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institute
of mine
seismology

Mine Seismology Workshop



11-15 March 2019, Luleå University of Technology, Sweden

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| Monday 11 March | 09h00 – 16h00 | Primer Course on the Basics of Mine Seismology |
| Tuesday 12 March | 09h00 – 17h00 | Presentations on Mine Seismology |
| | 19h00 | Dinner hosted by Institute of Mine Seismology |
| Wednesday 13 March | 09h00 – 17h00 | Presentations on Mine Seismology |
| Thursday 14 March | 09h00 – 17h00 | Seismological Courses and Training in IMS software |
| Friday 15 March | 09h00 – 17h00 | Seismological Courses and Training in IMS software |

Cost - EUR 100 / day incl. tea/coffee. The LTU students will be registered for free.

The registration is open at IMS web site. For more information on registration please contact Megan (accounts.au@IMSeismology.org, +61 3 6272 4281)

Monday 11 March – Day 1**Primer Course on the Basics of Mine Seismology**

The objective of the course is to explain the elementary principles of seismology and seismic monitoring in mines to non-seismologists: objectives of seismic monitoring in mines, seismic waves and seismic sources, seismic monitoring systems, location of seismic events, basic and derivative source parameters, source mechanisms, classification of seismic events, parameters of seismicity, analysis and interpretation of seismicity.

Tuesday 12 March – Day 2**Presentations on Mine Seismology**

The workshop is aimed to promote presentation and discussion of recent developments on the topics of mine seismology: mechanisms of seismic events and mechanics of rockburst damage, processing of seismic monitoring data, rock mass characterisation using active and passive seismic data, assessment of seismic and rockburst hazards. The first session is dedicated to the presentations of geotechnical practitioners, who will share their experience with seismic monitoring at particular mines.

If you would like to present please e-mail to Dmitriy.Malovichko@IMSeismology.org and Savka.Dineva@ltu.se.

Confirmed presentations:

Session 1: Implementation and applications of seismic monitoring in mines

The presentations in this section will have similar structure:

- Brief description of mining conditions and mining method.
- Objectives of seismic monitoring and expectations from the seismic monitoring system.
- Brief description of the evolution of seismic system.
- Routine analysis of seismic monitoring data: procedures, results and utilisation.
- Historical significant seismic events and how the system was helping.
- Cases of successful or unsuccessful utilisation of seismic system.

Garpenberg mine (Boliden), Sweden

Shahram Mozaffari

Kiruna mine (LKAB), Sweden

Mirjana Boskovic

Malmberget mine (LKAB), Sweden

Mats Stålnacke

Kittila mine (Agnico Eagle), Finland

Antti Pyy

Session 2: Seismic data acquisition, processing and interpretation

First results from testing of seismic acquisition using stacked five-element geophones versus two types of fibre-optic cables

Dr Björn Lund (Uppsala University, Sweden)

Bayesian Estimation of Mine Induced Seismicity (BEMIS)

Ville Tornman (LKAB, Sweden)

Passive seismic tomography results for Kiruna mine, Sweden

Dr Björn Lund (Uppsala University, Sweden)

Aspects of seismic monitoring of the rock mass adjacent to open pit slopes

Mikhail Kagan (Mining Institute of Kola Science Centre, Russian Academy of Sciences, Russia)

Identification and quantification of geological structures using source mechanisms and location uncertainty

Stephen Meyer (Institute of Mine Seismology, Australia)

Using seismic noise interferometry to image and monitor mining environments

Tjaart de Wit (Institute of Mine Seismology, Australia)

Using microseismic monitoring data in education at Oulu Mining School

Dr Elena Kozlovskaya (Oulu Mining School, Finland)

Wednesday 13 March – Day 3

Presentations on Mine Seismology

Session 3: Analysis of seismicity and hazard assessment

Seismic hazard in mining areas

Dr Stanisław Lasocki (Institute of Geophysics, Polish Academy of Sciences, Poland)

