GeoWatch

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Foreword from the CEO

Scope

In a NPP appropriate instrumentation must be provided so that the seismic response of the safety-significant plant features can be evaluated promptly after an earthquake. Such an assessment includes both an evaluation of the seismic instrumentation data and a comprehensive plant walk-down.

GeoSIG Ltd. has high experience on seismic instrumentation networks in NPPs and is able to provide solutions for all different requirements.

As many other NPP, Beznau and Leibstadt were facing the situation of replacing the outdated seismic instrumentation. The instrumentations of both the NPPs are based on decentralized recorder solution.

In the case of NPP Beznau a fiberoptic approach is selected for the communication whereas in Leibstadt the communication between the central system and the recorders uses RS-485 with opto-couplers for the galvanic isolation. The speciality in Leibstadt is the reuse of the existing cabinet. GeoSIG was able to build the state of the art seismic instrumentation into the same cabinet where the former equipment was mounted. In the Korean NPP Ulchin a standard approach of centralised recording is implemented.

As a contribution to the 4th SINUG conference 2005, July 25 - 27 taking part in the Diablo Canyon NPP this issue of GeoWatch, is devoted to the mostly on the topic of NPP instrumentation.

Christoph Kündig

Beznau NPP Seismic Instrumentation Network

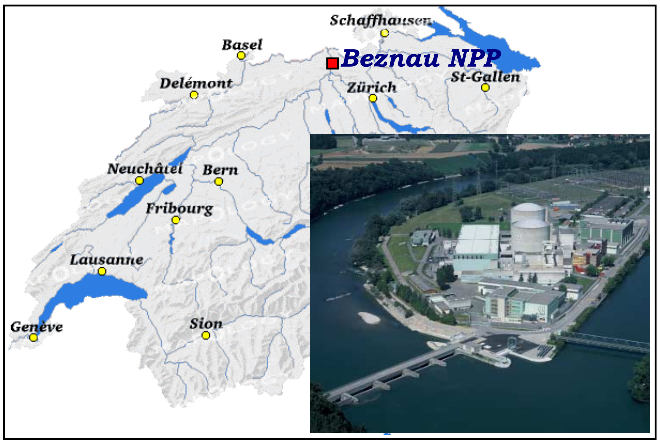


Figure 1. Location and general view of Beznau NPP

The Beznau Nuclear Power Plant is Switzerland's first NPP, which consists of two identical units: Beznau I and Beznau II, with outputs of 380 MW each, which went into operation in 1969 and 1971, respectively. Operated by the Nordostschweizerische Kraftwerke AG (NOK), which is a joint stock company of the cantons of Northeast Switzerland, the plant is located next to the Aare River near the town of Böttstein, approximately 30 km Northwest of Zurich, as seen on Figure 1.

System

The system in Beznau consists of a Central Processing Unit (CPU) and several distributed sensors with recorders.

The seismic instrumentation is continuously running during normal operation and during event downloading. The substantial components of the seismic instrumentation are equipped with appropriate power supply, emergency power supply (sensors with registration units), or 24-VDC supplies provided by the customer.

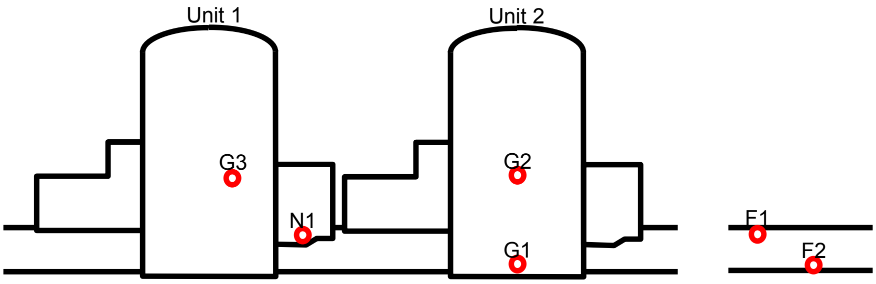
The six triaxial measuring sensors (AC-23 Sensor) and recorders (GSR-18 Strong Motion Recorder) have self-monitoring and testing facilities for periodic tests of the entire measurement chain. For each measuring channel, the recording threshold and the alarm limit values can be set individually.

