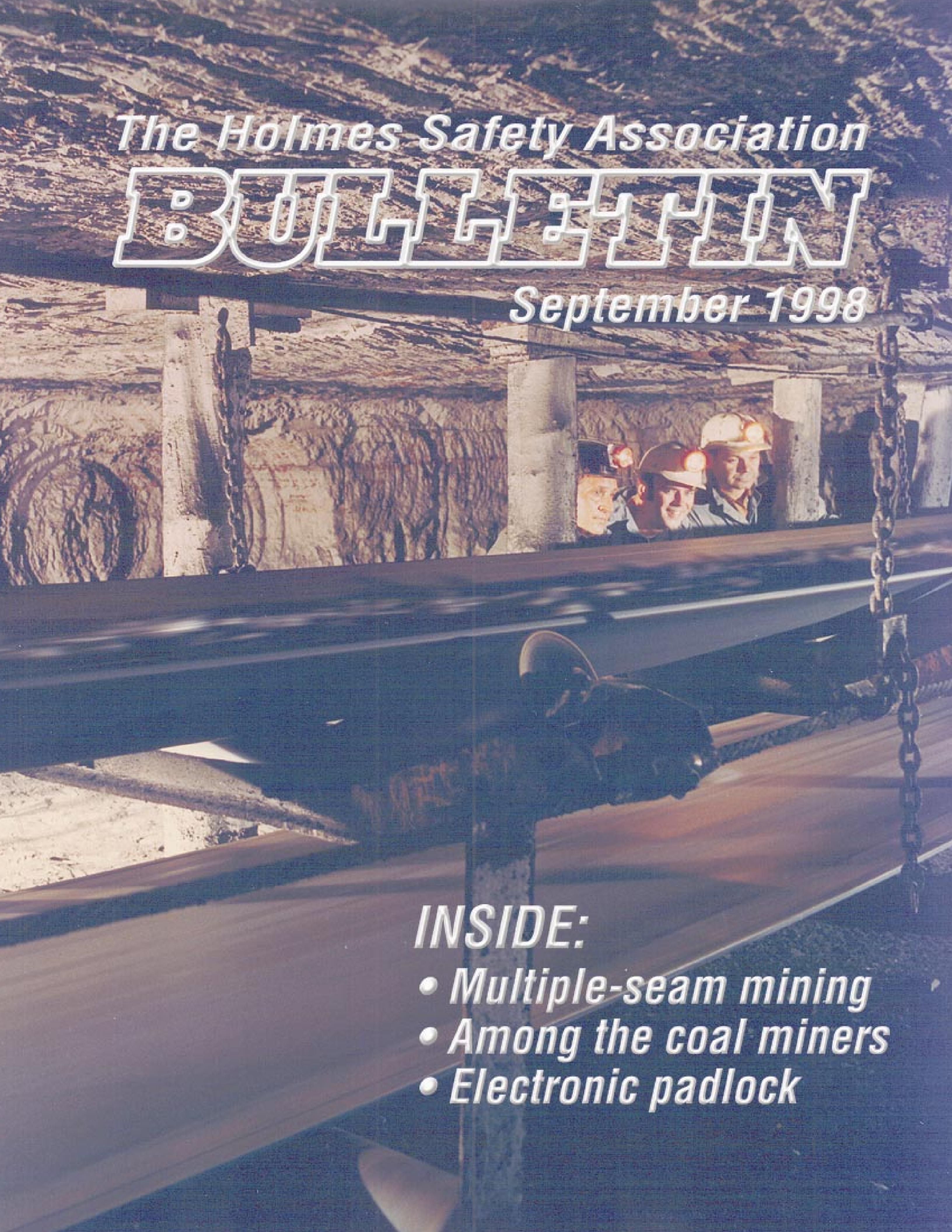
The Holmes Safety Association BULLETIN

September 1998



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Multiple-seam mining

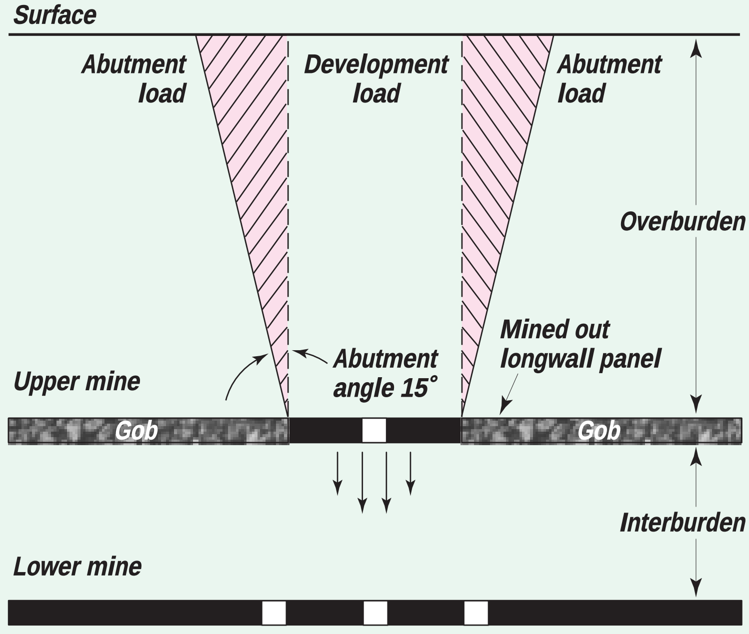
By Gregory J. Chekan

The Clean Air Act of 1992 required lower sulfur dioxide emissions, increasing demand for low-sulfur coal. Some of the the low-sulfur coalbeds in the Appalachian Coal Region occur at depths ranging from 500 to 2,000 feet. Historically, coal in this region has been mined without consideration for the influence on other adjacent coalbeds. As a consequence of this practice, environmentally acceptable compliance coal may be more difficult to mine because of ground control problems associated with multiple-seam mining. Developing design technology or models to safely mine coal above or below an existing mine provides an economic and employment opportunity and a domestic source for U.S. energy requirements.

Multiple-seam mining requires a comprehensive understanding of the stress transfer that occurs between two coalbeds. Obviously, mine design is crucial for roof, rib, and floor stability. Pillar and entry dimensions, positioning, as well as the timing during mine development, affect overall conditions in the mines.

