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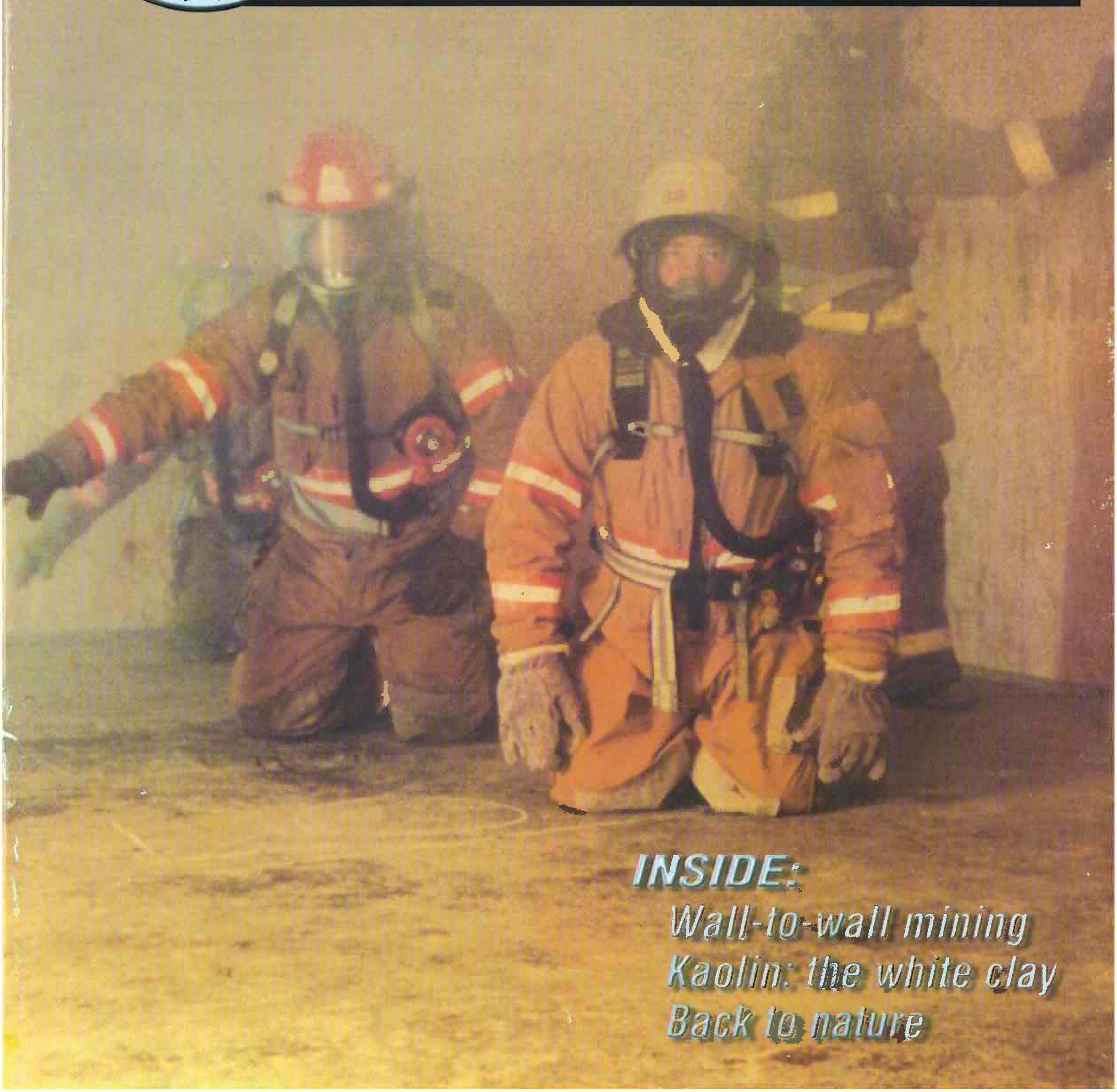

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The *Holmes Safety Association Bulletin* contains safety articles on a variety of subjects: fatal accident abstracts, studies, posters, and other health and safety-related topics. This information is provided free of charge and is designed to assist in presentations to groups of mine and plant workers during on-the-job safety meetings.

PLEASE NOTE: The views and conclusions expressed in *Bulletin* articles are those of the authors and should not be interpreted as representing official policy or, in the case of a product, represent endorsement by the Mine Safety and Health Administration.

THIS MONTH'S COVER: Provided by MSHA's Mine Safety Academy in Beckley, W.Va. The photo shows a mine rescue team practicing in a smoke-filled entry at the Academy's mine simulation laboratory.

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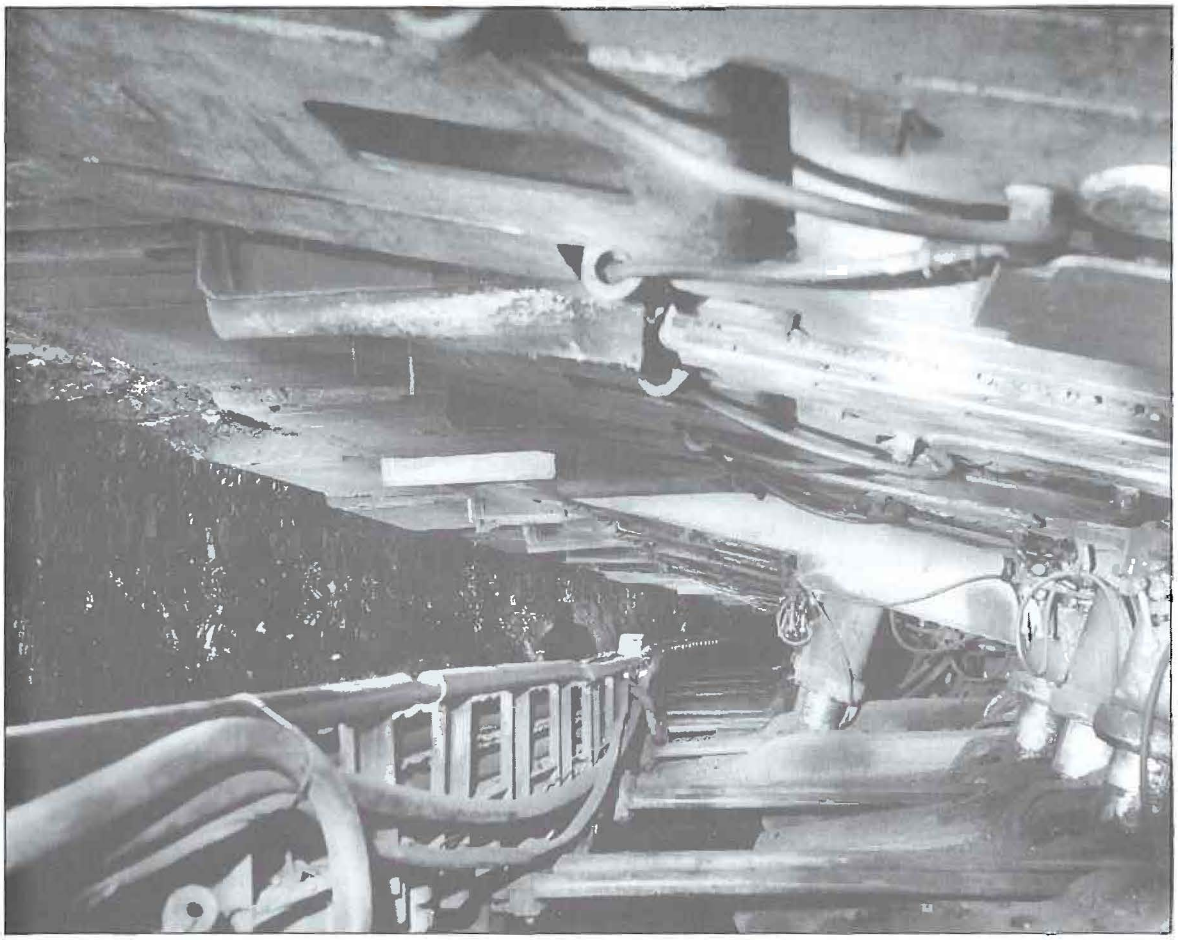


Wall-to-wall mining

Surface mines that have increasing overburden may be able to use longwall methods without the large capital investment required with underground mining

By: by Randall D. Peterson, P.E.

Unit costs for underground coal have declined greatly over the past 15 years due to continuing improvements in longwall mining technology. During this same time period, surface mines have experienced rising overburden removal and reclamation costs. Surface mine productivity improvements, at operations with increasing strip ratios, have not been able to offset the higher stripping costs.

These opposing trends have led several surface mining companies to consider making the transition to longwall mining methods, either to supplement surface operations or to replace them. This has resulted in the need to redefine surface and underground mining reserve boundaries and the economics that define them. More importantly, it has placed a large proportion of reserves (above the 5:1 strip ratio) within reach of unique economic mining opportunities. A unique mining method may allow surface mines, facing ever increasing stripping ratios, a way to discontinue stripping yet continue producing low cost, high volume coal from their remaining highwalls.

Traditionally, surface coal mining has been the most cost effective method of mining. The steady increase of scale in loading equipment, blasting methods, haulage, and conveying and crushing equipment have made modern surface coal mining methods more economic than they ever have been for mining low strip ratio coal deposits. The key to mining these deposits is simply the efficient movement of large volumes of material on a regular basis.

The availability of some low strip ratio coals, however, is steadily decreasing with the increased mining depletion rate. Many mines that initially began with low stripping ratios have now progressed to deeper reserves, with the result being increased overburden removal and reclamation costs. For mines with strip ratios above 5:1, this has driven their unit costs beyond that which operating efficiency improvements can totally offset.

Conversely, underground mining has traditionally been labor and development intensive, and much less capable of high volume output. As such, it has generally been reserved for those coals that command a higher market price.

The stereotypical paradigm of the high cost underground coal mine was shattered in the 1980s, when intense competition took place between all mines for a shifting market share. This led to intensive cost reduction efforts and ultimately the development of more efficient underground mines.

As coal companies struggled to gain market share, underground mines began to invest in longwall mining equipment to reduce labor costs and increase productivity. As capital was appropriated for the newest and the best, the longwall manufacturers responded with improvements resulting in higher productivity rates. The continual improvement of longwall mining equipment and methods has evolved in a cyclical fashion to become cost competitive with some surface mines.

Along with the evolution of equipment, the need to accommodate an efficient transition from surface mining to longwall mining has evolved with the need to plan underground mines within traditional surface reserve boundaries. It is with this planning in mind that opportunities for the best access to reserves should be kept in perspective. Moreover, the delineation of surface and underground boundaries must be left open to economic directives. This will require both surface and underground mining engineers to work together to arrive at the most efficient mines whether they are surface, underground, or something in between.

Wall-to-wall mining methods

Wall-to-wall mining (WWM) is a cross between surface and underground mining. It is designed to achieve the goals of low-cost, highvolume coal production from mines that can access the coal seam from the highwall or an exposed outcrop. It is a method of retreat longwall mining from a surface mine's highwall—hence the term wall-to-wall mining.

Essentially, the method operates the same way that a traditional longwall panel would except that the direction of retreat is toward the highwall instead of toward a set of mains or submains. WWM takes advantage of the fact that the coal seam can be accessed at the surface by eliminating all the mains and submains necessary to access the mining panel. In essence, the surface highwall or outcrop cut becomes analogous to the traditional mains since panels are driven from it.

The lateral extent to which WWM can be applied is nearly unlimited in both directions. In the direction along the highwall, panels can be taken adjacent to each other in successive manner. In the other direction, the panel length can be extended to reach the extent of the lease. Traditionally, belt tensions limited the practical length of a panel to less than a mile. However, the use of Booster/Tripper Drives (BTDs) has been proven at several western longwall mines to permit the operation of extremely long panels.

