GeoWatch

June 2005, Issue 25

GeoSIG

Table of Contents

IA-1 Internet Accelerograph Is Now Available With 50 micro g Noise Floor

Introduction

The revolutionary Internet Accelerograph IA-1 is now optionally available with a remarkable noise floor of 50 µg with respect to its low cost and versatility.

As described in detail in GeoWatch 19 as well as fully documented on our web site, IA-1 introduces a perfect opportunity to implement high density monitoring networks. This fact is also demonstrated within a latest report, which is under preparation by Pacific Geoscience Center of GSC (http://www.pgc.nrcan.gc.ca/). A short preliminary summary from this report is presented below:

Internet Accelerographs produce largest strong motion single-event data set to date in British Columbia, Canada.

Two earthquakes of M_W 5.8 [M_L 5.5] and M_W 6.4 [M_L 6.1] occurred on the 15th and 19th of July 2004, respectively, approximately 30 km off the west coast of Vancouver Island. They were shallow strike-slip fault earthquakes (~12 km focal depth). Both earthquakes were felt across Vancouver Island and as far east as the Sunshine Coast (~200 km) and the greater Vancouver region (~300 km). The M_W 5.8 earthquake showed observable waveforms on 34 of 60 Internet Accelerograph instruments and triggered two non-communicating (stand alone) strong motion instruments. The M_W 6.4 earthquake showed observable waveforms on 41 of 60 Internet Accelerograph instruments and triggered three non-communicating strong motion instruments. The largest peak horizontal ground accelerations recorded were 6.19 cm/s^2 and 13.78 cm/s^2 for the M_W 5.8 and M_W 6.4 events, respectively.

Table 1. Details of the 15th and 19th July 2004 earthquakes:

Date and Time (UTC)		Lat (N)	Lon (W)	Depth (km)	M_W	M_L
15 July 2004	12:06:50	49.51	127.23	12	5.8	5.5
19 July 2004	08:01:46	49.41	127.30	12	6.4	6.1

In 2002, the GSC (Geological Survey of Canada) began the process of replacing non-communicating instruments in its existing strong motion network across southwestern British Columbia with Internet Accelerograph instruments that communicate in real-time over the Internet (Rosenberger et al., 2004). The instrument is equipped with solid-state micro electro mechanical (MEMS) acceleration sensors that have a dynamic range from below the felt level (0.5 mg) to 4g. An embedded computer controls data acquisition, computes continuous data streams of derivative ground motion parameters and provides full Internet connectivity for several standard protocols. Data are acquired and stored in a ring buffer, irrespective of whether an event is detected or not. The ring buffer has a capacity of about 1.5 days before older data are finally overwritten.

The ring buffer data can be directly retrieved over the Internet at any time. The instrument also triggers on signals that it recognizes as events and stores them separately. The GSC Internet Accelerographs employ a short-time-average, long-time-average (STA-LTA) ratio trigger algorithm. Short and long time intervals are typically set to 3-s and 9-s respectively and the threshold ratio is set from 1.8, for a very quiet station, to 4.5, for a station with frequent transient noise events. The instruments are typically installed at ground level or in the basement of a one or two storey building.

The M_W 5.8 and M_W 6.4 offshore Vancouver Island earthquakes have provided the largest acceleration data sets in South Western British Columbia to date, directly related to the installation of the Internet Accelerograph instruments. The ability to communicate with the IA instruments over the Internet provides rapid, easy, and inexpensive access to data. It also allows rapid determination of whether the instrument is on-line, which has been a problem in the past with the non-communicating instruments. Near real time reporting of *peak ground acceleration* (PGA), *velocity* (PGV) and *spectral intensity* (kSI) from the IA instruments has the potential to produce very rapid *Shake Maps* in the future. The ability of the Internet Accelerograph instruments to continuously record data provides recordings from low-level earthquake ground motion, whereas the older non-communicating instruments may not have triggered at the same location.

