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Summary

The SIL project is a cooperative Nordic project for earthquake prediction research in the earthquake-prone area of the South Iceland Lowland (SIL). Scientists and technical engineers from all the Nordic countries have cooperated on this project since 1986 and came to a formal end on November 21, 1995. The real start of the project was after its funding was secured in 1988. The project was financially supported by the Nordic Council of Ministers, by the Science Foundations of Denmark, Norway and Sweden and the Government of Iceland.

The basic idea behind the SIL project was to study and monitor the physical processes leading to earthquakes. It was concluded that small earthquakes would carry the most significant information about crustal processes in the focal regions of large earthquakes. Small earthquakes (microearthquakes) occur very frequently in earthquake zones. So if it would be possible to extract information from them, an almost continuous information would be gained about the stress conditions in the crust. Therefore the main objective of the SIL project was to create a seismic acquisition and evaluation system which in real-time would evaluate information carried by small earthquakes to discover if stresses were changed, if faults were moved or other possible changes premonitory to earthquakes.

The main results of the SIL project can be summarized as follows:

1) An automatic seismic acquisition and evaluation system was successfully developed and has been in automatic operation since July 1991. This system automatically locates earthquakes within minutes of their occurrence and provides increasing amount of information of crustal processes related to the occurrence of the earthquakes. Since the autumn of 1992 an alert system has been in operation which provides information about changes in earthquake activity. The SIL system which was developed on basis of 8 seismic stations in South Iceland is now covering almost all of the plate boundary in Iceland, presumably with 33 SIL stations at the end of 1996. The SIL system is widely known as being in the forefront in the world in processing information carried by microearthquakes. Besides being of a scientific value the SIL system is already a practical tool for mitigating seismic and volcanic risk in Iceland.

2) It has been shown that small earthquakes reflect tectonic processes. Small earthquakes can be used for exact mapping of active faults in the crust and the movements along these faults. They can be used for observing stresses and stress changes.

3) The technology developed parallel with the SIL system has opened various applications for the SIL network. The quality of the system to trace active faults at depth can be applied in monitoring the effects of thermal energy excavation from depth and for finding water-carrying veins at depth. The system is now a basis for developing a new portable seismic system in Sweden.

4) The SIL project and the SIL system are the main pillars of a new EC project, Earthquake Prediction Research in a Natural Laboratory (PRENLAB). It is a project of 6 European countries and it is in many ways a continuation of the SIL project.
Earthquake prediction is one of the most pressing challenges of geosciences, i.e. to know where a dangerous earthquake will strike, how it will strike and when. The SIL project has paved the road for earthquake prediction research in Iceland and is a significant contribution of the Nordic countries to other earthquake-prone countries of the world.
1 The background of the SIL project

The general objective of the SIL project is a concerted research effort among the Nordic countries towards earthquake prediction and mitigation of earthquake risk in the earthquake-prone area of the South Iceland Lowland (SIL).

In a letter to the Nordic Council of Ministers dated November 3, 1986, 8 Nordic scientists applied for funds to carry out the project which was thoroughly described in the report Seismiskt datamålingssystem för Södra Islands Lågland (Stefánsson et al. 1986).

However, the discussions for a Nordic earthquake prediction research proposal started much earlier. Its origin was in an ad hoc committee (CAHRT) set up in 1980 by the Council of Europe. The objective of CAHRT was to create an European earthquake prediction program. In the resolution of the committee, special emphasis was placed on concerted research efforts in five so-called test areas, among them the South Iceland Lowland, which is cut through by the South Iceland seismic zone. Following these recommendations the chairmen of CAHRT, Luis Mendes-Victor from Portugal and Ola Dahlmann from Sweden visitied Iceland on behalf of the committee and stressed the importance of Iceland as a test area in their report (Dahlmann and Mendes-Victor 1983).

During a meeting of Nordic seismologists, i.e. at the 15th Nordic Seminar on Detection Seismology in Tällberg, Sweden, in 1984, concerted Nordic efforts for creating a prediction research program based on South Iceland Lowland as the test area was discussed and a group emerged to specify a project which could provide the necessary background for an application to the Nordic Council of Ministers. The next step was a meeting of a group of seismologists and engineers in Oslo in April 1986 which laid the basis for the report and the application as mentioned above to the Nordic Council of Ministers in November 1986.

