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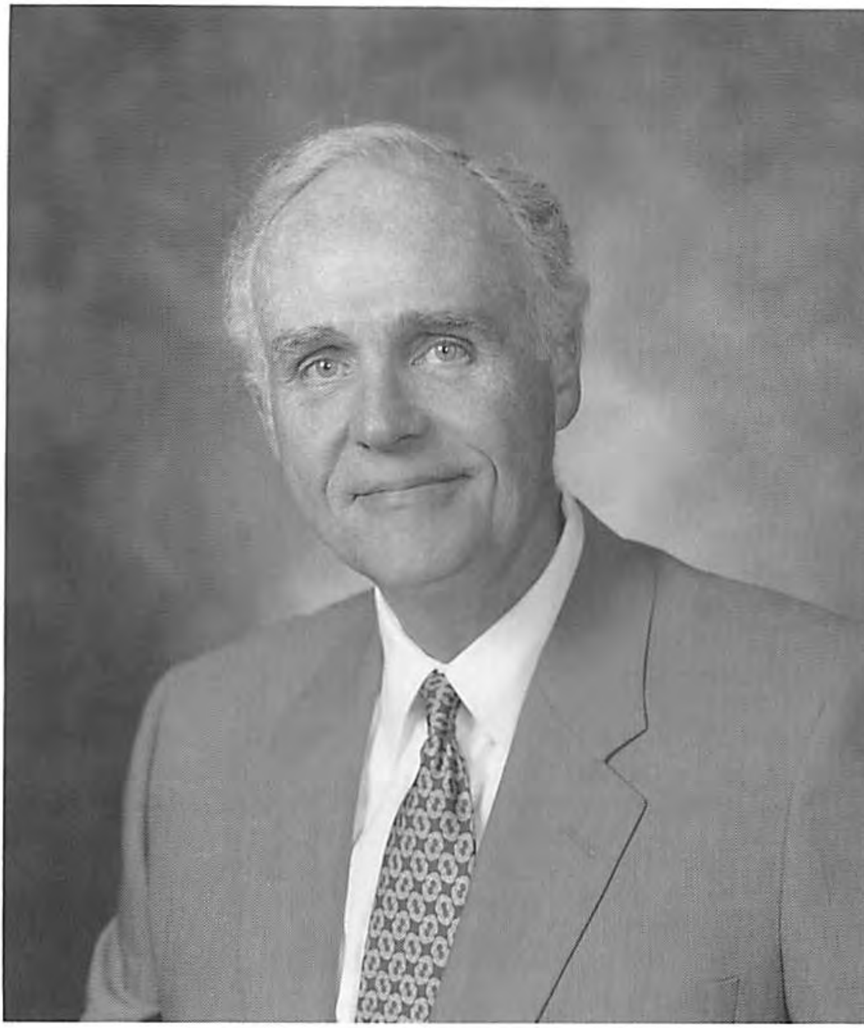

Michael K. Reilly

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THE COAL MINER

TRUE – he plays no grandstand role in life
But his importance is vital, great and just:
For without his toil in earth's caverns deep,
Civilization would soon crumble into the dust.
AD 1964 From his poem – Vachel Davis

(Dedicated on State Capitol Lawn, Springfield , Illinois, October 16, 1964)

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PROCEEDINGS
OF THE
ILLINOIS MINING INSTITUTE

CENTENNIAL MEETING
Collinsville, Illinois
Thursday and Friday, September 24-25, 1992

The opening session of the Centennial Meeting of the Illinois Mining Institute was convened at 10:00 A.M., Thursday, September 24, 1992, in the La Salle Room of the Gateway Center. Michael K. Reilly, President of the Institute, presided.

Michael Reilly: My name is Mike Reilly. I am President of the Illinois Mining Institute. I call to order this 100th annual meeting. I am honored to have served as your president during the centennial year. Today, reaching a 100 year anniversary in any business or association is a remarkable accomplishment. The only way it happens is through the excellent efforts of many people.

A great deal of thought, planning and hard work has gone into the preparation for this centennial meeting. I hope that you enjoy the program that we have put together for this very special anniversary. A lot of very capable people have worked hard to make this an event you will remember, and without slighting anyone, I'd just like to recognize a few. I haven't seen Doc Harrell yet, but Doc Harrell and 25 others headed up the Centennial Committee and for over two years they have been planning and working and doing an awful lot to make this a special meeting. I think it will be, and I am really pleased that there is a good turnout. Also I would like to recognize Fred Bauer and his cochairman, Jerry Watkins, who coordinated the Advertising Committee. This committee is extremely critical to raising the necessary funds to support the Institute's meetings and scholarship awards through exhibit fees and advertising revenues, and this is their best yet. I would also like to thank Heinz Damberger and Phyllis Godwin; without their continued followup and outstanding support, we would not have this meeting. They've sure kept me on line and all of the other committees. They just do an outstanding job. Our thanks also to the exhibitors and coal companies who have given additional support for this meeting. All of the exhibit space has been taken. I would ask you to please support these exhibitors by taking the time to see what they have on display.

Don Arrowsmith, Manager of Technical Services, Zeigler Coal Company is going to chair this morning's technical session. It was supposed to be chaired by Dave Young; but Dave Young, Vice President of our Illinois Division, was called out of town, so Don is going to take care of both the session today and tomorrow.

But before I turn it over to Don, I need to make a few announcements. One thing you'll notice is there are guards at the exhibit hall and the Mississipian Room where some of the exhibits are located. We have some very old mining lamps and other items that people have spent a great deal of time and money collecting, and we want to make sure those are taken care of. So anybody that goes into those exhibit rooms must have a badge. If a guard stops you for not having one, you'll know why.

Our luncheon meeting will be at 12:30 in this same room so we need to keep the program moving today. Hopefully, the program will finish about noon; that gives them about half an hour to set this room up for lunch. In addition to the several award presentations and recognitions, Dave O'Neal, Assistant Secretary of the Interior, will be our keynote speaker. Dave is a native of Illinois, born and raised very close by here and has been a great supporter of our industry.

Also, I would remind you that the trade exhibits will be open from 1:00 p.m. to 6:00 p.m. Please take time to visit those exhibits. There will be the always popular fellowship hour. This fellowship hour will be right in the exhibit hall from 4:00 to 6:00 p.m. Starting at 6:00 this evening, there will be a reception right outside this room in the function area, and at 7:00, we'll have dinner and dance. The Don James band, a well-known St. Louis area dance band, will be here this evening.

Tomorrow morning the business session will commence at 8:00 a.m. in this room, the La Salle Room. An 8:00 a.m. starting time shouldn't be too early for coal miners. They are used to starting early even if sometimes they are out late. We will also have a free continental breakfast in the exhibit hall starting at 8:00 a.m., and the trade exhibits will be open from 8:00 a.m. until noon. The second technical session will start here tomorrow morning at 10:00 a.m., and Don has assembled an additional panel of outstanding speakers for tomorrow's program.

Finally, in order to keep our records up to date, I'd like to ask if any of you know of a member of IMI that has passed away this past year. Please let Heinz, Phyllis Godwin or somebody at the registration table know. And now, Don, it is your turn.

THURSDAY MORNING TECHNICAL SESSION

Don Arrowsmith: Good morning and welcome. I would like to mention that most of the talks will run for about twenty minutes with a few minutes for questions. I will allow a certain number of questions, depending on time, trying to keep us on schedule. Everyone needs to pay very special attention to the talks because if there aren't enough questions, I'll point to someone and you'll have to come up with a question right away.

Our first speaker is Dr. Paul Chugh, Chairman of the Mining Engineering Department of Southern Illinois University at Carbondale. I imagine everyone in this room has worked with Paul at one time or another. He is one of the foremost authorities on ground control in the Illinois Basin. With that I will keep it short and let him start. Dr. Chugh.

Paul Chugh: Thank you, Don. I appreciate your introduction. It is indeed an honor and a privilege to kick off the first session of the 100th Illinois Mining Institute meeting. I am a little bit nervous today, and I hope I can pull through to your expectations. This morning, I will try to present to you the results of a ground control and subsidence study of a longwall mine in southern Illinois. I have one of the co-authors, Dr. Yu, in the audience, and I appreciate all the efforts that he has put in. Before I start off with my technical presentation, I would like to go ahead and recognize the efforts of those who have contributed to it. The Illinois Mine Subsidence Research Program is funding this program. The U. S. Bureau of Mines is putting quite a bit of money into it, as well as the mining companies, and finally, the College of Engineering at SIU-C. Without the support and cooperation of the mining company, we would not have been able to conduct the study, even if the money had been available. So my special thanks to the mining company for their effort.

Let me give you the background of why we started this study. If you take a look at longwall mining research, today there are two areas that really need further attention. One is the gate roadway design, and the other is the correlation between the surface movements and the underground in-mine performance of the chain pillars and mine entries. As far as the gate roadway design is concerned, a lot of work has been done over the years. In the future, as our longwall faces progress at a much faster rate, we will have to continue to do the work on how many chain pillars will be needed, what should be the geometry of chain pillars, and on how the stresses tend to redistribute during extraction over the entries and chain pillars. As for the correlation between surface and underground movements, little work has been done in the past. People have either looked at surface motions only, or they have looked at underground motion. But little work has been done to correlate the two. So with this as background, we established the goals of this study.

Don Arrowsmith opens the Thursday technical session of the 100th Annual Meeting.

A GROUND CONTROL AND SUBSIDENCE STUDY OF A LONGWALL MINE IN SOUTHERN ILLINOIS

YOGINDER P. CHUGH, ZHANJING YU and PAUL E. MILLER
Department of Mining Engineering
Southern Illinois University
Carbondale, Illinois

ABSTRACT

This paper presents the results of an ongoing field geotechnical study in a longwall mine in southern Illinois. The study includes both surface and underground instrumentation and monitoring. Surface subsidence monitoring includes vertical and horizontal deformations of sixty-five monuments along and across the study panel, and underground instrumentation includes measurement of changes with face retreat in vertical pressure and horizontal deformation of chain pillars, and roof-floor convergence, roof sag, and floor heave in entries. An attempt is made to correlate the surface and in-mine ground movements. A hyperbolic tangent equation appears to fit changes in pillar deformation, convergence, and surface subsidence data as a function of face position very well. The developed equations may be used by the mining industry to plan additional supports in entries, vacating surface structures, and in planning land use over mined-out areas.

INTRODUCTION

Ground mechanics in longwall mining should consider surface and subsurface deformations as well as stresses and displacements in the vicinity of the longwall face as they impact face and mine stability. In the past, most studies (Mark, 1990; Newman, 1989; Peng and Chiang, 1984; Bauer and Hunt, 1982; among others) emphasized either surface deformations or in-mine stability studies. In this research, both surface deformations and in-mine stability studies are being conducted. Its objectives are to study: 1) subsidence characteristics, including time effects; 2) stress and deformation changes in chain pillars as a function of time and face location; 3) roof, pillar and floor deformations in entries as a function of time and face location; and 4) relationships between the surface subsidence and underground strata behavior. Subsidence over chain pillars is of considerable interest to the coal industry in the Illinois Coal Basin, and the long-term goal of this research is to design chain pillars with controlled subsidence movements.

MINE DESCRIPTION AND GEOLOGY

The mine extracts the Herrin (No.6) Coal seam in southern Illinois at an average depth of 650 feet from the surface. A typical lithologic log for a borehole in the area is shown in figure 1. The thickness of the coal in this area varies from 100 to 120 inches which includes a 5- to 13-inch shale parting (blue band) 18 to 20 inches above the coal bottom. Core-holes near this site indicate an immediate roof of 4.5 to 5.5 feet of black shale with a relatively competent 21-foot thick limestone immediately above. The black shale breaks into small discs quite easily, with occasional pyrite flakes. About 6 to 12 inches of coal is left along the roof in the gate entries to avoid the falls of the immediate roof bed which is typically sensitive to moisture. Roof bolts are anchored into the limestone bed. The immediate floor strata consist of light gray underclay ranging from 2 to 5 feet in thickness, underlain by 10 to 15 feet of hard calcareous shale, with limestone nodules throughout. In this area, the Springfield (No. 5) Coal seam is 40 to 50 feet below the Herrin Coal seam. Near the surface, the core-holes show 30 to 50 feet of glacial material underlain by layers of shale, limestone, sandstone, and coal beds.

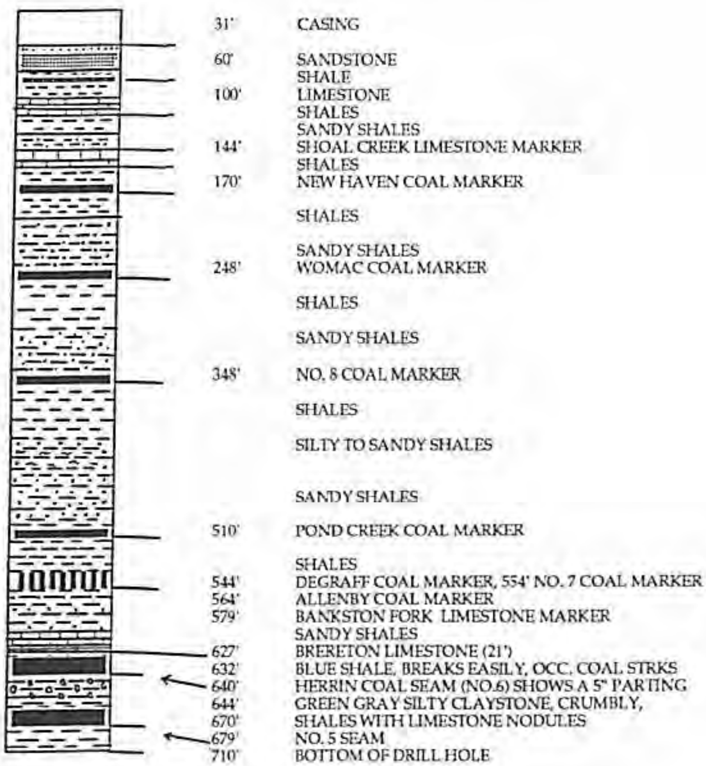

Figure 1. Lithologic log of the studied area.

The chain pillars are designed on 120 feet x 60 feet centers, using a three-entry system with 15.5 feet wide entries (figure 2). The pillars are offset at the crosscuts by approximately 15 feet. The longwall face is 960 feet wide and 7,000 feet long in the east-west direction. Two panels had already been extracted immediately to the north of the study panel, and two more panels immediately to the south of the study panel will be extracted in the future (the layout permitted us to plan the study over the next three years). The longwall face retreats approximately 30 feet per day toward the east. Dowty two-leg 500-ton shield supports are used on the face. Additional roof supports are used in between crosscuts at the head and tailgate entries on an as-needed-basis using timber sets, crib blocks and truss bolting. Escapeways along the solid coal block are also timbered with sets containing an 8-foot cross beam and two posts 8 in. x 8 in. in cross-section.

The gate and tail entries of the previously mined panels were physically examined to determine the extent and range of the floor heave, pillar settlements, pillar failures and roof failures. Floor heave down the center of the tail entries was visible, but it was not discernible in the headgate entries. The interface between the pillar and the floor was dug at a few locations in tailgate entries which revealed that the coal pillar had punched at least 6 inches into the weak floor. Occasional roof falls were observed along the gate entries. Most pillars were, however, intact, with little rib sloughing, and it was concluded that pillar instrumentation would stand a chance for survival for long-term monitoring.

INSTRUMENTION AND LAYOUT

The instrumentation chain pillars underground were selected about 720 feet away from the panel's termination point and about 1,000 feet away from the retreating longwall.

The surface and underground instrumentation layouts are shown in figures 2 and 3. Surface instrumentation consisted of subsidence monitoring for vertical and horizontal displacements. The underground instrumentation consisted of measuring roof-floor convergence, lateral pillar deformations, pillar loads, roof sag and floor heave. Underground instrumentation began on February 1, 1992, and by February 29, 1992, most of the instrumentation had been completed. At that time, the longwall face was within 310 feet of the nearest underground instrumentation point. A brief discussion of the instrumentation and data gathering is presented here, and a detailed description is given by Chugh et al. (1992) elsewhere.

Subsidence Instrumentation

Figure 3 illustrates the subsidence monitoring network. Four subsidence monitoring lines consisting of 65 monuments were established. The main monitoring line is along the transverse direction of the panel, and the three fork lines are along the longitudinal direction of the panel. The

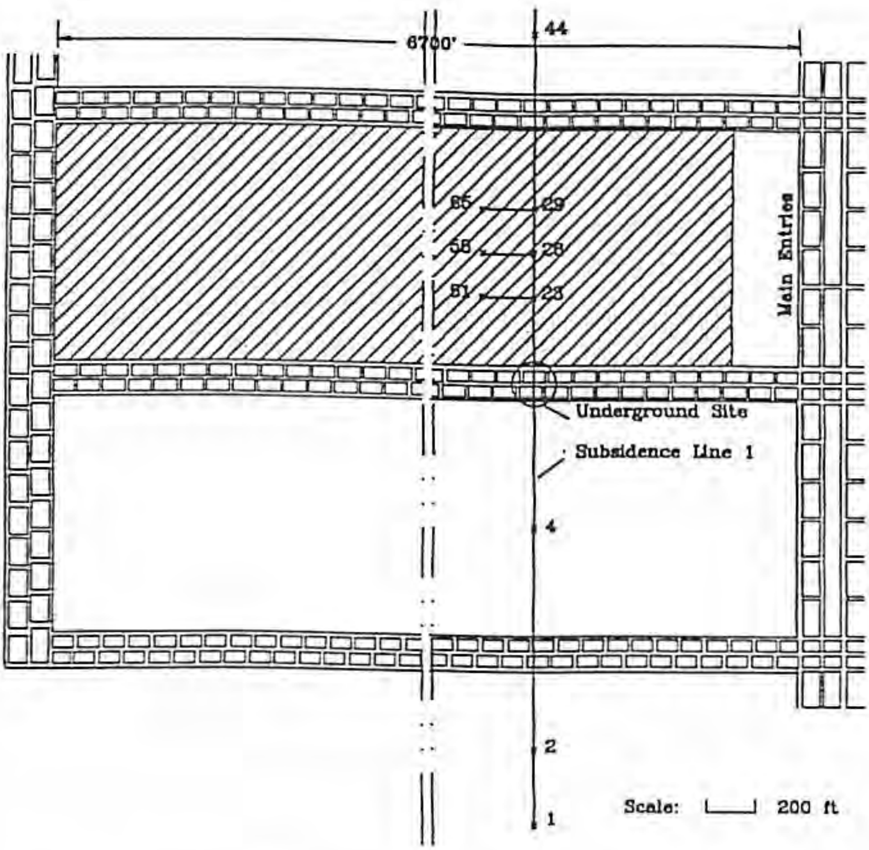

Figure 2. Panel layout and the location of the monitoring site.

monuments were located at 60-feet intervals over the center of the panel and at 30-feet intervals near the edges. The distance between monuments along the longitudinal forks was 60 feet. A 7-foot subsidence monitoring point, with a frost-free design, was used in the study. Vertical displacement was measured with Second Order-Class II accuracy level surveying. The requirement for accuracy for such a survey is 8 mm $\sqrt{k}$ where k is the loop distance in km. An autoset level with an optical micrometer (least count 0.0001 m or 0.000328 feet) and two invar leveling rods were utilized for measurement. Horizontal displacement measurements were taken using a steel tape with a resolution of 0.010 feet. The readings were estimated to the nearest 0.005 feet. The distance between two monuments was measured two times and averaged. Vertical displacements of monuments, not undergoing subsidence, fluctuated within 3 mm due to measurement and physical change errors.

Subsidence surveys were conducted at intervals varying from two days to seven days, depending upon expected movements. The baseline data were collected on February 7, 1992. The subsidence monitoring line was undermined on or about March 16, 1992.

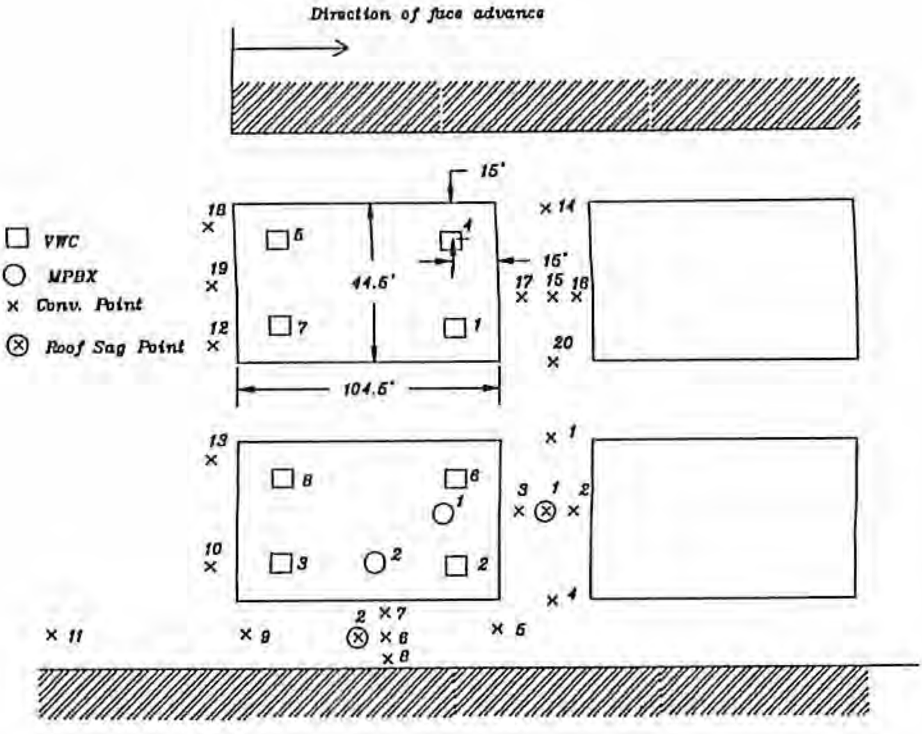

Figure 3. Layout of the underground instrumention.

Vibration Wire Stress Meters

Pillar stress changes were measured using the vibrating wire stress meter (VWS). A total of eight VWSs were installed in the two chain pillars on the headgate of the panel as shown in figure 3. The VWS holes were drilled horizontally from the rib, and one VWS was installed in each hole at a depth of 15 feet. At the time of the installation, the longwall face was about 550 feet behind the outby row of the VWSs (VWSs 4-1-6-2 as shown in figure 3). VWS #5 was destroyed when the face passed by, and VWSs #1, #4, and #6 were blocked due to the collapse of the middle entry when the face was located about 400 feet outby of the instrumented pillars. The VWSs were monitored at intervals varying from two to thirty days, depending upon the expected changes. The accuracy of the VWS measurement is about 3.5 psi.

Roof-Floor Convergence Measurement

A convergence station consisted of a "S" hook attached to the head of a roof bolt and an eye bolt anchored 6 inches into the floor. In order to prevent floor monitoring points from being run over by mining machinery, the eye-bolts in the floor were covered with PVC caps. Twenty convergence stations were installed at Site 1 and the location of each station is shown in figure 3. All the stations were located around the two instrumented pillars, except No. 11 which was about 200 feet inby. A tape extensometer with the resolution of 0.005 in. was utilized for convergence measurement.

Horizontal Pillar Deformation

Horizontal pillar deformations were monitored using a MPBX probe. Two MPBX monitoring sets were installed as shown in figure 3, one 20 feet deep, the other 5 feet deep from the pillar rib. A MPBX set-up consists basically of three components: borehole C-anchors, a probe guide and an expansion shell anchor. The borehole C-anchor is a polymer cylinder with a magnet set in the anchor body, and a maximum of ten anchors may be installed in one hole. A PVC probe guide tube runs through the anchors, and the position of each magnet relative to a magnet in the surface anchor is measured using the flexible Sonic probe and a readout box. The accuracy of the measurements is expected to be on the order of 0.5 percent of the length being measured. Differential displacements between any two anchors can be calculated by referring to the surface anchor.

Roof Sag Measurement

Roof sag measures displacement of the roof only in contrast to convergence which measures roof-floor displacement. Two roof sag stations were installed at Site 1 as shown in figure 3. Roof sag was measured similarly to convergence. Instead of a 6-inch floor anchor, a 5-foot bolt, grouted in competent floor strata, was used. Since the vertical displacement of the weak floor strata is not measured by this station, the measured convergence is primarily roof sag if the displacement of the hard strata below the weak floor is negligible. All underground instrumentation was monitored at intervals varying from two to thirty days, depending upon the expected changes.

RESULTS AND DISCUSSION

Subsidence Across the Panel

The progressive vertical subsidence, horizontal strain, slope and curvature profiles across the panel with retreating face are shown in figures 4 through 7.

The maximum subsidence measured is 5.71 feet which represents a subsidence factor of 0.75. Actual mined height of the seam, as provided by the company, was used in this calculation. The location of the maximum subsidence is skewed toward the tailgate side because of the influence of the adjacent mined-out panel. The skewness gradually shifts toward the headgate side as the overburden settles (figure 4). The maximum strain, slope and curvature observed are 0.0188, 0.047 and 3.85/mile, respectively. These values are all above the threshold values from a structural damage point of view (Yu et al., 1988).

The angle of draw values on the headgate side (based on 0.01 feet and 0.03 feet of edge vertical subsidence) are about 30.1 degrees and 20.5 degrees, respectively.

The location of the point of maximum tensile strain and the inflection point are over the mined out area (figures 5 and 7). The maximum tensile strain on the headgate and tailgate sides are located about 115 feet and 13 feet from the panel edge. The location of the maximum tensile strain matches very well with the location of the cracks observed on the surface by visual inspection. The offset distance, which is the distance of the inflection point from the panel edge, is 164 feet on the headgate side and 55 feet on the tailgate side. The measurements on the tailgate side, however, reflect subsidence due to retreating of the study panel only.

The subsidence over the tailgate entries is much larger (19.78 in.) than that over the headgate entries (2.4 in.) as shown in figure 4. The larger subsidence on the tailgate side may be due to both pillar failure and floor failure. The maximum subsidence, strain, slope and curvature on the tailgate side are, however, much smaller than those on the headgate side (figures 4 through 7) due to more uniform subsidence, and due to the fact that subsidence monuments on the tailgate side were installed after the longwall face to the north had been mined.

Most of the subsidence occurs after the longwall face has passed the surface monitoring points. Only about 5 percent of the total subsidence had occurred when the face was vertically below the surface monitoring line. About 85 percent of the total subsidence had occurred within 10 days when the face retreated about 265 feet (0.4 H) outby of the monitoring line.

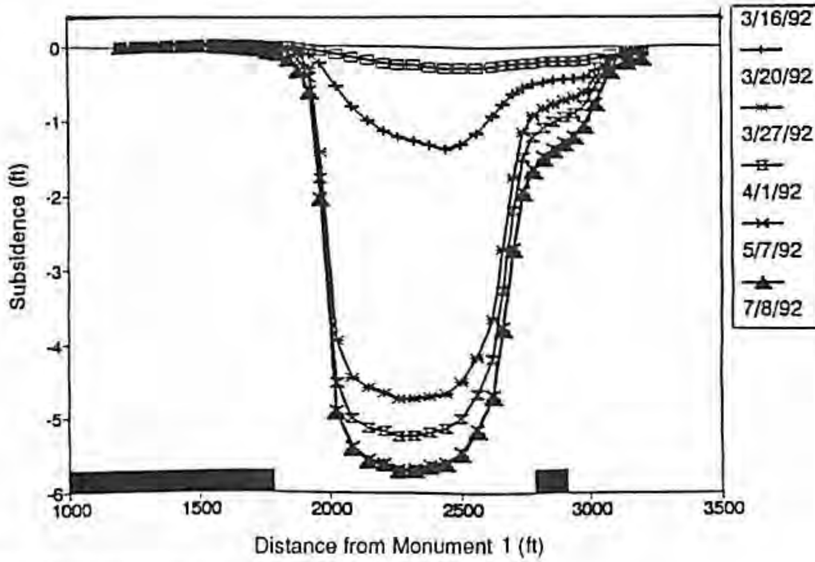

Figure 4. Subsidence across the panel.

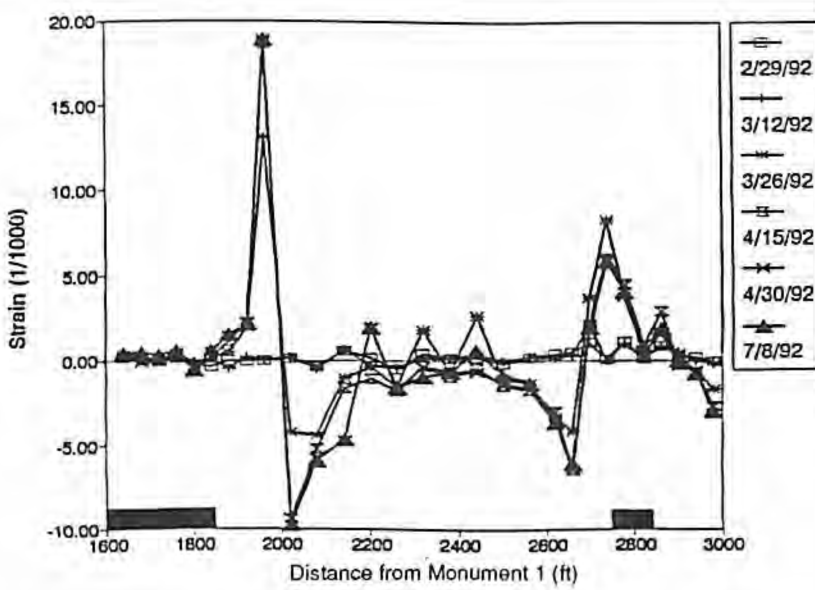

Figure 5. Horizontal strain across the panel.

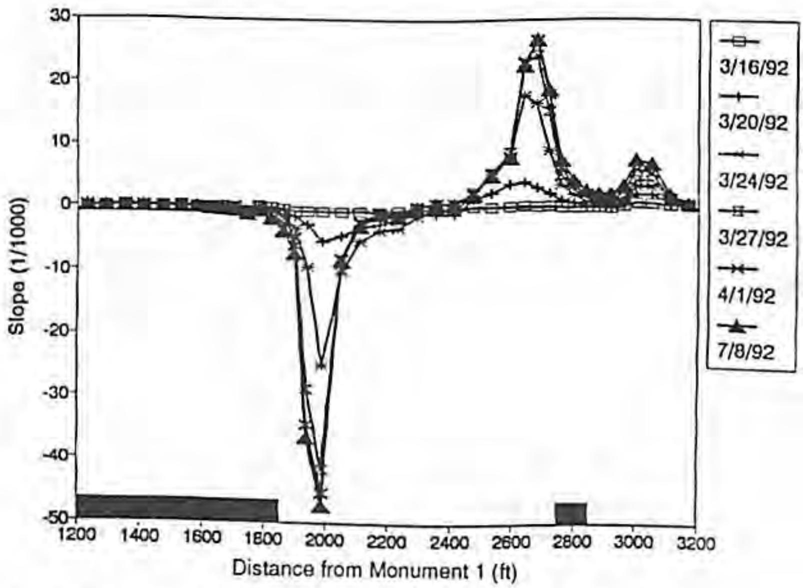

Figure 6. Slope across the panel.

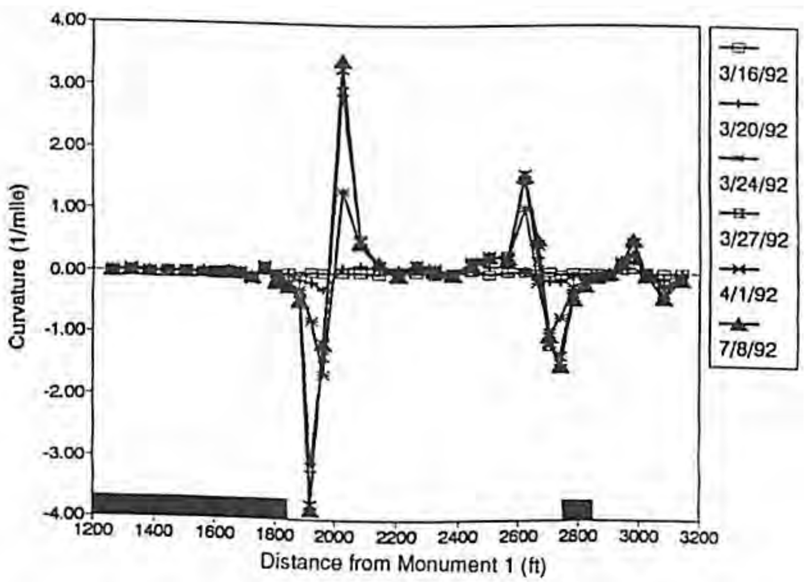

Figure 7. Curvature across the panel.

Subsidence Along the Panel

The dynamic subsidence profiles for the three longitudinal fork lines were very similar. Therefore, the progressive subsidence, and horizontal strain only along the middle fork are shown in figures 8 and 9.

- The lengths of the monitoring forks are not long enough and should be about 450 feet long to observe a complete dynamic subsidence cycle.

- The locations of the maximum tensile strains for the Middle, South and North fork lines are 75 feet, 105 feet and 105 feet behind the face (in the gob area), respectively. These values are appropriate because at the middle of the panel the overburden has less support from the chain pillar than at the edges and therefore it tends to break more quickly at the panel center than at the side of the panel.

- The displacements of the inflection points toward the gob is 164 feet for the middle line, 210 feet for the south line and 150 feet for the north line, respectively. These values are similar to those calculated across the panel.

- In general, the maximum traveling horizontal strain, slope and curvature values for all the forks are less than the static ones (those across the panel). For example, the maximum values for the traveling horizontal strain, slope and curvature along the middle line are 0.00965, 0.026 and 1.46/mile, which are 51%, 55.3% and 38% of the static values, respectively.

Subsidence as a Function of Time or Face Position

Normalized measured vertical subsidence, S/Smax as a function of normalized face position (d/H) for a point on the monitoring line in the center of the panel is shown in figure 10. The above two variables were correlated using a general hyperbolic tangent equation below

$$\frac{S}{S_{\max}} = \frac{1}{2}\left(1\text{-}\tanh\left(B\frac{A-d}{H}\right)\right) \tag{1}$$

where A and B are constants. The predicted and measured data are shown in figure 10 and indicate very good fit between the two. A and B values used are 200 feet and 4.67, respectively. The curve may be subdivided into three phases.

Phase I - It represents small amount of total subsidence (5 to 10 percent) and subsidence occurs slowly at an approximately linear rate with face retreat.

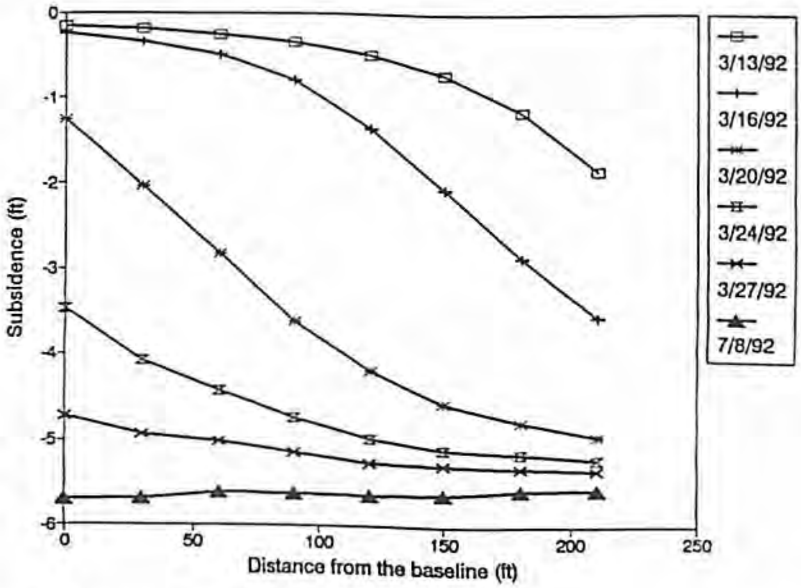

Figure 8. Subsidence along the panel.

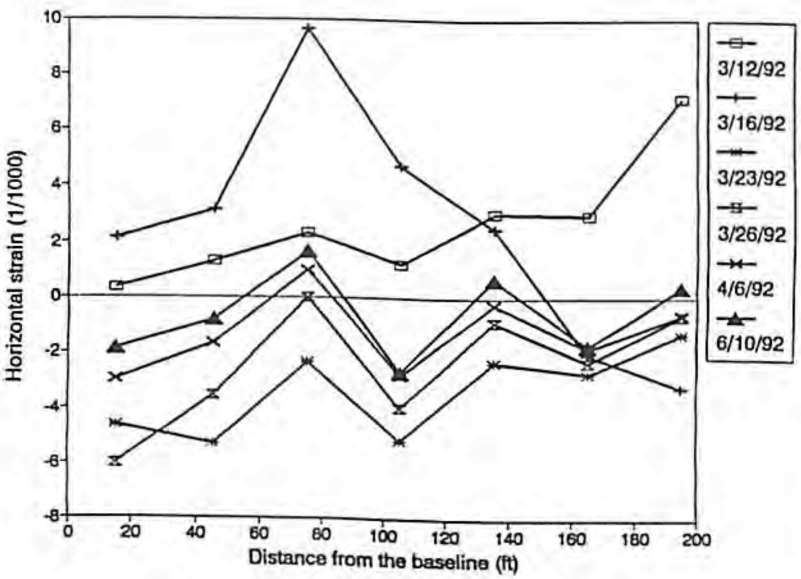

Figure 9. Horizontal strain along the panel.

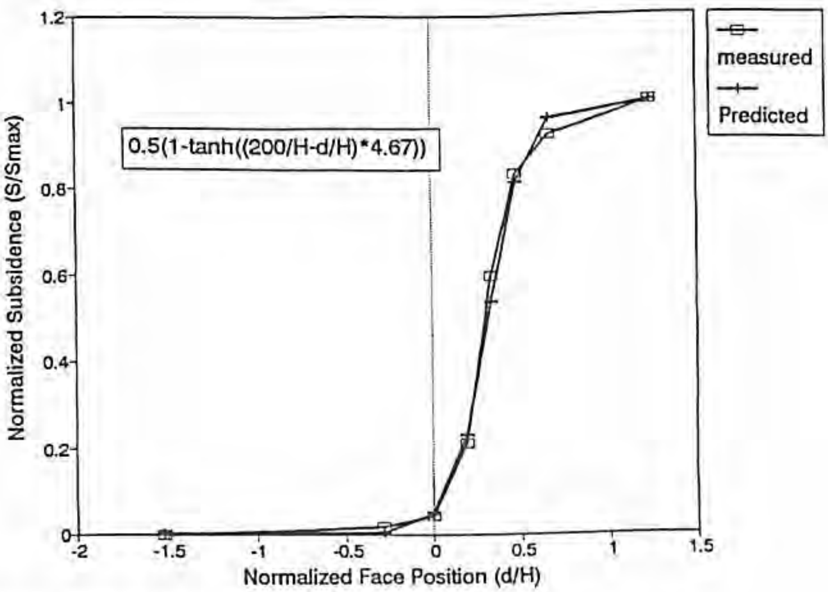

Figure 10. Subsidence as a function of face position.

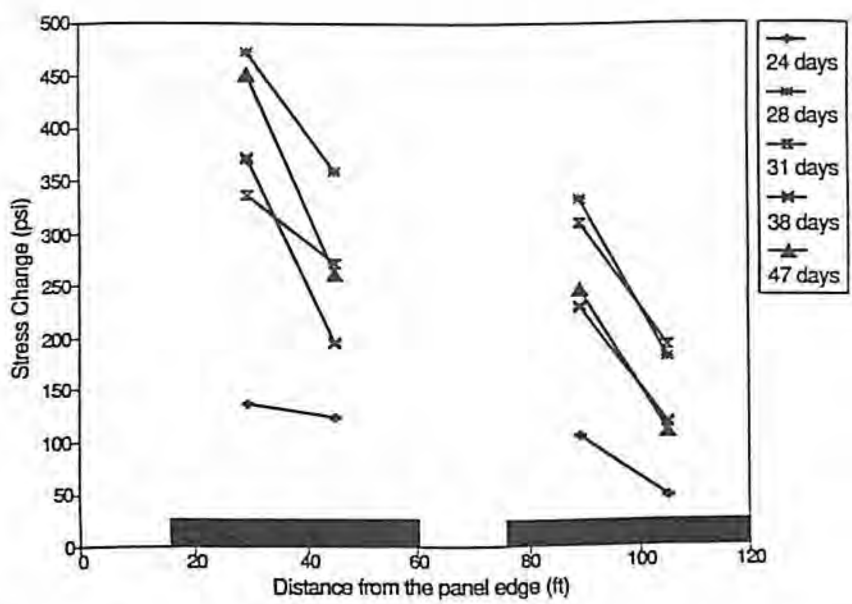

Figure 11. Distribution of stress changes in the chain pillars along the transverse direction.

Phase II- It represents accelerated subsidence rate and most of the subsidence occurs during this phase. Subsidence rate during this phase may also be assumed linear. About 80 percent of the total subsidence occurs during this phase.

Phase III- Subsidence rate during this phase decays exponentially as the distance from the face to the monitoring point increases. This represents the residual subsidence and about 5 to 10 percent of the total subsidence occurs during this phase.

An attempt was also made to fit the data for convergence, and lateral pillar deformations to the generalized equation above. The results of these analyses are presented later in this paper.

Instead of d/H, the equation may be written in terms of any time (t) and time T required to reach maximum subsidence:

$$\frac{S}{S_{max}} = \frac{1}{2}\left(1\text{-}\tanh\left(\frac{t-\frac{T}{2}}{C}\right)\right) \qquad (2)$$

where C and T are constants. The above equation was fitted to the data and for T=100 days and C= 6 days, the correlation coefficient for the best-fit line was 0.994. Approximate subsidence rates during Phase I, Phase II, and Phase III are given in table 1.

Stress Changes in the Chain Pillars

The stress changes along the VWS lines 4-1-6-2, which represent the distribution of stress changes in the two pillar in the transverse direction, are shown in figure 11. It is difficult to determine from the data if and how much of the pillars have yielded, because only two VWSs were installed along the transverse line of each pillar.

The stress changes in the two rows of VWSs (inby and outby) as a function of face location, are shown in figures 12 and 13. Figure 14 shows stress changes versus time for the VWSs which were not destroyed during the mining process.

The stress changes begin to increase rapidly when the face is roughly 150 to 200 feet behind (inby) the instrument locations, peak when the face reaches the instrumentation location, drop a little bit immediately after the face passes, and then increase again very slowly after the face is outby of the instrumentation location. This sequence of stress changes suggests that the stress drop after the face passes may be an "elastic drop" due to load decrease or plastic drop due to yielding of coal pillar or weak floor. The average rates of incremental stress changes during Phases I, II, and III are given in table 1.

