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Design Practices for Multiple-Seam Room-and-Pillar Mines

Objective

Provide room-and-pillar operators with practical information and guidelines concerning multiple-seam mine design to reduce ground problems associated with the interaction of adjacent workings.

Background

Interactions of multiple-seam operations can cause ground problems resulting from the transfer of stress, strata displacement, and caving due to subsidence. Such interactions are a common occurrence, resulting in loss of coal reserves and increased operating costs. Studies estimate that 140 billion metric tons of coal, representing 68 percent of the minable reserves in the United States, are subject to multiple-seam mining. In many instances, mining sequence is based primarily on availability and economics, with little regard for the effects mining would have on coalbeds above and below the one being mined. These practices could have strong implications for resource conservation. For instance, West Virginia, Virginia, and Kentucky have over 90 minable coalbeds, many of which are classified as "low sulfur." Many coal analysts speculate that the 1992 Clean Air Act and new compliance coal standards may shift future mining to these reserves. But without competent design strategies, interactions between vertically adjacent operations will increase the difficulty and expense of mining.

Effective mine planning and design are essential for avoiding ground problems related to multiple-seam mining. To avoid higher mining costs, operators should focus on adopting practices and procedures that prevent and control interactions in multiple seams. The U.S. Bureau of Mines (USBM), in an effort to improve mine planning, is investigating multiple-seam room-and-pillar design and development.

Approach

Factors that influence interactions between operations can be classified as either "geologic" or "mine design" parameters. The geologic parameters include the depth, interburden thickness and physical characteristics, coalbed thickness and physical characteristics, immediate roof-and-floor stratigraphy, and in situ stress fields. The mine design parameters include the seam sequence, pillar size and strength, entry widths and roof spans, percent extraction, mining height, geometric layout of the workings, support methods, and the time delay between mining seams. Optimization of mine design factors is the primary means for controlling interactions between operations.

Of the design factors, three are considered primary and have significant influence in seam interaction. These factors are very closely related and should be weighed equally for effective mine planning. First, the sequence or order in which the seams will be mined will determine the *type* of interaction. Second, the design of pillars and entries will determine the *magnitude* of interaction. Third, the geometric layout of the workings will determine the *location* of interaction. Other parameters fixed by the geologic environment, such as depth and interburden thickness, will influence interaction magnitude and location and must also be considered in the design process.

Empirical investigations involving case study documentation and analysis have constituted most of the USBM research and have provided important information in the development of design procedures. However, computer-based numerical models are gaining more research attention because they can provide insight into relative stress transfer and distribution in multiple seams. The analysis of different designs using numerical models has considerable potential in helping operators find solutions to complex multiple-seam interactive problems. The USBM's MULSIM/NL model is a boundary element model for calculating stresses and displacements in tabular deposits. The MULSIM/NL model was used to evaluate stress distribution and transfer for design problems that are commonly encountered in multiple-seam room-and-pillar layouts.

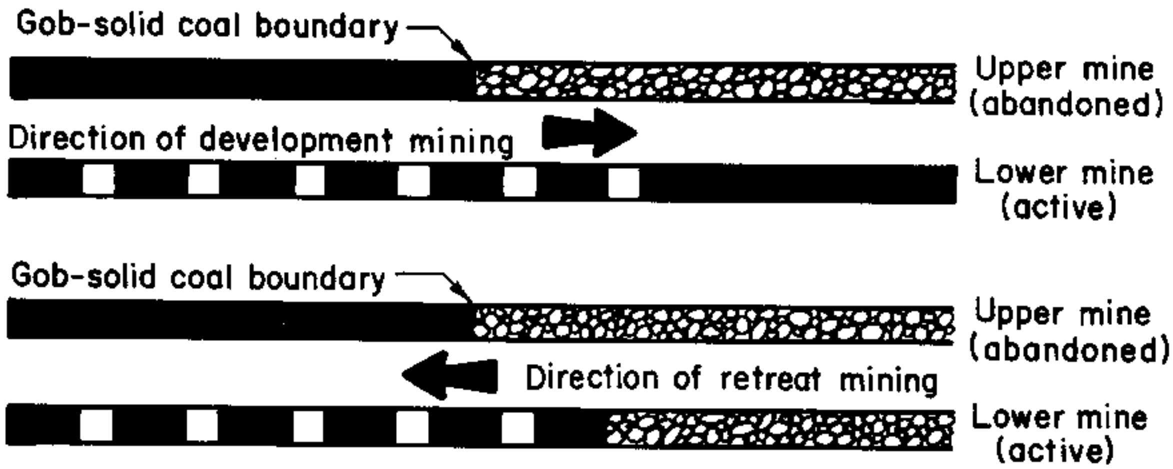
Accomplishments

Some primary findings from these investigations are summarized as follows:

1. To ensure optimum ground conditions, coalbeds should be mined in descending order. This extraction order prevents coalbeds from being damaged by caving and other strata displacements caused by subsidence.
2. Two basic approaches are available for pillar design: yield pillars and conventional pillars. For the most part, further study is required to assess the performance of yield pillars under multiple-seam conditions. However, there are several conventional pillar design approaches available to the operator that have demonstrated their success in the field.
3. There are two basic approaches to laying out room-and pillar panels in successive seams: superpositioned panels or offset panels. Superpositioned panel arrangements will be used, in most instances, for all extraction sequences. Offset arrangements will be used to avoid interactions when geologic conditions are not favorable.
4. High-stress zones are usually encountered in the lower mine when mining occurs beneath an isolated barrier pillar or a gob-solid coal boundary in the upper mine. Stress can be reduced in the lower mine pillars by retreat mining from the gob to the solid side of the boundary and supporting the barrier edge with a row of pillars.

For More Information

USBM Information Circular 9403 and Reports of Investigation 9056, 9066, 9173, and 9176 provide more detail on multiple-seam room-and-pillar design. For a copy of these reports or for additional information concerning the USBM multiple-seam research program, contact Gregory J. Chekan, U.S. Bureau of Mines, Pittsburgh Research Center, P.O. Box 18070, Cochrans Mill Road, Pittsburgh, PA 15236; telephone (412) 892-6749.



Studies show that stress in the lower mine pillars can be reduced when you are mining beneath a gob-solid coal boundary in a overlying mine by following two design criteria: (1) Develop pillars from the solid to the gob side of the boundary, and then retreat pillars from the gob to the solid side, and (2) support the boundary edge with a row of pillars.