



HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

Institute of Seismology

Annual report 2008



Cover Central facility of the FINES array.

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1 The Institute

The Institute of Seismology is an independent research institute directly under the Senate of the University of Helsinki. It was founded in 1961. The main tasks of the Institute are defined in its statutes: 1) to carry out seismological research and observatory activities, 2) to maintain and operate the Finnish seismological network, 3) to take care of the international seismological cooperation in Finland, and 4) monitoring seismology as agreed with the authorities and 5) to support the teaching of seismology within the University of Helsinki.

2 The year 2008: An overview

At the end of 2008, the total number of permanent personnel was 21. About one third of the staff are researchers, one third technical staff and one third analysts, research assistants and administrative personnel. The Institute has also provided temporary employment to students working on their PhD or MSc theses - with researchers of the Institute as supervisors - and gaining practical training in seismology. Two long term employees, Pirjo and Pauli Grönholm, retired in 2008. It was also a great loss to the institute when technician Aarre Hannula passed away unexpectedly.

In 2008 the researchers of the Institute have given lectures at the departments of geology and physics and acted as PhD and MSc thesis supervisors.

The national seismic network operated by the Institute of Seismology consists of 16 stations. Many of the stations belong to different global seismic networks, transmitting data in real time to the data centres. The KEV station in Kevo is a part of the global IRIS net-

work, the array station FINES belongs to the nuclear test monitoring network of the CTBTO and the data from 6 stations are transmitted to the GEO-FON data centre in Potsdam. The seismic station established during the International Polar Year at the Aboa station in Antarctica, continued its operation.

Data from all Finnish stations, including the four stations operated by the University of Oulu in northern Finland, and one in Åland operated by the Uppsala University, are analysed at the Institute. Seismic observatory activities have been continued for the needs of the international seismological community and the Comprehensive Test Ban Treaty Organization (CTBTO) in Vienna. The national monitoring activities were supported by the Ministry of Foreign Affairs.

The main research areas of the institute are the structure of the lithosphere, regional seismicity and methods of seismic monitoring. Among the lithospheric studies the most important projects in 2008 were the analysis of the data from the HIRE and FIRE seismic reflection surveys, large international active and passive seismic surveys in central and eastern Europe, seismic refraction surveys in Finland utilizing quarry blasts and tomographic studies of the Fennoscandian Shield. The main emphasis in seismicity studies has been on historical earthquakes in northern Europe and on the focal mechanisms of the Finnish earthquakes.

The researchers of the institute have given 75 presentations at scientific meetings and published 28 articles, seven of them in refereed journals. The researchers have given tens of television, radio and newspaper interviews on earthquakes.

The researchers have represented Finland as scientific experts in the Working Group B of the CTBTO.

Together with the Finnish Meteorological Institute and the Finnish Marine Research Institute, the institute has continued in planning the Finnish Natural Disaster Warning Centre.

The institute organized in Saariselkä together with the Geological Survey of Finland the 13th International Meeting of Deep Seismic Profiling of the Continents and their margins - SEISMIX2008. There were 107 participants at the meeting from all over the world.

3 Institute board

Chairman

Juha Karhu, Professor

Department of Geology, UH

Vice Chairman

Lauri Pesonen, Professor

Division of Geophysics, UH

Members

Outi Holopainen, Head of Unit

Unit for Arms Control,
Ministry for Foreign Affairs

Annakaisa Korja, Seismologist

Institute of Seismology, UH

Pasi Lindblom, Chief Technician

Institute of Seismology, UH

Pekka Nurmi, Research Director

Geological Survey of Finland

Martti Koivula, Lieutenant colonel

Finnish Defence Forces

Secretary

Katriina Arhe, Amanuensis

Institute of Seismology, UH

4 Personnel

Heikkinen, Pekka, Ph.D., Director
Ahonen, Jari, Electrician
Arhe, Katriina, M.Sc., Amanuensis
Franssila, Maija, B.A., Leading Analyst
Grönholm, Pauli, Research Technician
Grönholm, Pirjo, Seismic Analyst
Hakulinen, Anja, Financial Secretary
Hannula, Aarre, Research Technician
Heinonen, Suvi, M.Sc., Research Assistant
Hyvönen, Tellervo, Ph.D., Seismologist
Juntunen, Anssi, Research Technician
Karkkulainen, Kati, M.Sc., Amanuensis
Keskinen, Jukka, Computing Coordinator
Komminaho, Kari, M.Sc., Computing Coordinator
Korja, Annakaisa, Ph.D., Seismologist

Pauli Grönholm retired 31.3.2008

Pirjo Grönholm retired 31.7.2008

Aarre Hannula passed away 18.3.2008

Temporary employees:

Heikkinen, Tuomas
Häkkinen, Tuulia
Keskinen, Johanna
Maijanen, Harri
Wanne, Kaisa
Vesterinen, Henrik

Kortström, Jari, M.Sc., Seismologist
Kuusisto, Minna, Phil. Lic., Amanuensis
Lindblom, Pasi, Chief Technician
Malm, Marianne, B.Sc., Research Assistant
Mäntyniemi, Päivi, Ph.D., Seismologist
Nurminen, Niina, M.Sc., Research Assistant
Raime, Merja, Seismic Analyst
Tarvainen, Matti, Ph.D., Seismologist
Tiira, Timo, Ph.D., Seismologist
Tuominen, Mira, Research Assistant
Uski, Marja, Phil.Lic., Seismologist
Valtonen, Outi, Research Assistant
Vasamies-Leppänen, Leena, B.Sc., Seismic Analyst
Westerlund, Kari, Station Operator

5 Observatory activities

5.1 Regional seismicity 2008

In 2008, source parameters of about 13770 seismic events in Northern Europe were determined. Among them 213 events were classified as earthquakes (Fig. 1), the rest were rock bursts or industrial explosions. Of the earthquakes 31 occurred in Finland. The seismicity was concentrated in the Kuusamo area and western Finnish Lapland. The greatest earthquake in Finland was a magnitude $M_L=2.2$ event at Kolari on 19th January (Fig. 2).

The greatest regional earthquake ($M_L=4.9$) happened on January 16th close to the town Ystad in southern Sweden. It was widely felt in the region and as far north as in the Stockholm area.

Relatively high levels of mining-induced seismicity (earthquakes and rock bursts) were observed in the Malmberget and Kiruna districts in northern Sweden. On February 4th, two earthquakes of $M_L=2.3$ and 1.9 in the Kiruna mine induced a cave-in, killing one person.

In fall, the newest version of the interactive data analysis tool, Geotool, was taken into use. This update required considerable revisions also to the waveform database and event location software.

The automatic event detection and location system was running in real-time mode. However, automatic procedures for event detection, identification and magnitude estimation were upgraded throughout the year.

The automatic analysis system made use of real-time waveform data from the following networks: Institute of Seismology of the University of Helsinki (16 stations), the Sodankylä Geophysical Observatory of the University of Oulu (4 stations), the Geological

Survey of Estonia (EST, 3 stations) and the University of Uppsala (2 stations). For specific events, additional waveform data were obtained from other cooperative agencies in Denmark, Norway, north-western Russia and Sweden.

Fully automatic event determinations were placed on our web site within half an hour of the event occurrence. The final results, in which the automatic solution were retrieved by an analyst and complemented with parameter data from other agencies, were published in the monthly bulletins "Seismic Events in northern Europe" and the annual report "Earthquakes in northern Europe". Since January 2008, the monthly bulletins have been compiled in cooperation with EST, who provides accurate locations and other source information (responsible mine, charge size etc.) for events occurred in Estonia and other Baltic countries.

The bulletins were sent by email to seismological institutes in the Nordic countries, International Seismological Centre (ISC) in United Kingdom and upon request to other institutions. The earthquake catalogue for Fennoscandia in 1375-2006 was updated with the data from the annual earthquake report. The earthquake data and the monthly bulletins are also available at: www.seismo.helsinki.fi.

Macroseismic observations were collected using special questionnaires given out on the web site. In addition to local earthquakes, observations of noise and unusual tremor caused by, e.g. frost shocks, supersonic flights or explosions at construction sites were reported.

The authorities and the Finnish media were immediately informed of large earthquakes or otherwise interesting seismic events.