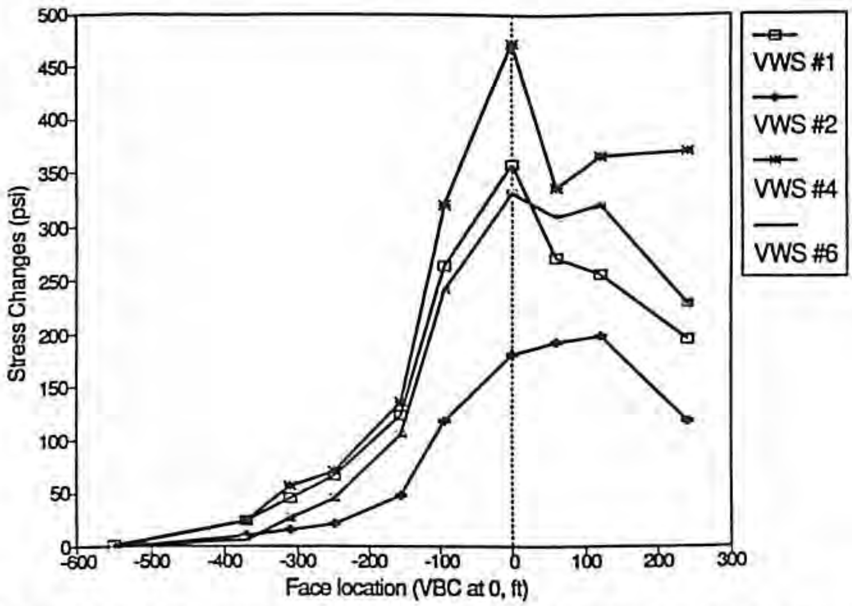

Figure 12. Pillar stress changes as a function of face position for the outby row of VWS.

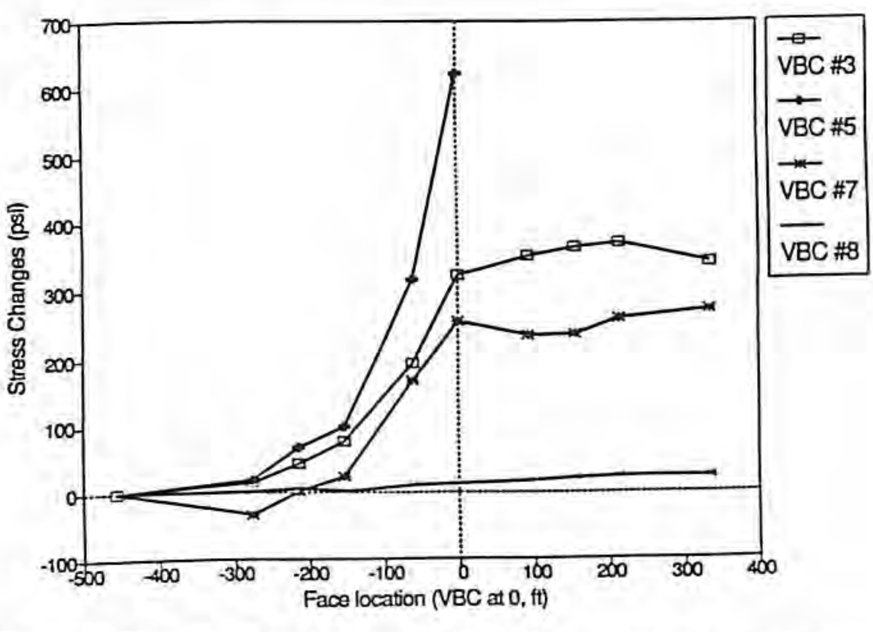

Figure 13. Pillar stress changes as a function of face position for the inby row of VWS.

Table 1. Length and rate of changes in the three phases for the paramenters.

	Phase I		Phase II		Phase III		Units
Paramenters	Range of d/H	Rate	Range of of d/H	Rate	Range of d/H	Rate	
Subsidence	-0.5 to 0	2.6×10^{-3}	0 to 0.7	0.14	>0.7	2.95×10^{-3}	in./ft
Pillar Deform.	<-0.14	2.08×10^{-5}	-0.14 to 0.19	5.38×10^{-4}	>0.19	4.37×10^{-5}	in./ft
Pillar Stress	<-0.4	0.055	-0.4 to 0	0.95	>0	Drop	psi/ft
Convergence	<0.25	2.3×10^{-4}	-0.25 to -0.48	2.7×10^{-3}	>0.48	6.25×10^{-4}	in./ft

The peak value of the abutment pressure at the edge of the pillar is estimated as 2 to 3 times the pre-mining vertical stress. This is based on the maximum observed stress change of about 620 psi which is approximately equal to the premining vertical stress, and an additional stress due to development of chain pillars.

Roof-Floor Convergence and Roof Sag

Roof-floor convergence as a function of time and face location for some of the convergence points is shown in figures 15 and 16. Some of the 20 convergence points were destroyed by mining activities after they were installed.

The magnitude and rate of the convergence vary with the location of measurement. For example, the convergence values at points 3 and 4 in the crosscut are much greater than points 5 and 9 in the entry farthest from the panel. The average rates of convergence during Phases I, II and III are given in table 1. The normalized convergence as a function of normalized face location can be predicted using Equation 1 for A=50 feet. Based on limited data available, roof sag is estimated as about 25 percent of the roof-floor convergence; the remaining 75 percent is the floor heave.

Lateral Pillar Deformation

Lateral pillar deformation data along and across the panel and as a function of face position are shown in figures 17 and 18. The deformation as a function of face position can be predicted by equation 1 by assigning A=0. The three-phase classification is also applicable to lateral pillar deformation, rates in the three phases are shown in table 1.

SYNTHESIS OF DATA

Surface Subsidence, Convergence, Pillar Stress and Pillar Deformation as a Function of Face Position

A plot of different normalized variables above as a function of d/H are shown in figure 19, and the rates for each variable in different Phases are given in table 1.

Figure 19 indicates that stress changes in the pillar move into Phase II when d/H is about -0.6. Surface subsidence enters Phase II when d/H=0. This shift is also reflected in moving from Phase II to Phase III for all these variables. There also appears to be a phase shift between occurrence of the peak incremental stress on pillars and peak convergence and lateral pillar deformation. This is probably because of the time-dependent deformation effects. The plots above can be used by the industry for planning additional supports in gate entries as well as planning land and structure use on the surface. An attempt will be made to plot similar data from other longwall faces in the Illinois Coal Basin to develop unified plots for use by industry.

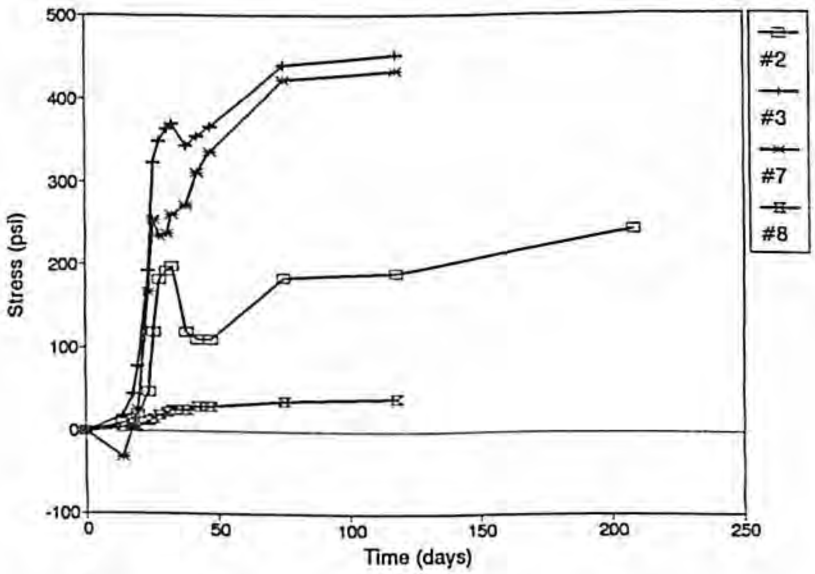

Figure 14. Pillar stress changes as a function of time.

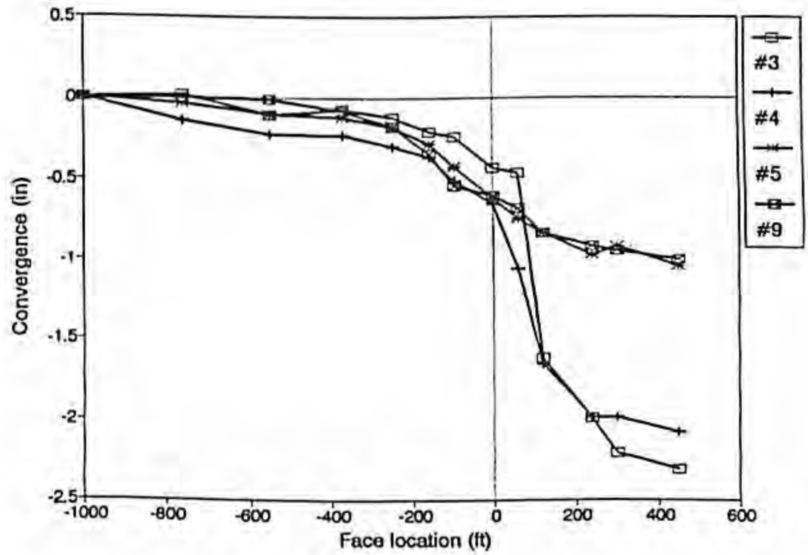

Figure 15. Convergence as a function of face position.

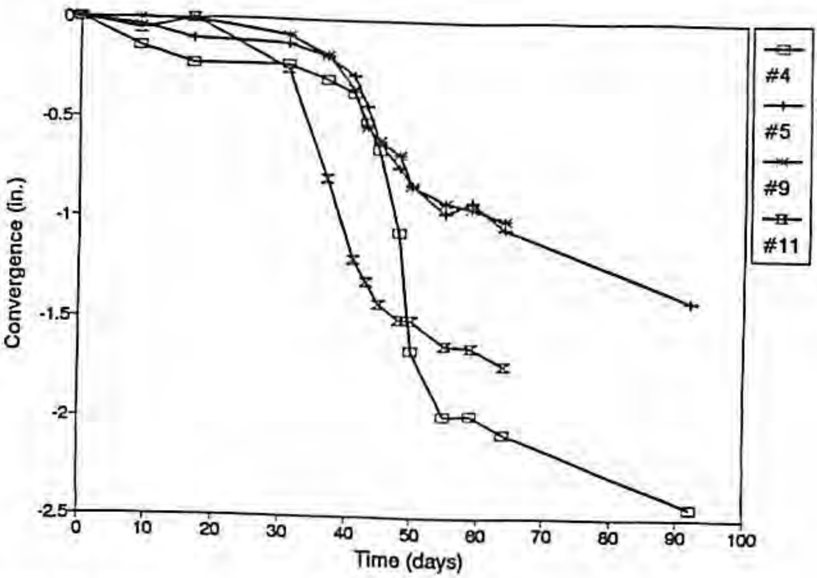

Figure 16. Convergence as a function of time.

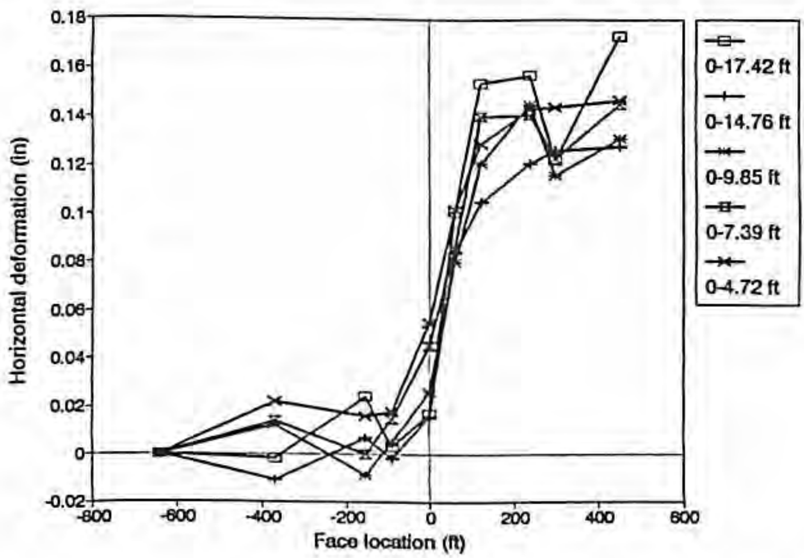

Figure 17. Lateral pillar deformation along the panel as a function of face position.

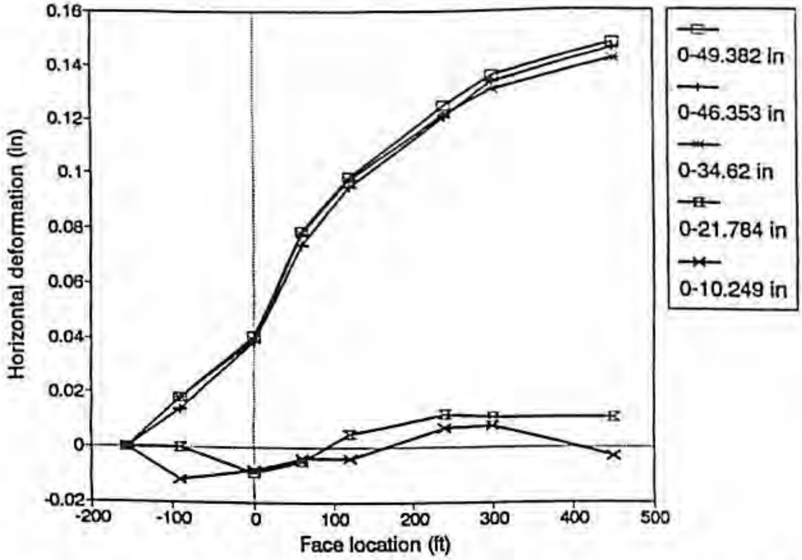

Figure 18. Lateral pillar deformation across the panel as a function of face position.

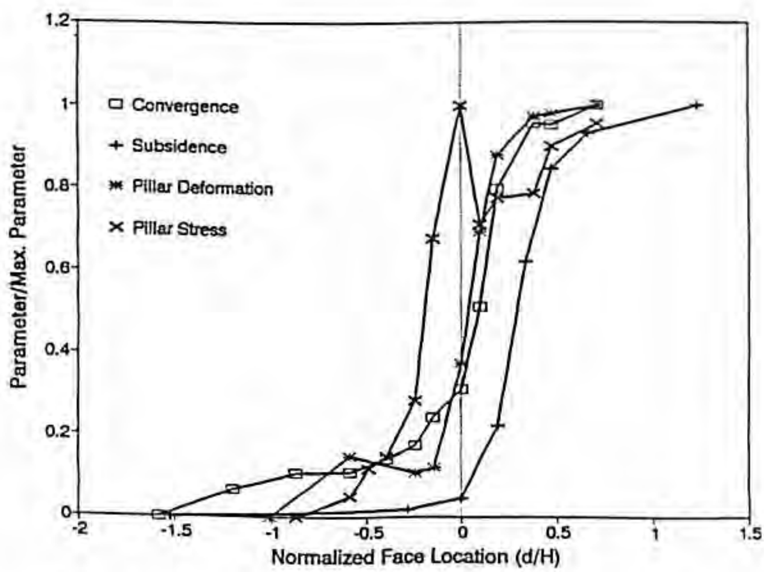

Figure 19. Various ground control parameters versus face position.

Subsidence Factor as a Function of Width to Depth Ratio

The data on width to depth ratio (W/H) and subsidence factor (S_{max}/h) for Illinois longwall coal mines were compiled (Hood, 1981; Bauer and Hunt, 1982; Mehnert et al., 1992 and Bureau of Mines, 1992) and plotted in figure 20. Statistical analysis did not yield significant correlation between the subsidence factor and the W/H ratio. A slight increase in subsidence factor with increasing W/H ratio is indicated. The subsidence factor calculation is sensitive to time and the mining height. The data presented in figure 20 may or may not have been calculated for the same time, and furthermore it may not have been calculated for the average mined-seam thickness below the subsidence line. These differences do not permit accurate analysis of data in figure 20.

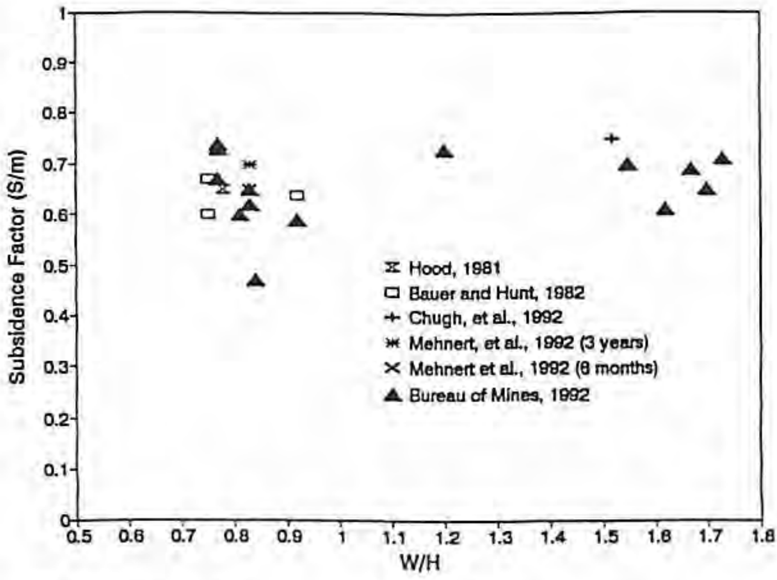

Figure 20. Subsidence factor versus W/H ratio.

CONCLUDING REMARKS

This paper has presented preliminary results of an ongoing study to develop subsidence characteristics and data on in-mine ground movements. These results will be used to assess performance of the geometry of chain pillars. Alternative geometries for chain pillars will be developed and their performance simulated using SIU PANEL.3D and the laminated models. It is expected that these studies will lead to design of chain pillars in Illinois Basin coal mines.

ACKNOWLEDGEMENT

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Don Arrowsmith: Thank you, Dr. Chugh. We have time for a couple of questions. I don't want to have to point someone out just yet.

Frank Kendorsky. I have been trying to put together some information on the subsidence factor just due to weak floor settlement. It looks like you have a little bit of data there on your tail gate entries. It looks like maybe a .2 or .25 subsidence factor of the seam height compared with what you got on the surface. Does that seem to be consistent with what you are saying?

Paul Chugh: Yes, that is about right. It depends of course on the thickness of your weak load strata. We have seen less than that, and of course, we have seen even more than that. The last couple of days, we had a visitor from the U. S. Bureau of Mines; we have been discussing this whole issue for western mines. They are seeing significantly higher subsidence factors due to weaker loads out west than perhaps we are seeing here, and in fact, he suggested that some of the work we are doing here would be very applicable to the western mines. In Alabama, they are again starting to see some significant problems due to floor heaving around their chain pillars. They are also having pillar-type problems similar to those we are seeing here. But, to focus on your question: yes, anywhere between .15 to .25.

Don Arrowsmith: Okay. As work like this continues, we get a little bit smarter each year. We are heading in the right direction. The next speaker is Ted Triplett. He is with the Twin Cities Research Center of the U. S. Bureau of Mines. Ted came there from Virginia Tech and his work over the years has been in subsidence.

Ted Triplett: Thank you, Don.

ILLUSTRATIONS OF THE VALUE OF SUBSIDENCE PREDICTION IN THE ILLINOIS COAL BASIN[1]

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United States Bureau of Mines
Minneapolis, Minnesota

INTRODUCTION

The mining of coal underground can create vertical and horizontal movements at surface level, which are manifested as induced slopes, curvatures and strains (Shadbolt, 1978; Singh, 1978). These slopes and strains damage surface or underground features, such as houses and buildings, power lines, pipelines, crops, or aquifers. Under present technological and economic conditions, subsidence prevention above longwall mines is not feasible. Nonetheless, it has been demonstrated, particularly in Europe, that surface subsidence can be predicted and controlled, thereby lessening the adverse effects of ground movements (Kratzsch, 1983; Triplett, 1983). With a reliable prediction technique available, subsidence can be predicted as part of the mining plan and, if environmentally or economically unacceptable situations are foreseen, remedial measures can be implemented. However, to be useful, the technique must be able to predict all of the components of subsidence as well as the damaging manifestations, i.e., vertical and horizontal movements, slopes, curvatures and strains.

This paper presents research, conducted by the Bureau of Mines, on modifying the influence function method to predict subsidence of the ground surface. The required functions have been determined for two case studies of subsidence above longwall coal panels in Illinois. However, the goal of subsidence engineering is not to predict subsidence, but to predict and mitigate subsidence damage. Therefore, the technique has been enhanced to calculate slope and curvature, and a method has been developed to predict strain using these curvatures and simply measured site constant. The application of the technique then is demonstrated for the prediction of pre-subsidence and post-subsidence shoreline contours around Rend Lake,

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[1]This paper was originally published as "The Practical Application of Subsidence Prediction in the Illinois Coal Basin" at the Fourth Ground Control Conference for Midwestern U. S. Coal Mines.

Illinois, the prediction of induced slopes as it relates to crop or power line damage, and the prediction of curvature for the estimation of potential structural damage.

LINEAR EQUATIONS IN CAUSE AND EFFECT

Linear equations frequently can be used to model physical problems in which the effects of several causes are to be superimposed. In these problems, a distribution of causes, $c(\xi)$, is assumed to exist over the volume, V, in a homogeneous region, $\Re$, and the resultant distribution of effects, $e(x)$, is to be determined. The variables x and ξ are defined as representing position in space of any dimension within some interval in the region $\Re$. Assuming superposition is valid, the total effect at a point x due to a distribution of causes within the entire region is (Hildebrand, 1965):

$$e(x) = \int G(x, \xi)\, c(\xi)\, dV. \qquad (1)$$

The function $G(x, \xi)$ is called the influence function of the problem and represents the effect at x due to a unit concentrated cause at ξ.

From these considerations, and the explanation of the procedure as given by Brauner (1973), the intensities previously used for subsidence prediction can be represented by a step function equal to one over the extracted area and equal to zero elsewhere. Employing a step function for the intensities may be appropriate under the conditions for which the influence function approach was first applied, that is, for stowed panels. However, the intensity function must be modified for caved panels (Triplett and Yurchak, 1990a). The total caving region can be represented in two dimensions by an intensity function which changes across the width of the panel, thereby incorporating such factors as the break angle of the immediate roof, incomplete convergence near the edge of the panel, and convergence of the entries adjacent to the mined panel. This function is similar to those assumed by other researchers when implementing corrections to the influence function approach (Berry and Sales, 1962; Kratzsch, 1983; Adamek and Jeran, 1985; Heasley and Saperstein, 1986). However, the inclusion of this function is not a correction; rather, equation 1 requires that the intensities of the causes be represented by $c(\xi)$. The intensity functions shown in figure 1 are given as a ratio of the maximum subsidence. Even though the intensities shown vary along one dimension, the function actually varies across both the width and length of the panel, and necessarily represents the geometry of the mining plans.

DETERMINING THE INFLUENCE AND INTENSITY FUNCTIONS FOR A LONGWALL PANEL

Field data from southern Illinois were used to demonstrate the influence function approach. In the first case study, a 260 m wide and 190 m deep

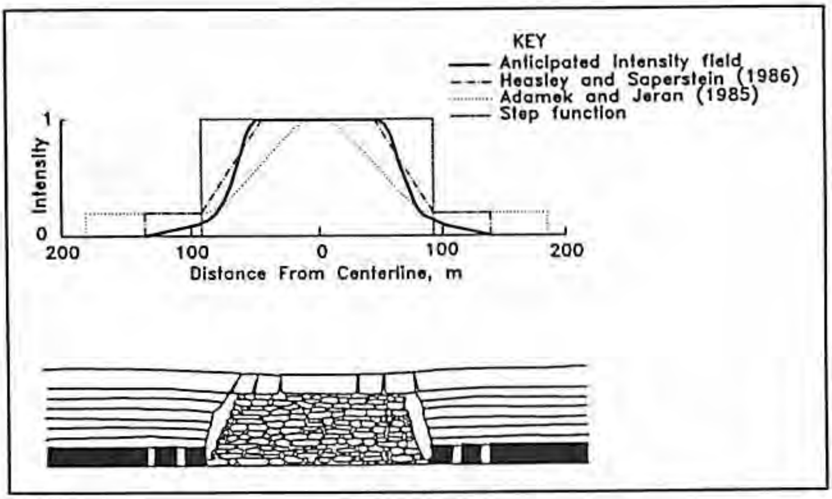

Figure 1. Various intensity functions for longwall caving (Triplett and Yurchak, 1990a).

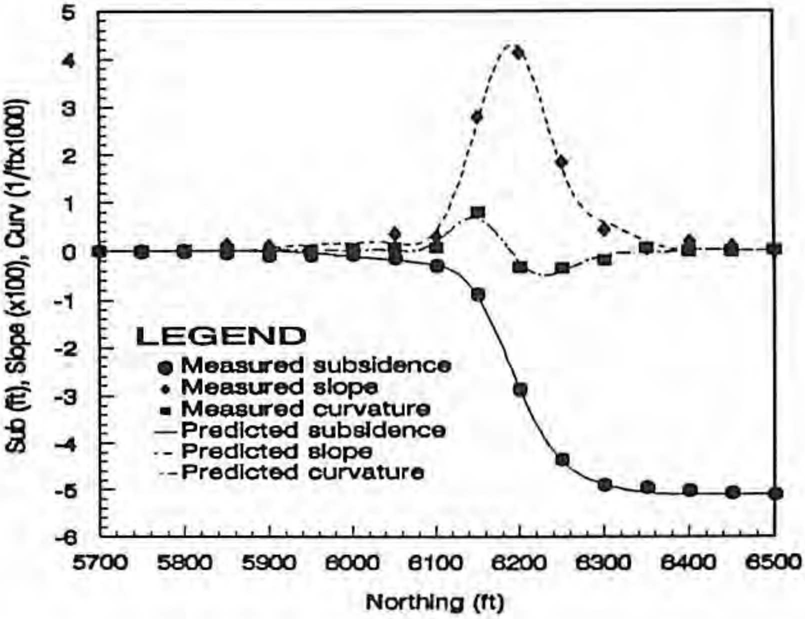

Figure 2. Measured and matched subsidence, slope and curvature for case study 1.

panel was mined from west to east in the 2.4 m thick Herrin (No. 6) seam. In figure 2, subsidence data above the longwall panel were matched using the influence function:

$$G((x_1, \xi_1, x_2, \xi_2) = \frac{nS_{max}}{B^2} \exp\left[\frac{-n\pi\{(x1 - \xi_1)2+(x2 - \xi_2)^2\}}{B^2}\right] \quad (2)$$

with n equal to 3 (Triplett and Turchak, 1990a). The corresponding intensity field was:

$$\begin{aligned} c(y) &= .00106y & y&= 0 \text{ to } 47.2 \\ &= .91 - (.043/(0.05 + .081e^{-.282(90.5-y)} & y&=47.2 \text{ to } 90.5 \quad (3) \\ &= .85 + .00459\,(y-90.5) & y&=90.5 \text{ to } 121 \\ &= 1 & y &= 121 \text{ to centerline} \end{aligned}$$

where y in meters to the ξ_1 direction and is measured toward the panel centerline from the point of no convergence, found by matching the data to be 46 m into the entries beside the edge of the panel. The radius of the influence function, B, consequently was 45 m. This function is similar to that shown by the solid line in figure 1. Assuming the validity of the intensity field, the caving characteristics within the extracted area close to the edge seem to be important, since the intensity function is small in this area. These characteristics may include the shape of the caving zone and incomplete convergence near the edge. Also, the effect of chain pillar convergence is evident, since the intensity function is non-zero for some distance outside the edge of the panel.

The accuracy of this process is increased by matching the measure slope and curvature with the first and second partial derivatives of equation 1. For example, the derivatives with respect to the northing, or x_1, direction are:

$$\frac{\partial s\,(x_1, x_2)}{\partial x_1} = \int_{\Re} \frac{\partial G((x_1, x_2, \xi_1, \xi_2)}{\partial x_1}\, c\,(\xi_1, \xi_2)\, d\,(\xi_1, \xi_2) \quad (4)$$

$$\frac{\partial s\,(x_1, x_2)}{\partial x_1^2} = \int_{\Re} \frac{\partial G((x_1, x_2, \xi_1, \xi_2)}{\partial x_1^2}\, c\,(\xi_1, \xi_2)\, d\,(\xi_1, \xi_2) \quad (5)$$

where $s(x_1, x_2)$ is the subsidence at the surface. In these equations, ξ_1 and ξ_2 represent the northing and easting coordinates of a mine level point, and the above integrals are taken over the area in which intensities occur. Since x_1 and x_2 represent the northing and easting coordinates of a surface point, equation 4 yields the slope and equation 5 yields the curvature along a surface subsidence profile in the x_1 direction. If both the influence and intensity functions chosen to match the measured subsidence are correct, then the slopes and curvatures given by equations 4 and 5 should match the slopes and curvatures calculated along the measured profile. As a check, the first and second derivatives of the influence function were taken in the x_1 direction, and the predicted slopes and curvatures were compared with actual values produced by the derivatives of a fifth-order spline function fit to the subsidence data (figure 2). The ability of these functions to predict the slopes and curvatures suggests that the functions are appropriate for this case study.

Figure 3 shows subsidence data of a second case study above another longwall panel in the same mine. The panel was 260 m wide and 158.5 m deep, with a mining height of about 2.3 m. The subsidence data were matched using an influence function identical to that found for the first case study, except the radius of influence is decreased from 45 m to 40 m due to a shallower mining depth. The corresponding intensity field was:

$$
\begin{aligned}
c(y) &= .0007y && \text{for } y = 0 \text{ to } 43 \text{ m} \\
c(y) &= .96 - (.028/(.03 + .93e^{-.651(86.3-y)})) && \text{for } y = 43 \text{ to } 86.3 \text{ m} \\
c(y) &= .93 + .00244(y-86.3) && \text{for } y = 86.3 \text{ to } 115 \text{ m} \\
c(y) &= 1 && \text{for } y = 115 \text{ m to centerline}
\end{aligned}
\qquad (6)
$$

where y is assumed to be 40.4 m into the entries beside the edge of the panel. Again, the accuracy of the match was increased by comparing the slopes and curvatures as well as the subsidence (figure 3).

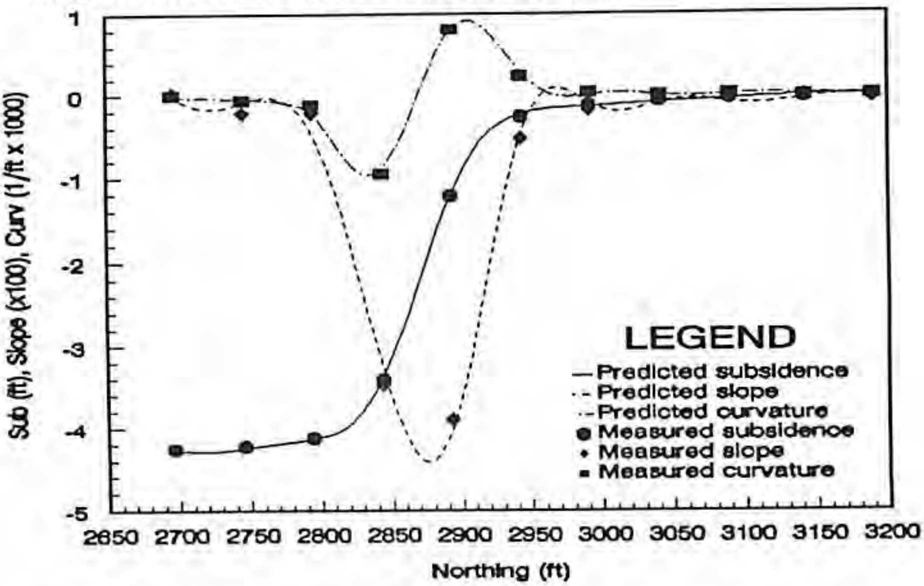

Figure 3. Measured and matched subsidence, slope and curvature for case study 2.

The subsidence data were matched empirically for these case studies, with the intensity function being a function of the geometry of the mine and time. The difference in the intensity functions for these two case studies may be the result of the timing of the data collection. The subsidence profile for case study 2 was measured before the residual movements of the trough were completed; therefore, the profile is expected to change with time. However, the ability of the technique to match subsidence profiles for different times during and after undermining establishes the potential of including a time parameter in the calculations. This facility easily could be incorporated into the prediction program by including various intensity functions based on the mine geometry at any given time.

APPLICATION OF SUBSIDENCE PREDICTION

As explained by Shadbolt (1978) and Singh (1978), damage to structures by subsidence is due to at least one of the following components:

- *Vertical displacement (subsidence)* affects structures that depend on the retention of a given level, i.e., dams, water courses and drainage patterns, water tables, etc.
- *Differential subsidence (slope)* affects all gradient-sensitive structures, in particular tall buildings, railroad tracks and highways, storage tanks and gravity drainage systems.
- *Differential slope (curvature)* causes shear and bending stresses to all structures and its intensity is sufficient to produce substantial damage.
- *Horizontal strain* is the major cause of structural damage, inducing tensile or shear cracks and buckling, which may cause distortion, fracture or failure.

Because of these different manifestations of subsidence, a prediction technique must produce not only the vertical displacements, but also the induced slopes and curvatures. Following are several examples which use the influence function technique to predict these quantities.

Vertical Displacement and Subsidence Contours

The results of subsidence prediction are most commonly given in the form of a subsidence profile over a single longwall panel. Even though this information may be valuable, the usefulness of the data is enhanced if the subsidence is predicted over a spatial area, particularly if post-subsidence contours are calculated from pre-subsidence contours and the predicted subsidence. An example of this capability is given by a case study around Rend Lake in southern Illinois. A longwall panel was being mined under the lake, and the coal company needed to predict the post-subsidence lakeshore contour. Figure 4 shows the panel layout. To predict the subsidence above this panel, the diverse geometries were represented by an intensity function which varied above the panel and was based on those previously described. The influence function in equation 2 was used, with the area of influence being changed due to a change in depth. The southern edge is particularly complicated, and three zones were identified and modeled. The first zone was adjacent to a previously mined panel; therefore, only the additional subsidence from mining the new panel had to be predicted. The second zone included the four-entry system in the chain pillars beyond the mined out area, and the third zone included the three-entry system. Figure 5 shows the pre- and post- subsidence contours, with the 410m line representing the lakeshore.

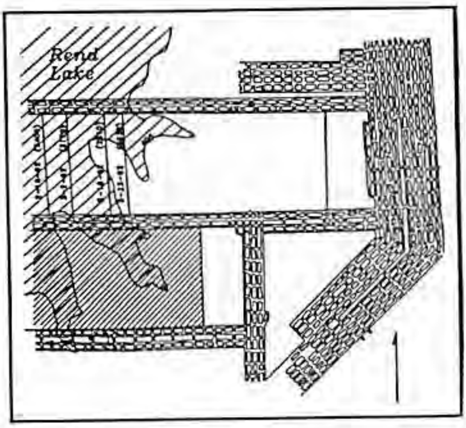

Figure 4. Plan of eastern end of longwall panel under Rend Lake.

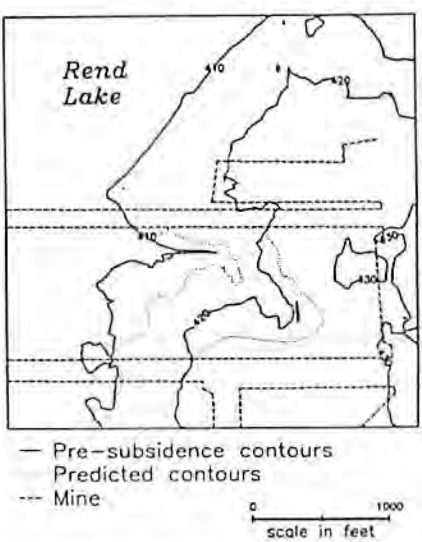

Figure 5. Pre- and post-subsidence contours of Rend Lake.

Differential Subsidence, or Slope

As shown by the above example, the simple prediction of subsidence can be a valuable product. However, several researchers have demonstrated that, under certain conditions, slope is the prominent damaging manifestation of subsidence. The harmful effects of slope on high-tension power lines is described by van der Merwe (1992), while the impacts of slope on crop yield is given by Darmody et al. (1988). Powell and Triplett (1988) and Kratzsch (1983) also defined tilt in a structure as a damage. Figure 6 shows two longwall panels in western Kentucky which are undermining farmland and high-tension power lines. In this case, induced slopes could damage crops or power lines directly, or could adversely affect drainage. Subsidence was predicted by representing the entire mine by a varying intensity function and using the influence function given in equation 2, since the geology was nearly identical, again, with the area of influence being changed due to a change in depth. Figure 7 shows the slopes for the northern one-third of the study area before mining and after the mining of both panels. Because the subsidence and slopes could be predicted by any time, this example also demonstrates that the technique could be used for dynamic subsidence prediction. Figure 8 demonstrates the effect of subsidence on drainage by tracing the paths which water droplets would follow before and after subsidence, showing the potential for ponding after mining these panels.

Differential Slope, or Curvature

Shadbolt (1978) and Singh (1978) described the impacts of curvature on structures. The harmful effects of curvature on various foundations also is described by Bennett et al. (1992). An example of the value of curvature predictions can be given for the case study around Rend Lake shown in figure 4. In this case, a levee was to be built to protect the land from inundation. Unfortunately, the Corps of Engineers could not design the levee in time to build the structure before under-mining. However, the area was monitored and post-subsidence contours will be compared to those predicted. Nevertheless, the case study can be used to demonstrate the use of subsidence prediction. The contours in figure 6 could be used for siting the levee. However, this structure was to be constructed before undermining; therefore, the levee could be damaged by horizontal strain. Triplett et al. (1992) showed that the strain from subsidence at one site in Illinois was due to bending. These findings have been duplicated in other areas of Illinois, particularly by Van Roosendaal et al. (1992). Thus, areas of high strain can be located by predicting areas of high curvature. Figure 9 shows the curvature profiles for cross-sections in the three different zones described earlier. Since the geometric conditions along the northern edge of the panel do not change, the curvatures are identical in all three zones. However, the curvatures do vary along the southern edge of the panel. Even though the maximum values of curvature are similar, the location of the maximum curvature does change, and should be considered when siting the levee.

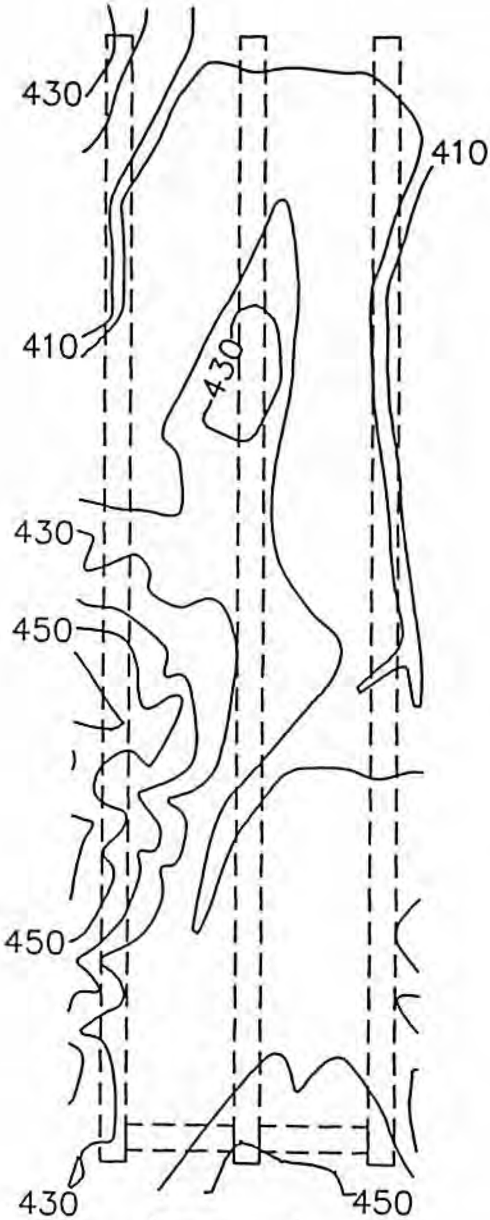

Figure 6. Panel layout for longwall mine in western Kentucky.

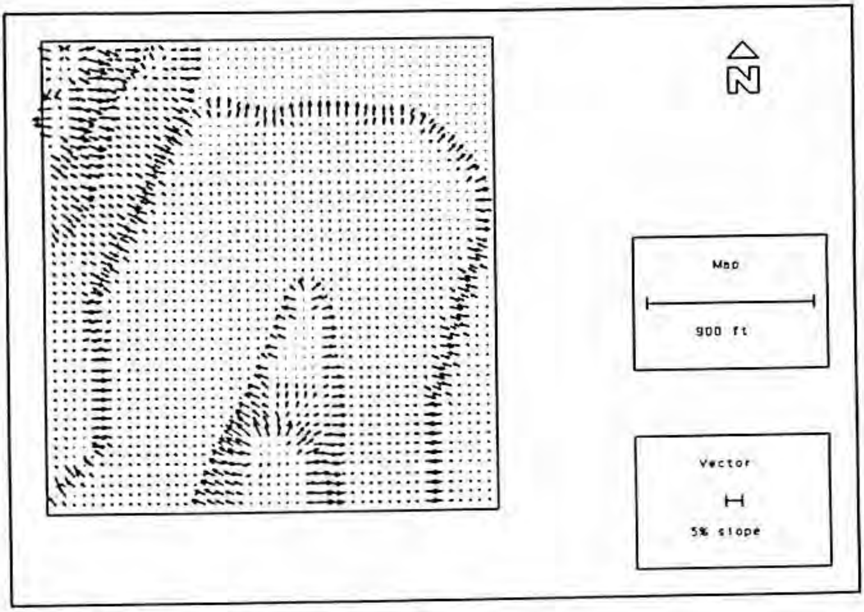

Figure 7a. Pre-subsidence slope vectors.

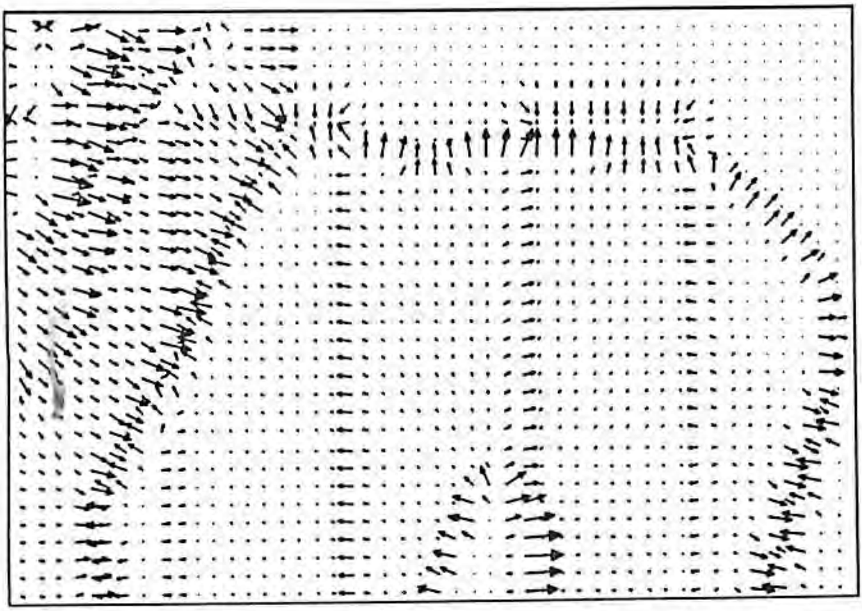

Figure 7b. Detail of post-subsidence vectors after mining of both panels.