The local GSR-18 has sufficient storage capacity for the complete recording of an event; i.e., main- and after-shocks. In order to analyze weak-motion signals as well, the data are acquired with a resolution of 1:131'000 (18 Bit).

The schematic location of these instruments can be seen in Figure 2.

The alarm transmission and communication between the recorders and the Central Processing Unit (CPU) takes place via fiberoptic cable. After an event, the locally registered data are taken over automatically by the central processing unit where our state-of-the-art Data Acquisition Software, GeoDAS, is utilized for reliable system operation to:

- Monitor the stations,
- Download event recordings automatically,
- Check system state of health, which can be used to analyze the detailed cause of any malfunction,
- Analyze downloaded data by means of seismic and OBE/SSE checks,
- Issue alarms.



F1: Freefield at surface
F2: Freefield on bedrock
N1: State of Emergency building, mat foundation
G1: Security building, mat foundation
G2: Security building, operation floor level 340
G3: Security building, operation floor level 340

Figure 2. Schematic DRU locations in Beznau NPP.

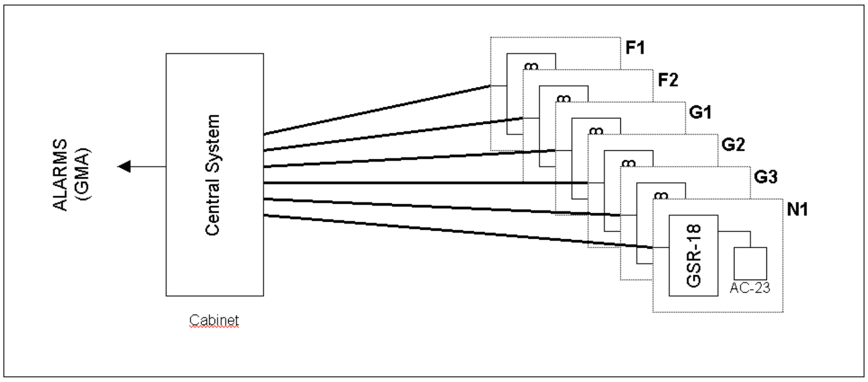


Figure 3. Overview of Seismic Instrumentation of Beznau NPP.

Figure 4. Seismic Safe CPU Cabinet in Beznau NPP.

GeoDAS is used for setup and data retrieval of the six Detection and Recording Units (DRUs) as seen in Figure 3. It is configured to continuously check the recorders for new event recordings. As soon as there is new data, it is downloaded automatically, as well as left in the memory of the recorders for redundancy purposes. Thereafter, data is analysed by means of seismic and OBE/SSE checks. GeoDAS also checks the SOH (error status) of the recorders and can be used to analyse the detailed cause of any malfunction. GeoDAS is communicating with all stations in parallel, as a result of the dedicated serial communication links that are provided by the system hardware. This means that downloading of all DRUs' data in case of a common trigger takes place promptly.

Figure 5. Freefield Station at surface (F1).

Recording threshold and the alarm limit values can be set individually for each measuring channel, and there are self-monitoring and testing facilities for periodic testing of the entire measurement chain. Here, there are three alarm levels; “trigger”, “calculated”, and “system failure”.

Furthermore, it is also possible to retrieve data with a laptop PC directly from the local recorders. In the case of a recording, the system starts automatically a pre-defined evaluation. The results of this high-speed evaluation are stored in the PC of the central processing unit in defined files and printed out automatically.

The CPU is inserted in an earthquake-safe cabinet, which was verified for seismic safety, including specific accessories. The sensors, recording units, and fiberoptic converters are supplied in housings adapted to the respective site conditions.

