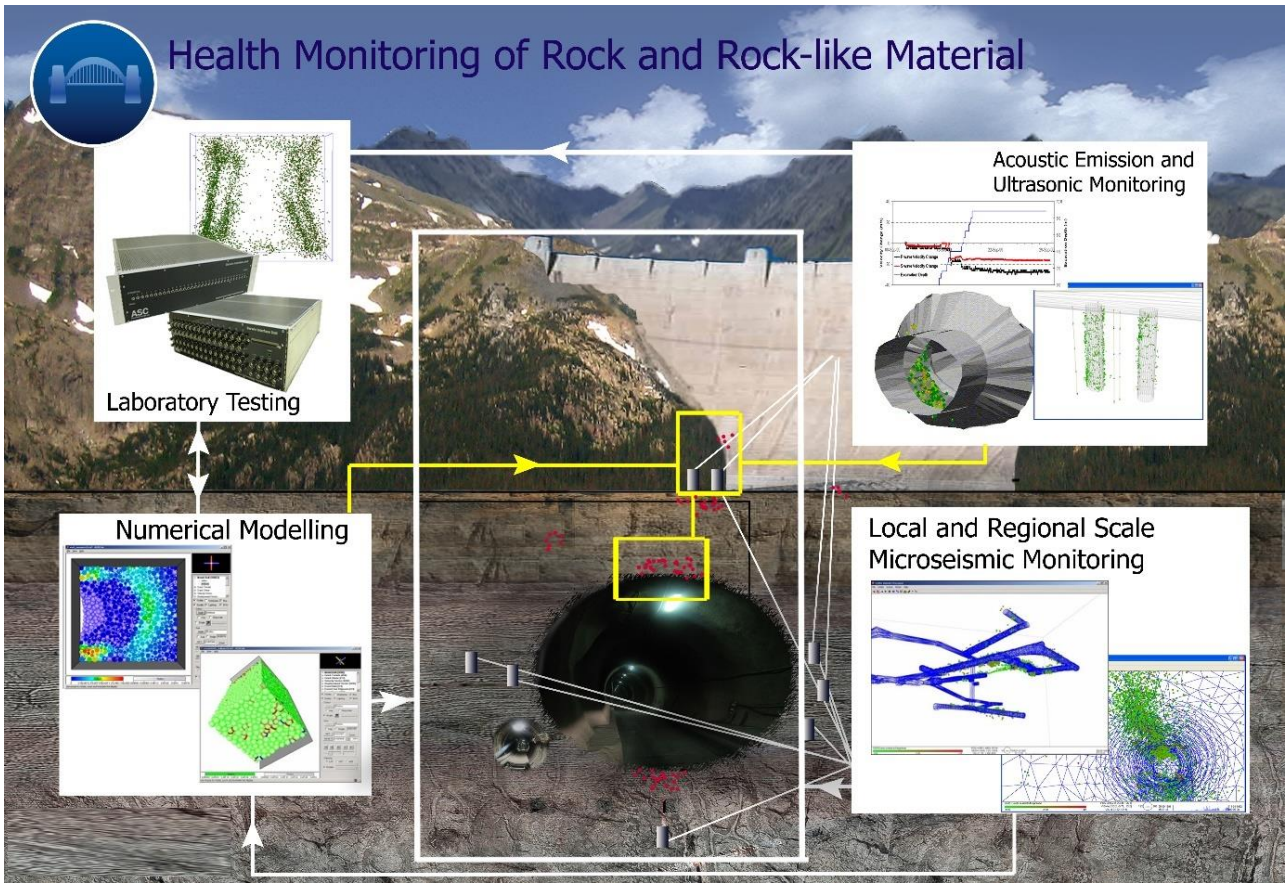
ASC
Applied Seismology
Consulting

CIVIL ENGINEERING



Microseismic and ultrasonic monitoring, both passive and active, allows engineers to non-destructively monitor the integrity of engineered structures and locate areas of weakness. Local and regional seismic monitoring is an essential tool in the assessment of risk around engineering structures and in site characterisation prior to the construction of major infrastructure. The combination of passive and active seismic and ultrasonic monitoring provides a unique tool for:

- Monitoring of structural responses during environmental loading and concrete curing.
- Safety monitoring of tunnels and underground infrastructure.
- Site characterisation and suitability assessment
- Slope stability analysis and integrity assurance.
- Early warning of catastrophic failure of rock, concrete and engineered materials.
- Investigation of active fault zones, compaction and subsidence in and around engineered structures.

