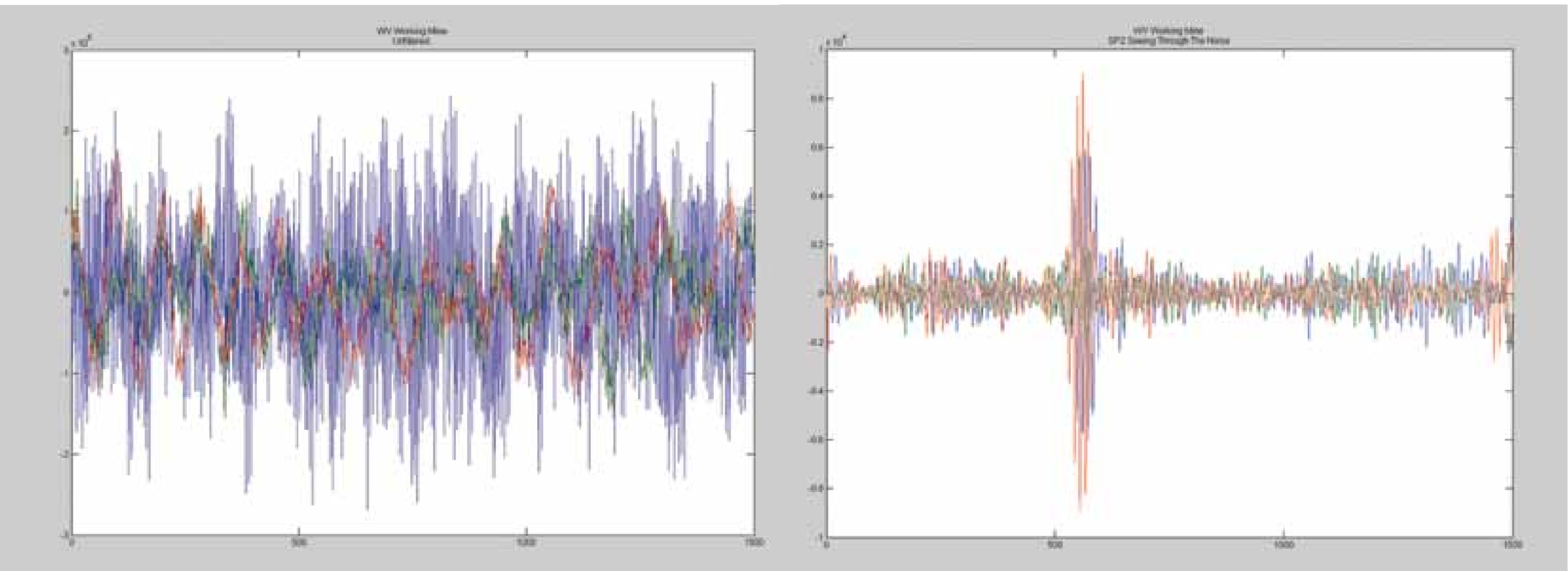
Locating trapped miners

UK-based SureWave Technology Ltd has successfully demonstrated its ability to locate trapped miners underground using its revolutionary micro seismic technology. The test was carried out at a working longwall coal mine in North West Virginia, and commenced at noon 23 February; by 1.05 pm, the 'trapped miners' were located.

SureWave Technology can identify microscopic sounds a thousand or more feet below the earth's surface

Simulating the trapped miners was achieved by 'trapped miners' striking the roof, within a fully functioning coal mine, with a crib block, a 6" x 6" x 42" wooden timber commonly found in coal mines. Two location tests were undertaken – the first at 780 feet, the second at 1040 feet. In both tests, SureWave's technology clearly identified the 'trapped miners' signal by filtering out the majority of the background noises present within the mine.