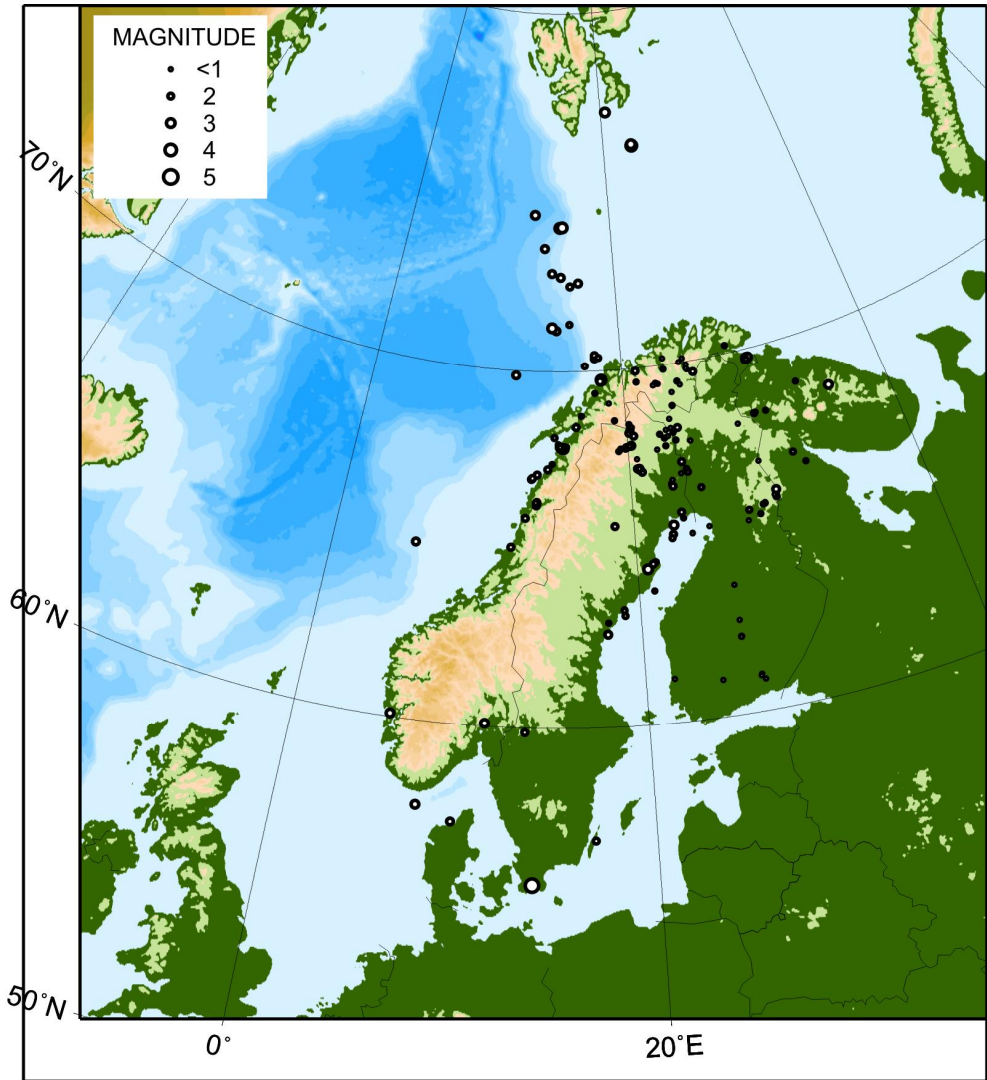


Fig. 1. The regional earthquakes recorded by Finnish seismic stations in 2008.

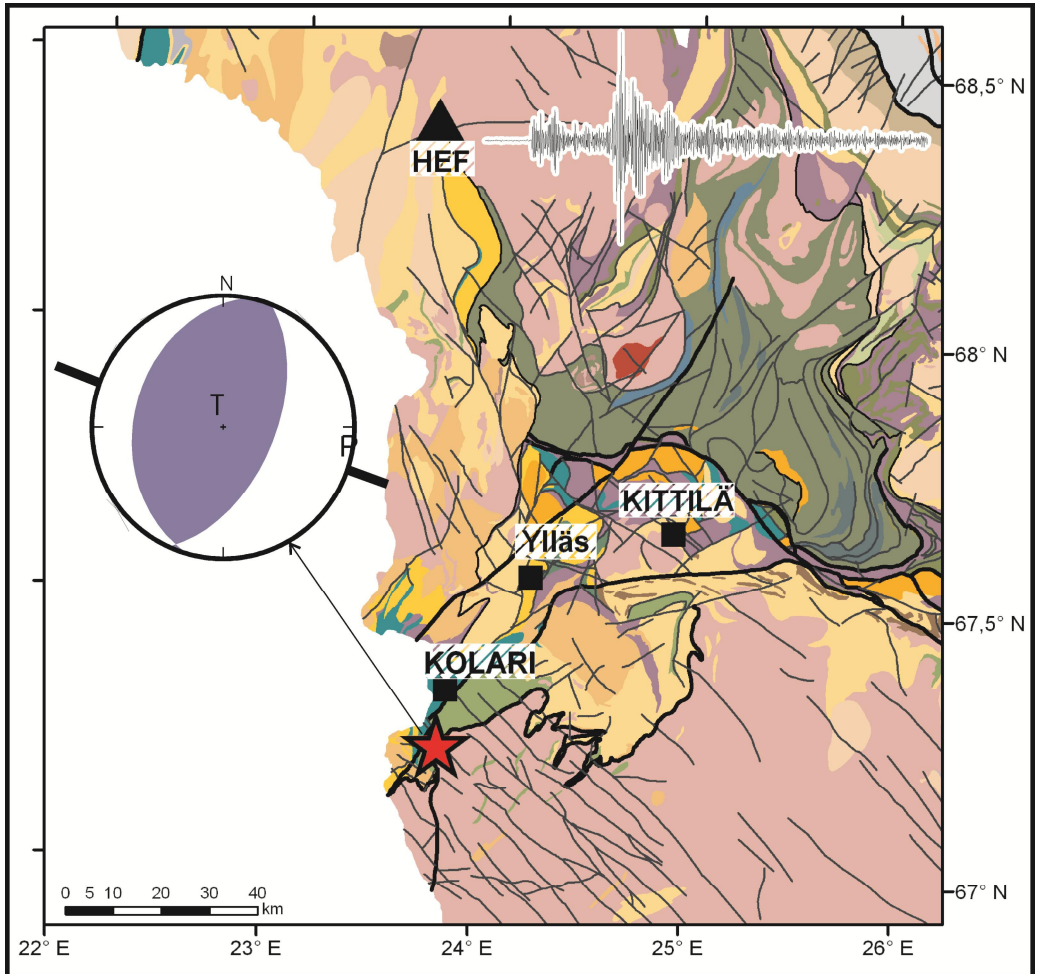


Fig. 2. Earthquake of magnitude 2.2 in Kolar 19th January 2008.

5.2 Global seismicity 2008

In 2008 a global real time monitoring system was started at the institute. The system is based on the SeisComp3 data analysis software made by GFZ Potsdam's GEOFON project. The software package is free to GEOFON's partner networks. It utilizes the data available at SeedLink servers around the world to detect and locate large earthquakes.

About 3700 teleseismic events (distance from the recording station > 1500 km) were recorded and analysed at the Institute. Parameter data of the events were sent to international seismic data centers: NEIC in Denver (USA), EMSC in Bruyeres-le-Chatel (France), RAS in Obninsk (Russia) and International Seismological Centre (UK). Significant or other interesting seismic events were reported to the Finnish news agencies.

A total of 12 earthquakes of magnitude 7 or above occurred in 2008. The strongest one of magnitude 7.9 occurred in Eastern Sichuan, China, on May 12th, where more than 87 000 people were killed. The earthquake occurred on the northwestern margin of the Sichuan Basin and it destroyed almost completely the areas of Beichuan, Dujiangyan, Wuolong and Yingxiu.

6 Seismograph stations, seismic data centre and technical development

6.1 Seismograph station network

The Institute of Seismology maintains and operates 16 seismograph stations. One of them, FINES, is a small aperture array comprising 16 substations. FINES is one of the 50 primary stations

of the International Monitoring System (IMS).

The NUR station in Nurmijärvi is used as test facility with no permanent instrumentation.

Thirteen of the stations operated by the Institute were equipped with modern broad-band STS-2 or GÜRALP seismometers. The data are transferred from the stations to the Institute either through ADSL, SAT-DSL or telephone modems. Also, satellite connection was installed at FINES for backup purposes.

The temporary network in Kuusamo continued its operation unchanged.

6.2 Seismic data centre

The Institute of Seismology collects and stores recordings from all the seismograph stations in Finland. The raw data from the stations are retrieved in real time, and they were stored automatically on computer hard disks. This caused a need of bigger storage capacity. Consequently, new hard disk sets, allowing several years of data storing, were purchased.

Fetching of detected events was made automatic and safe with simply-to-use user interface. SeisComp recording system was installed at eleven stations. Waveform data from the SeisComp stations are distributed in real time to the GEOFON and ORFEUS international data centres. Thus, these stations will be a part of the Automatic GEOFON Global Seismic Monitor earthquake alert system and the Virtual European Broadband Seismograph Network (VEBSN) maintained by ORFEUS.

6.3 The electronic laboratory and the workshop

The instruments deployed or to be deployed at the seismograph stations have been repaired and upgraded at the Institute. Also, the inspections, testing, tuning and calibrations of some new instruments are done at the Institute.

Further, the electronic laboratory took care of instrument calibration at stations.

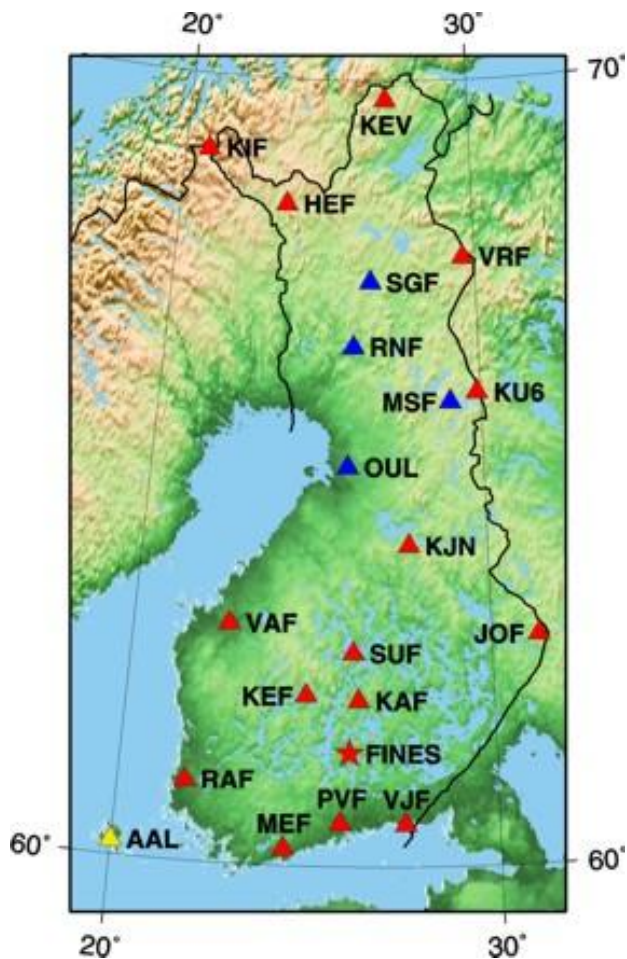


Fig. 3. The seismic stations in Finland. Blue triangles are the seismograph stations operated by the University of Oulu and the yellow one stations by Uppsala University.

