ASC Applied Seismology Consultants

Issue 2

ASC Newsletter: Issue 2

Welcome to the second issue of the Applied Seismology Consultants Newsletter.

In this edition, an advanced microseismic analysis is described which has been developed by ASC and Itasca as part of the Mass Mining Technology (MMT) Project; a new procedure for relative location has been added to InSite; an update of conference recently attended by ASC is presented; and the OMNIBUS project that has been coordinated by ASC is reviewed.

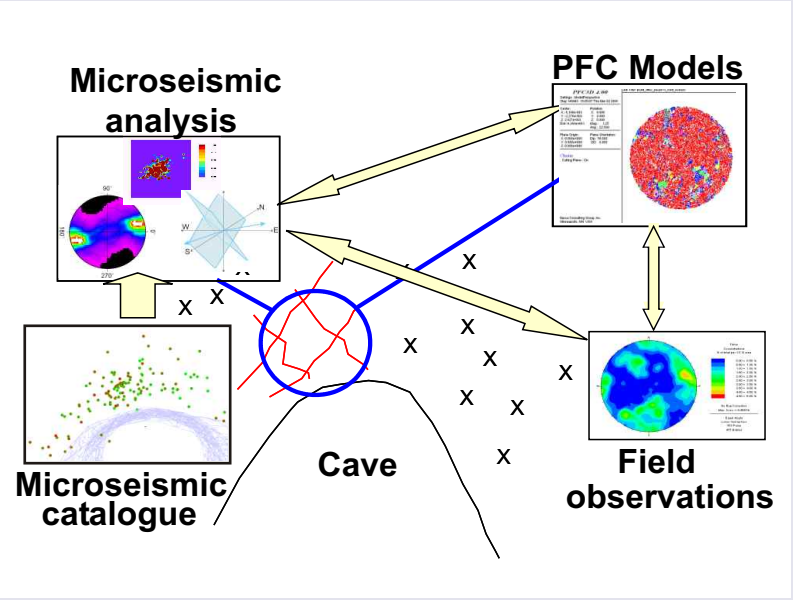
Advanced Microseismic Analysis in Caving Prediction

ASC and Itasca Consulting Group are continuing a long tradition of collaboration as joint research partners in the Mass Mining Technology (MMT) Project, an industrially-funded project supporting fundamental research into the mechanics of caving, blasting and flow in underground mass mining. The strength of collaboration between ASC and Itasca lies in the ability to study fundamental modes of rock fracture, using the Particle Flow Code (PFC) to create and test "synthetic rock" and comparing the predicted spatial and temporal trends in fracturing directly with microseismic data obtained in the laboratory or field. This represents a powerful combination of tools that can be applied to a wide range of rock mechanics problems. The technique has been successfully employed within pioneering research projects to reproduce *in situ* seismicity measured in massive brittle rock (*Hazzard and Young*, 2004) and has been applied to the analysis of damage around underground excavations (*Young et al.*, 2004).

The primary objectives of the MMT research are to extend the technique to the prediction of *jointed* rock mass behavior in three dimensions, to use this in the development of improved tools for prediction of cave growth, fragmentation and subsidence and to extract more value from microseismic data in caving prediction and monitoring. At the core of the new methodology is the construction and testing of "Synthetic Rock Mass" (SRM) samples for predicting rock mass behavior. SRM samples are three-dimensional and simulate rock as an assembly of bonded spheres (intact rock) with an embedded discrete network of disc-shaped flaws (joints).

The Lift 2 block cave at Rio Tinto's E26 Mine in Southeast Australia has been employed as a case study to test the potential for application of SRM technology and advanced microseismic analysis to caving prediction. ASC employed a number of novel microseismic data techniques that enhance the information currently retrieved from microseismic catalogues to develop an understanding of the fracturing and yield that accompanied undercutting and caving at a case study block cave. Through a series of analyses, cave-induced microseismicity showed its potential to provide further insight into the fracture network (interpreting existing seismic parameters in terms of fracture clustering, preferred orientation, size and spacing) and its correlation with different factors present in the production environment.

Itasca constructed a number of SRM samples for the various geomechanical domains at the mine and subjected them to representative cave-induced stresses. The tests provide a significant volume of information including fracture orientations, rock mass modulus, strength, brittleness and fragmentation. Comparison of the predicted and *in situ* fracture modes and orientations derived from the microseismic catalogue indicated very similar trends and represented a significant validation of the SRM approach.