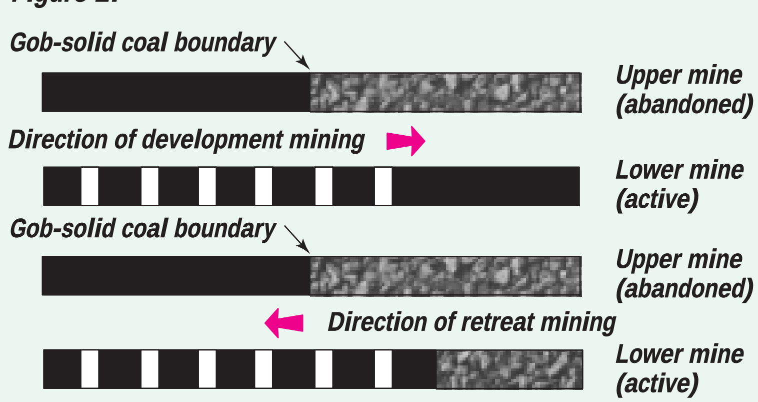
Multiple-seam mining research, for the most part, has concentrated on two areas. The first area constitutes the bulk of the research to date and involves the analysis of field data. These empirical studies involved observation or use of geomechanical instrumentation to gather data leading to descriptive conclusions of ground problems and design recommendations for improving operation stability. Empirical studies based on case study documentation have revealed the factors under which interactions of the coalbeds are most likely to occur. These studies showed that both geology and mine design influence interactive distance, magnitude, and location.

Figure 1.—



Other multiple-seam research involves the use of numerical methods for predicting interactive problems. These methods combine case study results with theoretical and statistical analysis in attempting to develop optimum mining plans for multiple-seam conditions. Photoelastic and numerical models have provided insight and improved understanding of mining-induced stress and interactions with other workings. Numerical models can also simulate relative stress distribution and transfer under varied design parameters or conditions.