7 Seismological verification

Seismic methods are the most efficient and fastest way to detect and locate possible underground violations of the Comprehensive Test Ban Treaty. According to this, the monitoring seismology is one of the basic operations and activities at the Institute of Seismology. The monitoring seismology was financially supported by the Ministry for Foreign Affairs.

The small-aperture array FINES (PS17) belongs to the International Monitoring System (IMS) as one of the 50 primary seismic stations. Its operation is based on the mutual contract between the Institute of Seismology and the Provisional Technical Secretariat of the CTBTO. Upgrading of FINES continued.

Scientists and technicians of the Institute attended meetings of the Working Group B in Vienna, and the Quality Assurance and the National Data Centre Workshops in Vienna.

Five seismic events located near well-known nuclear test sites or being suspicious in nature were reported to authorities according to mutual contracts.

8 Research

The research at the Institute focuses on three major areas: seismic studies of the lithosphere, earthquakes in the Fennoscandian Shield and seismic monitoring methods. These are the fields where the Institute can produce significant scientific contribution due to its resources, and geographical location. The first two are also fields, where integration with the efforts of other earth science institutions in Finland enhances the status of the research. One of the main tasks of the Institute is the seismic monitoring for the purposes of national security as well as for ef-

forts in nuclear disarmament. A successful operation in this field requires active research in seismological monitoring methods.

8.1 Research on monitoring seismology

Noise measurements (Jukka Keskinen and Jari Kortström)

The building noise and vibrations characteristics were estimated in the new building of the nanotechnology laboratory of the Helsinki University of Technology.

UHHA project (Jari Kortström and Päivi Mäntyniemi)

The general aim of the UHHA project is to set up an alarm, warning and information exchange system that rescue personnel can use in the event of an emergency. The UHHA system can provide information about the accident site and persons at risk to rescue service personnel in order to support decision-making.

The UHHA project is funded by the Finnish Funding Agency for Technology and Innovation (TEKES). It involves a wide range of participants, such as Valtion Teknillinen Tutkimuskeskus (VTT), Helsinki University of Technology (TKK), University of Helsinki, the Finnish Meteorological Institute (FMI), Insta Ltd and Finnish Chemicals Ltd.

The UHHA concept is applied to a domestic chemical accident and an international natural disaster. A disastrous earthquake hitting a tourist resort on the island of Crete, Greece was selected a test case.

One part of the work is to create a situation picture of the affected area from basic earthquake parameters.

Investigations as to the feasibility of sending warnings and earthquake information to the tourists at risk are carried out.

8.2 Structure of the lithosphere

High resolution seismic reflection survey (Pekka Heikkinen and Suvi Heinonen)

In May 2006 a high resolution seismic survey was conducted in Outokumpu, at the 2.5 km deep bore hole. The seismic survey consisted of four main parts: 1) a zero offset VSP (Vertical Seismic Profiling), 2) a series of walk-away VSP measurements at various azimuths and three depths, 3) a far-offset multilevel VSP and 4) a high resolution surface reflection survey. The field work was carried out with the personnel from the GFZ-Potsdam, the Geological Survey of Finland, the University of Alberta and the Institute of Seismology.

Processing of the seismic data from Outokumpu is mainly done by students in University of Alberta. However, processing of the high resolution seismic reflection data was performed by Suvi Heinonen, who visited University of Alberta in autumn 2007. A close collaboration between Institute of Seismology and University of Alberta was found viable and during 2008 the results of the studies related to Outokumpu survey were presented in numerous meetings (e.g. Seismix2008, Lito2008, AGU). Master's thesis of Suvi Heinonen and Heather Schijns from University of Alberta were also finalized during 2008.

The main goal of this project was to map in detail the deep structure Outokumpu that is a classical Precambrian ore province. The processing of the seismic surface data

revealed a good correlation to the geological and geophysical borehole data of Outokumpu deep drill hole and to the results of the seismic surveys done in Outokumpu during the FIRE project in 2001-2003.

The institute is a partner in a research program HIRE (High Resolution Reflection Seismics for Ore Exploration, 2007-2010) of the Geological Survey of Finland. This project applies high resolution reflection seismic method on exploration targets and mining camps for improved structural mapping and 3D modeling of important mineral resource areas in Finland. The general aims of the HIRE project are (1) to introduce reflection seismic surveys as an exploration tool for the Precambrian crystalline bedrock, (2) to apply 3D visualization and modelling techniques in interpretation, and (3) to improve the structural data base on the most important mineral resource provinces in Finland. In 2007-2008 data acquisition was done at 16 sites in Finland. In the HIRE project the Institute is responsible for the final processing of the data. The Geological Survey works in co-operation with the Institute in interpretation, research and modelling of the data.

Crustal structure and evolution of the Fennoscandian Shield (Annakaisa Korja, Pekka Heikkinen, Tuulia Häkkinen and Kaisa Wanne)

Information on the crustal structure and its evolution is a prerequisite in any seismic event detection programs or mineral exploration strategies. Crustal scale reflection and refraction studies have three goals: 1) to map the 3D-distribution of seismic properties: velocity, reflectivity and elastic constants in Fennoscandia, 2) to understand how the seismic structures were formed and how they can be used to outline mineral exploration strategies, 3) to apply and develop

new seismic research methods and techniques for Precambrian bedrock.

The project has been studying the structural architecture and evolution of the Fennoscandian Shield via FIRE reflection datasets. The results confirm that the crust is extremely thick and that has been formed by accretion of older crustal blocks and intervening sedimentary basins in plate tectonic processes. The results also indicated large-scale reactivation of the crust after the accretionary event. The stabilization event was rather profound as it resulted in layering of the crust and the development of low angle fabrics, which indicate considerable deformation and displacement of bedrock units relative to their post-accretionary positions. The phase is important to mineral exploration as it determines whether the geological formations are destroyed or preserved and it also controls the present distribution of geological formations and shear zones.

The project has been developing both computer-based processing methods and field-based geological interpretation methods. Processing methods have focused in finding the optimal velocities for migration. The field based methods have concentrated on how to identify seismic reflection on outcrop with the help of structural geology tools. The field studies have revealed that most prominent reflections and disruptions are usually shear zones, highly strained rocks or faults on outcrops. The low angle structures that dominate the seismic sections have proved to be low angle shear zones or highly strained rocks with low angle lineation, which have either been over-looked or misinterpreted previously.

The group consists of researchers from the University of Helsinki (O.T. Rämö, T. Häkkinen), Turku (T. Kilpeläinen, K. Wanne), Frankfurt (C. Dietl, B. Saha)

and the Geological Survey of Finland (M. Nironen, P. Hölttä, R. Lahtinen, I.T. Kukkonen). In 2008, the field work was financed by Renlunds's Foundation and it took place in Pyhäsalmi-Pihtipudas area where T. Häkkinen started her MSc-thesis on structural evolution of the Pyhäsalmi migmatite complex and in Karstula area, where K. Wanne correlated the results of analogue modelling with field observations as part of her PhD thesis. The first international paper of FIRE-datasets was published in GSA Penrose conference Special Publication on "When did plate tectonics begin on planet Earth?". Two papers were accepted for publication in the Geological Society of London Special Papers series and one paper by AGU in EOS.

The formation and structural evolution of the Baltic Shield also studied in more global scale and 3 000 Ma years lasting plate tectonic perspective with the help of two reflection seismic transects: 3600 km long North European Transect and about 1000 km long Gulf of Finland-White Sea Transect. North European Transect covering the Baltic and Bothnian Seas (BABEL), Lapland (FIRE4) and the Barents Sea (1-AR) is compiled together with Sevgeomor (St. Petersburg) and White Sea transect covering Russian Karelia (4B) and eastern and southern Finland (FIRE1&2) is compiled together with SpetsGeofizika (Moscow) and the Geological Survey of Finland.

Visualisation of seismic 3-D data (Timo Tiira, Kari Komminaho, Tellervo Hyvönen and Annakaisa Korja)

An interactive tool for 3-D seismic and other geophysical data visualisation is being developed using OpenDX data visualisation environment. The functions of the visualisation tool

include visualisation of 3-D gridded data, comparison of different 3-D data sets by simple mathematical relations, contour, continuous colour and colour band representation on any plane across the 3-D data set, animation of 2-D slices running across the data set, comparison of different 2-D and 3-D

data sets and models. The visualization of large 3D-geoscientific data in OpenDX- environment and in virtual reality is developed together with CSC, University of Jyväskylä, Helsinki University of Technology and the Geological Survey of Finland.