2 The basic objectives of the SIL project

The main objective of the project was outlined in the report as follows:

"This earthquake monitoring project aims to reduce losses due to damaging earthquakes, primarily by achieving a deeper understanding of where and when great earthquakes can occur. It is our judgement that the best results can be achieved by acquiring a knowledge of the physics and dynamics of the crustal deformations taking place in the region. The acquisition of such knowledge and its use for earthquake risk assessment by deterministic modelling of the dynamics of the area, will result in scientific advancement of general interest and of value to other earthquake-prone regions of the world.

The physics of crustal deformation processes will therefore be one of the main targets in this project."
It was stated that the study of frequently occurring microearthquakes was of central importance for understanding the physics of the earthquake source zones, and by their frequency they would give a semicontinuous record of changes in the regions of possible large earthquakes. It was stated on the basis of some experience from microearthquake studies in Sweden and Denmark that earthquakes down to magnitude 1 may be related to regional tectonic stress fields and this indicated that data extracted from microearthquakes give direct information about ongoing crustal deformations that may be the same process that produces damaging earthquakes.

Therefore, the creation of and installation of a data acquisition system capable of collecting and evaluating high-quality seismic data from microearthquakes was proposed. To be able to cope with the enormous amount of information carried by microearthquakes, the evaluation had to be automatic, making use of the fast development in modern computer techniques leading to very powerful and cheap computers on the mass market. The new system should also be a semi-real-time system so that the information carried by the microearthquakes could be used for warning purposes, as the microearthquakes would in many cases be the first indication about changes in and near the source region.

Besides the creation of the acquisition system, a minor request for research was included in the application to the Nordic Council of Ministers. This was mainly thought of for a research fellowship, i.e., a researcher from outside Iceland who would help to bring to Iceland relevant knowhow and experience from the other Nordic countries. This was modified later, and in the "Second general report" (Stefánsson et al. 1989) is written about how to use the research part of the fund: "Research which in first hand has the objective to improve the parameter settings of the system and to collect and prepare high-quality data on earthquakes and earthquake-related phenomena".

The total amount of money applied for to the Nordic Council of Ministers was 6.9 MSEK for a 5-6 years project aiming at creating a seismic acquisition and evaluation system. The cost applied for included initial cost for equipment for 8 SIL stations in the South Iceland Lowland and the SIL center at the Icelandic Meteorological Office, and for a 5 years project and system operation. Of these 6.9 MSEK, 0.9 MSEK were allocated to research mainly aimed at system development.

The idea was that the scientific objectives of the project should be achieved in first hand through creating high-quality data for further research.
3 The design objectives of the SIL network

The design objectives of the SIL network have basically been described (Boðvarsson 1988a; Stefánsson et al. 1989). The basic design criteria can be summarized as follows:

1. To collect wide dynamic range of earthquake data with sensitivity down to magnitude zero.

2. Sampling rate of 100 samples/sec and 1 ms clock accuracy for good resolution of the high frequency local earthquakes.

3. To take advantage of the modern relatively cheap computer technology available on the market to create a system based on much computer power at the station sites, i.e., high level evaluation at the remote sites. The main reason for this was the objective to create a system which would be cheap in operation, i.e., to save money on data transfer, without losing data from earthquakes with significant information, which means to keep the sensitivity such that earthquakes down to magnitude zero would be recorded. Another reason for having much computer power at the site stations was to make it easy to attach other sensors to the system to monitor other earthquake related geophysical data.

4. To follow intensively changes in ongoing deformation processes, by fast automatic evaluation of data. To reveal in semi-real-time as much information as possible from microearthquake recordings as well as from other available geophysical recordings about processes which could be precursory to earthquakes.

4 The main achievements of the project

The main achievements of the SIL project can be summarized as follows:

A seismic acquisition and evaluation system has been created and operated which renders in semi real-time (a few minutes off real-time) information about locations and a multiplicity of source parameters of at least, according to experience, 1000 earthquakes per day. The system to some extent collects data from other geophysical sensors. The system also now collects automatically teleseismic data of significance for those who are working on global tomography.

The system renders in real-time (within seconds) information of site station evaluations of great value for alert purposes.

An alert system has been built on the top of the SIL evaluation system which is now the main alerting system in Iceland concerning seismic and volcanic activity.

The significance of the system for risk mitigation is twofold. Firstly the early information and alerting capabilities of the system and secondly the existing
capabilities and the potential capabilities of the system for mapping subsurface faults and fault instability.

