

# Breakthrough in micro seismic technology locates 'trapped miners'

IN A VERIFICATION TEST AT A WORKING LONGWALL COAL MINE IN NORTH WEST VIRGINIA

In a recent verification test at a working coal mine in northwest Virginia, SureWave Technology successfully demonstrated its ability to locate trapped miners underground using its revolutionary micro seismic technology. The test commenced at noon February 23. At 1.05 PM, the 'trapped miners' were located.

The simulation of trapped miners was achieved by 'trapped miners' striking the roof, within a fully functioning coal mine, with a 'Crib block' – a 152 x 152 x 1,067 mm wooden timber commonly found in coal mines. Two location tests were undertaken – the first at 238 m, the second at 317 m. In both tests, SureWave's technology clearly identified the signal by filtering out the majority of the background noises present within the mine.

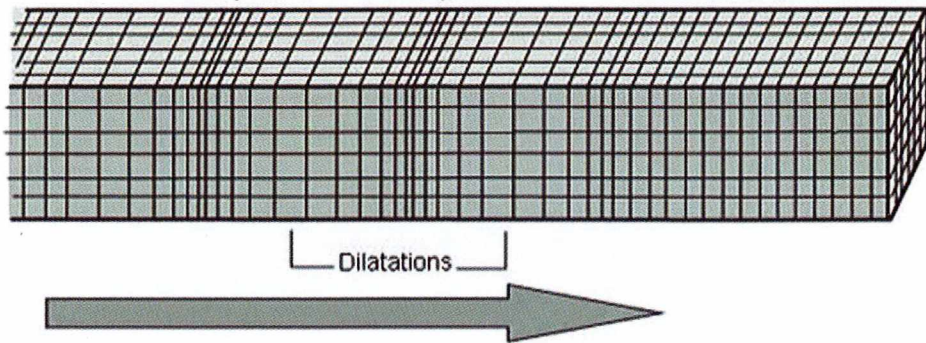
Philip Shaw, Managing Director and Chief Scientist, stated "Based on [the] test, we are confident our state of the art technology would be able to locate miners trapped to a depth of up to 2000 ft (over 600 m). What is also remarkable about SureWave's technology is that it is capable of detecting and locating within minutes or so of being deployed". He then added that to the best of his knowledge, "there is no other technology in the world that can identify these microscopic sounds a thousand or more feet below the earth's surface, which are typically masked by the surrounding noise and rapid attenuation".

Keith Heasley, Professor of Mining Engineering at West Virginia University who facilitated and directed the testing procedures at the coal mine commented, "I was pleased to clearly see the signal from the miners pounding on the roof at that depth. This system performed much better than other systems I have seen".

Shaw 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.

Ten years later having perfected his technology in mine safety, the use for locating trapped miners was an obvious product evolution. He explains: "Given the system's ability to accurately locate underground acoustic events many thousands of times smaller than the noise generated by the activity from the working mine, the technology is ideal to detect events underground and locate these signals in a few seconds".

*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 first demonstration took place at the Blue John Cavern in Derbyshire, England last December where SureWave located the sound of stamping feet 106 m underground.

SureWave Technology can be used by operators to monitor the stresses within the mine, enabling them to be forewarned and hence prevent a calamitous event occurring within the working mine. At the same time they will have the ability to locate anyone should they become trapped through other events.

David Manning, an investor and SureWave director, added, "As we all know it took 17 days to determine that the Chilean miners were alive and locate them. Based on today's successful demonstration, our technology would probably have located them in hours". Manning also raised the security applications of the technology noting, "Since we are certain we can find men up to 2,000 feet underground, we can obviously very easily find individuals doing shallow tunnelling under secure perimeters".

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 i.e. in 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.

*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*

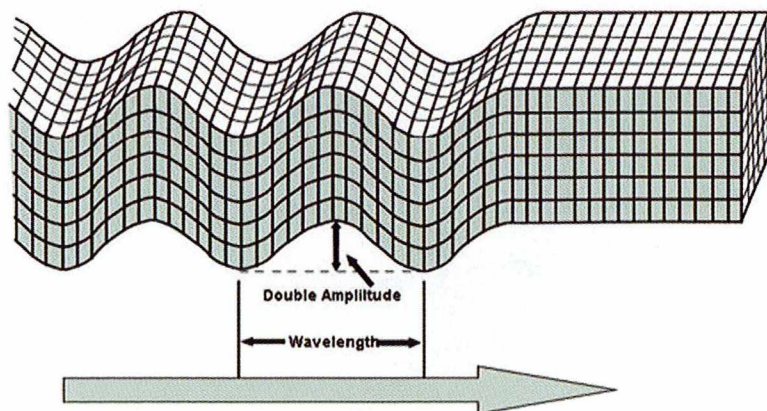
Each event is recorded as a dataset of event time (to ±1 ms), displacement, acceleration, velocity, frequency are then analysed into magnitudes in three orthogonal directions

Events are located by finding the direction of polarization 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 e.g. by assuming that events cannot occur above the ground.