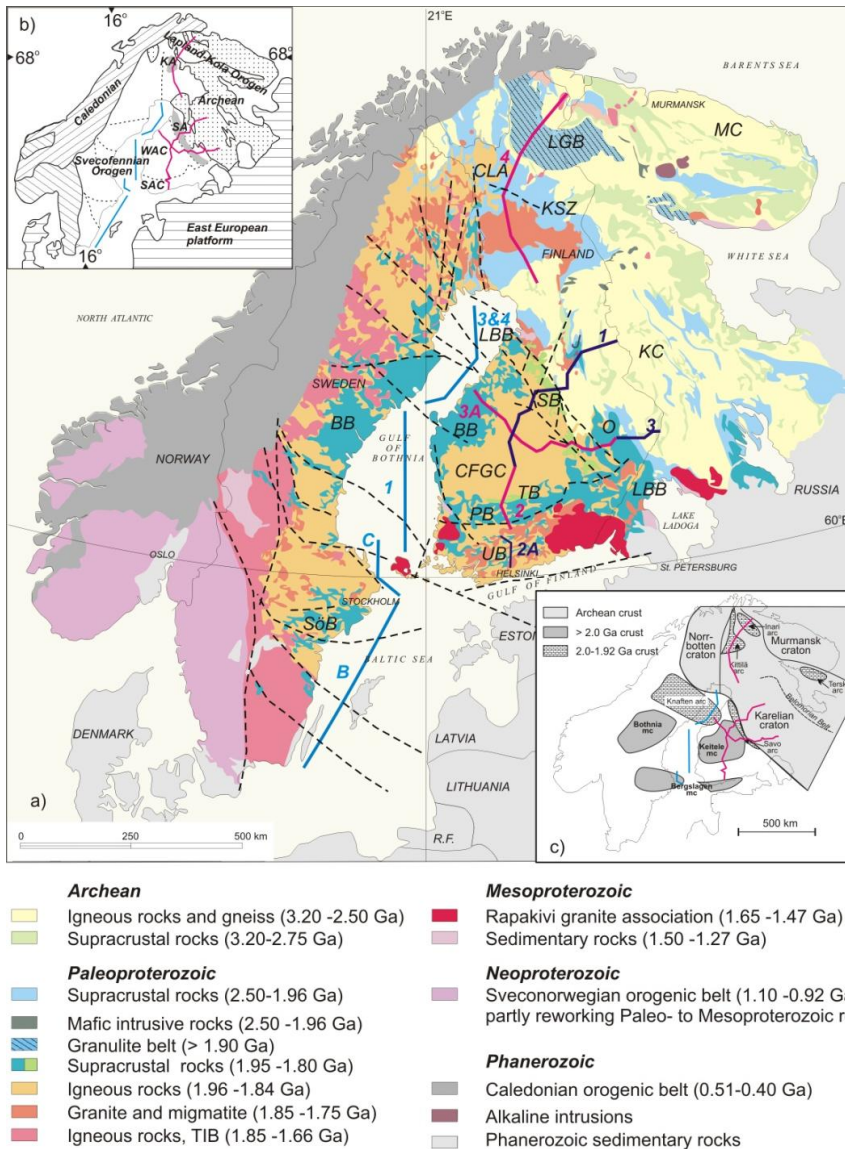


Fig. 4. Seismic lines on a lithological map of Fennoscandia/ Northern Europe. The tectonic lineaments are marked with dash lines.

Deep seismic soundings in Central and Eastern Europe (Timo Tiira and Kari Komminaho)

The institute has taken part in several active seismic sounding projects in Central and eastern Europe in start of the century. CELEBRATION 2000 was the largest deep seismic sounding project ever in Europe. The experiment included 15 lines spreading on territories of Poland, Czech Republic, Hungary, Slovakia, Austria, Germany, Belarus and Russia. Also groups from USA, Canada, Finland, Denmark and Turkey take part in the project. ALP 2002 was an international seismic co-operation project with a goal to increase knowledge of the structure and evolution of the lithosphere in eastern Alps and neighbouring areas. Deep seismic sounding experiment SUDETES 2003 covered south-western Poland, the Czech Republic and parts of Germany, Slovakia and Hungary. The overall scientific objective of the SUDETES project was to investigate the deep crustal structure and geodynamics of the northern part of the Bohemian Massif. 2008 the work continued in PANCAKE project spanning from north-western Ukraine to Hungary. A joint interpretation of the data sets from these and earlier projects will produce a 3-D model of the lithosphere and it seeks to resolve the major plate tectonic features of the area.

Moho map of Europe (Timo Tiira and Kari Komminaho)

A new European Moho depth map was compiled from more than 250 data sets of individual seismic profiles, 3-D models obtained by body and surface waves, receiver function results and maps of seismic and/or gravity data compilations. The map is the first digital, high-resolution map of the Moho depth for the whole European

Plate, extending from the mid-Atlantic ridge in the west to the Ural Mountains in the east, and from the Mediterranean Sea in the south to the Barents Sea and Spitsbergen in the Arctic in the north. The map is stored in a digital database that is easily interpreted, amended, and transmitted. The database will be useful for many applications, e.g. for tomographers: natural source tomography could get valuable additional information. The database could be used to form a starting model for tomography or to plan new experiments, or to improve estimating seismic hazards. The study is conducted by ESC Working Group on "Crustal Structure Maps of Europe".

Passive seismic surveys in Central and Eastern Europe (Timo Tiira and Kari Komminaho)

The main interest in studies of the structure of Earth has shifted from the Crust to deeper parts of the Lithosphere. Therefore active seismic experiments have given way to passive experiments. ALPASS is a passive seismic monitoring experiment mostly in Austria. The field measurements took place from spring 2005 to spring 2006. The aim of the project is to reveal upper mantle, lower lithosphere, and asthenosphere beneath the wider Eastern Alpine region, including the Bohemian Massif, the Carpathians, the Pannonian Basin, and the Dinarides. The main scientific goals of ALPASS are to develop a tomographic image of the P-wave velocity structure of the upper mantle, the lower lithosphere and the asthenosphere down to 670 km and the detection of large scale anisotropy, to calculate receiver functions to resolve the upper mantle discontinuities and the Moho, to invert surface wave dispersion and to evaluate local earthquakes, to obtain precise hypocenter locations and moment tensors in order to delineate active faults and similar geodynamical

relevant zones. The main aim of the PASSEQ experiment is to study seismic structure of the mantle in Central Europe in the TransEuropean Suture Zone (TESZ), particularly in the Teisseyre-Tornquist Zone (TTZ) in Poland, between young Palaeozoic platform of the Western Europe and much older Precambrian East European platform. The knowledge of deep structure of the TTZ is important for understanding the tectonic processes of the area of Europe. From May 2006 to spring 2008 about 150 seismic stations records continuously the local, regional and teleseismic earthquakes along a corridor about 300 km wide and 1000 km long crossing the TTZ. The temporary seismic array extended from Germany and Czech Republic, through Poland to Lithuania. The main target of PASSEQ is an investigation of the structure of the upper mantle, particularly: structure of lower lithosphere, lithosphere-asthenosphere boundary (LAB) and discontinuities "410" and "660" in transition from East European Craton (EEC) to Variscan Europe. These discontinuities have very important significance in rheology processes and mantle convection. The research methods will include P residuals method, receiver function analysis, teleseismic tomography, surface wave tomography and anisotropy studies.

Deep seismic soundings in Finland (Timo Tiira and Kari Komminaho)

Deep seismic sounding line LAPWIDE runs from Kostamus quarry in Russia to Pokka in Kittilä, Finland. The profile crosses the major tectonic units in the northern Finland including areas prospective for metals and diamonds. The experiment will provide new information about crustal thickness and velocity distribution within the crust and upper mantle. The field measurements were done in autumn 2007 within 4 weeks period. Signals from several

quarries and mines online and offline and from demolition explosion site of the Finnish Defence Forces in Hukkakero were recorded with portable seismic stations and permanent stations in the area. Total number of the stations was about 110. The interpretation and modelling of the data will be done using ray tracing in 2D and synthetic seismograms. The resulting data set can be combined with data from other experiments in the region and used in 3D tomography to define seismic velocity structure of the crust and the depth of Moho discontinuity. The interpretation and modelling of the 2D data along profile will continue 2009.

Field measurements on line Vaasa-Kymenlaakso started 2008 using short period (SP) stations aiming to get a more detailed 2D tomographic image of the crust. The field measurements will continue 2009 using also broadband (BB) seismometers in small scale passive experiment. The data from passive experiment will be combined with data from permanent seismic stations in the area and with data from passive experiment SVEKALAPKO. The improved data set will be used to define asthenosphere-lithosphere boundary in the area. Also other deep discontinuities "410" and "660" will be studied.

Crustal tomography of the central Fennoscandian Shield (Tellervo Hyvönen, Timo Tiira, Kari Komminaho, Annakaisa Korja and Pekka Heikkinen)

An updated seismic tomography model was inverted for the central Fennoscandian Shield, including southern and central Finland. The amount of the P-wave and S-wave travel time data was doubled adding local seismic events recorded at permanent seismic stations in Finland. The number of the receivers totals 565

and the number of the seismic sources was increased to 2895. In addition, more Moho reflections of the PMP- and SMS-waves were measured. Thereupon, the study area was expanded and the regional ray coverage became denser. The seismic tomography program Jive3D was used to model the 3-D velocity structure of the crustal lithosphere. The inversion of the seismic P- and S- wave travel times resulted in both the Vp model and the Vs model and, furthermore, the Vp/Vs distribution in the crust. The Pg-wave residuals of the tomography model were investigated in search for implications of crustal azimuthal anisotropy.