Figure 2.—



Health and safety research has provided practical information and guidelines on multiple-seam design for both longwall and room-and-pillar mining. For instance, a method was developed to assist operators size lower-seam gate road pillars when super-positioning is practiced in longwall mining, as shown in Figure 1.

In room-and-pillar operations, high stress zones are usually encountered in the lower mine when mining beneath an isolated barrier pillar or a gob-solid coal boundary in the upper mine. To reduce stress in the lower mine pillars, retreat mine from the gob to the solid side of the boundary and support the barrier edge with a row of pillars, as shown in Figure 2.

*Reprinted from NIOSH's Pittsburgh Research Center's **Mining Health and Safety Update—Research Profiles**.*

Information Circulars 9360 and 9403 provide more detail on multiple-seam research. For a copy of these reports or additional information, call Greg Chekan at (412) 892-6749 or Dave Ingram at (412) 892-6547.

Mechanical hard rock mining: present and future

The advantages offered by mechanical mining have been demonstrated in the underground mining of coal, evaporites and other soft minerals.

Mechanical mining and the advancements in automation technologies have been the principal drivers towards the realization of enhanced productivity in soft rock mining.

For the past two decades, emphasis has been placed on developing mechanical mining technology for hard rock applications to achieve similar productivity improvements and cost reductions. The benefits of mechanical mining are numerous, particularly in an industry where market conditions continue to dictate higher production and lower costs while maintaining high safety standards.

Other benefits of mechanical mining include reduced ground support and labor requirements and the elimination of blast and diesel fumes. These benefits further make this technology an attractive alternative to drill and blast for hard rock mining. Mechanical mining is conducive to full implementation of remote control and automation technologies that are under development to achieve further productivity and safety improvements in underground mining.

Mine development has been the main focus area for mechanical miners by manufacturers and mining companies. Potential applications include ore body access, haulage and ventilation drifts, undercut and exploration drifts.

The economic use of this technology in mine production is still considered many years away. It would need a major technological breakthrough that would make mechanical rock fragmentation competitive with the large-scale, low-cost production blasting operations.

The TBM revolution

The transfer of existing rock excavation technology from the civil underground construction field has been one approach to the development of mechanical hard rock mining technologies. In this regard, tunnel boring machines (TBM) have revolutionized the civil tunnel construction field. So TBMs are the obvious candidate for use in mine development.

Some of the earlier attempts of this technology transfer failed to meet expectations. This was due to the use of existing machinery that was not suited for the conditions and requirements of mine development projects. However, when a machine was modified or a new one was built to meet the needs of mine development, the application of TBMs resulted in cost and time savings compared to conventional methods.

Two examples of successful TBM applications in hard rock mining are the Stillwater Mine and Magma Copper's San Manuel Mine. In the latter case, a 4.62-m(15-ft-) diem TBM drove more than 10 km (6 miles) of tunnels for the development of the Lower Kalamazoo ore body. After initial startup problems and certain machine modifications, this TBM was able to attain an average advance rate of about 22 m/day (72 ft/d). This rate could not be matched with even the most advanced drilland-blast method.

TBMs are large, heavy pieces of equipment designed primarily to excavate long, straight tunnels. Therefore, their application to mining is limited to longer drives without sharp turns, as was the case at Magma. In response to the needs of the mining industry, TBM manufacturers have developed designs to allow a tighter turning radius and more system flexibility with the capability to handle adverse and changing ground conditions.

Despite these new features, however, TBMs still are not suited for the day-to-day development needs of hard rock mining where system mobility and versatility are important. However, for initial mine development efforts where long drivages are generally required, TBMs are a cost-effective and productive alternative to drill and blast.

It is also important that mine development plans are tailored along the capabilities and limitations of TBM technology to gain the utmost benefit from its application. This means making every attempt to configure the development plans to best fit the basic features of TBM excavation.

The hard rock mining industry needs a mobile excavator that can meet the daily development requirements of the mine. This means a "continuous