Significant scientific outcome of the project are both based on direct scientific work within the project as well as on work carried out on basis of evaluated data from the SIL system.

It is a significant achievement of the SIL project that 18 stations in Iceland are operated from the SIL center at the end of 1995, compared to the 8 in the original project. During 1996 15 new permanent stations are presumed to be installed in the SIL system.

The installation cost for the 25 stations already in operation or planned, in addition to the original SIL stations, is estimated 4 MSEK. The yearly operation cost of the additional stations is 1200 KSEK. Most of this contribution stems from the recognition of the significance of the system for mitigating seismic and volcanic risk, and the significance of the system towards earthquake prediction and risk mitigation. Some of the contribution stems from the significance of the system for scientific work in general, especially studies of faults, stresses and tomography.

It is a significant achievement of the SIL project that the research project "Earthquake Prediction Research in a Natural Laboratory" (Stefánsson 1995) has now been promised 500.000 ECU, i.e. 4.3 MSEK. It is a two years project and it is a continuation of the SIL project and based on its achievements. Of this amount 55% will be entirely devoted to research projects based on data from the SIL system. The other 45% go to projects that are closely related to the SIL project and to the SIL system achievements.

4.1 The SIL system achievements

For information on the SIL system achievements and facilities, see the following reports and other publications: Stefánsson et al. 1993, 1995; Böðvarsson 1996; Böðvarsson & Rognvaldsson 1992; Böðvarsson et al. 1996; Slunga et al. 1994b and the attached documentation.

The outcome of the SIL project can be summarized as follows:

1 The SIL system was in partial operation from the autumn of 1990, and in full operation since the end of 1990. From July 1991 the system has been in full automatic operation. The system is very stable in operation and the up-times for individual site station operation is well over 95% of the time.

2 Automatic alert system based on central evaluation of a multiplicity of information (central alert) has been in practical operation since the autumn of 1992. It provides automatic alarm if certain parameters describing the situation within defined earthquake or volcanic zones are surpassed.
3 Station alert has been in operation since early 1995. It indicates increased noise, directivity and large earthquakes. It alerts within a few seconds. The station alert also includes strainmeters. The station alert is still more or less in a testing period and its practicability is so far not as much as the central alert.

4 The SIL system provides automatically and on a routine basis information on earthquakes, down to the sizes of microearthquakes which occur almost continuously. This is information on:

- Hypocenter locations
- Fault plane solutions
- Magnitudes based on maximum velocity amplitudes and moment magnitudes based on spectral amplitudes and focal mechanism
- Source parameters like corner frequency, radius of source, slip on the earthquake fault and stress drop in the earthquakes

5 Detection algorithms for safer detection of phases are under steady development, more accurate time picking and better characterizing. Neural network analysis is used in practice for distinguishing between P and S on the site stations. In preparation is to use on-line neural network analysis for more purposes, for example for picking polarities of phases.

6 Multievent analysis for very exact relative (10 meters) and absolute location of similar events is available in the system and used in mapping active minifaults and fault segments at depth and is the basis for inverting for the stress tensor. The multievent location analysis can now be run automatically on a daily basis. This has been done for testing purposes. The goal is to run this analysis on-line, as a part of the on-line automatic analysis.

7 There are several processes available at the SIL center for manual analysis and for reviewing the automatic analysis. Still there is a manual supervision and control of all the automatic analysis. This is done for safer results and for creating a better learning set for neural net analysis.

Among significant tools in the SIL center for manual analysis can be mentioned:

- OK: A tool for analysis of waveform data
- QUAKE-LOOK: A tool for recognizing and mapping active faults at depth

There are several tools available for displaying and following up seismic activity.

8 The experience with the SIL system indicates that the goal of a completely automatic source monitoring is within sight. This means that the automatic source monitoring is so good that little would be gained by transmitting the waveforms. This is of great significance for remote areas where the only communication might be satellite communication and for areas where seismicity is very high for example in volcanic areas or in the preparatory period of large earthquakes, in which cases manual interpretation is not practically possible in the given time space.

9 A “SIL User Manual” covering all the system is now available.
4.2 Scientific achievements

Some overview on the scientific achievements can be obtained in the following papers and reports: Stefánsson et al. 1993, 1995; Slunga et al. 1994b; Rögnvaldsson and Slunga 1994a; Böðvarsson 1996. The scientific outcome is to a large extent linked to the technical development as most of the research was as planned devoted to “improve the parameter settings of the system and to collect and to prepare high quality data on earthquakes and earthquake related phenomena”. Some significant scientific results will be outlined below.