Seismic anisotropy of the lithosphere beneath Fennoscandia (Tellervo Hyvönen, Timo Tiira, Annakaisa Korja and Kari Komminaho)

The seismic anisotropy of the mantle lithosphere using the data of the SVEKALAPKO Seismic Tomography Project has been studied in cooperation with the research team of the Geophysical Institute in Prague and the Universities of Helsinki and Oulu. A review of the seismic anisotropy results and an estimation of the lithosphere thickness beneath the Fennoscandian Shield were published in Tectonophysics.

The anisotropy of the central Fennoscandian crust was investigated by using the crustal P-wave residuals from the updated seismic tomography model. Indications of azimuthally oriented anisotropy were found in two upper layers of the crust. The results were presented in the IGC meeting in Oslo and Lithosphere 2008 symposium in Oulu. The manuscript of an article is under preparation.

Crustal structure of Kainuu-Peräpohjola region (Marja Uski and Timo Tiira)

This project has been carried out in cooperation with the Institute of Geophysics, University of Warsaw, with the main objective to derive a detailed crustal model for the Kainuu-Peräpohjola region. The study area includes the seismically most active areas in Finland, i.e. Kuusamo, Bothnian Bay and western Finnish Lapland. Improved knowledge on crustal velocity structure is used in local seismicity studies to resolve the 3-D earthquake distribution and to build a link between earthquakes and local geology. In addition, accurate information on Moho geometry is needed for local tomographic studies.

A database of local earthquakes and explosions was collected, pre-processed and analysed for this study. The data were recorded by the permanent seismic stations and the Kuusamo temporary seismic network in 2003-2007. These data were supplemented with events recorded during the Svekalapko seismic tomography experiment in 1998-1999 and with five seismic profiles recorded by mobile stations during several years.

8.3 Seismicity studies

Earthquake source mechanisms (Marja Uski, Tellervo Hyvönen and Annakaisa Korja)

Recent crustal movements and the stability of fracture zones are of great interest as the safety of the site for a repository of spent nuclear fuel in Finland is being estimated. Our joint geophysical study is focused on determining source mechanisms for recent earthquakes in Finland, on identifying active faults associated with

earthquakes, and on gaining information on the in situ stresses causing earthquakes.

In the pilot study a procedure was developed for determining source mechanisms of earthquakes recorded by a sparse local network. The database consisted of three earthquakes that occurred in different seismotectonic regions. The events were relocated using P- and S-phase arrival times from the nearest seismic stations, and velocity models derived for the source areas from deep-seismic sounding results. Fault plane solutions were calculated using P-wave polarities together with SV/P and SH/P phase amplitude ratios. Synthetic waveform modelling was used to constrain the focal and structural parameters. The faults and the fracture sets were identified from high-resolution aeromagnetic data and topographic maps. The focal planes were correlated with these lineaments.

For a comprehensive study on the contemporary state of stress and earthquake triggering mechanisms in Finland, a more extensive database of earthquake mechanisms is needed. The method has been further developed and adapted to the Anjalankoski earthquake swarm in 2003 and to several individual earthquakes. In cooperation with the Pyhäsalmi mine, we tested the reliability of phase amplitude ratio method in constraining source mechanism and focal depth. Source parameters of the earthquake at Pyhäsalmi mine on December 13th, 2007 were compared against the independent data provided by the mine-wide local network.

Seismicity studies at Kuusamo (Marja Uski and Annakaisa Korja)

In a low-seismicity region such as Finland, earthquakes are weak and randomly scattered. However, analysis

of micro earthquakes (with magnitude less than 2) recorded by a dense local network can provide reliable data on the local stress field and slip pattern as well as on active faults and their geometry.

In 2003-2007, a temporary network of six three-component stations has been installed at Kuusamo, the seismically most active area in Finland. The Kuusamo region is transected by two major shear zones. One is a NE-oriented zone starting from central Finland and continuing to the White Sea, other one a NW-SE-striking zone bound by Näränkäväära, Iiväära and Mustaväära. Earthquake activity seems to cluster at the intersections of these zones. The Kuusamo network, supplemented with the permanent station at Maaselkä (MSF), is covering the areas of enhanced seismicity.

In 2005-2008, a data base of local earthquakes and explosions has been collected and analysed. Source mechanisms have been determined for most of the earthquakes, and recurring blasting sites have been mapped. The data have been used to determine an improved crustal model for the Kuusamo region. Next, the optimal crustal model and a relative location scheme will be applied to the events in order to constrain the three-dimensional distribution of earthquakes.

Historical earthquakes in Northern Europe (Päivi Mäntyniemi)

This research focuses on pre-instrumental earthquakes in Northern Europe defined as including the Baltic and Nordic countries. The studies conducted so far have dealt with earthquakes in the late 1800s and early 1900s. As an outcome, a doctoral dissertation consisting of macroseismic studies on historical earthquakes in the region has been finished. This work

included investigations ranging from searches in libraries and archives to applying statistical methods to questionnaire data.

Creating intensity data point (IDP) collections for selected earthquakes in the region constitutes a relevant part of this work. An example is the detailed study on the earthquake of 4 November 1898, including a complete collection of IDPs and a list of available primary sources, published recently.

A new subproject was commenced with Russian colleagues at the Institute of the Physics of the Earth, Russian Academy of Sciences, in Moscow. The work is carried out in co-operation with Drs. Ruben and Tatiana Tatevossian. The area of interest includes the Kola Peninsula, Russian Karelia and Northeastern Finland. The aim is to improve the present understanding of historical seismic activity and selected cross-border earthquakes in this area with the help of bilateral investigations. One basic outcome of such studies is given as unified maps, currently in short supply. The puzzling earthquakes in 1626, two shocks close in space and time followed by a long interruption of earthquake reporting, were selected as one important example of historical seismicity. The search for primary sources of these events was begun.

Natural and controlled source seismic studies of endglacial faults (Jari Kortström and Marja Uski)

The project is carried out in cooperation with the Department of

Earth Sciences, University of Uppsala and the NORSAR research institute. The acquisition of earthquake data continued through 2008. Funding for the project on geometry, kinematics and mechanics of endglacial faulting in northern Scandinavia was received from Swedish Research Council for the years 2008-2009. Preliminary location of the events from August 2007 to March 2008 has been performed and the data from April to October 2008 is being processed. A seismic reflection seismic survey was acquired across the Skellefteå endglacial fault during 2008.

ABOA, seismic broad-band station in Antractica (Pekka Heikkinen, Timo Tiira and Kari Komminaho)

Institute of Seismology has set up a seismic station in Antractica during the International Polar Year (IPY). Seismic broad-band station ABOA has been operating since 18.1. 2007. The station is situated at the Finnish Antarctic research station Aboa (73°03'S, 13°25'W) in Queen Maud Land, Antarctica. Aboa is located 130 km from the shore, in the Vestfjella Mountains. The station is equipped with Streckeisen STS2 broad-band seismometer and Reftek 130 digitizer/data logger. The ABOA station is a standalone station without any communication links. The data is collected once a year during a service visit. Cooperation with Alfred Wegener Institute in Germany has been started.

9 Visits

9.1 Visits abroad

Arhe, Katriina 08.-09.10.	Tallinn, Estonia	Analyst seminar
Franssila, Maija 04.-06.06.	Oslo, Norway	The 39 th Nordic Seismology Seminar
08.-09.10.	Tallinn, Estonia	Analyst seminar
Heikkinen, Pekka 21.01.	Uppsala, Sweden	Uppsala University, Department of Earth Sciences
22.02.-01.03.	Vienna, Austria	30 th WG-B
18.-21.02.	Moscow, Russia	HIRE-Meeting
13.-19.04.	Vienna, Austria	General Assembly of the European Geosciences Union
24.-26.08.	Vienna, Austria	31 st WG-B
05.-12.09.	Crete, Greece	ESC, 31st General Assembly
27.-29.11.	Uppsala, Sweden	Uppsala University, Department of Earth Sciences
09.-13.12.	Moscow, Russia	HIRE-Meeting
Heinonen, Suvi 08.-09.10.	Tallinn, Estonia	Analyst seminar
15.-19.12.	San Francisco, USA	AGU Fall Meeting
Hyvönen, Tellervo 06.-14.08.	Oslo, Norway	33 rd International Geological Congress
Karkkulainen, Kati 08.-09.10.	Tallinn, Estonia	Analyst seminar
Komminaho, Kari 10.-22.10.	Ukraine	Institute of Geophysics, Academy of Sciences of Ukraine
Korja, Annakaisa 13.-19.04.	Vienna, Austria	General Assembly of the European Geosciences Union
06.-14.08.	Oslo, Norway	33 rd International Geological Congress
Kortström, Jari 13.03.	Uppsala, Sweden	Department of Earth Sciences, Uppsala University