Sheri Molnar, Andreas Rosenberger

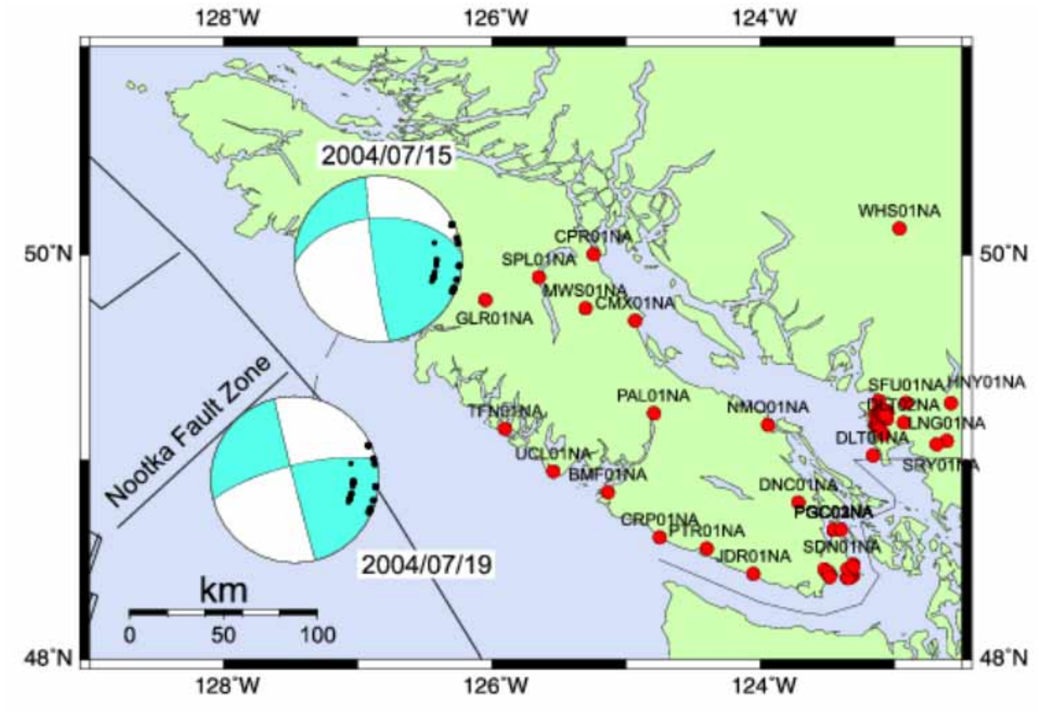

Figure 1. At the time of the earthquakes about 60 IA instruments were installed and operational in South-West British Columbia, Canada. Instrument locations are shown with red dots. The events were recorded by 34 (2004-06-15, M_W 5.8) and 41 (2004-06-19, M_W 6.4) IA instruments respectively. As of June 2005 about 80 IA s are installed and operational.

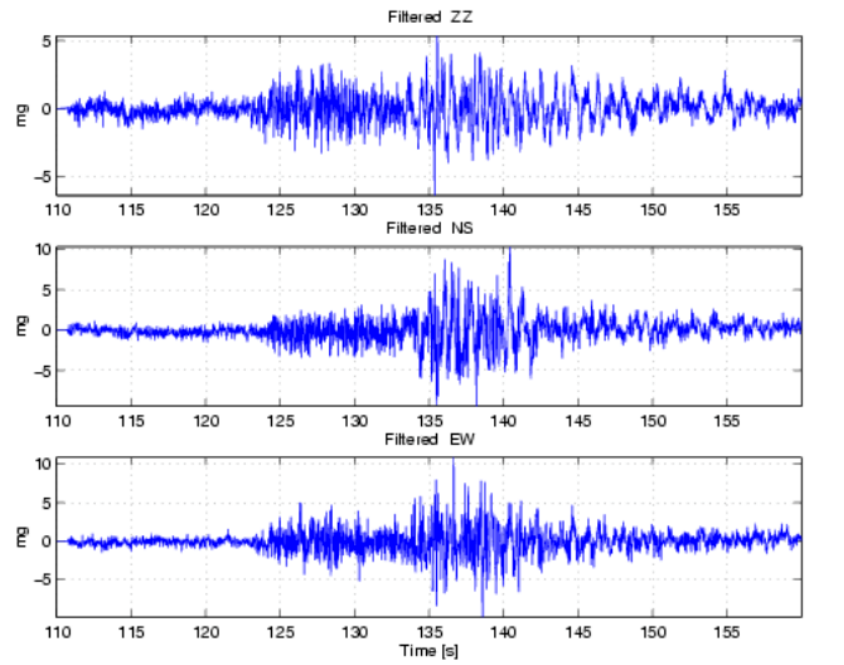

Figure 2. Three channel recording from an IA in Gold River, BC, Canada, about 120 km from the epicenter of the July 19, 2004, M_W 6.2 earthquake.

The Gold River IA instrument reported ground motion parameters over the Internet in a message shown below, 60 seconds after it was triggered by the seismic wave:

"GLR01NACN Mon Jul 19 08:02:14 2004 -Event parameters PGA 1.3989e-02, PGV 1.0867e-03, PGD 4.6815e-04, kSI 2.3899e-03". Values are with reference to 1g (~9.81 m/sec^2), spectral intensity (kSI) translates to about 1 cm/s in units of velocity.