Basically, the BTD arrangement enables a distribution of mechanical power and belt tension across the entire length of the belt rather than a single point so that belt tensions are no longer the constraint they once were. The use of these with WWM permits the method's use for mining panels in excess of 20,000 feet (ft) long. Since the lease boundaries at some operations parallel their final highwalls by design, all the reserves are within reach of these long panels. Consequently, for these cases, WWM is an option for mining the entire reserve all the way from the highwall to the lease boundary.

In addition to high recovery from the longwall panel blocks, common highwall mining methods can be used to recover coal from the highwall slope barrier. Where WWM can be used, recovery rates will approach those of efficient surface mining.

WWM was primarily designed to facilitate the transition from surface to underground mining. The steps to implementation of WWM involve highwall preparation, portal installation, and the installation of mine systems.

Highwall preparation

Preparation for WWM begins with the design of the last cut of the surface mine. This entails taking the necessary steps to ensure that the final highwall is stable and will remain so until mining and reclamation activities are complete.

To ensure slope stability, engineering must consider several rock mechanics issues, including the following:

Final blast design—plans should incorporate presplitting and stipulate that no cast blasting be used that could damage the future integrity of the highwall;

Final highwall alignment—where possible, corners should be avoided as they will decrease the capabilities of the rock mass to bridge abutment loads, and straight alignment will help facilitate overland conveyor installation;

Slope design—specify the slope angle and secondary support methods to ensure both highwall and spoil pile slope stability;

Strata bridging capabilities—establish minimum cover depths and

design the longwall shield supports and longwall face width. This will be important upon longwall recovery because the free face of the highwall combined with relatively shallow overburden may place a large proportion of the entire dead weight of the overburden upon the shields;
Barrier pillar design—to protect the highwall and to safely recover the longwall; and
Mining-induced seismicity potential—to examine the effect of longwall operations upon the highwall slope stability during longwall retreat.

Upon completion of the last surface cut, loose material should be scaled down from the highwall. The areas directly around future fan, tipple, and entrance openings in the highwall should have some form of secondary highwall support installed to stabilize the slopes above them. Split sets, rock bolts, or cable bolts with wire mesh, chain link, composite mesh, or a geotechnical fabric can all be used for secondary support.

Portal preparation

A unique characteristic of WWM is its need to accommodate the periodic set-up of portals along the highwall. For this, a relocatable portal unit can be used for modular installation at the highwall.

For the belt portal, a relocatable tipple unit with attached control center will facilitate the set-up of the panel belt and the operation of the longwall, this unit facilitates the transfer of coal to the tail loading section of an overland conveyor while protecting the enclosed drive and transfer point. Within the enclosed transfer area, a remote discharge for the longwall panel belt is housed along with the necessary rollers to take the bottom belt to the outby side of the overland conveyor to a gravity belt storage unit (GBSU). The GBSU is designed to accommodate the routine installation and removal of the belt as longwall panels are developed and retreated. This same unit also houses an optional information/communications/dispatching and control center.

For ventilation portals, a skid mounted relocatable fan unit provides fan protection from highwall rock slides, automatic closing doors, and weak-wall explosion doors. Due to the decreased ventilation requirements, the horsepower requirements of these fans are much less than they would be for a comparable fixed portal mine. This is primarily due to lower resistance with the close access of the face to the surface combined with the reduction of volume requirements associated with the elimination of leakage during retreat mining.

For the entrance portal, a skid mounted canopy is provided. This is similar to the ones used with highwall mining. It simply protects people entering the mine.

In each portal installation, the relocatable units are designed for installation with threaded, resin-grouted rock bolts. These bolts are installed in the pit floor and highwall slope rock where they provide leveling and anchoring points for the fabricated steel work.

Mine systems

The mine systems can be installed concurrent with the installation of gateroad portal structures. Electrical power distribution equipment and switch gear can all be located on a portable substation. Many of the surface mines have devised units like this to provide portable power to shovels and other large electrical equipment; thus, this equipment may already be available. In some cases the voltages may even be compatible with the underground equipment; in others it will be necessary to replace transformer components. Underground mining will require a separate circuit for mine fans.

Water supply systems can be installed with a tank mounted on the surface above the highwall. In many cases, this elevation difference may provide enough pressure for supply water, but in others a booster pump may be required.

For mine dewatering, where panels are retreating in an up-dip direction, sumps and pumps can be located in the bleeder at the inby end of the panel. This water can be pumped to the surface through the permanent bleeder entries connecting with the highwall or through a case bore hole or ventilation raise. In the case where panels are retreating down-dip toward the highwall, sumps should be located along the highwall to collect both surface water and mine water drainage. In either case, highwall and pit preparation should include the construction of sumps to handle surface run-off and diversion ditches to prevent runoff from entering the underground mine.

Bulk rock dust systems can be set up along the highwall in a convenient area near the rock dust pump location. Rock dusting of the belt can be assisted with the flow-through ventilation system provided by WWM.

During retreat, all of the intake air must flow through the head gate to get to the return. Consequently, a thorough dusting of the belt line can

The majority of the longwall photos used in this article are placed for interest only and were provided by David Lauriski, general manager of Energy West's Deer Creek Mine in Huntington, Utah.

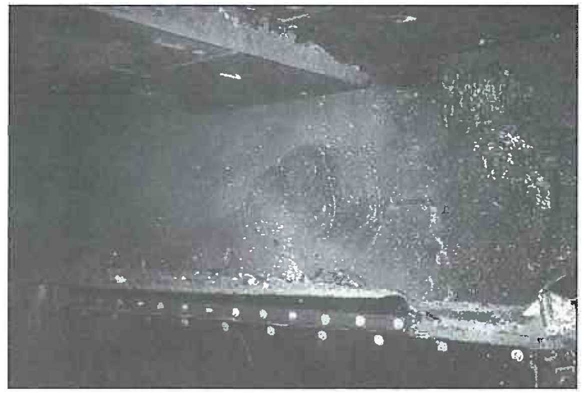
be scheduled on a periodic basis, when no one is in the mine, by closing off all of the intakes to the mine with exception of the beltway that is left open to airflow at both ends. This will temporarily convert the beltway to a high velocity airway since all of the air entering the mine will have to pass through it. This high velocity can then be used to carry rock dust long distances down the belt line all the way to the mining face. Normally during operation, regulations for belt lines require that airflow is isolated in the beltway. However, since such an activity can be scheduled during times when people are out of the mine, mine power has been disconnected and no coal is left on the belt, MSHA could be petitioned to allow such practice to become part of the approved ventilation plan for the mine.

The installation of underground conveyor systems is facilitated by the portable tipple as described. The surface overland conveyor is installed along the pit floor corridor between the highwall and the spoil pile. The overland conveyor can be installed using threaded bolts for anchoring and leveling on the pit floor.

Where should WWM be considered?

In the case of a surface mine making the transition to WWM, the physical limitations will be primarily geotechnical. The longwall panel will need enough overburden to bridge abutment loads effectively. Consequently, the method is best for reserves with increasing overburden. In a situation where a surface mine is facing an ever increasing strip ratio, WWM may be the appropriate answer to lower cost mining.

The transition from surface mining to WWM will be capital intensive. The potential operational savings must be weighed in a comparison with financial scenarios modeling the cost of continued surface mining against the expected costs of WWM.



In the case of a new reserve considering longwall mining, WWM should be considered for areas where the outcrop can be cut to access the coal seam directly, especially where lease boundaries parallel the outcrop and permit long panel lengths. In such cases, the operational cost savings of WWM may more than offset the costs to prepare the access when compared to traditional underground longwall mining.

When should it be considered?

Timing will be an essential element for the best application of WWM. Planning should consider deferring reclamation activities that would cover or prevent access to the coal seam. Moreover, the use of highwall mining machines and/or augers could preclude the use of WWM. Similarly, underground workings driven to access panels in the traditional way may preclude or limit the development of long panels.

WWM does have some potential advantages over continued surface mining, such as less surface disturbance—a reduction in topsoil stripping, overburden removal, and reclamation of the surface above the coal. Where WWM can be deployed from an exposed highwall, topsoil stripping and the removal of overburden can be completely eliminated—albeit, some subsidence impacts will have to be addressed.

For a new mine where WWM is developed from a highwall prepared from an outcrop contour, some stripping will still be required to expose the coal seam, to prepare gateroad access and to provide a corridor for a tipple, substation, and overland conveyor. The volume of material excavated in obtaining access will be typically much less than that required with total stripping operations. Another major advantage of longwall mining is that it consolidates production to one active mining area. This has been an advantage that underground miners realized early with longwall. It was found that there were several operational advantages favoring one high capacity longwall unit that could provide the majority of the production from one area in the mine rather than having multiple lower capacity production units spread over a large area of the reserve.

While some of the reasons for this, in the underground case, are different, the underlying principles are the same. In the underground case, improvements in ventilation efficiency, conveyor utilization, reduced travel time, and more effective supervision were realized with the introduction of longwall mining. In the surface case, especially where trucks and shovels are used, the optional use of WWM permits a consolidation of production from a single area with the opportunity for effective use of high capacity overland conveyors.

Similarly, power, water, and communication systems are simplified, and dispatching multiple trucks to multiple loading sites becomes unnecessary. Moreover, the development and maintenance of haulage roads, spoil piles, topsoil piles, and access roads to multiple mining areas can be substantially reduced.

This means that surface dust control can be greatly reduced even to the extent that it may be feasible to pave the road to portal areas and eliminate the need to provide and maintain water trucks for dust suppression. It also means that where WWM is economically justified, the majority of the large expensive surface mining equipment can be eliminated, along with its maintenance.

The system also has improved safety advantages. The high automation capabilities of modern longwall systems reduce manpower exposure to equipment and in total census requirements for the mine. This has positive safety implications for WWM. Accidental incidents will be reduced as will the severity of them, especially when compared with the option of larger and larger surface mining equipment exposing more people to hazards.

Advantages over conventional methods

The advantages of WWM when compared to traditional underground mining predominately stem from the fact that coal is accessed directly from the surface rather than from underground mains development. The following is a list of some of the potential advantages: accelerated cash flow and decreased development—the early access to coal highly favors WWM in financial analysis.

The reasons are two-fold. First, the immediate access of coal from the outcrop cut allows two or more continuous miners to begin development immediately. Using continuous miners for gateroad development production levels of more than 1 million tons per year (tpy) could be attainable for each continuous miner unit. Hence with two units, a production level of more than 2 million tpy could be achieved from gateroad development immediately upon startup.

Second, the earliest possible production of low cost longwall coal is made possible by eliminating the need to develop mains and submains. By beginning both headgate and tailgate road development directly from the highwall, a 5-mile long panel, for example, will take less than a year to completely develop. Thus, in addition to having immediate production from two continuous miner units, low cost longwall coal production is moved closer to time zero for Net Present Value (NPV) evaluations.

Preferred mining sequence

Rarely in a new mine is there the opportunity to mine early coal in an outby direction away from lease boundaries or reserve limits with a retreating longwall, The reasons for this are simply a matter of early mine economics and panel access geometry. Traditional fixed portal access schemes with their mains, submains, and barrier pillars limit access to the first longwall panel. Consequently, mains development is on the critical path and precedes panel development.

In the interest of time, the site for the first panel is sometimes chosen in the middle of the block rather than near the boundary edge from whence successive panel extraction should best retreat away. This can culminate in a pinch point between panels with a loss of reserves. Consequently, from the mine layout standpoint, this necessity for early coal, encumbered by the presence of mains, submains, and barriers, complicates the mining sequence. Indeed, some underground mines were developed this way to the later chagrin of their operators.

Panel access from the highwall or outcrop bench, without mains, eliminates the need to select panel sites prematurely and permits the retreat mining of all panels in an outby direction.