The locations of events can be displayed three-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 3D 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 longwall coalface, there is virtually no recorded micro seismic activity at seam level. Most activity occurs about 150 m ▶

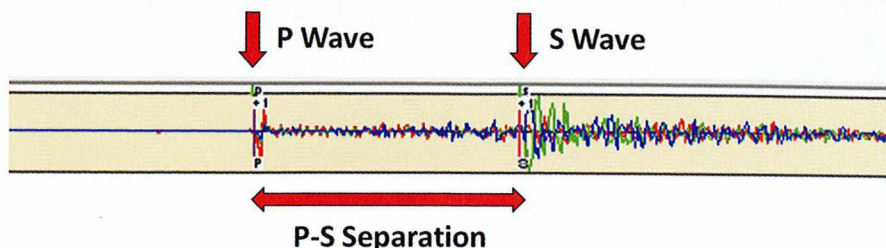




*The greater the separation between P-wave and S-wave arrivals, the greater the distance between the sensor and source event*

above the seam i.e. 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.

[www.surewavetechnology.co.uk](http://www.surewavetechnology.co.uk)

## PRODUCTIVE CONVEYING AT M-CLASS MINING IN THE US

Joy Mining recently completed the installation of two 2,130 mm belt width slope conveyors for M-Class Mining's new Sugar Camp Energy underground coal mine located in the State of Illinois. Both are rated at 9,072 t/h. The Slope A conveyor, 1,060 m long with 145 m of vertical lift, is comprised of an 5,966 kW four-pulley remote drive with a 112 kW constant tension vector winch electric take-up. The take-up is installed near the Slope A tail end which is half the distance from the surface to the coal seam.

The Slope B conveyor, 1,143 m long with 91 m of vertical lift, is comprised of a 4,475 kW four-pulley remote drive with another 112 kW constant tension vector winch electric take-up. The take-up is located near the tail end in the coal seam. The Slope B conveyor discharges onto the Slope A conveyor midway down the mine slope at a 171° transfer angle.

Both slope conveyors include 1,830 mm diameter by 2,360 face width drive and discharge pulleys weighing up to 28.7 t each. The take-up and tail pulleys are 1,520 mm in diameter by 2,360 mm face.



All of the surface conveyors at Sugar Camp Energy were also included in Joy's scope of supply. The surface conveyors include an 2,130 belt width raw coal stacker, a 1,520 mm plant feed conveyor, a 1,830 mm clean coal collecting conveyor and clean coal stacker conveyor, a 1,520 mm refuse collecting conveyor with 1,070 mm sub-refuse conveyors, and a 1,830 mm belt width train load out conveyor. All surface conveyors have been operating since May 2010.

Conveyor systems for all underground operations are also part of this project and will be installed as mine plans are implemented. Mainline conveyors will be 1,830 mm systems and longwall panel conveyors will be 1,520 mm systems. Components for all conveying systems were manufactured at Joy's plants in Winfield, Alabama and Salyersville, Kentucky.

[www.joy.com](http://www.joy.com)

*A 2,130 mm belt with underground 171° conveyor transfer*

## Joy Global in deal to buy LeTourneau

Joy Mining and P&H Mining Equipment owner Joy Global, has signed an agreement to acquire a 100% ownership interest in LeTourneau Technologies from Rowan Companies for \$1.1 billion. The deal brings together one of the leading manufacturers of surface rope shovels for mining with the world's leading supplier of large wheel loaders for mining. Joy Global is likely to have felt pressure to grow further following the Bucyrus/Caterpillar deal.

The move should make for an interesting future in product development. LeTourneau is well known as an innovative group, such as its development of switch-reluctance (SR) wheel motors for its electric drive loader range. The company is also famous for its huge L-2350 loader, which is capable of loading 400 short

ton trucks. After a slow start in early years of sales, this model is now experiencing renewed demand with the booming coal industry. It is also often forgotten that LeTourneau at one time manufactured mining trucks – the Titan range – including a concept model for a 320 short ton model, the T-2320, back in 1992.

LeTourneau operates two business segments — mining products and drilling products. LeTourneau's drilling products business is a leading designer of offshore jack-up drilling rigs as well as a manufacturer of the primary components for these rigs. It is also a major manufacturer of drilling equipment for large land and offshore rigs and of specialty steel products.

Mike Sutherlin, Joy Global President and Chief Executive Officer commented: "The

LeTourneau mining products business is a natural fit with our P&H business. It adds another solution for surface loading that complements our electric mining shovels, and gives us access to smaller and non-electrified mines."

Randy Baker, President and COO of P&H Mining Equipment said, "The addition of LeTourneau's front-end loaders will enhance our product offering and leverage our existing manufacturing and product distribution networks. We expect a smooth integration since P&H already serves as a dealer for LeTourneau in key geographies around the world. In addition, LeTourneau's electric drive technology is more efficient than mechanical drive systems, which has resulted in strong order growth." [www.joyglobal.com](http://www.joyglobal.com)