1. With the good hypocenter locations achieved in the SIL system evaluation and the large amount of earthquakes monitored, a detailed picture of the seismicity of Iceland has emerged, significantly more detailed than earlier was possible to obtain.

2. By comparison between fault plane solutions of earthquakes evaluated by the SIL system it has been shown that microearthquakes express the regional stress field and known tectonic features. This is significant in light of the views that prevailed for a while among many seismologists that such information could not be read from microearthquakes.

3. Depth distribution of earthquakes in the South Iceland seismic zone is linked to stable motion at depth, and thus supports the existence of and contributes to the explanation of strain waves as a significant factor in variable seismic rate.

4. By a method of “multievent analysis of similar events” which has been developed and verified by using SIL data, exact locations and exact mapping of active fault segments have shown to be possible. The resolution is within tens of meters. This achievement has paved the road for application of the SIL system for monitoring the effects of extraction of hydrothermal energy from depth and for application of the SIL system for mitigating seismic risk. This also helps to invert fault plane solutions for stress tensor monitoring in seismic zones and also to improve crustal models.

5. It has been shown that it is possible with fully automatic processes and in real-time to obtain high level source information carried by microearthquakes. These automatic evaluation processes can be steadily enhanced to provide early signs of changes in the focal region of earthquakes, giving a better hope for detecting precursory changes.

6. Information of structural features are gradually emerging from evaluation of SIL data besides the information on faults and cracks. The existence of anisotropy expressed in S-wave splitting has been demonstrated. The velocity models have been refined on basis of information from microearthquakes recorded in the SIL system.

7. From observing seismic activity several examples have been seen of features expected or physically plausible in the preparatory period of intermediate size earthquakes. Among such features are quiescence, clustering and migration.
4.3 Achievements for risk mitigation

The achievements of the SIL project and of the SIL system for risk mitigation are manifold. Reports and articles include: Stefánsson et al. 1995; Stefánsson 1995; Rögnvaldsson and Björnsson 1995; Linde et al. 1993; Böðvarsson 1996. Some of the most significant are listed below.

1. The fast automatic recognitions and evaluations of weak earthquakes are of great significance for volcanic warnings and for giving early information of what is going on in earthquake-prone areas. The alert system which has been built onto the SIL system for taking advantage of these properties of the system are used in practice in Iceland for mitigating risk.

2. The possibility of detecting and mapping active faults at depth and stress tensor monitoring will become a significant contribution to hazard assessment. It will create a physical basis for understanding where fault will open to the surface in the next large earthquake. This is among the most challenging goals of seismology. The potential destruction near open faults is usually by far the most severe.

3. The SIL system capabilities have found new applications for monitoring the environmental effects of water and energy extraction from hydrothermal areas and in general for understanding better the hydrothermal systems and for mitigating risks there.

4. Even if it cannot be claimed that earthquake prediction will be possible, generally speaking, the follow-up and the understanding of physical processes connected with deformation in earthquake-prone areas may lead to useful short term predictions. The SIL system can provide such information in real-time. This is also of significance after the start of large earthquake sequences, when it may be vital to know what happens next.

5 The SIL steering committee, overview of activities

In a letter to the Nordic Council of Ministers dated November 3, 1986 the following 8 Nordic scientists applied for funds to carry out the SIL project:

- Hilmar Bungum, NORSAR, Kjeller, Norway
- Reynir Böðvarsson, Uppsala University, Sweden
- Páll Einarsson, University of Iceland, Reykjavík, Iceland
- Jørgen Hjelme, KMS Office of Seismology, Copenhagen, Denmark
- Eystein Husebye, University of Oslo, Norway
- Heikki Korhonen, University of Helsinki, Finland
- Ragnar Shinga, FOA, Stockholm, Sweden
- Ragnar Stefánsson, Icelandic Meteorological Office, Reykjavík, Iceland

These persons created a steering committee which had a meeting in Helsinki, October 3, 1987, coinciding with the meeting of the Nordic Seminar on Detection Seismology, an open Nordic group of seismologists which traditionally meets once a year in one of
the Nordic countries. From this on all steering committee meetings have coincided with the Nordic Seminars.