More flexible gateroad development—the number of continuous miner units deployed to keep pace with longwall development in a traditional underground mine is limited to the outby infrastructure capacity which must handle both longwall production and continuous miner production. Most longwall mines have experienced situations where they have had to throttle longwall production, enabling development to proceed due to belt limitations.

This development and production mix paradigm does not exist with WWM for two reasons. First, development units do not share the same belts as the longwall. Secondly, in the event that development gets behind, more continuous miner units can be added from the highwall or outcrop access with separate belt haulage and ventilation. It also would be possible to use smaller belts since the belts only have to handle longwall production.

In addition, to early initial production, the method accommodates a higher proportion of longwall coal than does any other method. This is due to the fact that the amount of development is reduced to an absolute minimum. Moreover, the development that is done is entirely dedicated to production and recovery rates are higher since a higher proportion of longwall coal is mined. For example, using three entry gateroads for 5-mile long, 1,000-ft wide panels with 300-ft wide highwall barriers, 98% of total mine production is recovered with the longwall and overall recovery is 87%.

The uniformity and simplicity of the layout with panels cascading along the highwall is essentially the same for the first panel as it is for each successive panel. Hence, there will be little or no decrease in productivity due to receding face maturity. In other words, belt system availability and travel time to get to the face will remain relatively

constant throughout the mine's life. Another attractive feature of the method is that it completely eliminates the need for main and submain belts, as well as complex ventilation, electrical, water, and communication systems, while providing direct escape routes and both man and materials access.

The elimination of main and submain belts further eliminates the need to maintain rock dust, fire suppression, and monitoring systems in these areas and the labor to patrol, inspect, and monitor them. Moreover, by providing a more direct route to the surface, the overall conveying distance is reduced, as is belt wear.

In addition, mine electrical and water systems are greatly simplified due to the lack of mains and submains and the indirect passage routes that must be taken around and through them.

The ventilation system is greatly simplified because there are no airway crossings, and overcasts and undercasts are not required. Development ventilation uses a simple relocatable exhausting fan installed at the highwall portal. This fan only needs to be capable of supplying the air to a single gateroad development. Hence, even though the length of the airway is quite long, the quantity required is small, relative to the cross sectional area available with three entry development. Thus, the head loss is not extraordinarily high and the operating pressures of the fan can be kept at a manageable level, even with a limited number of airways. Upon development of successive panels, the fan can be relocated to the next gateroad portal site and the airway then converted to intake for the retreat operation. Face ventilation can be provided in the usual manner with either auxiliary fans or line curtain.

A permanent exhausting fan can be installed at the inby end of the first panel atop a borehole raise connecting the surface with the bleeder/set-up rooms. This raise is optional to supplement flow-through ventilation coursed through to the tailgate returns. If a bleederless system is required, the borehole may be omitted. On retreat, all air that enters the mine must course its way past the working face to get to the return; consequently all leakage is eliminated. This is a range of 40% to 75% of the total air entering the mine.

The savings in leakage will manifest itself in the form of reduced power costs. Other operational advantages stem from the fact that complete control of the air can be managed from the surface.

With WWM there is no need for regulators because all the air is going to the same place (a single split is provided for each working face). Consequently, all air can be shut off from the surface by simply closing the intake openings and shutting off the fan(s).

Since each working place has a fresh air split, there is never contamination to the fresh air supply from events occurring in adjacent panels.

Catastrophic loss and injury risks are reduced. Loss due to mine fire should be reduced, due to the simplified ventilation system. If a fire were to occur, for example, all air into the working area can be controlled and/or sealed at the highwall portals and the bleeder holes. Moreover, the remaining reserve can be completely isolated from the fire by simply leaving a small barrier pillar before the next panel. But most importantly, the people in the mine can be evacuated directly to the surface through either intake or return escape routes without having to navigate a web of development workings.

In the case of seismic events (bounces or bumps) or mine explosions, the method offers much less risk to ventilation system operation, due to stoppings being blown out by air blasts. WWM's flow-through ventilation system works independently of the stoppings. Intake and return airways are separated by the longwall panel block and the fans are protected from air blasts, so that in the event an air blast or explosion should occur, the ventilation system remains intact and can be completely controlled from the surface.

With fewer overall equipment components, the WWM method has the advantage of less maintenance with higher equipment availability. This is especially true for the conveyer system. The overall system availability for conveyers, operating in series, is a function of the cumulative availabilities (multiplicative for that of each drive, take-up, and transfer).

The WWM method, with its direct alignment and lack of transfer points, permits the use of booster/trapper drives, and variable frequency drives with load sharing between motors to distribute the horsepower across the entire length of the belt. The distribution of drive power along the belt permits the panel to drive longer distances without the need for an intermediate terminal group or transfer point.

There are many advantages to the multiple drive arrangement, including the provisions for redundant drive capacity in the event that one of the drives are lost and the integrated and automated nature of the components, which improves operation, control, and monitoring from the surface or remote location malfunction.

Longwall recovery and panel moves are simplified. Upon panel completion, the WWM method recovers longwall equipment from the panel within close proximity to the surface. Consequently, the entire face can be disassembled and queued sequentially on the surface for installation in the next panel. in other words, all the shields can be queued in the same sequence as they were recovered. The face conveyer, motors, and controls can be placed on the pit floor in the same order as they were removed.

A staging area, adjacent to the highwall, can be prepared early to facilitate the loading, unloading, and testing of equipment. Staging and maintenance could be performed from a relocatable shop fitted with a bridge crane, power equipment, and hydraulic testing facilities to allow maintenance to be performed without hauling the equipment a great distance. This is a great advantage because much of the time required to move a longwall panel is typically involved in the logistics of moving equipment from one panel to the next within the confinement of the underground mine openings. The ability to stage and organize such a move from a prepared surface area or facility within the proximity of mine power permits a thorough visual and operational inspection of the equipment before it is installed in the next panel. The ability to use surface equipment to facilitate maintenance and handling activities will also be an advantage.

Haulage systems improve

Using the WWM method, the entire underground belt system is extracted with each panel. Hence it provides the opportunity to renovate, rebuild, improve, or add updated features or even replace the entire belt system with a wider belt upon the completion of each panel at a much lower capital cost.

Experience at highly productive western U.S. longwall mines attests to the ever present need to increase belt system capacity. A common constraint at these mines is their need to throttle their longwall production to either permit development or just to accommodate the limits of their outby system.

Potential disadvantages

Shallow cover would preclude the use of WWM especially where fractures and jointing exist. Consequently, it should be the first criteria investigated in feasibility evaluation. This is a potential disadvantage when comparing WWM to either surface or underground options.

The transition from surface to underground mining will require the purchase of new equipment. This is true whether WWM is considered or not. With WWM however, some of the surface equipment can be effectively used in opening up new benches for portal and tipple installation. Along with new equipment, there will be a need to acquire new skills necessary to operate it.

The use of WWM from the highwall will require that the highwall remain open for a long period of time. In the financial evaluation this may actually be an advantage because it will defer the cost of reclamation. However, it may be a disadvantage if it disrupts efficient reclamation activities.

The use of WWM will be limited to those areas where longwall panels can be driven at more or less right angles to the highwall for long enough distances to accommodate the development of longwall panels.

Consequently, WWM should not be used for small isolated reserve blocks or for ones with highly irregular shapes that might preclude an economical design.

Subsidence could open airways to the gob through cracks which could short circuit ventilation capacity. This would create the need for surface disturbance and reclamation of it in that it may require that a dozer be maintained on the surface at all times to keep cracks filled.

In cold climates it may be necessary to provide more ventilation heating than would be required with a traditional underground mine with extensive mains due to the close proximity to the surface and the lower potential for geothermal heating of the air.

WWM, especially where it is used from a prepared outcrop bench, will have more surface disturbance and will require more reclamation than would a traditional underground mine.

The potential application of WWM will be site and situation-specific. However, there are two general situations when it should be considered: for surface mines with increasing stripping ratios and overburden thickness sufficient geomechanically to bridge loads, and for new underground mines with extensive outcrop access.

In these two situations if the advantages outlined above can be realized, the end result should be a reduction in unit operating costs. The primary factors contributing to this will be:

- a high proportion of low cost is mined with the high productivity and efficiency of longwall mining;
- production areas are consolidated to a single area, and a more efficient recovery of the reserve is achieved;
- less move time is required between longwall panels;
- less labor is required to monitor and maintain the mains or haulroads and the mines supporting infrastructure;
- lower roof support costs due to less mains and less long term openings;
- lower ventilation costs due to elimination of overcasts and regulators with less stoppings and less leakage;
- less power line losses due to less distribution equipment and fewer underground belts; less accidents due to reduced manpower census; and
- less travel time to and from the mining area, and more effective supervision due to better visibility and communication with the work force (less mine areas to patrol).

Timing and planning are both essential elements for the effective implementation of WWM. The method will best be used in situations where excavation of the final highwall can be planned ahead of time.

Moreover, methods that exploit the highwall for easy coal may preclude the more prudent use of WWM. Consequently, it is imperative that evaluations consider WWM early in long range planning.

Peterson is project manager for Norwest Mine Services and consults on feasibility and design evaluations for a number of new mining projects.

Santa Fe Pacific Gold

California's second largest gold mine puts priority on people, desert protection

Where Highway 78 cuts through the Imperial Sand Dunes in the shadow of the Chocolate Mountains east of Brawley, CA, the horizon is interrupted by a uniquely designed dome.

It is a voluntary environmental measure that cost the Mesquite Mine $800,000 to design and build. It is only one representation of a consistent policy of respect for history and the environment that was in force even before commercial gold production began in 1986 under the ownership of Gold Fields Mining Corp.

The mushroom-shaped dome has a dual benefit in this pocket of the Great Sonoran Desert that sprawls into northern Mexico. It was designed not only to protect the coarse ore stockpile underneath but to contain the finely ground top dust to protect air quality as well.

Santa Fe Pacific Gold Corp. has continued to recognize the need for environmental safeguards and is exploring for new reserves at the second largest gold mine in California.

Mesquite Mine Manager, Jim Voorhees, is especially proud of the mine's 1995 record as a year without a lost-time accident. Mesquite won the President's Award from Santa Fe Pacific Gold and helped make 1995 the safest year on record for the corp.'s operating mines.

The zero lost-time accident record for 1995 compare with a 1994 record of seven lost-time accidents. Voorhees credits the improvement to "a lot more attention to safety on the part of workers and management."

He also concedes an incentive program gave the safety focus a boost. It put extra money in workers' pockets on a monthly basis, depending on the record for the preceding 30 days.

The Mesquite Mine won the coveted Safety Performance Award from the California Mining Association in 1990.

Mesquite Mine is in the process of upgrading its equipment as well as its safety record, according to the manager.

"It is an operationally significant program, "Voorhees says. "We have acquired several 150-ton haul trucks that were transferred from the Twin Creeks mine.

"There is a big difference between 150-ton haulers and the 85-ton trucks we've been using."

The mine has just ordered a new hydraulic shovel—an O & K RH 170. The 24-yard bucket is a significant increase from the 17-yard bucket in the largest shovel currently on site.

The huge, rumbling equipment operating at Mesquite Mine today would have terrified the prehistoric peoples who may have roamed the area as long as 10,000 years ago. They would have awed the Spanish explorers lured to the arid land 200 years ago by Indian tales of gold.

Fencing at the mine protects a number of geoglyphs, a petroglyph, and a section of a historic wagon trail. More than 100 sites were documented or recovered before commercial mining was allowed to begin in 1986.

Mesquite Mine was one of the early heap leach operations in the United States and, as a protection for wildlife, had pond covers constructed for heap leach solutions and used drip irrigation on the leach pads.

Liner systems under the heap leach pads protect against seepage into ground water, and ponds which contain process solutions have double liners and leachate collection systems.