Figure 6. Freefield Station on bedrock (F2).

Figure 7. Recorder at freefield station on bedrock (F2).

Leibstadt NPP Seismic Instrumentation Network

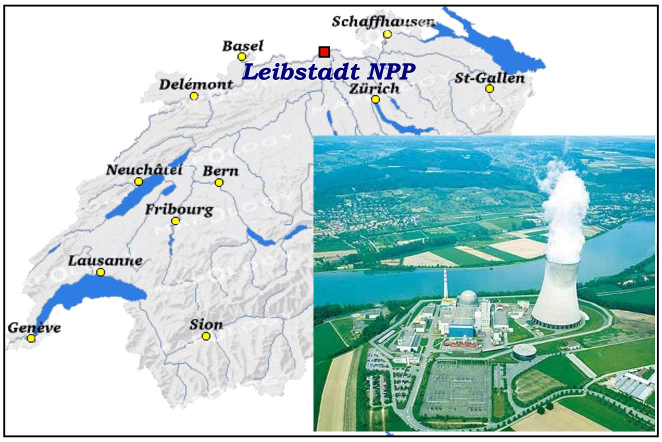


Figure 8. Location and general view of Leibstadt NPP.

Approximately 40% of Switzerland's power production comes from the nuclear energy. Leibstadt Nuclear Power Plant is the fifth plant in Switzerland, starting commercial operation on December 15th, 1984. The NPP is situated on the Aare delta between Koblenz, Switzerland and Waldshut, Germany. It provides over 9 billion kilowatt-hours annually to the Swiss power network and is connected to the European compound network.

System

The system in Leibstadt consists of a Central Processing Unit (CPU) and several distributed sensors with recorders. In order to achieve a certain level of redundancy, the storage of the motion signals from the sensors takes place first in the recorders. The schematic location of these instruments can be seen in Figure 9 and Figure 10.

The Seismic Instrumentation system for Leibstadt NPP has many similarities with the system provided to Beznau NPP by GeoSIG Ltd. It also consists of a Central Processing Unit (CPU) and five distributed Detection and Recording Units (DRUs). Typical DRU comprises of two instruments; one AC-23 Triaxial Sensor and one GSR-18 Strong Motion Recorder.

The alarm transmission and communication between the GSR-18 and the CPU take place via RS-485/Alarm cable. After an event, the CPU acquires the locally recorded data automatically. In addition, it is also possible to retrieve the data with a laptop computer directly from the GSR-18.

As soon as recording starts, the system automatically initiates a pre-defined evaluation. The results of this automatic evaluation are stored in the computer of the CPU in pre-defined files and can be printed out. The CPU is housed in an existing earthquake-safe cabinet, including specified accessories, and is shown in Figure 12.

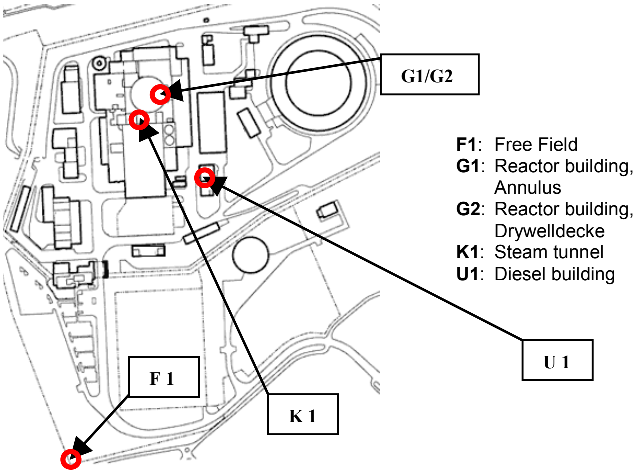


Figure 9. Schematic DRU locations in Leibstadt NPP.