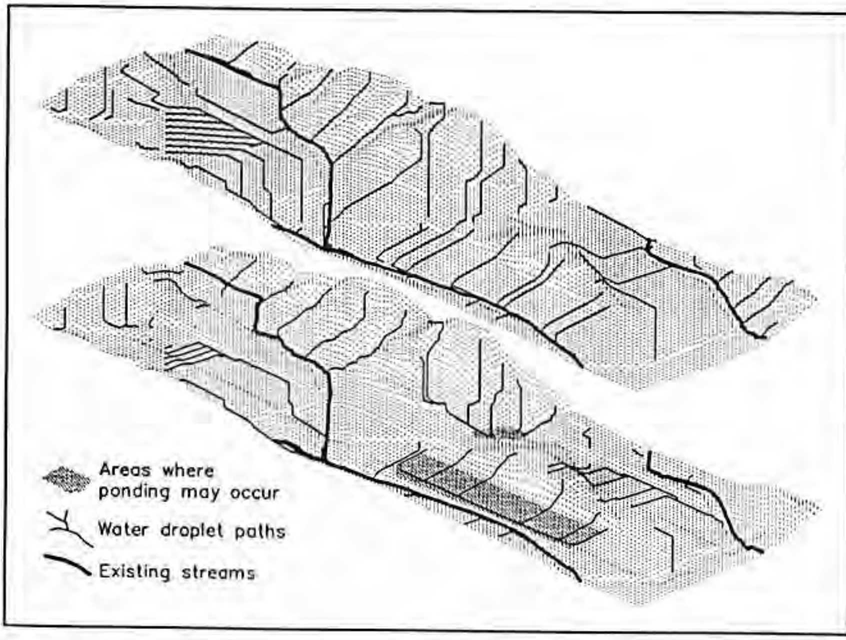

Figure 8. Water drainage patterns before (top) and after mining (bottom).

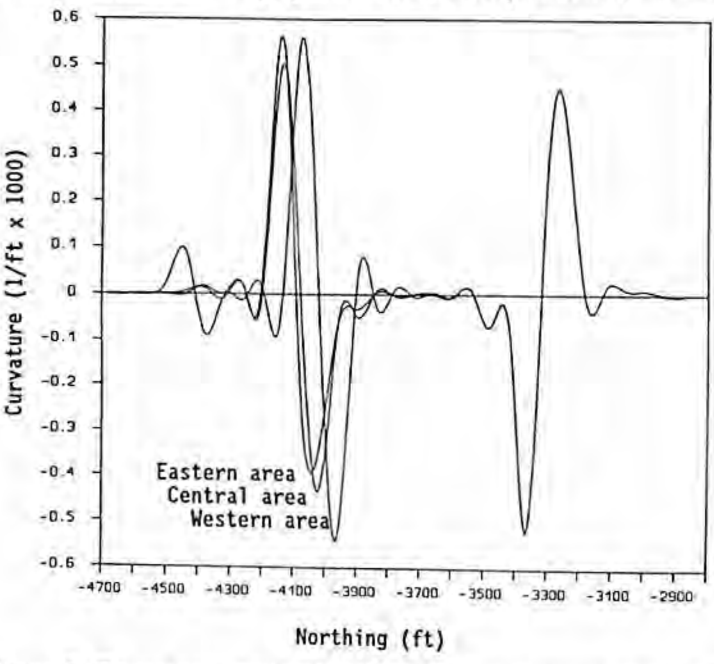

Figure 9. Curvature profiles for three different geometrical mining conditions.

CONCLUSIONS

This paper presents research on modifying the influence function method to predict subsidence of the ground surface. The required functions were determined for two case studies of subsidence above long-wall coal panels in Illinois. However, the goal of subsidence engineering is not to predict subsidence, but to predict and mitigate subsidence damage. Therefore, the technique was enhanced to calculate slope and curvature. Possible applications of the technique then were demonstrated for the prediction of pre-subsidence and post-subsidence shoreline contours around Rend Lake, with these predictions currently being verified by subsidence monitoring. Induced slopes above two adjacent longwall panels in western Kentucky were predicted to assess crop or power line damage, and the potential for ponding was identified. Finally prediction of curvature for the estimation of structural damage in siting of a levee was demonstrated.

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Don Arrowsmith: Thank you, Ted. Again, we have a couple of minutes for questions if anyone has any.

Our next speaker is Bob Bauer. He is the Head of the Engineering Geology Section at the Illinois State Geological Survey. He has been with the Survey for sixteen years. Obviously, he is intimately familiar with what goes on in the Illinois Basin. His topic is monitoring problems: are we really measuring mine subsidence; a question we all have.

Bob Bauer: Thanks, Don.

MONITORING PROBLEMS: ARE WE REALLY MEASURING COAL MINE SUBSIDENCE

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ABSTRACT

Geology and weather effects produce natural ground movements that may be misinterpreted as mine subsidence. Weather, local geology and vegetation clearly influence the elevation of the ground surface through frost action, changes in groundwater levels and soil moisture content. Common practices of monument and benchmark design and placement do not address the problem of natural ground movements. Monuments can be designed to minimize some natural ground movements. Differential displacements can be reduced by knowledgeable placement of benchmarks and monuments which are of similar design and construction. Commonly, the threshold values of movement for the determination of mine-induced subsidence are set from 0.01 to 0.03 feet of movement along with the accuracy of individual surveys dictated by closure error. Accuracy is more than the amount of closure error; it should include the range of elevation changes (error band) determined for each monument over a period of time before it is disturbed by mining. Multiple baseline surveys of the entire monitoring system, conducted before the onset of subsidence, should be used to establish subsidence detection limits.

INTRODUCTION

Accurate surveying techniques and precise instrumentation are currently used to monitor coal mine subsidence. Modern equipment and well-trained surveying personnel allow for the detection of very small ground movements that may be wrongly attributed to coal mining. Such interpretations have resulted in lengthy debates and, in some cases, litigation concerning large angles of draw surrounding modern coal mines.

Surveying errors may be related to one or more of three sources: 1) operator error, 2) equipment precision and 3) natural conditions. The natural conditions affecting survey results include the geologic materials and atmospheric conditions (weather) of the area being monitored. This paper concentrates on these naturally induced errors (geology and weather) found in monitoring small areas associated with coal mine subsidence research. Three specific topics are discussed: observations of natural ground movements, how benchmark and monument design can diminish the effect of natural ground movements, and the establishment of realistic limit errors that account for the entire monitoring system, including natural ground movements.

Local geology and weather produce natural ground movements that may be interpreted as subsidence. Specifically, frost and soil moisture changes can cause movements of survey monuments that may be mistaken for subsidence. The impact of movements caused by geology and weather are documented throughout the state by the Illinois Mine Subsidence Insurance Fund. These movements are large enough to damage foundations and structures and represent 85 percent (about 4,200 claims) of all the subsidence insurance claims over the past twelve years.

When subsidence survey monuments differ from benchmarks in design and setting, natural weather-related fluctuations can affect them differently, resulting in differential movements that may be incorrectly interpreted as mine-induced subsidence. It is nearly impossible, and generally impractical, to anticipate all weather conditions, to account for all geologic variability, or to investigate a site completely to determine all potential causes of differential movements. Therefore, care in the construction and type of monuments and benchmarks, along with proper selection of locations, can help eliminate most differential movements, but not absolute movements.

Reliance on precise surveying instruments and accurate surveying techniques that produce small closure errors has led many to believe that subsidence-induced ground movements can be measured to one-hundredth or one-thousandth of a foot. However, these apparent subsidence movements generally are not distinguishable from natural ground movements, which can be of the same or even a larger magnitude. Consequently, realistic detection limits for subsidence-related movements should take into account the possibility of movements from processes other than subsidence, in addition to the accuracy of the surveying techniques used.

OBSERVATIONS

Natural Ground Movements

Measurements of natural ground displacements are cited throughout the literature (table 1). Natural ground displacements can be produced by groundwater fluctuations, changes in moisture content of soils below and around monuments and foundations (especially during drought conditions), frost heave, and uplift from tree removal. Information from the literature cited in table 1 (with graphic representation in figure 1) reports that downward movements of 0.01 to 0.33 ft and upward movements of 0.069 to 0.49 ft have been documented.

O'Rourke and others (13) suggest that monuments be anchored below the zone of seasonal moisture change. Defining the moisture fluctuation zone may be difficult because near-surface groundwater changes and the

Table 1. Measured natural vertical ground displacements.

Author	Amount of Movement	Comments
Bauer, 1983 (1)	-0.0185 x drop in groundwater level	0.02 ft drop in 1.5 years
Cheney & Burford, 1974 (2)	0.0689 ft of uplift in 14 yrs.	from removal of trees
Chugh, 1990 (3)	0.0098 to 0.013 ft	difference between frost-free monument and 5 ft rebar
Coolings & Ward, 1948 (4)	0.33 ft max. typically 0.082 to 0.164 ft	from trees drying out ground down to a depth of 10 ft
Kaplar, 1970 (5)	0.045 ft heave rate per day	heave from frost formation in glacial till
Powell & Yarbrough, 1988 (6)	±0.21 ft	drought and effects of trees
Samuels & Cheney, 1974 (7)	0.164 to 0.49 ft of heave	over 13 years from tree removal
Subsidence Engineer's Handbook, 1965 and 1975 (8 & 9)	0.098 ft @ 1 ft & 0.0164 ft @ 4 ft	movements of plates buried in soil
	0.065 to 0.249 ft	drought and trees
	±0.08 ft	3 to 5 ft deep monuments
Shadbolt & Mabe, 1968 (10)	±0.328 ft	seasonal and climatic effects
Yarbrough, 1982 (11)	0.23 ft	foundation drop from dought
Cote and Hanna, 1980 (12)	0.03 to 0.05 ft	3 to 35 ft long frost-free monuments in loess

extent of the capillary fringe are usually not determined and/or monitored. Data may exist for water-producing zones for wells, but these zones are not typically identical to those at the very near surface. Also, our experience at the Survey has shown that there are many areas where groundwater levels fluctuate seasonally as much as 10 to 15 feet, especially in gravelly soils and thick loess. In addition, all areas could be impacted by unexpected or extended drought conditions. Coolings and Ward (4) showed that trees dried out clays 10 feet below the ground surface and dropped houses 0.25 feet at a distance of 80 feet from a row of black poplars and within 30 feet of mature oak trees. In Illinois, Yarbrough (11) and Powell and Yarbrough (6) have shown trees to affect the ground surface by 0.23 feet.

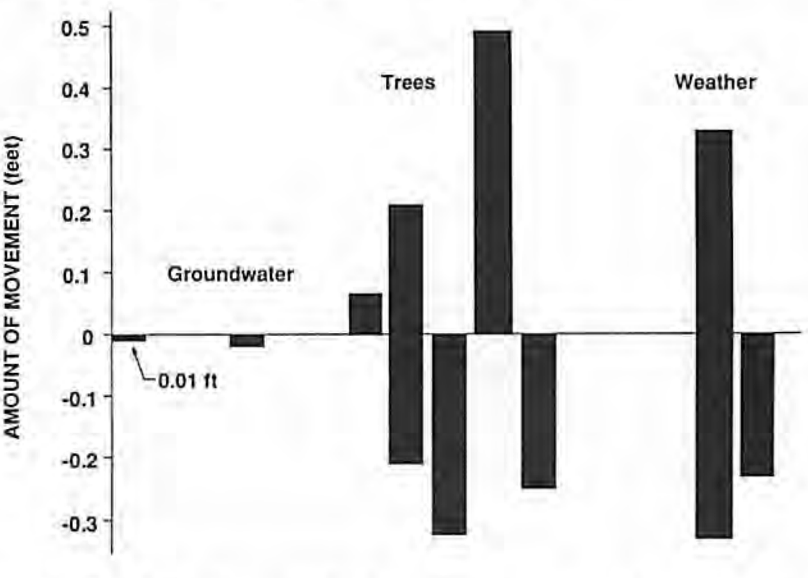


Figure 1. Bar chart schematically showing the amounts of natural vertical ground displacements cited in table 1.

Reports of movement of buried plates (7 and 9) and 5-foot steel rods concreted in place (figure 2) and on several types of construction of 5-foot rods (3) show that geology and weather can affect them. Chugh compared a 5 foot long rod driven into the ground next to a 5 foot long frost-free monument. While monitoring during the summer months only, he observed differential movements of 0.0098 to 0.013 feet between the two types of monuments.

Experiments by Cote and Hanna (12) on the accuracy of surveying and the design of benchmarks showed large fluctuations in data. The benchmarks were 3 and 35 foot long rods designed with casing and insulation that were compared to a typical campus benchmark of a bronze plate in concrete. All were anchored in loess and showed fluctuations of 0.03 to 0.05 feet. Figure 3 shows the relative elevation difference between the 3-foot and 35-foot, frost-free monuments.

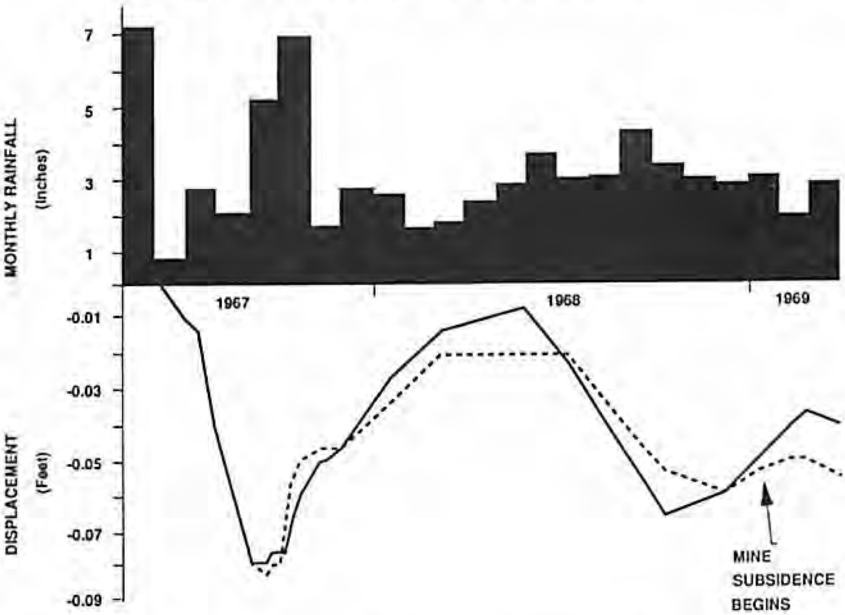


Figure 2. Reproduction of figure 7 from the Subsidence Engineers' Handbook (9) showing the reaction to changes in precipitation of two rods concreted in clayey soils.

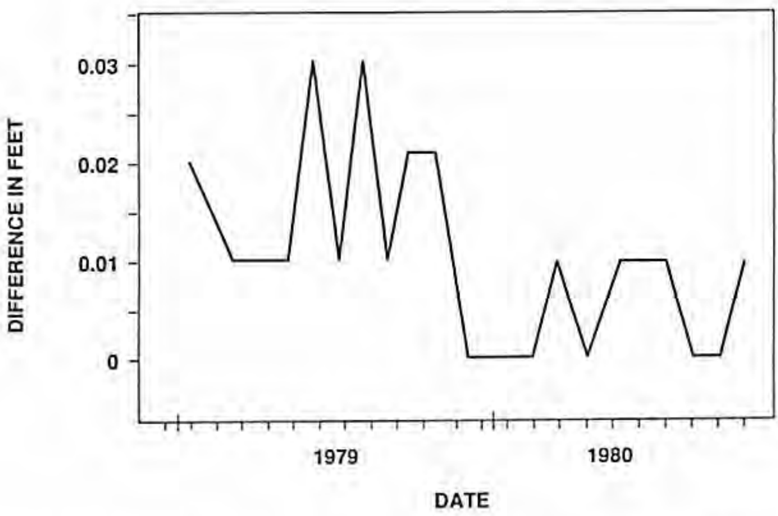


Figure 3. Relative elevation difference recorded between 3 ft and 35 ft long frost-free monuments in loess (12)

As demonstrated by these studies, weather, local geology, and vegetation influence the elevation of the ground surface through changes in soil moisture content causing consolidation and shrink-swell. Therefore, it is important that subsidence monitoring programs account for natural ground movements through benchmark and monument design and placement, and by setting realistic detection limits for subsidence induced by mining.

Benchmarks and Monuments

Benchmarks typically used in surveying as control points are bronze disks set in the top of a concrete post or in the foundation of a structure, a culvert headwall, a spike driven into the base of a tree, bridge abutments or piers, masonry retaining walls, fire hydrants, curb catch basins, and crosses chiseled in concrete sidewalks. Many of these traditional benchmarks (concrete posts, foundations, trees, masonry walls and sidewalks) are affected by geology and weather. Others are tied into systems (hydrants and sewers), have extremely deep foundations, or rest on bedrock (bridge abutments and piers) and are less affected by natural conditions.

Monuments for monitoring coal mine subsidence are typically pipe, rebar, or coal mine roof bolts driven into the ground. Other designs isolate the upper few feet of the rod from the effects of frost heave. These frost-free monuments are built by placing a casing in a hole augered the same diameter as the casing in the upper few feet of soil. Then, the rod is placed in the casing and driven into the ground below the depth of the casing. The annulus between the rod and casing is filled with insulation and the casing is capped.

Unwanted differential movements between the benchmarks and monitoring points can be produced when each is constructed differently. This is demonstrated by a case in which two different parties monitoring coal mine subsidence used the same frost-free monuments but separate benchmarks. Party A used benchmarks constructed similarly to the monuments, while party B used a National Geodetic Benchmark. (This Geodetic Benchmark is a concrete post in the ground which is not isolated from weather effects in the upper part of the soil; it has a bronze marker on top). Party B, using the Geodetic Benchmark, showed all subsidence monuments fluctuating up and down by about 0.03 feet. Party A, using frost-free monuments and benchmarks, showed that the Geodetic Benchmark appeared to rise and fall almost 0.03 feet (figure 4). The benchmarks whose fluctuations are shown in figure 2 were constructed similarly to the Geodetic Benchmark but in a clay-rich soil, which has a greater impact on monument movement because of the greater reaction of clays to moisture changes.

In another case, monuments constructed of 3-foot rods were driven into the ground in an area which has about 20 to 30 feet of glacial material over a shale bedrock. The benchmark was a bridge abutment that was founded on bedrock. Figure 5 shows fluctuations of as much as 0.12 feet in a line of

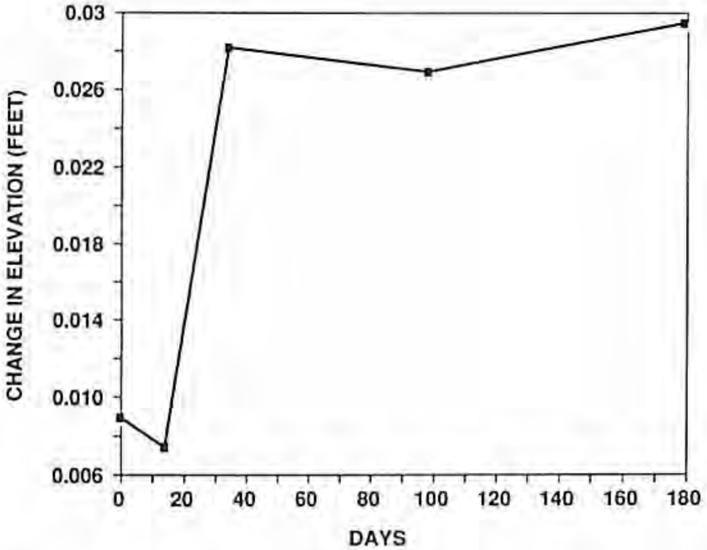


Figure 4. Fluctuation of a Geodetic Benchmark through time as the result of changes in moisture content changes in the soil.

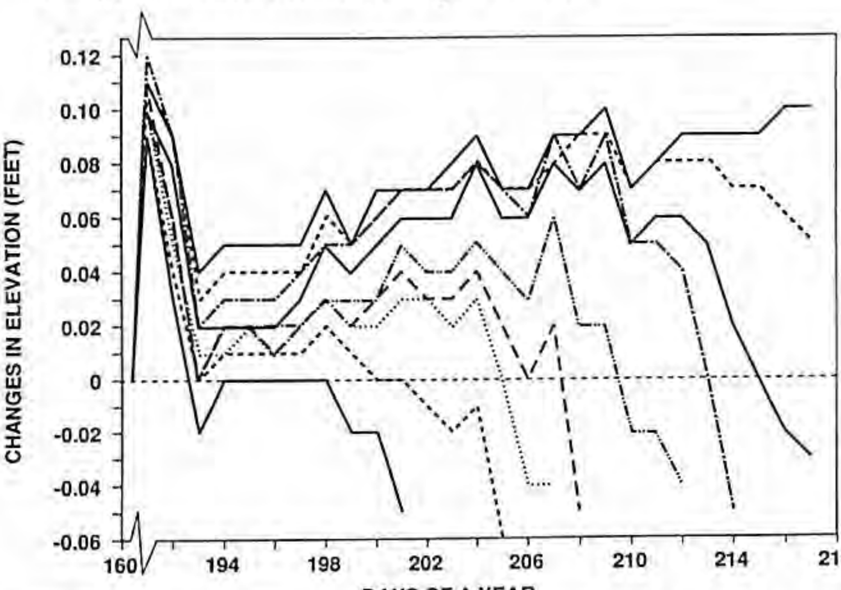
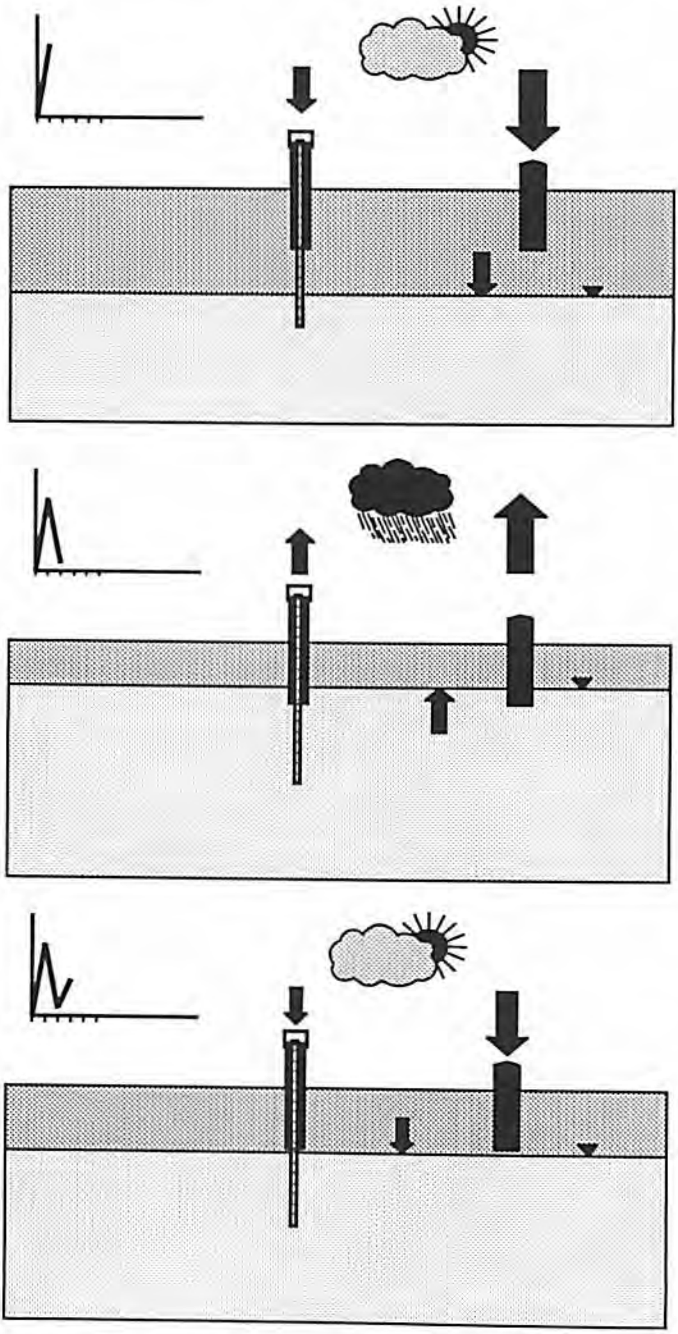


Figure 5. Recorded changes in elevation from June to early August for eight monuments spaced at equal intervals in front of an advancing longwall face. Seven of the eight monuments ultimately show initiation of subsidence in this figure.



Figures 6a, b, & c. Schematic showing how changes in moisture content and groundwater fluctuations affect benchmarks and monuments of differing construction. Using the concrete post as a reference (benchmark) produces graph of alleged movements of monument.

monuments in front of a moving longwall face. All the monuments in the glacial material fluctuated up and down in relative unison by survey date, until subsidence affected them. These measured fluctuations were not related to problems with individual surveys since most closures reflected second order accuracy or better. The dissimilar construction of the benchmark and the monuments caused them to be affected to differing degrees by geology and weather. This is diagrammatically shown in figure 6 where differences in monument and benchmark construction are affected various amounts by changes in soil moisture content and groundwater table. Monitoring of this situation documents differential vertical movement between the two construction types with results depicted in the upper left-hand corner of figures 6a, b, and c.

These examples demonstrate that to avoid errors, both monuments and benchmarks should be anchored below the frost line and should be located in similar settings of soil composition, groundwater hydrology, and vegetation. If the monitoring area is small, soils are similar, monuments and benchmarks are similarly constructed and are near similar vegetation, then the impact of weather on the monuments and benchmarks will also be similar. If benchmarks and monuments are affected equally, then differential movements should be at a minimum.

It is also advisable to use more than one benchmark. Benchmarks should be located within relatively short sighting distances. They should also be placed at different distances from the subsiding panels so that a single safe distance is not assumed before subsidence. All benchmarks should be surveyed each time the monuments are surveyed. This provides a separate control on the benchmarks and assures that damage to one benchmark will not impact the monitoring program.

Limit Value or Error Band

Many researchers have noted a limit value or error band that is applied to survey information to determine when individual monuments are being affected by coal mine subsidence. Table 2 lists some of the published values used for the limit value or error band developed by evaluating discrepancies of surveying. Equipment precision contributes only a part of the limit value or error band used to determine the onset of mine subsidence.

Articles on subsidence monitoring typically present the precision of the instruments used and the limits of closure errors (accuracy) as defined by the National Geodetic Survey's five classes of leveling (27). The monument or benchmark design is rarely discussed nor is the reproducibility of elevations for each monument through time before it subsides. The accuracy of the combined system of surveyors, equipment and monuments/ benchmarks should be checked through repeated surveys before subsidence influences the monuments.

An error band can be produced for each monitoring job. Multiple surveys of the monuments through time before subsidence will produce a

Table 2. Published values for limit value or error band applied to survey data.

Author	Value
Bauer & Hunt, 1982 (14)	0.03 ft
Hood et al., 1981 (15)	0.03 ft
Jack, 1986 (16)	±0.0164 ft
Kapp, 1973a, 1973b, 1978, 1981 & 1986 (17-21)	0.009 to 0.019 ft
Khair & Molesky, 1988 (22)	0.04 ft
Luo & Peng, 1992 (23)	0.012 to 0.024 ft for total station
O'Connor et al., 1983 (24)	±0.03 ft
Subsidence Engineers' Handbook, 1975 (9)	±0.0164 ft
Piper, 1981 (25)	0.02 ft
Voight & Pariseau, 1970 (26)	0.01 ft

surveys of the monuments through time before subsidence will produce a range of measured discrepancies in elevation. This presents a practical picture of the accuracy of the combined system encompassing the people, equipment, geology and weather. For the example shown in figure 7, the deviation of four surveys for a transverse monument line indicated an error band of about ±0.0066 feet based on the difference between the maximum elevation changes. Completing this exercise before subsidence begins also displays errors in the monitoring system. In figure 7, the error band is widest for the left half of the figure. The sharp rise to the wider part of the error band

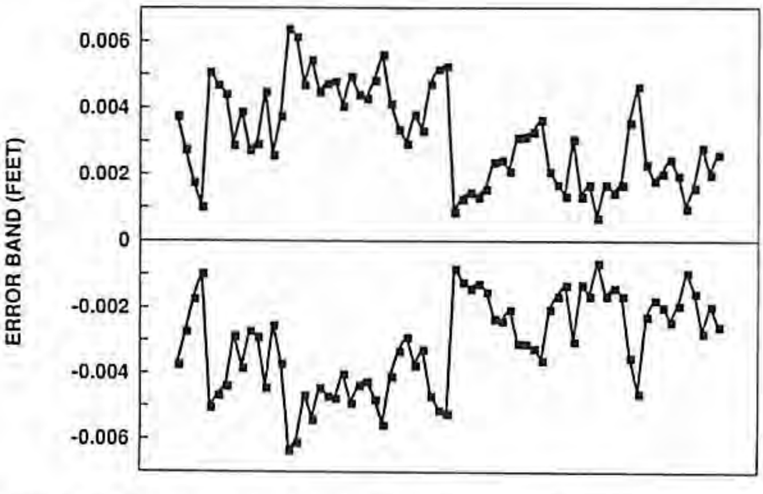


Figure 7. Error band in reproducing the elevation of monuments during four surveys before subsidence.

represents the location where the survey changed direction from a transverse monument line to measure a short longitudinal monument line. This appears to have added some errors to the remainder of the surveying of the transverse line, increasing the error band width. By evaluating surveying data well before subsidence begins, surveying procedures can be adjustedto produce more accurate monitoring during subsidence.

CONCLUSION

Great care is needed to produce accurate measurements during surveying for coal mine subsidence research. Elements that may produce changes in elevation of monuments and benchmarks should be taken into account when designing a monitoring program. Standardized procedures and precise instruments allow detection of very small movements. Many researchers monitoring subsidence have documented large ground surface displacements due to changes of moisture content in the soils caused by weather and/or vegetation. Many of these moisture changes can affect the soils at depths of 10 feet, and the effects of trees or prolonged drought (4) may reach as deep as 30 to 80 feet. This precludes the installation of survey monuments that reach below the depth affected by soil moisture changes.

The use of benchmarks of a design different from the subsidence monitoring monuments has been shown to produce differential movements between the two since each is affected uniquely by moisture content changes. The benchmarks should be of the same design and construction as the monuments and placed in the same soil and vegetation setting. They will then be similarly affected by weather conditions, and the possibility of differential movements will be significantly reduced.

Sources of errors can be detected and the accuracy of subsidence monitoring improved by running multiple surveys of benchmarks and monuments before they are affected by subsidence. This procedure will produce an error band for all monuments and allows for the detection of procedural problems that can be corrected before subsidence monitoring.

All monitoring programs may not need to be concerned with these movements depending upon the purpose of the program, but the magnitude of naturally caused elevation changes must be recognized.

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Don Arrowsmith: Thanks very much. During that talk, I was making some notes. Actually, what it was, was a list of people that I would like to send that talk to. Do we have any questions?

This is some excellent information and when the Proceedings come out, a lot of us will be looking at it very closely. When you start talking hundredths and thousandths of a foot, we have that brought back to us many times. We will move on then to our next speaker Brad Rigsby, who is a mine engineer with Cutler Mining. They are doing something a little different, which is subsidence in very low cover with full pillar extraction, so they can handle it quite well. Brad's experience is with Arch, and prior to that for a while with Kerr-McGee. So he is somebody who is talking with position and knowledge from the Illinois Basin. Brad.

Brad Rigsby: Thank you, Don.

MINE SUBSIDENCE AT THE KATHLEEN MINE

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INTRODUCTION

If you mention the phrase "Arch of Illinois" (formerly Southwestern Illinois Coal Corporation) to anyone around this area, they automatically think of the famous Captain Mine or Streamline Mine. The people of Cutler, Illinois, know these names well. Streamline Mine worked its East C field for years before abutting State Route 150 just north of the village of 523 people. Also, up until the late seventies, the people in town watched as the huge Marion 6360 stripping shovel approached the southern perimeter of town, moving millions of yards of rock and clay as it exposed the Springfield (No. 5) and Herrin (No. 6) seams before stopping just one quarter of a mile south of town.

Unfortunately, the 6360 pit suffered from the same chronic illness that all other mining operations do; it worked in a depletable resource. All that any curious eyes could see was a "dead strip pit" that might make for some decent fishing someday. That might have been the case, had Arch not decided that additional production capacity was needed. Instead of using a traditional mining method for that company to make up the shortfall (i.e. open up another pit), management decided that a contractor would be commissioned under the name of Carter Coal Corporation to breathe new life into the old 6360 pit by means of a drift mine.

Since the shovel operation removed two seams of coal, the pit would have to be backfilled with approximately twenty-five feet of material in order to reach the Herrin (No. 6) Coal level, and the spoils would have to be sloped to 20 percent grade in order to harbor the stacker belt to the raw pile. Today, Kathleen Mine has 15,000 raw tons of storage capacity. All coal is hauled to the Arch of Illinois Preparation Plant by haul truck some three miles away where it is cleaned and sold under long-term contract.

Once the site was developed by August 1984, Carter Coal punched into the highwall via five entries and continued developing territory. By March of the following year, the mine had three units, with each unit operating two shifts per day, five days per week, with one being idle each shift for maintenance work. Therefore, on any given shift, there were always two units running, with maintenance being pulled on the third section.

Kathleen Mine continued to produce coal until its shutdown in June, 1986. At that point, Carter Coal Corporation ceased to be an entity. In

October, 1989, Kathleen Mine was reopened under Cutler Mining Company, a wholly-owned subsidiary of Arch Mineral Corporation. Kathleen Mine quickly returned to six unit shifts per day and, presently, has an annual production of 1.3 to 1.4 million clean tons.

OPERATIONS

Equipment

Originally, Kathleen Mine operated Joy 12CM11 continuous miners with two Joy 10SC22B D.C. shuttle cars behind the miner. It should be pointed out that all equipment purchased in the beginning was "used" equipment.

When the mine reopened, the miners received their first upgrade and became Joy 12CM7s. These machines were superior to the others in many ways. The ripper-chain design was done away with and gear-driven cutters with a "hard-head" design were installed. Electrically, the machine was upgraded from 480 volts to 950 volts. The cutter motors were increased from 135 to 210 horsepower. The miners were also equipped with remote control, which facilitated longer cuts.

In February of 1990, Kathleen Mine tested its first Simmons-Rand Una-hauler. With its articulating body and battery power source, the advantages of the ramcars over the traditional cable-bound shuttle car became very clear. The Una-haulers added flexibility to mine planning. They also offered an application for utility purposes. Not long after that first trial, Kathleen Mine would have nine of the 848 Simmons-Rand Una-haulers, three for each miner.

By the end of 1991, Kathleen Mine had begun its second continuous miner upgrade program. The existing 12CM7s would become 12CM7/12s. Again, the miner would undergo an evolution in several major and minor areas:

- The conveyor was widened from 30 to 38 inches.
- The newer machine has dual drive motors in the gathering head. Thus, the horsepower was doubled from 70 to 140 horsepower.
- Gear-driven tramming replaced the upright chain.
- The tramming speed was increased from 65 to 85 fpm.
- Old style contactors were changed to vacuum contactors.
- Solid state drive.
- Wider crawlers.

Due to the addition of these bigger continuous miners and the battery-powered ramcars, Kathleen Mine has realized a year-to-date average productivity rate in excess of 1600 raw tons per unit shift. This kind of productivity has certainly helped make Kathleen Mine what it is today: the most profitable operation within Arch Mineral Corporation.

Mining Methods

In the beginning, Kathleen Mine started developing main entries to the north along the western edge of Cutler's corporate limits and to the east along the strip mining extents of Captain Mine, with high-extraction panels projecting north off of the East Mains. No planned subsidence activity occurred in these areas, as the surface was either under adverse ownership or Kathleen had no subsidence rights. In spite of this, the intent for the rest of the reserve owned by Ark Land Company, the real estate arm of Arch Mineral Corporation, was to plan for subsidence from the very beginning.

After the temporary shutdown, additional reserves were added to the Kathleen Mine block. These came in the form of one field known as the West EX field and more coal along Captain Mine's Pit #7, both of which were uneconomical to strip. Since most development up to the shutdown had occurred in the east, this additional coal would further delay any planned subsidence activity due to a lack of subsidence rights in that area.

One can tell by looking at the mine map, that Kathleen Mine, for the most part, is going after what everyone else left behind. The boundaries of the mine block are either strip-mining limits or abandoned underground works, some of which date back to the pre-World War I era. The irregular perimeter was perhaps the main reason that there was no conception of longwall plans for this mine. Hence, any increased coal recovery would have to come from full pillar extraction.

By the spring of 1991, development work would return to the West EX reserve, where all coal, and the majority of the surface, was controlled by Ark Land Company. It was here that Kathleen would see the first "pillaring" activity.

The 1st West Panel off of the Main South was driven 15 entries wide by means of a super-section. Entries were 50 feet apart and cross-cuts were on 100-foot centers. Some pillars were left to maintain a set of double entries for the bleeder system around the gob. The pillars in the end of the panel were developed on 100-foot centers to "shore up" the integrity of the back bleeders.

Once developed, pillaring would begin on the left side of the panel and proceed to the right. This process would continue throughout the end of the 1st West Panel.

In areas bolted during development, posts may be removed by hand if the roof shows no signs of weakness and the workmen remain under the area supported by adjacent posts. More commonly, regardless of good or bad top, straps or cables are attached to the posts prior to their being set.

These straps or cables are tied to a common cable and attached to the miner. The miner then pulls the posts to their next set-up and all workmen are kept out of the area.

We can deviate from the previously mentioned sequence where adverse conditions make it impractical to attack the pillar as indicated. Such deviation is only permitted where equivalent support is maintained in the alternate method. A mirror image of the previously mentioned plan is acceptable.

Revision To Pillar Plan

As the 1st West Panel was developed and pillared, it became apparent that the haulage on the unit would be strained. Logistically, there were other problems associated with having 15 developing faces. The bleeders of the 1st West Panel remained in excellent condition, with very little deterioration of the roof. They also remained mostly dry, with only a couple of exceptions. Hence, a new pillar plan was developed that would allow Kathleen Mine to recover the bleeders of the previously mined panel and reduce the number of developing faces to eight.

As mentioned, the new panel configuration consists of eight entries developed to the back end of the panel where two entries are driven off to connect with the bleeder entries of the previous panel. At this point, the direction of air in the old intake side of the previous panel is reversed. Once the bleeder system is established, rooms are developed and holed into the previous bleeder entries. At that time, pillaring begins with the bleeder pillars being extracted first. Next, the blocks developed in the rooms are pulled, and then, three rows of five blocks across the panel entries are also removed. This process is systematically continued as the unit retreats out of the panel.

The third panel is developed and pillared identically to the second panel, with the result being three panels on the same bleeder split of air. Once a three-panel set is completed, the panels are sealed and mining is either being continued or started on the next set of panels.

ROCK MECHANICS

Now that the process which leads to subsidence has been discussed, it is time to examine the results of Kathleen Mine's underground activities.

Up to this point, Kathleen Mine's method or mode of operation has been discussed. One can say that there is nothing extraordinary about this operation, other than maybe it is very productive. Yet, there is one distinguishing feature about Kathleen. Perhaps no other operating mine in Illinois is mining coal by any caving method at depths as shallow as 100 to 110 feet! So far the deepest cover that has been undermined at Kathleen Mine is 145 feet.

Since inception, there have been several concerns regarding a full caving mining method at such shallow overburden. Will the roof cave well and quickly? Or will the Brereton limestone exhibit a bridging effect, thereby placing higher stresses on the active pillar line? Will there be an override, not only the active pillar line, but out into the main entries as well?

Even though the aquifer that most people in the area tap with their wells is far below the mine workings, would the unconsolidated material be able to seal out any surface run-off? To satisfy some of these concerns, Kathleen Mine personnel visited other mines with equivalent overburden, both within the area and outside, to observe any problems that they might be experiencing.

In the mid-1980s, AMAX Coal Company's Harco Drift Mine was utilizing a pillaring method. They were operating under approximately 130 to 140 feet of cover. To our knowledge, Harco Mine was not experiencing any difficulty in getting the roof to cave. Longwall mines in Ohio and West Virginia, with 140 and 160 feet of cover respectively, were also visited.

With some concerns put to rest, Kathleen Mine proceeded with its plans for full pillar extraction.

Results

The results of the caving mining system employed at Kathleen Mine have been very interesting. In most cases, the roof has caved very quickly. Typically, the stumps stand until the active pillar line is about 100 feet away, then the roof will cave up to the active pillar. To date, there has been no evidence of override. The strength and integrity of the bleeder pillars has not appeared to have been compromised, either, even long after mining has stopped as in the 1st West Panel.

Of special interest is the amount of subsidence that has been observed on the surface. All of Kathleen Mine's planning for its areas of high extraction mining were based on an angle of draw of 35 degrees. Also during planning, the following premise was assumed to be true: the amount of subsidence due to caving mining systems, whether it is longwalling, shortwalling, or full pillar extraction, is inversely proportional to the amount of overburden above the seam being extracted. In other words, the more shallow the mine workings, the greater the subsidence on the surface as a percentage of the extracted seam height. In fact, as much as 80 percent of the extracted height was expected to be observed on the surface.

Unfortunately, the textbooks will have to be rewritten due to phenomena that have occurred at Kathleen Mine. For a mining height of approximately 6.5 feet, the greatest subsidence realized to date has been 3.6 feet, with most monuments in the middle of the trough showing movement less than 3.5 feet. To coincide with this lower than expected subsidence inside the trough, a limited amount of subsidence has been seen outside the area of extraction. At this time, it would not be prudent to say exactly what the angle of draw is for two reasons: 1) monument data are still being collected and studied, and 2) there is still some discussion on the criteria for determining what is or is not subsidence.

The movement at the edge of the extraction area is worth noting, however. On the north side of the panel, at a monument just four feet north of the inside edge of the bleeder pillars, a vertical displacement of only 0.14 feet has been measured. On the south side of the first panel, at a monument directly over the inside edge of the bleeders, only 0.19 feet has been measured. Any other movement outside the edge of the extraction area has been less than or equal to 0.10 feet except in those cases where the monument was disturbed by farm equipment. Without stating exactly what the angle of draw is, the angle is believed to be decidedly less than the 35 degrees originally used as a basis for planning.

Theories

How can one explain this anomaly? To answer this question, one must examine the lithological makeup of the strata above Kathleen Mine's workings. Under some 20 to 30 feet of unconsolidated material, there are four prominent limestone members among various layers of Pennsylvanian shales. Each is also very competent. In theory, it is believed that an almost vertical shearing is taking place. Furthermore, it is believed that any "draw" that is occurring is starting at the top inside edge of the uppermost limestone member. This is a broad step away from the traditional angle of draw, which begins at the edge of the extraction area or the remaining pillars in the bleeder line.

SUBSIDENCE MITIGATION

The impact of Kathleen Mine's planned subsidence activities have been minimal. After pillaring began in the 1st West Panel, it was decided that it was economically and practically justified to subside the Arch of Illinois spur to the Union Pacific railroad. This spur runs northwesterly across some of the first few panels before intersecting the ICG spur, which runs the length of one of the panels. This would not interrupt Arch of Illinois' shipments as most of the coal is shipped on the ICG spur. Nevertheless, the former would have to be raised. Also any interruption to the natural drainage has been mitigated by ditching in the vicinity of the rail.

