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A Twelve Pound Solution to a Weighty Problem

With the help of a 12-pound hammer and “dinner-sized” metal plates, geophysicist and seismic imaging specialist Professor Gerard Schuster plans to make his mark on the underground mining industry. As a 30-year veteran in the development of seismic modeling and imaging methods, he has spent the majority of his career teaching university students, developing geophysical methods for imaging oil and gas underground, and investigating the mitigation of earthquake hazards. He will now dedicate the next few months to testing and developing a scientific approach that may help locate miners trapped underground. The technology employed by Schuster and his team of scientists at the University of Utah sounds like something out of a science fiction film—time reversal mirrors.

It was a tragic day in August 2007 that inspired Schuster’s idea. A mine in Huntington, Utah, called Crandall Canyon, collapsed and killed six miners after a catastrophic coal outburst. Ten days later, the mine claimed the lives of three additional men during rescue efforts. Schuster had just returned from Saudi Arabia after five months of conducting research in seismic

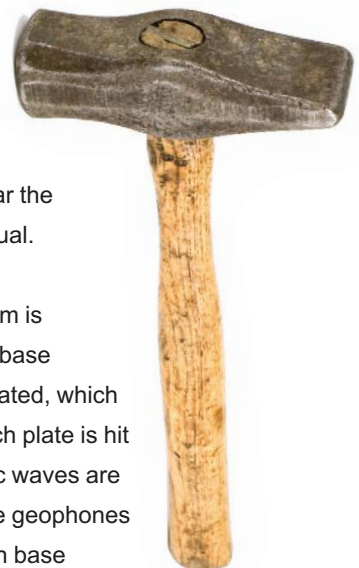
exploration methods when he heard news of the accident. He had also just read an article in the publication *Science* about the concept of time reversal mirrors (TRM) and used this idea for his research in enhanced oil recovery at the Saudi Aramco research center in Dhahran. Schuster made an immediate connection. “I thought, oh, this is something that can be used for mine rescues,” Schuster recalled. “It’s an unconventional solution that some mining professionals haven’t thought about.”

The technology used in the miner-locating system has been around since the 1970s to search for oil and was later investigated by the military to communicate and locate submarines with quiet propulsion systems. TRM technology records sound waves and projects them back exactly to their point of origin. Acoustics specialists build a TRM using an array of piezoelectric transducers. These devices can act both as microphones, which convert sound pressure fluctuations into electric signals, and as loudspeakers, which convert electric signals into vibrations that people hear as sounds.

The system devised by Schuster and University of Utah scientists, works by bolting metal plates, 300 feet apart, along the walls of an underground mine. Each plate is accompanied by a 12-pound hammer. In the instance of a mine collapse, a trapped miner would use the hammer to bang on a metal plate. On the surface, cables are strung along the ground above and “geophones” are spaced at regular intervals along the cables. Geophones listen for seismic waves created when miners use the sledgehammer to bang on a metal plate.

The harder the plate is hit, the better the safety team above ground can hear the trapped individual.

Once the system is installed, each base station is calibrated, which means that each plate is hit and the seismic waves are recorded by the geophones overhead. Each base



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station has a distinct seismic wave “fingerprint” that is referred to as a calibration record. If miners are trapped and bang the metal plate at the nearest base station, the resulting seismic recording is compared to the calibration records and will allow rescuers to determine precisely which base station plate was thumped, and thus, where the miners are located. The system would cost about \$100,000 for a typical mine.

According to Schuster, mine rescue workers sometimes use a type of listening device to help locate trapped miners, but it is not as effective as it could be. “Current methods take only a small sample of the seismic fingerprint to identify the miner’s location. For example, imagine taking an image of

someone and only being able to determine that they have blue eyes and blonde hair. This leads to ambiguity in identification,” Schuster said. “The time reversal mirror technology provides much more detail. It would often allow us to unambiguously determine hair color, eye color, height, weight, gender, etc.”

Schuster and his team of researchers at the University of Utah began testing the approach in 2007. They have performed computerized simulations and field tests in a utility tunnel beneath the University of Utah campus and in an abandoned copper mine near Tucson, Arizona. Both tests proved successful, but the next few months will serve as the tipping point. This spring,

Professor Schuster, his colleague Sherif Hanafy and their team successfully tested their method on a sandstone mesa near Moab, Utah and have plans this summer to begin testing in a Nevada gold mine more than 500 feet underground. He admits that the response from the mining industry has been luke-warm. “Most people are taking a wait-and-see position. But the response from some miners has been positive,” he said. “It’s not guaranteed to work every time, but it looks promising.”

References:

1. <http://www.newscientist.com/>
2. University of Utah. (2009, March 27). New Listening Device Should Help Find Trapped Miners. *ScienceDaily*. <http://www.sciencedaily.com/releases/2009/03/090326084756.htm>