Other IA instruments up to 250 km away from the epicenter sent similar reports.

Reference:

Rosenberger, A., K. Beverley, and G. Rogers, 2004. The new strong motion seismic network in southwest British Columbia, Canada, in *Proceedings of the 13th World Conference on Earthquake Engineering*, Vancouver, August, Paper #3373.

After the Tsunami Disaster,
A Proposal for Increasing Awareness and Preparedness Against Natural Disasters

Highlights

- National alarm system run by a national institution
- Interoperability with international alarm and warning facilities
- Based on existing and well known technology
- Lower-cost, Easier financing
- Shorter realization time
- Little administrative intervention
- Maximum efficiency and credibility
- Multiple utilization areas

Introduction

The December 26, 2004 Earthquake and Tsunami disaster have demonstrated that the countries in South East Asia with coastlines at the Indian Ocean are critically exposed to the earthquake hazard and associated risks, whereas they were ill prepared against such a phenomenon.

In any region around the world that is susceptible to such hazards, an increased public and governmental awareness has to be developed and related preventative measures have to be taken to improve the preparedness for the potential occurrence of such disasters in the future.

It can be considered that such a development and improvement effort is not trivial, if initiated to cover a region consisting of several countries, given the national, cultural and political diversity. Thus, if one wants to improve the awareness and preparedness of the government and the population, the only way will be through a national alarm system run by a national institution. The system then should run in co-ordination with international facilities.

Such an alarm system is a low-cost system compared to such as ocean wide tsunami alarm systems or multinational warning infrastructures, which require continuous international co-operation and intergovernmental agreements, whereas the proposed system can be installed within much shorter time and requires minimum administrative expenses and intervention.

We briefly emphasize in this GeoWatch, the critical issues and system components in realizing such a national system for one country, in the light of the broad experience GeoSIG Ltd. has gained through realizing such projects over the years.