Philip Shaw, the company's MD, first developed this technology over a decade ago. His original goal was to monitor mine stresses to give advanced warning of structural failure in UK coal mines. Shaw's technology successfully forewarned of a mine collapse 18 weeks before it occurred. The new technology was first eemonstrated at the Blue John Cavern in Derbyshire, England last December where SureWave located the sound of stamping feet 350 feet (106m) underground. Mine owners, through SureWave Technology, now have the ability to monitor the stresses within the mine enabling them to be forewarned and hence prevent a calamitous event occurring within the working mine.



The graph on the left displays typical noise picked up from a working mine, whilst the graph on the right shows how SureWave Technology filters out unwanted background noise.

How does it work?

Mining excavations cause changes in the stress field in the surrounding rock mass, which in turn cause seismic events. Most seismicity is expected above and behind the working face or the caving zone. Rock mechanics models can be used to predict how the rock mass behaves as a result of changes in the stress field. Seismometers are located in boreholes, while the recording unit is located on the surface. Each event is recorded as a dataset of event time (to +/- 1 mSec), displacement, acceleration, velocity, frequency are then analysed into magnitudes in three orthogonal directions.

Events are located by finding the direction of polarisation of the P-wave to give the source-receiver direction. The difference between P-wave and S-wave arrival times gives the distance to the source from the receiver. This in fact gives two locations in opposite directions, so an assumption is made to remove one of the locations, for example, by assuming that events cannot occur above the ground.

The locations of events can be displayed 3-dimensionally, highlighting if there is cause for concern. A random scatter would indicate normal micro seismic activity. However, a cluster of events is indicative of excessive stress in the rock structure at that location. A further refinement of the data is a 3-dimensional display where each event is depicted as seismic moment (colour) and source radius, magnitude and velocity in three directions (ellipse).

In the case of the long wall coalface, there is virtually no recorded micro seismic activity at seam level. Most activity occurs about 150m above the seam ie; in and above the sandstone. This agrees to a good extent with the rock mechanics model. The stress levels and clustering is indicative of a major cause for concern.

The location of oil or water deposits or of large cavities comes from the seismic signals which are generated by echoes from the boundaries of the deposits or cavities. Usually these signals are at a low signal level and are normally swamped by background noise. The sensitivity and wide dynamic range of the equipment allows these signals to be captured and identified.

P-wave

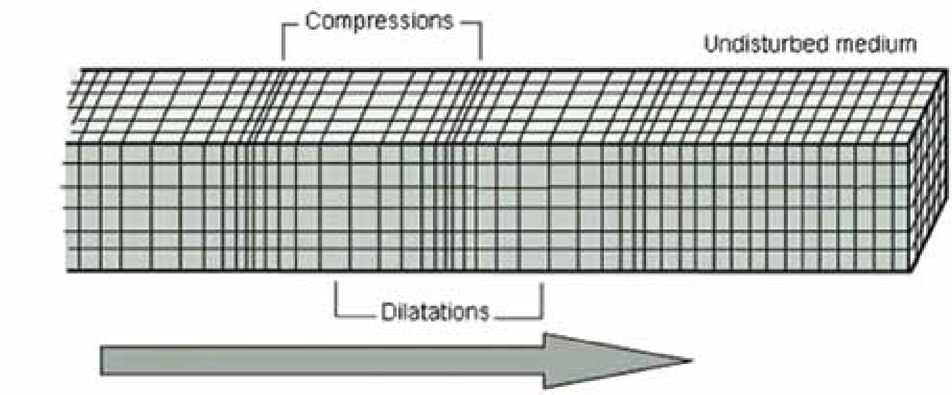
The P-wave or primary wave is a fast propagating seismic wave. The P-wave moves through solid rock and liquids. It pushes and pulls the rock as it moves through the medium. Particles in the medium have vibrations that are parallel to the direction of wave propagation.

S-Wave

S-waves or secondary waves travel much slower and can only move through solid material. This wave moves rock up and down, or side-to-side. Particles in the medium have vibrations that are orthogonal to the direction of wave propagation.

The greater the separation between P-wave and S-wave arrivals, the greater the distance between the sensor and source event.

P Wave



S Wave