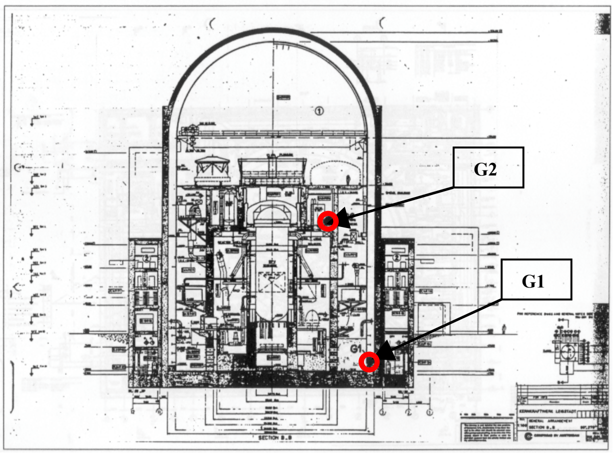


Figure 10. Schematic DRU locations in Leibstadt NPP.

As soon as recording starts, the system automatically initiates a pre-defined evaluation. The results of this automatic evaluation are stored in the computer of the CPU in pre-defined files and can be printed out. The CPU is housed in an existing earthquake-safe cabinet, including specified accessories, and is shown in Figure 12. GeoSIG was able to build the state of the art seismic instrumentation into the same cabinet where the former equipment was mounted.

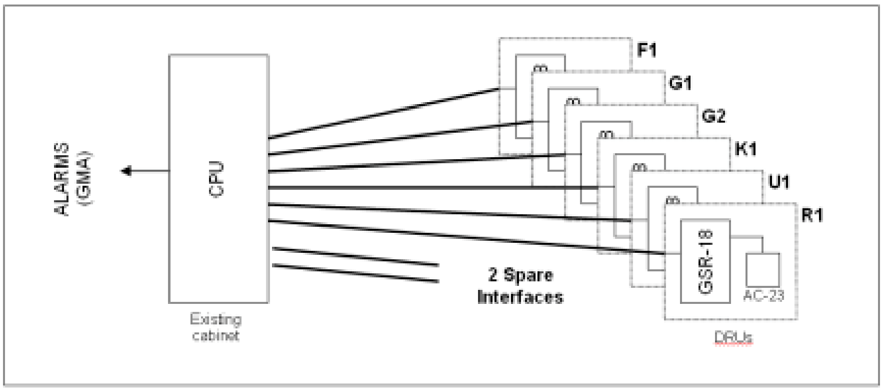


Figure 11. Overview of Seismic Instrumentation of Leibstadt NPP.

Figure 12. Reuse of the existing cabinet for the GeoSIG CPU in Leibstadt NPP.

Ulchin NPP Units 5/6 Seismic Monitoring System (SMS)

UNIT	1	2	3	4	5	6
OUTPUT(MWe)	950	950	1.000	1.000	1.000	1.000
TYPE OF REACTOR	PWR	PWR	PWR	PWR	PWR	PWR
REACTOR SYSTEM SUPPLIER	Framatome	Framatome	Doosan / KOPEC / CE	Doosan / KOPEC / CE	Doosan	Doosan
TURBINE GENERATOR SUPPLIER	Alstom	Alstom	Doosan / GE	Doosan / GE	Doosan	Doosan
ARCHITECT ENGINEERING	Framatome / Alstom	Framatome / Alstom	KOPEC / S & L	KOPEC / S & L	KOPEC	KOPEC
DATE OF COMMERCIAL OPERATION(SCHEDULED DATE)	'88.9.10	'89.9.30	'98.8.11	'99.12.31	'04.7.29	('05. 6)

Figure 13. Location and the Specifications of Ulchin NPP.

Seismic Monitoring System for Ulchin NPP Units 5/6 nuclear power plant has been shipped in 2002 and installed in 2003.

We are pleased to announce that in December 2004, we have received the final notice of acceptance after successful installation and start-up period operation of the system.

Figure 14. Ulchin NPP Unit 5.