Applied Seismology Consulting provides full solutions for the monitoring of engineered structures at all scales:

- coupled innovative high-frequency electronics architecture with real-time data processing software to provide cost-effective solutions with the highest possible data-flow rates and acoustic acquisition specifications tailored to the technological challenges of each project

- hardware-independent integrated software tool for acoustic and seismic data acquisition, processing, management and visualisation providing a full three-dimensional microseismic analysis for both passive and active surveys.

- fully-featured AE microseismic training courses focussed on the principles behind the technology, processing algorithms and hands-on experience of using ASC's hardware and software.

Case Studies

Tunnelling

Tunnels used throughout the engineering industry are monitored and investigated to ensure structural integrity, provide forewarning of any failures and feedback aid in the design of future structures. The aim is to map fracture networks and gain information on rock damage; particular attention is given towards the excavation disturbed zone (EDZ) as this is the area that is most damaged by the excavation process and stress redistribution.

ASC use several non-destructive methods to provide better understanding of the structural changes and changes in material properties occurring around the tunnels. Continuous microseismic (MS) monitoring is a technique that monitors MS events over an array of sensors covering a medium scale volume (typically hundreds to thousands of metres). Continuous acoustic emission (AE) monitoring is a passive technique that records the acoustic emissions of the structure over an array of sensors covering a smaller volume. Processing this data results in a map of fracturing throughout the structure based on the source locations of the MS events and AEs recorded and also source mechanism information.

Ultrasonic velocity surveys are employed at regular intervals to monitor changes in the material properties of the structure, in particular changes in P and S wave velocities.

The Mine-by experiment at AECL's (now CNL) Underground Research Laboratory was designed to investigate the rock failure process around a mechanically excavated tunnel. The absence of AE or MS events within the rock mass approximately a metre away from the excavation surface indicated damage was localised near the excavation surface.

SKB's Prototype Repository Experiment was designed to simulate a disposal tunnel in a real deep repository for disposal of high-level radioactive waste. The aim was to test and demonstrate the integrated function of the repository components under realistic conditions at full scale, comparing results with models and assumptions.

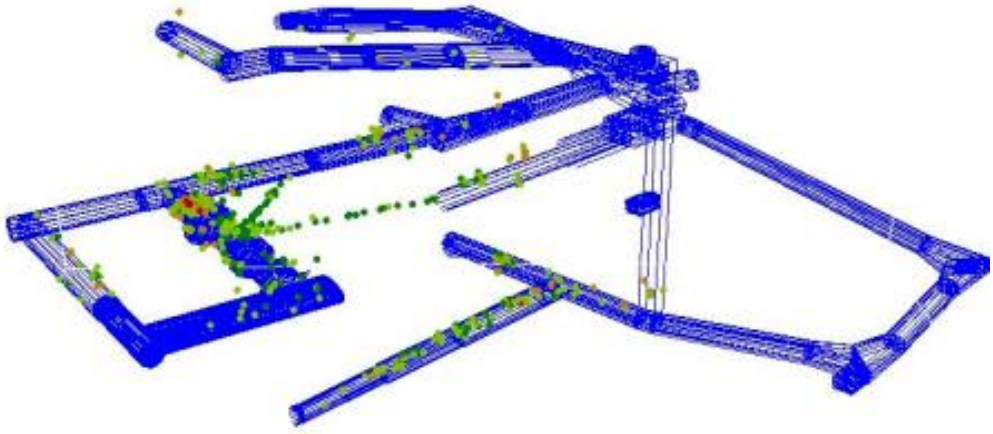


Figure 1: AECL's Underground Research Lab showing all tunnels and some of the microseismicity induced during and after its excavation.

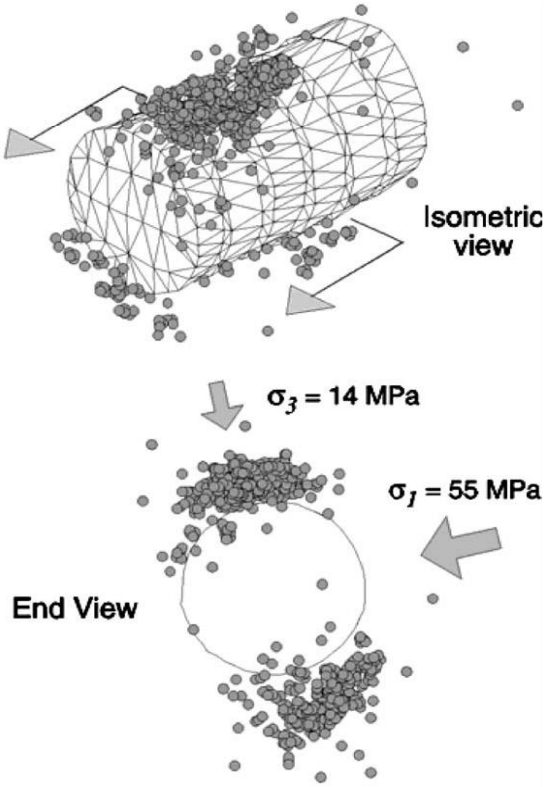


Figure 2: Microseismic event source locations recorded around the Mine-by Experiment tunnel at AECL's Underground Research Laboratory.

