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# Use of Seismic Tomography To Identify Geologic Hazards in Underground Mines

## Objective

Develop geophysical techniques suitable for enhancing miner safety. Specifically, to use geophysical methods to detect hazardous conditions in a rock mass in deep underground mines as well as to assess the mechanical integrity and monitor changes of the rock.

## Background

Currently, no adequate method exists to determine the amount of relative stress in large rock pillars in deep underground mines. The greater the stress, the greater the chance of violent ground failure, which is a safety hazard to miners. Existing methods to determine stress are time consuming and expensive and can only be used in localized areas. Also, the measurements collected are often of limited quality. Seismic tomography, as used to determine stress, is based on the principle that P-wave velocities in highly stressed rock will be relatively higher than P-wave velocities in rock under less stress. In this technique, seismic waves are generated that penetrate a rock mass and, based on measurements of apparent velocities, used to develop stress gradient contours (tomograms). The benefits of using seismic tomography to identify high stress in deep underground pillars include the method's reliability, cost effectiveness, and efficiency. Engineers can evaluate stresses large rock masses, as well as monitor pillars during the mining cycle.

## How It Works

This method requires striking a source location with a 4.5-kg sledgehammer fitted with a trigger connected to a seismograph and then recording the first arrival of the seismic wave at stations where receivers (geophones) have been installed. Geophones are mounted to a rib using rock bolt plates that are drilled, tapped, and surveyed using the mine coordinate system. Each geophone is hooked to a seismic cable connected to the seismograph, and a two-pair shielded cable is used both for communication and as a trigger for the seismograph. A signal-stacking seismograph is used to record P-wave arrivals, and all seismic data are transferred from the seismograph to a personal computer (PC). The travel times (first arrivals) are "picked" from the seismic records. All receiver and source location coordinates (x,y,z) are input into a spreadsheet, and travel times are entered into a software program (3DTOM) for reconstruction. Finally, contouring software is used to smooth the tomograms and add text and mine openings for final presentation and interpretation.

## Tests Results

Spokane Research Laboratory personnel have conducted six seismic tomography surveys at three deep underground mines. The technique has proven to be reliable in each survey, and high stresses in the mapped rock masses have corresponded with later seismic activity, rock bursts, and major ground falls. In all the surveys, low-velocity areas corresponded with fractured rock and mine openings, and high-velocity areas corresponded with unmined pillars above stopes, corners of pillars, and known areas of high stress.

## Summary

Spokane Research Laboratory personnel have developed a PC-based seismic tomography method that is reliable, cost-effective, and efficient. This method is capable of mapping and monitoring large rock masses. This technology can be used to identify high-stress conditions that may result in ground failure and affect the safety of miners.

**U.S. Department of Health and Human Services**

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National Institute for Occupational Safety and Health

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# For More Information

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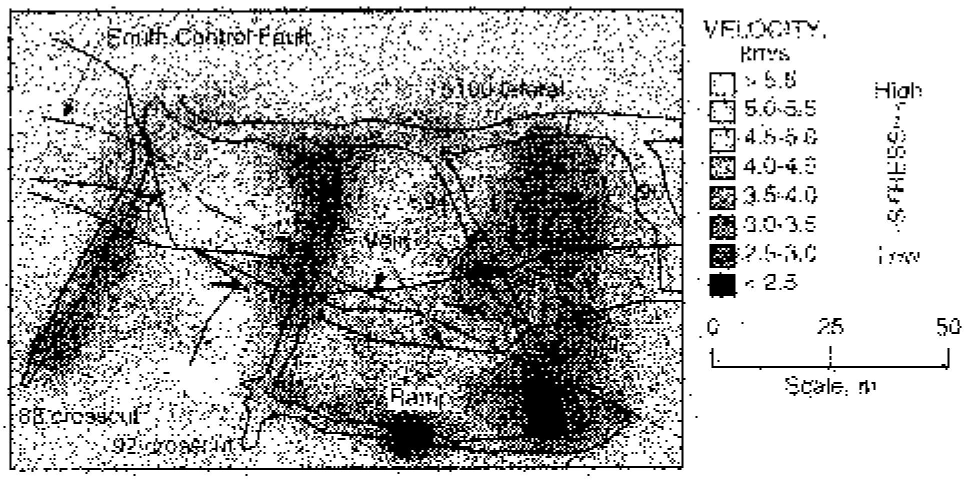
To receive additional information about mining issues or other occupational safety and health problems, call **1-800-35-NIOSH (1-800-356-4674), or visit the NIOSH Home Page on the World Wide Web at http://www.cdc.gov/niosh/homepage.html**

**As of October 1996 the safety and health research functions of the former U.S. Bureau of Mines are now located in the National Institute for Occupational Safety and Health (NIOSH).**




**Example of seismic tomogram**