CONCLUSION

At this point, a great deal of skepticism probably exists over the theory of "vertical shearing." To illustrate management's confidence in this theory, one must examine a certain powerline. The 138KV line, which feeds the entire Arch of Illinois complex, runs roughly parallel to the 1st West Panel and just over the bleeders along the north side of the panel. In some cases, the poles were located inside the bleeders out in the extraction area. Sometimes, only a single pillar was left to support the power poles. The result was that the surface cracks propagated around the remaining pillar, and the lights stayed on at Arch of Illinois.

Finally, the question arises, "What are the implications of this reduced angle of draw?" The answer is very simple. When laying out a mine plan, the operator must take into consideration the safety and welfare of the public. Just as Cutler Mining Company believes in that rule, it is also committed to the premise that the welfare of the employees must be considered. In planning future panels that abut adverse surface right-of-ways or structures, a smaller offset can be used. Therefore, the recovery of the resource is increased.

Don Arrowsmith: Thanks very much, Brad. We will take a couple of minutes for questions. I have seen this; it is interesting, and, for anybody that is considering full subsidence in low cover, it would be well worthwhile to talk to Brad and try to pin him down later. What they did around the power poles, you can stand there on that rail spur and see it just as plain as anything. It is worth the trip.

Question: What is the extraction ratio?

Brad Rigsby: Oh, we are probably getting between 70 and 80 percent of the pillar that remains; so I don't think the stumps are giving any significant support as to why we are seeing a reduced amount of subsidence. We are getting quite a bit of the pillar. The only thing I can offer as an explanation about the reduced subsidence is maybe that the four limestone members are probably creating a blocking effect, adding to the swell.

Don Arrowsmith: I think we had some good talks here. There is some good information. The speakers will be around; and sometimes it is easier to talk with someone face to face rather than in a room like this. We will wrap things up then, and thank you very much for attending.

Barbara Stephens and Dorothy Swingle (IMI Advertising Committee member) of AMAX Coal Co.'s Wabash Mine inspect the commemorative classic shotgun raffled off during the Centennial meeting.

LUNCHEON MEETING

Mike Reilly: Good afternoon. Welcome to the Annual Luncheon. We are going to change the schedule a bit and have our luncheon address first. Our speaker today is Mr. Dave O'Neal. Dave is from this part of Illinois and is a former lieutenant governor of Illinois and a past Assistant Secretary of Mine Safety and Health Administration. It was while Dave was Assistant Secretary of MSHA that he addressed our luncheon in 1988. On October 16, 1989, Dave was appointed Assistant Secretary for Land and Minerals Management, Department of the Interior, by President Bush, and, today, he manages three principal bureaus of the Department of the Interior: the Bureau of Land Management, the Minerals Management Service and the Office of Surface Mining Reclamation and Enforcement. The Bureau of Land Management (BLM), under Assistant Secretary O'Neal's direction, manages 272 million acres of public land, about one-eighth of the nation. He also serves, through operation of the Minerals Management Service, the environmentally responsible exploration and development of the mineral, oil and gas resources of over two billion acres of the U.S. outer continental shelf and exclusive economic zone. The third bureau under the direction of Dave O'Neal is the Office of Surface Mining and Reclamation Enforcement. OSM's mission is to protect American environment from any adverse effects of surface coal mining while maintaining a strong domestic coal industry capable of contributing significantly to the nation's energy security. It is with great pleasure that I welcome David C. O'Neal, the Department of Interior's Assistant Secretary for Land and Minerals to this Centennial Meeting of the Illinois Mining Institute. It is good to have you back with us, Dave.

Dave O'Neal. Thank you, Mike. He didn't mention that the job I had that was the most fun was when I was Sheriff of St. Clair County. Having been the first Republican in thirty years elected in that county, it was really an experience.

LUNCHEON ADDRESS

DAVID C. O'NEAL
Assistant Secretary for Land and Minerals Management
U. S Department of the Interior
Washington, D. C.

I was interested in the program this morning. I sat through most of it on subsidence. The thing that really caught my eye, to be honest with you, was the Cutler Mining Company. Most people in Washington, I daresay, would know nothing about the Cutler Mining Company. I don't know too much about Cutler Mining Company either, other than my father was born in Cutler and my mother was born in Campbell Hill. They used to date one another by way of one of the railroad pump cars. You remember how they would fix the track; they'd throw the switch at Steeleville and go on down to pick up Mom at the brickyard there in Campbell Hill. Any of you from that area know what I'm talking about. My mom and dad went on their honeymoon when they got married way back when in West Frankfort. West Frankfort had a new hotel at that time and they had something there my mom and dad weren't used to, true story: electric lights! They were very shy and they got to their room for the honeymoon night–first night together, and here is this electric light and this bulb. There were no switches. You had to know that you had to unscrew the bulb; that is how you turned it out. They didn't know that. They weren't about to spend their first night together in a lit up room. I'll tell you how they solved that. My dad got a chair. There was a little J hook up in the ceiling that the wire stretched across, and he took it out of there, took it over and opened a dresser drawer, put the light bulb in and shut the dresser drawer. My mother and father passed away in 1976, but I'll never forget that story, and I thought I'd share it with you.

It is good to be back. As Mike told me earlier, he thought I was glad to be back. I wanted to cover a few things with you today and still leave time for some question and answers you might have.

August the 3rd, as most of you know, is the fifteenth anniversary of the Surface Mining Act. Anniversaries make us think about what we've done–how far we've come and where we are heading. I would suggest to you that a lot of folks that were opposed to it in the beginning probably are not quite so opposed to the Surface Mining Act today. I think the reclamation efforts that have come out of it especially for the abandoned mine lands, have really shown the American public what can be done when American initiative is put to work. The acid runoff and a lot of the problems we had in Illinois, I think have been and are being addressed. I think there have been millions of acres of lands subject to the Surface Mining Act. I see that, in the future, a lot of our problems with wetlands can be mitigated through some of the reclamation practices we have, if we will write rules that will allow the companies to get their bonds back after they have done that kind of reclamation. What was the exception in surface mining is now the norm. What was unusual is now common place. Good reclamation is now the industry standard, and the industry people I talk to pride themselves in the kind of reclamation projects they come up with. So we are pretty proud of the fact that the industry and the states have responded the way they have.

I wanted also to talk to you today a little about the Senate energy bill. I think that we have had some departures from the normal there. I think the fact that Rockefeller came forward with a bill to pay off a private debt that was entered into by private entities, shows you how far we've come along the trail of liberalism. I know that some of the companies here today probably benefit from that, but the majority of you don't. And if you allow that to happen, they are going to find all sorts uses for your Abandoned Mined Lands (AML) money, and you can forget about ever having that yoke from around your neck.

The other thing I would talk to you about is some of the other coal-related things in the Senate energy bill. They are not too ominous in the Senate bill, but they are in the House bill. And I think that you can't look at one without the other, since it is in conference today. The only good news I bring to you is that I don't think, in my personal opinion, and I'm wrong so much you can't put much stock in that, I just don't think there is going to be an energy bill. I don't believe the Congress of the United States, with their liberal leadership, is going to give George Bush one thing he can hang his hat on between now and November 3rd. They are just not gonna do it! They have been mean-spirited for four years, and they are going to continue to be mean-spirited, and I just don't see them coming with any kind of bill that won't force him to veto it. And the energy bill is something the President has pushed since his initial energy strategy in February of 1991.

For the valid existing rights (VER) part in the House energy bill–they are still at it–they want to go with the good-faith, all-permits test. The Congress, and I don't know what makes them do it, will fly in the face of the Constitution every time they get a chance. You can't use good-faith, all-permits. You've got to use a takings test. Our proposedVER rule that will be out by about the end of this year, is just that. It uses takings as the base, and that's the only way you can have a valid existing rights bill. I've talked to House members, I've talked to their staff about what they are doing with VER–they could care less! I just personally think too much of the Constitution to violate it the way it is being violated with total disdain. There is just no concern.

There is subsidence in the House bill. That is an interesting story I'm going to have to share with you. When I had a bunch of people a couple of years ago come into the Secretary's office with their bottles of dirty water and with their stories, I looked at the Secretary and the Secretary said, "If that is occurring, then I want subsidence rules out there quickly. "

I said "Mr. Secretary, I agree with you. Let's do a 'Notice of Inquiry' just to make sure this is right, and we'll write a tough one; we'll stop this kind of thing from happening." And that was the feeling. I mean people had really been wronged, and the companies had not in any way, according to them, tried to help with that situation. Last year we had a Notice of Inquiry, and we had six hearings throughout the United States–one in Washington, D. C., the rest in coal country–Pikeville, Kentucky and other areas, so that everybody had a chance to get there and testify. We had 77 individuals testify. And the Office of Surface Mining was ready to go with that regulation. I said, "Wait a minute. Were these people sworn?"

"Well, no."

"Well, let's check out their testimony." So we did. We took two weeks, sent out teams from OSM to check each and every person of the 77. What we found was, seven didn't exist. They weren't there. No place to be found. That left us with 70. Sixteen were found not to be mine-related. That takes us down to 54. Of those 54, 38 had been compensated. Now we are down to 16. Of those 16, four had never reported it to anybody because they didn't know they were supposed to. Don't ask me why. They had not talked to a state agency. They had not talked to the federal government, nor had they talked to the coal company. They have since been reimbursed. That left us with 12, and of those 12, ten were in litigation. To me, the system was working, and I could not write rules and regulations to put a 50 million dollar a year plus burden on anything or anybody, for, at the very least, a localized issue to where sometimes the states, if they are not a primacy state, aren't really going like they should on the issue. That also is easily overcome.

When I went to the Secretary and told him that I couldn't in good conscience go forward, there were a lot of people mad. The special interests in Washington were really upset. So I went to different editorial boards and explained to them why I had done what I did. So, the Congress–Chairman Miller and Nick Joe Rahall–blasted me, talking about all the problems that they knew about and they were going to put it in legislation. So I wrote them both a letter, and I talked to their staffs and asked them to send me the information they have that I don't have. I let them know that I'll still come with a proposed rule and we'll go with subsidence. I requested them to give me that information; but, it wasn't forthcoming. A Kentucky newspaper said they have 5,000 or 1,000 examples. I called them up and I said, "Send me just 100 of them! Let me know. I want to look into them. If there is a wrong, we'll right it. I want to make sure the system is working as I think it is from our Notice of Inquiry." No response from that newspaper.

By the way, as an interesting side effect, there was a nasty article written in the *Philadelphia Enquirer* about subsidence and about me, so I went up and talked to their editorial board and their reporter and told them what I told you, and they said, "Well, those 38 people that signed the waiver and accepted the money, they are not happy about it."

Well, I said "I don't know, I'm not happy with my broker if I sell my stock and it goes up the next week, but that is kind of normal in America."

"Well, we think that OSM ought to look at all those kind of contracts that are written between that individual and the company and give the okay."

I said, "You think we should be experts on the property values of every place in the United States and we should do that? That's not the role of the federal government."

And they looked at me and said, "We think it is."

So there is a big philosophical disagreement with me and some of the folks out there in America. And I guess if there is enough of them that feel that way, I won't be around after November 3rd. But, as long as I am around, we are going to talk about the facts and the issues and get to the bottom of it.

The other thing they want to do is to put an extension on the AML funds. They want to put the extension on until 2010. They don't know what happened the first 15 years. How come they want to put another 15 or 20 years on it? I also asked staff about that. I said, "You know we have said let's add two more years, to go to 1997. By then we'll really know what is going to be needed. Maybe we ought to change our priority rating. Maybe we ought to do some things to make those fine-tune adjustments. Maybe there are some states behind other states, like Pennsylvania with probably the most abandoned mines. Let's do something so we can go in and get this burden off of industry." Nobody wants to talk about that.

We signed the clean air measure. The President authored that. That has probably given a lot of you a problem, and I can understand. The good news is we are spending upwards of five billion dollars on clean coal technology. I talked to Jim Randall yesterday on the phone and told him that I read the article he wrote about some of the liquefication technology they are trying to do; I told him that I thought this and a lot of the other things are quite exciting. I think if we are going to have a sound energy strategy in the United States, one of the abutments of that has to be coal because of the tremendous amounts of coal that we have. Nobody wants to destroy the environment. But there are people who write books and say in their books that the masters of industry are the demons of the world. Others write in their books that the combustion engine ought to be done away with, it is the worst thing that man has ever found, and that all fossil fuels should be done away with. Well, perhaps 30 or 40 years from now, we are going to have the technology that allows us to dosomething else, if we haven't found ways to clean up fossil fuels, but don't cut your nose off to spite your face.

When the President came out with his national energy strategy in 1991, February 3, 1991, he was quite explicit. It is very simple. There are three things we have to do. We have to conserve and have a legitimate conservation program, and he gave some definite examples of how we can conserve. And then he said the second phase has to be increased R&D for alternate sources, and he talked about that and some of the things we ought to be spending our money for. And the third thing is to increase domestic production in a sound environmental way. Capitol Hill took that call up. The only thing is, they forgot about the third–increased production. They stopped opening ANWR (Artic Natural Wildlife Refuge); they stopped a lot of things. The problem you have is, if we are going to have alternate sources of energy and they are 20 or 30 years away, coal and oil and gas are the bridge to the future. What are we going to do if we don't have those things, those alternative sources that are economically viable? Somebody said, "Well, for running automobiles, you can use liquified natural gas." And that's true. But you can't drive more than 200 miles from your source of gas. And if you want to make sure that is as common place as filling stations, it is going to be a $12 billion nut. So, we've got to plan for these things, it's just not waving a magic wand and saying, "We are now going to use solar power." If you use all of the kinds of fuels that you think of as alternate sources that are available today in the United States, you are going to be able to replace one percent of the conventional energy sources–*one percent* or less. We cannot yet give up all those conventional resources to go with alternate fuels. Hopefully some day, but we are not there.

On regulatory review, we've completed the first stage of our review of regulations as part of the President's federal-wide effort to reduce unnecessary regulatory burden. I think you have seen some of the areas we have been involved in. I mentioned three, the extension of AML fee collection authority through September 1995. The new regulations include provisions for eligibility of both coal and non-coal reclamation projects, as well as provisions for the collection and allocation of AML fees to eligible projects. We are developing a regulation that would eliminate a lot of useless inspection of abandoned sites. We issued a Notice of Inquiry last year seeking comments on the methods to establish the weight of coal at the point of sale. I think that is exceptionally important if we want to make sure there is a level playing field. Clarifying what records operators have to keep and for how long, I think is important. One thing I have on my desk right now is exploration permits, a second on individual civil penalties, and a third on temporary cessation. Those are proposed rules that have been out. We have had the comment periods, and we are now looking at what those comment periods produced. We are documenting that, and it looks to me like we'll probably decide not to go final on those three. We expect other changes coming out of our regulatory review that I think will have positive economic benefits but also be a great plus for the environment. I'll probably save anything else and maybe discuss it in some questions and answers that you might have of me.

I would like to comment on your 100th anniversary. We just had a fifteenth at OSM. You have a 100th anniversary. I want to congratulate you all for the job that has been done through those 100 years, and I think it is interesting how the job has changed. The first times I started being involved that much with coal and coal technology was in 1976 when I took over as Lieutenant Governor and the Abandoned Mined Land Reclamation Council. I was told by a member of the Illinois Geological Survey on the way over from the airport today that one of the programs we put together is still going strong and that is not only the technology transfer, but the way that we can respond to emergencies on subsidence in Illinois by using OSM and the State Geological Survey, as well as local units of government and the state. I recall right after we put that group together, some of you in the room probably remember, there was a big subsidence case down in a place called Energy, Illinois. It was a Friday when it happened. We called the folks together. We had a contractor on Saturday, the gas lines were fixed, the homes were shored up and the contractor was paid with a check from OSM on Monday at noon. That kind of cooperation is what we need, and we should work out the red tape so that we can have that kind of cooperation for the benefit of not only the public, but the entire mining community.

So, I congratulate all of you on your century of progress. It is my privilege to be here with you, and I'd like to take any questions you might have about something that we've done that we shouldn't have done or something you think we ought to do. I'll remind you of how many times we've sat and said, I wish we had one of those guys from Washington here, I'd like to give him a piece of my mind. He's here, and you lose all complaining rights for one year if you don't speak up now.

Question: I just wonder if OSM has made any effort to get people out of Washington and out of large area offices to see a coal mine so they would have a vague understanding of what we are talking about when we say things are not the same in Illinois as they are in West Virginia or Pennsylvania?

Dave O'Neal: Not only are we trying to do that, somebody must have told you we are trying to move some people around, but we also are trying to implement what we call a mobility and tenure policy so that people aren't in the same place more than five years. We are having a lot of trouble in the Congress on that one, because a lot of their leaks are out in different areas; that is important. One other thing that is just as important, is to get people from out in the coal fields into Washington and people from the business sector into Washington to see how that world works. Because I'm going to tell you something you are going to laugh at, but it is the truth: we don't deal with facts in Washington, we deal with perception. And if the perception is that you and your industry are bad guys, you are bad guys. And until that perception is changed, they don't pay too much attention to your facts. That is as candid as I can be with you. So it is just as important for our people and those career professionals to know about the coal fields, to be underground and to look at those surface mines and be out there and understand what those problems are. It is just as important for the people in this room and the people out in the fields to know how the Congress works, including the fact that there are sixty thousand employees of the 535 congressmen and senators—sixty thousand!

I was in a meeting on the hill not too long ago, and there were twelve people there discussing a very important issue. I mean, I've owned my own businesses—I've had to make payroll. I said to the group (I guess the average age was 28—they are the ones really making the decisions in the Congress, because the congressman is trying to get re-elected), "How many of you here have owned your own business?" Nobody raised their hand. "How many of you have ever worked in the private sector?" Nobody raised their hand. They are going to make laws that affect you, and they don't know what the hell they are doing, I'm telling you. I happen to think that you should not be allowed to be a staff on the hill unless you have worked in the private sector for at least five years. They come right out of school. They go right in there from their textbooks and what some liberal teacher has been teaching them all through college and now they get into Congress and they are going to do all these things that those textbooks said. Because we didn't open ANWR for oil and gas development, it cost us 750,000 jobs in this country over a relatively short period of time, according to Warden Business School; 750,000 jobs. The same senators that stopped it, the Tim Worths and the rest, are the same people that are now talking about job creation. And I think they are doing it with a straight face. I don't think they understand. I really don't think they understand. Mike Hayden, who is now the Assistant Secretary for National Parks and Fish and Wildlife Service, was a former governor of Kansas. He has an environmental degree. When Mike first came on I was talking to him about ANWR and he said, "Well, I'm not so sure we ought to open ANWR."

I said before you talk to anybody, you fly up there look at it, this pristine wilderness where there is a town and a runway. And he flew up there and came back and said "Why, there is more wildlife along the pipeline than there is in the coastal plain of ANWR." And that's true. But we have allowed certain special interests to sway our views. Let me give you one other example of the problem we've got. We had a spill from the Exxon Valdiz. Terrible disaster. And because of that spill, the Congress put moratoria on all outer continental shelf drilling. Now, when you stop producing at home, you have to tanker more in and the chances of environmental disaster is from tankers, not from drilling. Think about that. That is what we are working with on a daily basis.

Question: How many people in this room have perhaps had the opportunity to work in Washington or to go to Washington? I went there and tried to do my thing. When I left that job, I gave a talk to people about my Washington experiences. I always ended that talk with the challenge to them that if they had the opportunity to go to Washington, they ought to do so; they will understand better how the system works.

Dave O'Neal: It is important, I appreciate you saying that. I'll tell you one person you can be very glad is there and that is T Ary. T is someone you might not like personally; or you might like him personally, I don't know. But you always know where he stands. T is not shy. I must tell you a funny story. A couple of months ago, I was with some scientists from China and then went up to Russia to talk about natural resource development and putting together different partnerships. I flew from Bejing to Harbin and then drove three hours in a car up to Daqing, which is their big oil field. And the guy walks out in Daqing–I mean you are out in nowhere out there–and he comes over to me and says, through the interpreter, "How's my friend T Ary?" T Ary is not old enough to be to all the places that he has been in his life. But in Europe, in Russia and up in Magdalen, they knew about T Ary. So, I'm a real fan of T's.

I thank you for allowing me to come talk to you today. I'll say this, I've always said it in closing any of my remarks and that is that I'm in that office at 6:30 in the morning, that is 5:30 your time because I want to be prepared for that day so that my people can get to me. I don't want to appear to be too busy. By the time they get there at 8:00, I'm ready. That means that you can get hold of me by calling that office at that time. If you ever need anything, or you want to voice an opinion and you don't want to go through OSM or you think there is something I ought to know about personally, take me up on my offer. I've always made that offer. A lot of folks have taken me up on it, and I've learned a lot. The decisions we make affect a lot of things, and it is important I know from every aspect, how the quantitative nature of that decision is going to be. I need to know from you just what you think and for you to think that I already know that it is wrong. Call me even if it is redundant. Let us know. I appreciate your allowing me to be here. Thank you.

Michael Reilly: Thank you very much, Secretary O'Neal, for your remarks. It is always nice to hear from the other side–somebody from Washington. Things are different in Washington; it is a different world. I've spent some time there. I've never worked there, but in the last few years, spent some time there and it is amazing.

What I would first like to do, we still have a pretty good agenda, is to introduce the people at the head table. Starting from my right is Betty Daly; she is president of the Miners' Institute Foundation in Collinsville. Maybe a little later, Betty, I'll give you a chance to say a few words, if you would like. Next to Betty is Doc Harrell. Most all of you know Doc Harrell, he's been in the mining business forever. He has done an absolutely outstanding job heading up the Centennial Committee. He and 25 others worked very hard, did a great deal of work. Please make sure you stop by the exhibits of the miners' lamps, the pictures, the movies. There has been a great deal of thought put into this; don't leave without seeing that because I really think it is worth seeing. Brud Leighton; Dr. Leighton is Chief of the Illinois State Geological Survey–just been a great help to our industry, he and his people. Tim Hickman, Director of Abandoned Mine Lands Reclamation Council. Joe Spivey, President of the Illinois Coal Association. Fred Dalton, Mayor of Collinsville. I'll give you a few minutes, Fred, when I finish the introductions. Bob Shanks, President of Arch of Illinois and is getting in line to take over this job one of these days after the fellow on my left. Bob Danko, Peabody Coal Company, President-elect for the Illinois Mining Institute. C. Dayton McReaken, is on Bob's left, and Dayton is going to be our honorary lifetime member. I'll have a few more words to say about Dayton in a few minutes. Next to Dayton is Mrs. McReaken. Dayton refers to her as the Queen, and I think that is a great title; to live with Dayton for that long, I think that is great. Next to Dayton is Ron Morse, Director of the Department of Mines and Minerals in the State of Illinois. Next to Ron is Mrs. Walter Brandlein, wife of Walt Brandlein, a dear friend of all of us. Walt has been a very important part of this Institute for many, many years, as member and chairman of the Advertising Committee. He passed away earlier this year, and we miss him a great deal. Next to Mrs. Brandlein is Carol Brandlein Efrid, the daughter of Walt and Mrs. Brandlein. Tom Sadler and his wife; Tom was our honorary member in 1992 and a longtime and active member of the Advertising Committee. Lanny Bell, honorary member and longtime active member and chairman of the Advertising Committee, is on the far end. He will present some awards for the Advertising Committee. That is our head table. We should give them a big hand. I'm supposed to have a list of other important guests, but I think you are all important.

At this time I will give a few minutes to the Mayor of Collinsville. Fred, if you would like to welcome people here.

Fred Dalton: Thank you very much. It is a pleasure to represent the city of Collinsville and to be here to welcome all of you of the Illinois Mining Institute to your convention here in Collinsville. I understand this is the second or third time, and I have to plead ignorance on that case; I'm a new mayor, by the way. So it is certainly a pleasure to have you. I would hope that you enjoy yourself as you stay here. We have much we are proud of in Collinsville. I am not a native of Collinsville; I was a native of southern Illinois a little more south than this, in Marion. Coal mining there was a major industry when I was growing up. And when I came to Collinsville, it was a major industry here, too. So once again, it is a pleasure to welcome you all here, and it is our pleasure to have you with us. Thank you very much.

Michael Reilly: Thank you, Fred. We are happy to be here in Collinsville.

At this time, I am going to take a few minutes just to give you some of my ideas on the Institute and the coal industry. I'm very happy you are all here. We have a great turnout and it is a centennial year. As I said earlier this morning, if you reach 100 years in anything today, in any business or association, it is really outstanding. I don't know what the next 100 years are going to be but we have great people. I don't know if you know, I'm Mike Reilly. I'm President of the Mining Institute, I'm also chairman and CEO of Zeigler Coal Company. We are located in Fairview Heights. We moved down here about six years ago from the Chicago area, and we are happy to be here.

But I am very proud to have the honor to represent the Illinois Mining Institute in this its 100th year. And I thank the Institute for granting me this privilege. When the Institute offered me the honor of its presidency, in this centennial year, I hesitated. My hesitation came from a sudden burst of modesty. Or more precisely, honesty. I thought what have I done to deserve the Institute's presidency in the centennial year. I mean the Institute has been a pioneer in important mining innovations. As I thought about whether I deserved the honor, I recalled a story about Jack Benny. He'd been offered a special award by his Hollywood peers, and at first he hesitated, believing he didn't deserve it as much as others. Then Benny said, "I don't deserve this award, but I have arthritis and I don't deserve that either." So Benny took the award and I accepted the Institute's presidency, deserving or not. Because this is an election season and you can tell that from the previous speaker, not talking about you Fred, but the Secretary, full of political claims and counter claims, I should make one point clear from the outset. I was not, repeat, not present 100 years ago when the IMI was founded. Sometimes I feel like it. I started in the business 40 years ago, 1951, with Freeman Coals. So, it has been a long time. I was a young kid then.

In that year that the IMI was founded, 1892, the entire state of Illinois was producing close to 18 million tons of coal a year. Most of the Institute's charter members traveled by passenger train to attend the meeting. I'm also a little young to have taken part in the annual river boat outings, which some of you probably remember, during the '20s, '30s and '40s. I'm sorry I missed out on those, because I found an interesting reference in the 1939 Proceedings. The author recalls: "I freely admit that on the first three or four boat trips, our conduct might not have been such that would have met with the wholehearted approval of the WCTU (Women's Christian Temperance Union)." He goes on to describe what he labels excruciatingly funny incidents, but notes more seriously that business was conducted and great benefits derived.

In looking at the first volume of IMI's journal, I was reminded that our purpose was and still is, "...gathering together to read, discuss, and publish on subjects germane to industry and securing whatever mutual advantages might be derived from conference on the best and safest methods of producing coal."

We should feel proud that Illinois was the first state to establish a mining institute, and the fact that Illinois was first is appropriate. Indeed, the first discovery of coal in north America occurred in what is now Illinois, not far from here. Authorities differ, but one account says that explorer Father Hennepin discovered coal in 1669, near where Ottawa is today.

Another account gives credit for the first discovery of north American coal to Joliet and Father Marquette in 1673. Whether it was 1669 or 1673, Illinois was first; coal wouldn't be discovered anywhere else in north America for almost another century. Coal mining of any scale didn't begin in Illinois until the early 1800s. Outcroppings along the Big Muddy river in Jackson County were mined as early as 1810. Two decades later, flat boats filled with Illinois coal were floated down the Mississippi to New Orleans. In 1833, some six thousand tons were hauled by wagon from Belleville to St. Louis.

In those early days, there was little demand for coal. But with the growth of railroads and manufacturing, demand grew rapidly. In the 1850s and '60s, railroads and industry led to the development of the great coal fields of Alton, Kingston, Rock Island, Danville, Braidville, Braceville and many others.

In the last half of the ninteenth century, Illinois rail trackage more than tripled. That strong growth wouldn't have happened to that degree or that rapidly without the great Illinois coal deposits. Indeed, our state has greater resources of bituminous coal than any other state. Almost two-thirds of Illinois lies over coal-bearing rock. Eighty-six of our 102 counties have coal deposits. And if you are talking about bituminous coal, Illinois has about one-fourth of the country's recoverable reserves. So, it can fairly be said that Illinois and the Illinois Mining Institute have an honest claim to our rich history and expertise in coal mining.

And now let's name some names and cite some facts about Illinois Mining Institute innovations. Two major innovations are things we take for granted every time we go underground. Example number one, rock dusting. In the 1920s, Institute members John Jones and DeWitt Buchanan perfected the technique of rock dusting in Illinois mines and released all their patents to the public domain. Today, rock dusting is used in mines world-wide to control dust explosions.

Example number two, roof bolting. In 1946, Jim Conway introduced roof bolting to support mine roofs. That happened to be the year that our Murdock mine opened up in the central part of the state. The Murdock mine, I was told, was ready to close within six months after they opened it because they couldn't control the roof. It is a fairly shallow mine and roof bolts saved that mine and it worked for 46 years after that and provided a great deal of employment. Today, roof bolting is common practice in mines all over the world.

These and more mining innovations came from Illinois and IMI members. They helped make mining safe and efficient, and in so doing, they contributed to the well-being of everyone in our profession.

To continue our march of time review, coal's great growth, of course, came from electricity. It seems impossible now to think that electricity is not available almost everywhere. But it was only 12 years before the IMI was organized that New York's Pearl Street power station became the first to offer consumers electricity on demand. Thomas Edison showed remarkable foresight when he said that one day only the very rich will be able to afford to light their homes with candles. Of course, Edison was right, but his prediction didn't come true overnight. By the turn of the century, only 10,000 Americans had electric lights. In one more decade, the number had mushroomed to three million and was growing rapidly. Abundant, inexpensive coal allowed the growth of easily affordable electricity, and IMI mining pioneers helped make coal mining safe and efficient.

Today, almost 90 percent of the coal mined in the U.S. generates electricity. Coal-fired plants produce almost 60 percent of the country's electricity—more than gas, oil, nuclear and hydro-electric power combined. And in this age of environmental concern, electricity's use will continue to grow. Indeed, because of environmental issues, increasingly electricity will displace other energy sources. The primary reason is that electricity is generated in centralized locations, so it is far easier to control emissions. That makes electricity the most environmentally responsible fuel we have that is also widely available and inexpensive. That is why the Environmental Protection Agency is working with electric utilities to replace gasoline-burning motors with electricity.

Here is a quick example, your lawnmower. Did you realize a gasoline-powered lawn mower creates as much pollution in one hour of operation as driving a car 50 miles? An electric mower on the other hand produces 70 percent less pollution, plus you don't wake the neighbors. The same goes for all sorts of gasoline-powered devices, from leaf blowers and farm tractors to automobiles. Electric versions using inexpensive power from inexpensive coal would create a much cleaner environment. In short, while we assemble here to celebrate a rich history of America's coal mining pioneers, I believe it is clear that Illinois coal should have a rich future.

Certainly, as in our past 100 years, the industry will undergo great change. There will continue to be hard times with the good. But I find it inconceivable that this great Illinois resource, which today directly supports some 12,500 jobs and an annual payroll of $500 million and an additional $1.5 billion in direct economic value each year, will not continue to be a mainstay of environmentally responsible economic growth in this state, throughout the midwest, and beyond. The important economic role of coal in Illinois is only one reason we gather today to observe and celebrate the 100th anniversary of the Illinois Mining Institute.

There are other reasons that, I believe, are equally important, if perhaps more difficult to quantify. I see three reasons why the Institute's centennial merits our notice and celebration. First, in the economic role of coal, we've touched on, put briefly, we meet today to celebrate the centennial of an organization that helped support the creation of hundreds of thousands of jobs for generation after generation of Illinois men and increasingly, Illinois women. The IMI helped make these jobs safer and better. Another reason to celebrate IMI's centennial, is what I consider the public interest role of coal mining. That public interest role has been a vital, indeed irreplaceable responsibility, and that role has been to mine the coal that lights our neighbors homes, powers factories and supports our fellow citizens' quality of life. The IMI has helped make mining's public interest role as efficient and as cost-effective as possible. The third reasons we are here is to celebrate 100 years of hard working men and women who produce these economic and social benefits for society at large. This is what I consider the human dimension of mining. We today celebrate a century of men and women who uniquely, I believe, look after one another, help and respect one another. People in this room could tell hundreds of stories about this human quality; you've all witnessed it, you've all felt it. I don't think anyone could be around coal mining and not feel it. In conclusion, for these three reasons, we gather to mark and celebrate the centennial of the Illinois Mining Institute. And it is for these reasons that I am proud to be one of you this year and every year. Proud to be a miner and especially proud an Illinois Mining Institute miner. Thank you for coming, and thank you all for your part in making this a great success.

In order to make this whole thing a success, we rely on Heinz Damberger, Phyllis Godwin and all her helpers. Without their work, we would just never have a meeting, and I don't know if the Institute would continue without their great help. So I'd really like you to give them a big hand for all the work they have done.

At this time I would like to call on Bob Shanks, Chairman of the Scholarship Committee and ask him if he would tell us what the Scholarship Committee is doing and introduce anybody he would like to.

SCHOLARSHIP COMMITTEE REPORT

Robert Shanks: Thank you Mike. I think that the work that the Institute does in providing scholarships to our college students is probably the most important effort that the Institute undertakes year after year. In order to kick off my remarks, I'd first like to have the members of the Scholarship Committee stand. We have Jim Gill, with MAPCO; Paul Chugh, Southern Illinois University; and George Woods, who was here earlier, Southeastern Illinois Community Colleges. We met last month and discussed and prepared a recommendation for the Executive Board for next year's scholarship commitments. For the 1992-93 school year, the Institute has provided $9,000 in scholarships, and I believe that is an alltime record. Our recommendation for the following year has been to increase this by $1,000 to $10,000, and we are very pleased that the Executive Board supported our recommendation. The $9,000 in scholarships for this year was distributed last month to four schools. As I read those schools, I wonder if the faculty and students

from those institutions that are here today could stand and be recognized. University of Missouri at Rolla, Southern Illinois University in Carbondale, Wabash Valley College, and Rend Lake College. Let's give these people a round of applause.

During the Business session tomorrow morning, the individual recipients of these scholarships will be recognized and for those of you that won't be up tomorrow at 8:00 a.m., I'll read the names. I know a large percentage of these people are not here today, but for those that are, if you would please stand. From SIU: Patricia Lockett, Steve Albert, Gerald Cima, Aaron Haley, Lars Lindquist, Dennis Connor, and Richard Voyles; from Rend Lake: Steven Tate and Chad Campbell; from the University of Missouri at Rolla: Craig Sorenson and David Hamlin; and from Wabash Valley: Joseph Damrey, Frank Skaggs, James Bowles and Thomas Drone. Those people will be recognized tomorrow.

Michael Reilly: Thank you, Bob. At this time I would like to turn it over to Ron Morse, Director of the Illinois Department of Mines and Minerals; he has an award he would like to give, Ron.

LAND RECLAMATION AWARD

Ron Morse: Thank you, Michael. Let me read briefly before I introduce our recipient. It is my pleasure to announce this year's winner of the Illinois Department of Mines and Minerals Land Reclamation Award in the coal category, which is Arch of Illinois, Inc. Arch is being recognized for innovation in relocating, restoring and improving Pipestone Creek in Percy, Illinois. The project represents the first time that a large creek has been temporarily and then fully restored to its original channel in the midwest mining area. The creek has a watershed of 11.63 square miles, and originally crossed 5,000 acres slated for coal excavation at the Denmark Mine property. In order to keep flooding waters from entering the mine and thus endangering miners and damaging equipment, the creek had to be temporarily relocated to the perimeter of the mining area. Today the creek flows continuously, bending and twisting through crops and fields and trees. Flooding and erosion are better controlled, and the incorporation of a filtering system removes sediment and improves water quality. Additionally, the area now attracts diverse wildlife population providing habitat for numerous plants and wildlife species. Arch of Illinois, Inc.'s dedication to research, development and implementation and new reclamation technology during times of tightening and environmental regulations and costs exemplifies the commitment to excellence. Not only does the environment benefit from the company's achievements, but industry as whole.

I'd like to take just a second for a commercial. I certainly appreciate Arch's involvement in this. I think the Department of Mines and Minerals played a role in making this happen. The inspector at that mine, Don Blakely is here. I think he is the person that helped in this as much as we could possibly help, and it is my intention that projects like these can be enhanced by Mines and Minerals and that we never, never become a deterrent to good ideas and good production. With that, I'd like to ask Bob Shanks, President of Arch of Illinois, Inc., to come forward.

Robert Shanks: To help me receive this award, I'd like to ask Doug Downing, who handles our reclamation and permit planning and direction to come up and help me.

Ron Morse: Fortunately, I have two things. I'll wait for Mr. Downing, who is a product of Illinois Mines and Minerals Land Reclamation Division school of better management. The certificate simply states: "Surface Mine Land Reclamation Award. Coal Achievement. Superior Achievement in Reclamation in 1992 Presented to Arch of Illinois, Inc., for the Pipestone Creek Restoration Project." It is our pleasure to award this to Arch of Illinois, Inc.

Robert Shanks: I'd like to thank the Department of Mines and Minerals and share your comments that this really has been a team effort between our employees, especially led by Doug and his staff and the hardworking employees at the Denmark Mine that have made this possible. Certainly, we have appreciated and gained from the input from Ron and Don, also. Thank you very much.

Douglas Downing (left) and Robert Shanks (right), Arch of Illinois, receive 1992 Land Reclamation Award from Ron Morse, Director of the Illinois Department of Mines and Minerals.

Michael Reilly: Thanks, Ron and congratulations Bob and Doug. The next order of business is our honorary lifetime membership award.

HONORARY MEMBERSHIP AWARD

Michael Reilly: At the annual meeting each year, we recognize outstanding service to the Illinois mining industry by selecting an individual for honorary lifetime membership in the Institute. Normally, the chairman of the Honorary Membership Committee makes this presentation. However, because of my own longtime personal relationship with this year's recipient, Dick Shockley has graciously allowed me to handle this most pleasant task. Thanks, Dick.

Today's honoree, C. Dayton McReaken, more affectionately known as "Wormy" by his friends, continued a family tradition of working in coal mines which was started over 100 years ago, when his maternal grandfather worked in the coal mines in Ireland. Born in Panama, Illinois, in 1924, he moved to West Frankfort when he was four years old. It was in West Frankfort that he married his high school sweetheart, Dorothy, whom he refers to as the Queen. Dorothy, we are honored to have you with us today. By the way, for those few of you who don't already know, I'm sure that Wormy will be happy to let you know how he picked up the nickname Wormy. It has to do with more than just being known as someone who wormed his way through tight places.

Dayton's coal mining career began in 1942 at age 17 at Chicago, Wilmington and Franklin's Orient No. 2 mine in West Frankfort. At that time, his earnings were $5.96 a day. He was employed seven years as a UMWA miner working in several classifications. He worked eight years as a federal and state mine inspector and 27 years in management. He worked as a laborer, a face boss, mine manager, safety director, superintendent and general superintendent. He was also on the Illinois State Mine Rescue team for six years working on mine fires and explosions.

In 1972, he was appointed Director of Mines and Minerals by then Governor Richard Olgilvie, serving two years in that capacity. Dayton retired in 1987 from Zeigler Coal Company where he was general superintendent of our Zeigler No. 5 mine. Ever since he worked with Zeigler, I've known Wormy, and he has just been an outstanding employee. I don't think there is anybody more loyal to the company and to the coal industry than Wormy McReaken is.

You've really had an outstanding career in the coal industry of Illinois and I'm proud to have known and worked with you during part of that time, Wormy. You are a real credit to our industry, and it is with great pleasure that I present to you a certificate naming you an honorary lifetime member of the Illinois Mining Institute.

C. Dayton Mc Reaken receives 1992 Honorary Membership certificate from Michael Reilly.

Wormy is usually at a loss for words, as most of you know. But, I'll see if he can find a few.

Dayton McReaken: Is Al Skinner, the editor of the magazine here today? As you know, he put my picture on the front page of the magazine this month, which was a big surprise to me. Now, in that picture, if you look at it again, you'll see on the right hand side of me is a blue dress with white dots on it, that's the Queen's arm. She was originally in that picture, but they put a mantrip in front of her, and she said that was alright with her, because as a homemaker for 49 years, she always was in the background. She is living proof, she has been my bride of 49 years, that there is nothing wrong with being in the background of a coal miner. As I've told you in that book, you had to be a good woman to put up with management people and mine rescue team people and all that for that many years, and I'll give the Queen the credit for raising my three children and for what they are today. Al stated in that book that I liked to tell tales. I'll have to admit I do a little bit, but I like amusement in things as much as anything else. When we received the picture on the front of that page, we explained it to my little four-year old grandson; he knew it was grandpa, of course. Now some people thought that was Ross Perot. He knew it was Grandpa. So we explained to him about us coming up here today, cause he was going to stay all night with us tonight tomorrow. What we were going to do up here at this 100th year celebration and all. And he interpreted to his mother that they was celebrating my 100th birthday. So you can visualize that as little children think, you are getting pretty old. I'm not going to take anymore time up here with you, but I've one more thing I want to tell. I'm sure glad our first speaker today, Mr. O'Neal said what he did, because he said what he thought and that is good. Mr. Reilly said what he thought and a few more did, so I get to say what I think. They paved the way for me. I'm going to tell one coal mining story.

I appreciate Tom Austin, Dick Shockley and Kim Underwood for throwing my hat in the ring for this privilege today and the rest of the Board members for giving it to me. I really appreciate it. I even like my picture being on the front of that magazine. I didn't think I would, but I did. And I don't know about Queen, I guess it is all right, but I hate for them to leave her out. But I'm going to tell you a coal mining story.

About 35 years ago in southern Illinois there was a mine fire. We lost three men in this fire and the mine was sealed up. At that time, Arthur Joe Williams and I were working for this coal company. Arthur Joe is a retired state mine inspector. Most of you people know him. Fine fellow. I was the safety director for the company and he was the second shift mine manager, but we were working with the mine rescue team on the recovery. We were going back in, advancing in this mine, building seals going in, advancing on the fresh air, airing them out, building on the apparatus, airing them out, moving on up. I am not going to explain all the procedure. Most of you know all of that anyway. We were about 1,500 feet from where the fire started, which normally should have taken about ten more days to do three or four sets of seals and move up. Well, a very energetic and good talking top management personnel decided to talk the state and federal inspectors into a decision. This decision was to open the intake and return the seals up 1,500 feet away from them by an hour and fifteen minute travel time, to open these seals up and hurry this thing up. Because Joe Williams and I were management personnel, we were picked to stay underground with this property, knock out this fresh air intake and the return on the stoppings, go in and explore the mine fire, the location where this mine fire started—that would save ten or fifteen days. We were supposed to do this at 12:15. Well, at about five after twelve, Joe Williams told me, "You know, Wormy, we are playing you bet your life."

I said, "Yeah, I sorta think that. But, you know this is a big decision because, when we do it, we might just have a few hours left; if we don't do it, we might just have a few days left with this coal company." We were company personnel. About five minutes before time to do the job, and I will say that Joe and I were going to do it. I don't know why, maybe because we thought we'd be president of the company in six months. I don't know. Young people have them silly ideas. But about five minutes before time for this to be done, the instructions were given on the top. The Springfield mine rescue team was there, and the state and federal and the management told the Springfield mine rescue team, "We got Wormy and Joe underground [everybody knew both of us] . They are going to do this job. What we want you fellas to do is to go on the bottom and stand by." One fella, who is in this building today, and I wanted to tell this story a lot, and I'm finally gonna get to tell it because when you get my age, you can't wait too long to tell your stories. Fred Rice was the captain of the rescue team. That's Fred Rice sittin' back there. I know most of you know him. Fred Rice stepped up to these people and he said. "Well, let me tell you somethin'. You people own this place, you people run this place." He talked to management, the state and the federal. "I'm not going underground and do that. I'm not taking my rescue team underground. All I want you to do is give me time to get my rescue team out of the county, so when you blow this place up, I won't be involved."