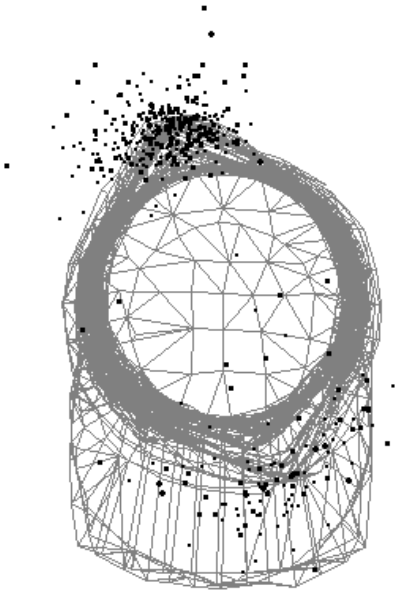


Figure 3: Development of a notch and roof and floor spalling shown by MS locations at the Mine-by tunnel at AECL's Underground Research Laboratory.

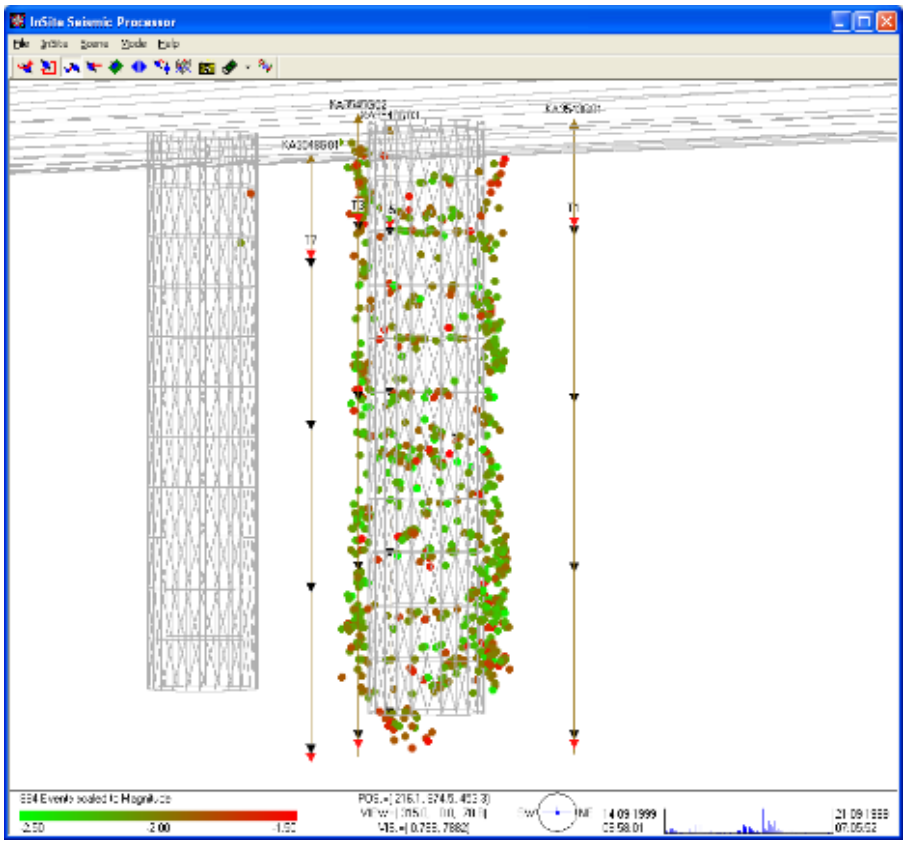


Figure 4: Sample located AE events scaled by magnitude in SKB's Prototype Repository.

Monitoring of Concrete Structures

ASC uses several non-destructive methods to provide the best understanding of the structural changes and changes in material properties occurring in concrete structures.