Wildlife protection is a priority at Mesquite. The desert tortoise is listed as threatened under the Endangered Species Act. A program exists to protect the tortoise and educate the public with "Awareness" signs as constant reminders.

Permanent employees and construction workers are provided with a formal tortoise protection training program. Special mesh fencing has been installed around project areas where there is high potential for tortoise migration.

Mesquite Mine presently employs 336 people with a payroll of $14 million. The operation buys $6 million annually from local vendors and pays $1 million annually in local property taxes.

Total proven and probable reserves amount to 1.1 million ounces of gold. At a current production rate of about 200,000 ounces of gold a year, the life of the mine is projected to last through 1999, according to Voorhees.

About 40 million tons of ore and overburden are mined annually in three open pits.

Santa Fe Pacific Gold, headquartered in Albuquerque, NM, is one of the largest gold mining companies in North America with mines in Nevada and California and exploration offices and projects throughout the world.

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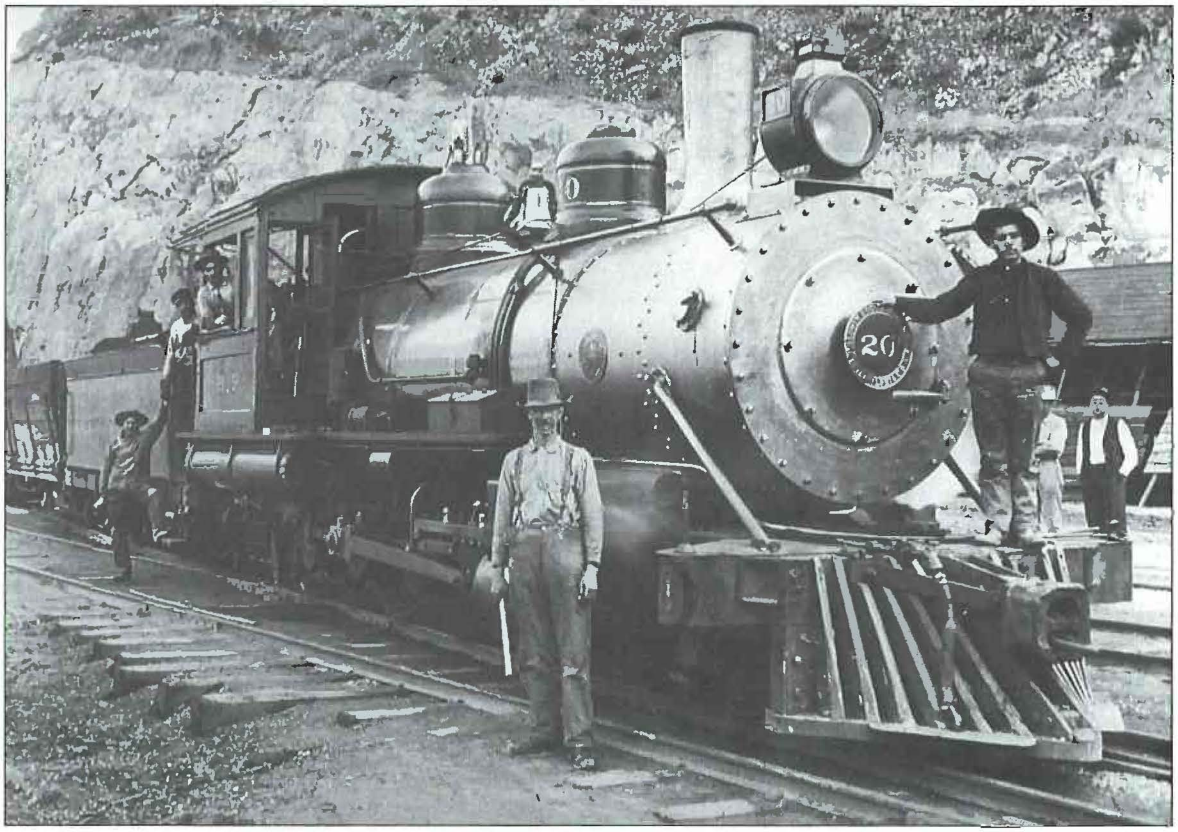


Sam Sidebotham, father of Tommy Sidebotham (an employee of Phelps Dodge at Morenci), a conductor on Clifton-Morenci's Coronado Railroad, stands holding brake club in front of No. 20—a narrow-gauge (36-inches between rails) Baldwin locomotive built in 1903. Manuel Baron, the engineer, is inside the cab. Standing next to him on the steps is the fireman, Teddy Geddy. Don Simon, the brakeman, stands with one foot on the step.
Photo information courtesy of David Myrick, Railroads of Arizona, Vol. III.

Arizona's mining history

Minerals' influence on Arizona researched & written by George Davis

This article identifies some of Arizona's famous mining towns and how they were founded.

Clifton—Morenci

One of the men who followed the gold rush to the Prescott area in 1863-64 was Henry Clifton. In 1865, he decided to explore the San Francisco River area near the New Mexico border and noted rich showings of copper.

In 1872, some men staked out the Copper Mountain and other claims and established the town of Clifton. Because of the long distances to haul ore, more capital was needed and in 1874, William and John Church acquired Joy's Camp and changed the name to "Morenci" (after a town in Michigan).

The whole area was developed around the copper ore found there. The Longfellow and Copper Mountain Mines were two of the larger mines of early day Clifton—Morenci.

Globe—Miami

In 1874, the Ben Regan Party came into the district. They found and produced some silver, but nothing like the silver mined in the McMillenville and Richmond Basin a few miles to the north.

After the discovery of the Silver King in 1875, Globe became more settled. But only after 1880, when the wonderful copper deposits started to become an economic value did the area really start to develop.

Jerome

In 1876, a group located and started working the claim that later became the famous United Verde Mine.

By 1881, twelve additional claims were located, These claims later became the holdings of the United Verde Copper Company.

In 1882, the famous town of Jerome began to prosper. The town of Clarkdale was later founded to support the Jerome mining activities and still later—the growing town and area of Cottonwood.

Bisbee

In 1877, an Army scout named John Dunn noticed some bright-colored cropping. Unable to give time to prospecting, he grubstaked George Warren, a miner (who's image is found in the Great Seal of Arizona). Warren staked claims and named the area the "Warren Mining District." Unfortunately, he lost his claims gambling.

Because of the need for money, George Bisbee of San Francisco was brought in and the settlement was named after him.

In 1880, Dr. James Douglas was brought to Bisbee and gave valuable mining advice which helped put the Copper Queen Mine and Bisbee on a sound technical basis.

Tombstone

The Tombstone District proper was discovered in 1877 by Ed Schieffelin. Traveling alone and prospecting in the Tombstone area, he found rich ore and staked the Tombstone and Graveyard claims.

In 1878, his brother Albert and Richard Gird (an assayer) came to the area to join Ed. Two days later, they discovered the Lucky Cuss and Toughnut.

By 1878, the district was christened "Tombstone." The name was suggested by Fort Huachuca soldiers who said that Ed Schieffelin would find nothing but his tomb-stone.

Several towns such as Charleston and Contention City were important communities connected to the silver strike.

In the 1880's, Tombstone was the largest town in Arizona.

By late 1876, more than 13,000 miners were located in Arizona. The rugged prospector with his burro, beans, and shovel had covered the entire territory.

One of the last periods of development for Arizona minerals was after 1880. There are many stories of the discoveries and development of minerals, mines, and communities for that period, but only three will be mentioned here.

Ray—Kearny

In the 1870's, some merchants in Tucson were attracted by copper prospects in Pinal County on Mineral Creek.

In 1884, the Ray Copper Company was incorporated and supposedly named for Ray Bullinger, the sister of an early-day prospector. The Ray Consolidated Copper Company was formed in 1906, and brought in laborsaving equipment which

began its era of tremendous success, but not until after numerous failures.

Superior

Minerals were first located in Superior in 1875n6. Work did not begin in earnest on the Silver King Mine until 1910. In 1912, work in depth proved the Silver Queen vein to be rich in ore. The town site of Superior was begun in the same year. In 1914, a railroad was built to connect Superior to the rail network, which allowed the ore to be shipped economically.

San Manuel

Minerals were located in the San Manuel area in 1870, but mining costs and surface ore samples kept any great activity from occurring until 1944. In December of 1944, drilling began its tremendous impact on development. Production began in 1956 and copper is expected to be produced well-into the twenty-first century.

There are more than 400,000 mining claims recorded in Arizona and an estimated 4,000 companies have been incorporated for the purpose of mining. This article has mentioned just a few of the hundreds of communities that were founded because of mineral resources.

It is hoped these articles will show Arizona's past and present economy is a result of her great mineral resources and the people who discovered and developed them.

Weather alert!

In approaching the winter season, miners need to exercise extreme care to protect themselves from overexpo-sure to cold temperatures, which can result in the condition known as hypothermia. Hypothermia is a general cooling of the entire body. The inner core of the body is chilled and the body cannot generate heat to stay warm. This is a serious condi-tion and is often fatal to the victim. To protect against hypothermia, dress warmly and stay dry. If necessary, when working in cold conditions, take frequent breaks in a warm atmosphere to maintain body temperature. In wet conditions, the temperature does not have to be extremely cold to present danger. Extended exposure to 45 degree water can result in hypothermia.

Recognizing hypothermia

Signs and symptoms of hypothermia are: shivering, numbness, low body temperature, drowsiness, numbing, incoherence and muscular weakness.

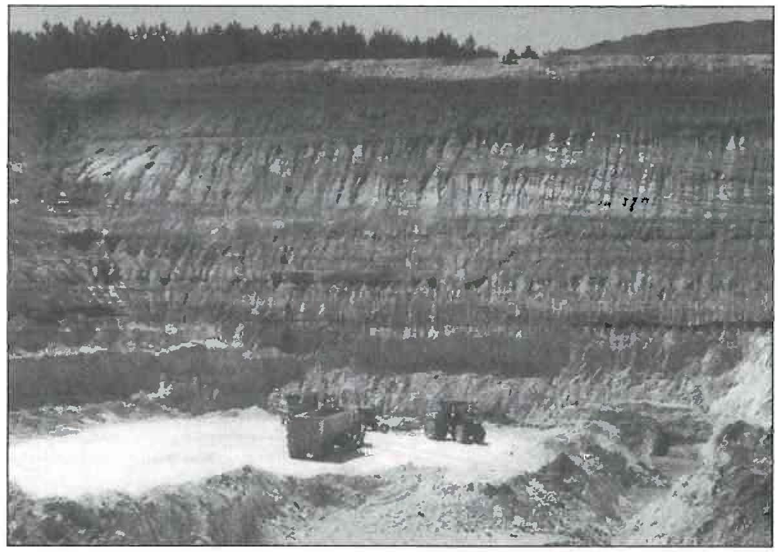
First aid for hypothermia

Get the victim into a warm area; remove all wet clothing. Wrap victim in warm blankets to maintain body heat (do not warm too quickly!). If victim is conscious, give warm liquids to drink, but avoid alcohol or caffeine—they tend to reduce the flow of warming blood to extremities. Try to keep victim awake. Get medical attention as soon as possible.

Reprinted from the Winter 1995 edition of the Arkansas Department of Labor's ***MSHA News.***

Kaolin: the white clay

By Kenneth Jackman



Kaolin is a naturally occurring white clay mineral found in abundance along Georgia's "Fall Line" which stretches from Macon to Augusta. It is also mined in neighboring South Carolina, Florida, California, Arizona, and Idaho.

Crude kaolin is made up of extremely fine particles of aluminum silicate with varying amounts of other minerals. After refining, kaolin is extremely white. It is relatively inert when mixed with other materials and has unique flow characteristics when incorporated or mixed with liquids or placed in fluid systems such as paints and paper coatings.