Well, they chickened out then. Fred stood his ground. Showed his guts. Ten days later, as we went back and they changed their mind and we advanced 100 foot at a time, 300 foot. We are only 50 feet from this job. At the time we opened this fire up it could do the same thing. Not going to take a lengthy time to tell you that. The events that took place when we opened this mine fire, 50 feet from it, we had the protection to fight it and everything right there with us. If it had been 1,500 foot, as we originally was going to do when we turned the air on it, and it took me and Joe one hour and fifteen minutes to get in there instead of five minutes, I wouldn't have been here today gettin' this. Thanks, Fred.

Michael Reilly: Great story. It is really nice to hear some of the real life stories. As I mentioned earlier, I imagine there are many out there that could tell us some great stories about coal mining and their experiences in Illinois. It is just a great industry to be in. I've been in it. Luckily, I got in it a long time ago. I've met so many great people in this industry. We're hangers on, you know. We don't know anything else to do I guess. So we stay with this industry. It is a tough industry, but boy it sure has great people, and you need them to survive in this industry. Wormy, congratulations. It is great to have you as an honorary member.

Are there any other honorary members or past presidents here today? If they would, I wish you would stand up.

Now I would like to introduce Lanny Bell. Lanny retired from Roberts and Schaefer Company and is a senior member and past chairman of the Advertising Committee, and I'd like to ask him to handle the presentations of honorary memberships to people on the Advertising Committee.

Lanny Bell: As a member of the Advertising Committee, I have a distinct pleasure of presenting three members of the Committee with lifetime honorary membership in the IMI. This membership is not given lightly. It is given to members who the Executive Board feels have years of long, faithful and meritorious service to the Institute. Members of the Advertising Committee are responsible for securing the advertisements you see in the Proceedings, the revenue from which helps underwrite the annual meeting and the presentation of scholarships to the various coal mining schools in our area. We have three people today. From the standpoint of longevity, Ray Taucher would be first, joining the IMI in 1961, working for many years as a representative of Consolidation Coal Company. We are sorry to say we just learned last week that Ray was ordered to the hospital for some medical tests, and of course he could not attend our meeting. Ray, a silent, calm gentleman worked without fanfare, contacting, with great results, many of our advertisers, who still buy space in the *Proceedings* today.

Second, would be Tom Sadler, working for many years for Old Ben Coal Corporation, joining the Institute in 1964. If any one of you out there has never heard Tom Sadler, you better check your hearing. Tom is an outgoing man and was never a stranger to anyone. But we soon found out that under the bluster, he's a pussycat, and, lucky for us, he's guided through life by the lovely Rosalee.

Tom Sadler receives Honorary Membership certificate from Lanny Bell.

The third would be Walter Brandlein. It has already been mentioned that Walt passed away early this year. Walt and I worked for the same company, and he was my boss for 25 years. Walt was also a calm, caring, patient man and loved all of his fellow workers very much. The love of his life, next to his wife and family and grandchildren, was fishing; he loved to fish for Coho. I can remember every evening in the Coho season, he bustled to catch that train, to get in that boat and go out on lake Michigan and catch the big one.

Walter E. Brandlein

I received my life membership a few years ago, and it now hangs proudly in my den with my other mementos of a long life of good things happening to me. Thank you.

Would Mrs. Brandlein and Carol and Tom Sadler come forward to the podium, please.

Pat, on behalf of this society, I really have a great pleasure in presenting this award. Walt fully deservedit, and I hope it will be hung in a place of honor.

Pat Brandlein: Thank you, Lanny. Thank you all.

Lanny Bell: Tom, it is with pleasure I present this to you for long and faithful service. You can see it is all framed, it has glass in it and all you need is a hammer and a nail. I know you can handle that.

And of course, we will mail to Mr. Taucher his certificate.

Lanny Bell (foreground) gives Honorary Membership certificate to the family of the late Walter E. Brandlein: Tom Brandlein (son), Pat Brandlein(wife) and Carol Brandlein Efrid (daughter)

Michael Reilly: Thank you, Lanny. Well, we are nearing the end of this luncheon. At this time, I would like to introduce the incoming IMI president, Bob Danko. Bob, you've been around working with us for a long time, so this should be a breeze for you to take over. I don't know, Bob, if this is what I give you or you give me [gavel].

Robert Danko: Well, I am honored and have been given the honor to present the President this year of the Centennial year of the IMI, Mike Reilly, with the gavel in appreciation of all the members of the IMI. Mike was selected over two years ago by the Executive Board. There was a lot of discussion of who in Illinois and in the coal field had the influence, the ability, the respect and the know-how to pull 100 years of a lot of good coal miners together. The presentation and the meeting that you've seen here today, shows the wisdom of the Board and the good decision that they made. And I think Mike deserves a hand and big congratulations for a job well done.

President-elect J. Robert Danko presents the souvenir gavel to President Michael K. Reilly.

Michael Reilly: Thank you very much, Bob. Bob will take over as soon as tomorrow's meeting finishes and set the plans for the next century. We have a lot of work for us in this industry and with Bob and other great people, we'll do fine. Heinz, did you want to mention anything about what we are selling out there?

Heinz Damberger: Yes, I should point out to you we are having a raffle for a shotgun. I think most of you know about it. Tickets are for sale out in the lobby. It will be raffled off at the end of our meeting tomorrow.

There are also all kinds of mementos for sale out in the lobby, and I hope you will take advantage of them.

Michael Reilly: Thank you, Heinz. Just to remind you of the balance of the program: exhibits are open, it would be nice if you go out and see what is displayed out there both in the history side of it and also the equipment and materials the exhibitors have in the hall. There will be a fellowship hour from 4:00 to 6:00 p.m. in the exhibit hall, and I hope to see you all there. And then the reception for those that are coming to the dinner will be just outside this room starting at 6:00 p.m. this evening. Then dinner will begin at 7:00 p.m. There is a business meeting tomorrow morning at 8:00 a.m. The exhibits will be open from 8:00 a.m. til noon tomorrow and there is a technical session that will start at 10:00 a.m. and go til noon. Again, be sure to look at the safety lamps, the pictures, the movies—all the items that are placed out there because there has been a great deal of work in gathering that and I think you will really enjoy it. It won't be here after tomorrow. With that, I am going to adjourn and thank you all for your attention.

THURSDAY EVENING DINNER

Michael Reilly: Don't worry, there aren't anymore speeches coming. I just wanted to welcome you all and hope you are enjoying the meal. Thank you for coming. I think it has been a great meeting.

Some of the past presidents and honorary members were not at the lunch, and I'd like everybody who is a past president or honorary member to stand up please so we can recognize you. Let's give them a big hand of applause. We do have a program tonight that will take maybe fifteen minutes or so. Chris Ledvina is with us, and he, together with Heinz Damberger and Jack Simon, has done all the work of putting a collection of photographs together in a booklet of the history of the Illinois mining industry. He is now going to show us some other historic pictures, not in that booklet, of individuals whohave been important to the mining industry. With that I would like to thank you all for coming.

It is my pleasure to introduce Chris. Chris Ledvina is a professor at Northeastern Illinois University. He has done a great job in putting this booklet together, and I know he will have a finished book for us sometime next year.

PERSONALITIES OF THE IMI AND ILLINOIS MINING INDUSTRY

CHRISTOPHER T. LEDVINA
Northeastern Illinois University
Chicago, Illinois

Ladies and gentlemen, it is certainly a pleasure to be here tonight. Fellow members of the Institute, I think the founding members of the Illinois Mining Institute would be very pleased to see this meeting 100 years after they did their work in 1892.

It is interesting to go back and reflect on the history of Illinois coal mining that has gone past us in the last 100 years. I know that we are all itching to get out on the dance floor, so I'll be very brief. What I would like to present is a small sampling of some of the personalities that have molded and shaped the coal industry in Illinois over the last 100 years and that have molded and shaped the course of the Illinois Mining Institute and sometimes fought to keep it alive.

It is unfortunate that a lot of the early history of the Illinois Mining Institute was lost, especially the first thirty years or so. Mostly, the people I'm going to be presenting tonight are personalities from the history of the Illinois Mining Institute. Then I'm going to move on to some personalities who shaped the coal industry of Illinois.

Three people for whom, unfortunately, we could locate no photographs were the founders of the Institute themselves. There is a small piece of history in the brochure accompanying the photographic exhibit that outlines some of the contributions these three people have made. James Simpson was the founder of the Illinois Mining Institute and its first president, in 1892; he came from Consolidated Coal Company of St. Louis. Richard Ramsey was the first chair, and Hugh Murray was its first secretary.

Many years later, we start to pick up on some more documented history. But much of the course of the Institute, mostly through coal's golden years in Illinois, circa 1900s through maybe 1925 to 1930, was unfortunately lost. No proceedings were published during this time, and there is a paucity of photographs. But the record picks up in approximately 1934. John E. Jones and Bela Schonthal are shown together in figure 1. Bela, who was with his own firm selling mining equipment and supplies, was secretary of the IMI from 1929 to 1954. He gave many long years of service to the Institute. John E. Jones is another Illinois mining legend. We are going to get to him in a couple of seconds.

Ben Shull (figure 2), was director of the Department of Mines and Minerals for many years and president of the IMI from 1943-44. I met him once back in the seventies; it was a real pleasure; he was quite a character.

Figure 3 shows George Wilson, H. C. Livingston and Bela Schonthal. George Wilson was a noted coal geologist who worked many years at the Illinois State Geological Survey. There has been a tradition established that the secretary-treasurer is from the Coal Section at the State Geological Survey, and George Wilson was the first of that genre. He became Secretary-Treasurer in 1954. Livingston, from Truax-Traer, now Consolidation, was president of the IMI 1957-58.

Next we have Paul Weir (figure 4), another Illinois mining legend. He was IMI president 1938-39. He formed the Paul Weir company of consulting engineers and geologists.

Clayton Ball (figure 5), another celebrated geologist, worked many years for the Paul Weir Company. He had worked for the State Geological Survey in the late- to mid-twenties. He became President and Chief Executive Officer of Paul Weir Company and was IMI president 1951-52.

Most of the people I have presented so far have been long deceased. The next two characters are very much alive (figure 6). I suspect one or more of them may be here tonight: Gene Moroni, on the left, and Jack Weir on the right. Jack was the last president of Paul Weir Company before the company changed hands. He was president of the IMI in 1962-63; Jack Weir and Paul Weir were the only father and son presidents in IMI history. Gene Moroni was president of the IMI 1963-64; he became an honorary life member in 1984; a true living legend.

Next is Morris Leighton (figure 7), Chief of the Illinois State Geological Survey from 1923 to 1954, who became an honorary life member of the IMI in 1965. We also have in this picture John Broadway who worked many years with Zeigler and Bell & Zoller Coal Company. He was president of the IMI in 1965-66.

In the next picture, we have Peter Rourke presenting the honorary life membership to Tom Garwood (figure 8). I think anyone in this room who has ever had a chance to speak to Tom Garwood for even a minute or two felt the warmth and affection this man had for others and the coal industry of the state. I know this from my own career; Tom was very good to me in a couple of run-ins in my early years. Here he receives his honorary lifetime membership in 1979. He had a large collection of safety lamps, many of which are shown in our exhibit in the Mississippian Room.

Clascenna Harvey (figure 9) is a luminary from IMI days from the sixties to the early eighties in Springfield. She was a pianist and organist at many of the luncheons and evening functions of the Institute. I'm sure many of us remember Clascenna.

C. C. Conway, on the left of figure 10, was chief engineer of Consolidated Coal Company. More about him in a few minutes. The others are Walter Spotte of Joy Manufacturing and Carl Hayden, who was president of the IMI 1942-43. Carl was also vice president of Sahara Coal Company and was very active in the management of Sahara up through his own nineties. I guess what I am trying to say, he worked actively into and past his ninetieth birthday.

The next figure (11) represents a personal favorite of mine, Gilbert H. Cady. He is the father of Illinois coal geology. He instituted a lot of the research work that led to the discovery of many of Illinois' coal reserves, especially its low sulphur reserves. He did much underground geologic work linking geologic problems to roof control and mining conditions. He started his career in 1907 at the State Geological Survey, and he was active until his death in 1970.

Also, we have in this photo H. D. Meiser, who was a very prominent geologist with the United States Geological Survey.

I think everyone remembers Betty Conerty (figure 12), a true luminary of the Illinois mining industry. Her cheerful enthusiasm and her lively disposition kept us going in a lot of rough times. She is shown with Jack Simon. Jack was a good steward during his tenure as Secretary-Treasurer, demonstrated by the good sense of hiring Betty Conerty. Betty retired as Administrative Assistant in 1986. Phyllis Godwin took over her position, and with all the work Phyllis has done to make this Centennial possible, she will surely become equally famous.

Moving on for another couple of minutes into luminaries or personalities of Illinois mining history in general. The history of coal mining in Illinois has certainly generated some interesting characters, mine operators, managers, administrators and in a few cases, organizers, representatives from labor–characters one and all.

Herbert Bell (figure 13) was the CEO of Bell & Zoller during the early years of the 1900s when Bell & Zoller acquired the operating properties of Zeigler Coal Company. Bell & Zoller continued to operate Zeigler mines for many years, up until the middle 1950s.

Another luminary is DeWitt Buchanan, Sr., also known as Buck Buchanan (figure 14). Buck has more than an interesting history. In fact, following himself and his son, who was to succeed him, Buck more or less tripped upon the Wilmington Star Mining Company that his father acquired as part of a bad debt settlement. He took the Wilmington Star Mining Company and built it into what became Old Ben through the acquisition of reserves in Franklin, Williamson, and Jefferson counties. Ultimately, through Buck's work with his father's orphan coal company, he amassed probably what was the single largest holding of high-quality coal in Illinois. Also, Buck Buchanan contributed greatly to mine safety, working with John E. Jones in the development of rock dusting.

DeWitt Buchanan, Jr. (figure 15), succeeded Buck as president and CEO of Old Ben; he passed away in 1984. Although DeWitt, Jr., wasn't active in the golden years of mining like his father was, he went on through his career to develop the boring type continuous miner, or certainly had a lot to do with its development. He also was very active in the National Coal Association, and through his efforts and that of others, people like Gene Moroni and several people with Freeman United, longwall mining was first attempted in Illinois.

Figure 16 shows C. C. Conway, otherwise known as Jim Conway, the father of roof bolting, who worked with Consolidated Coal Company in 1948, in Mine No. 7. He took a principle he observed in other rock suspension or rock bolting situations and applied it for the first time to underground coal mining. This he did in Illinois and basically gave us roof bolting as we know it today.

In the lamp exhibit room, the Mississippian Room, you can see two of the actual original prototype roof bolts that C. C. Conway used in 1948. The work of C. C. Conway is going to be long remembered because roof bolting greatly reduced the death toll and the source of injuries caused by roof falls.

Henry Crown (figure 17) had a long and complicated career as an industrialist with Materials Service Corporation and Chicago Wilmington and Franklin Coal Company (later to be Freeman-United). He founded General Dynamics and through the Crown family trust, there are still significant coal holdings in Illinois. Several mines have been named after Henry Crown. He is also, in the Chicago area, a prominent philanthropist.

John E. Jones, otherwise known as rock dust Johnnie (figure 18) is of particular interest. In 1917, following a Thanksgiving night explosion at the new North Mine near Christopher, Illinois, John E. Jones decided, along with Buck Buchanan, to put into effect the idea of using rock dust-dispensing devices to extinguish coal dust explosions. Through the work of John E. Jones, rock dust became a universal safety measure used in all coal mines around the world. John E. Jones also introduced closed lights and put an end to the open carbide lights commonly in use at that time. He was a state mine inspector and hired later by Buck as Old Ben's safety engineer.

It is said that Rock Dust Johnnie was not safe on some streets in southern Illinois late at night because the miners didn't believe much in some of his ideas, especially the idea of using closed lights. But, of course, that is history now and closed lights are part of our everyday mining lives.

Mother Jones (figure 19) was a suffragist and one of the founders of what we know today as the United Mine Workers. Most of her activites were in central and southern Illinois. She herself became a living legend in the area of labor and organization.

Joseph Francis Joy (figure 20) was not exactly an Illinoisan; however, most of his inventions at some point (some of the less successful ones you can see out in the hallway as models) found their way into the mainstream, commonly through trials in the Illinois Basin area. This is especially true of the Joy loader and the Joy mechanical cutter. These machines began the march of mechanization in the 1920s.

Joseph Leiter was definitely a character from the Illinois mining history (figure 21). In approximately 1905, he founded the Zeigler Coal Company which was named after his father, Levi Zeigler Leiter. Both Joseph and his father were Chicago industrialists. Joseph Leiter attempted to corner the Chicago grain futures market one year, failed at it miserably, lost a significant portion of his family's fortune, and then decided to get into the coal business. He went down to Franklin County and purchased approximately 35,000 acres of high-quality Franklin County coal and opened up the Zeigler No. 1 Coal Mine. He believed that Zeigler No. 1 was a mine so advanced and mechanized, so much ahead of its time, that he dated the cornerstone 2909 instead of the year 1909. After a few months of operation, there were several disastrous explosions at this mine and numerous problems with labor unrest. Joseph Leiter felt that because his mine was so highly mechanized, he should pay less of a tonnage wage than was then common. The result was two years of explosions and labor strife and, eventually, the taking over of Zeigler operations by Bell and Zoller.

Another luminary from Illinois mining history who became a legend in his own time is John L. Lewis (figure 22). This is one of the few photos I could find of John L. Lewis where he was not angry. Those who knew him said he could be very tough, yet very gentle. John L. Lewis was hated by some, loved by many others. Coal company operators were known to say, "I hate this man, I wish I could hire a thousand of him." John L. was born in Iowa and moved to Springfield, Illinois, when he was a teenager. There, he began work in the coal mines of the Springfield area as a trapper and then later as a miner. He acquired his interest in the coal mining labor movement there and went on to become president of the United Mine Workers of America from 1919 to 1960. Interestingly enough, his brother Howard Lewis was a vice president of Old Ben Coal Company.

John Mitchell (figure 23), definitely an Illinois boy, born in Braidwood, is shown during the mining boom years of the late 1860s. He became president of the United Mine Workers from 1898 to 1907 and more or less shaped the course of what was to become the more modern version of the United Mine Workers that John L. Lewis was to inherit and build up to the size it became.

Frank Nugenf (figure 24), who recently passed away, was President and CEO of Freeman-United Coal Mining Company. He was very active in the National Coal Association and became an honorary life member of the Illinois Mining Institute in 1972. His accomplishments with Freeman-United included experimental longwall operations as well. He was truly a visionary and pioneer in mining.

The legend of Francis S. Peabody (figure 25) is certainly spectacular. Francis S. Peabody was born in 1859. The best we could do was kind of a rough sketch. He opened up a wholesale coal dealership in Chicago and later moved into the mining area. Eventually, he formed what is known today as the Peabody Coal Company. His son Jack (figure 26) became president of Peabody Coal Company and continued on well into the middle 1900s, even as a director of Eastern Airlines. Jack's son Stivey (figure 27) was President of Peabody in 1914. I don't know anymore about him. I think we may have this date a little early; maybe it should be 1929 or 1930.

And finally, a group of personalities who rarely make it to IMI meetings, but some do: the miners themselves. We should honor all of those who work on top or underground, whether they be management or rank and file. One of my favorite photos shows several miners and their mule (figure 28) at Zeigler Mine No. 1, circa 1909. Note the carbide lamps. I don't know what they are telling the mule. I'm sure it was funny. Nearly 100 years later (figure 29), these miners are four very close friends I worked with at Old Ben 26. Very little has changed over a century. The carbide lamps are gone, the mule is gone, but the love for the industry, the camaraderie between people working underground, has certainly remained the same. As a tribute to those who work below, the bronze statue on the East lawn of the capitol building of which we have a replica at the registration desk (figure 30). It is almost the trademark of Illinois coal mining.

I hope this has given us a brief tour through some of the personalities that have come out through the years, both with the IMI and the history of coal mining as well. Thank you very much.

Figure 1. John E. Jones (left) and Bela Schonthal (right), 1954

Figure 2. Ben Shull, 1957

Figure 3. George Wilson, H. C. Livingston and Bela Schonthal (left to right), 1958

Figure 4. Paul Weir, 1962

Figure 5. Clayton Ball, 1963

Figure 6. E. T. (Gene) Moroni (left) and Jack Weir (right), 1963

Figure 7. Morris Leighton (left) and John Broadway (right), 1965

Figure 8. Peter Rourke (left) and Tom Garwood (right), 1979

Figure 9. Clascenna Harvey, 1983

Figure 10. C. C. (Jim) Conway, Walter Spott and Carl Hayden (left to right), 1980

Figure 11. Gilbert Cady (left) and H. D. Meiser (right), 1940

Figure 12. Jack Simon and Betty Conerty, 1982

Figure 13. Herbert Bell, c., 1920

Figure 14. DeWitt "Buck" Buchanan, Sr., c., 1940

Figure 15. DeWitt Buchanan, Jr.

Figure 16. C. C. (Jim) Conway, c., 1975

Figure 17. Henry Crown

Figure 18. John E. "Rock Dust Johnny" Jones

Figure 19. Mother Jones

Figure 20. Joseph Francis Joy

Figure 21. Joseph Leiter, c., 1902

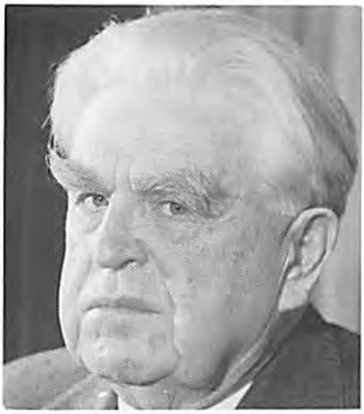


Figure 22. John L. Lewis

Figure 23. John Mitchell

Figure 24. Frank Nugent

Figure 25. Francis S. Peabody

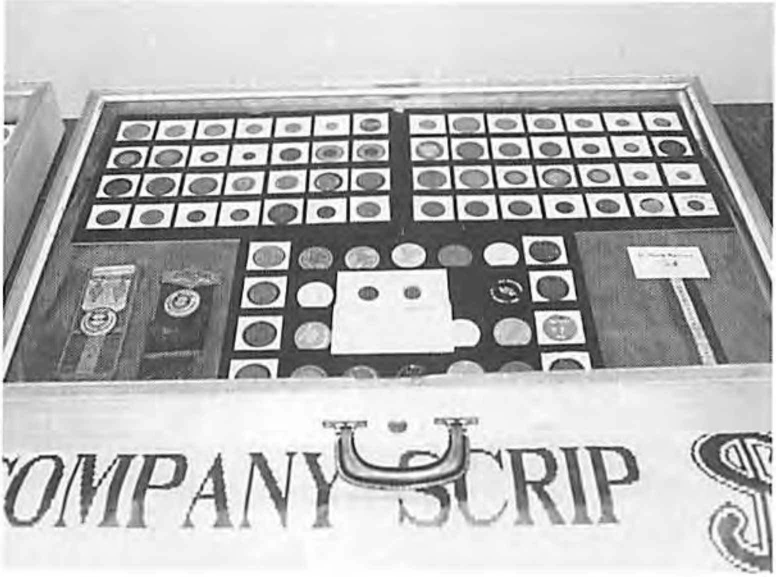
Figure 26. Stuyvesant (Jack) Peabody

Figure 27. Stuyvesant (Stivey) Peabody

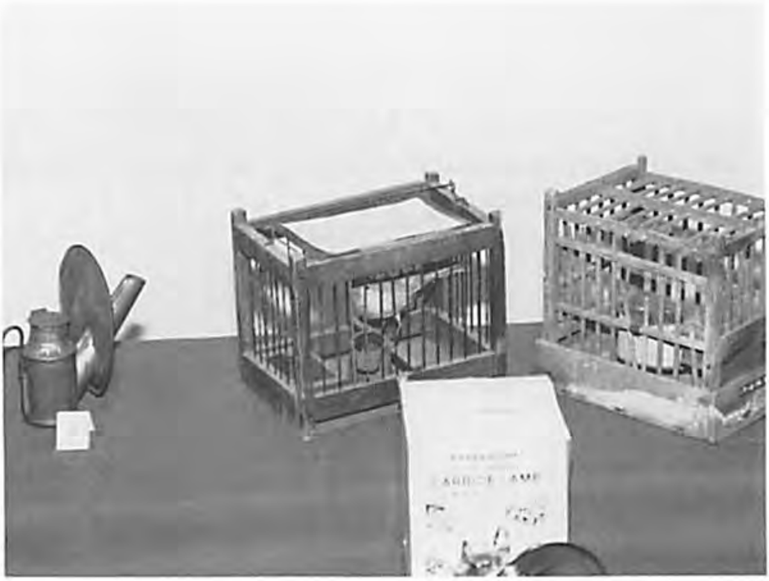
Figure 28. Zeigler Mine No. 1 miners, c., 1909

Figure 29. Old Ben Mine 26 miners, c., 1990

Figure 30. Coal Miner's statute, East Lawn State Capitol building, Springfield



Pieces of coal mine scrip(above) and UMWA convention badges(below), part of approximately 200 pieces of scrip and badges from the collections of Mark Ballard and Robert Fox.



Cages for mine canaries and an early hand-held carbide lamp (above), from the collections of Bill Mullins, Tom Garwood, and Robert Fox. Below is the display of a pictorial history of coal mining in Illinois–an exhibit of over 100 photos, primarily from the photo collections of the Illinois State Geological Survey, Southern Illinois University and Zeigler Coal Company.

FRIDAY MORNING

BUSINESS MEETING

Michael Reilly: Good morning and welcome to our Business Meeting. My name is Mike Reilly, and I'm the President of the Illinois Mining Institute this year. The Secretary-Treasurer of the Institute, Heinz Damberger, is the first person on our agenda this morning. He will give us a financial report. Heinz.

SECRETARY-TREASURER'S REPORT

Heinz Damberger: Thank you Mike. I am happy to report an increase of nearly $30,000 in assets over last year. About half of that increase is because of a 80 percent increase in exhibit fees income. Our exhibit hall is full; every space is sold. Also included in that increase at the cutoff date of August 31 are $15,500 in donations. An additonal $5,000 in donations came in after the August 31 cutoff.

Our main items of expense, the operating expenses, this year were higher because of the extra expenses we had in connection with this meeting. However, I think we will come out quite well. While we do show a large surplus in income right now, there are quite a few income items included that reflect convention activities; for instance, we have collected dinner ticket proceeds from those who pre-registered. There are people who have already paid for the lunch, and we have a significant increase in pre-registered people. So, there is an increase in income for which we haven't yet paid the expenses. This is basically balanced, so a $30,000 increase is not all going to show up in the final bottom line after the bills for the Centennial meeting are paid. If you have any questions, I'll be happy to at least try to answer them. Thank you.

FINANCIAL STATEMENT SUMMARY

Cash Balance Beginning 9/1/90	$22,346	Cash Balance Ending 8/31/91	$49,617
INCOME		EXPENSES	
Advertising	22,531	General Operating Expense	26,588
Annual Dues	15,640	Annual Meeting Expenses	21,314
Luncheon Receipts	2,935	Publication Expenses-	
Dinner Dance Receipts	2,350	Proceedings	12,445
Exhibit Fees	29,963	Scholarships	9,000
Registration Fees	877		
Donations	15,500		
Interest	1,105	Subtotal Expense	69,347
Miscellaneous	498		
Convention Cash	600		
Subtotal Income	96,618		
TOTALS	$118,964		$118,964

Assets as of August 31, 1991

Fixed Assets		Liquid Assets	
Computer	9,606	Cash	49,617
Software/Accessories	3,108	Bonds	500
Office Equipment & Furniture	2,116		
	14,830		50,117

TOTAL ASSETS ON 8/31/92	$64,947
TOTAL ASSETS ON 9/1/91	$34,753
1991-92 GAIN	$30,194

Michael Reilly: Thank you, Heinz, sounds like we are in good shape financially. I would like to thank all the companies that I contacted. I don't think Peabody's name showed up on the list in the program, but Peabody Coal Company contributed like everybody else. It came in later, and I didn't know we were going to print anything on it. But anyway, everybody contributed. So now we shouldn't have to ask for any money for another 100 years.

NOMINATING COMMITTEE REPORT

Michael Reilly: The next item on our agenda this morning is our Nominating Committee report which I will read. The nominations from the Nominating Committee were:

President	Robert Danko, Peabody Coal Co.
First Vice President	Robert Shanks, Arch of Illinois, Inc.
Second Vice Pres.	Dave Webb, Freeman-United Coal Corp.
Secretary-Treasurer	Heinz Damberger, IL State Geological Survey

Four new Executive Board membersto serve to 1995:

Dave Young, Zeigler Coal Co.
Bert Hall, Amax Coal Co.
Aaron Jackson, Kerr-McGee Coal Co.
John Lanzerotte, Monterey Coal Co.

George Oberlick, Turris Coal Co. (will serve the remainder of Brad Peterson's term since Brad was transferred to Houston)

Are there any other nominations from the floor? These nominations were approved by the Board Wednesday night, but are there any other nominations? If not, I would like to ask for a motion to approve these people as nominated by the Nominating Committee.

[*The Motion to accept the slate as presented was made and seconded. Members voted to approve the slate of officers by unanimous voice vote*]

HONORARY MEMBERSHIP COMMITTEE REPORT

Michael Reilly: Just to report that, for people who were here yesterday at the luncheon, Richard Shockley and his committee nominated Dayton McReaken as our honorary member. We have presented his honorary lifetime membership to him at the luncheon meeting yesterday.

In addition, there were three longtime, very active members on the Advertising Committee. The Advertising Committee is extremely important to this Institute, and the honorary memberships given out yesterday were to Walter Brandlein of Roberts & Schaefer, Walt passed away earlier this year, the award was given to his wife, Tom Sadler of Old Ben Coal Co., and Ray Taucher of Consolidation Coal Co.

ADVERTISING COMMITTEE REPORT

Heinz Damberger: Fred Bauer asked me to report to you for him because he wants to thank the exhibitors personally this morning. He didn't get around yesterday because of some emergency items relating to the blimp. The Advertising Committee has been very active this past year, and very successful. You are seeing part of the success in the exhibit hall–it is sold out. Of course, that contributes significantly to the increase in income to the Institute.

Our advertising in the *Proceedings* is also up compared to last year at this time, so we are doing well there as well. The advertising over the years has been going down, but we have leveled off the last several years, but I think we are starting to come out of the valley and picking up additional ads and certainly that is to the credit of the Advertising Committee that we currently have. It is a very active committee and has had very energetic chairmen: Fred Bauer and Jerry Watkins. You have seen in the lobby the baseball caps and belt buckles and coffee mugs that are being sold as Centennial souvenirs–that is one of the Centennial initiatives of the Advertising Committee. Not everything will be sold at the end of this meeting, but we are getting close and we expect to generate several thousand dollars of income. You have also seen the shotgun that is out there that is being raffled off. Not all the tickets have been sold there either, but we are getting very close to selling all the tickets and this is expected to create several thousand dollars income for us as well. These are some of the activities of the Advertising Committee for the Centennial that help us defer the extra cost. This has been a super committee, and I have enjoyed working with these fellows.

Michael Reilly: Thank you Heinz, any questions, up to this point? If not, we will move to the Scholarship Committee Report. I'll ask Bob Shanks, chairman of that committee to come forward.

SCHOLARSHIP COMMITTEE REPORT

Robert Shanks: Thank you, Mike. It has been my privilege again this year to serve as chairman of our Scholarship Committee. Joining me on the committee were Jim Gill, Vice President of Operations, MAPCO Coal; George Woods, Dean of Mining Technology, Wabash Valley College; and Paul Chugh, Professor and Chairman of the Department of Mining Engineering at SIU, Carbondale. Our committee met in July and developed our recommendations for the Board for our scholarship program for the 1993-94 school year, and I am pleased to announce that our commitment to the scholarship program has once again increased. We will be providing a total of $10,000 in scholarships for 1993-94, an increase of $1,000 over last year. The distribution of the scholarships for the 1993-94 year will be as follows:

Southern Illinois University at Carbondale	$4,500
University of Missouri at Rolla	3,500
Wabash Valley College	1,500
Rend Lake College	500

At this time I would like to give each of the schools that are represented here today a moment to discuss any new and exciting things that are going on with their programs and then we will hand out the scholarship certificates following those remarks for each school. I'd like to start things off with Dr. John Wilson from University of Missouri at Rolla.

John Wilson: Congratulations on your hundred year anniversary. People might not know that Rolla's mining department, which was in fact the first department at UMR, Missouri School of Mines, is 123 years old this year. So, we've been around a while, too. Coming from England, where everything is old, I feel like I am carrying on the tradition here. I would just like to talk about one or two things and events that occurred last year. We completed our faculty staffing because of increased enrollment we have experienced. Jerry Tien was appointed an assistant professor. We have a new professor coming in who is going to be working in research as well as teaching mining. Because of the unfortunate death of Troy Harris, we lost our experimental mine manager; he has been replaced by Ron Robinson who is here and is very familiar with and plays a very big part in making sure our students get good practical training.

At UMR (I did not create this, but I certainly support it), we emphasize the undergraduate program although we have a strong graduate program. I believe industry can place undergraduate mining engineers as opposed to Ph.D and M.S. graduates. Having said that, I am pleased to tell you that we now have a total of 100 students. We had 45 about two years ago. Of that 100, 91 are undergraduates and nine are graduate students. We are getting near to what I consider the optimum. We don't need 200 students; we need a certain critical mass, and I think we have achieved that, thanks to scholarships like we just heard about a few minutes ago. The scholarship helps us to pick the cream of the crop, frankly. Rolla gets about 700 students in it's freshman engineering program. You are up for grabs unless a student says he specifically wants to do mining or mechanical; but we have a chance to recruit the undecided. And the attractions are financial aid, summer jobs, and permanent employment. We have been very fortunate to attract some good kids. In fact, the average ACT of the entering year was 30 at UMR; that is a pretty high ACT. I'm new to academia, but that appears to me to be a good number.

We should mention also that Norman Smith, who is here today and has been coming here for years, was promoted to full professor this year, and it is ample reward for his contributions. He is very close to the students and a great asset to me in helping me to get into academia.

Last year we graduated one Ph.D., one M.S. and five undergraduates. They all have jobs. The undergraduates went into jobs ranging from machinery manufacturing, to hard rock mining, to coal mining and one is doing graduate work. That is a small number but that is sort of coming out of the bottom of the barrel. This year we expect seven students, and then the numbers go up to 10 or 15 a year. This makes me feel a bit better, because when mining companies come recruiting on the campus, it is a bit embarrassing when you haven't gotten any names, or the students that you've got have already accepted jobs. We get a lot of financial support from industry which helps us recruit better quality students. We are getting near the critical mass. If we have a total 120 students, graduates and undergraduates, I think there will always be 85 to 90 percent of those who will be future mining engineers as opposed to graduate students. We are getting close to that. I suspect we are going to meet the five-year plan next year, which is two years ahead of plan. From a practical standpoint, that is a good number to work with. The facilities we have can accommodate that, and I think it is consistent with the ups and downs of the industry. If you can even them out because we are able to place students in quarrying and hard rock as well, it gives us a good blend. Some schools don't have that luxury, especially out in the East.

I should mention that the Illinois Mining Institute is very useful to us, not only from the point of your funding, but many of our students take their field trips there. We visit longwalls in Illinois, we go look at draglines operating, we go out and see the simulator (at SIU). The mines have been extremely cooperative and we really appreciate that. Our scholarship fund, to which you contribute, has been steadily increasing, and, to be honest with you, without the opportunity to offer financial support to a student with an appropriate entry-level GPA, we would not be able to get the enrollment that we have. Once we get them into the department and some of the student activities, we have a pretty good retention ratio, better than some other departments. The summer jobs also help. You have no idea how important that is to a student. I'm telling him to do it. The best thing they can have on a resume is having worked two or three summers. These two guys getting the IMI awards have also been working in Illinois this summer.

Another important part of our program is the organized activities. The student chapter of SME is very active. We have a mine rescue team which enters regional and national tournaments. This year we might even field two teams. The students meet every two weeks; we have guest speakers representing coal companies and hard rock mines. On their field trip last year, they went off to mines out in South Dakota, Michigan, and Wisconsin; next year it will be the Southeast or Northeast. We try to blend the practical with the classwork. This has always been done at Rolla, and I just wanted to let you know that the tradition is continuing. Thanks for the chance to speak.

Robert Shanks: Would David Hamlin and Craig Sorenson step up please? Congratulations!

University of Missouri-Rolla scholarship winners David Hamlin (right) and Craig Sorenson (left) with Professor John Wilson.

Robert Shanks: Paul Chugh, Chairman of the Department of Mining Engineering at Southern Illinois University, will give their report. Paul.

Paul Chugh: Thank you. Last year we were awarded $4,000 in scholarship money from IMI and these scholarships are given to seven students. The amount of scholarship varied between $500 to $750. All these students have a GPA of at least 2.5 and the average GPA for these seven students was a little bit over 3.

Let me just share with you a little bit about our department. The Department of Mining Engineering is not only kicking, it is doing extremely well. We have an enrollment of 30 undergraduate students all from the state of Illinois, 20 graduate students, six post-doctoral staff and four full-time researchers. Last year we brought in close to three-quarter of a million dollars in research monies. The areas of research that we are excelling in are ground control and mine subsidence; we are also going in a big way into coal processing and mine development. Right now we are doing a lot of work on management of coal combustion residues. We think we will continue to grow in that area over the next four or five years. This summer we placed about 80 to 85 percent of our students into summer jobs. We graduated one student with an undergraduate degree, five graduate students and one Ph.D. student. Again, all the students are well-placed. In fact, this year we could have placed another eight or nine if we had had the people. And I agree with Dr. Wilson, that we just did not produce enough people.

The faculty of the department has revised the curriculum to accommodate the needs of the aggregate industry. We have about five students pursuing degrees in the aggregate program at the present time.

Our department is directed by an advisory committee consisting of about 13 people from the industry, the state, and the federal government. The advisory committee has directed us more or less not to produce more than ten students each year, so our goal is to increase our enrollment to a level of about 40 or 45 students and basically keep it at that particular point. We are concentrating our efforts on attracting our students from the community colleges, particularly four of them: John A. Logan, Rend Lake, Shawnee and Southeastern. That gives us two years to work with these students and any fluctuations in the demands of the industry can be easily corrected by attracting students from the community colleges. So our goals are to get our enrollment up to 40 students next year and try to maintain it at that level. Hopefully that will produce about eight or nine students each year.

Next year we are hoping to produce three undergraduate students and again about five to six graduate students. Within the graduate program, I have the list with me, we have about five students of about twenty who are American-born people. This is becoming a major issue nationally. We had a visitor from the Bureau of Mines only a few days ago and who requested a list of these people, and I have supplied them with that particular list.

At this point in time, I would like to thank the Illinois Mining Institute for supporting the mining program at Southern Illinois University, and I hope you will continue to do so in the future. Thank you. The students left yesterday and I don't know whether there are any here this morning. I told them I would accept all of the scholarships on their behalf.

Robert Shanks: Well, I will just run through the names of the SIU scholarship winners: Patricia Lockett, Steve Albert, Jared Cima, Aaron Haley, Lars Lindquist, Dennis Connor and Richard Voyles.

Now John Howard of Wabash Valley College.

John Howard: As many of you know, it is very difficult to be a fulltime student and work and have family responsibilities. As a result of that, none of our scholarship recipients were able to be here today. We had some available yesterday, but Friday created a conflict for them.

I would like to say just a few words to the Institute. The nineties are trying times for the coal industry, and I appreciate the continued support of the IMI to our students. One thing I feel good about is that those students entering a two-year Associate degree program are not coming with the idea of some false hope of landing an entry-level job in the next year or two. That is for certain. They are here because they want to be, and they are all focusing on four-year degrees. I think that is proper and appropriate at this time. The administrations of Illinois Eastern Community Colleges and our institution, Wabash Valley College, plus all of the cooperative community colleges within the state that we work with asked me to extend our thanks to the Institute and congratulate you all on the 100th anniversary. If I could add a personal thanks to all of you who are involved in this. I think this probably the best institute that I've attended. The displays are wonderful and attendance seems to be good. Well done. Thank you. We have scholarships this year for James Bowles, Thomas Drone, Frank Skaggs and Joseph Damrey.

Robert Shanks: D. J. Johnson, Rend Lake College.

D. J. Johnson: At Rend Lake College, we are not placing a lot of people in the mining industry right now. But we do have some fine students enrolled in our industrial technology department and we think the two young men we have here today would be a good contribution to SIU or to Rolla or to some other school. We have taken the scholarship money that the Institute has given us and selected two freshmen that were excelling and working hard and that the faculty felt like they would be worthy recipients of your support. We have both of the gentlemen with me here today: Chad Campbell from McLeansboro and Steven Tate from Mt. Vernon.

On behalf of the administration of Rend Lake College, we would like to thank you for the continued support. I don't know of anything better that we could spend our dollars on than supporting our young people who can help perpetuate a good mining industry. Thank you.

Rend Lake College scholarship winners Chad Campbell and Steven Tate (center) with Electrical Instructor Chris Nielsen (left), and Mining Instructor D. J. Johnson (right).

Robert Shanks: Thank you all. That concludes our Scholarship Committee report.

Michael Reilly: I would like to congratulate all the students, professors, and administrators of the colleges. Let's give them a big hand of applause. Thank you, Bob. Great job.

Next is the Centennial Committee's report. Doc, have you anything you would like to tell us about your work?

Doc Harrell: I would like to thank all the members of the committee and all the other people who helped. We just went around and asked everybody to help, and if it wasn't for all you pitching in, we couldn't have done it. Heinz and his staff were very helpful. They worked diligently and the exhibits and everything turned out great.

M. V (Doc) Harrell, Chairman of the Ad Hoc Committee for the Centennial Meeting.

Michael Reilly: Good. I'll second all that because it really has been an effort of just a tremendous amount of people. It has been a very good meeting; everybody seems to be pleased, and I'd like to think we can get even better as we go along–you know, think of new ideas and better ways to get people together to exchange ideas to continue to improve the safety and efficiency at our mines so we can be in there for the long term. I think exchanging ideas and getting together like this will help us do that.

Regarding the time capsule, if there is anything that anybody feels should be put in that time capsule let us know.

Heinz Damberger (left) and Mike Reilly (right) hold the IMI Centennial time capsule which will hold historical artifacts past and present.

I would like to remind you of the free continental breakfast which is in the exhibit hall, maybe get in there and thank some of the exhibitors for coming and hopefully they will be back for next year. I would like to ask you also, to let Heinz or Phyllis Godwin know if you know of any former members who have passed away since the last meeting, so we can keep our records up to date. Any other business for this meeting?

Heinz Damberger: There are still some raffle tickets around for the shotgun. It will be raffled off at the end of our technical session. Most of the people who have their names in there are not here so chances are that somebody who is not here will be the winner. We will pull the winner at about 11:45. Also, if you wish to buy an extra IMI Centennial memento, we will be selling them for $15 and we will announce it to the membershipafter the meeting.