System

The configuration of the system is based on classical topology of central recording and the design is according to the NRC REGULATORY GUIDE 1.12. The system includes also 2 seismic switches that will be activated in case acceleration at basement exceeds OBE or SSE level.

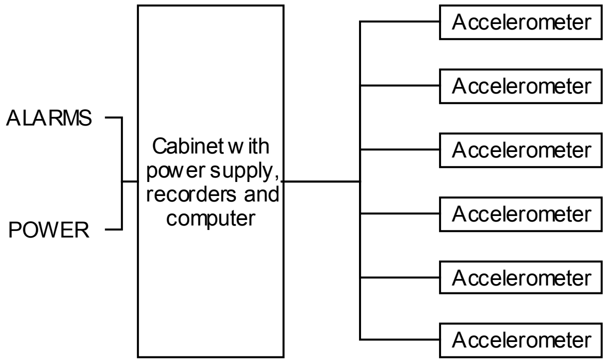


Figure 15. Central Recording Topology.

In case of an event, the computer processes the recorded data and performs automatically the OBE exceedance evaluation according to NRC REGULATORY GUIDE 1.166.

Figure 16. Ulchin NPP Unit 5 during installation of SMS.

The Customer have performed the installation with full support from GeoSIG Engineer Team.

Figure 17. Central recording and processing system.

Figure 18. Field accelerometer, customer installation.

For such high level application, GeoSIG has always a great flexibility in designing such system according to world-approved standard and also taking care of specific customer needs.

GSR Spare Boards for NPP Instrumentation

Many NPPs are equipped with the GNC central recording system using AllView software and SSA-320 accelerometers. During the recent month GeoSIG provided for different NPPs GNC spare boards such as the GSR-16 recording module card, the GNC-master card, backplanes or front panel boards.

This allows an extension of the lifetime of the existing instrumentation. GeoSIG is in the position to manufacture boards with revisions dating more than 10 years back along with the appropriate firmware versions.

Beside spare boards delivery an upgrade of the DOS based AllView software to the Windows based GeoDAS software is possible.

Last but not least, GeoSIG can offer the service for testing, calibrating and repairing the SSA-320 sensors installed in many NPPs.

Seismic Check in NPP Seismic Instrumentation Networks

Overview

At each of the Detection and Recording Units (DRUs), the recorders continually store data from their dedicated accelerometers in their pre-event ring buffers and check whether a trigger condition is fulfilled.

The user defines whether the feature of the seismic test is used and of course the appropriate parameters for the seismic test suiting the conditions of the site can be configured with GeoDAS.

When a movement occurs and acceleration values above the predefined trigger level are experienced, a trigger alarm is set off and the event is recorded. The CPU computer utilising GeoDAS then retrieves the event from all DRUs, checks whether it is a seismic event or not and calculates the RSA and the CAV based on free-field recorder data. Based on this, further alarms are set.

Event-data recorded by each DRU are analysed for OBE/SSE, whereas only freefield stations are used for generation of OBE/SSE alarms.

After an event is recorded the CPU computer will retrieve the recorded data from all DRUs for further analysis. Automatic analysis after retrieval of data in the computer will decide if the event is seismic or non-seismic.

The operator can repeat any of the tests referred to in the mentioned table (Table 1) in deciding whether the event is classed as seismic or not.

Table 1. Example of Seismic /Non-Seismic event detection process

Number	Tests for 'seismic event detection'	Non-seismic Event if…	Seismic Event if…
1	Number of DRU locations with recordings	Only 1 recorder triggered	2 of 6 recorders triggered
2	Duration	Duration is below 2 s	Duration is above 2 s
3	FFT	FFT shows frequency peak above 33 Hz	FFT shows frequency peak below 33 Hz

Seismic event

In case of the event is classified as seismic by the system, RSA, RSV and CAV calculations are performed, and the results are compared with allowed levels for the following criteria to establish its degree of severity and activate further alarms / relays. Results of the tests are displayed on the CPU computer monitor and if required also printed.