05.-08.05.	Barcelona, Spain	2008 Orfeus Co-ordination Meeting
04.-06.06.	Oslo, Norway	The 39 th Nordic Seismology Seminar
18.-22.08.	Kjeller, Norway	NORSAR, NERIES TA Programme
08.-09.10.	Tallinn, Estonia	Analyst seminar
Lindblom, Pasi		
10.-14.03.	Pretoria, South Africa	Joint IMS/IDC Regional Technical Training Course
05.-09.05.	Baden bei Wien	NDC Evaluation Workshop
04.-06.06.	Oslo, Norway	The 39 th Nordic Seismology Seminar
01.-05.08.	Vienna, Austria	31st WG-B and Waveform Expert Group Meeting (CTBTO)
10.-14.11.	Vienna, Austria	Third Operation and Maintenance Workshop
24.11.-05.12.	Vienna, Austria	Advanced NDC Training Course for Technical Staff
Malm, Marianne		
08.-09.10.	Tallinn, Estonia	Analyst seminar
Mäntyniemi, Päivi		
17.-30.05.	Moscow, Russia	Institute of the Physics of the Earth
07.-12.09.	Crete, Greece	ESC, 31st General Assembly
Raime, Merja		
08.-09.10.	Tallinn, Estonia	Analyst seminar
Tarvainen, Matti		
12.-15.02.	Vienna, Austria	Waveform Expert Group Meeting (CTBTO)
18.-22.02.	Vienna, Austria	30 th WG-B
03.-05.03.	Vienna, Austria	CTBT – ISS
08.-12.09.	Vienna, Austria	31 st WG-B
15.-17.09.	Vienna, Austria	CTBT – ISS
Tiira, Timo		
13.-19.04.	Vienna, Austria	General Assembly of the European Geosciences Union
22.-26.05.	Zakopane, Poland	CELEBRATION 2000 Workshop
07.-12.09.	Crete, Greece	ESC, 31st General Assembly
10.-22.10.	Ukraine	Institute of Geophysics, Academy of Sciences of Ukraine
Tuominen, Mira		
08.-09.10.	Tallinn, Estonia	Analyst seminar

Uski, Marja		
13.3.	Uppsala, Sweden	Department of Earth Sciences, Uppsala University
04.-06.06.	Oslo, Norway	The 39 th Nordic Seismology Seminar
08.-09.10.	Tallinn, Estonia	Analyst seminar
Valtonen, Outi		
08.-09.10.	Tallinn, Estonia	Analyst seminar
Vasamies- Leppänen, Leena		
08.-09.10.	Tallinn, Estonia	Analyst seminar

9.2 Visitors

Peter Labák	23.-25.4.	Geophysical Institute, Slovak Academy of Sciences, Bratislava
Nina Ivanova Yuri Roslov	21.-22.5.	Sevmorgeo, St. Petersburg, Russia
Beata Plesiewicz Jacek Trojanowski	27.-30.5.	Institute of Geophysics, Polish Academy of Science, Warsaw, Poland
David Snyder	27.5.-26.6.	Geological Survey of Canada, Ottawa
Søren Gregersen	6.-9.11.	Geological Survey of Denmark and Greenland, Copenhagen

10 Presentations 2008

Maan ytimestä avaruuteen – Symposium, January 9-11, 2008, Helsinki, Finland

Heikkinen, P.: Maankuoren rakenne Suomen alueella

Centenary Conference ELGI (Eötvös Loránd Geophysical Institute), February 28, 2008, Budapest, Hungary

Brückl, E., Behm, M., CELEBRATION 2000, ALP 2002 and ALPASS Working Groups (incl. Kommihaho, K. and Tiira, T.): Crustal structures and tectonic processes in the Eastern Alps revealed by recent controlled source seismic experiments (invited)

Joint IMS/IDC Regional Technical Training Course for Station Operators and NDC Technical Staff, March 10-13, 2008, Pretoria, South Africa

Lindblom, P.: Data and Data Quality. Operators' Responsibilities in Producing Good Data

EGU General Assembly 2008, April 13-18, 2008, Vienna, Austria

Grad, M., Tiira, T., ESC Moho Working Group: European plate Moho depth map (poster)

Hausmann, H., Hoyer, S., Zeisz, K., Schurr, B., Brückl, E., CBP Team and ALPASS Team (incl. K. Kommihaho and T. Tiira): Seismicity of the Vienna Basin from the temporary ALPASS and CBP deployments (poster)

Korja, A., Heikkinen, P. and Roslov, Y.: North European Transect – a preliminary compilation (poster)

Korja, A., Heikkinen, P. and Kosunen, P.: Crustal structure of the collapsed Palaeoproterozoic Svecofennian Orogen

Kozlovskaya, E., Janik, T., Yliniemi, J., Heikkinen, P. and FIRE Working Group (incl. J. Keskinen, A. Korja and T. Tiira): Petrological crust-mantle boundary vs. seismic Moho in the central Fennoscandian Shield: constraints from collocated wide-angle and near-vertical seismic profiles (poster)

Kozlovskaya, E. and POLONET/ LAPNET Working Group (incl. P. Heikkinen): POLONET/LAPNET - a multidisciplinary seismic array research in northern Fennoscandia: first results (poster)

Majdanski, M., Swieczak, M., Grad, M., Kozlovskaya, E., Wilde-Piorko, M., POLONAISE'97 WG, SUDETES 2003 WG (incl. K. Kommihaho and T. Tiira): Multidisciplinary model of the crust and upper mantle in Trans-European Suture Zone in Poland (poster)

Silvennoinen, H., Kozlovskaya, E., Yliniemi, J., Tiira, T. and FIRE Working Group (incl. P. Heikkinen, J. Keskinen and A. Korja): Interpretation of wide-angle reflection and refraction recordings of Vibroseis signals and 3D gravity modelling along FIRE4 profile, northern Finland (poster)

The 39th Nordic Seismology Seminar, June 4-6, 2008, Oslo, Norway

Kortström, J. and Uski, M.: Automatic Location of Regional Events with Sparse Seismic Network

Lindblom, P.: Data and data quality Operators' responsibilities in producing good data

Lund, B., Karlsson, E., Erlendsson, P., Juhlin, C., Dehghannejad, A., Bödvarsson, R., Kvaerna, T. and Uski, M.: The Pärvie project: Background and current status

Nikulin, V., Soosalu, H., Uski, M. and Pacesa, A.: Testing the location and discrimination capability of Nordic-Baltic virtual seismic network in the Baltic region (poster)

Soosalu, H., Uski, M. and Kortström, J.: Joint Finnish-Estonian Seismic Analysis of Quarry Blasts in NE Estonia

Uski, M., Tiira, T., Grad, M. and Yliniemi, J.: Crustal velocity models and Moho map for the Kainuu-Peräpohjola region in Finland (poster)

SEISMIX2008, The 13th International Symposium on Deep Seismic Profiling of the Continents and Their Margins, June 8-13, 2008, Saariselkä, Finland

Grad, M., Tiira, T. & ESC Moho Working Group: European plate crust and new digital Moho depth map (poster)

Heikkinen, P., Kukkonen, I.T., Suleimanov, A. and Zamoshnyaya, N.: Seismic image of the Fennoscandian Shield

along the Baltic Sea – White Sea (oral & poster)

Heinonen, S., Schijns, H., Schmitt, D., Heikkinen, P. and Kukkonen, I.T.: Seismic reflectivity and anisotropy in Outokumpu, Finland based on high resolution seismic survey and borehole data (poster)

Janik, T., Grad, M., Guterch, A. and CELEBRATION2000 Working Group (incl. K. Komminaho, T. Tiira): 2,5-D seismic modeling of the Lithosphere between EEC and Carpathians mountains on the base of the net of CELEBRATION2000 profiles (poster)

Janik, T., Kozlovskaya, E., Heikkinen, P., Yliniemi, J. and Silvennoinen, H.: Comparison of P- and S-wave velocity models of POLAR and HUKKA wide-angle reflection and refraction profiles with FIRE4 reflection transect, the northern Fennoscandian Shield (poster)

Korja, A., Heikkinen, P., Roslov, Y., Ivanova, N.M., Verba, M.L., Sakoulina, T.S. and Patison, N.L.: North European transect – A preliminary compilation (poster)

Korja, A., Kosunen, P. and Heikkinen, P.: Collapse structures of the Svecofennian orogen

Kozlovskaya, E., Janik, T., Yliniemi, J. and Heikkinen, P.: Petrological crust-mantle boundary vs. seismic Moho in the central Fennoscandian Shield: Constraints from collocated wide-angle and near-vertical seismic profiles

Kozlovskaya, E. and POLENET/LAPNET Working Group (incl. P. Heikkinen): POLENET/LAPNET – A multidisciplinary

seismic array research in northern Fennoscandia: First results

Kukkonen, I.T. and HIRE Working Group (incl. P. Heikkinen): Project HIRE: high resolution reflection seismic surveys in ore exploration of crystalline rock areas

Kukkonen, I.T., Kuusisto, M., Lehtonen, M. and Peltonen, P.: Uppermost mantle reflectors and Moho-cutting reflectors in central Fennoscandia: Delamination structures? (oral & poster)

Patison, N.L. Sorjonen-Ward, P., Ojala, V.J. and Korja, A.: Tectonic setting of Finnish mineral deposits: Evidence from the Finnish reflection experiment? (FIRE)

Silvennoinen, H., Kozlovskaya, E., Yliniemi, J., Tiira, T. and FIRE Working Group: Interpretation of wide-angle reflection and refraction recordings of vibroseis signals and 3D gravity modelling along FIRE4 profile, northern Finland (poster)

Uski, M., Tiira, T., Grad, M. and Yliniemi, J.: Crustal velocity models and Moho map for the Kainuu-Peräpohjola region in Finland (poster)

Waveform expert group meeting (CTBTO), August 1-5, 2008, Vienna, Austria

Lindblom, P.: Station operator and data quality

33rd International Geological Congress, August 6-14, 2008, Oslo, Norway

Brückl, E., Behm, M., Grad, M., Simone, O. and Celebration 2000 and Alp 2002 Working Groups: Tec-

tonic interpretation of deep geophysical data from the Eastern Alps

Grad, M. and Tiira, T.: Three crustal domains of the European plate - new digital Moho depth map

Guterch, A., Grad, M., Keller, G.R. and Celebration 2000, Polonaise'97, Sudetes 2003, ALP 2002 Working Groups: A new generation of long range controlled source seismic experiment in Central Europe. Review of the basic results

Heikkinen, P., Kukkonen, I., Suleimanov, A. and Zamoshnyaya, N.: Seismic image of the Fennoscandian Shield along the Baltic Sea - White Sea transect