Used in large volumes by manufacturers of paper, paint, rubber, plastics, fiberglass, ceramics, insecticides, and a myriad of other products, kaolin imparts a glossy white surface to paper and permits uniform retention of ink on the paper surface. Most high gloss coatings on magazines, catalogs, and periodicals contain kaolin. Kaolin is also used as an "extender" pigment in paint. It makes the titanium oxide pigment, commonly used in paint, which is also extremely white, scatter light more efficiently. It is used to reinforce, stiffen, and harden rubber. Kaolin is incorporated into literally hundreds of products that we use and enjoy daily. Interior and exterior paints, dishes, carpeting, rubber-soled shoes, and plastic parts for autos, televisions, and even computers all contain kaolin. Kaolin is mined from the surface by stripping away the overlying earth. The kaolin is then dug and transported by truck or pipeline to nearby processing plants. Deposits may cover a few acres to several hundred acres. The overlying earth is laid aside into previously mined areas. The "back filling" method of surface mining leads to early reclamation of the land.

U.S. production reached an all-time high of 8.3 million tons in 1994. Approximately 30 percent of this tonnage was exported to Europe, Japan, and the Pacific basin countries. In fact, kaolin is the largest volume export commodity passing through the port of Savannah. Although American kaolin products are generally superior in quality, they face strong pricing competition from kaolin products produced in Brazil, Australia, and Europe.

Capital invested in mine and production equipment and facilities reached $1.6 billion in 1994. To meet growing competition, a large amount of this capital has becn sharply focused on production expansion and automationn research and quality control. Developing and producing new products, improving quality, and lowering production costs with new refining technologies are key elements in maintaining a competitive edge.

Employment opportunities are extremely important in the primarily rural counties where kaolin is mined and processed. In Georgia, the largest producer of kaolin, the industry provides direct employment for more than 4,000 Georgians. Average pay for kaolin employees in 1994 was $46,000 plus benefits. It's estimated that another 4,000 Georgians are employed indirectly by the kaolin industry through contractcd services and suppliers.

Environmental protection and land reclamation are key elements to kaolin mining. Reclamation begins with the strategic placement of the overburden as it is stripped away to expose the kaolin. After mining, the land is graded and contoured, and a permanent vegetative cover is established. Trees are planted on most of the reclaimed lands. The industry takes pride in returning the land to a productive use for the benefit of future generations.

Kaolin is a unique mineral, and the United States—partlcularly Georgia—is fortunate to have an abundance of it.

Other kaolin producers around the world want to sell their products in the United States and foreign markets. This means America's kaolin producers will continue to face strong competition.

Two new producers of kaolin will be coming on line in Brazil this year, adding to the worldwide competitive situation that confronts the American kaolin industry. To remain competitive, the U.S. kaolin industry must continue to produce high quality products while also finding ways to reduce their delivered cost.

Kenneth Jackman is executive vice president, China Clay Producers Association, based in Atlanta, Ga.

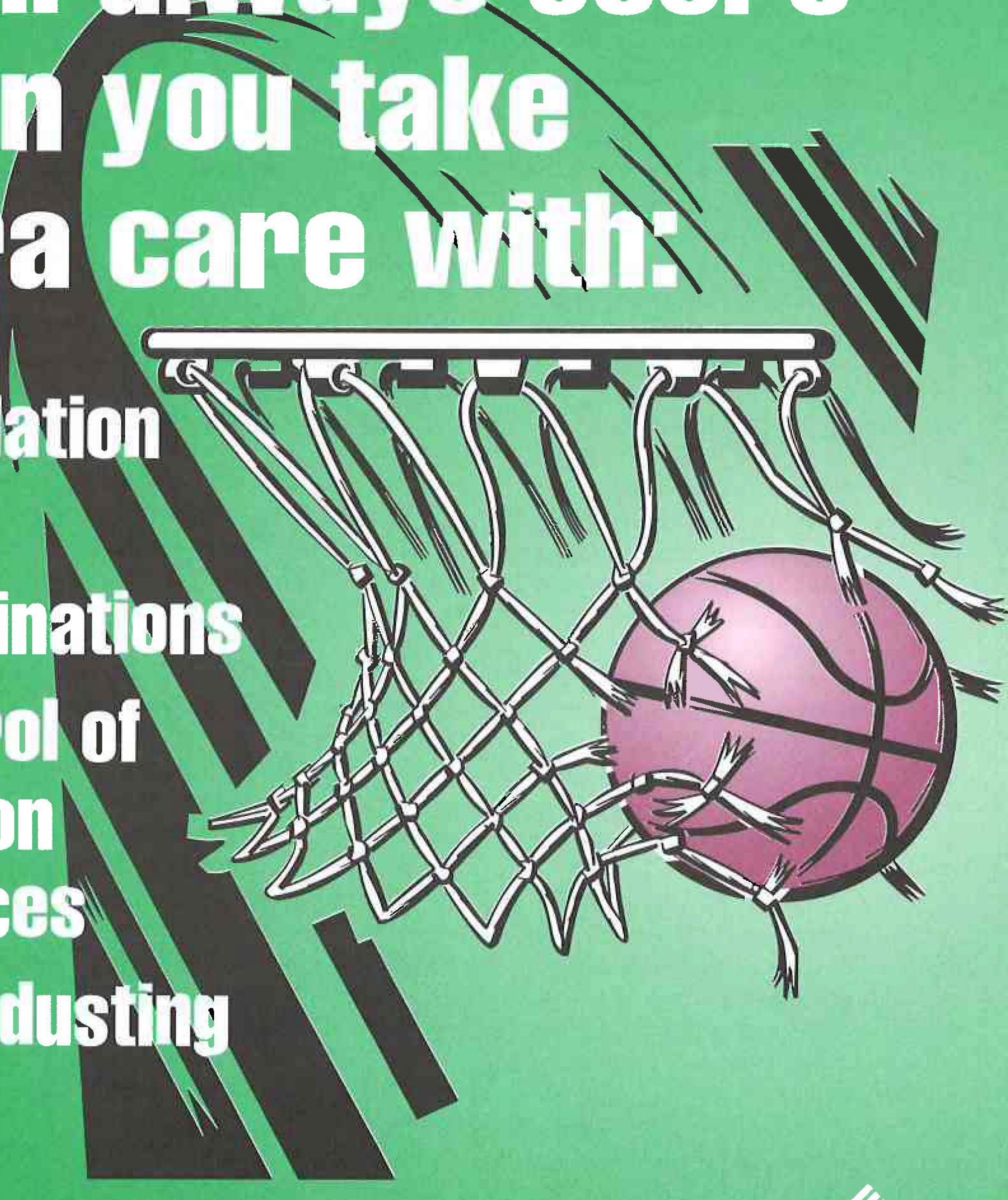
Reprinted from the July/August 1996 edition of ***MiningVoice.***

WINTER ALERT

October through March 1996-97

You'll always score when you take extra care with:

- Ventilation
- Mine examinations
- Control of ignition sources
- Rock dusting



U.S. Department of Labor — Robert B. Reich, Secretary
Mine Safety and Health Administration — J. Davitt McAteer, Assistant Secretary

Study committee unveils findings on black lung

Suggests ways to combat disease

For the first time since black lung disease among the nation's coal miners was officially recognized in 1969, the federal government is taking another look. This time, a blue-ribbon panel has issued 20 recommendations in hopes of eliminating the occupational hazard.

In a 116-page report issued on November 20, 1996, the nine-member advisory committee, appointed by Labor Secretary Robert Reich, revealed a technically exhaustive review of practically every aspect of pneumoconiosis, as well as silicosis.

Silicosis refers to rock dust exposure, and black lung is caused by breathing in coal dust particles over a long period of time.

Black lung findings unveiled

The committee's recommendations include a number of items likely to get the attention of the coal industry, particularly those items that carry potential costs along with the solutions.

The panel recommends that the federal Mine Safety and Health Administration (MSHA) take full charge of the current coal mine dust-sampling program to determine if mine operators are ventilating their mines as required.

MSHA technicians currently handle around 25 percent of dust sampling collected, with about 75 percent collected and analyzed by mine operators. The panel recommends MSHA expand collection and analysis.

Also, the committee recommended that MSHA inspectors increase their presence at mines determined to have a history of violating dust-exposure limits.

Other recommendations include:

- Establish separate possible exposure limits for silica and coal mine dust and consider lowering the allowable exposure limit on coal dust.
- Require operator to verify that their dust-control plans are effective before MSHA approves the plan.
- Include surface coal miners in periodic X-rays now referred to underground miners.
- Reduce silica exposure at coal mines.
- Improve dust-control measures at surface coal mines.
- Improve miner training and awareness of dust hazards and prevention.
- Improve research on ways to achieve continuous monitoring of dust levels and mining control technologies up par with production technologies.

MSHA Chief J. Davitt McAteer said he believes costs don't unravel the recommendations because "what we tried to do is look at what we have in place now. And it costs money already."

He said a cost/benefits ratio will probably show a net savings for the industry.

For instance, the industry might be willing to pay for MSHA's expanded role in dust sampling. McAteer said.

While MSHA would have to expand its technical facilities and personnel, operators wouldn't have to pay for their own sampling facilities and personnel.

"We think there is a whole group of industry representatives who will support this report and the recommendations," said McAteer.

"It doesn't mean this will be eagerly adopted or universally loved by all, but the makeup of the committee had industry representatives as well as labor. The ideas and recommendations were hashed out pretty thoroughly."

Among other observations, the panel noted that reliance on environmental control measures as the primary means of protecting coal miners for the last 25 years has resulted in a significant decrease in silicosis and black lung.

Environmental controls refer to ventilation and other measures such as suppression of dust generation, dilution or capture of dust particles.

"In general, however, improvements in environmental control technology have not kept pace with increases in production technology," reads the report. "The committee encourages the development and use of improvements in technology to control miners exposure to respirable coal mine dust."

The report took note of the industry's suggestion that the use of breathing devices could help achieve the elimination of black lung. But the panel did not seem eager to equip miners with space helmets.

Environmental controls "must continue as the primary means of protection for miners," their report notes.

However, the panel was apparently impressed with an Airstream helmet that pumps filtered air continuously across a miner's face.

A study on workers who wore the helmets at four mines indicated an effective protection of more than 83 percent.

Industry representatives on the committee urged that operators who are in compliance with environmental controls and supplement their efforts with Airstream helmets should be "recognized as making a good faith effort toward compliance."

Reclaiming land through phytoremediation proves that sometimes the most high-tech solution is actually low tech

Back to nature

By Michelle Bing

One of the newest reclamation technologies doesn't rely on complicated algorithms or sophisticated machinery, but on something we all are familiar with— nature itself. Phytoremediation uses plants to clean up contaminated land and water sites. The tools of trade are alfalfa, grasses, Indian mustard, even sunflowers—backed up, of course, by hard science.

Phytoremediation focuses on the power of nature to heal itself, somewhat like the proven process of bioremediation, which uses bacteria and other microorganisms to degrade contaminants in soil and water. But phytoremediation is more proactive than bioremediation, improves the appearance of sites more quickly, and, in some cases, can clean up sites that are not receptive to the use of bacteria.

The process encompasses a variety of techniques. According to the firm Phytotech, a leading proponent of the technology based in Monmouth Junction, N.J., phytoremediation of metal contaminants takes three forms:

- ***Phytoextraction***—using metal-absorbing plants that transport and concentrate metals from the soil into the roots and above-ground shoots;
- ***Rhizofiltration***—using plant roots to absorb, concentrate and precipitate toxic metals from water; and
- ***Phytostabilization***—using plants to prevent the movement of toxic metals into soils and groundwater.

Getting the lead out

Phytotech's unique approach to cleaning up metal contaminants from both ground and water began about five years ago when scientist Ilya Raskin, formerly a professor of

Highlights

- The increasingly popular concept of using plants to clean up contaminated land and water sites originated when a plant biologist at Rutgers University read a series of 60-year-old Russian articles describing the use of wild plants to help find metal-rich mining sites.
- Metal phytoremediation costs a great deal less than traditional reclamation and clean-up technologies.