ASC and Itasca thank the sponsors of the MMT project for the opportunity to conduct this fundamental research. We see significant potential for the application of Synthetic Rock Mass testing and linked microseismic analyses to other mine design problems and fields of engineering and look forward to future opportunities for collaboration in consulting, design and research.

Hazzard, J. F., and R. P. Young (2004), Numerical investigation of induced cracking and seismic velocity changes in brittle rock, Geophys. Res. Lett., 31, L01604, doi:10.1029/2003GL019190.

Young, R.P., Collins, D.S., Hazzard, J., Heath, A., Pettitt, W.S., Baker, C., Billaux, D., Cundall, P., Potyondy, D., Dedecker, F., Svemar, C., & Lebon, P., (2004). An Innovative 3-D Numerical Modelling Procedure for Simulating Repository-Scale Excavations in Rock – SAFETI, *in Proceedings of the Euradwaste'04 Conference on Radioactive Waste Management Community Policy and Research Initiatives*, Luxembourg.

Conferences

ASC has presented at two conferences in the past six months.

EUROCK 2006 was held at the University of Liege, Belgium between 9th and 12 May 2006. The major theme of the conference was “Multiphysics coupling and long term behaviour in rock mechanics”. Two papers were presented on scaled seismic studies around a deep repository, and interpretation of fracture geometry from induced microseismic events. ASC also presented its products and services at the Technical Exhibition.
Link: http://www.eurock06.ulg.ac.be/

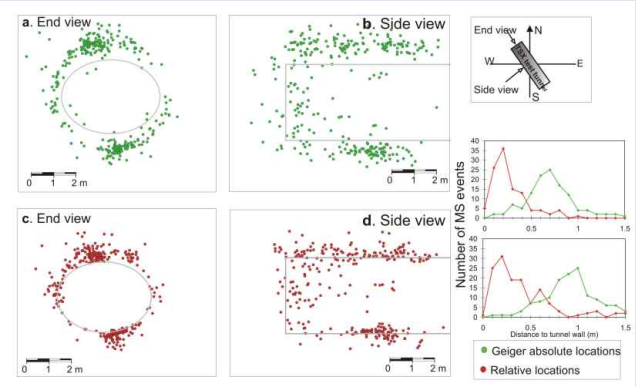
ASC were also in attendance at the ISSMGE Fifth International Congress on Environmental Geotechnics at Cardiff, UK held between 26th and 30th June 2006. Two communications were given on validating 3-D models and monitoring the rock barrier of a radioactive waste repository.
Link: http://www.grc.cf.ac.uk/5iceg/

Relative Location Now In InSite

The InSite Seismic Processor now contains a relative-location algorithm in the location module, following the approach reported by *Reyes-Montes et al.*[2005].

The method has been used to relocate events recorded during excavation of the TSX tunnel at the Underground Research Laboratory (URL), Canada. Locations are improved by an order of magnitude, and define clear structures with planes parallel to the tunnel perimeter.

Classical location routines can often not resolve the potential coalescence of the induced microcracks, since the location accuracy is in the order of magnitude of the largest fractures observed. This is improved by the relative-location technique, in which events are relocated relative to a master event.



Developing AE and Ultrasonic Technologies

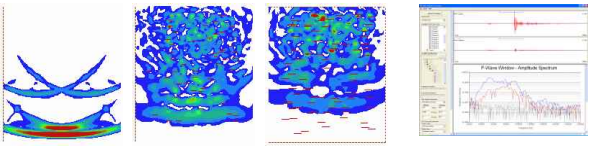
ASC has completed scientific coordination of the OMNIBUS project. This formed part of the fifth EURATOM framework programme; a research and training initiative to help exploit the full potential of nuclear energy. The objective was to develop an ultrasonic tool to monitor the rock barrier at potential geological radioactive waste disposal sites.

The project has resulted in the development and testing of an innovative and unique ultrasonic data-acquisition system for ultrasonic survey and acoustic emission (AE) monitoring for both soft-rock and hard-rock situations.



An advanced processing strategy has also been developed that correlates full-waveform data with many numerical modelling simulations.

An OMNIBUS data acquisition system has already been supplied to a nuclear waste stakeholder and is currently acquiring data in an underground laboratory 450m below the surface. It is hoped that the technology developed will not only be used by organisations charged with evaluating, selecting and operating deep geological repositories for nuclear waste, but also be used in other fields such as civil engineering, mining, and petroleum engineering.



The work involved close collaboration with partners in the UK and Europe, including the University of Liverpool, INERIS and ANDRA.

A copy of the OMNIBUS Final Report is available from our website. Contact ASC for further information and

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