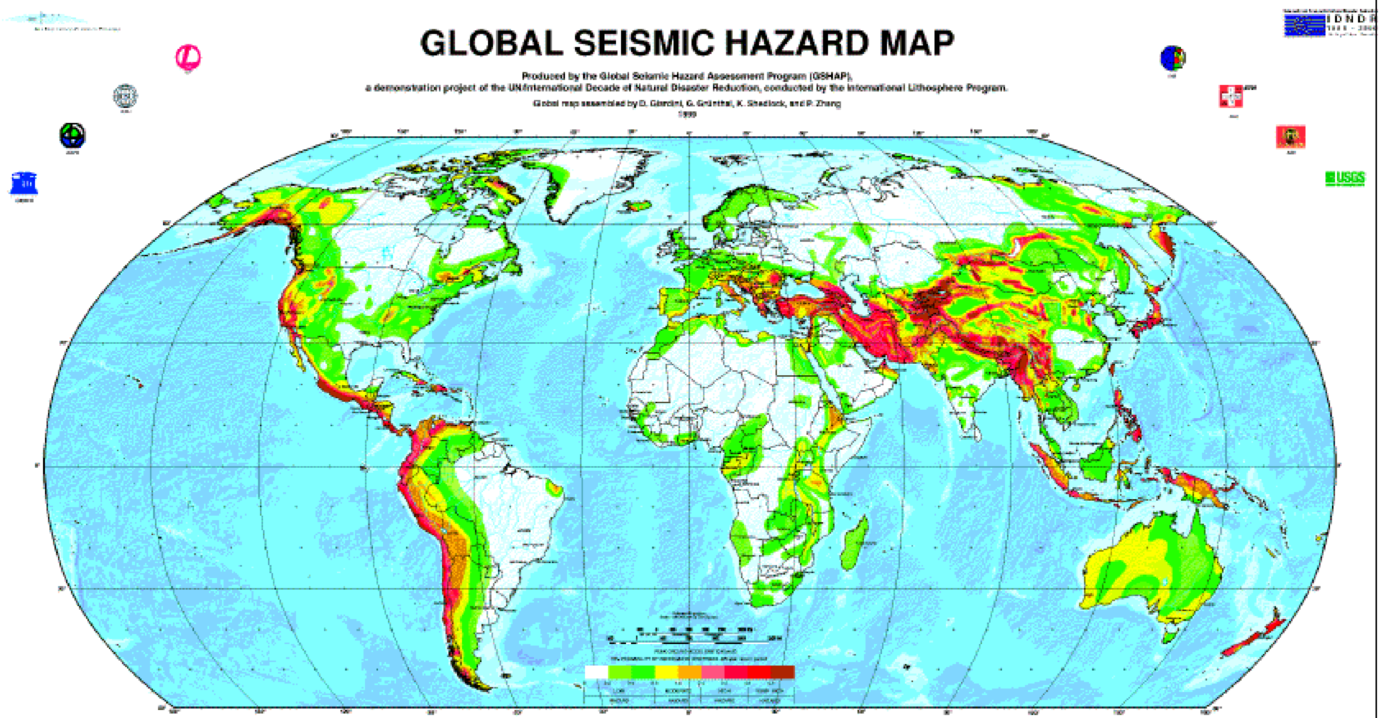

Figure 3. Seismic hazard predicted in terms of Peak Ground Acceleration [m/s2] with 10% probability of exceedance in 50 years, by the Global Seismic Hazard Assessment Program (GSHAP) in 1999.

Description

Country and Locations

The country, in which such an alarm system is to be deployed, has to be classified according to:

- Vulnerability (hazard assessment and risk analysis in relation to the monitored phenomenon, e.g. Figure 3)
- Capability (interested, dedicated and capable scientific and professional institutions and organizations)
- Infrastructure (reliable communication, broadcasting and transportation facilities)

The locations of monitoring stations should be identified according to the following site properties:

- Optimum distribution and placement (for better identification and representation of the expected ground motions)
- Remoteness, accessibility and security (isolated from noise and environmental effects, relatively easily reachable, well secured against tampering and intrusion)
- Reliable power and communication (robust power supply or solar power, backed up with battery, good reception of communication signal)

System and Operations

The system should consist of the topology illustrated in Figure 4, with the context described below:

Stations

The system should have an adequate number of stations equipped with strong motion and/or seismic sensors, digitizers and recorders as well as robust and redundant communication methods and links:

- Minimum 10 to 20 stations (depending on the area to be covered, and on the predicted vulnerability)
- Power autonomy and data storage minimum 48 hours (in case communication is interrupted, data should not be lost and be easily retrievable from the autonomously operating station manually)
- One on-line main communication method (e.g. GSM/SMS or satellite)
- One dial-up and provisional communication method (e.g. land line phone or radio telemetry)
- Continuous health checking (State of Health of each station is a critical issue in having reliable system response)

Management Center

The center should be designed and organized such that it has:

- Uninterrupted operability (fully autonomous power & communication, and structurally intact)
- Dedicated personnel (24 hours a day, 365 days a year)
- Controlled and monitored automatic operation (A fully automatic center is never a reliable solution, simplest methods work the best)
- Permanently open communication channels (redundant phone lines, antennas, etc)
- Broadcast to several types of media (TV, Radio, SMS, email, Fax, direct alarm / sirens, etc)
- Interaction with international organizations (to receive and transmit warnings and information and to promptly treat the incoming international data)