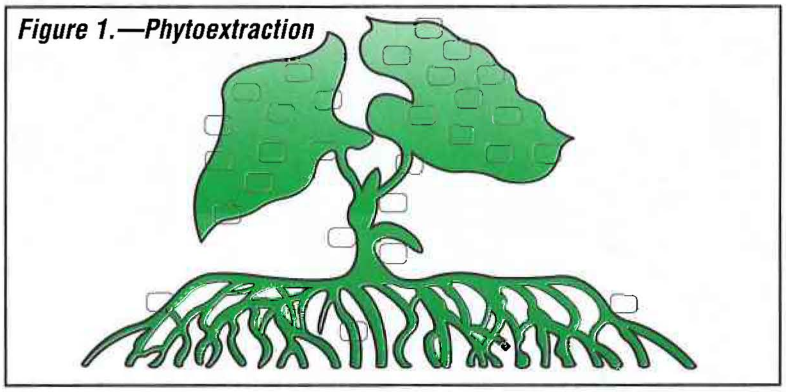


Figure 1.—Phytoextraction

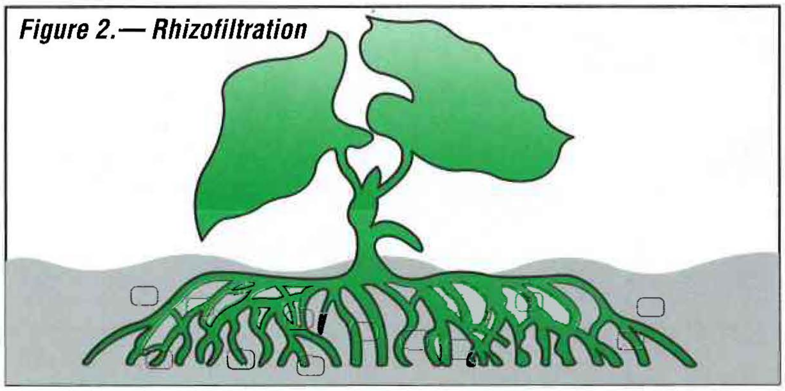


Figure 2.— Rhizofiltration

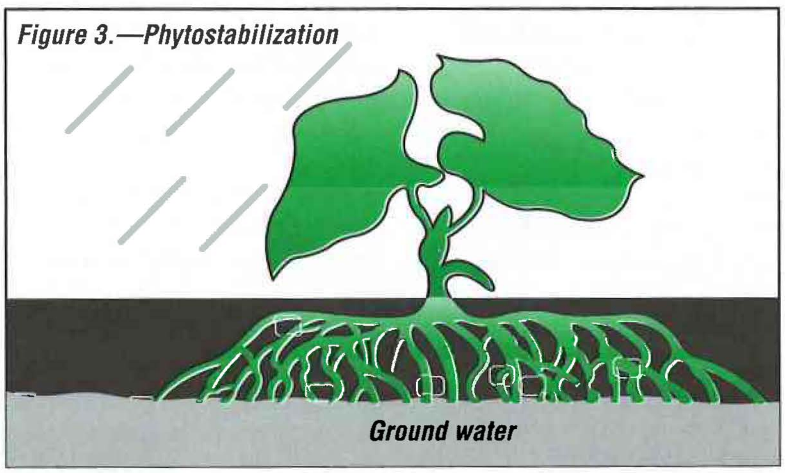


Figure 3.—Phytostabilization

plant biology at Rutgers University, read several 60-year-old Russian journal articles describing the use of wild plants, known for their metal-absorb-ing properties, to help find metal-rich mining sites. Raskin decided to take the process a few steps further by looking for metal-absorbing plants that could be cultivated and used to systematically clean up sites contaminated with radioactive metals or metals such as lead.

The process he came up with is quite simple for such a complicated problem. Plants absorb heavy metals from soil or water, then are harvested, leaving the soil and water in place with only residual amounts of pollutants. The harvested plants are reduced to ash or vitrified and disposed of in a safe place. Often, nonradioactive metals can be recovered from the ash and recycled.

Of course, the route to metal phytoremediation was not quite so simple. Dr. Raskin and his co-workers spent years of research to determine the ideal plants, finally focusing on the Indian mustard plant (Brassica juncea) and the sunflower. The mustard plant has proven to be excellent at absorbing metals through its roots, then transporting the metals upward into the shoots and leaves in the process called phytoextraction. The sunflower, on the other hand, absorbs heavy metals only into its roots, making it a better candidate for removing heavy metals from streams or other bodies of water in the process called rhizofiltration.

Phytotech's use of sunflowers received a lot of attention recently after the firm tested rafts of hydroponically-grown sunflowers in a lake near the Chernobyl nuclear site. As predicted, the sunflowers removed large quantities of both cesium and strontium from the water. According to Phytotech president and CEO, Burt Ensley, the firm would have cleaned up the entire 150,000-liter pond if it could have increased the amount of sunflowers to about 110 pounds.

In the United States, Phytotech has used sunflowers at an Energy Department facility in Ashtabula, Ohio, to remove uranium from water. At that field test, working on a much larger scale than at the Chernobyl trial, the firm reduced uranium concentrations by 95 percent within the first 24 hours.

"The uranium concentration in the outlet water never exceeded 5 ppb and, in most cases, was 1 ppb or less—well below the EPA groundwater standard of 20 ppb," notes Dr. Ensley. The metal concentrations in the root tissue of the sunflowers were 5,000 to 10,000 times greater than that of the water. Further, Ensley explains, because the sunflowers keep the heavy metals in their roots, the plant shoots didn't contain uranium, so they could be disposed of as non-radioactive waste.

Phytotech's field trials highlighted an additional benefit beyond the

clean-up process itself. Metal phytoremediation costs a great deal less than traditional reclamation and clean-up technologies. Phytotech scientists estimate the cost of rhizofiltration using sunflowers at a mere $2 *to* $6 per thousand gallons of water treated, including capital and waste disposal costs. According to Ensley, such methods as precipitation and microfiltration can cost anywhere from $35 to $80 per thousand gallons of water. As an added bonus, phytoremediation also improves the appearance of sites while improving their quality.

Down to the Roots

Another leading company in the emerging phytoremediation industry, Phytokinetics of Logan, Utah, concentrates on a different technique which uses microbes in the roots of plants to break down organic contaminants. The process is a kind of "hyper-bioremediation," according to Derek Knight, an environmental engineer at the firm. He explains, "The rhizo-sphere around the roots of plants has incredibly large amounts of microbes, which eat the organics."

Grasses and alfalfa are excellent phytoremediators, as are other easily cultivated, deep-rooted plants that have fibrous root zones with a lot of smaller roots. For aquatic sites, poplar trees are good because they send their water-loving roots down deep, causing a depression in the water table. Contaminants migrating in the groundwater stop around the depression where they are biodegraded.

Knight says that Phytokinetics' organic phytoremediation is best for really big sites where contaminants are in the top meter of the soil." There's no heavy machinery to raise contaminate-laden dust, nor is any soil removed for storage at a waste disposal site. Instead, the firm removes only a 55-gallon drum of soil to test plant growth. After choosing the most appropriate plant, the scientists go in with typical farming equipment, plant the seeds and add nutrients, then let them grow. The plants do the rest of the work as their large root zones stimulate the growth of naturally occurring microorganisms, which, in turn, biodegrade the contaminants in the soil.

The advantage of using plants to break down organic contaminants is twofold. First, like metal phytoremediation, the cost is low—almost ten times lower than the cost of physically removing the soil to a waste disposal site. Organic phytoremediation on a one-acre site, according to Phytokinetics President An Ferro, runs about $2,000 to $5,000—much lower than the $600,000 to $1 million required to excavate and transport the top meter of soil from the same site. Second, the vegetation planted on the site reduces soil erosion from wind and water, thereby helping to prevent the spread of contaminants, while simultaneously improving the appearance of the land.

On the other hand, not every site is a phytoremediation candidate. Knight points out that large sites with contamination only in the top two to three feet of soil will benefit the most. The plants send roots down much further, sometimes up to eight feet, but most of the microbiological activity takes place closer to the surface of the soil.

The other drawback is time. Phytoremediation, of organics or metals, can take up to five years. The long process makes it impractical for some locations that will be reused. For other sites, however, the land might be idle anyway, making phytoremediation a possibility.

More of the Same

The future of these "low-tech" technologies appears promising. Although phytoremediation is not appropriate for all mine reclamation, it can be used in a variety of situations for both organic and metal contaminants. Its biggest advantage is its combination of low cost with the growing appeal of using natural remedies to restore contaminated sites. Indeed, phytoremediation is just one of the holistic approaches emerging in land reclamation.

For example, Asarco's Mission copper mining site in Arizona is using cattle grazing to revegetate tailings (as described in the May/June 1996 issue of *MiningVoice)*. Newmont Mining in Telluride, Colo., is revegetating its tailings piles by creating soil out of the tailings material itself rather than moving nearby topsoil to cover the site.

These types of projects are "becoming standard practice," says John Bosma, senior editor at *Technology Transfer Week.* He points out that coal mining sites have been using ground cover to reclaim tailings sites for years and are "developing special vegetation for those types of sites." Phytoremediation simply is an extension of this process.

When you come down to it, such natural technologies are the mining industry's way of practicing what some Native American cultures have done for hundreds of years: whenever you borrow one item from the earth, you give the earth another item back. And, as is often the case, sometimes the best gifts are the most simple ones.

Reprinted from the July/August 1996 edition of ***Mining Voice.***

What is human factors research?

- *A roof bolter reaches for a lever while guiding the drill with his other hand. Since he's watching the drill and many of the controls look and feel alike, he hits the wrong control and crushes his hand.*
- *Six hours into the night shift, an ore truck driver dozes off. The truck plows over the berm and down into the pit.*
- *Fleeing a fire, a face crew sees smoke in the intake entry. Assuming the fire is ahead, they cross over to another entry, but soon encounter even worse smoke.*

These very different accidents have at least one factor in common: the *human* factor. The actions, decisions, thoughts, or perceptions of one or more humans contributed to the accident. These are just a few examples of safety problems researched by the Human Factors Group of the Pittsburgh Research Center, U.S. Department of Energy.

Human Factors is a young science that emerged during the late 1950s and early 1960s. Its practitioners study human abilities and characteristics, and work to apply that information to the safe design and operation of equipment, systems, and jobs. By taking the strengths and limitations of human beings into consideration, Human Factors designers can make jobs safer, more productive, and more rewarding.

Human Factors research in mining started over 20 years ago. The Federal Coal Mine Health and Safety Act of 1969 spawned new studies of industrial safety problems in mining. These studies showed that 50% to 85% of all mining injuries are due, in large part, to human error. The evidence suggested that poorly designed equipment, work environments, and ineffective training are often the cause of these performance errors.

This led to the formation of a specialized Human Factors research program. Today, our group employs more than 20 experts in industrial engineering, social sciences, computers, biomechanics, education, training, and other related disciplines. These researchers work in teams to address safety problems and provide usable solutions to the mining community.

Some examples of useful products or information that we've developed include:

- How to lift without hurting your back. Or better yet, how to get the job done *without* dangerous lifting.
- An improved method for donning a self-rescuer in a mine fire (the "3+3 method").
- Software that lets you design a permissible illumination system for a mining machine while maximizing visibility.
- Training exercises that use three-dimensional slides to teach miners how to recognize hazardous roof.
- How to implement new technologies, such as automation: what works and what doesn't.

If you have suggestions for new research areas or want more information on what we've already done, please feel free to contact us.

Robert F. Randolph, Research Psychologist, (412) 892-4360 (randolrf@ptmba.usbm.gov).

