Microseismic monitoring and event classification

CSIRO is developing microseismic techniques that will improve our understanding of fracture processes. These techniques increase the value of data captured by microseismic monitoring.

Services

CSIRO has been actively conducting research and development on the application of microseismic monitoring to the resources industry for over 20 years. We provide the following services:

- design and installation of microseismic monitoring systems
- conducting field microseismic monitoring
- processing and interpretation of microseismic data
- analysis of ground response to mining, civil engineering and earthquakes
- geothermal activity assessment.

We are actively developing the microseismic technique to automate and improve the accuracy of event location and classification. We are also working to use microseismic data to understand fracture processes and characterise the rock mass being monitored.

Research activities

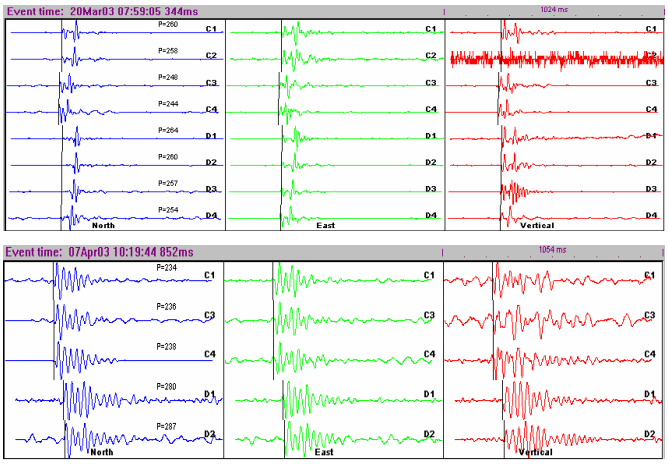
Analysis of microseismic waveforms can yield crucial information about the processes occurring at the source. Understanding the details of the fracturing processes elucidates the rock–mass response to stress changes due to mining and stimulation, allowing proactive measures to be taken to control the process.

For example, rocks can fail in different ways, depending on the stresses, the rock strength, and local pre-existing weaknesses, such as jointing, fracturing, and bedding planes. Rock failure in tension has different geotechnical implications to rock undergoing shear failure, and also has a different seismic signature. Similarly, failures along existing weaknesses can be differentiated from failure through intact massive rock formations, and this also has geotechnical implications.

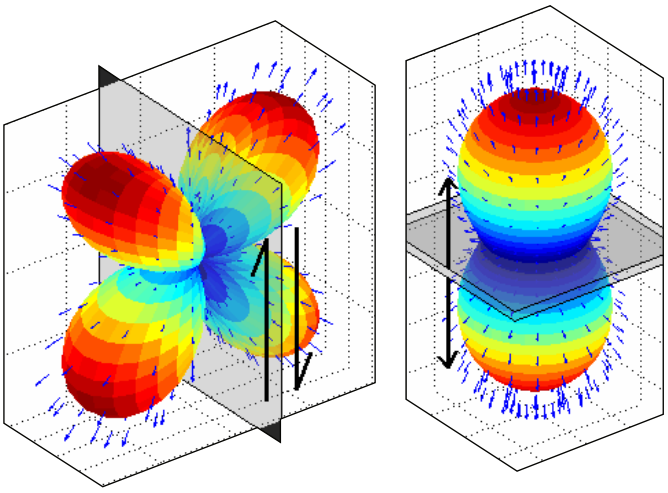
Most seismic waves measured during mining of orebodies and stimulation of a geothermal resource will be due to shear failure on existing fractures.

There is potential for microseismic data to provide information on a reservoir's properties and how they evolve through time. For example, shear wave splitting may be able to show how the amount of fracture space changes in response to stimulation.

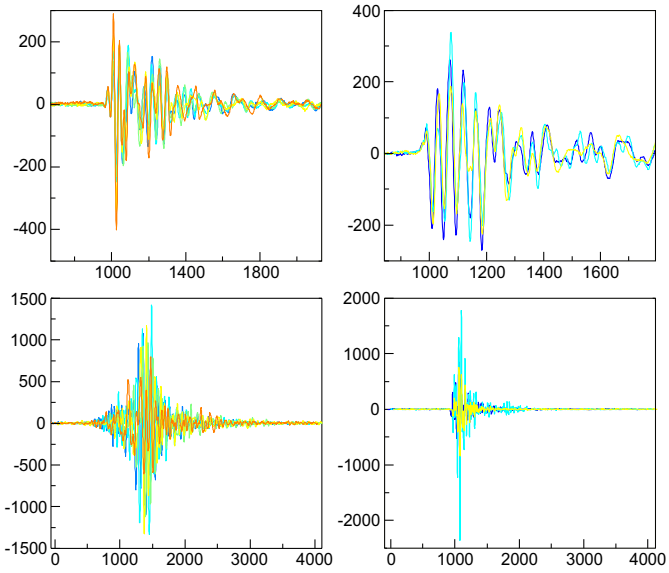
A typical microseismic survey will record thousands of fracture events. CSIRO is working on automatic classification techniques so that the origins of these different classes of events can be distinguished. One successful approach is the use of self-organising maps applied to seismic waveforms.



Microseismic data from an open-pit mine in a geothermal area. Seismograms show (top) a fracture event caused by mining-induced stress changes in the rock, and (bottom) geothermal activity below the pit floor. The seismic waveforms have a distinctly different character.



Shear (left) and tensile (right) seismic events have different radiation patterns: the dependence of seismic amplitude on direction. The strength of the P-wave arrivals as a function of direction are shown here.



Example automatically-generated clusters of seismic waveforms. Each group of waves is caused by a set of fractures with similar source characteristics.

Working with CSIRO

We are able to provide design and installation of microseismic arrays, as well data analysis. We can also integrate our data analysis with fracture modelling capabilities within CSIRO.

CSIRO has well established relationships with Australian and international research institutions, universities, governments and industry. CSIRO provides a range of partnering and technology transfer arrangements.

Key contacts

Joel Sarout
Team Leader
Onshore Gas Program
t +61 8 6436 8770
e joel.sarout@csiro.au