Michael Reilly: There is one other item; there is a technical session at 10:00 a.m., and I understand there will be some very interesting papers. Thank you all for coming and we'll see you here for the technical session at 10:00 this morning.

THURSDAY MORNING TECHNICAL SESSION

Don Arrowsmith: Thank you for coming this morning. Our first speaker is Donald Hanson from the Argonne National Laboratory. He has a B.S. in electrical engineering, a Masters in mathematics, and a MBA and a Ph.D. in electrical engineering. He has more initials after his name than any of us. This morning we would like to keep the talks in the 20 to 25 minute range with questions afterward, depending on the level of interest. Yesterday, a lot of people tried to pin the speakers down later, but you won't have that luxury today, since the meeting is over at noon and the speakers will be heading home just like you are. If you have questions, the best thing is to ask them right after their talk. So we will begin with Donald Hanson.

Donald Hanson: I thought I would begin with a background. My mother's family came from Scotland and her grandfather was a coal miner in Scotland and he married the woman from the Hamilton Line, the Duke of Hamilton in Edinborough, but then that family disowned her so they had to come to America with their twelve children. The father and all the boys worked in the coal mines around Coal City. So this was my mother's background. I went to school in Urbana and all my degrees are in engineering. However, it was the time in the sixties and seventies when there was a lot of emphasis on interdisciplinary studies, so I spent half my time studying economics. My background has been more academic in that I went for a teaching job and I have been basically teaching economics since then. The topic I am going to talk about today is economics. At Argonne, I've been involved in a number of studies involving the coal markets. We worked on the NAPAP study, the acid precipitation study preparing the emissions an coal market impacts for that, published in 1990. We also worked with the Department of Energy on the global warming study, their national energy strategy, and more recently now the Title I of the Clean Air Act which has to do with urban ozone. You would think urban ozone comes from hydrocarbons of automobiles, and solvents, and paint and stuff; but even coal gets into that environmental issue because they don't know whether NOx helps or hurts urban ozone.

TRADING SULFUR EMISSION PERMITS: EFFECTS OF THE 1990 CLEAN AIR ACT AMENDMENTS

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INTRODUCTION

Thank you for inviting me to speak today at the Centennial meeting of the Illinois Mining Institute. Coal mining is in my family background as well, as my mother reminds me, since her grandmother was one of eight children who came over from Scotland and settled in the Braidwood and Coal City, Illinois, area, where the father and brothers worked in the mines.

At Argonne National Laboratory, we have a great deal of interest in the coal resource and Clean Coal Technology, (CCT). We had helped to develop dry scrubbing technology, and we are currently active in developing Integrated Gasification Combined Cycle (IGCC) and combined SO_2 and NO_X removal technologies. My own field is energy and environmental economic analysis and, in addition to Argonne, I teach at DePaul University and consult on Midwest issues at the Federal Reserve Bank in Chicago.

I have spent much of the last ten years developing computer simulation models representing the impacts of environmental policies on electric utilities, the coal industry and the economy as a whole. This work has been sponsored by the National Acid Precipitation Assessment Program (NAPAP), the U.S. Department of Energy, the U.S. Environmental Protection Agency and the Federal Reserve Bank.

Today I will talk about the 1990 Clean Air Act Amendment (CAAA) which will affect the coal market. I will focus on the sulfur dioxide (SO_2) requirements and not nitrogen oxides (NO_X) or other aspects of the CAAA regulations. We are currently undertaking computer simulation studies of the coal market, SO_2 tradable allowance market and the electric utility sector. Anyone interested in this analysis should contact me, and I will provide our results and would appreciate your comments.

REVIEW OF CLEAN AIR ACT REQUIREMENTS

When the Clean Air Act was passed in 1970, Congress envisioned a more rapid turnover of plant facilities and planned the ratcheting down of emissions of common pollutants such as SO_2 and NO_X, and particulate matter

(PM), through a New Source Review process imposing more stringent emission rate standards called New Source Performance Standards (NSPS). As new facilities with lower emissions rates meeting NSPS penetrated the market, total emissions would decline.

This idea went a step further in the 1977 Clean Air Act Amendments with Revised New Source Performance Standards (RNSPS) in which new plants were required to apply SO_2 removal technology, with the required removal rate decreasing for coals with lower sulfur content. The removal requirement effectively mandated scrubbers to be built for all new coal-fired power plants. However, very few coal-fired power plants have been built in the 1970s and 1980s partly because of the lack of electric load growth, the completion of nuclear plants that had been in the construction pipeline, the application of refurbishment techniques to extend the life of existing power plants and the desire by electric utilities to avoid the New Source Review process.

Congress has now introduced a new program to focus on the existing, higher-emitting power plants: Acidic Deposition Control which is Title IV of the 1990 CAAA. The goal is to reduce SO_2 emissions by 10 million tons per year from the 1980 level, approximately a 40 percent reduction. Phase I, starting January, 1995, affects the 267 largest generating units in the country at 110 plant locations. Phase II, starting January, 2000, affects virtually all units greater than 25 megawatts (MW) and all newly built units. An interesting feature of Title IV is the provision of tradable SO_2 emission allowances. The affected units in Phase I can trade their allowances (as long as local air quality standards or other state implementation plan provisions are not violated). The affected Phase I units know their initial allowances so they can either: 1) reduce emission to exactly equal their allowances, 2) reduce emissions further and sell or bank the excess allowances or 3) reduce emissions less requiring additional allowances. Whether it is cheaper to reduce emissions to a point more or less than one's allowance allocation depends on whether the facility's abatement cost per ton to reduce emissions further is more or less than the price of allowances (or for internal company trades, more or less than the company's valuation of allowances). In fact, the cost savings per ton of SO_2 is the difference between the prices of allowances (PA) and this marginal abatement cost (MAC), i.e., (PA – MAC). Economists (believing in perfectly free markets) argue that trades will take place until all opportunities to save costs have been exhausted.

However, electric utilities are regulated firms; they pass their costs on to customers in electric rates, and each state's public utility commission such as the Interstate Commerce Commission in Illinois, has to approve this process. Hence, there is a lot of regulatory uncertainty, which may be a barrier to trading among companies; but I do see active trading among units within the same company.

Let's go back to the question of how utilities know what their allowances are. For Phase II, allowances are distributed nationally in an amount of 8.95

million tons of SO_2 per year, consistent with the 10 million ton reduction goal from 1980. The majority of these allowances are distributed by a formula which is the product of the required average national emission rate of 1.2 lb. of SO_2 per million Btu heat input times the unit's average (or baseline) heat input between 1985 and 1987. This baseline heat input is intended to reflect a unit's typical operating rate. For Phase I, the allowances are initially distributed only to the 267 affected units using a formula of 2.5 lb. per million Btu average emission rate times the baseline heat input. Allowances not used or sold in Phase I can be banked for use in Phase II.

There are a number of special allowance allocation provisions which I don't have time to describe here, but I would be glad to provide further information and guidance to anyone who is interested.

I think this group would be particularly interested in the Phase I and Phase II extensions for technology adoption. A reserve of 3.5 million tons of SO_2 allowances was set aside to be used for a two-year extension for adding a scrubber in 1997. This program has an added benefit because scrubbing at rates less than 1.2 lb. per million Btu will receive extra allowances for further emission reductions, the so-called 2-for-1 program. The Phase II extension gives a four-year delay to the year 2004 for those units adopting approved CCT.

IMPACTS ON THE COAL MARKET

What does this program of tradable, bankable SO_2 emission allowances mean for the coal market? Basically, lower sulfur coals will be in higher demand than higher sulfur coals, all else equal. A price premium will arise reflecting a valuation not only of the heating value per ton of coal but also a penalty on the sulfur content. The market, however, is pretty smart (an economist would say, "very efficient"). The market will not price the sulfur content of coal itself but instead will price the resulting SO_2 emissions which is the relevant "opportunity cost." That is, a ton of SO_2 emissions uses up one allowance and the valuation of this allowance is equivalent to the penalty on the coal that produced the SO_2. This distinction is not academic. It will have real effects on coal prices. Differences in bottom ash sulfur capture rates between coals (such as bituminous and sub-bituminous ranks) will be reflected in their sulfur penalties. If a coal is scrubbed, it will be the after-scrubbed emissions which translate into a price penalty on the coal.

Of course, the scrubber itself has an operating cost and a capital cost (to be amortized over its life), and these costs must be considered as utilities choose compliance options. High-sulfur coal, if it is to be scrubbed or used with other low-emitting CCT, must be priced competitively.

I expect that a pattern of mine-mouth coal prices will arise that will encourage low-sulfur coal production and, to a lesser extent, medium-sulfur coal production, and it will be rough for high-sulfur coal profitability. However, I expect that all these coals will be produced and that we will see a lot of blending of coals of different sulfur contents so that emissions stay close to the initial allowances given to a unit. Blending of coals to stay close to one's allocated allowances eliminates the need to buy or sell large quantities of allowances; a prospect that many utilities seem to view as undesirable.

This outlook calls for further efficiency gains in mining and for the development of lower cost control technologies so that high-sulfur coals stay competitive in the marketplace. For the high-sulfur coal option it is just as good to lower the cost of scrubbing, limestone injection or CCT, as it is to lower mining costs. Fortunately for the high-sulfur coal industry, scrubbing and other removal technologies have been rapidly moving down the learning curve, yielding major cost reductions.

RELATIONSHIP BETWEEN THE COAL MARKET AND THE SO_2 ALLOWANCE MARKET

The presence of SO_2 tradable allowances should give rise to a lot of clever marketing ideas for those in the business of selling coal. The coal can be marketed along with any excess allowances needed to offset excess emissions from the coal. This is a common trick in marketing called tie-in sales. It is beyond the scope of this paper but there are also ways to hedge against risks in coal prices and in utility earnings by holding emissions allowances in your portfolio. The outcome for future allowance prices will reflect the risky outcomes you are trying to hedge against. These desirable risk-hedging properties of allowances may cause a more active market in trading than many people expect. As you know, the Chicago Board of Trade will be offering spot and futures market contracts in SO_2 allowances. This process will help in "price discovery" of SO_2 emission reductions and the associated price penalties on sulfur in coal.

FUTURE COAL MARKET ANALYSIS

A couple of years ago, John Molburg, who works with me at Argonne, did an impact analysis of the 1990 CAAA on electric utilities an the coal market (Molburg et al., 1991). Currently, we have upgraded our modeling capabilities and soon will be issuing some new analysis and reports. I would be glad to distribute this work to interested people and would look forward to getting their feedback.

REFERENCES

Molburg, J.C., J. A. Fox, G. Pandola and C. M. Cilek, 1991, Analysis of the Clean Air Act Amendments of 1990: A Forecast of the Electric Utility Industry Response to Title IV, Acid Deposition Control. ANL/EAIS/TM-81, Oct. 1991, 76p.

Molburg, J. C., 1993, The Utility Industry Response to Title IV: Generation Mix, Fuel Choice, Emissions and Costs. Journal of the Air and Waste Management Association, v. 43, p. 180-186.

Heinz Damberger: Are these permits already being traded actively?

Don Hanson: Phase I starts in 1995, and those utility plants that are controlled under Phase I know who they are and what their allowances will be, so they know their situation. The Phase II is where you will have a more active market that starts in the year 2000, and trades there will start in March, 1993. They will also be traded on the Chicago Board of Trade. The official announcement just came out that CBOT will have a formal contract, and they plan to start that contract this spring. To my knowledge there have only been two informal trades so far, Wisconsin Power and Light to TVA. One of the first things George Bush did when he got into office was try to re-authorize the Clean Air Act; the principle of having a market for emission permits was a main point. So he wants to see all this trading even this early on. We are not talking compliance with the more stringent standards. Phase II has a standard of 1.2 lbs per million Btu. We are not talking about compliance with that until the year 2000. So we are eight years away, and they want to see all this active market trading. I don't think that is a measure of the success of the Clean Air Act because I think much of the trades in terms of cost savings will take place within companies. My theory is that firms are indifferent on whether they buy the higher or lower sulfur coal, at least for individual units. There probably won't exist a lot of trading regions and firms. However, the fact that you can allow trading among units is going to save a lot of costs over a system where each unit was given a rate or emissions like the old regulatory process where there is a state implementation plan, and every unit has to have its own emissions rate. Now you can trade emission rates among units. I think that will save a lot of costs, but I don't think we will see a real active allowance market. Any other questions? Thank you very much.

Don Arrowsmith: Next, we are going to hear about some fine coal cleaning. Sulfur is the thing a lot of people are keying in on and it tends to be the size fraction where we have the most effect. Our next couple of talks deal with that. The first one is by Daniel Placha, who is a senior process engineer with CLI out of Pittsburgh. He is going to be giving us some guidelines in selecting a fine coal-cleaning circuit--something a lot of people are getting into, not only for the recovery. We have been throwing away fine coal for a long time at a lot of plants, and deeper cleaning may have an effect on the sulfur.

Daniel Placha: Good morning. With this talk today, I am going to try to give you some guidelines for selecting a fine coal cleaning circuit.

SELECTING A FINE COAL CLEANING CIRCUIT

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INTRODUCTION

Fine coal cleaning circuits, processing all or a portion of the 28 mesh x 0 raw coal are an essential part of coal preparation plant flowsheets. Numerous reasons have made fine coal cleaning circuits an essential part of modern coal preparation plant flowsheets:

- Profit margins on coal sales have steadily decreased causing plant operators to maximize plant yield at a given quality through individual cleaning circuit optimization.

- The amount of fine coal has steadily increased and the quality decreased due to changes in mining techniques and nonselective mining, respectively.

- Ever increasing pressure to decrease sulfur and ash contents in the final product.

The following discusses some broad guidelines on selecting the proper fine coal cleaning circuits and to concentrate on two fine coal cleaning circuits that seem to have the most promise commercially: spiral concentrators and fine heavy media cyclones.

FINE COAL CLEANING CIRCUIT DESIGN CRITERIA

In order to design the correct fine coal circuit for a given coal, a review of the raw coal size distribution data is necessary to determine the circuit's potential feed capacity. Also, a detailed washability should be performed on the size fraction(s) that make up the feed to the fine coal circuit. With this information in hand, computer simulations can be performed to determine individual yield/quality curves for different pieces of fine coal cleaning equipment and how that equipment compares to the theoretical washability curve.

Generally the following rules apply when cleaning fine coal in physical processes: (1) the cleaning circuit utilized to clean a given size fraction, say 28 mesh x 100 mesh, will clean the 28 mesh particles at a lower specific gravity than the 100 mesh particles; (2) cleaning efficiency is reduced as particle size decreases; (3)the finer the particle, the higher the lowest achievable separating gravity; (4) the wider the size range, the higher the effective separating gravity; and (5) most fine coal circuits are inefficient when exposed to large amounts of near gravity material (defined as ± 0.10 specific gravity units from separating specific gravity).

Most fine coal circuits in operation have specific problems that have led to decreased efficiencies: (1)A high percentage of plus 28 mesh material reporting to the fine coal circuit. This is all right in some circuits such as hydrocyclones, but detrimental in others such as froth flotation. (2) Inability to efficiently size at 100 mesh. This usually leads to contamination of final clean coal product from misplaced 100 mesh x 0 material. (3) Variability in solids concentration to the fine coal circuit, which decreases circuit efficiency. (4) Minimal separating gravity control. (5) An excessive size range treated in a given circuit, which reduces circuit efficiency.

Therefore, it is not only important that fine coal be treated in the correct cleaning circuit, but it also must be properly sized prior to processing. A sizing circuit similar to the one shown in figure 1 accurately sizes fine coal prior to fine coal cleaning circuits and also takes into consideration the above mentioned problems. Some companies have incorporated a portion or all of these design concepts into existing plants successfully. Highlights of figure 1 are: (1) Efficient removal of the 100 mesh x 0 size fraction prior to processing the plus 100 mesh size fraction, through utilization of classifying cyclones and dewatering screens in closed circuit. (2) A constant surface moisture feed to the plus 100 mesh cleaning circuit. (3)Accurate sizing of the 100 mesh x 325 mesh size fraction for processing in flotation or after fine coal circuits. (4) Removal of the 325 mesh x 0 size fraction to minimize process problems in the 100 mesh x 325 mesh cleaning circuit. This is very important when there are large amounts of clay present in the plant feed. (5) Independent control of three separate size fractions. Each size is accurately segregated for processing. (6) Each fine coal circuit operates on a narrow size range, improving efficiency.

CLI Corporation has concentrated its efforts on fine coal cleaning circuit applications for the plus 100 mesh size fraction. Many options are available for cleaning this size fraction: (1) hydrocyclones; (2) concentrating tables; (3) fine coal jigs; (4) coarse froth flotation conventional cells; (5) coarse froth flotation column cells; (6) cpiral concentrators; and (7) fine heavy media cyclones.

Hydrocyclones are gravity cleaning devices that have several process deficiencies: (1) Hydrocyclones operate with a bypass fraction of misplaced material as shown in figure 2. This necessitates that a secondary circuit be installed to recover the bypass material. (2) Hydrocyclone performance as indicated by probable error (Ep) is poor with Ep values usually ranging from 0.25 to 0.30 when processing time 28 mesh x 100 mesh size fraction. (3) Hydrocyclones cannot clean efficiently below 1.60 separating specific gravity in the 28 mesh x 100 mesh size fraction. (4) Hydrocyclone performance is highly dependent on feed percent solids and cannot tolerate wide tonnage fluctuations. (5) Hydrocyclone design makes it very difficult to monitor or change the specific gravity of separation.

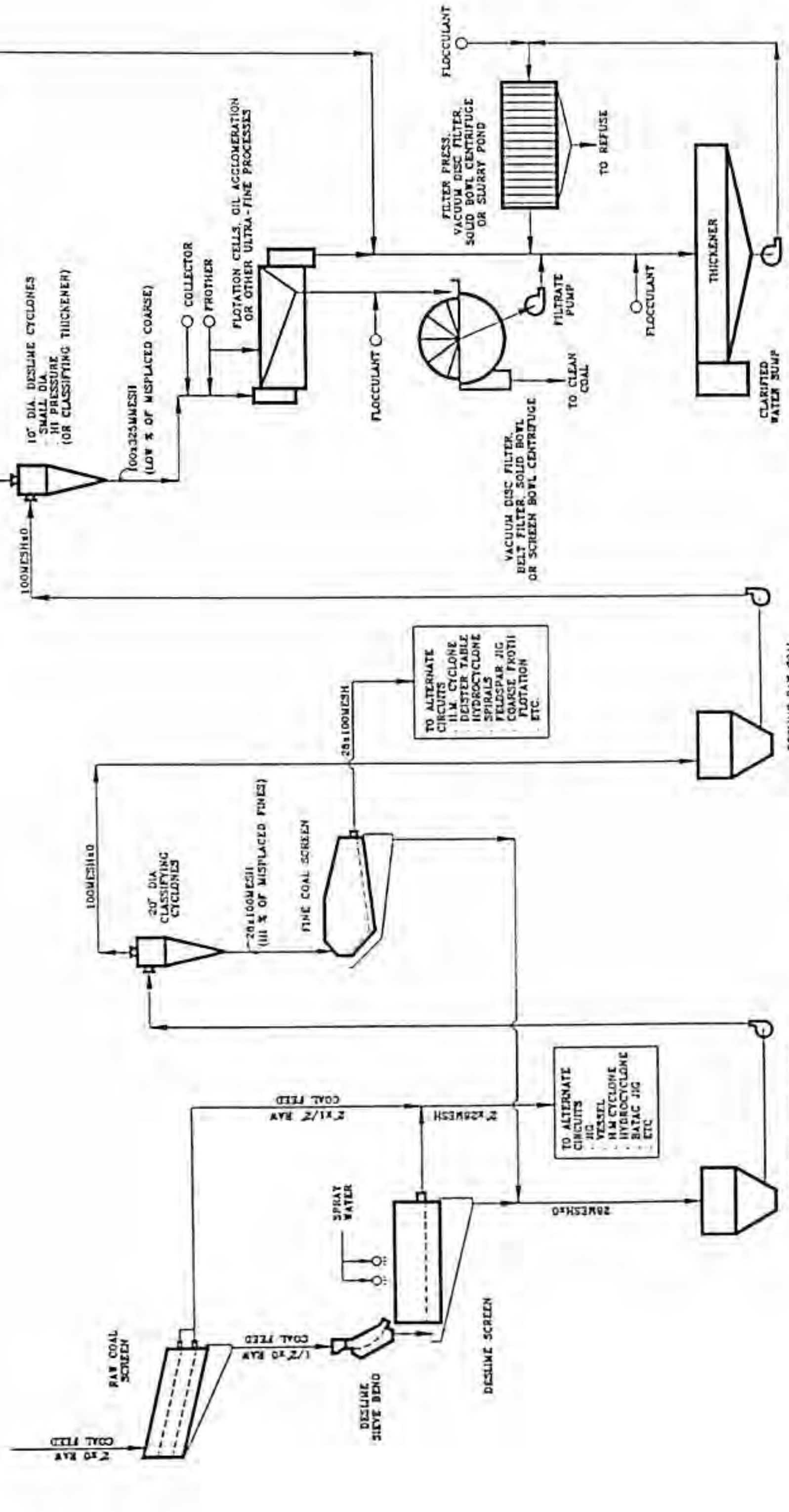

Figure 1. Fine coal sizing and concentration flow sheet.

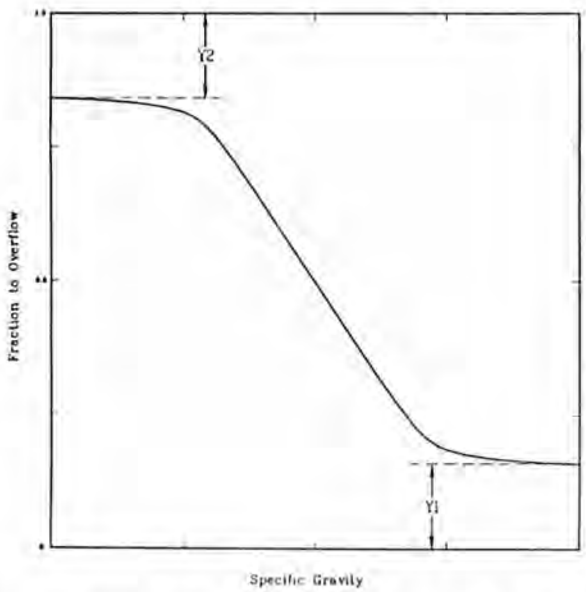

Figure 2. Water only performance curve showing bypass fractions.

Concentrating tables and fine coal jigs have exhibited similar process deficiencies that hydrocyclones have shown. Coarse froth flotation utilizing conventional flotation cells is very dependent on many factors including surface chemistry, water quality, feed percent solids, reagent type and dosage, aeration rate, etc. This causes flotation cells to become very difficult to monitor and control resulting in fluctuations in product quality. In addition, long lead times are required to reset flotation circuit variables to produce required product qualities.

Column flotation cells are relatively new to the industry and seem to have certain process advantages, such as a better ability to reject clays due to a deeper froth bed, no mechanisms required, etc. However, column cells may be more suitable to finer size fractions say, 100 mesh x 0.

The two remaining circuits, namely spiral concentrators and fine heavy media cyclones exhibit the best balance of capital cost, operating and maintenance cost, efficiency and flexibility as shown in table 1.

SPIRAL CONCENTRATORS

Spiral concentrators are helical troughs mounted on a vertical column. From one to three troughs can be mounted in parallel on one column, depending on customer preference and floor space availability. Each trough (or start) is fitted with a feed box. The starts are uniform in pitch and profile, and are fitted with adjustable splitters at the discharge end. One or two splitters can be installed, resulting in a two- or three-product split, respectively. Note that the spiral is one of the only fine cleaning devices that segregates the middlings product accurately from the clean coal and rejects.

Table 1. Relative comparisons of fine coal cleaning circuits.

	Capital Cost	Operating & Maintenance Cost	Efficiency	Flexibility
Fine Heavy Media Cyclones	5	4	5	5
Spiral Concentrators	3	2	3	4
Hydrocyclones	3	2	2	2
Concentrating Tables	2	2	2	3
Fine Coal Jigs	3	2	2	3
Coarse Froth Flotation Conventional	4	3	2	2
Coarse Froth Flotation Column	3	3	2	2

Legend
1 2 3 4 5
Low - Medium - High

Normally, spirals are installed in banks, containing from 4 to 24 starts in one bank. Each bank is fitted with a gravity distributor feeding each start.

The mechanism of separation in a spiral is governed by two forces; centrifugal and gravity. As slurry descends the trough, particles form a stratified bed and are subjected to a flowing film separation. High density particles segregate to the bottom of the stratified bed and migrate radially inward due to trough profile and pitch design. Light density particles move radially outward, since the centrifugal force acting on these particles is greater than the gravitational force component. Figure 3 presents a cross section of a spiral stream, indicating the forces acting on the particles.

Located at the discharge of the spiral trough are adjustable arrowhead splitters which separate stratified/segregated slurry into clean coal, middlings, and refuse. Spiral middlings can be treated by several methods: (1) a splitter box diverting middlings to clean coal or refuse; (2) recleaning by second stage spiral circuitry with product being recirculated; (3) recleaning by second stage spiral circuit with product combined with primary spiral circuit clean coal; and (4) a separate middlings product for sale or blending elsewhere.

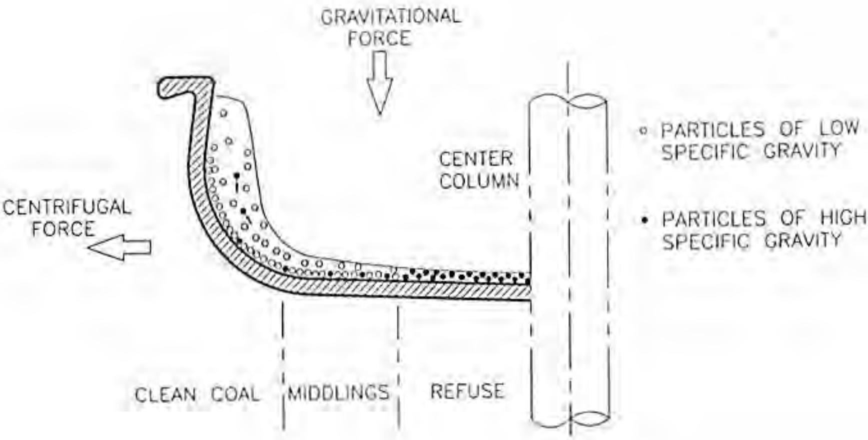

Figure 3. Cross-section of a spiral stream.

Experience indicates that minimal amounts of misplacement occur to the clean coal and refuse streams. However, misplacement of clean coal to middlings is common as shown in the performance data in table 2. To maximize overall circuit efficiency, a secondary spiral circuit is sometimes required. The number of starts required for a secondary circuit is normally 10 to 20 percent of that required for the primary circuit. Typical results on Appalachian coal indicate high efficiencies for single stage spirals.

Table 2. Spiral performance test–one meter diameter start.

	Top x 100 Mesh	100 Mesh x 0
Screen Analyses (Wt. %)		
Feed	71.06	28.94
Product	72.75	27.25
Middlings	69.92	30.08
Refuse	73.91	26.09
Ash (Wt. %)		
Feed	21.69	43.40
Product	7.26	40.18
Middlings	40.09	49.08
Refuse	85.27	73.88
Actual Recovery to Clean Coal	74.54	90.24
Actual Recovery to Middlings	12.02	0.28
Theoretical Recovery to Clean Coal	80.41	
Organic Efficiency	92.70	
Separation Gravity	1.83	
Probable Error	0.16	
Near Gravity Material (±0.10 S.G. Units)	2.26	
Float in Middlings (% of Product)	52.30	
Foat in Refuse (% of Product)	2.23	
Sink in Clean Coal (% of Product)	2.09	
Total Misplaced Material (% of Feed)	8.14	

Distribution to Products

	Product	Middlings	Refuse
Float x 1.30	97.46	2.38	0.16
1.30 x 1.40	91.05	8.46	0.49
1.40 x 1.50	87.28	12.10	0.62
1.50 x 1.60	85.90	13.52	0.58
1.60 x 1.70	65.95	31.67	2.38
1.70 x 1.80	57.23	40.16	2.61
1.80 x 1.90	47.93	48.29	3.78
1.90 x 2.00	31.65	61.83	6.52
2.00 x 2.10	21.58	69.93	8.49
2.10 x 2.20	14.75	70.92	14.33
2.20 x Sink	3.65	15.65	80.70

To properly design a spiral circuit, a detailed washability of the feed should be obtained. Also, the following design criteria must be investigated: (1) feed size; (2) mass flow rate; (3) solids concentration; (4) splitter position; and (5) volumetric flow rate.

Spiral concentrators are capable of processing 16 mesh x 100 mesh (1mm x 0.15mm) efficiently at separating gravities ranging from 1.65 to 2.00. Typically, preparation plants utilize heavy media cyclones to treat the 16 mesh x 28 mesh (1mm x 0.5mm) size fraction. This material is combined with the plus 16 mesh size fraction, usually up to a top size of 1/2 inch. When this size fraction is treated in a heavy media cyclone circuit, the 16 mesh x 28 mesh size fraction is cleaned at a higher separating gravity and much lower efficiency than the plus 16 mesh size fraction. The efficiency of separation in a spiral for the 16 mesh x 28 mesh size fraction is very similar to that of a heavy media cyclone, as shown in figure 4.

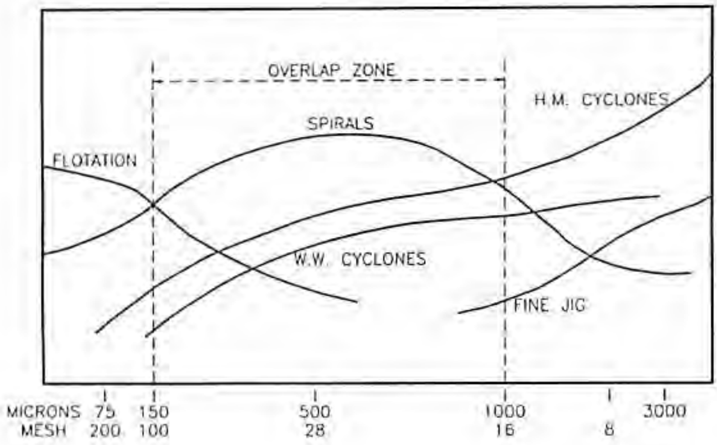

Figure 4. Relative efficiencies.

This analysis applies only when the heavy media cyclone circuit is cleaning at high separating gravities (1.50 and above). At lower separating specific gravities, the use of heavy media cyclones with the properly designed media circuit is usually mandated.

Treating the 16 mesh x 28 mesh size fraction with the 28 mesh x 100 mesh in spirals offers the following advantages: (1) allows more efficient desliming at 1mm; (2) increases the capacity of the heavy media cyclone circuit since the average grain size is increased; (3) decreases magnetite losses in the heavy media cyclone circuit, due to more efficient draining and rinsing of products; and (4) decreases operating costs of the heavy media cyclone circuit since magnetite losses will be lower, power consumption reduced, etc.

As stated earlier, anywhere from one to three troughs can be mounted in parallel on one column. To obtain maximum efficiency, loading should not exceed 4 STPH per start. Test work indicates that efficiency decreases rapidly at greater feed rates. Figure 1 shows that spiral concentrator feed is usually classifying cyclone underflow. Optimum solids concentration feeding the spiral is 30 to 35 percent by weight. However, fluctuations from 25 percent to as high as 40 percent can be tolerated with no decrease in efficiency. This gives the spiral an advantage over other devices, as it can tolerate wide raw coal feed fluctuations. This becomes particularly useful if the feed to the plant is from an open stockpile that tends to generate wide swings in size analysis due to segregation.

The specific gravity of separation can be adjusted by movement of the arrowhead splitters located at the discharge of the spiral. For a three-product separation, two splitters are used; one to perform the separation between clean coal and middlings, and one to perform the separation between middlings and refuse. Table 3 presents the effect of the clean coal splitter (i.e., splitter between clean coal and middlings) position on clean coal quality and yield. As the width of the clean coal stream increases by moving the cutter further away from the outside edge of the trough, the clean coal yield increases and the quality deteriorates.

The volumetric flow rate must be constant for efficient spiral operation. This is accomplished through utilization of a gravity-fed slurry distributor, as shown in figure 5. A high level overflow is provided to maintain a constant head on the distributor outlets. Overflow is recycled to the classifying cyclone feed sump. Flow rates are controlled by replaceable parallel throat orifices in the distributor outlets.

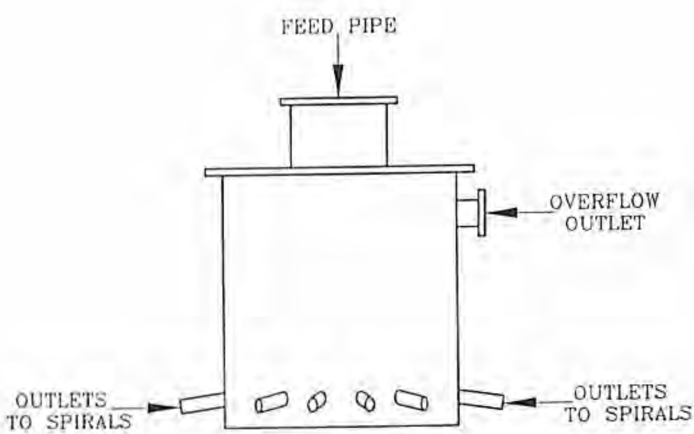

Figure 5. Spiral feed distributor.

Table 3. Effect of clean coal splitter position on clean coal yield and quality.

	Feed				Stream Width (in.)		
Test	Ash (Wt. %)	TPH	USGPM	Pct. Sol. (Wt. %)	Clean Coal	Middlings	Refuse
I	27.97	4.58	40.00	40.20	5.00	4.00	6.25
II	28.45	4.38	40.00	38.40	4.50	4.50	6.25
IV	27.55	3.94	37.50	36.80	6.00	3.00	6.25

		Top x 100 Mesh			100 Mesh x 0		
	Sample Description	SizeAsh (Wt. %)	Recovery (Wt. %)	Size Ash (Wt. %)	Recovery (Wt. %)	(Wt. %)	(Wt. %)
Test: II	Feed	71.06	21.69	--	28.94	43.40	--
	Clean Coal	72.75	7.26	74.54	27.25	40.18	90.24
	Middlings	69.92	40.09	12.02	30.08	49.08	0.28
	Refuse	73.91	85.27	13.44	26.09	73.88	9.48
	Refuse + Middlings	71.80	63.93	25.46	28.20	73.18	9.76
Test: III	Feed	70.79	22.55	--	29.21	42.75	--
	Clean Coal	71.83	6.71	70.85	28.17	37.17	79.74
	Middlings	70.48	36.06	14.41	29.52	49.62	8.63
	Refuse	71.76	85.51	14.73	28.24	75.91	11.63
	Refuse + Middlings	71.44	61.05	29.15	28.56	64.71	20.26
Test: IV	Feed	70.98	19.90	--	29.02	46.28	--
	Clean Coal	70.52	8.17	81.83	29.48	37.62	75.76
	Middlings	68.01	51.61	6.83	31.99	51.70	0.37
	Refuse	72.90	85.46	11.33	27.10	73.69	28.86
	Refuse + Middlings	70.77	72.72	18.17	29.23	73.35	24.24

FINE HEAVY MEDIA CYCLONES

Fine heavy media cyclones are a natural extension of conventional heavy media technology. Utilization of fine heavy media cyclones permits efficient separations at low specific gravities (<1.60 S.G.), which are not feasible in any other commercial fine coal cleaning circuit.

Although high levels of process efficiency can be achieved in fine heavy media cyclones, capital costs are often very high, since the circuit is much more complex when compared to alternative fine coal cleaning circuits. Many instances will occur in which fine heavy media cyclones are the only alternative, for example, when it is necessary to achieve an efficient low gravity separation to meet rigorous sulfur limitations or when the amount of near gravity material is excessive.

A survey of international publications and an examination of existing system designs in the United States, Australia and South Africa show that a firm understanding of three parameters are necessary for successful low gravity separations of fine coal utilizing fine heavy media cyclones: (1) cyclone geometry; (2) cyclone feed pressure; and (3) recirculating media quality.

Cyclone Geometry and Pressure

CLI Corporation was involved in extensive testing at a commercial plant where a range of cyclone diameters ranging from 6 inches to 20 inches were tested under similar conditions.

The cyclone geometry and feed pressure were the variables investigated during this study. The results of this test work showed that at low separating gravities and constant feed pressures, efficiency improved as cyclone diameter increased, which corresponded to a decrease in the g-forces exerted on the feed particles. However, other test work has shown the exact opposite to be true.

It is believed that these conflicting conclusions have been made due to the size distribution of magnetite used during testing. The results of the CLI test work were based on commercially available magnetite. Size classification of the commercial magnetite occurs, due to the coarse size distribution, especially at high g-forces (i.e. small diameter cyclones), thus reducing performance. Large diameter cyclones reduce classification effects thus improving performance.

If fine magnetite is utilized, then size classification effects are reduced thus giving improved performance for small diameter, high g-force cyclones. Investigations by others show that performance improved with decreasing diameter, but beyond a certain point magnetite classification was so severe that performance actually decreased.

During the CLI test work it was apparent that the ratio of vortex finder diameter to apex diameter was critical to efficient performance. The optimum ratios varied depending on cyclone diameter and media quality.

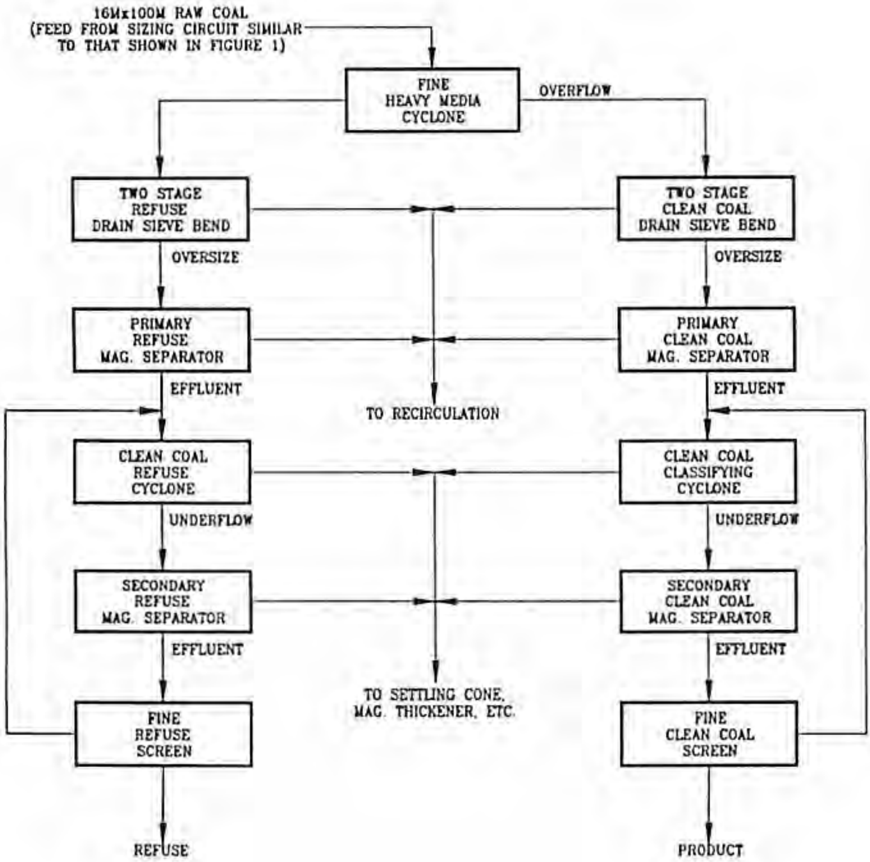

Figure 6. Fine heavy media cyclone simplified block diagram.

Recirculating Media Quality

The most critical factors in fine heavy media cyclone circuit design is the size distribution of the recirculating magnetics, and the amount of nonmagnetic contamination. Test work has proven that the retention of ultra fine magnetite particles (i.e. <5 microns) is critical to the efficient performance of the fine heavy media cyclone circuit. Also, nonmagnetic contaminants in the recirculating media must be kept to a minimum in order to optimize performance.

Extensive testing has shown that a properly designed fine heavy media cyclone circuits must include proper cyclone geometry and feed pressure and an efficient method of retaining fine magnetite while keeping nonmagnetics in the recirculating media to a minimum.

Figure 6 shows a block diagram representing a fine heavy media cyclone circuit. A circuit similar to this is installed and successfully operating at a commercial plant in Australia. There are many technical innovations in this circuit: (1) two stage vibrating sieve bends for draining and rinsing magnetite from the cyclone products. The sieve bends utilize fine wire with 0.25mm slotted openings to keep contamination of the recirculating media to a minimum; (2) magnetic separators that utilize a CLI Corporation patented tank design. These separators are high capacity units that have given excellent recovery results (<0.5 grams per liter in effluent) and have given relatively clean magnetic separator concentrates; and (3) a high frequency recovery screen for dewatering cyclone products. Testing has shown that this circuit is capable of consistently producing high efficiency low gravity separators with acceptable magnetite losses.

SUMMARY

To properly design a fine coal cleaning circuit, a detailed review of the size distribution and washability data is necessary. It is important to determine what specific gravity of separation is required, since this will allow selection of the proper cleaning equipment.

Spiral circuits have proven to be beneficial for processing fine coal. However, raw coal washability characteristics must indicate that a medium to high specific gravity separation is required. Also, little near gravity material must be present in order for spirals to work efficiently.

Fine heavy media cyclones have proven to be the most flexible and efficient cleaning circuit for fine coal if the capital cost can be justified. Fine heavy media cyclone circuits can tolerate large amounts of near gravity material which other fine coal cleaning circuits cannot tolerate.

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Question: What effect does this fine coal cleaning have on moisture in the coal?

Daniel Placha: That is really a whole separate issue. What happens is you have to weigh the effects of what kinds of moisture you have to have with your customer versus what is achievable through recovering this material and what type of devices you have to use for drying it; for instance, maybe a screen bolt centrifuge versus a thermal dryer. Obviously, if you have to put in a thermal dryer to recover this fine coal, then it is a matter of economics that probably doesn't justify it.

Don Arrowsmith: Thank you, Dan. Next is Albert Deaton. Albert is currently with Deister Concentrator Company; prior to that he was with Zeigler working at the Old Ben Mine 20 in West Virginia where he was involved in installing column flotation cells and did such a successful job that the manufacturer hired him away from us. He is going to give a presentation on column flotation which should follow up where Daniel left off. [Mr. Deaton's paper was not available for publication.]

Don Arrowsmith: Our next speaker is Dan Wooton. He has been with MAPCO since 1980 as a project engineer and a shift foreman, mine superintendent, general superintendent and, according to a note I have here, was just recently promoted to Operations Manager for the Central Region. He now works out of Henderson, Kentucky, instead of at the mine in Carmi. Congratulations on the promotion. As everybody is aware, Pattiki had a mine fire a while back and it was potentially a very severe situation, which was handled and taken care of. That is what Dan is going to give us some information about.

Dan Wooton: Before I get going everybody stand up and stretch, please. I know you have been sitting there for about an hour and a half. I might put you to sleep, and I hate to start off with you already half asleep; I want to get credit for the whole job. Thank you.