Reprinted from the August 1996 edition of the U.S. Department of Energy's ***Mining Health and Safety UPDATE,*** *Vol. 1, No. 2—the latest developments in Federal mine health and safety research.*

General health

Aspirin and colorectal cancer

Women who can take aspirin may be getting other benefits as well. Over a 20-year period, women who took 4 to 6 aspirin tablets per week had a significant reduction in the risk of colorectal cancer.

New England Journal of Medicine, September 1995

Rapid hair loss signals heart problems

It's not how much hair men lose, but how fast they lose it that increases the risk of heart attack. Men who lose a substantial amount of hair in a short time are at higher risk.

American Journal of Epidemiology August 1995

Utah coal producers look to Pacific rim for future growth

Salt Lake City, Utah—Coal producers depend on instate power generators to buy more than half the fuel they mine, but the mining companies are banking a piece of their future on a California coast construction project.

Three of the state's largest mining companies have invested $22 million in an expansion of the Port of Los Angeles that they hope will boost exports to the Pacific rim—one of the hottest coal markets in the world.

The Coastal Corp., Cyprus AMAX Minerals, and Andalex Resources Inc. are not alone in their venture. Some 25 Asian energy, shipping, and financial firms also have equity positions in the project, as do Union Pacific Railroad and Savage Industries, another Utah company that will operate part of the new shipping terminal, scheduled for completion in mid-1997.

Environmental groups point to the port expansion as evidence that Andalex Resources has intentions of extracting more coal from southern Utah's Kaiparowits Plateau than the Dutch-owned company has let on. The Southern Utah Wilderness Alliance has appealed state approval for part of Andalex's proposed Smokey Hollow mine, saying regulators should consider the entire project and its environmental impacts.

Andalex was among dozens of coal producers in the West who gathered in Los Angeles in March 1991 to hear port officials propose expansion of their coal shipping facilities. The facility is a cornerstone to a larger overhaul of the port. "We're already exporting 2 million tons to Japan," said Mike Rounds, spokesman for Cyprus. "A new port facility with a capacity of 10 million tons per year will do nothing but enhance our ability to export."

More than half the coal mined in Utah fuels the coal-fired power plants operating in the state. Analysts and Utah coal producers predict future demand is limited at home, forcing producers to look for more buyers out of state.

Electric utilities in the East are buying up increasing amounts of Utah coal, which burns cleaner, to help operators comply with federal clean air standards. And massive development of coal-fired electrical generation in the Pacific Rim has caught the attention of Utah coal producers.

"The Pacific Rim coal market is the hottest coal market in the world and we are expending considerable resources to enlarge our position there," said Rounds, whose employer is the second-largest coal producer in the country.

Englewood, Colo.-based Cyprus produces 4 million tons of coal annually from its Star Point mine in central Utah and construction of a third mine in the area is under way. The new Willow Creek mine is expected to yield some 3-5 million tons annually, with two-thirds of it to be marketed along the Pacific rim.

Coastal, which has the largest position in the port facility among Utah coal producers, is keeping quiet about its future plans as it awaits a buyer for its Utah coal properties, which shipped 1.2 million tons out of a total 9.3 million tons of coal to the Pacific Rim last year.

Andalex hopes a modernized port and the involvement of Union Pacific will shave enough off its transportation costs at the company's Pinnacle and proposed Smokey Hollow mines to compete with producers in the Pacific Rim.

The Kaiparowits project has been criticized by opponents as a high-priced boondoggle because Andalex plans to truck coal from the mine to rail heads more than 200 miles away, increasing transportation costs an estimated $2-$5 a ton.

But Andalex, which claims its Kaiparowits transportation costs would be no different than its existing central Utah operation, said the expanded shipping terminal should cut those costs.

Japan and other Pacific Rim nations need the fuel, analysts said.

"What's driving the development in Los Angeles is a lot of new plans to build new coal-fired generating plants (in Japan, Taiwan, South Korea and Hong Kong)," said Jeff Watkins, vice president at Hill & Associates, an energy management consulting firm in Annapolis, Maryland. Japan in particular is converting its electricity generating plants from oil to coal to reduce costs and exposure to oil price swings.

Japanese utilities have invested in American coal properties, Watkins said. And while no one involved or familiar with the Los Angeles expansion can recall a foreign business over investing in an American port, Japan has done it elsewhere.

Watkins said Japan's strategy is to secure a reliable source of fuel at the cheapest price, which means Utah coal producers shouldn't necessarily read Japan's 49% equity position in the port as an assurance to buy imported coal.

Watkins explained that if past projects are an indication, Japan could use the port's intended affect on reducing American prices as leverage against Australia and Indonesia to cut their coal prices.

"They look at that investment as competition to other suppliers," he said. "Even if they don't take any coal, they can recoup their cost with cheaper competitive prices."

*Reprinted from the September 1996 issue of Acquire's **COAL TODAY**.*

Far left, George C. Scott, in a scene from the movie Patton. At left, Scott gets help with his boots during the icy January filming.

On location as a legendary hero goes underground

By James E. Casto, associate editor

Legendary actor George C. Scott is best known for his Oscar-winning role as George S. Patton, the tough-as-nails World War 11 general.

But during his distinguished career on stage, screen and television, Scott has played a bit of everything, from a malevolent prosecutor in *Anatomy of a Murder* to a high-stakes gambler in *The Hustler*, from an embittered excop in *The New Centunons* to a dedicated doctor in *The Hospital*.

Now he can add yet another job title to that long and varied list of occupations: coal miner.

A made-for-TV movie starring Scott as a miner was filmed entirely on location in the Appalachian mountains of southwestern Virginia in January. As yet unnamed, the film is scheduled for airing later this year on the CBS Television Network.

Scott stars as a courageous miner who risks everything to help his teen-age granddaughter keep her baby.

Starring with Scott are Ally Sheedy, Rachel Leigh Cook, Don Diamont—and the miners of Buchanan County's Crystal Bay Mining Company. The Crystal Bay mine, operated by Steve Wolford for Permac Inc., was the backdrop for several of the film's crucial scenes.

Filmed primarily in Virginia's Tazewell and Buchanan counties, with a few additional scenes shot in adjacent Mercer County, W.Va., the movie utilized approximately 375 local extras, including Crystal Bay's miners, and pumped an estimated $1.5 million into the regional economy.

The Virginia Coal Council was instrumental in locating the mining site for the film's makers, Televideo Entertainment and the Landsburg Company.

Emily Fisher, a spokeswoman for the council, gives high marks to the film's producer, Linda Otto, and director, Graeme Campbell, for their determination to make it as authentic as possible. In several instances, she reports, that meant rewriting the original script.

The film's opening scene. for example. is a dramatic rescue in which Scott pulls a fellow miner to safety when the mine floods.

"In the script," says Fisher, they had the flood starting when a miner threw a pickax at the mine wall. The movie is based on an actual West Virginia child custody case that occurred in the late 1970s and '80s, and that's the period the film is set in. But it was clear these guys had no idea what modern coal mining was all about. So we took them in and showed them, and we got the script changed. They gave us a lot of input because they were very interested in doing it right."

Fisher is also pleased that Clayton Harris. the fictional coal miner played by Scott. is shown living in a house that's nothing fancy. but nonetheless is neat and well-kept." She admits to being concerned that the film, in keeping with the familiar inaccurate stereotype of coal mining communities. might have shown him living in a tar-paper shack.

The film, she notes, also highlights the essential goodness of the mine community," when it rallies to the aid of Clayton (Scott).

Clayton, well liked and respected by his fellow miners and others, has lovingly raised his granddaughter Ms. Baker (played by Cook) from infancy in the absence of her rebellious, alcoholic single mother, Angie Baker (Sheedy).

When Emma turns 15, she decides, very much against her grandfather's wishes, to visit her mother in hopes she can forge some sort of meaningful relationship with her. The alcoholic

Angie greets her daughter with indifference, but the attractive Emma catches the eye of Angie's attractive live-in boyfriend, Ray Wilcox (Don Diamont), who sets out to seduce her—and succeeds.

When Emma learns she is pregnant, she decides to keep and raise the child, who is born with a severe asthmatic condition. Clayton convinces Emma to allow him to adopt the child so that the mounting medical bills can be covered by Clayton's health insurance.

A defiant Ray denies Clayton's appeal for adoption and petitions the court for sole custody of the child, which the court grants. Fearing the sickly child will die in Ray's care, Clayton, with the support of the sympathetic coal-mining community, goes on the run with the child. risking imprisonment for kidnapping.

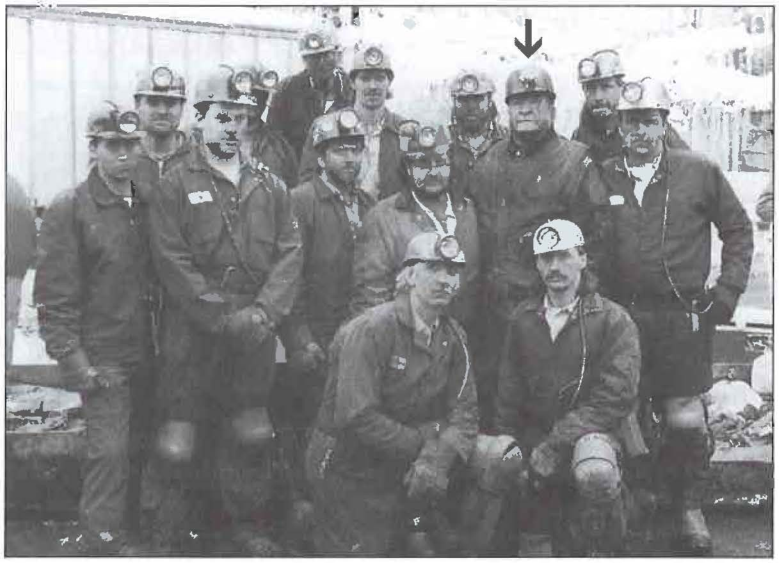
In addition to the opening showing the mine flood, other mining-related scenes include a highspeed chase of a coal truck by sheriff's deputies and Clayton's escape into the mine with his infant greatgrandson.

The extras in the film's mining scenes were played by two dozen or so real Crystal Bay miners. One miner, Ferrell Compton, had several lines of dialogue, making him eligible for a membership card in the Screen Actor's Guild.

"A.T. Massey supplied us some wonderful film footage for use as a background to the credies," adds Fisher. "It shows some continuous mining and roof bolting and is truly impressive to see."

"All in all," she says, "I think the film provides a really positive look at miners and mining."

Across the state line in Tazewell, Va., a scene was shot in the Straus Episcopal church with Michael Martin, artistic director of the local Princess Arts Group, playing the church's pastor.



◀ *At right, Scott (standing third from right) with the Crystal Bay miners.*

Martin is a seasoned actor but nonetheless admits to being flustered when he found himself eye-to-eye with Scott as miner Clayton.

Martin rehearsed the scene several times with a stand-in taking Scott's place. Then, without Martin realizing it, Scott took the stand-in's place. Martin explains what happened next:

"When the director called, 'Action!' I went through the benediction, came down off the pulpit and to the pew where Scott would be sitting.

"I got to the spot and leaned up, as I had done four or five times, with a double sitting in for Scott. But when I started to deliver my line, I realized I was looking right into the eyes of General Patton."

Instead of the double, it was actually the gravel-voiced Scott in the church.

"Nobody had told me Scott had been brought into the set," Martin says. "It startled the hell out of me.

I knew we were going to be working together. but I had been used to seeing this double sitting there. And I was expecting to find his double sitting there again. It was a startling moment.

"The director asked, 'Don't you have a line here?'

"Nothing was coming out of my mouth Martin says that once he regained his composure, he got along just fine with Scott, who won, but refused to accept, an Oscar for his title role in 1970s Patton.

"He's not an actor, of course, he's a deity of some sort," Martin says of Scott.

