explosions at Novaya Zemlya. Although most of the observed pulses on the magnetic records coincide in time with reported arrivals of seismic waves no definite conclusion on the origin of these pulses can be drawn.

Operating principles and preliminary results from a Thomas 6-dimensional seismometer installed at the Hagfors Observatory

T Risbo

A seismic mass has as a stiff body 6 mechanical degrees of freedom. In conventional inertial seismometers mechanical constraints are placed on the seismic mass so that only one degree of freedom is left. In the present seismometer a 6 degree of freedom suspension of the seismic mass has been achieved with complete symmetry. The instrument is capable of measuring all 3 components of translation and in principle also 3 components of rotation of the underground. The system is realized as an accelerometer covering the frequency range 0.01 - - 100 Hz with piezo-electric transducers.
A description of the system is given and some results presented.

Location accuracy of Helsinki tripartite array

I Nopcnen and M-L Mäki

Location of teleseismic events is done by measuring the azimuth and apparent velocity of P-wave. For events in the distance range 30 - 90 degrees the average location error is 560 km and with a 90% probability less than 830 km, when no corrections are used. These large location errors seem mainly to be due to non-regular deviations from the assumed spherical symmetricity of the earth, and the errors can be reduced by employing regional corrections. An attempt is made to decrease the errors by mapping from the observed azimuths and slownesses into those calculated from the USCGS epicenters. Within this distance range, in a certain month (October) all events larger in magnitude than 5.5 could be located, half of the events in the magnitude range 5.0 - 5.4 could be located.
For events in the distance range from 2 to 30 degrees the average location error is 7% of distance and with 90% probability less than 11% of distance. For events nearer than 10 degrees an iterative location procedure is used, employing the S-P intervals and P arrival times.

Location capabilities of the Hagfors Observatory for teleseismic events

H Israelson

A comparison between the USCGS and the Hagfors epicenter determinations for some 300 shallow focus events in the distance range 20 to 100 degrees has been made.
So far results indicate a systematic mislocation pattern. The error vectors are discussed in relation to anomolous source and recieving conditions.

Location accuracy of the Nordic station network

G Hörnström

Events recorded during 1970 by three or more Nordic stations have been routinely located. Two methods of epicenter determination have been used. The two methods, one iterative the other a least square solution are presented. The results for March 1970 are compared with epicenters given by USCGS and the sources of errors are briefly discussed.

Study of P-wave velocity below Moho

M T Porka, H Korhonen and K Saviaro

Seismograms recorded during the Trans-Scandinavian Profile of 1969 at the stations Kajaani, Oulu, Maaselkä and Sodankylä are used to determine the P-wave velocities for the distances from 400 km to 1300 km. An apparent velocity of 8.50 km/s was found. After making a correction due to the curvature of the earth the velocity of about 8.40 km/s was obtained at an approximate depth of 83 km. Some comparison is made with other results from Fennoscandian area.

Location capability of the Hagfors Observatory for local events

R Slunga

A preliminary investigation of the location ability of the Hagfors Observatory has been made based on travel times according to the FOA report "On Scandinavian Travel Times" by Ola Dahlman. That means that a plane layer model with no dips has been used. The methods used will briefly be discussed and their results when applied to the explosions of the Trans-Scandinavian Seismic Profile of 1969 will be presented.

Location of near events by the Finnish station network

I Noponen

The near event location work in Finland will be computerized. In order not to decrease the amount of information available, use is made of all body wave phases read from the seismograms, and the hypocenter which gives the best fit to all data is calculated by an iteration process. Weights are applied to the readings and the program has an ability in one run to change the phase identification and to drop readings with too large residuals.
Examples of the output, which is in a bulletin format, are shown.

On the spectral character of surface waves from the Sino-Soviet region

E Rygg

Surface waves from the Sino-Soviet region have been used to develop the dispersive filter function of the earth between two stations (KRK - KON). Various ways of applications are suggested, among them long period beamforming.

On the application of experimentally generated chirp signals

L Bruland

Surface waves from different parts of the world have been analyzed to find the frequency variation for wave trains from specific regions.
The frequency curves thus obtained provide a simple data base for constructing chirp filters for various regions. Considerable SNR gain is demonstrated.