Hyvönen, T., Tiira, T., Korja, A., Komminaho, K. and Heikkinen, P.: Seismic 3D velocity modelling of the crust in southern and central Finland – indications of seismic anisotropy

Janik, T., Grad, M., Guterch, A. and Celebration 2000 Working Group: Seismic models of the lithosphere between EEC and Carpathians mountains on the base of Celebration2000 project

Janik, T., Kozlovskaya, E., Heikkinen, P., Yliniemi, J. and Silvennoinen, H.: Evidence for preservation of crustal root beneath the Proterozoic Lapland-Kola orogen in the northern Fennoscandian shield derived from P- and S- wave velocity models of POLAR and HUKKA wide-angle reflection and refraction profiles and FIRE4 reflection tr

- Korja, A., Heikkinen, P. and Roslov, Y.: North European Transect
- Korja, A., Lahtinen, R., Nironen, M. and Heikkinen, P.: Seismic images of the Svecofennian accretioary orogen
- Kozlovskaya, E., Janik, T. and Heikkinen, P.: Petrological crust-mantle boundary vs. seismic Moho in the central Fennoscandian Shield: constraints from collocated wide-angle and near-vertical seismic profiles
- Kukkonen, I., Kuusisto, M., Lehtonen, M. and Peltonen, P.: Delamination of eclogitized lower crust: Control on the crust-mantle boundary in the central Fennoscandian shield
- Majdański, M., Grad, M., Guterch, A. and SUDETES Working Group: The structure of the crust and the upper mantle in the northern Bohemian massif and Sudetes based on data from seismic experiment SUDETES 2003
- Schijns, H., Schmitt, D., Heikkinen, P. and Kukkonen, I.: An anisotropic velocity model from VSP measurements in the ICDP outokumpu scientific drillhole, Finland
- Silvennoinen, H., Kozlovskaya, E., Yliniemi, J., Tiira, T. and FIRE Working Group: Interpretation of wide-angle reflection and refraction recordings of Vibroseis signals and 3-D gravity modelling along FIRE4 profile, northern Finland
- Uski, M., Sahala, K. and Korja, A.: Phase amplitude ratio method in constraining source parameters of small earthquakes (poster)
- Uski, M., Tiira, T., Grad, M. and Yliniemi, J.: Crustal structure of the Finnish part of the Archean Karelian craton
- European Seismological Commission, 31st General Assembly, September 7 – 12, Crete, Greece**
- Grad, M., Tiira, T. and ESC Working Group (incl. Komminaho, K. and Kortström, J.): European Plate Moho Depth Map
- Heikkinen, P., Kukkonen, I.T., Suleimanov, A. and Zamoshnyaya, N.: Seismic Image of the Fennoscandian Shield Along the Baltic Sea - White Sea Transect (poster)
- Tatevossian, R. and P. Mäntyniemi: Did more than one earthquake occur in NE Europe in the spring/summer of 1626?
- Pangeo 2008, September 22-25, 2008, Vienna, Austria**
- Behm, M., et CELEBRATON 2000, ALP 2002, SUDETES 2003 Working Groups (incl. K. Komminaho and T. Tiira): Poisson's ratio of the crust and Moho structure from shear wave analyses in the Eastern Alps and their surroundings
- Brückl, E., Lippitsch, R., Mitterbauer, U., et ALPASS working groups (incl. K. Komminaho and T. Tiira): Alpass - Teleseismic tomography of the Eastern Alps
- Grad, M., Brückl, E., Guterch, A., Behm, M., Šumanovac, F., et POLONAISE97, CELEBRATION 2000, ALP 2002, SUDETES 2003 Working Groups (incl. K. Komminaho and T. Tiira): Huge seismic

experiments in Central Europe - lithospheric structure between Eastern Alps, Dinarides and Bohemian Massif (poster)

Hausmann, H., Hoyer, S., Schurr, B., Brückl, E., Houseman, G., et ALPASS and CBP Working Group (incl. K. Komminaho and T. Tiira): Erfassung der Seismizität des Wiener Beckens durch die temporären Netzwerke Alpass und CBP (poster)

Analyst Seminar, Institute of Seismology and Geological Survey of Estonia, October 8-9, Tallinn, Estonia

Heinonen, S.: High resolution reflection seismic data from Outokumpu

Kortström, J., Karkkulainen, K. and Valtonen, O.: Experiences of using the new Geotool++

Malm, M.: Impact crater research with seismic methods

Valtonen, O.: Seismic anisotropy

LITHOSPHERE 2008 – Fifth Symposium on the Structure, Composition and Evolution of the Lithosphere in Finland, November 5-6, 2008, Oulu, Finland

Heikkinen, P.J., Kukkonen, I.T., Suleimanov, A. and Zamoshnyaya, N.: Seismic image of the Fennoscandian Shield along the Baltic Sea - White Sea Transect

Heinonen, S., Schjins, H., Schmitt, D., Heikkinen, P. and I. Kukkonen, I.: Processing of high resolution reflection data of Outokumpu (poster)

Hyvönen, T., Tiira, T., Valtonen, O., Korja, A. and Komminaho, K.: Indications of seismic anisotropy in the crust of the central Fennoscandian Shield (poster)

Korja, A., Heikkinen, P.J., Roslov, Y., Ivanova, N., Verba, M. and Sakoulina, T.: North European Transect - a preliminary compilation (poster)

Korja, A., Kosunen, P. and Heikkinen, P.J.: Lateral spreading of the Svecofennian Orogen

Koskinen, P. and Valtonen, O.: Solid earth geophysics field course 2007 (poster)

Kozlovskaya, E., Janik, T., Yliniemi, J. and Heikkinen, P.: Petrological crust-mantle boundary vs. seismic Moho in the central Fennoscandian Shield: constraints from collocated wide-angle and near-vertical seismic profiles (poster)

Kozlovskaya, E., Silvennoinen, H., Jämsen, T. and POLENET / LAPNET Working Group (incl. P.Heikkinen): POLENET/LAPNET - a multidisciplinary seismic array research in northern Fennoscandia (poster)

Malm, M., Pesonen, L.J. and Heikkinen, P.J.: Seismic Research of Impact Craters and the Seismic Velocity Analysis of the Keurusselkä Impact Structure, Central Finland (poster)

Silvennoinen, H., Kozlovskaya, E., Yliniemi, J. and Tiira, T.: Interpretation of wide-angle reflection and refraction recordings of Vibroseis signals and 3D gravity modelling

along FIRE4 profile, northern Finland

Uski, M., Sahala, K. and Korja, A.: Phase amplitude ratio method in constraining the source parameters of a small earthquake (poster)

Third Operation and maintenance workshop (CTBTO), November 10-14, 2008, Vienna, Austria

Lindblom, P.: Relative noise level within an array used as an indicator to reveal site specific quality problems

Congress of the International Polar Year 2007/08, November 12-13, 2008, Espoo Finland

Korja, A., Heikkinen, P.J., Roslov, Y., Ivanovna, N., Verba, M., and Sakoulina, T.: North European Transect

Kozlovskaya, E., Silvennoinen, H., Jämsen, T. and POLENET/LAPNET Working Group (incl. P.J. Heikkinen): POLENET/LAPNET – a multidisciplinary seismic array research in northern Fennoscandia

AGU Fall Meeting, December 15-19, 2008, San Francisco, USA

Heinonen, S.E., Schijns, H., Schmitt, D.R., Heikkinen, P.J., Kukkonen, I., and Duo, X.: Processing of high resolution seismic reflection data of Outokumpu, Finland (poster)

Schijns, H., Duo, X., Heinonen, S., Schmitt, D.R., Kukkonen, I. and Heikkinen, P.: Multi-azimuth Anisotropic Velocity Measurements in Fractured Crystalline Rock From the International Continental Drilling Program Outokumpu Borehole, Finland (poster)

11 Papers

11.1 Articles in refereed journals

Grad, M., Brückl, E., Majdanski, M., Behm, M., Guterch, A., and CELEBRATION 2000 and ALP 2002 Working Groups (incl. Komminaho, K. and Tiira, T.), 2008. Crustal structure of the Eastern Alps and their foreland: seismic model beneath the CEL10/Alp04 profile and tectonic implications. *Geophys. J. Int.*, Accepted 2008 November 27.

Korja, A. and Heikkinen, P.J., 2008. Seismic images of Paleoproterozoic microplate boundaries in the Fennoscandian Shield, in: Condie, K.C. and Pease, V., eds., *When Did Plate Tectonics Begin on Planet Earth?* Geological Society of America Special Paper 440, 229-248.

Kukkonen, I.T., Kuusisto, M., Lehtonen, M. and Peltonen, P., 2008. Delamination of eclogitized lower crust: Control on the crust-mantle boundary in the central Fennoscandian shield. *Tectonophysics*, 457, 111-127.

Mäntyniemi, P., 2008. Earthquake of 4 November 1898 in northern Europe: New insights. *Journal of Geophysical Research*, VOL. 113, B11303, doi: 10.1029/2007JB005461.

Plomerová, J., Babuška, V., Kozlovskaya, E., Vecsey, L. and Hyvönen, L.T., 2008. Seismic anisotropy – A key to resolve fabrics of mantle lithosphere of Fennoscandia. *Tectonophysics*, 462, 125-136.