- Continuous acoustic emission (AE) monitoring is a passive technique that records the acoustic emissions of the structure over an array of sensors. This can provide a map of fracturing through the structure based on the source locations of the AE's recorded.
- Ultrasonic velocity surveys are employed at regular intervals to monitor changes in the material properties of the structure more specifically the changes in P and S wave velocities.

The methods used to monitor concrete structures can be illustrated by the monitoring of the concrete bulkhead in the Tunnel Sealing Experiments (TSX) for AECL during the curing period. The TSX was designed to test seal technology and to measure seal performance.

To do this the seals were monitored as they were subjected to combinations of heat and pressure. The concrete monitoring array consisted of 24 ultrasonic transducers 16 of which were used to continuously monitor AE events whilst the other 8 were used for active velocity surveys.

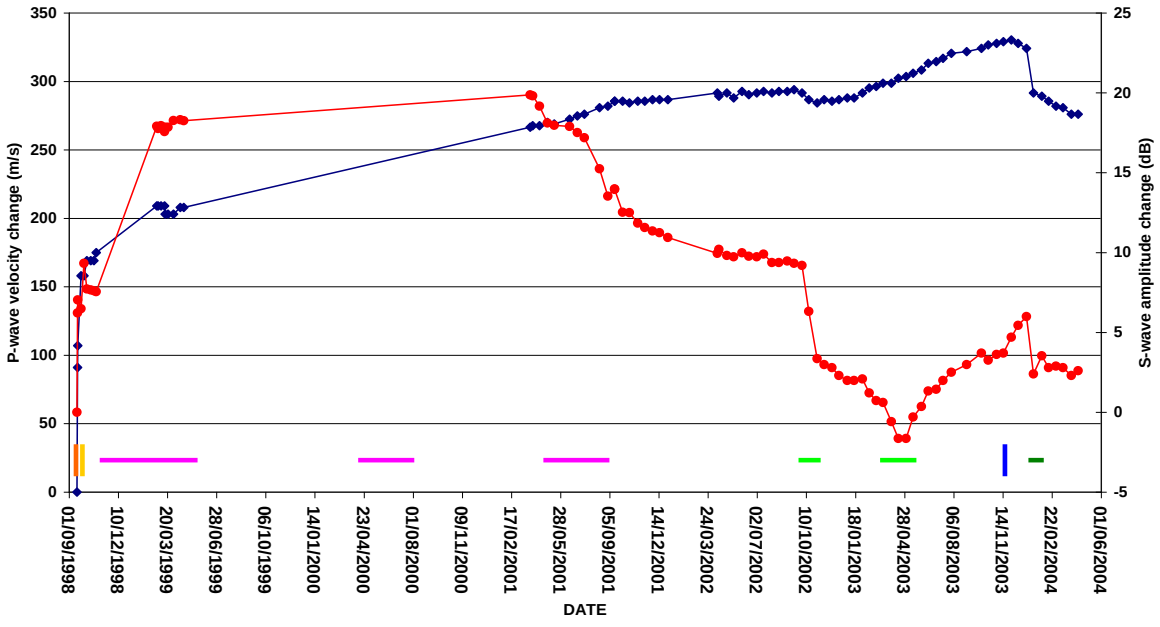


Figure 5: P-wave velocity and amplitude for a ray-path through the concrete bulkhead over a 5-year period of the TSX. (Blue = P-wave, red = S-wave)

At Fracture Nucleation	During Fracture Propagation	After Complete Fracture Growth

Figure 6: Located AE events at 3 different stages through the curing stage of the TSX (16th September - 27th October 1998).

Microseismic processing and Quality Control

REAL-TIME MONITORING

MONITORING DESIGN

MICROSEISMIC TRAINING

CUSTOM SOLUTIONS

QUALITY ASSURANCE

ASC offers a fully integrated service for real-time and post-processing of microseismic data. We have reviewed, quality checked and analysed third-party seismic and microseismic datasets from a wide range of applications. Our seismic and microseismic processing quality control service focuses on the review of location uncertainty and source parameter calculation, specifically sensitivity to velocity uncertainty, tool orientations, location algorithm and phase identification.

Our fully integrated microseismic processing service can provide:

- Seismic risk analysis
- Site and regional seismic characterisation
- Monitoring of regional natural and induced seismicity
- Acoustic Emission and ultrasonic monitoring of material testing
- Imaging of Excavation Damage Zone
- Quality control of acquisition settings and seismic and acoustic datasets
- Instrumentation and monitoring of critical structures
- Enhanced analysis of acoustic monitoring data
- Software Training and Consulting
- Acoustic and seismic monitoring array design
- Validation of geomechanical models

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