TESTING MINE EMERGENCY PREPAREDNESS: THE PATTIKI MINE FIRE OF NOVEMBER, 1991

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INTRODUCTION

On November 5 and 6, 1991, MAPCO Coal experienced an event that thoroughly tested mine emergency preparedness. Federal law requires all mine operators to have an emergency preparedness plan in place. We had the cause and case to thoroughly test this plan. It worked very well, and today, I would like to share with you what we did so that you might be better informed. And, if you have to deal with such a situation, you'll deal with it more effectively.

The event occurred at the Pattiki Mine which is near Carmi, Illinois, in southeastern Illinois. The coal is accessed by production and service shafts. The Herrin (No. 6) seam is approximately 1,000 feet deep and 60 inches thick. Coal is mined conventionally, with four producing sections utilizing the room-and-pillar method. Again, consider the 1,000 feet depth, which certainly affects pillar pressures, and the soft fireclay bottom. The fire was of a spontaneous combustion origin, and we believe the depth of overburden and the fireclay, which is constantly having to be taken up and stored, were a major factor in the development of the spontaneous combustion.

FIRE IN THE MINE: FIRST RESPONSE

On November 5, around noon, the Pattiki lead-mechanic, Walter Wood, was repairing a piece of mobile equipment in the neutral air course, approximately four miles from the shaft bottom. At Pattiki, we utilize a seven-entry system: two intake entries, two neutral entries, and three return entries. Mr. Wood was working in these neutral entries and noticed a haze that was suspended in the air. At this point, the carbon monoxide monitoring system had not alarmed. This monitoring system detects carbon monoxide at extremely low levels and is located along the conveyor belt in the neutral entry. It alarms at 25 parts per million (ppm). Mr. Wood informed the mine foreman of the haze, and together they investigated. There was no smell, thus, they weren't overly concerned. Utilizing a hand-held CO detector, they determined that there was a small concentration of

CO present, and it appeared that apparently there was something overheating. When they investigated the intake, the CO was approaching 100 ppm. The mine manager, Denver Merritt, made the immediate decision to evacuate the coal mine. These individuals responded excellently to the situation. They did not know what was wrong, but they did know it was potentially hazardous and took very prompt and proper action. Due to their quick decisions, the workforce was never jeopardized by this situation.

The evacuation of the coal mine began, and, except for the pump men and some other people that we located in remote parts of the mine, the mine was evacuated promptly and very orderly.

The next priority was to locate the source of the smoke and the CO. Again, there was not a lot of smoke; it was primarily the CO that was indicative of a problem. From the surface, Danny Franklin, shift foreman, and Tommy Steele, safety director, started at the shaft traveling the intake air courses, headed inby. Simultaneously, individuals explored outby in the intakes, leaving from where the problem was originally identified.

Effectively taking charge at this stage in the mine emergency plan was the most important reaction that we had. There were several people that took the initiative to attempt to locate the problem and investigate it instead of sitting back and waiting for someone to open the mine emergency plan booklet and see what to do next. Their initiative was of great importance at the onset, as well as in the later phases of the operation.

An initial process of implementing the mine emergency plan is immediate notification of the two regulatory authorities: The Mine Safety and Health Administration (MSHA) and the Illinois Department of Mines and Minerals (IDMM). The IDMM was easily notified. However, the telephone system in the MSHA Benton subdisrict office was not operating properly that particular day; it continued to ring, but no one answered. We finally called the district office in Vincennes, and they faxed a message to the subdistrict office to call us—that our coal mine was on fire. They responded quickly after they got that message! The fax machine worked out great, and it documented the time of the actual call. I suggest you consider utilizing it in such situations.

The fire was eventually discovered in a set of parallel intake entries (seven entries that were dedicated completely to intake air). As a result, there were no conveyor belts, no sources of electricity, no equipment of any kind in this area. The area had been mined approximately four months previously. Except for the examiner traveling through the area, there was no activity whatsoever. It was really surprising to us that there would be a combustion source in such an area. The location was 2,000 feet away from the main water line, so the first firefighting problem encountered was getting water to the fire.

After locating the fire, the first step was to establish communications between the surface command center and the scene in order to communicate exactly the extent of the problem and the course of action to be taken.

The same mechanic that had initially detected the haze, established the communications post and began monitoring who was moving into and out of the mine, as well as what supplies and equipment were needed down at the scene—a very critical position. Again, his initiative was a key component to the emergency response.

ACTIVITIES AT THE SCENE

The Firefighting Effort

As preparation was made to fight the fire, 300,000 cubic feet a minute (cfm) of intake air were flowing through these seven entires. The fire was isolated in the No. 1 and No. 2 entries, and the initial reaction was to divert as much air off of those two entries as possible. This was accomplished through the use of check curtains. But, not having a water line in the area, the supply people were busy reclaiming water lines stored in the nearby, and they began laying 2,000 feet of two-inch water line to the fire scene. This was a major task which took about two hours to get everything completed.

The first indication of a mistake in implementation of the emergency plan was the lack of sufficient mobile equipment to utilize. When evacuating a coal mine, the primary focus is to get everyone outside, and, of course, these guys thinking the coal mine is on fire, are very anxious to get outside. However, in the evacuation process, we neglected to consider what equipment might be necessary at an outby location. Thus, all personnel were evacuated leaving the equipment inby.

Since the supply trailers and battery-powered scoops were inby the fire location and we did not know the CO content of the inby air movement, we were not able to access this equipment. As a result, when we began mobilizing supplies to the area, there was inadequate equipment, and this inadequacy became a major factor in the firefighting and sealing efforts. The only water line that was available, without going inby the fire to reclaim four-inch line, was the two-inch line. So, that is what was laid.

Pattiki had a 3,000 cfm foam generator. Somehow, during its transportation to the scene, a connecting adapter was lost, greatly slowing the process of setting the generator and applying foam to the fire. Once the water line was utilized, it also became apparent that a single, two-inch water line could not provide an adequate quantity of water necessary to sustain firefighting activities. The utility crew immediately began laying an additional two-inch line, which provided two parallel two-inch water lines, approximately 2,000 feet long.

There were 12 mine rescue teams that responded to this event. The teams that possessed fire-fighting turnout gear, AMAX and Kerr-McGee, were more effective in approaching the fire itself because they were able to withstand the severe heat. There was no visible flame for several hours during this event; basically, the teams were dealing with heat, steam and smoke. The heat was very intense as the roof had heated up. The apparatus of choice was the Draeger BG 174. There were two teams that responded with PA-80s, but they did not have enough capacity for sustained firefighting activities.

As was mentioned, the foam generator was not effectively utilized. The lost adapter cost critical time. When it finally was installed, it was set as close as possible to the fire. Men were applying water to the fire while setting the generator, but a roof fall forced their retreat. As a result, the foam generator was lost and was never started. Fortunately, the Peabody Camp Complex team brought a diesel-powered foam generator–an excellent piece of equipment. However, the two-inch water lines lacked the capacity to apply the 80 psi that was necessary to allow the generator to function. Thus, when the foam generator was started, the diesel engine turned the fan, placing 7,000 cfm of air across the fire, but with no foam! This is when they first saw the flames because they came back toward the firefighters. Neither foam generator was successfully utilized in this situation.

Sealing the Fire Area

The CO was first discovered by the lead-mechanic around noon. The decision to seal was made approximately 18 hours later, at 6:00 a.m. the next morning. MSHA, IDMM and ourselves jointly decided that the situation was getting out of control and to allow the fire to develop any further inby would jeopardize the entire coal mine. There were three fresh mine rescue teams that had just arrived and they were deployed to the inby end of the fire to seal the fire.

Safely sealing the fire area was a sensitive operation. When a fire area is sealed, it contains volatile gases; an ignition source is present, and methane dilution is interrupted. Thus, it is very critical how this sealing process is coordinated. There were two rescue teams on the inby end and two on the outby end, building the seals simultaneously. In addition, there were approximately 20 utility personnel still underground. They had been providing support work and laying the water line, and they, too, had joined in the sealing effort. Bore holes were being drilled from the surface into the fire area. Two drill rigs were mobilized, but they couldn't actually drill into the mine workings until everyone was evacuated from the coal mine. They drilled to within 20 feet of the coal seam and then waited until the mine was completely evacuated.

For any of you that haven't had to order carbon dioxide, we went through a unique experience to do that. The purchasing agent contacted a supplier in Peoria to have the carbon dioxide delivered. These people had never heard of White County Coal Corporation and didn't particularly care that they just had. They were not anxious to ship over a hundred tons of carbon dioxide without some type of upfront money. The purchasing agent wired them $5,000 so they would ship the carbon dioxide. The lesson learned was to have those arrangements made well in advance, before your coal mine is on fire.

Relay and Communications

There was a key miscommunication early in the event. As the plan coordinator, I spoke directly with the fire scene during the entire ordeal. The first underground individual responsible for communications was a section foreman. He had previous mine rescue experience and is a very competent individual. The problem was, he had worked as a section foreman driving these entries, which were driven toward the bottom. What was outby to him and what was outby to everyone else were two different things. He was facing toward the shaft bottom when he was talking inby, instead of facing toward the face. He relayed the information outside that the extent of the fire had been identified on the inby end, which indicated to MSHA, IDMM, and myself, that the fire area was contained. Thus, it was assumed that the application of foam and water would extinguish the fire. Consequently, we operated with an incorrect assumption causing us to underestimate the fire's extent for several hours; this significantly affected early decision-making.

Supporting the Personnel

As I mentioned, we had 12 mine rescue and fire brigade teams involved in the effort. They included teams from Pattiki Mine, Dotiki Mine, Retiki Mine, Kerr-McGee, AMAX-Wabash Mine, Costain Mining Company and Peabody Camp Complex. There was a 24-hour a day representation of MSHA and IDMM personnel. The company corporate people were well represented, as well as the legal department. There was a firefighting consultant present and 22 hourly employees underground, as well as a dozen on the surface, totalling about 150 people. It takes a lot of food and support to be able to sustain people, especially when working 36 continuous hours. There are some things we learned from the team members being exposed to the severe heat and smoke. They needed a lot of food because they were working very strenuously.

The local McDonald's supplied all the sandwiches, fries, and soft drinks that we requested. These were transported underground, but they were not very well received by the firefighters. By the time fast food travels underground and cools off, it tastes rubbery, and the sweet, carbonated soft drinks were not favorites of the firefighters, either. What seemed to be preferred during this event were lunch meats and sandwiches that could be put together individually. Fruit was also very popular, and sport-drink type of liquids which replace electrolytes and quenched thirst were the most popular beverage.

On the surface, we were feeding approximately 50 people every meal. Hot meals, including spaghetti and fried chicken, were provided by local restaurants. When people work 36 continuous hours during something like this and are not getting the necessary rest, they need a lot of nutrition. I urge any of you responsible for support planning to have someone that is talented at contacting food service establishments and keeping food there; it really sustained our efforts during this ordeal.

THE THINGS THAT WENT RIGHT

The Mine Emergency Plan was successfully and efficiently implemented. It was not a plan assembled by someone in a safety department then thrown up on the shelf to be accessed whenever needed. Rather, it was developed by a group of people who were going to implement this plan and actually perform the roles. I believe that this was the key to the effective response to the situation.

The prompt laying of the water line was a superhuman effort by the utility people. When it became apparent that the one line was not adequate, they reacted quickly and got the other one completed.

The Rescue Teams

I could describe for 30 minutes, alone, the efforts of the rescue teams that responded to this event and still not say enough. We had available a list of teams that would respond to such an occurrence. This list included an estimated time of arrival for each of those teams, and every one of those teams arrived exactly when they said they were going to be there. Every one of those teams went down there, stood in the face of the fire and fought valiantly in the hazardous environment. They just did a tremendous job. They exemplified the principles of premier performance and teamwork during the entire event.

There are people in our industry that believe mine rescue is nothing but a competitor sport, and there are even people in the coal mines who are jealous of these guys who get the new uniforms, hard hats and boots every year, travel around and miss work. But the professionalism that was displayed by the individuals on these mine rescue teams is what saved the coal mine. They developed their professionalism through the training they go through for competition. Supporting mine rescue and the individuals dedicated to it should be a priority for all of us.

Equipment Loaned by Other Mines

As I mentioned, the battery-powered equipment and supply trailers were inby the fire, so, as a result, we didn't have adequate equipment with which to work. Other MAPCO Coal mines had a trucker haul us their supply trailers and battery-powered scoops. Wabash Mine had a diesel-powered scoop on the way to us from Louisville. Peabody Coal brought their diesel-powered foam generator. There was a lot of help from other people in obtaining sufficient equipment. We absolutely could not have fought the fire, transported people, or built the seals without the equipment that was loaned to us.

Communication and Cooperation

This was the greatest display of teamwork that I've ever witnessed. MSHA and the IDMM were closely involved in every discussion and decision. Every coal company that responded had their teams and top people there; they also were involved in the decision-making process. It was a wonderfully open and free-flowing situation, and that is what produced successful decision-making.

All of the things that went wrong were physical things beyond our control. When you look at the things that went right, you see that they were human things–they were all responses by people. I believe this to be the key to the success of the operation. The reason for the response was that we all had a common goal; we wanted to extinguish the fire, save the coal mine for the livelihood of the people that worked there, and have no one injured in the process. Again, MSHA, IDMM and each coal company that was represented engaged in complete teamwork. There was no dissension. Communication was open and honest. There weren't any secrets; everybody knew what was going on. We sat down at a table until we reached a consensus. Once consensus was reached, that was the way we went. It was pure group decision-making.

Bill Moser from West Virginia University happened to be at Kerr-McGee doing a training session, and he came over with the team. It was so reassuring to see an individual like Bill Moser walk in your office at 1:00 a.m. when your coal mine is on fire. You don't even know the guy is in the state, and he walks in your office. We had resource people who just appeared, and it was an outstanding relief to see them.

In May, we again implemented the mine emergency plan to re-explore the area, and it was another fantastic exhibit of teamwork and cooperation. We re-explored this area hoping to rehabilitate it and use it as ventilation courses. The oxygen content was approximately three percent, methane content was 23 percent, and very little CO was detected. Since the exploration effort proved that there was too much bad roof for rehabilitation, the fire area has now been permanently sealed, and we are in the process of driving a set of entries that will serve as the main intake for the remainder of the life of the mine.

LESSONS LEARNED FROM THE EVENT

- Have a good water supply system. Our goal now is to sustain 200 gallons of water a minute at 200 PSI. Know that you are going to have to sustain firefighting activities for an extended period of time, and I think you'll re-evaluate your water lines.

- When you evacuate the coal mine, bring out equipment with you, if at all possible. Our people were never in danger, and I wish we had taken a little more time to evacuate the coal mine and bring out the equipment with us.

- The sealing plan wasn't conceived or thought through until it became very apparent that the fire was out of control. If we had it to do over, we would have someone developing a sealing plan, well before it was actually required.

- Food and sleep. A lot of people worked 36 to 38 hours without any sleep. As a result, this impacted the quality of decisions we were making. We have since modified our plan so that we work in shifts. I don't know how you go to sleep when your coal mine is on fire, but we do know we are going to spell each other and not get into that situation again. Rotate the decision makers!

CONCLUSION

There are two thoughts I want to leave with you today. The first is to urge you to *develop* a mine emergency plan. You notice I use the work "develop" instead of the word "write", because develop means: have the people put this plan together who are going to be the ones that act on it if it has to be implemented. Don't let someone in the safety department put it together for you, put it up on a shelf and report that you are in compliance. Have the people who are going to react be the ones to write it. I think you'll find that you are going to have a much better plan. In our case, the plan never came off the shelf because everyone knew exactly what their roles were–they had written the plan.

The second thought is to test the plan. I am fortunate to work for a company that believes in testing emergency plans through the utilization of mock mine disasters. We've been through three mock disasters; two in western Kentucky and one in eastern Kentucky. Monterey Coal Company is outstanding in this area, and I have attended two of their mock disasters. There are other companies that are very intent on testing their plans, and I suggest to you that you take the opportunity to test the plan under simulated conditions before you have to use it under real conditions.

In conclusion, plan for the worst, but expect the best. Plan for the worst of all the physical things to happen. Expect the best because that is what you are going to get out of the people who respond. People really rise to the occasion. The mine rescue teams are outstanding; they've been through the training, they know what to expect and they are going to rise to the occasion. So plan for the worst–you can expect physical limitations–but know that your people are going to rise and overcome these obstacles.

As a result of the response received from the rescue teams and all the individuals that made efforts, Pattiki Mine missed only four days of production, in spite of a mine fire on the main intake. This is phenomenal! There are 264 families who are continuing to enjoy their livelihood, just as they were before the event occurred.

In closing, I'd like to simply say thanks to all that helped us survive this incident. Thank you!

Question: Do you think the foam machines would have operated the way you wanted them to?

Dan Wooton: Potentially so. There were so many roof falls in the fire area that we couldn't actually get in there to see to what extent the fire had developed. We'd like to think we would have extinguished it, instead of having to seal it. But I don't know. The fire was in the roof and under the pillars, so I don't know if the foam would have been totally effective or not, but we'd like to think that it would have.

Question: You said you put the CO_2 down the bore hole?

Dan Wooton: Right, we put down 127 tons of CO_2. One borehole hit exactly on top of the fire, one borehole hit in the pillar and one, I don't where it went. We ended up using primarily one hole right on top of the fire. The oxygen content got up in about three weeks, and, over the Thanksgiving holiday, we put in 20 more tons.

Question: Could CO_2 have been transported underground and injected through the seals?

Dan Wooton: No, we wouldn't have been able to do that. Transporting it down there would have an insurmountable problem. We would have kept drilling holes, if necessary. We had two rigs, and we would have continued to drill holes until we punched something.

Don Arrowsmith: Thanks very much, Dan. I know from talking with some of the people involved who went there, the mine rescue teams and some of the other people that went and helped, that the openness of MAPCO, the trading of information and the decision-making process helped the people involved learn a lot. Not only did they go and help, but they learned a lot to apply in other situations and possibly save some lives or a coal mine. And, we can too, based on what we learned here. Thank you.

To those who responded in our time of need . . . Thanks!

THE ILLINOIS MINING INSTITUTE'S FIRST HUNDRED YEARS– A BRIEF HISTORY

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Early History

One hundred years ago coal had already been mined in Illinois for commercial and home use for about 80 years, and the coal mining industry of Illinois was challenging those of eastern states for leadership in production and technological innovation. Coal production had increased by more than 50 percent during the past decade and reached about 17 million tons in 1892.

The first state mining law was passed in 1872, and a law establishing a state mine inspectorate was adopted in 1883, in the wake of the Diamond Mine disaster. The miners and several mine owners lobbied for the establishment of an inspectorate. A Board of Examiners was created to screen candidates for state mine inspector. In 1891, the Illinois legislature enacted a law requiring mine managers (called pit bosses up to then) to prove their competency before the Board of Examiners. While the Board of Examiners was in session in December 1891, in East St. Louis, to certify the competency of the first group of mine managers, James C. Simpson, general manager of Consolidated Coal Company of St. Louis, invited the Board members and leading men in the mining industry to a meeting and banquet in Staunton, in Macoupin County. Simpson convened the meeting to show the newest type mine fan that had recently been installed at one of his company's mines and to engage in discussion and good fellowship. During the banquet he proposed that they organize a mining institute. Three of the five members of the Board of Examiners, Hugh Murray, Richard Ramsay and Walton Rutledge, were present. A committee of three was elected from among those attending to plan the establishment of the Illinois Mining Institute.

The founding meeting was held February 17, 1892 in the State Capitol in Springfield. Hugh Murray, president of Valley and Golf Coal Company, presented the committee's recommendations for purpose, organization, membership, and frequency of meetings. Officers were elected and 27 charter members signed up. The founding members included all five state mine inspectors and all five members of the Board of Examiners. James C. Simpson became the first president of the Illinois Mining Institute and John S. Lord, secretary of the Bureau of Labor Statistics in Springfield, was elected secretary.

The first regular meeting took place May 17, 1892 at the State Capitol. Proceedings of the three regular meetings held in 1892, four in 1893 and one each in1894 and 1895 were promptly published in "quarterly" issues of the

Journal of the Illinois Mining Institute. Lord was praised for his efforts and the quality of the publication. The nine issues were combined into three volumes of 740 pages of well illustrated text, including 54 technical papers and lengthy follow-up discussions of papers, some extending over two meetings. In addition, minutes of business meetings, by-laws, a list of newly elected members and 10 to 19 pages of advertisements were included. The first volume was handsomely bound in half leather.

A one time membership fee was $5 and annual dues were $5. (The $10 each new member had to pay is equivalent to about $150 today). Membership had increased to 189 after the first year, but it had dropped to 151 by the October 1894 meeting, the last meeting for which we have membership records. New by-laws published in the last issue of the *Journal*, which covered the April 1895 meeting, state that annual dues were $3 per year, apparently a change from the original $5 per year.

The Institute became inactive in 1895, apparently because of poor attendance at the quarterly meetings and a dwindling membership. A resolution was passed at the October 1894 meeting to hold only two meetings per year. The next meeting, held April 17-18, 1895 in Joliet, is the last meeting for which we have a record.

Revival of the Institute

In fall 1911, Professor H. H. Stoek, chairman of the Department of Mining at the University of Illinois, and Dr. H. Foster Bain, chief emeritus of the Illinois State Geological Survey, called leaders of the mining industry to a meeting in Urbana to present papers on progress in the science of mining engineering. The University of Illinois and the Illinois Geological Survey both had strong programs in mining engineering, coal geology and beneficiation. Stoek and Bain urged the revitalization of the Illinois Mining Institute and for Institute meetings again. The first regular meeting was held in Springfield in the spring of 1912; however, a meeting that was held on November 19, 1914 in the City Hall of Springfield is referred to as the "second annual meeting" in the published proceedings of the meeting (IMI archives). This might indicate that regular annual fall meetings did not begin until 1913. Meetings were apparently held twice annually from 1912 to 1928, but written records, in the form of proceedings, exist only for the meetings of November 19, 1914, in Springfield, and May 27-29, 1915, in Danville. Several "recollections of older days" published in the 50th anniversary volume of 1942 contain some information on the years between 1912 and 1928. New by-laws were adopted on June 24, 1913, amended on November 12, 1926, and again on November 8, 1929, but only the 1929 version has been preserved.

Publication of Proceedings

During 1928 and 1929 a committee of three Executive Board members Paul Weir, Bela Schonthal and D. D. (Whitey) Wilcox, and the IMI President

John E. Jones, developed plans for the permanent publication of the Institute's proceedings. Six monthly *Bulletins* were published from February to July 1928 on an experimental basis. The *Bulletin* was announced as the "official organ" of the IMI and contained "some news items and highly technical papers prepared with great care by outstanding mining men of Illinois." The 16- to 24-page *Bulletins* contained brief articles on such pertinent topics as mine ventilation, haulage, use of electricity, and coal-related legislation, as well as monthly coal production and employment reports by the Director of the Department of Mines and Minerals, news items, reports on meetings, and advertisements.

The committee submitted its recommendations for a permanent IMI publication at the annual meeting on November 8, 1929, in Danville. They were adopted and promptly implemented. The first volume of the new *Proceedings*, published in spring of 1930, contained papers presented at the two 1929 meetings, minutes of the business meetings, IMI by-laws, a list of boat trip participants, a complete membership list, and 34 pages of advertising. This basic format has been followed ever since. Starting in 1939, the *Proceedings* were bound in a hard cover.

An advertising committee, under the leadership of Secretary-Treasurer Bela Schonthal, secured advertisements for the *Proceedings* volumes. This committee has helped assure the financial soundness of the Institute to the present day. Schonthal remained Secretary-Treasurer for a quarter century and was a significant force in organizing meetings, publishing the *Proceedings*, and putting the Institute on a sound financial basis.

Scholarships Program

The scholarships program was established in 1941 under IMI President M. M. Leighton, chief of the Illinois State Geological Survey, after "considerable study" during the previous year by IMI officers and President Roy L. Adams of Old Ben Coal Corporation. A scholarship was awarded anually to a deserving freshman, sophomore, junior, and senior in mining engineering at the University of Illinois. The first recipient was Marion B. Walls, a 1934 graduate of the West Frankfort Community High School. He received $100 per year (equivalent to about $800 today) for four years until his graduation in October 1944. Walls, attempting to establish a tradition, repaid his scholarship in 1946 to 1948, but to our knowledge no other scholarship recipient repeated his example. The number of scholarships decreased to one in during the war years of 1944 and1945, and none were granted the next year. Scholarships for recipients who had been drafted were held for them until after the war.

Individual scholarships were increased to $200 in 1950, then to $400 in 1956, $500 in 1958, $600 in 1968, and $750 in 1972. From 1941 to 1959, scholarships were awarded only at the University of Illinois, never exceeding three per year. Beginning in 1960 (possibly a little earlier) one IMI scholarship was offered at the University of Missouri-Rolla, which was then called the School of Mines. The University of Illinois discontinued its undergraduate program in mining engineering in 1965, but each year a graduate student in mining engineering continued to receive an IMI scholarship until 1970. The University of Wisconsin-Platteville (then Wisconsin State University at Platteville) and Southern Illinois University joined the scholarship program in 1968. They initially received one $750 scholarship each. Three community colleges in southern Illinois offering mining technology programs were added in 1973, each receiving $500 awards. In 1983, a $750 scholarship was given to the University of Southern Indiana in Evansville, and later raised to $1,500. The University of Southern Indiana, however, dropped out of the program in 1989 when it discontinued its mining engineering program. The University of Wisconsin-Platteville reduced its mining engineering program in 1988 to an "emphasis" on civil engineering, causing a reduction in IMI scholarships at the university and eventual elimination of the program in 1991.

Total IMI scholarship distributions are as follows:

1941	100	1964	500
1942	400	1965-67	1,500
1943-44	200	1968	1,800
1945	0	1969-70	3,000
1946-48	200	1971	2,400
1949	300	1972	3,750
1950-55	200	1973-82	5,250
1956	400	1883-84	5,600
1957	800	1985-87	5,700
1958-59	1,500	1988	8,250
1960	1,000	1989-90	9,500
1961	1,500	1991-92	8,000
1962-63	2,000	1993	10,000

Scholarships awarded by the Institute during more than 50 years amount to about $158,000, which in current dollars, is equivalent to about $330,000. Rightfully, the scholarship program has occasionally been called the crown jewel of the Institute.

Several mining and supply companies and an individual also sponsored scholarships through the Institute between 1948 and 1965. As many as 16 were sponsored in a year (1951). Companies that sponsored scholarships were Peabody Coal Company (6 years, up to 8 per year), Old Ben Coal Company (15 years, up to 5 per year), Sahara Coal Company (14 years, up to 5 per year) and Stonefort Coal Company and Northern Illinois Coal Corporation (each 1 year, 1 per year). Alfred E. Pickard, Tamping Bag Company, Mt. Vernon, and the Henry A. Petter Supply Company each sponsored one scholarship per year from 1948 to 1954 and 1951 to 1955, respectively.

Boat Trips on the Mississippi, Illinois, and Ohio Rivers

The IMI summer meetings of 1918 to 1946, were held on a steamer of the Eagle Packet Company in St. Louis. Most of the meetings were usually held in June on the S. S. Golden Eagle under the helm of Captain W. H. ("Buck") Leyhe. The trips ended abruptly in 1947 when the Golden Eagle went down on Grand Tower Towhead in May 1947 and no replacement ship for the June 1947 meeting could be found on such short notice. (More than 90 reservations for the trip had already been received).

The story of how these boat trips came into being, as recorded in the 1942 *Proceedings* by their "instigator" Sam T. Jenkins of the Goodman Manufacturing Company, is entertaining reading. The boat trips were originally two nights and the better part of three days, but they were later shortened to one night and two full days. Except for the first few trips, papers were presented and discussed on the boat and included in the *Proceedings*. Many memories were created during these trips and old friendships were renewed and new ones made. The spring meetings ended after 1946, and only one meeting was held (in the fall) each year thereafter.

Meeting Places

The location and facility where the annual meetings were held contributed much to the character of the meetings. This is certainly more true of the spring meetings held on river steamers from 1918 to 1946. The annual fall meeting was held in Danville, Centralia, Springfield, and Danville again from 1929 to 1932, respectively. For the next 53 years, the annual meeting was held in Springfield, initially at the Abraham Lincoln Hotel (1930 to 1963) then the Hotel St. Nicholas (to 1970), and finally the Holiday Inn East (to 1985). To bring the meeting place closer to the center of mining in southern Illinois, the Institute met at the Ramada Hotel in Mt. Vernon from 1986 to 1990. In 1991, the meeting was moved to its present site, the newly constructed Gateway Center in Collinsville. The adjacent Holiday Inn serves as headquarter hotel. The new facility provides larger space required for the trade exhibits that were added in 1987. The atrium in the center of the Ramada Hotel in Mt. Vernon had been used for exhibits, but space was tight (42 booths at the most) and the exhibits displaced a restaurant normally located there.

Additional Readings on the History of IMI

The following papers, published in the IMI annual *Proceedings* volumes, contain additional information on the history of the Institute. The 1967 and 1992 *Proceedings* volumes also contain complete bibliographies of original papers published in IMI publications.

1929: The Early History of the Illinois Mining Institute–J. E. Jones (reprinted in 1967)
1939: History of the Illinois Mining Institute Boat Trips–J. A. Jefferis
1942: Organization and Early History, Illinois Mining Institute–F. E. Weissenborn
1942: Some Recollections of Older Days–E. McAuliffe, F. F. Tirre, T. Moses
1942: Our First Boat Trip - Why? How?–S. T. Jenkins
1942: The Annual Boat Trips–Captain W. H. ("Buck") Leyhe
1944: Recollections on Early Mining in Illinois–J. J. Rutledge
1956: Captain William H. Leyhe, an Appreciation–J. E. Jones
1959: Memorial for Bela Schonthal–P. Weir
1967: Diamond Jubilee of the Illinois Mining Institute - Its Contribution to the Coal Industry–P. Weir
1967: The Purposes of the Institute–J. C. Simpson (Reprint from *Journal* of the Illinois Mining Institute, vol. 1, 1892/93)
1992: Personalities of the IMI and Illinois Mining Industry–C. T. Ledvina

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Significant reports on coal mining and related information have had early exposure in print in the publications of the Institute throughout its 100-year history. The following compilation is an attempt to record all original articles published by the Institute.

Reprints of many other articles were also published in the Institute Proceedings, many of them authored by members of the Institute. As most of these articles were originally published in well-known scientific or trade journals, they are not listed in the accompanying list.

The publications listed here and the reprinted papers were made available to the Illinois coal mining industry when they were current and thus were more readily disseminated than would have been practical in other ways.

The Institute was established in 1892, but the organization was inactive from 1895 through 1911. For the period 1912 to 1927, printed material is in the Institute Archives only for 1914 and 1915. The Institute's annual boat trip on the Mississippi began in 1918, but there was no publication until 1928 in terms of the Institute records. The Secretary's office continues to be interested in obtaining early printed material and other archival items relating to the Institute.

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CONSTITUTION AND BYLAWS*

ARTICLE I.

Name and Purpose

The Illinois Mining Institute has for its object the advancement of the mining industry by encouraging and promoting the study and investigation of mining problems, by encouraging education in practical and scientific mining, and by diffusing information in regard to mining that would be of benefit to its members.

ARTICLE II.

Membership

Section 1. Any person directly engaged or interested in any branch of mining, mining supplies, mining appliances, or mining machinery may become an active member of the Institute. Any persons desiring to become a member of the Institute shall fill out a blank for that purpose giving name, residence, age and occupation. This application shall be accompanied by the current year's dues as established by the Executive Board.

Section 2. Honorary Member–Annually, one or more members recommended by a committee and approved by the Executive Board who has rendered outstanding service to the Illinois Mining Institute, and thereby to the coal industry of the state may be elected as an Honorary Member with dues being waived.

Section 3. The annual dues for active members and registration fees for the annual meeting shall be determined by action of the Executive Board. Any person in arrears on October 1, of the current year, after having been sent two notifications of dues, shall be dropped from membership. Members in arrears for dues will not receive the printed proceedings of the Institute.

Section 4. Any active member may become a life member by the payment of twelve times annual dues and shall be exempt from further payment of dues.

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*Last changed during 97th annual meeting, September, 1989. Previously amended at Annual Meetings of 1926, 1929, 1935, 1938, 1964, 1970, 1971, 1975, 1980 and 1983.

ARTICLE III.

Officers and Executive Board

Section 1. The offices shall consist of a President, First Vice-President, Second Vice-President, and Secretary-Treasurer. The services of all officers shall be without compensation.

Section 2. Nominations for officers and the Executive Board shall be made by a nominating committee of three (3) appointed by the President at least thirty days before the annual meeting, provided that anyone can be nominated on the floor of the meeting for any office for which an election is being held.

Section 3. The President, First Vice-President, Second Vice-President, and Secretary-Treasurer shall be elected annually by the members present at the business meeting of the regular annual meeting and shall hold office for the ensuing year.

Four Executive Board members shall also be elected and shall hold office for the ensuing three years.

Section 4. In case of death, resignation, or expulsion of any officer, the Executive Board may fill the vacancy by appointment until the next regular meeting, when the vacancy shall be filled by regular election. In case of a vacancy of the office of President, the duties shall devolve upon the First Vice-President.

Section 5. The Executive Board shall consist of the officers, the 12 elected Board members, and three ex-officio members. The three ex-officio Board members are the current director of the State of Illinois Department of Mines and Minerals, the President of the Illinois Coal Association and the retiring President of the Institute.

ARTICLE IV.

Duties of Officers and Executive Board

Section 1. The President shall perform the duties commonly performed by the presiding officer and chairman and shall, with the Executive Board, exercise a general supervision over the affairs of the Institute between sessions.

Section 2. The First Vice-President shall preside in the absence of the President and perform all the duties of the President. The Second Vice-President shall perform all duties of the First Vice-President in the absence of the First Vice-President.

The Secretary-Treasurer shall keep a true record of each meeting, shall read and file all resolutions and papers that come before the Institute, and sign all orders for money, and shall purchase necessary supplies.

The Secretary-Treasurer shall keep a true record of all money received and payments made on account of the Institute; shall pay out no money except on personally signed order, and shall retain these orders as vouchers; shall give bond in such sum at the Institute may provide, the premium on said bond being paid by the Institute.

The Secretary-Treasurer shall act as editor-in-chief for the Institute and may furnish the newspapers and other periodicals such accounts of our transactions and discussion as are proper to be published. The Secretary-Treasurer's own judgment is to prevail in such matters unless objection is lodged at a regular meeting or by the Executive Board.

Section 4. The President shall appoint an auditing committee annually to audit the accounts of the Secretary-Treasurer, and said audit shall be submitted to the annual meeting of the Institute.

Section 5. The Executive Board shall perform the duties specifically prescribed by this constitution; it shall supervise the expenditures and disbursements of all money of the Institute, and no expenditure other than current expenses shall be authorized without first having the approval of the Executive Board, and shall perform such other duties as may be referred to them by regular or special meeting of the Institute.

Section 6. The Executive Board may delegate work responsibility to Institute committees, appointed by the President, for conducting selected business of the Institute, but with all actions being subject to Executive Board approval.

ARTICLE V.

Meetings

Section 1. The annual meeting shall be held in the fall of each year and on such days and in such places as may be determined by the Executive Board of the Institute. Notice of all meetings shall be given at least thirty days in advance of such meetings.

Section 2. Meetings of the Executive Board shall be held on the call of the President, or at the request of three members of the Executive Board, the President shall call a meeting of the board.

ARTICLE VI.

Amendments

Section 1. This Constitution may be altered or amended at any regularly called meeting by a a majority vote of the members present, provided notice in writing has been given at a previous annual meeting of said proposed change of amendment.

ARTICLE VII.

Order of Business

At all meetings the following shall be the order of business.

(1) Reading of minutes.
(2) Report of Executive Board.
(3) Report of officers.
(4) Report of committees.
(5) Election of new members.
(6) Unfinished business.
(7) New business.
(8) Election of officers.
(9) Program.
(10) Adjournment.

ARTICLE VIII.

Dissolution

In the event of complete dissolution of the Institute, the cash assets of the Institute will be distributed to universities where the Institute has provided past scholarships on an equal basis, for support of scholarships in Mining Engineering. Equipment will be donated to any not-for-profit organization that the Executive Board may determine to be worthy recipients.

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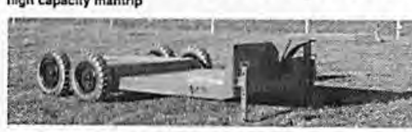

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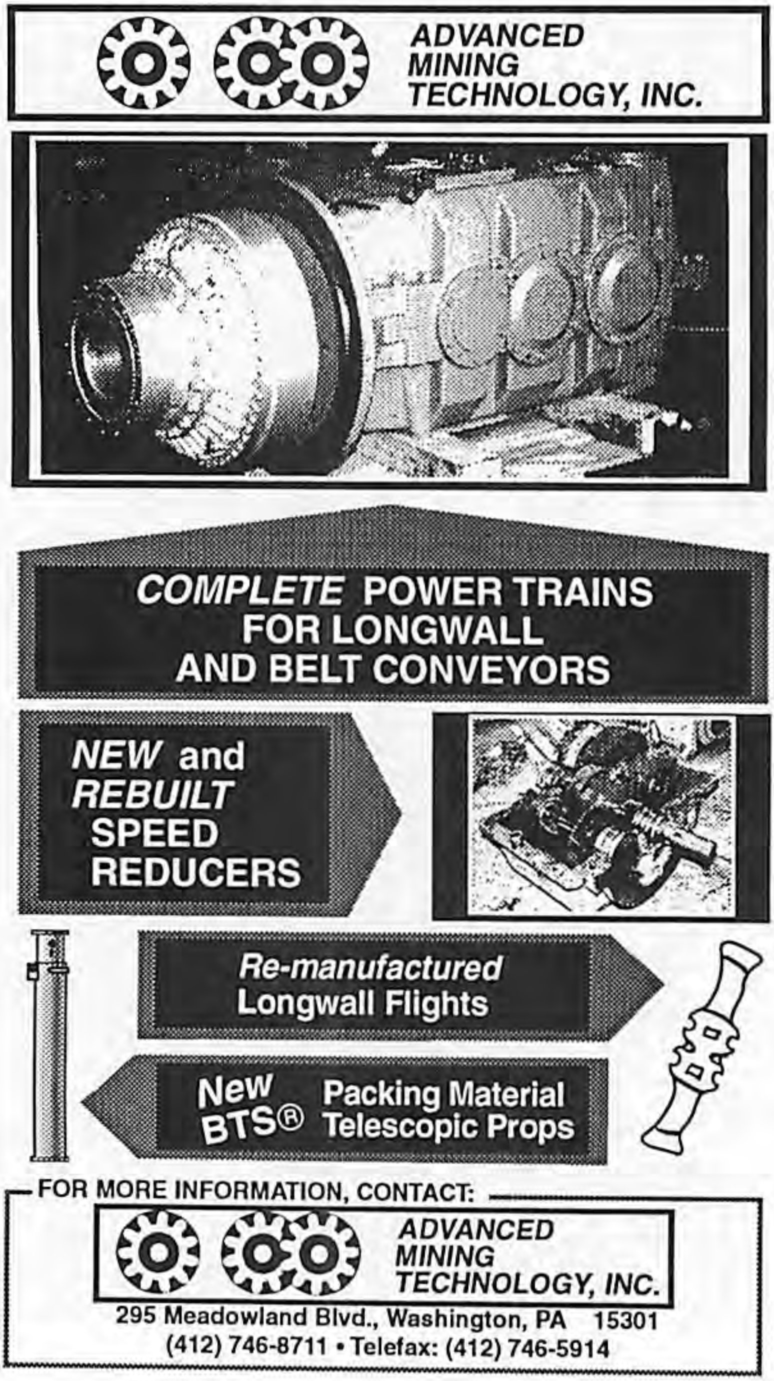
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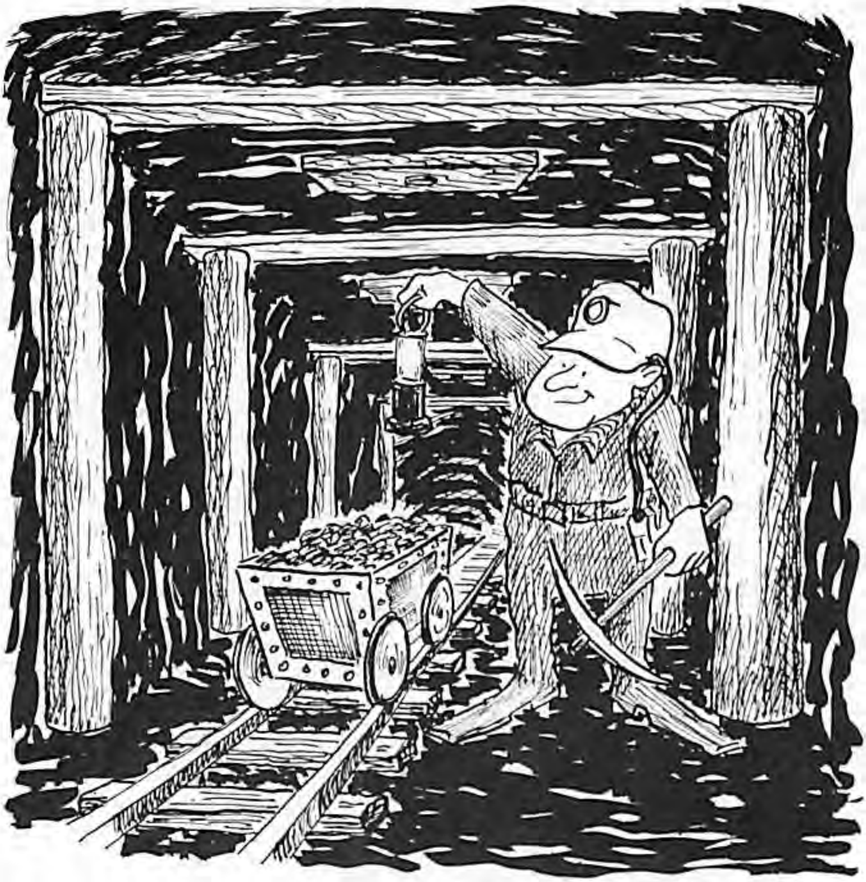

