**Introduction**

During an On-Site Inspection (OSI) it is essential to get a fast overview of recorded seismic signal classes to evaluate the local seismicity, and in particular to investigate on suspicious events eventually representing aftereffects from an underground nuclear explosion (UNE). The seismic aftereffects monitoring system (SAMS) of an OSI comprises up to fifty mini-arrays each having six traces of continuous waveform data. The sought-after events can have a magnitude as low as M<sub>c</sub> -2.0, and a duration of just a few seconds which makes it particularly hard to discover them in the large data set.

**Event detection**

To overcome the first challenge of event detection we use a specific form of spectrogam, the four-traces Super-Sonogram to raise these signals from stationary background noise and to test on array-wide signal coherency. The Super-Sonograms proved to be indispensable in manual screening of IFEO8 data and get implemented into SAMS.

**Mini-arrays (SNS)**

Seismic measurement during an OSI is done with mini-arrays (Seismic Navigating Systems, SNS). One SNS consists of:

1. 1 central 3-component seismometer
2. 3 satellite vertical seismometers

The inspection area for an OSI is limited to 1000 m² and each SNS covers an area of approximately 20 m² to detect events of magnitude M<sub>c</sub> < 2.

It requires approximately 35 SNS to cover an inspection area.

**Sonogram**

Seismic aftereffects of UNEs are often too weak and too short to be recognized in the seismograms. The Super-Sonogram is an intermediate step that allows to derive the original signal classes to evaluate the local seismicity, and in particular to investigate on suspicious signals. The Super-Sonogram allows two steps of event detection:

1. **Power spectral density** through short-term-fourier-transformation (STFT)
2. **Logarithmic frequency and amplitude-scaling**

**Feature extraction**

Feature extraction is done by the Sonogram computation which is enhanced by the following methods:

- **Normalisation to provide an amplitude invariant clustering**
- **Transformation with Principal Component Analysis (PCA) of the first 5 principal components**
- **2-D similarity function optimized for fuzzy comparison of Super-Sonograms**

**Unsupervised classification**

We test unsupervised classification on the dataset of the PISCO '94 project which measured seismicity in the central Andes of northern Chile. We try to classify the 15 signal classes to determine five types of events which occur in different regions of the measurement area.

**Self-organizing Map [Kohonen(2001)]**

Grouping event classes without prior knowledge, i.e., the task of unsupervised classification is handled by Self-organizing Maps (SOM). The SOM creates a map of representatives for each event type arranged by proximity of features, giving us a synoptic and topological overview of the acquired seismic data.

**Outlook**

The data of only one station of the dataset was used for the unsupervised classification. As a next step surrounding stations will be integrated in the classification process and decisions based on signal coherency and logic will be involved.

**Acknowledgements**

The GeophysicsSuite software development is funded by the CTBTO in line with the OSI Seismic Aftereffects Monitoring system development. The PISCO '94 dataset was used for this study which is free available through the GEOFOON [http://geofoon.org/psico94/psico94/] project. Hypocenters were calculated by Graeber (Graeber(1997)).

**References**


**Further Information**

http://www.nanoseismic.net