Video on NPP Seismic Instrumentation now available

A picture says more than 1000 words. Based on this slogan GeoSIG produced a video about the seismic instrumentation of the Nuclear Power Plant Beznau.

It shows the control room in which the alarm actuators of the seismic instrumentation are located. The two different free field stations and one representative station within the plant are shown. The central system with the different components and the hot spare installation are presented.

Person interested in getting a copy of the video are invited to contact GeoSIG under info@GeoSIG.com.

Johannes Grob celebrates 50th birthday

Johannes Grob, the president of GeoSIG Ltd., turned 50 on 10th July, 2005. GeoSIG organized a surprise party for him on 9th July, together with participation of different GeoSIG representatives from all around the world.

It was a lovely day on and around the Lake of Lucerne in the center of Switzerland.

We wish Johannes another healthy and successful 50 years!

Apprentice - Sebastien Lienhard

The apprenticeship in Switzerland is the most common form of education after the basic school. This system has a very good reputation. Therefore in Switzerland about 70 % of the 16 years old boys and girls go for an apprenticeship. More than 300 different professions can be selected. This system allows the Swiss industry to have continuously a good stock of young, very well educated professionals available. GeoSIG is committed to this system. Currently there are 4 apprentices following these educations in the topic of electronics. One of them is Sebastien Lienhard. He just graduated with success and achieved the Swiss Federal Certificate in the domain of electronics. This certificate keeps him all the options open for a broad future. He is also committed in Kung-Fu, which brings him a life-view of broad perspectives.

The GeoSIG team congratulates him for his achievements.

The Albanian Earthquake of 10th July 2005

Introduction

GeoSIG have been operating a number of seismic stations in its R&D lab in Echallens, close to GeoSIG Production Department in Cugy, both in the vicinity of Lausanne (Figure 19).

One of these stations, EH1 have recorded the Albanian earthquake of 10.07.2005, 13:10:01.1 UTC. In this issue we report this record in conjunction with Schweizerischer Erdbebendienst (SED, Swiss Seismological Service) report, which consists of waveforms from 6 Swiss stations as shown on Figure 19 and Figure 20. We also show a strong motion recording for the same time period from another GeoSIG station, EH2, at the same location, for comparison.

Station EH1

The station consists of a GSR-24 Seismic Recorder and three prototypes of the new low noise version of the VE-51 Uniaxial (Vertical) Velocity Sensor that are being tested.