An executive committee was also created at the meeting in Helsinki for a more effective operation and for saving travel cost. It consisted of R. Stefánsson (chairman), R. Böðvarsson, J. Hjelme and E. Husebye. The executive committee held 5 meetings during 1988 and 1989, sometimes coinciding with the yearly meetings of the steering committee.

The executive committee held the following meetings:

- Copenhagen, January 12-13, 1988
- Copenhagen, July 11-12, 1988
- Reykjavík, September 10-12, 1988
- Bergen, February 13-14, 1989
- Sunne, September 24, 1989

At the SIL steering committee meeting in Sunne, September 28, 1989, the executive committee was dissolved.

As is explained elsewhere the 3 main financial pillars behind the project were:

Firstly a support of the Nordic Council of Ministers, secondly of the Research Councils of Sweden, Denmark and Norway for initial costs, development and research, and thirdly a support from the Icelandic Government (through Veðurstofa Íslands, the Icelandic Meteorological Office) for operation of the SIL project and of the emerging SIL system.

At an early stage a contract was signed between the Nordic Council of Ministers and Veðurstofa Íslands for the managing of the project and a contract was agreed between Veðurstofa Íslands and the SIL steering committee about a common responsibility for carrying through the project. In that agreement it was declared that Veðurstofa Íslands would provide localities for researchers devoted to work for the project.

Ragnar Stefánsson was elected project manager at the SIL steering committee meeting in Helsinki 1987 and Reynir Böðvarsson was elected to lead the technical development work.

Following steering committee meetings were held:

- Helsinki, October 3, 1987
- Oslo, October 6, 1988
- Sunne, September 28, 1989
- Copenhagen, October 3, 1990
- Reykjavik, June 12, 1991
- Espoo, September 4, 1992
- Bergen, June 18, 1993
- Stockholm, August, 1994
There was a change in the SIL steering committee, when Jens Havskov, University of Bergen, formally replaced Eystein Husebye at the steering committee meeting on June 12, 1991. Urmas Luosto replaced Heikki Korhonen at the meeting on June 18, 1993.

The staff members of the research unit of the Nordic Council of Ministers have always obtained information about the SIL steering committee meetings, but they have only once attended such a meeting, i.e. in Oslo in October 1988.

A more detailed description of the work carried out during the time of the SIL project can be found in the two major general progress reports (Stefánsson et al. 1986, 1989), and in the annual and the semiannual progress reports listed below.

The SIL project was originally planned as a 5-6 years project. After funding was secured the project could be started fully in 1988. The steering committee has continued its work even if the 5-6 years estimated project time has elapsed. The reason is that even if it can be claimed that the SIL project had fulfilled its original goals two years ago, the SIL system has been in steady development and the steering committee has considered it useful for the development to be able meet yearly for consultations.

The development of the SIL system has been both as concerns its acquisition and evaluation capabilities and as concerns its extensions exceeded by far its original scope. This extension and further development has in first hand been supported by Icelandic authorities, hazard defence and communities. All this support has been offered because of the risk mitigating capabilities of the SIL system. Thus the SIL steering committee has considered it to be its duty to continue while it was considered useful for the development.

One significant reason for not dissolving the SIL steering committee is that it is considered significant to document the SIL system as a whole and there are still some money left over to enhancing this documentation.

The "SIL User Manual" is available now. It contains all information needed for implementation and operation of a network utilizing the SIL concept. Recent documentation work, earlier reports and international publications with additions and modifications have been assembled in this manual. However, a software user manual is never complete. More work needs to be done on troubleshooting, operational examples and last but not least a detailed section on how to install and implement the SIL system at new sites. This section would include description of hardware, acquisition software and processing software ranging from phase detections to fault plane solutions.

6 Financial overview

The income and expenditure in the SIL project can be divided into two branches. In first hand the funds that were received and accounted for by Veðurstofa Íslands. An overview of income and expenditure is shown (Appendix 4) revised by the Icelandic State Revision. The other branch is the Institute of Geophysics, Section for Solid
Earth Physics, University of Uppsala. That institution received all the funds allocated from the Swedish Science Foundation (Naturvetenskapliga Forskningsrådet, NFR) for the SIL project, to be spent there for development work, supervised by the NFR (Appendix 5).

The total amount of the funds received by Veðurstofa Íslands for the project were ISK 40,056,824. The funds were received from the Nordic Council of Ministers and science foundations in Denmark and Norway, and the total amount also includes rent (Appendix 4). The amount of funds received by University of Uppsala was SEK 832,000 (Appendix 5).