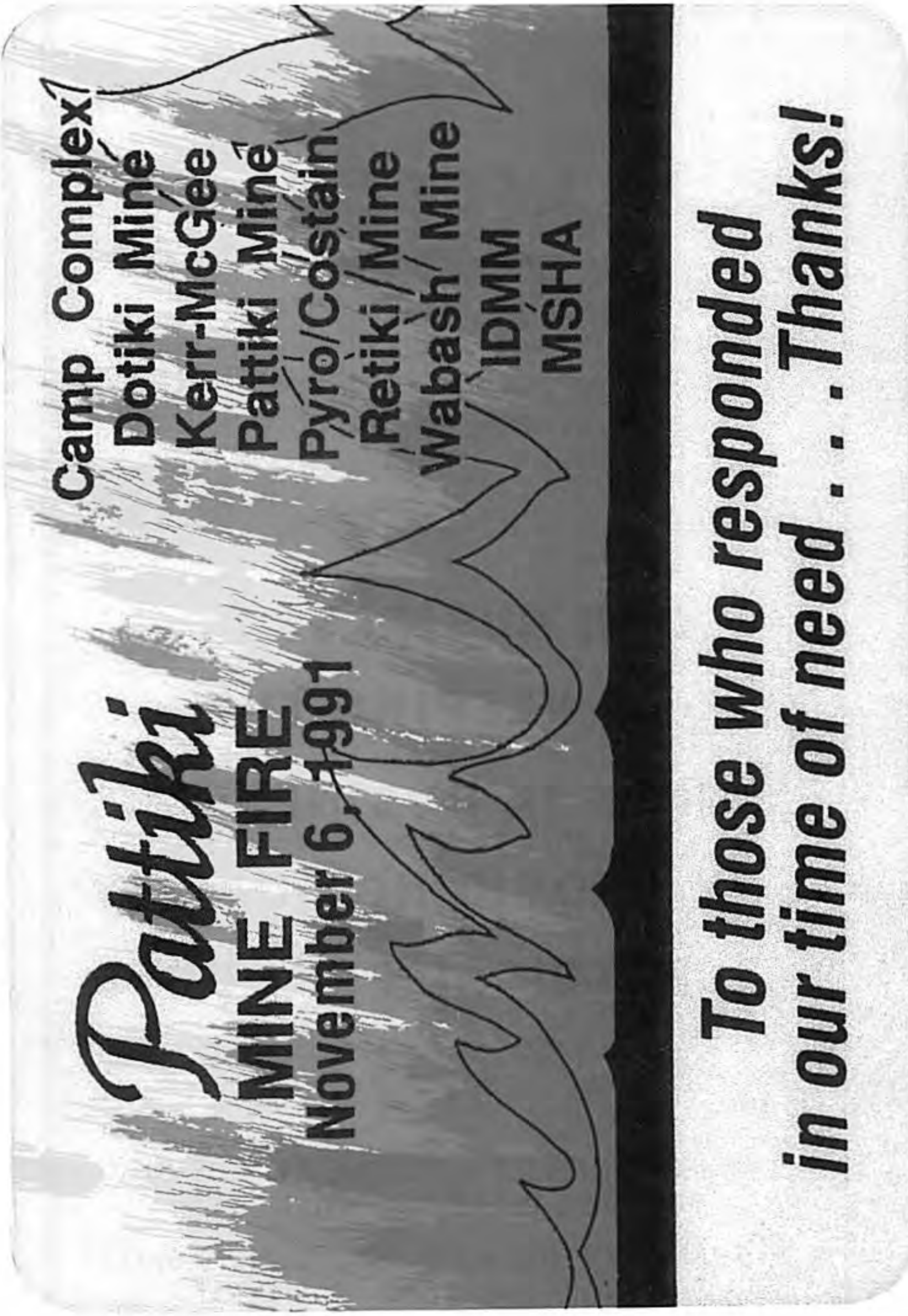
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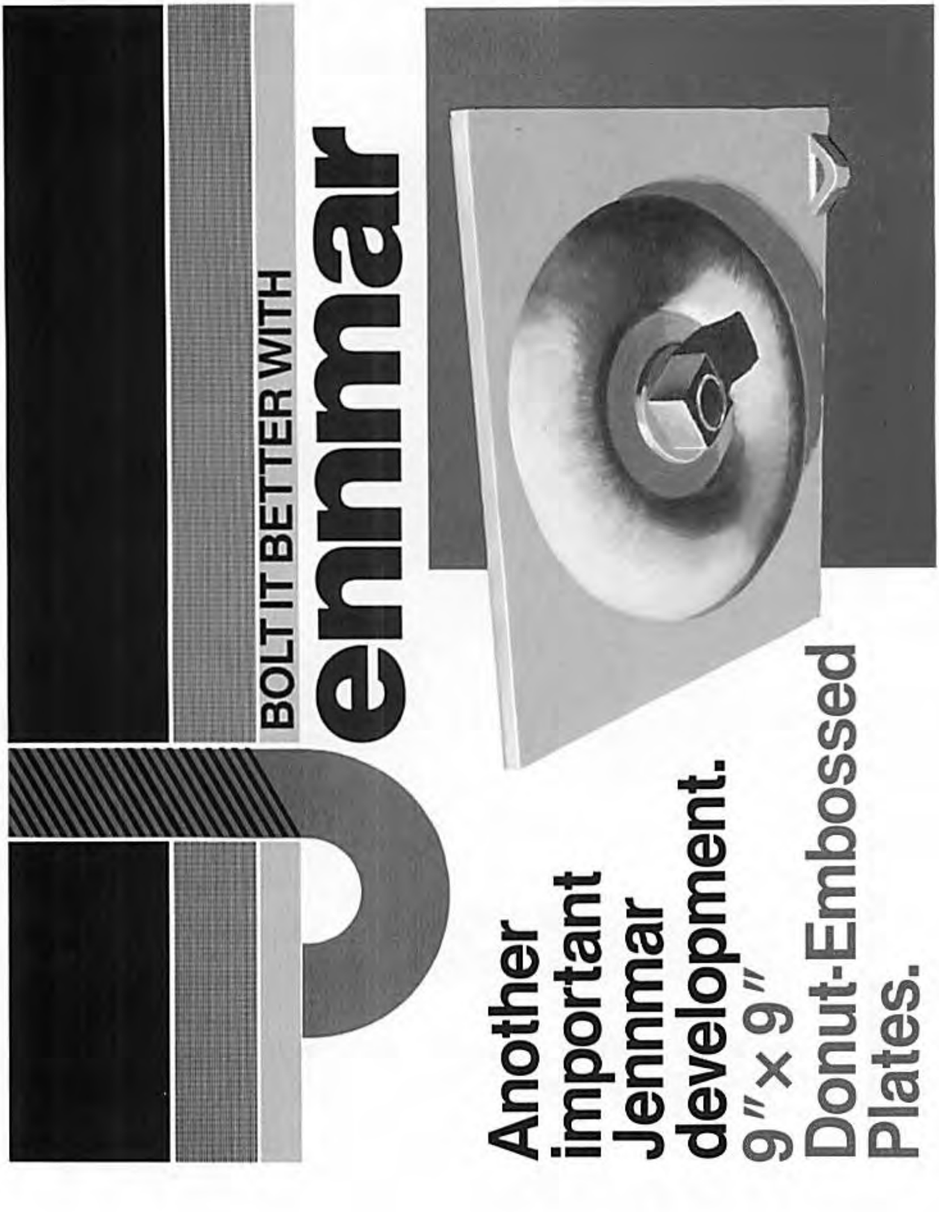
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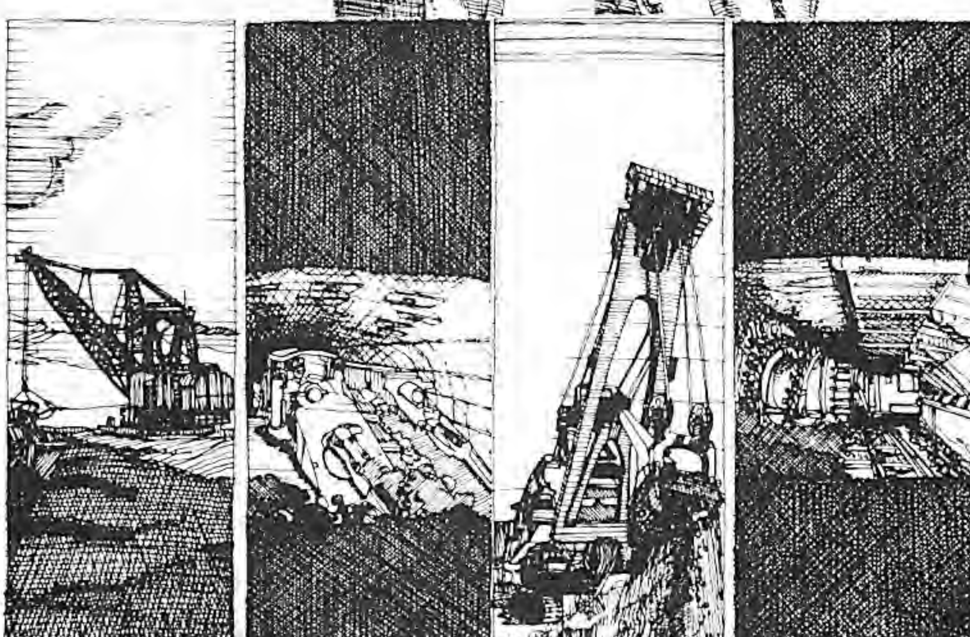

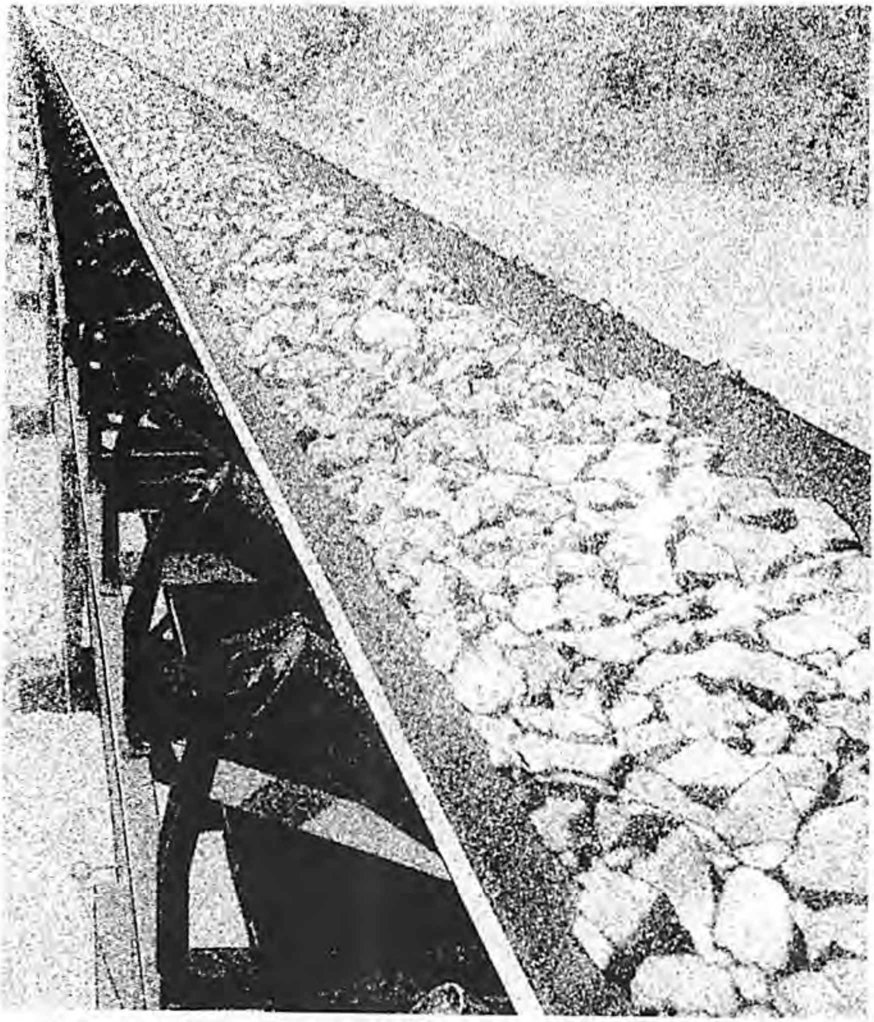

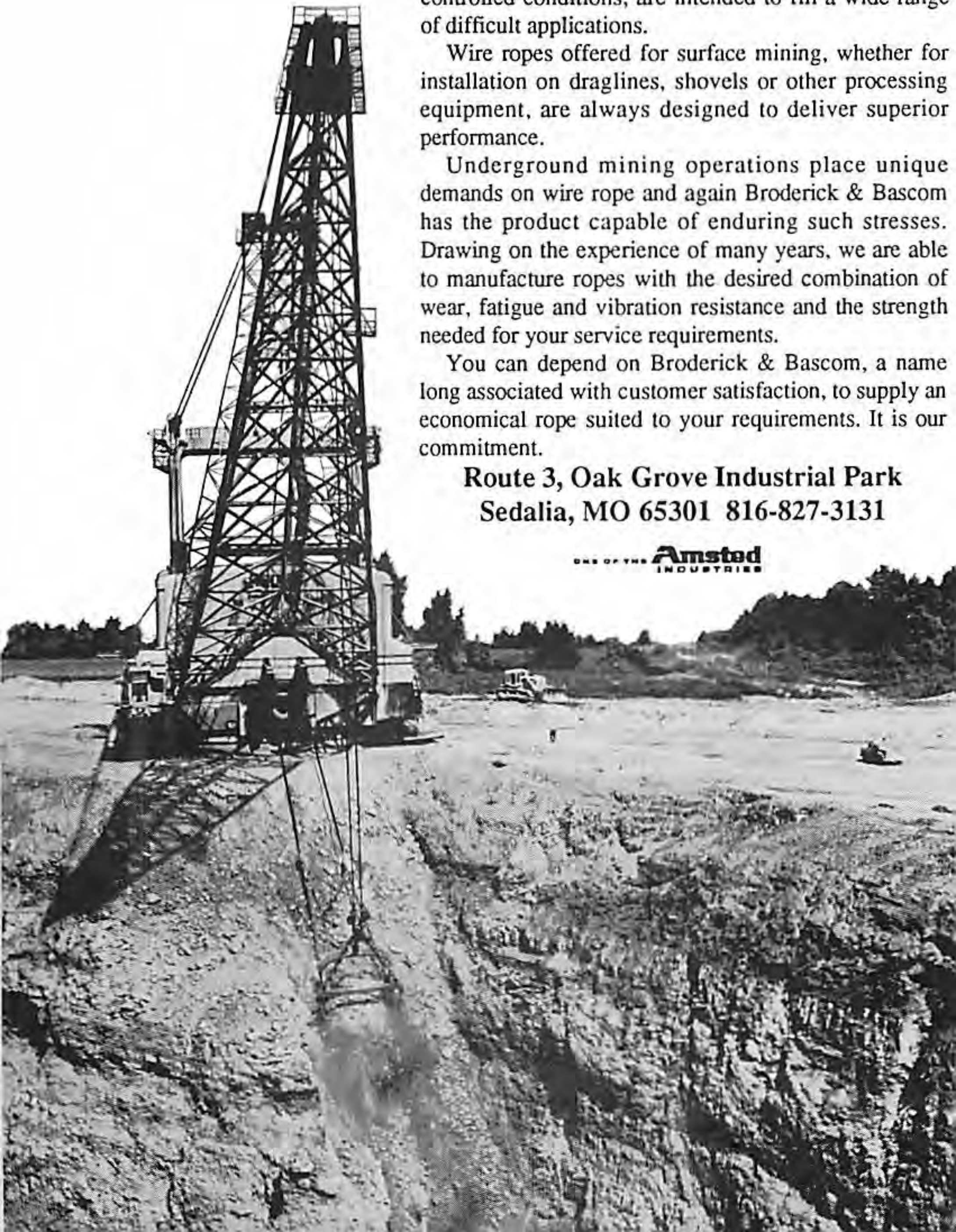

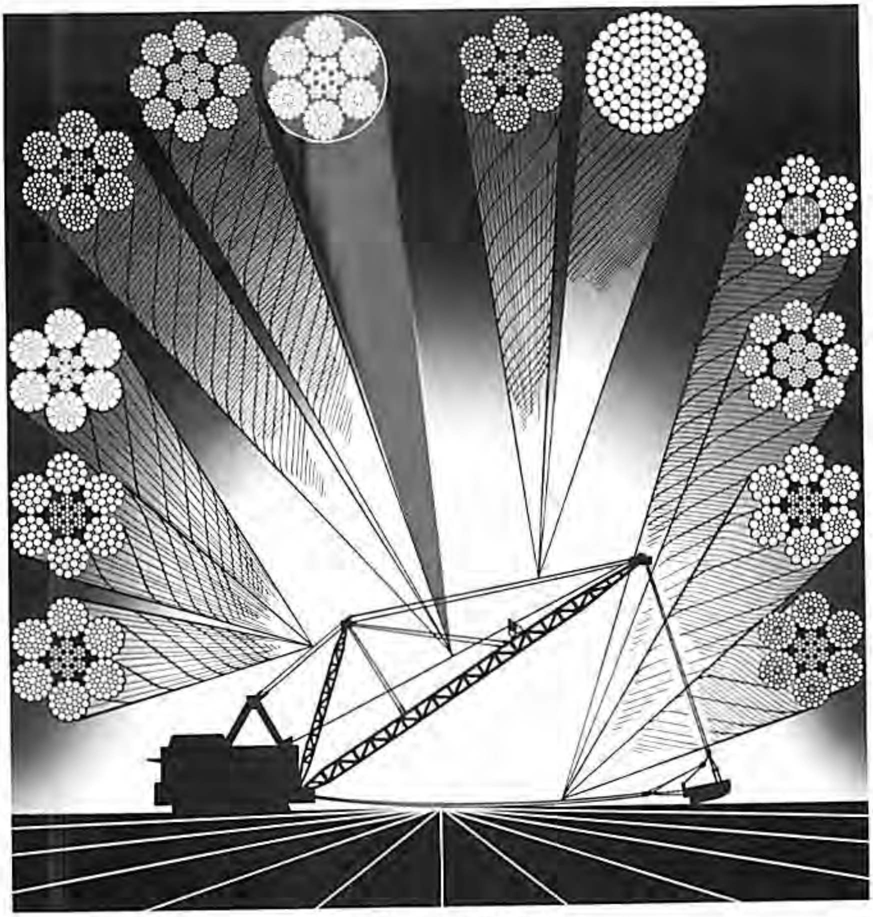

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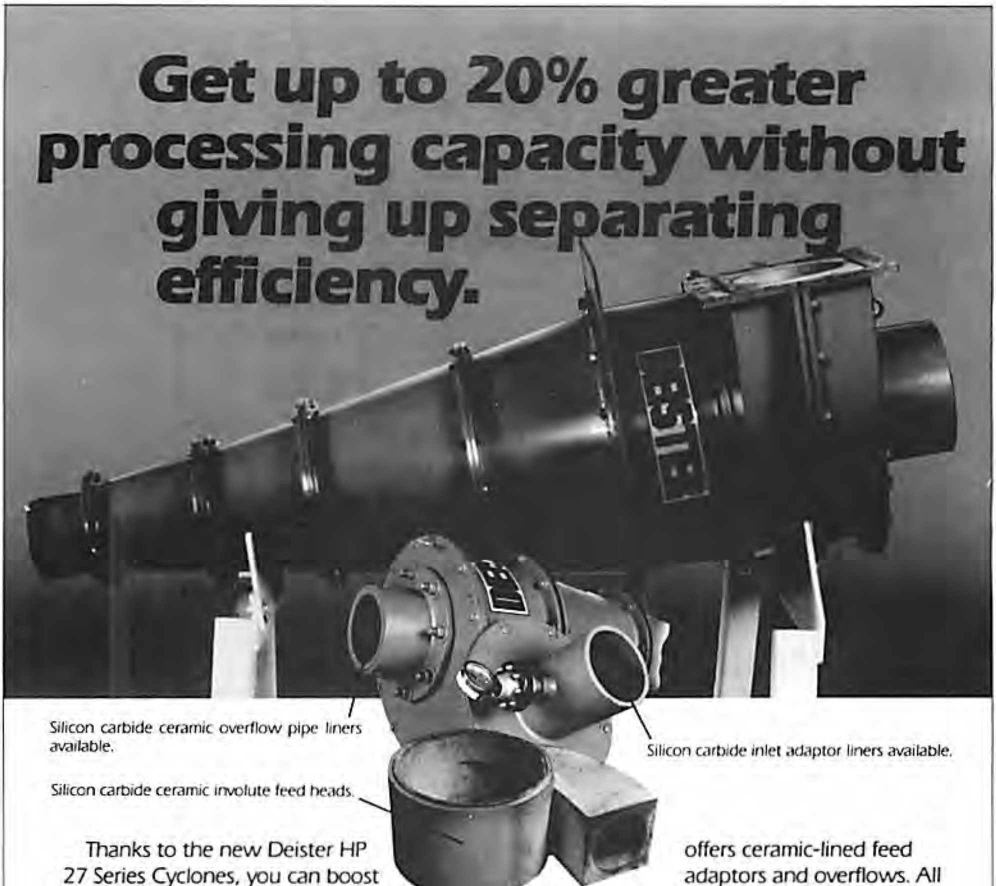

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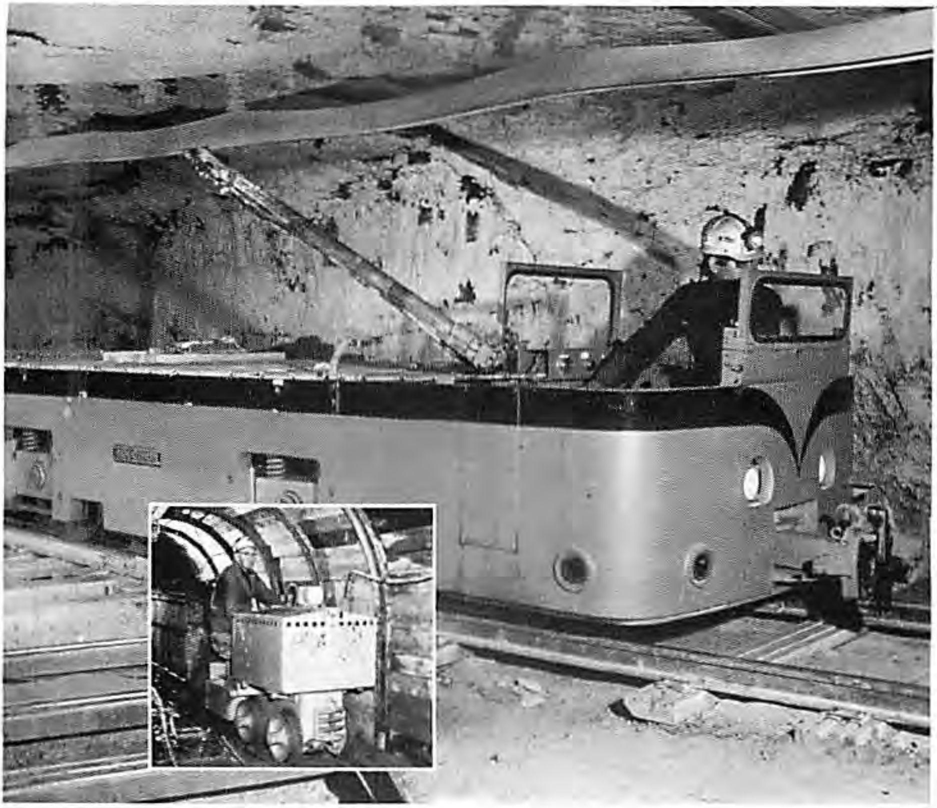


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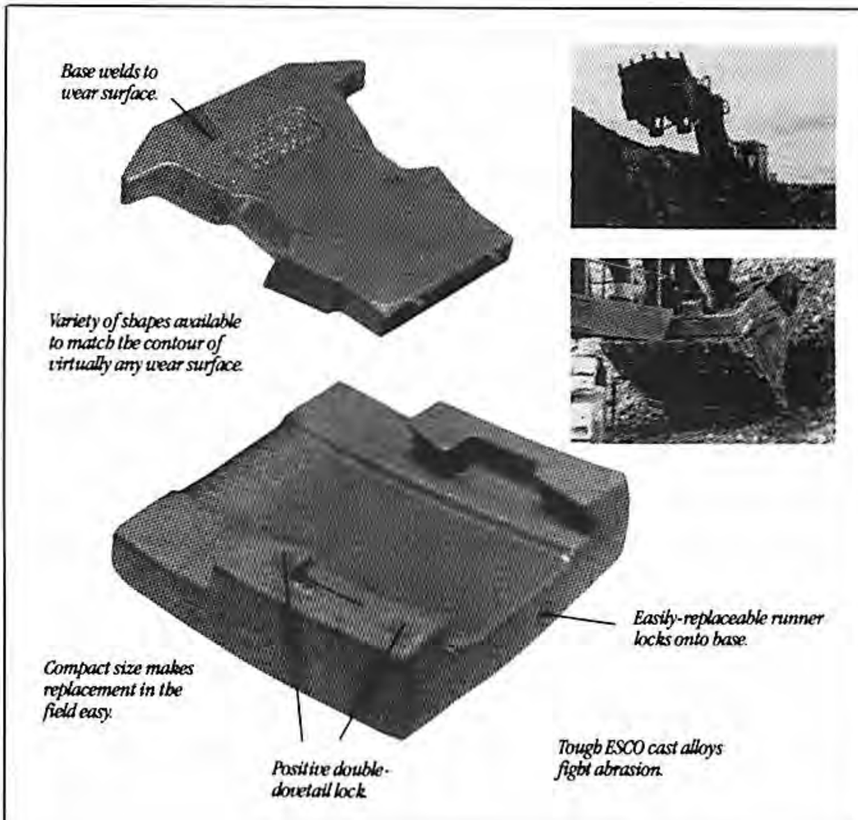

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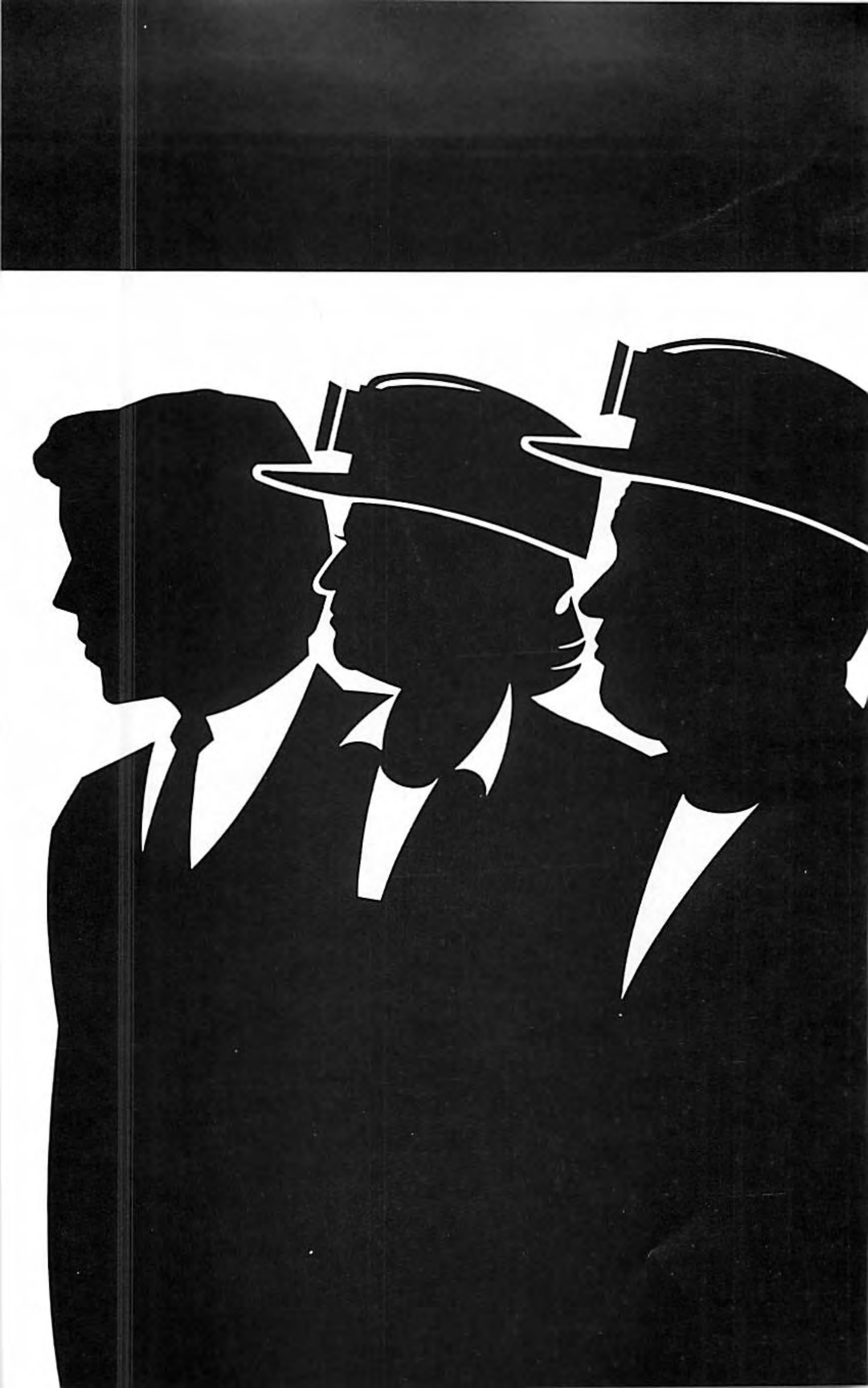


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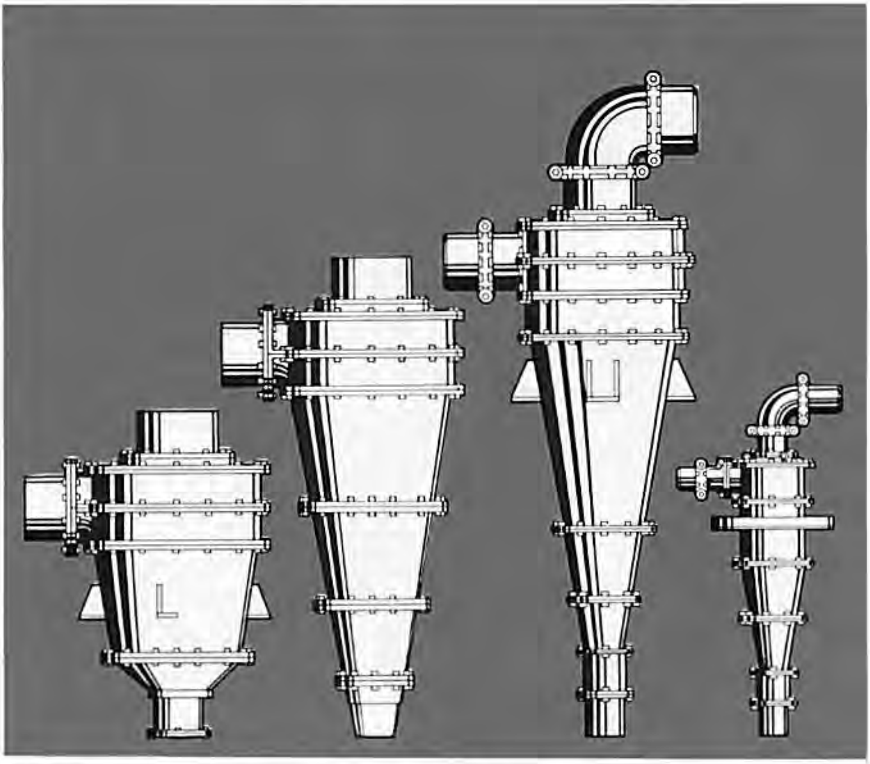

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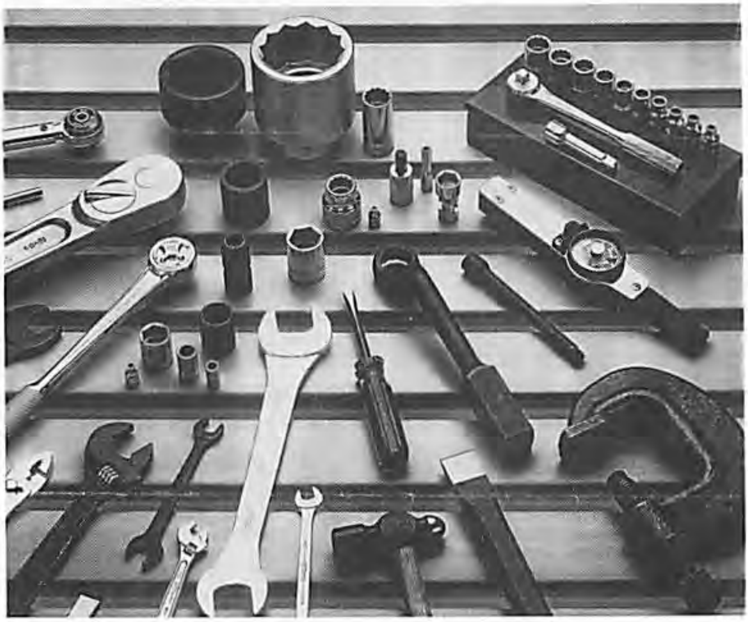

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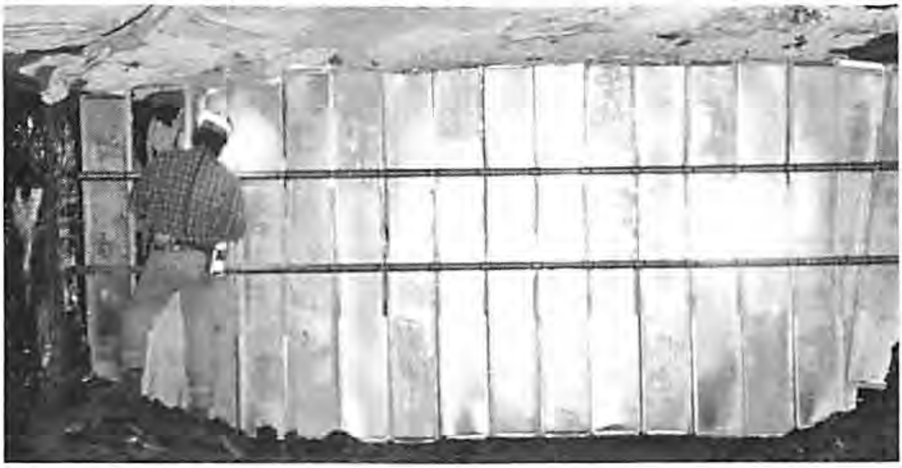


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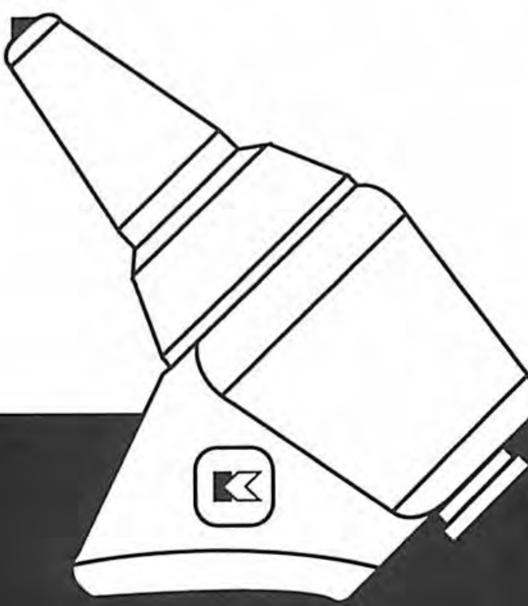

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When most believed the only good coal was Eastern coal, Joseph Leiter declared that someday Illinois mines would supply Chicago and the nation.

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And when most laughed at Joseph Leiter for leaving Chicago for a rural coal field in Franklin County, he quietly constructed Zeigler Mine No. 1 — and had the last laugh.

In 1902, Joseph Leiter surprised friends and colleagues by venturing from the safe Chicago haven of his father, retailing giant Levi Zeigler Leiter. But by 1908, Zeigler Mine No. 1 was the third-largest producing mine in the nation, and within 20 years his coal was common in 14 Mississippi Valley states, from Texas to Minnesota.

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Zeigler's recent past offers a striking echo to those early days. In 1985, Chairman and Chief Executive Officer Mike Reilly and President Chand Vyas led a group of investors in buying out the Chicago-based Company from its parent — and moving the headquarters south to Fairview Heights, Illinois.

▲

Today, at a time when many are skeptical of coal's long-term promise, Zeigler subsidiaries continue the dream as fast-growing, safe, low-cost coal producers.

▲

And we keep surprising the industry.

▲

With Zeigler Coal Holding Company's recent purchase of Shell Mining Company, our coal producing subsidiaries now have annual sales in excess of $1 billion. They have recoverable coal reserves of about 3.5 billion tons. And they have an annual production of more than 40 million tons.

▲

In fact, Zeigler's operating companies now rank as the nation's largest independent coal producers — and the fourth largest overall.

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Far more important than size, though, is the quality of our people, who possess the courage, capabilities and commitment needed to manage and operate the best coal companies in the United States. Through the finest skill and the strongest will, they provide the perfect blend of time-honored dedication and state-of-the-art techniques.

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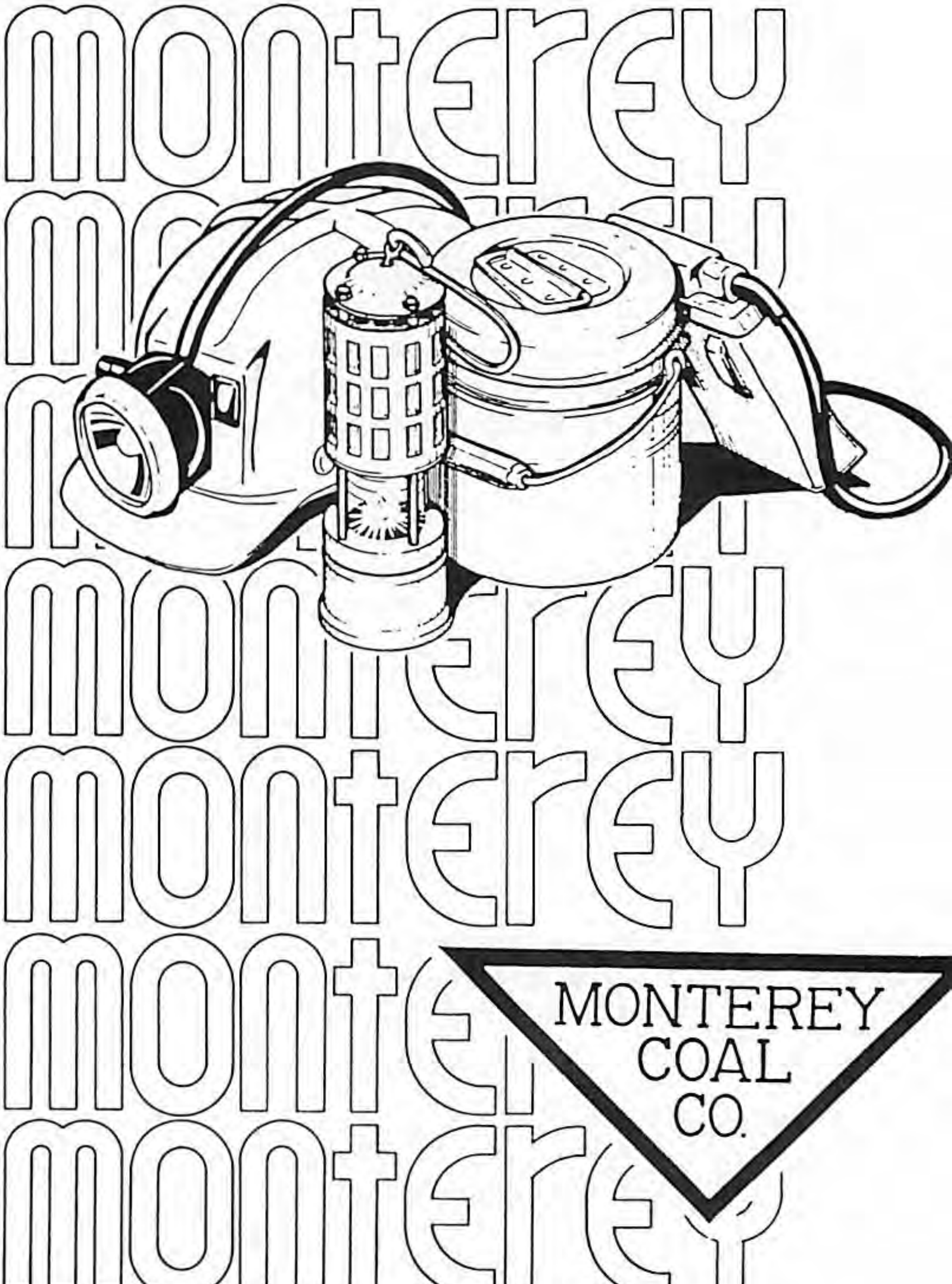
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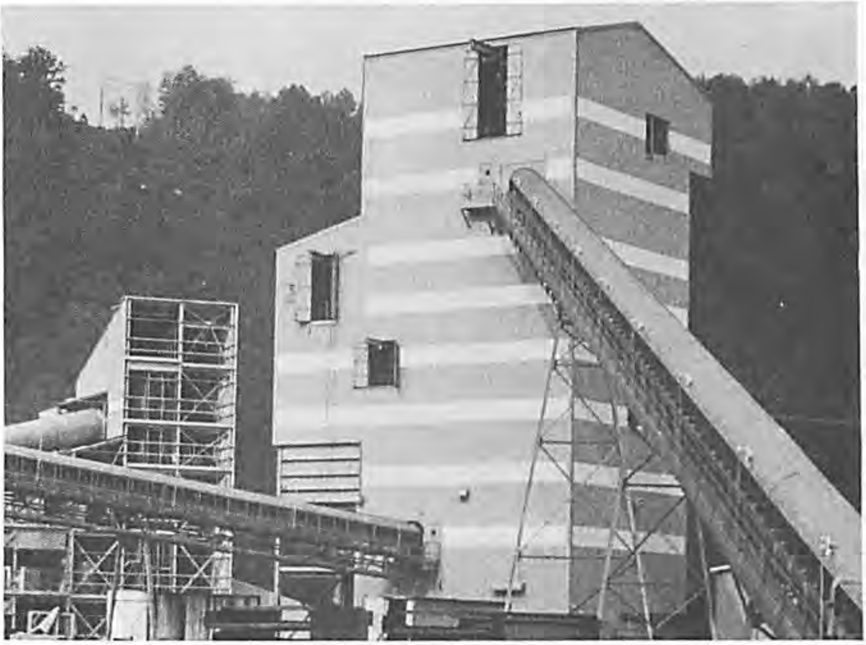

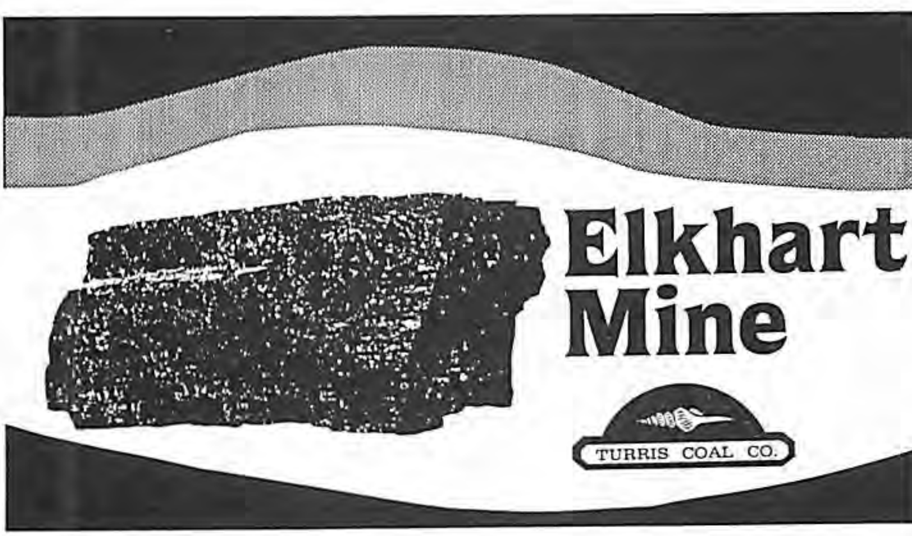
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