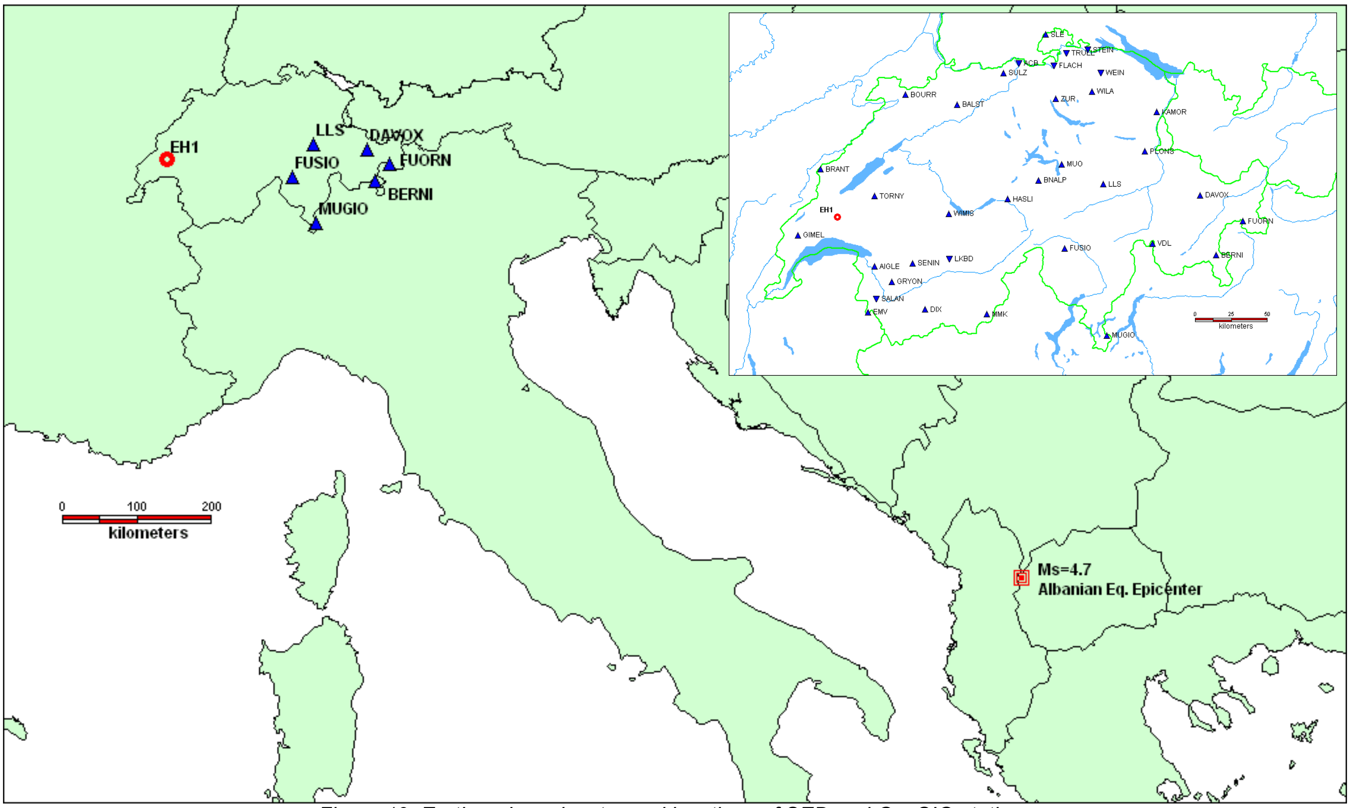


Figure 19. Earthquake epicentre and locations of SED and GeoSIG stations

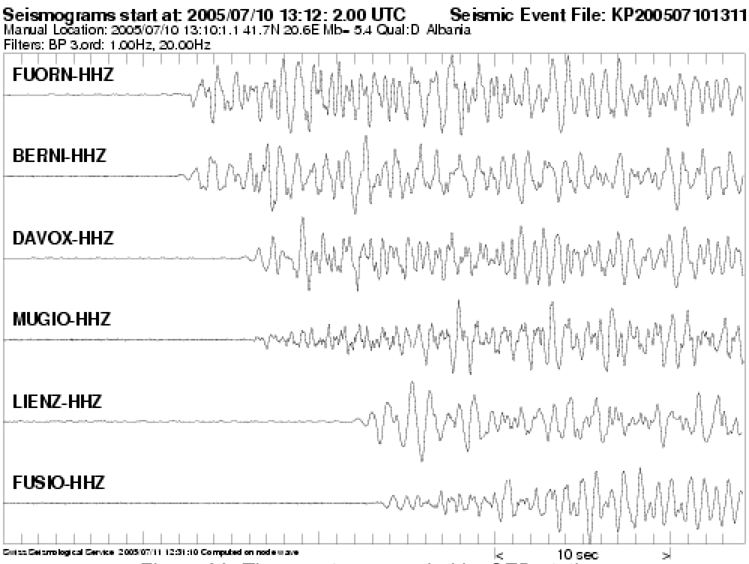


Figure 20. The event as recorded by SED stations

According to SED the magnitude of the Albanian earthquake is calculated as M_S=4.7 and M_b=5.4, whereas the location is at 41.7N – 20.6E. The same earthquake was also reported on USGS and EMSC (European Mediterranean Seismological Centre) with M_W=5.2.