Of the funds received by Veðurstofa Íslands ISK 38,571,630 were used for equipment and development work as specified in Appendix 4. This leaves ISK 1,485,194. At the final meeting of the SIL steering committee in Copenhagen, November 21, 1995, it was decided that all which was left over at the formal end of the SIL project should be used for necessary documentation of the SIL project and for reporting as said in minutes of the SIL steering committee meeting November 21, 1995 (Appendix 1) and the statement of the SIL steering committee (Appendix 2). Appendix 3 contains a signed declaration of Reynir Böðvarsson and Ragnar Slunga about the formal ownerships of the software which is used in the system.

From the beginning of the SIL project the Icelandic Government has provided the funds for operation, including of course significant part of the development. The yearly cost of operation was during the time period from 1987-1992 as is shown in Table 1. After late 1992 the SIL network started to be extended very fast and the involvement of the Icelandic state increased.

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<th>Year</th>
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<tr>
<td>1988</td>
<td>3,705,585</td>
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<td>1989</td>
<td>4,908,769</td>
<td>(557 KSEK)</td>
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<td>1990</td>
<td>7,299,823</td>
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<td>1991</td>
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<tr>
<td>1992</td>
<td>8,496,287</td>
<td>(856 KSEK)</td>
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</tbody>
</table>
7 List of publications related to the SIL project or based on SIL data

Atakan, K., B. Brandsdóttir, P. Halldórsson & G.Ó. Friðleifsson 1995a. Some comments on the local site effects: A case study from Iceland. In: Abstracts from the 18th European Regional Earthquake Engineering Seminar, September 4-8, 1995, Lyon, France.


Husebye, E. 1988a. SIL project - event detection.

Husebye, E. 1988b. The SIL project - task inventory.


Vogfjörð, K.S. Use of secondary body phases in the SIL data swarms for determining the depth of earthquakes. Work in progress.
Minutes of SIL (South Iceland Lowland) steering committee meeting 21 NOV 1995.

Present were: Ragnar Stefansson, Steinunn Jakobsdottir, Reynir Bodvarsson, Ragnar Slunga, Conrad Lindholm, Pekka Heikkinen, Soren Gregersen and Niels Petersen from Nordisk Ministerraad, Forskningsafdelingen.

1. Ragnar Stefansson was elected chairman of the meeting.
Soren Gregersen was elected secretary of the meeting.

2. The meeting agenda was accepted.

3. The minutes of the previous steering committee meeting were handed out at the meeting. The most crucial point of the minutes was corrected to: The software implemented into the SIL system was discussed, and it was decided, that Reynir Bodvarsson and Ragnar Slunga should present a statement about the ownership/copyright in written form.

The statement, which was accepted with a small modification, is included with these minutes Appendix 1). It follows the decision of the previous steering committee meeting, that the software is available on a non-commercial basis, but implementation must be done in cooperation with the authors of the software.

4. A draft of the final progress report of the SIL project was handed out at the meeting. Comments by steering committee members will be taken into account until the end of the year 1995.

A SIL Users Manual was given to the SIL steering committee members. In the final report it is mentioned, that this manual is still in the process of improvement. It was decided that the remaining money of the common Nordic SIL project, 176,537 Danish Crowns, will be used for travel to the steering committee meeting in Copenhagen, and for further documentation (see the enclosed general statement of the closing of the common Nordic SIL project, Appendix 2).

A brochure of the SIL project was presented to the steering committee at the meeting.

5. The common Nordic SIL project is hereby decided closed and the steering committee is abolished. International cooperation around the SIL-network of seismographs is continued by some partners in a project funded by the European Union.

6. Reynir Bodvarsson acknowledged the good cooperation, which had prevailed in the common Nordic SIL project.

Soren Gregersen.
Updating the SIL software manual.

The SIL steering committee decided to commission to the Icelandic Meteorological Office to update and publish the SIL User Manual. The steering committee agreed to grant 103,800 Swedish Crowns for this purpose. This agreement is acknowledged by the Icelandic Meteorological Office. This updating and publishing must be finished by the end of 1996. The Icelandic Meteorological Office will deliver 10 copies of the updated manual and full accounting to the SIL steering committee at the latest by April 1 1997.

Final reporting.