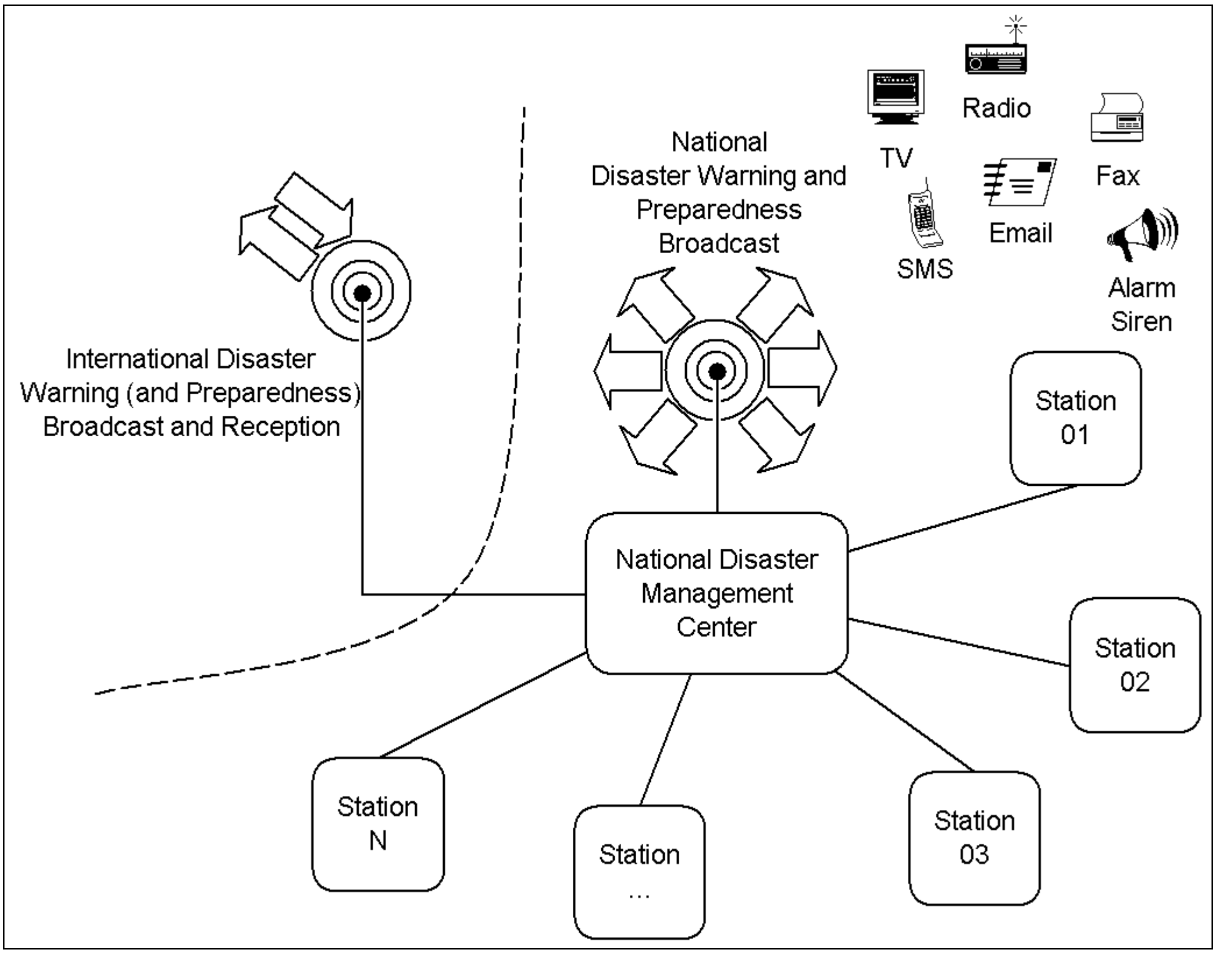

Figure 4. Proposed system topology.

Realisation and Operation

System development and realization require several tasks to be performed. A basic list of these tasks can be sorted by time as follows:

- Pre-study on Feasibility, Vulnerability and Optimization
- Obtaining legal permits, resolving official matters
- Design
- Site Preparation
- Production and testing
- Shipment, Installation and Commissioning
- Training and Supervision
- Servicing and Maintenance

Key Benefits and Facts

The main benefits and objectives of an alarm system are as follows:

- A well functioning alarm system strengthens credibility of the agencies and institutions in charge of the protection of the population, as well as the sponsors of such system.
- Building and developing awareness and preparedness against natural disasters require other social and political campaigns to be conducted in parallel with such an alarm system project.
- A prerequisite for an efficient alarm system is the strong will of an institution and the people to make it work.

- Timely warning allows minimizing the loss of lives and the number of injured people in the case of a catastrophic event.
- The technology is available and in use for reliable and inexpensive warning systems based on seismic sensors.
- The alarm systems are extremely efficient when they provide minimum warning times of several minutes.
- The proposed system can be utilized for several monitoring needs, such as seismic detection, early warning, rapid response, tsunami prediction, prediction of volcanic eruptions, prediction of landslides, estimate of damage to different types of structures and infrastructure projects including large dams, nuclear power plants, gas and oil pipelines, large bridges, tunnels, railways, etc.

Conclusion

GeoSIG Ltd. can provide with its broad experience in designing, manufacturing, installation and maintenance of such systems and thus can offer state of the art solutions. The technology to build and install such a system is readily available and has been deployed successfully by GeoSIG Ltd.

A well-designed and maintained alarm system can save a large number of casualties, and it can increase the social and political consciousness as well as the responsiveness to the natural disasters within the subject country and region.

GeoSIG Strong Motion Instruments Recorded Sumatra Earthquake from 7850 km Away

Introduction

As reported by IRIS (Incorporated Research Institutions for Seismology - http://www.iris.iris.edu/sumatra/FirstPage.htm), Magnitude 9.0 earthquake near Sumatra on December 26, 2004 was one of the most significant seismic events on Earth during the past 100 years. While earthquake damage and casualties were limited to the immediate vicinity of the earthquake, tsunamis generated by this event caused over 150,000 deaths in the Indian Ocean region spanning more than 10 nations.