Wilde-Piórko, M., Geissler, W.H., Plomerová, J., Grad, M., Babuška, V., Brückl, E., Cyziene, J., Czuba, W., England, R., Gaczyński, E., Gazdova, R., Gregersen, S., Guterch, A., Hanka, W., Hegedus, E., Heuer, B., Jedlicka, P., Lazauskiene, J., Keller, G.R., Kind, R., Klinge, K., Kolinsky, P., Komminaho, K., Kozlovskaya, E., Krüger, F., Larsen, T., Majdanski, M., Málek, J., Motuza, G., Novotný, O., Pietrasiak, R., Plenefisch, Th., Ružek, B., Sliampa, S., Sroda, P., Swieczak, M., Tiira, T., Voss, P. and Wiejacz, P., 2008. PASSEQ 2006–2008: Passive seismic experiment in Trans-European Suture Zone. *Zeitschrift Studia Geophysica et Geodaetica*. Volume 52, Number 3, 439-448. doi:10.1007/ s11200-008-0030-2.

11.2 Congress publications and reports

Brückl, E., Behm, M., CELEBRATION 2000, ALP 2002 and ALPASS Working Groups (incl. Komminaho, K. and Tiira, T.), 2008. Crustal structures and tectonic processes in the Eastern Alps revealed by recent controlled source seismic experiments. Invited Lecture at Centenary Conference ELGI, Budapest 28th February 2008. Extended abstract, 10 p.

Heikkinen, P., Kukkonen, I. T., Kuusisto, M. and Heinonen, S. (Eds.), 2008. *The 13th International Symposium on Deep Seismic Profiling of the Continents and Their Margins*, Abstracts, Saariselkä, Finland, 8 – 13 June 2008. Institute of Seismology, University of Helsinki, Report S-50, 76 p.

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- Heinonen, S., Schjins, H., Schmitt, D., Heikkinen, P. and I. Kukkonen, 2008. Processing of high resolution reflection data of Outokumpu. In: Korja, T., Arhe, K., Kaikkonen, P., Korja, A., Lahtinen, R. and Lunkka, J.P. (Eds.), 2008. *Lithosphere 2008 – Fifth Symposium on the Structure, Composition and Evolution of the Lithosphere in Finland. Programme and Extended Abstracts*, Oulu, Finland, November 5-6, 2008. Institute of Seismology, University of Helsinki, Report S-53, 17-20.
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12 Memberships in scientific organizations

Heikkinen, Pekka	European Seismological Commission Representative of Finland IASPEI / Finnish National Committee chairman ILP / National Committee chairman IUGG / National committee member MATINE (Scientific Advisory Board for Defence, Regional monitoring division) vice chairman
Korja, Annakaisa	ILP/ Finnish National Committee secretary Nordforsk – Advanced studies in seismological studies in Nordic countries coordinator IODP/ESSAC alternate member IODP/Finnish National Support Group member Nordisk Vulkanologisk Institut (NORDVULK) alternate board member Coordination group of the Antarctic research member Geophysica member of the editorial board
Kortström, Jari	ORFEUS working group on BB siting and station standards member
Uski, Marja	MATINE (Scientific Advisory Board for Defence, Regional monitoring division) member

13 Teaching

Members of the staff have given lectures and supervised students in seismological MSc- and PhD- theses at the Division of Geophysics of the Department of Physical Sciences and at the Department of Geology. The teaching is supported by the use of seismic data collected at the Institute. The Institute has actively supported the students of geophysics and geology in their studies and theses. In addition, students have been working as trainees at the Institute in analysis work and research projects.

<u>Course</u>	<u>Lecturer</u>
Seismic waves	Pekka Heikkinen
Earthquake seismology	Päivi Mäntyniemi
Tectonics	Annakaisa Korja
Lithosphere geophysics	Pekka Heikkinen, Tellervo Hyvönen and Annakaisa Korja

Theses in 2008

Päivi Mäntyniemi, PhD	Macroseismology as a component of seismicity assessments in an intraplate region: studies of Northern Europe with emphasis on Finland (opponent: Peter Labák, Slovak Academy of Sciences, Slovakia)
Tellervo Hyvönen, PhD	Seismic tomography and earthquake mechanism beneath the Central Fennoscandian Shield (opponent: Søren Gregersen, Geological Survey of Denmark and Greenland, Denmark)

Suvi Heinonen, MSc
Kati Karkkulainen, MSc
Johanna Keskinen, MSc
Antti Lakio, MSc
Harri Majjanen, MSc
Elisa Rautioaho, MSc

Marianne Malm, BSc

Doctoral theses in preparation

Suvi Heinonen:	Application of reflection seismics to ore exploration (University of Helsinki, Supervisors: Pekka Heikkinen, Ilmo Kukkonen and David Snyder)
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Marja Uski:	Source parameters of seismic events in the Fennoscandian Shield (University of Helsinki, Supervisor: Annakaisa Korja)
Henna Valpu:	Amplitudes, rates, and mechanisms of sea level change in the past (New Jersey Shallow Shelf) (University of Oulu, Supervisors: Annakaisa Korja and Kari Strand)
Kaisa Wanne:	The Svecofennian post-orogenic extension - a geological, geophysical and experimental approach (University of Turku, Supervisors: Annakaisa Korja and Timo Kilpeläinen)

14 Information services

The Institute of Seismology provides information to the general public and mass media on significant seismic events. Several TV-, radio- and newspaper interviews were given during the year. The aim is to give rapid and reliable information on the size, location and other relevant data about such events. The scientists of the Institute have given popular presentations on earthquakes and seismicity.

The personnel of the Institute were informed of current events and issues by e-mail, at staff meetings and informal gatherings.

Acronyms

AAL	Seismic station, Åland
AGU	American Geophysical Union
BABEL	Baltic and Bothnian Echoes from the Lithosphere
CTBT	Comprehensive Test Ban Treaty
CTBTO	Comprehensive Test Ban Treaty Organization
ECEES	European Conference on Earthquake Engineering and Seismology
ECORD	European Consortium for Ocean Research Drilling
EGU	European Geosciences Union
ESC	European Seismological Commission
EMSC	European-Mediterranean Seismological Center
ESF	European Science Foundation
EUROBRIDGE	EUROPROBE project
EUROPROBE	Research program of ESF
FINES	Regional seismic array, Sysmä
FIRE	Finnish Reflection Experiment
GGT	Global Geotransects
HEF	Seismic station, Enontekiö
HIRE	High Resolution Reflection Experiment - Project
IASPEI	International Association of Seismology and Physics of the Earth's Interior
IDC	International Data Center (CTBTO)
ILP	International Lithosphere Program
IRIS	Incorporated Research Institutions for Seismology
IUGG	International Union of Geodesy and Geophysics
IMS	International Monitoring System (CTBTO)
IODP/ESSAC	Integrated Ocean Drilling Program/ECORD Science Support and Advisory Committee
IODP/iSSP/ECORD	Integrated Ocean Drilling Program/intermit Site Survey Panel/ European Consortium for Ocean Research Drilling
ISC	International Seismological Center
IUGG	International Union of Geodesy and Geophysics
JOF	Seismic station, Ilomantsi
KAF	Seismic station, Kangasniemi
KEF	Seismic station, Keuruu
KEV	Seismic station, Kevo
KIF	Seismic station, Kilpisjärvi
KJN	Seismic station, Kajaani
KU4	Seismic station, Kuusamo
MATINE	Maanpuolustuksen tieteellinen neuvottelukunta (Scientific Advisory Board for Defence)
MEF	Seismic station, Kirkkonummi
MSF	Seismic station, Kuusamo
NARS	Network of Autonomously Recording Seismographs

NEIC	National Earthquake Information Center, USA
NORSAR	Norwegian Seismic Array
NUR	Seismic station, Nurmijärvi
OSI	On-site inspection (CTBTO)
OUL	Seismic station, Kiiminki
ORFEUS	Observatories and Research Facilities for European Seismology
PTS	Provisional Technical Secretariat (CTBTO)
PVF	Seismic station, Pernaja
RAF	Seismic station, Laitila
RAS	Russian Academy of Sciences
SGF	Seismic station, Sodankylä
SGU	Geological Survey of Sweden
SUF	Seismic station, Sumiainen
SVEKALAPKO	EUROPROBE project
UH	University of Helsinki
VAF	Seismic station, Ylistaro
VSU	Seismic station, Vasula, Estonia
VJF	Seismic station, Virolahti
VRF	Seismic station, Värriö
WGB	Working Group B of CTBTO

Appendix: R-Reports (Bulletins) in 2008

- M. Uski and M. Franssila, 2008. Seismic events in northern Europe, June 2007. University of Helsinki, Institute of Seismology, Report R-251 (www.seismo.helsinki.fi/bulletin/list/pdfbulletin200706.pdf), 227 p.
- M. Uski and L. Vasamies-Leppänen, 2008. Seismic events in northern Europe, July 2007. University of Helsinki, Institute of Seismology, Report R-252 (www.seismo.helsinki.fi/bulletin/list/pdfbulletin200707.pdf), 205 p.
- M. Uski and M. Franssila, 2008. Seismic events in northern Europe, August 2007. University of Helsinki, Institute of Seismology, Report R-253 (www.seismo.helsinki.fi/bulletin/list/pdfbulletin200708.pdf), 240 p.
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- M. Uski and L. Vasamies-Leppänen, 2008. Seismic events in northern Europe, October 2007. University of Helsinki, Institute of Seismology, Report R-255 (www.seismo.helsinki.fi/bulletin/list/pdfbulletin200710.pdf), 258 p.
- M. Uski and M. Raime, 2008. Seismic events in northern Europe, November 2007. University of Helsinki, Institute of Seismology, Report R-256 (www.seismo.helsinki.fi/bulletin/list/pdfbulletin200711.pdf), 271 p.
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