A draft scientific report has been discussed. The final scientific report and the final accounting to be audited by the Icelandic state auditor will be sent to the organisations, who financed the project: The Nordic Council of Ministers and the national research foundations. The final scientific and financial reports will be delivered at the latest by April 1 1997.
APPENDIX 3

The formal ownerships of the software implemented into the SIL system.

The data acquisition software that has been implemented into the SIL system by Reynir Bodvarsson during support from NFR is according to present rules formally owned by Reynir Bodvarsson. Software developed during later phases of the project is not affected by these rules.

The software for seismological analysis that has been developed at the Swedish National Defence Research Institute and that has been implemented into the SIL system by Ragnar Slunga is formally owned by the Swedish National Defence Research Institute (FOA). Software specifically developed for the SIL project is not affected by these rules of FOA.

The SIL project and in the future the operators of the network (IMO) established by the SIL project have the right to use all of the implemented software.

If the software is to be implemented by IMO outside Iceland this should preferably be done in cooperation with the authors.

Uppsala Nov 16, 1995
Reynir Bodvarsson

Stockholm Nov 16, 1995
Ragnar Slunga


**Noter**

1) På grund af projektet var oprettet en valutabankkonto, da alle bidragerne i DKK er inset på kontoen. Indtægtsposter (bidrag) i opgørelsen er i IKK. Det samme gælder når bankkontoen er hævet til betalig af omkostninger. Som konsekvens er projektet's indtægter, som består af er bidrag samt renteindtægter med kursvingninger, summeret i én tal. På opgørelsestidspunktet er bankbeholdning i DKK 69.968, indtægtsført med hensyn til valutakurs maj ultimo 1996.

Den øverste tabell viser projektet's total intægter og den nedeste viser oprindelige bidrag samt renteindtægter. Indtægtsført bidrag samt renteindtægter

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<tr>
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<td>40.056.824</td>
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</tbody>
</table>

Oprindelig bidrag samt renteindtægter

| Nordisk Ministerråd | 3.000.000 DKK |
| Norges Almenvitenskabelige | 322.587 DKK |
| Kort og Matrikastyrelsen | 113.466 DKK |
| Geodædisk Institut | 485.333 IKK |
| Kort og Matrikalsstyrelsen | 884.127 IKK |
| Rentetilskrivning | 514.465 DKK |

2) Kontoen udstyr var bogført med moms total IKK 22.644.701, men momsbeløbet var refunderet IKK 2.092.219. Udstyret's nettobeløb er IKK 20.552.482.
### SIL projektet 1988 - 31. maj 1996

<table>
<thead>
<tr>
<th>Reslutatsopgørelse</th>
<th>Noter</th>
<th>Beløb i IKK</th>
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<tr>
<td><strong>Intægter</strong></td>
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<td>Bidrag og renteindtægter i alt</td>
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<td>40.056.824</td>
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<tr>
<td><strong>Udgifter</strong></td>
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<td>Lønomkostninger</td>
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<td>Specialistomkostninger</td>
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<td>Køb af tjeneste</td>
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<td>Rejseomkostninger</td>
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<td>Bygningsvarer</td>
<td>2)</td>
<td>814.296</td>
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<td>Udstyr</td>
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<td>Andet</td>
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<td><strong>Overskud</strong></td>
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### Balance

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<th>Aktiver</th>
<th>Passiver/egenkap</th>
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<td>Bankkonto</td>
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<td>Tilgodehavende hos Vejrinsitutet</td>
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<td>Egenkapital</td>
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<table>
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<th>Aktiver</th>
<th>Passiver/egenkap</th>
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<tr>
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<td>1.485.194</td>
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</table>

Omtående oplysningers rigtighed bekræfies.

RIGSREVISIONEN, den 12. juli 1996
P. r. v.

Sigurður Þórðarson

Sigurjón I. Haraldsson
APPENDIX 5
1996-03-15

UPPSALA UNIVERSITET
Institutionen för geofysik

Icelandic Meteorological Office
Att: Ragnar Stefansson
Bustadavegur 9
Reykjavik


Ingegerd Ohlsson
högsk sekre

REYNIR BÖDVARSSON

<table>
<thead>
<tr>
<th>Kontrakt</th>
<th>Projekt</th>
<th>Bidrag</th>
<th>Period</th>
<th>Disp tom</th>
<th>Kontonr</th>
<th>Anm</th>
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<tbody>
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<td>NFR G-GU 4601-106</td>
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