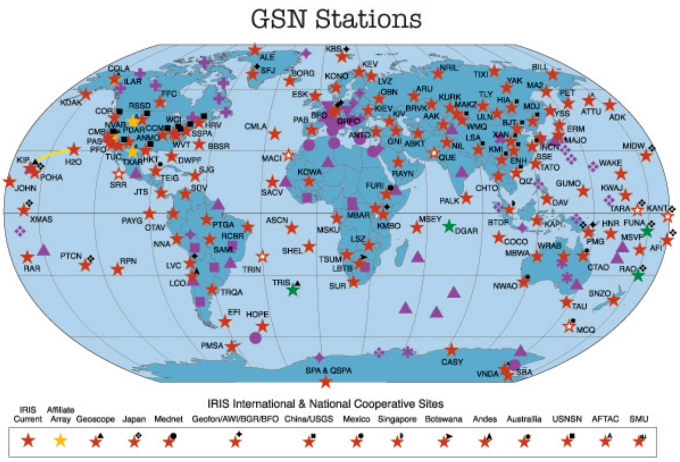

Figure 5. This map shows the locations of the Global Seismographic Network as operated by the IRIS Consortium.

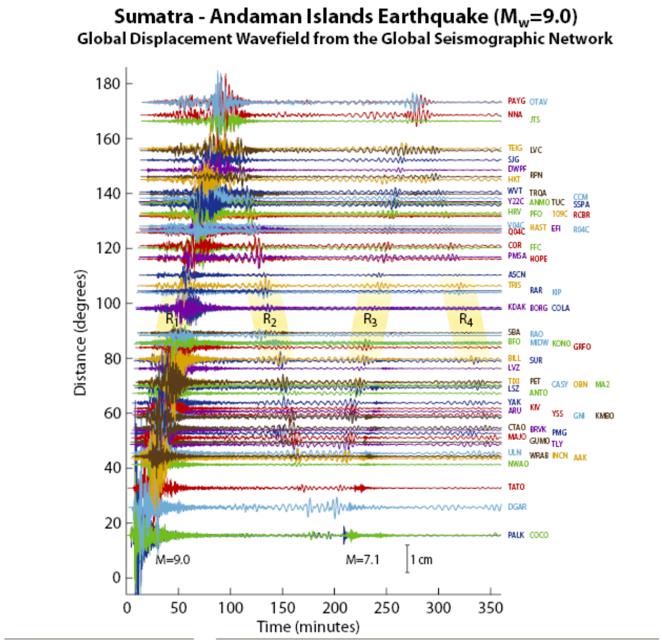

Figure 6. This record section plot displays vertical displacements of the Earth's surface recorded by seismometers plotted with time. The traces are arranged by distance from the epicenter in degrees. (IRIS Consortium)

GeoSIG Instruments within Istanbul EWRR

Istanbul Earthquake Early Warning and Rapid Response System uses GeoSIG accelerographs deployed at the coastline of the Marmara sea as shown in Figure 7. The system has recorded the Sumatra Earthquake.

The stations consist of CMG-5T force balance accelerometers and state of the art GSR-24 24-Bit data acquisition systems with real time data transmission via spread spectrum telemetry to the network control center in KOERI. Continuous data retrieval and transmission facility has enabled KOERI to identify this remarkable recording of the event at a distance of more than 7800 km away.

Examples of the full waveforms are shown on Figure 8 and were kindly provided by the Department of Earthquake Engineering of Kandilli Observatory and Earthquake Research Institute of Bogazici University - KOERI.

(http://www.koeri.boun.edu.tr/depremmuh).

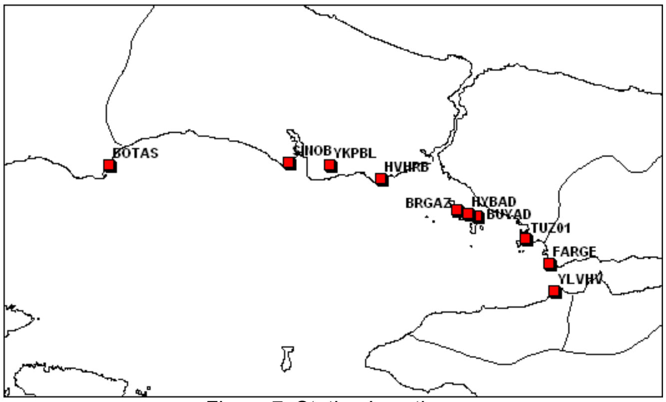

Figure 7. Station Locations.

