The Seismic Aftershock Monitoring System (SAMS) for OSI – Experience from IFE14

Nicolaí Gestermann¹, Benjamin Sick², Martin Häge³, Thomas Blake³, Peter Labak⁴, Manfred Joswig²

¹Federal Institute for Geosciences and Natural Resources, Hannover, Germany
²Institute for Geophysics, University of Stuttgart, Germany
³Geophysics Section, Dublin Institute for Advanced Studies, Dublin, Ireland
⁴CTBTO, Vienna, Austria
Contact: nicola@gestermann@bgr.de

Introduction

The aim of the Seismic Aftershock Monitoring System (SAMS) is to detect and localize small aftershocks in the vicinity of a possible explosion within an inspection area (IA) of an OSI. The success of SAMS depends on the effective use of the main elements, hardware, software, deployment strategy, the search logic and not least the effective use of personnel. All elements of SAMS were tested and improved during the Build-Up Exercises (BUE) which took place in Austria and Hungary. IFE14 provided more realistic environment in terms of climate and hazardous terrain conditions with limited resources. Significant variations in topography of the IA of IFE14 in the mountainous Dead Sea Area of Jordan led to considerable limitations which were not expected from experiences made during BUE. The experiences learned in the field as a result of this exercise will be used to improve SAMS for future activities.

Data Analysis

The data analysis is divided into two steps. Data screening of the detection processes based on supersongrams. Small events are more easily detectable than in the time domain. Hypocenters of detected events are determined with program JHyponlze. All results of the array processing (apparent velocity and back azimuth) and onset times are included.

SAMS Station Network

The SAMS station network is shown on the map on the left hand side. In total 16 stations were installed. Only the central elements of the triparticle array were installed at stations SJ05, 06, 14 and 23. It was not possible to install the three additional array elements at those sites. Substantial parts of the IA could not be reached by vehicles. Many challenges from high elevation differences, unclear property access and unsafe areas complicated the station deployment significantly.

Station Deployment

The IA of IFE14 posed a serious challenge to the inspection team for both selection of site locations for mini arrays and their security in the field. The best practice for seismometer installation in this environment could not be carried out due to the time pressure of the exercise. The APS equipment for the position finding worked quite well in Jordan but does not work in environments with high elevation differences and dense vegetation.

Detection Threshold of Network

The mini arrays and 3-component stations should be deployed throughout the inspection area for optimal sensitivity to detect and locate events with magnitudes of -2.0 (ML). Without additional information about the capability of the stations, the design of the network should aim at uniform coverage of the IA.

Scenario Events

With the data of the Seismic Aftershock Monitoring System eight seismic events could be detected and located within the Inspection Area. (see map on the left hand side). Three of the events were small blasts and part of the exercise scenario. They were conducted unknown for the IT to test the detection capability of SAMS.

Conclusion

- The hardware and software of SAMS worked very well. There is no need to make general changes on the system except the use of telemetry between array elements at one site to remove the vulnerability of unprotected over ground cables between stations and the Base of Operation.
- The use of telemetry would simplify the installation of arrays and would reduce the work load. This would improve the total efficiency and quality control of the data of SAMS significantly.
- The number of stations was less than planned and the magnitude threshold of -2.0 ML could probably not be reached for the entire inspection area.
- Nevertheless all three small blasts of the scenario could be clearly detected. The calculated epicenters were in good agreement with the locations of the explosions.
- Reliable and precise network metadata were identified as crucial to ensure the necessary accuracy of epicentre locations. A Huddle test before the start of the field activities could be helpful.
- Best practice for seismometer installations under different terrain and climatic conditions could improve the data quality and facilitate the work of inspectors.
- Software tools for detection threshold estimation, data availability visualisation and automatic data quality control would be helpful during an OSI.