The GeoSIG station and recording details are as follows:

Location

CH-1040 Echallens

Coordinates: 46.7N – 6.8E

Altitude: 621m

Recording

- Event recorded from datastream by GeoDAS
- Trigger bandpass filter 0.2 - 2 Hz
- STA/LTA ratio trigger mode
- STA: 2 sec; LTA: 180 sec; Ratio: 4
- LTA updated during recording
- Pre-event: 10 sec; Post-event: 10 sec
- Maximum duration: 60 sec

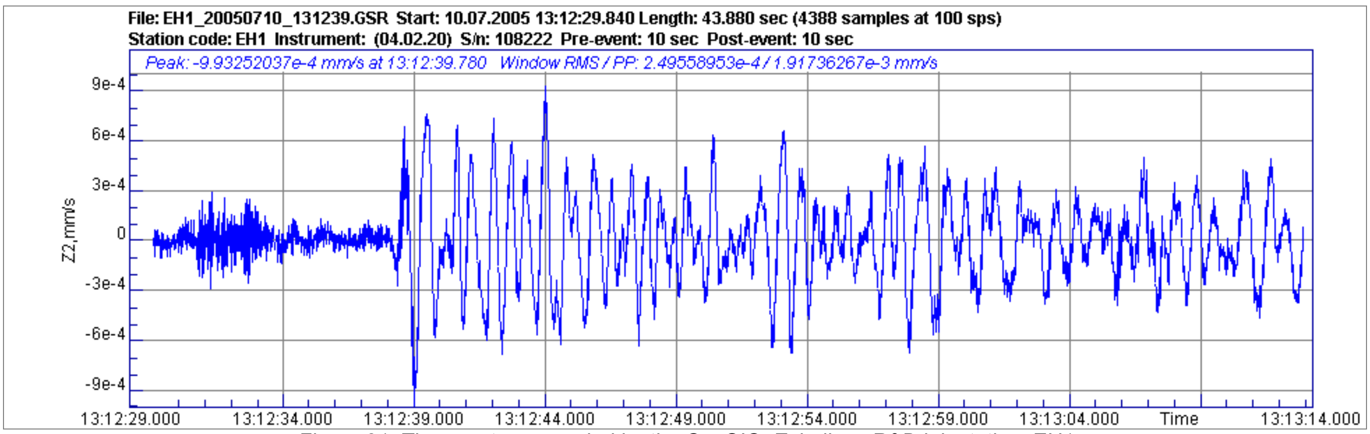


Figure 21. The event as recorded by the GeoSIG, Echallens R&D lab station, EH1

Station EH2

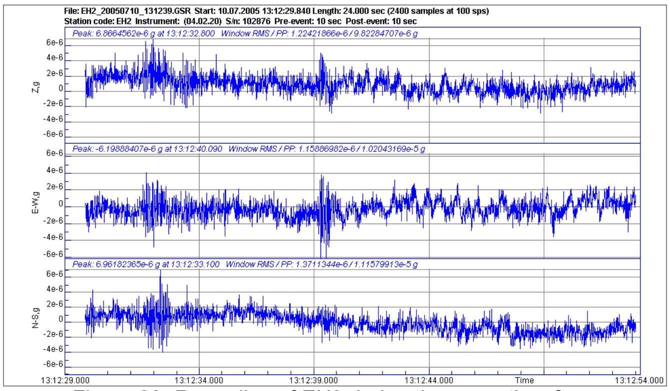


Figure 22. Recording of EH2 during the same time frame

The station consists of a GSR-24 Seismic Recorder and a CMG-5T Triaxial Force Balanced Accelerometer.

Location

CH-1040 Echallens

Coordinates: 46.7N – 6.8E

Altitude: 621m

Recording

Datastream by GeoDAS

Although a high quality accelerometer is used, it is not easy to see such an event with a frequency range of 0.5 – 1.5 Hz. If a strong bandpass filter is applied, a very small signal can be seen.

This demonstrates the advantage of a seismometer in comparison with an accelerometer in case of distant seismic events.

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