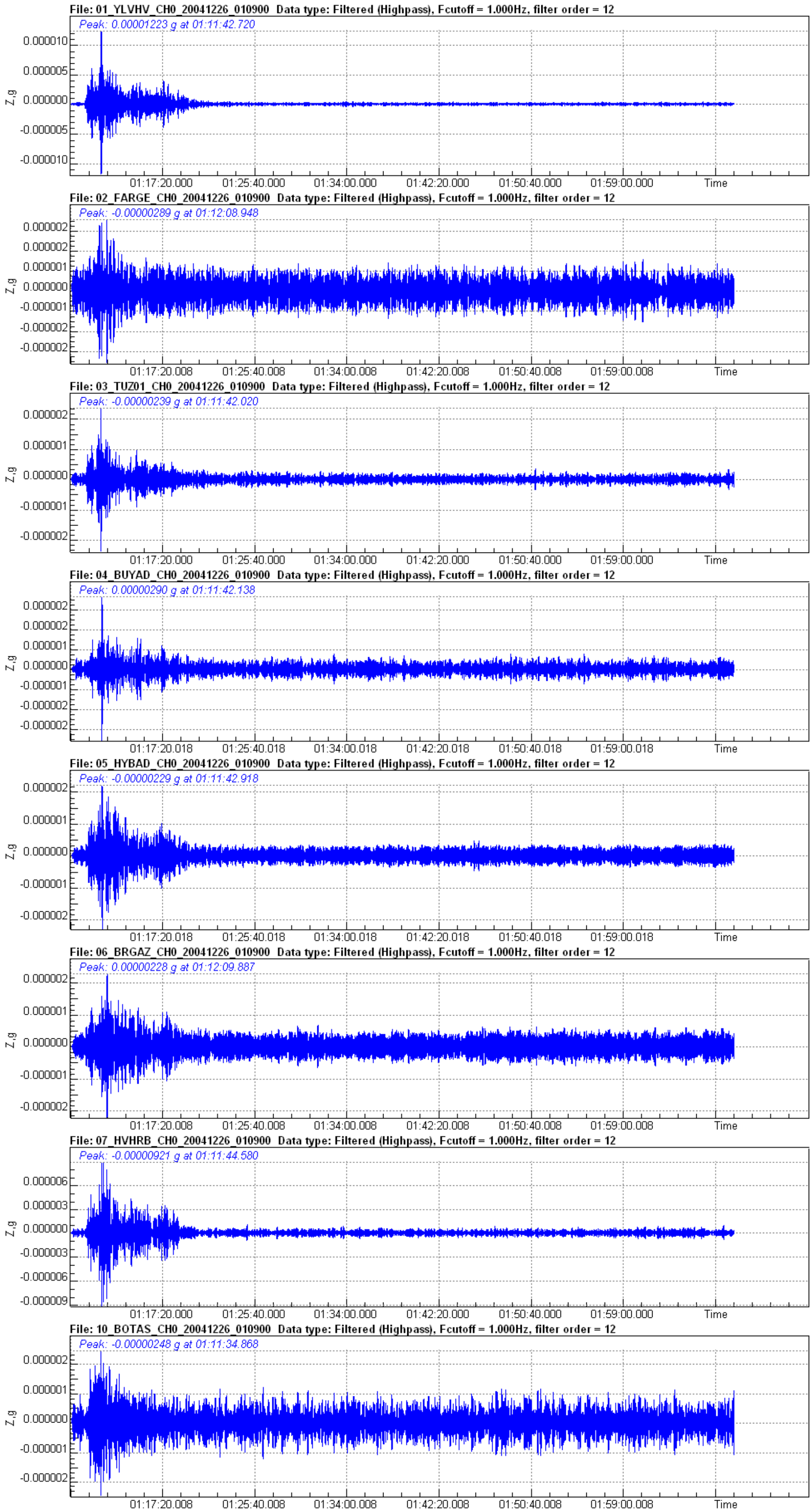

Figure 8. Recorded Event Waveforms

GeoSIG Seismic Instrumentation in Leibstadt NPP Detected the German Earthquake of 5th December 2004

Introduction

On Sunday 5.12.2004 at 01:53 UTC (02:53 Central European Time), an earthquake with a magnitude ML=5.3, according to GEOFON, occurred in Freiburg, Germany. The epicenter of the earthquake is reported as 8.0ºE, 48.2ºN.

(http://www.gfz-potsdam.de/geofon/alerts/ev041205015256/)

As reported in GeoWatch 21, Leibstadt NPP is equipped with a GeoSIG seismic instrumentation system, which consists of a Central Processing Unit (CPU) and five distributed Detection and Recording Units (DRUs). A typical DRU comprises of two instruments; one AC-23 Triaxial Sensor and one GSR-18 Strong Motion Recorder.