"He didn't say anything when I missed the line. He's maybe used to that. I don't doubt that the same thing would have happened if I had been eye-to-eye with Liz Taylor or Paul Newman."

Like Martin, Fisher also is high in her praise of Scott, noting that even though the weather during the January filming was bitter cold and snowy the veteran actor went through his paces without complaint—-just as if he were snug and warm back in a Hollywood studio.

But Fisher reserves her highest accolades for the two dozen or so Crystal Bay miners who worked in the film.

"They're all 'stars' in my book" she says.

Reprinted from the Huntington, W.Va. ***Herald-Dispatch.***

Holmes Safety Assocation proposed constitution changes

In accordance with Section 15 of the Holmes Safety Association Bylaws, Section 11(d) selection is proposed to be amended as follows:

Amendment to Section 11(d) Holmes Safety Association By-Laws

In order to reflect the National Scope of the Holmes Safety Association, the Annual Society spring meeting location should be rotated among the following four zones listed below. Annual meeting site location will be rotated in the following order: Zone one, Zone two, Zone three, Zone four. Each year, at the annual spring meeting, representatives from the following four zones may petition Executive Committee to consider their particular location as a meeting site for the next meeting in their particular zone. Should no representative of a particular zone desire to host the next annual meeting, the annual meeting site will be rotated to the next zone.

Zone 1

Mississippi	Tennessee
West Virginia	South Carolina
Maryland	Louisiana
Alabama	Virginia
Georgia	Washington, DC
Arkansas	Kentucky
North Carolina	Florida

Zone 2

Missouri	Washington
Montana	South Dakota
Iowa	Wisconsin
Oregon	Wyoming
Nebraska	Alaska
Illinois	Idaho
North Dakota	Minnesota

Zone 3

Michigan	Ohio
New York	Connecticut
Maine	Indiana
New Jersey	Rhode Island
New Hampshire	Pennsylvania
Delaware	Massachusetts
Vermont	

Zone 4

California	Arizona
Kansas	Hawaii
Nevada	New Mexico
Oklahoma	Utah
Colorado	Texas

Supporting Rationale

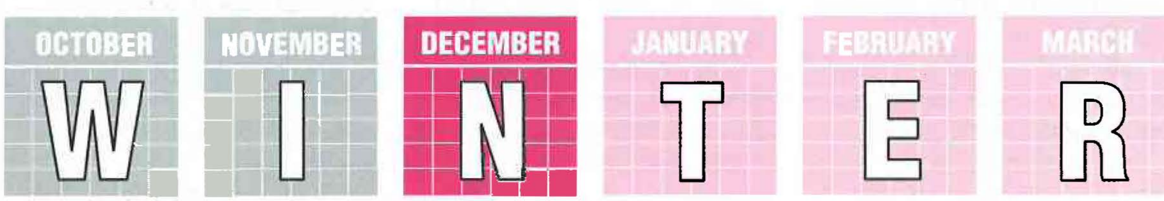
By realigning some of the locations Zone 1 and placing them in Zone 2 will more evenly distribute the representation of Holmes chapters around the country.

Submitted by: Robert Glatter, National Secretary/Treasurer, HSA

Fly ash oyster reef experiment yields promising results

Richmond, Va.—Two years of study by environmental scientists from several Virginia research institutions have found that pellets produced from power plant fly ash and cement can be an effective substitute for natural shells in the restoration of oyster beds. If the findings are confirmed by additional research, the cement-ash pellets could play an important role in revitalizing Virginia's diminishing oyster industry. Virginia Power provided principal funding for the project as part of its ongoing effort to find beneficial reuses for power station coal ash.

*Reprinted from the Sept. '96 issue of Automation News Network's **Industry.Net Report** of Pittsburgh, Pa.*



ALERT reminder: ● *Always maintain adequate mine ventilation and make frequent checks for methane and proper airflow.* ● *Know your mine's ventilation plan and escapeways. Properly maintain methane detection devices. Communicate changing mine conditions to one another during each shift and to the oncoming shift.* ● *Control coal dust with frequent applications of rock dust.* ● *Make frequent visual and sound checks of mine roof during each shift. NEVER travel under unsupported roof.*

1995 "Sentinels of Safety" trophy awarded to Chesterhill Stone Co.

In October of 1995 the **East Fultonham Limestone Quarry** was recognized by the presentation of the **"Sentinels of Safety Award"** from J. Davitt McAteer, Asst. Secretary, U.S. Department of Labor, Mine Safety and Health Administration. This award is given to those operations who work at least 30,000 employee-hours in a calendar year (1995) without a lost-time injury.

The purpose is to recognize Chesterhill Stone Co.'s East Fultonham mining operation's safety record (34,815 safe productive hours without a lost-time injury in 1995) and to stimulate greater interest in safety and to encourage development of more effective accident prevention programs among the Nation's mineral extractive industries. Chesterhill Stone is a member of the Mid-Ohio Chapter of the Holmes Safety Association.

Company safety awards

The management of Chesterhill Stone Co. realize the importance of a safe and productive workplace. To be able to make these announcements of continuous "Safety Days" is a direct reflection upon the record of their workmen and the safe attitudes they have of their workplace.

"Chesterhill Stone Co. is a company under a common ownership. Their production of quality products and customer service are known throughout the industry."

Chesterhill Stone Co. is pleased to announce that their mining and processing facilities have accumulated over 670 days in 1995 and 1996 of continuous safe production of quality aggregate products with no lost time accidents. These facilities have remained safe in 1996 and endeavor to continue this trend into the year 2,000 and beyond.

As of October 31, 1996 the East Fultonham Limestone Quarry had 670 days; the Beverly Ash Plant 3,441 days; and the Stockport Sand and Gravel had 1,326 days without a lost-time accident.

While the "Ash Plant" is an OSHA facility the men are trained as MSHA employees, this enables us to allow these men to work at the quarry or the sand and gravel operations if required.

Submitted by: J. Mark Moellendick, Compliance Officer, Chesterhill Stone Co., P.O. Box 599, McConnelsville, Ohio 43756 (614) 962-5621 (Fax) 962-3556

Front Row: ***George Hill (Supvr.); Bob Alexander; Tom Pletcher; Mark Stimmel; Jeff Wise; Jeff James; Richard Skinner; Bob Greuey; Brad Shriner; and Bucky Gheen.*** *Back Row:* ***John Beall; Chris Wilson; Chuck Snider; Bob Watts (Weigh-Master); Gerald Moler; Steve Alloway; Jerry Inman; and Jeff Pinkerton (absent—John Price, Supvr.; & Bob Sullivan, Gen. Mgr.)*** *Photo by: J. Mark Moellendick, Compliance Officer*

THE LAST WORD...

Time is like money, the less we have of it to spare the further we make it go.—Josh Billings

Knowledge is power if you know about the right person.—Ethel Watts Mumford

A tool is but the extension of a man's hand, and a machine is but a complex tool. He that invents a machine augments the power of man and the well-being of mankind.—Henry Ward Beecher

Time, whose tooth gnaws away at everything else, is powerless against truth.—Thomas Huxley

Medicine is the only profession that labors incessantly to destroy the reason for its own existence.—James Bryce

Our greatest glory consists not in never falling, but in rising every time we fall.—Oliver Goldsmith

A retentive memory is a good thing, but the ability to forget is the true token of greatness.—Elbert Hubbard

Gossip is the art of saying nothing in a way that leaves practically nothing unsaid.—Walter Winchell

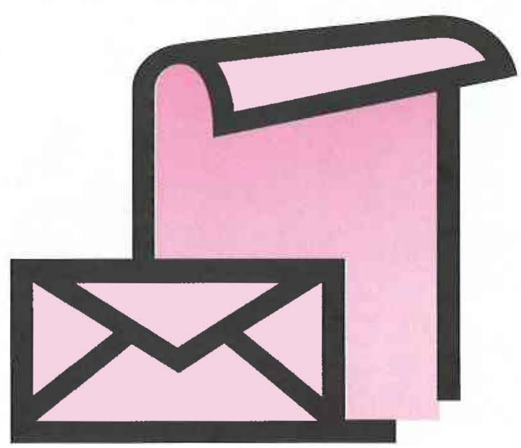
Dost thou love life? Then do not squander time, for that is the stuff life is made of.—Benjamin Franklin

NOTICE: We welcome any materials that you submit to the Holmes Safety Association Bulletin. We **DESPERATELY** need color photographs suitable for use on the front cover of the ***Bulletin.*** We cannot guarantee that they will be published, but if they are, we will list the contributor(s). Please let us know what you would like to see more of, or less of, in the Bulletin.

REMINDER: The District Council Safety Competition for 1996 is underway—please remember that if you are participating this year, you need to mail your quarterly report to:

Mine Safety & Health Administration
Educational Policy and Development
Holmes Safety Association Bulletin
P.O. Box 4187
Falls Church, Virginia 22044-0187

Please address all editorial comments to the editor, Fred Bigio, at the above address or at: MSHA—US DOL, 5th floor—EPD #535A, 4015 Wilson Blvd., Arlington, VA 22203-1984. Phone us at (we love to hear from you): (703) 235-1400



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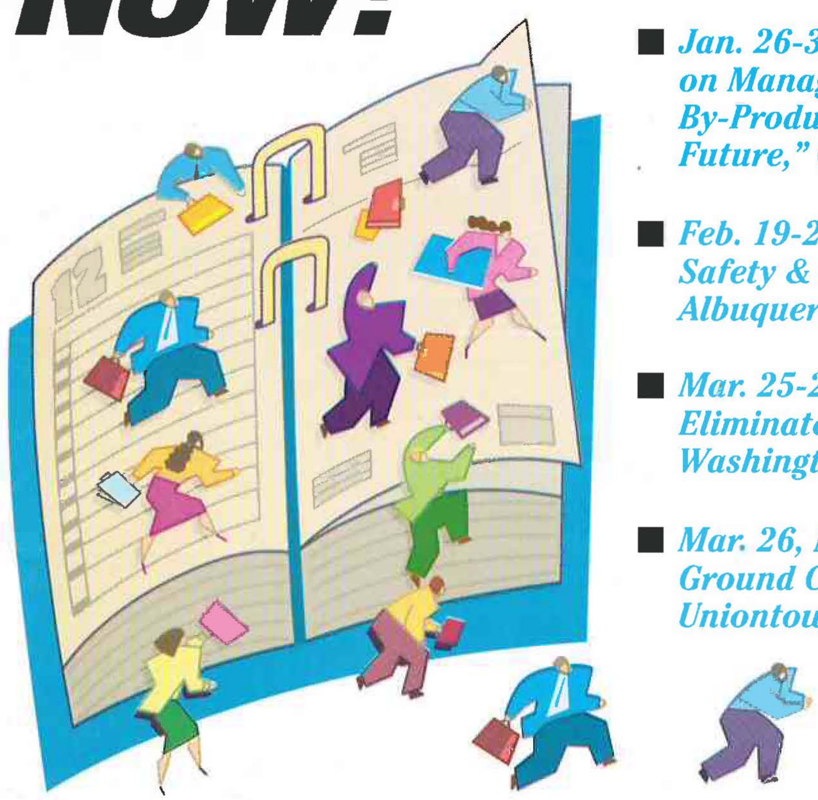
JOIN and GROW with us

Mark your calendar NOW!

Upcoming events:



- *Jan. 26-30, 12th International Symposium on Management and Use of Coal Combustion By-Products: "Innovation for a Sustainable Future," Orlando, FL*
- *Feb. 19-21, South Central Dist. Joint Mine Safety & Health Conf., Sheraton Uptown, Albuquerque, NM*
- *Mar. 25-26, National Conference to Eliminate Silicosis, Mayflower Hotel, Washington, D.C.*
- *Mar. 26, NIOSH Open Industry Briefings on Ground Control in Pillar Retreat Mining, Uniontown, PA*