Development of numerical modelling of mining induced seismicity

Dr Jonny Sjöberg (Itasca Consultants AB, Sweden)

Rock mechanical risk assessment for induced seismicity based on numerical modelling

Dr Jessa Vatcher (Itasca Consultants AB, Sweden)

Stochastic modelling of induced seismicity (due to hydrofracturing and underground mining)

Dr Alexander Garcia-Aristizabal (Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Bologna, Italy)

Tracking elasticity changes in underground mines using spectral analysis of clustered induced seismicity

Dr Nicola Piana Agostinetti (Dublin Institute for Advanced Studies, Ireland)

The integrated approach to seismic hazard evaluation

Dr Olga Zhuravleva, Dr Aleksander Kozyrev (Mining Institute of Kola Science Centre, Russian Academy of Sciences, Russia)

Factors of increasing the seismic activity when developing the Khibiny rockburst hazardous deposits and their connection with stress-strain state of the rock mass

Dr Inna Semenova, Dr Aleksander Kozyrev, Dr Olga Zhuravleva (Mining Institute of Kola Science Centre, Russian Academy of Sciences, Russia)

Rock mass mechanical behavior in deep mines: in situ monitoring and numerical modelling for improving seismic hazard assessment

Dr Francesca De Santis (INERIS, France)

Applications of seismic data for safe and sustainable underground mining

Dr Savka Dineva (Luleå University of Technology, Sweden)

Seismic response of underground excavations and ground support system at Kirunavaara underground mine

Dr Ping Zhang (Luleå University of Technology, Sweden)

Temporal and spatial distribution of seismicity after blasting in a sublevel stoping mine in Sweden

Irem Guclu (Luleå University of Technology, Sweden)

Forecast of seismic and ground motion hazard for the scenarios of future mining

Dr Dmitriy Malovichko (Institute of Mine Seismology, Australia)

Thursday 14 March – Day 4**Seismological Courses and Training in IMS Software - Processing**

There will be a combination of theoretical presentations and practical exercises explaining and illustrating the processing of seismic monitoring data.

Processing of Seismic Data in IMS Trace, Stephen Meyer

- Seismic database: structure, basic procedures.
- Location of seismic events: picking of wave arrivals, methods of location, velocity model, location uncertainty, problems with the location, improvement of the location.
- Source parameters: source spectra, calculation settings, constraints and issues with source parameters (bandwidth of sensors, local site effects).
- Data manipulations: parameter filters, exporting seismic and ground motion parameters, exporting of seismograms

Utility of Seismic Source Mechanisms, *Dr Dmitriy Malovichko*

- Mechanisms of seismic sources: slip on a structure, pillar burst and abutment failure, rock fall, blast.
- Forensic analysis of large and damaging seismic events: understanding the source and damage.
- Source mechanisms and stress field: inversion of the orientation of principal stresses and calibration of numerical models.
- Evaluation of source mechanisms in IMS Trace: methods, constraints and issues (orientation and response of sensors).

Utility of Continuous Data and Ambient Seismic Noise, *Tjaart de Wit*

- Monitoring stress changes and cave front tracking with ambient seismic noise in mines (SCAN).
- Monitoring the stability of tailings dams with seismic noise.
- Passive seismic exploration: high resolution imaging without a source.

Friday 15 March – Day 5**Seismological Courses and Training in IMS Software - Data Analysis and Interpretation**

There will be a combination of theoretical presentations and practical exercises explaining and illustrating the analysis of seismic monitoring data.

Monitoring Seismicity with IMS Ticker3D, *Stephen Meyer*

- System health and management.
- Recent and long-term seismicity.
- Tools: production data management, basic reports.

Interpretation and Analysis of Seismicity in IMS Vantage, *Dr Dmitriy Malovichko*

- Visualisation and filtering of seismicity.
- Plots: time histories and correlation of seismic parameters, analysis of source mechanisms (stereonet, source-type).
- Comparing seismic data with numerical stress models.
- Evaluation of seismic and ground motion hazard.