This event was recorded with these instruments and here, only the free field event recording is given. (Figure 9)

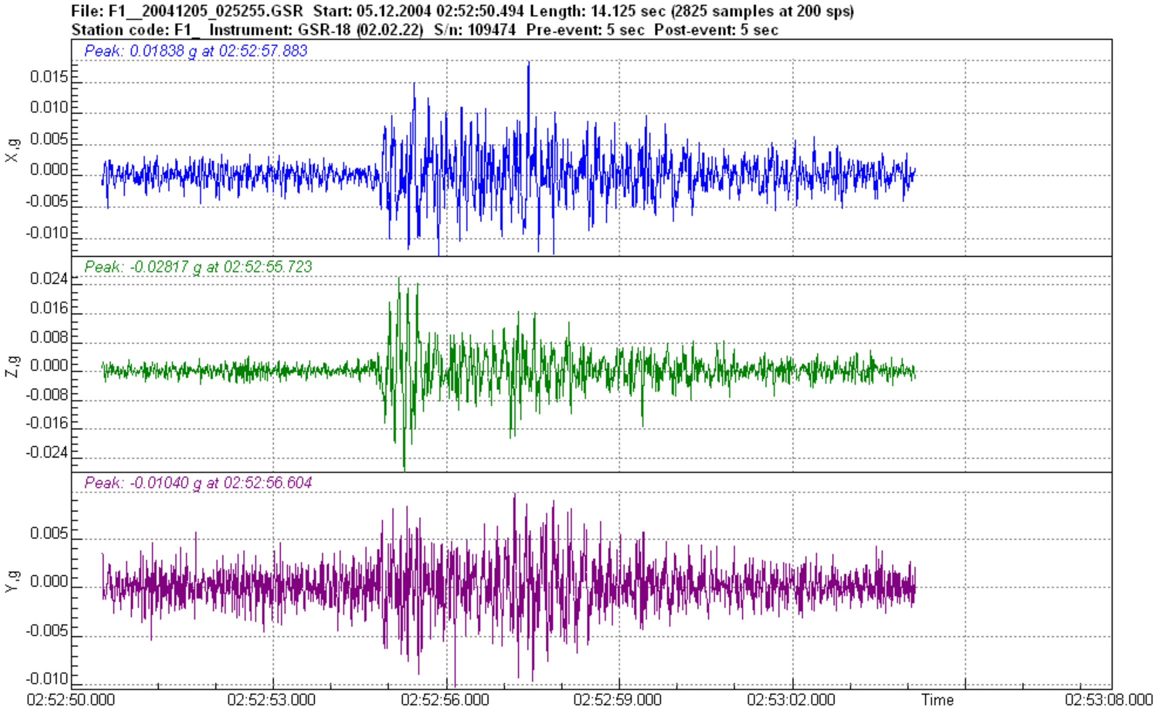

Figure 9. Free Field Recording, Leibstadt NPP.

GeoSIG Contributes in USGS Article on Dense Arrays

John R. Evans (USGS Menlo Park, CA), Robert H. Hamstra, Jr. (Circuit Solutions, CA), Christoph Kündig (GeoSIG Ltd.), Patrick Camina (GeoSIG Ltd.) and John A. Rogers (DAQ Systems, MT) have published a paper with the title “TREMOR: A wireless MEMS accelerograph for dense arrays” in Earthquake Spectra, Volume 21, No. 1, 2005. (http://www.eeri.org/cds_publications/spectra_about.html)

Since the past decade, GeoSIG had been interested in low cost and efficient strong motion instrumentation particularly for urban seismology and high density instrument networks. This paper presents an overview on various aspects and requirements of such an instrumentation basing on the TREMOR instrument that was the product of the cooperation between USGS and GeoSIG, as well as presenting the remarkable results obtained in using TREMOR in Oakland, California, one of the most densely instrumented urban centers in the United States.

David Cirjanic, Electrical Technician, Joins GeoSIG Family

David Cirjanic has joined the GeoSIG Family as an Electrical Technician specialized in Digital & Analog Electronics, Telemechanics, Pneu-matics and Industrial Automation.

With David our technical development and production team is now reinforced further in mechanical aspects as well as product testing automation.

David will be working in our production department in Cugy, Lausanne.

We warmly welcome David to our Team.

GeoSIG Ltd. - Europastrasse 11 - 8152 Glattbrugg - Switzerland
Tel.: +41 44 810 21 50 - Fax: +41 44 810 23 50 - Email: info@geosig.com - www.geosig.com